Deformation of a Rift in Ross Ice Shelf

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Background

The Ross Ice Shelf in Antarctica is a sheet of ice on land which extends over the ocean (Figure 1), and has a cold water cavity beneath it (Figure 2). This particular shelf has a few rifts apparent from satellite images. One such rift is of particular interest based on data from nearby seismic arrays (Figure 3).

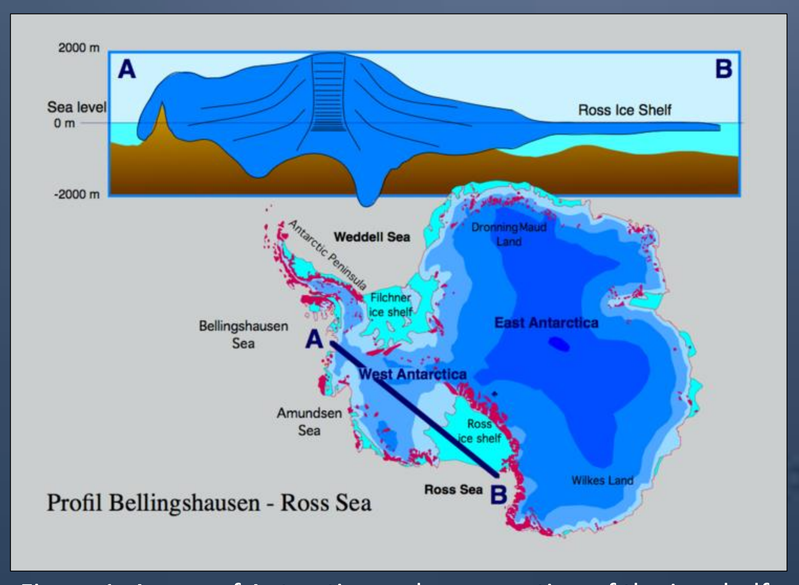

Figure 1: A map of Antarctica and cross section of the ice shelf

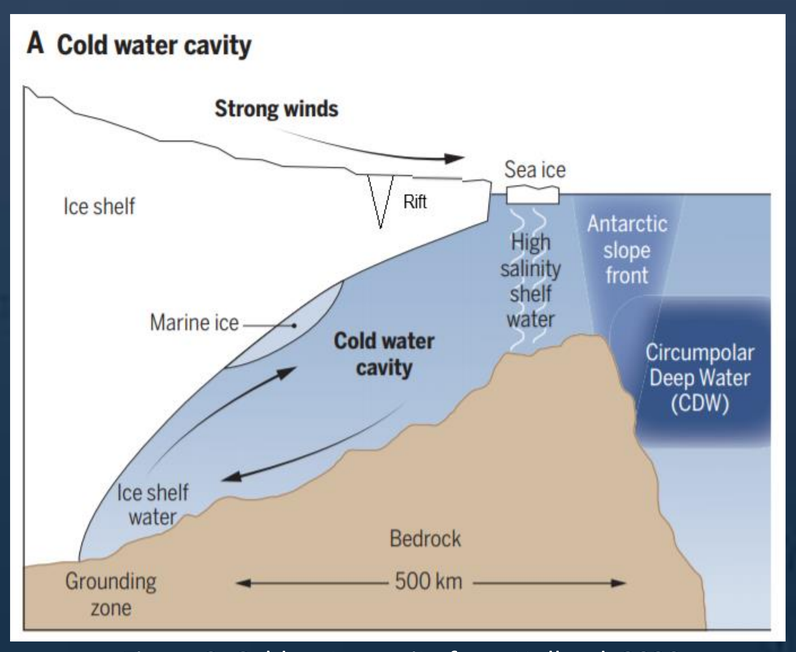

Figure 2: Cold water cavity from Holland, 2020

Figure 3: Satellite image of the fissure taken on March 3rd, 2020

Data and Analysis

Figures 4 and 5 show the deformation of the rift. These figures show three pairs of images from 2017 to 2020. The dilatation images show volume change, with red being compression and blue being extension, and the shear images show lateral motion. These image pairs show a change in the area where deformation is occurring. The first image pairs show deformation concentrated toward the top of the rift. The second pairs show a concentration of deformation in the middle of the rift. The last pairs show the deformation toward the bottom of the rift. Therefore, over time the deformation has shifted downward. The internal areas of the fracture confirm that it is a rift in the ice.

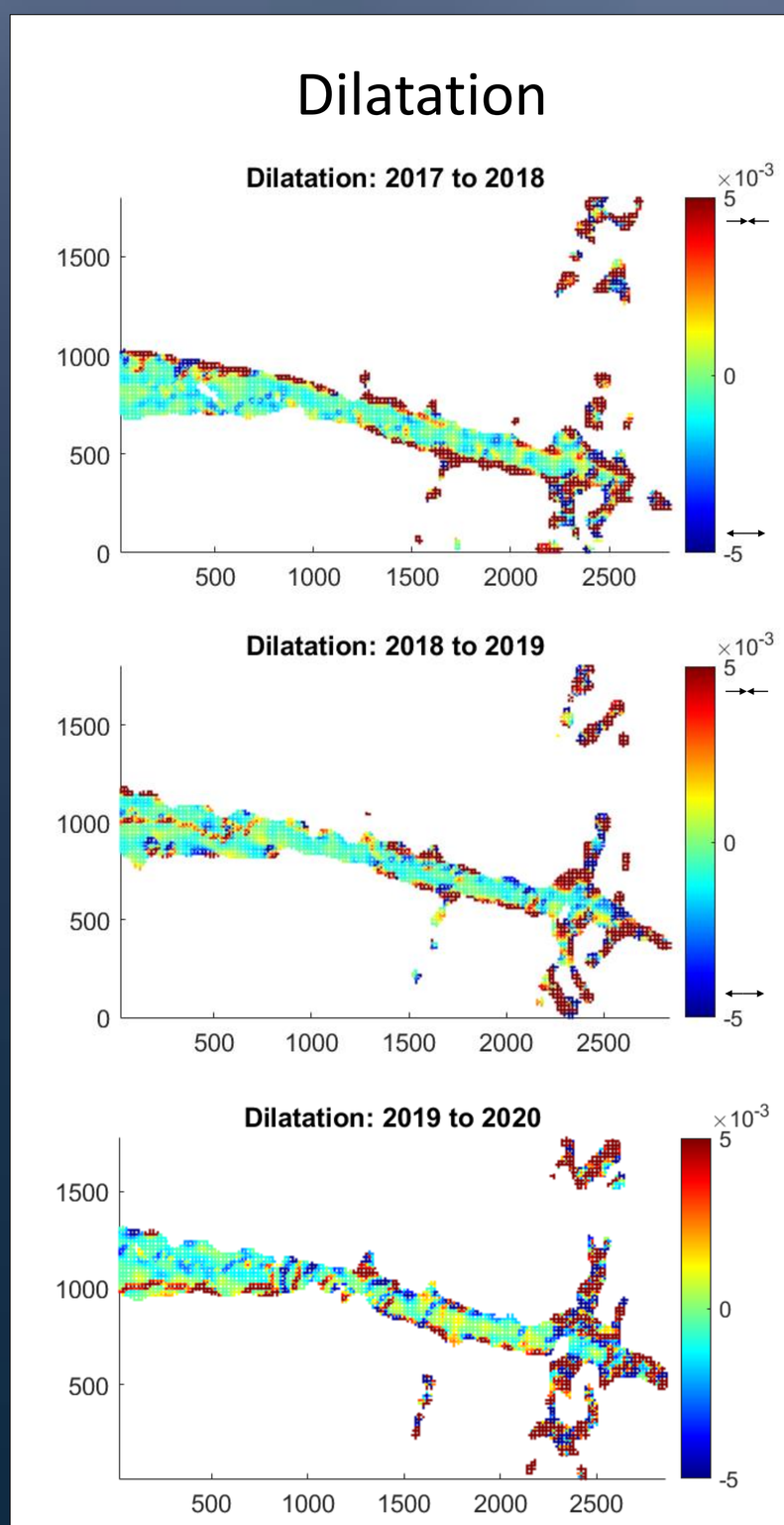

Figure 4: Three image pairs showing dilatation

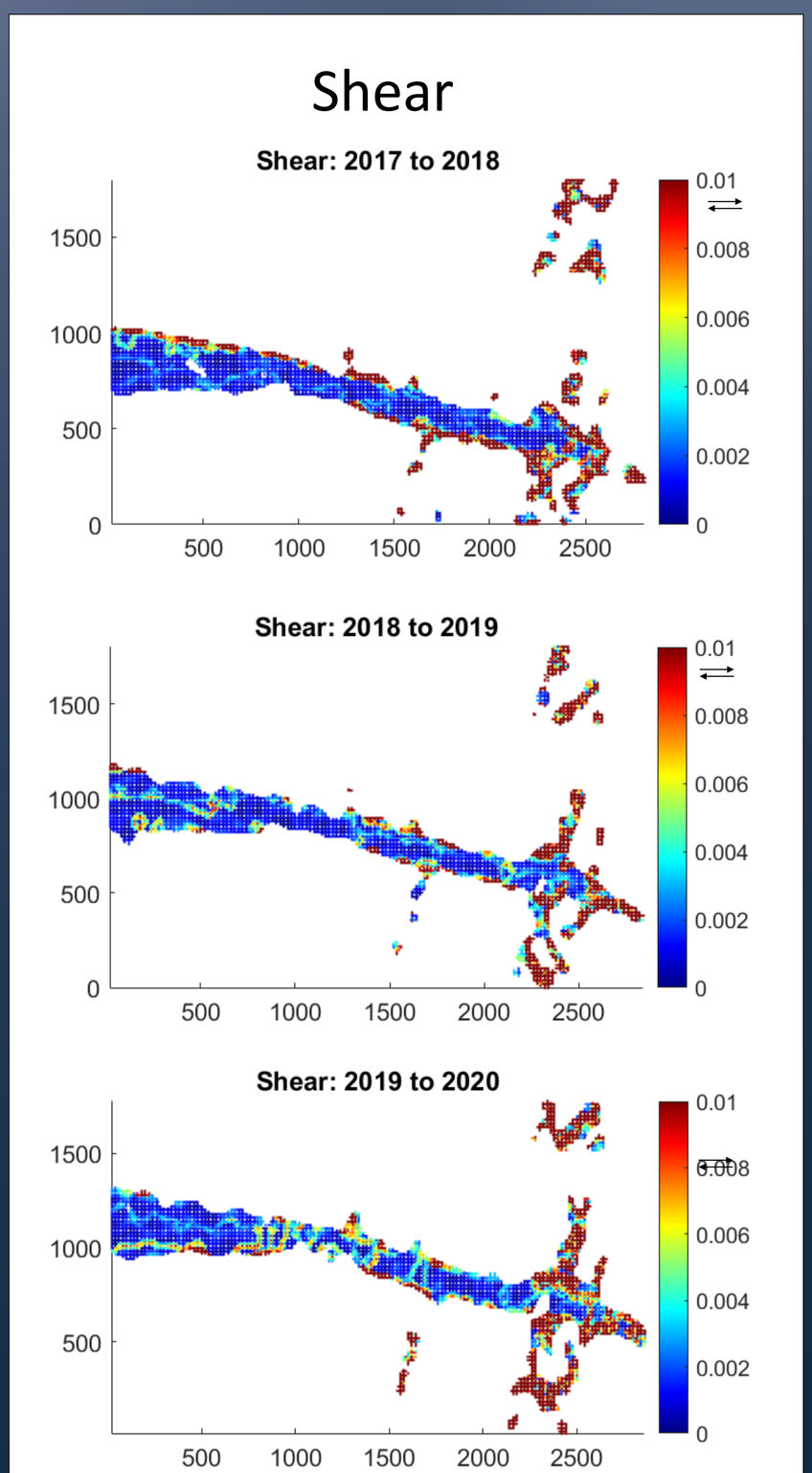

Figure 5: Three image pairs showing shear motion

Purpose and Methodology

The purpose of this research is to determine if there is any surface deformation, or change of shape, occurring within the rift. To begin, Sentinel 2 satellite images of the fissure were downloaded from Google Earth Engine. The dates of these images ranged from 2017 to 2020. Pairs of images from about a year apart were then analyzed. The pairs of images were converted into a usable format, adjusted, and cropped. Then, a pixel tracking method was applied in order to determine the internal movement of the rift from year to year. Finally, outputs were generated in the forms of displacement, strain rate, dilatation, rotation, and shear motion.

Conclusions

In the future, other fractures on the Ross Ice Shelf could be analyzed to determine if they exhibit similar pattens of deformation. Other future work could include studying the currents of the Southern Ocean to determine if the flow of warm water might change the cold water cavity beneath Ross Ice Shelf (Figure 2). This could also include studying the water circulation in the cavity to see if it has any impact on the deformation inside the rift.

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References: Milliner, C., and A. Donnellan (2020). Using Daily Observations from Planet Labs Satellite Imagery to Separate the Surface Deformation between the 4 JulyMw6.4Foreshock and 5 JulyMw7.1 Mainshock during the 2019 Ridgecrest Earthquake Sequence, Seismol. Res. Lett.XX,1–12,doi:10.1785/0220190271. David M. Holland, Keith W Nicholls, Aurora Basinski (2020). The Southern Ocean and its interaction with the Antarctic Ice Sheet. Hannes Grobe 21:51, 12 August 2006 (UTC), Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany. Wikimedia Commons