

Spring Snow Depth on Arctic Sea Ice using IceBridge: Validation and Study

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## Bromine Ozone and Mercury Experiment (BROMEX) ground surveys:





With an average of 37 (T1) and 52 (T2) measurements per transect, <±1 cm in situ uncertainty per average within "footprint."



<±1 cm in situ uncertainty per "footprint." ±5.7 cm uncertainty for IceBridge.



	In Situ	IceBridge
Mean (cm):	23.1	22.7
Std. Dev.:	4.6	7.2

## Methods:

- In W99, Soviet snowline measurements were averaged in each grid for each month.
- Data fitted to the following 2D quadratic equation in rectangular coordinates:



Soviet ice station in March and April (blue), and Operation IceBridge flights (red).

 $H = Ho + Ax + By + Cxy + Dx^2 + Ey^2$ 

[snow depth] = [snow depth at N. Pole] + [coefficients]\*[location] Can be solved for the least squares solution: Ax = b



- 37±26% decrease in the "western" Arctic.
  From 35.1±9.4 cm to 22.0±2.5 cm.
- 52±11% decrease in the Beaufort and Chukchi seas.
  - From 32.8 ±9.4 cm to 15.4 ±2.5 cm.

## Hindsight:

- IceBridge validation: IceBridge can accurately measure snow depth on flat sea ice.
  - Specific outline of ground-truthing needs:
    - Locations, types of measurements, measurement density.
- <u>W99 comparison</u>: Spring snow has thinned in the western Arctic, with the greatest thinning occurring in the Beaufort and Chukchi Seas.
  - Has the snow cover actually thinned?
    - More validation efforts needed on variable sea ice topography.

**Future work:** Extensive statistical analyses in determining the uncertainties/accuracy of the results, particularly in the IceBridge snow thickness product.

## References & Acknowledgements:

- BRomine Ozone and Mercury EXperiment (BROMEX): Son Nghiem, Matthew Sturm, Don Perovich, and many others.
- IceBridge: Kurtz, N., M. Studinger, J. Harbeck, V. Onana, and S. Farrell. 2012. *IceBridge Sea Ice Freeboard, Snow Depth, and Thickness.*, [N. Hemisphere, 2009-2012]. Boulder, Colorado USA: National Snow and Ice Data Center. http://nsidc.org/data/idcsi2.html
- USSR Drifting Ice Station: Arctic Climatology Project. 2000. Environmental working group Arctic meteorology and climate atlas. Edited by F. Fetterer and V. Radionov. Boulder, CO: National Snow and Ice Data Center. CD-ROM. http://dx.doi.org/10.7265/N5MS3QNJ



