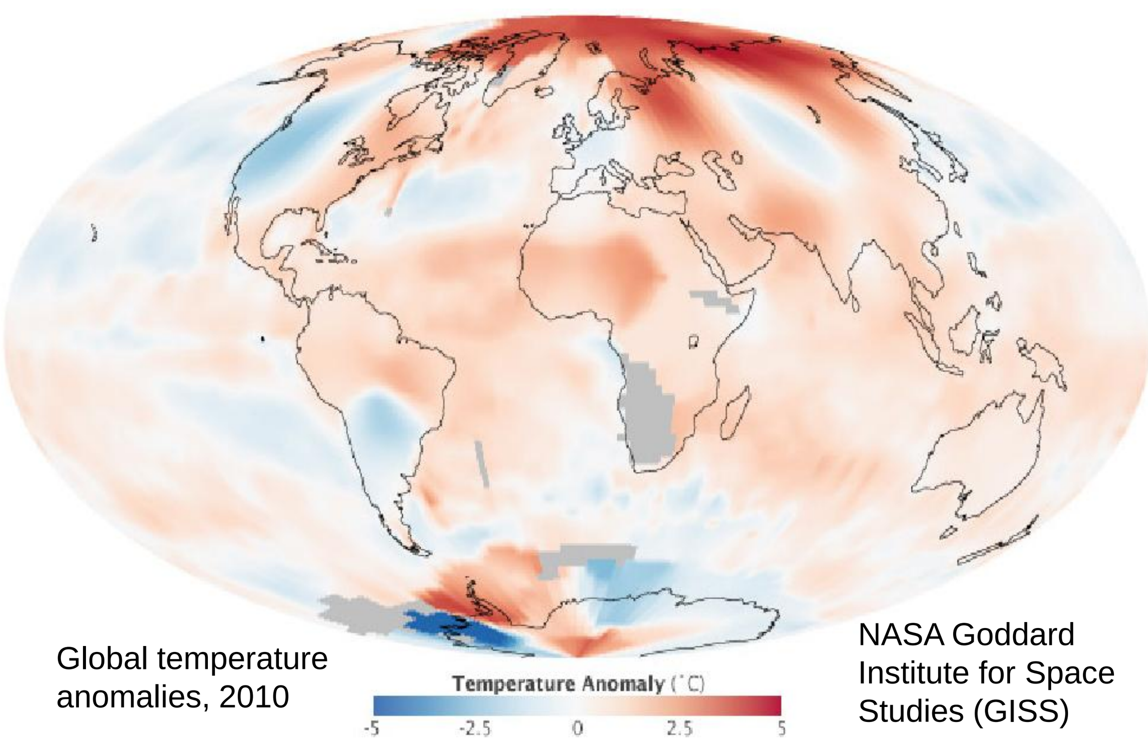
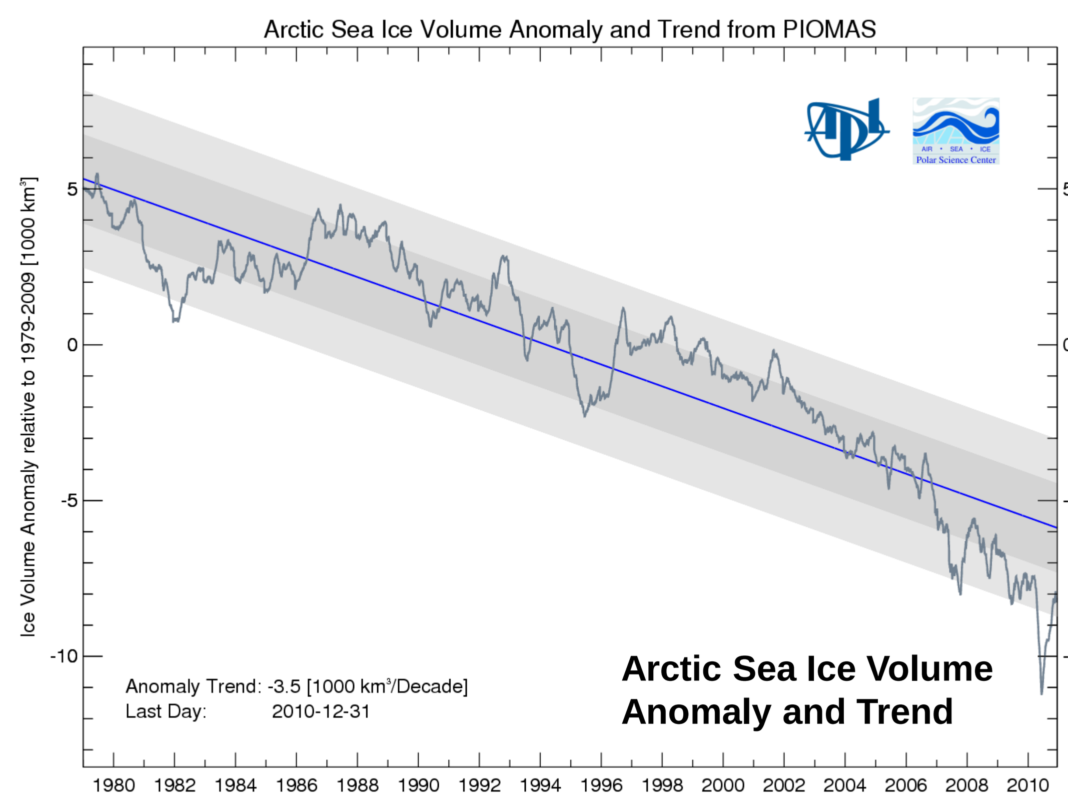
ARCTIC SEA ICE:
USING AIRBORNE TOPOGRAPHIC MAPPER MEASURMENTS (ATM) TO DETERMINE SEA ICE THICKNESS

Midn 1/C Eric T. Brugler



Global temperature anomalies, 2010

NASA Goddard Institute for Space Studies (GISS)



Arctic Sea Ice Volume Anomaly and Trend

Introduction

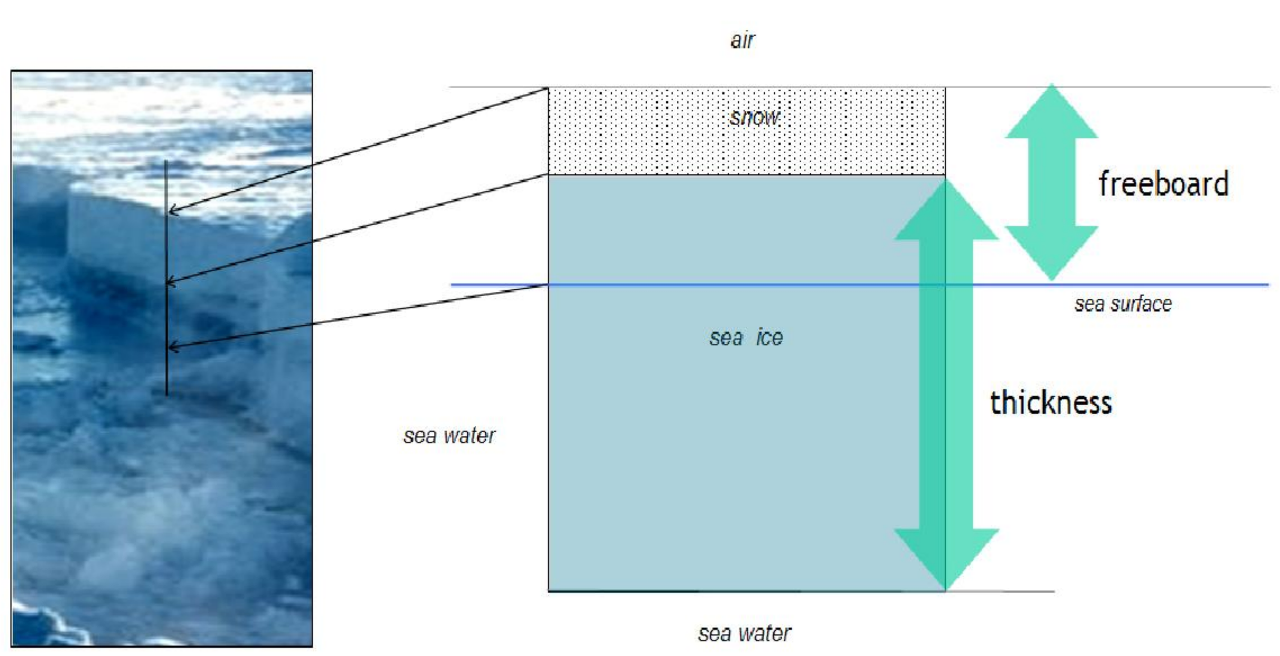
With the Arctic changing faster than any place on earth, ice-diminishment is cause for immediate concern. Although projections vary, scientists agree that the Arctic is headed toward ice-free summers, which in turn poses numerous challenges for the United States Navy. An open ocean in the near future may increase water traffic, create boundary disputes, and raise questions over sea sovereignty, calling upon American diligence in defending its borders and keeping Arctic sea lanes free and safe. Thus, because of the growing national security implications, it is important to study the altering Arctic environment in greater detail now so that the U.S. Navy is better prepared to operate there in the future.

NASA's P-3B Aircraft

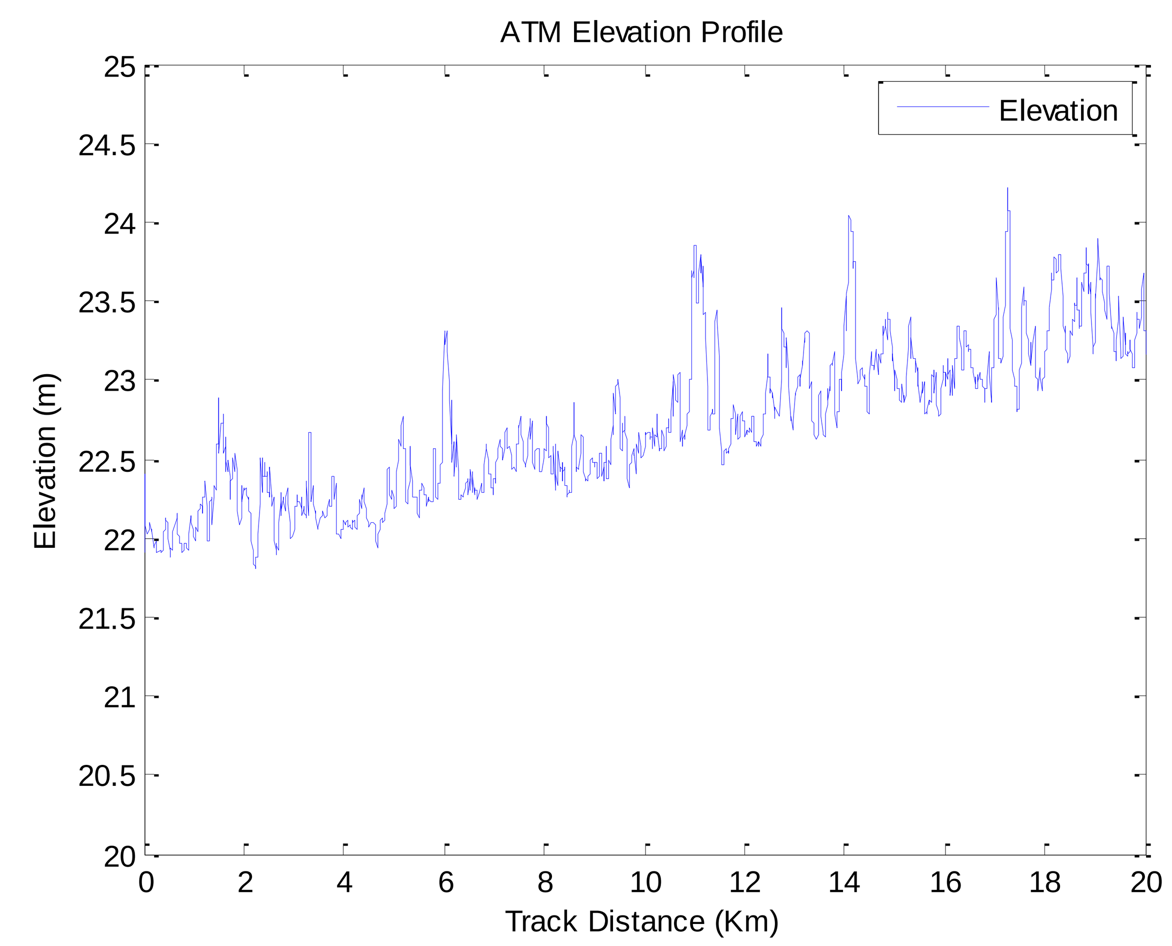
View of sea ice flying1500 feet over Arctic Ocean

Materials

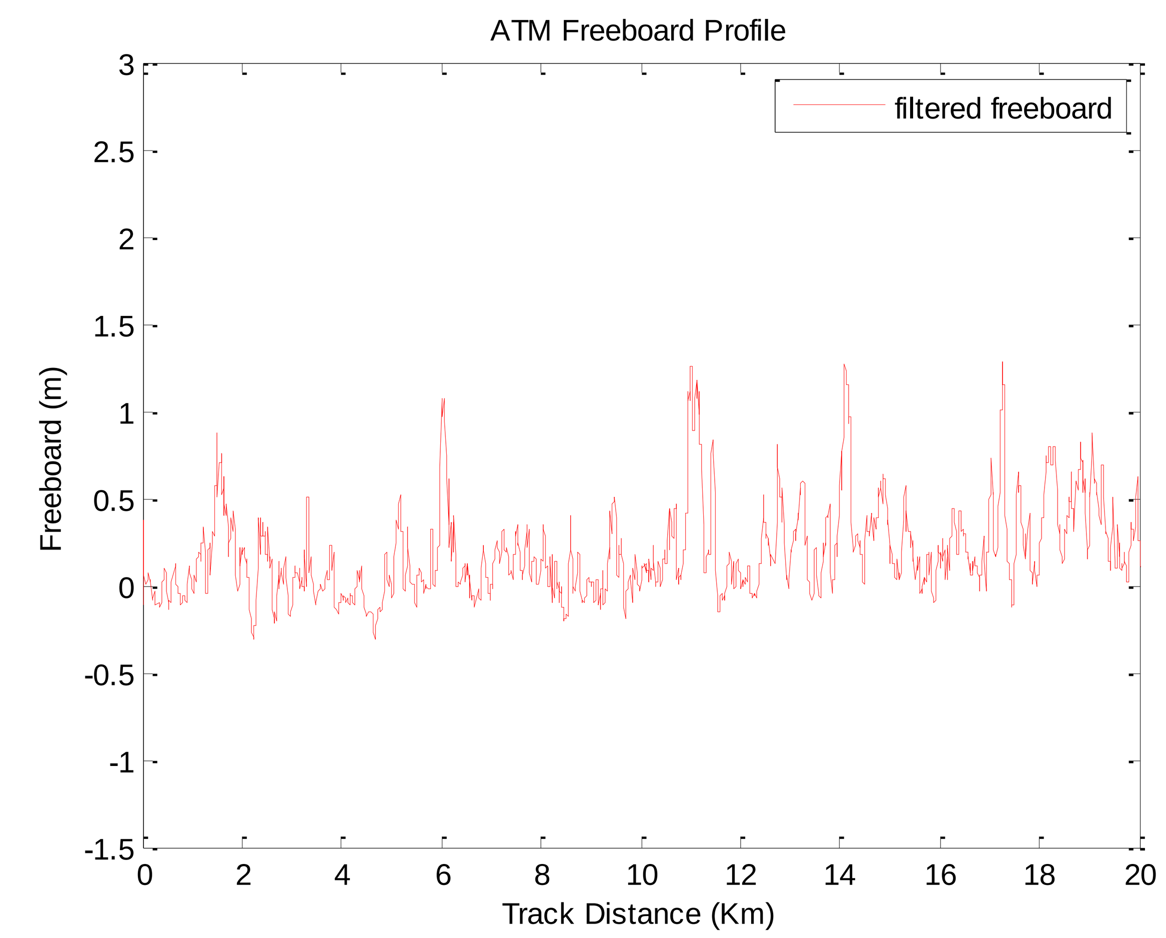
NASA's annual Operation IceBridge will bridge the gap between ICESat and ICESat-2. The airborne measurements will provide the data necessary for a three-dimensional view of Arctic and Antarctic ice sheets, ice shelves and sea ice. This paper looks at the steps, process and approximations behind determining sea ice thickness given raw sea ice elevation data collected from the Airborne Topographic Mapper (ATM), a laser altimeter that took measurements during NASA's IceBridge campaign in 2009 and continues to be the primary laser altimeter used in IceBridge today.



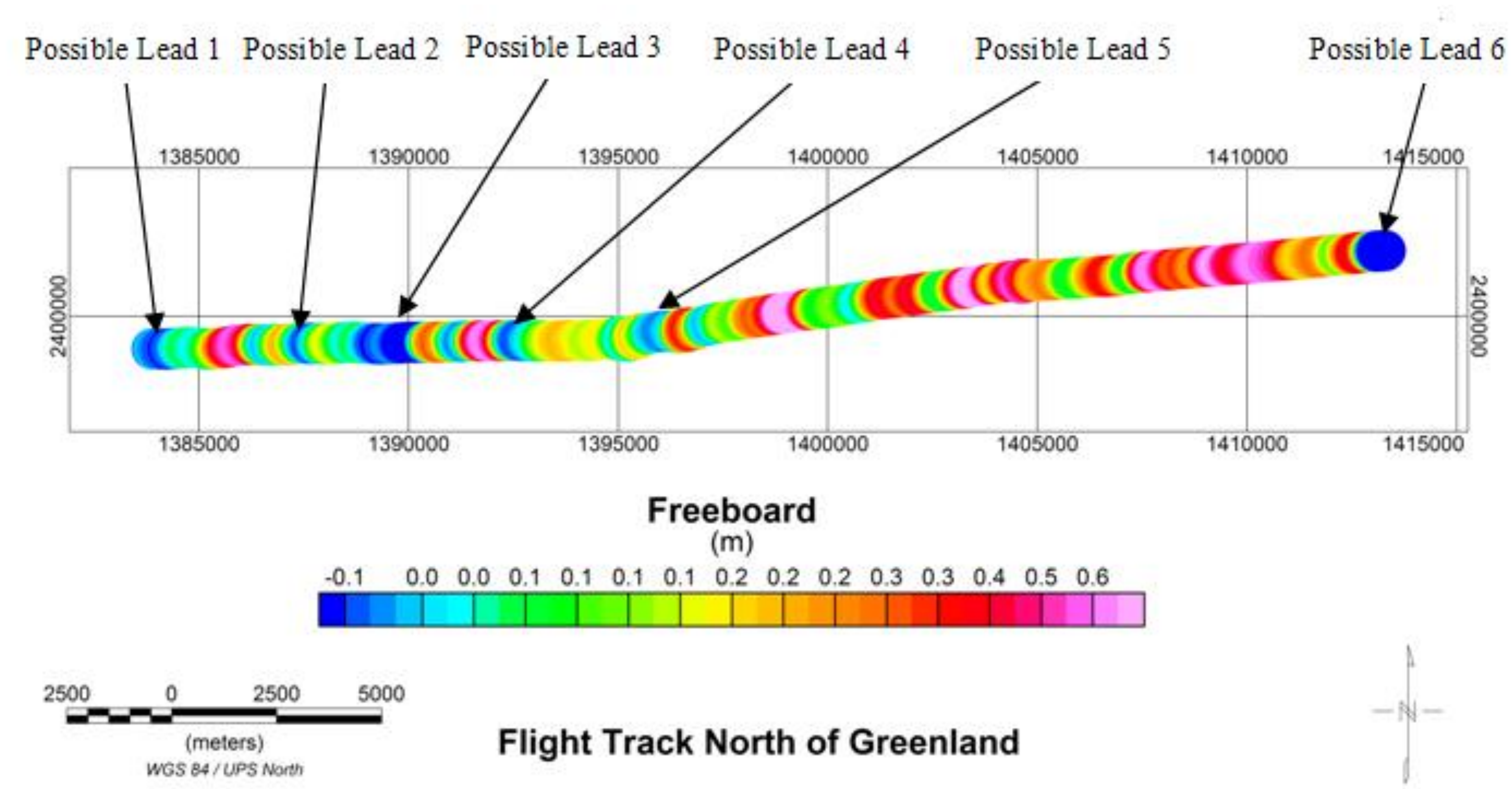
This figure shows a lead in the sea ice and the components associated with the lead. It is a very good visual representation of sea ice freeboard (Kwok, 2010).



Elevation data taken over flight track in relation to WGS-84 ellipsoid



Sea ice freeboard along flight track referenced to EGM-96 geoid



A 20 km flight track of the freeboard elevations in reference to the EGM96 geoid taken North of Greenland during the 2009 IceBridge campaign.

Conclusions

As the earth warms, signs of climate change range from subtle to significant, with the most dramatic alterations occurring in the Arctic. Obtaining accurate sea ice thickness measurements over a large area are needed in order to track any further variations and predict possible changes. Therefore, it is necessary to understand the steps used in determining sea ice thickness based off laser altimetry data gathered during NASA's Operation IceBridge. Using the Airborne Topographic Mapper (ATM), sea ice elevation can be measured from an aircraft flying overhead. From this elevation data, an approximate freeboard is calculated in relation to the earth's geoid model. By determining locations of leads in the ice, further calculations may be performed to get a sea ice freeboard measurement. Then, through the use of the hydrostatic equation, sea ice thickness may be inferred for the region between successive leads. This makes flying over a lead in the ice is very important for determining the exact sea surface elevation. Although summed up in a few steps there are many factors that make this calculation much harder than it appears.

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