Antarctic Sea Ice Thickness and Concentration from Ship-based and Satellite Derived Measurements

I. Introduction:
Justification of study

II. Background

Ice Thickness:
- ASPeCt protocol and history
- Previous Research
  - Ice Charts
  - ULS-Upper Looking Sonar
  - Autosub (Banks, 2006)
  - Ice Thickness Distribution for Bellingshausen and Amundsen Seas (Worby et al., 1996)
  - Thickness distribution of Antarctic Sea Ice (Worby et al., 2008)
  - Ship-based electromagnetic ice thickness measurements (Haas, 2007).

Ice Concentration:
- Previous Research
  - Ice Conc (Hall, et al. 2002)
  - EIS Cam (Weissling, et al., 2008)
  - Antarctic Sea Ice Variability (Cavalieri, et al. 2008)
  - Studies of the Antarctic Sea Ice Edgleg and Ice Extent from Satellite and ship observations (Worby et al., 2004)
  - Sea Ice Conc., Ice Temperature, and Snow Depth Using AMSR-E Data (Comiso, et al., 2003)
  - Fast Ice distribution in E. Antarctica during 1997-1999 with RADARSAT. (Giles et al., 2008)
  - Summer and early-fall sea ice conc. (Knuth et al., 2006)
III. Methods
a. Data description of ASPeCt protocol dealing with sea ice thickness distributions, deformations, and errors applied with previous results and drilling profile.
b. Concentration measurements – ship, satellite, and airplane.

c. Limitations:

ASPeCt: Problems that tend to incorporate a level of bias to ship-based ice observations:

i. Thickness distributions,

ii. Sea ice deformation, individual perceptions

iii. Vessel routes that tend to navigate in thinner ice conditions and lead.

iv. Ice observers are unable to calibrate their eye with in situ measurements for ice thickness and ridge height measurements.

EM-31:

i. Underestimate thickness for ridged areas

In Situ:

i. Labor intensive

ii. Lacking large spatial area for datasets

EIS Cam:

i. High percentage of ridged floes (observed further in MIZ) break into component parts when hit by the ship. (Worby et al., 1996)

- Overturned ice broken by the ship > ~1m and deformed and/or ridged ice does not accurately represent ice conditions:
  » Ridging or deformed ice often breaks to form Brash per the ships breaking potential

ii. Horizontal shearing of banded or weaker basal layers within the vertical profile.

iii. Thin ice is usually rafted or broken so accurate minimum ice thickness of overturned ice is a few centimeters
potentially underestimates of the frequency of very thin ice (secondary
and tertiary). \textit{(Toyota et al., 2004)}

iv. Limited field of view

Satellite Products:

i. Underestimate ice concentration due to flooded interface between sea
ice and snow.

**IV. The Problem**

a. How can ship-based ASPeCt ice observations be adjusted to accurately
reflect ice conditions?

b. Necessary to try to implement devices on the ship that could help to phase
out the current ship-based ice observations for a more automated methods
that would reflect more qualitative and accurate data of ice conditions.

**V. Part I: EIS Cam and EM-31 analysis for Ice Thickness**

c. Description of EM-31 device, calibration, and process
   i. Methodology: How ice thickness was measured and processed
d. Description of technical process involved with installing ice cameras in
   specific locations and positions on the ship
   i. Downward View
   ii. Side View
e. Downward View
   i. Methodology: How images were processed and georeferenced
      through ENVI.
      1. Measurements of all overturned ice compared with ASPeCt
         protocol from SIMBA cruise. Analysis of comparision
         using histogram of true ice thickness representation from
         camera.
f. Side View
   i. Methodology: Orthorectification of georeferenced images to look
      at floe size and ice concentration with ENVI.
      1. Classification of ice and open water areas compared with
         ASPeCt protocol from SIMBA cruise.

**VI. Part II: Comparison of RADARSAT, EnviSAT, and AMSR-E products for ice concentration.**

a. Description of products used that coincide with SIMBA cruise.
   ii. Methodology: Using coast 2005 feature class in ArcGIS to orient
       satellite products, and ice observation shapefile track data.
       AMSR-E reprojection in Hegtool in ENVI.
1. Using ENVI to determine ice concentration with RADARSAT and AMSR-E.
   a. Combine ship based ice observations from October 26, 2007 at 09:00 and 10:00 GMT with RADARSAT image 62509 at 9:33 GMT.

VII. Results
   g. EIS Cam - DSR paper – ice thickness distribution
   h. Sea Ice Thickness Distribution at 90W Longitude: Comparison with ASPeCt, EM-31, and Ice Cam Observations – DSR paper – ice thickness distribution

VIII. Conclusion:
   j. Potential future projects
References:


