US Interagency Arctic Buoy Program (USIABP) & International Arctic Buoy Programme (IABP)

Robust Autonomous Arctic Observations – Successes and Challenges

for

Arctic Observing Open Science Meeting

November 18, 2015

by

Ignatius Rigor, Pablo Clemente-Colón, Curtis Reinking, Micki Ream, and many others.

US Interagency Arctic Buoy Program (USIABP)

National Ice Center & Polar Science Center APL/UW

- **Goal:** Observe air, sea and ice using drifting buoys.
- **USIABP coordinates US contributions to the International Arctic Buoy Programme (IABP),** which has 34 Participants from 10 different countries, including the WCRP and EUMETNET.
- **Observations are used for both operations** (WMO/IOC GTS) **and research** (http://IABP.apl.washington.edu)**.**
  - forecasting weather and ice conditions,
  - validation and forcing of climate models,
  - validation of satellite data,
  - assimilated into reanalysis fields (e.g. NCEP/NCAR), and
  - for studies of climate change.
- **Data are archived** at ISDM, CADIS, etc.
- **Contributors to USIABP:** CG, DOE, NASA, Navy (NAVO, NRL, ONR), NIC, NOAA (ARO, NESDIS, OCO), NSF, Shell.

US Interagency Arctic Buoy Program (USIABP)

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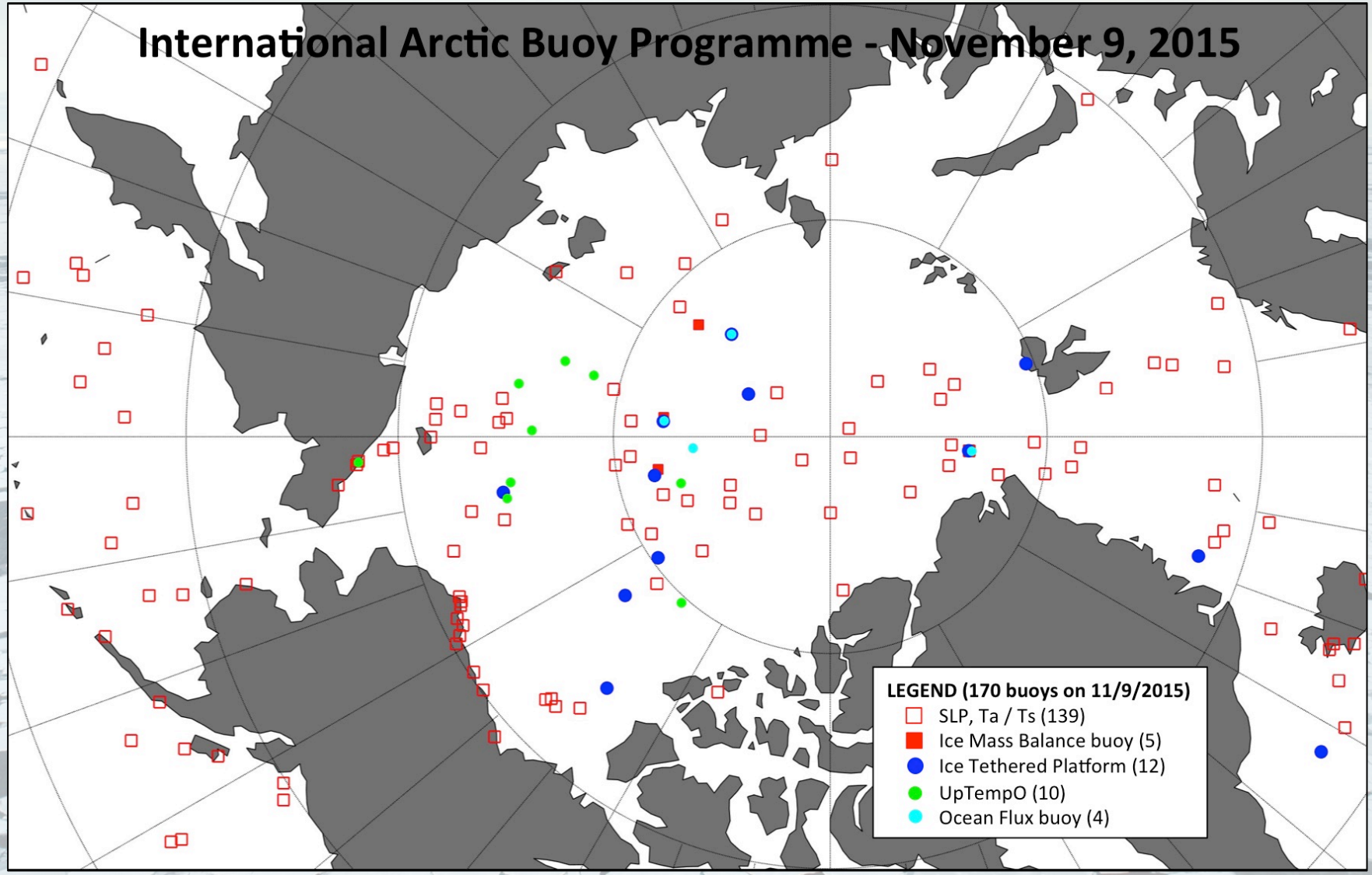


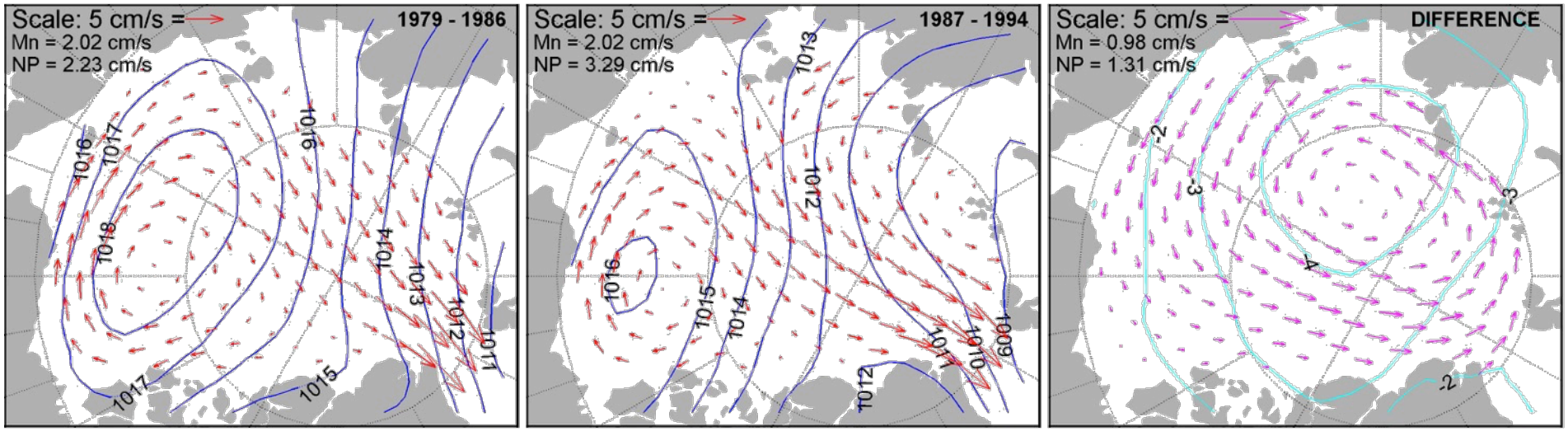
International Arctic Buoy Programme

North Pole Environmental Observatory

A myriad of meteorological, ice, ocean and webcam buoys.

Source: psc.apl.washington.edu/northpole

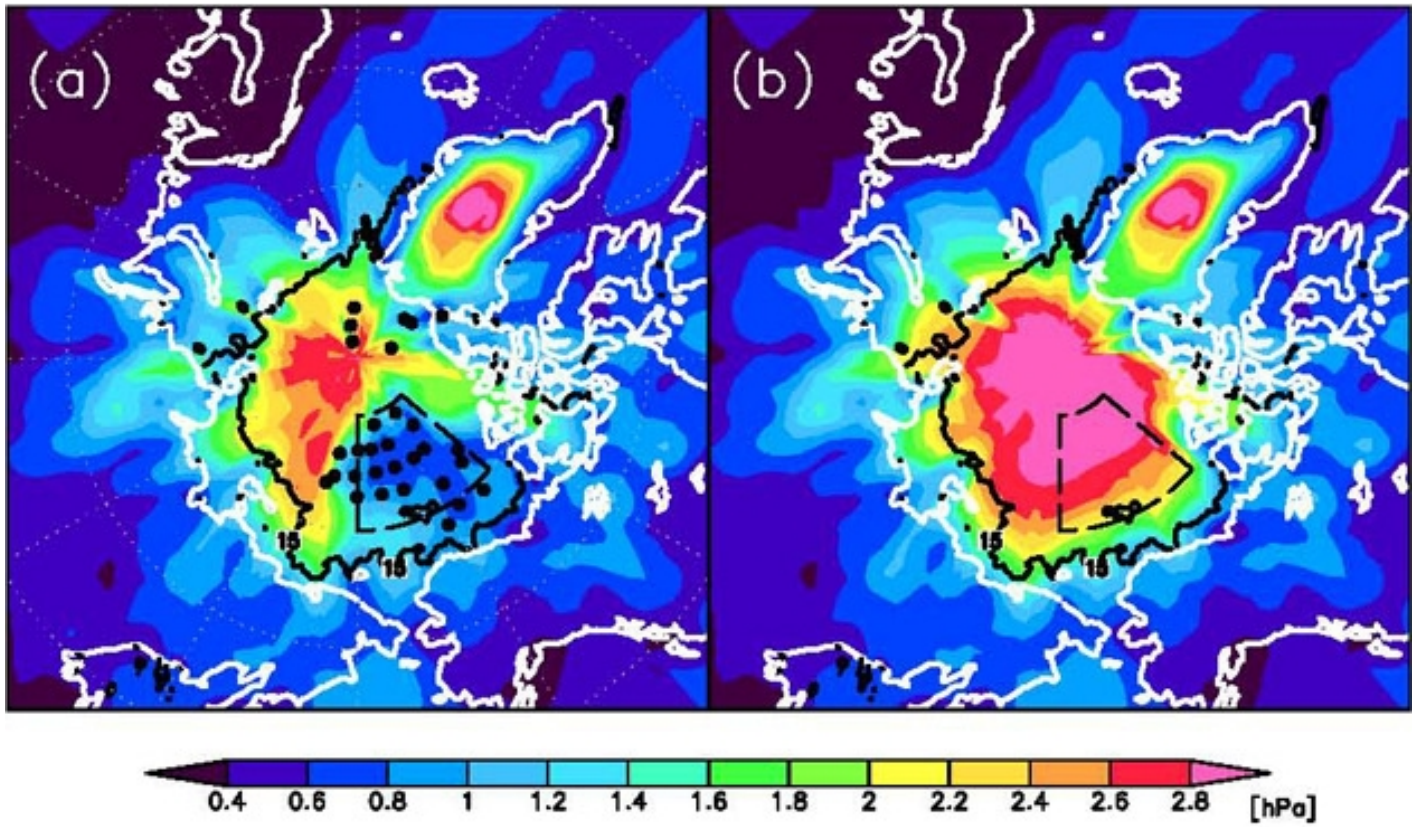
Changes in Atmospheric Circulation 1979 – 1994



Using the IABP Sea Level Pressure (SLP) fields, Walsh et al. (1996) showed that SLP dropped by as much as 4 mb over the Arctic Ocean, which drives a counter-clockwise anomaly in ice motion (right). These figures show the mean field of SLP and ice motion for 1979 – 1986 (left), 1987-1994 (middle), and the the difference between these two 8 year periods (right). This is one of the first studies to report Arctic Climate Change!

(Adapted from Walsh et al. 1996)

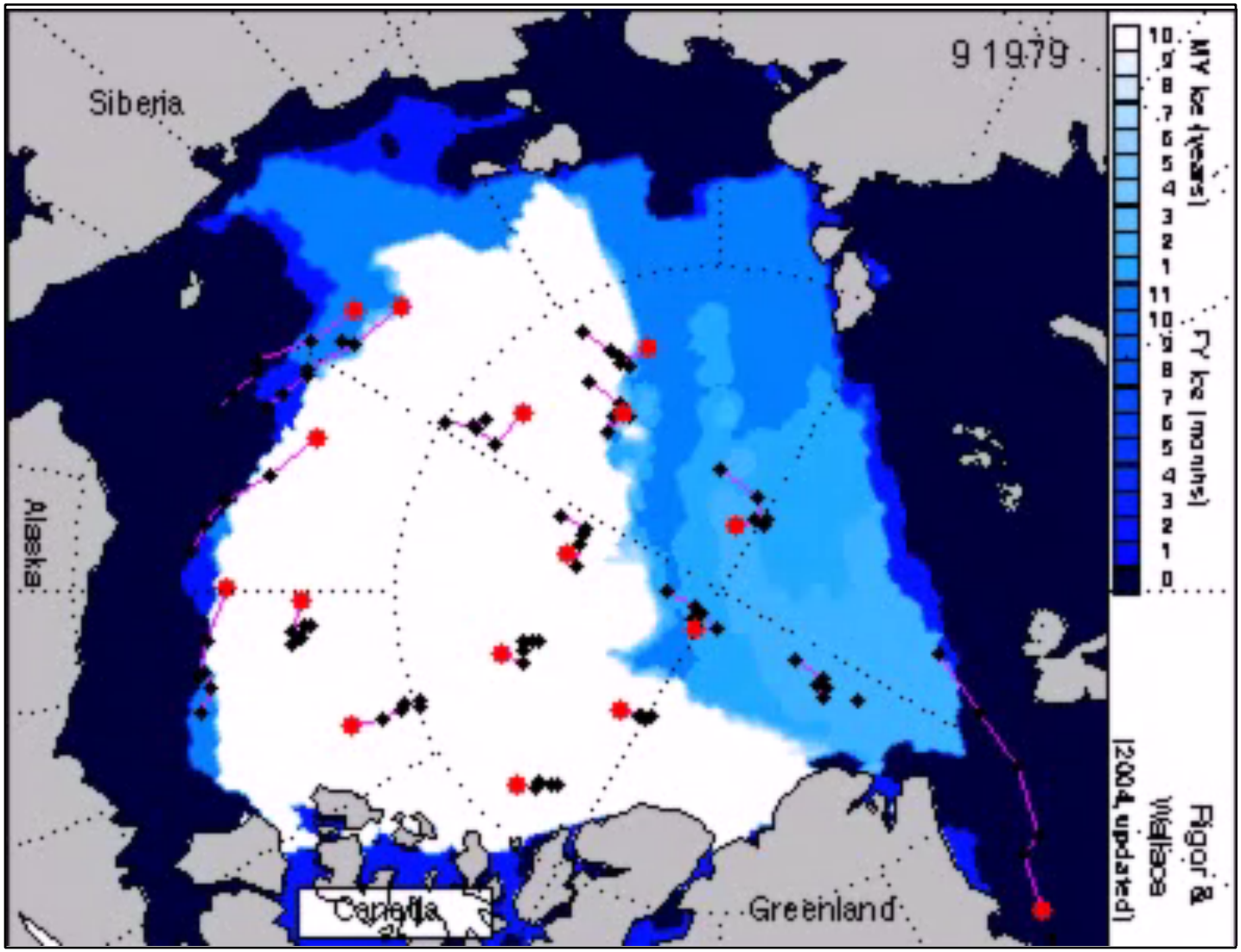
Impact of buoy obs. on SLP fields.



The spread between SLP Reanalyses is low in areas where there are buoy observations (left). The spread increases to cover the whole Arctic when the buoys are removed from the reanalyses (right). The buoy obs. also help constrain of estimates of wind and heat.

(Inoue et al, 2009)

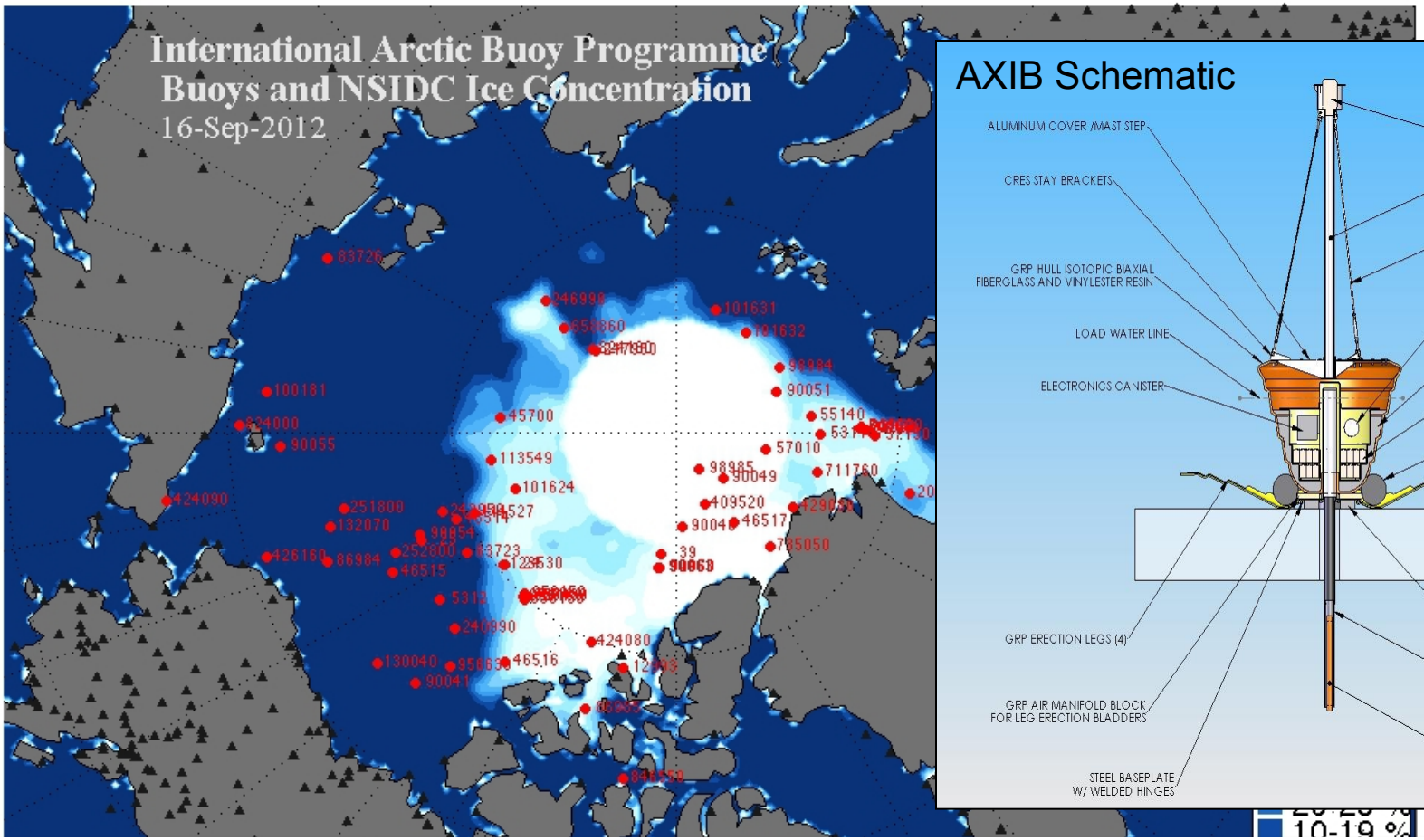
Retreat of Arctic Sea Ice



- Sea ice grows thicker with age.
- Prior to 1989, ice over 80% of the Arctic Ocean is at least 10 years old.
- High Arctic Oscillation (AO) winds flushed most of the older thicker sea ice out of the Arctic.
- Younger (thinner) Ice persists through today despite "normal" AO conditions.

(Rigor and Wallace, 2004; updated)

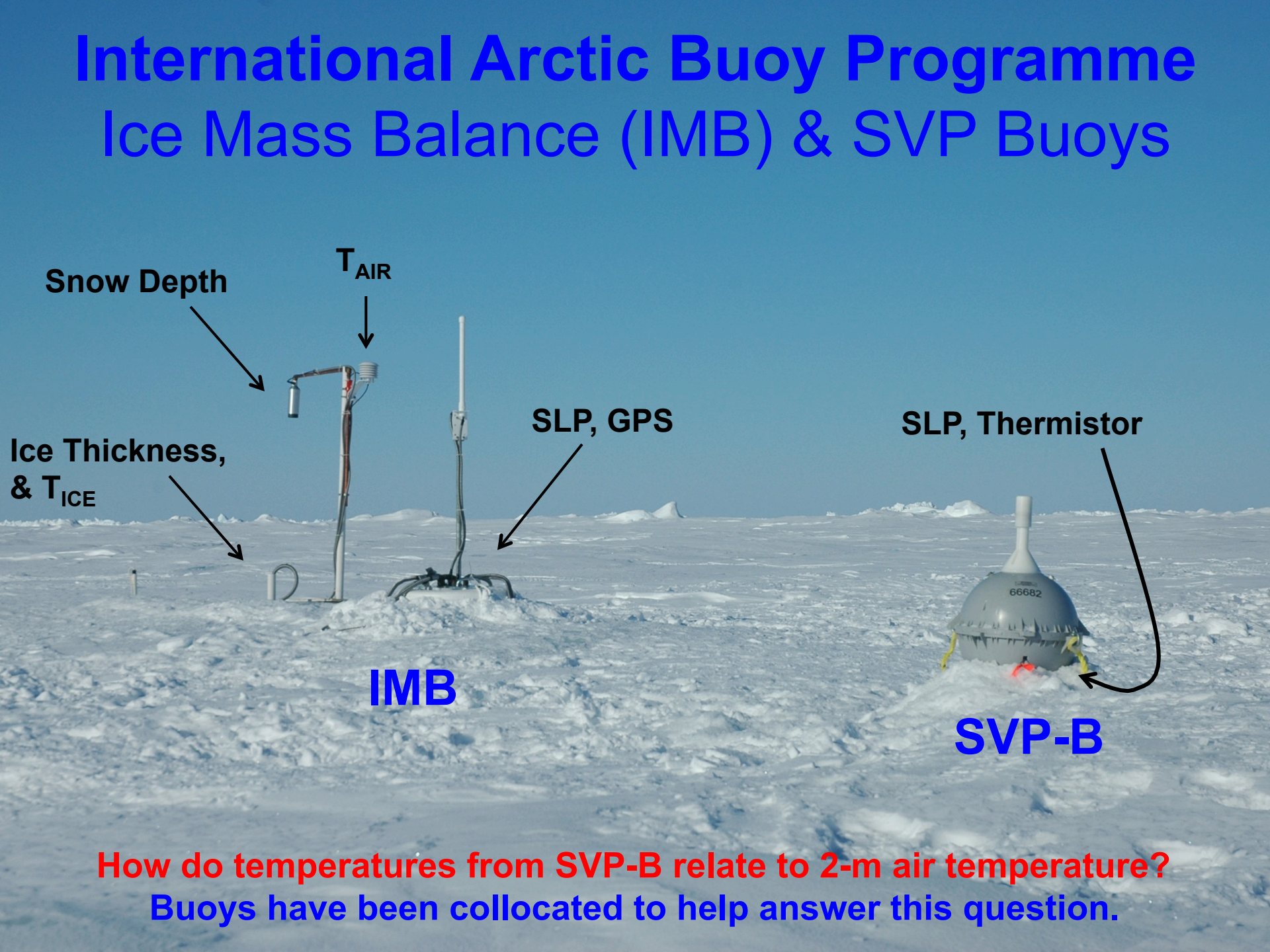
Arctic Sea Ice Extent
Record Minimum



- Developed by USIABP through a NOAA SBIR.
- Capable of surviving in ice, and open water through freeze/thaw cycles.
- Sensors include air and surface temperature, and surface pressure.

International Arctic Buoy Programme

Ice Mass Balance (IMB) & SVP Buoys



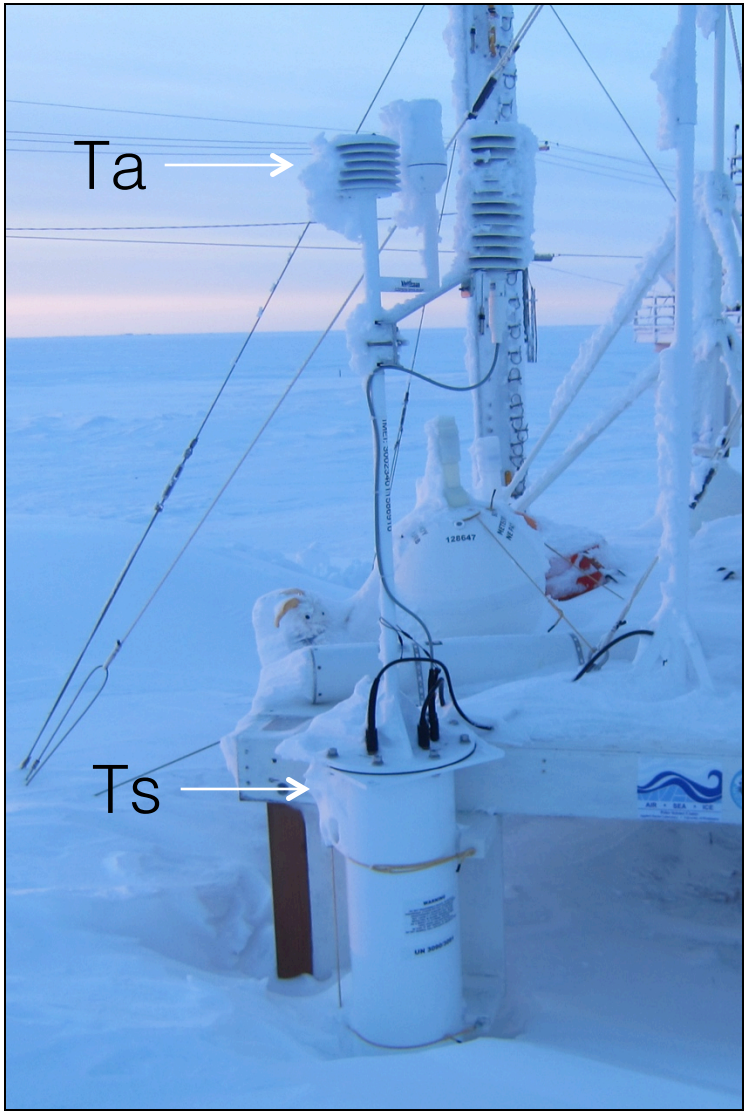
How do temperatures from SVP-B relate to 2-m air temperature?

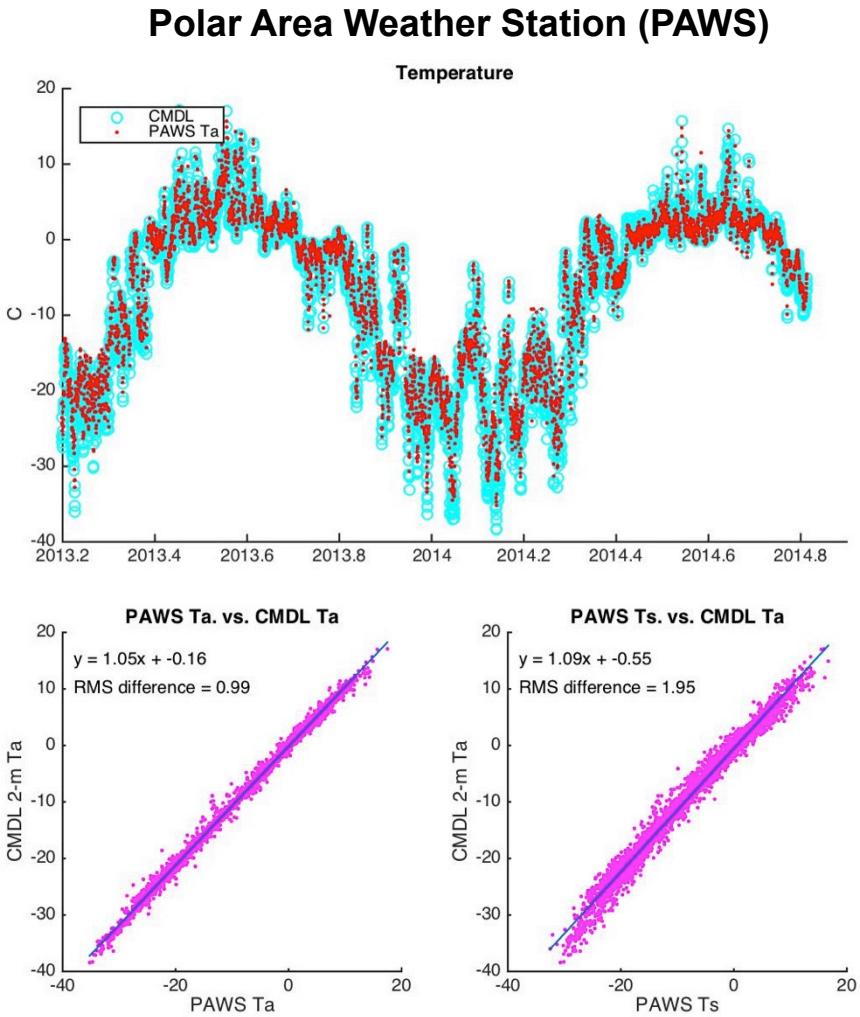
Buoys have been collocated to help answer this question.

International Arctic Buoy Programme
Arctic Observing Experiment

An assessment of the myriad of meteorological, ice, ocean and webcam buoys.

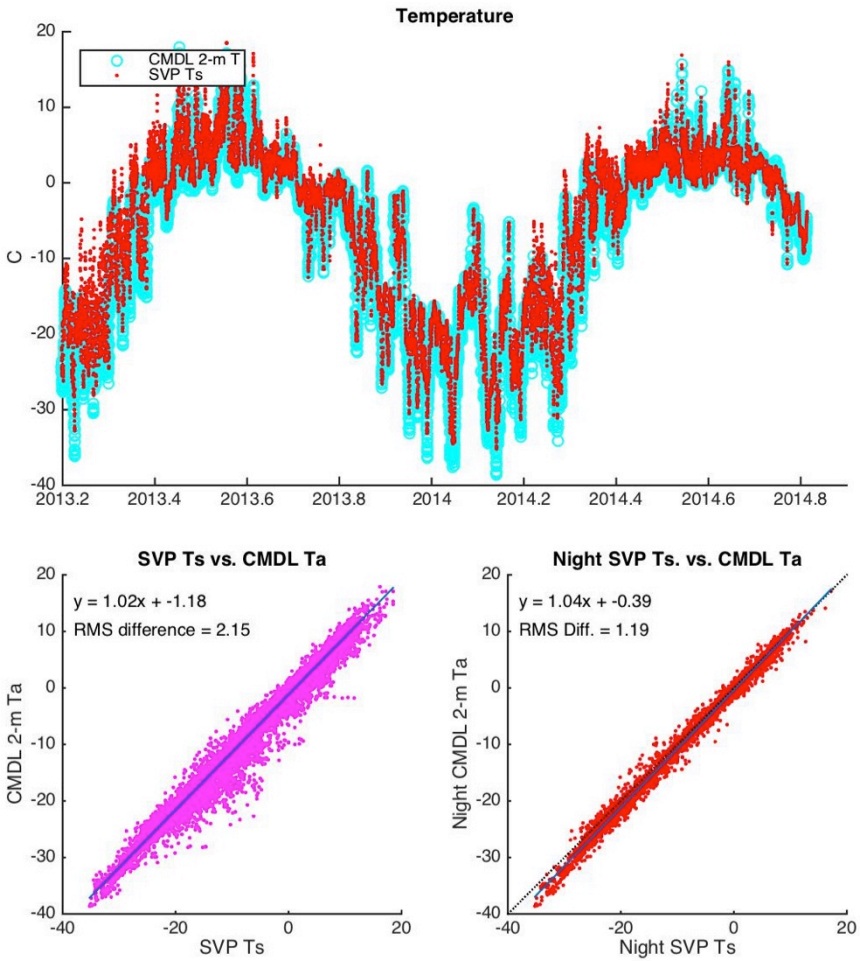
International Arctic Buoy Programme
Arctic Observing Experiment



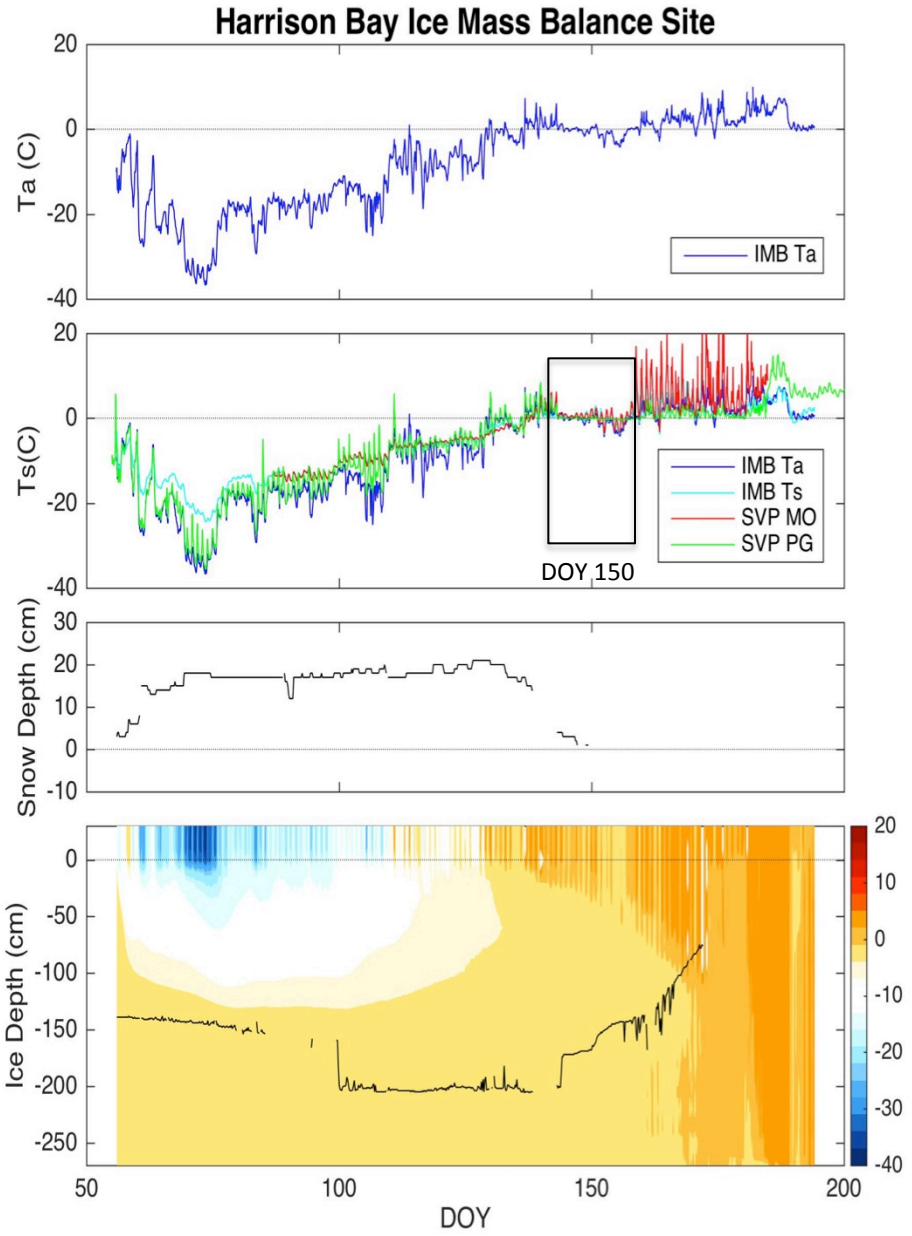


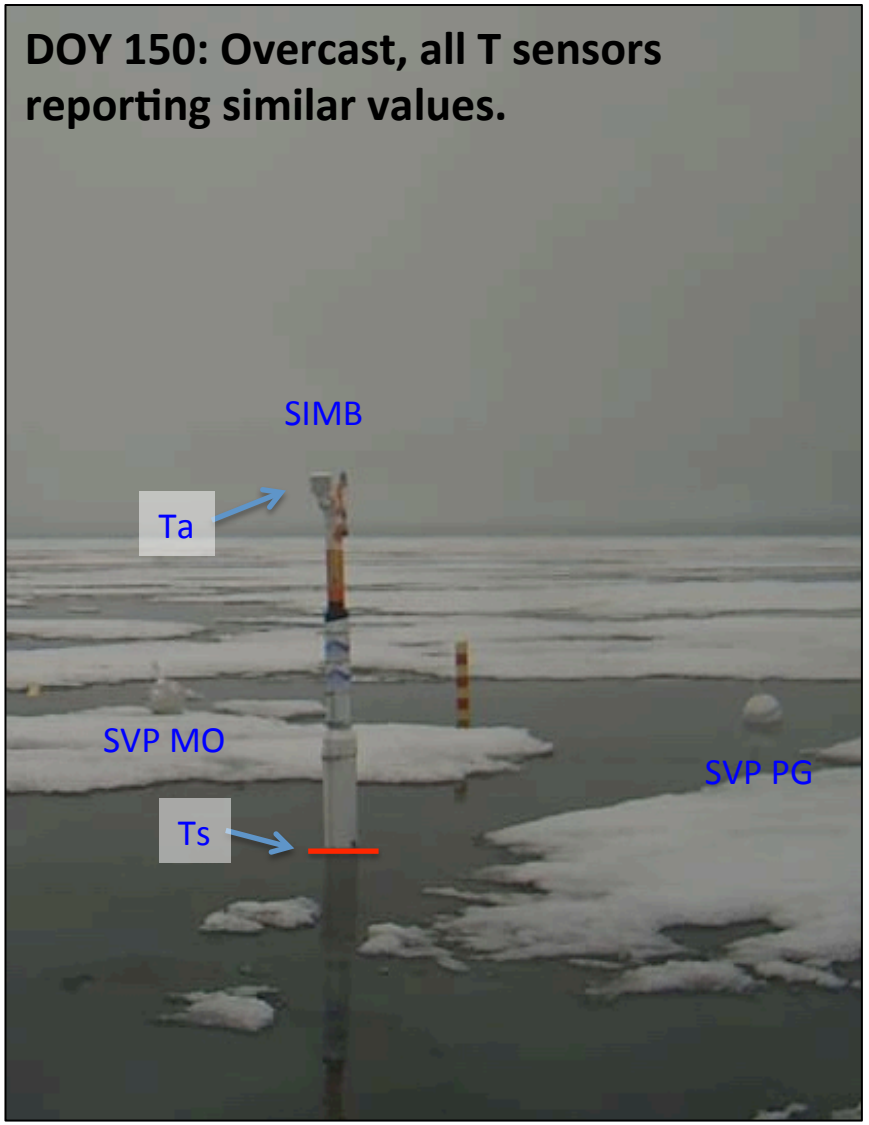
International Arctic Buoy Programme
Arctic Observing Experiment

Surface Velocity Program (SVP) Buoy



IABP Arctic Observing Experiment

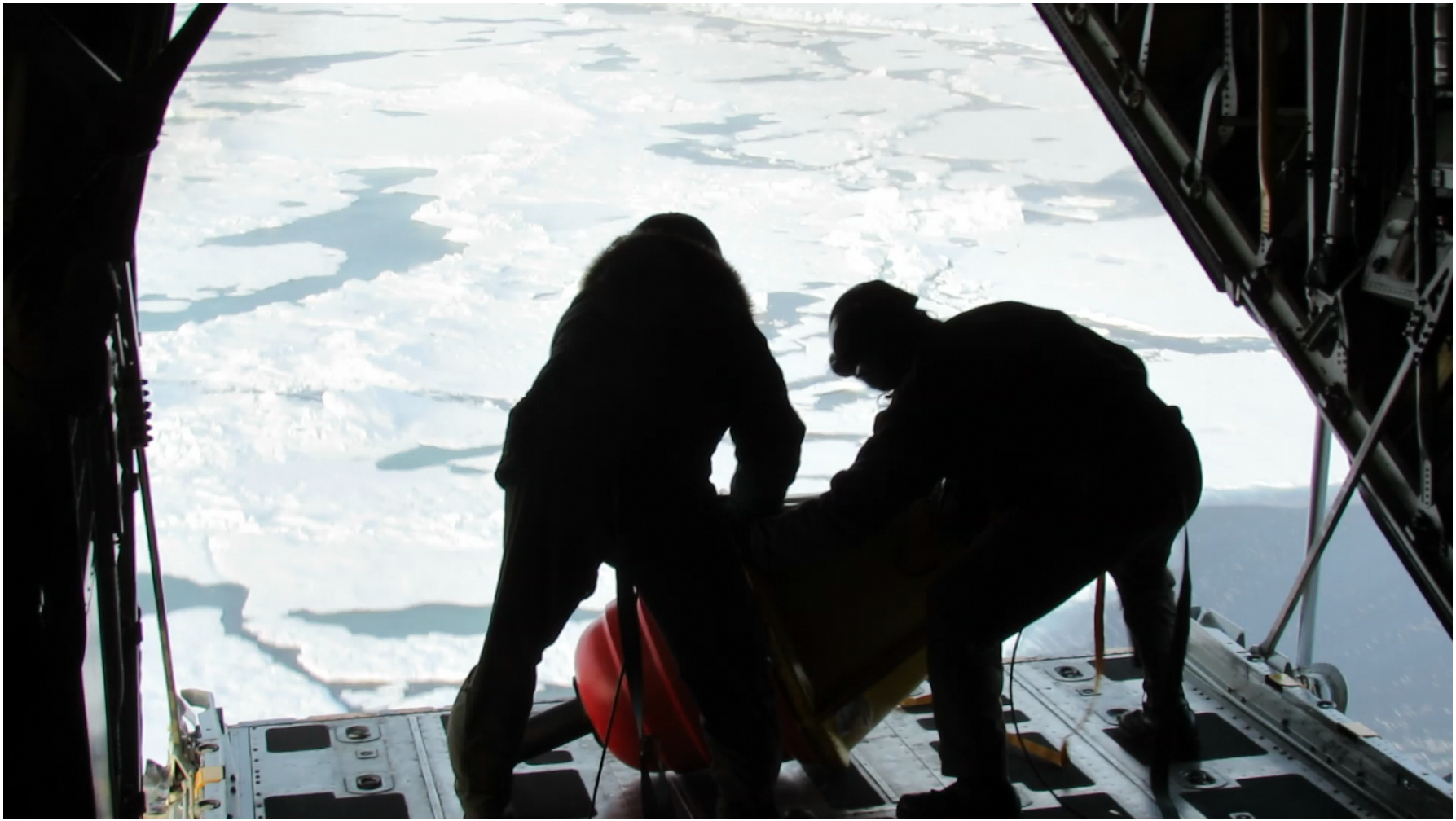




Spring Deployments by Landing on Sea Ice

Summer Deployments by Air Drop

Airborne Seasonal Ice Beacon (AXIB)



Deployment of AXIB buoy at North Pole

Interagency! CG, NAVO, NSF, NOAA, ONR

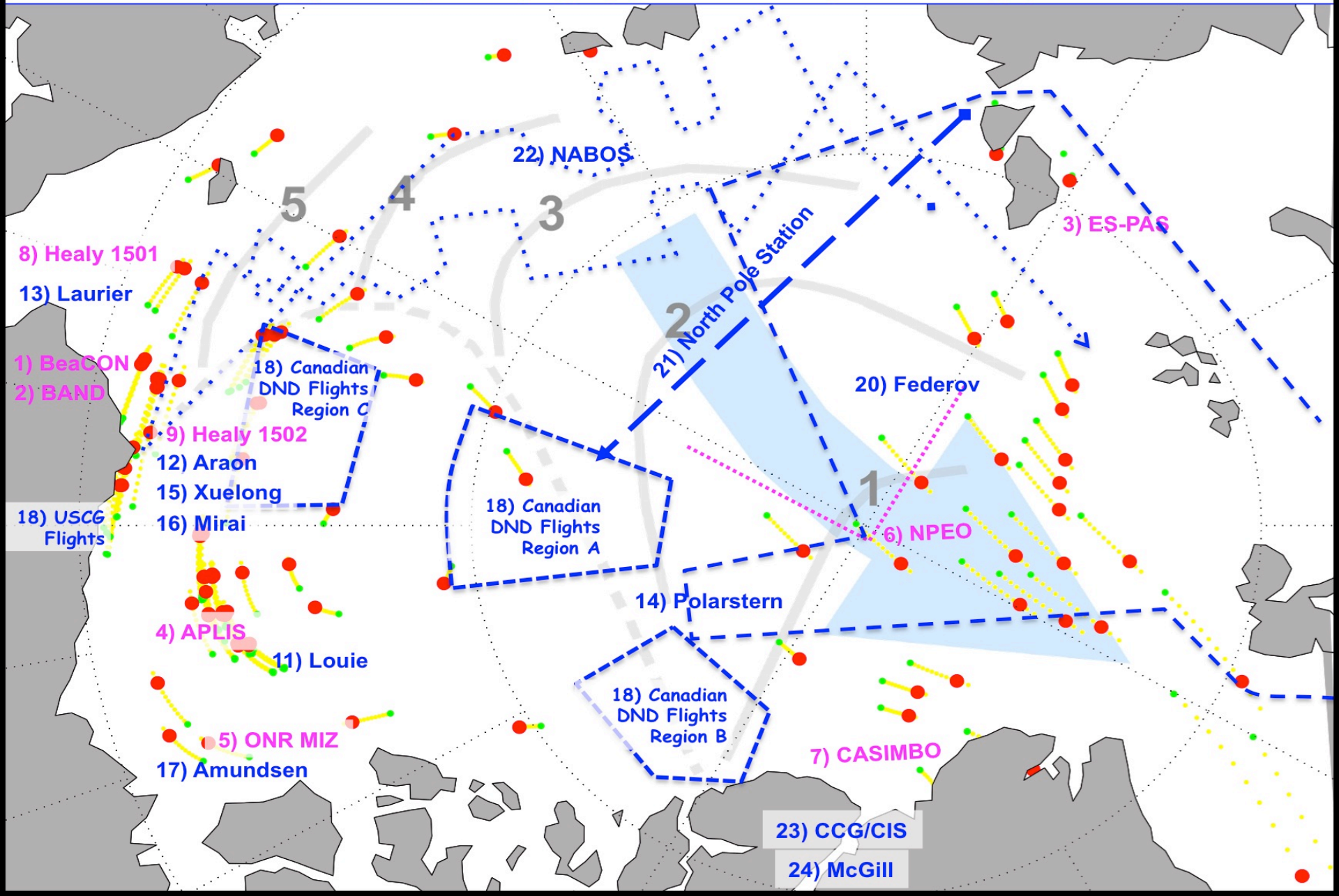
Summer Deployments by Ship

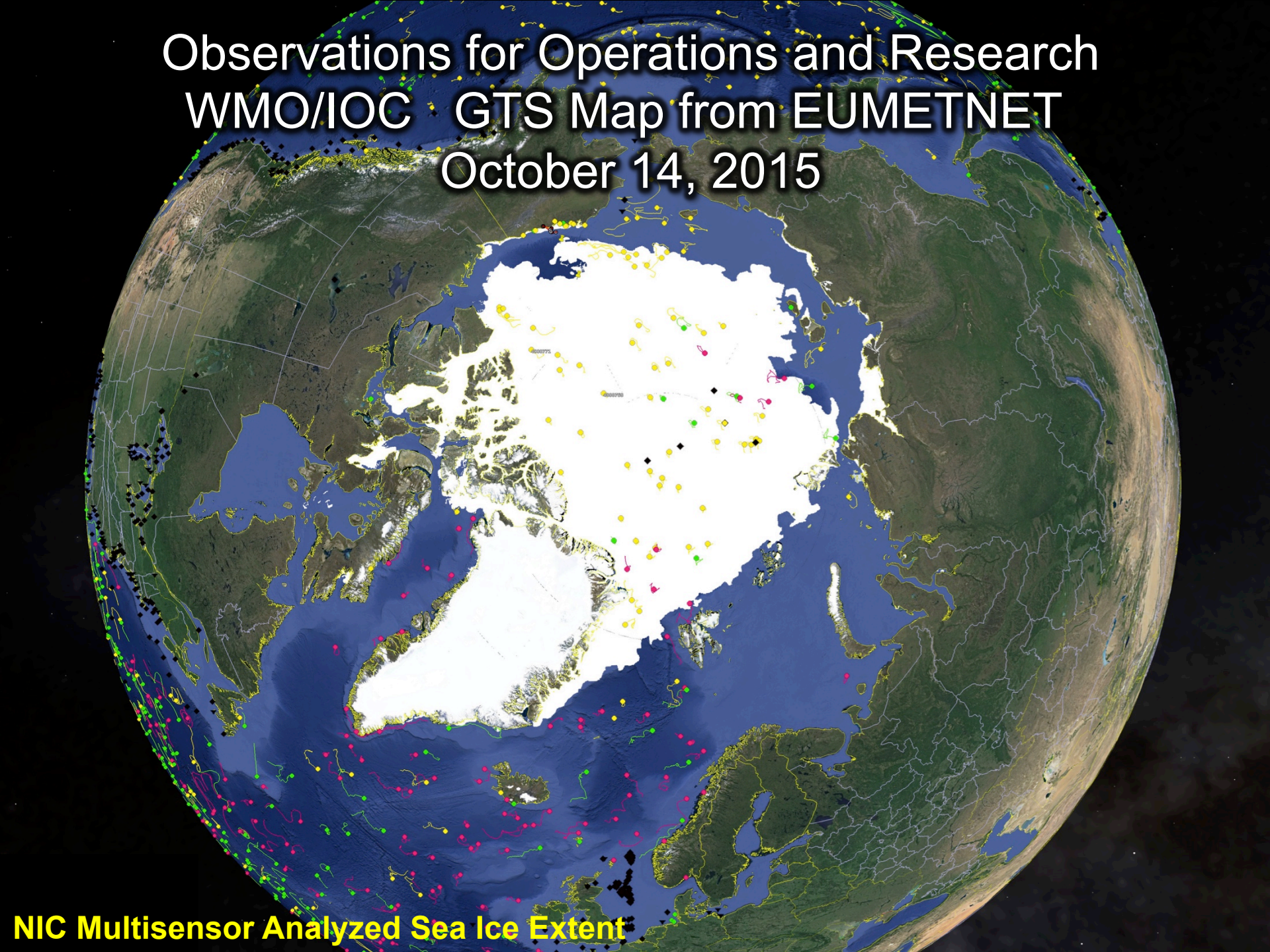
US CGC Healy & German R/V Polarstern at the North Pole

International collaboration deployed 35 buoys this summer!

IABP Deployment Plans – Residence Time

The dots show the location of drifting buoys reporting June 2015, and expected positions on September 1, 2015. Spring deployments are shown pink. Summer deployments are shown in blue.




Observations for Operations and Research
WMO/IOC GTS Map from EUMETNET
October 14, 2015
NIC Multisensor Analyzed Sea Ice Extent

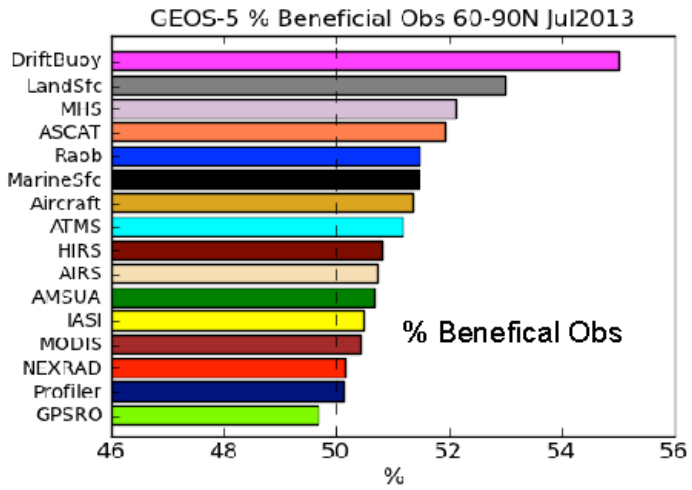
Show IABP Web Page

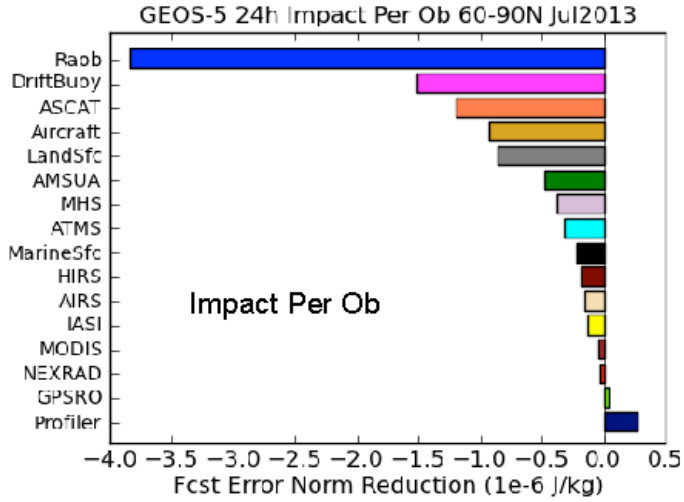
SUMMARY

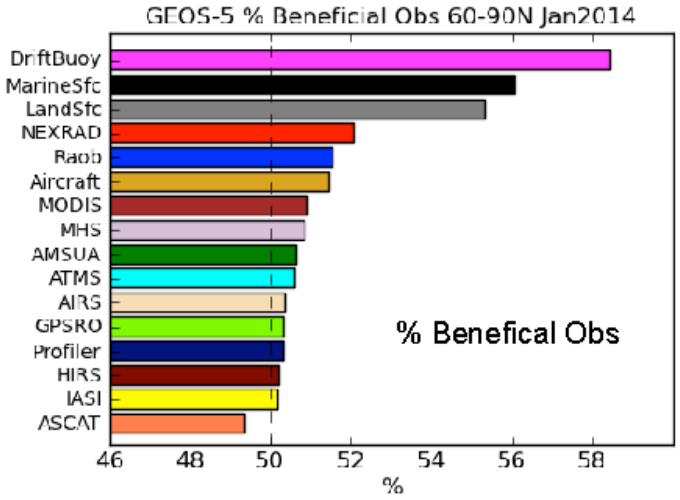
- IABP AON currently has 170 buoys reporting (158 with air pressure and temperature).
- Successes:
  - Extensive interagency and international collaboration.
  - Observations openly shared on GTS and IABP server.
  - Over 800 papers have been published since 1979.
- Challenges:
  - Sea ice is more dynamic.
  - US economic embargo prevents purchase of Ukrainian/Russian buoys, and limits deployments in Eurasian Arctic.

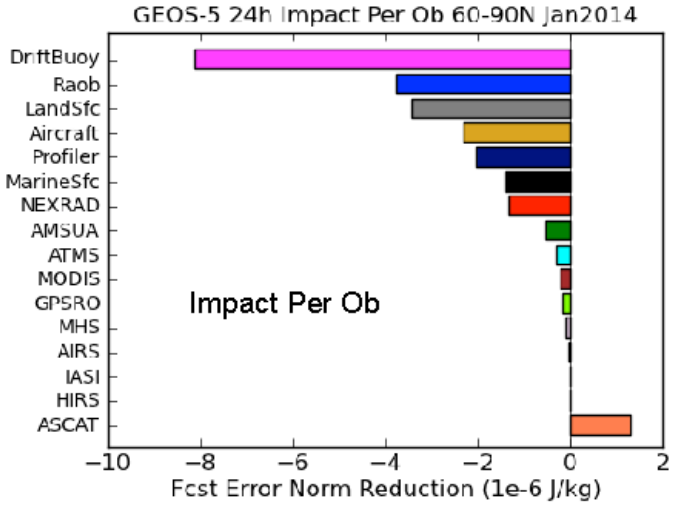
NIC Multisensor Analyzed Sea Ice Extent

Impact of Observations in Real-Time Data Assimilation-Forecast System









Observations from Drifting Buoys have the highest % of beneficial observations to improve weather forecasts. During summer radiosondes have more impact, but buoys are second.

Courtesy of Ron Gelaro, NASA