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Estimating melt pond bathymetry from aerial images using photogrammetry

Niels Fuchs¹, Marcel König², and Gerit Birnbaum¹

¹Alfred-Wegener-Institute Helmholtz Centre for Polar and Marine Research, Climate Sciences, Bremerhaven, Germany (niels.fuchs@awi.de)

²Kiel University, Department of Geography, Earth Observation and Modelling, Kiel, Germany

Melt ponds play a key role for the summery energy budget of the Arctic sea-ice surface. Observational data that enable an integrated understanding and improved formulation of the thermodynamic and hydrological pond system in global climate models are spatially and temporally limited.

Previous studies of shallow water bathymetry of riverbeds and lakes, experimental studies above sea ice and increasing availability of high-resolution aerial sea ice imagery motivated us to investigate the possibilities to derive pond bathymetry from photogrammetric multi-view reconstruction of the summery ice surface topography.

Based on dedicated flight grids and simple assumptions we were able to obtain pond depth with a mean deviation of 3.5 cm compared to manual in situ observations. The method is independent of pond color and sky conditions, which is an advantage over recently developed radiometric retrieval methods.

We present the retrieval algorithm, including requirements to the data recording and survey planning, and a correction method for refraction at the air— pond interface. In addition, we show how the retrieved elevation model synergize with the initial image data to retrieve the water level of each individual pond from the visually determined pond exterior.

The study points out the great potential to derive geometric and radiometric properties of the sea-ice surface emerging from the increasingly available image data recorded from UAVs or aircraft.