



Ice Mass & Sea Level Unit 3: GROUP B Ice Velocity Group

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You have been provided with a map of Greenland illustrating ice velocities in 2008–2009. The four study sites on which you will focus your attention are circled on the map.

Part 1: Greenland ice sheet velocity

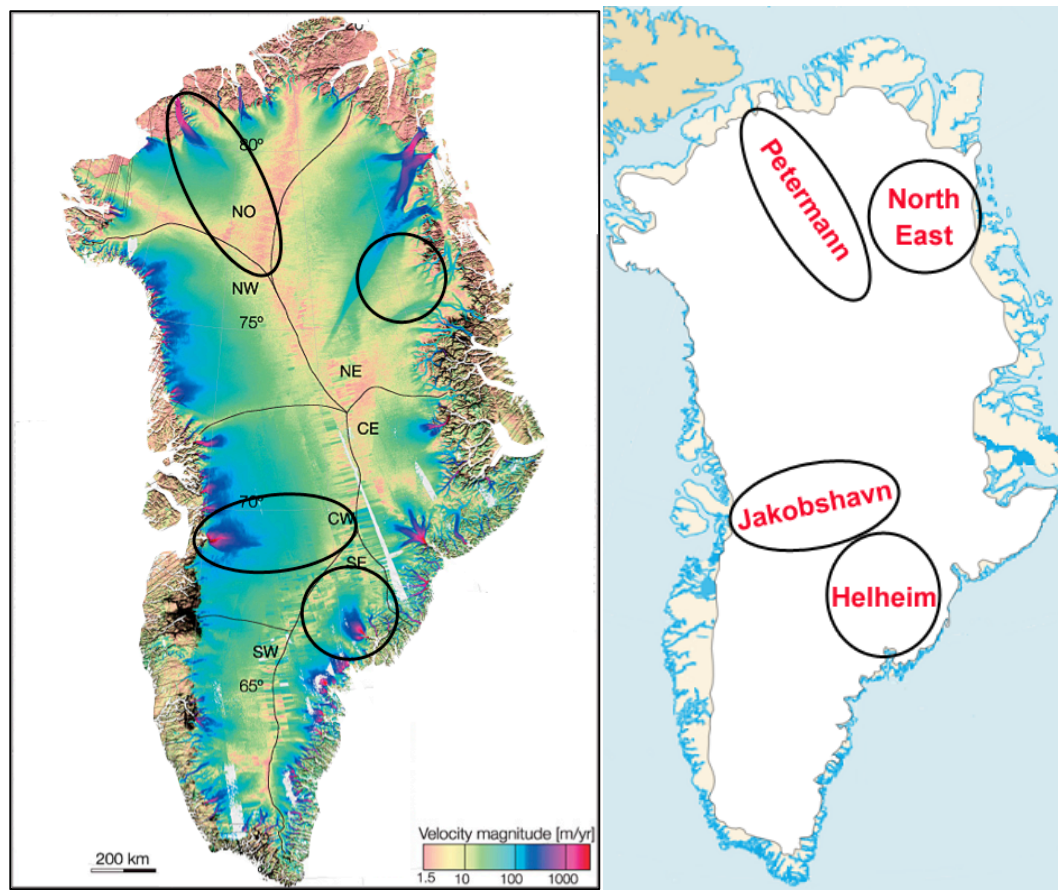


Figure 1: Left: Greenland ice velocity, created using multiple InSAR scenes between 2008–2009 (modified from Rignot and Mouginot, 2012). Right: Greenland map with four study area names.

(1) According to the color scale, what is the range of ice velocities on the map? Which color is used to designate the slowest moving ice? Which color is used to designate the fastest moving ice?

(2) Overall, do ice velocities seem to be greatest in the interior of Greenland or near the coast? Suggest a reason for this observation.

Part 2: Greenland glacier velocity

The map that you just studied includes ice sheet-wide data from a relatively short period of time. It is also useful to study how, if at all, ice velocities change over longer timescales. Three of the four study sites circled on the map are along the coast: the northernmost study site is Petermann Glacier, the study site in the west is Jakobshavn Isbræ, and the study site on the east coast is Helheim Glacier. You have been provided with ice velocity maps for each of these coastal study sites.

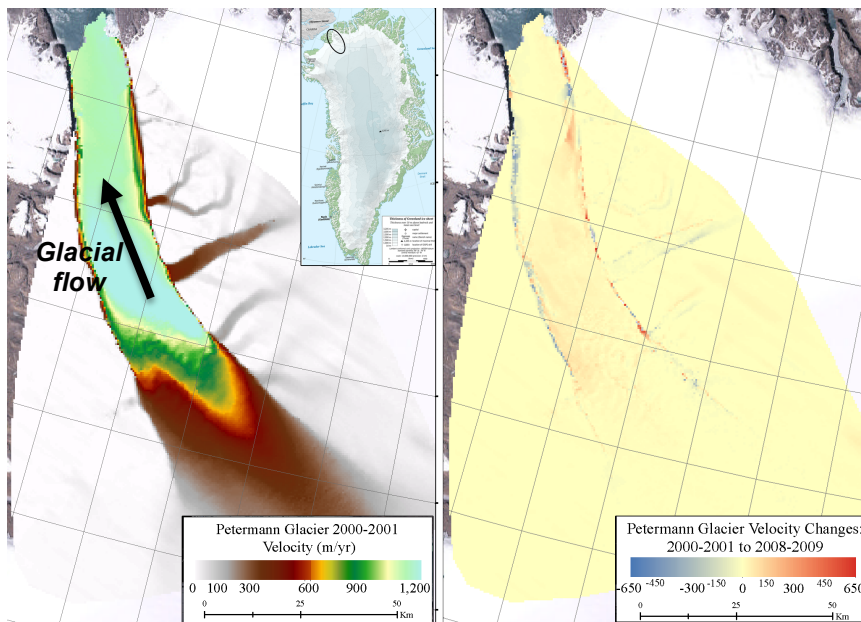


Figure 2: Petermann Glacier ice velocity in 2000–2001 (left) and the difference in ice velocity from 2000–2001 and 2008–2009 (right). Maps are created using InSAR-derived velocity maps freely available at the NSIDC (<http://nsidc.org/data/nsidc-0478/>) and described in Joughin et al., 2010.

The maps above show the last ~80 km (~50 miles) of Petermann Glacier before the glacier enters the ocean (shown in black). The elongated shape is the trunk of Petermann Glacier, but also note that several tributary glaciers feed into the main glacier. The map on the left illustrates the velocity of the glacier in 2000–2001 calculated from InSAR scenes. The map on the right shows how the glacier's velocity changed between 2000–2001 and 2008–2009. Start by looking at the left map.

(3) According to the data, were all parts of the Petermann Glacier moving at the same speed in 2000–2001? If not, what was the approximate range of speeds that the glacier exhibited?

(4) In 2000–2001, how did the velocity at the front of the glacier compare to areas of the glacier further upslope?

(5) Next, take a look at the map on the right.

- What color is used to represent areas whose velocity increased between 2000–2001 and 2008–2009?
- What color is used to represent areas whose velocity decreased between 2000–2001 and 2008–2009?
- What color is used to represent areas that showed no change in velocity between these two time periods?

(6) Describe where on the glacier you observe the greatest increases in velocity (acceleration).

(7) How did the velocity at the tongue (very end) of the glacier change over the 8-year time period measured?

(8) Overall, do you see more red or blue on Petermann Glacier? Does this indicate that more areas of Petermann Glacier sped up or slowed down during the 8-year time period?

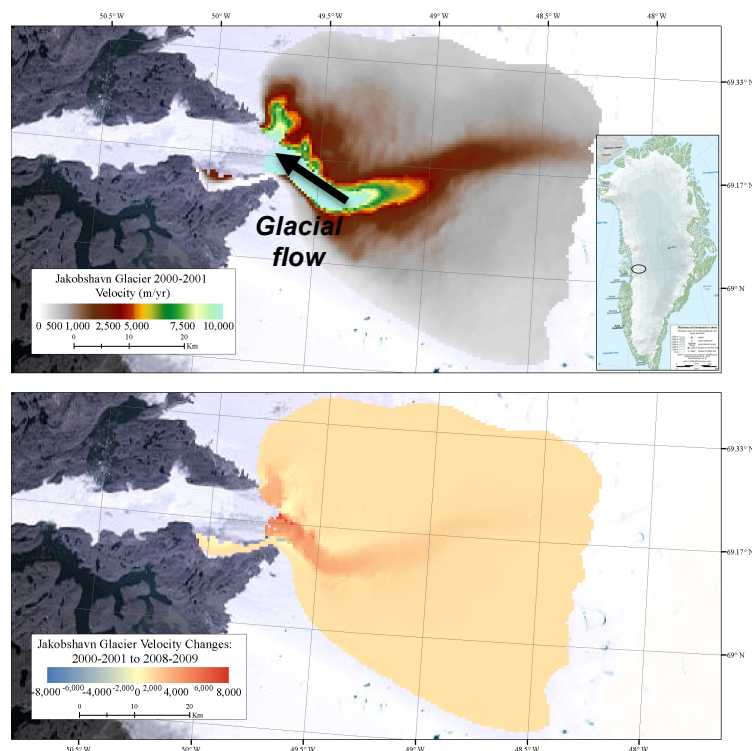


Figure 3: Jakobshavn Isbræ ice velocity in 2000–2001 (top) and the difference in ice velocity from 2000–2001 and 2008–2009 (bottom). Maps are created using InSAR-derived velocity maps freely available at the NSIDC (<http://nsidc.org/data/nsidc-0478/>) and described in Joughin et al., 2010.

The maps above show a portion of Jakobshavn Isbræ before the glacier enters the ocean (shown in black). “Isbræ” means *glacier* in Danish (many Greenlandic locations have Danish names due to the history of Danish explorers and settlers in Greenland). The elongated shape is the trunk of Jakobshavn Isbræ, which moves downslope from east to west. The map on the left illustrates the velocity of the glacier in 2000–2001 taken from InSAR measurements. The map on the right shows how the glacier’s velocity changed between 2000–2001 and 2008–2009. Start by looking at the map on the left.

(9) According to the data, which glacier moves more rapidly: Jakobshavn or Petermann? How much faster?

(10) In 2000–2001, how did the velocity of the western end of the glacier compare to areas of the glacier further upslope?

(11) Overall, do you see more red or blue on Jakobshavn Isbræ? Does this indicate that more areas of Jakobshavn Isbræ sped up or slowed down during the 8-year time period?

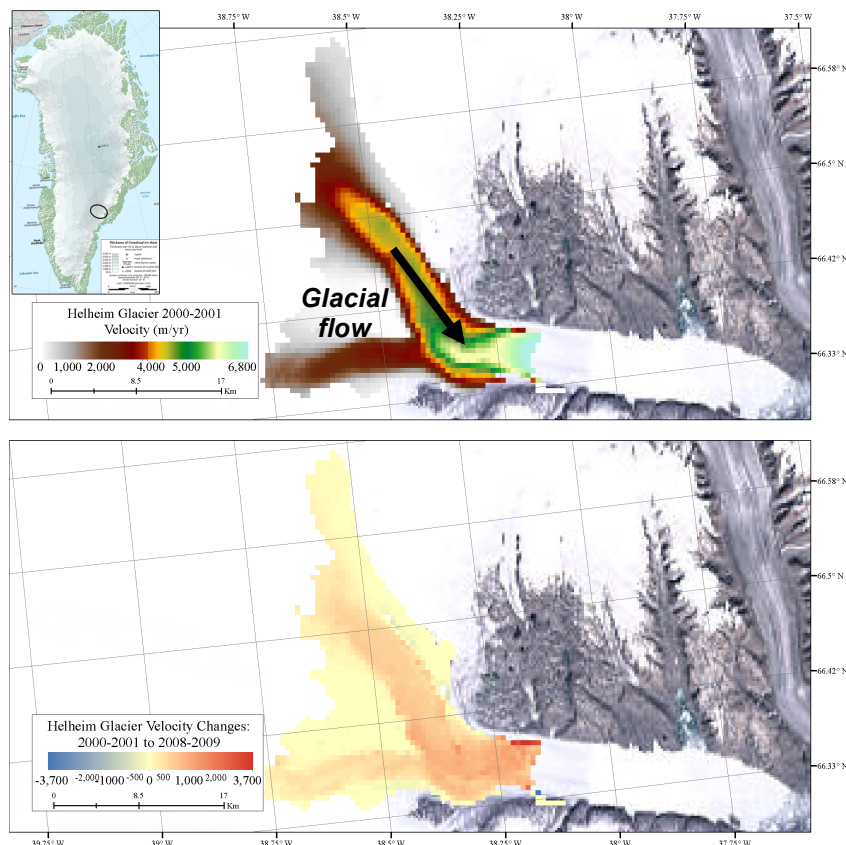


Figure 4: Helheim Glacier ice velocity in 2000–2001 (top) and the difference in ice velocity from 2000–2001 and 2008–2009 (bottom). Maps are created using InSAR-derived velocity maps freely available at the NSIDC (<http://nsidc.org/data/nsidc-0478/>) and described in Joughin et al., 2010.

The maps above show a portion of Helheim Glacier. The elongated shape is the trunk of the glacier, which moves downslope and ultimately enters the ocean (shown in black) from east to west. The top map illustrates the velocity of the glacier in 2000–2001 taken from InSAR measurements. The bottom map shows how the glacier's velocity changed between 2000–2001 and 2008–2009.

(12) In 2000–2001, which area of Helheim was moving faster: the eastern portion or the areas of the glacier further upslope?

(13) Using the lower map:

- As you move toward the ocean (from west to east), do the velocity data indicate that the glacier sped up or slowed down over the 8-year period in question?
- Find the area of Helheim that experienced the greatest change in velocity during the 8-year period. Did this area speed up or slow down? By how much?

(14) Overall, are the ice velocity trends that you observe for Helheim most similar to the Petermann ice velocity data or the Jakobshavn ice velocity data? Briefly explain your answer.

(15) Consider the images that you have just studied. Where does the moving ice ultimately wind up? How might this change the characteristics of a particular glacier?

Part 3: Greenland mass loss predictions

Now that you have looked at some Greenland ice velocity data, it is time to predict where you'd expect the greatest changes in ice mass to occur. An increase in ice mass indicates that a particular glacier is growing (and decelerating). In contrast, a glacier that exhibits a decrease in ice mass is shrinking (and accelerating).

Instructions:

- Notice that on your blank map labeled “prediction,” you have been given a scale bar with different colors representing large decrease in ice mass, slight decrease in ice mass, no change in ice mass, slight increase in ice mass, and large increase in ice mass. Using this scale, please shade the four study sites circled on the map to reflect your predictions about how much relative ice mass change has occurred in these areas between (approximately) 2000 and 2009.
- You have an identical blank map labeled “evidence.” On this map, please make some written notes near the Petermann, Jakobshavn, and Helheim study sites about the *evidence* that you used to make your predictions. For example, what did you notice about your Petermann ice velocity data? What did your ice velocity data look like for Helheim? You can use words/phrases like fast, slow, speeding up, slowing down, consistent speed, etc. In making these predictions, it is important to think about the fate of moving ice and how ice movement at a glacier's trunk can influence the glacier's mass. This map should support/justify the predictions that you made.
- When you are finished with these two maps, you should be able to present them to someone in another group and explain to him/her your predictions for changes in ice mass and how you came up with your predictions.

(11) How certain are you in your predictions? If you are uncertain, which additional pieces of information would be useful in making your predictions?

