



NRL Use of IceBridge Sea Ice Products

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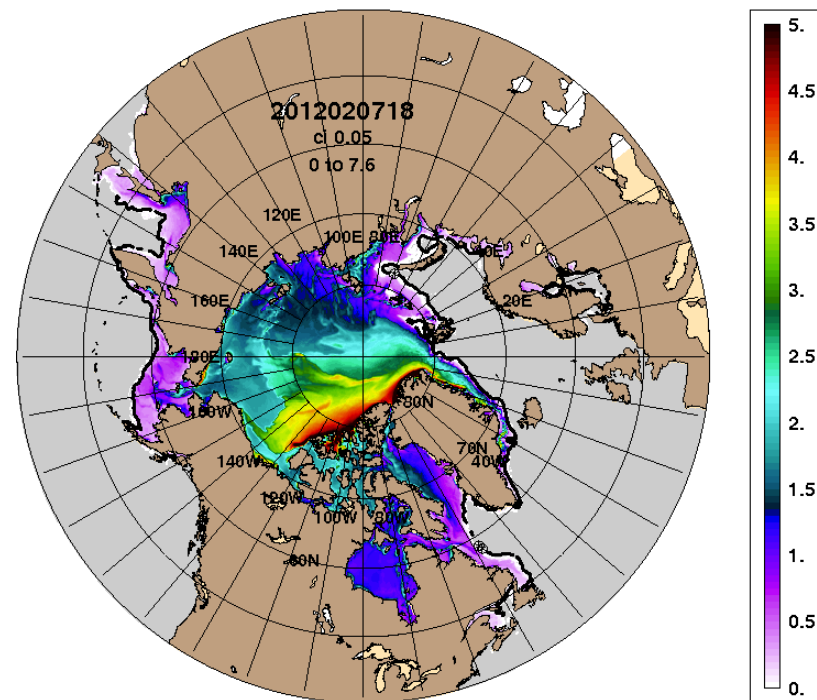
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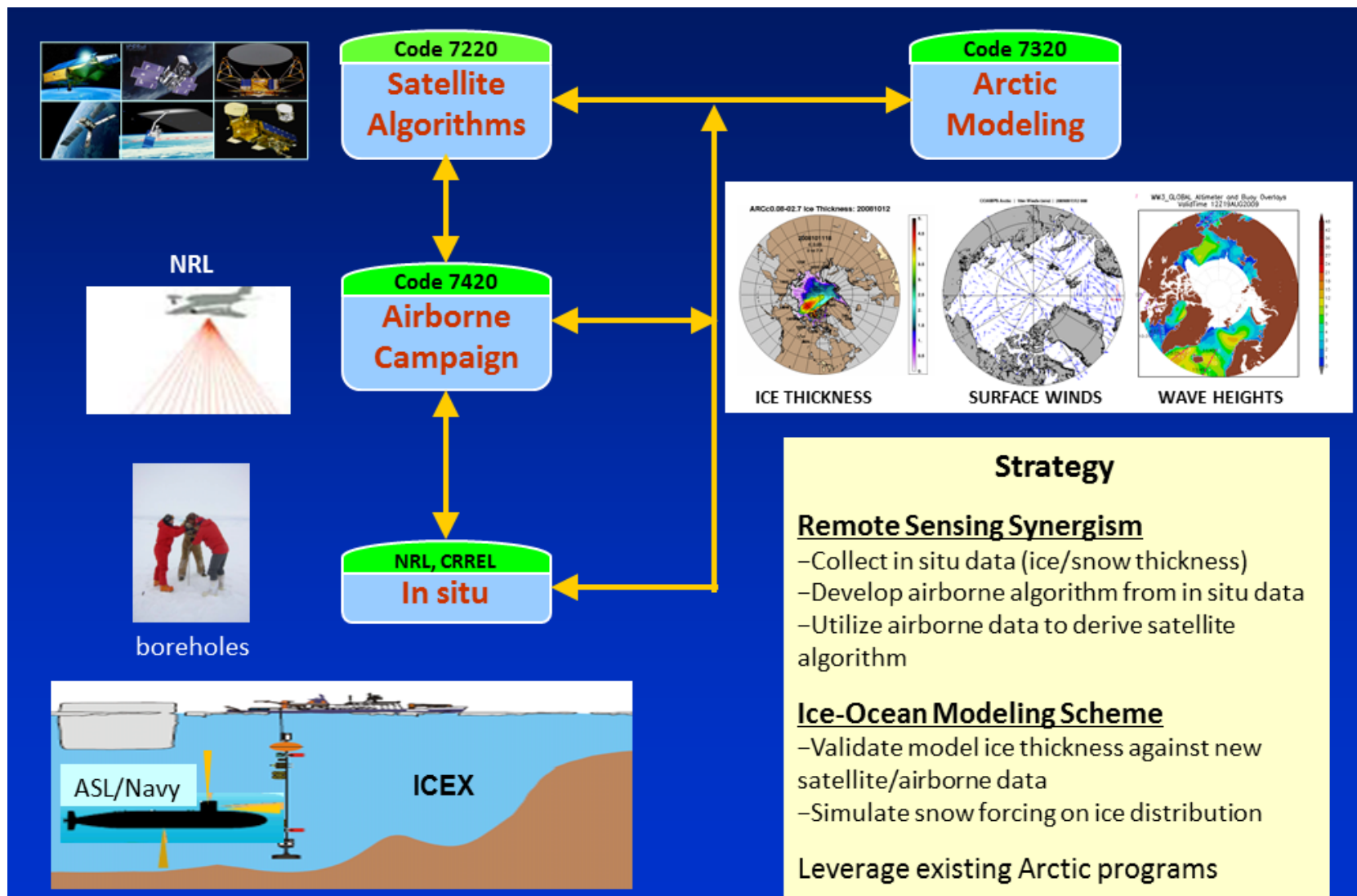
ARCc0.08-03.5 Ice Thickness: 20120205



IceBridge Science Team Meeting

January 2012, Goddard Space Flight Center, Greenbelt, MD

NRL 6.1 Program: Determining the Impact of Sea Ice Thickness on the Arctic's Naturally Changing Environment (DISTANCE)





NRL Use of IceBridge Sea Ice Products

- **NRL Arctic Cap Nowcast/Forecast System (ACNFS) ice model validation and IceBridge data assimilation (Rick Allard, Pamela Posey)**
 - Injected the IceBridge snow depth and ice thickness data into the data subsystem
 - Preliminary ACNFS and IceBridge data comparisons are encouraging
 - Working on assimilation of IceBridge ice thickness and snow data into ACNFS ice model
- **Coordinated airborne campaigns with OIB (John Brozena, Joan Gardner)**
 - ICEX 2010, 2011, 2012, 2013, **2014**
 - Use combined Lidar/Radar approach
 - Acquiring a snow radar from U Kansas (similar to what is flown on IceBridge)
- **Coordinated filed work with OIB (Jackie Richter-Menge, Don Perovich)**
 - ICEX2011, **2014**
 - Snow depth and ice thickness, and Snow/ice surface roughness
 - Characterization of snow and ice vertical profiles
- **Sensor physics and snow/ice retrievals (Li Li, David Truesdale)**
 - Impacts of snow/ice/lead properties on radar/radiometer signatures
 - EM Model development and validation using NRL/CRREL and IceBridge data sets (ATM, Ku-band radar altimeter, DMS, CAMBOT, and snow depth).
 - Model up-scaling from airborne (NRL/IceBridge) to satellite (CryoSat-2/AMSR-2/WindSat) platforms

Leveraging IceBridge Data is Essential for the Success of the DISTANCE Program



NRL Arctic Cap Nowcast /Forecast System (ACNFS)



- A Coupled Sea Ice & Ocean Model

<http://www7320.nrlssc.navy.mil/hycomARC/>

- 1/12° (3.5 km at Pole) horizontal resolution

- Ice Model (CICE)

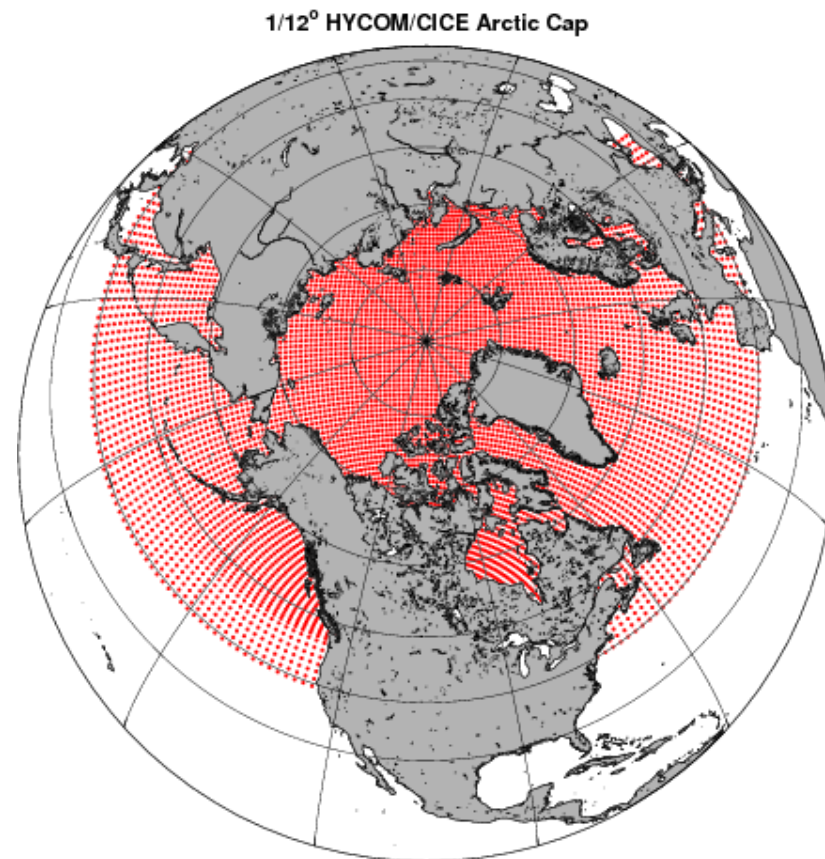
- Ocean Model (HYCOM)

- » Receives boundary conditions from 1/12° global model

- Navy Coupled Ocean Data Assimilation (NCODA) System

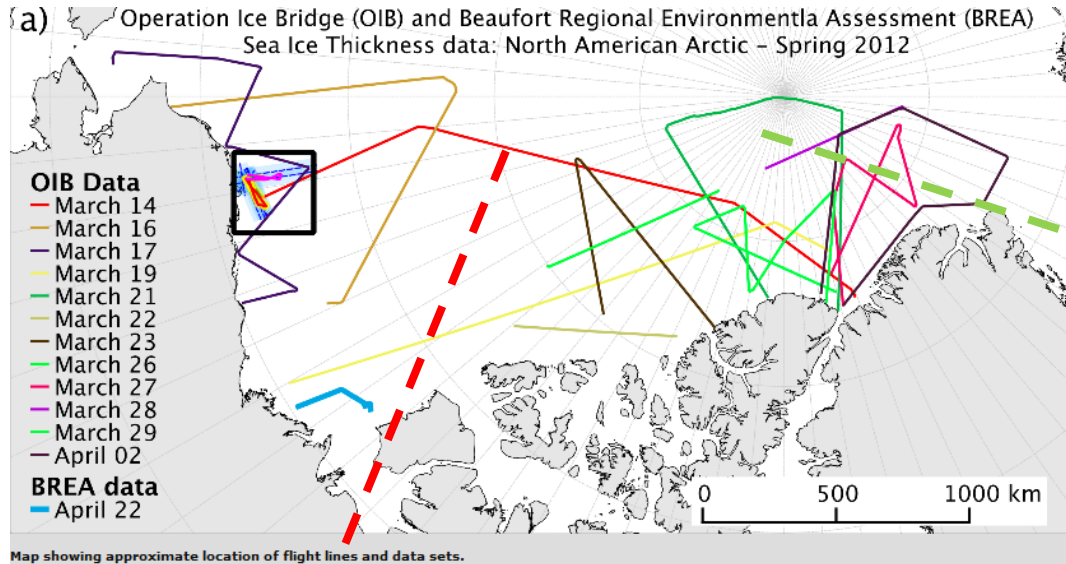
- Data Products:

- Ice thickness, ice concentration, ice speed and drift, sea surface height (SSH), sea surface temperature (SST) and sea surface salinity (SSS)



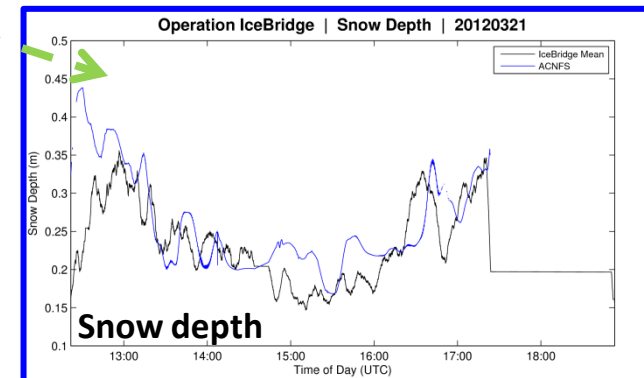
ACNFS model domain: every 20th grid point plotted

Preliminary Examination of 2012 NASA IceBridge Data

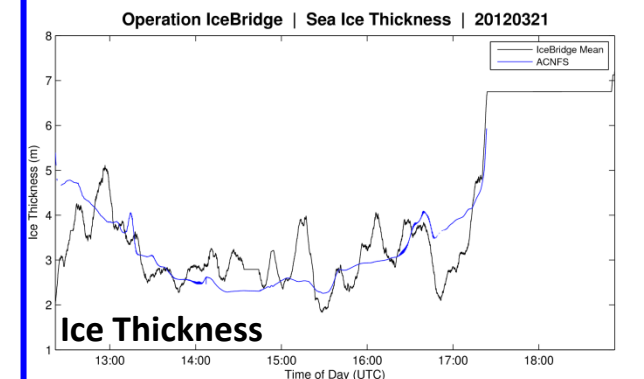
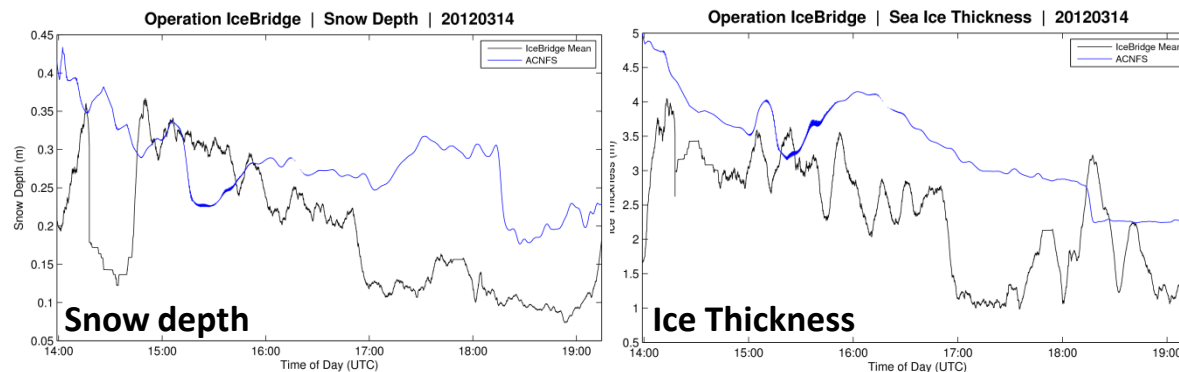


Observation ———
Model ———

March 21, 2012



March 14, 2012



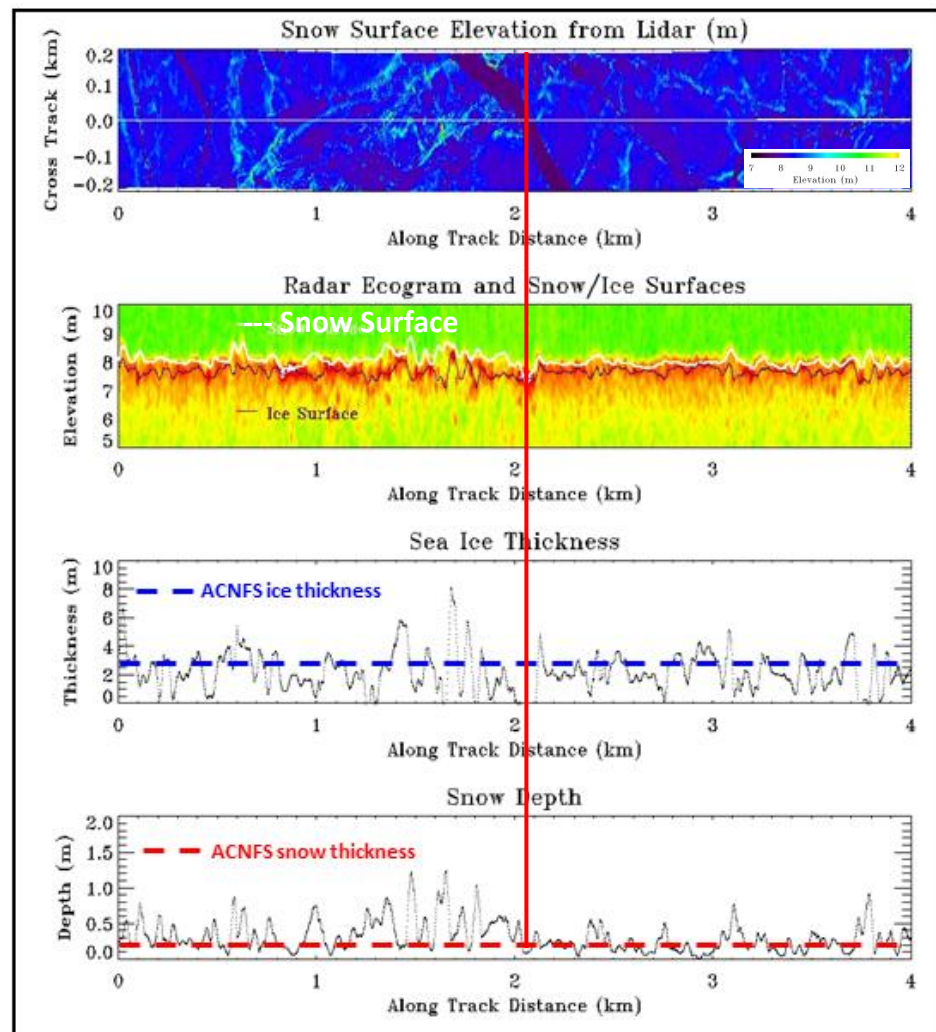
Long Term Goal: Ability to assimilate remotely sensed ice thickness and snow data into ice model



Sea Ice Thickness and Snow depth Estimates Using NASA IceBridge Airborne Radar+LiDAR Data



- NRL has developed a preliminary combined laser/radar altimeter algorithm for retrieving sea ice thickness and snow-on-ice depth.
- First CryoSat-2 underflight flown by NASA IceBridge on 20 April 2010.
- [Top right panel](#) shows snow surface elevation measured by Airborne Topographic Mapper (ATM) LiDAR at 500m altitude.
- [Second panel](#) shows ku-band radar altimeter ecogram data at lower resolution ($\sim 16 \times 10$ m) to detect snow and ice surfaces.
- [Bottom panels](#) depict derived sea ice thickness and snow depth; ACNFS data shown as dashed line.

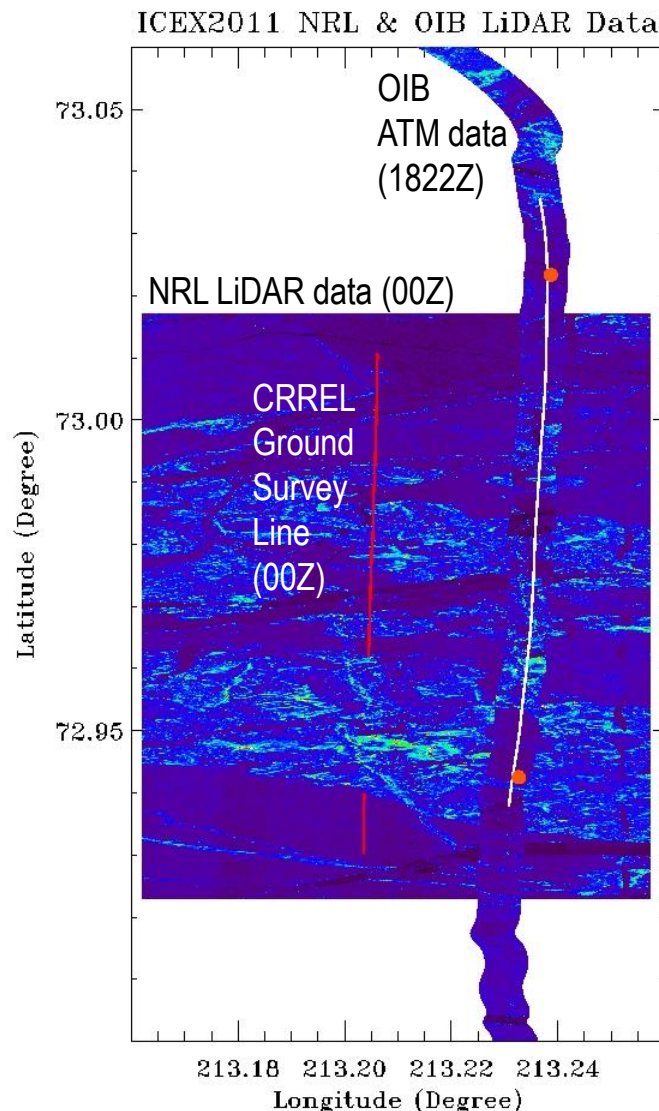


CryoSat-2 Underflight by NRL & IceBridge (Mar 23, 2011)



Geolocation derived
from DMS data
using Google Earth.
Estimation error: 700m

- [Goal](#): Sensor signatures and their up-scaling from airborne to satellite.
- [NRL LiDAR](#): Snow surface roughness.
- [CRREL In Situ](#): Validation
- [OIB LiDAR/Radar](#): Data synergism.
- [OIB DMS/CAMBOT](#): Snow/ice characterization, geolocation.

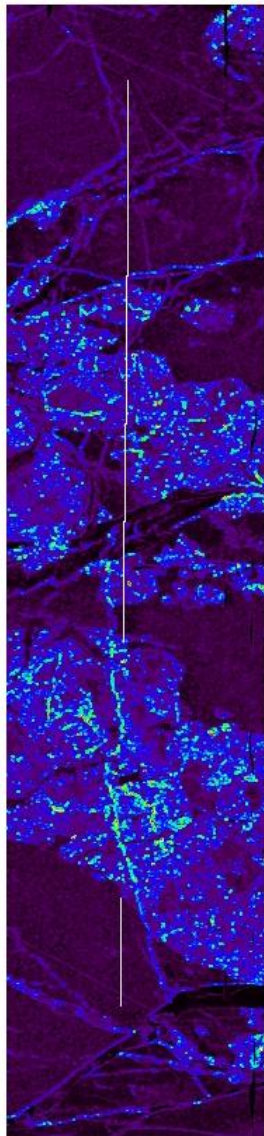




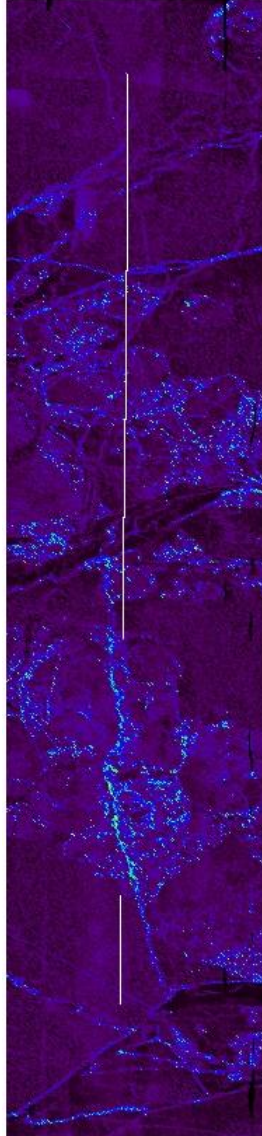
NRL LiDAR Data Collection and Snow Surface Roughness (Mar 23, 2011)



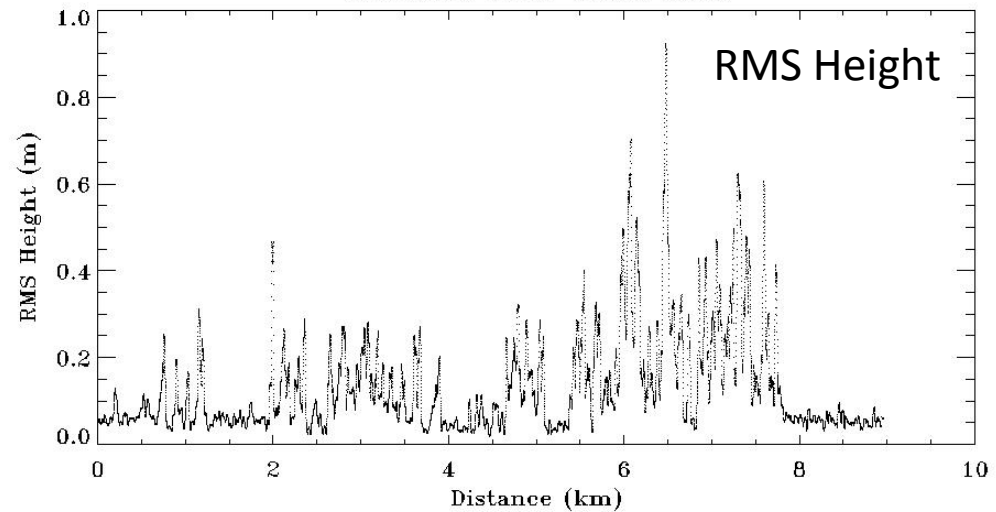
RMS Height



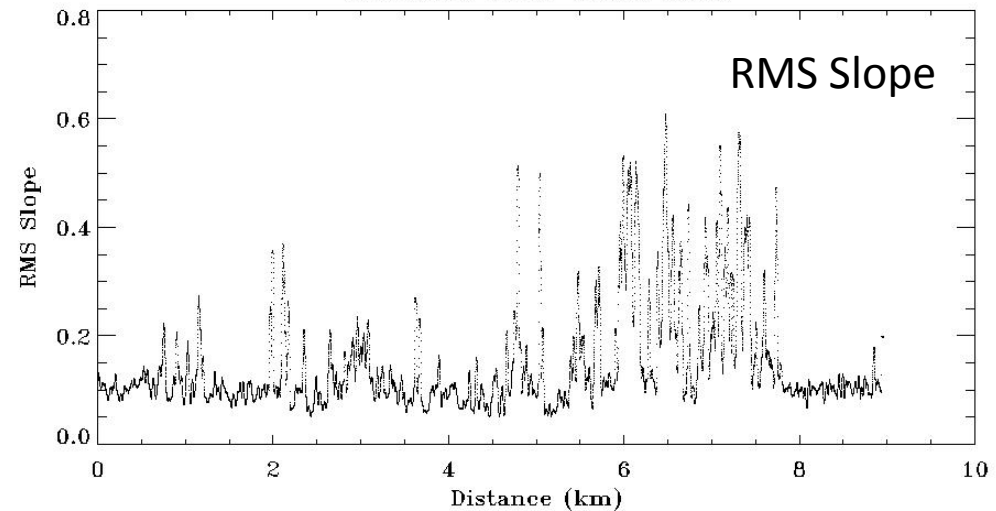
RMS Slope



NRL ICEX 2011 Lidar Data



NRL ICEX 2011 Lidar Data

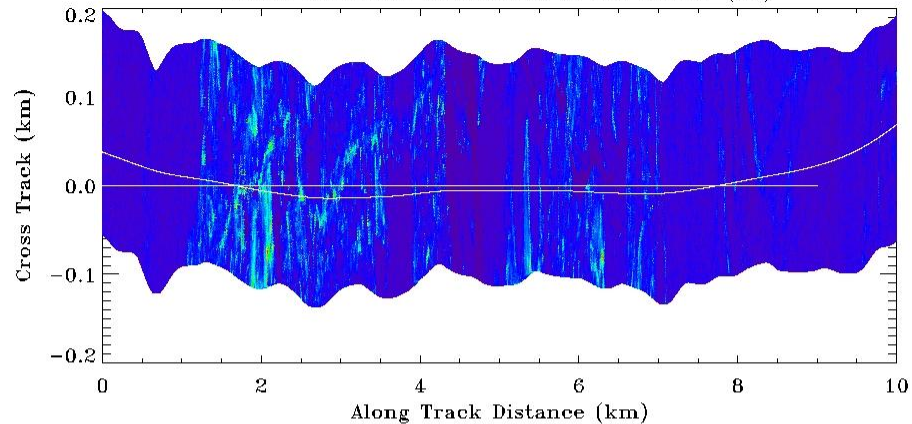




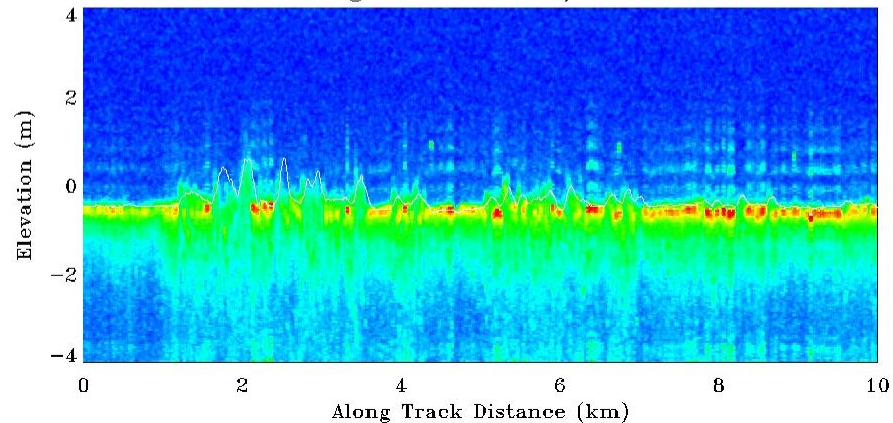
IceBridge Combined Ku-Band Radar+ ATM Data



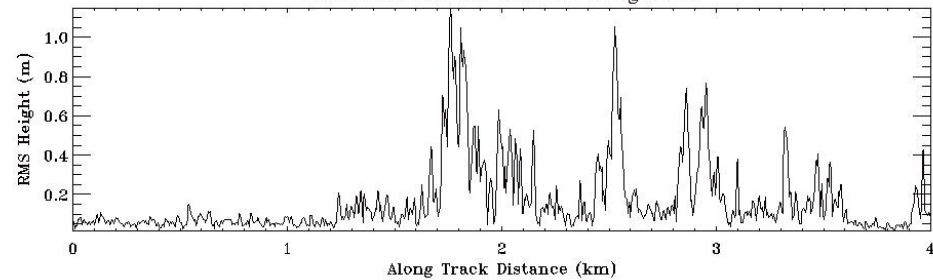
Snow Surface Elevation from Lidar (m)



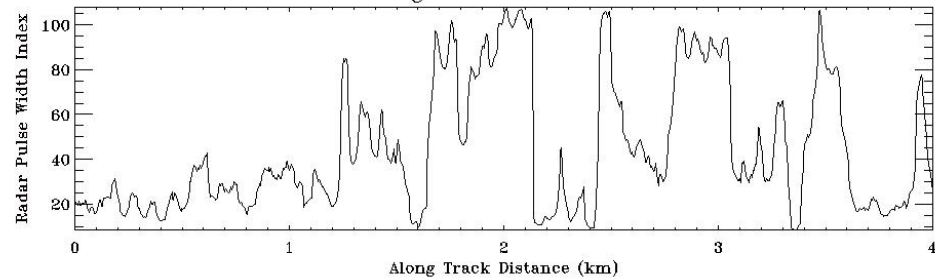
Radar Ecogram and Snow/Ice Surfaces



ATM Data Derived Surface Roughness



IceBridge Ku-Band Radar Echo



IceBridge Ku-Band Radar Echo

