Intra-annual and Long-term Dynamic Behaviour of Hubbard and Valerie Glaciers, Alaska

by

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Authors Declaration

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Statement of Contributions

Data analysis and writing of this thesis was done by Courtney Bayer, which is presented in the manuscript option. There is one manuscript, titled *Patterns and drivers of seasonal and long-term velocity variability of Hubbard and Valerie glaciers,* which is developed as a manuscript tailored for submission to the Journal of Glaciology or a journal of a similar scope. Co-authors of this manuscript include Wesley Van Wychen for overseeing and guiding the research and writing process, Anna Wendleder for providing TerraSAR-X/TanDEM-X synthetic aperture radar data, and Brittany Main for providing RADARSAT-2 derived velocities.

Abstract

Western North American mountain regions are warming at a faster rate than the global average, which is influencing the retreat and melting of glaciers, with a 75% disappearance of glacier volume in Western North America possible by 2100. The impacts of this are wide reaching, including increasing contributions to sea level rise, decreased freshwater availability, loss of stability of mountain slopes and changing aquatic ecosystems. Hubbard and Valerie glaciers are in the St. Elias Mountains of Alaska/Yukon, which is an important area of study as Alaskan glaciers are likely to respond to climate change differently than glaciers in other regions of the world. The studies on seasonal velocity flow of both glaciers have been limited, with few recent reports of dynamics and mass balance. The goals of this study were to 1) determine the seasonality of Hubbard and Valerie glaciers by creating the densest record of flow to date from July 2013-April 2022; 2) analyze the long-term velocity trend from 1985-2022 to confirm if both glaciers are decelerating; and 3) use surface elevation change and temperature data to analyze potential drivers of the determined velocity patterns. The velocity record of Hubbard and Valerie glaciers was created using ITS_LIVE, RADARSAT-2, RADARSAT Constellation Mission, and TerraSAR-X/TanDEM-X derived measurements. Valerie glacier had an expected seasonal pattern of peak velocities in May and minimum velocities between August-November. Hubbard Glacier had a seasonal pattern that had never been identified in previous studies, with peak velocities between December-February, velocities dropping slightly between January-April, a second velocity peak in May, and minimum velocities in August/September. The May peak and late summer minimum of both glaciers was determined to be from surface melt reaching the bed, increasing flow speeds with an inefficient drainage system before changing to a channelized subglacial hydrological system that causes a velocity drop. It is likely Hubbard Glacier's winter velocity peak and slowdown before its May peak is internally driven, however the exact driver was not identified. The long-term velocity trend revealed Hubbard Glacier is decelerating, with a minimal deceleration near its terminus that was similar to the minimal deceleration on Valerie Glacier, while there was increased deceleration further up-glacier. For both glaciers, the deceleration did not match the expected patterns of thinning/thickening. Previous instances of pulsing were not resolved in this data. Overall, this study helps improve the knowledge of tidewater glacier dynamics through the identification of a unique intra-annual velocity pattern and can assist in improving sea level rise, ice dynamics, and mass loss models.

Acknowledgements

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List of Abbreviations

AAR	Accumulation Area Ratio
Auto-RIFT	Autonomous Repeat Image Feature Tracking
DEM	Digital Elevation Model
ELA	Equilibrium Line Altitude
InSAR	Synthetic Aperture Radar Interferometry
ITS_LIVE	Inter-Mission Time Series of Land Ice Velocity and Elevation
LC	Landsat
NCC	Normalized Cross Correlation
PDD	Positive Degree Day
R2	RADARSAT-2
RCM	RADARSAT Constellation Mission
SAR	Synthetic Aperture Radar
S1	Sentinel-1
S2	Sentinel-2
TDX	TanDEM-X
TSX	TerraSAR-X

Chapter 1: Introduction

1.1 Introduction

Human-induced global warming is changing climate patterns throughout the world, with global warming from the pre-industrial period until present day likely to cause impacts that may continue to be observed for centuries to millennia (IPCC, 2018). The cryosphere in particular is being greatly impacted by human-induced climate change, with changes seen all the way from high mountains, polar regions, and into the ocean (Figure 1-1) (Abram et al., 2019). Changes to the cryosphere (including observed declines in low-elevation snow cover, glaciers and permafrost) are affecting physical, biological, and human systems, for example, agriculture, tourism, and cultural values (Hock et al., 2019). Over the past few decades, mountain regions in Western North America have experienced a warming rate per decade of ~0.3 ± 0.2°C, which is larger than the 0.2 ± 0.1°C global warming rate per decade (Hock et al., 2019; IPCC, 2018).

Glaciers are retreating, and the melting of glaciers can greatly impact sea level rise due to the input of fresh water (Abram et al., 2019). Glaciers in Western North America have already lost a substantial amount of mass (Figure 1-2), and looking towards future change, models project substantial glacial volume loss within Western Canada and the US, with 75% of current glacier volume possibly disappearing by 2100 (Hugonnet et al., 2021; Bliss et al., 2014). With glaciers retreating and permafrost thawing, mountain slopes are losing stability and changing the integrity of infrastructure (Hock et al., 2019). This results in changes to natural hazard frequency, location and duration, with more people exposed to these hazards through tourism (Hock et al., 2019). Glaciers also hold freshwater that is critical to water supply (~half of the world's population relies on water from mountain runoff), and with this water supply changing, impacts will affect aquatic habitats, hydroelectric power, recreation, tourism, agriculture, and industry (Brahney et al., 2017; Clarke et al., 2015; Bolch et al., 2010).

Given this background, the goal of this thesis is to investigate glacier change in one important location within Western North America; the fast flowing Hubbard and Valerie glaciers of the St. Elias Icefield. Given that the determination of glacier flow patterns is important for understanding how dynamic discharge and mass loss are changing over time, and to improve predictions of glacier contributions to sea level rise (Van Wychen et al., 2016).

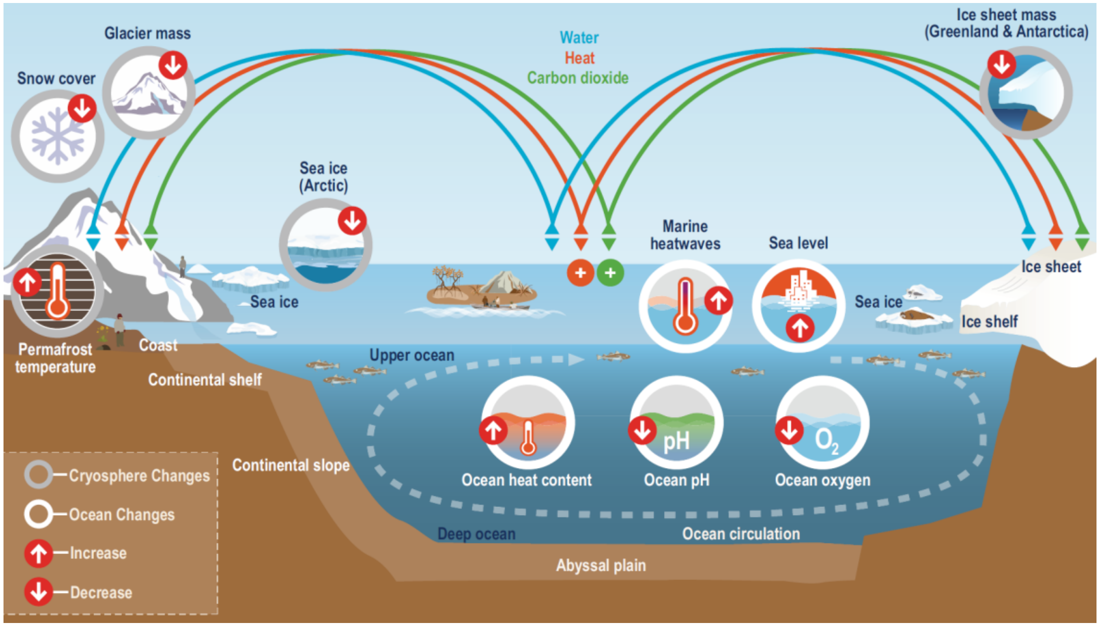

Figure 1-1: Summary of changes to the cryosphere and ocean. The blue arrows represent the movement of water, the red arrow represents the movement of heat, and the green arrow represents the movement of caron dioxide (Abram et al., 2019).

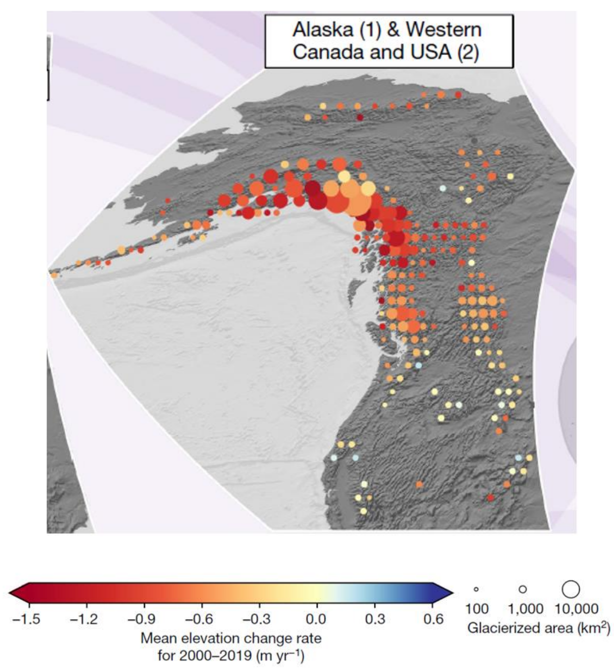

Figure 1-2: Elevation change from 2000-2019 of Western North American glaciers, with the colour of each circle representing the mean elevation change rate from 2000-2019 and the size of the dot representing the size of the glacierized area (modified from Hugonnet et al., 2021).

Although Hubbard Glacier has a long-documented history, research gaps exist when looking at specific details of glacier behaviour, with no recent investigation of variability of seasonal glacier flow that has been undertaken (Trabant et al., 2003). For example, Hubbard Glacier's seasonality and/or subglacial discharge has been analyzed in a few studies (Trabant et al., 2003; Ritchie et al., 2008; Stearns et al., 2015) and with remote sensing methods now commonly used for velocity determination, terminus velocities can be fully resolved (Waechter et al., 2015; Stearns et al., 2015; Van Wychen et al., 2018). With the increase in the amount of remote sensing data available, there is an opportunity to resolve seasonality in much more detail than was previously possible. This is important, because this can also be used to determine long-term velocity patterns on Hubbard Glacier which have been difficult to disentangle from the large seasonal variability of the glacier that has not been well quantified (Stearns et al., 2015). Similarly, only one study was found that briefly mentions the seasonality of Valerie Glacier, although there are some reports of the glacier experiencing a dynamic instability known as 'pulsing' (Trabant et al., 1991; Mayo, 1989; Ritchie et al., 2008). In the future, the effects of climate change will likely be different for glaciers in Alaska in terms of their long-term dynamic response than other regions of the world, and this study on Hubbard and Valerie glaciers can used to better understand how glaciers in this region of the world are behaving dynamically (Burgess et al., 2013a).

Monitoring of glaciers within Yukon/Alaska is limited, with most programs initiated on relatively small glaciers, and with only 3-4 long-term mass balance programs (Arendt et al., 2002). Hugonnet et al. (2021) found that Alaska accounted for 25% of glacier mass loss globally and that thinning rates were accelerating. The last report specifically investigating the mass balance of Hubbard Glacier was conducted in 2003 and found that it had a positive mass balance from 1959-2000 that was measured through the glacier's thickness changes (Trabant et al., 2003). This is different than other Alaskan Glaciers, as the majority of those studied are thinning along their lengths (Hugonnet et al., 2021).

1.2 Research Objectives

The major objective of this thesis is to explore glacier variability and change for two glaciers in Western North America that are currently understudied: the very large tidewater-terminating Hubbard and Valerie glaciers of the St. Elias Icefield. These glaciers provide key case studies of how climate change is impacting glaciers within Alaska. The major research objectives of this study are listed below.

1) Build a dense record of ice motion for Hubbard and Valerie glaciers that can be used to resolve the seasonality of both glaciers over the last ~decade;
2) Create a long-term velocity record of ice motion to determine whether the long-term deceleration of Hubbard Glacier that has been previously reported continues to present day and determine the long-term velocity trend of Valerie Glacier;
3) Utilize records of climate and surface elevation change data to explore the seasonal and long-term drivers of ice dynamics at Hubbard and Valerie glaciers.

The work done in this thesis will greatly increase our understanding of seasonal glacier flow patterns of tidewater glaciers of Western North America, which can help improve the understanding of how much water is being contributed to the ocean for sea level rise. Also, determining the elevation change allows a greater understanding of how fast these glaciers are losing mass, which can help with future mass loss projections.

1.3 Thesis Structure

There are five chapters within this thesis, with the format following the ‘thesis by manuscript’ style. Chapter 1 provides a broad introduction on why the work of this thesis is important and the specific research goals. Chapter 2 is a background chapter, encompassing a description of the study site and a literature review. Chapter 3 explains the methods used for reaching the objectives of this thesis. Chapter 4 presents and interprets the results of this study and is presented as the manuscript entitled *Patterns and drivers of seasonal and long-term velocity variability of Hubbard and Valerie glaciers*. Finally, Chapter 5 provides a summary of the work presented in this thesis, including discussions of the limitations and overall significance, and ideas for how this work can be expanded in the future.

Chapter 2: Study Site and Literature Review

2.1 Study Site

In Western North America (specifically southern British Columbia, the Rocky Mountains, and southern parts of the Alaskan Panhandle), climate is relatively maritime and, in comparison to northern glaciated regions in Canada, these regions have high levels of accumulation and ablation (Van Wychen et al., 2018). The St. Elias Mountains reach higher than 4,600 m a.s.l. and includes some of the tallest Canadian mountains (Bevington & Menounos, 2022). The mountains along the coast of Western Canada have an abundance of glaciers and include both volcanic and non-volcanic mountains (Bevington & Menounos, 2022). Low elevations, combined with maritime climates, typically results in less glaciated areas in Western Canada (like Vancouver Island), while glaciers at high elevations exist in the northern, central, and southern Rocky Mountains (Bevington & Menounos, 2022). The specific area of interest for this thesis are Hubbard and Valerie glaciers, which are located in Western North America, and described in the following sections.

2.1.1 Hubbard and Valerie Glaciers

Hubbard Glacier (Figure 2-1) is a large tidewater terminating outlet glacier, previously measured to be 123 km in length, making it the largest calving glacier inside North America and the largest tidewater glacier globally when excluding the poles (Trabant et al., 2003; Ritchie et al., 2008). The glacier has a grounded terminus and a calving face that is 11.4 km in width (Meier & Post, 1987; Trabant et al., 2003). Hubbard Glacier begins in the flanks of Mount Logan in the St. Elias Mountains (Yukon, Canada) and flows from its upper accumulation area to its terminus in Disenchantment Bay and Russel Fjord (near Alaska) (Ritchie et al., 2008; Van Wychen et al., 2018).

Valerie Glacier is a tributary glacier that connects to the west of Hubbard Glacier, with its terminus having ice flowing parallel to Hubbard Glacier's terminus for ~10 km (Mayo, 1988; labelled on Figure 2-1). Valerie and Hubbard Glaciers are separated by a medial moraine, and ice from Valerie Glacier comprises the first 2 km of the western calving front of Hubbard Glacier's terminus (Ritchie et al., 2008).

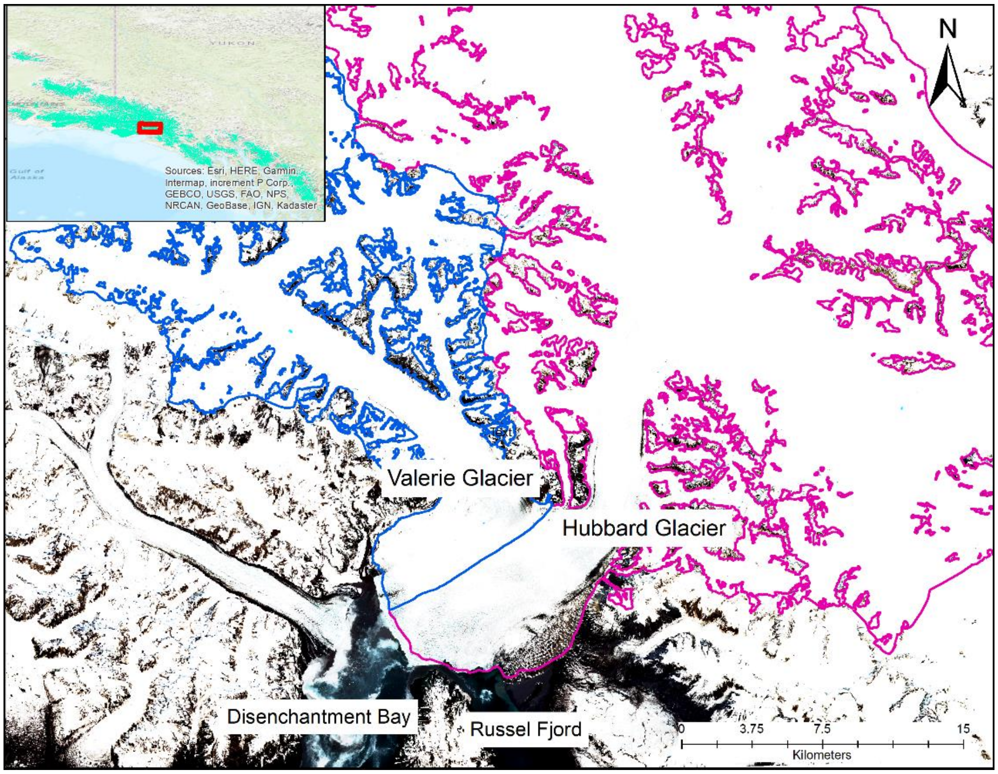

Figure 2-1: Hubbard Glacier outlined in pink, and Valerie Glacier outlined in blue from RGI Consortium (2017) (Sentinel-2 imagery from 11/06/2021, in WGS 1984 UTM Zone 7N). The inset shows the Alaskan glaciated regions (RGI Consortium, 2017), and the location of Hubbard and Valerie glaciers is indicated with the red box (World Topographic Map, in WGS 1984).

2.2 Background and Literature Review

2.2.1 Glacier Mass Balance and Climate Change

Glacier mass balance is determined through the summation of all forms of accumulation and ablation occurring at a glacier over a specified time period (usually one year) and is a factor influencing glacier advance and retreat (Zemp et al., 2013; Intsiful, 2020). Accumulation is mainly caused by liquid water refreezing and by precipitation falling onto the glacier in the form of snow (Intsiful, 2020). Accumulation can also involve blown snow and avalanches (Benn & Evans, 2013). Ablation is generally caused by the melting and runoff of ice and snow from warm air temperatures, calving, and sublimation (Intsiful, 2020). A glacier is said to be in balance when its ablation and accumulation are the same and consequently the glacier's mass will not change (Huss & Hock, 2018). If there is net accumulation, the glacier's mass balance will be positive and the glacier will grow, while a glacier will shrink when the ablation exceeds accumulation (Intsiful, 2020; Benn & Evans, 2013). The zones of accumulation and ablation are divided by the equilibrium line, which can provide information on glacier retreat or advance (Intsiful, 2020).

Above the equilibrium line, the accumulation zone has net mass gain, while below the equilibrium line (ablation zone), there is a net mass loss (Benn & Evans, 2013).

Mass balance is a useful measurement that can give information on climate change, with increasing temperatures largely leading to glacier mass loss (Zemp et al., 2013; Wouters et al., 2019). Depending on the glacier, its response to climate change can occur immediately or be delayed for years, meaning that changes observed today can be the response to climate changes over multiple decades (Brahney et al., 2017). Mass balance is important as mass loss from glaciers leads to increased sea level rise (Zemp et al., 2013).

An individual glaciers' mass balance can vary between years, but from 2002 to 2016, a global decline in glacier mass was observed (Wouters et al., 2019). From 1961-2016, the change in glacier mass globally was −9,625 ± 7,975 Gt, with ~3,000 Gt lost since 2003 (Zemp et al., 2019; Wouters et al., 2019). The amount of mass lost since 2003 is equivalent to ~8 mm of sea level rise (Wouters et al., 2019). Glacier shape, size, hypsometry, geologic setting, and feedback mechanism influence how individual glaciers respond to climate change (Comeau et al., 2009). For example, Bolch et al. (2010) found that glaciers south of 60°N in the Canadian Cordillera in Western Canada that were further from an ocean lost more mass than maritime glaciers. Since individual glaciers can respond differently, some may be able to survive future climate scenarios by retreating to higher elevations (Clarke et al., 2015). Glaciers retreating to higher elevations can also have a lower albedo from snowline retreat through exposing different glacier ice earlier in the melt season, which can cause increased melt in the summer (Comeau et al., 2009). Annual variations in mass balance have partly been assumed to be caused by large-scale atmospheric circulation changes and can reveal climatic patterns through its relationship to precipitation and temperature (Wouters et al., 2019; Shea & Marshall, 2007). However, glaciers in different locations around the world are affected differently due to local atmospheric circulation changes (Wouters et al., 2019). Within the northern hemisphere, interannual variability of mass balance can be changed by Arctic Oscillation (AO), Pacific Decadal Oscillation (PDO), El Niño-Southern Oscillation (ENSO), and North Atlantic Oscillation (NAO) (Wouters et al., 2019).

2.2.1.1 Glacier Mass Balance and Climate Change at Hubbard Glacier

Alaska has relatively few mass balance programs (3-4 long-term programs), with the majority on relatively small glaciers (Arendt et al., 2002). Glaciers within Alaska are experiencing accelerated thinning rates, and account for 25% of global glacier mass loss (Hugonnet et al., 2021). From 1959 to 2000, Hubbard Glacier's thickness was measured to determine its mass balance, which was found to be positive (Figure 2-2) (Trabant et al., 2003). During this 41-year period, the change of thickness of Hubbard Glacier varied, with 120 m of thickening occurring near its terminus, and 27 m of thinning at higher altitudes (2560 m) (Trabant et al., 2003). As reported by Trabant et al. (2003), at the higher elevation of 2200-2600 m, Hubbard Glacier experienced volume decreases. Hubbard Glacier's behaviour contrasts most Alaskan Glaciers, as out of 67 glaciers analyzed from the mid-1950s to the mid-1990s, the majority of those experienced thinning along their lengths, while less than 5% showed thickening (Arendt et al., 2002). However, the rate of thickening of Hubbard Glacier's lower 6 km has been decreasing, with values of 2.7 m/yr in 1948-1959, 2.1 m/yr from 1948-1978, 1.4 m/yr from 1959-1978, 1.7 m/yr between 1978-1988, and 1.4 m/yr from 1988-1999 (Trabant et al., 2003).

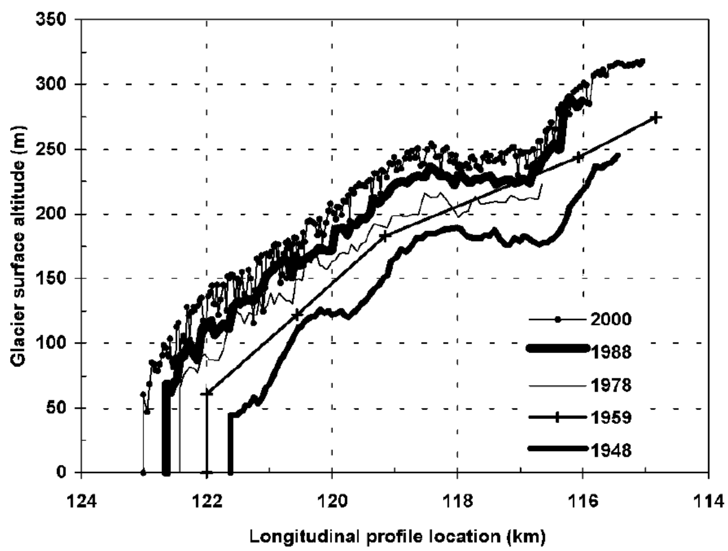

Figure 2-2: Thickening of Hubbard Glacier's terminal lobe. Data used for this comparison is from 1948, 1959, 1978, 1988, and 2000 (Trabant et al., 2003).

Since 1895, Hubbard Glacier has slowly been advancing, although seasonal advances of up to 100 m are superimposed on this (Trabant et al., 2003). The advance into Russel Fjord has been faster than that into Disenchantment Bay due to deeper water in Disenchantment Bay (200 m vs 30 m at Russel Fjord) (Trabant et al., 2003). The advance into deeper water is slower because a larger volume is needed for a terminal moraine to keep the water shallower at the glacier's calving face (Trabant et al., 2003).

In 2003, it was suggested that Hubbard Glacier is not as sensitive to moderate climate change due to the majority (95%) of the glacier lying in the accumulation zone, having a positive mass balance, and undergoing an advance (Trabant et al., 2003). Therefore, climate change may not influence Hubbard Glacier for a long time until its accumulation area ratio (AAR) is lower than 0.7 (Trabant et al., 2003; Trabant et al., 1991). This would occur only when the equilibrium line altitude (ELA) rises by 1,000 m, with Hubbard Glacier's AAR being reported as 0.95 (due to its high ELA of 1,000 m) (Trabant et al., 2003, Trabant et al., 1991). Sensitivity to climate will occur when calving glaciers have melting losses near equilibrium with the accumulation area's mass flux (Trabant et al., 2003). However, Hubbard Glacier may become sensitive to tidal currents that melt/erode ice as it reaches the end of Russell Fjord (Trabant et al., 2003). If Hubbard Glacier continues to advance, the length of the tidal channel connecting Russel Fjord and Disenchantment Bay will increase, reduce energy, and thus reduce melt/erosion and current-induced calving at the ice face (Trabant et al., 2003).

2.2.1.1.1 Melt and Calving of Hubbard and Valerie Glaciers

Sea levels get large contributions of water from mountain glaciers, which effects future sea level rise (Burgess et al., 2013a). Previously, rain input into dammed lakes have caused outburst floods on Hubbard Glacier (Trabant et al., 2003). This occurred in August 2002, after a moraine blocked the entrance to Russel Fjord and water levels increased to overflow the moraine (Trabant et al., 2003). After the outburst flood, the lake drained, allowing tidal exchange with Russel Fjord to occur again (Trabant et al., 2003). Tidal currents affect erosion and melt on Hubbard Glacier, with the narrow entrance to Russel Fjord having the slowest advance due to extreme tidal currents causing large amounts of erosion and melt (Trabant et al., 2003). Seasonally, surface water will warm from April-August, which leads to an increase in submarine melt and iceberg calving and ultimately to increasing retreat (Ritchie et al., 2008). Subglacial freshwater discharge at Hubbard Glacier's terminus drives sea-water convection, increasing the amount of warm saline waters to the calving front (Ritchie et al., 2008).

Calving rates of Hubbard Glacier are estimated to be the highest rates of steady-state discharge of all glaciers globally, outside of Greenland and Antarctica (Waechter et al., 2015). The findings of Burgess et al. (2013a) show the best estimate of volumetric flux from Hubbard Glacier (without Valerie Glacier) to be 2.48 km^3/yr, and for Valerie Glacier to be 0.22 km^3/yr. Waechter et al. (2015) found the best calving flux estimate of Hubbard Glacier (when including Valerie

Glacier) to be 5.48 km^3/yr, which is 27.17% of the total calving flux for central Alaska. However, as previously stated, current-induced calving, melt and erosion may eventually decrease as the length of Hubbard Glacier increases, as a result of an increasing length of tidal channel connection between Russel Fjord and Disenchantment Bay that causes a reduction in the energy gradient through the passage (Trabant et al., 2003).

Looking towards future change, a glacier mass balance modelling study that used a multi-model mean forced by temperature and precipitation scenarios projected substantial volume losses in the glaciers within Western Canada and the US (Bliss et al., 2014). Specifically, it is possible >75% of current glacier volume will disappear by 2100, normalized to the 2003-2012 means (Bliss et al., 2014). Radić & Hock (2011) found through a multimodel mean that Alaska was one of the global regions that contributes the most to sea level rise from mountain glacier and ice cap losses by 2100 (0.026 ± 0.007 m SLE). However, these projections use surface glacier mass balance models that neglect calving losses from tidewater glaciers, meaning the sea level rise from glaciers may be higher than the value provided by Radić & Hock (2011).

2.2.2 Melt and Water Supply

Water stored and released from glaciers has impacts on many different people and things. Glaciers hold large amounts of freshwater and are a critical resource for water supply, as runoff in mountain systems supply water to approximately half of the world's population (Brahney et al., 2017). The global retreat of glaciers is a large concern for how long glaciers can be relied on for water supply (Huss and Hock, 2018). The communities that are put at risk are those with water coming from glacier-fed rivers whose streamflow will see large changes if glaciers stop contributing meltwater (Anderson & Radić , 2020). There are many other impacts of changing meltwater supply, with aquatic habitats, hydroelectric power, recreation, tourism, agriculture, and industry going to be affected (Clarke et al., 2015; Bolch et al., 2010).

Annually, streamflow changes in times of glacier accumulation and ablation, with increased flow during times of net ablation (summer months) and decreased flow during times of net accumulation (Bliss et al., 2014). This is the result of glaciers storing water when the weather is wet and cold, while releasing water when it is warm and dry (Comeau et al., 2009).

With rising temperatures and glacier retreat, more water is being released from the glacier's long-term storage (Huss & Hock, 2018). Initially, there will be an increase in annual runoff until ‘peak water’ occurs (Huss & Hock, 2018). After this peak, smaller levels of runoff will be observed as glaciers becomes smaller, the snowline rises, and temporary meltwater storage is decreased (Huss & Hock, 2018; Brahney et al., 2017). It is possible that the annual runoff of a glacier can return to the same level it was at before its retreat if the glacier reaches a new state of equilibrium in its mass balance and no other components of the water balance have changed (Huss & Hock, 2018). However, Huss & Hock (2018) state that their conclusion of annual runoff returning to its pre-retreat value differs from conclusion of other researchers, as others have found that annual runoff will fall below its initial value (for example, Milner et al., 2009 and Baraer et al., 2012). Huss & Hock (2018) state the differences may arise from their methodological approach of using a fixed glacier area, while the other studies utilize a changing glacierized area. For mid- and high-latitude glaciers, it is expected that melt season runoff will become less than its original level before glacier retreat due to less water availability from its long-term storage (Huss & Hock, 2018). This results in the glacier’s water balance to be unaltered, with the exception of glacier-storage change (Huss & Hock, 2018). Overall, this will cause a reduction in water resource availability in the future (Bliss et al., 2014).

2.2.3 Glacier Dynamics and Subglacial Hydrology

Glacier dynamics refers to the movement of glaciers and is caused by a combination of internal deformation, bed deformation and basal sliding, summarized in Figure 2-3 (Hoffman & Price, 2014). Internal deformation of a glacier is always present and generally involves either pure shear or simple shear, resulting from the gravitational driving stress (Benn & Evans, 2013). Pure shear involves the glacier being flattened/stretched, while simple shear involves the glacier being skewed without being flattened/stretched (Benn & Evans, 2013). This movement is referred to as ice creep, when the ice crystals have movement within or between them, instead of fracturing (Benn & Evans, 2013). The speed of deformation from ice creep is influenced by temperature, size/orientation of ice crystals, presence of impurities (i.e., gas bubbles or rock particles), and water content (Benn & Evans, 2013).

Bed deformation occurs when the materials of a glacier bed can deform due to stresses caused by the ice and generally occurs within the first few centimeters of the bed (Benn & Evans, 2013). This type of movement will not occur if the glacier is sitting on hard rock, but rather only occurs on unlithified sediment or sedimentary rocks that are poorly constrained (Benn & Evans, 2013). For both bed deformation and basal sliding, geometry and water pressure at the bed of the glacier are extremely important (Alley, 1989). Water reaching the bed is commonly from surface meltwater transferring downwards and can modify glacier motion through changing the subglacial water pressure or bed contact (Hoffman & Price, 2014). Increasing water at the bed leads to decreased bed deformation (even though till strength decreases) due to the decoupling of the glacier and the bed, however, this leads to increased basal sliding, explained below (Benn & Evans, 2013).

Basal sliding involves the glacier slipping over its bed (Benn & Evans, 2013). The more sliding a glacier experiences, the higher its basal water pressure (Hoffman & Price, 2014). If the glacier has a frozen bed, the bed can resist a greater amount of shear stress before sliding can occur, leading to small amounts of sliding (Benn & Evans, 2013). A glacier with a wet bed has resistance to sliding resulting from obstacles on the bed (form drag) and debris in the basal ice (frictional drag) (Benn & Evans, 2013). When obstacles are in the bed, the glacier may experience regulation and cause the ice upglacier of the object to melt so water can flow over it before refreezing after the object (Benn & Evans, 2013). Enhanced creep also allows ice to flow past an obstacle by deforming the ice around/over the obstacle (Benn & Evans, 2013). The mechanism used will depend on the size of the object, where regulation is more effective for small obstacles and enhanced creep is more effective for large obstacles (Benn & Evans, 2013).

Basal sliding can occur with or without cavitation, which involves the formation of water-filled cavities between the ice and the glacier bed (Benn & Evans, 2013). When these cavities form, this leads to the objects on the bed becoming submerged (decreasing resistive stresses), the 'hydraulic jack' mechanism, and decreasing ice-bed coupling (Benn & Evans, 2013). Hydraulic jacking occurs when the pore pressure in the sediment/rock under a glacier increases and is larger than the other forces acting on the fracture, causing a fracture to dilate/propagate and increases glacier flow rates (Lönnqvist & Hökmark, 2010; Hall et al., 2021; Hooke, 2019).

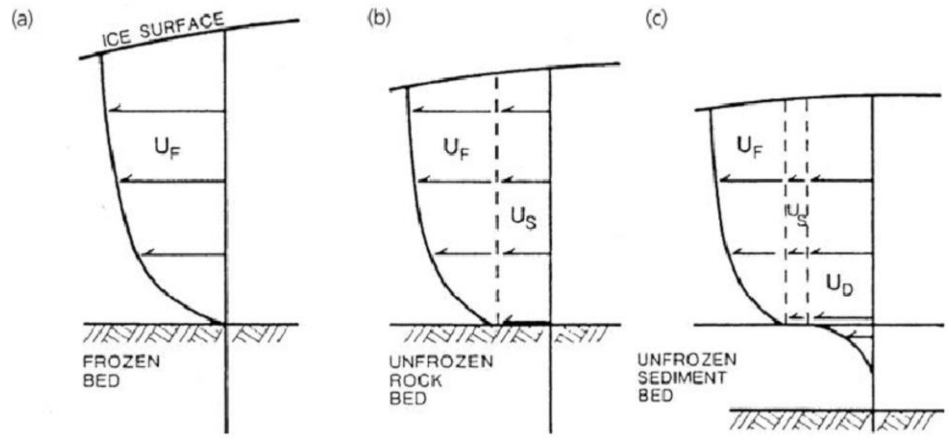

Figure 2-3: Movement of a glacier from a) only internal deformation, b) internal deformation and basal sliding, c) internal deformation, basal sliding, and bed deformation (Boulton, 1996).

Subglacial channels greatly impact flow speeds of a glacier (Benn & Evans, 2013). If subglacial flow paths have a large transport capacity relative to the amount of subglacial water there is, basal sliding and bed deformation will be slow or non-existent (Alley, 1989). These are efficient localized drainage systems with low water pressure that quickly move water through the network (Benn & Evans, 2013; Hewitt & Fowler, 2008). This is commonly seen in glaciers with thick, high-permeability subglacial aquifers, glaciers with slow basal melt, and small glaciers with short paths for subglacial water to exit the glacier (Alley, 1989). Conversely, if water at the glacier bed cannot be efficiently transported out from underneath the glacier, it will accumulate and increase the water pressure at the base of the glacier, with water being spread out at the ice-bed interface in a thin film, as a distributed, inefficient drainage system (Alley, 1989; Hewitt & Fowler, 2008). However, increasing water at the bed can continue to develop the system into channelized flow (Alley, 1989). The quantity of meltwater, type of glacier bed, and the glacier's potential gradient's direction/magnitude will affect the size, shape, and type of water path (i.e. channels, cavities, films), shown in Figure 2-4 (Hewitt & Fowler, 2008; Alley, 1989).

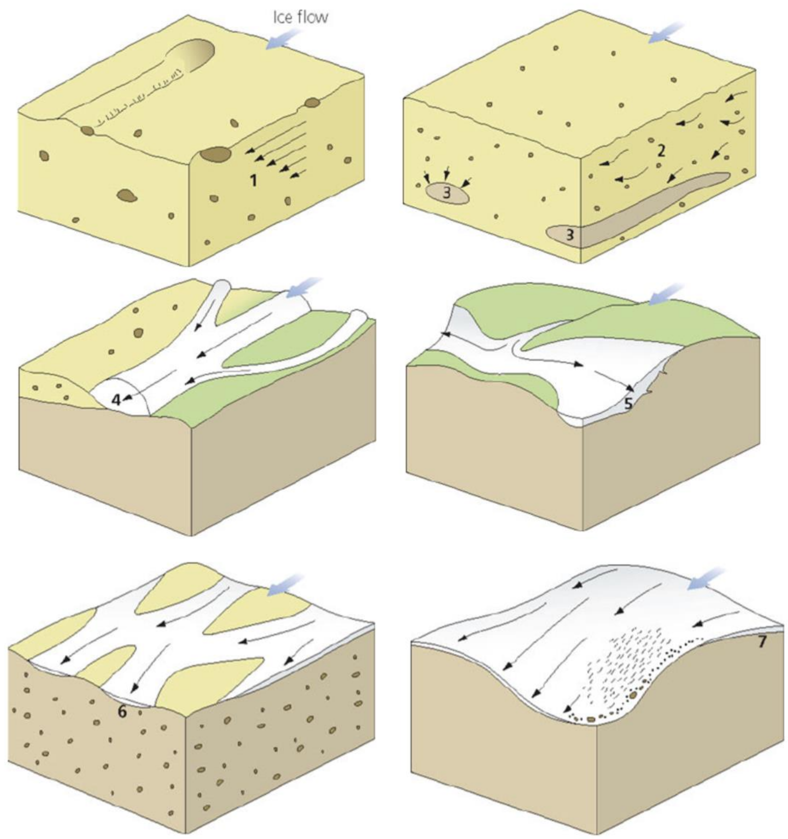

Figure 2-4: Subglacial systems. 1) Till deformation (inefficient). 2) Darcian porewater flow (inefficient). 3) Pipe flow (efficient). 4) Dendritic network (efficient). 5) Linked cavities (inefficient). 6) Braided channels (inefficient). 7) Thin film (inefficient). (Benn & Evans, 2013).

2.2.3.1 Seasonal Subglacial Hydrology and Velocity Changes

There are three main factors controlling seasonal changes to subglacial hydrology: weather conditions, snowline retreat, and distribution of moulins and crevasses (Nienow et al., 1998). Nienow et al. (1998) found that seasonal velocity changes result from the evolution of the subglacial hydrology throughout the melt season, changing from a distributed network to a more channelized and efficient system towards the end of the melt season. This generally causes high velocities in the spring, intermediate velocities in the summer, and minimum velocities experienced during the late summer or fall (Armstrong et al., 2017). Seasonal flow can be modified due to accumulation and ablation of glaciers and can affect the glacier's geometry and thus its mass balance (Paterson, 1964; Turrin et al., 2014). For example, rainstorms occurring early in the melt season may also facilitate the formation of efficient subglacial drainage channels (Nienow et al., 1998). The magnitude and duration of a water pressure perturbation in the subglacial drainage system will affect the rate and pattern of channel growth (Nienow et al., 1998). These channels tend to extend down-glacier, although some channel growth can be up-glacier in certain instances (Nienow et al., 1998). For example, up-glacier channel growth was made possible from snowline retreat and its relation to its firn aquifer, crevasses and moulins of the glacier's surface, where the rate of snowline retreat and extension of the channelized system up-glacier were comparable (Nienow et al., 1998). The efficient channels may not survive until the next melt season, and a distributed system may form again due to ice deformation (Nienow et al., 1998).

2.2.3.2 Glacier Surging/Pulsing

Glaciers that surge undergo two phases that can range from a few years to several decades; one of fast flow (surge/active phase) and one of slow flow (quiescent phase), with surge velocities reaching one to two orders of magnitude higher than quiescent phase velocities (Benn & Evans, 2013). Surges are generally internally triggered, although internal dynamics are often influenced by external factors (Benn & Evans, 2013). The quiescent phase involves a buildup of ice up-glacier in the reservoir area that increases the ice surface gradient until a surge occurs (Benn & Evans, 2013). Once the surge begins, ice is rapidly moved from the up-glacier reservoir area and moved down-glacier to the receiving area, resulting in the surface lowering in the reservoir area and thickening in the receiving area (Benn & Evans, 2013). The surge may cause the glacier to advance, although the surge may not always travel all the way to the glacier's terminus (Benn & Evans, 2013). Glaciers show a characteristic surge front, which is a bulge in the ice caused by the meeting of fast, surging ice and slower ice (Benn & Evans, 2013). Surges of land-terminating glaciers often travel down-glacier, while tidewater glaciers can have the surge start in the lower tongue and travel up-glacier (Benn & Evans, 2013).

Glacier pulses occur periodically when a glacier has fast unstable flow, with these movements in-between normal flow and surging (Mayo, 1978). A link between basal hydrology and pulsing of glaciers may exist, as pulsing may occur when a large glacier-dammed lake drains (Turrin et al., 2014). However, the exact cause of glacier pulsing has yet to be identified (Turrin et al., 2014). Within Alaska, there are ~140 glaciers featuring physical characteristics of pulsing (i.e. wavy medial moraines, large-scale wavy foliation, boudinage on part of the glacier), identified by A. Post and L.R. Mayo (Turrin et al., 2014). During a glacier pulse, mass can be rapidly moved to lower elevations and the ablation zone (Turrin et al., 2014). Within the Canadian Arctic, glacier pulsing is classified differently than glacier surging due to the fast motion of a pulse originating near the glacier terminus and propagating up-glacier but is limited to where the glacier bed is below sea level (Van Wychen et al., 2016). Many of these glaciers do not show enough evidence to be classified as surging, but their unstable flow variations lead to the classification of pulse-type (Van Wychen et al., 2016).

Both Hubbard and Valerie glaciers were found to have pulsed in the past (Mayo 1988; Mayo, 1989; Trabant et al., 1991; Ritchie et al., 2008). The velocity of Hubbard Glacier is also influenced by its tributary glaciers, with times of increased velocity on Hubbard Glacier possibly resulting from its tributary glaciers pulsing (Ritchie et al., 2008). Previously, Hubbard Glacier had pulses in 1986 and 1989, and previous work has speculated that Valerie Glacier experiences 'pulse-like' surges every several years (Mayo 1988; Mayo 1989; Trabant et al., 1991; Ritchie et al., 2008). In May of 1986, Valerie glacier had a 'weak surge' that increased velocities past 13,150 m/yr and caused Hubbard Glacier to advance 600-700 m and block the entrance to Russel Fjord, creating a glacier-dammed lake (Mayo 1988; Mayo, 1989). Displacements of the medial moraine between Hubbard and Valerie glaciers led Ritchie et al. (2008) to believe this was due to increased flow speeds and a similar pulsing event to that seen by Mayo (1989), observed between August 1993-August 1995 and July 2000-September 2002.

2.2.3.3 Tidewater Glacier Cycle

The tidewater glacier cycle is one of cyclical advance and retreat (Figure 2-5), which is not directly related to climate and often involves fast flow for temperate glaciers (Meier & Post, 1987). There are many factors that affect how long each advance and retreat stage lasts, including the geometry of both the drainage basin and fjord, the distributions of the glacier's mass balance, how available erodible material is, and more (Meier & Post, 1987). The cycle has four discrete stages, the first being the advance phase where calving flux is decreased due to shoal development and advection (Brinkerhoff et al., 2017). Next is the extended phase, where advance is halted due to equilibrium in accumulation and ablation (Brinkerhoff et al., 2017). The retreat phase begins once it cannot be grounded by the shoal due to insufficient thickness of glacial ice, leading to basal drag decreasing, instability, and ungrounding (Brinkerhoff et al., 2017). The retreat phase is completed once the glacier becomes re-grounded on bedrock and the terminus position returns to where it would be without sedimentation, typically kilometers shorter than the terminus position in the advanced stage (Brinkerhoff et al., 2017). For the advance stage to restart, a sediment shoal is rebuilt (Brinkerhoff et al., 2017).

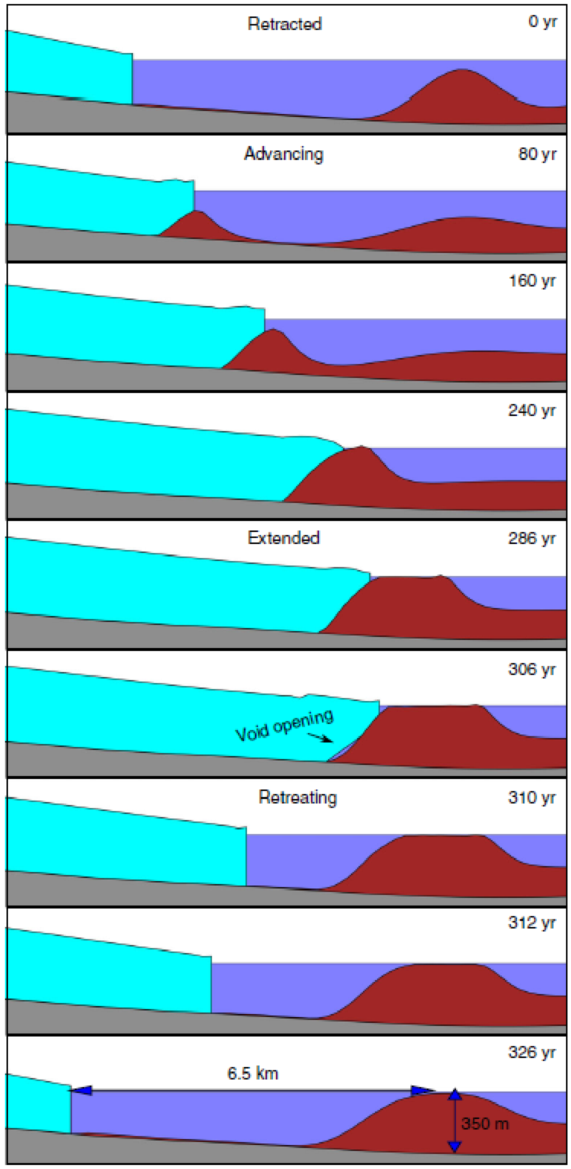

Figure 2-5: Glacier geometry changes during the tidewater glacier cycle and the cycle between retreat and advance occurring over hundreds of years (Brinkerhoff et al., 2017).

Hubbard Glacier is one of the advancing tidewater glaciers located in Alaska, with its rate of advance being ~35 m/yr in 2014, although it previously had periods of faster and slower advance (Stearns et al., 2015). It is currently thought to be in the early phase of advance of a tidewater glacier cycle, with a tidewater glacier's advance possibly lasting a millennium (Trabant et al., 2003; Meier & Post, 1987). High water pressure exists at the bed (close to the ice pressure), as this is needed to expel the water into the sea by overcoming the seawater pressure that exists at the terminus (Meier & Post, 1987). Temperate tidewater glaciers can move faster than polar tidewater glaciers, which may be due to more basal water availability for sliding in temperate settings (Meier

& Post, 1987). However, some of these glaciers show evidence of little seasonal variation that points to movement being caused mostly by internal deformation (Meier & Post, 1987). A fast, grounded tidewater glacier has its flow rates mostly dependent on calving and sea level boundary conditions at its terminus (Meier & Post, 1987). Advance into deeper water is possible if the glacier has a moraine shoal in front of the terminus to aid in calving reduction (Meier & Post, 1987). Due to the need to create a terminal moraine, Hubbard Glacier is advancing faster into Russell Fjord than Disenchantment Bay due to Disenchantment Bay being deeper (200 m) then Russel Fjord (30 m) (Trabant et al., 2003).

The retreat phase of tidewater glaciers largely depends on the depth of water and may range in duration from a few decades to a century (Meier & Post, 1987). The speed of the retreat phase is caused by deep water and calving rates of the glacier's terminus, with common rates of retreat up to 100 m/yr (Meier & Post, 1987; Trabant et al., 2003). Also, there may be a feedback mechanism where once retreat begins, the glacier's backpressure decreases (and thus causes thinning and increases velocity, while it decreases effective pressure at the bed), which increases stretching and calving (Meier & Post, 1987). High velocities of ice and calving can be reached from this (Meier & Post, 1987). Between 1130 and 1891, Hubbard Glacier was in its retreat phase, with an average rate of 80 m/yr (Trabant et al., 2003).

Ritchie et al. (2008) reported that the terminus of Hubbard Glacier changed seasonally, with October-May showing advance and May-October showing retreat, possibly a result of water temperatures. Although seasonal retreats of up to 500 m were observed, there was a net advance of the terminus from 1992-2006 (Ritchie et al., 2008). However, the tidewater glacier cycle is not directly related to changes in the climate, with calving glaciers in the retreat phase hardly sensitive to climate (Meier & Post, 1987; Trabant et al., 2003). Ritchie et al. (2008) confirms this, as they stated that correlations with warmer temperatures and increased calving was not consistent.

2.2.3.4 Dynamics of Hubbard and Valerie Glaciers

Waechter et al. (2015) provided the first study with full coverage of the velocities of Hubbard Glacier's catchment, with Hubbard Glacier's velocity shown in Figure 2-6. Hubbard Glacier is one of the 12 glacier systems in Alaska with velocities greater than 365.25 m/yr seen over large portions of the glacier (Burgess et al., 2013a). Van Wychen et al. (2018) helped to fill the knowledge gaps of velocity at Hubbard Glaciers terminus and found that Hubbard Glacier was one of the fastest in the St. Elias Mountains during the winters of 2007/08 and 2009/10, with velocities greater than 2,200 m/yr.

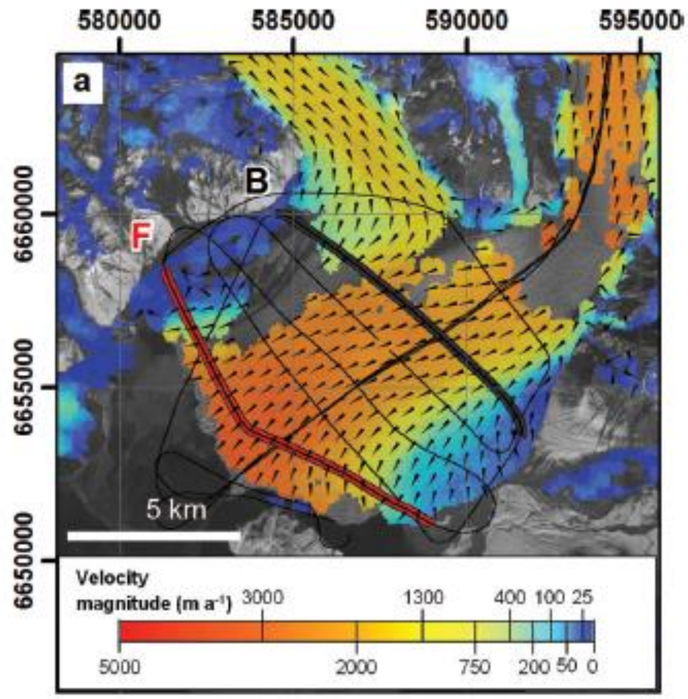

Figure 2-6: Velocity of Hubbard Glacier's terminus from RADARSAT-2 imagery in spring 2012 (modified from Waechter et al., 2015).

Seasonal variations in surface ice velocity at the terminal lobe of Hubbard Glacier have been observed from aerial and satellite images (processed with analytical methods, identifying repeat serac and crevasse patterns), with differences as large as ~730.5 m/yr (Trabant et al., 2003). Stearns et al. (2015) also found that velocities can vary seasonally from 1,500 to 5,200 m/yr. Generally, the fastest glacier flow occurs between May and June (~2,959 m/yr) and the slowest flow seen in September to November at ~2,447 m/yr (Trabant et al., 2003). Ritchie et al. (2008) found embayment locations likely corresponding to subglacial drainage, but these locations moved over the years. From the summer to the fall, the openings were seen, but were closed during the winter (Ritchie et al., 2008). Ritchie et al. (2008) state that the surface melt also caused the subglacial discharge to peak around mid- to late summer. The most recent measurement provided by Trabant et al. (2003) showed surface ice flow of ~4,200 m/yr near the glacier's terminus in July and August 2001. However, Hubbard Glacier's fast speeds are not necessarily a result of tidewater glacier dynamics, as other extremely fast glaciers in the region are land terminating (Burgess et al., 2013a). Instead, this is likely from having large coastal accumulation areas in high elevations, meaning that the large amounts of accumulation cause high flow rates as the glacier tries to maintain balance (Burgess et al., 2013a). The dynamics are likely also different than other glaciers due to high velocities and driving stresses without the loss of mass (Burgess et al., 2013a).

Valerie Glacier has had extremely limited work on resolving its seasonal velocities, but Trabant et al. (1991) deployed a satellite data telemetry transmitter and marine navigation receiver on Valerie Glacier's surface that began on 22 December 1987, and used radio beacons to resolve velocities. During this period, there were no unusual motion events, with seasonal changes ranging from ~500 m/yr to ~2,000 m/yr seen between 1986-1989 (Trabant et al., 1991).

Due to the large seasonal variability, it can be difficult to determine long-term velocity patterns (Stearns et al., 2015). Trabant et al. (2003) removed seasonal variability at a point along the centerline of the glacier, approximately 3 km above the 1997 terminus location (shown in Figure 2 of Trabant et al. (2003) paper) and found that from 1978-1997 there was a slowdown from 7.7 m/day to 6.7 m/day. Without removing seasonal variability in 11 points near Hubbard Glacier's calving face, a ~0.05 m/day deceleration was observed (Trabant et al., 2003). Larger rates of deceleration are observed at larger distances from the glacier's calving front due to the decrease of surface strain rates (Trabant et al., 2003). Glaciers in Alaska may have a different response to climate change through changes to their long-term dynamics than ice sheets will, due to the high accumulation rates in Alaska causing the downstream flux (Burgess et al., 2013a).

Overall, Hubbard and Valerie glaciers make for an interesting study due to the large seasonal variability in velocities, long-term changes in velocities, and the tidewater glacier cycle playing a role in their dynamic behaviour. Previous studies of these glaciers do not have their velocities very well resolved nor looked at intra-annual velocities over a long time period, which this thesis will do in the highest temporal resolution and densest velocity record to date.

Chapter 3: Methodology

This chapter presents the methodology used in this thesis to investigate the behaviour of Hubbard and Valerie glaciers. The methods were primarily remote sensing based, with synthetic aperture radar (SAR) data and optical imagery used to determine glacier velocities. Pre-derived rates of elevation change were used to determine geometry changes of Hubbard and Valerie glaciers. Supplementary climate data was provided by reanalysis data, due to the lack of in-situ weather stations around Hubbard and Valerie glaciers.

3.1 Methods

3.1.1 *Synthetic Aperture Radar*

Synthetic aperture radar (SAR) produces images by emitting energy from the sensor and detecting how much is reflected by the earth’s surface and received back at the sensor (Figure 3-1) (EarthData, 2020). This technique relies on active microwave reflectivity, with the energy received after reflecting off the earth referred to as backscatter (Bamler, 2000; Lauknes, 2010). The energy emitted, which is not obscured by clouds and does not require the sun’s illumination of the earth, means that images can be collected day or night and regardless of weather conditions (EarthData, 2020; Bamler, 2000). The signal is, however, responsive to structure and moisture of the earth’s surface (EarthData, 2020). The time between when a pulse is transmitted and when its “echo” is received provides information on distance and location (Government of Canada, 2015). The signal the receiver obtains, the backscatter, contains information on both the amplitude and phase of the returned energy and are often digitally processed on ground stations, although onboard processing exists (Franceschetti & Lanari, 2018). The spatial resolution of the obtained data is dependent on both the wavelength and antenna length, where a longer antenna for a specific wavelength increases the resolution (EarthData, 2020). A simulated long antenna for SAR is achieved by combining acquisitions from the forward motion of a shorter antenna (EarthData, 2020). Figure 3-1 shows a schematic of a SAR satellite, where the look angle represents the angle between the satellite beam and the surface normal (Lauknes, 2010).

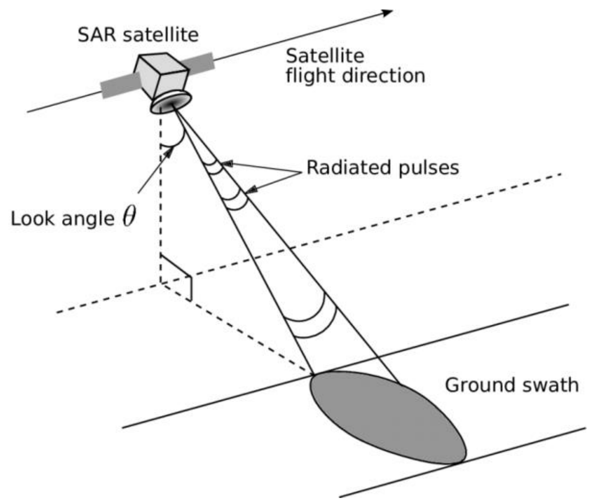

Figure 3-1: Schematic of a SAR satellite, showing the satellite's flight direction, radiated pulses, look angle, and ground swath (Lauknes, 2010).

The microwaves used in this technique can have different wavelengths and are categorized into different bands (see Table 3-1). For example, X-band has a wavelength of ~3 cm, C-band ~6 cm, and L-band with ~24 cm (Bamler, 2000; EarthData, 2020). For monitoring of the cryosphere and glaciers, the most commonly used bands are X, C and L (EarthData, 2020; Wang et al., 2021). The longer the wavelength, the further it is typically able to penetrate, and this impacts the utility of different sensors for observing different land cover types (Balmer, 2000; EarthData, 2020). Commonly, it is the amplitude or intensity images that are of interest, although phase can be used for offset tracking and is of interest during SAR interferometry (InSAR) processing (Bamler, 2000; Schellenberger et al., 2016). The brightness of an image can be influenced by surface roughness, the incidence angle, density/distribution of the scatterer, and the dielectric constant of the material (Bamler, 2000).

Table 3-1: The band, frequency, wavelength, and application for SAR (from EarthData, 2020).

Band	Frequency	Wavelength	Typical Application
Ka	27–40 GHz	1.1–0.8 cm	Rarely used for SAR (airport surveillance)
K	18–27 GHz	1.7–1.1 cm	rarely used (H_2O absorption)
Ku	12–18 GHz	2.4–1.7 cm	rarely used for SAR (satellite altimetry)
X	8–12 GHz	3.8–2.4 cm	High resolution SAR (urban monitoring,; ice and snow, little penetration into vegetation cover; fast coherence decay in vegetated areas)
C	4–8 GHz	7.5–3.8 cm	SAR Workhorse (global mapping; change detection; monitoring of areas with low to moderate penetration; higher coherence); ice, ocean maritime navigation
S	2–4 GHz	15–7.5 cm	Little but increasing use for SAR-based Earth observation; agriculture monitoring (NISAR will carry an S-band channel; expends C-band applications to higher vegetation density)
L	1–2 GHz	30–15 cm	Medium resolution SAR (geophysical monitoring; biomass and vegetation mapping; high penetration, InSAR)
P	0.3–1 GHz	100–30 cm	Biomass. First p-band spaceborne SAR will be launched ~2020; vegetation mapping and assessment. Experimental SAR.

SAR sensors can have varying polarization, although they are generally linear (EarthData, 2020). The electromagnetic wave that is transmitted has a specific orientation of the plane it is oscillating in, and this changes how the microwaves will interact with the surface (EarthData, 2020; Government of Canada, 2015). H represents horizontal polarization and V represents vertical polarization (EarthData, 2020). The polarization of SAR data is given by two letters (ex. HH, HV, VH, and VV), with the first representing the polarization of the emitted signal and the second is the polarization of the received signal (EarthData, 2020). It is also possible for the waves to have a circular polarization when being transmitted, although this is less common than the linear polarization (Jet Propulsion Laboratory, n.d.). Circular polarization is created when H and V signals are both emitted but have a phase shift of 90°, resulting in a circular wave motion (Jet Propulsion Laboratory, n.d.). Compact-pol exists in a hybrid system that can transmit with a circular polarization but receives linear polarizations (Jet Propulsion Laboratory, n.d.).

3.1.2 *Glacier Motion Tracking and GAMMA RS Software*

Glacier motion is commonly determined from SAR data, popularly through image matching/offset and speckle tracking, coherence tracking, and differential InSAR (Schellenberger et al., 2016). The process of offset tracking looks for re-occurring patterns of amplitude and/or phase in two SAR images to provide displacements in range and azimuth directions (Schellenberger et al., 2016). Offset tracking is less affected by changes from rain or snow, snow drift, melt, or movement of the glacier itself compared to InSAR techniques, however, this results in a lower resolution of glacier velocities (Schellenberger et al., 2016). Because of this, offset tracking is more advantageous on larger glaciers with large displacements (Schellenberger et al., 2016). Due to the large size and fast velocities of Hubbard Glacier, offset tracking is a robust way of determining motion. Another important aspect of offset tracking in comparison to InSAR techniques, is that InSAR provides displacements in the one-dimensional line of sight of the sensor, so it is spatially limited compared to offset tracking (Fuhrmann & Garthwaite, 2019).

In this thesis, offset tracking in GAMMA RS software was used to determine glacier motion and is a commonly used software package for this purpose (Strozzi et al., 2002; Schellenberger et al., 2016). The image with the earlier date was used as the reference image, with the later dated image used as the secondary image. In general, the code first changes the images from proprietary SAR images into a format GAMMA expects (SLC and MLI), creates a lookup table, resamples a DEM to radar geometry (in this case, DEMs were obtained from Copernicus (retrieved from https://panda.copernicus.eu/web/cds-catalogue/panda)), resamples the secondary SLC to the geometry of the reference SLC using the lookup table (coregistration) to ensure the secondary image matches the geometry of the reference, and creates a new MLI with the resampled SLC. Next, the offset tracking algorithm is conducted using a cross correlation procedure that looks for nearly identical features between two SAR images, using defined patches/windows of a specified pixel size (Strozzi et al., 2002). Coherence between the two images is required for the speckle pattern to be correlated and allows for small window sizes to be used, while the loss of coherence would require larger window sizes and decreased accuracy (Strozzi et al., 2002). The slant-range and azimuth offsets are used in the search for the cross-correlation maximum, which gives the image offset (Strozzi et al., 2002). Once this offset is found, glacier motion is separated from the different satellite orbit configurations between images through subtracting orbital offsets, resulting in a displacement of glacier motion given in meters (Strozzi et al., 2002). For 3-D displacements, a DEM is combined with the slant-range and azimuth displacement (Strozzi et al., 2002). Complex values are changed to real values, before finally creating GeoTIFF files with the magnitude of displacement (Figure 3-2 and Figure 3-3). These files were scaled to meters of displacement between two images and were imported into ArcMap 10.8.1 to be converted to standardized m/yr value (described in Section 3.1.5 later in this chapter).

To determine the window and step size used for offset tracking, experimental runs of the GAMMA software using different values were conducted with TerraSAR-X (TSX) data. The experimental combinations used were as follows: window size of 400 x 400 pixels with the step size of 100 x 100 pixels, window size of 300 x 300 pixels with the step size of 75 x 75 pixels, window size of 200 x 200 pixels with the step size of 50 x 50 pixels, window size of 300 x 150 pixels with the step size of 75 x 38 pixels, window size of 150 x 300 pixels with the step size of 38 x 75 pixels, and window size of 150 x 150 pixels with the step size of 38 x 38 pixels. For Hubbard Glacier, the window size of 200 x 200 pixels, and step size of 50 x 50 pixels was determined to provide the best results, with this step and pixel size used for the entirety of the study on Hubbard Glacier with TSX and RADARSAT Constellation Mission (RCM). RADARSAT-2 (R2) data was provided for this study in a pre-processed format, and image chip sizes of ~500 m x ~500 m in GAMMA were used, as described in Main et al. (2022) (although the data was used without the post-processing described in the Main et al. (2022) paper).

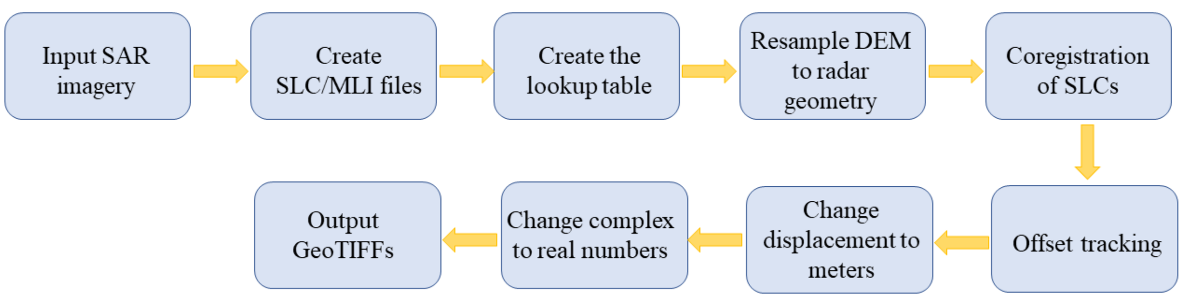

Figure 3-2: Schematic of the offset tracking procedure as implemented within the GAMMA RS software package.

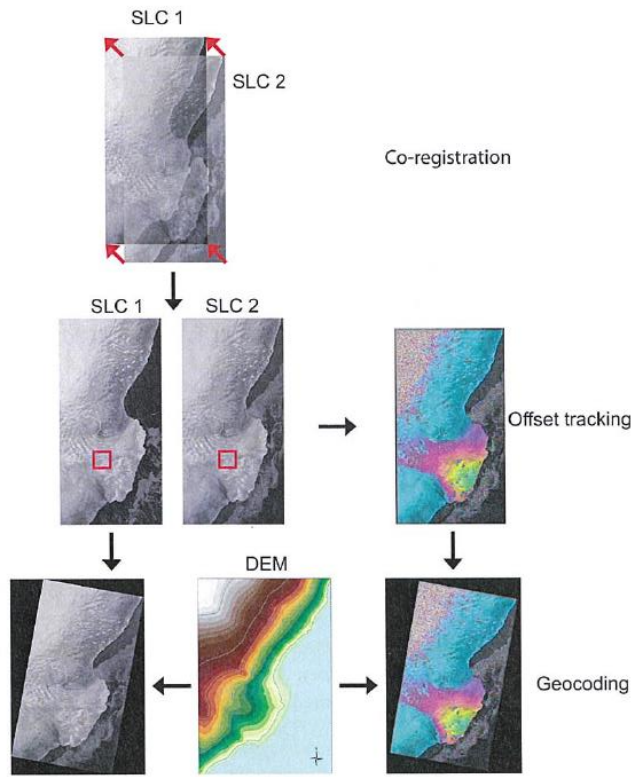

Figure 3-3: GAMMA workflow of offset tracking with a) the coregistration of SLC images, b) offset tracking and c) using a DEM to geocode the SAR intensity image and velocity map (modified from Schellenberger, 2016).

The Copernicus DEMs used are derived from WorldDEM^{TM}, an edited digital surface model from data collecting in the TanDEM-X Mission (Airbus Defence and Space GmbH, 2020). The downloaded products were the DGED GLO-30 products, which have a latitude grid spacing of 1 arc second (Airbus Defence and Space GmbH, 2020). The longitude grid spacing varies depending on the latitude of interest (Airbus Defence and Space GmbH, 2020). Between 50-60°, there is a longitude grid spacing of 1.5 arc seconds, and between 60-70°, the grid spacing is 2 arc seconds (Airbus Defence and Space GmbH, 2020). Hubbard Glacier is mainly above 60° N, although its most southern tip falls below this.

3.1.3 *SAR Datasets*

Measurements of ice motion are determined using the offset tracking approach outlined above from data collected by multiple SAR satellites (Table 3-2), including TerraSAR-X/TanDEM-X (provided by German Aerospace DLR), RADARSAT-2 (provided by Brittany Main), and RADARSAT Constellation Mission (provided by Natural Resources Canada).

Table 3-2: SAR data used in this work, including RADARSAT-2 (Main et al., 2022), RADARSAT Constellation Mission (Government of Canada, 2021a), and TerraSAR-X (Airbus Defence and Space, 2015).

Sensor	Beam Mode	Band	Polarization	Resolution of detected products	Orbital Repeat Pass Period (Days)
RADARSAT-2	Ultrafine	C-band	HH	3 m x 3 m for Ultrafine	24
RADARSAT Constellation Mission	High Resolution 5 m	C-band	HH	5 m x 5 m	4
TerraSAR-X	StripMap	X-band	HH	9 m x 9 m	11

RADARSAT-2 is a C-band satellite that was launched on 14 December 2007 and is still active to date (Government of Canada, 2021a). R2 is owned by MacDonald, Dettwiler and Associates Ltd. (MDA) (Government of Canada, 2021a). This satellite is at an altitude of 798 km and completes its orbit in 100.7 minutes (Government of Canada, 2021a). The polarizations of R2 available are HH, VV, HV, and VH (Government of Canada, 2021a). R2 images in multiple beam modes dependent on polarization type, with the selective single polarization (transmit H or V, receive H or V) including spotlight, ultra-fine, wide ultra-fine, extra-fine, multi-look fine, wide multi-look fine, and ship detection (Government of Canada, 2021a). In this study, ultra-fine beam mode and HH polarization in either 24- or 48-day spacings are used.

On 12 June 2019, RCM was launched, consisting of three satellites completely identical to each other (Government of Canada, 2021a; Government of Canada, 2020). These C-band satellites are owned by the Government of Canada and are still currently active (Government of Canada, 2021a). The altitude of RCM ranges from 586-615 km and completes an orbit in 96.4 minutes (Government of Canada, 2021a). The available beam modes of RCM include low resolution 100 m, medium resolution 50 m, medium resolution 30 m, medium resolution 16 m, high resolution 5 m, very high resolution 3 m, low noise, ship detection, spotlight, and quad-polarization (Government of Canada, 2021a). RCM also images in multiple polarizations (HH, VV, HV, VH, compact polarimetry) (Government of Canada, 2021a). Here, the high resolution 5 m beam mode is used with the HH polarization.

In June 2007, the German X-band SAR satellite TSX was launched (Airbus Defence and Space, 2015). TanDEM-X (TDX) was launched in June 2010 and is nearly identical to TSX, with TSX and TDX operating closely together (Airbus Defence and Space, 2015). While working together, these satellites are able to acquire data for the global WorldDEM Digital Elevation Model (Airbus Defence and Space, 2015). TSX has an 11 day repeat pass and an altitude of 514 km at the equator (Airbus Defence and Space, 2015). There are multiple imaging modes possible for TSX, including standard TerraSAR-X operational mode, SpotLight, StripMap, and ScanSAR (Airbus Defence and Space, 2015). Single and dual polarization are most common for these imaging modes, but quadruple polarization is available on some imaging modes (Airbus Defence and Space, 2015). In this study, TSX/TDX data with HH polarization and Stripmap beam mode was used.

3.1.4 Offset Tracking Velocity Errors

To determine if real change has occurred between two velocity products, the velocity difference must be bigger than the sum of the errors of the products. Errors in offset tracking products are often from images chips being misregistered, with high coherence needed for a high accuracy (Van Wychen et al., 2012). The loss of coherence can be caused by changing surface features, such snowfall and melt, which can lead to a lower accuracy (Van Wychen et al., 2012). To determine the error of offset tracking method, a common method used is to determine the value of displacements over bedrock, which are stable ground and should have no displacement (Schellenberger et al., 2016). The highest accuracy and best coregistration of this method would result in the smallest displacement over bedrock (Schellenberger et al., 2016).

To bound uncertainty in this study values from previous studies that have investigated uncertainty margins from the different satellites are utilized in this thesis (summarized in Table 3-3). TSX imagery has a 6 m/yr uncertainty in surface velocity determined through offset tracking in GAMMA RS (Samo, 2022), offset tracking of RCM data has an error of 7.8 m/yr (Van Wychen et al., 2022), and speckle tracking of R2 imagery showed an uncertainty of ~8.7 m/yr (Van Wychen et al., 2016). The speckle tracking of R2 imagery was done using a MATLAB algorithm, however, the MATLAB script (GRAY method) and offset tracking in GAMMA Remote Sensing Software provide comparable results (Schellenberger et al., 2016). Due to the fast velocities of Hubbard and Valerie glaciers (discussed in Section 4.4.1), the velocity errors are negligible due to the variation in glacier motion exceeding the error bounds. For all the uncertainties listed here, the general error for velocity maps created in GAMMA is expected to be under 9 m/yr.

Table 3-3: Errors of TSX (Samo, 2022), RCM (Van Wychen et al., 2022) and R2 (Van Wychen et al., 2016) used in offset tracking.

SAR Sensor	Error
TSX	6 m/yr
RCM	7.8 m/yr
R2	~8.7 m/yr

3.1.5 ITS_LIVE Velocity Products

Pre-derived glacier velocity products were retrieved from the Jet Propulsion Laboratory of NASA's Inter-Mission Time Series of Land Ice Velocity and Elevation (ITS_LIVE) online portal (https://nsidc.org/apps/itslive/). This program provides global data on the surface velocity and elevation change of glaciers and ice sheets (Gardner et al., 2019a). Velocity products are created by a method of offset tracking; autonomous Repeat Image Feature Tracking (auto-RIFT) of Landsat 4, 5, 7, and 8, Sentinel-1 and Sentinel-2 data (Gardner et al., 2019a), with Gardner et al. (2018) providing full documentation on the feature tracking methodologies used for this dataset. Before auto-RIFT, pre-processing was done to normalize image radiance that results locally from shadows, topography, and sun angles (done through applying a 5 by 5 Wallis operator) (Gardner et al., 2018). After pre-processing, matching features between image pairs are searched for using normalized cross correlation (NCC) and finding a local NCC maxima at a specified search distance (Gardner et al., 2018). A sparse NCC search (1/16 of full search) is followed by a dense search, with the template size not allowing overlap of adjacent template search chips (Gardner et al., 2018). A dense search is guided by the mean and standard deviations of the x and y displacements, and pixel template chips being either 16 x 16 or 32 x 32 (chosen based on the expected surface velocity gradients) (Gardner et al., 2018). If the velocity is unable to be resolved at these pixel template chips sizes, those areas will use increasing template chip sizes (32, 64 and 128), although this deteriorates the spatial resolution (Gardner et al., 2018).

To find successful matches a novel approach was used; a normalized displacement coherence (NDC) filter (Gardner et al., 2018). There is an acceptance criterion (iterated 3 times) where if there are 7 or more values in a 5 x 5 pixel centered window that are within one-quarter of the x and y search displacement components, the normalized displacements are accepted (Gardner et al., 2018). A final iterative filter is used twice that accepts values within 4 times the 5 x 5 window mean absolute deviation (Gardner et al., 2018). Spatially coherent errors that cause match blunders are removed in the merging process, combining information from all of the image pairs (Gardner et al., 2018). Other errors can arise from scale distortions from the Antarctic Polar Stereographic projection used, image geometry causing geolocation errors (~15 m), and match blunders that require post-processing (Gardner et al., 2018). The image pair velocities have pixel sizes of 120 x 120 m, while the annual velocity mosaics have a pixel size of 240 x 240 m.

For the analysis of Hubbard Glacier, image-pair velocities of Alaska and Western North America were downloaded with a time separation between images being >7 and <30 days to allow for a sub-monthly temporal resolution to be analyzed from July 2013 to April 2022. The density of velocity products increased throughout the study period as a result of new sensors being launched, such as Sentinel-1A launching in April 2014, Sentinel-2A in June 2015, Sentinel-1B in April 2016, and Sentinel-2B in March 2017 (European Space Agency, 2021; European Space Agency 2020). The image-pairs downloaded provided data from Sentinel-1, Sentinel-2, and Landsat-8. These image pairs were imported into ArcMap and manual filtering was done to remove velocity maps that had poor coverage and did not cover the majority of Hubbard Glacier's lowermost terminus.

Valerie Glacier image-pair data was downloaded from the ITS_LIVE widget (https://itslive-dashboard.labs.nsidc.org/). Two points were selected, with the 'near confluence' point located at latitude 60.0758, longitude -139.4337, while the 'up-glacier' point is located at latitude 60.1018, longitude -139.4687. Data was downloaded in a CSV file and filtered using MS Excel by selecting a time separation between 7-30 days and separated based on the satellite used to obtain the data.

In addition to pre-derived image-pair velocities, ITS_LIVE also provides annual velocity mosaics for the major glaciated regions of the world. These use imagery from the Landsat 4, 5, 7, and 8 sensors (Gardner et al., 2019a). These velocity products were obtained for Alaska and Western North America from 1985-2018 in the GeoTIFF format, used in the analysis of both

Hubbard and Valerie glaciers. The data in this period was not complete, with more scarcity prior the launch of Landsat 8 in 2013 which improved coverage (Gardner et al., 2019b).

Once GeoTIFF files containing velocity information were obtained, they were imported into ArcMap, as described in the following section. Possible errors of the ITS_LIVE velocity data can be in the range of 20-30 m/yr (Gardner et al., 2018).

3.1.6 ArcMap and Further Analysis of Velocity Products

Once GeoTIFF files containing velocity information were obtained, they were imported into ArcMap 10.8.1 for further analysis. The velocity outputs from the GAMMA offset tracking are scaled in meters between the image acquisitions and therefore need to be normalized to m/yr. This is done by applying Equation 3-1 to all SAR derived glacier velocity products using the 'Raster Calculator' tool in ArcMap:

$$\frac{m}{yr} = \left(\frac{velocity\ (m)}{\#\ of\ days\ between\ image\ acquistions}\right)\left(\frac{365.25\ days}{1\ year}\right) \tag{3-1}$$

This step conversion was not necessary for the data obtained from the ITS_LIVE mission as it is provided scaled in m/yr.

3.1.6.1 Glacier Velocity Extraction

To analyze velocity changes, velocity data from all sources (ITS_LIVE data and GAMMA RS data) was extracted using the following method for Hubbard Glacier. A centerline shapefile was created manually for Hubbard Glacier. This was done by creating a polyline shapefile in ArcCatalog 10.8.1, changing the coordinates to WGS 1984 UTM Zone 7N, importing it into ArcMap, using the 'Edit Features' toolbar to create features, and then manually drawing the line. Using the 'Edit Features' toolbar, points were created every 100 m along the centerline using a points file created in ArcCatalog in WGS 1984, and velocity data was extracted from these points using the 'Extract Multi to Point' tool. The data contained in the shapefile was then exported into an Excel file. Along Hubbard Glacier's centerline, three specific points were of interest; 1 km, 5 km, and 10 km from the terminus were used, shown in Figure 4-1. These were chosen to understand how the terminus of Hubbard Glacier is behaving (1 km point) and how this behaviour may change when moving up-glacier.

Velocity data derived in GAMMA RS and annual ITS-LIVE data for Valerie Glacier were extracted at the same two point locations as the ITS_LIVE image-pair data were obtained for, one near the confluence of Valerie and Hubbard glaciers, and one further up glacier (removed from the influence of Hubbard Glacier), also shown in Figure 4-1. These points for Valerie Glacier were made by creating a point shapefile in ArcCatalog in WGS 1984 and importing it into ArcMap. The point files were then edited, using the 'Edit Features' toolbar to create features. When the shapefile of interest was highlighted in the 'Create Features' window, the map was right clicked and 'absolute xy' was selected. The coordinates of interest were entered, before saving the edits. The 'near confluence' point is located at latitude 60.0758, longitude -139.4337, while the 'up glacier' point is located at latitude 60.1018, longitude -139.4687. Data at these two specific points along Valerie Glacier were extracted in the same way using the 'Extract Multi to Point' tool before being exported into an Excel file.

The data that was exported into Excel contains the velocities determined from each image pair. The combined GAMMA RS and ITS_LIVE dataset resulted in Hubbard Glacier's 1 km location having 1,153 velocity data points, Hubbard Glacier's 5 km location having 1,274 velocity data points, Hubbard Glacier's 10 km location having 801 velocity data points, the near confluence location on Valerie Glacier having 1,273 velocity data points, and the up-glacier location having 994 velocity data points (Appendix). In Excel, the middle date (between the reference and the secondary image) was determined through summing the dates and then dividing by 2. The resulting date was used as the x-value for graphing the specific velocity value. After work in Excel was finished, graphing was conducted using MATLAB. To graph the velocity data as a timeseries, a running mean line using k=3 was used to show trends.

3.1.7 Climate Analysis

Climate reanalysis data was used to understand the climate of the region and if temperature fluctuations may be the cause of any velocity variabilities that are found. Reanalysis data was required for this, as there was not any available in situ measurements of Hubbard Glacier. The reanalysis products that were downloaded are NCEP-NCAR reanalysis 1 (Kalnay et al., 1996) provided by NOAA PSL, Boulder, Colorado, USA. Mean daily air temperature at sigma level 995 downloaded for 2013-2022 from https://psl.noaa.gov/data/gridded/data.ncep.reanalysis.html as a representation of surface temperatures and was used to calculate the Positive Degree Day (PDD) sums for each month in the 2013-2022 period (explained further below). The reanalysis surface air temperature products are provided in a 2.5° x 2.5° grid.

A positive degree day (PDD) sum is the sum of temperatures above 0°C during a specific period (Braithwaite, 1995). This can be related to glacier melting, as it is presumed that PDD sums are proportional to the amount of snow/ice melt (Braithwaite, 1995). PDD sums used as melt indices gained popularity in mid-20th century with the availability of mass-balance series (Braithwaite & Hughes, 2022). The use of daily mean temperatures to sum >0°C temperatures is a traditional method of calculating PDD sums (Braithwaite & Hughes, 2022). A custom code was created to determine the number of PDDs for each month in the period that daily mean data was downloaded for. This code involved determining the grid cell closest to Hubbard Glacier through indexing to the glacier's closest latitude (60.0450275) and longitude (-139.3904589), transforming temperature from Kelvin to Celsius, and, if the daily mean surface temperature in that cell was above 0°C, the values for that month were cumulatively summed.

3.1.8 Elevation Change

Pre-derived glacier surface elevation change rate data originally determined and reported by Hugonnet et al. (2021) was used to explore how glacier geometry changed over the last ~two decades. These glacier surface change data were downloaded for the N60W140 tile which provides coverage of Hubbard and Valerie glaciers from Theia Cartographic Layers at 100 m x 100 m resolution in five-year intervals starting in 2000 (2000-2004, 2005-2009, 2010-2014, and 2015-2019) (data openly available: https://www.sedoo.fr/theia-publication-products/?uuid=c428c5b9/df8f-4f86/9b75/e04c778e29b9). The change in glacier surface elevation is determined from openly available satellite and airborne elevation data from 2000-2019. Most of the data comes from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) stereo images but elevation data is also provided from additional sources such as ArcticDEM, Reference Elevation Model of Antarctica (REMA), and TanDEM-X 90 m global DEM (Hugonnet et al., 2021). Data used has an error of less than 0.5 m through using TanDEM-X as the reference for co-registration and bias correction in ice-free regions (Hugonnet et al., 2021). The global elevation changes are not affected by elevation change bias (0.001 ± 0.011 m/yr) caused by regional and seasonal vertical shifts from snow cover differences (Hugonnet et al., 2021). Full documentation and description of how surface elevation products were derived for this dataset is provided by Hugonnet et al. (2021). The obtained elevation change tiles for the 2000-2004, 2005-2009, 2010-2014 and 2015-2019 periods were imported into ArcMap and the data was extracted along Hubbard Glacier's centerline for each epoch using the same method of velocity extraction as detailed in section 3.1.4.1.

3.1.9 Methods Summary

Collectively, the datasets outlined in this chapter allow for the investigation of the dynamic and geometry evolution of Hubbard and Valerie glaciers in support of the research objectives outlined in Section 1.2. A flow chart of the use of the methods described in this chapter is shown in Figure 3-4.

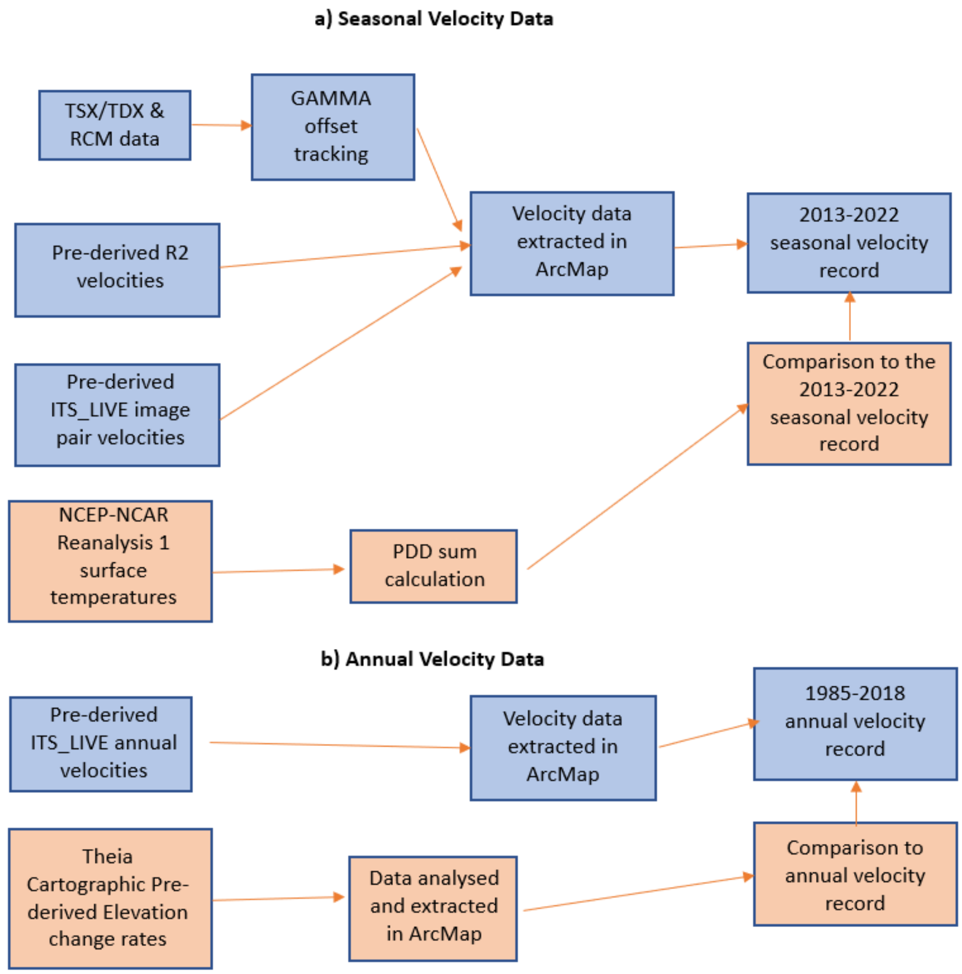

Figure 3-4: Summary of the methods used in this thesis, with the blue boxes representing velocity data and the orange boxes representing potential drivers. a) represents the data used in the creation and analysis of the 2013-2022 seasonal velocity record, while b) represents the data used in the creation and analysis of the annual 1985-2018 velocity record.

Chapter 4: Patterns and drivers of seasonal and long-term velocity variability of Hubbard and Valerie glaciers

Abstract

Hubbard Glacier is a large fast-flowing tidewater terminating glacier in the St. Elias Mountains and is connected at its terminus to Valerie Glacier. Although Hubbard Glacier has been shown to experience large intra-annual velocity changes and have a long-term deceleration, previous studies that have examined seasonality have only been able to do so on a limited timescale without a dense record of motion. In terms of variability of Valerie Glacier, it too has been understudied, with only one study reporting its seasonal behaviour. The goal of this study was to combine ITS_LIVE, RADARSAT-2, RADARSAT Constellation Mission, and TerraSAR-X/TanDEM-X derived velocity data to create the densest record of motion ever constructed for Hubbard and Valerie glaciers from July 2013-April 2022 to explore seasonal velocity variability of both glaciers. ITS_LIVE annual mosaics from 1985-2018 were used to analyze the long-term velocity trend of Hubbard and Valerie glaciers. These records were examined to see if pulses that were previously reported on either glacier can be observed, although it was found that these pulses were unable to be resolved. Elevation and temperature were analyzed as potential drivers for long-term and seasonal velocity changes. Valerie Glacier had a 'typical' seasonal pattern of fast flow in May, with minimum flow sometime between August-November before accelerating again. Hubbard Glacier displayed a unique seasonal pattern that has not been observed previously. It showed two periods of fast motion; one in December-February before velocities dropped slightly between January-April, accelerating towards its second peak around May, then reaching minimum velocities in late August/September. It is inferred that the spring peaks and late summer/fall minimums on both glaciers are due to melt reaching the bed and influencing the subglacial hydrology. The cause of the winter peak and slight velocity drop before the spring peak on Hubbard Glacier has not been determined and should be a topic for future studies, although it is hypothesized to be an internal process. Both glaciers showed a long-term deceleration, although larger changes were seen further up-glacier than near the terminus on Hubbard Glacier and were minimal on Valerie Glacier, and a direct relationship to thinning was not found.

4.1 Introduction

Glacier dynamics in Alaska can vary interannually, however, winter velocities have shown synchronicity throughout the region, which suggests that Alaskan glaciers may have a common mechanism for velocity changes, likely hydrological (Burgess et al., 2013b). For example, fast winter velocities in Alaska occurred at the same time two glaciers within the region surged (Burgess et al., 2013b). Armstrong et al. (2017) studied land terminating glaciers in the Wrangell and St. Elias Ranges in Alaska and suggested that summer speedups were caused by hydraulically-induced enhanced basal motion. Not all glaciers studied had the summer speed up, although the majority that did not were quiescent-stage surge-type glaciers that likely have different coupling mechanisms for meltwater and basal motion (Armstrong et al., 2017).

Hubbard Glacier is known for its very high velocities and is one out of 12 systems in Alaska with velocities higher than 365.25 m/yr over most of its length (Burgess et al., 2013a). These 12 systems are likely operating differently than other fast velocity glaciers outside of Alaska as they maintain high velocities without high rates of mass loss, due to their linkage to high accumulation rates (Burgess et al., 2013a). Not only does it differ from other glaciated regions, but Hubbard Glacier has previously shown behaviour that differs from other glaciers within Alaska and does not show a large response to climate but has flow speeds mostly controlled by geometry (Ritchie et al., 2008; Stearns et al., 2014). There have been a couple observations of pulsing activity for Hubbard Glacier, observed in the spring of 1986 and 1989, and reported by Trabant et al. (1991). However, Hubbard Glacier is not identified as a surging glacier, but is very dynamically active (Clarke & Holdsworth, 2002).

Long-term velocity trends on Hubbard Glacier have previously been difficult to determine because of sparse measurements and large variation in flow speeds seasonally (Stearns et al., 2015). When removing seasonal variability, Hubbard Glacier was found to have a linear deceleration from 1978 to 1997 and decreased from ~2,800 m/yr to ~2,200 m/yr (Trabant et al., 2003). Stearns et al. (2015) found velocities varied seasonally from 1,500 to 5,200 m/yr, while Trabant et al. (2003) also found large seasonal flow changes of up to 730.5 m/yr. Stearns et al. (2015) found the fastest flow over most regions of Hubbard Glacier’s terminus occurred in April/May and slowest flow in October/November, and Trabant et al. (2003) found maximum flow in May/June and minimum in September/November, which is the usual trend of Alaska tidewater glaciers (Stearns et al., 2015).

Most research done on Valerie Glacier (Hubbard Glacier’s tributary glacier) has been related to pulsing activity (in 1986, August 1993-August 1995, and July 2000-September 2002), where velocities reached higher than ~13,150 m/yr in 1986 (Ritchie et al., 2008; Mayo, 1988; Mayo, 1989). Few studies have investigated the seasonal flow patterns of Valerie Glacier, although Trabant et al. (1991) analyzed Valerie Glacier's velocity from ~1986-1989, which had large seasonal variations (flow speeds in this period ranged from ~500 m/yr to ~2,000 m/yr), with no unusual speed up events. Stearns et al. (2015) investigated seasonality at different sections along Hubbard Glacier's terminus and found the region with ice flowing in from Valerie Glacier had a slightly different pattern than other regions of Hubbard Glacier's terminus, with the highest velocities in July/August. A long-term flow pattern of Valerie Glacier was not found to have been reported in previous work.

With more remote sensing data available, velocity trends of Hubbard and Valerie glaciers can now be resolved in a higher temporal resolution than has been analyzed in the past. Given this background, the goals of this work are to utilize a large catalogue of remote sensing data in order to:

1) build a dense record of ice motion for Hubbard and Valerie glaciers that can be used to resolve the seasonality of both glaciers over the last ~decade;
2) create a long-term velocity record of ice motion to determine whether the long-term deceleration of Hubbard Glacier that has been previously reported continues to present day and determine the long-term velocity trend of Valerie Glacier;
3) utilize records of climate data and surface elevation change to explore the seasonal and long-term drivers of ice dynamics at Hubbard and Valerie glaciers.

Collectively, this study contributes to the understanding of how large tidewater glaciers are evolving within Alaska which can help further resolve current dynamic and mass balance conditions within the region and ultimately understand its impact on sea level rise. Not only can this help with our current understanding of ice dynamics, but it can assist in the improvement of surface mass balance projections for mountain glaciers, which are limited due to tidewater glacier dynamics not being resolved or understood well (Burgess et al., 2013a).

4.2 Study Area

Many glacier types exist in a high concentration in the ranges of the St. Elias Mountains, which borders Alaska and Canada (Clarke & Holdsworth, 2002). The St. Elias Icefield acts as both a hydrologic and climatic divide, with Hubbard and Valerie glaciers located in this mountain range

(Figure 4-1; Clarke & Holdsworth, 2002). Globally, Hubbard Glacier is the largest tidewater glacier outside of the poles, with its grounded terminus having a calving front that is 11.4 km in width (Ritchie et al., 2008; Meier & Post, 1987; Trabant et al., 2003). Hubbard Glacier begins on Mount Logan's flank at 5,959 m (Yukon, Canada) and shares névés and divides with other valley glaciers (such as Kaskawulsh and Logan glaciers), then flows >120 km to sea level where it terminates in Disenchantment Bay and Russel Fjord (Yakutat Bay, Alaska) (Ritchie et al., 2008; Stearns et al., 2015; Clarke & Holdsworth, 2002). Valerie Glacier is a tributary glacier of Hubbard Glacier, contributing ice onto the western edge of Hubbard Glacier's terminus (Mayo, 1988; Ritchie et al., 2008). A medial moraine exists between the two glaciers, marking their separation (Ritchie et al., 2008).

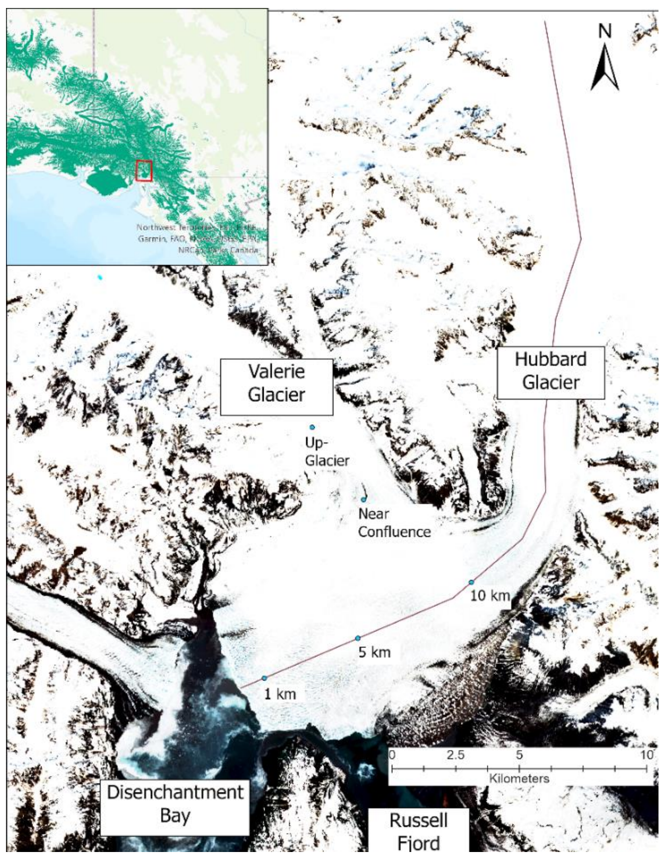

Figure 4-1: Hubbard Glacier and Valerie Glacier (Sentinel-2 imagery from 11/06/2021, in WGS 1984 UTM Zone 7N), with Hubbard Glacier's centerline shown, with locations of data extraction marked at 1 km, 5 km, and 10 km from the terminus. Two points on Valerie Glacier near the confluence of Hubbard Glacier and further up-glacier and the locations of data extraction. Inset: Alaskan glaciated regions (RGI Consortium, 2017) with the red box showing the location of Hubbard Glacier (Esri World Topographic Map, in WGS 1984 Web Mercator).

4.3 Data and Methods

4.3.1 *Velocity Data*

4.3.1.1 ITS_LIVE Data

Pre-derived glacier velocity products for Hubbard and Valerie glaciers were retrieved from NASA MEaSUREs Inter-Mission Time Series of Land Ice Velocity and Elevation (ITS_LIVE) online portal (https://nsidc.org/apps/itslive/). This program provides global data on the surface velocity and elevation change of glaciers and ice sheets from 1985-2018 (Gardner et al., 2019a). Image-pair velocities of Alaska and Western North America are determined using the autonomous Repeat Image Feature Tracking (auto-RIFT) algorithm between repeated acquisitions of Sentinel-1, Sentinel-2, and Landsat 8 satellite imagery with ≤ 60% cloud cover (Gardner et al., 2019b), with Gardner et al. (2018) providing full documentation on the used methods used for this dataset. These products have a pixel resolution of 120 m and velocity products were constrained to a time separation between images of 7-30 days. This allowed for a sub-monthly temporal resolution of the dynamics of both Hubbard and Valerie glaciers to be obtained between July 2013 to April 2022. Data is more scarce towards the beginning of the ITS_LIVE record, with the density of velocity products in the dataset increasing at the end of 2016, as a result of the launch of more sensors that could be used for this work (Gardner et al., 2019b; European Space Agency, 2021; European Space Agency 2020). After importing these velocity maps into ArcMap 10.8.1, manual filtering was completed to remove velocity data that did not cover the majority of Hubbard Glacier's lowermost terminus.

Valerie Glacier data was downloaded from the ITS_LIVE widget from https://itslive-dashboard.labs.nsidc.org/. Two points were selected, with the 'near confluence' point located at latitude 60.0758, longitude -139.4337, while the 'up-glacier' point is located at latitude 60.1018, longitude -139.4687. The 'Export Data' button was selected, and data downloaded in a CSV. In Excel, the data was filtered for those of interest by selecting a time separation of between 7-30 days and separated based on the satellite used to obtain the data.

In addition to the pre-derived image pair velocities, ITS_LIVE also provides annual composite velocity data for the major glaciated regions of the world, produced using the same auto-RIFT method (Gardner et al., 2018). For this study, annual velocity products with a pixel resolution of 240 m from 1985-2018 of Alaska and Western North America was retrieved from the ITS_LIVE portal which were created using Landsat 4, 5, 7 and 8 sensors and were created through error weighted averages if the middle date of the image pairs fell within that calendar year (Gardner et al., 2019a). Error margins for the ITS_LIVE velocity products are in the order of 20-30 m/yr (Gardner et al., 2018), which is relatively negligible when compared to the high flow speeds that have been reported for Valerie and Hubbard Glaciers (Waechter et al., 2015; Van Wychen et al., 2018).

4.3.1.2 GAMMA RS Data

To augment the pre-derived velocity products provided by ITS_LIVE, additional velocity measurements were generated from offset tracking of SAR imagery (TerraSAR-X/TanDEM-X (TSX/TDX), RADASAT-2 (R2), and RADARSAT Constellation Mission datasets (RCM)) using the GAMMA RS software. The GAMMA software reads SLC files and uses a cross correlation algorithm to determine how far the windows of pixels moved between the reference and secondary images (Strozzi et al., 2002). For TSX/TDX and RCM data, a window size of 200 x 200 pixels and a step size of 50 x 50 pixels were used for offset tracking. R2 velocity data was obtained pre-processed with image chip sizes of ~500 x 500 m used in the creation of the velocity maps, as described in Main et al. (2022). For the cross-correlation algorithm to work the input image pairs need to have been acquired in the same image geometry, determined by the repeat pass of the satellite. For this, TSX/TDX image pairs have an 11-day spacing, RCM data has multiples of 4 days, and R2 is multiples of 24 days. Image coherence is an important aspect of whether velocities are able to be well resolved using this method, with the loss of coherence resulting in a lower accuracy (Van Wychen et al., 2012). Coherence can be affected by changing surface features, such as melt and snowfall on the glacier surface (Van Wychen et al., 2012).

Once completed, the GAMMA workflow outputs the calculated displacements in a geocoded GeoTIFF file which are scaled to meters of displacement between the two images. In order to standardize these outputs to the common unit of m/yr of the ITS_LIVE velocity products, these files are imported into a geographic information system (ArcMap 10.8.1) and modified. This is done by applying equation 4-1 to all SAR derived glacier velocity products using the 'Raster Calculator' tool in ArcMap:

$$\frac{m}{year} = \left(\frac{velocity\ (m)}{\#\ of\ days\ between\ image\ acquistions}\right)\left(\frac{365.25\ days}{1\ year}\right) \tag{4-1}$$

4.3.1.3 Glacier Velocity Extraction for Hubbard and Valerie Glaciers

To provide a detailed determination of the seasonality variability of both Hubbard and Valerie glaciers, the velocity data from all sources (ITS_LIVE data and GAMMA RS data was imported into ArcMap 10.8.1 and was analyzed at five locations (three locations on Hubbard Glacier and two locations on Valerie Glacier) from July 2013-April 2022. On Hubbard Glacier, the velocity data was extracted along a manually digitized approximation of the glacier centreline, and analyzed at a distance of at 1 km, 5 km, and 10 km from the terminus (shown in Figure 4-1). Velocity data of Valerie Glacier was extracted at one point near the confluence with Hubbard Glacier and one further up-glacier (shown in Figure 4-1). These points on Valerie Glacier were selected in order to evaluate the velocity fluctuations near the confluence of Valerie Glacier and Hubbard Glacier and at a location further removed from the influence of Hubbard Glacier. The combined velocity dataset resulted in 1,153 velocity samples at Hubbard Glacier's 1 km location, 1,274 velocity samples at Hubbard Glacier's 5 km location and 801 velocity samples at Hubbard Glacier's 10 km location. For Valerie Glacier, 1,273 velocity samples were obtained confluence location and 994 velocity samples at the up-glacier location (dates of images listed in the Appendix).

4.3.2 Climate Analysis

Climate was analyzed using reanalysis data from NCEP-NCAR reanalysis 1 (Kalnay et al., 1996) provided by NOAA PSL, Boulder, Colorado, USA. Mean daily air temperatures at sigma level 995, representing surface temperatures, were downloaded for 2013-2022 from https://psl.noaa.gov/data/gridded/data.ncep.reanalysis.html, and were used to calculate the number of Positive Degree Day (PDD) sums for each month in the 2013-2022 period. The reanalysis surface air temperature products are provided on a 2.5° x 2.5° grid, and the grid cell closest to Hubbard Glacier was used. To calculate PDD sums, the first step transformed the temperature from Kelvin to Celsius, and then if the daily mean surface temperature in that cell was above 0°C, the values for that month were cumulatively summed.

4.3.3 Elevation Change

Pre-derived glacier surface elevation change data originally determined and reported by Hugonnet et al. (2021) was used to explore if glacier geometry has evolved over the last ~two decades. These glacier surface change data were downloaded for the N60W140 tile which provides coverage of Hubbard and Valerie glaciers from Theia Cartographic Layers at 100 m x 100 m resolution in five-year intervals starting in 2000 (2000-2004, 2005-2009, 2010-2014, and 2015-2019) (data openly available: https://www.sedoo.fr/theia-publication-products/?uuid=c428c5b9/df8f-4f86/9b75/e04c778e29b9). Full documentation as well as a description of how the surface elevation products were derived for this dataset is provided by Hugonnet et al. (2021). However, in brief, the change in glacier surface elevation is determined from openly available satellite and airborne elevation data from 2000-2019. Most of the data comes from Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) stereo images, but elevation data is also provided from additional sources such as ArcticDEM, Reference Elevation Model of Antarctica (REMA), and TanDEM-X 90 m global DEM (Hugonnet et al., 2021). Error associated with these products is expected to be <0.5 m by using TanDEM-X as the reference for co-registration and bias correction in ice-free regions (Hugonnet et al. 2021). The obtained elevation change tiles for the 2000-2004, 2005-2009, 2010-2014 and 2015-2019 periods were imported into ArcMap and data were extracted along Hubbard Glacier's centerline (shown in Figure 4-1) for each epoch.

4.4 Results

4.4.1 General Velocity Structure of Hubbard and Valerie Glaciers

Figure 4-2 provides the general velocity structure of Hubbard and Valerie glaciers. With respect to Hubbard Glacier, higher velocities are found close to its terminus where the glacier front meets the ocean. Moving up-glacier from the terminus, glacier velocities decrease reaching a minimum ~5.5 km from the glacier front. After this point, velocities increase again and reach a maximum ~12 km from the glacier front in a location where the glacier is constricted between valley walls and has a relatively steep slope. Although this pattern of ice motion is observed at all times, there is a large amount of temporal variability in glacier motion. For example, at 1 km from Hubbard Glacier's terminus, the velocities ranged seasonally from ~435 m/yr to ~4,300 m/yr, at 5 km from the terminus velocities ranged seasonally from ~230 m/yr to ~2,600 m/yr and at the location 10 km from the terminus velocities ranged seasonally from ~700 m/yr to ~2,500 m/yr. Valerie Glacier experiences faster velocities when moving up-glacier away from its terminus, although with large seasonal variations in its velocity also observed. When approaching Hubbard Glacier, Valerie Glacier had 'near confluence' velocities in the range of ~20 m/yr to ~1,600 m/yr. Further up-glacier, velocities ranged from ~80 m/yr to ~1,700 m/yr. A further description of the seasonality of both glaciers is provided in the following sections.

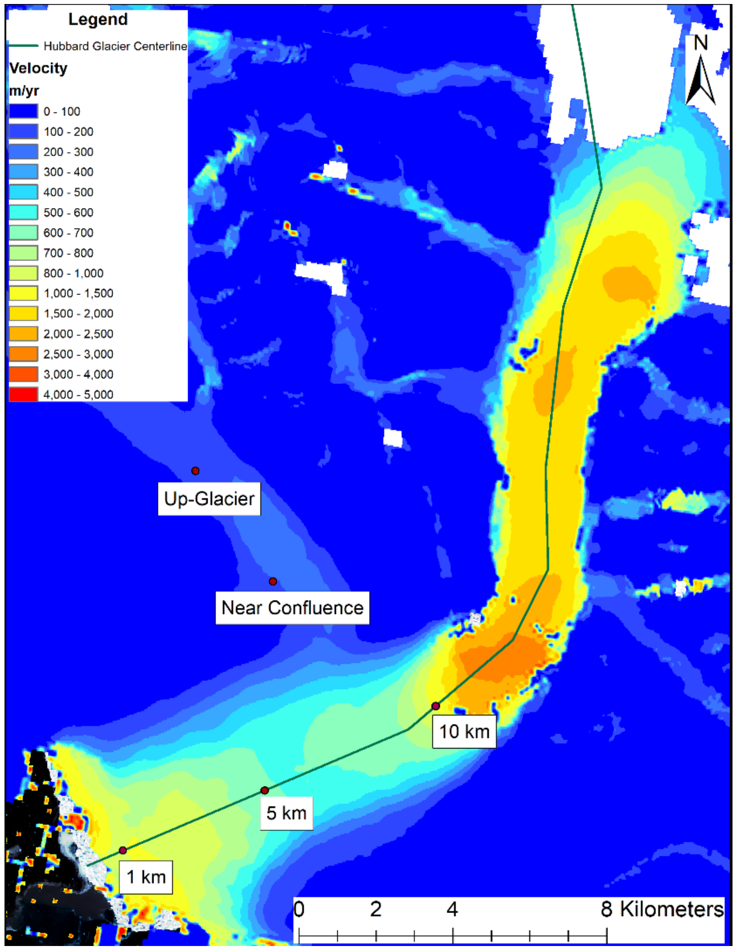

Figure 4-2: Glacier velocities of Hubbard and Valerie glaciers from TSX data on 21/08/2015 to 01/09/2015 (optical imagery: Sentinel-2 imagery from 11/06/2021, in WGS 1984 UTM Zone 7N).

4.4.2 Seasonality of Hubbard and Valerie Glaciers

Figure 4-3 a-e, presents the velocity structure of Hubbard and Valerie glaciers from July 2013 to May 2022 from the extracted remote sensing derived displacement maps at 5 distinct locations (identified with teal dots on Figure 4-1). Seasonality of glacier motion is much more detailed after 2016 due to the wider availability of glacier velocity maps after this time, and 2022 data does not cover the full year. As such, the description and quantification of seasonality that follow focuses on the time period of January 2017 to January 2022.

Seasonally, at all three locations on Hubbard Glacier, two velocity peaks and two velocity drops were observed each year (Figure 4-3 a-c). This velocity pattern was most evident at the location 1 km from the terminus, with the same pattern, albeit with a much smaller amplitude, also observed at the 5 km and 10 km points. Therefore, this discussion is focused on the 1 km point. At this location, one velocity peak occurred in the winter months (varying between December and

February in different years) before velocities dropped slightly and reach a minimum between the end of January-April (again, varying between years). At 1 km from the terminus, Hubbard Glacier's velocity exceeded ~4,800 m/yr at its maximum during this winter peak (January 2020) and reached lower than ~1,800 m/yr when it drops after the peak (March 2021). The drop between this peak and following minimum was generally less than ~1,800 m/yr, although velocities dropped as much as ~3,000 m/yr from January-April 2020. Velocities increased after this minimum to a second velocity peak that occurred in the spring/summer (most commonly in May, with fast velocities also often seen in April/June), where velocities at 1 km from the terminus reached higher than ~3,500 m/yr at its maximum (May 2019). After this spring/summer peak, velocities dramatically decreased, with this drop often larger than what occurred after the winter velocity peak, to reach minimum velocities in the late summer/fall (August/September). These were the slowest velocities of the year, reaching as low as ~370 m/yr at 1 km from the terminus (September 2018). This drop in velocity was always larger than 2,000 m/yr and reached higher than ~3,000 m/yr in 2018.

Although the spring/summer velocities reach a peak, often the fastest velocities of the year were during the wintertime peak, with this pattern most obvious in the lowermost terminus region. For example, at 1 km from the glacier's terminus, the fastest velocities of the year occurred in winter in 2017 (velocity peak in December), 2019 (peak velocities in December), 2020 (peak velocities in January), and 2021 (peak velocities in December).

Unlike Hubbard Glacier, Valerie Glacier (Figure 4-3 d, e) only experienced one seasonal velocity peak and velocity drop each year. The velocity peak occured in spring (generally in May) after a gradual acceleration from the winter until this peak. Velocities were observed to reach higher than ~1,600 m/yr at the near confluence point and ~1,760 m/yr at the up-glacier point. Following this peak, velocities decrease rapidly until dropping to its minimum velocities, then plateauing at this low flow speed in late the fall, with velocities as low as ~20 m/yr at the near confluence point (minimum velocities varying between September-November) and ~81 m/yr at the up-glacier point (August/September). After the minimum velocities, flow speeds gradually increase until the spring peak was reached again. This pattern was consistent in all years analyzed.

4.4.3 Positive Degree Days and Climate Analysis

Figure 4-3 f shows the PDD sums from 2013-2022, with this analysis also focusing on January 2017-December 2021 to allow for a direct comparison to seasonal velocity trends. The general PDD sum seasonal cycle is described here, although some years may have differences in the timing of increases and decreases of values. Generally, January-March had minimal PDD sums (<10°C), with March/April PDD sums increasing but still small (<25°C), coinciding with increasing velocities on Hubbard and Valerie Glaciers until their peak velocities around May. After April, PDD sums continued to increase until the maximum was reached in July/August (maximum values in July 2019 reaching ~370°C), with minimum velocities following close after these maximum PDD sum values are reached (August/September for Hubbard Glacier, August-November for Valerie Glacier). After the maximum PDD sums are reached, values begin to decrease but are still relatively high until September/October (>100°C). Following this until the end of the year, values keep decreasing and become minimal again around November/December (<6°C, although maximum December PDD sum of ~17°C occurred in 2017).

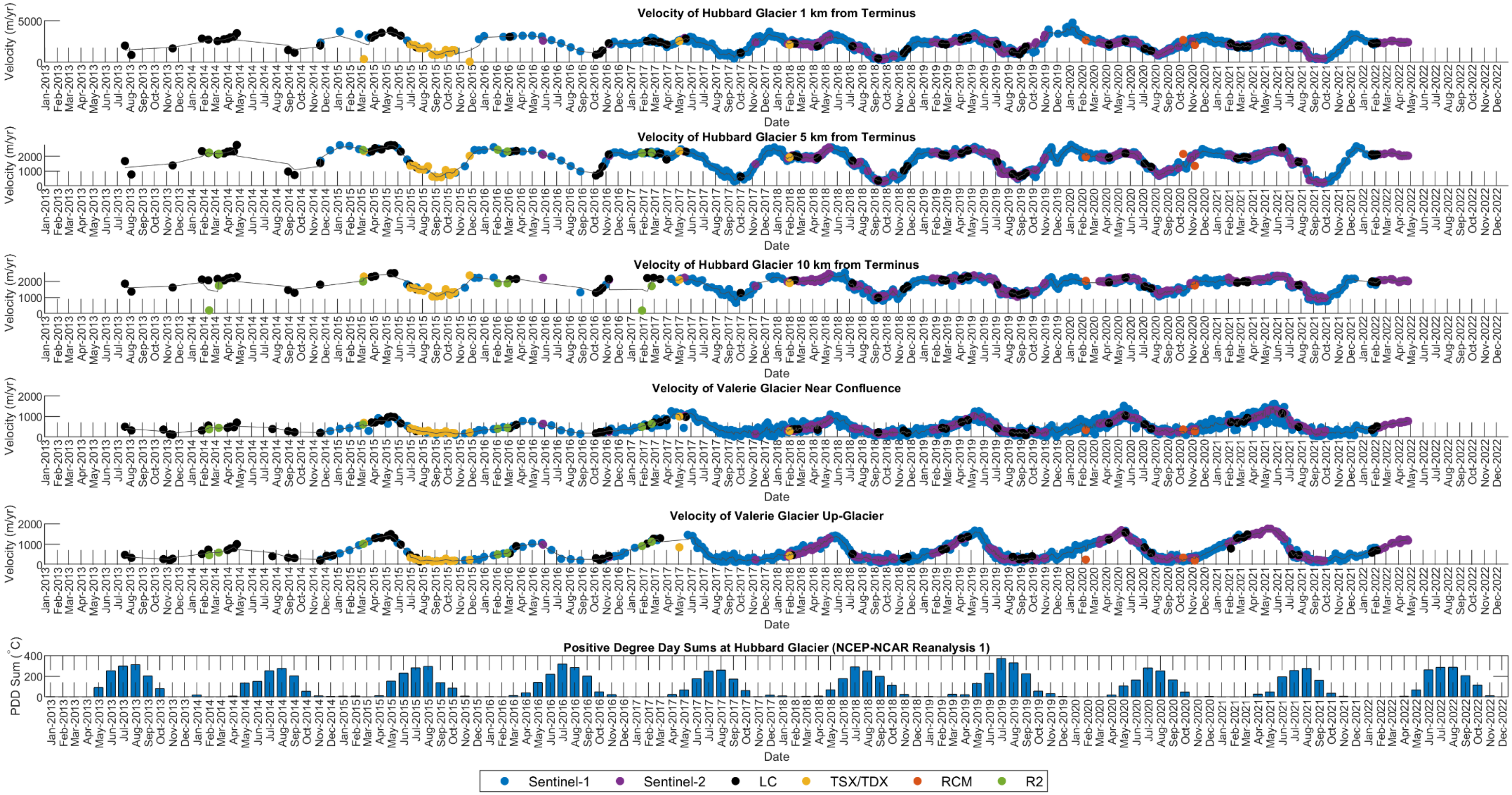

Figure 4-3: Velocity of Hubbard Glacier at 1 km (a), 5 km (b) and 10 km (c) from its terminus. The velocity of Valerie Glacier is shown near the confluence point with Hubbard Glacier (d) and further up-glacier (e). To graph the velocity data as a timeseries, a running mean line using k=3 was used. The PDD sums (f) are shown. LC is Landsat, TSX/TDX is TerraSAR-X/TanDEM-X, RCM is RADARSAT Constellation Mission, and R2 is RADARSAT-2. RADARSAT Constellation Mission Imagery © Government of Canada (2020), RADARSAT is an official mark of the Canadian Space Agency.

4.4.4 Long-term velocity trends of Hubbard and Valerie Glaciers

The long-term velocity trend of Hubbard Glacier is shown in Figure 4-4. At 5 km, and 10 km from the terminus, a deceleration is observed from 1985-2018 while a very slight deceleration trend is observed from 1989-2018 at the 1 km location. The largest deceleration is seen at 5 km from the terminus (linear line of best fit slope of ~-24), followed by 10 km from the terminus (linear line of best fit slope of ~-19), and the smallest and very minor deceleration was at 1 km from the terminus (linear line of best fit slope of ~-0.7). The 1 km location had a pattern that was different from the other points, with a larger amplitude of speed up and slow downs, although those tended to cancel each other out and resulted in the minimal deceleration.

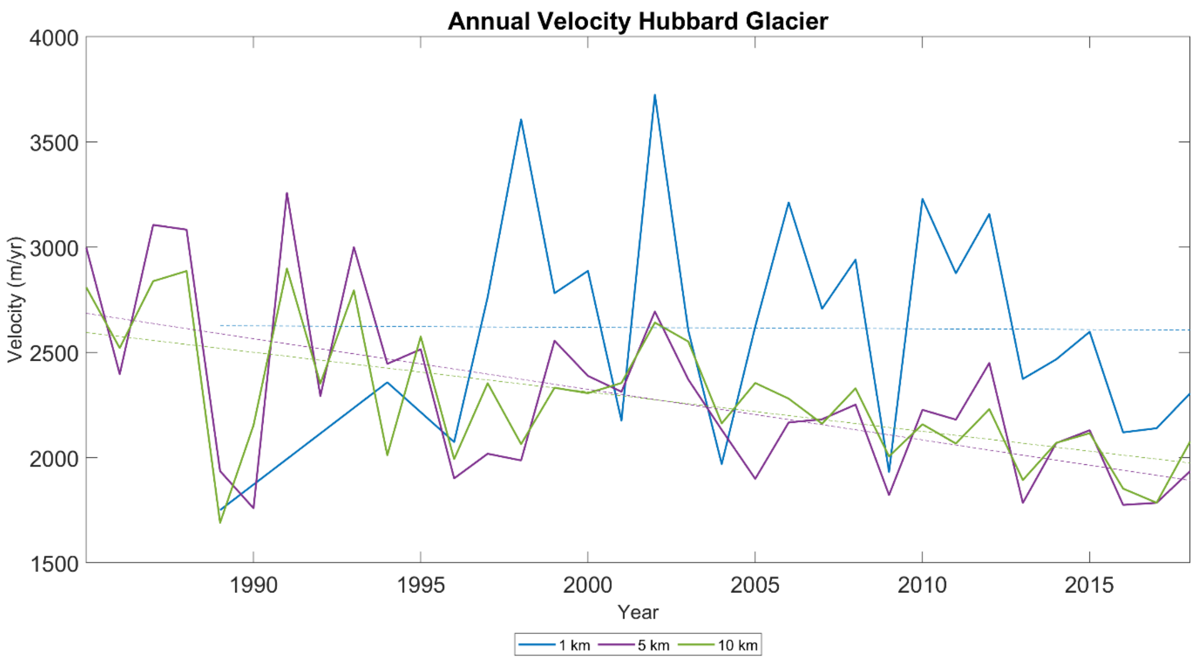

Figure 4-4: Annual Velocity of Hubbard Glacier from 1985-2018 at 1 km, 5 km, and 10 km from the terminus. The dashed line represents the linear line of best fit.

The long-term velocity trend of Valerie Glacier is also one of deceleration (Figure 4-5). Although it was decelerating from 1985-2018, both near the confluence and further up-glacier, the deceleration was minor. This is seen in the linear line of best fit slope being ~-4.6 at the near confluence point, and ~-1.7 at the up-glacier point.

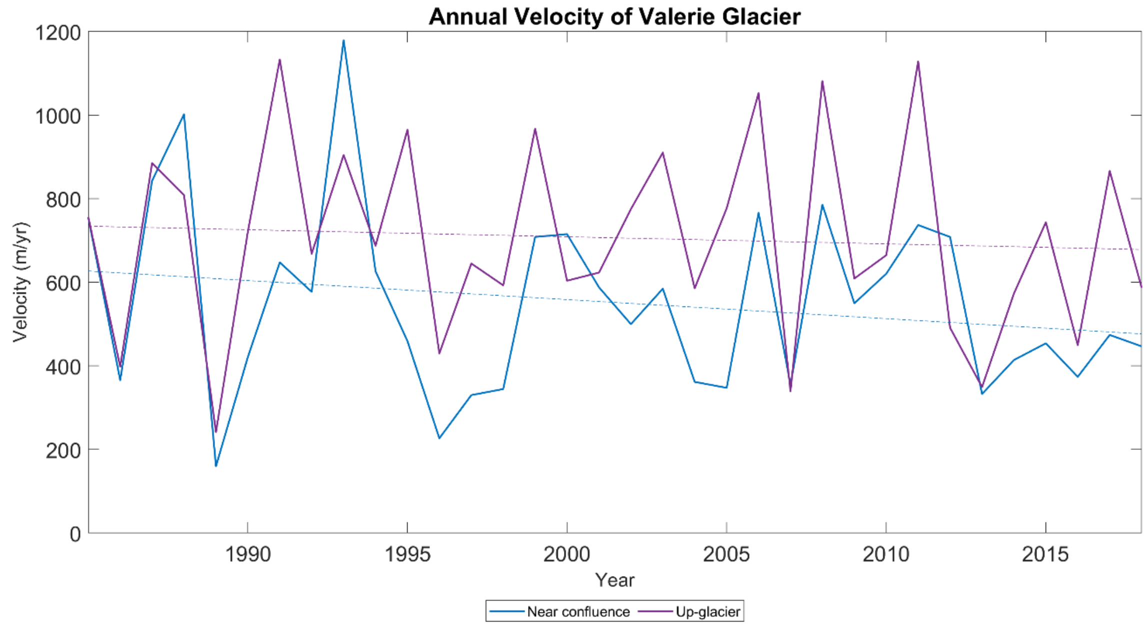

Figure 4-5: Annual Velocity of Valerie Glacier from 1985-2018 at one point near its terminus, and one point further up-glacier, with the dashed lines representing the linear line of best fit.

4.4.5 Elevation Changes

Over Hubbard Glacier, there were some regions near the terminus and on the southeastern edge of the glacier that were thickening throughout each 5-year epoch from 2000-2019 (Figure 4-6). From 2000-2004, the thickening in the southeastern edge of Hubbard Glacier generally ranged from ~2-7 m/yr. In this time period, on the edge of Hubbard Glacier's terminus, most thickening was in the range of ~5-10 m/yr, although it was observed to exceed ~12 m/yr. From 2005-2009, the thickening around the glacier's southeastern edge began decreasing from the previous epoch, with most thickening around ~2-5.5 m/yr. There was a smaller spatial distribution of thickening of the terminus during this time, with most values in the range of ~5-8 m/yr, although values ~10 m/yr were observed. 2010-2014 continued the trend of decreasing thickening over Hubbard Glacier, with less spread of thickening across its southeastern side, although the southeastern edge thickening was still mostly in the range of ~2-5.5 m/yr. In this time, most thickening on the terminus was around ~4-7 m/yr, although the terminus thickening was observed to exceed ~8.3 m/yr. 2015-2019 showed the least thickening of all the epochs. The southeastern edge of the glacier generally had thickening in the range of ~0.2-3 m/yr. The edge of Hubbard Glacier's terminus had most thickening values in the range of ~2-7 m/yr, although the maximum thickening exceeded ~12 m/yr.

The elevation change along the first 10 km of Hubbard Glacier's centerline (Figure 4-7) shows within ~0.5-0.6 km of the terminus over all years (2000-2019), thickening occurred, although this value decreased over each epoch. From 2000-2004, this maximum was ~8.6 m/yr, decreased to ~7.6 m/yr from 2005-2009, ~6.3 m/yr from 2010-2014, and ~4 m/yr from 2015-2019. After ~2.5 km from the terminus from 2000-2004, and after ~4 km from the terminus from 2005-2009, the centerline values were all above zero (representing thickening). However, after 2010, there is a general trend of thinning along the centerline, with the majority of centerline values from 2010-2014 after ~1.5 km from the terminus and 2015-2019 values after ~2.5 km from the terminus being below zero (representing thinning).

Much of the region of confluence between Valerie Glacier and Hubbard Glacier until the terminus was thickening from 2000-2004 and 2005-2009 (Figure 4-6). In each epoch throughout the whole period of 2000-2019, the thickening of Valerie Glacier within its lower region has been decreasing, and there were increased areas of thinning. At the near confluence point (as indicated on Figure 4-1), the rate of thinning increased in each epoch. The rate of thinning from 2000-2004 was ~0.08 m/yr, 2005-2009 was ~0.3 m/yr, 2010-2014 was ~0.4 m/yr and 2015-2019 was ~0.7 m/yr. At the up-glacier location of Valerie Glacier (also indicated on Figure 4-1), from 2000-2014, thickening occurred (at a decreasing rate from each consecutive epoch), with thinning from 2015-2019. From 2000-2004, the rate of thickening was ~0.5 m/yr, in 2005-2009 it was ~0.2 m/yr, and from 2010-2014 it was ~0.07 m/yr. The thinning from 2015-2019 occurred at a rate of ~0.15 m/yr.

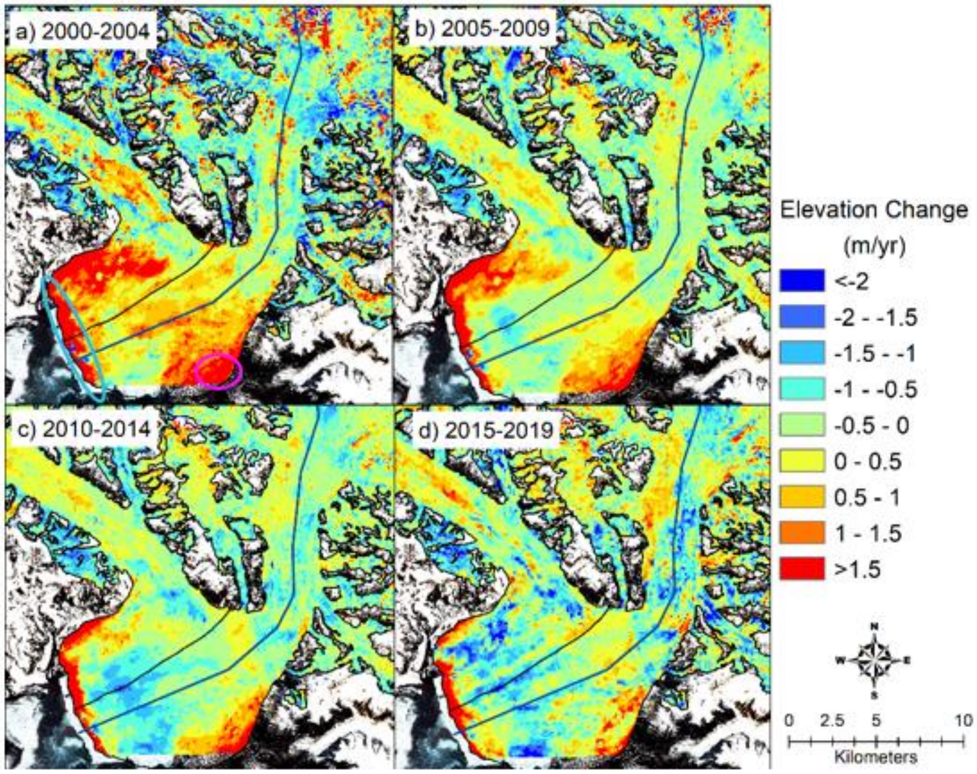

Figure 4-6: Elevation Changes of Hubbard and Valerie Glaciers in five-year intervals from 2000-2020 from Theia Cartographic Layers clipped to the RGI extent of Hubbard and Valerie glaciers (black outline), with Hubbard Glacier's centerline shown in blue (RGI Consortium, 2017). The pink circle in a) represents the southeastern corner, while the blue circle in a) represents the terminus edge, which have both shown to have a general trend of thickening from 2000-2019.

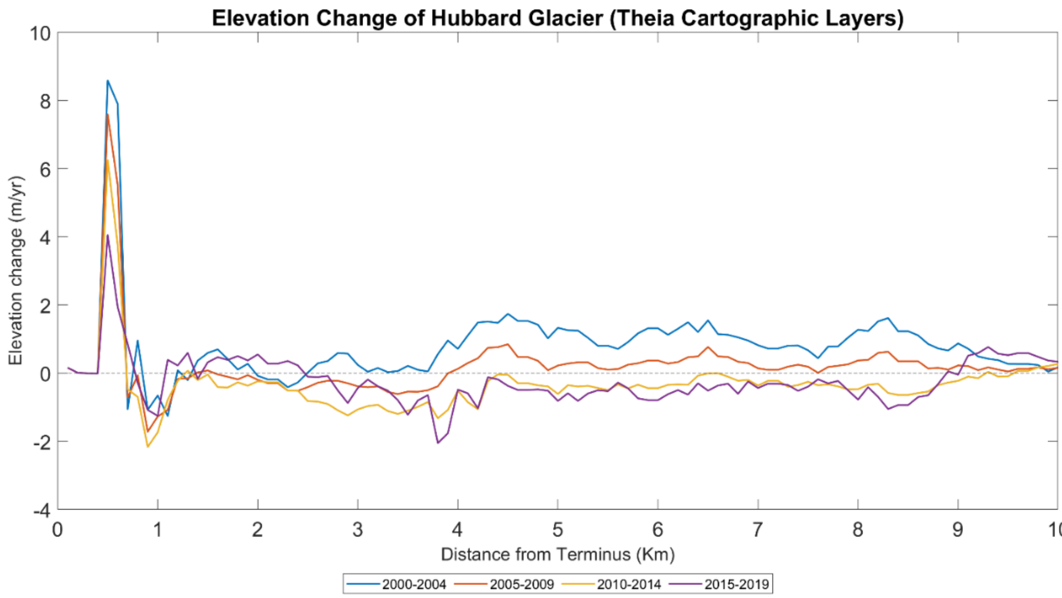

Figure 4-7: Elevation changes along Hubbard Glacier's centerline from 2000-2020 in five-year intervals.

4.5 Discussion

4.5.1 Seasonality of Hubbard Glacier

Figure 4-8 displays a summary of the seasonal patterns Hubbard Glacier experienced, including its subglacial hydrology, ice motion, and melt, which are described throughout the following sections.

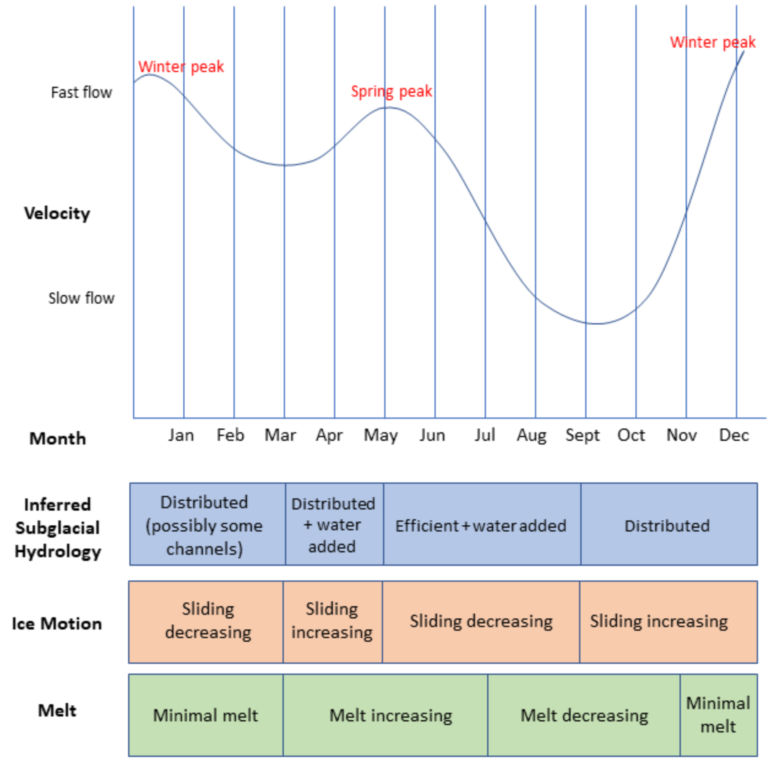

Figure 4-8: Summary of Hubbard Glacier's seasonal patterns. The velocity figure shows the fast winter and spring peaks, and the minimums after each peak. The subglacial hydrology is described as distributed or efficient, ice motion describes if sliding of the glacier on its bed is increasing or decreasing, and melt describes how much melt was observed from the PDD sums.

The late-spring/early-summer velocity speed up on Hubbard Glacier follows the expected velocity response of a glacier to inputs of melt water into an inefficient subglacial drainage network (Willis, 1995; Nienow et al., 1998). For example, each year Hubbard Glacier's velocities increased until a velocity peak was observed in May (Figure 4-3 a-c & Figure 4-8) which coincides with the increasing monthly PDD sums throughout the spring/summer (Figure 4-3 f). This suggests that early in the melt season, identified as the period from April–May each year (Figure 4-3 f), when PDD sums were increasing from month-to-month, the melt that was being generated was being transmitted to the glacier bed and into an inefficient sub-glacial drainage network. This led to increased glacier velocities (Figure 4-3 a-c & Figure 4-8) as the glacier can slide more easily over a well lubricated bed (hard-bedded) or have more bed deformation (soft-bedded) (Willis, 1995).

The velocities of Hubbard Glacier decelerate each year after the May peak and reached the lowest velocities of the year in August/September (Figure 4-3 a-c) over a period of time when monthly PDD were diminishing from their peak in July/August until December (Figure 4-3 f).

This evolution in dynamic response to air temperatures and, by proxy surface melt, is likely explained by a switch to an efficient glacial drainage system that is able to quickly move surface meltwater through the englacial and subglacial drainage networks (Figure 4-8). This leads to less lubrication between the glacier and its bed, thereby increasing friction or decreasing till deformation, and causing flow speeds to decrease (Willis, 1995). This hypothesis is supported by the findings of Ritchie et al. (2008) who examined imagery and found that 50% of summers had embayments located on the terminus at Disenchantment Bay. These were likely caused by increased calving at the terminus front as a result of increased subglacial drainage, where from the summer to the fall, the openings were seen, but were closed during the winter (Ritchie et al., 2008).

Each year, the flow speeds of Hubbard Glacier rebounded relatively quickly (from November to December) after the annual velocity minimum was observed in August/September (Figure 4-3 a-c). To account for this behaviour, it is argued that the overall fast movement of Hubbard Glacier may quickly cause ice deformation and destruction of the efficient subglacial channels that were developed during the summer, causing the distributed sub-glacier system to rapidly reform again (Nienow et al., 1998). The only way for efficient channels to enlarge or be maintained is if the amount of surface meltwater reaches the bed in appreciable quantities (Willis, 1995). Although PDD sums were greater than zero over this period, albeit diminishing from month to month after July/August each year (Figure 4-3 f), it is unlikely the amount of melt that was generated was sufficient to maintain this efficient subglacial drainage network.

An interesting aspect of Hubbard Glacier is the relatively high flow speeds that were reached during the winter season (peak velocities varying between December-February each year; Figure 4-3 a-c & Figure 4-8). From a purely remote sensing-based approach it is difficult to determine the exact cause of the high winter velocities, but a few theories are presented here. It is unknown if Hubbard Glacier has a hard or soft bed, however, if a hard bed exists, the cause of the winter speedup may be due to trapped water existing at high pressures in the subglacial channels (linked-cavity systems), which decreases friction at the bed and allows sliding to occur throughout the winter (Willis, 1995). If Hubbard glacier is soft-bedded, fast winter velocities may be facilitated from bed deformation because of water trapped within till or from till failure by liquefaction (Willis, 1995). An example of a glacier that showed slower summer velocities than annual speeds is Hintereisferner, although it had little to no meltwater reaching the bed to affect the subglacial drainage (Blümcke & Finsterwalder, 1905; Willis, 1995). Therefore, the winter velocities were likely the result of increased ice deformation and/or basal motion through enhanced basal deformation and regelation as a result of accumulation of snow increasing glacier thickness (Blümcke & Finsterwalder, 1905; Willis, 1995). The high winter velocities of Hubbard Glacier were consistent in all years in this study, but this pattern was not found on Valerie Glacier (Figure 4-3 d-e), meaning that the process that was causing high flow rates for Hubbard Glacier at this time is likely internal to Hubbard Glacier. For example, if the process was being driven solely by climate conditions, a similar winter velocity peak for Valerie Glacier would also be expected. This is supported by the hypothesis of Enderlin et al. (2018) stating that seasonal changes in flow speeds and basal drag are controlled through a glacier's geometry which has a connection to its subglacial hydrology. However, the study by Enderlin et al. (2018) was focusing on geometry of retreating tidewater glaciers, although it is possible this also applies to advancing tidewater glaciers due to the evidence shown in this study (Enderlin et al., 2018).

After the velocity peak between December-February on Hubbard Glacier, the velocities dropped slightly to reach a low point between the end of January and April. This is unexpected behaviour and the exact cause of this was not determined from a remote sensing focus. However, we hypothesize that although the subglacial hydrologic network was distributed, it may have had a minor re-organization where water found preferential paths to create some channels, which lead to the drop in velocity. These channels may get destroyed quickly due to the relatively fast flow speeds and change back to the fully distributed network, leading to the increasing velocities until the spring peak.

It is important to note that the seasonal variations on Hubbard Glacier diminish when moving up-glacier, meaning this process may be linked to ocean processes at the calving front. It is also possible that the increased velocity variability further down-glacier may be caused by pressure variations from variations in surface water input (Willis, 1995). These pressure variations can be the result of higher melt rates in the lower ablation area, having thinner snowpacks further downglacier (this decreases the attenuating influence), and an increased chance of the creation of an efficient englacial hydrologic system down-glacier (Willis, 1995). However, this efficient system was stated to be from lower ice-deformation rates in the down-glacier region, which was not observed on Hubbard Glacier (Willis, 1995). The water pressure down-glacier is more probable to be a higher percentage of the ice overburden pressure compared to regions further up-glacier (Willis, 1995).

4.5.2 Comparison of Hubbard Glacier's Seasonal Flow with Previous Studies

The large degree of velocity data provided in this study has provided a significant improvement on the understanding of the seasonality of flow of Hubbard Glacier over previous studies. For example, Stearns et al. (2015) found that the general seasonal pattern of Hubbard Glacier was one of maximum velocities occurring in April/May and minimum velocities in October/November for most regions along its terminus. Similarly, Trabant et al. (2003) found fastest flow in May/June and slowest in September/November, which conforms with the spring peak and fall drop presented here. However, neither of those works described the fast overall motion during the winter months that is reported here. The differences in the seasonal pattern may arise from our study using data with a higher temporal resolution, as the velocity data used in Stearns et al. (2015) may be averaging out the winter velocity peak due to their winter velocities being determined through averaging fall to spring data. As well, Trabant et al. (2003) analyzed two different velocity datasets, one of a fixed location consisting of 22 image pairs, and one set on a moving location with 11 velocity measurements. Through the limited amount of speed measurements, this pattern may not have been captured in the Trabant et al. (2003) study. The amount of data used in this study was not available until synthetic aperture radar become popular and an increased number of sensors were launched, allowing this study to characterize seasonality on Hubbard and Valerie glaciers in a way that was not possible in the past.

Moon et al. (2014) provided one of the largest characterizations of seasonal patterns of ice motion using records of tidewater glacier motion from Greenland. Here, we use the schemes identified in that paper to further investigate the drivers of flow variations for Hubbard Glacier. Hubbard Glacier's seasonal flow (Figure 4-9) does not fit exactly into any of the behaviours identified by Moon et al. (2014) but appears most similar to the "Type 3" behaviour, albeit with some differences. Type 3 behaviour is characterized by maximum velocities in the spring/summer, slowing velocities over the summer, leading to minimum velocities in the late summer before velocities speed up again over the winter (Moon et al., 2014). Conceptually, the late summer slowdown observed on Type 3 glaciers is believed to be caused by the subglacial hydrology changing from an inefficient to an efficient network (Moon et al., 2014), which conforms with the arguments put forth for Hubbard Glacier. However, Hubbard Glacier differs from Type 3 behaviour in the fact that winter velocities are high, as shown in Figure 4-9. Given that Hubbard Glacier does not fit completely into any of the three categorizations by Moon et al. (2014) further demonstrates the uniqueness of this behaviour. This difference might arise from the number of observations used, where the glaciers studied by Moon et al (2014) only had 3-6 measurements annually from 2009-2013, although a few glaciers had more frequent measurements. Kehrl et al. (2017) found that Kangerlussuaq Glacier in Greenland behaved similarly to what is presented here for Hubbard Glacier, with a velocity peak in the summer due to temperatures increasing melt that reached the bed, and a velocity peak in the winter due to retreat of the ice-shelf.

Columbia and Post glaciers are tidewater glaciers located in Alaska that also experience interannual velocity changes in a similar way to Hubbard Glacier, with seasonal velocity patterns assumed to be caused by changes to the subglacial hydrological network, and both glaciers had larger variations in flow speeds closer their termini than further up-glacier (Enderlin et al., 2018). Enderlin et al. (2018) used 89 velocity fields from 2012-2016, and despite the similarities of Columbia Glacier and Hubbard Glacier, the first half of their study period showed Columbia and Post glaciers generally having maximum velocities in May/June, then a rapid drop in velocities to reach minimum velocities in October/November (Enderlin et al., 2018). However, in 2014, Post Glacier showed unusual flow behaviour with increased flow speeds and two velocity peaks, which is similar to the unique pattern we observed on Hubbard Glacier (Enderlin et al., 2018). The behaviour of Post Glacier differed from Hubbard Glacier as that anomalous year also had much higher flow speeds than average before dropping to much lower flow speeds than average for the 2015 minimum, which is not observed on Hubbard Glacier as the pattern of two velocity peaks occurred in all years analyzed from January 2017 to January 2022 (Enderlin et al., 2018). Although there are differences between the results of Enderlin et al. (2018) and what is reported here, it would be interesting for future work to study Columbia and Post glaciers in the same resolution of Hubbard and Valerie glaciers to determine if Hubbard Glacier's unique seasonal pattern is also observed on similar glaciers (i.e. large size, tidewater) when the density of data allows the observation. The seasonal behaviour of Hubbard Glacier is unusual for Alaska, and it is likely that previous studies never observed this seasonal pattern due to their data density being much sparser compared to what is presented here.

4.5.3 Seasonality of Valerie Glacier

Valerie Glacier's seasonal behaviour is summarized in Figure 4-10, showing the seasonal changes to its velocity, subglacial hydrology, ice motion, and melt.

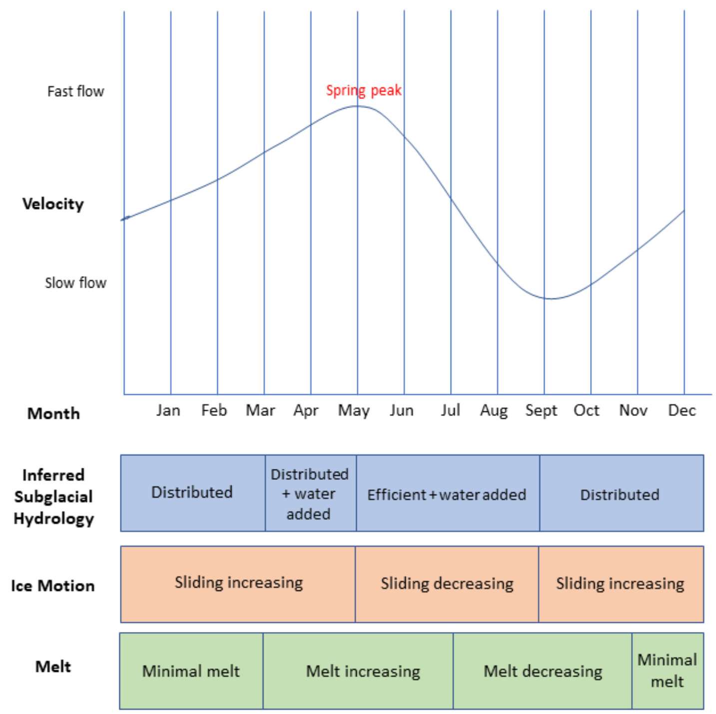

Figure 4-10: Summary of Valerie Glacier's seasonal patterns. The velocity figure shows the maximum velocity in the spring, followed by minimum velocities in the fall. The inferred subglacial hydrology describes if the system is distributed or efficient, ice motion describes if the glacier is increasing or decreasing sliding on its bed, and melt describes how much melt was observed from the PDD sums.

Valerie Glacier showed a very traditional melt-induced flow variability signal and can be explained in the same way as the spring peak on Hubbard Glacier; through changes to subglacial hydrology (Willis, 1995). The velocities of Valerie Glacier increased until the spring peak was reached, coincident with warming temperatures that increased melt that is inferred to be delivered to the bed and increased basal water pressure. During this time, the discharge of water out from beneath the glacier is likely low to moderate, leading to the lubrication of the bed of the glacier and a short-term increase in flow speeds (Willis, 1995). As the melt season progresses, the distributed network that leads to the spring velocity peak evolved into a channelized/efficient system by the end of the melt season, leading to the termination of fast spring velocities, and was followed by intermediate summer velocities and minimum velocities in later summer/fall (Nienow et al., 1998; Armstrong et al., 2017). This is supported by the distribution of PDD sums (Figure 4-

3 f), with peak melt conditions occurring with velocity minimums. Valerie Glacier experienced gradually increasing velocities following the minimum fall velocities, suggesting the efficient channels evolved back to a distributed system because of ice deformation (Nienow et al., 1998).

This differed from Hubbard Glacier as Valerie Glacier only experienced one velocity peak and one velocity drop each year, unlike Hubbard Glacier that had two velocity peaks and drops. The winter velocity peak observed on Hubbard Glacier did not exist on Valerie Glacier, although they both had a spring peak around the same time each year, and late summer/fall minimums. Valerie Glacier's fastest velocities were in the spring, as opposed to Hubbard Glacier's fastest velocities commonly observed in the winter. Also, Valerie Glacier did not rebound to faster velocities after its minimum velocities were reached as quickly as Hubbard Glacier did, and in comparison, it had a more gradual speedup until its spring peak was reached again. The slower acceleration of Valerie Glacier may have been caused by its slower velocities than Hubbard Glacier, which would have taken longer to destroy the efficient drainage network.

4.5.4 Pulses of Hubbard and Valerie Glaciers

Pulsing has previously been identified on both Hubbard and Valerie glaciers (Mayo 1988; Mayo, 1989; Trabant et al., 1991; Ritchie et al., 2008), and here we look at the long-term velocity trend of both glaciers (Figure 4-4 and Figure 4-5) to determine if these pulses are observed. Glacier pulses occur periodically when the glacier has fast unstable flow, with these movements in-between normal flow and surging (Mayo, 1978). Ritchie et al. (2008) argue that every several years Valerie Glacier experiences pulse-like surges, and Mayo (1989) stated that Valerie Glacier experienced a weak surge in 1986, with velocities reaching higher than ~13,150 m/yr (Mayo, 1988; Mayo, 1989). When looking at the annual velocity data, Valerie Glacier does not show fast velocities in 1986; rather it is a velocity minimum in the ITS_LIVE record (Figure 4-5). Displacements of the medial moraine between Hubbard and Valerie glaciers led Ritchie et al. (2008) to believe this was due to increased flow speeds and similar events to that seen by Mayo (1989), observed between August 1993-August 1995 and July 2000-September 2002. When comparing this to the annual velocities found in this work, 1993 showed fast velocities and a slowdown at the near confluence point after this year, while up-glacier continued to have fast velocities until 1995. In 2000, fast velocities were observed, but followed a similar pattern to that seen in 1993-1995 where near-terminus velocities decreased after this, while up-glacier continued to be fast. As well, Valerie Glacier velocities presented here never reach above 1,200 m/yr, which is much slower than those observed by Mayo (1988) and Mayo (1989). Therefore, none of the pulses were readily resolved in the annual velocity dataset presented here.

The velocity peaks on Hubbard Glacier may be the result of its tributary glaciers experiencing pulsing, as was suggested by Ritchie et al. (2008), or Hubbard Glacier pulsing itself (Trabant et al., 1991). This has been confirmed to happen when Valerie glacier experiences pulses, as Mayo (1989) found that Hubbard Glacier increased in velocity (reached around 5,000 m/yr and was observed through the glacier's advance) during the pulse of Valerie Glacier in 1986, and Trabant et al. (1991) also characterized Hubbard Glacier's motion as a pulse in its lower region in 1986. Trabant et al. (1991) characterized a pulse in the spring of 1989 on Hubbard Glacier through aerial photographic and telemetry data, which showed velocities reaching around ~4,750 m/yr near Hubbard Glacier's equilibrium line. However, like the pulse on Valerie Glacier in 1986, our annual velocity dataset shows a minimum in 1989. The dataset here (Figure 4-4) showed maximum velocities in 2002 at 1 km from the terminus being ~3,725 m/yr, lower than the velocities observed in previous surges (Mayo, 1989).

Through this, we find that the annual velocities presented here do not fully encapsulate previous pulsing events, likely a result of sampling issues. It is possible that the fast velocities may be averaged out in the annual data if the pulses did not encompass the full year, as the fast pulse velocities of Hubbard Glacier typically lasts months (Trabant et al., 1991). Another problem may arise from the ITS_LIVE data that is used to create annual velocity mosaics not being collected at the specific timing of the pulses. As shown in the previous section, there are large variations in flow speeds of both glaciers between different months of the year, meaning that if velocity measurements used to determine annual averages were only collected in times of seasonal fast or slow flow, there may be large differences from one year to the next, with pulses not necessarily captured in the specific time of measurement. Differences may also arise from the work of Ritchie et al. (2008) inferring velocity from the medial moraine displacement, rather than having direct velocity measurements. However, if these pulses are expected to occur every several years on Valerie Glacier, the dense timeseries from 2013-2022 should have shown something representative of a surge (Ritchie et al., 2008). This could be a focus for future work to determine if the glaciers are still experiencing pulses, or if previous pulses were misidentified or misinterpreted.

4.5.5 Long-term velocity changes of Hubbard and Valerie Glaciers

The Trabant et al. (2003) study found that Hubbard Glacier experienced a ~621 m/yr deceleration between 1978-1997 by removing seasonality from their dataset and looking at speeds in the same season that had a period of ≥9 months. Similar to the velocities near the terminus used by Trabant et al. (2003), seasonality was not removed from our long-term velocity data set, which may be the cause of the jumps in velocity between years. However, the velocity jumps may also be due to Alaskan glacier velocities varying inter-annually, even when considering seasonality (Burgess et al., 2013a). This has also been observed before in Greenland, where a glacier's seasonal velocity patterns can vary from one year to the next, which may be caused by differences in subglacial hydrology (Moon et al., 2014). Even with these jumps in velocity in our dataset, a deceleration is still observed at all locations along Hubbard Glacier (although very minimally at 1 km from the terminus), leading to the conclusion that the deceleration of Hubbard Glacier has continued from 1985-2018.

Hubbard Glacier was thickening near its terminus, and thinning when moving up-glacier (Figure 4-6 and Figure 4-7), which is similar to the findings of previous studies (Trabant et al., 2003). Glacier thickness and surface conditions influence the effective basal water pressure and thus the velocity of a glacier, where increasing glacier thickness can increase flow rates (Willis, 1995; Bindschadler et al., 1977). However, it is hard to determine an exact relationship between the thickening/thinning rates of Hubbard Glacier and the long-term deceleration at the 1 km, 5 km, and 10 km points. This is because at 1 km from the terminus, there was the smallest deceleration from 1989-2018 of all three locations, but this region would be expected to slow down the most due having the most thinning. In comparison, the 5 km point thickened from 2000-2009, and 10 km location thickened from 2000-2019 (Figure 4-7). These two regions would be expected to have less of a deceleration than the 1 km point, due to increasing surface thickness increasing flow rates, although this was not observed (Willis, 1995; Bindschadler et al., 1977). This points to the deceleration being influenced by more than just elevation change, as Trabant et al. (2003) found that deceleration occurred in some regions of increasing thickness and may be the result of surface strain rates.

Valerie Glacier also showed long-term velocity decreases from 1985-2018 at both the near confluence and up-glacier points, although the decrease was small (Figure 4-5). Seasonality was also not removed from this dataset, which is likely a factor of why there were jumps in Valerie Glacier's velocities between years, although this may partly be due to inter-annual variations in velocities (Burgess et al., 2013a). Similar to Hubbard Glacier, a direct relationship between thickening/thinning and flow rates was difficult to determine. A larger deceleration was observed at the near confluence point where thinning did occur from 2000-2019, while a smaller deceleration occurred at the up-glacier point where it was thickening from 2000-2014 and thinned from 2015-2019. This is again similar to the findings of Trabant et al. (2003) where deceleration still occurred in regions of thickening, like at the up-glacier point on Valerie Glacier.

4.6 Conclusions

This study examined the seasonality of Hubbard and Valerie glaciers at a higher resolution than previously possible and provided the densest velocity record of Hubbard and Valerie glaciers ever created. This record reveals that Hubbard Glacier's seasonality increases when moving towards its calving front, and it experiences two velocity peaks and drops throughout the year, one peak in the spring/summer (May) before dropping to minimum velocities in August/September, peaking again in the winter (December-February), before dropping slightly between January-April. This is different from the behaviour of Valerie Glacier, which experiences one velocity peak in the spring/summer (May) before dropping to minimum flow speeds between August-November. The summertime velocity peak of both glaciers was argued to be caused by rising temperatures increasing meltwater and raising water pressure at the bed, which allows enhanced basal sliding (Willis, 1995). Once seasonal melt increases enough, efficient channels form, leading to minimum velocities in late summer/fall, generally around when PDD values are decreasing, but still high (Nienow et al., 1998; Armstrong et al., 2017). On both glaciers, the efficient channels shift back to a distributed system due to ice deformation, leading to both glaciers speeding up, although Hubbard Glacier at a faster rate than Valerie Glacier, likely due to its faster velocities (Nienow et al., 1998). Although there are similarities between Hubbard and Valerie glaciers and Columbia and Post glaciers, there are differences between their seasonality, further showing how unique this velocity pattern within Alaska is (Enderlin et al., 2018).

A cause of this wintertime velocity peak observed on Hubbard Glacier was not determined, but a few methods for fast velocities were hypothesized. First, this may also be due to water trapped beneath the glacier, although the method of increased velocities differs depending on if Hubbard

Glacier has a hard of soft bed (Willis, 1995). If a hard bed exists, fast winter velocities may result from water increasing lubrication beneath the bed, while if it has a soft bed, it might have fast winter velocities from water causing bed deformation or till failure (Willis, 1995). Second, fast winter velocities may be caused by increased ice deformation and/or basal motion by increased basal deformation and regelation due increasing thickness from snow accumulation (Blümcke & Finsterwalder, 1905; Willis, 1995). Due to fast winter velocities not found on neighbouring Valerie Glacier, it is likely the driver of the winter velocity peak is an internal process to Hubbard Glacier. This study can also not draw any firm conclusions to the cause of the velocity drop after the winter velocity peak, although it is hypothesized that water may be finding preferential paths and increasing the efficiency of the subglacial drainage before being destroyed by the fast velocities and becoming fully distributed again to reach the spring peak.

The annual velocity observations from 1985-2018 shows periods of speeds ups and periods of slowdowns, although previous instances of pulses that occurred in 1986, August 1993-August 1995 and July 2000-September 2002 on Valerie Glacier, and 1986 and 1989 on Hubbard Glacier were not evident in this dataset (Mayo 1988; Mayo, 1989; Ritchie et al., 2008; Trabant et al., 1991). This may be due to this study using a different method than previous ones and having sampling issues of the ITS_LIVE dataset (where the annual velocities did not capture pulses). However, in the dense velocity dataset from 2013-2022, there were no instances of glacier pulses. Due to this, we are unable to make any conclusions of glacier pulses on Hubbard and Valerie glaciers. The determination of pulsing of these glaciers is of importance because if sediments continue to accumulate in the Gilbert Point Gap, then the calving rate reduces and a pulse of Valerie Glacier would accelerate Hubbard's terminus advance at Gilbert Point, which might cause Russel Fjord to be blocked again (Ritchie et al., 2008).

This study also found that Hubbard and Valerie glaciers have both experienced long-term (1985-2020) velocity decreases, although a direct relationship between thickening/thinning and this long-term deceleration was not found. Therefore, the long-term deceleration of Hubbard and Valerie glaciers may be influenced by other factors, such as surface strain rates (Trabant et al., 2003).

Overall, it would be beneficial for both the winter velocity peak and the velocity drop before the spring peak be the focus of future work, as no firm conclusions to the cause of these can be made. Both glaciers would benefit from future analysis of their pulsing events, as no instances of pulsing were able to be resolved in both velocity datasets provided here. Lastly, the factors influencing their deceleration could be a topic of further study, as they are both influenced by more than just changes to glacier thickness.

Chapter 5: Conclusions

5.1 Summary

Western North America is warming at a higher rate than the global average and this is leading to a decline in glaciers in this region (Hock et al., 2019). The dynamics of glaciers are being altered due to the changing climate, leading to different behaviours of mass loss and dynamic discharge, which affects how much glaciers contribute to sea level rise (Van Wychen et al., 2016). One difference in glacier dynamics is occurring in Alaska, where glaciers within Alaska likely have a different long-term dynamic response to climate change compared to glaciers in other regions of the world where outlet glaciers are major influencers of downstream fluxes, creating a need for this dynamic response to be identified (Burgess et al., 2013a). To characterize these changes to glaciers in Western North America, the major goal of this thesis was to examine the flow behaviour of two Alaskan tidewater glaciers: Hubbard and Valerie glaciers. This was done through using a combination of SAR and optical imagery to create an extremely dense record of glacier motion at the highest temporal resolution possible. Also, with Alaska accounting for 25% of mass loss globally, but very few long-term mass balance programs that mostly focus on relatively small glaciers, another goal of this thesis was to determine how much elevation change has occurred in the recent past at the two study sites (Hugonnet et al., 2021; Arendt et al., 2002). The full objectives of this thesis are listed below.

1) Build a dense record of ice motion for Hubbard and Valerie glaciers that can be used to resolve the seasonality of both glaciers over the last ~decade;
2) Create a long-term velocity record of ice motion to determine whether the long-term deceleration of Hubbard Glacier that has been previously reported continues to present day and determine the long-term velocity trend of Valerie Glacier;
3) Utilize records of climate data and surface elevation change to explore the seasonal and long-term drivers of ice dynamics at Hubbard and Valerie glaciers.

5.2 Primary Findings

This section explains the primary findings for each of the research objectives of the thesis, subdivided into sections for each objective.

5.2.1 *Objective 1 – Dense Velocity Dataset and Seasonality*

The first objective of this study was to resolve the seasonality of Hubbard and Valerie glaciers through creating the densest record of motion possible. This was done through using a combination of pre-derived glacier velocities from ITS_LIVE that included S1, S2, and Landsat 8 data, as well as glacier velocities derived from SAR imagery through the GAMMA software (R2, TSX/TDX, and RCM). This record extended from the summer of 2013 to the summer of 2022, however, due to the density of data increasing in 2016, this study quantified seasonality from January 2017-January 2022. The seasonality of Valerie Glacier was determined to be the 'typical' seasonal pattern with peak velocities around May (velocities exceeding ~1,600 m/yr near the terminus and ~1,760 m/yr up-glacier) before dropping in late summer/fall where it reaches its minimum velocities between August-November (as low as ~20 m/yr near the terminus and ~81 m/yr up-glacier), before gradually increasing velocities again until the following May. Hubbard Glacier behaved differently, having two velocity peaks during the year; one in the winter (varying between December-February) before velocities lowered slightly between end of January to April, before rising to another velocity peak around May (although sometimes observed in April/June). At 1 km from the terminus, velocities reached higher than ~4,800 m/yr during the winter peak, before dropping lower than ~1,800 m/yr after the peak. At this time, velocities were observed to drop as much as ~3,000 m/yr, although the drop was generally less than ~1,800 m/yr. The May velocity peak reached as high as ~3,500 m/yr, before dropping to a fall minimum as slow as ~370 m/yr before increasing again for the winter peak. At this minimum after the May peak, velocities generally dropped more than ~2,000 m/yr, but a drop of as much as ~3,000 m/yr was possible.

5.2.2 *Objective 2 – Long-term Dynamics and Deceleration*

The second research objective for Hubbard and Valerie glaciers was to determine if Hubbard Glacier is still experiencing a long-term deceleration that had been previously reported, and to determine what the long-term velocity pattern of Valerie Glacier is. This was done by analyzing the ITS_LIVE annual mosaics from 1985-2018, and from 1989-2018 at the 1 km from the terminus point on Hubbard Glacier. Hubbard Glacier has been decelerating throughout this period, with the biggest change observed at 5 km from the terminus, then 10 km from the terminus, with the smallest deceleration observed at 1 km from the terminus. Valerie Glacier is also experiencing a slight velocity deceleration, with the slightly stronger deceleration near the terminus than the up-glacier point. During this period on both glaciers, there were multiple velocity peaks and drops, however, the velocity record used here does not coincide with previously observed pulses that were reported to have occurred in 1986, August 1993-August 1995, and July 2000-September 2002 on Valerie Glacier, and the spring of 1986 and 1989 on Hubbard Glacier, likely due to sampling issues (Mayo 1988; Mayo, 1989; Ritchie et al., 2008; Trabant et al. 1991).

5.2.3 *Objective 3 – Climate and Elevation Analysis*

The final objective for Hubbard and Valerie glaciers was to determine the drivers of the ice motion for the seasonal and long-term dynamics observed through looking at PDD sums and elevation changes. PDD sums were used as a proxy to understand melt on the surface of the glaciers, and led to the argument that the spring velocity peak on both glaciers is influenced by temperatures and subglacial hydrology. With increasing temperatures and PDD sums in the spring and summer, more meltwater is inferred to be able to reach the glacier bed, which lubricates it and allows for more basal sliding (Willis, 1995). The increasing meltwater at the bed will continue to evolve the subglacial network, until it switches from an inefficient to an efficient system towards the end of the melt season, resulting in increased friction at the bed and decreased flow speeds (Nienow et al., 1998). The drop in velocities after the spring peak occurs around the same time as maximum PDD sums, supporting this hypothesis.

The winter velocity peak of Hubbard Glacier may also be influenced by the glacier's subglacial hydrology from water trapped under the glacier (Willis, 1995). Previous work has shown that the fast velocities can occur in the winter from water beneath a hard bedded glacier increasing the lubrication and sliding, while on a soft bedded glacier it can cause bed deformation and till failure (Willis, 1995). It is also possible for increased accumulation of snow in the wintertime to increase the glacier thickness and cause it to flow at fast speeds (Blümcke & Finsterwalder, 1905; Willis, 1995). The winter velocity peak was also not seen on Valerie Glacier, leading to the conclusion that there is an internal driver on Hubbard Glacier causing the winter velocity peak.

Elevation change data from 2000-2019 was used to explain the long-term deceleration that was observed on both Hubbard and Valerie glaciers. When a glacier thins, the effective basal water pressure and velocity of the glacier is affected, with decreasing thickness leading to decreased flow rates (Willis, 1995; Bindschadler et al., 1977). A direct relationship between thinning rates and long-term velocity decreases could not be found in this dataset. On Hubbard Glacier, the region that showed the most thinning (1 km from the terminus) had the smallest deceleration. On Valerie

Glacier, the up-glacier point showed thickening throughout the majority of this analysis (2000-2014) yet still showed a trend of deceleration. Therefore, it is likely that a different driver is affecting the long-term deceleration, such as strain rates, as suggested by Trabant et al. (2003).

5.3 Limitations

The major limitation of this study is that all velocity data was derived from remote sensing data, with no ground observation data available to validate these measurements. However, the methods of image matching/offset tracking used in this study have been used in previous studies and are common ways to derive glacier motion from optical and SAR imagery (Schellenberger et al., 2016). Similarly, all climatic conditions were inferred from reanalysis data as there were no automatic weather stations on the glaciers or within its valley. Due to this, the reanalysis data could not be validated, but was used to understand the general trends observed. There were no direct measurements of melt and subglacial hydrology made in this study, with PDD sums used as a proxy for understanding melt reaching the glacier bed. Although PDD sums have often been used as to estimate how much melt a glacier experiences, it is not an exact measurement (Braithwaite, 1995). Another limitation arose from the climate analysis in this study only focusing on temperature, without any precipitation data analyzed. It is possible that if the wintertime experienced rain events, that this could be one of the drivers for the winter velocity peak. Another possible driver of glacier motion that was not analyzed in this work was the influence the ocean has on the glaciers, as both are tidewater terminating.

5.4 Significance

The velocity record created in this study is the densest record that has been published to date for Hubbard and Valerie glaciers, from the summer of 2013 to the summer of 2022. Image pairs used in this study had as little as 4-day spacings due to novel RCM data used. Through this, a new pattern of glacier motion on Hubbard Glacier was observed that previous studies had not previously been identified, with each year having two peaks of fast velocities, between December-February and around May. With this pattern consistent in all years that seasonality was analyzed and this pattern not seen on Valerie Glacier, it is proposed that Hubbard Glacier has some internal mechanism creating this pattern. Through this study, the knowledge of seasonal velocity behaviour on tidewater glaciers has been expanded. This allows for a greater understanding of how dynamic discharge may be changing with the changing climate, and thus, a better understanding of glacier contributions to sea level rise.

5.5 Future Work

Beneficial future work would involve determining the cause of the fast winter velocities observed on Hubbard Glacier. Due to time constraints on this thesis, more driving factors could not be assessed, and no conclusion could be made for what is causing its unique seasonal pattern. For example, some of the drivers that could be analyzed are seasonal glacier retreat, bed topography, sea ice, precipitation, the ocean's influence on the glaciers, and further research/modelling of the subglacial hydrology system. Some of these drivers could be analyzed through fieldwork at Hubbard Glacier. Field measurements would also allow for validation of the remote sensing methods used in this work and could involve the set up of an automatic weather station to more accurately analyze how climatic conditions are influencing seasonal velocity variations.

The pulsing of Hubbard and Valerie Glaciers could be a focus on future work, as the data presented here showed no instances of glacier pulsing. Therefore, it is difficult to accept the characterization of these glaciers as "pulse-type". Future work could look more at the time between pulses, as it seems longer than every few years on Valerie glacier that was reported by Ritchie et al. (2008).

The annual long-term velocity record on Hubbard Glacier could be improved through showing all the individual image pairs used to create the ITS_LIVE mosaics, rather than averaging them into one annual value. This would more accurately show when speed up events occurred and could look for pulsing events that could not be accurately observed in the annual data. Another improvement for data access would be for all SAR data being openly available. As of August 2023, R2 and RCM were not openly available.

It would also be beneficial for more glaciers to have their seasonal velocity patterns analyzed with a similar density in the velocity record like what was presented for Hubbard Glacier. Previous studies that looked at Hubbard Glacier's seasonal velocity pattern with much less data than what was presented here did not find the winter velocity peak (Trabant et al., 2003; Stearns et al., 2015). Therefore, it is possible that this velocity pattern occurs on more glaciers within Alaska, and globally, but has not been resolved in previous studies. This dynamic behaviour could then be applied to mass loss and sea level rise models.

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Appendix

The image pairs and dates of velocity measurements used in this study for Hubbard and Valerie glaciers are given in five tables below to show the data that was available at the 1 km (Appendix Table 1), 5 km (Appendix Table 2), and 10 km (Appendix Table 3) points on Hubbard Glacier, and the near confluence (Appendix Table 4) and up-glacier points (Appendix Table 5) on Valerie Glacier, as is shown in Figure 4-1. If multiple images were provided on the same date at different times, the one with most spatial coverage over the terminus was used.

Appendix Table 1: Images used in the analysis at the 1 km from the terminus point on Hubbard Glacier. LC is Landsat, S1 is Sentinel-1 (includes Sentinel-1a and Sentinel-1b), S2 is Sentinel-2 (includes Sentinel-2a and Sentinel-2b), TSX/TDX is TerraSAR-X/TanDEM-X, and RCM is RADARSAT Constellation Mission.

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
LC	12/07/2013	28/07/2013	20/07/2013
LC	28/07/2013	13/08/2013	05/08/2013
LC	08/11/2013	24/11/2013	16/11/2013
LC	20/01/2014	05/02/2014	28/01/2014
LC	05/02/2014	21/02/2014	13/02/2014
LC	28/02/2014	16/03/2014	08/03/2014
LC	16/03/2014	01/04/2014	24/03/2014
LC	25/03/2014	10/04/2014	02/04/2014
LC	01/04/2014	17/04/2014	09/04/2014
LC	10/04/2014	26/04/2014	18/04/2014
LC	17/04/2014	03/05/2014	25/04/2014
LC	23/08/2014	08/09/2014	31/08/2014
LC	08/09/2014	24/09/2014	16/09/2014
LC	11/11/2014	27/11/2014	19/11/2014
S1	08/11/2014	02/12/2014	20/11/2014
S1	26/12/2014	19/01/2015	07/01/2015
S1	12/02/2015	08/03/2015	24/02/2015
TSX/TDX	03/03/2015	14/03/2015	08/03/2015
S1	08/03/2015	01/04/2015	20/03/2015
LC	19/03/2015	04/04/2015	27/03/2015
LC	28/03/2015	13/04/2015	05/04/2015
LC	13/04/2015	29/04/2015	21/04/2015
LC	06/05/2015	22/05/2015	14/05/2015
LC	15/05/2015	31/05/2015	23/05/2015
LC	31/05/2015	16/06/2015	08/06/2015
S1	12/06/2015	06/07/2015	24/06/2015
LC	23/06/2015	09/07/2015	01/07/2015
TSX/TDX	27/06/2015	08/07/2015	02/07/2015
TSX/TDX	08/07/2015	19/07/2015	13/07/2015
LC	09/07/2015	25/07/2015	17/07/2015
S1	06/07/2015	30/07/2015	18/07/2015
TSX/TDX	19/07/2015	30/07/2015	24/07/2015
TSX/TDX	30/07/2015	10/08/2015	04/08/2015
S1	30/07/2015	23/08/2015	11/08/2015
TSX/TDX	10/08/2015	21/08/2015	15/08/2015
TSX/TDX	21/08/2015	01/09/2015	26/08/2015
S1	23/08/2015	16/09/2015	04/09/2015
TSX/TDX	01/09/2015	12/09/2015	06/09/2015
TSX/TDX	12/09/2015	23/09/2015	17/09/2015
S1	16/09/2015	10/10/2015	28/09/2015
TSX/TDX	23/09/2015	04/10/2015	28/09/2015
TSX/TDX	04/10/2015	15/10/2015	09/10/2015

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
TSX/TDX	09/10/2015	20/10/2015	14/10/2015
TSX/TDX	15/10/2015	26/10/2015	20/10/2015
S1	10/10/2015	03/11/2015	22/10/2015
TSX/TDX	22/11/2015	03/12/2015	27/11/2015
S1	08/12/2015	01/01/2016	20/12/2015
S1	21/12/2015	14/01/2016	02/01/2016
S1	07/02/2016	02/03/2016	19/02/2016
LC	27/02/2016	14/03/2016	06/03/2016
S1	02/03/2016	26/03/2016	14/03/2016
S1	26/03/2016	19/04/2016	07/04/2016
S1	19/04/2016	13/05/2016	01/05/2016
S1	13/05/2016	06/06/2016	25/05/2016
S2	18/05/2016	07/06/2016	28/05/2016
S1	06/06/2016	30/06/2016	18/06/2016
S1	30/06/2016	24/07/2016	12/07/2016
S1	24/07/2016	17/08/2016	05/08/2016
S1	17/08/2016	10/09/2016	29/08/2016
LC	29/09/2016	15/10/2016	07/10/2016
LC	08/10/2016	24/10/2016	16/10/2016
LC	15/10/2016	31/10/2016	23/10/2016
LC	31/10/2016	16/11/2016	08/11/2016
S2	25/10/2016	24/11/2016	09/11/2016
S1	02/11/2016	26/11/2016	14/11/2016
S1	09/11/2016	03/12/2016	21/11/2016
S1	26/11/2016	20/12/2016	08/12/2016
S1	07/12/2016	31/12/2016	19/12/2016
S1	20/12/2016	13/01/2017	01/01/2017
S1	31/12/2016	24/01/2017	12/01/2017
S1	13/01/2017	06/02/2017	25/01/2017
S1	24/01/2017	17/02/2017	05/02/2017
LC	04/02/2017	20/02/2017	12/02/2017
S1	06/02/2017	02/03/2017	18/02/2017
S1	13/02/2017	03/03/2017	22/02/2017
S1	17/02/2017	01/03/2017	23/02/2017
S1	13/02/2017	15/03/2017	28/02/2017
LC	20/02/2017	08/03/2017	28/02/2017
S1	17/02/2017	13/03/2017	01/03/2017
S1	01/03/2017	13/03/2017	07/03/2017
S1	02/03/2017	14/03/2017	08/03/2017
S1	03/03/2017	15/03/2017	09/03/2017
S1	02/03/2017	26/03/2017	14/03/2017
S1	03/03/2017	27/03/2017	15/03/2017
LC	08/03/2017	24/03/2017	16/03/2017
S1	14/03/2017	26/03/2017	20/03/2017
S1	14/03/2017	07/04/2017	26/03/2017
S1	26/03/2017	07/04/2017	01/04/2017
LC	24/03/2017	09/04/2017	01/04/2017

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	27/03/2017	08/04/2017	02/04/2017
S1	07/04/2017	19/04/2017	13/04/2017
S1	07/04/2017	01/05/2017	19/04/2017
S1	08/04/2017	02/05/2017	20/04/2017
S1	19/04/2017	01/05/2017	25/04/2017
S1	19/04/2017	13/05/2017	01/05/2017
TSX/TDX	28/04/2017	09/05/2017	03/05/2017
S1	01/05/2017	13/05/2017	07/05/2017
S1	02/05/2017	26/05/2017	14/05/2017
S2	06/05/2017	26/05/2017	16/05/2017
LC	11/05/2017	27/05/2017	19/05/2017
S1	18/05/2017	30/05/2017	24/05/2017
S1	13/05/2017	06/06/2017	25/05/2017
S1	18/05/2017	11/06/2017	30/05/2017
S1	30/05/2017	11/06/2017	05/06/2017
S1	30/05/2017	23/06/2017	11/06/2017
S1	06/06/2017	18/06/2017	12/06/2017
S1	11/06/2017	23/06/2017	17/06/2017
S1	06/06/2017	30/06/2017	18/06/2017
S1	11/06/2017	05/07/2017	23/06/2017
S1	18/06/2017	30/06/2017	24/06/2017
S1	23/06/2017	05/07/2017	29/06/2017
S1	23/06/2017	17/07/2017	05/07/2017
S1	05/07/2017	17/07/2017	11/07/2017
S1	17/07/2017	29/07/2017	23/07/2017
S1	17/07/2017	10/08/2017	29/07/2017
S1	29/07/2017	10/08/2017	04/08/2017
S1	29/07/2017	22/08/2017	10/08/2017
S1	05/08/2017	17/08/2017	11/08/2017
S1	06/08/2017	18/08/2017	12/08/2017
S1	06/08/2017	18/08/2017	12/08/2017
S1	10/08/2017	22/08/2017	16/08/2017
S1	05/08/2017	29/08/2017	17/08/2017
S1	06/08/2017	30/08/2017	18/08/2017
S1	10/08/2017	03/09/2017	22/08/2017
S1	17/08/2017	29/08/2017	23/08/2017
S1	18/08/2017	30/08/2017	24/08/2017
S1	22/08/2017	03/09/2017	28/08/2017
S1	17/08/2017	10/09/2017	29/08/2017
S1	18/08/2017	11/09/2017	30/08/2017
S1	18/08/2017	11/09/2017	30/08/2017
S1	22/08/2017	15/09/2017	03/09/2017
S1	29/08/2017	10/09/2017	04/09/2017
S1	30/08/2017	11/09/2017	05/09/2017
S1	03/09/2017	15/09/2017	09/09/2017
S1	29/08/2017	22/09/2017	10/09/2017
S1	30/08/2017	23/09/2017	11/09/2017

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	03/09/2017	27/09/2017	15/09/2017
S1	10/09/2017	22/09/2017	16/09/2017
S1	11/09/2017	23/09/2017	17/09/2017
S1	11/09/2017	23/09/2017	17/09/2017
S1	15/09/2017	27/09/2017	21/09/2017
S1	11/09/2017	05/10/2017	23/09/2017
S1	15/09/2017	09/10/2017	27/09/2017
S1	23/09/2017	05/10/2017	29/09/2017
LC	25/09/2017	11/10/2017	03/10/2017
S1	22/09/2017	16/10/2017	04/10/2017
S1	23/09/2017	17/10/2017	05/10/2017
S1	23/09/2017	17/10/2017	05/10/2017
S1	05/10/2017	17/10/2017	11/10/2017
S1	09/10/2017	21/10/2017	15/10/2017
S1	05/10/2017	29/10/2017	17/10/2017
S1	16/10/2017	28/10/2017	22/10/2017
S1	17/10/2017	29/10/2017	23/10/2017
S1	17/10/2017	29/10/2017	23/10/2017
S1	21/10/2017	02/11/2017	27/10/2017
S1	17/10/2017	10/11/2017	29/10/2017
S1	28/10/2017	09/11/2017	03/11/2017
S1	29/10/2017	10/11/2017	04/11/2017
S1	29/10/2017	10/11/2017	04/11/2017
S1	02/11/2017	14/11/2017	08/11/2017
S2	04/11/2017	14/11/2017	09/11/2017
S1	02/11/2017	26/11/2017	14/11/2017
S1	09/11/2017	21/11/2017	15/11/2017
S1	10/11/2017	22/11/2017	16/11/2017
S1	14/11/2017	26/11/2017	20/11/2017
S1	09/11/2017	03/12/2017	21/11/2017
S1	21/11/2017	03/12/2017	27/11/2017
S1	26/11/2017	08/12/2017	02/12/2017
S1	03/12/2017	15/12/2017	09/12/2017
S1	08/12/2017	20/12/2017	14/12/2017
S1	03/12/2017	27/12/2017	15/12/2017
S1	15/12/2017	27/12/2017	21/12/2017
S1	20/12/2017	01/01/2018	26/12/2017
S1	15/12/2017	08/01/2018	27/12/2017
S1	20/12/2017	13/01/2018	01/01/2018
S1	27/12/2017	08/01/2018	02/01/2018
S1	28/12/2017	09/01/2018	03/01/2018
S1	01/01/2018	13/01/2018	07/01/2018
S1	27/12/2017	20/01/2018	08/01/2018
S1	28/12/2017	21/01/2018	09/01/2018
S1	01/01/2018	25/01/2018	13/01/2018
S1	08/01/2018	20/01/2018	14/01/2018
S1	09/01/2018	21/01/2018	15/01/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	13/01/2018	25/01/2018	19/01/2018
S1	09/01/2018	02/02/2018	21/01/2018
S1	09/01/2018	02/02/2018	21/01/2018
S1	13/01/2018	06/02/2018	25/01/2018
S1	21/01/2018	02/02/2018	27/01/2018
S2	23/01/2018	02/02/2018	28/01/2018
S2	23/01/2018	07/02/2018	30/01/2018
S1	25/01/2018	06/02/2018	31/01/2018
S1	20/01/2018	13/02/2018	01/02/2018
S1	21/01/2018	14/02/2018	02/02/2018
S2	28/01/2018	07/02/2018	02/02/2018
TSX/TDX	28/01/2018	08/02/2018	02/02/2018
S2	23/01/2018	17/02/2018	04/02/2018
S1	25/01/2018	18/02/2018	06/02/2018
S2	28/01/2018	17/02/2018	07/02/2018
S1	02/02/2018	14/02/2018	08/02/2018
S1	02/02/2018	14/02/2018	08/02/2018
LC	31/01/2018	16/02/2018	08/02/2018
S2	02/02/2018	17/02/2018	09/02/2018
S1	06/02/2018	18/02/2018	12/02/2018
S2	07/02/2018	17/02/2018	12/02/2018
S1	02/02/2018	26/02/2018	14/02/2018
LC	07/02/2018	23/02/2018	15/02/2018
S2	02/02/2018	04/03/2018	17/02/2018
S1	06/02/2018	02/03/2018	18/02/2018
S1	13/02/2018	25/02/2018	19/02/2018
S2	07/02/2018	04/03/2018	19/02/2018
S1	14/02/2018	26/02/2018	20/02/2018
S1	18/02/2018	02/03/2018	24/02/2018
S2	17/02/2018	04/03/2018	24/02/2018
S1	13/02/2018	09/03/2018	25/02/2018
S1	14/02/2018	10/03/2018	26/02/2018
S1	14/02/2018	10/03/2018	26/02/2018
S1	18/02/2018	14/03/2018	02/03/2018
S1	25/02/2018	09/03/2018	03/03/2018
S1	26/02/2018	10/03/2018	04/03/2018
S1	02/03/2018	14/03/2018	08/03/2018
S1	25/02/2018	21/03/2018	09/03/2018
S2	25/02/2018	22/03/2018	09/03/2018
S1	26/02/2018	22/03/2018	10/03/2018
S2	04/03/2018	24/03/2018	14/03/2018
S1	09/03/2018	21/03/2018	15/03/2018
S1	10/03/2018	22/03/2018	16/03/2018
S2	04/03/2018	29/03/2018	16/03/2018
S2	04/03/2018	03/04/2018	19/03/2018
S1	14/03/2018	26/03/2018	20/03/2018
S1	09/03/2018	02/04/2018	21/03/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	10/03/2018	03/04/2018	22/03/2018
S1	14/03/2018	07/04/2018	26/03/2018
S1	21/03/2018	02/04/2018	27/03/2018
S2	22/03/2018	01/04/2018	27/03/2018
S1	22/03/2018	03/04/2018	28/03/2018
S2	24/03/2018	03/04/2018	29/03/2018
S2	22/03/2018	06/04/2018	29/03/2018
S1	26/03/2018	07/04/2018	01/04/2018
S2	22/03/2018	11/04/2018	01/04/2018
S1	21/03/2018	14/04/2018	02/04/2018
S1	22/03/2018	15/04/2018	03/04/2018
S2	24/03/2018	13/04/2018	03/04/2018
S2	22/03/2018	16/04/2018	03/04/2018
S2	29/03/2018	13/04/2018	05/04/2018
S2	01/04/2018	11/04/2018	06/04/2018
S1	26/03/2018	19/04/2018	07/04/2018
S1	02/04/2018	14/04/2018	08/04/2018
S2	03/04/2018	13/04/2018	08/04/2018
S2	01/04/2018	16/04/2018	08/04/2018
S1	03/04/2018	15/04/2018	09/04/2018
S1	03/04/2018	15/04/2018	09/04/2018
S2	06/04/2018	16/04/2018	11/04/2018
S1	07/04/2018	19/04/2018	13/04/2018
S2	29/03/2018	28/04/2018	13/04/2018
LC	05/04/2018	21/04/2018	13/04/2018
S2	01/04/2018	26/04/2018	13/04/2018
S1	02/04/2018	26/04/2018	14/04/2018
S2	03/04/2018	28/04/2018	15/04/2018
S2	06/04/2018	26/04/2018	16/04/2018
S2	11/04/2018	26/04/2018	18/04/2018
S1	14/04/2018	26/04/2018	20/04/2018
S2	13/04/2018	28/04/2018	20/04/2018
S1	15/04/2018	27/04/2018	21/04/2018
S1	15/04/2018	27/04/2018	21/04/2018
S2	16/04/2018	26/04/2018	21/04/2018
S2	06/04/2018	06/05/2018	21/04/2018
S2	11/04/2018	06/05/2018	23/04/2018
S1	19/04/2018	01/05/2018	25/04/2018
S2	13/04/2018	08/05/2018	25/04/2018
S1	14/04/2018	08/05/2018	26/04/2018
S2	16/04/2018	06/05/2018	26/04/2018
S1	15/04/2018	09/05/2018	27/04/2018
S1	15/04/2018	09/05/2018	27/04/2018
S1	19/04/2018	13/05/2018	01/05/2018
S2	26/04/2018	06/05/2018	01/05/2018
S2	16/04/2018	16/05/2018	01/05/2018
S1	26/04/2018	08/05/2018	02/05/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	27/04/2018	09/05/2018	03/05/2018
S1	27/04/2018	09/05/2018	03/05/2018
S2	28/04/2018	08/05/2018	03/05/2018
S2	26/04/2018	16/05/2018	06/05/2018
S1	01/05/2018	13/05/2018	07/05/2018
S1	26/04/2018	20/05/2018	08/05/2018
S2	28/04/2018	18/05/2018	08/05/2018
S1	27/04/2018	21/05/2018	09/05/2018
S2	06/05/2018	16/05/2018	11/05/2018
S1	01/05/2018	25/05/2018	13/05/2018
S2	08/05/2018	18/05/2018	13/05/2018
S1	08/05/2018	20/05/2018	14/05/2018
S1	09/05/2018	21/05/2018	15/05/2018
S1	09/05/2018	21/05/2018	15/05/2018
S1	13/05/2018	25/05/2018	19/05/2018
S1	08/05/2018	01/06/2018	20/05/2018
S1	09/05/2018	02/06/2018	21/05/2018
S1	20/05/2018	01/06/2018	26/05/2018
S1	21/05/2018	02/06/2018	27/05/2018
S1	25/05/2018	06/06/2018	31/05/2018
S1	20/05/2018	13/06/2018	01/06/2018
S1	21/05/2018	14/06/2018	02/06/2018
S1	21/05/2018	14/06/2018	02/06/2018
S1	25/05/2018	18/06/2018	06/06/2018
S1	01/06/2018	13/06/2018	07/06/2018
S1	02/06/2018	14/06/2018	08/06/2018
S1	06/06/2018	18/06/2018	12/06/2018
S1	01/06/2018	25/06/2018	13/06/2018
S1	02/06/2018	26/06/2018	14/06/2018
S1	06/06/2018	30/06/2018	18/06/2018
S1	13/06/2018	25/06/2018	19/06/2018
S1	14/06/2018	26/06/2018	20/06/2018
S1	14/06/2018	26/06/2018	20/06/2018
S1	18/06/2018	30/06/2018	24/06/2018
S1	14/06/2018	08/07/2018	26/06/2018
S1	14/06/2018	08/07/2018	26/06/2018
S1	18/06/2018	12/07/2018	30/06/2018
S1	26/06/2018	08/07/2018	02/07/2018
S1	26/06/2018	08/07/2018	02/07/2018
S1	30/06/2018	12/07/2018	06/07/2018
S1	26/06/2018	20/07/2018	08/07/2018
S1	26/06/2018	20/07/2018	08/07/2018
LC	01/07/2018	17/07/2018	09/07/2018
S2	02/07/2018	17/07/2018	09/07/2018
S1	30/06/2018	24/07/2018	12/07/2018
S2	02/07/2018	22/07/2018	12/07/2018
S2	05/07/2018	20/07/2018	12/07/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	08/07/2018	20/07/2018	14/07/2018
S1	08/07/2018	20/07/2018	14/07/2018
S2	02/07/2018	01/08/2018	17/07/2018
S2	05/07/2018	30/07/2018	17/07/2018
S1	12/07/2018	24/07/2018	18/07/2018
S1	08/07/2018	01/08/2018	20/07/2018
S1	12/07/2018	05/08/2018	24/07/2018
S2	17/07/2018	01/08/2018	24/07/2018
S2	20/07/2018	30/07/2018	25/07/2018
S1	20/07/2018	01/08/2018	26/07/2018
S2	22/07/2018	01/08/2018	27/07/2018
S1	24/07/2018	05/08/2018	30/07/2018
S1	20/07/2018	13/08/2018	01/08/2018
S1	05/08/2018	05/08/2018	05/08/2018
S1	24/07/2018	17/08/2018	05/08/2018
S1	01/08/2018	13/08/2018	07/08/2018
S1	05/08/2018	17/08/2018	11/08/2018
S1	01/08/2018	25/08/2018	13/08/2018
S2	01/08/2018	31/08/2018	16/08/2018
S1	12/08/2018	24/08/2018	18/08/2018
S1	13/08/2018	25/08/2018	19/08/2018
S1	17/08/2018	29/08/2018	23/08/2018
S1	12/08/2018	05/09/2018	24/08/2018
S1	13/08/2018	06/09/2018	25/08/2018
S1	17/08/2018	10/09/2018	29/08/2018
S1	24/08/2018	05/09/2018	30/08/2018
S1	25/08/2018	06/09/2018	31/08/2018
S1	29/08/2018	10/09/2018	04/09/2018
S1	24/08/2018	17/09/2018	05/09/2018
S2	31/08/2018	10/09/2018	05/09/2018
S1	25/08/2018	18/09/2018	06/09/2018
S2	03/09/2018	13/09/2018	08/09/2018
S1	29/08/2018	22/09/2018	10/09/2018
S2	03/09/2018	18/09/2018	10/09/2018
S1	05/09/2018	17/09/2018	11/09/2018
LC	03/09/2018	19/09/2018	11/09/2018
S1	06/09/2018	18/09/2018	12/09/2018
S1	06/09/2018	18/09/2018	12/09/2018
S2	08/09/2018	18/09/2018	13/09/2018
S2	31/08/2018	30/09/2018	15/09/2018
S1	10/09/2018	22/09/2018	16/09/2018
S1	05/09/2018	29/09/2018	17/09/2018
S2	05/09/2018	30/09/2018	17/09/2018
S1	06/09/2018	30/09/2018	18/09/2018
S1	06/09/2018	30/09/2018	18/09/2018
S2	10/09/2018	30/09/2018	20/09/2018
S1	10/09/2018	04/10/2018	22/09/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	17/09/2018	29/09/2018	23/09/2018
S2	08/09/2018	08/10/2018	23/09/2018
S1	18/09/2018	30/09/2018	24/09/2018
S1	18/09/2018	30/09/2018	24/09/2018
S2	13/09/2018	08/10/2018	25/09/2018
S1	22/09/2018	04/10/2018	28/09/2018
S2	18/09/2018	08/10/2018	28/09/2018
S1	17/09/2018	11/10/2018	29/09/2018
S1	18/09/2018	12/10/2018	30/09/2018
S1	18/09/2018	12/10/2018	30/09/2018
S1	22/09/2018	16/10/2018	04/10/2018
S1	29/09/2018	11/10/2018	05/10/2018
S1	30/09/2018	12/10/2018	06/10/2018
S1	30/09/2018	12/10/2018	06/10/2018
S1	04/10/2018	16/10/2018	10/10/2018
S1	29/09/2018	23/10/2018	11/10/2018
S1	30/09/2018	24/10/2018	12/10/2018
S1	30/09/2018	24/10/2018	12/10/2018
S1	04/10/2018	28/10/2018	16/10/2018
S1	11/10/2018	23/10/2018	17/10/2018
S1	12/10/2018	24/10/2018	18/10/2018
S1	12/10/2018	24/10/2018	18/10/2018
S2	08/10/2018	28/10/2018	18/10/2018
S2	08/10/2018	02/11/2018	20/10/2018
S1	16/10/2018	28/10/2018	22/10/2018
S1	11/10/2018	04/11/2018	23/10/2018
S1	12/10/2018	05/11/2018	24/10/2018
S1	16/10/2018	09/11/2018	28/10/2018
S1	23/10/2018	04/11/2018	29/10/2018
S1	24/10/2018	05/11/2018	30/10/2018
S1	28/10/2018	09/11/2018	03/11/2018
S1	23/10/2018	16/11/2018	04/11/2018
S1	24/10/2018	17/11/2018	05/11/2018
S1	28/10/2018	21/11/2018	09/11/2018
S1	04/11/2018	16/11/2018	10/11/2018
S1	05/11/2018	17/11/2018	11/11/2018
LC	06/11/2018	22/11/2018	14/11/2018
S1	09/11/2018	21/11/2018	15/11/2018
S1	04/11/2018	28/11/2018	16/11/2018
S1	05/11/2018	29/11/2018	17/11/2018
S1	09/11/2018	03/12/2018	21/11/2018
S1	16/11/2018	28/11/2018	22/11/2018
S1	17/11/2018	29/11/2018	23/11/2018
LC	15/11/2018	01/12/2018	23/11/2018
S1	21/11/2018	03/12/2018	27/11/2018
S1	16/11/2018	10/12/2018	28/11/2018
S1	17/11/2018	11/12/2018	29/11/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	21/11/2018	15/12/2018	03/12/2018
S1	28/11/2018	10/12/2018	04/12/2018
S1	29/11/2018	11/12/2018	05/12/2018
S1	03/12/2018	15/12/2018	09/12/2018
S1	28/11/2018	22/12/2018	10/12/2018
S1	03/12/2018	27/12/2018	15/12/2018
S1	10/12/2018	22/12/2018	16/12/2018
S1	11/12/2018	23/12/2018	17/12/2018
S1	15/12/2018	27/12/2018	21/12/2018
S1	15/12/2018	08/01/2019	27/12/2018
S1	23/12/2018	04/01/2019	29/12/2018
S1	27/12/2018	08/01/2019	02/01/2019
S1	22/12/2018	15/01/2019	03/01/2019
S1	23/12/2018	16/01/2019	04/01/2019
S1	04/01/2019	16/01/2019	10/01/2019
S1	08/01/2019	20/01/2019	14/01/2019
S1	04/01/2019	28/01/2019	16/01/2019
S1	15/01/2019	27/01/2019	21/01/2019
S1	16/01/2019	28/01/2019	22/01/2019
S2	18/01/2019	02/02/2019	25/01/2019
S1	20/01/2019	01/02/2019	26/01/2019
S1	16/01/2019	09/02/2019	28/01/2019
S1	20/01/2019	13/02/2019	01/02/2019
S1	28/01/2019	09/02/2019	03/02/2019
S2	31/01/2019	10/02/2019	05/02/2019
S1	01/02/2019	13/02/2019	07/02/2019
S2	31/01/2019	15/02/2019	07/02/2019
S1	27/01/2019	20/02/2019	08/02/2019
S1	28/01/2019	21/02/2019	09/02/2019
S2	02/02/2019	22/02/2019	12/02/2019
S2	31/01/2019	25/02/2019	12/02/2019
S1	01/02/2019	25/02/2019	13/02/2019
S2	02/02/2019	27/02/2019	14/02/2019
S1	09/02/2019	21/02/2019	15/02/2019
S2	10/02/2019	25/02/2019	17/02/2019
LC	10/02/2019	26/02/2019	18/02/2019
S1	13/02/2019	25/02/2019	19/02/2019
S2	15/02/2019	25/02/2019	20/02/2019
S1	09/02/2019	05/03/2019	21/02/2019
S2	10/02/2019	07/03/2019	22/02/2019
S1	13/02/2019	09/03/2019	25/02/2019
S2	15/02/2019	07/03/2019	25/02/2019
S1	20/02/2019	04/03/2019	26/02/2019
S1	21/02/2019	05/03/2019	27/02/2019
LC	19/02/2019	07/03/2019	27/02/2019
S2	25/02/2019	07/03/2019	02/03/2019
S1	25/02/2019	09/03/2019	03/03/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	20/02/2019	16/03/2019	04/03/2019
S1	21/02/2019	17/03/2019	05/03/2019
S1	25/02/2019	21/03/2019	09/03/2019
S1	04/03/2019	16/03/2019	10/03/2019
S1	05/03/2019	17/03/2019	11/03/2019
S2	25/02/2019	27/03/2019	12/03/2019
S2	27/02/2019	29/03/2019	14/03/2019
S1	09/03/2019	21/03/2019	15/03/2019
S1	04/03/2019	28/03/2019	16/03/2019
S1	05/03/2019	29/03/2019	17/03/2019
S2	07/03/2019	27/03/2019	17/03/2019
S2	07/03/2019	01/04/2019	19/03/2019
S1	09/03/2019	02/04/2019	21/03/2019
S1	16/03/2019	28/03/2019	22/03/2019
S2	07/03/2019	06/04/2019	22/03/2019
S1	17/03/2019	29/03/2019	23/03/2019
S1	21/03/2019	02/04/2019	27/03/2019
S1	16/03/2019	09/04/2019	28/03/2019
S1	17/03/2019	10/04/2019	29/03/2019
S2	27/03/2019	06/04/2019	01/04/2019
S1	21/03/2019	14/04/2019	02/04/2019
S1	28/03/2019	09/04/2019	03/04/2019
S1	29/03/2019	10/04/2019	04/04/2019
S2	29/03/2019	13/04/2019	05/04/2019
LC	30/03/2019	15/04/2019	07/04/2019
S1	02/04/2019	14/04/2019	08/04/2019
S1	28/03/2019	21/04/2019	09/04/2019
S1	29/03/2019	22/04/2019	10/04/2019
S2	29/03/2019	28/04/2019	13/04/2019
S1	02/04/2019	26/04/2019	14/04/2019
S1	09/04/2019	21/04/2019	15/04/2019
S1	10/04/2019	22/04/2019	16/04/2019
S1	10/04/2019	22/04/2019	16/04/2019
S2	01/04/2019	01/05/2019	16/04/2019
S2	06/04/2019	01/05/2019	18/04/2019
S1	14/04/2019	26/04/2019	20/04/2019
S2	13/04/2019	28/04/2019	20/04/2019
S1	09/04/2019	03/05/2019	21/04/2019
S1	10/04/2019	04/05/2019	22/04/2019
LC	15/04/2019	01/05/2019	23/04/2019
S1	14/04/2019	08/05/2019	26/04/2019
S1	21/04/2019	03/05/2019	27/04/2019
S1	22/04/2019	04/05/2019	28/04/2019
S1	26/04/2019	08/05/2019	02/05/2019
S1	21/04/2019	15/05/2019	03/05/2019
S1	22/04/2019	16/05/2019	04/05/2019
S1	22/04/2019	16/05/2019	04/05/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	26/04/2019	20/05/2019	08/05/2019
S2	28/04/2019	18/05/2019	08/05/2019
S1	03/05/2019	15/05/2019	09/05/2019
S1	04/05/2019	16/05/2019	10/05/2019
S1	08/05/2019	20/05/2019	14/05/2019
S1	03/05/2019	27/05/2019	15/05/2019
S1	04/05/2019	28/05/2019	16/05/2019
S1	08/05/2019	01/06/2019	20/05/2019
S1	15/05/2019	27/05/2019	21/05/2019
S1	16/05/2019	28/05/2019	22/05/2019
S1	16/05/2019	28/05/2019	22/05/2019
S1	20/05/2019	01/06/2019	26/05/2019
S1	15/05/2019	08/06/2019	27/05/2019
S1	16/05/2019	09/06/2019	28/05/2019
S1	16/05/2019	09/06/2019	28/05/2019
S2	18/05/2019	07/06/2019	28/05/2019
S1	20/05/2019	13/06/2019	01/06/2019
S1	27/05/2019	08/06/2019	02/06/2019
S1	28/05/2019	09/06/2019	03/06/2019
S1	28/05/2019	09/06/2019	03/06/2019
S1	01/06/2019	13/06/2019	07/06/2019
S1	27/05/2019	20/06/2019	08/06/2019
S1	28/05/2019	21/06/2019	09/06/2019
S1	01/06/2019	25/06/2019	13/06/2019
S1	08/06/2019	20/06/2019	14/06/2019
S1	09/06/2019	21/06/2019	15/06/2019
S1	09/06/2019	21/06/2019	15/06/2019
S2	10/06/2019	20/06/2019	15/06/2019
S2	07/06/2019	27/06/2019	17/06/2019
S2	10/06/2019	25/06/2019	17/06/2019
S1	13/06/2019	25/06/2019	19/06/2019
S1	08/06/2019	02/07/2019	20/06/2019
S2	10/06/2019	30/06/2019	20/06/2019
S1	09/06/2019	03/07/2019	21/06/2019
S1	09/06/2019	03/07/2019	21/06/2019
S2	07/06/2019	07/07/2019	22/06/2019
S2	10/06/2019	05/07/2019	22/06/2019
S1	13/06/2019	07/07/2019	25/06/2019
S2	20/06/2019	30/06/2019	25/06/2019
S2	10/06/2019	10/07/2019	25/06/2019
S1	20/06/2019	02/07/2019	26/06/2019
S1	21/06/2019	03/07/2019	27/06/2019
S1	21/06/2019	03/07/2019	27/06/2019
S2	20/06/2019	05/07/2019	27/06/2019
S2	25/06/2019	05/07/2019	30/06/2019
S2	20/06/2019	10/07/2019	30/06/2019
S1	25/06/2019	07/07/2019	01/07/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	20/06/2019	14/07/2019	02/07/2019
S2	27/06/2019	07/07/2019	02/07/2019
S2	25/06/2019	10/07/2019	02/07/2019
S1	21/06/2019	15/07/2019	03/07/2019
S1	21/06/2019	15/07/2019	03/07/2019
S2	30/06/2019	10/07/2019	05/07/2019
LC	27/06/2019	13/07/2019	05/07/2019
S1	25/06/2019	19/07/2019	07/07/2019
S1	02/07/2019	14/07/2019	08/07/2019
S1	03/07/2019	15/07/2019	09/07/2019
S1	03/07/2019	15/07/2019	09/07/2019
S2	27/06/2019	22/07/2019	09/07/2019
S1	07/07/2019	19/07/2019	13/07/2019
S1	02/07/2019	26/07/2019	14/07/2019
S2	07/07/2019	22/07/2019	14/07/2019
S1	03/07/2019	27/07/2019	15/07/2019
S1	03/07/2019	27/07/2019	15/07/2019
S2	30/06/2019	30/07/2019	15/07/2019
S1	05/07/2017	29/07/2021	17/07/2019
S2	05/07/2019	30/07/2019	17/07/2019
S2	10/07/2019	25/07/2019	17/07/2019
S1	07/07/2019	31/07/2019	19/07/2019
S1	14/07/2019	26/07/2019	20/07/2019
S2	05/07/2019	04/08/2019	20/07/2019
S2	10/07/2019	30/07/2019	20/07/2019
S1	15/07/2019	27/07/2019	21/07/2019
S1	15/07/2019	27/07/2019	21/07/2019
S2	07/07/2019	06/08/2019	22/07/2019
S2	10/07/2019	04/08/2019	22/07/2019
S1	19/07/2019	31/07/2019	25/07/2019
S1	14/07/2019	07/08/2019	26/07/2019
S1	15/07/2019	08/08/2019	27/07/2019
S1	15/07/2019	08/08/2019	27/07/2019
S2	22/07/2019	06/08/2019	29/07/2019
S1	19/07/2019	12/08/2019	31/07/2019
S1	26/07/2019	07/08/2019	01/08/2019
S2	22/07/2019	11/08/2019	01/08/2019
S1	27/07/2019	08/08/2019	02/08/2019
S1	27/07/2019	08/08/2019	02/08/2019
S1	31/07/2019	12/08/2019	06/08/2019
S2	22/07/2019	21/08/2019	06/08/2019
S1	26/07/2019	19/08/2019	07/08/2019
S1	27/07/2019	20/08/2019	08/08/2019
S1	27/07/2019	20/08/2019	08/08/2019
S2	30/07/2019	19/08/2019	09/08/2019
S2	04/08/2019	19/08/2019	11/08/2019
S1	31/07/2019	24/08/2019	12/08/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	07/08/2019	19/08/2019	13/08/2019
LC	05/08/2019	21/08/2019	13/08/2019
S2	06/08/2019	21/08/2019	13/08/2019
S1	08/08/2019	20/08/2019	14/08/2019
S1	08/08/2019	20/08/2019	14/08/2019
S2	30/07/2019	29/08/2019	14/08/2019
S2	11/08/2019	21/08/2019	16/08/2019
S2	04/08/2019	29/08/2019	16/08/2019
S1	12/08/2019	24/08/2019	18/08/2019
S1	07/08/2019	31/08/2019	19/08/2019
S2	06/08/2019	05/09/2019	21/08/2019
S2	11/08/2019	05/09/2019	23/08/2019
S2	19/08/2019	29/08/2019	24/08/2019
S2	21/08/2019	05/09/2019	28/08/2019
S2	19/08/2019	08/09/2019	29/08/2019
LC	21/08/2019	06/09/2019	29/08/2019
S1	20/08/2019	13/09/2019	01/09/2019
S2	21/08/2019	15/09/2019	02/09/2019
S2	29/08/2019	08/09/2019	03/09/2019
LC	30/08/2019	15/09/2019	07/09/2019
S2	05/09/2019	15/09/2019	10/09/2019
LC	06/09/2019	22/09/2019	14/09/2019
S1	12/09/2019	24/09/2019	18/09/2019
S2	08/09/2019	03/10/2019	20/09/2019
S1	27/09/2017	09/10/2021	03/10/2019
S2	03/10/2019	13/10/2019	08/10/2019
S1	27/09/2017	21/10/2021	09/10/2019
S2	03/10/2019	18/10/2019	10/10/2019
S1	07/10/2019	19/10/2019	13/10/2019
S1	19/10/2019	31/10/2019	25/10/2019
S2	20/10/2019	09/11/2019	30/10/2019
S1	19/10/2019	12/11/2019	31/10/2019
S2	25/10/2019	09/11/2019	01/11/2019
S1	30/10/2019	11/11/2019	05/11/2019
S1	31/10/2019	12/11/2019	06/11/2019
S1	04/11/2019	16/11/2019	10/11/2019
S1	31/10/2019	24/11/2019	12/11/2019
S1	28/11/2019	10/12/2019	04/12/2019
S1	17/12/2019	29/12/2019	23/12/2019
S1	18/12/2019	30/12/2019	24/12/2019
S1	22/12/2019	03/01/2020	28/12/2019
S1	17/12/2019	10/01/2020	29/12/2019
S1	29/12/2019	10/01/2020	04/01/2020
S1	30/12/2019	11/01/2020	05/01/2020
S1	03/01/2020	15/01/2020	09/01/2020
S1	10/01/2020	22/01/2020	16/01/2020
S1	11/01/2020	23/01/2020	17/01/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	15/01/2020	27/01/2020	21/01/2020
S1	10/01/2020	03/02/2020	22/01/2020
S1	15/01/2020	08/02/2020	27/01/2020
S1	22/01/2020	03/02/2020	28/01/2020
S1	23/01/2020	04/02/2020	29/01/2020
S1	27/01/2020	08/02/2020	02/02/2020
S1	22/01/2020	15/02/2020	03/02/2020
S1	23/01/2020	16/02/2020	04/02/2020
S1	27/01/2020	20/02/2020	08/02/2020
S1	03/02/2020	15/02/2020	09/02/2020
S1	04/02/2020	16/02/2020	10/02/2020
S1	04/02/2020	16/02/2020	10/02/2020
S1	08/02/2020	20/02/2020	14/02/2020
S1	03/02/2020	27/02/2020	15/02/2020
S1	04/02/2020	28/02/2020	16/02/2020
S1	04/02/2020	28/02/2020	16/02/2020
S1	08/02/2020	03/03/2020	20/02/2020
S1	15/02/2020	27/02/2020	21/02/2020
S1	16/02/2020	28/02/2020	22/02/2020
S1	16/02/2020	28/02/2020	22/02/2020
S1	20/02/2020	03/03/2020	26/02/2020
S1	15/02/2020	10/03/2020	27/02/2020
S1	16/02/2020	11/03/2020	28/02/2020
S1	16/02/2020	11/03/2020	28/02/2020
S1	20/02/2020	15/03/2020	03/03/2020
S1	27/02/2020	10/03/2020	04/03/2020
S1	28/02/2020	11/03/2020	05/03/2020
S1	28/02/2020	11/03/2020	05/03/2020
S1	03/03/2020	15/03/2020	09/03/2020
S1	27/02/2020	22/03/2020	10/03/2020
S1	28/02/2020	23/03/2020	11/03/2020
S1	28/02/2020	23/03/2020	11/03/2020
S1	03/03/2020	27/03/2020	15/03/2020
S1	10/03/2020	22/03/2020	16/03/2020
S2	06/03/2020	26/03/2020	16/03/2020
S1	11/03/2020	23/03/2020	17/03/2020
S1	11/03/2020	23/03/2020	17/03/2020
S2	11/03/2020	26/03/2020	18/03/2020
S2	06/03/2020	31/03/2020	18/03/2020
S1	15/03/2020	27/03/2020	21/03/2020
S2	11/03/2020	31/03/2020	21/03/2020
S1	10/03/2020	03/04/2020	22/03/2020
S1	11/03/2020	04/04/2020	23/03/2020
S1	11/03/2020	04/04/2020	23/03/2020
S2	11/03/2020	10/04/2020	26/03/2020
S1	15/03/2020	08/04/2020	27/03/2020
S1	22/03/2020	03/04/2020	28/03/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	23/03/2020	02/04/2020	28/03/2020
S1	23/03/2020	04/04/2020	29/03/2020
S1	23/03/2020	04/04/2020	29/03/2020
S1	27/03/2020	08/04/2020	02/04/2020
S2	26/03/2020	10/04/2020	02/04/2020
S1	22/03/2020	15/04/2020	03/04/2020
S1	23/03/2020	16/04/2020	04/04/2020
S1	23/03/2020	16/04/2020	04/04/2020
S2	23/03/2020	17/04/2020	04/04/2020
S2	31/03/2020	10/04/2020	05/04/2020
S1	27/03/2020	20/04/2020	08/04/2020
S1	03/04/2020	15/04/2020	09/04/2020
LC	01/04/2020	17/04/2020	09/04/2020
S2	02/04/2020	17/04/2020	09/04/2020
S1	04/04/2020	16/04/2020	10/04/2020
S1	04/04/2020	16/04/2020	10/04/2020
S2	26/03/2020	25/04/2020	10/04/2020
S2	31/03/2020	25/04/2020	12/04/2020
S1	08/04/2020	20/04/2020	14/04/2020
S2	02/04/2020	27/04/2020	14/04/2020
S1	03/04/2020	27/04/2020	15/04/2020
S1	04/04/2020	28/04/2020	16/04/2020
S1	04/04/2020	28/04/2020	16/04/2020
S2	02/04/2020	02/05/2020	17/04/2020
S2	10/04/2020	25/04/2020	17/04/2020
S1	08/04/2020	02/05/2020	20/04/2020
S1	15/04/2020	27/04/2020	21/04/2020
S1	16/04/2020	28/04/2020	22/04/2020
S1	16/04/2020	28/04/2020	22/04/2020
S2	17/04/2020	27/04/2020	22/04/2020
S2	10/04/2020	05/05/2020	22/04/2020
S2	17/04/2020	02/05/2020	24/04/2020
S2	10/04/2020	10/05/2020	25/04/2020
S1	20/04/2020	02/05/2020	26/04/2020
S1	15/04/2020	09/05/2020	27/04/2020
S1	16/04/2020	10/05/2020	28/04/2020
S1	16/04/2020	10/05/2020	28/04/2020
S2	17/04/2020	12/05/2020	29/04/2020
S2	25/04/2020	05/05/2020	30/04/2020
S1	20/04/2020	14/05/2020	02/05/2020
S2	25/04/2020	10/05/2020	02/05/2020
S1	28/04/2020	10/05/2020	04/05/2020
S1	28/04/2020	10/05/2020	04/05/2020
S2	27/04/2020	12/05/2020	04/05/2020
S2	25/04/2020	15/05/2020	05/05/2020
S2	02/05/2020	12/05/2020	07/05/2020
S1	02/05/2020	14/05/2020	08/05/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	28/04/2020	22/05/2020	10/05/2020
S1	28/04/2020	22/05/2020	10/05/2020
S2	05/05/2020	15/05/2020	10/05/2020
S2	27/04/2020	27/05/2020	12/05/2020
S1	02/05/2020	26/05/2020	14/05/2020
S2	02/05/2020	27/05/2020	14/05/2020
S1	09/05/2020	21/05/2020	15/05/2020
S1	10/05/2020	22/05/2020	16/05/2020
S1	10/05/2020	22/05/2020	16/05/2020
S2	12/05/2020	27/05/2020	19/05/2020
S2	05/05/2020	04/06/2020	20/05/2020
LC	12/05/2020	28/05/2020	20/05/2020
S1	10/05/2020	03/06/2020	22/05/2020
S1	10/05/2020	03/06/2020	22/05/2020
S2	10/05/2020	04/06/2020	22/05/2020
S2	10/05/2020	09/06/2020	25/05/2020
S2	15/05/2020	04/06/2020	25/05/2020
S2	12/05/2020	11/06/2020	27/05/2020
S2	15/05/2020	09/06/2020	27/05/2020
S1	22/05/2020	03/06/2020	28/05/2020
S1	22/05/2020	03/06/2020	28/05/2020
S1	26/05/2020	07/06/2020	01/06/2020
S1	21/05/2020	14/06/2020	02/06/2020
S1	22/05/2020	15/06/2020	03/06/2020
S1	22/05/2020	15/06/2020	03/06/2020
S2	27/05/2020	11/06/2020	03/06/2020
S1	26/05/2020	19/06/2020	07/06/2020
S1	28/05/2019	21/06/2021	08/06/2020
S1	03/06/2020	15/06/2020	09/06/2020
S1	03/06/2020	15/06/2020	09/06/2020
S2	27/05/2020	26/06/2020	11/06/2020
S1	07/06/2020	19/06/2020	13/06/2020
S1	03/06/2020	27/06/2020	15/06/2020
S2	11/06/2020	26/06/2020	18/06/2020
S1	14/06/2020	26/06/2020	20/06/2020
S1	15/06/2020	27/06/2020	21/06/2020
S1	15/06/2020	27/06/2020	21/06/2020
S2	11/06/2020	01/07/2020	21/06/2020
S1	19/06/2020	01/07/2020	25/06/2020
S1	14/06/2020	08/07/2020	26/06/2020
S1	15/06/2020	09/07/2020	27/06/2020
S1	15/06/2020	09/07/2020	27/06/2020
S1	19/06/2020	13/07/2020	01/07/2020
S1	26/06/2020	08/07/2020	02/07/2020
S1	27/06/2020	09/07/2020	03/07/2020
S1	27/06/2020	09/07/2020	03/07/2020
S2	26/06/2020	16/07/2020	06/07/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	01/07/2020	13/07/2020	07/07/2020
LC	29/06/2020	15/07/2020	07/07/2020
S1	26/06/2020	20/07/2020	08/07/2020
S2	01/07/2020	16/07/2020	08/07/2020
S1	27/06/2020	21/07/2020	09/07/2020
S1	01/07/2020	25/07/2020	13/07/2020
S1	08/07/2020	20/07/2020	14/07/2020
S1	09/07/2020	21/07/2020	15/07/2020
S1	13/07/2020	25/07/2020	19/07/2020
S1	08/07/2020	01/08/2020	20/07/2020
S1	09/07/2020	02/08/2020	21/07/2020
LC	15/07/2020	31/07/2020	23/07/2020
S1	13/07/2020	06/08/2020	25/07/2020
S1	20/07/2020	01/08/2020	26/07/2020
S2	16/07/2020	05/08/2020	26/07/2020
S1	21/07/2020	02/08/2020	27/07/2020
S1	25/07/2020	06/08/2020	31/07/2020
S1	20/07/2020	13/08/2020	01/08/2020
S1	21/07/2020	14/08/2020	02/08/2020
S1	25/07/2020	18/08/2020	06/08/2020
S1	01/08/2020	13/08/2020	07/08/2020
S1	02/08/2020	14/08/2020	08/08/2020
S2	29/07/2020	18/08/2020	08/08/2020
S1	06/08/2020	18/08/2020	12/08/2020
S1	01/08/2020	25/08/2020	13/08/2020
S1	06/08/2020	30/08/2020	18/08/2020
S1	13/08/2020	25/08/2020	19/08/2020
S1	14/08/2020	26/08/2020	20/08/2020
S2	05/08/2020	04/09/2020	20/08/2020
S1	18/08/2020	30/08/2020	24/08/2020
S1	13/08/2020	06/09/2020	25/08/2020
S1	14/08/2020	07/09/2020	26/08/2020
S1	14/08/2020	07/09/2020	26/08/2020
S1	18/08/2020	11/09/2020	30/08/2020
S2	18/08/2020	12/09/2020	30/08/2020
S1	25/08/2020	06/09/2020	31/08/2020
S1	26/08/2020	07/09/2020	01/09/2020
S1	30/08/2020	11/09/2020	05/09/2020
S1	25/08/2020	18/09/2020	06/09/2020
S1	26/08/2020	19/09/2020	07/09/2020
S2	04/09/2020	14/09/2020	09/09/2020
S1	30/08/2020	23/09/2020	11/09/2020
RCM	09/09/2020	13/09/2020	11/09/2020
S1	06/09/2020	18/09/2020	12/09/2020
S1	07/09/2020	19/09/2020	13/09/2020
S1	07/09/2020	19/09/2020	13/09/2020
S1	11/09/2020	23/09/2020	17/09/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	06/09/2020	30/09/2020	18/09/2020
S1	07/09/2020	01/10/2020	19/09/2020
S1	07/09/2020	01/10/2020	19/09/2020
S1	11/09/2020	05/10/2020	23/09/2020
S1	18/09/2020	30/09/2020	24/09/2020
S1	19/09/2020	01/10/2020	25/09/2020
S1	19/09/2020	01/10/2020	25/09/2020
S1	23/09/2020	05/10/2020	29/09/2020
S2	14/09/2020	14/10/2020	29/09/2020
S1	18/09/2020	12/10/2020	30/09/2020
S1	19/09/2020	13/10/2020	01/10/2020
S1	30/09/2020	12/10/2020	06/10/2020
S1	01/10/2020	13/10/2020	07/10/2020
S1	01/10/2020	13/10/2020	07/10/2020
S1	05/10/2020	17/10/2020	11/10/2020
S1	30/09/2020	24/10/2020	12/10/2020
S1	12/10/2020	24/10/2020	18/10/2020
S1	13/10/2020	25/10/2020	19/10/2020
S1	13/10/2020	25/10/2020	19/10/2020
S1	12/10/2020	05/11/2020	24/10/2020
S1	13/10/2020	06/11/2020	25/10/2020
S1	13/10/2020	06/11/2020	25/10/2020
S1	17/10/2020	10/11/2020	29/10/2020
S1	24/10/2020	05/11/2020	30/10/2020
S1	25/10/2020	06/11/2020	31/10/2020
S1	25/10/2020	06/11/2020	31/10/2020
RCM	31/10/2020	04/11/2020	02/11/2020
S2	19/10/2020	18/11/2020	03/11/2020
S2	22/10/2020	16/11/2020	03/11/2020
S1	24/10/2020	17/11/2020	05/11/2020
S1	25/10/2020	18/11/2020	06/11/2020
S1	25/10/2020	18/11/2020	06/11/2020
RCM	04/11/2020	16/11/2020	10/11/2020
S1	05/11/2020	17/11/2020	11/11/2020
S1	06/11/2020	18/11/2020	12/11/2020
S1	06/11/2020	18/11/2020	12/11/2020
S1	10/11/2020	22/11/2020	16/11/2020
S1	05/11/2020	29/11/2020	17/11/2020
S1	06/11/2020	30/11/2020	18/11/2020
S1	17/11/2020	29/11/2020	23/11/2020
S1	18/11/2020	30/11/2020	24/11/2020
S1	18/11/2020	30/11/2020	24/11/2020
S1	22/11/2020	04/12/2020	28/11/2020
S1	17/11/2020	11/12/2020	29/11/2020
S1	18/11/2020	12/12/2020	30/11/2020
S1	18/11/2020	12/12/2020	30/11/2020
S1	22/11/2020	16/12/2020	04/12/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	29/11/2020	11/12/2020	05/12/2020
S1	30/11/2020	12/12/2020	06/12/2020
S1	30/11/2020	12/12/2020	06/12/2020
S1	04/12/2020	16/12/2020	10/12/2020
S1	29/11/2020	23/12/2020	11/12/2020
S1	30/11/2020	24/12/2020	12/12/2020
S1	04/12/2020	28/12/2020	16/12/2020
S1	11/12/2020	23/12/2020	17/12/2020
S1	12/12/2020	24/12/2020	18/12/2020
S1	16/12/2020	28/12/2020	22/12/2020
S1	11/12/2020	04/01/2021	23/12/2020
S1	12/12/2020	05/01/2021	24/12/2020
S1	16/12/2020	09/01/2021	28/12/2020
S1	23/12/2020	04/01/2021	29/12/2020
S1	28/12/2020	09/01/2021	03/01/2021
S1	23/12/2020	16/01/2021	04/01/2021
S1	24/12/2020	17/01/2021	05/01/2021
S1	28/12/2020	21/01/2021	09/01/2021
S1	04/01/2021	16/01/2021	10/01/2021
S1	09/01/2021	21/01/2021	15/01/2021
S1	04/01/2021	28/01/2021	16/01/2021
S1	05/01/2021	29/01/2021	17/01/2021
S1	09/01/2021	02/02/2021	21/01/2021
S1	16/01/2021	28/01/2021	22/01/2021
S1	17/01/2021	29/01/2021	23/01/2021
S1	21/01/2021	02/02/2021	27/01/2021
S1	16/01/2021	09/02/2021	28/01/2021
S1	17/01/2021	10/02/2021	29/01/2021
S2	27/01/2021	06/02/2021	01/02/2021
S1	21/01/2021	14/02/2021	02/02/2021
S1	28/01/2021	09/02/2021	03/02/2021
S2	27/01/2021	11/02/2021	03/02/2021
S1	29/01/2021	10/02/2021	04/02/2021
S1	29/01/2021	10/02/2021	04/02/2021
LC	30/01/2021	15/02/2021	07/02/2021
S1	02/02/2021	14/02/2021	08/02/2021
S1	28/01/2021	21/02/2021	09/02/2021
S2	04/02/2021	14/02/2021	09/02/2021
S1	29/01/2021	22/02/2021	10/02/2021
S1	29/01/2021	22/02/2021	10/02/2021
S1	02/02/2021	26/02/2021	14/02/2021
S1	09/02/2021	21/02/2021	15/02/2021
S1	10/02/2021	22/02/2021	16/02/2021
S1	10/02/2021	22/02/2021	16/02/2021
S2	06/02/2021	03/03/2021	18/02/2021
S1	14/02/2021	26/02/2021	20/02/2021
S1	09/02/2021	05/03/2021	21/02/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	11/02/2021	03/03/2021	21/02/2021
S2	06/02/2021	08/03/2021	21/02/2021
S1	10/02/2021	06/03/2021	22/02/2021
LC	15/02/2021	03/03/2021	23/02/2021
S2	11/02/2021	08/03/2021	23/02/2021
S1	14/02/2021	10/03/2021	26/02/2021
S1	21/02/2021	05/03/2021	27/02/2021
S1	22/02/2021	06/03/2021	28/02/2021
S1	26/02/2021	10/03/2021	04/03/2021
S1	21/02/2021	17/03/2021	05/03/2021
S1	22/02/2021	18/03/2021	06/03/2021
S1	22/02/2021	18/03/2021	06/03/2021
S1	26/02/2021	22/03/2021	10/03/2021
S1	05/03/2021	17/03/2021	11/03/2021
LC	03/03/2021	19/03/2021	11/03/2021
S1	06/03/2021	18/03/2021	12/03/2021
S2	03/03/2021	28/03/2021	15/03/2021
S1	10/03/2021	22/03/2021	16/03/2021
S1	05/03/2021	29/03/2021	17/03/2021
S1	06/03/2021	30/03/2021	18/03/2021
S2	03/03/2021	02/04/2021	18/03/2021
S2	08/03/2021	28/03/2021	18/03/2021
LC	12/03/2021	28/03/2021	20/03/2021
S2	08/03/2021	02/04/2021	20/03/2021
S1	10/03/2021	03/04/2021	22/03/2021
S1	17/03/2021	29/03/2021	23/03/2021
S2	08/03/2021	07/04/2021	23/03/2021
S1	18/03/2021	30/03/2021	24/03/2021
S1	18/03/2021	30/03/2021	24/03/2021
S1	22/03/2021	03/04/2021	28/03/2021
S1	17/03/2021	10/04/2021	29/03/2021
S1	18/03/2021	11/04/2021	30/03/2021
S1	18/03/2021	11/04/2021	30/03/2021
S2	28/03/2021	07/04/2021	02/04/2021
S1	22/03/2021	15/04/2021	03/04/2021
S1	29/03/2021	10/04/2021	04/04/2021
S1	30/03/2021	11/04/2021	05/04/2021
S1	30/03/2021	11/04/2021	05/04/2021
S2	28/03/2021	17/04/2021	07/04/2021
S1	03/04/2021	15/04/2021	09/04/2021
S2	02/04/2021	17/04/2021	09/04/2021
S2	28/03/2021	22/04/2021	09/04/2021
S1	29/03/2021	22/04/2021	10/04/2021
S1	30/03/2021	23/04/2021	11/04/2021
S1	30/03/2021	23/04/2021	11/04/2021
S2	02/04/2021	22/04/2021	12/04/2021
S2	07/04/2021	17/04/2021	12/04/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	28/03/2021	27/04/2021	12/04/2021
S2	02/04/2021	27/04/2021	14/04/2021
S2	07/04/2021	22/04/2021	14/04/2021
S1	03/04/2021	27/04/2021	15/04/2021
S1	10/04/2021	22/04/2021	16/04/2021
S1	11/04/2021	23/04/2021	17/04/2021
S1	11/04/2021	23/04/2021	17/04/2021
S2	02/04/2021	02/05/2021	17/04/2021
S2	07/04/2021	27/04/2021	17/04/2021
S2	07/04/2021	02/05/2021	19/04/2021
S2	15/04/2021	25/04/2021	20/04/2021
S1	15/04/2021	27/04/2021	21/04/2021
S1	15/04/2021	27/04/2021	21/04/2021
S1	10/04/2021	04/05/2021	22/04/2021
S2	17/04/2021	27/04/2021	22/04/2021
S1	11/04/2021	05/05/2021	23/04/2021
S1	11/04/2021	05/05/2021	23/04/2021
S2	17/04/2021	02/05/2021	24/04/2021
S2	22/04/2021	02/05/2021	27/04/2021
S1	22/04/2021	04/05/2021	28/04/2021
S1	23/04/2021	05/05/2021	29/04/2021
S1	23/04/2021	05/05/2021	29/04/2021
S1	23/04/2021	05/05/2021	29/04/2021
S1	27/04/2021	09/05/2021	03/05/2021
S1	27/04/2021	09/05/2021	03/05/2021
S1	22/04/2021	16/05/2021	04/05/2021
S1	23/04/2021	17/05/2021	05/05/2021
S1	23/04/2021	17/05/2021	05/05/2021
S1	23/04/2021	17/05/2021	05/05/2021
S1	27/04/2021	21/05/2021	09/05/2021
S1	27/04/2021	21/05/2021	09/05/2021
S1	04/05/2021	16/05/2021	10/05/2021
S2	25/04/2021	25/05/2021	10/05/2021
S1	05/05/2021	17/05/2021	11/05/2021
S1	05/05/2021	17/05/2021	11/05/2021
S1	05/05/2021	17/05/2021	11/05/2021
S1	09/05/2021	21/05/2021	15/05/2021
S1	09/05/2021	21/05/2021	15/05/2021
S1	04/05/2021	28/05/2021	16/05/2021
S1	05/05/2021	29/05/2021	17/05/2021
S1	05/05/2021	29/05/2021	17/05/2021
S1	05/05/2021	29/05/2021	17/05/2021
S1	09/05/2021	02/06/2021	21/05/2021
S1	09/05/2021	02/06/2021	21/05/2021
S1	16/05/2021	28/05/2021	22/05/2021
S1	17/05/2021	29/05/2021	23/05/2021
S1	17/05/2021	29/05/2021	23/05/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	21/05/2021	02/06/2021	27/05/2021
S1	16/05/2021	09/06/2021	28/05/2021
S1	17/05/2021	10/06/2021	29/05/2021
S1	17/05/2021	10/06/2021	29/05/2021
S2	25/05/2021	04/06/2021	30/05/2021
S2	25/05/2021	09/06/2021	01/06/2021
S1	21/05/2021	14/06/2021	02/06/2021
S1	28/05/2021	09/06/2021	03/06/2021
S1	29/05/2021	10/06/2021	04/06/2021
S1	29/05/2021	10/06/2021	04/06/2021
S2	25/05/2021	14/06/2021	04/06/2021
S2	01/06/2021	11/06/2021	06/06/2021
S2	25/05/2021	19/06/2021	06/06/2021
S1	02/06/2021	14/06/2021	08/06/2021
S1	28/05/2021	21/06/2021	09/06/2021
S2	04/06/2021	14/06/2021	09/06/2021
S1	29/05/2021	22/06/2021	10/06/2021
S1	29/05/2021	22/06/2021	10/06/2021
S2	04/06/2021	19/06/2021	11/06/2021
S1	02/06/2021	26/06/2021	14/06/2021
S2	09/06/2021	19/06/2021	14/06/2021
S1	09/06/2021	21/06/2021	15/06/2021
LC	07/06/2021	23/06/2021	15/06/2021
S1	10/06/2021	22/06/2021	16/06/2021
S1	10/06/2021	22/06/2021	16/06/2021
S1	14/06/2021	26/06/2021	20/06/2021
S1	09/06/2021	03/07/2021	21/06/2021
S2	11/06/2021	01/07/2021	21/06/2021
S1	10/06/2021	04/07/2021	22/06/2021
S1	10/06/2021	04/07/2021	22/06/2021
S1	14/06/2021	08/07/2021	26/06/2021
S1	21/06/2021	03/07/2021	27/06/2021
S1	22/06/2021	04/07/2021	28/06/2021
S1	22/06/2021	04/07/2021	28/06/2021
S1	26/06/2021	08/07/2021	02/07/2021
S1	21/06/2021	15/07/2021	03/07/2021
S1	22/06/2021	16/07/2021	04/07/2021
S1	22/06/2021	16/07/2021	04/07/2021
S2	19/06/2021	19/07/2021	04/07/2021
S1	26/06/2021	20/07/2021	08/07/2021
S2	01/07/2021	16/07/2021	08/07/2021
S1	03/07/2021	15/07/2021	09/07/2021
S1	04/07/2021	16/07/2021	10/07/2021
S1	04/07/2021	16/07/2021	10/07/2021
S1	08/07/2021	20/07/2021	14/07/2021
S2	01/07/2021	31/07/2021	16/07/2021
S1	15/07/2021	27/07/2021	21/07/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	16/07/2021	28/07/2021	22/07/2021
S1	16/07/2021	28/07/2021	22/07/2021
S2	16/07/2021	31/07/2021	23/07/2021
LC	18/07/2021	03/08/2021	26/07/2021
S2	19/07/2021	03/08/2021	26/07/2021
S2	16/07/2021	15/08/2021	31/07/2021
S1	27/07/2021	08/08/2021	02/08/2021
S1	28/07/2021	09/08/2021	03/08/2021
S1	28/07/2021	09/08/2021	03/08/2021
S2	31/07/2021	15/08/2021	07/08/2021
S1	09/08/2021	21/08/2021	15/08/2021
S1	09/08/2021	21/08/2021	15/08/2021
S2	31/07/2021	30/08/2021	15/08/2021
S1	13/08/2021	25/08/2021	19/08/2021
S2	15/08/2021	30/08/2021	22/08/2021
S1	21/08/2021	02/09/2021	27/08/2021
S1	21/08/2021	02/09/2021	27/08/2021
S1	25/08/2021	06/09/2021	31/08/2021
S1	01/09/2021	13/09/2021	07/09/2021
S1	02/09/2021	14/09/2021	08/09/2021
S1	02/09/2021	14/09/2021	08/09/2021
S2	30/08/2021	19/09/2021	09/09/2021
S1	06/09/2021	18/09/2021	12/09/2021
S2	07/09/2021	22/09/2021	14/09/2021
S1	13/09/2021	25/09/2021	19/09/2021
S1	14/09/2021	26/09/2021	20/09/2021
S1	14/09/2021	26/09/2021	20/09/2021
S1	18/09/2021	30/09/2021	24/09/2021
S2	19/09/2021	04/10/2021	26/09/2021
S1	26/09/2021	08/10/2021	02/10/2021
S1	26/09/2021	08/10/2021	02/10/2021
S1	30/09/2021	12/10/2021	06/10/2021
S1	08/10/2021	20/10/2021	14/10/2021
S1	08/10/2021	20/10/2021	14/10/2021
S1	12/10/2021	24/10/2021	18/10/2021
S1	20/10/2021	01/11/2021	26/10/2021
S1	20/10/2021	01/11/2021	26/10/2021
S1	24/10/2021	05/11/2021	30/10/2021
S1	31/10/2021	12/11/2021	06/11/2021
S1	01/11/2021	13/11/2021	07/11/2021
S1	01/11/2021	13/11/2021	07/11/2021
S1	05/11/2021	17/11/2021	11/11/2021
S1	12/11/2021	24/11/2021	18/11/2021
S1	13/11/2021	25/11/2021	19/11/2021
S1	24/11/2021	06/12/2021	30/11/2021
S1	25/11/2021	07/12/2021	01/12/2021
S1	29/11/2021	11/12/2021	05/12/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	06/12/2021	18/12/2021	12/12/2021
S1	07/12/2021	19/12/2021	13/12/2021
S1	11/12/2021	23/12/2021	17/12/2021
S1	23/12/2021	04/01/2022	29/12/2021
S1	04/01/2022	16/01/2022	10/01/2022
S1	16/01/2022	28/01/2022	22/01/2022
LC	17/01/2022	02/02/2022	25/01/2022
LC	17/01/2022	10/02/2022	29/01/2022
S1	24/01/2022	05/02/2022	30/01/2022
S1	28/01/2022	09/02/2022	03/02/2022
LC	02/02/2022	10/02/2022	06/02/2022
S2	30/01/2022	19/02/2022	09/02/2022
S2	30/01/2022	01/03/2022	14/02/2022
S2	19/02/2022	01/03/2022	24/02/2022
S2	19/02/2022	06/03/2022	26/02/2022
S2	01/03/2022	26/03/2022	13/03/2022
S2	01/03/2022	31/03/2022	16/03/2022
S2	06/03/2022	26/03/2022	16/03/2022
S2	06/03/2022	31/03/2022	18/03/2022
S2	26/03/2022	10/04/2022	02/04/2022
S2	31/03/2022	10/04/2022	05/04/2022
S2	26/03/2022	15/04/2022	05/04/2022
S2	31/03/2022	15/04/2022	07/04/2022
S2	26/03/2022	20/04/2022	07/04/2022
S2	31/03/2022	20/04/2022	10/04/2022
S2	10/04/2022	20/04/2022	15/04/2022
S2	31/03/2022	30/04/2022	15/04/2022
S2	10/04/2022	30/04/2022	20/04/2022
S2	15/04/2022	30/04/2022	22/04/2022
S2	20/04/2022	30/04/2022	25/04/2022

Appendix Table 2: Images used in the analysis at the 5 km from the terminus point on Hubbard Glacier. LC is Landsat, S1 is Sentinel-1 (includes Sentinel-1a and Sentinel-1b), S2 is Sentinel-2 (includes Sentinel-2a and Sentinel-2b), TSX/TDX is TerraSAR-X/TanDEM-X, R2 is RADARSAT-2, and RCM is RADARSAT Constellation Mission.

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
LC	12/07/2013	28/07/2013	20/07/2013
LC	28/07/2013	13/08/2013	05/08/2013
LC	08/11/2013	24/11/2013	16/11/2013
LC	20/01/2014	05/02/2014	28/01/2014
LC	05/02/2014	21/02/2014	13/02/2014
R2	03/02/2014	27/02/2014	15/02/2014
LC	28/02/2014	16/03/2014	08/03/2014
R2	27/02/2014	23/03/2014	11/03/2014
LC	16/03/2014	01/04/2014	24/03/2014
LC	25/03/2014	10/04/2014	02/04/2014
LC	01/04/2014	17/04/2014	09/04/2014
LC	10/04/2014	26/04/2014	18/04/2014
LC	17/04/2014	03/05/2014	25/04/2014
LC	23/08/2014	08/09/2014	31/08/2014
LC	08/09/2014	24/09/2014	16/09/2014
LC	11/11/2014	27/11/2014	19/11/2014
S1	08/11/2014	02/12/2014	20/11/2014
S1	02/12/2014	26/12/2014	14/12/2014
S1	26/12/2014	19/01/2015	07/01/2015
S1	19/01/2015	12/02/2015	31/01/2015
S1	12/02/2015	08/03/2015	24/02/2015
R2	22/02/2015	18/03/2015	06/03/2015
TSX/TDX	03/03/2015	14/03/2015	08/03/2015
S1	08/03/2015	01/04/2015	20/03/2015
LC	19/03/2015	04/04/2015	27/03/2015
LC	28/03/2015	13/04/2015	05/04/2015
S1	01/04/2015	25/04/2015	13/04/2015
LC	13/04/2015	29/04/2015	21/04/2015
S1	25/04/2015	19/05/2015	07/05/2015
LC	29/04/2015	15/05/2015	07/05/2015
LC	06/05/2015	22/05/2015	14/05/2015
LC	15/05/2015	31/05/2015	23/05/2015
S1	19/05/2015	12/06/2015	31/05/2015
LC	31/05/2015	16/06/2015	08/06/2015
S1	12/06/2015	06/07/2015	24/06/2015
LC	23/06/2015	09/07/2015	01/07/2015
TSX/TDX	27/06/2015	08/07/2015	02/07/2015
TSX/TDX	08/07/2015	19/07/2015	13/07/2015
LC	09/07/2015	25/07/2015	17/07/2015
S1	06/07/2015	30/07/2015	18/07/2015
TSX/TDX	19/07/2015	30/07/2015	24/07/2015
TSX/TDX	30/07/2015	10/08/2015	04/08/2015

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	30/07/2015	23/08/2015	11/08/2015
TSX/TDX	10/08/2015	21/08/2015	15/08/2015
TSX/TDX	21/08/2015	01/09/2015	26/08/2015
S1	23/08/2015	16/09/2015	04/09/2015
TSX/TDX	01/09/2015	12/09/2015	06/09/2015
TSX/TDX	12/09/2015	23/09/2015	17/09/2015
S1	16/09/2015	10/10/2015	28/09/2015
TSX/TDX	23/09/2015	04/10/2015	28/09/2015
TSX/TDX	04/10/2015	15/10/2015	09/10/2015
TSX/TDX	09/10/2015	20/10/2015	14/10/2015
TSX/TDX	15/10/2015	26/10/2015	20/10/2015
S1	10/10/2015	03/11/2015	22/10/2015
S1	03/11/2015	27/11/2015	15/11/2015
TSX/TDX	22/11/2015	03/12/2015	27/11/2015
S1	27/11/2015	21/12/2015	09/12/2015
S1	08/12/2015	01/01/2016	20/12/2015
S1	21/12/2015	14/01/2016	02/01/2016
S1	14/01/2016	07/02/2016	26/01/2016
R2	24/01/2016	17/02/2016	05/02/2016
S1	07/02/2016	02/03/2016	19/02/2016
R2	17/02/2016	12/03/2016	29/02/2016
LC	27/02/2016	14/03/2016	06/03/2016
S1	02/03/2016	26/03/2016	14/03/2016
LC	14/03/2016	30/03/2016	22/03/2016
S1	26/03/2016	19/04/2016	07/04/2016
S1	19/04/2016	13/05/2016	01/05/2016
S1	13/05/2016	06/06/2016	25/05/2016
S2	18/05/2016	07/06/2016	28/05/2016
S1	06/06/2016	30/06/2016	18/06/2016
S1	30/06/2016	24/07/2016	12/07/2016
S1	24/07/2016	17/08/2016	05/08/2016
S1	17/08/2016	10/09/2016	29/08/2016
LC	29/09/2016	15/10/2016	07/10/2016
LC	08/10/2016	24/10/2016	16/10/2016
LC	15/10/2016	31/10/2016	23/10/2016
S1	16/10/2016	09/11/2016	28/10/2016
S1	20/10/2016	13/11/2016	01/11/2016
LC	31/10/2016	16/11/2016	08/11/2016
S2	25/10/2016	24/11/2016	09/11/2016
S1	02/11/2016	26/11/2016	14/11/2016
S1	09/11/2016	03/12/2016	21/11/2016
S1	13/11/2016	07/12/2016	25/11/2016
S1	26/11/2016	20/12/2016	08/12/2016
S1	03/12/2016	27/12/2016	15/12/2016
S1	07/12/2016	31/12/2016	19/12/2016
S1	20/12/2016	13/01/2017	01/01/2017
S1	31/12/2016	24/01/2017	12/01/2017

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	13/01/2017	06/02/2017	25/01/2017
R2	18/01/2017	11/02/2017	30/01/2017
S1	24/01/2017	17/02/2017	05/02/2017
LC	04/02/2017	20/02/2017	12/02/2017
S1	06/02/2017	02/03/2017	18/02/2017
S1	13/02/2017	03/03/2017	22/02/2017
S1	17/02/2017	01/03/2017	23/02/2017
R2	11/02/2017	07/03/2017	23/02/2017
S1	13/02/2017	15/03/2017	28/02/2017
LC	20/02/2017	08/03/2017	28/02/2017
S1	17/02/2017	13/03/2017	01/03/2017
S1	01/03/2017	13/03/2017	07/03/2017
S1	02/03/2017	14/03/2017	08/03/2017
S1	03/03/2017	15/03/2017	09/03/2017
S1	02/03/2017	26/03/2017	14/03/2017
S1	03/03/2017	27/03/2017	15/03/2017
LC	08/03/2017	24/03/2017	16/03/2017
S1	14/03/2017	26/03/2017	20/03/2017
S1	14/03/2017	07/04/2017	26/03/2017
S1	26/03/2017	07/04/2017	01/04/2017
LC	24/03/2017	09/04/2017	01/04/2017
S1	27/03/2017	08/04/2017	02/04/2017
S1	26/03/2017	19/04/2017	07/04/2017
S1	07/04/2017	19/04/2017	13/04/2017
S1	07/04/2017	01/05/2017	19/04/2017
S1	08/04/2017	02/05/2017	20/04/2017
S1	19/04/2017	01/05/2017	25/04/2017
S1	19/04/2017	13/05/2017	01/05/2017
TSX/TDX	28/04/2017	09/05/2017	03/05/2017
S1	01/05/2017	13/05/2017	07/05/2017
S1	02/05/2017	26/05/2017	14/05/2017
S2	06/05/2017	26/05/2017	16/05/2017
LC	11/05/2017	27/05/2017	19/05/2017
S1	18/05/2017	30/05/2017	24/05/2017
S1	13/05/2017	06/06/2017	25/05/2017
S1	18/05/2017	11/06/2017	30/05/2017
S1	30/05/2017	11/06/2017	05/06/2017
S1	30/05/2017	23/06/2017	11/06/2017
S1	06/06/2017	18/06/2017	12/06/2017
S1	11/06/2017	23/06/2017	17/06/2017
S1	06/06/2017	30/06/2017	18/06/2017
S1	11/06/2017	05/07/2017	23/06/2017
S1	18/06/2017	30/06/2017	24/06/2017
S1	23/06/2017	05/07/2017	29/06/2017
S1	23/06/2017	17/07/2017	05/07/2017
S1	05/07/2017	17/07/2017	11/07/2017
S1	17/07/2017	29/07/2017	23/07/2017

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	17/07/2017	10/08/2017	29/07/2017
S1	29/07/2017	10/08/2017	04/08/2017
S1	29/07/2017	22/08/2017	10/08/2017
S1	05/08/2017	17/08/2017	11/08/2017
S1	06/08/2017	18/08/2017	12/08/2017
S1	06/08/2017	18/08/2017	12/08/2017
S1	10/08/2017	22/08/2017	16/08/2017
S1	05/08/2017	29/08/2017	17/08/2017
S1	06/08/2017	30/08/2017	18/08/2017
S1	10/08/2017	03/09/2017	22/08/2017
S1	17/08/2017	29/08/2017	23/08/2017
S1	18/08/2017	30/08/2017	24/08/2017
S1	22/08/2017	03/09/2017	28/08/2017
S1	17/08/2017	10/09/2017	29/08/2017
S1	18/08/2017	11/09/2017	30/08/2017
S1	18/08/2017	11/09/2017	30/08/2017
S1	22/08/2017	15/09/2017	03/09/2017
S1	29/08/2017	10/09/2017	04/09/2017
S1	30/08/2017	11/09/2017	05/09/2017
S1	03/09/2017	15/09/2017	09/09/2017
S1	29/08/2017	22/09/2017	10/09/2017
S1	30/08/2017	23/09/2017	11/09/2017
S1	03/09/2017	27/09/2017	15/09/2017
S1	10/09/2017	22/09/2017	16/09/2017
S1	11/09/2017	23/09/2017	17/09/2017
S1	11/09/2017	23/09/2017	17/09/2017
S1	15/09/2017	27/09/2017	21/09/2017
S1	11/09/2017	05/10/2017	23/09/2017
S1	15/09/2017	09/10/2017	27/09/2017
S1	23/09/2017	05/10/2017	29/09/2017
LC	25/09/2017	11/10/2017	03/10/2017
S1	22/09/2017	16/10/2017	04/10/2017
S1	23/09/2017	17/10/2017	05/10/2017
S1	23/09/2017	17/10/2017	05/10/2017
S1	05/10/2017	17/10/2017	11/10/2017
S1	09/10/2017	21/10/2017	15/10/2017
S1	05/10/2017	29/10/2017	17/10/2017
S1	09/10/2017	02/11/2017	21/10/2017
S1	16/10/2017	28/10/2017	22/10/2017
S1	17/10/2017	29/10/2017	23/10/2017
S1	17/10/2017	29/10/2017	23/10/2017
S1	21/10/2017	02/11/2017	27/10/2017
S1	16/10/2017	09/11/2017	28/10/2017
S1	17/10/2017	10/11/2017	29/10/2017
S1	21/10/2017	14/11/2017	02/11/2017
S1	28/10/2017	09/11/2017	03/11/2017
S1	29/10/2017	10/11/2017	04/11/2017

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	29/10/2017	10/11/2017	04/11/2017
S1	02/11/2017	14/11/2017	08/11/2017
S1	28/10/2017	21/11/2017	09/11/2017
S2	04/11/2017	14/11/2017	09/11/2017
S1	29/10/2017	22/11/2017	10/11/2017
S1	09/11/2017	21/11/2017	15/11/2017
S1	10/11/2017	22/11/2017	16/11/2017
S1	14/11/2017	26/11/2017	20/11/2017
S1	14/11/2017	08/12/2017	26/11/2017
S1	21/11/2017	03/12/2017	27/11/2017
S1	26/11/2017	08/12/2017	02/12/2017
S1	21/11/2017	15/12/2017	03/12/2017
S1	22/11/2017	16/12/2017	04/12/2017
S1	03/12/2017	15/12/2017	09/12/2017
S1	08/12/2017	20/12/2017	14/12/2017
S1	03/12/2017	27/12/2017	15/12/2017
S1	08/12/2017	01/01/2018	20/12/2017
S1	15/12/2017	27/12/2017	21/12/2017
S1	16/12/2017	28/12/2017	22/12/2017
S1	20/12/2017	01/01/2018	26/12/2017
S1	15/12/2017	08/01/2018	27/12/2017
S1	16/12/2017	09/01/2018	28/12/2017
S1	20/12/2017	13/01/2018	01/01/2018
S1	27/12/2017	08/01/2018	02/01/2018
S1	28/12/2017	09/01/2018	03/01/2018
S1	01/01/2018	13/01/2018	07/01/2018
S1	27/12/2017	20/01/2018	08/01/2018
S1	28/12/2017	21/01/2018	09/01/2018
S1	01/01/2018	25/01/2018	13/01/2018
S1	08/01/2018	20/01/2018	14/01/2018
S1	09/01/2018	21/01/2018	15/01/2018
S1	13/01/2018	25/01/2018	19/01/2018
S1	09/01/2018	02/02/2018	21/01/2018
S1	13/01/2018	06/02/2018	25/01/2018
S1	21/01/2018	02/02/2018	27/01/2018
S2	23/01/2018	02/02/2018	28/01/2018
S2	23/01/2018	07/02/2018	30/01/2018
S1	25/01/2018	06/02/2018	31/01/2018
S1	20/01/2018	13/02/2018	01/02/2018
S1	21/01/2018	14/02/2018	02/02/2018
S2	28/01/2018	07/02/2018	02/02/2018
TSX/TDX	28/01/2018	08/02/2018	02/02/2018
S2	23/01/2018	17/02/2018	04/02/2018
S1	25/01/2018	18/02/2018	06/02/2018
S2	28/01/2018	17/02/2018	07/02/2018
S1	02/02/2018	14/02/2018	08/02/2018
S1	02/02/2018	14/02/2018	08/02/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
LC	31/01/2018	16/02/2018	08/02/2018
S2	02/02/2018	17/02/2018	09/02/2018
S1	06/02/2018	18/02/2018	12/02/2018
S2	07/02/2018	17/02/2018	12/02/2018
LC	07/02/2018	23/02/2018	15/02/2018
S2	02/02/2018	04/03/2018	17/02/2018
S1	06/02/2018	02/03/2018	18/02/2018
S1	13/02/2018	25/02/2018	19/02/2018
S2	07/02/2018	04/03/2018	19/02/2018
S1	14/02/2018	26/02/2018	20/02/2018
S1	18/02/2018	02/03/2018	24/02/2018
LC	16/02/2018	04/03/2018	24/02/2018
S2	17/02/2018	04/03/2018	24/02/2018
S1	14/02/2018	10/03/2018	26/02/2018
S1	18/02/2018	14/03/2018	02/03/2018
S1	25/02/2018	09/03/2018	03/03/2018
S1	26/02/2018	10/03/2018	04/03/2018
S1	02/03/2018	14/03/2018	08/03/2018
S1	25/02/2018	21/03/2018	09/03/2018
S2	25/02/2018	22/03/2018	09/03/2018
S1	26/02/2018	22/03/2018	10/03/2018
S1	02/03/2018	26/03/2018	14/03/2018
S2	04/03/2018	24/03/2018	14/03/2018
S1	09/03/2018	21/03/2018	15/03/2018
S1	10/03/2018	22/03/2018	16/03/2018
S2	04/03/2018	29/03/2018	16/03/2018
S2	04/03/2018	03/04/2018	19/03/2018
S1	14/03/2018	26/03/2018	20/03/2018
S1	09/03/2018	02/04/2018	21/03/2018
S1	10/03/2018	03/04/2018	22/03/2018
S1	10/03/2018	03/04/2018	22/03/2018
S1	14/03/2018	07/04/2018	26/03/2018
S1	21/03/2018	02/04/2018	27/03/2018
S2	22/03/2018	01/04/2018	27/03/2018
S1	22/03/2018	03/04/2018	28/03/2018
S2	24/03/2018	03/04/2018	29/03/2018
S2	22/03/2018	06/04/2018	29/03/2018
S1	26/03/2018	07/04/2018	01/04/2018
S2	22/03/2018	11/04/2018	01/04/2018
S1	21/03/2018	14/04/2018	02/04/2018
S1	22/03/2018	15/04/2018	03/04/2018
S2	24/03/2018	13/04/2018	03/04/2018
S2	22/03/2018	16/04/2018	03/04/2018
S2	29/03/2018	13/04/2018	05/04/2018
S2	01/04/2018	11/04/2018	06/04/2018
S1	26/03/2018	19/04/2018	07/04/2018
S1	02/04/2018	14/04/2018	08/04/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	03/04/2018	13/04/2018	08/04/2018
S2	01/04/2018	16/04/2018	08/04/2018
S1	03/04/2018	15/04/2018	09/04/2018
S1	03/04/2018	15/04/2018	09/04/2018
S2	06/04/2018	16/04/2018	11/04/2018
S1	07/04/2018	19/04/2018	13/04/2018
S2	29/03/2018	28/04/2018	13/04/2018
LC	05/04/2018	21/04/2018	13/04/2018
S2	01/04/2018	26/04/2018	13/04/2018
S1	02/04/2018	26/04/2018	14/04/2018
S1	03/04/2018	27/04/2018	15/04/2018
S1	03/04/2018	27/04/2018	15/04/2018
S2	03/04/2018	28/04/2018	15/04/2018
S2	06/04/2018	26/04/2018	16/04/2018
S2	11/04/2018	26/04/2018	18/04/2018
S1	07/04/2018	01/05/2018	19/04/2018
S1	14/04/2018	26/04/2018	20/04/2018
S2	13/04/2018	28/04/2018	20/04/2018
S1	15/04/2018	27/04/2018	21/04/2018
S1	15/04/2018	27/04/2018	21/04/2018
S2	16/04/2018	26/04/2018	21/04/2018
S2	06/04/2018	06/05/2018	21/04/2018
S2	11/04/2018	06/05/2018	23/04/2018
S1	19/04/2018	01/05/2018	25/04/2018
S2	13/04/2018	08/05/2018	25/04/2018
S1	14/04/2018	08/05/2018	26/04/2018
S2	16/04/2018	06/05/2018	26/04/2018
S1	15/04/2018	09/05/2018	27/04/2018
S1	15/04/2018	09/05/2018	27/04/2018
S1	19/04/2018	13/05/2018	01/05/2018
S2	26/04/2018	06/05/2018	01/05/2018
S2	16/04/2018	16/05/2018	01/05/2018
S1	26/04/2018	08/05/2018	02/05/2018
S1	27/04/2018	09/05/2018	03/05/2018
S1	27/04/2018	09/05/2018	03/05/2018
S2	28/04/2018	08/05/2018	03/05/2018
S2	26/04/2018	16/05/2018	06/05/2018
S1	01/05/2018	13/05/2018	07/05/2018
S1	26/04/2018	20/05/2018	08/05/2018
S2	28/04/2018	18/05/2018	08/05/2018
S1	27/04/2018	21/05/2018	09/05/2018
S1	27/04/2018	21/05/2018	09/05/2018
S2	06/05/2018	16/05/2018	11/05/2018
S1	01/05/2018	25/05/2018	13/05/2018
S2	08/05/2018	18/05/2018	13/05/2018
S1	08/05/2018	20/05/2018	14/05/2018
S1	09/05/2018	21/05/2018	15/05/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	09/05/2018	21/05/2018	15/05/2018
S1	13/05/2018	25/05/2018	19/05/2018
S1	08/05/2018	01/06/2018	20/05/2018
S1	09/05/2018	02/06/2018	21/05/2018
S1	13/05/2018	06/06/2018	25/05/2018
S1	20/05/2018	01/06/2018	26/05/2018
S1	21/05/2018	02/06/2018	27/05/2018
S1	25/05/2018	06/06/2018	31/05/2018
S1	20/05/2018	13/06/2018	01/06/2018
S1	21/05/2018	14/06/2018	02/06/2018
S1	21/05/2018	14/06/2018	02/06/2018
S1	25/05/2018	18/06/2018	06/06/2018
S1	01/06/2018	13/06/2018	07/06/2018
S1	02/06/2018	14/06/2018	08/06/2018
S1	06/06/2018	18/06/2018	12/06/2018
S1	01/06/2018	25/06/2018	13/06/2018
S1	02/06/2018	26/06/2018	14/06/2018
S1	06/06/2018	30/06/2018	18/06/2018
S1	13/06/2018	25/06/2018	19/06/2018
S1	14/06/2018	26/06/2018	20/06/2018
S1	14/06/2018	26/06/2018	20/06/2018
S1	18/06/2018	30/06/2018	24/06/2018
S1	14/06/2018	08/07/2018	26/06/2018
S1	14/06/2018	08/07/2018	26/06/2018
S1	18/06/2018	12/07/2018	30/06/2018
S1	26/06/2018	08/07/2018	02/07/2018
S1	26/06/2018	08/07/2018	02/07/2018
S1	30/06/2018	12/07/2018	06/07/2018
S1	26/06/2018	20/07/2018	08/07/2018
S1	26/06/2018	20/07/2018	08/07/2018
LC	01/07/2018	17/07/2018	09/07/2018
S2	02/07/2018	17/07/2018	09/07/2018
S1	30/06/2018	24/07/2018	12/07/2018
S2	02/07/2018	22/07/2018	12/07/2018
S2	05/07/2018	20/07/2018	12/07/2018
S1	08/07/2018	20/07/2018	14/07/2018
S1	08/07/2018	20/07/2018	14/07/2018
S2	02/07/2018	01/08/2018	17/07/2018
S2	05/07/2018	30/07/2018	17/07/2018
S1	12/07/2018	24/07/2018	18/07/2018
S1	08/07/2018	01/08/2018	20/07/2018
S1	12/07/2018	05/08/2018	24/07/2018
S2	17/07/2018	01/08/2018	24/07/2018
S2	20/07/2018	30/07/2018	25/07/2018
S1	20/07/2018	01/08/2018	26/07/2018
S2	22/07/2018	01/08/2018	27/07/2018
S1	24/07/2018	05/08/2018	30/07/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	20/07/2018	13/08/2018	01/08/2018
S1	05/08/2018	05/08/2018	05/08/2018
S1	24/07/2018	17/08/2018	05/08/2018
S1	01/08/2018	13/08/2018	07/08/2018
S1	05/08/2018	17/08/2018	11/08/2018
S1	01/08/2018	25/08/2018	13/08/2018
S2	01/08/2018	31/08/2018	16/08/2018
S1	12/08/2018	24/08/2018	18/08/2018
S1	13/08/2018	25/08/2018	19/08/2018
S1	17/08/2018	29/08/2018	23/08/2018
S1	12/08/2018	05/09/2018	24/08/2018
S1	13/08/2018	06/09/2018	25/08/2018
S1	17/08/2018	10/09/2018	29/08/2018
S1	24/08/2018	05/09/2018	30/08/2018
S1	25/08/2018	06/09/2018	31/08/2018
S1	29/08/2018	10/09/2018	04/09/2018
S1	24/08/2018	17/09/2018	05/09/2018
S2	31/08/2018	10/09/2018	05/09/2018
S1	25/08/2018	18/09/2018	06/09/2018
S2	03/09/2018	13/09/2018	08/09/2018
S1	29/08/2018	22/09/2018	10/09/2018
S2	03/09/2018	18/09/2018	10/09/2018
S1	05/09/2018	17/09/2018	11/09/2018
LC	03/09/2018	19/09/2018	11/09/2018
S1	06/09/2018	18/09/2018	12/09/2018
S1	06/09/2018	18/09/2018	12/09/2018
S2	31/08/2018	30/09/2018	15/09/2018
S1	10/09/2018	22/09/2018	16/09/2018
S1	05/09/2018	29/09/2018	17/09/2018
S2	05/09/2018	30/09/2018	17/09/2018
S1	06/09/2018	30/09/2018	18/09/2018
S1	06/09/2018	30/09/2018	18/09/2018
S2	10/09/2018	30/09/2018	20/09/2018
S1	10/09/2018	04/10/2018	22/09/2018
S1	17/09/2018	29/09/2018	23/09/2018
S1	18/09/2018	30/09/2018	24/09/2018
S1	18/09/2018	30/09/2018	24/09/2018
S2	13/09/2018	08/10/2018	25/09/2018
S1	22/09/2018	04/10/2018	28/09/2018
S2	18/09/2018	08/10/2018	28/09/2018
S1	17/09/2018	11/10/2018	29/09/2018
S1	18/09/2018	12/10/2018	30/09/2018
S1	18/09/2018	12/10/2018	30/09/2018
S1	22/09/2018	16/10/2018	04/10/2018
S1	29/09/2018	11/10/2018	05/10/2018
S1	30/09/2018	12/10/2018	06/10/2018
S1	30/09/2018	12/10/2018	06/10/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	04/10/2018	16/10/2018	10/10/2018
S1	29/09/2018	23/10/2018	11/10/2018
S1	30/09/2018	24/10/2018	12/10/2018
S1	30/09/2018	24/10/2018	12/10/2018
S1	04/10/2018	28/10/2018	16/10/2018
S1	11/10/2018	23/10/2018	17/10/2018
S1	12/10/2018	24/10/2018	18/10/2018
S1	12/10/2018	24/10/2018	18/10/2018
S2	08/10/2018	28/10/2018	18/10/2018
S2	08/10/2018	02/11/2018	20/10/2018
S1	16/10/2018	28/10/2018	22/10/2018
S1	11/10/2018	04/11/2018	23/10/2018
S1	12/10/2018	05/11/2018	24/10/2018
S1	16/10/2018	09/11/2018	28/10/2018
S1	23/10/2018	04/11/2018	29/10/2018
S1	24/10/2018	05/11/2018	30/10/2018
S1	28/10/2018	09/11/2018	03/11/2018
S1	23/10/2018	16/11/2018	04/11/2018
S1	24/10/2018	17/11/2018	05/11/2018
S1	28/10/2018	21/11/2018	09/11/2018
S1	04/11/2018	16/11/2018	10/11/2018
S1	05/11/2018	17/11/2018	11/11/2018
LC	06/11/2018	22/11/2018	14/11/2018
S1	09/11/2018	21/11/2018	15/11/2018
S1	04/11/2018	28/11/2018	16/11/2018
S1	05/11/2018	29/11/2018	17/11/2018
S1	09/11/2018	03/12/2018	21/11/2018
S1	16/11/2018	28/11/2018	22/11/2018
S1	17/11/2018	29/11/2018	23/11/2018
LC	15/11/2018	01/12/2018	23/11/2018
S1	21/11/2018	03/12/2018	27/11/2018
S1	16/11/2018	10/12/2018	28/11/2018
S1	17/11/2018	11/12/2018	29/11/2018
S1	21/11/2018	15/12/2018	03/12/2018
S1	28/11/2018	10/12/2018	04/12/2018
S1	29/11/2018	11/12/2018	05/12/2018
S1	03/12/2018	15/12/2018	09/12/2018
S1	28/11/2018	22/12/2018	10/12/2018
S1	29/11/2018	23/12/2018	11/12/2018
S1	03/12/2018	27/12/2018	15/12/2018
S1	10/12/2018	22/12/2018	16/12/2018
S1	11/12/2018	23/12/2018	17/12/2018
S1	15/12/2018	27/12/2018	21/12/2018
S1	11/12/2018	04/01/2019	23/12/2018
S1	15/12/2018	08/01/2019	27/12/2018
S1	23/12/2018	04/01/2019	29/12/2018
S1	27/12/2018	08/01/2019	02/01/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	22/12/2018	15/01/2019	03/01/2019
S1	23/12/2018	16/01/2019	04/01/2019
S1	27/12/2018	20/01/2019	08/01/2019
S1	04/01/2019	16/01/2019	10/01/2019
S1	08/01/2019	20/01/2019	14/01/2019
S1	04/01/2019	28/01/2019	16/01/2019
S1	08/01/2019	01/02/2019	20/01/2019
S1	15/01/2019	27/01/2019	21/01/2019
S1	16/01/2019	28/01/2019	22/01/2019
S2	18/01/2019	02/02/2019	25/01/2019
S1	20/01/2019	01/02/2019	26/01/2019
S1	16/01/2019	09/02/2019	28/01/2019
S1	20/01/2019	13/02/2019	01/02/2019
S1	28/01/2019	09/02/2019	03/02/2019
S2	31/01/2019	10/02/2019	05/02/2019
S1	01/02/2019	13/02/2019	07/02/2019
S2	31/01/2019	15/02/2019	07/02/2019
S1	27/01/2019	20/02/2019	08/02/2019
S1	28/01/2019	21/02/2019	09/02/2019
S2	02/02/2019	22/02/2019	12/02/2019
S2	31/01/2019	25/02/2019	12/02/2019
S1	01/02/2019	25/02/2019	13/02/2019
S2	02/02/2019	27/02/2019	14/02/2019
S1	09/02/2019	21/02/2019	15/02/2019
S2	10/02/2019	25/02/2019	17/02/2019
LC	10/02/2019	26/02/2019	18/02/2019
S1	13/02/2019	25/02/2019	19/02/2019
S2	15/02/2019	25/02/2019	20/02/2019
S1	09/02/2019	05/03/2019	21/02/2019
S2	10/02/2019	07/03/2019	22/02/2019
S1	13/02/2019	09/03/2019	25/02/2019
S2	15/02/2019	07/03/2019	25/02/2019
S1	20/02/2019	04/03/2019	26/02/2019
S1	21/02/2019	05/03/2019	27/02/2019
LC	19/02/2019	07/03/2019	27/02/2019
S2	25/02/2019	07/03/2019	02/03/2019
S1	25/02/2019	09/03/2019	03/03/2019
S1	20/02/2019	16/03/2019	04/03/2019
S1	21/02/2019	17/03/2019	05/03/2019
S1	25/02/2019	21/03/2019	09/03/2019
S1	04/03/2019	16/03/2019	10/03/2019
S1	05/03/2019	17/03/2019	11/03/2019
S2	25/02/2019	27/03/2019	12/03/2019
S2	27/02/2019	29/03/2019	14/03/2019
S1	09/03/2019	21/03/2019	15/03/2019
S1	04/03/2019	28/03/2019	16/03/2019
S1	05/03/2019	29/03/2019	17/03/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	07/03/2019	27/03/2019	17/03/2019
S2	07/03/2019	01/04/2019	19/03/2019
S1	09/03/2019	02/04/2019	21/03/2019
S1	16/03/2019	28/03/2019	22/03/2019
S2	07/03/2019	06/04/2019	22/03/2019
S1	17/03/2019	29/03/2019	23/03/2019
S1	21/03/2019	02/04/2019	27/03/2019
S1	16/03/2019	09/04/2019	28/03/2019
S1	17/03/2019	10/04/2019	29/03/2019
S2	27/03/2019	06/04/2019	01/04/2019
S1	21/03/2019	14/04/2019	02/04/2019
S1	28/03/2019	09/04/2019	03/04/2019
S1	29/03/2019	10/04/2019	04/04/2019
S2	29/03/2019	13/04/2019	05/04/2019
LC	30/03/2019	15/04/2019	07/04/2019
S1	02/04/2019	14/04/2019	08/04/2019
S1	28/03/2019	21/04/2019	09/04/2019
S1	29/03/2019	22/04/2019	10/04/2019
S2	29/03/2019	28/04/2019	13/04/2019
S1	02/04/2019	26/04/2019	14/04/2019
S1	09/04/2019	21/04/2019	15/04/2019
S1	10/04/2019	22/04/2019	16/04/2019
S1	10/04/2019	22/04/2019	16/04/2019
S2	01/04/2019	01/05/2019	16/04/2019
S2	06/04/2019	01/05/2019	18/04/2019
S1	14/04/2019	26/04/2019	20/04/2019
S2	13/04/2019	28/04/2019	20/04/2019
S1	09/04/2019	03/05/2019	21/04/2019
S1	10/04/2019	04/05/2019	22/04/2019
LC	15/04/2019	01/05/2019	23/04/2019
S1	14/04/2019	08/05/2019	26/04/2019
S1	21/04/2019	03/05/2019	27/04/2019
S1	22/04/2019	04/05/2019	28/04/2019
S1	26/04/2019	08/05/2019	02/05/2019
S1	21/04/2019	15/05/2019	03/05/2019
S1	22/04/2019	16/05/2019	04/05/2019
S1	22/04/2019	16/05/2019	04/05/2019
S1	26/04/2019	20/05/2019	08/05/2019
S2	28/04/2019	18/05/2019	08/05/2019
S1	03/05/2019	15/05/2019	09/05/2019
S1	04/05/2019	16/05/2019	10/05/2019
S1	08/05/2019	20/05/2019	14/05/2019
S1	03/05/2019	27/05/2019	15/05/2019
S1	04/05/2019	28/05/2019	16/05/2019
S1	08/05/2019	01/06/2019	20/05/2019
S1	15/05/2019	27/05/2019	21/05/2019
S1	16/05/2019	28/05/2019	22/05/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	16/05/2019	28/05/2019	22/05/2019
S1	20/05/2019	01/06/2019	26/05/2019
S1	15/05/2019	08/06/2019	27/05/2019
S1	16/05/2019	09/06/2019	28/05/2019
S1	16/05/2019	09/06/2019	28/05/2019
S2	18/05/2019	07/06/2019	28/05/2019
S1	20/05/2019	13/06/2019	01/06/2019
S1	27/05/2019	08/06/2019	02/06/2019
S1	28/05/2019	09/06/2019	03/06/2019
S1	28/05/2019	09/06/2019	03/06/2019
S1	01/06/2019	13/06/2019	07/06/2019
S1	27/05/2019	20/06/2019	08/06/2019
S1	28/05/2019	21/06/2019	09/06/2019
S1	01/06/2019	25/06/2019	13/06/2019
S1	08/06/2019	20/06/2019	14/06/2019
S1	09/06/2019	21/06/2019	15/06/2019
S1	09/06/2019	21/06/2019	15/06/2019
S2	10/06/2019	20/06/2019	15/06/2019
S2	07/06/2019	27/06/2019	17/06/2019
S2	10/06/2019	25/06/2019	17/06/2019
S1	13/06/2019	25/06/2019	19/06/2019
S1	08/06/2019	02/07/2019	20/06/2019
S2	10/06/2019	30/06/2019	20/06/2019
S1	09/06/2019	03/07/2019	21/06/2019
S1	09/06/2019	03/07/2019	21/06/2019
S2	07/06/2019	07/07/2019	22/06/2019
S2	10/06/2019	05/07/2019	22/06/2019
S1	13/06/2019	07/07/2019	25/06/2019
S2	20/06/2019	30/06/2019	25/06/2019
S2	10/06/2019	10/07/2019	25/06/2019
S1	20/06/2019	02/07/2019	26/06/2019
S1	21/06/2019	03/07/2019	27/06/2019
S1	21/06/2019	03/07/2019	27/06/2019
S2	20/06/2019	05/07/2019	27/06/2019
S2	25/06/2019	05/07/2019	30/06/2019
S2	20/06/2019	10/07/2019	30/06/2019
S1	25/06/2019	07/07/2019	01/07/2019
S1	20/06/2019	14/07/2019	02/07/2019
S2	27/06/2019	07/07/2019	02/07/2019
S2	25/06/2019	10/07/2019	02/07/2019
S1	21/06/2019	15/07/2019	03/07/2019
S1	21/06/2019	15/07/2019	03/07/2019
S2	30/06/2019	10/07/2019	05/07/2019
LC	27/06/2019	13/07/2019	05/07/2019
S1	25/06/2019	19/07/2019	07/07/2019
S1	02/07/2019	14/07/2019	08/07/2019
S1	03/07/2019	15/07/2019	09/07/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	03/07/2019	15/07/2019	09/07/2019
S2	27/06/2019	22/07/2019	09/07/2019
S2	25/06/2019	25/07/2019	10/07/2019
S2	30/06/2019	25/07/2019	12/07/2019
S1	07/07/2019	19/07/2019	13/07/2019
S1	02/07/2019	26/07/2019	14/07/2019
S2	07/07/2019	22/07/2019	14/07/2019
S1	03/07/2019	27/07/2019	15/07/2019
S1	03/07/2019	27/07/2019	15/07/2019
S2	05/07/2019	25/07/2019	15/07/2019
S2	30/06/2019	30/07/2019	15/07/2019
S1	05/07/2017	29/07/2021	17/07/2019
S2	05/07/2019	30/07/2019	17/07/2019
S2	10/07/2019	25/07/2019	17/07/2019
S1	07/07/2019	31/07/2019	19/07/2019
S1	14/07/2019	26/07/2019	20/07/2019
S2	05/07/2019	04/08/2019	20/07/2019
S2	10/07/2019	30/07/2019	20/07/2019
S1	15/07/2019	27/07/2019	21/07/2019
S1	15/07/2019	27/07/2019	21/07/2019
S2	07/07/2019	06/08/2019	22/07/2019
S2	10/07/2019	04/08/2019	22/07/2019
S1	19/07/2019	31/07/2019	25/07/2019
S1	14/07/2019	07/08/2019	26/07/2019
S1	15/07/2019	08/08/2019	27/07/2019
S1	15/07/2019	08/08/2019	27/07/2019
S2	22/07/2019	06/08/2019	29/07/2019
S2	25/07/2019	04/08/2019	30/07/2019
S1	19/07/2019	12/08/2019	31/07/2019
S1	26/07/2019	07/08/2019	01/08/2019
S2	22/07/2019	11/08/2019	01/08/2019
S1	27/07/2019	08/08/2019	02/08/2019
S1	27/07/2019	08/08/2019	02/08/2019
S1	31/07/2019	12/08/2019	06/08/2019
S2	22/07/2019	21/08/2019	06/08/2019
S2	25/07/2019	19/08/2019	06/08/2019
S1	26/07/2019	19/08/2019	07/08/2019
S1	27/07/2019	20/08/2019	08/08/2019
S1	27/07/2019	20/08/2019	08/08/2019
S2	30/07/2019	19/08/2019	09/08/2019
S2	04/08/2019	19/08/2019	11/08/2019
S1	31/07/2019	24/08/2019	12/08/2019
S1	07/08/2019	19/08/2019	13/08/2019
LC	05/08/2019	21/08/2019	13/08/2019
S2	06/08/2019	21/08/2019	13/08/2019
S1	08/08/2019	20/08/2019	14/08/2019
S1	08/08/2019	20/08/2019	14/08/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	30/07/2019	29/08/2019	14/08/2019
S2	11/08/2019	21/08/2019	16/08/2019
S2	04/08/2019	29/08/2019	16/08/2019
S1	12/08/2019	24/08/2019	18/08/2019
S1	07/08/2019	31/08/2019	19/08/2019
S1	08/08/2019	01/09/2019	20/08/2019
S1	08/08/2019	01/09/2019	20/08/2019
S2	06/08/2019	05/09/2019	21/08/2019
S2	11/08/2019	05/09/2019	23/08/2019
S1	12/08/2019	05/09/2019	24/08/2019
S2	19/08/2019	29/08/2019	24/08/2019
S1	19/08/2019	31/08/2019	25/08/2019
S1	20/08/2019	01/09/2019	26/08/2019
S1	20/08/2019	01/09/2019	26/08/2019
S2	21/08/2019	05/09/2019	28/08/2019
S2	19/08/2019	08/09/2019	29/08/2019
LC	21/08/2019	06/09/2019	29/08/2019
S1	24/08/2019	05/09/2019	30/08/2019
S1	19/08/2019	12/09/2019	31/08/2019
S1	20/08/2019	13/09/2019	01/09/2019
S1	20/08/2019	13/09/2019	01/09/2019
S2	21/08/2019	15/09/2019	02/09/2019
S2	29/08/2019	08/09/2019	03/09/2019
S1	31/08/2019	12/09/2019	06/09/2019
S1	01/09/2019	13/09/2019	07/09/2019
S1	01/09/2019	13/09/2019	07/09/2019
LC	30/08/2019	15/09/2019	07/09/2019
S2	05/09/2019	15/09/2019	10/09/2019
S1	31/08/2019	24/09/2019	12/09/2019
S1	01/09/2019	25/09/2019	13/09/2019
S1	01/09/2019	25/09/2019	13/09/2019
LC	06/09/2019	22/09/2019	14/09/2019
S1	05/09/2019	29/09/2019	17/09/2019
S1	12/09/2019	24/09/2019	18/09/2019
S1	13/09/2019	25/09/2019	19/09/2019
S1	13/09/2019	25/09/2019	19/09/2019
S2	08/09/2019	03/10/2019	20/09/2019
S1	12/09/2019	06/10/2019	24/09/2019
S1	13/09/2019	07/10/2019	25/09/2019
S1	24/09/2019	06/10/2019	30/09/2019
S1	25/09/2019	07/10/2019	01/10/2019
S1	27/09/2017	09/10/2021	03/10/2019
S1	29/09/2019	11/10/2019	05/10/2019
S1	24/09/2019	18/10/2019	06/10/2019
S1	25/09/2019	19/10/2019	07/10/2019
S1	25/09/2019	19/10/2019	07/10/2019
S2	03/10/2019	13/10/2019	08/10/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	27/09/2017	21/10/2021	09/10/2019
S2	03/10/2019	18/10/2019	10/10/2019
S1	29/09/2019	23/10/2019	11/10/2019
S1	06/10/2019	18/10/2019	12/10/2019
S1	07/10/2019	19/10/2019	13/10/2019
S1	11/10/2019	23/10/2019	17/10/2019
S1	06/10/2019	30/10/2019	18/10/2019
S1	07/10/2019	31/10/2019	19/10/2019
S1	11/10/2019	04/11/2019	23/10/2019
S1	18/10/2019	30/10/2019	24/10/2019
S1	19/10/2019	31/10/2019	25/10/2019
S1	19/10/2019	31/10/2019	25/10/2019
S1	23/10/2019	04/11/2019	29/10/2019
S1	18/10/2019	11/11/2019	30/10/2019
S2	20/10/2019	09/11/2019	30/10/2019
S1	19/10/2019	12/11/2019	31/10/2019
S1	19/10/2019	12/11/2019	31/10/2019
S2	25/10/2019	09/11/2019	01/11/2019
S1	23/10/2019	16/11/2019	04/11/2019
S1	30/10/2019	11/11/2019	05/11/2019
S1	31/10/2019	12/11/2019	06/11/2019
S1	31/10/2019	12/11/2019	06/11/2019
S1	04/11/2019	16/11/2019	10/11/2019
S1	30/10/2019	23/11/2019	11/11/2019
S1	31/10/2019	24/11/2019	12/11/2019
S1	31/10/2019	24/11/2019	12/11/2019
S1	04/11/2019	28/11/2019	16/11/2019
S1	11/11/2019	23/11/2019	17/11/2019
S1	12/11/2019	24/11/2019	18/11/2019
S1	12/11/2019	24/11/2019	18/11/2019
S1	16/11/2019	28/11/2019	22/11/2019
S1	12/11/2019	06/12/2019	24/11/2019
S1	16/11/2019	10/12/2019	28/11/2019
S1	24/11/2019	06/12/2019	30/11/2019
S1	28/11/2019	10/12/2019	04/12/2019
S1	23/11/2019	17/12/2019	05/12/2019
S1	24/11/2019	18/12/2019	06/12/2019
S1	24/11/2019	18/12/2019	06/12/2019
S1	28/11/2019	22/12/2019	10/12/2019
S1	06/12/2019	18/12/2019	12/12/2019
S1	10/12/2019	22/12/2019	16/12/2019
S1	06/12/2019	30/12/2019	18/12/2019
S1	10/12/2019	03/01/2020	22/12/2019
S1	17/12/2019	29/12/2019	23/12/2019
S1	18/12/2019	30/12/2019	24/12/2019
S1	22/12/2019	03/01/2020	28/12/2019
S1	17/12/2019	10/01/2020	29/12/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	18/12/2019	11/01/2020	30/12/2019
S1	22/12/2019	15/01/2020	03/01/2020
S1	29/12/2019	10/01/2020	04/01/2020
S1	30/12/2019	11/01/2020	05/01/2020
S1	03/01/2020	15/01/2020	09/01/2020
S1	29/12/2019	22/01/2020	10/01/2020
S1	30/12/2019	23/01/2020	11/01/2020
S1	03/01/2020	27/01/2020	15/01/2020
S1	10/01/2020	22/01/2020	16/01/2020
S1	11/01/2020	23/01/2020	17/01/2020
S1	15/01/2020	27/01/2020	21/01/2020
S1	10/01/2020	03/02/2020	22/01/2020
S1	11/01/2020	04/02/2020	23/01/2020
S1	15/01/2020	08/02/2020	27/01/2020
S1	22/01/2020	03/02/2020	28/01/2020
S1	23/01/2020	04/02/2020	29/01/2020
S1	27/01/2020	08/02/2020	02/02/2020
S1	22/01/2020	15/02/2020	03/02/2020
S1	23/01/2020	16/02/2020	04/02/2020
S1	27/01/2020	20/02/2020	08/02/2020
S1	03/02/2020	15/02/2020	09/02/2020
S1	04/02/2020	16/02/2020	10/02/2020
S1	04/02/2020	16/02/2020	10/02/2020
S1	08/02/2020	20/02/2020	14/02/2020
S1	03/02/2020	27/02/2020	15/02/2020
S1	04/02/2020	28/02/2020	16/02/2020
S1	04/02/2020	28/02/2020	16/02/2020
S1	08/02/2020	03/03/2020	20/02/2020
S1	15/02/2020	27/02/2020	21/02/2020
S1	16/02/2020	28/02/2020	22/02/2020
S1	16/02/2020	28/02/2020	22/02/2020
S1	20/02/2020	03/03/2020	26/02/2020
S1	15/02/2020	10/03/2020	27/02/2020
S1	16/02/2020	11/03/2020	28/02/2020
S1	16/02/2020	11/03/2020	28/02/2020
S1	20/02/2020	15/03/2020	03/03/2020
S1	27/02/2020	10/03/2020	04/03/2020
S1	28/02/2020	11/03/2020	05/03/2020
S1	28/02/2020	11/03/2020	05/03/2020
S1	03/03/2020	15/03/2020	09/03/2020
S1	27/02/2020	22/03/2020	10/03/2020
S1	28/02/2020	23/03/2020	11/03/2020
S1	28/02/2020	23/03/2020	11/03/2020
S1	03/03/2020	27/03/2020	15/03/2020
S1	10/03/2020	22/03/2020	16/03/2020
S2	06/03/2020	26/03/2020	16/03/2020
S1	11/03/2020	23/03/2020	17/03/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	11/03/2020	23/03/2020	17/03/2020
S2	11/03/2020	26/03/2020	18/03/2020
S2	06/03/2020	31/03/2020	18/03/2020
S1	15/03/2020	27/03/2020	21/03/2020
S2	11/03/2020	31/03/2020	21/03/2020
S1	10/03/2020	03/04/2020	22/03/2020
S1	11/03/2020	04/04/2020	23/03/2020
S1	11/03/2020	04/04/2020	23/03/2020
S2	11/03/2020	10/04/2020	26/03/2020
S1	15/03/2020	08/04/2020	27/03/2020
S1	22/03/2020	03/04/2020	28/03/2020
S2	23/03/2020	02/04/2020	28/03/2020
S1	23/03/2020	04/04/2020	29/03/2020
S1	23/03/2020	04/04/2020	29/03/2020
S1	27/03/2020	08/04/2020	02/04/2020
S2	26/03/2020	10/04/2020	02/04/2020
S1	22/03/2020	15/04/2020	03/04/2020
S1	23/03/2020	16/04/2020	04/04/2020
S1	23/03/2020	16/04/2020	04/04/2020
S2	23/03/2020	17/04/2020	04/04/2020
S2	31/03/2020	10/04/2020	05/04/2020
S1	27/03/2020	20/04/2020	08/04/2020
S1	03/04/2020	15/04/2020	09/04/2020
LC	01/04/2020	17/04/2020	09/04/2020
S2	02/04/2020	17/04/2020	09/04/2020
S1	04/04/2020	16/04/2020	10/04/2020
S1	04/04/2020	16/04/2020	10/04/2020
S2	26/03/2020	25/04/2020	10/04/2020
S2	31/03/2020	25/04/2020	12/04/2020
S1	08/04/2020	20/04/2020	14/04/2020
S2	02/04/2020	27/04/2020	14/04/2020
S1	03/04/2020	27/04/2020	15/04/2020
S1	04/04/2020	28/04/2020	16/04/2020
S1	04/04/2020	28/04/2020	16/04/2020
S2	02/04/2020	02/05/2020	17/04/2020
S2	10/04/2020	25/04/2020	17/04/2020
S1	08/04/2020	02/05/2020	20/04/2020
S1	15/04/2020	27/04/2020	21/04/2020
S1	16/04/2020	28/04/2020	22/04/2020
S1	16/04/2020	28/04/2020	22/04/2020
S2	17/04/2020	27/04/2020	22/04/2020
S2	10/04/2020	05/05/2020	22/04/2020
S2	17/04/2020	02/05/2020	24/04/2020
S2	10/04/2020	10/05/2020	25/04/2020
S1	20/04/2020	02/05/2020	26/04/2020
S1	15/04/2020	09/05/2020	27/04/2020
S1	16/04/2020	10/05/2020	28/04/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	16/04/2020	10/05/2020	28/04/2020
S2	17/04/2020	12/05/2020	29/04/2020
S2	25/04/2020	05/05/2020	30/04/2020
S1	20/04/2020	14/05/2020	02/05/2020
S2	25/04/2020	10/05/2020	02/05/2020
S1	27/04/2020	09/05/2020	03/05/2020
S1	28/04/2020	10/05/2020	04/05/2020
S1	28/04/2020	10/05/2020	04/05/2020
S2	27/04/2020	12/05/2020	04/05/2020
S2	25/04/2020	15/05/2020	05/05/2020
S2	02/05/2020	12/05/2020	07/05/2020
S1	02/05/2020	14/05/2020	08/05/2020
S1	27/04/2020	21/05/2020	09/05/2020
S1	28/04/2020	22/05/2020	10/05/2020
S1	28/04/2020	22/05/2020	10/05/2020
S2	05/05/2020	15/05/2020	10/05/2020
S2	27/04/2020	27/05/2020	12/05/2020
S1	02/05/2020	26/05/2020	14/05/2020
S2	02/05/2020	27/05/2020	14/05/2020
S1	09/05/2020	21/05/2020	15/05/2020
S1	10/05/2020	22/05/2020	16/05/2020
S1	10/05/2020	22/05/2020	16/05/2020
S2	12/05/2020	27/05/2020	19/05/2020
S1	14/05/2020	26/05/2020	20/05/2020
S2	05/05/2020	04/06/2020	20/05/2020
LC	12/05/2020	28/05/2020	20/05/2020
S1	10/05/2020	03/06/2020	22/05/2020
S1	10/05/2020	03/06/2020	22/05/2020
S2	10/05/2020	04/06/2020	22/05/2020
S2	10/05/2020	09/06/2020	25/05/2020
S2	15/05/2020	04/06/2020	25/05/2020
S1	14/05/2020	07/06/2020	26/05/2020
S2	12/05/2020	11/06/2020	27/05/2020
S2	15/05/2020	09/06/2020	27/05/2020
S1	22/05/2020	03/06/2020	28/05/2020
S1	22/05/2020	03/06/2020	28/05/2020
S1	26/05/2020	07/06/2020	01/06/2020
S1	21/05/2020	14/06/2020	02/06/2020
S1	22/05/2020	15/06/2020	03/06/2020
S1	22/05/2020	15/06/2020	03/06/2020
S2	27/05/2020	11/06/2020	03/06/2020
S1	26/05/2020	19/06/2020	07/06/2020
S1	28/05/2019	21/06/2021	08/06/2020
S1	03/06/2020	15/06/2020	09/06/2020
S1	03/06/2020	15/06/2020	09/06/2020
S2	27/05/2020	26/06/2020	11/06/2020
S1	07/06/2020	19/06/2020	13/06/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	03/06/2020	27/06/2020	15/06/2020
S1	03/06/2020	27/06/2020	15/06/2020
S2	11/06/2020	26/06/2020	18/06/2020
S1	07/06/2020	01/07/2020	19/06/2020
S1	14/06/2020	26/06/2020	20/06/2020
S1	15/06/2020	27/06/2020	21/06/2020
S1	15/06/2020	27/06/2020	21/06/2020
S2	11/06/2020	01/07/2020	21/06/2020
S1	19/06/2020	01/07/2020	25/06/2020
S1	14/06/2020	08/07/2020	26/06/2020
S1	15/06/2020	09/07/2020	27/06/2020
S1	15/06/2020	09/07/2020	27/06/2020
S1	19/06/2020	13/07/2020	01/07/2020
S1	26/06/2020	08/07/2020	02/07/2020
S1	27/06/2020	09/07/2020	03/07/2020
S1	27/06/2020	09/07/2020	03/07/2020
S2	26/06/2020	16/07/2020	06/07/2020
S1	01/07/2020	13/07/2020	07/07/2020
LC	29/06/2020	15/07/2020	07/07/2020
S1	26/06/2020	20/07/2020	08/07/2020
S2	01/07/2020	16/07/2020	08/07/2020
S1	27/06/2020	21/07/2020	09/07/2020
S1	01/07/2020	25/07/2020	13/07/2020
S1	08/07/2020	20/07/2020	14/07/2020
S1	09/07/2020	21/07/2020	15/07/2020
S1	13/07/2020	25/07/2020	19/07/2020
S1	08/07/2020	01/08/2020	20/07/2020
S1	09/07/2020	02/08/2020	21/07/2020
LC	15/07/2020	31/07/2020	23/07/2020
S1	13/07/2020	06/08/2020	25/07/2020
S1	20/07/2020	01/08/2020	26/07/2020
S2	16/07/2020	05/08/2020	26/07/2020
S1	21/07/2020	02/08/2020	27/07/2020
S1	25/07/2020	06/08/2020	31/07/2020
S1	20/07/2020	13/08/2020	01/08/2020
S1	21/07/2020	14/08/2020	02/08/2020
S1	25/07/2020	18/08/2020	06/08/2020
S1	01/08/2020	13/08/2020	07/08/2020
S1	02/08/2020	14/08/2020	08/08/2020
S2	29/07/2020	18/08/2020	08/08/2020
S1	06/08/2020	18/08/2020	12/08/2020
S2	05/08/2020	20/08/2020	12/08/2020
S1	01/08/2020	25/08/2020	13/08/2020
S1	06/08/2020	30/08/2020	18/08/2020
S1	13/08/2020	25/08/2020	19/08/2020
S1	14/08/2020	26/08/2020	20/08/2020
S2	05/08/2020	04/09/2020	20/08/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	18/08/2020	30/08/2020	24/08/2020
S1	13/08/2020	06/09/2020	25/08/2020
S1	14/08/2020	07/09/2020	26/08/2020
S1	14/08/2020	07/09/2020	26/08/2020
S2	20/08/2020	04/09/2020	27/08/2020
S1	18/08/2020	11/09/2020	30/08/2020
S2	18/08/2020	12/09/2020	30/08/2020
S1	25/08/2020	06/09/2020	31/08/2020
S1	26/08/2020	07/09/2020	01/09/2020
S2	20/08/2020	14/09/2020	01/09/2020
S1	30/08/2020	11/09/2020	05/09/2020
S1	25/08/2020	18/09/2020	06/09/2020
S1	26/08/2020	19/09/2020	07/09/2020
S2	04/09/2020	14/09/2020	09/09/2020
S1	30/08/2020	23/09/2020	11/09/2020
RCM	09/09/2020	13/09/2020	11/09/2020
S1	06/09/2020	18/09/2020	12/09/2020
S1	07/09/2020	19/09/2020	13/09/2020
S1	07/09/2020	19/09/2020	13/09/2020
S1	11/09/2020	23/09/2020	17/09/2020
S1	06/09/2020	30/09/2020	18/09/2020
S1	07/09/2020	01/10/2020	19/09/2020
S1	07/09/2020	01/10/2020	19/09/2020
S1	11/09/2020	05/10/2020	23/09/2020
S1	18/09/2020	30/09/2020	24/09/2020
S1	19/09/2020	01/10/2020	25/09/2020
S1	19/09/2020	01/10/2020	25/09/2020
S1	23/09/2020	05/10/2020	29/09/2020
S2	14/09/2020	14/10/2020	29/09/2020
S1	18/09/2020	12/10/2020	30/09/2020
S1	19/09/2020	13/10/2020	01/10/2020
S1	19/09/2020	13/10/2020	01/10/2020
S1	23/09/2020	17/10/2020	05/10/2020
S1	30/09/2020	12/10/2020	06/10/2020
S1	01/10/2020	13/10/2020	07/10/2020
S1	01/10/2020	13/10/2020	07/10/2020
S1	05/10/2020	17/10/2020	11/10/2020
S1	30/09/2020	24/10/2020	12/10/2020
S1	01/10/2020	25/10/2020	13/10/2020
S1	01/10/2020	25/10/2020	13/10/2020
S1	12/10/2020	24/10/2020	18/10/2020
S1	13/10/2020	25/10/2020	19/10/2020
S1	13/10/2020	25/10/2020	19/10/2020
S1	12/10/2020	05/11/2020	24/10/2020
S1	13/10/2020	06/11/2020	25/10/2020
S1	13/10/2020	06/11/2020	25/10/2020
S1	17/10/2020	10/11/2020	29/10/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	22/10/2020	06/11/2020	29/10/2020
S1	24/10/2020	05/11/2020	30/10/2020
S1	25/10/2020	06/11/2020	31/10/2020
S1	25/10/2020	06/11/2020	31/10/2020
RCM	31/10/2020	04/11/2020	02/11/2020
S2	19/10/2020	18/11/2020	03/11/2020
S2	22/10/2020	16/11/2020	03/11/2020
S1	24/10/2020	17/11/2020	05/11/2020
S1	25/10/2020	18/11/2020	06/11/2020
RCM	04/11/2020	16/11/2020	10/11/2020
S1	05/11/2020	17/11/2020	11/11/2020
S2	06/11/2020	16/11/2020	11/11/2020
S1	06/11/2020	18/11/2020	12/11/2020
S1	06/11/2020	18/11/2020	12/11/2020
S1	10/11/2020	22/11/2020	16/11/2020
S1	05/11/2020	29/11/2020	17/11/2020
S1	06/11/2020	30/11/2020	18/11/2020
S1	06/11/2020	30/11/2020	18/11/2020
S1	10/11/2020	04/12/2020	22/11/2020
S1	17/11/2020	29/11/2020	23/11/2020
S1	18/11/2020	30/11/2020	24/11/2020
S1	18/11/2020	30/11/2020	24/11/2020
S1	22/11/2020	04/12/2020	28/11/2020
S1	17/11/2020	11/12/2020	29/11/2020
S1	18/11/2020	12/12/2020	30/11/2020
S1	18/11/2020	12/12/2020	30/11/2020
S1	22/11/2020	16/12/2020	04/12/2020
S1	29/11/2020	11/12/2020	05/12/2020
S1	30/11/2020	12/12/2020	06/12/2020
S1	30/11/2020	12/12/2020	06/12/2020
S1	04/12/2020	16/12/2020	10/12/2020
S1	29/11/2020	23/12/2020	11/12/2020
S1	30/11/2020	24/12/2020	12/12/2020
S1	04/12/2020	28/12/2020	16/12/2020
S1	11/12/2020	23/12/2020	17/12/2020
S1	12/12/2020	24/12/2020	18/12/2020
S1	16/12/2020	28/12/2020	22/12/2020
S1	11/12/2020	04/01/2021	23/12/2020
S1	12/12/2020	05/01/2021	24/12/2020
S1	16/12/2020	09/01/2021	28/12/2020
S1	23/12/2020	04/01/2021	29/12/2020
S1	28/12/2020	09/01/2021	03/01/2021
S1	23/12/2020	16/01/2021	04/01/2021
S1	24/12/2020	17/01/2021	05/01/2021
S1	28/12/2020	21/01/2021	09/01/2021
S1	04/01/2021	16/01/2021	10/01/2021
S1	09/01/2021	21/01/2021	15/01/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	04/01/2021	28/01/2021	16/01/2021
S1	05/01/2021	29/01/2021	17/01/2021
S1	09/01/2021	02/02/2021	21/01/2021
S1	16/01/2021	28/01/2021	22/01/2021
S1	17/01/2021	29/01/2021	23/01/2021
S1	21/01/2021	02/02/2021	27/01/2021
S1	16/01/2021	09/02/2021	28/01/2021
S1	17/01/2021	10/02/2021	29/01/2021
S2	27/01/2021	06/02/2021	01/02/2021
S1	21/01/2021	14/02/2021	02/02/2021
S1	28/01/2021	09/02/2021	03/02/2021
S2	27/01/2021	11/02/2021	03/02/2021
S1	29/01/2021	10/02/2021	04/02/2021
S1	29/01/2021	10/02/2021	04/02/2021
S1	02/02/2021	14/02/2021	08/02/2021
S1	28/01/2021	21/02/2021	09/02/2021
S2	04/02/2021	14/02/2021	09/02/2021
S1	29/01/2021	22/02/2021	10/02/2021
S1	29/01/2021	22/02/2021	10/02/2021
S1	02/02/2021	26/02/2021	14/02/2021
S1	09/02/2021	21/02/2021	15/02/2021
S1	10/02/2021	22/02/2021	16/02/2021
S1	10/02/2021	22/02/2021	16/02/2021
S2	06/02/2021	03/03/2021	18/02/2021
S1	14/02/2021	26/02/2021	20/02/2021
S1	09/02/2021	05/03/2021	21/02/2021
S2	11/02/2021	03/03/2021	21/02/2021
S2	06/02/2021	08/03/2021	21/02/2021
S1	10/02/2021	06/03/2021	22/02/2021
LC	15/02/2021	03/03/2021	23/02/2021
S2	11/02/2021	08/03/2021	23/02/2021
S1	14/02/2021	10/03/2021	26/02/2021
S1	21/02/2021	05/03/2021	27/02/2021
S1	22/02/2021	06/03/2021	28/02/2021
S1	26/02/2021	10/03/2021	04/03/2021
S1	21/02/2021	17/03/2021	05/03/2021
S1	22/02/2021	18/03/2021	06/03/2021
S1	22/02/2021	18/03/2021	06/03/2021
S1	26/02/2021	22/03/2021	10/03/2021
S1	05/03/2021	17/03/2021	11/03/2021
LC	03/03/2021	19/03/2021	11/03/2021
S1	06/03/2021	18/03/2021	12/03/2021
S2	03/03/2021	28/03/2021	15/03/2021
S1	10/03/2021	22/03/2021	16/03/2021
S1	05/03/2021	29/03/2021	17/03/2021
S1	06/03/2021	30/03/2021	18/03/2021
S2	03/03/2021	02/04/2021	18/03/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	08/03/2021	28/03/2021	18/03/2021
LC	12/03/2021	28/03/2021	20/03/2021
S2	08/03/2021	02/04/2021	20/03/2021
S1	10/03/2021	03/04/2021	22/03/2021
S1	17/03/2021	29/03/2021	23/03/2021
S2	08/03/2021	07/04/2021	23/03/2021
S1	18/03/2021	30/03/2021	24/03/2021
S1	18/03/2021	30/03/2021	24/03/2021
S1	22/03/2021	03/04/2021	28/03/2021
S1	17/03/2021	10/04/2021	29/03/2021
S1	18/03/2021	11/04/2021	30/03/2021
S1	18/03/2021	11/04/2021	30/03/2021
S2	28/03/2021	07/04/2021	02/04/2021
S1	22/03/2021	15/04/2021	03/04/2021
S1	29/03/2021	10/04/2021	04/04/2021
S1	30/03/2021	11/04/2021	05/04/2021
S1	30/03/2021	11/04/2021	05/04/2021
S2	28/03/2021	17/04/2021	07/04/2021
S1	03/04/2021	15/04/2021	09/04/2021
S2	02/04/2021	17/04/2021	09/04/2021
S2	28/03/2021	22/04/2021	09/04/2021
S1	29/03/2021	22/04/2021	10/04/2021
S1	30/03/2021	23/04/2021	11/04/2021
S1	30/03/2021	23/04/2021	11/04/2021
S2	02/04/2021	22/04/2021	12/04/2021
S2	07/04/2021	17/04/2021	12/04/2021
S2	28/03/2021	27/04/2021	12/04/2021
S2	02/04/2021	27/04/2021	14/04/2021
S2	07/04/2021	22/04/2021	14/04/2021
S1	03/04/2021	27/04/2021	15/04/2021
S1	10/04/2021	22/04/2021	16/04/2021
S1	11/04/2021	23/04/2021	17/04/2021
S1	11/04/2021	23/04/2021	17/04/2021
S2	02/04/2021	02/05/2021	17/04/2021
S2	07/04/2021	27/04/2021	17/04/2021
S2	07/04/2021	02/05/2021	19/04/2021
S2	15/04/2021	25/04/2021	20/04/2021
S1	15/04/2021	27/04/2021	21/04/2021
S1	15/04/2021	27/04/2021	21/04/2021
S1	10/04/2021	04/05/2021	22/04/2021
S2	17/04/2021	27/04/2021	22/04/2021
S1	11/04/2021	05/05/2021	23/04/2021
S1	11/04/2021	05/05/2021	23/04/2021
S2	17/04/2021	02/05/2021	24/04/2021
S1	15/04/2021	09/05/2021	27/04/2021
S1	15/04/2021	09/05/2021	27/04/2021
S2	22/04/2021	02/05/2021	27/04/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	22/04/2021	04/05/2021	28/04/2021
S1	23/04/2021	05/05/2021	29/04/2021
S1	23/04/2021	05/05/2021	29/04/2021
S1	23/04/2021	05/05/2021	29/04/2021
S1	27/04/2021	09/05/2021	03/05/2021
S1	27/04/2021	09/05/2021	03/05/2021
S1	22/04/2021	16/05/2021	04/05/2021
S1	23/04/2021	17/05/2021	05/05/2021
S1	23/04/2021	17/05/2021	05/05/2021
S1	23/04/2021	17/05/2021	05/05/2021
S1	27/04/2021	21/05/2021	09/05/2021
S1	27/04/2021	21/05/2021	09/05/2021
S1	04/05/2021	16/05/2021	10/05/2021
S2	25/04/2021	25/05/2021	10/05/2021
S1	05/05/2021	17/05/2021	11/05/2021
S1	05/05/2021	17/05/2021	11/05/2021
S1	05/05/2021	17/05/2021	11/05/2021
S1	09/05/2021	21/05/2021	15/05/2021
S1	09/05/2021	21/05/2021	15/05/2021
S1	04/05/2021	28/05/2021	16/05/2021
S1	05/05/2021	29/05/2021	17/05/2021
S1	05/05/2021	29/05/2021	17/05/2021
S1	05/05/2021	29/05/2021	17/05/2021
S1	09/05/2021	02/06/2021	21/05/2021
S1	09/05/2021	02/06/2021	21/05/2021
S1	16/05/2021	28/05/2021	22/05/2021
S1	17/05/2021	29/05/2021	23/05/2021
S1	17/05/2021	29/05/2021	23/05/2021
S1	21/05/2021	02/06/2021	27/05/2021
S1	16/05/2021	09/06/2021	28/05/2021
S1	17/05/2021	10/06/2021	29/05/2021
S1	17/05/2021	10/06/2021	29/05/2021
S2	25/05/2021	04/06/2021	30/05/2021
S2	25/05/2021	09/06/2021	01/06/2021
S1	21/05/2021	14/06/2021	02/06/2021
S1	28/05/2021	09/06/2021	03/06/2021
S1	29/05/2021	10/06/2021	04/06/2021
S1	29/05/2021	10/06/2021	04/06/2021
S2	01/06/2021	11/06/2021	06/06/2021
S2	25/05/2021	19/06/2021	06/06/2021
S1	02/06/2021	14/06/2021	08/06/2021
S1	28/05/2021	21/06/2021	09/06/2021
S1	29/05/2021	22/06/2021	10/06/2021
S1	29/05/2021	22/06/2021	10/06/2021
S2	04/06/2021	19/06/2021	11/06/2021
S1	02/06/2021	26/06/2021	14/06/2021
S2	09/06/2021	19/06/2021	14/06/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	09/06/2021	21/06/2021	15/06/2021
LC	07/06/2021	23/06/2021	15/06/2021
S1	10/06/2021	22/06/2021	16/06/2021
S1	10/06/2021	22/06/2021	16/06/2021
S1	14/06/2021	26/06/2021	20/06/2021
S1	09/06/2021	03/07/2021	21/06/2021
S2	11/06/2021	01/07/2021	21/06/2021
S1	10/06/2021	04/07/2021	22/06/2021
S1	10/06/2021	04/07/2021	22/06/2021
S1	14/06/2021	08/07/2021	26/06/2021
S1	21/06/2021	03/07/2021	27/06/2021
S1	22/06/2021	04/07/2021	28/06/2021
S1	22/06/2021	04/07/2021	28/06/2021
S1	26/06/2021	08/07/2021	02/07/2021
S1	21/06/2021	15/07/2021	03/07/2021
S1	22/06/2021	16/07/2021	04/07/2021
S1	22/06/2021	16/07/2021	04/07/2021
S2	19/06/2021	19/07/2021	04/07/2021
S1	26/06/2021	20/07/2021	08/07/2021
S2	01/07/2021	16/07/2021	08/07/2021
S1	03/07/2021	15/07/2021	09/07/2021
S1	04/07/2021	16/07/2021	10/07/2021
S1	04/07/2021	16/07/2021	10/07/2021
S1	08/07/2021	20/07/2021	14/07/2021
S2	01/07/2021	31/07/2021	16/07/2021
S1	15/07/2021	27/07/2021	21/07/2021
S1	16/07/2021	28/07/2021	22/07/2021
S1	16/07/2021	28/07/2021	22/07/2021
S2	16/07/2021	31/07/2021	23/07/2021
LC	18/07/2021	03/08/2021	26/07/2021
S2	19/07/2021	03/08/2021	26/07/2021
S2	16/07/2021	15/08/2021	31/07/2021
S1	27/07/2021	08/08/2021	02/08/2021
S1	28/07/2021	09/08/2021	03/08/2021
S1	28/07/2021	09/08/2021	03/08/2021
S2	31/07/2021	15/08/2021	07/08/2021
S1	09/08/2021	21/08/2021	15/08/2021
S1	09/08/2021	21/08/2021	15/08/2021
S2	31/07/2021	30/08/2021	15/08/2021
S1	13/08/2021	25/08/2021	19/08/2021
S2	15/08/2021	30/08/2021	22/08/2021
S1	21/08/2021	02/09/2021	27/08/2021
S1	21/08/2021	02/09/2021	27/08/2021
S1	25/08/2021	06/09/2021	31/08/2021
S1	01/09/2021	13/09/2021	07/09/2021
S1	02/09/2021	14/09/2021	08/09/2021
S1	02/09/2021	14/09/2021	08/09/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	30/08/2021	19/09/2021	09/09/2021
S1	06/09/2021	18/09/2021	12/09/2021
S2	07/09/2021	22/09/2021	14/09/2021
S1	13/09/2021	25/09/2021	19/09/2021
S1	14/09/2021	26/09/2021	20/09/2021
S1	14/09/2021	26/09/2021	20/09/2021
S1	18/09/2021	30/09/2021	24/09/2021
S2	19/09/2021	04/10/2021	26/09/2021
S1	26/09/2021	08/10/2021	02/10/2021
S1	26/09/2021	08/10/2021	02/10/2021
S1	30/09/2021	12/10/2021	06/10/2021
S1	08/10/2021	20/10/2021	14/10/2021
S1	08/10/2021	20/10/2021	14/10/2021
S1	12/10/2021	24/10/2021	18/10/2021
S1	20/10/2021	01/11/2021	26/10/2021
S1	20/10/2021	01/11/2021	26/10/2021
S1	24/10/2021	05/11/2021	30/10/2021
S1	31/10/2021	12/11/2021	06/11/2021
S1	01/11/2021	13/11/2021	07/11/2021
S1	01/11/2021	13/11/2021	07/11/2021
S1	05/11/2021	17/11/2021	11/11/2021
S1	12/11/2021	24/11/2021	18/11/2021
S1	13/11/2021	25/11/2021	19/11/2021
S1	17/11/2021	29/11/2021	23/11/2021
S1	24/11/2021	06/12/2021	30/11/2021
S1	25/11/2021	07/12/2021	01/12/2021
S1	29/11/2021	11/12/2021	05/12/2021
S1	06/12/2021	18/12/2021	12/12/2021
S1	07/12/2021	19/12/2021	13/12/2021
S1	11/12/2021	23/12/2021	17/12/2021
S1	23/12/2021	04/01/2022	29/12/2021
S1	04/01/2022	16/01/2022	10/01/2022
S1	16/01/2022	28/01/2022	22/01/2022
LC	17/01/2022	02/02/2022	25/01/2022
LC	17/01/2022	10/02/2022	29/01/2022
S1	24/01/2022	05/02/2022	30/01/2022
S1	28/01/2022	09/02/2022	03/02/2022
LC	02/02/2022	10/02/2022	06/02/2022
S2	30/01/2022	19/02/2022	09/02/2022
S2	30/01/2022	01/03/2022	14/02/2022
S2	19/02/2022	01/03/2022	24/02/2022
S2	19/02/2022	06/03/2022	26/02/2022
S2	01/03/2022	26/03/2022	13/03/2022
S2	01/03/2022	31/03/2022	16/03/2022
S2	06/03/2022	26/03/2022	16/03/2022
S2	06/03/2022	31/03/2022	18/03/2022
S2	26/03/2022	10/04/2022	02/04/2022

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	31/03/2022	10/04/2022	05/04/2022
S2	26/03/2022	15/04/2022	05/04/2022
S2	31/03/2022	15/04/2022	07/04/2022
S2	26/03/2022	20/04/2022	07/04/2022
S2	31/03/2022	20/04/2022	10/04/2022
S2	10/04/2022	20/04/2022	15/04/2022
S2	31/03/2022	30/04/2022	15/04/2022
S2	10/04/2022	30/04/2022	20/04/2022
S2	15/04/2022	30/04/2022	22/04/2022
S2	20/04/2022	30/04/2022	25/04/2022

Appendix Table 3: Images used in the analysis at the 10 km from the terminus point on Hubbard Glacier. LC is Landsat, S1 is Sentinel-1 (includes Sentinel-1a and Sentinel-1b), S2 is Sentinel-2 (includes Sentinel-2a and Sentinel-2b), TSX/TDX is TerraSAR-X/TanDEM-X, R2 is RADARSAT-2, and RCM is RADARSAT Constellation Mission.

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
LC	12/07/2013	28/07/2013	20/07/2013
LC	28/07/2013	13/08/2013	05/08/2013
LC	08/11/2013	24/11/2013	16/11/2013
LC	20/01/2014	05/02/2014	28/01/2014
LC	05/02/2014	21/02/2014	13/02/2014
R2	03/02/2014	27/02/2014	15/02/2014
LC	28/02/2014	16/03/2014	08/03/2014
R2	27/02/2014	23/03/2014	11/03/2014
LC	16/03/2014	01/04/2014	24/03/2014
LC	25/03/2014	10/04/2014	02/04/2014
LC	01/04/2014	17/04/2014	09/04/2014
LC	10/04/2014	26/04/2014	18/04/2014
LC	17/04/2014	03/05/2014	25/04/2014
LC	23/08/2014	08/09/2014	31/08/2014
LC	08/09/2014	24/09/2014	16/09/2014
LC	11/11/2014	27/11/2014	19/11/2014
R2	22/02/2015	18/03/2015	06/03/2015
TSX/TDX	03/03/2015	14/03/2015	08/03/2015
LC	19/03/2015	04/04/2015	27/03/2015
LC	28/03/2015	13/04/2015	05/04/2015
LC	06/05/2015	22/05/2015	14/05/2015
LC	15/05/2015	31/05/2015	23/05/2015
S1	12/06/2015	06/07/2015	24/06/2015
LC	23/06/2015	09/07/2015	01/07/2015
TSX/TDX	27/06/2015	08/07/2015	02/07/2015
TSX/TDX	08/07/2015	19/07/2015	13/07/2015

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
LC	09/07/2015	25/07/2015	17/07/2015
S1	06/07/2015	30/07/2015	18/07/2015
TSX/TDX	19/07/2015	30/07/2015	24/07/2015
TSX/TDX	30/07/2015	10/08/2015	04/08/2015
TSX/TDX	10/08/2015	21/08/2015	15/08/2015
TSX/TDX	21/08/2015	01/09/2015	26/08/2015
TSX/TDX	01/09/2015	12/09/2015	06/09/2015
TSX/TDX	12/09/2015	23/09/2015	17/09/2015
S1	16/09/2015	10/10/2015	28/09/2015
TSX/TDX	23/09/2015	04/10/2015	28/09/2015
TSX/TDX	04/10/2015	15/10/2015	09/10/2015
TSX/TDX	09/10/2015	20/10/2015	14/10/2015
TSX/TDX	15/10/2015	26/10/2015	20/10/2015
S1	10/10/2015	03/11/2015	22/10/2015
S1	03/11/2015	27/11/2015	15/11/2015
TSX/TDX	22/11/2015	03/12/2015	27/11/2015
S1	27/11/2015	21/12/2015	09/12/2015
S1	08/12/2015	01/01/2016	20/12/2015
S1	14/01/2016	07/02/2016	26/01/2016
R2	24/01/2016	17/02/2016	05/02/2016
R2	17/02/2016	12/03/2016	29/02/2016
LC	27/02/2016	14/03/2016	06/03/2016
LC	14/03/2016	30/03/2016	22/03/2016
S2	18/05/2016	07/06/2016	28/05/2016
S1	17/08/2016	10/09/2016	29/08/2016
LC	29/09/2016	15/10/2016	07/10/2016
LC	08/10/2016	24/10/2016	16/10/2016
LC	15/10/2016	31/10/2016	23/10/2016
S1	20/10/2016	13/11/2016	01/11/2016
LC	31/10/2016	16/11/2016	08/11/2016
S2	25/10/2016	24/11/2016	09/11/2016
R2	18/01/2017	11/02/2017	30/01/2017
LC	04/02/2017	20/02/2017	12/02/2017
R2	11/02/2017	07/03/2017	23/02/2017
LC	20/02/2017	08/03/2017	28/02/2017
LC	08/03/2017	24/03/2017	16/03/2017
S1	07/04/2017	19/04/2017	13/04/2017
S1	19/04/2017	01/05/2017	25/04/2017
TSX/TDX	28/04/2017	09/05/2017	03/05/2017
S1	01/05/2017	13/05/2017	07/05/2017
S2	06/05/2017	26/05/2017	16/05/2017
S1	18/05/2017	30/05/2017	24/05/2017
S1	13/05/2017	06/06/2017	25/05/2017
S1	30/05/2017	11/06/2017	05/06/2017
S1	06/06/2017	18/06/2017	12/06/2017
S1	11/06/2017	23/06/2017	17/06/2017
S1	18/06/2017	30/06/2017	24/06/2017

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	23/06/2017	05/07/2017	29/06/2017
S1	05/07/2017	17/07/2017	11/07/2017
S1	17/07/2017	29/07/2017	23/07/2017
S1	29/07/2017	10/08/2017	04/08/2017
S1	05/08/2017	17/08/2017	11/08/2017
S1	06/08/2017	18/08/2017	12/08/2017
S1	06/08/2017	18/08/2017	12/08/2017
S1	10/08/2017	22/08/2017	16/08/2017
S1	06/08/2017	30/08/2017	18/08/2017
S1	17/08/2017	29/08/2017	23/08/2017
S1	18/08/2017	30/08/2017	24/08/2017
S1	22/08/2017	03/09/2017	28/08/2017
S1	29/08/2017	10/09/2017	04/09/2017
S1	30/08/2017	11/09/2017	05/09/2017
S1	03/09/2017	15/09/2017	09/09/2017
S1	30/08/2017	23/09/2017	11/09/2017
S1	10/09/2017	22/09/2017	16/09/2017
S1	11/09/2017	23/09/2017	17/09/2017
S1	15/09/2017	27/09/2017	21/09/2017
S1	11/09/2017	05/10/2017	23/09/2017
S1	23/09/2017	05/10/2017	29/09/2017
LC	25/09/2017	11/10/2017	03/10/2017
S1	22/09/2017	16/10/2017	04/10/2017
S1	05/10/2017	17/10/2017	11/10/2017
S1	09/10/2017	21/10/2017	15/10/2017
S1	16/10/2017	28/10/2017	22/10/2017
S1	17/10/2017	29/10/2017	23/10/2017
S1	17/10/2017	29/10/2017	23/10/2017
S1	21/10/2017	02/11/2017	27/10/2017
S1	28/10/2017	09/11/2017	03/11/2017
S1	29/10/2017	10/11/2017	04/11/2017
S1	29/10/2017	10/11/2017	04/11/2017
S2	04/11/2017	14/11/2017	09/11/2017
S1	09/11/2017	21/11/2017	15/11/2017
S1	10/11/2017	22/11/2017	16/11/2017
S1	08/12/2017	20/12/2017	14/12/2017
S1	15/12/2017	27/12/2017	21/12/2017
S1	16/12/2017	28/12/2017	22/12/2017
S1	20/12/2017	01/01/2018	26/12/2017
S1	27/12/2017	08/01/2018	02/01/2018
S1	08/01/2018	20/01/2018	14/01/2018
S1	09/01/2018	21/01/2018	15/01/2018
S1	21/01/2018	02/02/2018	27/01/2018
S2	23/01/2018	02/02/2018	28/01/2018
S2	23/01/2018	07/02/2018	30/01/2018
S2	28/01/2018	07/02/2018	02/02/2018
TSX/TDX	28/01/2018	08/02/2018	02/02/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	23/01/2018	17/02/2018	04/02/2018
S2	28/01/2018	17/02/2018	07/02/2018
LC	31/01/2018	16/02/2018	08/02/2018
S2	02/02/2018	17/02/2018	09/02/2018
S2	07/02/2018	17/02/2018	12/02/2018
LC	07/02/2018	23/02/2018	15/02/2018
S2	02/02/2018	04/03/2018	17/02/2018
S2	07/02/2018	04/03/2018	19/02/2018
S2	17/02/2018	04/03/2018	24/02/2018
S1	02/03/2018	14/03/2018	08/03/2018
S2	25/02/2018	22/03/2018	09/03/2018
S2	04/03/2018	24/03/2018	14/03/2018
S2	04/03/2018	29/03/2018	16/03/2018
S1	14/03/2018	26/03/2018	20/03/2018
S2	22/03/2018	01/04/2018	27/03/2018
S2	24/03/2018	03/04/2018	29/03/2018
S2	22/03/2018	06/04/2018	29/03/2018
S2	22/03/2018	11/04/2018	01/04/2018
S2	24/03/2018	13/04/2018	03/04/2018
S2	22/03/2018	16/04/2018	03/04/2018
S2	29/03/2018	13/04/2018	05/04/2018
S2	01/04/2018	11/04/2018	06/04/2018
S1	02/04/2018	14/04/2018	08/04/2018
S2	03/04/2018	13/04/2018	08/04/2018
S2	01/04/2018	16/04/2018	08/04/2018
S2	06/04/2018	16/04/2018	11/04/2018
S2	29/03/2018	28/04/2018	13/04/2018
S2	01/04/2018	26/04/2018	13/04/2018
S2	03/04/2018	28/04/2018	15/04/2018
S2	06/04/2018	26/04/2018	16/04/2018
S2	11/04/2018	26/04/2018	18/04/2018
S1	14/04/2018	26/04/2018	20/04/2018
S2	13/04/2018	28/04/2018	20/04/2018
S1	15/04/2018	27/04/2018	21/04/2018
S1	15/04/2018	27/04/2018	21/04/2018
S2	16/04/2018	26/04/2018	21/04/2018
S2	06/04/2018	06/05/2018	21/04/2018
S2	11/04/2018	06/05/2018	23/04/2018
S1	19/04/2018	01/05/2018	25/04/2018
S2	13/04/2018	08/05/2018	25/04/2018
S2	16/04/2018	06/05/2018	26/04/2018
S2	26/04/2018	06/05/2018	01/05/2018
S2	16/04/2018	16/05/2018	01/05/2018
S1	26/04/2018	08/05/2018	02/05/2018
S1	27/04/2018	09/05/2018	03/05/2018
S1	27/04/2018	09/05/2018	03/05/2018
S2	28/04/2018	08/05/2018	03/05/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	26/04/2018	16/05/2018	06/05/2018
S1	01/05/2018	13/05/2018	07/05/2018
S2	28/04/2018	18/05/2018	08/05/2018
S1	27/04/2018	21/05/2018	09/05/2018
S1	27/04/2018	21/05/2018	09/05/2018
S2	06/05/2018	16/05/2018	11/05/2018
S2	08/05/2018	18/05/2018	13/05/2018
S1	08/05/2018	20/05/2018	14/05/2018
S1	09/05/2018	21/05/2018	15/05/2018
S1	09/05/2018	21/05/2018	15/05/2018
S1	13/05/2018	25/05/2018	19/05/2018
S1	20/05/2018	01/06/2018	26/05/2018
S1	21/05/2018	02/06/2018	27/05/2018
S1	25/05/2018	06/06/2018	31/05/2018
S1	01/06/2018	13/06/2018	07/06/2018
S1	02/06/2018	14/06/2018	08/06/2018
S1	06/06/2018	18/06/2018	12/06/2018
S1	13/06/2018	25/06/2018	19/06/2018
S1	14/06/2018	26/06/2018	20/06/2018
S1	14/06/2018	26/06/2018	20/06/2018
S1	18/06/2018	30/06/2018	24/06/2018
S1	26/06/2018	08/07/2018	02/07/2018
S1	26/06/2018	08/07/2018	02/07/2018
S1	30/06/2018	12/07/2018	06/07/2018
LC	01/07/2018	17/07/2018	09/07/2018
S2	02/07/2018	17/07/2018	09/07/2018
S2	02/07/2018	22/07/2018	12/07/2018
S2	05/07/2018	20/07/2018	12/07/2018
S1	08/07/2018	20/07/2018	14/07/2018
S1	08/07/2018	20/07/2018	14/07/2018
S2	02/07/2018	01/08/2018	17/07/2018
S2	05/07/2018	30/07/2018	17/07/2018
S1	12/07/2018	24/07/2018	18/07/2018
S1	08/07/2018	01/08/2018	20/07/2018
S2	17/07/2018	01/08/2018	24/07/2018
S2	20/07/2018	30/07/2018	25/07/2018
S1	20/07/2018	01/08/2018	26/07/2018
S2	22/07/2018	01/08/2018	27/07/2018
S1	24/07/2018	05/08/2018	30/07/2018
S1	05/08/2018	05/08/2018	05/08/2018
S1	01/08/2018	13/08/2018	07/08/2018
S1	05/08/2018	17/08/2018	11/08/2018
S2	01/08/2018	31/08/2018	16/08/2018
S1	12/08/2018	24/08/2018	18/08/2018
S1	13/08/2018	25/08/2018	19/08/2018
S1	17/08/2018	29/08/2018	23/08/2018
S1	17/08/2018	10/09/2018	29/08/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	24/08/2018	05/09/2018	30/08/2018
S1	25/08/2018	06/09/2018	31/08/2018
S1	29/08/2018	10/09/2018	04/09/2018
S2	31/08/2018	10/09/2018	05/09/2018
S1	25/08/2018	18/09/2018	06/09/2018
S2	03/09/2018	13/09/2018	08/09/2018
S2	03/09/2018	18/09/2018	10/09/2018
S1	05/09/2018	17/09/2018	11/09/2018
LC	03/09/2018	19/09/2018	11/09/2018
S1	06/09/2018	18/09/2018	12/09/2018
S1	06/09/2018	18/09/2018	12/09/2018
S2	08/09/2018	18/09/2018	13/09/2018
S2	31/08/2018	30/09/2018	15/09/2018
S1	10/09/2018	22/09/2018	16/09/2018
S2	05/09/2018	30/09/2018	17/09/2018
S1	06/09/2018	30/09/2018	18/09/2018
S2	10/09/2018	30/09/2018	20/09/2018
S1	10/09/2018	04/10/2018	22/09/2018
S1	17/09/2018	29/09/2018	23/09/2018
S1	18/09/2018	30/09/2018	24/09/2018
S1	18/09/2018	30/09/2018	24/09/2018
S2	13/09/2018	08/10/2018	25/09/2018
S1	22/09/2018	04/10/2018	28/09/2018
S2	18/09/2018	08/10/2018	28/09/2018
S1	18/09/2018	12/10/2018	30/09/2018
S1	29/09/2018	11/10/2018	05/10/2018
S1	30/09/2018	12/10/2018	06/10/2018
S1	30/09/2018	12/10/2018	06/10/2018
S1	04/10/2018	16/10/2018	10/10/2018
S1	30/09/2018	24/10/2018	12/10/2018
S1	30/09/2018	24/10/2018	12/10/2018
S1	04/10/2018	28/10/2018	16/10/2018
S1	11/10/2018	23/10/2018	17/10/2018
S1	12/10/2018	24/10/2018	18/10/2018
S1	12/10/2018	24/10/2018	18/10/2018
S2	08/10/2018	28/10/2018	18/10/2018
S2	08/10/2018	02/11/2018	20/10/2018
S1	16/10/2018	28/10/2018	22/10/2018
S1	11/10/2018	04/11/2018	23/10/2018
S1	12/10/2018	05/11/2018	24/10/2018
S1	16/10/2018	09/11/2018	28/10/2018
S1	23/10/2018	04/11/2018	29/10/2018
S1	24/10/2018	05/11/2018	30/10/2018
S1	28/10/2018	09/11/2018	03/11/2018
S1	24/10/2018	17/11/2018	05/11/2018
S1	04/11/2018	16/11/2018	10/11/2018
S1	05/11/2018	17/11/2018	11/11/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
LC	06/11/2018	22/11/2018	14/11/2018
S1	09/11/2018	21/11/2018	15/11/2018
S1	16/11/2018	28/11/2018	22/11/2018
S1	17/11/2018	29/11/2018	23/11/2018
LC	15/11/2018	01/12/2018	23/11/2018
S1	21/11/2018	03/12/2018	27/11/2018
S1	16/11/2018	10/12/2018	28/11/2018
S1	28/11/2018	10/12/2018	04/12/2018
S1	29/11/2018	11/12/2018	05/12/2018
S1	03/12/2018	15/12/2018	09/12/2018
S1	10/12/2018	22/12/2018	16/12/2018
S1	15/12/2018	27/12/2018	21/12/2018
S1	23/12/2018	04/01/2019	29/12/2018
S1	27/12/2018	08/01/2019	02/01/2019
S1	22/12/2018	15/01/2019	03/01/2019
S1	04/01/2019	16/01/2019	10/01/2019
S1	04/01/2019	28/01/2019	16/01/2019
S1	15/01/2019	27/01/2019	21/01/2019
S1	16/01/2019	28/01/2019	22/01/2019
S2	18/01/2019	02/02/2019	25/01/2019
S1	20/01/2019	01/02/2019	26/01/2019
S1	28/01/2019	09/02/2019	03/02/2019
S2	31/01/2019	10/02/2019	05/02/2019
S2	31/01/2019	15/02/2019	07/02/2019
S2	02/02/2019	22/02/2019	12/02/2019
S2	31/01/2019	25/02/2019	12/02/2019
S2	02/02/2019	27/02/2019	14/02/2019
S1	09/02/2019	21/02/2019	15/02/2019
S2	10/02/2019	25/02/2019	17/02/2019
LC	10/02/2019	26/02/2019	18/02/2019
S2	15/02/2019	25/02/2019	20/02/2019
S2	10/02/2019	07/03/2019	22/02/2019
S2	15/02/2019	07/03/2019	25/02/2019
LC	19/02/2019	07/03/2019	27/02/2019
S2	25/02/2019	07/03/2019	02/03/2019
S1	04/03/2019	16/03/2019	10/03/2019
S2	25/02/2019	27/03/2019	12/03/2019
S2	27/02/2019	29/03/2019	14/03/2019
S1	09/03/2019	21/03/2019	15/03/2019
S2	07/03/2019	27/03/2019	17/03/2019
S2	07/03/2019	01/04/2019	19/03/2019
S1	16/03/2019	28/03/2019	22/03/2019
S2	07/03/2019	06/04/2019	22/03/2019
S1	17/03/2019	29/03/2019	23/03/2019
S1	21/03/2019	02/04/2019	27/03/2019
S2	27/03/2019	06/04/2019	01/04/2019
S1	28/03/2019	09/04/2019	03/04/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	29/03/2019	10/04/2019	04/04/2019
S2	29/03/2019	13/04/2019	05/04/2019
LC	30/03/2019	15/04/2019	07/04/2019
S1	28/03/2019	21/04/2019	09/04/2019
S2	29/03/2019	28/04/2019	13/04/2019
S1	09/04/2019	21/04/2019	15/04/2019
S1	10/04/2019	22/04/2019	16/04/2019
S1	10/04/2019	22/04/2019	16/04/2019
S2	01/04/2019	01/05/2019	16/04/2019
S2	06/04/2019	01/05/2019	18/04/2019
S1	14/04/2019	26/04/2019	20/04/2019
S2	13/04/2019	28/04/2019	20/04/2019
LC	15/04/2019	01/05/2019	23/04/2019
S1	14/04/2019	08/05/2019	26/04/2019
S1	21/04/2019	03/05/2019	27/04/2019
S1	22/04/2019	04/05/2019	28/04/2019
S1	26/04/2019	08/05/2019	02/05/2019
S1	21/04/2019	15/05/2019	03/05/2019
S1	22/04/2019	16/05/2019	04/05/2019
S2	28/04/2019	18/05/2019	08/05/2019
S1	03/05/2019	15/05/2019	09/05/2019
S1	04/05/2019	16/05/2019	10/05/2019
S1	15/05/2019	27/05/2019	21/05/2019
S1	16/05/2019	28/05/2019	22/05/2019
S1	16/05/2019	28/05/2019	22/05/2019
S2	18/05/2019	07/06/2019	28/05/2019
S1	27/05/2019	08/06/2019	02/06/2019
S1	28/05/2019	09/06/2019	03/06/2019
S1	28/05/2019	09/06/2019	03/06/2019
S1	01/06/2019	13/06/2019	07/06/2019
S1	08/06/2019	20/06/2019	14/06/2019
S1	09/06/2019	21/06/2019	15/06/2019
S1	09/06/2019	21/06/2019	15/06/2019
S2	10/06/2019	20/06/2019	15/06/2019
S2	07/06/2019	27/06/2019	17/06/2019
S2	10/06/2019	25/06/2019	17/06/2019
S1	13/06/2019	25/06/2019	19/06/2019
S2	10/06/2019	30/06/2019	20/06/2019
S2	07/06/2019	07/07/2019	22/06/2019
S2	10/06/2019	05/07/2019	22/06/2019
S2	20/06/2019	30/06/2019	25/06/2019
S2	10/06/2019	10/07/2019	25/06/2019
S1	20/06/2019	02/07/2019	26/06/2019
S1	21/06/2019	03/07/2019	27/06/2019
S1	21/06/2019	03/07/2019	27/06/2019
S2	20/06/2019	05/07/2019	27/06/2019
S2	25/06/2019	05/07/2019	30/06/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	20/06/2019	10/07/2019	30/06/2019
S2	27/06/2019	07/07/2019	02/07/2019
S2	25/06/2019	10/07/2019	02/07/2019
S2	30/06/2019	10/07/2019	05/07/2019
LC	27/06/2019	13/07/2019	05/07/2019
S1	02/07/2019	14/07/2019	08/07/2019
S1	03/07/2019	15/07/2019	09/07/2019
S1	03/07/2019	15/07/2019	09/07/2019
S2	27/06/2019	22/07/2019	09/07/2019
S2	25/06/2019	25/07/2019	10/07/2019
S2	30/06/2019	25/07/2019	12/07/2019
S1	07/07/2019	19/07/2019	13/07/2019
S2	07/07/2019	22/07/2019	14/07/2019
S2	05/07/2019	25/07/2019	15/07/2019
S2	30/06/2019	30/07/2019	15/07/2019
S2	05/07/2019	30/07/2019	17/07/2019
S2	10/07/2019	25/07/2019	17/07/2019
S1	14/07/2019	26/07/2019	20/07/2019
S2	05/07/2019	04/08/2019	20/07/2019
S2	10/07/2019	30/07/2019	20/07/2019
S1	15/07/2019	27/07/2019	21/07/2019
S1	15/07/2019	27/07/2019	21/07/2019
S2	07/07/2019	06/08/2019	22/07/2019
S2	10/07/2019	04/08/2019	22/07/2019
S1	19/07/2019	31/07/2019	25/07/2019
S1	15/07/2019	08/08/2019	27/07/2019
S2	22/07/2019	06/08/2019	29/07/2019
S2	25/07/2019	04/08/2019	30/07/2019
S1	26/07/2019	07/08/2019	01/08/2019
S2	22/07/2019	11/08/2019	01/08/2019
S1	27/07/2019	08/08/2019	02/08/2019
S1	27/07/2019	08/08/2019	02/08/2019
S1	31/07/2019	12/08/2019	06/08/2019
S2	22/07/2019	21/08/2019	06/08/2019
S2	25/07/2019	19/08/2019	06/08/2019
S1	26/07/2019	19/08/2019	07/08/2019
S1	27/07/2019	20/08/2019	08/08/2019
S2	30/07/2019	19/08/2019	09/08/2019
S2	04/08/2019	19/08/2019	11/08/2019
S1	07/08/2019	19/08/2019	13/08/2019
LC	05/08/2019	21/08/2019	13/08/2019
S2	06/08/2019	21/08/2019	13/08/2019
S1	08/08/2019	20/08/2019	14/08/2019
S1	08/08/2019	20/08/2019	14/08/2019
S2	30/07/2019	29/08/2019	14/08/2019
S2	11/08/2019	21/08/2019	16/08/2019
S2	04/08/2019	29/08/2019	16/08/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	12/08/2019	24/08/2019	18/08/2019
S1	07/08/2019	31/08/2019	19/08/2019
S1	08/08/2019	01/09/2019	20/08/2019
S2	06/08/2019	05/09/2019	21/08/2019
S2	11/08/2019	05/09/2019	23/08/2019
S2	19/08/2019	29/08/2019	24/08/2019
S1	19/08/2019	31/08/2019	25/08/2019
S1	20/08/2019	01/09/2019	26/08/2019
S1	20/08/2019	01/09/2019	26/08/2019
S2	21/08/2019	05/09/2019	28/08/2019
S2	19/08/2019	08/09/2019	29/08/2019
LC	21/08/2019	06/09/2019	29/08/2019
S1	24/08/2019	05/09/2019	30/08/2019
S1	19/08/2019	12/09/2019	31/08/2019
S1	20/08/2019	13/09/2019	01/09/2019
S2	21/08/2019	15/09/2019	02/09/2019
S2	29/08/2019	08/09/2019	03/09/2019
S1	31/08/2019	12/09/2019	06/09/2019
S1	01/09/2019	13/09/2019	07/09/2019
S1	01/09/2019	13/09/2019	07/09/2019
LC	30/08/2019	15/09/2019	07/09/2019
S2	05/09/2019	15/09/2019	10/09/2019
S1	31/08/2019	24/09/2019	12/09/2019
S1	01/09/2019	25/09/2019	13/09/2019
S1	01/09/2019	25/09/2019	13/09/2019
LC	06/09/2019	22/09/2019	14/09/2019
S1	12/09/2019	24/09/2019	18/09/2019
S1	13/09/2019	25/09/2019	19/09/2019
S1	13/09/2019	25/09/2019	19/09/2019
S2	08/09/2019	03/10/2019	20/09/2019
S1	12/09/2019	06/10/2019	24/09/2019
S1	13/09/2019	07/10/2019	25/09/2019
S1	24/09/2019	06/10/2019	30/09/2019
S1	25/09/2019	07/10/2019	01/10/2019
S1	27/09/2017	09/10/2021	03/10/2019
S1	29/09/2019	11/10/2019	05/10/2019
S1	24/09/2019	18/10/2019	06/10/2019
S1	25/09/2019	19/10/2019	07/10/2019
S1	25/09/2019	19/10/2019	07/10/2019
S2	03/10/2019	13/10/2019	08/10/2019
S2	03/10/2019	18/10/2019	10/10/2019
S1	06/10/2019	18/10/2019	12/10/2019
S1	07/10/2019	19/10/2019	13/10/2019
S1	11/10/2019	23/10/2019	17/10/2019
S1	06/10/2019	30/10/2019	18/10/2019
S1	07/10/2019	31/10/2019	19/10/2019
S1	11/10/2019	04/11/2019	23/10/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	18/10/2019	30/10/2019	24/10/2019
S1	19/10/2019	31/10/2019	25/10/2019
S1	19/10/2019	31/10/2019	25/10/2019
S1	23/10/2019	04/11/2019	29/10/2019
S2	20/10/2019	09/11/2019	30/10/2019
S1	19/10/2019	12/11/2019	31/10/2019
S2	25/10/2019	09/11/2019	01/11/2019
S1	23/10/2019	16/11/2019	04/11/2019
S1	30/10/2019	11/11/2019	05/11/2019
S1	31/10/2019	12/11/2019	06/11/2019
S1	31/10/2019	12/11/2019	06/11/2019
S1	04/11/2019	16/11/2019	10/11/2019
S1	30/10/2019	23/11/2019	11/11/2019
S1	31/10/2019	24/11/2019	12/11/2019
S1	11/11/2019	23/11/2019	17/11/2019
S1	12/11/2019	24/11/2019	18/11/2019
S1	12/11/2019	24/11/2019	18/11/2019
S1	16/11/2019	28/11/2019	22/11/2019
S1	12/11/2019	06/12/2019	24/11/2019
S1	16/11/2019	10/12/2019	28/11/2019
S1	24/11/2019	06/12/2019	30/11/2019
S1	28/11/2019	10/12/2019	04/12/2019
S1	23/11/2019	17/12/2019	05/12/2019
S1	24/11/2019	18/12/2019	06/12/2019
S1	06/12/2019	18/12/2019	12/12/2019
S1	10/12/2019	22/12/2019	16/12/2019
S1	17/12/2019	29/12/2019	23/12/2019
S1	18/12/2019	30/12/2019	24/12/2019
S1	22/12/2019	03/01/2020	28/12/2019
S1	29/12/2019	10/01/2020	04/01/2020
S1	30/12/2019	11/01/2020	05/01/2020
S1	03/01/2020	15/01/2020	09/01/2020
S1	10/01/2020	22/01/2020	16/01/2020
S1	11/01/2020	23/01/2020	17/01/2020
S1	23/01/2020	04/02/2020	29/01/2020
S1	04/02/2020	16/02/2020	10/02/2020
S1	08/02/2020	20/02/2020	14/02/2020
S2	06/03/2020	26/03/2020	16/03/2020
S2	11/03/2020	26/03/2020	18/03/2020
S2	06/03/2020	31/03/2020	18/03/2020
S2	11/03/2020	31/03/2020	21/03/2020
S2	11/03/2020	10/04/2020	26/03/2020
S2	23/03/2020	02/04/2020	28/03/2020
S2	26/03/2020	10/04/2020	02/04/2020
S2	23/03/2020	17/04/2020	04/04/2020
S2	31/03/2020	10/04/2020	05/04/2020
S1	03/04/2020	15/04/2020	09/04/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
LC	01/04/2020	17/04/2020	09/04/2020
S2	02/04/2020	17/04/2020	09/04/2020
S2	26/03/2020	25/04/2020	10/04/2020
S2	31/03/2020	25/04/2020	12/04/2020
S2	02/04/2020	27/04/2020	14/04/2020
S2	02/04/2020	02/05/2020	17/04/2020
S2	10/04/2020	25/04/2020	17/04/2020
S1	15/04/2020	27/04/2020	21/04/2020
S1	16/04/2020	28/04/2020	22/04/2020
S1	16/04/2020	28/04/2020	22/04/2020
S2	17/04/2020	27/04/2020	22/04/2020
S2	10/04/2020	05/05/2020	22/04/2020
S2	17/04/2020	02/05/2020	24/04/2020
S2	10/04/2020	10/05/2020	25/04/2020
S1	20/04/2020	02/05/2020	26/04/2020
S1	15/04/2020	09/05/2020	27/04/2020
S1	16/04/2020	10/05/2020	28/04/2020
S2	17/04/2020	12/05/2020	29/04/2020
S2	25/04/2020	05/05/2020	30/04/2020
S2	25/04/2020	10/05/2020	02/05/2020
S1	27/04/2020	09/05/2020	03/05/2020
S1	28/04/2020	10/05/2020	04/05/2020
S1	28/04/2020	10/05/2020	04/05/2020
S2	27/04/2020	12/05/2020	04/05/2020
S2	25/04/2020	15/05/2020	05/05/2020
S2	02/05/2020	12/05/2020	07/05/2020
S1	02/05/2020	14/05/2020	08/05/2020
S1	28/04/2020	22/05/2020	10/05/2020
S2	05/05/2020	15/05/2020	10/05/2020
S2	27/04/2020	27/05/2020	12/05/2020
S2	02/05/2020	27/05/2020	14/05/2020
S1	09/05/2020	21/05/2020	15/05/2020
S1	10/05/2020	22/05/2020	16/05/2020
S1	10/05/2020	22/05/2020	16/05/2020
S2	12/05/2020	27/05/2020	19/05/2020
S2	05/05/2020	04/06/2020	20/05/2020
LC	12/05/2020	28/05/2020	20/05/2020
S2	10/05/2020	04/06/2020	22/05/2020
S2	10/05/2020	09/06/2020	25/05/2020
S2	15/05/2020	04/06/2020	25/05/2020
S2	12/05/2020	11/06/2020	27/05/2020
S2	15/05/2020	09/06/2020	27/05/2020
S1	22/05/2020	03/06/2020	28/05/2020
S1	22/05/2020	03/06/2020	28/05/2020
S1	26/05/2020	07/06/2020	01/06/2020
S1	21/05/2020	14/06/2020	02/06/2020
S2	27/05/2020	11/06/2020	03/06/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	03/06/2020	15/06/2020	09/06/2020
S1	03/06/2020	15/06/2020	09/06/2020
S2	27/05/2020	26/06/2020	11/06/2020
S2	11/06/2020	26/06/2020	18/06/2020
S1	14/06/2020	26/06/2020	20/06/2020
S1	15/06/2020	27/06/2020	21/06/2020
S1	15/06/2020	27/06/2020	21/06/2020
S2	11/06/2020	01/07/2020	21/06/2020
S1	19/06/2020	01/07/2020	25/06/2020
S1	26/06/2020	08/07/2020	02/07/2020
S1	27/06/2020	09/07/2020	03/07/2020
S1	27/06/2020	09/07/2020	03/07/2020
S2	26/06/2020	16/07/2020	06/07/2020
S1	01/07/2020	13/07/2020	07/07/2020
LC	29/06/2020	15/07/2020	07/07/2020
S2	01/07/2020	16/07/2020	08/07/2020
S1	08/07/2020	20/07/2020	14/07/2020
S1	09/07/2020	21/07/2020	15/07/2020
S1	13/07/2020	25/07/2020	19/07/2020
LC	15/07/2020	31/07/2020	23/07/2020
S1	20/07/2020	01/08/2020	26/07/2020
S2	16/07/2020	05/08/2020	26/07/2020
S1	21/07/2020	02/08/2020	27/07/2020
S1	25/07/2020	06/08/2020	31/07/2020
S1	01/08/2020	13/08/2020	07/08/2020
S1	02/08/2020	14/08/2020	08/08/2020
S2	29/07/2020	18/08/2020	08/08/2020
S1	06/08/2020	18/08/2020	12/08/2020
S2	05/08/2020	20/08/2020	12/08/2020
S1	13/08/2020	25/08/2020	19/08/2020
S1	14/08/2020	26/08/2020	20/08/2020
S2	05/08/2020	04/09/2020	20/08/2020
S1	18/08/2020	30/08/2020	24/08/2020
S1	13/08/2020	06/09/2020	25/08/2020
S2	20/08/2020	04/09/2020	27/08/2020
S2	18/08/2020	12/09/2020	30/08/2020
S1	25/08/2020	06/09/2020	31/08/2020
S1	26/08/2020	07/09/2020	01/09/2020
S2	20/08/2020	14/09/2020	01/09/2020
S1	30/08/2020	11/09/2020	05/09/2020
S1	25/08/2020	18/09/2020	06/09/2020
S1	26/08/2020	19/09/2020	07/09/2020
S2	04/09/2020	14/09/2020	09/09/2020
RCM	09/09/2020	13/09/2020	11/09/2020
S1	06/09/2020	18/09/2020	12/09/2020
S1	07/09/2020	19/09/2020	13/09/2020
S1	07/09/2020	19/09/2020	13/09/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	11/09/2020	23/09/2020	17/09/2020
S1	06/09/2020	30/09/2020	18/09/2020
S1	07/09/2020	01/10/2020	19/09/2020
S1	07/09/2020	01/10/2020	19/09/2020
S1	11/09/2020	05/10/2020	23/09/2020
S1	18/09/2020	30/09/2020	24/09/2020
S1	19/09/2020	01/10/2020	25/09/2020
S1	19/09/2020	01/10/2020	25/09/2020
S1	23/09/2020	05/10/2020	29/09/2020
S2	14/09/2020	14/10/2020	29/09/2020
S1	18/09/2020	12/10/2020	30/09/2020
S1	30/09/2020	12/10/2020	06/10/2020
S1	01/10/2020	13/10/2020	07/10/2020
S1	01/10/2020	13/10/2020	07/10/2020
S1	05/10/2020	17/10/2020	11/10/2020
S1	01/10/2020	25/10/2020	13/10/2020
S1	01/10/2020	25/10/2020	13/10/2020
S1	12/10/2020	24/10/2020	18/10/2020
S1	13/10/2020	25/10/2020	19/10/2020
S1	13/10/2020	25/10/2020	19/10/2020
S2	14/10/2020	13/11/2020	29/10/2020
S2	22/10/2020	06/11/2020	29/10/2020
S1	24/10/2020	05/11/2020	30/10/2020
S1	25/10/2020	06/11/2020	31/10/2020
S1	25/10/2020	06/11/2020	31/10/2020
RCM	31/10/2020	04/11/2020	02/11/2020
S2	22/10/2020	16/11/2020	03/11/2020
S1	05/11/2020	17/11/2020	11/11/2020
S2	06/11/2020	16/11/2020	11/11/2020
S1	06/11/2020	18/11/2020	12/11/2020
S1	17/11/2020	29/11/2020	23/11/2020
S1	18/11/2020	30/11/2020	24/11/2020
S1	18/11/2020	30/11/2020	24/11/2020
S1	29/11/2020	11/12/2020	05/12/2020
S1	30/11/2020	12/12/2020	06/12/2020
S1	30/11/2020	12/12/2020	06/12/2020
S1	04/12/2020	16/12/2020	10/12/2020
S1	30/11/2020	24/12/2020	12/12/2020
S1	11/12/2020	23/12/2020	17/12/2020
S1	12/12/2020	24/12/2020	18/12/2020
S1	16/12/2020	28/12/2020	22/12/2020
S1	11/12/2020	04/01/2021	23/12/2020
S1	12/12/2020	05/01/2021	24/12/2020
S1	23/12/2020	04/01/2021	29/12/2020
S1	28/12/2020	09/01/2021	03/01/2021
S1	23/12/2020	16/01/2021	04/01/2021
S1	04/01/2021	16/01/2021	10/01/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	09/01/2021	21/01/2021	15/01/2021
S1	04/01/2021	28/01/2021	16/01/2021
S1	16/01/2021	28/01/2021	22/01/2021
S1	17/01/2021	29/01/2021	23/01/2021
S1	21/01/2021	02/02/2021	27/01/2021
S2	27/01/2021	06/02/2021	01/02/2021
S1	28/01/2021	09/02/2021	03/02/2021
S2	27/01/2021	11/02/2021	03/02/2021
S1	29/01/2021	10/02/2021	04/02/2021
S2	04/02/2021	14/02/2021	09/02/2021
S2	06/02/2021	03/03/2021	18/02/2021
S2	11/02/2021	03/03/2021	21/02/2021
S2	06/02/2021	08/03/2021	21/02/2021
LC	15/02/2021	03/03/2021	23/02/2021
S2	11/02/2021	08/03/2021	23/02/2021
LC	03/03/2021	19/03/2021	11/03/2021
S2	03/03/2021	28/03/2021	15/03/2021
S2	03/03/2021	02/04/2021	18/03/2021
S2	08/03/2021	28/03/2021	18/03/2021
LC	12/03/2021	28/03/2021	20/03/2021
S2	08/03/2021	02/04/2021	20/03/2021
S2	08/03/2021	07/04/2021	23/03/2021
S2	28/03/2021	07/04/2021	02/04/2021
S2	28/03/2021	17/04/2021	07/04/2021
S2	02/04/2021	17/04/2021	09/04/2021
S2	28/03/2021	22/04/2021	09/04/2021
S2	02/04/2021	22/04/2021	12/04/2021
S2	07/04/2021	17/04/2021	12/04/2021
S2	28/03/2021	27/04/2021	12/04/2021
S2	02/04/2021	27/04/2021	14/04/2021
S2	07/04/2021	22/04/2021	14/04/2021
S2	02/04/2021	02/05/2021	17/04/2021
S2	07/04/2021	27/04/2021	17/04/2021
S2	07/04/2021	02/05/2021	19/04/2021
S2	15/04/2021	25/04/2021	20/04/2021
S1	15/04/2021	27/04/2021	21/04/2021
S1	15/04/2021	27/04/2021	21/04/2021
S2	17/04/2021	27/04/2021	22/04/2021
S2	17/04/2021	02/05/2021	24/04/2021
S2	22/04/2021	02/05/2021	27/04/2021
S1	22/04/2021	04/05/2021	28/04/2021
S1	23/04/2021	05/05/2021	29/04/2021
S1	23/04/2021	05/05/2021	29/04/2021
S1	23/04/2021	05/05/2021	29/04/2021
S1	27/04/2021	09/05/2021	03/05/2021
S1	27/04/2021	09/05/2021	03/05/2021
S1	27/04/2021	21/05/2021	09/05/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	27/04/2021	21/05/2021	09/05/2021
S1	04/05/2021	16/05/2021	10/05/2021
S2	25/04/2021	25/05/2021	10/05/2021
S1	05/05/2021	17/05/2021	11/05/2021
S1	05/05/2021	17/05/2021	11/05/2021
S1	05/05/2021	17/05/2021	11/05/2021
S1	09/05/2021	21/05/2021	15/05/2021
S1	09/05/2021	21/05/2021	15/05/2021
S1	05/05/2021	29/05/2021	17/05/2021
S1	05/05/2021	29/05/2021	17/05/2021
S1	16/05/2021	28/05/2021	22/05/2021
S1	17/05/2021	29/05/2021	23/05/2021
S1	17/05/2021	29/05/2021	23/05/2021
S1	21/05/2021	02/06/2021	27/05/2021
S2	25/05/2021	04/06/2021	30/05/2021
S2	25/05/2021	09/06/2021	01/06/2021
S1	28/05/2021	09/06/2021	03/06/2021
S1	29/05/2021	10/06/2021	04/06/2021
S1	29/05/2021	10/06/2021	04/06/2021
S2	25/05/2021	14/06/2021	04/06/2021
S2	25/05/2021	19/06/2021	06/06/2021
S2	04/06/2021	14/06/2021	09/06/2021
S2	04/06/2021	19/06/2021	11/06/2021
S2	09/06/2021	19/06/2021	14/06/2021
S1	09/06/2021	21/06/2021	15/06/2021
S1	10/06/2021	22/06/2021	16/06/2021
S1	10/06/2021	22/06/2021	16/06/2021
S1	14/06/2021	26/06/2021	20/06/2021
S2	11/06/2021	01/07/2021	21/06/2021
S1	21/06/2021	03/07/2021	27/06/2021
S1	22/06/2021	04/07/2021	28/06/2021
S1	22/06/2021	04/07/2021	28/06/2021
S1	26/06/2021	08/07/2021	02/07/2021
S2	19/06/2021	19/07/2021	04/07/2021
S2	01/07/2021	16/07/2021	08/07/2021
S1	03/07/2021	15/07/2021	09/07/2021
S1	04/07/2021	16/07/2021	10/07/2021
S1	04/07/2021	16/07/2021	10/07/2021
S1	08/07/2021	20/07/2021	14/07/2021
S2	01/07/2021	31/07/2021	16/07/2021
S1	15/07/2021	27/07/2021	21/07/2021
S1	16/07/2021	28/07/2021	22/07/2021
S1	16/07/2021	28/07/2021	22/07/2021
S2	16/07/2021	31/07/2021	23/07/2021
LC	18/07/2021	03/08/2021	26/07/2021
S2	19/07/2021	03/08/2021	26/07/2021
S2	16/07/2021	15/08/2021	31/07/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	27/07/2021	08/08/2021	02/08/2021
S1	28/07/2021	09/08/2021	03/08/2021
S1	28/07/2021	09/08/2021	03/08/2021
S2	31/07/2021	15/08/2021	07/08/2021
S1	09/08/2021	21/08/2021	15/08/2021
S1	09/08/2021	21/08/2021	15/08/2021
S2	31/07/2021	30/08/2021	15/08/2021
S1	13/08/2021	25/08/2021	19/08/2021
S2	15/08/2021	30/08/2021	22/08/2021
S1	21/08/2021	02/09/2021	27/08/2021
S1	21/08/2021	02/09/2021	27/08/2021
S1	25/08/2021	06/09/2021	31/08/2021
S1	01/09/2021	13/09/2021	07/09/2021
S1	02/09/2021	14/09/2021	08/09/2021
S1	02/09/2021	14/09/2021	08/09/2021
S2	30/08/2021	19/09/2021	09/09/2021
S1	06/09/2021	18/09/2021	12/09/2021
S2	07/09/2021	22/09/2021	14/09/2021
S1	13/09/2021	25/09/2021	19/09/2021
S1	14/09/2021	26/09/2021	20/09/2021
S1	14/09/2021	26/09/2021	20/09/2021
S2	07/09/2021	07/10/2021	22/09/2021
S1	18/09/2021	30/09/2021	24/09/2021
S2	19/09/2021	04/10/2021	26/09/2021
S2	22/09/2021	07/10/2021	29/09/2021
S1	26/09/2021	08/10/2021	02/10/2021
S1	26/09/2021	08/10/2021	02/10/2021
S1	30/09/2021	12/10/2021	06/10/2021
S1	08/10/2021	20/10/2021	14/10/2021
S1	08/10/2021	20/10/2021	14/10/2021
S1	12/10/2021	24/10/2021	18/10/2021
S1	20/10/2021	01/11/2021	26/10/2021
S1	20/10/2021	01/11/2021	26/10/2021
S1	24/10/2021	05/11/2021	30/10/2021
S1	31/10/2021	12/11/2021	06/11/2021
S1	01/11/2021	13/11/2021	07/11/2021
S1	01/11/2021	13/11/2021	07/11/2021
S1	05/11/2021	17/11/2021	11/11/2021
S1	12/11/2021	24/11/2021	18/11/2021
S1	13/11/2021	25/11/2021	19/11/2021
S1	17/11/2021	29/11/2021	23/11/2021
S1	25/11/2021	07/12/2021	01/12/2021
S1	29/11/2021	11/12/2021	05/12/2021
S1	06/12/2021	18/12/2021	12/12/2021
S1	07/12/2021	19/12/2021	13/12/2021
S1	16/01/2022	28/01/2022	22/01/2022
LC	17/01/2022	02/02/2022	25/01/2022

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
LC	17/01/2022	10/02/2022	29/01/2022
S1	24/01/2022	05/02/2022	30/01/2022
S1	28/01/2022	09/02/2022	03/02/2022
LC	02/02/2022	10/02/2022	06/02/2022
S2	30/01/2022	19/02/2022	09/02/2022
S2	30/01/2022	01/03/2022	14/02/2022
S2	19/02/2022	01/03/2022	24/02/2022
S2	19/02/2022	06/03/2022	26/02/2022
S2	01/03/2022	26/03/2022	13/03/2022
S2	01/03/2022	31/03/2022	16/03/2022
S2	06/03/2022	26/03/2022	16/03/2022
S2	06/03/2022	31/03/2022	18/03/2022
S2	26/03/2022	10/04/2022	02/04/2022
S2	31/03/2022	10/04/2022	05/04/2022
S2	26/03/2022	15/04/2022	05/04/2022
S2	31/03/2022	15/04/2022	07/04/2022
S2	26/03/2022	20/04/2022	07/04/2022
S2	31/03/2022	20/04/2022	10/04/2022
S2	10/04/2022	20/04/2022	15/04/2022
S2	31/03/2022	30/04/2022	15/04/2022
S2	10/04/2022	30/04/2022	20/04/2022
S2	15/04/2022	30/04/2022	22/04/2022
S2	20/04/2022	30/04/2022	25/04/2022

Appendix Table 4: Images used in the analysis at the near confluence point on Valerie Glacier. LC is Landsat, S1 is Sentinel-1 (includes Sentinel-1a and Sentinel-1b), S2 is Sentinel-2 (includes Sentinel-2a and Sentinel-2b), TSX/TDX is TerraSAR-X/TanDEM-X, R2 is RADARSAT-2, and RCM is RADARSAT Constellation Mission. reference and secondary image dates were not obtained for Valerie Glacier during the ITS_LIVE data download that is described in Section 3.1.5.

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
LC	N/A	N/A	08/05/2013
LC	N/A	N/A	20/07/2013
LC	N/A	N/A	11/09/2013
LC	N/A	N/A	24/10/2013
LC	N/A	N/A	16/11/2013
LC	N/A	N/A	28/01/2014
LC	N/A	N/A	04/02/2014
LC	N/A	N/A	13/02/2014
R2	03/02/2014	27/02/2014	15/02/2014
R2	27/02/2014	23/03/2014	11/03/2014
LC	N/A	N/A	18/04/2014
LC	N/A	N/A	25/04/2014
LC	N/A	N/A	23/07/2014

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
LC	N/A	N/A	31/08/2014
LC	N/A	N/A	04/09/2014
LC	N/A	N/A	16/09/2014
LC	N/A	N/A	19/11/2014
S1	N/A	N/A	20/11/2014
S1	N/A	N/A	14/12/2014
LC	N/A	N/A	07/01/2015
S1	N/A	N/A	31/01/2015
S1	N/A	N/A	24/02/2015
R2	22/02/2015	18/03/2015	06/03/2015
TSX/TDX	03/03/2015	14/03/2015	08/03/2015
S1	N/A	N/A	20/03/2015
LC	N/A	N/A	27/03/2015
S1	N/A	N/A	09/04/2015
S1	N/A	N/A	13/04/2015
LC	N/A	N/A	21/04/2015
LC	N/A	N/A	04/05/2015
LC	N/A	N/A	14/05/2015
LC	N/A	N/A	23/05/2015
S1	N/A	N/A	31/05/2015
S1	N/A	N/A	24/06/2015
S1	N/A	N/A	01/07/2015
TSX/TDX	27/06/2015	08/07/2015	02/07/2015
S1	N/A	N/A	05/07/2015
LC	N/A	N/A	05/07/2015
TSX/TDX	08/07/2015	19/07/2015	13/07/2015
LC	N/A	N/A	17/07/2015
S1	N/A	N/A	18/07/2015
TSX/TDX	19/07/2015	30/07/2015	24/07/2015
TSX/TDX	30/07/2015	10/08/2015	04/08/2015
LC	N/A	N/A	06/08/2015
TSX/TDX	10/08/2015	21/08/2015	15/08/2015
TSX/TDX	21/08/2015	01/09/2015	26/08/2015
TSX/TDX	01/09/2015	12/09/2015	06/09/2015
S1	N/A	N/A	12/09/2015
TSX/TDX	12/09/2015	23/09/2015	17/09/2015
S1	N/A	N/A	28/09/2015
TSX/TDX	23/09/2015	04/10/2015	28/09/2015
TSX/TDX	04/10/2015	15/10/2015	09/10/2015
TSX/TDX	09/10/2015	20/10/2015	14/10/2015
TSX/TDX	15/10/2015	26/10/2015	20/10/2015
S1	N/A	N/A	22/10/2015
S1	N/A	N/A	08/11/2015
S1	N/A	N/A	15/11/2015
TSX/TDX	22/11/2015	03/12/2015	27/11/2015
S1	N/A	N/A	20/12/2015
S1	N/A	N/A	05/01/2016

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	11/01/2016
S1	N/A	N/A	26/01/2016
S1	N/A	N/A	01/02/2016
R2	24/01/2016	17/02/2016	05/02/2016
S1	N/A	N/A	19/02/2016
R2	17/02/2016	12/03/2016	29/02/2016
S1	N/A	N/A	14/03/2016
LC	N/A	N/A	22/03/2016
S1	N/A	N/A	08/05/2016
S1	N/A	N/A	25/05/2016
S2	N/A	N/A	28/05/2016
LC	N/A	N/A	03/06/2016
S1	N/A	N/A	18/06/2016
S1	N/A	N/A	04/07/2016
LC	N/A	N/A	10/07/2016
LC	N/A	N/A	11/08/2016
S1	N/A	N/A	12/08/2016
S1	N/A	N/A	29/08/2016
S2	N/A	N/A	11/09/2016
LC	N/A	N/A	16/10/2016
LC	N/A	N/A	23/10/2016
S1	N/A	N/A	28/10/2016
S1	N/A	N/A	14/11/2016
S1	N/A	N/A	21/11/2016
S1	N/A	N/A	25/11/2016
S1	N/A	N/A	07/12/2016
S1	N/A	N/A	15/12/2016
S1	N/A	N/A	19/12/2016
S1	N/A	N/A	01/01/2017
S1	N/A	N/A	04/01/2017
LC	N/A	N/A	04/01/2017
S1	N/A	N/A	05/01/2017
S1	N/A	N/A	25/01/2017
R2	18/01/2017	11/02/2017	30/01/2017
S1	N/A	N/A	04/02/2017
S1	N/A	N/A	11/02/2017
S1	N/A	N/A	12/02/2017
S1	N/A	N/A	22/02/2017
R2	11/02/2017	07/03/2017	23/02/2017
S1	N/A	N/A	23/02/2017
LC	N/A	N/A	28/02/2017
S1	N/A	N/A	09/03/2017
S1	N/A	N/A	10/03/2017
S1	N/A	N/A	11/03/2017
S1	N/A	N/A	12/03/2017
S1	N/A	N/A	14/03/2017
S1	N/A	N/A	15/03/2017

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
LC	N/A	N/A	16/03/2017
S1	N/A	N/A	20/03/2017
S1	N/A	N/A	26/03/2017
S1	N/A	N/A	08/04/2017
S1	N/A	N/A	09/04/2017
S1	N/A	N/A	10/04/2017
S1	N/A	N/A	11/04/2017
S1	N/A	N/A	11/04/2017
S1	N/A	N/A	12/04/2017
S1	N/A	N/A	13/04/2017
S1	N/A	N/A	19/04/2017
S1	N/A	N/A	20/04/2017
S1	N/A	N/A	25/04/2017
S1	N/A	N/A	02/05/2017
TSX/TDX	28/04/2017	09/05/2017	03/05/2017
S1	N/A	N/A	06/05/2017
S1	N/A	N/A	07/05/2017
S1	N/A	N/A	09/05/2017
S1	N/A	N/A	10/05/2017
S1	N/A	N/A	10/05/2017
S1	N/A	N/A	14/05/2017
S2	N/A	N/A	16/05/2017
LC	N/A	N/A	19/05/2017
S1	N/A	N/A	24/05/2017
S1	N/A	N/A	25/05/2017
S1	N/A	N/A	30/05/2017
S1	N/A	N/A	17/06/2017
S1	N/A	N/A	18/06/2017
S1	N/A	N/A	23/06/2017
S1	N/A	N/A	24/06/2017
S1	N/A	N/A	29/06/2017
S1	N/A	N/A	03/07/2017
S1	N/A	N/A	05/07/2017
S1	N/A	N/A	17/07/2017
S1	N/A	N/A	23/07/2017
S1	N/A	N/A	29/07/2017
S1	N/A	N/A	03/08/2017
S1	N/A	N/A	11/08/2017
S1	N/A	N/A	12/08/2017
S1	N/A	N/A	16/08/2017
S1	N/A	N/A	17/08/2017
S1	N/A	N/A	18/08/2017
S1	N/A	N/A	22/08/2017
S1	N/A	N/A	23/08/2017
S1	N/A	N/A	24/08/2017
S1	N/A	N/A	28/08/2017
S1	N/A	N/A	29/08/2017

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	30/08/2017
S1	N/A	N/A	30/08/2017
S1	N/A	N/A	03/09/2017
S1	N/A	N/A	09/09/2017
S1	N/A	N/A	10/09/2017
S1	N/A	N/A	11/09/2017
S2	N/A	N/A	11/09/2017
S1	N/A	N/A	12/09/2017
S1	N/A	N/A	15/09/2017
S1	N/A	N/A	16/09/2017
S1	N/A	N/A	17/09/2017
S1	N/A	N/A	17/09/2017
S1	N/A	N/A	21/09/2017
S1	N/A	N/A	23/09/2017
S1	N/A	N/A	27/09/2017
S1	N/A	N/A	29/09/2017
S1	N/A	N/A	08/10/2017
S1	N/A	N/A	09/10/2017
S1	N/A	N/A	11/10/2017
S1	N/A	N/A	15/10/2017
S1	N/A	N/A	17/10/2017
S1	N/A	N/A	21/10/2017
S1	N/A	N/A	22/10/2017
S1	N/A	N/A	23/10/2017
S1	N/A	N/A	23/10/2017
S1	N/A	N/A	27/10/2017
S1	N/A	N/A	28/10/2017
S1	N/A	N/A	29/10/2017
S1	N/A	N/A	29/10/2017
S1	N/A	N/A	06/11/2017
S1	N/A	N/A	07/11/2017
S1	N/A	N/A	08/11/2017
S1	N/A	N/A	09/11/2017
S1	N/A	N/A	10/11/2017
S1	N/A	N/A	14/11/2017
S1	N/A	N/A	15/11/2017
S1	N/A	N/A	16/11/2017
S1	N/A	N/A	20/11/2017
S1	N/A	N/A	21/11/2017
S1	N/A	N/A	26/11/2017
S1	N/A	N/A	27/11/2017
S1	N/A	N/A	01/12/2017
LC	N/A	N/A	02/12/2017
S1	N/A	N/A	06/12/2017
S1	N/A	N/A	08/12/2017
S1	N/A	N/A	08/12/2017
S1	N/A	N/A	14/12/2017

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	15/12/2017
S1	N/A	N/A	20/12/2017
S1	N/A	N/A	21/12/2017
S1	N/A	N/A	22/12/2017
S1	N/A	N/A	26/12/2017
S1	N/A	N/A	27/12/2017
S1	N/A	N/A	28/12/2017
S1	N/A	N/A	01/01/2018
S1	N/A	N/A	02/01/2018
S1	N/A	N/A	04/01/2018
S2	N/A	N/A	04/01/2018
S1	N/A	N/A	05/01/2018
S2	N/A	N/A	05/01/2018
S2	N/A	N/A	05/01/2018
S1	N/A	N/A	06/01/2018
S1	N/A	N/A	08/01/2018
S1	N/A	N/A	13/01/2018
S1	N/A	N/A	14/01/2018
S1	N/A	N/A	15/01/2018
S1	N/A	N/A	19/01/2018
S1	N/A	N/A	21/01/2018
S1	N/A	N/A	21/01/2018
S1	N/A	N/A	25/01/2018
S1	N/A	N/A	27/01/2018
S2	N/A	N/A	28/01/2018
S1	N/A	N/A	31/01/2018
S2	N/A	N/A	31/01/2018
S1	N/A	N/A	01/02/2018
S1	N/A	N/A	02/02/2018
S2	N/A	N/A	02/02/2018
TSX/TDX	28/01/2018	08/02/2018	02/02/2018
S1	N/A	N/A	03/02/2018
S1	N/A	N/A	04/02/2018
S1	N/A	N/A	05/02/2018
S1	N/A	N/A	06/02/2018
S1	N/A	N/A	06/02/2018
S1	N/A	N/A	07/02/2018
S1	N/A	N/A	07/02/2018
S1	N/A	N/A	14/02/2018
LC	N/A	N/A	15/02/2018
S2	N/A	N/A	17/02/2018
S1	N/A	N/A	18/02/2018
S1	N/A	N/A	19/02/2018
S1	N/A	N/A	20/02/2018
S2	N/A	N/A	20/02/2018
S1	N/A	N/A	24/02/2018
LC	N/A	N/A	24/02/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	25/02/2018
S2	N/A	N/A	25/02/2018
S1	N/A	N/A	26/02/2018
S1	N/A	N/A	26/02/2018
S1	N/A	N/A	01/03/2018
S1	N/A	N/A	03/03/2018
S1	N/A	N/A	04/03/2018
S2	N/A	N/A	04/03/2018
S1	N/A	N/A	05/03/2018
S1	N/A	N/A	05/03/2018
S2	N/A	N/A	05/03/2018
S1	N/A	N/A	11/03/2018
S1	N/A	N/A	12/03/2018
S1	N/A	N/A	14/03/2018
S2	N/A	N/A	14/03/2018
S1	N/A	N/A	15/03/2018
S1	N/A	N/A	16/03/2018
S2	N/A	N/A	17/03/2018
S2	N/A	N/A	19/03/2018
S1	N/A	N/A	20/03/2018
S1	N/A	N/A	21/03/2018
S1	N/A	N/A	22/03/2018
S1	N/A	N/A	22/03/2018
S1	N/A	N/A	26/03/2018
S1	N/A	N/A	27/03/2018
S2	N/A	N/A	27/03/2018
S1	N/A	N/A	28/03/2018
S2	N/A	N/A	29/03/2018
S2	N/A	N/A	30/03/2018
S1	N/A	N/A	03/04/2018
S2	N/A	N/A	04/04/2018
S1	N/A	N/A	09/04/2018
S1	N/A	N/A	10/04/2018
S1	N/A	N/A	11/04/2018
S1	N/A	N/A	12/04/2018
S1	N/A	N/A	13/04/2018
S2	N/A	N/A	13/04/2018
LC	N/A	N/A	13/04/2018
S1	N/A	N/A	14/04/2018
S2	N/A	N/A	14/04/2018
S1	N/A	N/A	15/04/2018
S1	N/A	N/A	15/04/2018
S2	N/A	N/A	16/04/2018
S2	N/A	N/A	16/04/2018
S1	N/A	N/A	19/04/2018
S2	N/A	N/A	19/04/2018
S1	N/A	N/A	20/04/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	21/04/2018
S1	N/A	N/A	21/04/2018
S2	N/A	N/A	21/04/2018
S2	N/A	N/A	21/04/2018
S2	N/A	N/A	21/04/2018
S2	N/A	N/A	24/04/2018
S1	N/A	N/A	25/04/2018
S1	N/A	N/A	26/04/2018
S2	N/A	N/A	26/04/2018
S2	N/A	N/A	26/04/2018
S1	N/A	N/A	27/04/2018
S1	N/A	N/A	27/04/2018
S2	N/A	N/A	02/05/2018
S1	N/A	N/A	08/05/2018
S1	N/A	N/A	09/05/2018
S2	N/A	N/A	09/05/2018
S1	N/A	N/A	10/05/2018
S1	N/A	N/A	11/05/2018
S1	N/A	N/A	12/05/2018
S1	N/A	N/A	13/05/2018
S2	N/A	N/A	13/05/2018
S1	N/A	N/A	14/05/2018
S1	N/A	N/A	15/05/2018
S1	N/A	N/A	15/05/2018
S1	N/A	N/A	19/05/2018
S1	N/A	N/A	20/05/2018
S1	N/A	N/A	21/05/2018
S1	N/A	N/A	25/05/2018
S1	N/A	N/A	26/05/2018
S1	N/A	N/A	27/05/2018
S1	N/A	N/A	31/05/2018
S1	N/A	N/A	02/06/2018
S2	N/A	N/A	04/06/2018
S2	N/A	N/A	04/06/2018
S2	N/A	N/A	05/06/2018
S1	N/A	N/A	06/06/2018
S1	N/A	N/A	07/06/2018
S1	N/A	N/A	09/06/2018
S1	N/A	N/A	10/06/2018
S1	N/A	N/A	10/06/2018
S1	N/A	N/A	13/06/2018
S1	N/A	N/A	14/06/2018
S1	N/A	N/A	18/06/2018
S1	N/A	N/A	19/06/2018
S1	N/A	N/A	20/06/2018
S1	N/A	N/A	20/06/2018
S1	N/A	N/A	24/06/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	26/06/2018
S1	N/A	N/A	26/06/2018
S1	N/A	N/A	30/06/2018
S1	N/A	N/A	01/07/2018
S2	N/A	N/A	02/07/2018
S1	N/A	N/A	04/07/2018
S1	N/A	N/A	05/07/2018
S1	N/A	N/A	06/07/2018
S1	N/A	N/A	08/07/2018
S2	N/A	N/A	13/07/2018
S1	N/A	N/A	14/07/2018
S1	N/A	N/A	14/07/2018
S2	N/A	N/A	17/07/2018
S1	N/A	N/A	18/07/2018
S2	N/A	N/A	18/07/2018
S1	N/A	N/A	20/07/2018
S1	N/A	N/A	24/07/2018
S2	N/A	N/A	25/07/2018
S2	N/A	N/A	25/07/2018
S1	N/A	N/A	26/07/2018
S2	N/A	N/A	27/07/2018
S1	N/A	N/A	30/07/2018
S1	N/A	N/A	01/08/2018
S1	N/A	N/A	02/08/2018
S1	N/A	N/A	02/08/2018
LC	N/A	N/A	02/08/2018
S1	N/A	N/A	03/08/2018
S1	N/A	N/A	04/08/2018
S2	N/A	N/A	04/08/2018
S1	N/A	N/A	05/08/2018
S2	N/A	N/A	05/08/2018
S1	N/A	N/A	06/08/2018
S1	N/A	N/A	07/08/2018
S1	N/A	N/A	07/08/2018
S2	N/A	N/A	09/08/2018
S1	N/A	N/A	13/08/2018
S2	N/A	N/A	16/08/2018
S1	N/A	N/A	17/08/2018
S1	N/A	N/A	18/08/2018
S1	N/A	N/A	19/08/2018
S1	N/A	N/A	23/08/2018
S1	N/A	N/A	24/08/2018
S1	N/A	N/A	25/08/2018
S1	N/A	N/A	29/08/2018
S1	N/A	N/A	30/08/2018
S1	N/A	N/A	31/08/2018
S1	N/A	N/A	01/09/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	03/09/2018
S1	N/A	N/A	04/09/2018
S1	N/A	N/A	04/09/2018
S2	N/A	N/A	04/09/2018
S1	N/A	N/A	05/09/2018
S1	N/A	N/A	05/09/2018
S1	N/A	N/A	11/09/2018
S1	N/A	N/A	12/09/2018
S2	N/A	N/A	13/09/2018
S2	N/A	N/A	15/09/2018
S1	N/A	N/A	16/09/2018
S1	N/A	N/A	17/09/2018
S1	N/A	N/A	18/09/2018
S1	N/A	N/A	18/09/2018
S2	N/A	N/A	18/09/2018
S2	N/A	N/A	18/09/2018
S2	N/A	N/A	20/09/2018
S1	N/A	N/A	22/09/2018
S1	N/A	N/A	23/09/2018
S2	N/A	N/A	23/09/2018
S1	N/A	N/A	24/09/2018
S1	N/A	N/A	24/09/2018
S2	N/A	N/A	26/09/2018
S2	N/A	N/A	26/09/2018
S1	N/A	N/A	28/09/2018
S2	N/A	N/A	28/09/2018
S1	N/A	N/A	29/09/2018
S1	N/A	N/A	30/09/2018
S1	N/A	N/A	30/09/2018
S2	N/A	N/A	02/10/2018
S1	N/A	N/A	03/10/2018
S2	N/A	N/A	03/10/2018
S2	N/A	N/A	07/10/2018
S1	N/A	N/A	09/10/2018
S1	N/A	N/A	10/10/2018
S1	N/A	N/A	11/10/2018
S1	N/A	N/A	12/10/2018
S1	N/A	N/A	16/10/2018
S2	N/A	N/A	16/10/2018
S1	N/A	N/A	17/10/2018
S1	N/A	N/A	18/10/2018
S1	N/A	N/A	18/10/2018
S2	N/A	N/A	18/10/2018
S2	N/A	N/A	18/10/2018
S2	N/A	N/A	21/10/2018
S1	N/A	N/A	22/10/2018
S1	N/A	N/A	23/10/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	24/10/2018
S1	N/A	N/A	28/10/2018
S1	N/A	N/A	29/10/2018
S1	N/A	N/A	30/10/2018
S2	N/A	N/A	04/11/2018
S2	N/A	N/A	05/11/2018
S1	N/A	N/A	08/11/2018
S1	N/A	N/A	09/11/2018
S2	N/A	N/A	09/11/2018
LC	N/A	N/A	09/11/2018
S1	N/A	N/A	10/11/2018
S1	N/A	N/A	11/11/2018
S1	N/A	N/A	12/11/2018
LC	N/A	N/A	14/11/2018
S1	N/A	N/A	15/11/2018
S1	N/A	N/A	16/11/2018
S1	N/A	N/A	17/11/2018
S1	N/A	N/A	21/11/2018
S1	N/A	N/A	22/11/2018
S1	N/A	N/A	23/11/2018
LC	N/A	N/A	23/11/2018
S1	N/A	N/A	27/11/2018
S1	N/A	N/A	28/11/2018
S1	N/A	N/A	29/11/2018
S1	N/A	N/A	02/12/2018
S2	N/A	N/A	02/12/2018
S1	N/A	N/A	06/12/2018
S1	N/A	N/A	07/12/2018
S2	N/A	N/A	07/12/2018
S1	N/A	N/A	09/12/2018
S1	N/A	N/A	09/12/2018
S1	N/A	N/A	10/12/2018
S1	N/A	N/A	10/12/2018
S1	N/A	N/A	15/12/2018
S1	N/A	N/A	16/12/2018
S1	N/A	N/A	17/12/2018
S1	N/A	N/A	21/12/2018
S1	N/A	N/A	23/12/2018
S1	N/A	N/A	27/12/2018
S1	N/A	N/A	29/12/2018
S1	N/A	N/A	02/01/2019
S2	N/A	N/A	04/01/2019
S1	N/A	N/A	06/01/2019
S1	N/A	N/A	07/01/2019
S1	N/A	N/A	08/01/2019
S2	N/A	N/A	08/01/2019
S1	N/A	N/A	09/01/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	09/01/2019
S1	N/A	N/A	10/01/2019
S1	N/A	N/A	14/01/2019
S1	N/A	N/A	16/01/2019
S1	N/A	N/A	20/01/2019
S1	N/A	N/A	21/01/2019
S1	N/A	N/A	22/01/2019
S1	N/A	N/A	26/01/2019
S2	N/A	N/A	26/01/2019
S1	N/A	N/A	28/01/2019
S1	N/A	N/A	01/02/2019
S2	N/A	N/A	03/02/2019
S1	N/A	N/A	04/02/2019
S1	N/A	N/A	05/02/2019
S1	N/A	N/A	06/02/2019
S1	N/A	N/A	07/02/2019
S2	N/A	N/A	07/02/2019
S1	N/A	N/A	08/02/2019
S1	N/A	N/A	08/02/2019
S2	N/A	N/A	11/02/2019
S1	N/A	N/A	13/02/2019
S2	N/A	N/A	13/02/2019
S1	N/A	N/A	15/02/2019
S2	N/A	N/A	15/02/2019
S2	N/A	N/A	18/02/2019
LC	N/A	N/A	18/02/2019
S1	N/A	N/A	19/02/2019
S2	N/A	N/A	20/02/2019
S1	N/A	N/A	21/02/2019
S2	N/A	N/A	23/02/2019
S1	N/A	N/A	25/02/2019
S2	N/A	N/A	25/02/2019
S1	N/A	N/A	26/02/2019
S1	N/A	N/A	27/02/2019
LC	N/A	N/A	27/02/2019
S1	N/A	N/A	01/03/2019
S1	N/A	N/A	02/03/2019
S1	N/A	N/A	03/03/2019
S1	N/A	N/A	04/03/2019
S1	N/A	N/A	05/03/2019
S1	N/A	N/A	06/03/2019
S1	N/A	N/A	06/03/2019
S1	N/A	N/A	07/03/2019
S1	N/A	N/A	07/03/2019
S2	N/A	N/A	07/03/2019
S2	N/A	N/A	09/03/2019
S2	N/A	N/A	09/03/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	N/A	N/A	14/03/2019
S1	N/A	N/A	15/03/2019
S1	N/A	N/A	16/03/2019
S1	N/A	N/A	17/03/2019
S2	N/A	N/A	17/03/2019
S2	N/A	N/A	20/03/2019
S1	N/A	N/A	21/03/2019
S1	N/A	N/A	22/03/2019
S2	N/A	N/A	22/03/2019
S1	N/A	N/A	23/03/2019
S1	N/A	N/A	27/03/2019
S1	N/A	N/A	28/03/2019
S1	N/A	N/A	29/03/2019
S1	N/A	N/A	01/04/2019
S1	N/A	N/A	03/04/2019
S1	N/A	N/A	04/04/2019
S1	N/A	N/A	05/04/2019
S1	N/A	N/A	05/04/2019
S1	N/A	N/A	11/04/2019
S1	N/A	N/A	12/04/2019
S2	N/A	N/A	13/04/2019
S1	N/A	N/A	14/04/2019
S1	N/A	N/A	15/04/2019
S1	N/A	N/A	16/04/2019
S1	N/A	N/A	16/04/2019
S2	N/A	N/A	16/04/2019
S2	N/A	N/A	19/04/2019
S1	N/A	N/A	20/04/2019
S1	N/A	N/A	21/04/2019
S2	N/A	N/A	21/04/2019
S1	N/A	N/A	22/04/2019
LC	N/A	N/A	23/04/2019
S1	N/A	N/A	26/04/2019
S1	N/A	N/A	27/04/2019
S1	N/A	N/A	28/04/2019
S2	N/A	N/A	02/05/2019
S1	N/A	N/A	03/05/2019
S2	N/A	N/A	07/05/2019
LC	N/A	N/A	07/05/2019
S1	N/A	N/A	10/05/2019
S1	N/A	N/A	11/05/2019
S1	N/A	N/A	12/05/2019
S1	N/A	N/A	14/05/2019
S1	N/A	N/A	15/05/2019
S1	N/A	N/A	16/05/2019
S1	N/A	N/A	20/05/2019
S1	N/A	N/A	21/05/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	22/05/2019
S1	N/A	N/A	22/05/2019
S1	N/A	N/A	26/05/2019
S1	N/A	N/A	27/05/2019
S1	N/A	N/A	28/05/2019
S1	N/A	N/A	28/05/2019
S2	N/A	N/A	28/05/2019
S2	N/A	N/A	04/06/2019
S1	N/A	N/A	08/06/2019
S2	N/A	N/A	08/06/2019
S1	N/A	N/A	09/06/2019
S1	N/A	N/A	10/06/2019
S1	N/A	N/A	11/06/2019
S1	N/A	N/A	11/06/2019
S1	N/A	N/A	12/06/2019
S1	N/A	N/A	12/06/2019
S1	N/A	N/A	13/06/2019
S1	N/A	N/A	14/06/2019
S1	N/A	N/A	15/06/2019
S1	N/A	N/A	15/06/2019
S2	N/A	N/A	15/06/2019
S2	N/A	N/A	17/06/2019
S2	N/A	N/A	18/06/2019
S1	N/A	N/A	19/06/2019
S1	N/A	N/A	20/06/2019
S2	N/A	N/A	20/06/2019
S1	N/A	N/A	21/06/2019
S1	N/A	N/A	21/06/2019
S2	N/A	N/A	22/06/2019
S2	N/A	N/A	23/06/2019
S1	N/A	N/A	25/06/2019
S2	N/A	N/A	25/06/2019
S2	N/A	N/A	25/06/2019
S1	N/A	N/A	26/06/2019
S1	N/A	N/A	27/06/2019
S1	N/A	N/A	27/06/2019
S2	N/A	N/A	28/06/2019
S2	N/A	N/A	30/06/2019
S2	N/A	N/A	30/06/2019
S1	N/A	N/A	02/07/2019
LC	N/A	N/A	04/07/2019
S1	N/A	N/A	06/07/2019
S1	N/A	N/A	07/07/2019
S1	N/A	N/A	08/07/2019
S1	N/A	N/A	09/07/2019
S1	N/A	N/A	09/07/2019
LC	N/A	N/A	09/07/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	10/07/2019
S1	N/A	N/A	10/07/2019
S1	N/A	N/A	13/07/2019
S1	N/A	N/A	14/07/2019
S1	N/A	N/A	15/07/2019
S1	N/A	N/A	15/07/2019
S2	N/A	N/A	15/07/2019
S2	N/A	N/A	15/07/2019
S2	N/A	N/A	18/07/2019
S1	N/A	N/A	19/07/2019
S1	N/A	N/A	20/07/2019
S2	N/A	N/A	20/07/2019
S2	N/A	N/A	20/07/2019
S1	N/A	N/A	21/07/2019
S1	N/A	N/A	21/07/2019
S2	N/A	N/A	22/07/2019
S2	N/A	N/A	23/07/2019
S1	N/A	N/A	25/07/2019
S1	N/A	N/A	26/07/2019
S1	N/A	N/A	27/07/2019
S1	N/A	N/A	27/07/2019
S2	N/A	N/A	30/07/2019
S1	N/A	N/A	31/07/2019
S1	N/A	N/A	01/08/2019
S2	N/A	N/A	02/08/2019
S1	N/A	N/A	04/08/2019
S1	N/A	N/A	05/08/2019
S2	N/A	N/A	05/08/2019
S1	N/A	N/A	06/08/2019
S1	N/A	N/A	07/08/2019
S1	N/A	N/A	08/08/2019
S1	N/A	N/A	08/08/2019
S2	N/A	N/A	10/08/2019
S1	N/A	N/A	13/08/2019
LC	N/A	N/A	13/08/2019
S1	N/A	N/A	14/08/2019
S1	N/A	N/A	14/08/2019
S2	N/A	N/A	14/08/2019
S2	N/A	N/A	14/08/2019
S2	N/A	N/A	16/08/2019
S2	N/A	N/A	17/08/2019
S1	N/A	N/A	18/08/2019
S1	N/A	N/A	19/08/2019
S1	N/A	N/A	20/08/2019
S1	N/A	N/A	20/08/2019
S2	N/A	N/A	21/08/2019
S1	N/A	N/A	24/08/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	N/A	N/A	24/08/2019
S2	N/A	N/A	24/08/2019
S1	N/A	N/A	25/08/2019
S1	N/A	N/A	26/08/2019
S1	N/A	N/A	26/08/2019
S2	N/A	N/A	29/08/2019
S2	N/A	N/A	29/08/2019
LC	N/A	N/A	29/08/2019
S1	N/A	N/A	30/08/2019
S1	N/A	N/A	31/08/2019
S1	N/A	N/A	02/09/2019
S1	N/A	N/A	03/09/2019
S1	N/A	N/A	04/09/2019
S1	N/A	N/A	05/09/2019
S1	N/A	N/A	06/09/2019
S1	N/A	N/A	06/09/2019
S1	N/A	N/A	07/09/2019
S1	N/A	N/A	07/09/2019
S2	N/A	N/A	08/09/2019
S1	N/A	N/A	13/09/2019
S1	N/A	N/A	13/09/2019
LC	N/A	N/A	14/09/2019
S1	N/A	N/A	17/09/2019
S1	N/A	N/A	18/09/2019
S1	N/A	N/A	19/09/2019
S1	N/A	N/A	19/09/2019
S2	N/A	N/A	21/09/2019
S1	N/A	N/A	24/09/2019
S1	N/A	N/A	25/09/2019
S1	N/A	N/A	30/09/2019
LC	N/A	N/A	30/09/2019
S1	N/A	N/A	01/10/2019
S1	N/A	N/A	03/10/2019
S1	N/A	N/A	04/10/2019
S1	N/A	N/A	05/10/2019
S2	N/A	N/A	07/10/2019
S2	N/A	N/A	09/10/2019
S1	N/A	N/A	11/10/2019
S1	N/A	N/A	12/10/2019
S1	N/A	N/A	13/10/2019
S1	N/A	N/A	17/10/2019
S1	N/A	N/A	18/10/2019
S1	N/A	N/A	19/10/2019
S1	N/A	N/A	23/10/2019
S1	N/A	N/A	24/10/2019
S1	N/A	N/A	25/10/2019
S1	N/A	N/A	25/10/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	29/10/2019
S1	N/A	N/A	30/10/2019
S2	N/A	N/A	30/10/2019
S1	N/A	N/A	31/10/2019
S1	N/A	N/A	31/10/2019
S1	N/A	N/A	03/11/2019
S1	N/A	N/A	10/11/2019
S2	N/A	N/A	10/11/2019
S1	N/A	N/A	11/11/2019
S1	N/A	N/A	16/11/2019
S1	N/A	N/A	17/11/2019
S1	N/A	N/A	18/11/2019
S1	N/A	N/A	18/11/2019
S1	N/A	N/A	22/11/2019
S1	N/A	N/A	24/11/2019
S1	N/A	N/A	28/11/2019
S1	N/A	N/A	30/11/2019
S2	N/A	N/A	02/12/2019
S2	N/A	N/A	03/12/2019
S1	N/A	N/A	08/12/2019
S2	N/A	N/A	08/12/2019
S1	N/A	N/A	09/12/2019
S1	N/A	N/A	10/12/2019
S1	N/A	N/A	11/12/2019
S1	N/A	N/A	11/12/2019
S1	N/A	N/A	12/12/2019
S1	N/A	N/A	16/12/2019
S1	N/A	N/A	18/12/2019
S1	N/A	N/A	22/12/2019
S1	N/A	N/A	23/12/2019
S1	N/A	N/A	24/12/2019
S1	N/A	N/A	28/12/2019
S1	N/A	N/A	29/12/2019
S1	N/A	N/A	30/12/2019
S1	N/A	N/A	06/01/2020
S1	N/A	N/A	07/01/2020
S1	N/A	N/A	08/01/2020
S1	N/A	N/A	09/01/2020
S1	N/A	N/A	10/01/2020
S1	N/A	N/A	10/01/2020
S1	N/A	N/A	15/01/2020
S1	N/A	N/A	16/01/2020
S1	N/A	N/A	17/01/2020
S1	N/A	N/A	21/01/2020
S1	N/A	N/A	22/01/2020
S1	N/A	N/A	23/01/2020
S1	N/A	N/A	27/01/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	28/01/2020
S1	N/A	N/A	29/01/2020
S1	N/A	N/A	02/02/2020
S1	N/A	N/A	04/02/2020
S1	N/A	N/A	05/02/2020
S1	N/A	N/A	06/02/2020
S1	N/A	N/A	07/02/2020
S1	N/A	N/A	08/02/2020
S2	N/A	N/A	09/02/2020
S1	N/A	N/A	14/02/2020
S1	N/A	N/A	15/02/2020
S1	N/A	N/A	16/02/2020
S1	N/A	N/A	16/02/2020
S1	N/A	N/A	20/02/2020
S1	N/A	N/A	21/02/2020
S1	N/A	N/A	22/02/2020
S1	N/A	N/A	22/02/2020
S1	N/A	N/A	26/02/2020
S1	N/A	N/A	27/02/2020
S1	N/A	N/A	28/02/2020
S1	N/A	N/A	28/02/2020
S1	N/A	N/A	01/03/2020
S1	N/A	N/A	02/03/2020
S1	N/A	N/A	03/03/2020
S1	N/A	N/A	04/03/2020
S2	N/A	N/A	04/03/2020
S1	N/A	N/A	05/03/2020
S2	N/A	N/A	05/03/2020
S1	N/A	N/A	06/03/2020
S1	N/A	N/A	06/03/2020
S1	N/A	N/A	07/03/2020
S1	N/A	N/A	07/03/2020
S2	N/A	N/A	11/03/2020
S1	N/A	N/A	15/03/2020
S1	N/A	N/A	16/03/2020
S2	N/A	N/A	16/03/2020
S1	N/A	N/A	17/03/2020
S1	N/A	N/A	17/03/2020
S2	N/A	N/A	19/03/2020
S2	N/A	N/A	19/03/2020
S1	N/A	N/A	21/03/2020
S2	N/A	N/A	21/03/2020
S1	N/A	N/A	22/03/2020
S1	N/A	N/A	23/03/2020
S1	N/A	N/A	23/03/2020
S2	N/A	N/A	26/03/2020
S1	N/A	N/A	27/03/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	28/03/2020
S2	N/A	N/A	28/03/2020
S1	N/A	N/A	29/03/2020
S1	N/A	N/A	29/03/2020
S1	N/A	N/A	01/04/2020
S1	N/A	N/A	02/04/2020
S1	N/A	N/A	03/04/2020
S1	N/A	N/A	04/04/2020
S1	N/A	N/A	04/04/2020
S1	N/A	N/A	05/04/2020
S1	N/A	N/A	05/04/2020
S2	N/A	N/A	06/04/2020
S2	N/A	N/A	11/04/2020
S1	N/A	N/A	12/04/2020
S2	N/A	N/A	13/04/2020
S1	N/A	N/A	14/04/2020
S2	N/A	N/A	15/04/2020
S1	N/A	N/A	16/04/2020
S1	N/A	N/A	16/04/2020
S2	N/A	N/A	17/04/2020
S2	N/A	N/A	18/04/2020
S1	N/A	N/A	20/04/2020
S1	N/A	N/A	21/04/2020
S1	N/A	N/A	22/04/2020
S1	N/A	N/A	22/04/2020
S2	N/A	N/A	22/04/2020
S2	N/A	N/A	23/04/2020
S2	N/A	N/A	25/04/2020
S2	N/A	N/A	25/04/2020
S1	N/A	N/A	26/04/2020
S1	N/A	N/A	27/04/2020
S1	N/A	N/A	28/04/2020
S1	N/A	N/A	28/04/2020
S2	N/A	N/A	30/04/2020
S2	N/A	N/A	30/04/2020
S1	N/A	N/A	01/05/2020
S1	N/A	N/A	03/05/2020
S1	N/A	N/A	03/05/2020
S2	N/A	N/A	04/05/2020
S2	N/A	N/A	04/05/2020
S2	N/A	N/A	05/05/2020
S2	N/A	N/A	05/05/2020
S1	N/A	N/A	09/05/2020
S1	N/A	N/A	10/05/2020
S1	N/A	N/A	11/05/2020
S1	N/A	N/A	12/05/2020
S1	N/A	N/A	14/05/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	15/05/2020
S2	N/A	N/A	15/05/2020
S1	N/A	N/A	16/05/2020
S1	N/A	N/A	16/05/2020
S1	N/A	N/A	20/05/2020
S2	N/A	N/A	20/05/2020
S2	N/A	N/A	20/05/2020
LC	N/A	N/A	20/05/2020
S1	N/A	N/A	22/05/2020
S1	N/A	N/A	22/05/2020
S2	N/A	N/A	23/05/2020
S2	N/A	N/A	25/05/2020
S2	N/A	N/A	25/05/2020
S1	N/A	N/A	26/05/2020
S2	N/A	N/A	27/05/2020
S1	N/A	N/A	28/05/2020
S1	N/A	N/A	28/05/2020
S2	N/A	N/A	28/05/2020
S2	N/A	N/A	07/06/2020
S1	N/A	N/A	08/06/2020
S1	N/A	N/A	09/06/2020
S1	N/A	N/A	10/06/2020
S1	N/A	N/A	11/06/2020
S1	N/A	N/A	11/06/2020
S1	N/A	N/A	12/06/2020
S1	N/A	N/A	12/06/2020
S1	N/A	N/A	13/06/2020
S1	N/A	N/A	15/06/2020
S1	N/A	N/A	15/06/2020
S1	N/A	N/A	19/06/2020
S2	N/A	N/A	19/06/2020
S1	N/A	N/A	20/06/2020
S1	N/A	N/A	21/06/2020
S1	N/A	N/A	21/06/2020
S2	N/A	N/A	21/06/2020
S1	N/A	N/A	25/06/2020
S1	N/A	N/A	26/06/2020
S1	N/A	N/A	27/06/2020
S1	N/A	N/A	27/06/2020
S2	N/A	N/A	05/07/2020
S1	N/A	N/A	06/07/2020
S1	N/A	N/A	07/07/2020
LC	N/A	N/A	07/07/2020
S1	N/A	N/A	08/07/2020
S1	N/A	N/A	09/07/2020
S1	N/A	N/A	10/07/2020
S1	N/A	N/A	10/07/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	13/07/2020
S1	N/A	N/A	14/07/2020
S1	N/A	N/A	15/07/2020
S1	N/A	N/A	19/07/2020
S1	N/A	N/A	20/07/2020
S1	N/A	N/A	21/07/2020
LC	N/A	N/A	23/07/2020
S1	N/A	N/A	25/07/2020
S1	N/A	N/A	26/07/2020
S2	N/A	N/A	26/07/2020
S1	N/A	N/A	27/07/2020
S1	N/A	N/A	31/07/2020
S1	N/A	N/A	02/08/2020
S1	N/A	N/A	04/08/2020
S1	N/A	N/A	05/08/2020
S1	N/A	N/A	07/08/2020
S1	N/A	N/A	08/08/2020
S2	N/A	N/A	08/08/2020
S1	N/A	N/A	13/08/2020
S2	N/A	N/A	13/08/2020
S1	N/A	N/A	18/08/2020
S1	N/A	N/A	19/08/2020
S1	N/A	N/A	20/08/2020
S2	N/A	N/A	20/08/2020
S1	N/A	N/A	24/08/2020
S1	N/A	N/A	25/08/2020
S1	N/A	N/A	26/08/2020
S1	N/A	N/A	26/08/2020
S2	N/A	N/A	28/08/2020
S1	N/A	N/A	30/08/2020
S1	N/A	N/A	31/08/2020
S2	N/A	N/A	31/08/2020
S1	N/A	N/A	01/09/2020
S1	N/A	N/A	02/09/2020
S1	N/A	N/A	03/09/2020
S1	N/A	N/A	04/09/2020
LC	N/A	N/A	04/09/2020
S1	N/A	N/A	05/09/2020
S1	N/A	N/A	06/09/2020
S1	N/A	N/A	06/09/2020
S1	N/A	N/A	07/09/2020
S2	N/A	N/A	07/09/2020
S2	N/A	N/A	09/09/2020
RCM	09/09/2020	13/09/2020	11/09/2020
S1	N/A	N/A	13/09/2020
S1	N/A	N/A	13/09/2020
S1	N/A	N/A	17/09/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	18/09/2020
S1	N/A	N/A	19/09/2020
S1	N/A	N/A	19/09/2020
S1	N/A	N/A	23/09/2020
S1	N/A	N/A	24/09/2020
S1	N/A	N/A	25/09/2020
S1	N/A	N/A	25/09/2020
S1	N/A	N/A	29/09/2020
S2	N/A	N/A	29/09/2020
S1	N/A	N/A	30/09/2020
S1	N/A	N/A	01/10/2020
S1	N/A	N/A	02/10/2020
S1	N/A	N/A	02/10/2020
S1	N/A	N/A	03/10/2020
S1	N/A	N/A	04/10/2020
S1	N/A	N/A	04/10/2020
S2	N/A	N/A	04/10/2020
S2	N/A	N/A	04/10/2020
S1	N/A	N/A	05/10/2020
S1	N/A	N/A	05/10/2020
S2	N/A	N/A	05/10/2020
S1	N/A	N/A	12/10/2020
S1	N/A	N/A	13/10/2020
S1	N/A	N/A	13/10/2020
S1	N/A	N/A	18/10/2020
S1	N/A	N/A	19/10/2020
S1	N/A	N/A	19/10/2020
S1	N/A	N/A	24/10/2020
S1	N/A	N/A	25/10/2020
S1	N/A	N/A	25/10/2020
S1	N/A	N/A	29/10/2020
S1	N/A	N/A	30/10/2020
S2	N/A	N/A	30/10/2020
S1	N/A	N/A	31/10/2020
S1	N/A	N/A	31/10/2020
S1	N/A	N/A	01/11/2020
RCM	31/10/2020	04/11/2020	02/11/2020
S1	N/A	N/A	03/11/2020
S1	N/A	N/A	03/11/2020
S2	N/A	N/A	06/11/2020
S1	N/A	N/A	09/11/2020
S1	N/A	N/A	10/11/2020
RCM	04/11/2020	16/11/2020	10/11/2020
S1	N/A	N/A	11/11/2020
S2	N/A	N/A	11/11/2020
S1	N/A	N/A	12/11/2020
S1	N/A	N/A	16/11/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	17/11/2020
S1	N/A	N/A	18/11/2020
S1	N/A	N/A	18/11/2020
S1	N/A	N/A	22/11/2020
S1	N/A	N/A	23/11/2020
S1	N/A	N/A	24/11/2020
S1	N/A	N/A	24/11/2020
S1	N/A	N/A	28/11/2020
S1	N/A	N/A	29/11/2020
S1	N/A	N/A	30/11/2020
S1	N/A	N/A	30/11/2020
S2	N/A	N/A	05/12/2020
S1	N/A	N/A	08/12/2020
S1	N/A	N/A	09/12/2020
S1	N/A	N/A	10/12/2020
S1	N/A	N/A	11/12/2020
S1	N/A	N/A	11/12/2020
S1	N/A	N/A	12/12/2020
S1	N/A	N/A	16/12/2020
S1	N/A	N/A	17/12/2020
S1	N/A	N/A	18/12/2020
S1	N/A	N/A	22/12/2020
S1	N/A	N/A	23/12/2020
S1	N/A	N/A	24/12/2020
S1	N/A	N/A	28/12/2020
S1	N/A	N/A	29/12/2020
S2	N/A	N/A	02/01/2021
S1	N/A	N/A	12/01/2021
S1	N/A	N/A	15/01/2021
S1	N/A	N/A	16/01/2021
S1	N/A	N/A	17/01/2021
S1	N/A	N/A	21/01/2021
S1	N/A	N/A	22/01/2021
S1	N/A	N/A	23/01/2021
S1	N/A	N/A	27/01/2021
S1	N/A	N/A	28/01/2021
S1	N/A	N/A	29/01/2021
S1	N/A	N/A	02/02/2021
S2	N/A	N/A	04/02/2021
S1	N/A	N/A	06/02/2021
S2	N/A	N/A	06/02/2021
S1	N/A	N/A	07/02/2021
S1	N/A	N/A	08/02/2021
S1	N/A	N/A	10/02/2021
S1	N/A	N/A	10/02/2021
S1	N/A	N/A	14/02/2021
S1	N/A	N/A	15/02/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	16/02/2021
S1	N/A	N/A	16/02/2021
S2	N/A	N/A	19/02/2021
S1	N/A	N/A	20/02/2021
S1	N/A	N/A	21/02/2021
S2	N/A	N/A	21/02/2021
S2	N/A	N/A	21/02/2021
S1	N/A	N/A	22/02/2021
LC	N/A	N/A	23/02/2021
S2	N/A	N/A	24/02/2021
S1	N/A	N/A	26/02/2021
S1	N/A	N/A	27/02/2021
S1	N/A	N/A	28/02/2021
S1	N/A	N/A	01/03/2021
S1	N/A	N/A	02/03/2021
S1	N/A	N/A	04/03/2021
S1	N/A	N/A	05/03/2021
S1	N/A	N/A	06/03/2021
S1	N/A	N/A	07/03/2021
S1	N/A	N/A	08/03/2021
S1	N/A	N/A	08/03/2021
S1	N/A	N/A	16/03/2021
S2	N/A	N/A	16/03/2021
S1	N/A	N/A	17/03/2021
S1	N/A	N/A	18/03/2021
S2	N/A	N/A	18/03/2021
S2	N/A	N/A	18/03/2021
LC	N/A	N/A	20/03/2021
S2	N/A	N/A	21/03/2021
S1	N/A	N/A	22/03/2021
S1	N/A	N/A	23/03/2021
S2	N/A	N/A	23/03/2021
S1	N/A	N/A	24/03/2021
S1	N/A	N/A	24/03/2021
S1	N/A	N/A	28/03/2021
S1	N/A	N/A	29/03/2021
S1	N/A	N/A	30/03/2021
S1	N/A	N/A	30/03/2021
S1	N/A	N/A	01/04/2021
S1	N/A	N/A	02/04/2021
S1	N/A	N/A	02/04/2021
S2	N/A	N/A	02/04/2021
S1	N/A	N/A	03/04/2021
S1	N/A	N/A	04/04/2021
S1	N/A	N/A	05/04/2021
S1	N/A	N/A	06/04/2021
S1	N/A	N/A	06/04/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	N/A	N/A	06/04/2021
S1	N/A	N/A	07/04/2021
S1	N/A	N/A	07/04/2021
S2	N/A	N/A	07/04/2021
S1	N/A	N/A	15/04/2021
S2	N/A	N/A	15/04/2021
S2	N/A	N/A	15/04/2021
S1	N/A	N/A	16/04/2021
S1	N/A	N/A	17/04/2021
S1	N/A	N/A	17/04/2021
S2	N/A	N/A	17/04/2021
S2	N/A	N/A	17/04/2021
S2	N/A	N/A	20/04/2021
S2	N/A	N/A	20/04/2021
S1	N/A	N/A	21/04/2021
S2	N/A	N/A	22/04/2021
S1	N/A	N/A	23/04/2021
S1	N/A	N/A	23/04/2021
S2	N/A	N/A	25/04/2021
S1	N/A	N/A	27/04/2021
S2	N/A	N/A	27/04/2021
S1	N/A	N/A	28/04/2021
S1	N/A	N/A	29/04/2021
S1	N/A	N/A	29/04/2021
S1	N/A	N/A	01/05/2021
S1	N/A	N/A	03/05/2021
S1	N/A	N/A	04/05/2021
S1	N/A	N/A	04/05/2021
S1	N/A	N/A	05/05/2021
S1	N/A	N/A	05/05/2021
S1	N/A	N/A	12/05/2021
S1	N/A	N/A	15/05/2021
S1	N/A	N/A	16/05/2021
S1	N/A	N/A	17/05/2021
S1	N/A	N/A	17/05/2021
S2	N/A	N/A	17/05/2021
S1	N/A	N/A	21/05/2021
S1	N/A	N/A	22/05/2021
S1	N/A	N/A	23/05/2021
S1	N/A	N/A	23/05/2021
S1	N/A	N/A	27/05/2021
S1	N/A	N/A	28/05/2021
S1	N/A	N/A	29/05/2021
S1	N/A	N/A	29/05/2021
S2	N/A	N/A	30/05/2021
S1	N/A	N/A	03/06/2021
S1	N/A	N/A	03/06/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	N/A	N/A	06/06/2021
S1	N/A	N/A	10/06/2021
S1	N/A	N/A	11/06/2021
S1	N/A	N/A	14/06/2021
S2	N/A	N/A	14/06/2021
S1	N/A	N/A	15/06/2021
LC	N/A	N/A	15/06/2021
S1	N/A	N/A	16/06/2021
S1	N/A	N/A	16/06/2021
S2	N/A	N/A	16/06/2021
S1	N/A	N/A	20/06/2021
S1	N/A	N/A	21/06/2021
S2	N/A	N/A	21/06/2021
S1	N/A	N/A	22/06/2021
S1	N/A	N/A	22/06/2021
S1	N/A	N/A	26/06/2021
S1	N/A	N/A	27/06/2021
S1	N/A	N/A	28/06/2021
S1	N/A	N/A	28/06/2021
LC	N/A	N/A	02/07/2021
S2	N/A	N/A	04/07/2021
S2	N/A	N/A	06/07/2021
S1	N/A	N/A	09/07/2021
S1	N/A	N/A	11/07/2021
S1	N/A	N/A	11/07/2021
S1	N/A	N/A	14/07/2021
S2	N/A	N/A	16/07/2021
S1	N/A	N/A	21/07/2021
S1	N/A	N/A	22/07/2021
S1	N/A	N/A	22/07/2021
S2	N/A	N/A	24/07/2021
S2	N/A	N/A	24/07/2021
LC	N/A	N/A	26/07/2021
S2	N/A	N/A	27/07/2021
S2	N/A	N/A	31/07/2021
S1	N/A	N/A	02/08/2021
S1	N/A	N/A	06/08/2021
S1	N/A	N/A	07/08/2021
S2	N/A	N/A	08/08/2021
S1	N/A	N/A	09/08/2021
S1	N/A	N/A	09/08/2021
S1	N/A	N/A	15/08/2021
S1	N/A	N/A	15/08/2021
S2	N/A	N/A	15/08/2021
S1	N/A	N/A	19/08/2021
S2	N/A	N/A	23/08/2021
S1	N/A	N/A	27/08/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	27/08/2021
S1	N/A	N/A	31/08/2021
S1	N/A	N/A	01/09/2021
S1	N/A	N/A	02/09/2021
S2	N/A	N/A	02/09/2021
S1	N/A	N/A	04/09/2021
S1	N/A	N/A	05/09/2021
S1	N/A	N/A	06/09/2021
S2	N/A	N/A	06/09/2021
S1	N/A	N/A	07/09/2021
S2	N/A	N/A	07/09/2021
S2	N/A	N/A	09/09/2021
S2	N/A	N/A	15/09/2021
S1	N/A	N/A	19/09/2021
S1	N/A	N/A	20/09/2021
S1	N/A	N/A	20/09/2021
S2	N/A	N/A	22/09/2021
S1	N/A	N/A	24/09/2021
S2	N/A	N/A	27/09/2021
S2	N/A	N/A	30/09/2021
S1	N/A	N/A	01/10/2021
S1	N/A	N/A	02/10/2021
S1	N/A	N/A	02/10/2021
S1	N/A	N/A	03/10/2021
S2	N/A	N/A	04/10/2021
S2	N/A	N/A	04/10/2021
S1	N/A	N/A	05/10/2021
S2	N/A	N/A	05/10/2021
S1	N/A	N/A	06/10/2021
S1	N/A	N/A	06/10/2021
S1	N/A	N/A	07/10/2021
S1	N/A	N/A	07/10/2021
S1	N/A	N/A	14/10/2021
S1	N/A	N/A	14/10/2021
S1	N/A	N/A	18/10/2021
S1	N/A	N/A	26/10/2021
S1	N/A	N/A	26/10/2021
S1	N/A	N/A	30/10/2021
S1	N/A	N/A	03/11/2021
LC	N/A	N/A	03/11/2021
S1	N/A	N/A	04/11/2021
S1	N/A	N/A	04/11/2021
S1	N/A	N/A	05/11/2021
S1	N/A	N/A	05/11/2021
S1	N/A	N/A	11/11/2021
S1	N/A	N/A	18/11/2021
S1	N/A	N/A	19/11/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	23/11/2021
S1	N/A	N/A	30/11/2021
S1	N/A	N/A	03/12/2021
S2	N/A	N/A	04/12/2021
S2	N/A	N/A	04/12/2021
S2	N/A	N/A	04/12/2021
S2	N/A	N/A	06/12/2021
S1	N/A	N/A	09/12/2021
S1	N/A	N/A	12/12/2021
S1	N/A	N/A	13/12/2021
S1	N/A	N/A	17/12/2021
S1	N/A	N/A	29/12/2021
S1	N/A	N/A	22/01/2022
LC	N/A	N/A	25/01/2022
LC	N/A	N/A	29/01/2022
S1	N/A	N/A	30/01/2022
S2	N/A	N/A	14/02/2022
S2	N/A	N/A	24/02/2022
S2	N/A	N/A	27/02/2022
S1	N/A	N/A	02/03/2022
S2	N/A	N/A	04/03/2022
S2	N/A	N/A	14/03/2022
S2	N/A	N/A	16/03/2022
S2	N/A	N/A	16/03/2022
S2	N/A	N/A	19/03/2022
S2	N/A	N/A	15/04/2022
S2	N/A	N/A	15/04/2022
S2	N/A	N/A	20/04/2022
S2	N/A	N/A	23/04/2022
S2	N/A	N/A	25/04/2022
S2	N/A	N/A	04/05/2022
S2	N/A	N/A	04/05/2022
LC	N/A	N/A	02/06/2022
S2	N/A	N/A	04/08/2022
S2	N/A	N/A	04/08/2022
S2	N/A	N/A	02/09/2022
S1	N/A	N/A	01/10/2022
S2	N/A	N/A	04/10/2022

Appendix Table 5: Images used in the analysis at the up-glacier point on Valerie Glacier. LC is Landsat, S1 is Sentinel-1 (includes Sentinel-1a and Sentinel-1b), S2 is Sentinel-2 (includes Sentinel-2a and Sentinel-2b), TSX/TDX is TerraSAR-X/TanDEM-X, R2 is RADARSAT-2, and RCM is RADARSAT Constellation Mission. reference and secondary image dates were not obtained for Valerie Glacier during the ITS_LIVE data download that is described in Section 3.1.5.

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
LC	N/A	N/A	08/05/2013
LC	N/A	N/A	20/07/2013
LC	N/A	N/A	11/09/2013
LC	N/A	N/A	24/10/2013
LC	N/A	N/A	16/11/2013
LC	N/A	N/A	28/01/2014
LC	N/A	N/A	04/02/2014
LC	N/A	N/A	13/02/2014
R2	03/02/2014	27/02/2014	15/02/2014
R2	27/02/2014	23/03/2014	11/03/2014
LC	N/A	N/A	18/04/2014
LC	N/A	N/A	25/04/2014
LC	N/A	N/A	12/05/2014
LC	N/A	N/A	23/07/2014
LC	N/A	N/A	31/08/2014
LC	N/A	N/A	04/09/2014
LC	N/A	N/A	16/09/2014
LC	N/A	N/A	19/11/2014
S1	N/A	N/A	20/11/2014
S1	N/A	N/A	14/12/2014
LC	N/A	N/A	21/12/2014
LC	N/A	N/A	07/01/2015
S1	N/A	N/A	31/01/2015
S1	N/A	N/A	24/02/2015
R2	22/02/2015	18/03/2015	06/03/2015
TSX/TDX	03/03/2015	14/03/2015	08/03/2015
S1	N/A	N/A	20/03/2015
S1	N/A	N/A	09/04/2015
S1	N/A	N/A	13/04/2015
LC	N/A	N/A	21/04/2015
LC	N/A	N/A	04/05/2015
LC	N/A	N/A	14/05/2015
LC	N/A	N/A	23/05/2015
S1	N/A	N/A	31/05/2015
S1	N/A	N/A	24/06/2015
S1	N/A	N/A	01/07/2015
TSX/TDX	27/06/2015	08/07/2015	02/07/2015
LC	N/A	N/A	05/07/2015
TSX/TDX	08/07/2015	19/07/2015	13/07/2015
LC	N/A	N/A	17/07/2015
S1	N/A	N/A	18/07/2015
TSX/TDX	19/07/2015	30/07/2015	24/07/2015

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
LC	N/A	N/A	26/07/2015
TSX/TDX	30/07/2015	10/08/2015	04/08/2015
LC	N/A	N/A	06/08/2015
TSX/TDX	10/08/2015	21/08/2015	15/08/2015
TSX/TDX	21/08/2015	01/09/2015	26/08/2015
TSX/TDX	01/09/2015	12/09/2015	06/09/2015
S1	N/A	N/A	12/09/2015
TSX/TDX	12/09/2015	23/09/2015	17/09/2015
S1	N/A	N/A	28/09/2015
TSX/TDX	23/09/2015	04/10/2015	28/09/2015
TSX/TDX	04/10/2015	15/10/2015	09/10/2015
TSX/TDX	09/10/2015	20/10/2015	14/10/2015
TSX/TDX	15/10/2015	26/10/2015	20/10/2015
S1	N/A	N/A	22/10/2015
S1	N/A	N/A	08/11/2015
S1	N/A	N/A	15/11/2015
TSX/TDX	22/11/2015	03/12/2015	27/11/2015
S1	N/A	N/A	20/12/2015
S1	N/A	N/A	05/01/2016
S1	N/A	N/A	11/01/2016
S1	N/A	N/A	26/01/2016
S1	N/A	N/A	01/02/2016
R2	24/01/2016	17/02/2016	05/02/2016
S1	N/A	N/A	19/02/2016
R2	17/02/2016	12/03/2016	29/02/2016
S1	N/A	N/A	14/03/2016
LC	N/A	N/A	22/03/2016
S1	N/A	N/A	08/05/2016
S1	N/A	N/A	25/05/2016
S2	N/A	N/A	28/05/2016
LC	N/A	N/A	03/06/2016
S1	N/A	N/A	18/06/2016
S1	N/A	N/A	04/07/2016
LC	N/A	N/A	10/07/2016
LC	N/A	N/A	11/08/2016
S1	N/A	N/A	12/08/2016
S1	N/A	N/A	29/08/2016
S2	N/A	N/A	11/09/2016
LC	N/A	N/A	16/10/2016
LC	N/A	N/A	23/10/2016
S1	N/A	N/A	28/10/2016
S1	N/A	N/A	21/11/2016
S1	N/A	N/A	25/11/2016
S1	N/A	N/A	07/12/2016
S1	N/A	N/A	15/12/2016
S1	N/A	N/A	19/12/2016
R2	18/01/2017	11/02/2017	30/01/2017
R2	11/02/2017	07/03/2017	23/02/2017

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	23/02/2017
LC	N/A	N/A	28/02/2017
S1	N/A	N/A	11/03/2017
LC	N/A	N/A	16/03/2017
S1	N/A	N/A	08/04/2017
S1	N/A	N/A	09/04/2017
S1	N/A	N/A	10/04/2017
S1	N/A	N/A	11/04/2017
S1	N/A	N/A	11/04/2017
S1	N/A	N/A	12/04/2017
TSX/TDX	28/04/2017	09/05/2017	03/05/2017
S1	N/A	N/A	06/05/2017
S1	N/A	N/A	07/05/2017
S1	N/A	N/A	09/05/2017
S1	N/A	N/A	10/05/2017
S1	N/A	N/A	10/05/2017
S1	N/A	N/A	24/05/2017
S1	N/A	N/A	17/06/2017
S1	N/A	N/A	18/06/2017
S1	N/A	N/A	23/06/2017
S1	N/A	N/A	24/06/2017
S1	N/A	N/A	29/06/2017
S1	N/A	N/A	03/07/2017
S1	N/A	N/A	17/07/2017
S1	N/A	N/A	29/07/2017
S1	N/A	N/A	11/08/2017
S1	N/A	N/A	16/08/2017
S1	N/A	N/A	17/08/2017
S1	N/A	N/A	18/08/2017
S1	N/A	N/A	23/08/2017
S1	N/A	N/A	24/08/2017
S1	N/A	N/A	28/08/2017
S1	N/A	N/A	30/08/2017
S1	N/A	N/A	03/09/2017
S2	N/A	N/A	11/09/2017
S1	N/A	N/A	12/09/2017
S1	N/A	N/A	16/09/2017
S1	N/A	N/A	17/09/2017
S1	N/A	N/A	21/09/2017
S1	N/A	N/A	23/09/2017
S1	N/A	N/A	27/09/2017
S1	N/A	N/A	29/09/2017
S1	N/A	N/A	08/10/2017
S1	N/A	N/A	09/10/2017
S1	N/A	N/A	11/10/2017
S1	N/A	N/A	17/10/2017
S1	N/A	N/A	21/10/2017
S1	N/A	N/A	22/10/2017

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	23/10/2017
S1	N/A	N/A	23/10/2017
S1	N/A	N/A	28/10/2017
S1	N/A	N/A	29/10/2017
S1	N/A	N/A	06/11/2017
S1	N/A	N/A	07/11/2017
S1	N/A	N/A	08/11/2017
S1	N/A	N/A	09/11/2017
S1	N/A	N/A	10/11/2017
S1	N/A	N/A	15/11/2017
S1	N/A	N/A	16/11/2017
S1	N/A	N/A	27/11/2017
S1	N/A	N/A	01/12/2017
LC	N/A	N/A	02/12/2017
S1	N/A	N/A	06/12/2017
S1	N/A	N/A	08/12/2017
S1	N/A	N/A	08/12/2017
S1	N/A	N/A	14/12/2017
S1	N/A	N/A	15/12/2017
S1	N/A	N/A	20/12/2017
S1	N/A	N/A	21/12/2017
S1	N/A	N/A	22/12/2017
S1	N/A	N/A	26/12/2017
S1	N/A	N/A	27/12/2017
S1	N/A	N/A	28/12/2017
S1	N/A	N/A	01/01/2018
S2	N/A	N/A	04/01/2018
S1	N/A	N/A	05/01/2018
S2	N/A	N/A	05/01/2018
S2	N/A	N/A	05/01/2018
S1	N/A	N/A	06/01/2018
S1	N/A	N/A	08/01/2018
S1	N/A	N/A	13/01/2018
S1	N/A	N/A	14/01/2018
S1	N/A	N/A	15/01/2018
S1	N/A	N/A	19/01/2018
S1	N/A	N/A	21/01/2018
S1	N/A	N/A	21/01/2018
S1	N/A	N/A	25/01/2018
S1	N/A	N/A	27/01/2018
S2	N/A	N/A	28/01/2018
S1	N/A	N/A	31/01/2018
S2	N/A	N/A	31/01/2018
S1	N/A	N/A	01/02/2018
S1	N/A	N/A	02/02/2018
S2	N/A	N/A	02/02/2018
TSX/TDX	28/01/2018	08/02/2018	02/02/2018
S1	N/A	N/A	03/02/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	05/02/2018
S1	N/A	N/A	06/02/2018
S1	N/A	N/A	06/02/2018
S1	N/A	N/A	07/02/2018
S1	N/A	N/A	07/02/2018
S2	N/A	N/A	17/02/2018
S1	N/A	N/A	20/02/2018
S2	N/A	N/A	25/02/2018
S1	N/A	N/A	01/03/2018
S2	N/A	N/A	04/03/2018
S1	N/A	N/A	05/03/2018
S1	N/A	N/A	05/03/2018
S1	N/A	N/A	11/03/2018
S1	N/A	N/A	12/03/2018
S2	N/A	N/A	14/03/2018
S2	N/A	N/A	17/03/2018
S2	N/A	N/A	19/03/2018
S1	N/A	N/A	20/03/2018
S2	N/A	N/A	27/03/2018
S1	N/A	N/A	28/03/2018
S2	N/A	N/A	29/03/2018
S2	N/A	N/A	30/03/2018
S1	N/A	N/A	03/04/2018
S2	N/A	N/A	04/04/2018
S1	N/A	N/A	09/04/2018
S1	N/A	N/A	10/04/2018
S1	N/A	N/A	11/04/2018
S1	N/A	N/A	12/04/2018
S2	N/A	N/A	14/04/2018
S2	N/A	N/A	19/04/2018
S1	N/A	N/A	20/04/2018
S1	N/A	N/A	21/04/2018
S1	N/A	N/A	21/04/2018
S2	N/A	N/A	21/04/2018
S2	N/A	N/A	21/04/2018
S2	N/A	N/A	24/04/2018
S1	N/A	N/A	25/04/2018
S2	N/A	N/A	26/04/2018
S2	N/A	N/A	26/04/2018
S1	N/A	N/A	27/04/2018
S1	N/A	N/A	27/04/2018
S2	N/A	N/A	02/05/2018
S1	N/A	N/A	08/05/2018
S1	N/A	N/A	09/05/2018
S2	N/A	N/A	09/05/2018
S1	N/A	N/A	10/05/2018
S1	N/A	N/A	11/05/2018
S1	N/A	N/A	12/05/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	13/05/2018
S2	N/A	N/A	13/05/2018
S1	N/A	N/A	14/05/2018
S1	N/A	N/A	15/05/2018
S1	N/A	N/A	15/05/2018
S1	N/A	N/A	19/05/2018
S1	N/A	N/A	20/05/2018
S1	N/A	N/A	21/05/2018
S1	N/A	N/A	25/05/2018
S1	N/A	N/A	26/05/2018
S1	N/A	N/A	27/05/2018
S1	N/A	N/A	31/05/2018
S2	N/A	N/A	04/06/2018
S2	N/A	N/A	04/06/2018
S2	N/A	N/A	05/06/2018
S1	N/A	N/A	06/06/2018
S1	N/A	N/A	07/06/2018
S1	N/A	N/A	09/06/2018
S1	N/A	N/A	10/06/2018
S1	N/A	N/A	10/06/2018
S1	N/A	N/A	13/06/2018
S1	N/A	N/A	14/06/2018
S1	N/A	N/A	18/06/2018
S1	N/A	N/A	19/06/2018
S1	N/A	N/A	20/06/2018
S1	N/A	N/A	20/06/2018
S1	N/A	N/A	24/06/2018
S1	N/A	N/A	26/06/2018
S1	N/A	N/A	26/06/2018
S1	N/A	N/A	30/06/2018
S1	N/A	N/A	01/07/2018
S2	N/A	N/A	02/07/2018
S1	N/A	N/A	05/07/2018
S1	N/A	N/A	06/07/2018
S1	N/A	N/A	08/07/2018
S2	N/A	N/A	13/07/2018
S1	N/A	N/A	14/07/2018
S1	N/A	N/A	14/07/2018
S2	N/A	N/A	17/07/2018
S1	N/A	N/A	18/07/2018
S2	N/A	N/A	18/07/2018
S1	N/A	N/A	20/07/2018
S1	N/A	N/A	24/07/2018
S2	N/A	N/A	25/07/2018
S2	N/A	N/A	25/07/2018
S1	N/A	N/A	26/07/2018
S2	N/A	N/A	27/07/2018
S1	N/A	N/A	30/07/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
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S1	N/A	N/A	02/08/2018
LC	N/A	N/A	02/08/2018
S1	N/A	N/A	03/08/2018
S2	N/A	N/A	04/08/2018
S1	N/A	N/A	05/08/2018
S1	N/A	N/A	06/08/2018
S1	N/A	N/A	07/08/2018
S1	N/A	N/A	07/08/2018
S1	N/A	N/A	13/08/2018
S2	N/A	N/A	16/08/2018
S1	N/A	N/A	18/08/2018
S1	N/A	N/A	19/08/2018
S1	N/A	N/A	23/08/2018
S1	N/A	N/A	24/08/2018
S1	N/A	N/A	25/08/2018
S1	N/A	N/A	29/08/2018
S1	N/A	N/A	30/08/2018
S1	N/A	N/A	31/08/2018
S1	N/A	N/A	01/09/2018
S1	N/A	N/A	04/09/2018
S2	N/A	N/A	04/09/2018
S1	N/A	N/A	05/09/2018
S1	N/A	N/A	05/09/2018
LC	N/A	N/A	07/09/2018
S1	N/A	N/A	11/09/2018
S1	N/A	N/A	12/09/2018
S2	N/A	N/A	13/09/2018
S2	N/A	N/A	15/09/2018
S1	N/A	N/A	16/09/2018
S1	N/A	N/A	18/09/2018
S1	N/A	N/A	18/09/2018
S2	N/A	N/A	18/09/2018
S2	N/A	N/A	18/09/2018
S2	N/A	N/A	20/09/2018
S2	N/A	N/A	21/09/2018
S1	N/A	N/A	22/09/2018
S1	N/A	N/A	23/09/2018
S2	N/A	N/A	23/09/2018
S1	N/A	N/A	24/09/2018
S1	N/A	N/A	24/09/2018
S2	N/A	N/A	26/09/2018
S1	N/A	N/A	28/09/2018
S2	N/A	N/A	28/09/2018
S1	N/A	N/A	30/09/2018
S2	N/A	N/A	02/10/2018
S2	N/A	N/A	03/10/2018
S2	N/A	N/A	07/10/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
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S1	N/A	N/A	10/10/2018
S1	N/A	N/A	11/10/2018
S1	N/A	N/A	12/10/2018
S2	N/A	N/A	16/10/2018
S1	N/A	N/A	17/10/2018
S1	N/A	N/A	18/10/2018
S1	N/A	N/A	18/10/2018
S2	N/A	N/A	18/10/2018
S2	N/A	N/A	18/10/2018
S2	N/A	N/A	21/10/2018
S1	N/A	N/A	22/10/2018
S1	N/A	N/A	23/10/2018
S1	N/A	N/A	24/10/2018
S1	N/A	N/A	28/10/2018
S1	N/A	N/A	29/10/2018
S1	N/A	N/A	30/10/2018
S2	N/A	N/A	04/11/2018
S2	N/A	N/A	05/11/2018
S1	N/A	N/A	09/11/2018
S2	N/A	N/A	09/11/2018
S1	N/A	N/A	11/11/2018
S1	N/A	N/A	12/11/2018
LC	N/A	N/A	14/11/2018
S1	N/A	N/A	15/11/2018
S1	N/A	N/A	16/11/2018
S1	N/A	N/A	17/11/2018
S1	N/A	N/A	21/11/2018
S1	N/A	N/A	22/11/2018
S1	N/A	N/A	23/11/2018
LC	N/A	N/A	23/11/2018
S1	N/A	N/A	27/11/2018
S1	N/A	N/A	28/11/2018
S1	N/A	N/A	29/11/2018
S1	N/A	N/A	02/12/2018
S2	N/A	N/A	02/12/2018
S1	N/A	N/A	06/12/2018
S2	N/A	N/A	07/12/2018
S1	N/A	N/A	09/12/2018
S1	N/A	N/A	09/12/2018
S1	N/A	N/A	10/12/2018
S1	N/A	N/A	15/12/2018
S1	N/A	N/A	16/12/2018
S1	N/A	N/A	17/12/2018
S1	N/A	N/A	21/12/2018
S1	N/A	N/A	23/12/2018
S1	N/A	N/A	27/12/2018
S1	N/A	N/A	29/12/2018

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
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S2	N/A	N/A	04/01/2019
S1	N/A	N/A	06/01/2019
S1	N/A	N/A	07/01/2019
S1	N/A	N/A	08/01/2019
S2	N/A	N/A	08/01/2019
S1	N/A	N/A	09/01/2019
S1	N/A	N/A	09/01/2019
S1	N/A	N/A	10/01/2019
S1	N/A	N/A	14/01/2019
S1	N/A	N/A	16/01/2019
S1	N/A	N/A	20/01/2019
S1	N/A	N/A	21/01/2019
S1	N/A	N/A	22/01/2019
S1	N/A	N/A	26/01/2019
S2	N/A	N/A	26/01/2019
S1	N/A	N/A	28/01/2019
S1	N/A	N/A	01/02/2019
S2	N/A	N/A	03/02/2019
S1	N/A	N/A	04/02/2019
S1	N/A	N/A	05/02/2019
S1	N/A	N/A	06/02/2019
S1	N/A	N/A	07/02/2019
S2	N/A	N/A	07/02/2019
S1	N/A	N/A	08/02/2019
S1	N/A	N/A	08/02/2019
S2	N/A	N/A	11/02/2019
S1	N/A	N/A	13/02/2019
S2	N/A	N/A	13/02/2019
S1	N/A	N/A	15/02/2019
S2	N/A	N/A	15/02/2019
S2	N/A	N/A	18/02/2019
LC	N/A	N/A	18/02/2019
S1	N/A	N/A	19/02/2019
S2	N/A	N/A	20/02/2019
S1	N/A	N/A	21/02/2019
S2	N/A	N/A	23/02/2019
S1	N/A	N/A	25/02/2019
S2	N/A	N/A	25/02/2019
S1	N/A	N/A	26/02/2019
S1	N/A	N/A	27/02/2019
LC	N/A	N/A	27/02/2019
S1	N/A	N/A	01/03/2019
S1	N/A	N/A	02/03/2019
S1	N/A	N/A	03/03/2019
S1	N/A	N/A	05/03/2019
S1	N/A	N/A	06/03/2019
S1	N/A	N/A	06/03/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
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S2	N/A	N/A	07/03/2019
S2	N/A	N/A	09/03/2019
S2	N/A	N/A	09/03/2019
S2	N/A	N/A	14/03/2019
S1	N/A	N/A	15/03/2019
S2	N/A	N/A	17/03/2019
S2	N/A	N/A	20/03/2019
S2	N/A	N/A	22/03/2019
S1	N/A	N/A	23/03/2019
S1	N/A	N/A	27/03/2019
S1	N/A	N/A	01/04/2019
S1	N/A	N/A	04/04/2019
S1	N/A	N/A	05/04/2019
S1	N/A	N/A	05/04/2019
S1	N/A	N/A	11/04/2019
S1	N/A	N/A	12/04/2019
S2	N/A	N/A	13/04/2019
S1	N/A	N/A	14/04/2019
S1	N/A	N/A	15/04/2019
S1	N/A	N/A	16/04/2019
S1	N/A	N/A	16/04/2019
S2	N/A	N/A	16/04/2019
S2	N/A	N/A	19/04/2019
S1	N/A	N/A	20/04/2019
S1	N/A	N/A	21/04/2019
S2	N/A	N/A	21/04/2019
LC	N/A	N/A	23/04/2019
S1	N/A	N/A	26/04/2019
S1	N/A	N/A	27/04/2019
S1	N/A	N/A	28/04/2019
S2	N/A	N/A	02/05/2019
S1	N/A	N/A	03/05/2019
S2	N/A	N/A	07/05/2019
S1	N/A	N/A	11/05/2019
S1	N/A	N/A	12/05/2019
S1	N/A	N/A	14/05/2019
S1	N/A	N/A	15/05/2019
S1	N/A	N/A	20/05/2019
S1	N/A	N/A	21/05/2019
S1	N/A	N/A	22/05/2019
S1	N/A	N/A	22/05/2019
S1	N/A	N/A	26/05/2019
S1	N/A	N/A	27/05/2019
S1	N/A	N/A	28/05/2019
S1	N/A	N/A	28/05/2019
S2	N/A	N/A	04/06/2019
S1	N/A	N/A	08/06/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
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S1	N/A	N/A	09/06/2019
S1	N/A	N/A	10/06/2019
S1	N/A	N/A	11/06/2019
S1	N/A	N/A	11/06/2019
S1	N/A	N/A	12/06/2019
S1	N/A	N/A	12/06/2019
S1	N/A	N/A	13/06/2019
S1	N/A	N/A	14/06/2019
S1	N/A	N/A	15/06/2019
S1	N/A	N/A	15/06/2019
S2	N/A	N/A	15/06/2019
S2	N/A	N/A	17/06/2019
S2	N/A	N/A	18/06/2019
S1	N/A	N/A	19/06/2019
S1	N/A	N/A	20/06/2019
S2	N/A	N/A	20/06/2019
S1	N/A	N/A	21/06/2019
S1	N/A	N/A	21/06/2019
S2	N/A	N/A	22/06/2019
S1	N/A	N/A	25/06/2019
S2	N/A	N/A	25/06/2019
S1	N/A	N/A	26/06/2019
S1	N/A	N/A	27/06/2019
S1	N/A	N/A	27/06/2019
S2	N/A	N/A	28/06/2019
S2	N/A	N/A	30/06/2019
S2	N/A	N/A	30/06/2019
S1	N/A	N/A	02/07/2019
LC	N/A	N/A	04/07/2019
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S1	N/A	N/A	07/07/2019
S1	N/A	N/A	08/07/2019
S1	N/A	N/A	09/07/2019
S1	N/A	N/A	09/07/2019
LC	N/A	N/A	09/07/2019
S1	N/A	N/A	10/07/2019
S1	N/A	N/A	10/07/2019
S1	N/A	N/A	13/07/2019
S1	N/A	N/A	14/07/2019
S1	N/A	N/A	15/07/2019
S1	N/A	N/A	15/07/2019
S2	N/A	N/A	15/07/2019
S2	N/A	N/A	15/07/2019
S2	N/A	N/A	18/07/2019
S1	N/A	N/A	19/07/2019
S1	N/A	N/A	20/07/2019
S2	N/A	N/A	20/07/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	N/A	N/A	20/07/2019
S1	N/A	N/A	21/07/2019
S1	N/A	N/A	21/07/2019
S2	N/A	N/A	22/07/2019
S2	N/A	N/A	23/07/2019
S1	N/A	N/A	25/07/2019
S1	N/A	N/A	26/07/2019
S1	N/A	N/A	27/07/2019
S1	N/A	N/A	27/07/2019
S2	N/A	N/A	30/07/2019
S1	N/A	N/A	31/07/2019
S1	N/A	N/A	01/08/2019
S2	N/A	N/A	02/08/2019
S1	N/A	N/A	04/08/2019
S1	N/A	N/A	05/08/2019
S1	N/A	N/A	06/08/2019
S1	N/A	N/A	07/08/2019
S1	N/A	N/A	08/08/2019
S2	N/A	N/A	10/08/2019
S1	N/A	N/A	13/08/2019
LC	N/A	N/A	13/08/2019
S1	N/A	N/A	14/08/2019
S1	N/A	N/A	14/08/2019
S2	N/A	N/A	14/08/2019
S2	N/A	N/A	14/08/2019
S2	N/A	N/A	16/08/2019
S2	N/A	N/A	17/08/2019
S1	N/A	N/A	18/08/2019
S1	N/A	N/A	19/08/2019
S1	N/A	N/A	20/08/2019
S2	N/A	N/A	21/08/2019
S1	N/A	N/A	24/08/2019
S2	N/A	N/A	24/08/2019
S2	N/A	N/A	24/08/2019
S1	N/A	N/A	25/08/2019
S1	N/A	N/A	26/08/2019
S1	N/A	N/A	26/08/2019
S2	N/A	N/A	29/08/2019
S2	N/A	N/A	29/08/2019
LC	N/A	N/A	29/08/2019
S1	N/A	N/A	30/08/2019
S1	N/A	N/A	31/08/2019
S1	N/A	N/A	02/09/2019
S1	N/A	N/A	05/09/2019
S1	N/A	N/A	06/09/2019
S1	N/A	N/A	06/09/2019
S1	N/A	N/A	07/09/2019
S1	N/A	N/A	07/09/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	N/A	N/A	08/09/2019
S1	N/A	N/A	13/09/2019
S1	N/A	N/A	13/09/2019
LC	N/A	N/A	14/09/2019
S1	N/A	N/A	18/09/2019
S1	N/A	N/A	19/09/2019
S1	N/A	N/A	19/09/2019
S2	N/A	N/A	21/09/2019
S1	N/A	N/A	25/09/2019
S1	N/A	N/A	30/09/2019
LC	N/A	N/A	30/09/2019
S1	N/A	N/A	01/10/2019
S1	N/A	N/A	03/10/2019
S1	N/A	N/A	05/10/2019
S2	N/A	N/A	07/10/2019
S2	N/A	N/A	09/10/2019
S1	N/A	N/A	11/10/2019
S1	N/A	N/A	12/10/2019
S1	N/A	N/A	13/10/2019
S1	N/A	N/A	17/10/2019
S1	N/A	N/A	18/10/2019
S1	N/A	N/A	19/10/2019
S1	N/A	N/A	23/10/2019
S1	N/A	N/A	24/10/2019
S1	N/A	N/A	25/10/2019
S1	N/A	N/A	25/10/2019
S1	N/A	N/A	29/10/2019
S1	N/A	N/A	30/10/2019
S2	N/A	N/A	30/10/2019
S1	N/A	N/A	31/10/2019
S1	N/A	N/A	31/10/2019
S1	N/A	N/A	03/11/2019
S2	N/A	N/A	10/11/2019
S1	N/A	N/A	11/11/2019
S1	N/A	N/A	16/11/2019
S1	N/A	N/A	17/11/2019
S1	N/A	N/A	18/11/2019
S1	N/A	N/A	18/11/2019
S1	N/A	N/A	22/11/2019
S1	N/A	N/A	24/11/2019
S1	N/A	N/A	28/11/2019
S1	N/A	N/A	30/11/2019
S2	N/A	N/A	02/12/2019
S2	N/A	N/A	03/12/2019
S1	N/A	N/A	08/12/2019
S2	N/A	N/A	08/12/2019
S1	N/A	N/A	09/12/2019
S1	N/A	N/A	10/12/2019

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	11/12/2019
S1	N/A	N/A	11/12/2019
S1	N/A	N/A	12/12/2019
S1	N/A	N/A	16/12/2019
S1	N/A	N/A	18/12/2019
S1	N/A	N/A	22/12/2019
S1	N/A	N/A	23/12/2019
S1	N/A	N/A	24/12/2019
S1	N/A	N/A	28/12/2019
S1	N/A	N/A	29/12/2019
S1	N/A	N/A	30/12/2019
S1	N/A	N/A	07/01/2020
S1	N/A	N/A	08/01/2020
S1	N/A	N/A	09/01/2020
S1	N/A	N/A	10/01/2020
S1	N/A	N/A	10/01/2020
S1	N/A	N/A	15/01/2020
S1	N/A	N/A	16/01/2020
S1	N/A	N/A	17/01/2020
S1	N/A	N/A	21/01/2020
S1	N/A	N/A	22/01/2020
S1	N/A	N/A	23/01/2020
S1	N/A	N/A	27/01/2020
S1	N/A	N/A	28/01/2020
S1	N/A	N/A	29/01/2020
S1	N/A	N/A	02/02/2020
S1	N/A	N/A	04/02/2020
S1	N/A	N/A	06/02/2020
S1	N/A	N/A	07/02/2020
S1	N/A	N/A	08/02/2020
S2	N/A	N/A	09/02/2020
S1	N/A	N/A	14/02/2020
S1	N/A	N/A	16/02/2020
S1	N/A	N/A	16/02/2020
S1	N/A	N/A	20/02/2020
S1	N/A	N/A	21/02/2020
S1	N/A	N/A	22/02/2020
S1	N/A	N/A	22/02/2020
S1	N/A	N/A	26/02/2020
S1	N/A	N/A	28/02/2020
S1	N/A	N/A	01/03/2020
S1	N/A	N/A	02/03/2020
S1	N/A	N/A	03/03/2020
S2	N/A	N/A	04/03/2020
S2	N/A	N/A	05/03/2020
S1	N/A	N/A	06/03/2020
S1	N/A	N/A	07/03/2020
S1	N/A	N/A	07/03/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	N/A	N/A	11/03/2020
S1	N/A	N/A	16/03/2020
S2	N/A	N/A	16/03/2020
S1	N/A	N/A	17/03/2020
S2	N/A	N/A	19/03/2020
S2	N/A	N/A	19/03/2020
S1	N/A	N/A	21/03/2020
S2	N/A	N/A	21/03/2020
S2	N/A	N/A	26/03/2020
S1	N/A	N/A	28/03/2020
S2	N/A	N/A	28/03/2020
S1	N/A	N/A	29/03/2020
S1	N/A	N/A	01/04/2020
S1	N/A	N/A	02/04/2020
S2	N/A	N/A	06/04/2020
S2	N/A	N/A	11/04/2020
S2	N/A	N/A	13/04/2020
S2	N/A	N/A	15/04/2020
S2	N/A	N/A	18/04/2020
S2	N/A	N/A	22/04/2020
S2	N/A	N/A	23/04/2020
S2	N/A	N/A	25/04/2020
S2	N/A	N/A	25/04/2020
S2	N/A	N/A	30/04/2020
S2	N/A	N/A	30/04/2020
S1	N/A	N/A	01/05/2020
S1	N/A	N/A	03/05/2020
S1	N/A	N/A	03/05/2020
S2	N/A	N/A	04/05/2020
S2	N/A	N/A	04/05/2020
S2	N/A	N/A	05/05/2020
S2	N/A	N/A	05/05/2020
S1	N/A	N/A	09/05/2020
S1	N/A	N/A	12/05/2020
S1	N/A	N/A	20/05/2020
S2	N/A	N/A	20/05/2020
S2	N/A	N/A	20/05/2020
LC	N/A	N/A	20/05/2020
S2	N/A	N/A	23/05/2020
S2	N/A	N/A	25/05/2020
S2	N/A	N/A	25/05/2020
S2	N/A	N/A	27/05/2020
S1	N/A	N/A	28/05/2020
S1	N/A	N/A	28/05/2020
S2	N/A	N/A	28/05/2020
S2	N/A	N/A	07/06/2020
S1	N/A	N/A	09/06/2020
S1	N/A	N/A	10/06/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	11/06/2020
S1	N/A	N/A	12/06/2020
S1	N/A	N/A	12/06/2020
S1	N/A	N/A	13/06/2020
S1	N/A	N/A	15/06/2020
S1	N/A	N/A	15/06/2020
S1	N/A	N/A	19/06/2020
S2	N/A	N/A	19/06/2020
S1	N/A	N/A	20/06/2020
S1	N/A	N/A	21/06/2020
S1	N/A	N/A	21/06/2020
S2	N/A	N/A	21/06/2020
S1	N/A	N/A	25/06/2020
S1	N/A	N/A	26/06/2020
S1	N/A	N/A	27/06/2020
S1	N/A	N/A	27/06/2020
S2	N/A	N/A	05/07/2020
S1	N/A	N/A	07/07/2020
LC	N/A	N/A	07/07/2020
S1	N/A	N/A	08/07/2020
S1	N/A	N/A	09/07/2020
S1	N/A	N/A	10/07/2020
S1	N/A	N/A	10/07/2020
S1	N/A	N/A	13/07/2020
S1	N/A	N/A	14/07/2020
S1	N/A	N/A	15/07/2020
S1	N/A	N/A	19/07/2020
S1	N/A	N/A	20/07/2020
S1	N/A	N/A	21/07/2020
LC	N/A	N/A	23/07/2020
S1	N/A	N/A	26/07/2020
S2	N/A	N/A	26/07/2020
S1	N/A	N/A	27/07/2020
S1	N/A	N/A	31/07/2020
S1	N/A	N/A	02/08/2020
S1	N/A	N/A	07/08/2020
S1	N/A	N/A	08/08/2020
S2	N/A	N/A	08/08/2020
S1	N/A	N/A	13/08/2020
S2	N/A	N/A	13/08/2020
S1	N/A	N/A	18/08/2020
S1	N/A	N/A	19/08/2020
S1	N/A	N/A	20/08/2020
S2	N/A	N/A	20/08/2020
S1	N/A	N/A	24/08/2020
S1	N/A	N/A	25/08/2020
S1	N/A	N/A	26/08/2020
S1	N/A	N/A	26/08/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	30/08/2020
S1	N/A	N/A	31/08/2020
S2	N/A	N/A	31/08/2020
S1	N/A	N/A	01/09/2020
S1	N/A	N/A	02/09/2020
S1	N/A	N/A	03/09/2020
LC	N/A	N/A	04/09/2020
S1	N/A	N/A	06/09/2020
S1	N/A	N/A	06/09/2020
S2	N/A	N/A	07/09/2020
S2	N/A	N/A	09/09/2020
RCM	09/09/2020	13/09/2020	11/09/2020
S1	N/A	N/A	13/09/2020
S1	N/A	N/A	13/09/2020
S1	N/A	N/A	18/09/2020
S1	N/A	N/A	19/09/2020
S1	N/A	N/A	19/09/2020
S1	N/A	N/A	24/09/2020
S1	N/A	N/A	25/09/2020
S1	N/A	N/A	25/09/2020
S2	N/A	N/A	29/09/2020
S1	N/A	N/A	30/09/2020
S1	N/A	N/A	01/10/2020
S1	N/A	N/A	02/10/2020
S1	N/A	N/A	02/10/2020
S2	N/A	N/A	04/10/2020
S2	N/A	N/A	04/10/2020
S2	N/A	N/A	05/10/2020
S1	N/A	N/A	12/10/2020
S1	N/A	N/A	13/10/2020
S1	N/A	N/A	18/10/2020
S1	N/A	N/A	19/10/2020
S1	N/A	N/A	19/10/2020
S1	N/A	N/A	24/10/2020
S1	N/A	N/A	25/10/2020
S1	N/A	N/A	25/10/2020
S1	N/A	N/A	29/10/2020
S2	N/A	N/A	30/10/2020
S1	N/A	N/A	31/10/2020
S1	N/A	N/A	01/11/2020
RCM	31/10/2020	04/11/2020	02/11/2020
S2	N/A	N/A	06/11/2020
S1	N/A	N/A	09/11/2020
S1	N/A	N/A	10/11/2020
RCM	04/11/2020	16/11/2020	10/11/2020
S1	N/A	N/A	11/11/2020
S2	N/A	N/A	11/11/2020
S1	N/A	N/A	12/11/2020

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	16/11/2020
S1	N/A	N/A	17/11/2020
S1	N/A	N/A	18/11/2020
S1	N/A	N/A	18/11/2020
S1	N/A	N/A	22/11/2020
S1	N/A	N/A	23/11/2020
S1	N/A	N/A	24/11/2020
S1	N/A	N/A	24/11/2020
S1	N/A	N/A	28/11/2020
S1	N/A	N/A	29/11/2020
S1	N/A	N/A	30/11/2020
S1	N/A	N/A	30/11/2020
S2	N/A	N/A	05/12/2020
S1	N/A	N/A	08/12/2020
S1	N/A	N/A	09/12/2020
S1	N/A	N/A	11/12/2020
S1	N/A	N/A	11/12/2020
S1	N/A	N/A	12/12/2020
S1	N/A	N/A	16/12/2020
S1	N/A	N/A	17/12/2020
S1	N/A	N/A	18/12/2020
S1	N/A	N/A	22/12/2020
S1	N/A	N/A	23/12/2020
S1	N/A	N/A	24/12/2020
S1	N/A	N/A	28/12/2020
S1	N/A	N/A	29/12/2020
S2	N/A	N/A	02/01/2021
S1	N/A	N/A	12/01/2021
S1	N/A	N/A	16/01/2021
S1	N/A	N/A	17/01/2021
S1	N/A	N/A	21/01/2021
S1	N/A	N/A	22/01/2021
S1	N/A	N/A	23/01/2021
S1	N/A	N/A	27/01/2021
S1	N/A	N/A	28/01/2021
S2	N/A	N/A	04/02/2021
S2	N/A	N/A	06/02/2021
S1	N/A	N/A	07/02/2021
S1	N/A	N/A	08/02/2021
S1	N/A	N/A	10/02/2021
S1	N/A	N/A	15/02/2021
S1	N/A	N/A	16/02/2021
S1	N/A	N/A	16/02/2021
S2	N/A	N/A	19/02/2021
S1	N/A	N/A	20/02/2021
S2	N/A	N/A	21/02/2021
S2	N/A	N/A	21/02/2021
LC	N/A	N/A	23/02/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S2	N/A	N/A	24/02/2021
S1	N/A	N/A	27/02/2021
S1	N/A	N/A	28/02/2021
S1	N/A	N/A	01/03/2021
S1	N/A	N/A	07/03/2021
S1	N/A	N/A	08/03/2021
S1	N/A	N/A	08/03/2021
S2	N/A	N/A	08/03/2021
S2	N/A	N/A	16/03/2021
S2	N/A	N/A	18/03/2021
S2	N/A	N/A	18/03/2021
LC	N/A	N/A	20/03/2021
S2	N/A	N/A	21/03/2021
S2	N/A	N/A	23/03/2021
S1	N/A	N/A	01/04/2021
S1	N/A	N/A	02/04/2021
S2	N/A	N/A	02/04/2021
S1	N/A	N/A	06/04/2021
S1	N/A	N/A	06/04/2021
S2	N/A	N/A	06/04/2021
S1	N/A	N/A	07/04/2021
S1	N/A	N/A	07/04/2021
S2	N/A	N/A	07/04/2021
S2	N/A	N/A	15/04/2021
S2	N/A	N/A	15/04/2021
S2	N/A	N/A	17/04/2021
S2	N/A	N/A	17/04/2021
S2	N/A	N/A	20/04/2021
S2	N/A	N/A	20/04/2021
S2	N/A	N/A	22/04/2021
S2	N/A	N/A	25/04/2021
S2	N/A	N/A	27/04/2021
S1	N/A	N/A	01/05/2021
S2	N/A	N/A	17/05/2021
S2	N/A	N/A	30/05/2021
S2	N/A	N/A	06/06/2021
S1	N/A	N/A	10/06/2021
S1	N/A	N/A	11/06/2021
S2	N/A	N/A	14/06/2021
S2	N/A	N/A	16/06/2021
S1	N/A	N/A	20/06/2021
S2	N/A	N/A	21/06/2021
S1	N/A	N/A	27/06/2021
S1	N/A	N/A	28/06/2021
S1	N/A	N/A	28/06/2021
LC	N/A	N/A	02/07/2021
S2	N/A	N/A	04/07/2021
S2	N/A	N/A	06/07/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	11/07/2021
S1	N/A	N/A	11/07/2021
S1	N/A	N/A	14/07/2021
S2	N/A	N/A	16/07/2021
S1	N/A	N/A	21/07/2021
S1	N/A	N/A	22/07/2021
S1	N/A	N/A	22/07/2021
S2	N/A	N/A	24/07/2021
S2	N/A	N/A	24/07/2021
S2	N/A	N/A	26/07/2021
LC	N/A	N/A	26/07/2021
S2	N/A	N/A	27/07/2021
S2	N/A	N/A	31/07/2021
S1	N/A	N/A	02/08/2021
S2	N/A	N/A	08/08/2021
S1	N/A	N/A	15/08/2021
S1	N/A	N/A	15/08/2021
S2	N/A	N/A	15/08/2021
S1	N/A	N/A	19/08/2021
S2	N/A	N/A	23/08/2021
S1	N/A	N/A	27/08/2021
S1	N/A	N/A	27/08/2021
S1	N/A	N/A	31/08/2021
S2	N/A	N/A	02/09/2021
S2	N/A	N/A	06/09/2021
S1	N/A	N/A	07/09/2021
S2	N/A	N/A	07/09/2021
S2	N/A	N/A	09/09/2021
S2	N/A	N/A	15/09/2021
S1	N/A	N/A	19/09/2021
S1	N/A	N/A	20/09/2021
S2	N/A	N/A	22/09/2021
S1	N/A	N/A	24/09/2021
S2	N/A	N/A	27/09/2021
S1	N/A	N/A	01/10/2021
S2	N/A	N/A	04/10/2021
S2	N/A	N/A	04/10/2021
S2	N/A	N/A	05/10/2021
S1	N/A	N/A	07/10/2021
S1	N/A	N/A	07/10/2021
LC	N/A	N/A	07/10/2021
S1	N/A	N/A	14/10/2021
S1	N/A	N/A	18/10/2021
S1	N/A	N/A	26/10/2021
S1	N/A	N/A	26/10/2021
S1	N/A	N/A	30/10/2021
LC	N/A	N/A	03/11/2021
S2	N/A	N/A	07/11/2021

Sensor	Reference Image Date	Secondary Image Date	Middle Date Used for Graphing/Analysis
S1	N/A	N/A	11/11/2021
S1	N/A	N/A	18/11/2021
S1	N/A	N/A	19/11/2021
S1	N/A	N/A	23/11/2021
S1	N/A	N/A	30/11/2021
S2	N/A	N/A	04/12/2021
S2	N/A	N/A	04/12/2021
S2	N/A	N/A	04/12/2021
S2	N/A	N/A	06/12/2021
S1	N/A	N/A	09/12/2021
S1	N/A	N/A	12/12/2021
S1	N/A	N/A	13/12/2021
S1	N/A	N/A	17/12/2021
S1	N/A	N/A	29/12/2021
S1	N/A	N/A	22/01/2022
LC	N/A	N/A	25/01/2022
LC	N/A	N/A	29/01/2022
S1	N/A	N/A	30/01/2022
S2	N/A	N/A	14/02/2022
S2	N/A	N/A	24/02/2022
S2	N/A	N/A	27/02/2022
S1	N/A	N/A	02/03/2022
S2	N/A	N/A	04/03/2022
S2	N/A	N/A	14/03/2022
S2	N/A	N/A	16/03/2022
S2	N/A	N/A	16/03/2022
S2	N/A	N/A	19/03/2022
S2	N/A	N/A	15/04/2022
S2	N/A	N/A	15/04/2022
S2	N/A	N/A	20/04/2022
S2	N/A	N/A	23/04/2022
S2	N/A	N/A	25/04/2022
S2	N/A	N/A	04/05/2022
S2	N/A	N/A	04/05/2022
LC	N/A	N/A	02/06/2022
S2	N/A	N/A	04/08/2022
S2	N/A	N/A	04/08/2022
S2	N/A	N/A	02/09/2022
S1	N/A	N/A	01/10/2022
S2	N/A	N/A	04/10/2022