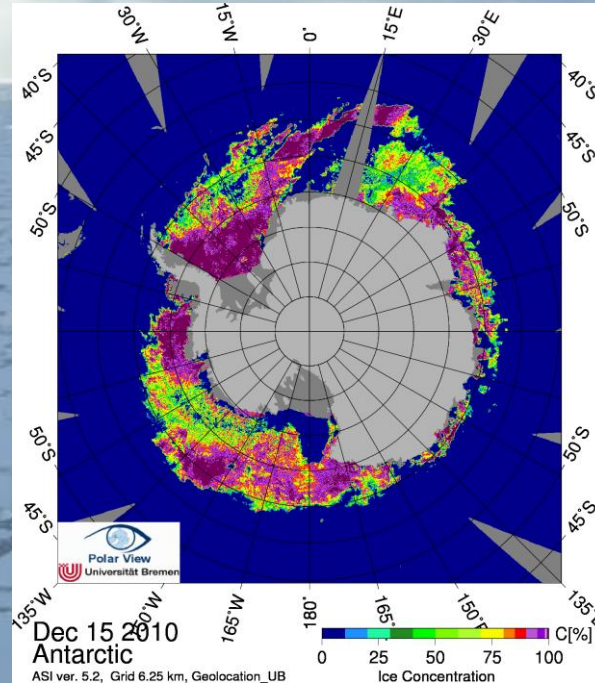


The Sea Ice System in Antarctic Summer



Sea ice geophysics in the Bellingshausen –
Amundsen – Ross Sea Sectors
Oden Southern Ocean Expedition

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Brent Stewart²

Anne Marie Wotkyns³

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¹University of Texas at San Antonio

²Hubbs-SeaWorld Research Institute

³Polartrec – Arctic Research Consortium of the U.S.

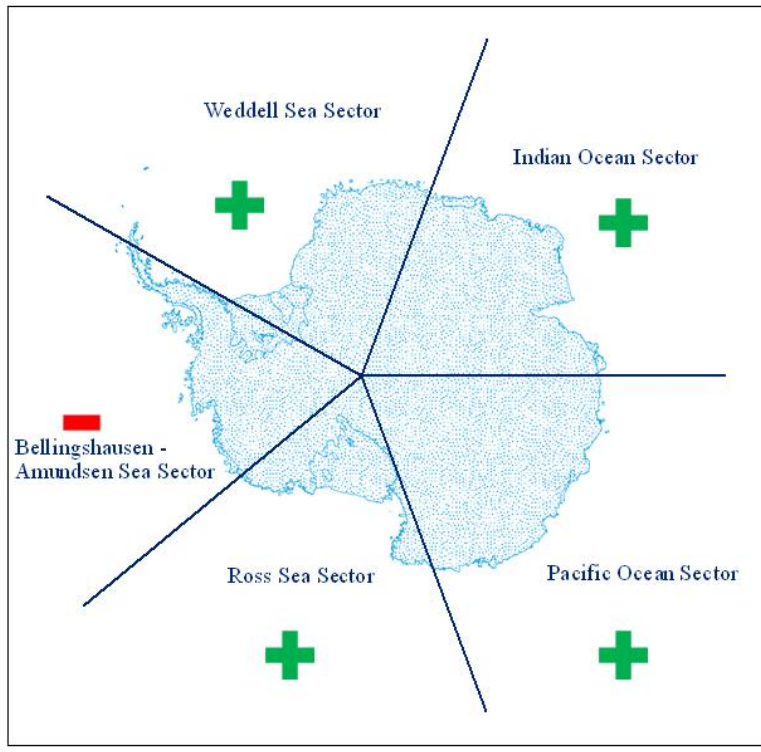


- Sea ice extent in the Antarctic has increased by $\sim 1\%$ /decade in the satellite era (30 yrs)
- Contrasting trends have been observed
 - Bell/Amund sector with $- 5.7\%$ /decade
 - Ross sector with $+ 4.2\%$ /decade
- B-A-R seas least studied sea ice region to date

Science objectives:

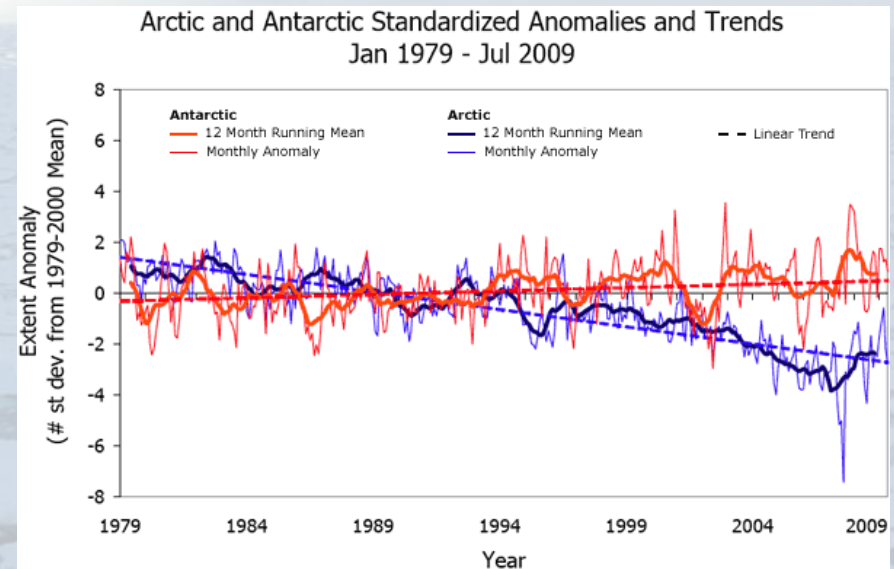
- Collect spatio-temporal sea ice geophysical data (eg. sea ice/snow thickness and structure, ice concentration, floe sizes, sea ice topography)
- Validate/develop algorithms for remote sensing of Antarctic sea ice and for sea ice modeling using the surface measurements as ground truth

Sea Ice Extent from Satellite Passive Microwave Radiometers



Weddell Sea = + 0.7% decade⁻¹
Ross Sea = + 4.2% decade⁻¹
Pacific Ocean = + 1.2% decade⁻¹
Indian Ocean = + 1.9% decade⁻¹
Bellingshausen/Amundsen Sea = - 5.7% decade⁻¹
(Comiso and Nishio, 2008)

Increasing Trend in Antarctica ~
1% decade⁻¹



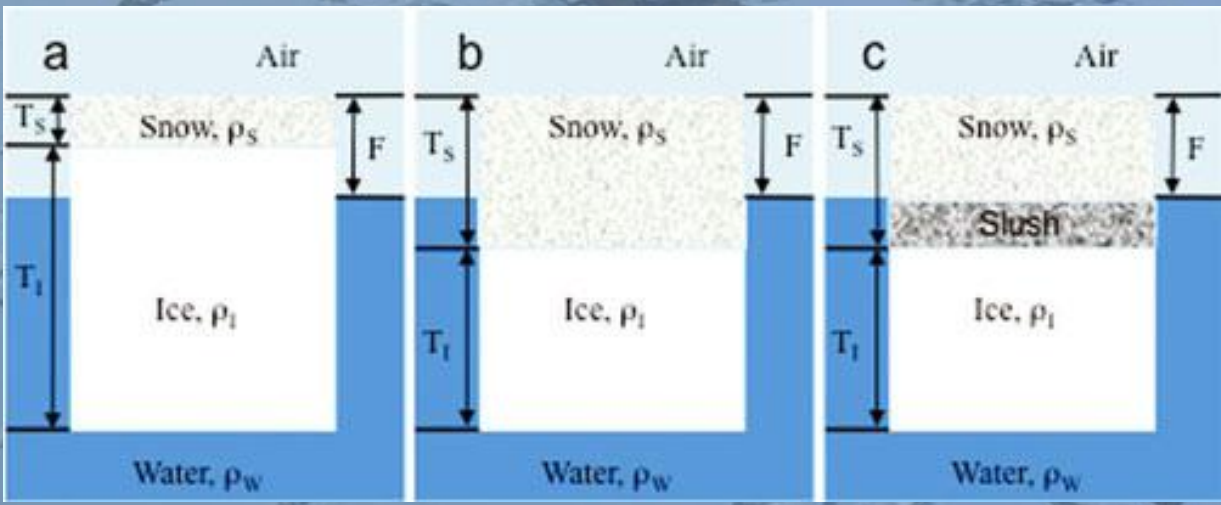
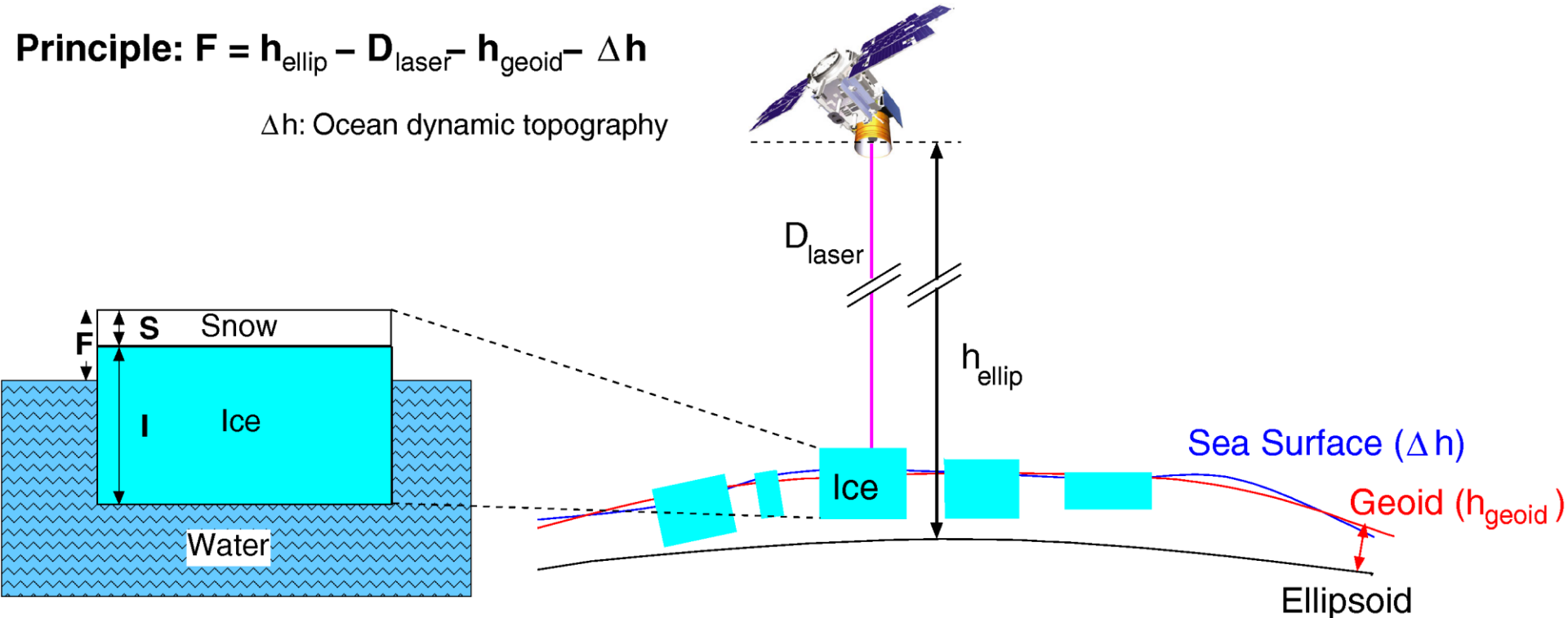
**But, mass-balance requires
understanding of volumetric change**

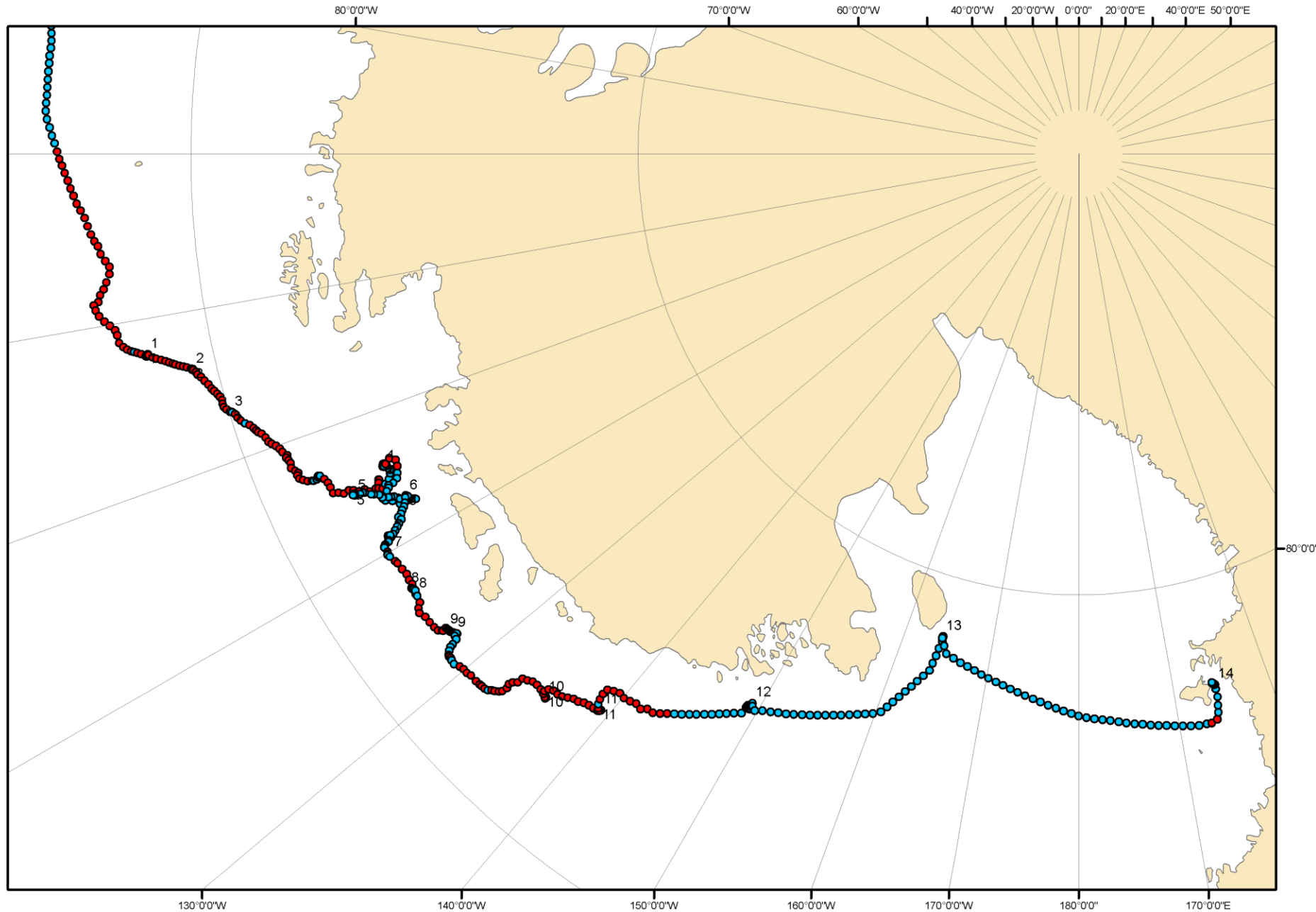
Methodology

- Underway standardized sea ice observation
 - ASPeCt (Antarctic SeaIce Processes and Climate protocols)
- Underway sea ice digital ortho-photography
 - EISCam (Evaluative Imagery Support Camera)
- In situ electromagnetic induction (EMI) sounding for sea ice thickness
- In situ ice mass balance buoys (IMB's) for long term temporal series (ice thickness, snow depth, meteorology, temp/thermal properties, GPS positioning, Iridium com link)
- In situ Terrestrial Lidar Scanning (TLS) for sea ice/snow surface topography and morphology

Principle: $F = h_{\text{ellip}} - D_{\text{laser}} - h_{\text{geoid}} - \Delta h$

Δh : Ocean dynamic topography





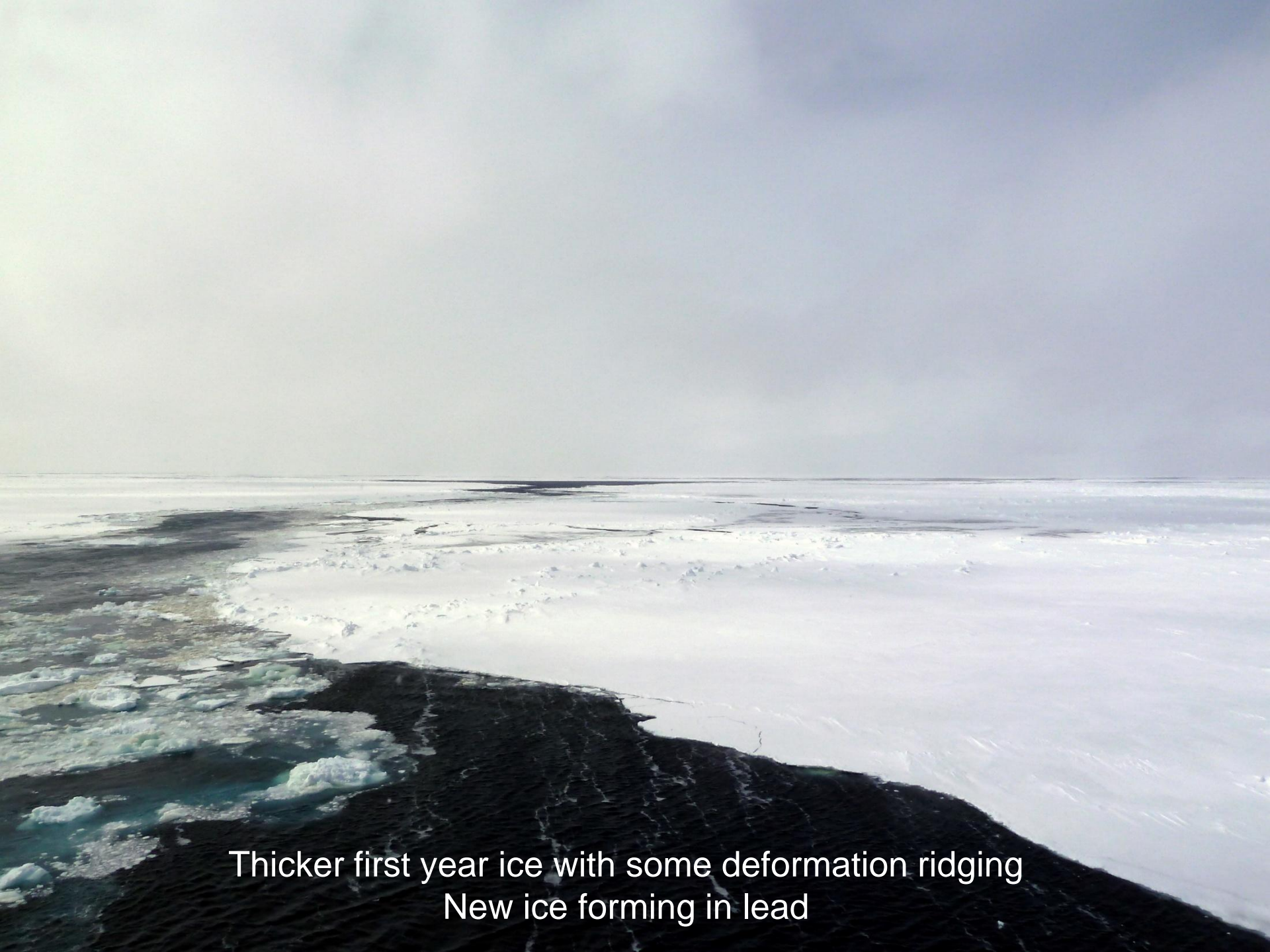
OSO1011 Cruise Track and Science Station Map



Thin first year ice recently broken up by ocean swell in advanced state of melt



First year ice broken up by ocean swell



Thicker first year ice with some deformation ridging
New ice forming in lead



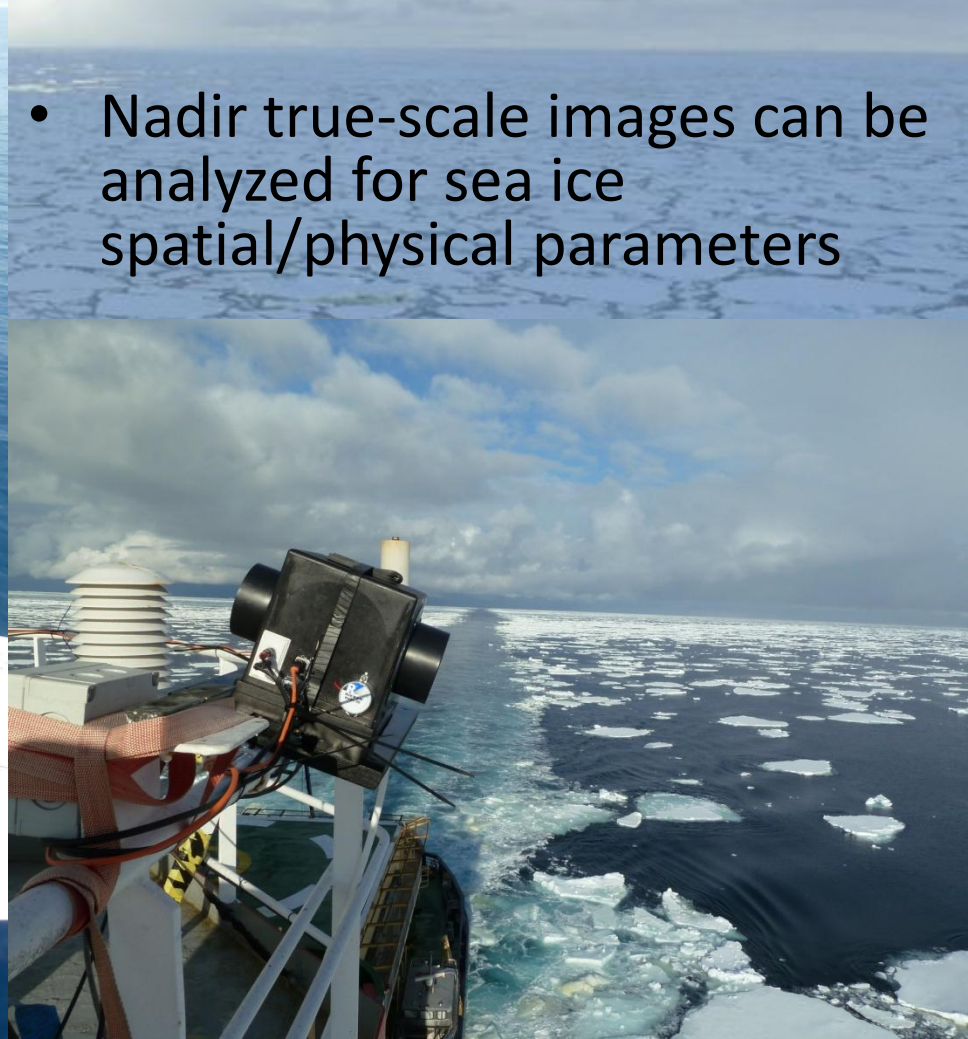
Small floes of thick highly deformed multiyear ice with snow cover



Extensive sheet of thick deformed multiyear ice with snow cover

EISCam sea ice digital ortho-photography

- Acquired oblique-view digital imagery is reprojected (orthorectified) to a nadir view
- Nadir true-scale images can be analyzed for sea ice spatial/physical parameters



Sample view from
EISCam v1
NB Palmer 2007



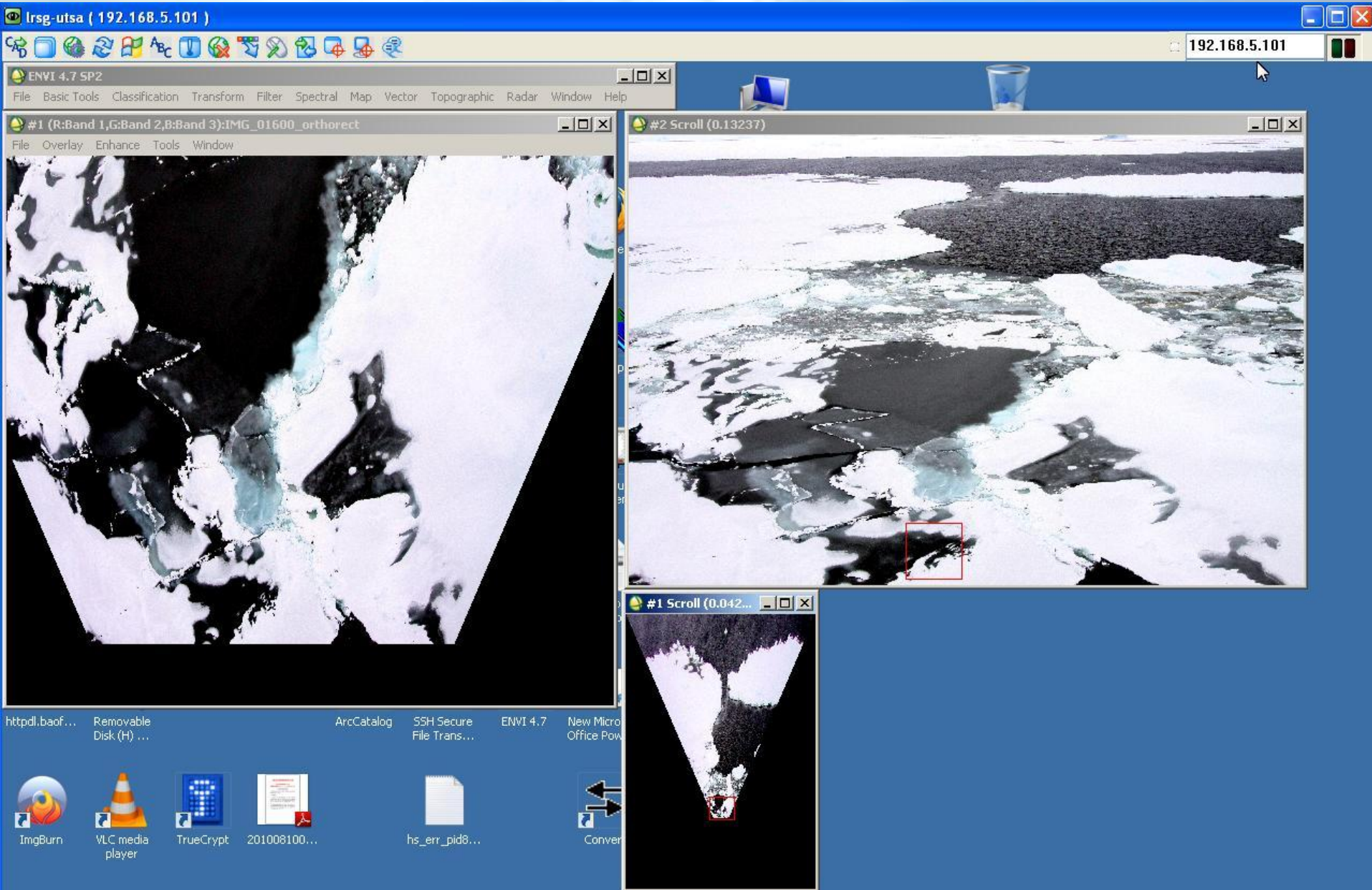
Vertical height above water line – 25.3 m
Frame rate – 1 frame every 20 seconds
Image dim: 704 x 480
Analog video

Sample view from
EISCam v2
Oden 2010

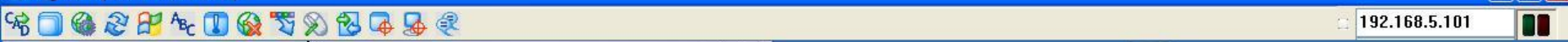


Vertical height above water line – 25.5 m
Frame rate – 1 frame every 20/30 seconds
Image dim: 4752 x 3168
Digital SLR

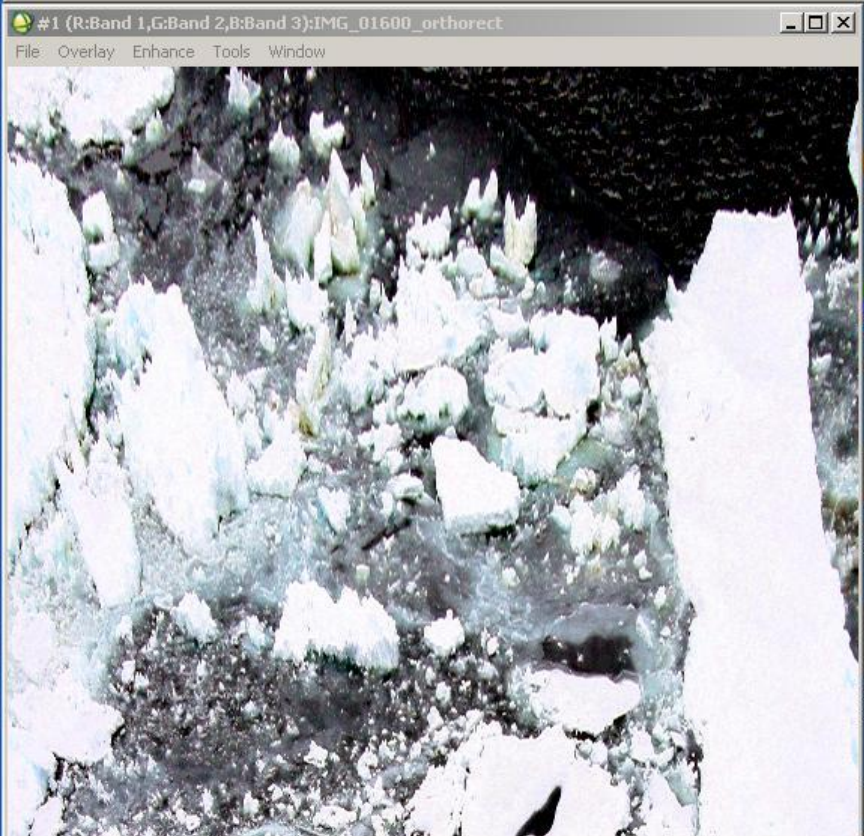
Evaluation of the orthorectification



lrsq-utsa (192.168.5.101)



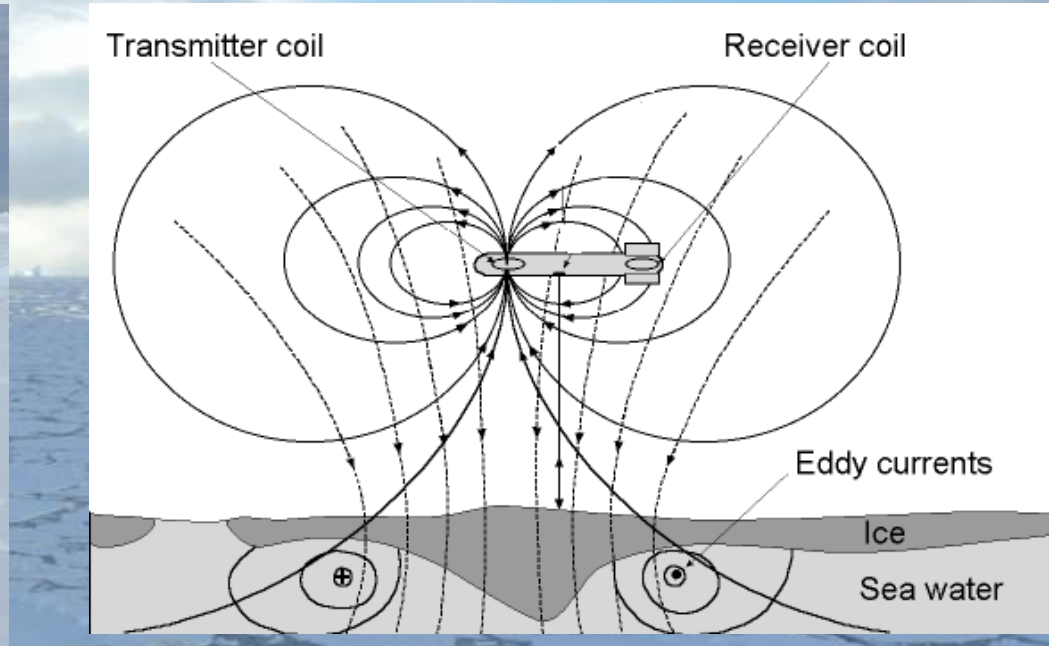
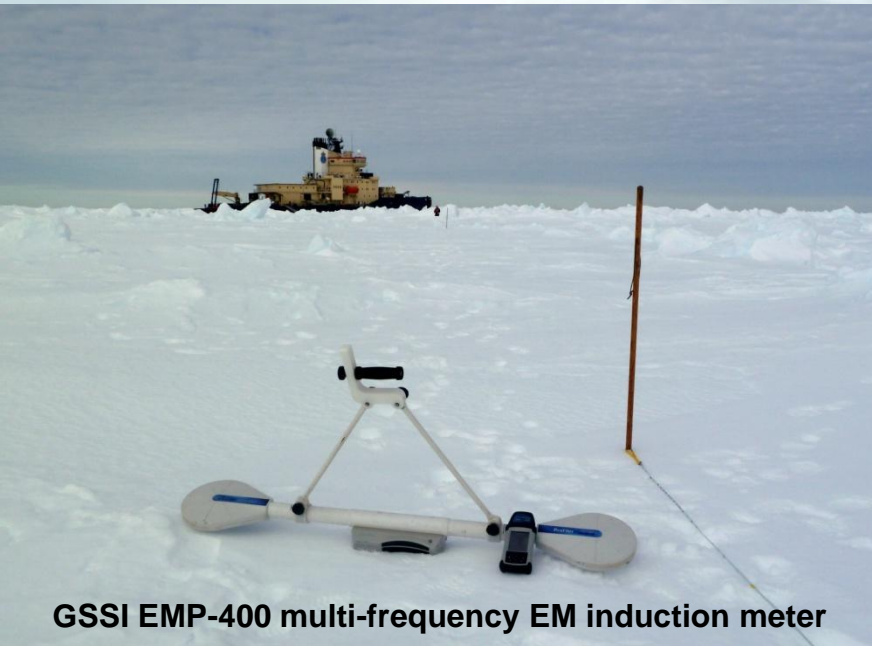
ENVI 4.7 SP2
File Basic Tools Classification Transform Filter Spectral Map Vector Topographic Radar Window Help



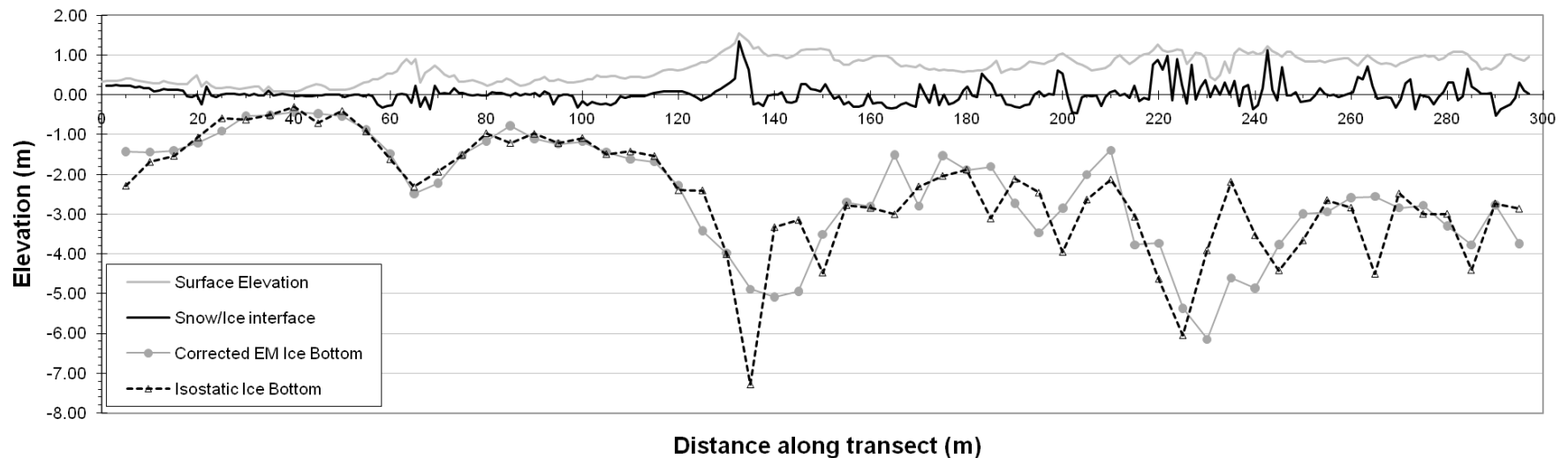
httpdl.baof... Removable Disk (H)... ArcCatalog SSH Secure File Trans... ENVI 4.7 New Micro Office Pow...



EMI Sounding for ice thickness



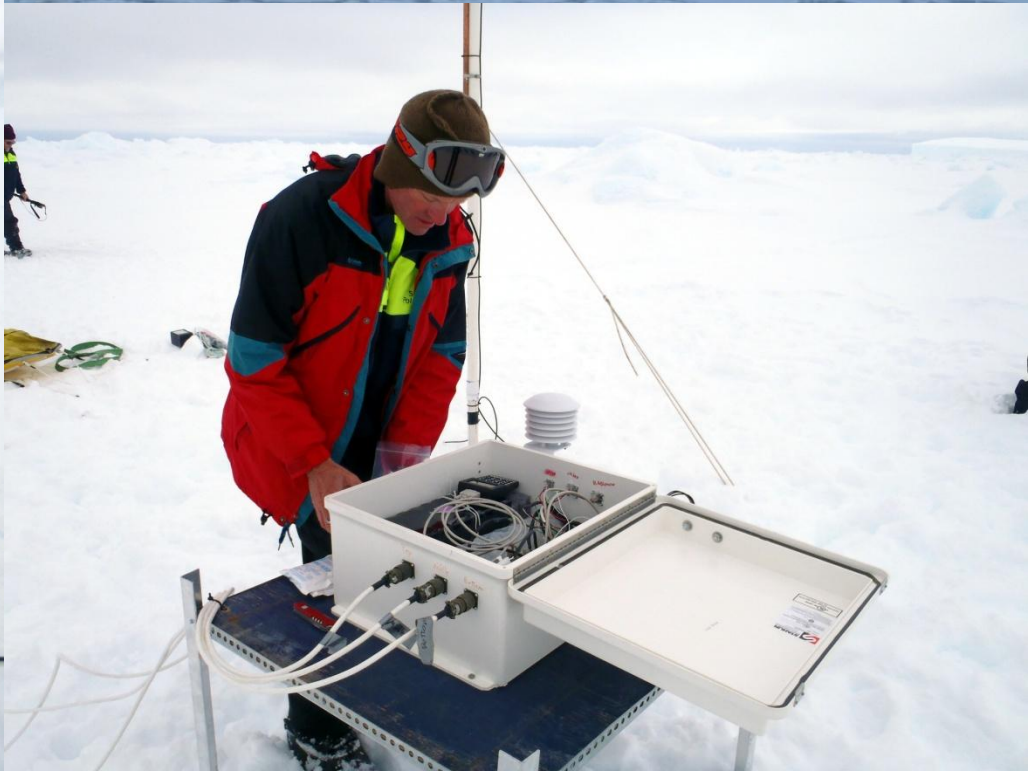
Fabra Site - Line 1B



IMB Installations

- 2 CRREL Ice Mass Balance buoys sited on 24 hr stations
 - Radiometer and Seabird
 - Snow depth sonic pinger, ice bottom pinger, under ice PAR radiometer, temperature, pressure (under ice), conductivity, GPS geolocation, Iridium com link
- 2 SAMS buoys (sited at 6 hr stations)
 - Air/ice/sea water thermal conductivity and derived temperature, GPS geolocation, Iridium com link

CRREL IMB installation



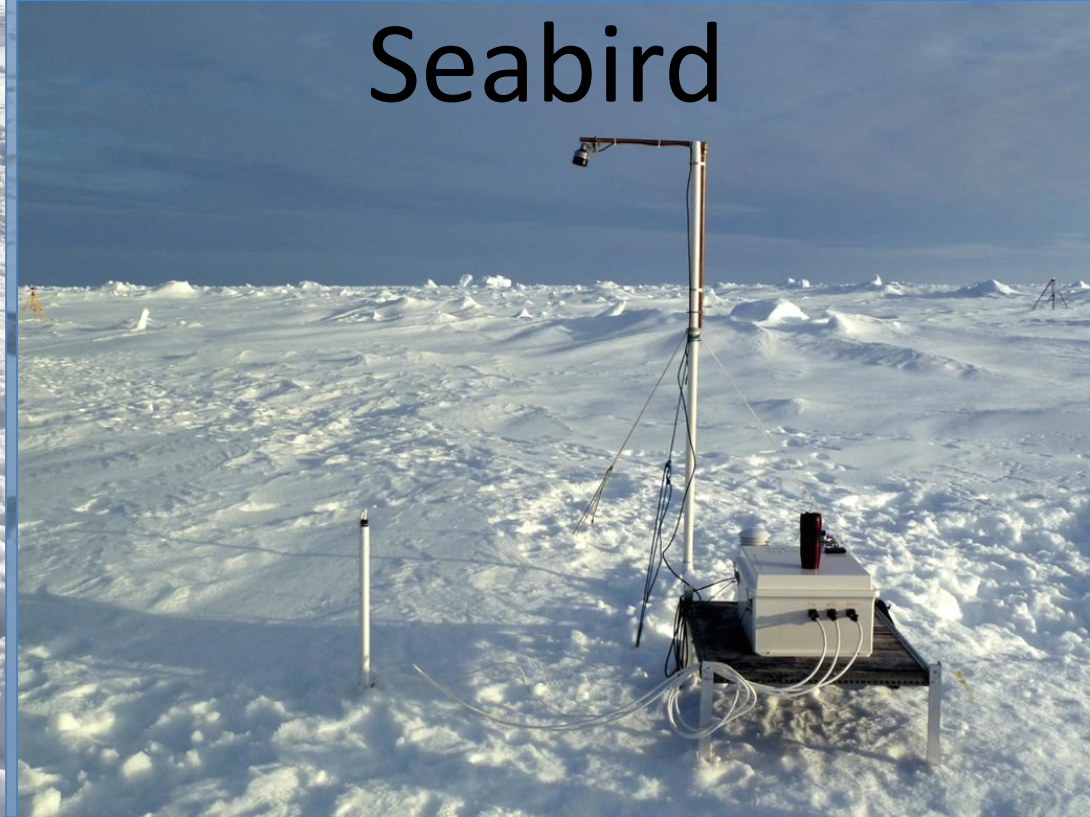
Radiometer

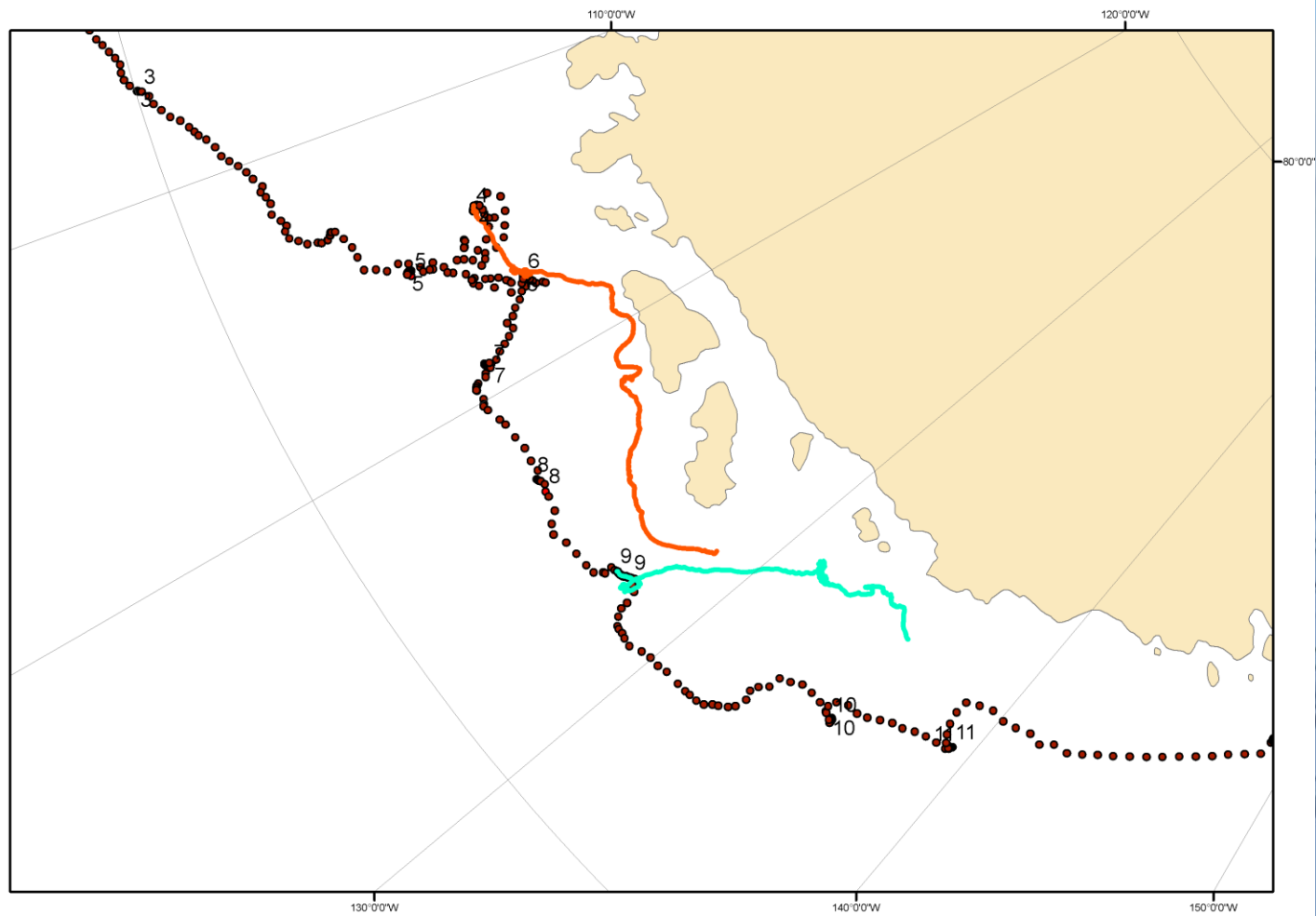


CRREL IMB's

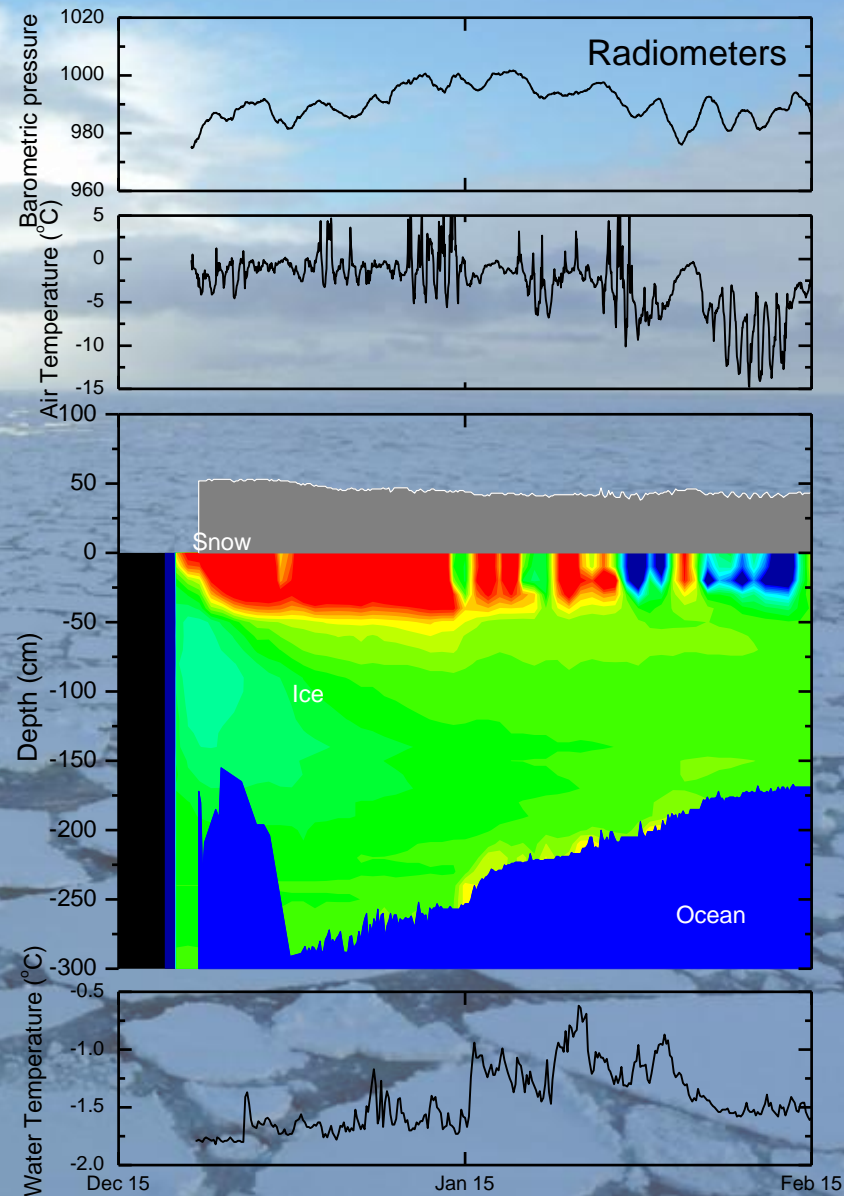
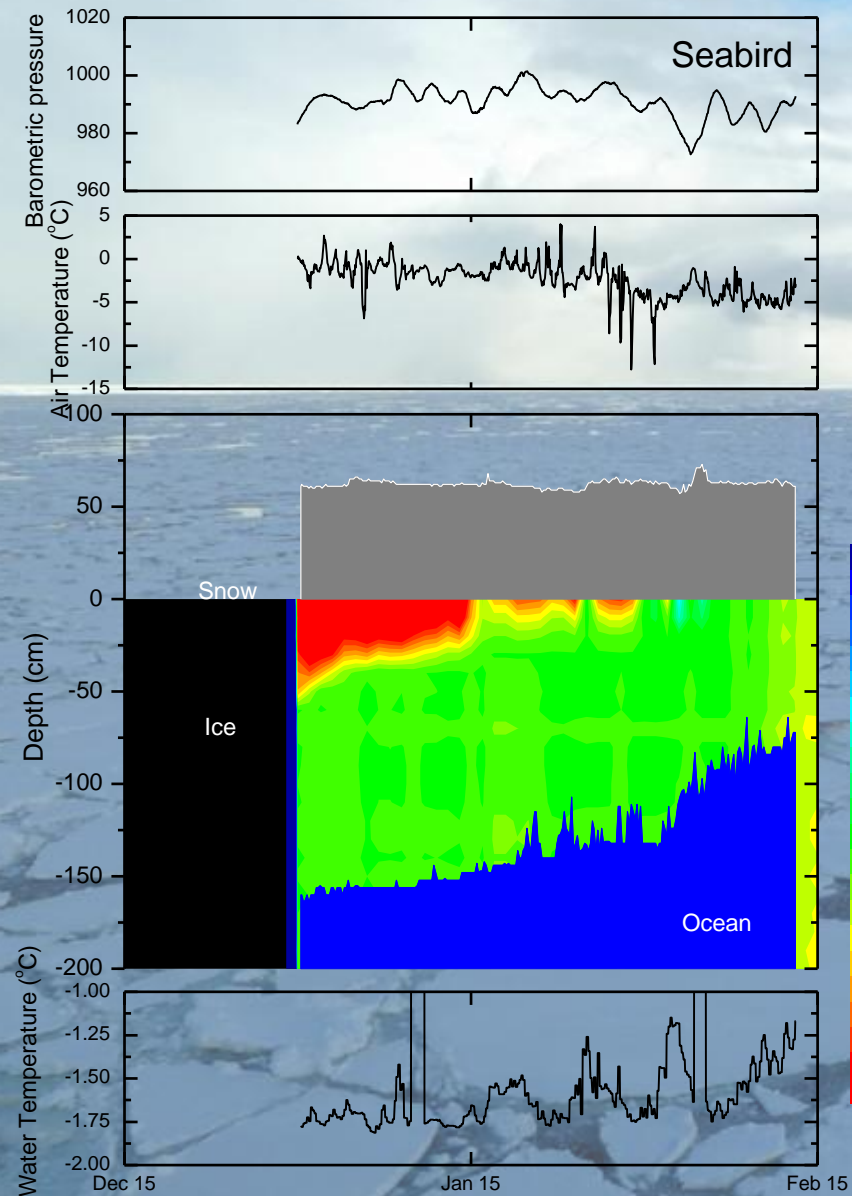


Seabird

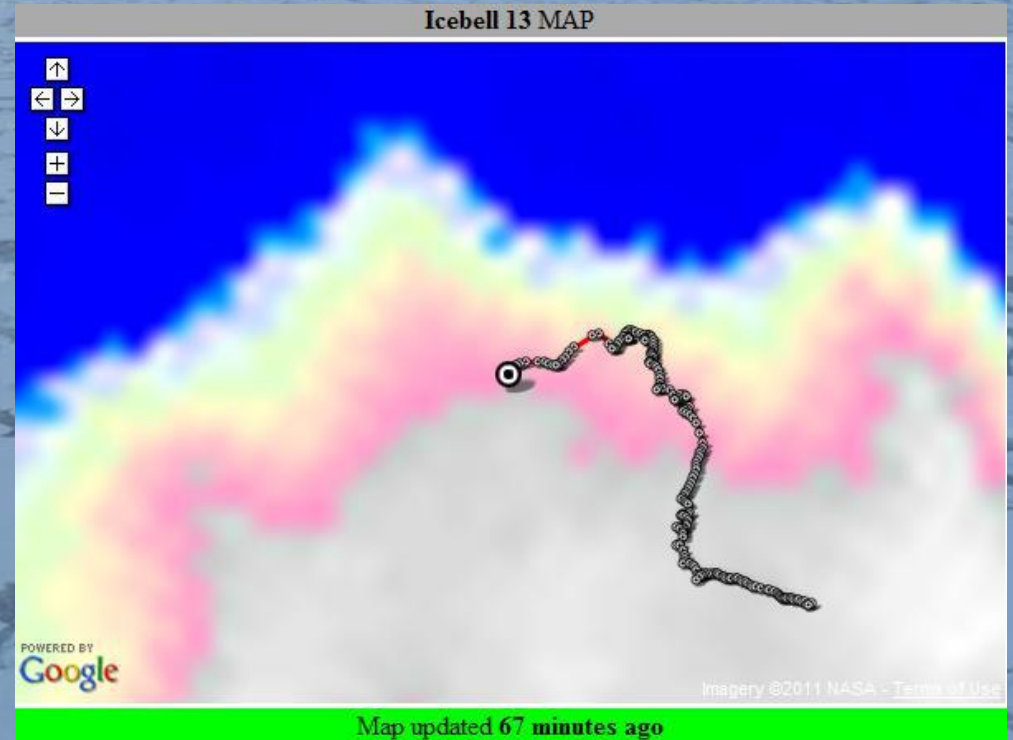




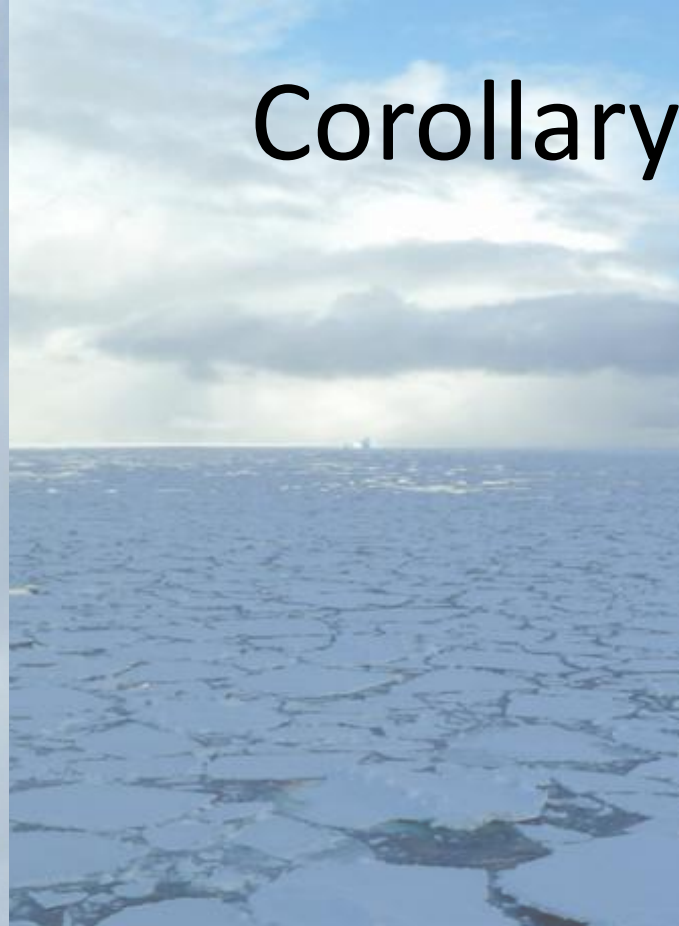
OSO1011 Cruise and IMB Drift Track



SAMS SIMBA Buoys



Corollary activities

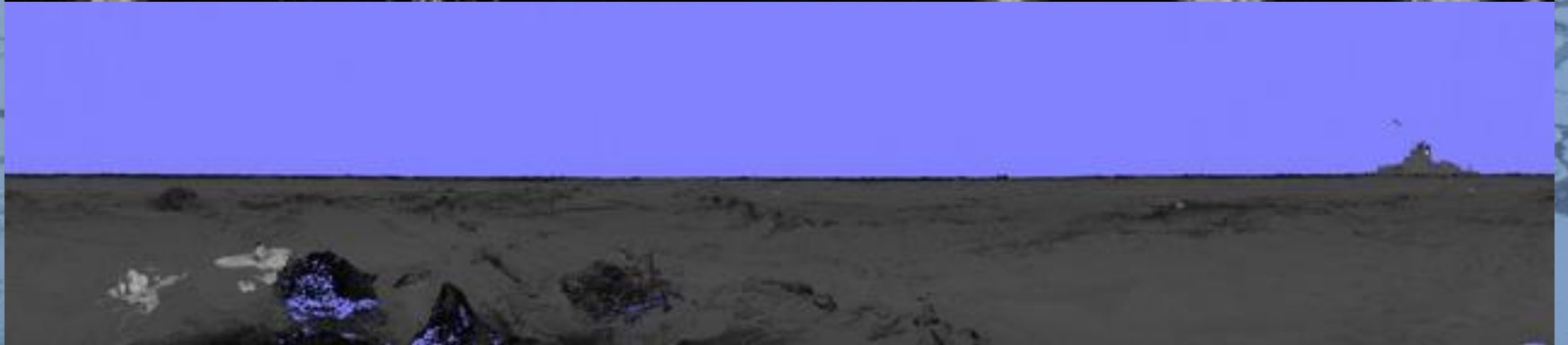


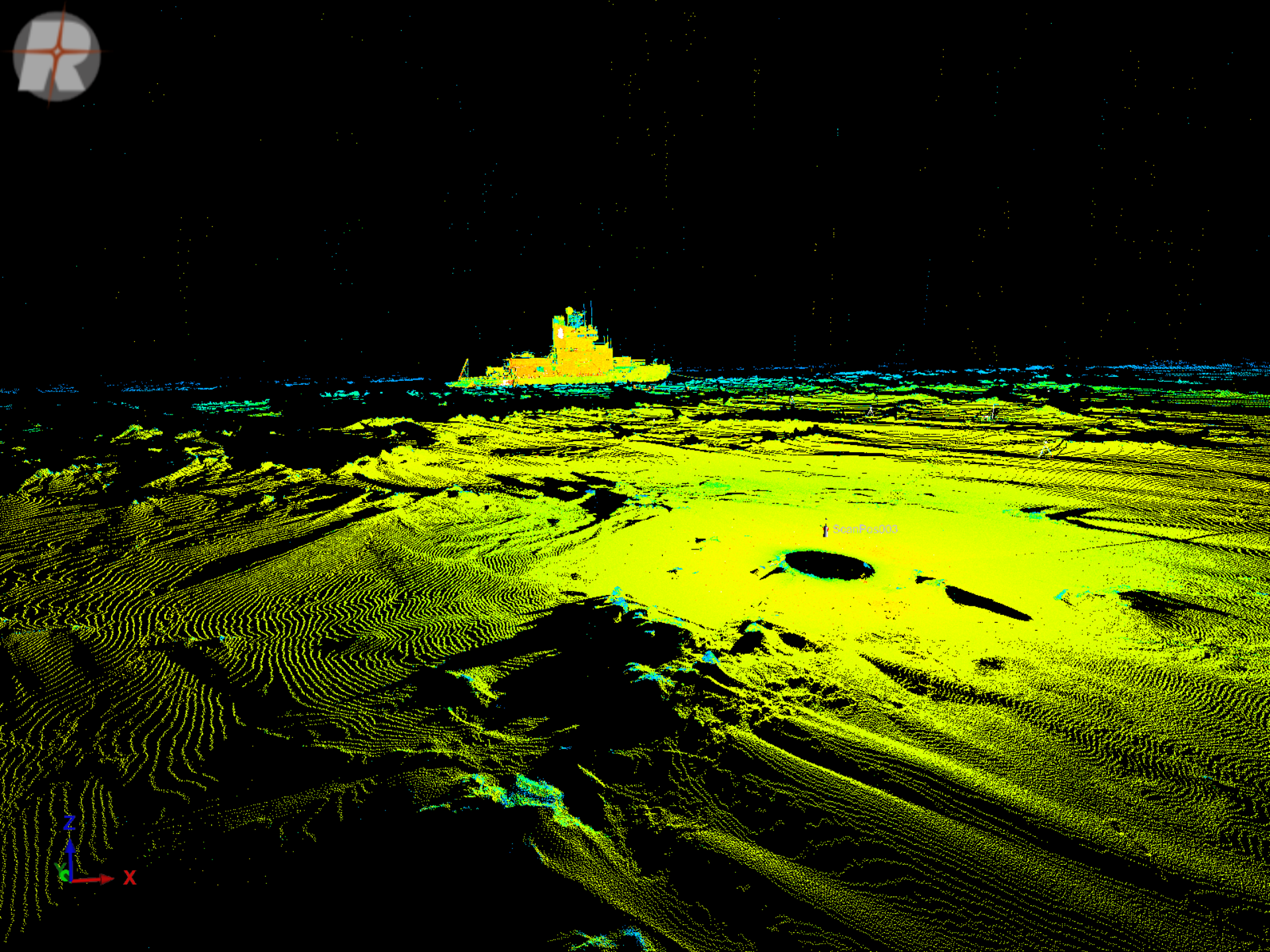
What is “LiDAR”?

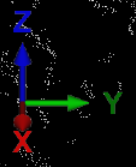
- LiDAR = Light Detection And Ranging
- Satellite-based LiDAR
 - ICESat I (operational until April 2010)
 - ICESat II (launch 2016)
- Airborne LiDAR
 - NASA’s Ice Bridge polar flights
 - BAS IceBell project
- Terrestrial LiDAR
 - Oden’s Amundsen survey
 - JC Ross’s Weddell/Bell. survey

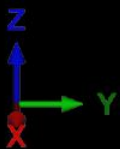
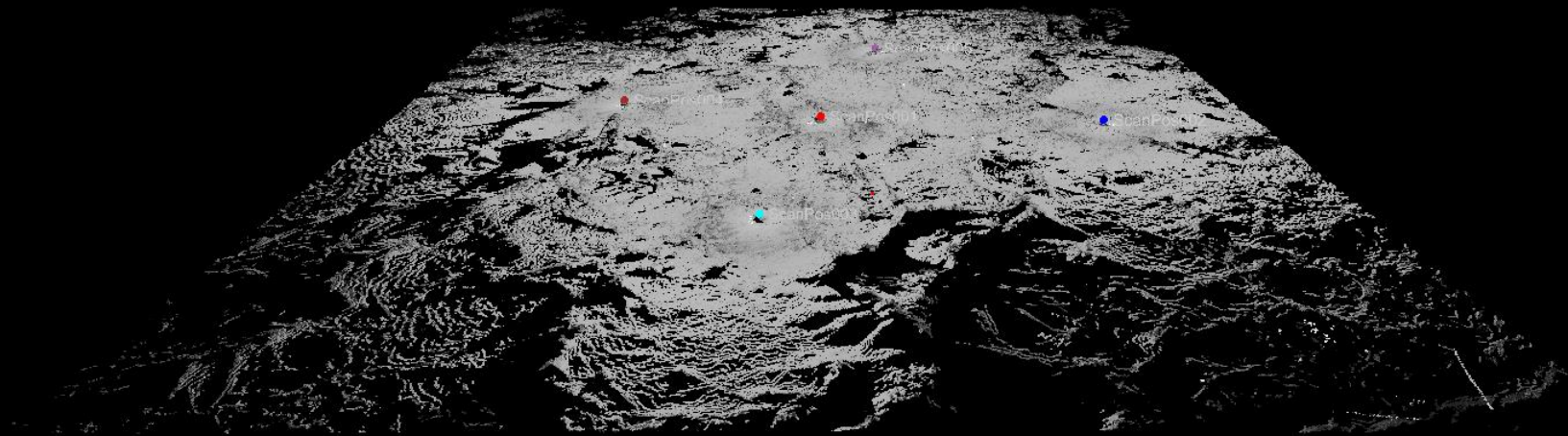


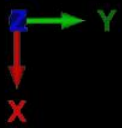
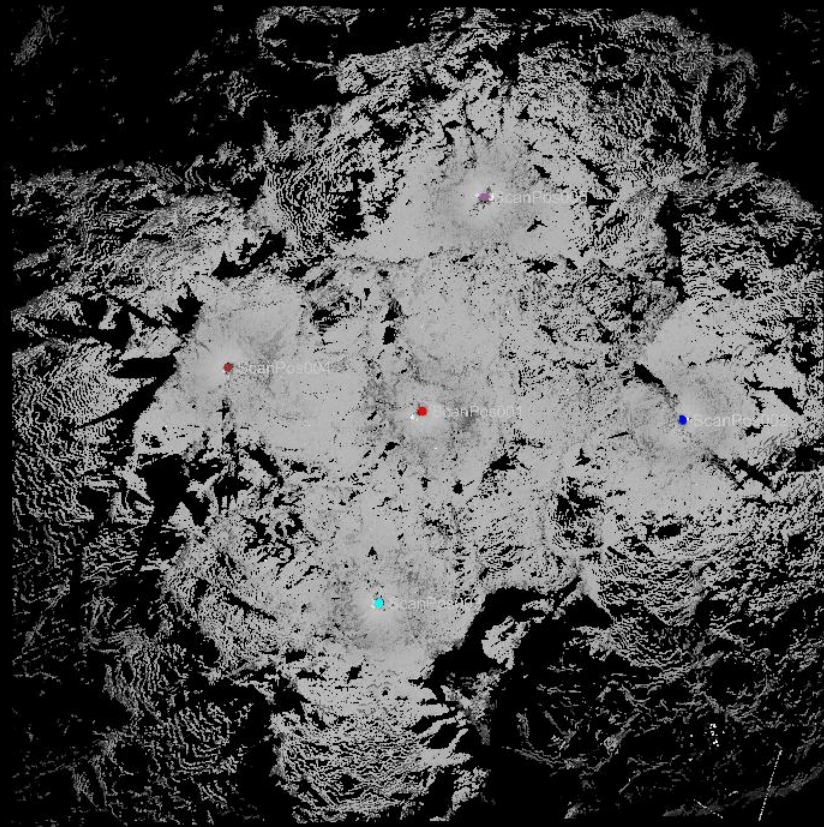
Panorama LiDAR scan













Questions?

