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A changing sea ice cover in the Arctic Ocean is an early indicator of a climate in transition, the sea ice has in addition a large impact on the climate. The annual and interannual variations of the sea ice cover have been observed by satellites since the start of the satellite era in 1979, and it has been in retreat every since. The mass balance of the sea ice is an important input to climate models, where the ice thickness is the most uncertain parameter. In this study, data from the CryoSat-2 radar altimeter satellite are used. CryoSat-2 has been measuring the sea ice in the Arctic Ocean since 2010, but there remain uncertainties in the accuracy of its elevation retrieval. A threshold retracker is developed to derive surface elevations and shows good results over the sea ice cover.

To validate the satellite measurements, a comparative assessment of sea ice freeboard is presented, where airborne laser altimeter data from DTU Space together with data from the European Space Agency's (ESA) CryoSat Calibration and Validation Experiment (CryoVEx) and the National Aeronautics and Space Administration's (NASA) Operation IceBridge (OIB) are used over a first and multi-year ice area. Comparing the modal freeboard heights of 55 cm retrieved from the laser scanner data with the 25 cm retrieved from CryoSat-2 indicates a snow layer of 30 cm, due to the theory that a laser is reflected at the air/snow interface, while the radar is reflected at the snow/ice interface. In the other area, the modal freeboard is found to be 35 cm for both the airborne and satellite data implying, that the radar signal is here reflected from the snow surface, probably due to weather conditions. CryoSat-2 is very sensitive to returns from specular surfaces, even if they appear o_-nadir. This contaminates the "true" signal resulting in o_-ranging elevations. Filtering out these o_-ranging elevations are succeeded and results in more than 60% rejection of CryoSat observations. The correlation between the radar satellite and airborne laser measurements is improved after a drift correction is applied, and at an acceptable level (r=0.604), but more knowledge of the datasets are needed to improve this correlation.

Leads are used to form the local sea surface height, and are crucial in the freeboard retrieval. Leads are detected from the CryoSat data by looking at the waveforms. In an independent study, the sea surface height is obtained by using Global Positioning System (GPS) measurements and geophysical parameter corrections on the sea ice north of Greenland. In the same study the ocean tides are examined and show, that the ocean tide model AOTIM-5 works good in the Arctic Ocean, but less good in costal areas and in fjord systems. The Greenland fjords exhange freshwater between the glaciers and the ocean. Measuring a snapshot of the ice mélange in front of Kangiata Nun`ta Sermia in southwest Greenland with airborne LiDAR, gives an estimate of the ice discharge since last autum. The total volume of 1:70 _ 1:26 GT ice in the inner fjord is found, which is 38% of the yearly ice flux. In a preliminary study, the freeboard and ice thickness distribution over the entire Arctic Ocean are computed for the CryoSat record for autum and fall, respectively in the period from 2010 to 2013. Annual and interannual variations are observed and a mean freeboard thinning of 1:5 cm/year is found. For the ice thickness determination, two methods are tested using climatology snow depths or an emperical relationship for the ice thickness distribution. The autumn mean thickness trend varies between -8:1 to -11:6 cm/year between the two methods, and -15:7 to -16:9 cm/year for the spring trends.

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