Landsat Multispectral imagery analysis of Hiawatha Crater, Greenland

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Abstract

Faculty and students at Elizabeth City State University have investigated the distal ejecta associated with a possibly fragmented, asteroid or comet that may have impacted the Laurentide ice sheet, contributing to a millennium long climatic cooling known as the Younger Dryas climate change. A large, apparently young crater recently discovered beneath Hiawatha Glacier in northwest Greenland might be associated with this event. Some evidence of a thermal anomaly beneath the ice has been reported. Moulin ‘chimneys’ have been observed near the Glacier’s margin but none yet through the thicker ice covering the crater’s center. It may be possible for evidence of thermal activity to survive the ≈900-meter ascent to the surface through a yet to be detected moulin. Students will examine archived satellite thermal imaging of the Hiawatha Glacier overlying the crater for any surface expression of a possible sub-glacial thermal anomaly and report their results.

Methodology

The overall research consisted of the students learning to use two specific software packages for the accomplishment of analyzing the area encompassing the Hiawatha Crater as well as its surroundings. The first software package being utilized was MultiSpec, the second being ENVI, both providing analysis tools for multispectral images. MultiSpec is Freeware while ENVI is commercial software.

Software

- ENVI
- MultiSpec

Data

Data for this research originates from datasets that were being hosted on the Earth Explorer website from satellites Landsat 5, 7, and 8. The datasets were collected in 1987, 1990, and 2018. The images of each dataset can contain a variety of Bands that emphasize various portions of the electromagnetic spectrum, which in turn emphasizes different details within each image.

Example of Region Investigated

To observe the Hiawatha Crater for any alterations that may have occurred as a result or partly due to phenomena concerning climate change. To examine such, distinct areas of the Hiawatha crater and sometimes the surrounding landscape were examined to observe whether there were any noticable differences across the decades from which the data was collected.

Example of Region Investigated (Continued)

Subject 1 (August 14th, 1987)

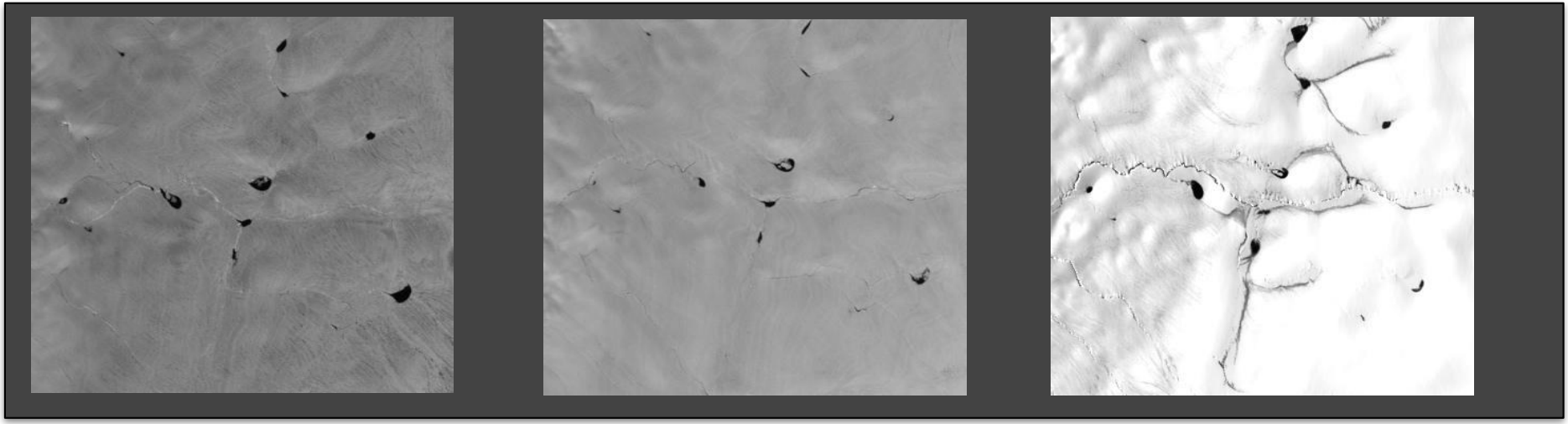
Subject 2 (July 22nd, 1999)

Subject 3 (July 26th, 2018)

Example of Region Investigated (Continued)

Subject 1 displays the start of the observation of the peculiar feature of the Hiawatha crater. From Subject 1 to Subject 2 there is a noticeable shift in the position of the ice from the right to the left. The feature in Subject 1 and 2 seems to be moving from the surrounding surface on the right to the surrounding landscape on the left. Comparing Subject 2 to Subject 3 shows that the feature has merged with the landscape on the right.

Melt Lakes



Subject 1 (August 14th, 1987)

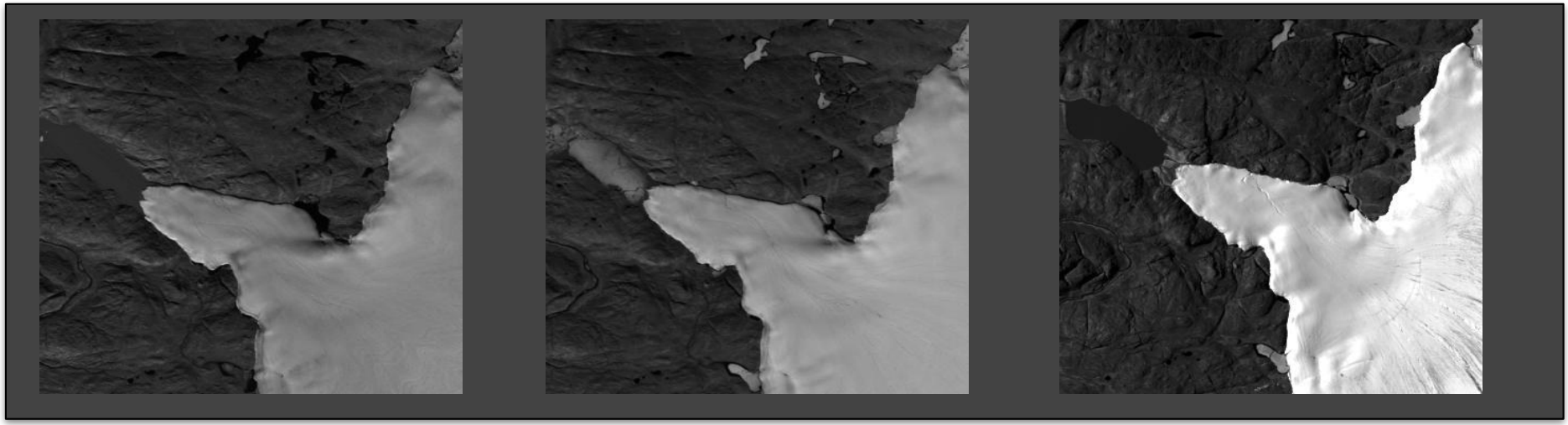
Subject 2 (July 22nd, 1999)

Subject 3 (July 26th, 2018)

Melt Lakes (Continued)

The melt lakes from Subject 1 to Subject 2 shows a significant decrease in the numerous lakes throughout the images. From Subject 2 to Subject 3 there was a noticeable increase in the size of the features. Subject 3 shows some identical characteristics to Subject 1 but several melt lakes did not return to their original size. Although, Subject 1 was obtained three weeks later in the summer so more meltwater may have collected.

Glacier’s Leading Edge



Subject 1 (August 14th, 1987)

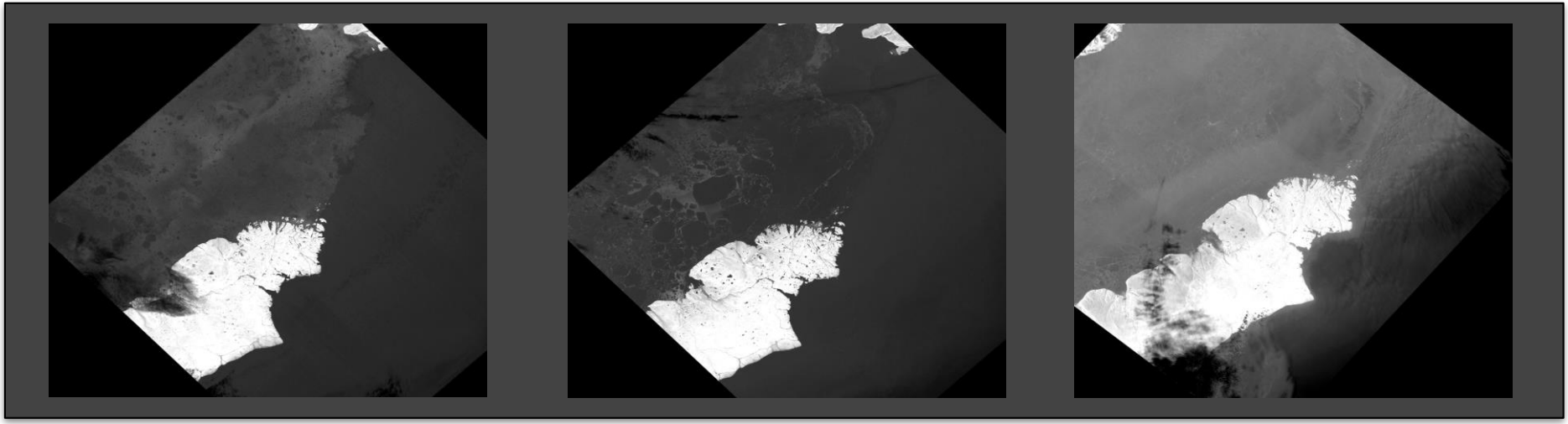
Subject 2 (July 22nd, 1999)

Subject 3 (July 26th, 2018)

Glacier’s Leading Edge (Continued)

The difference in the imagery may be due to the simple differences in the weather (it was colder in July of 1999 than August of 1987 and July of 2018.) The glacier leading edge has not advance or retreated during the thirty years of observation.

Thermal Imagery



Subject 1 (August 14th, 1987)

Subject 2 (July 22nd, 1999)

Subject 3 (July 26th, 2018)

Thermal Imagery (Continued)

There were no apparent thermal anomalies over the period of thirty years.

Conclusion

The current data is insufficient to make any definite conclusions as to whether the Hiawatha crater is being affected by climate change. More data would have to be collected and analyzed before any such argument could be made.

Future Work

- Collection of a significant amount of data to allow for examination of features of the Hiawatha crater and surrounding area for evidence of being affected by global warming.
- Training of future teams to become skilled in using software such as MultiSpec or Envi to examine multispectral images of the data.
    - Ensuring that future teams have the proper background and information to be able to effectively work with in the research and enable its progression.
- Implementation of programs to assist in identifying features of interest in the multispectral images.

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Questions?