Initial Development of a WebXR Platform for Ice Penetrating Radar Data, to Improve our Understanding of Polar Ice Sheets

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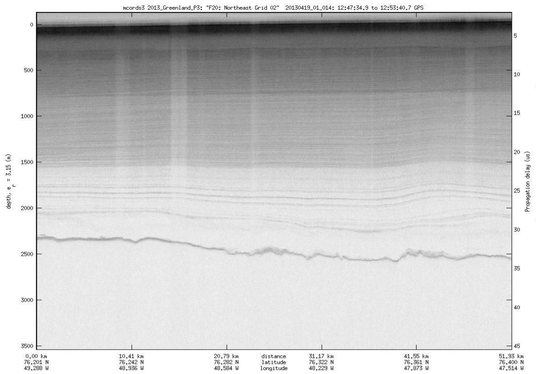


Ice Sheets

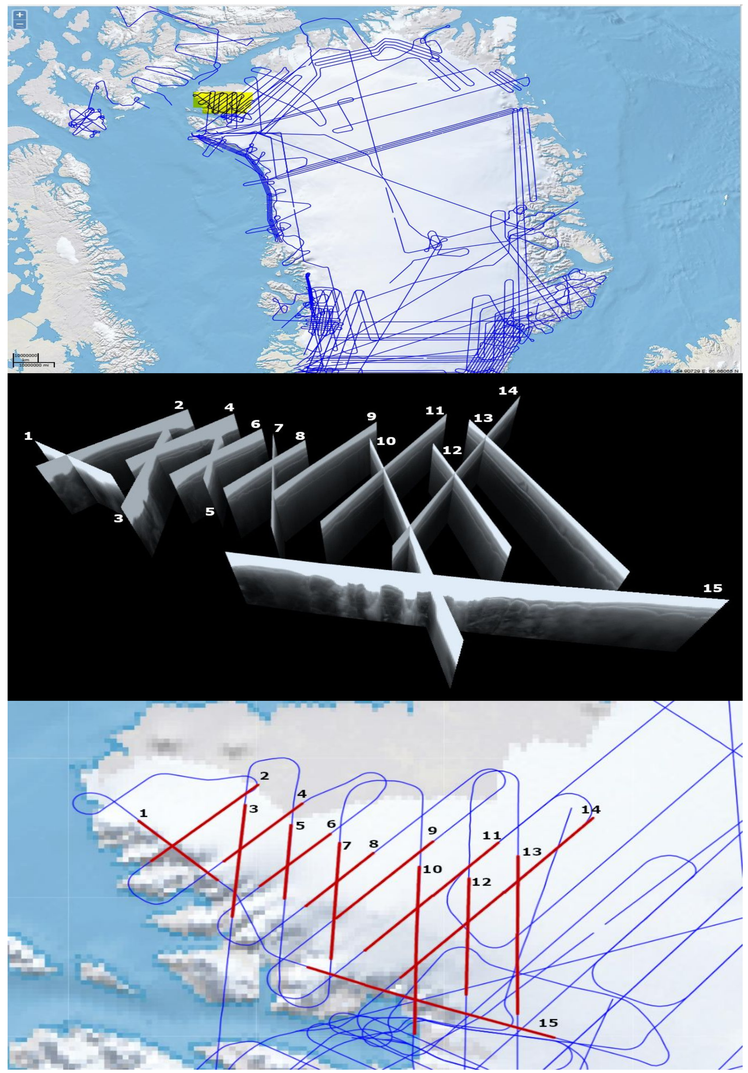
- Earth's ice sheets contain a historical record of events.
  - Volcanic eruptions, Melt, and other properties.
- CReSIS provides ice-penetrating radar imagery, collected from flights over Greenland and Antarctica
  - Each layer has different electrical properties which are reflected differently in the radar

Project Objectives

- Earth's ice sheets are the largest source of uncertainty in models of future sea level rise and the topology of ice layers within the Ice Sheets contain information about the physical processes that govern ice dynamics.
- Topology of Greenland's ice layers is captured in ice-penetrating radar imagery, collected from both airborne and ground-based platforms which is then visualized in 3D space as fence diagrams.
  - These diagrams are contained to the 2D surface they are rendered on.
- We anticipate that hypothesis generation by polar scientists will be improved in speed and quality with an immersive view.

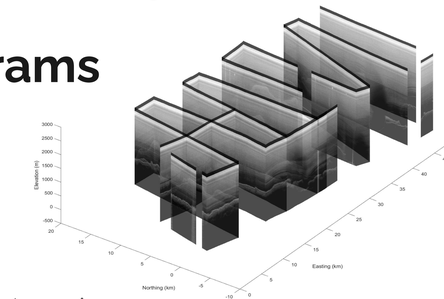
Spatial Positioning

- Elevation varies across radar images, therefore, we process each image to ensure a common elevation across each row of pixels.
  - Rounding errors are generally indistinguishable to the eye.
- The latitude and longitude of each radar slice is transformed into the desired cartesian coordinate space of virtual reality.
- By setting the radar images at the midpoint of each segment we could then extend the image to clever the appropriate distance and rotate to the calculated slope.
- Two locations were chosen and radar images were taken and provide the basis of our initial development



Fence Diagrams

Radar images are captured from overlapping flight paths in many areas of Greenland. The example to the right shows a Matlab fence diagram of radar data collected at Hercules Dome, Antarctica.



UI in WebXR

- Using A-Frame, we were able to leverage a wide range of community-developed tools for spatial navigation.
- WebXR voids making users (e.g. glaciologists) compile or install software.
- WebXR is platform independent, so relatively agnostic to rapidly developing technology (we anticipate it will "just work" on Meta Quest 3, Apple Vision Pro, etc)
- Developed controls which allow scientists to scale, rotate and move through the world with the handheld controllers (similar to touch-screen maps)
- Transforming the world as pairs of points are clicked and dragged in three dimensions allowing for movement through the fence diagram in an intuitive way and allowing the movement allowed by a headset.

Future Work

- Initial development of this system seems to suggest promising results for the utility of an XR visualization of fence diagrams.
- Developing controls for such layer annotation, combined with visualizations of automated annotation, would further strengthen the understanding of ice sheet flow.
- In addition to the capabilities of the software we also plan to develop a series of tasks and questions to best evaluate the efficacy of such a system.