

Sediments and sea ice deformation: UAV observations of sea ice topography evolution throughout the melt season

Madison Harasyn¹ (harasynm@myumanitoba.ca), Dustin Isleifson^{1 2}, Ryan Galley¹ & David Barber¹

¹Centre for Earth Observation Science, University of Manitoba, Winnipeg

²Department of Electrical & Computer Engineering, University of Manitoba, Winnipeg



University of Manitoba



Motivation

- Sediments are hypothesized to enhance the rate of sea ice surface melt by decreasing surface albedo
- Enhanced surface melt influences the sea ice surface topography/roughness, as well as increasing surface wetness
- As a result, sediment presence on the ice surface could impact both optical and radiometric satellite-borne measurements (through changes in albedo and surface wetness, respectively)

Data Collection

- Experiment conducted at the Sea Ice Experimental Research Facility (SERF), located at the University of Manitoba
- Manually distributed fine grained sand randomly across one half of the sea ice surface
- Collected aerial surveys of sea ice with sufficient overlap for digital elevation model (DEM) generation
- Meteorological conditions continuously measured using surface sensors



Photo credit: Tommy Pontbriand

Figure 1a) Aerial optical imagery of the sea ice surface, with the non-sediment covered ice shown at the top and sediment covered ice at the bottom of each image. Images correspond to sampling dates, marked in red across the metrological graph.

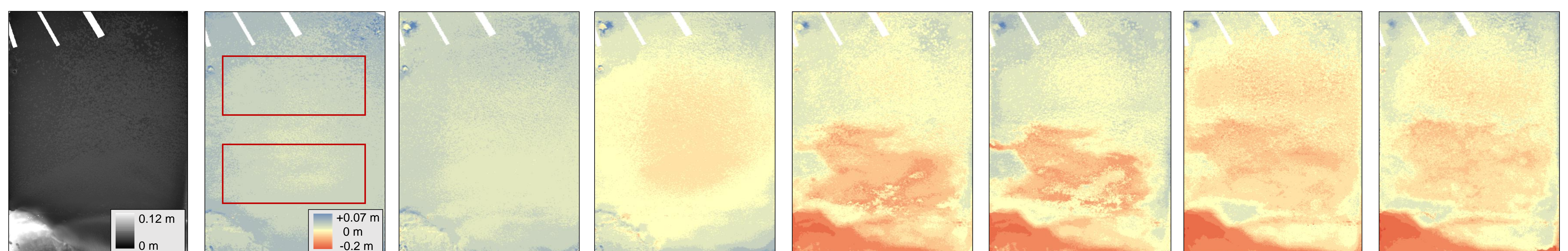
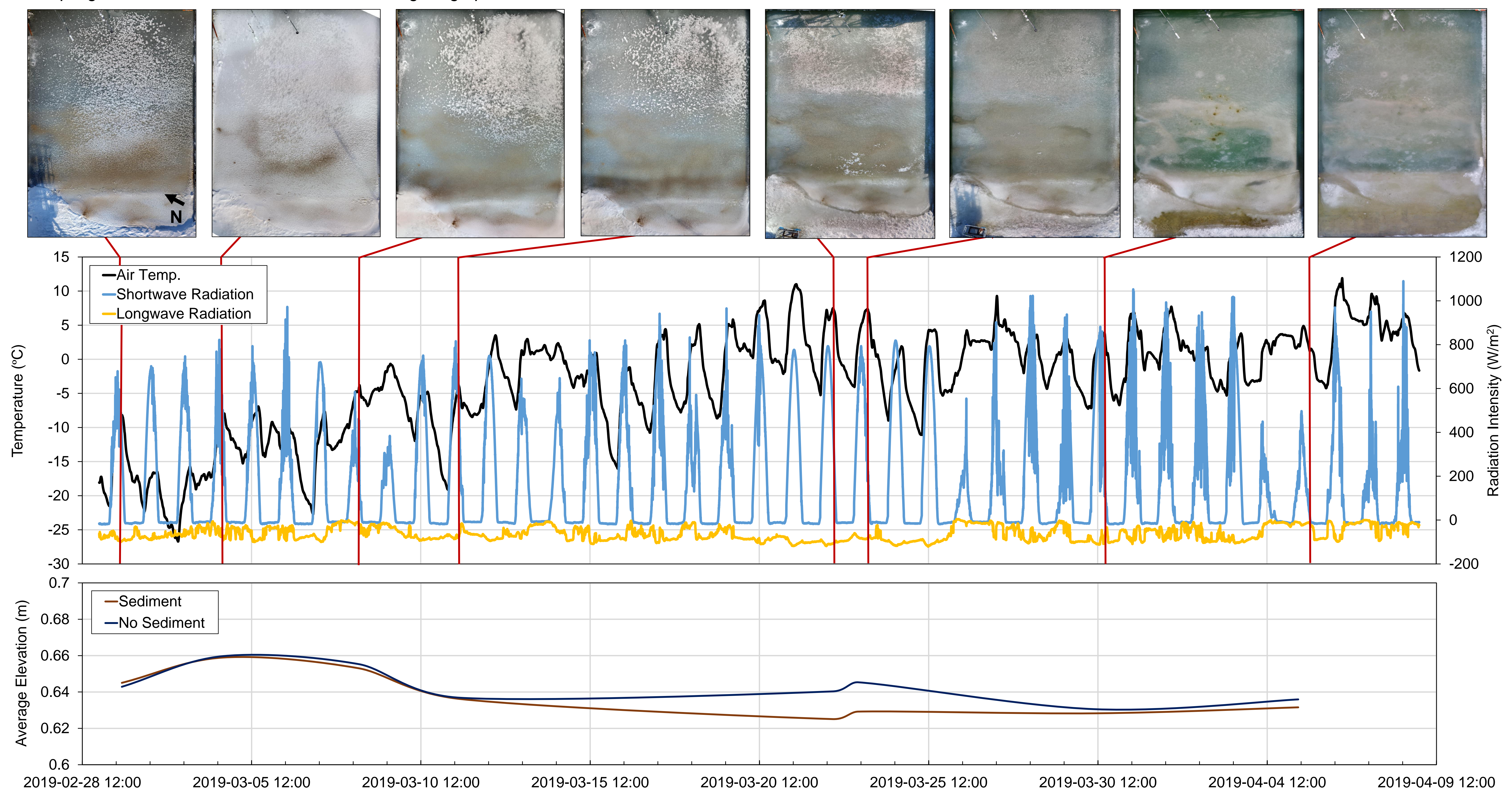


Figure 1b) DEM of the original ice surface (left) and the change in surface elevation for the consecutive sampling dates. Extents used for surface elevation averaging (above) shown in red.

Data Analysis

- Subtracted each DEM from original sea ice surface heights to obtain the spatial change in surface heights (Fig. 1b)
- Averaged surface heights within bounding box of sediment and non-sediment laden ice (Fig. 1b), to determine average change in elevation over the duration of the experiment

Future Work

- Develop a method of sediment concentration classification to map the movement of sediments on the sea ice surface throughout melt progression
- Derive a quantitative relationship between sediment concentration and rate of surface elevation change
- Conduct statistical analysis to identify 'tipping point' of ice surface melt with and without sediment in relation to change in metrological variables

Results

- Presence of sediment caused initial melt of frost flowers early in experiment, even while atmospheric temperatures remained below 0°C (Fig. 1a)
- Melt observed on sediment ice 9 days earlier in comparison to non-sediment ice, leading to 1.5 cm difference in average surface elevation (Fig. 1b) - may be related to two days of high total incoming shortwave radiation (June 21 & 22, Fig. 1a)
- Late into the melt season, non-sediment ice begins to melt and drives an averaging of surface elevation, likely as melt water pools to fill lower elevation areas

About the Author

Madison Harasyn is a recent MSc. graduate, and current research associate at the Centre for Earth Observation Science. Her research involves UAV mapping of sea ice surface features and topography using a variety of sensor types, with a general interest in remote sensing of the cryosphere.



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