Measurement of sea ice thickness distribution along the coast of Qaanaaq, Greenland, using UAV-SfM technology

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UAV-SfM technique has potential as a new and simple method for measuring sea ice elevation and thickness. However, UAV flights in the high Arctic winter have some technical difficulties. In March 2018 and 2019, we tried UAV photogrammetry for sea ice along the coast of Qaanaaq, NW Greenland (77.4° N, 69.2° W), in order to build a safe and efficient UAV flight in the high Arctic winter. Air temperature fluctuated between −34°C and −25°C for both survey periods. In the first year, aerial photography by a rotary UAV covered an area of 1.26 km^2 with four days of fieldwork. The first trial of UAV flight in the high arctic winter faced several problems; low battery at cryogenic temperature, compass error due to high declination and shortness of flight distance. In addition, much time had to be taken to place GCPs (ground controlling points). A generated sea ice DEM reproduced sea ice morphology faithfully, but was partially distorted due to insufficient GCP placement. In the second year, a fixed-wing UAV was applied for efficient aerial photography in harsh conditions and, additionally, several improvements were made to alleviate the flight problems that occur in high Arctic winter. The UAV mounted a RTK GNSS module, which made it possible to reduce model distortion derived from insufficient GCP placement and improve working efficiency. The UAV images covered an area of 0.75 km^2 with a total flight time of only 30 minutes. New sea ice DEM has an accuracy of less than 10 cm and less distortion overall. Sea ice thickness was estimated from the sea ice DEM on the assumption that isostasy between snow cover, ice free-board and draft.

Keywords: UAV, SfM, Sea ice

