OIB Science Team Meeting: Sea Ice Workshop

30 January 2013

Objective: Review and advance the status of OIB Sea Ice Community Products

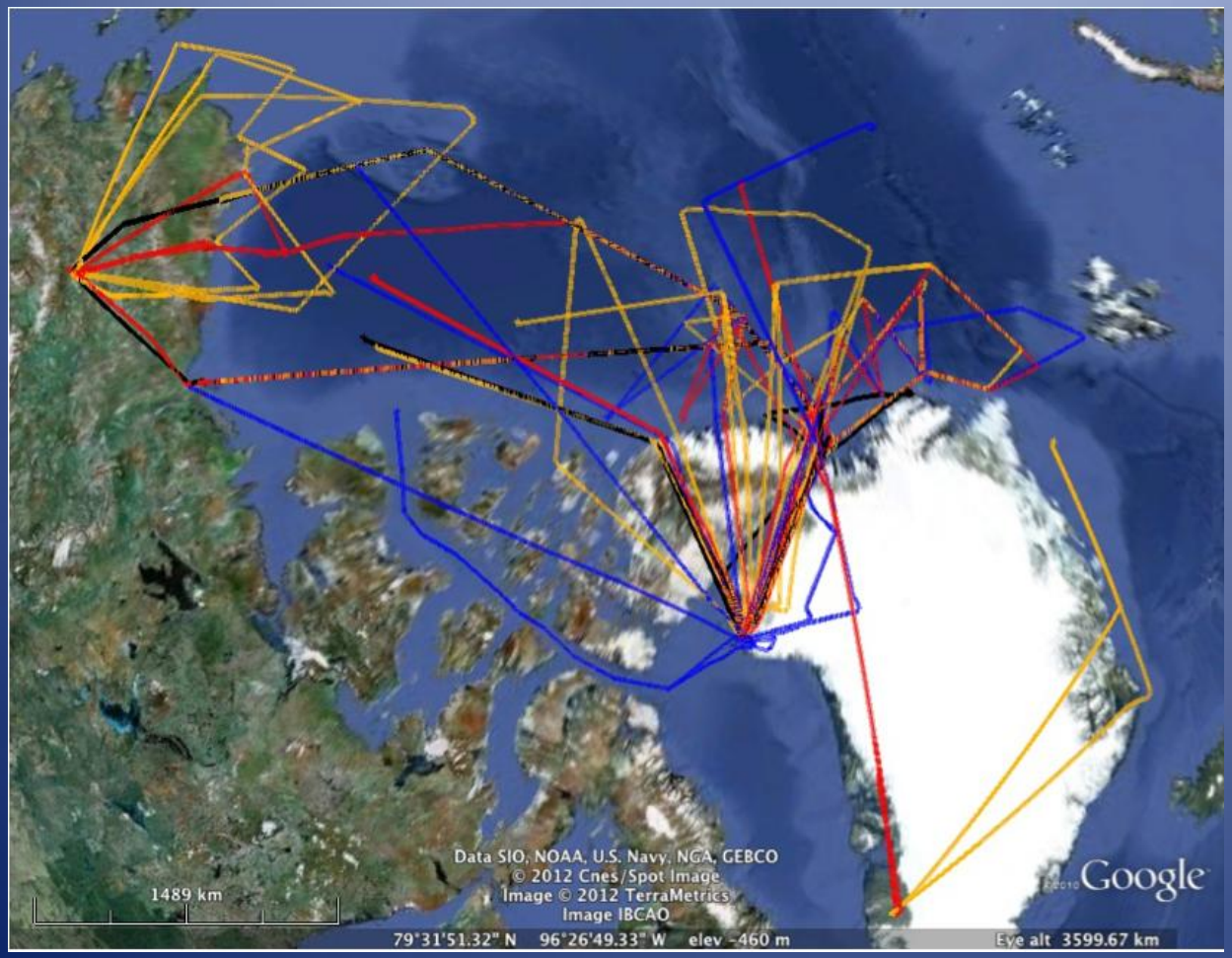
OIB Sea Ice Science Goals

- ***Document the spatial and interannual changes in the mean sea ice thickness and the thickness distribution (and snow depth) in the Arctic and Southern Oceans between ICESat and ICESat-2, in support of climatological analyses and assessments.***

- ***Improve sea ice thickness retrieval algorithms by advancing technologies for measuring sea ice surface elevation, freeboard, and snow depth distributions on sea ice.***

NASA Operation IceBridge

NASA airborne mission, multi-instrument suite, launched in March 2009 to bridge gap between ICESat and ICESat-2



Arctic Sea Ice Flights

2009: 6

2010: 8

2011: 9

2012: 14

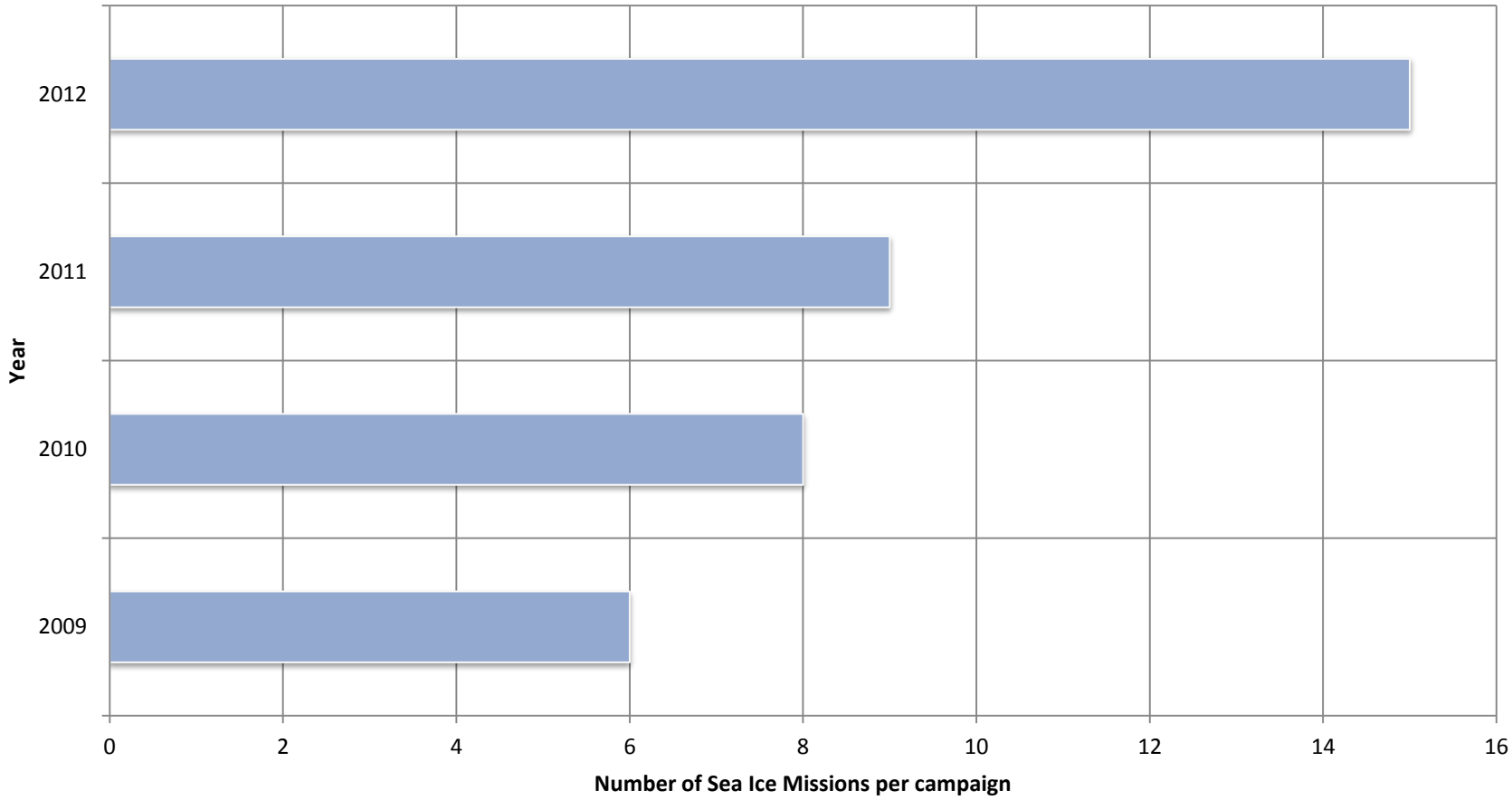
Instrumentation

- ATM Laser Altimeter
- Kansas Snow Radar
- Digital Photography
- LVIS laser (high altitude)
- LDEO Gravimeter
- Thermal imager (KT19)

More info at: nsidc.org/data/icebridge/

Accomplished Sea Ice Missions P-3B

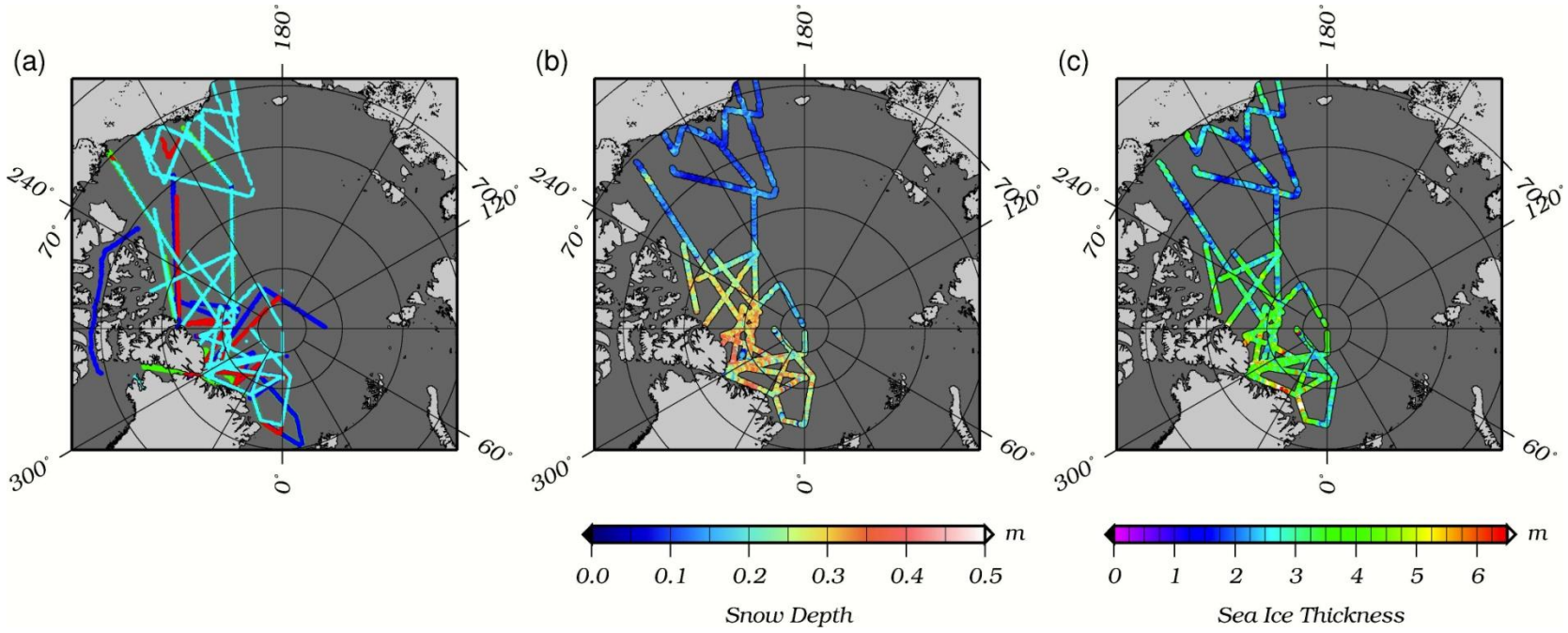
Comparison with previous campaigns



2012: Significant increase in scope of sea ice missions

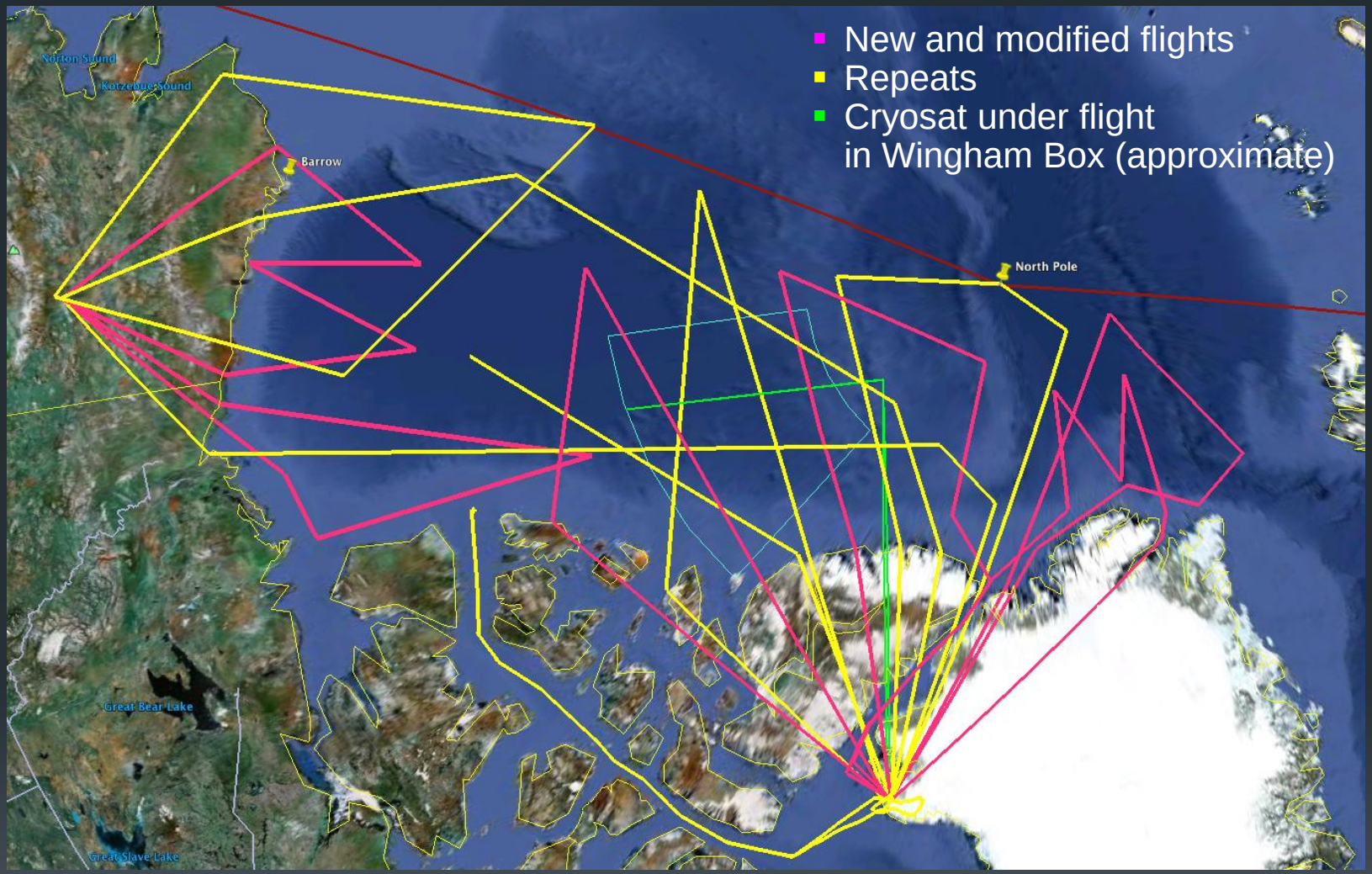
IceBridge: 2012 Arctic Campaign

Quick-look sea ice products



Snow depth and ice thickness estimates available within 1 month

IceBridge 2013 Arctic Campaign: Draft flight line recommendations



- 15 Flight lines (14 in 2012)
- March 20 – April 2: 14 day window of operation (21 in 2012)
- Thule: Primary base of operation; temporary relocation in Fairbanks
- Reflects early coordination with ESA, CSA, ONR MIZ

OIB Science Team Meeting: Sea Ice Workshop

Agenda

- **Session 1: Current Efforts – Successes and Challenges in Generating and Using IceBridge Sea Ice Products**
  - Presentations from researchers using sea ice data from OIB (~ 10 min. each)
  - Discussion: Identify and address gaps in the collection, delivery and use of IceBridge sea ice community products
- **Session 2: Exploring Opportunities for Collaboration**
  - Discussion: Identifying and coordinating opportunities for collaboration
    - Complementary airborne, satellite and ground activities: Cal/val
    - Arctic 2013: ESA, CSA, ONR MIZ, NRL, AOX/NAICEX/BROMEX , AWI Polar5,Others?
    - Arctic 2014: ESA CryoVEx, ONR MIZ, NRL DISTANCE, Others?
    - Antarctic
- **Session 3: Future Arctic Sea Ice Observations: Increased Utilization of Sub-Orbital Assets**
  - Kick off: Ideas from IceBridge Sea Ice Science Team
  - Discussion: Without consideration of logistic or resource constraints, develop prioritized list of sea ice observations that would benefit from the increased use of autonomous airborne platforms

Future Arctic Sea Ice Observations: Increased Utilization of Sub-Orbital Assets

Motivating Questions:

- How is the ice pack changing from year to year in terms of snow depth and ice thickness distributions and what is causing the changes? What is natural variability and what is forced? What are the relative roles of the atmosphere and ocean in forcing the changes?

- What physical processes need to be better represented in models to improve predictions of the state of the sea ice cover and how can we best collect observations to aid in model improvements?

- How can we best take advantage of a suite of instrument measurements, mounted on sub-orbital platforms, to make accurate observations of the state of the ice pack and ocean and how can we know the accuracies of the resulting estimates? Are new instruments needed?

Future Arctic Sea Ice Observations: Increased Utilization of Sub-Orbital Assets

Key observations, measured (if at all possible) coincidentally:

- Parameters with highest priority:
  - Ice thickness
  - Snow depth
- Other parameters of high interest (many required to arrive at those of highest interest):
  - Freeboard
  - Surface elevation
  - Surface temperature
  - Lead statistics
  - Surface roughness
  - Surface reflectance

Future Arctic Sea Ice Observations: Increased Utilization of Sub-Orbital Assets

Temporal sampling:

- Spring, prior to melt (ala current OIB campaign)
  - Cross-basin survey of ice thickness and snow cover
  - Per current practice, March remains an ideal time for this survey
    - Provides good snapshot of ice conditions just prior to melt (e.g. maximum thickness distribution and snow depth)
    - Snow surface cold and dry
- Summer melt season into fall freeze up
  - Cross-basin surveys of surface conditions (e.g. melt pond evolution, albedo); once per month
  - Lagrangian approach
    - Track specific regions (i.e. set of floes) to monitor evolution of surface conditions
    - Drop location trackers from P3 during initial spring survey and/or use data from IABP
    - Monitor different regions with a range of ice types
      - » Beaufort/Chukchi: first year deformed and undeformed
      - » High Arctic (North of Canadian Archipelago) : Multiyear
- Winter (early October and late December)
  - Cross-basin survey of ice thickness and snow cover
    - Provides a snapshot of ice conditions at the onset of ice growth season just after the September sea ice minimum.
    - Two measurement campaigns (one in early October) and a second later in December would allow direct measurement of snow accumulation

Future Arctic Sea Ice Observations: Increased Utilization of Sub-Orbital Assets

Spatial sampling:

- Highest priority: Beaufort/Chukchi Seas region
  - Region seeing a lot of change (e.g. summer ice extent and composition of ice cover) in recent years
  - Area with highest US interest
- Canadian Beaufort
  - Feeds ice to the Alaskan/Chukchi region via the Beaufort Gyre
- Sea Ice North of the northern coasts of Greenland and Canadian Archipelago
  - Thickest ice
- Eastern Arctic (outside of Russian EEZ)
  - Dearth of information
  - May require diplomatic agreement

Future Arctic Sea Ice Observations: Increased Utilization of Sub-Orbital Assets

Assets:

- Instrumentation:
  - Snow radar (or the equivalent) very important!
  - Also priority: Airborne laser altimeter (lidar); High-resolution digital camera; Ku-band radar altimeter
  - Strategic overlap of aircraft platforms? (e.g. lidars operated at high-altitude, radars at lower altitudes)
- Airborne Platforms: Conventional airborne platforms (e.g. P3 and DC8)
  - Continue basin-scale surveys of ice thickness and snow depth, also provide info on lead and surface roughness characteristics
  - Instrument suite that we have learned to optimize and for which algorithms have been developed for the derivation of ice thickness and snow depth.
  - Barrow base of operations: Enables enhanced coverage of high priority areas (e.g. Alaskan Beaufort/Chukchi region and Canadian Beaufort)
- UAS:
  - New platforms should be integrated with conventional, airborne platforms to effectively assess accuracy and utility of new observations from unmanned aircraft
  - Global Hawk:
    - Not currently configured for snow depth measurements
    - Mindful of issues with cloud cover, especially in summer
    - Concern over footprint size, relative to spatial variability of surface features
  - Ikhana
    - Wide range of instruments, providing observations on just about everything
    - Concern about spatial coverage/range