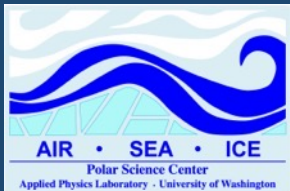


What are capabilities and gaps in ongoing and planned in-situ observational programs?

Ignatius Rigor
and Participants of the
International Arctic Buoy Programme (IABP)

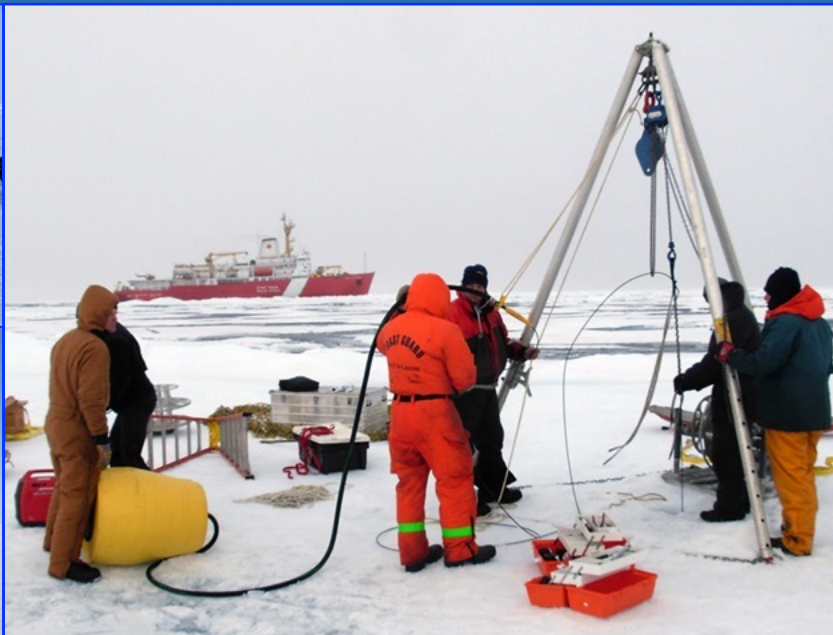
June 2022



International Arctic Buoy Programme (IABP)



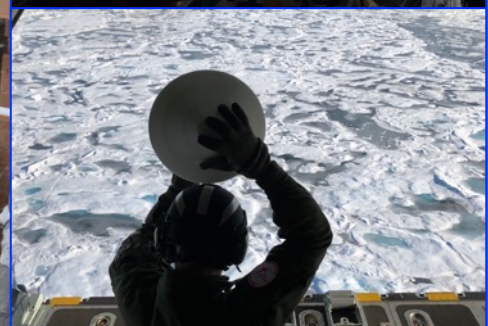
Spring



Summer

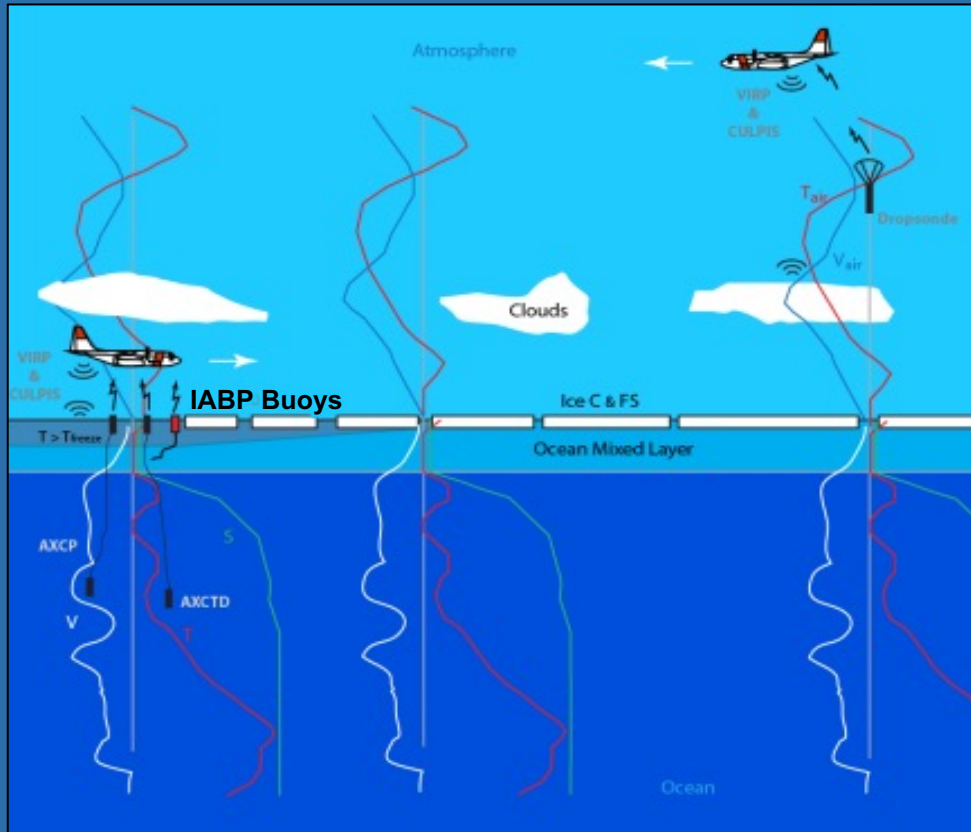


Fall



The IABP maintains the fundamental Arctic Observing Network observing ice/ocean circulation, surface meteorology, and oceanography.

Seasonal Ice Zone Reconnaissance Surveys (SIZRS)

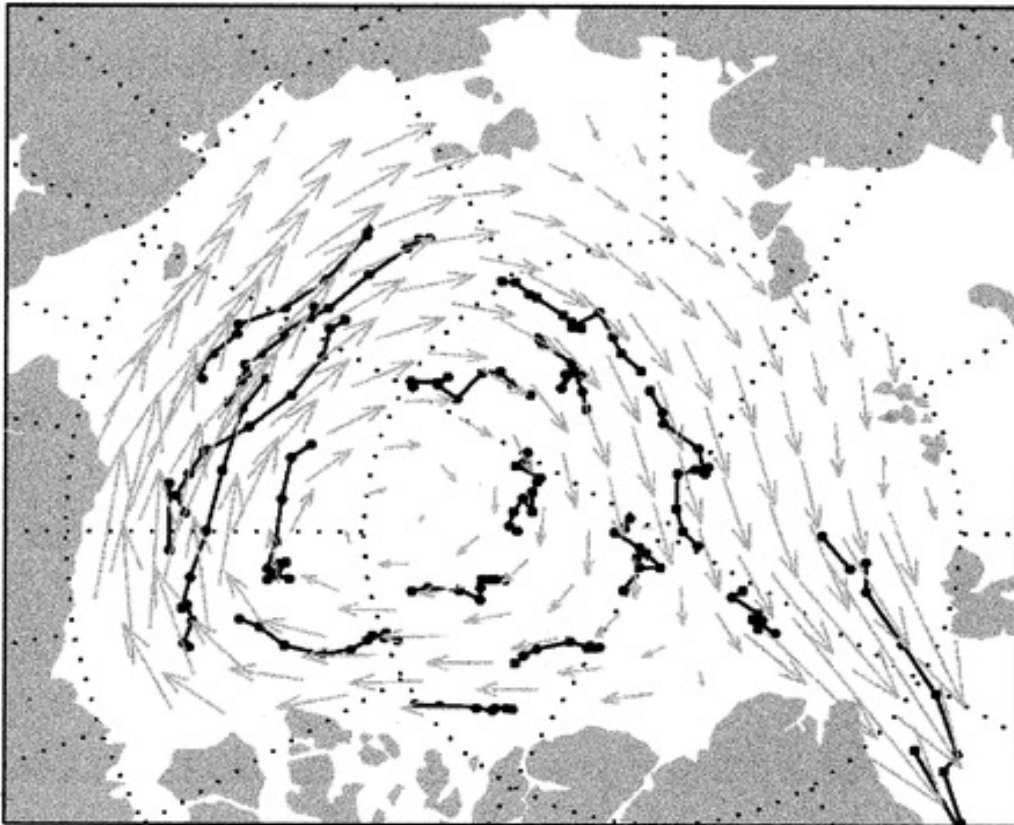


Deployments during SIZRS flights with the US Coast Guard. IABP Buoys are typically deployed with AXCTD/AXCPs flying northward, while dropsondes are deployed on the way home.

Sea Ice Drift

(a)

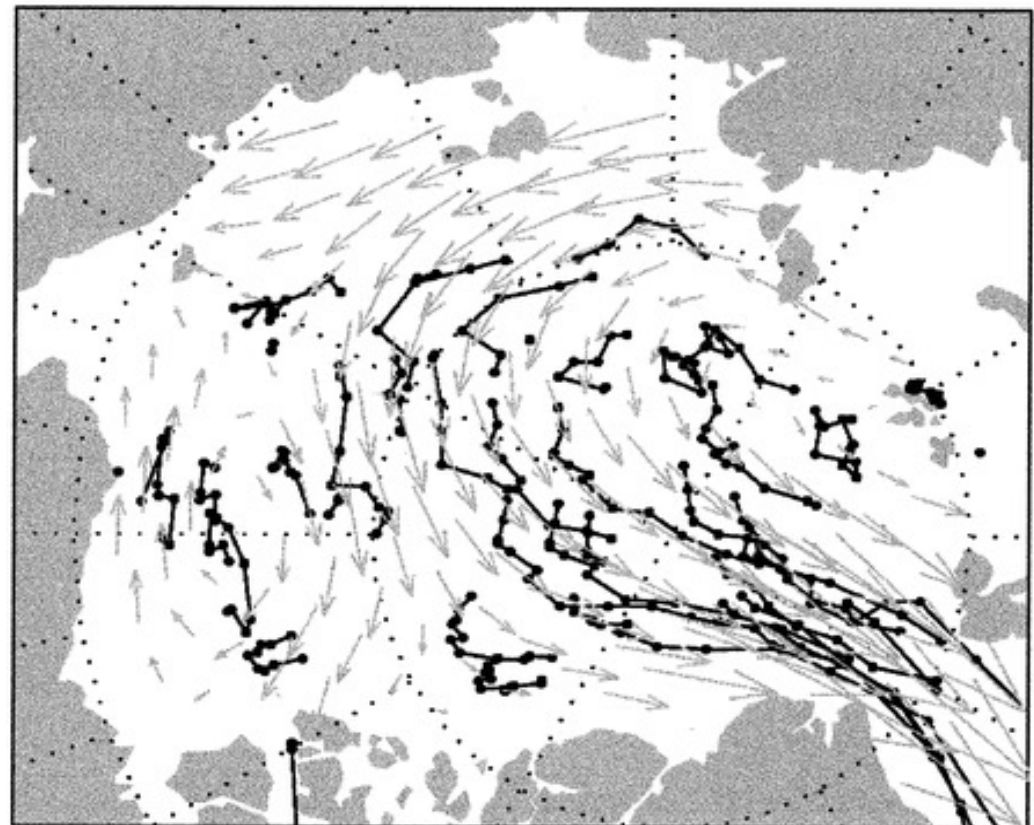
1979



Scale: 2 cm/s = →

(b)

1994

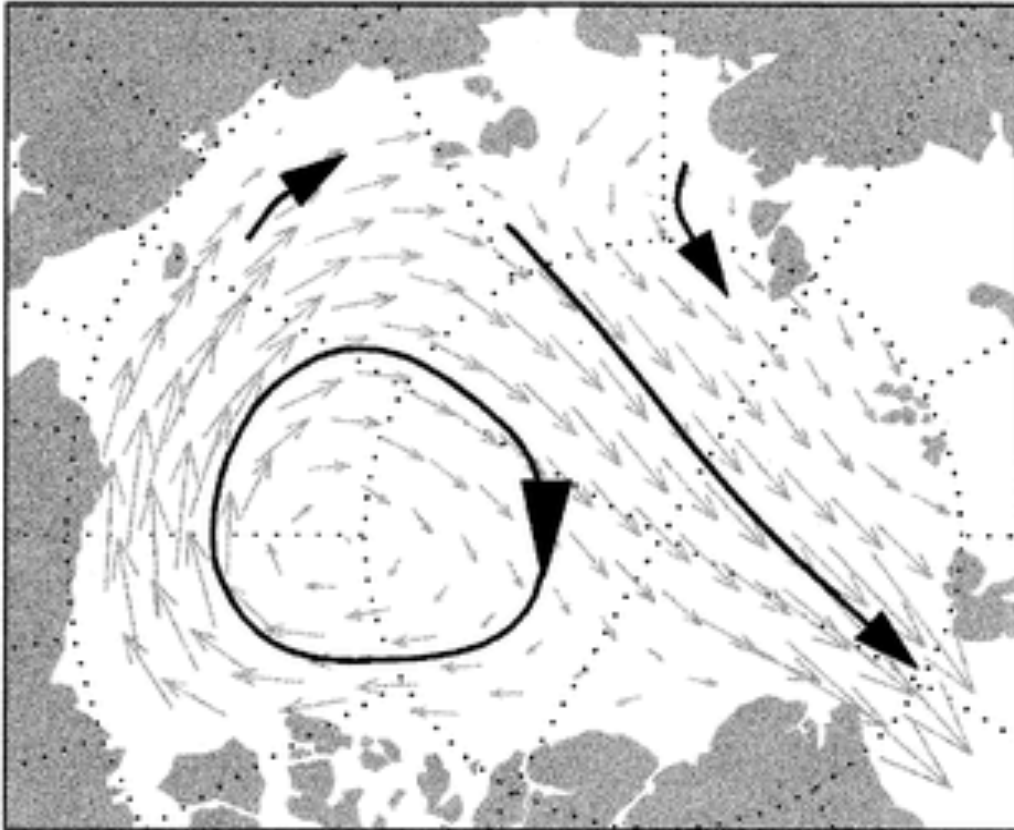


Scale: 2 cm/s = →

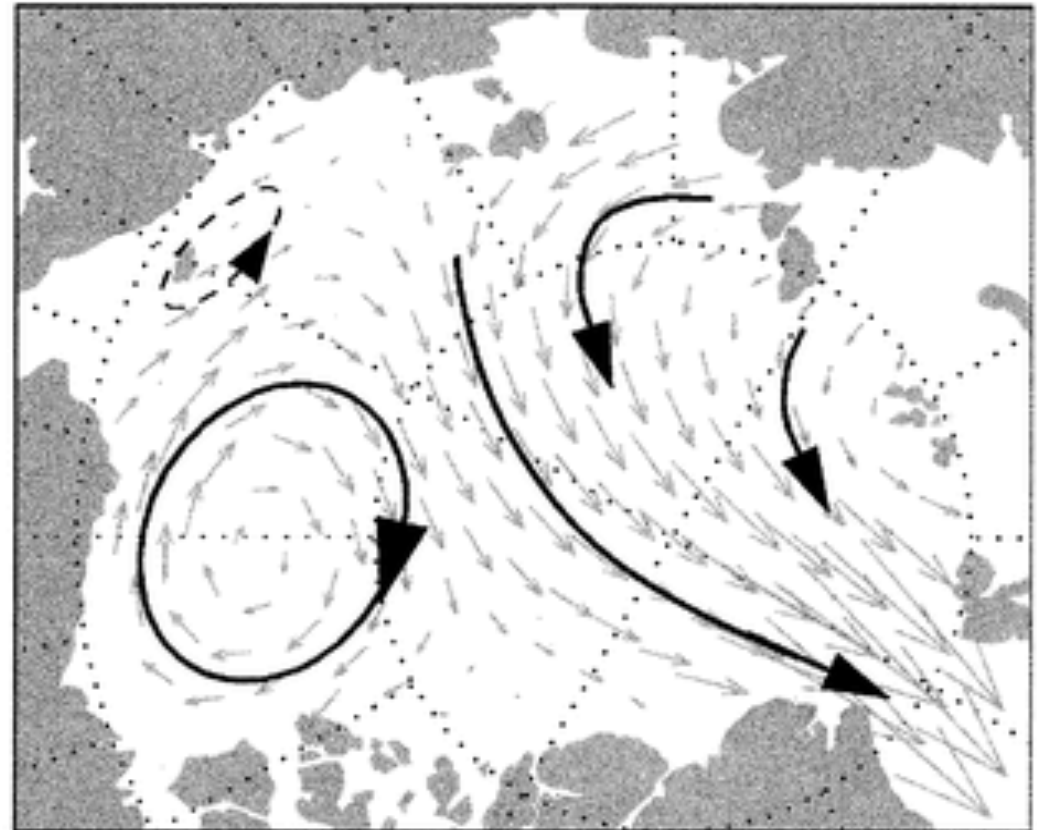
Rigor et al., 2002

Sea Ice Drift Changes w/ Arctic Oscillation

(c) Low Index

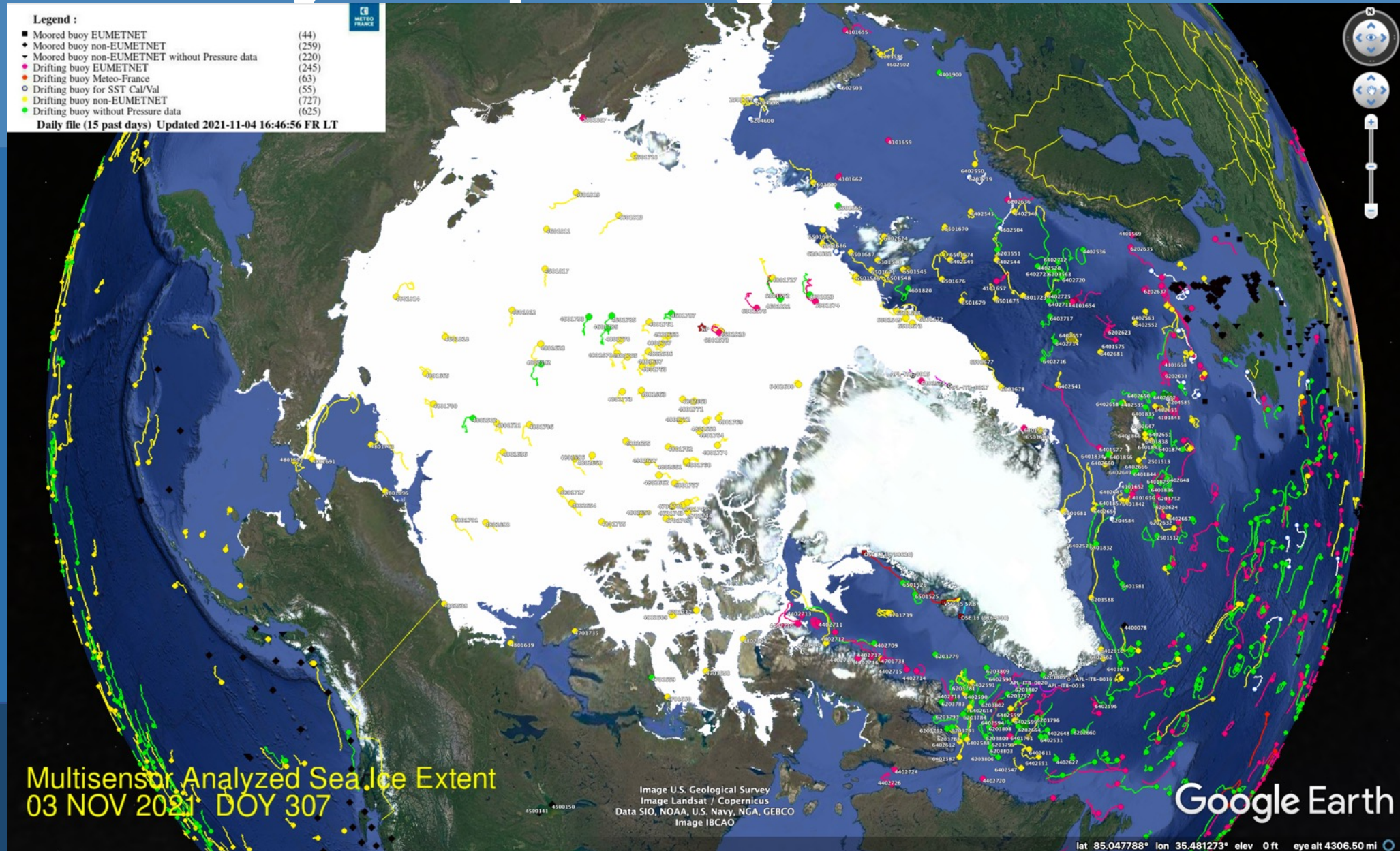


(d) High Index

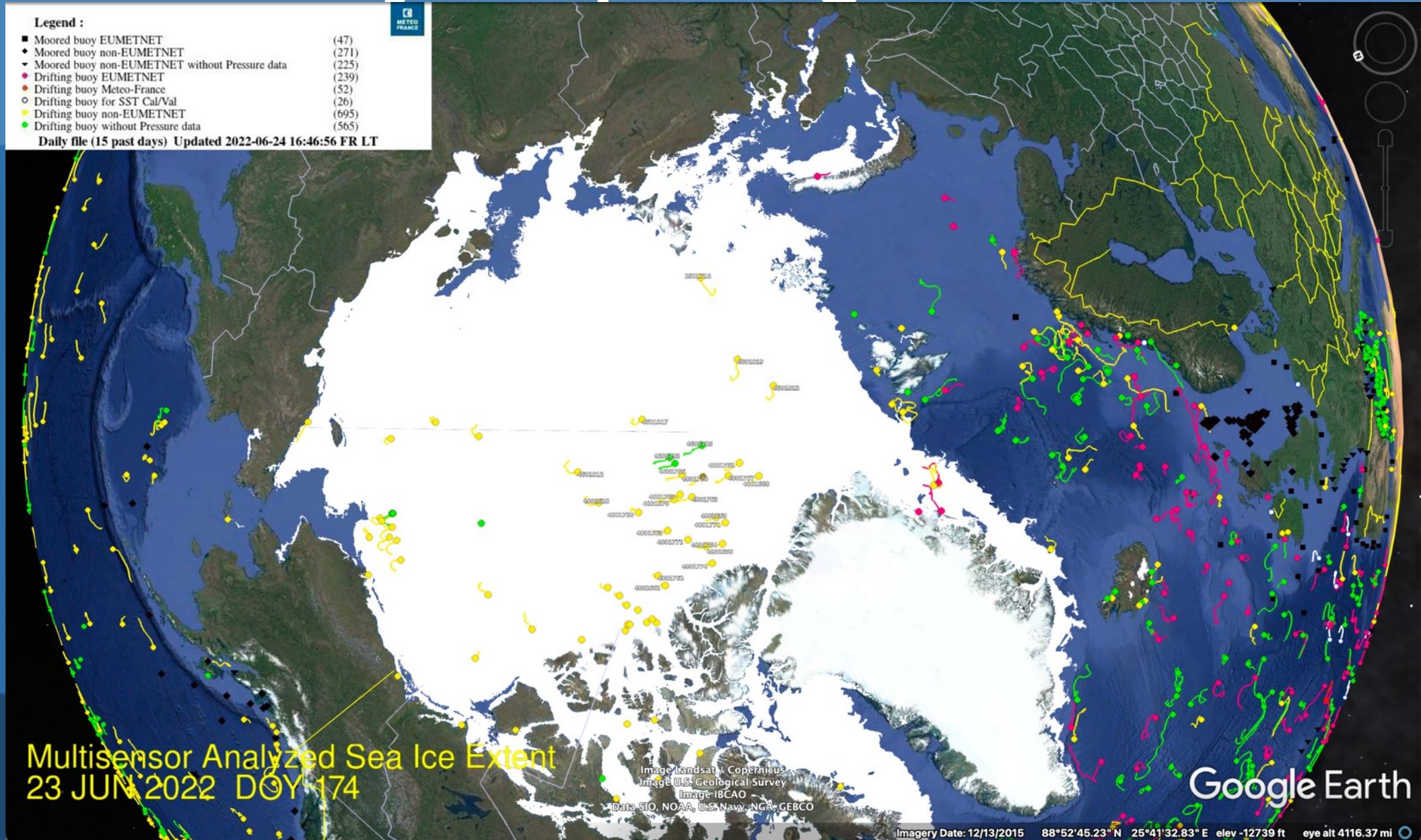


Rigor et al., 2002

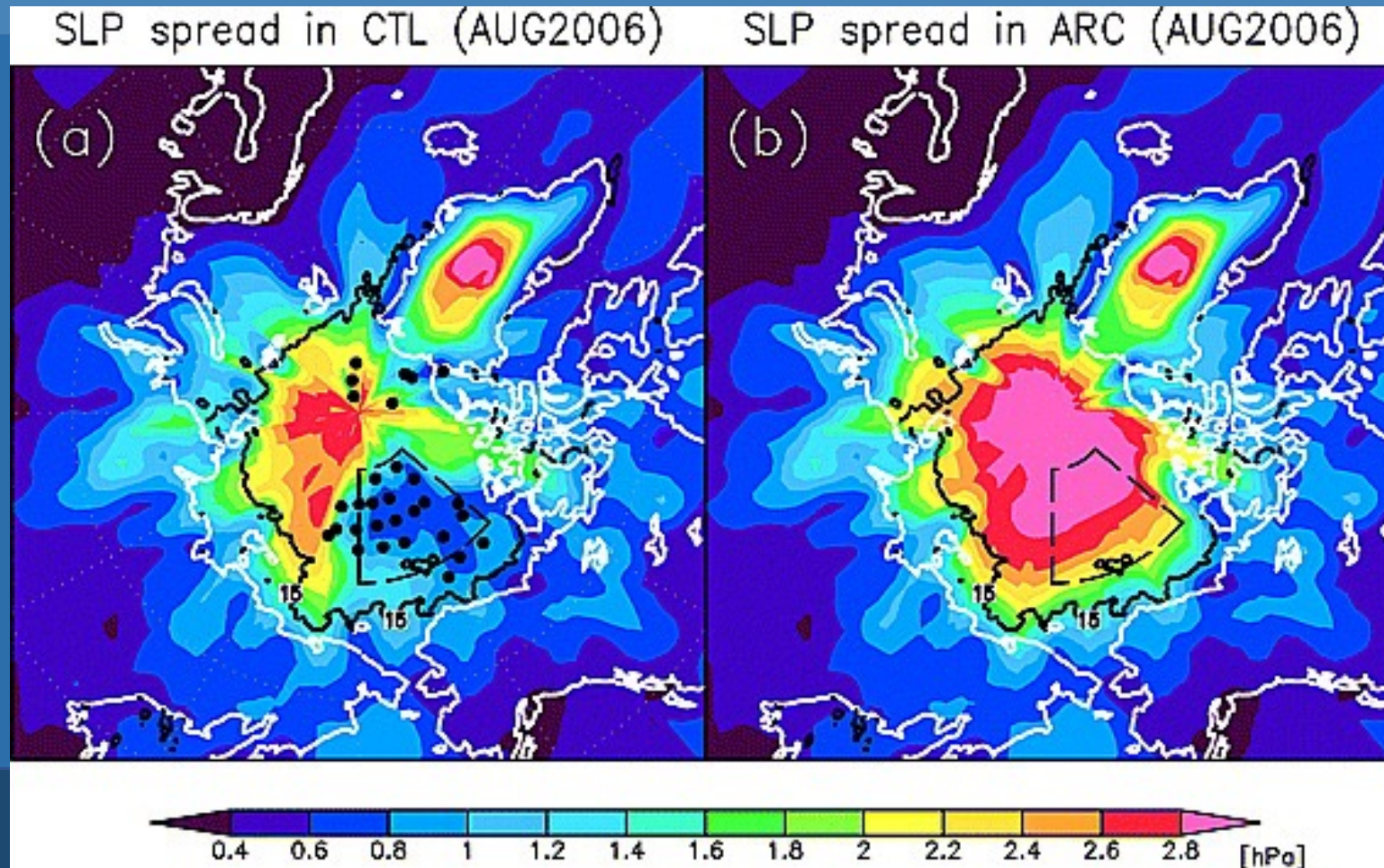
IABP Buoys Reporting in November 2021



IABP Buoys Reporting in June 2022



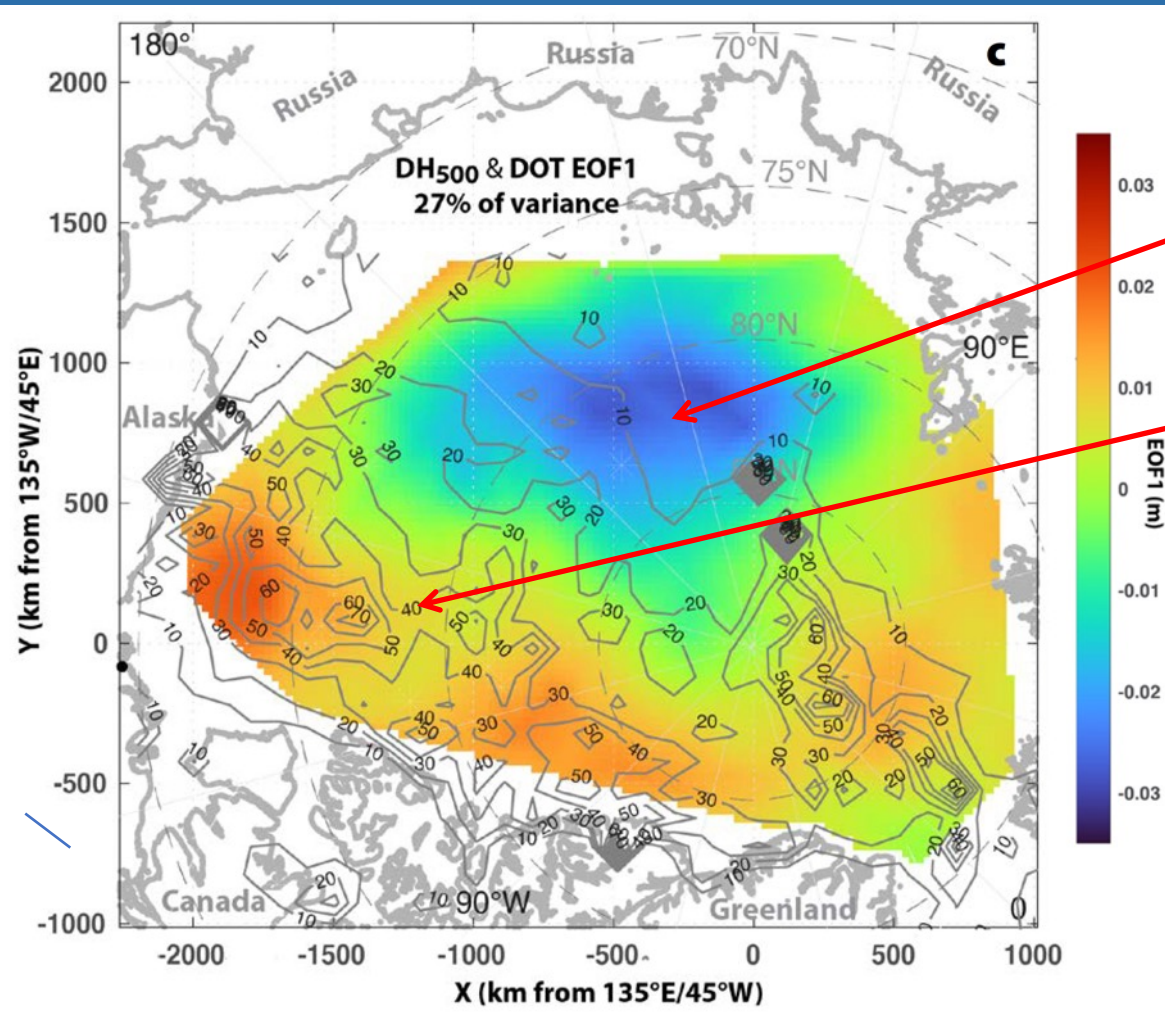
Impact of observations from Arctic drifting buoys on the reanalysis of surface fields



Inoue et al., 2009

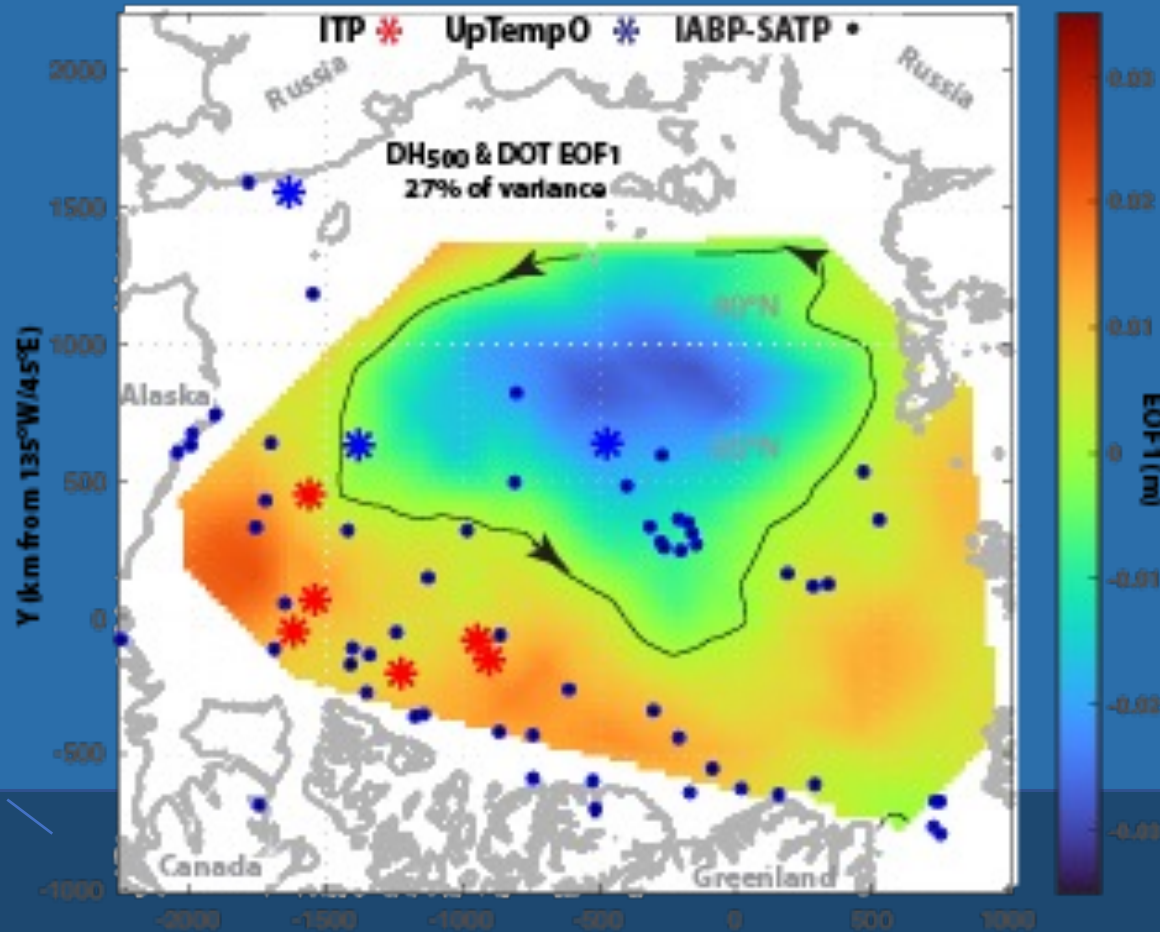
Our In Situ Observations Miss the Fundamental Mode Of Circulation Change

Percent chance of finding an IABP buoy in a 250-km square based on buoy tracks from 2001 to 2021



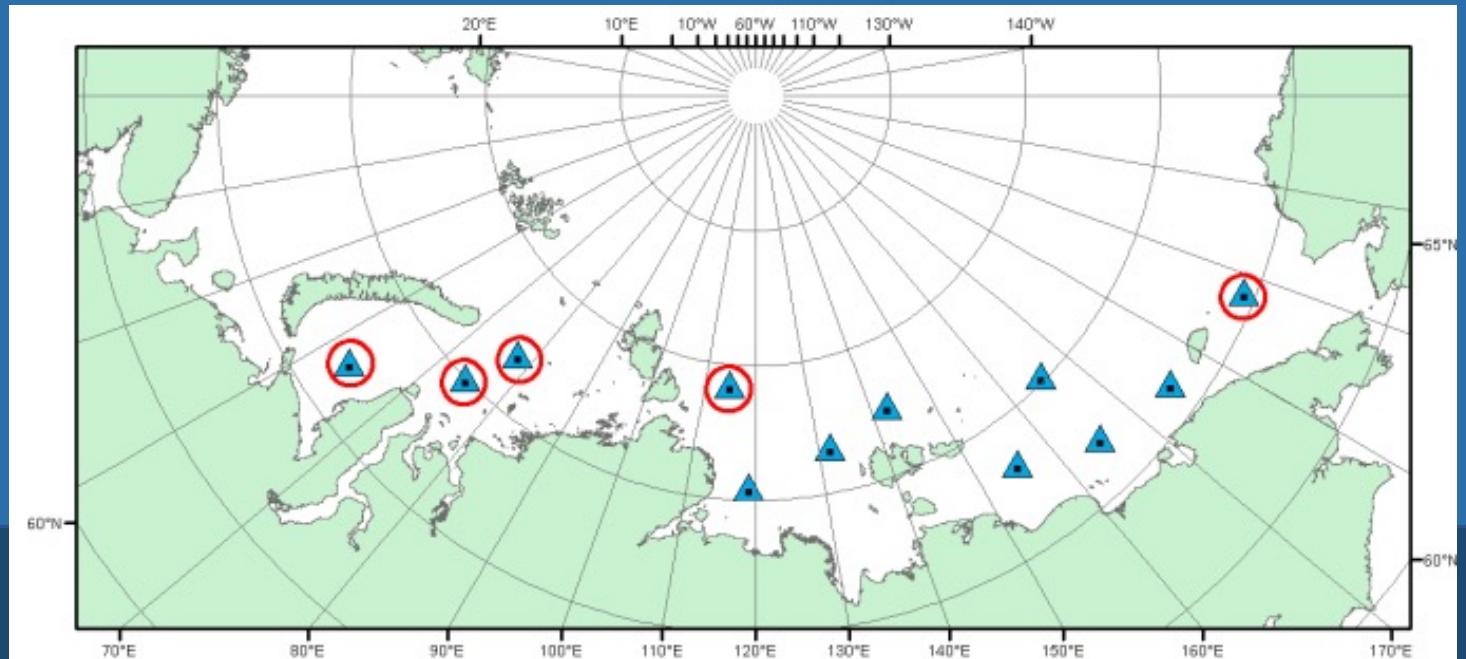
- The probability contours roughly align with EOF1 contours.
- The odds of finding a buoy inside EOF1's dominant feature are < 10%.
- The odds of finding a buoy inside the Beaufort Sea are 30-60%.
- 20 years of looking for the keys to circulation change under the Beaufort Gyre lamp post

Our In Situ Observations Miss the Fundamental Mode Of Circulation Change



US-IABP / AARI Collaboration

- Russian Ice breakers Akademik Fedorov, and Mikhail Somov.
- Deploy Marlin Yug buoys
 - 12 Ice Balls (GPS, SLP, Ts)
 - 8 Ice Balls w/ ice thermistor strings



KV Svalbard – NERSC CAATEX & AMOS

November, 2020

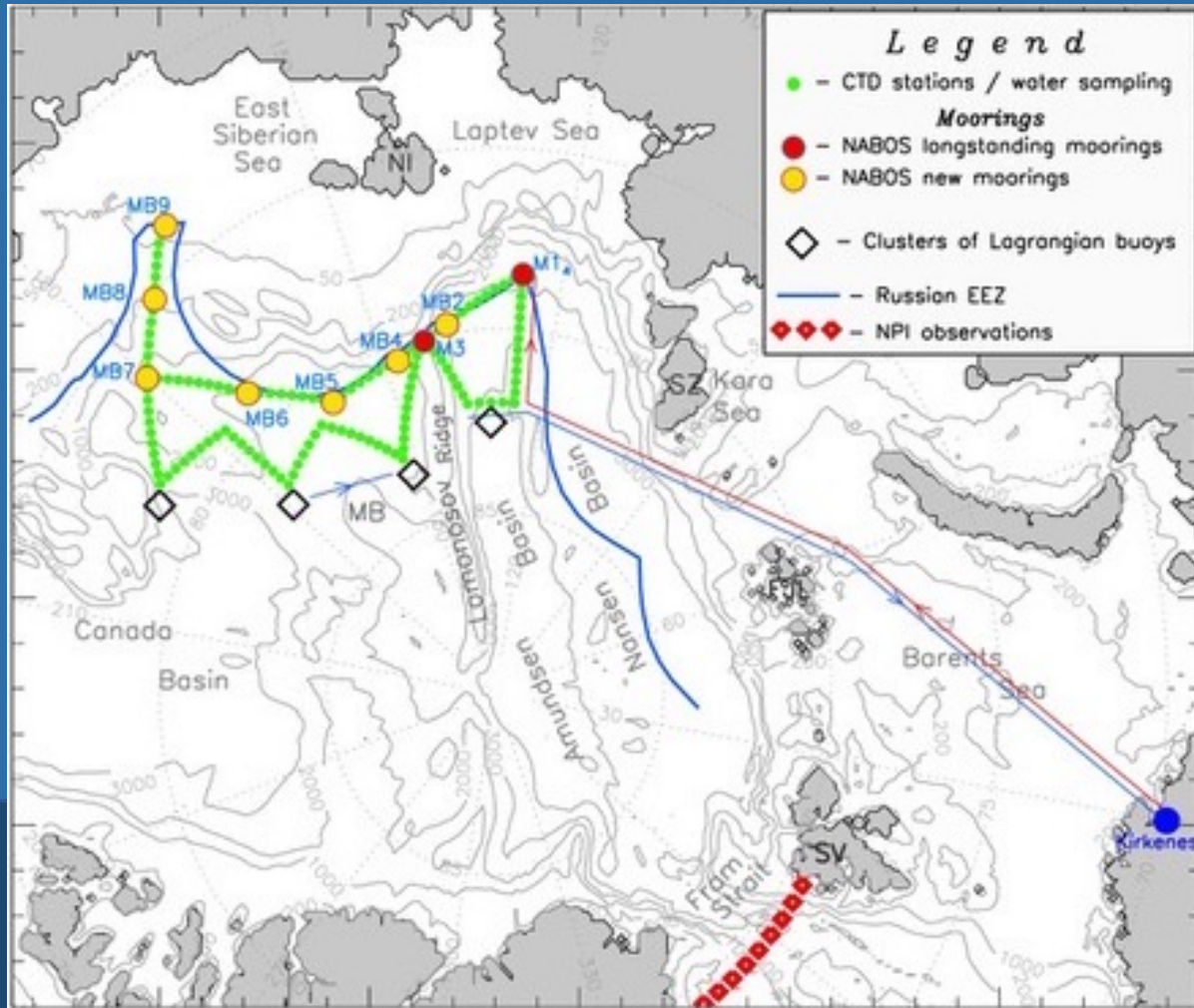


- 2 clusters of Ice Balls and boxes of wooden boats from Float Your Boat outreach projects of USCG, NERSC, APL/UW, were deployed in August (not shown on map).
- 10 SVP-Bs (from CGC Healy) were deployed along Northern Sea Route, Chukchi and Beaufort seas.
- 3rd Ice Ball and boxes of wooden boats were deployed at SIO-1 (from CGC Healy)
- 4th Ice Ball and wooden boats will be deployed where Nansen's Fram was set in the ice 125 years ago.



Nansen and Amundsen Basin Observing System (NABOS)

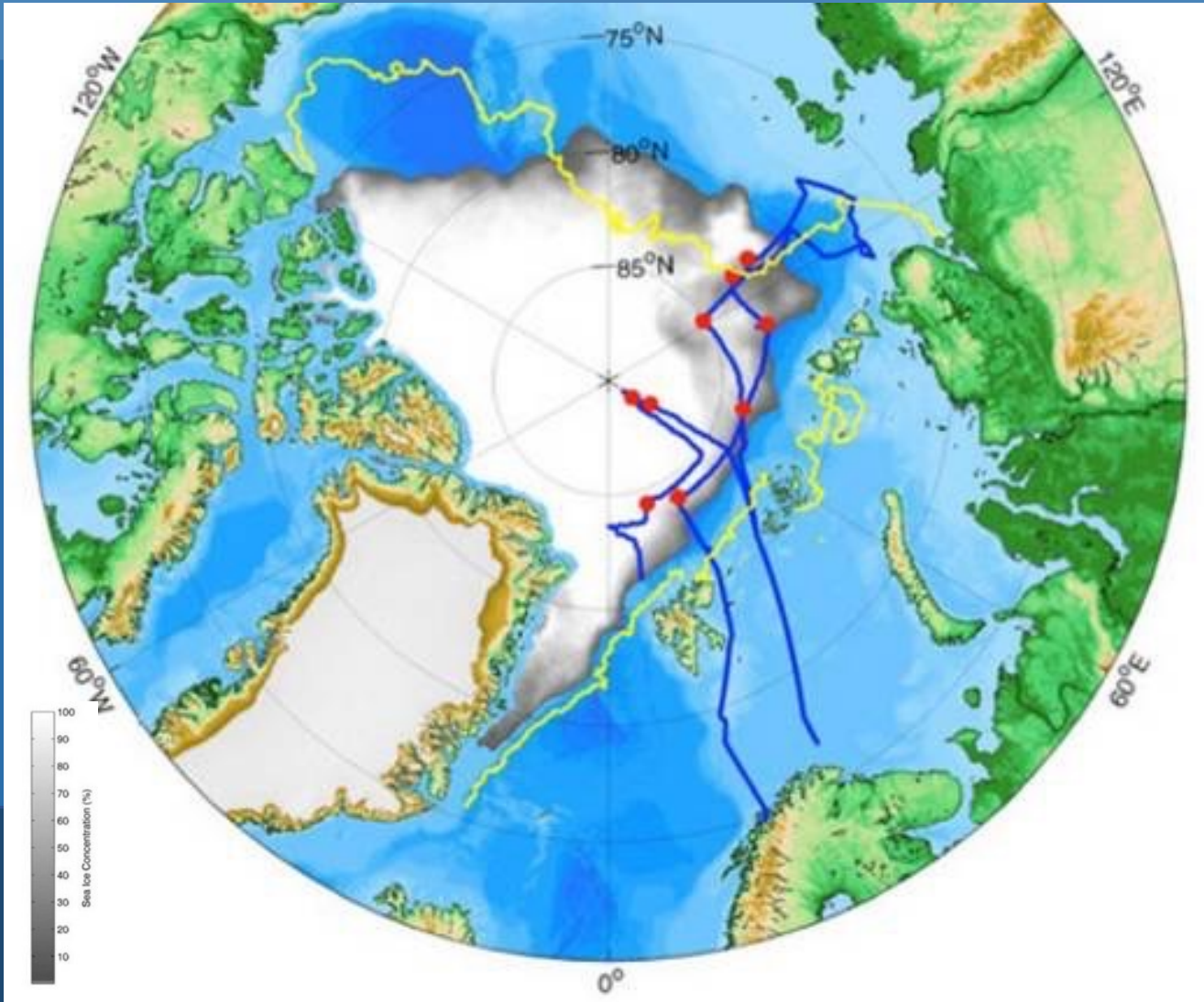
RV Akademik Tryoshnikov (?), Sept/Oct. 2023



- Objective: Service moorings, CTD Surveys, and deploy autonomous and ice-based assets.
- Chief Scientist: Igor Polyakov
<ivpolyakov@alaska.edu>
- Buoys:
 - N AXIB
 - N ITP
 - N SIMB3
 - N Ice Balls
 - N Etc.

RV Polarstern, Aug-Sep. 2023

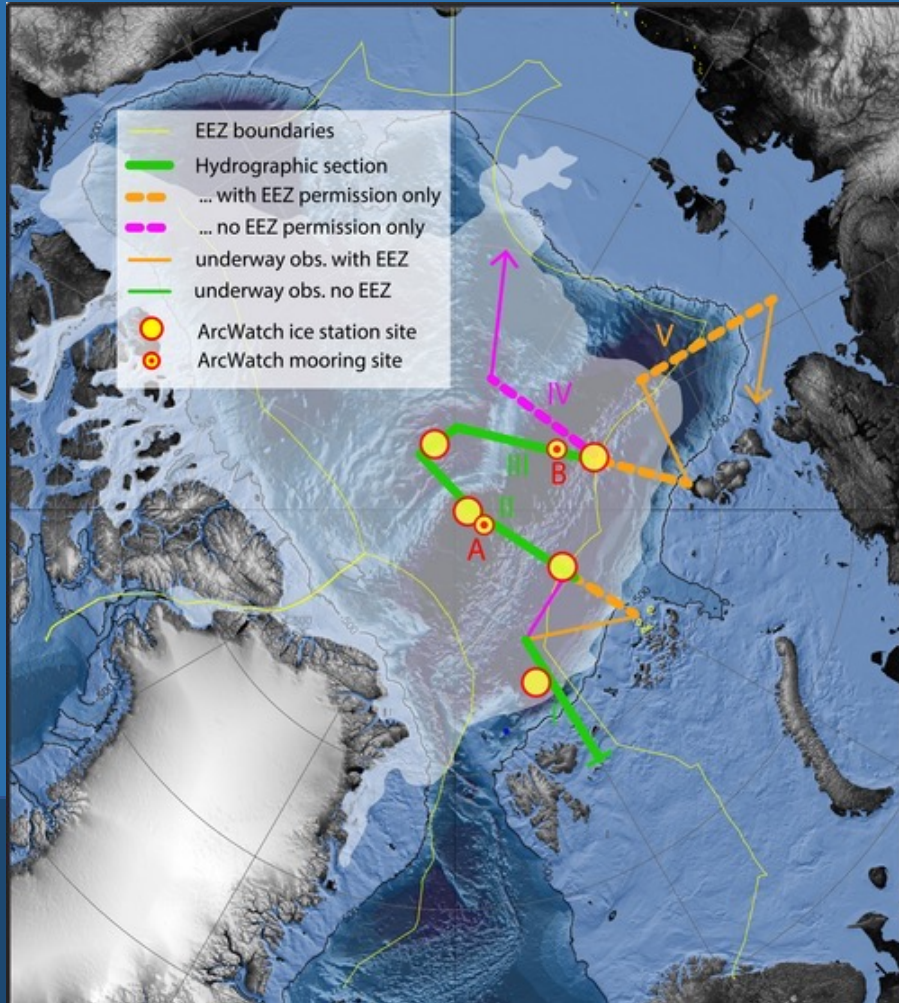
PS138; Project: ARCWATCH 1 (GPF 20-1_029)



- Disciplines: Sea Ice including physics, cryo-pelagic and cryo-benthic coupling; Chemical and Physical Oceanography; Marine Biology, including Ocean Optics, Planktology, Sedimentology, Biogeochemistry, Microbiology, and Benthology; Marine Technology.
- Chief Scientist Antje Boetius
<Antje.Boetius@awi.de>
- Buoys:
 - N AXIB
 - N ITP
 - N SIMB3
 - N Ice Balls
 - N Etc.

RV Polarstern, Aug-Sep. 2024

PS143; Project: ARCWATCH-2 (GPF 20-2_070)



- Disciplines: Chemical Oceanography; Physical Oceanography; Pelagic, Benthic and Sea-ice Biology; Sea-ice Physics.
- Chief Scientist: Walter Geibert
<walter.geibert@awi.de>
- Buoys:
 - N AXIB
 - N ITP
 - N SIMB3
 - N Ice Balls
 - N Etc.

ICE-PPR Buoy Deployment Plans

July – August 2022

Leads: John Woods, Ignatius Rigor

- ICE-PPR coordinates defense assets from Arctic countries to support research.
- Drop Locations will be determined by
 - a) Current state of buoy array
 - b) Sea Ice and Weather conditions
- METOC/Imagery Support can be coordinated with USA/CAN/DEN Ops Centers
- Science Team interested to be engaged with Flight Crew for coordination



Pri 1 WX



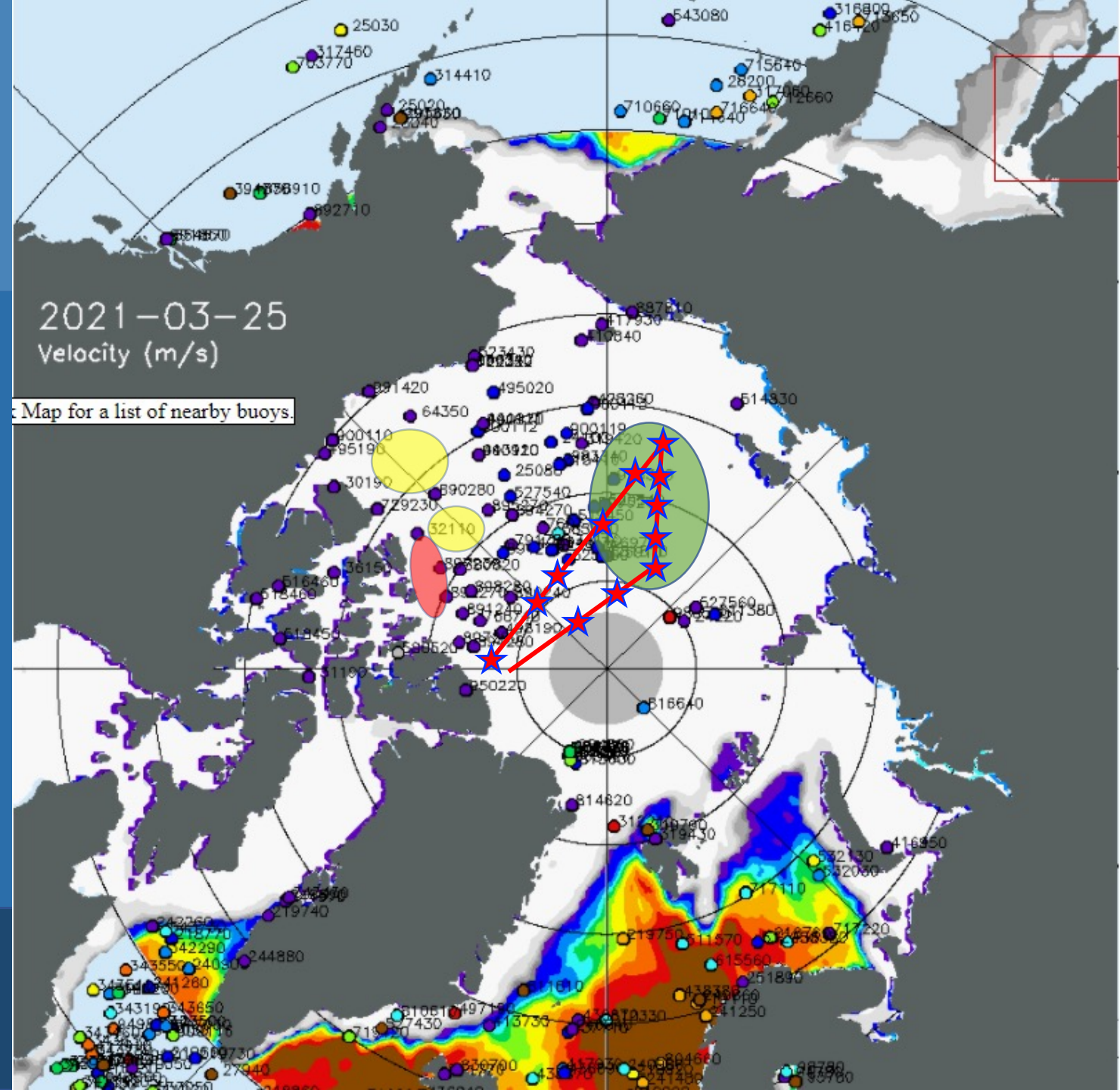
Pri 2 WX



Pri 2 Bergs

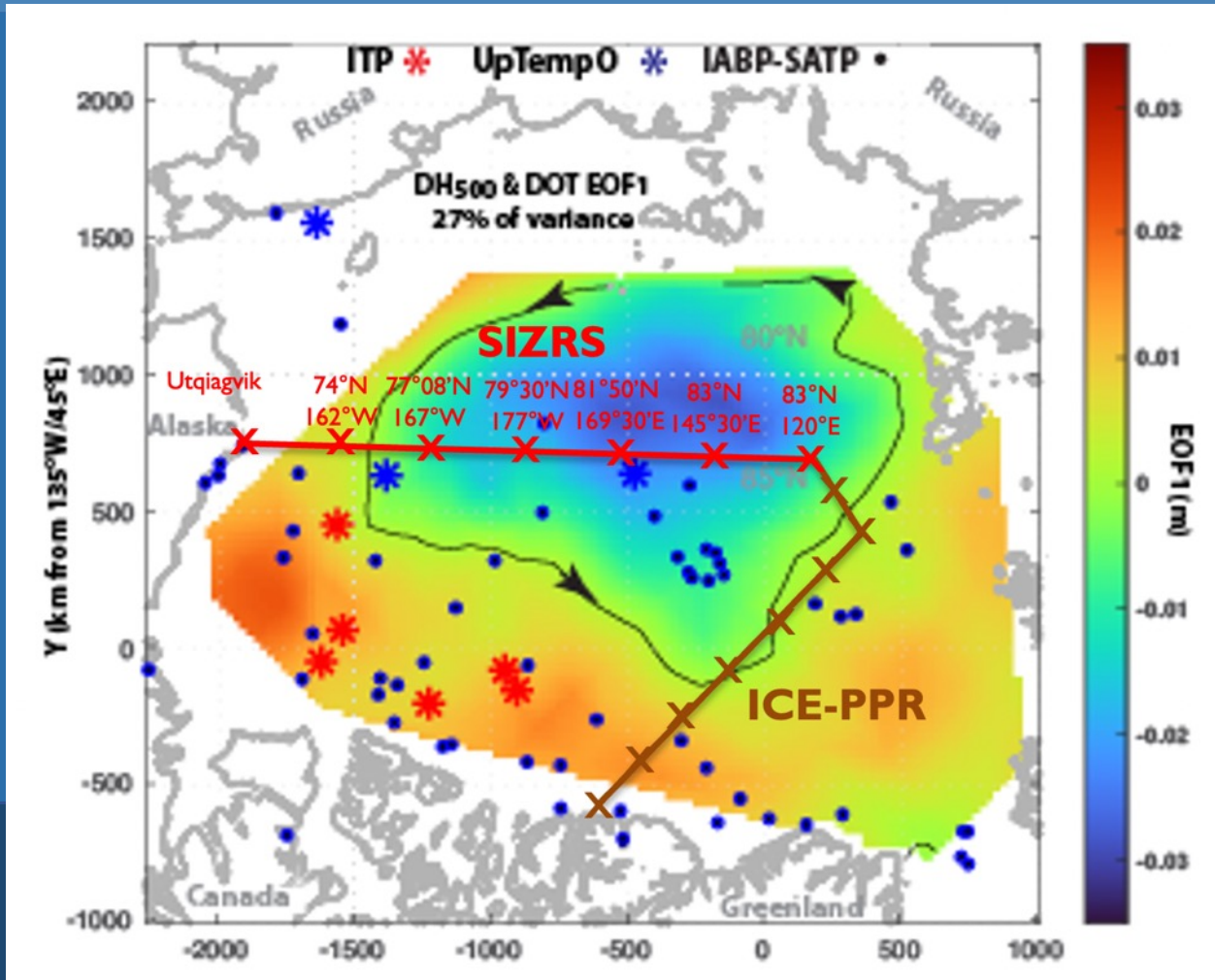


Priority 1 may take multiple flights for proper seeding



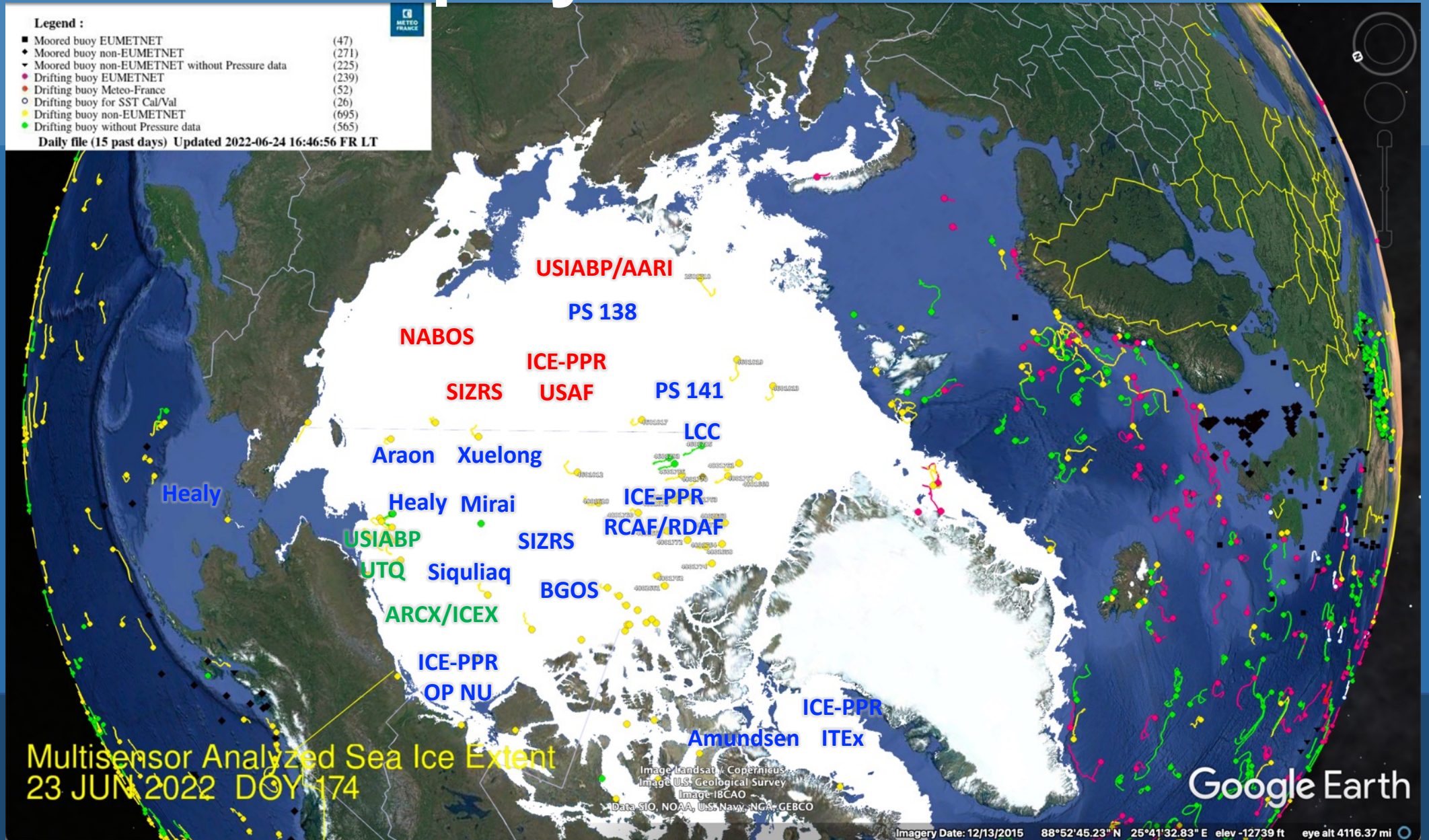
Alternate Ways of in Situ Sampling the Heart of Variability

EOF1 + Buoys
March 15, 2019
+
Long-range
Aircraft
Planned SIZRS
and ICE-PPR
Flight-lines to
Sample the
Cyclonic Mode

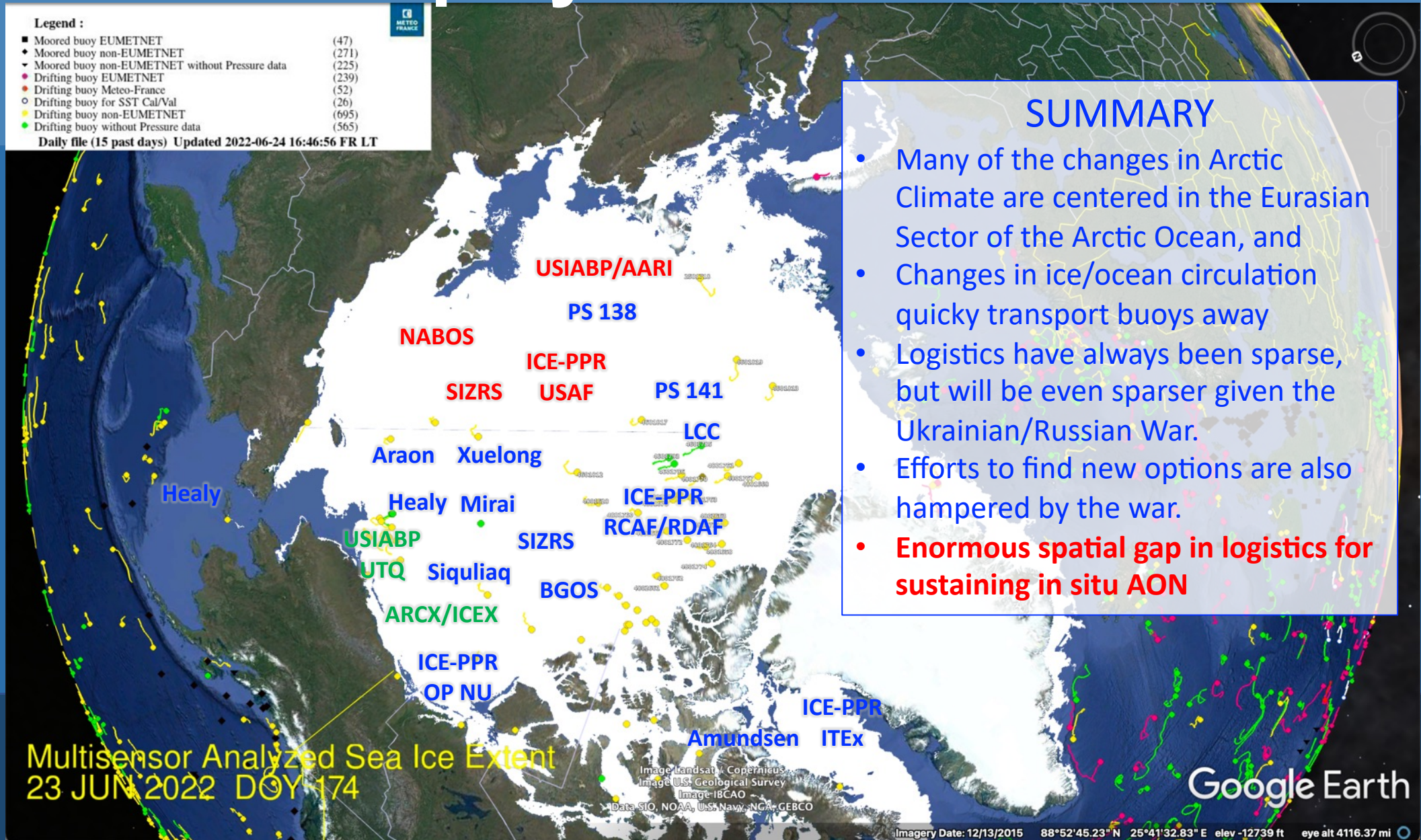


- Hydrographic surveys and buoy deployments using long range aircraft can yield snapshot sections through the change sensitive regions, e.g.,
- Seasonal Ice Zone Reconnaissance Surveys (SIZRS) aboard US Coast Guard C-130s makes monthly summer AXCTD, AXCP, and dropsonde sections and deploys buoys across the Beaufort Sea SIZ.
- International Cooperative Engagement Program for Polar Research (ICE-PPR) uses C-130s from 7 partner nations to deploy buoys and expendable probes.

IABP Deployment Plans 2023+

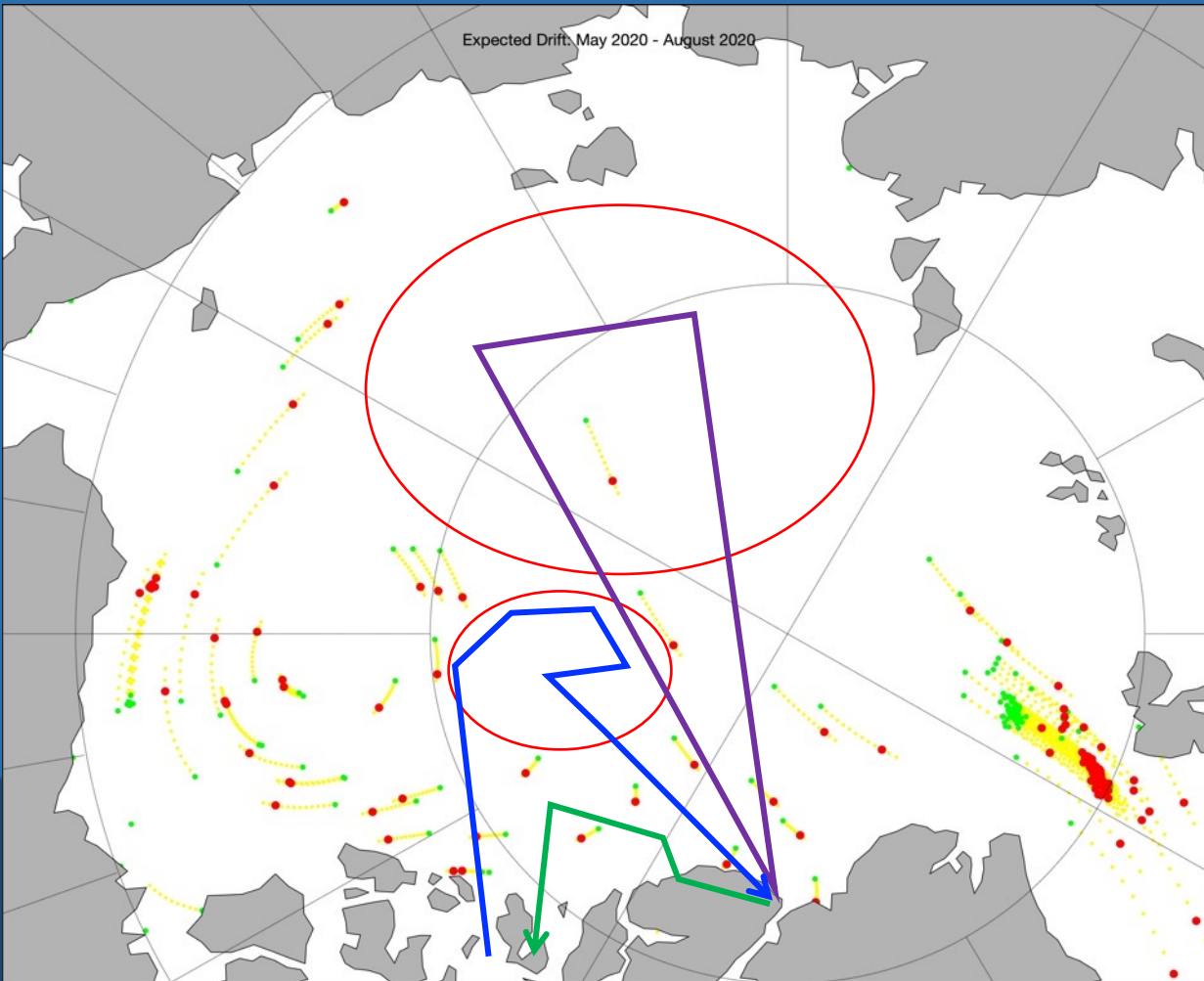


IABP Deployment Plans 2023+



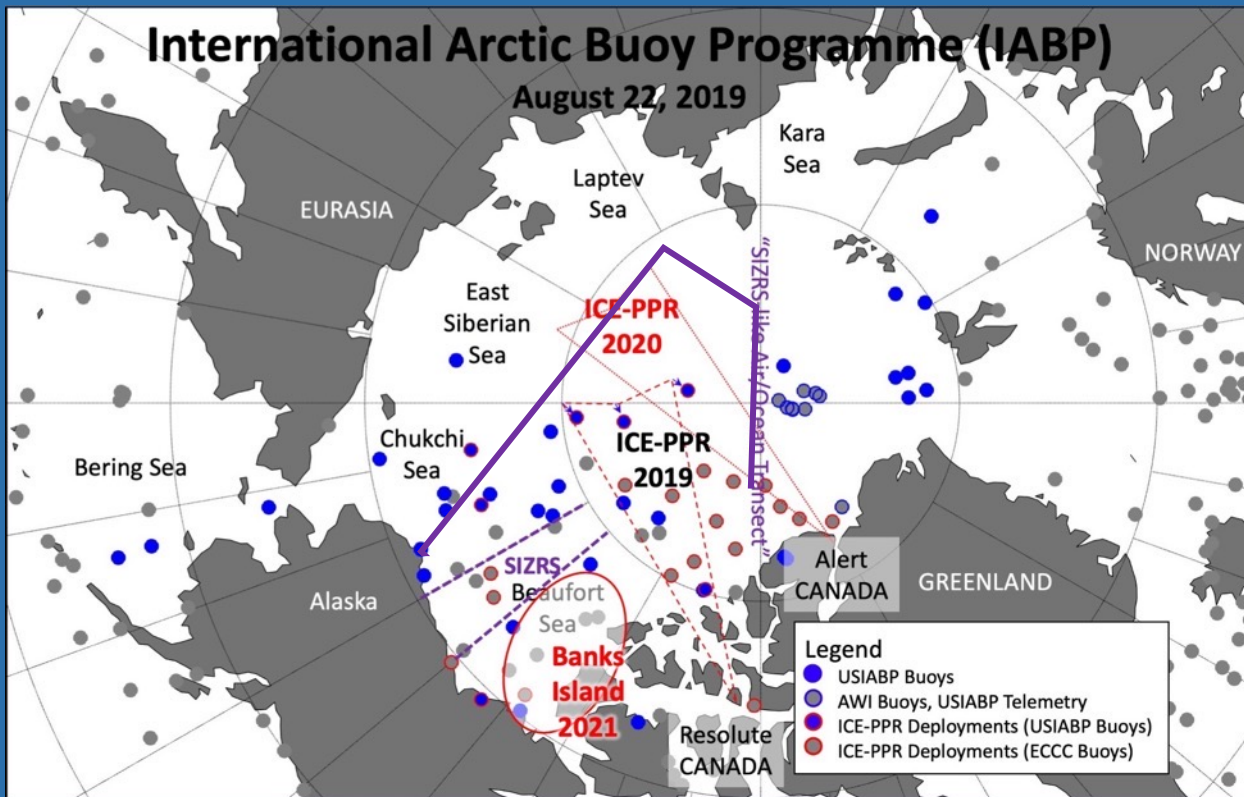
END

ICE-PPR Resolute, Alert, Thule July 2021 (TBD)



- 2020 RCAF/ECCC
- Buoys:
 - 2 ICEXAIR
 - 4 AXIBs
 - 12 SVP-AD
 - Lots of Ice Trackers
 - Lots of Ice Trackers w/ Barometers
 - N UpTempOs
- Flight 1: Resolute -Canadian High Arctic – Alert (SVP-AD and Ice Trackers)
- Flight 2: Alert - Eurasian Arctic – Alert (AXIB and SVP-AD)
- Flight 3: Alert – Ice Island Tagging – Resolute (SVP-AD and Ice Trackers)

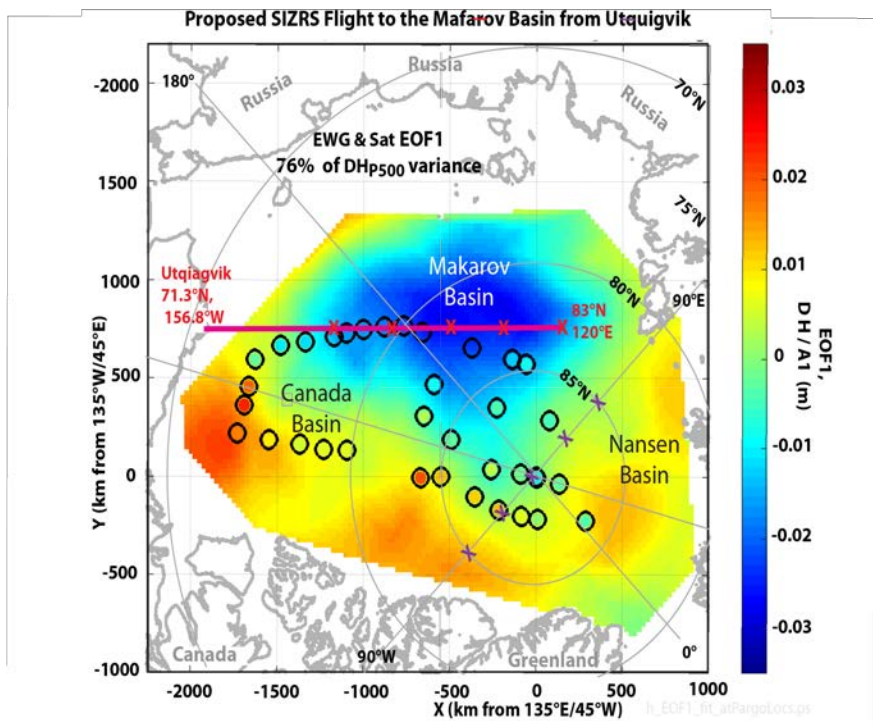
ICE-PPR Plans 2022



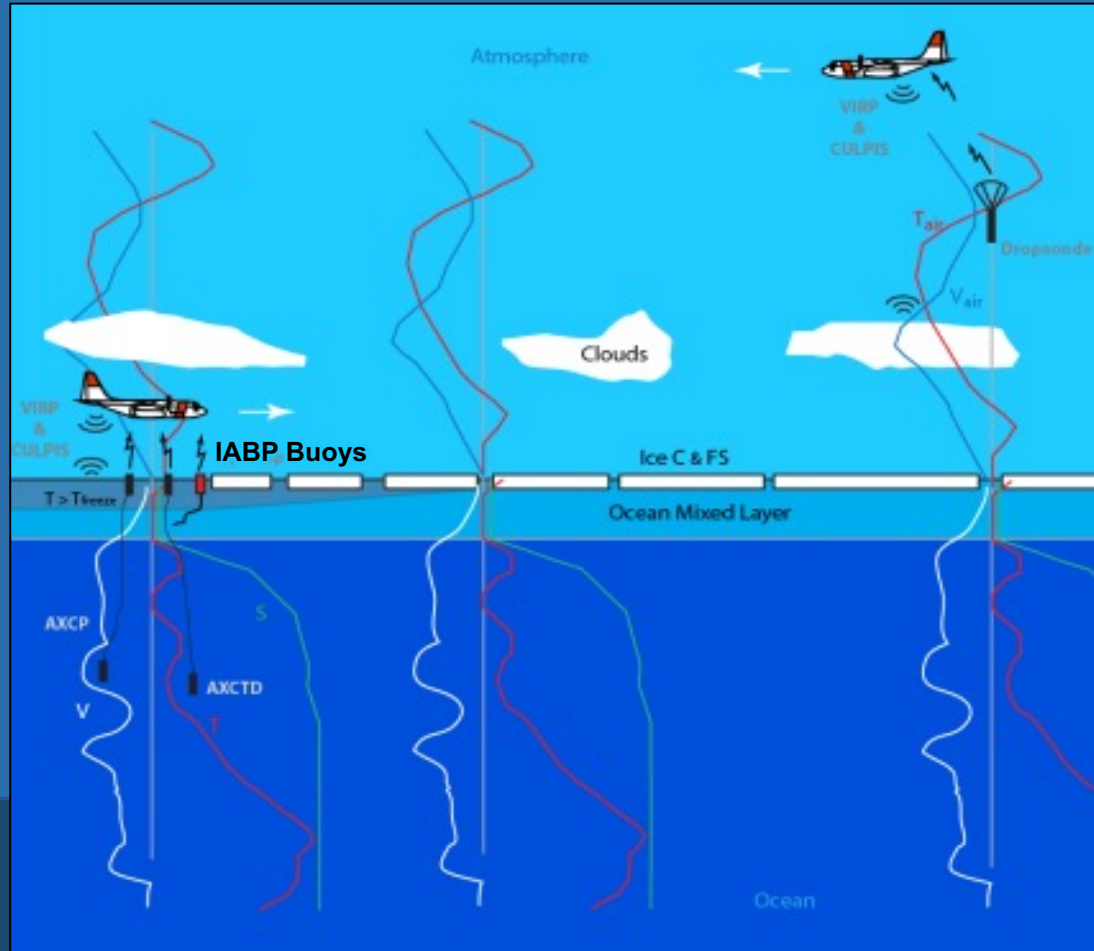
- CA DND
Inuvik/Tuktoyaktuk/Sachs Harbor, February (canceled)
- USIABP UTQ, Mar. 28–Apr. 7
- RCAF High Arctic, June/July
- HMCS Harry DeWolf (JACO cruise NW of Thule), July
- USAF Eurasian Basin, TBD

Seasonal Ice Zone Reconnaissance Surveys

SIZRS August 2022 Deployments



Color contours show the most significant pattern of sea surface height variability from US-Russian hydrography 1950-89 and satellite altimetry 2004-2019. The center of maximum variability and circulation is the blue area in the Makarov Basin. The proposed SIZRS USCG C-130J flight (red line) would be the first section of hydrographic measurements across this critical region since the 1993 cruise of the USS PARGO.



IABP Buoy,
AXCTD/AXCP
and Dropsonde
Deployments

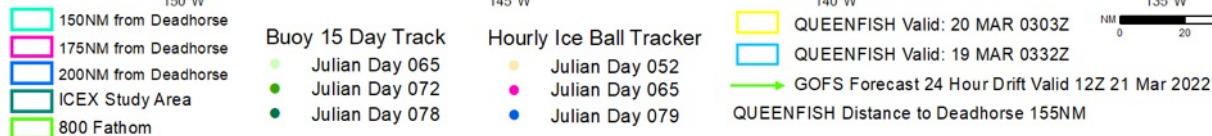
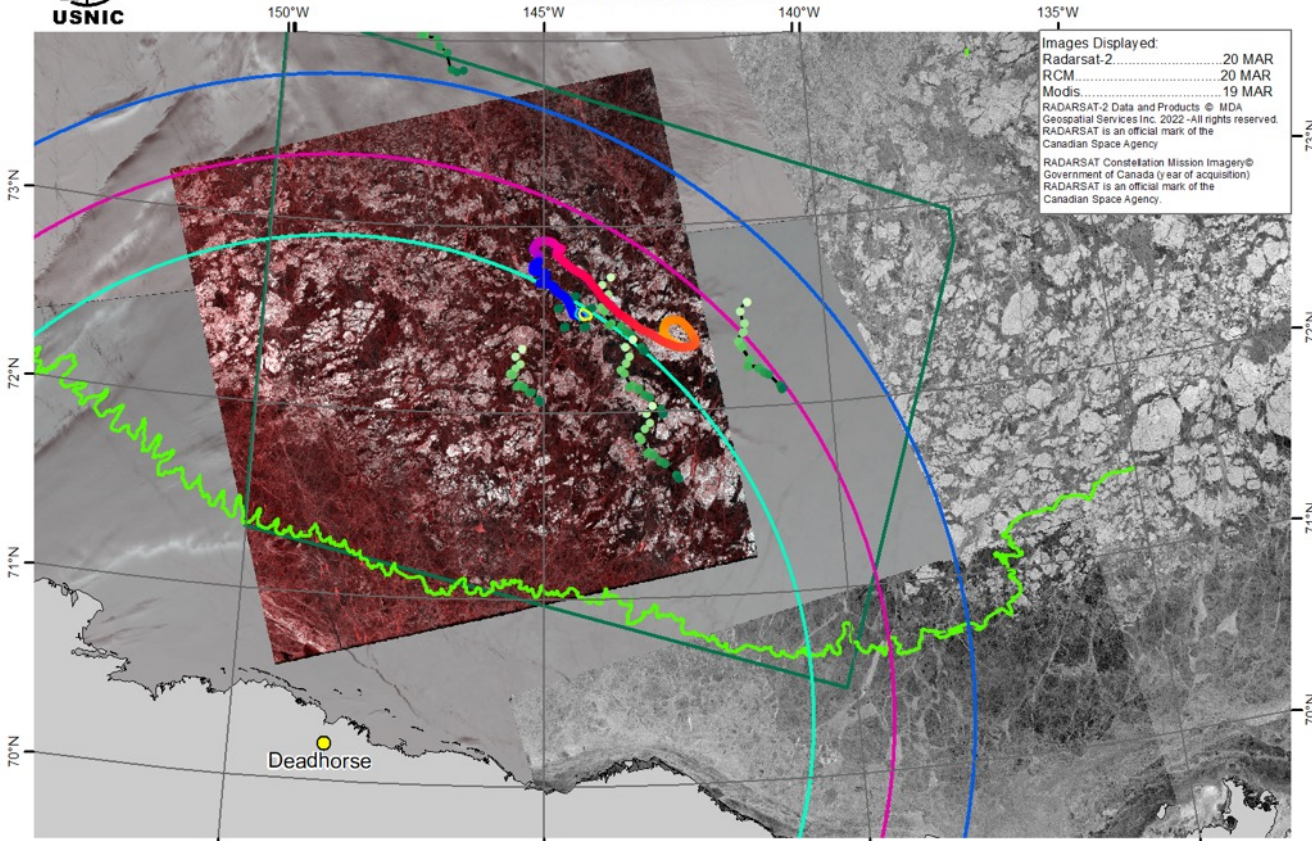
ICEX (US Navy Arctic Submarine Lab) February/March 2022



U. S. NATIONAL ICE CENTER
CURRENT ICE CONDITIONS
PRODUCED: 20 MAR 2022

POC:USNIC CDO
301-817-3975
NIC_ANALYST@NOAA.GOV

Images Displayed:
Radarsat-220 MAR
RCM20 MAR
Modis19 MAR
RADARSAT-2 Data and Products © MDA
Geospatial Services Inc. 2022 -All rights reserved.
RADARSAT is an official mark of the
Canadian Space Agency
RADARSAT Constellation Mission Imagery©
Government of Canada (year of acquisition)
RADARSAT is an official mark of the
Canadian Space Agency.

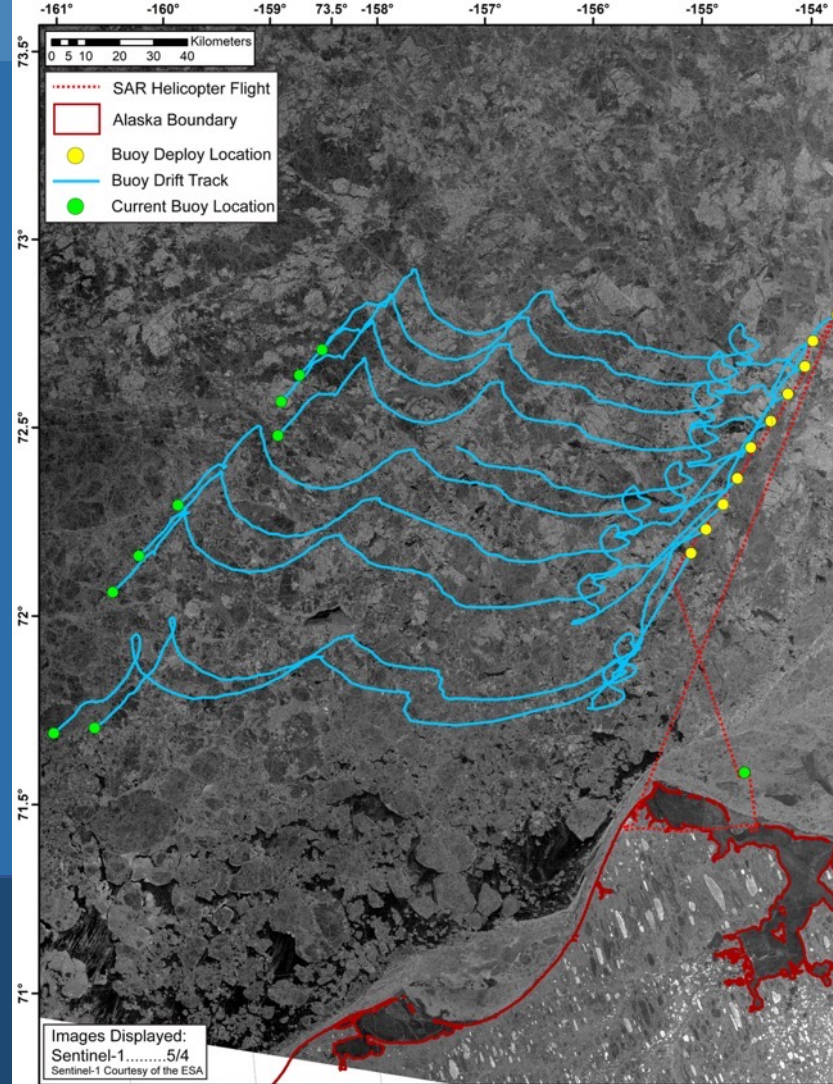


2022 Deployments: **29 Buoys**

- 1 APL/UW Dynamic Ocean Topography (DOT) buoys
- 6 USIABP Ice Balls
- 3 ASL Ice Trackers
- 6 ASL Ice Deformation Array (Periph Buoys)
- 1 ASL Sidekick Webcam
- 12 JAMSTEC buoys
 - 6 Ice Trackers
 - 5 Ice Balls
 - 1 SideKick
 - 1 WARM-like Buoy

USIABP Utqiagvik, Alaska

April 2022 Deployments

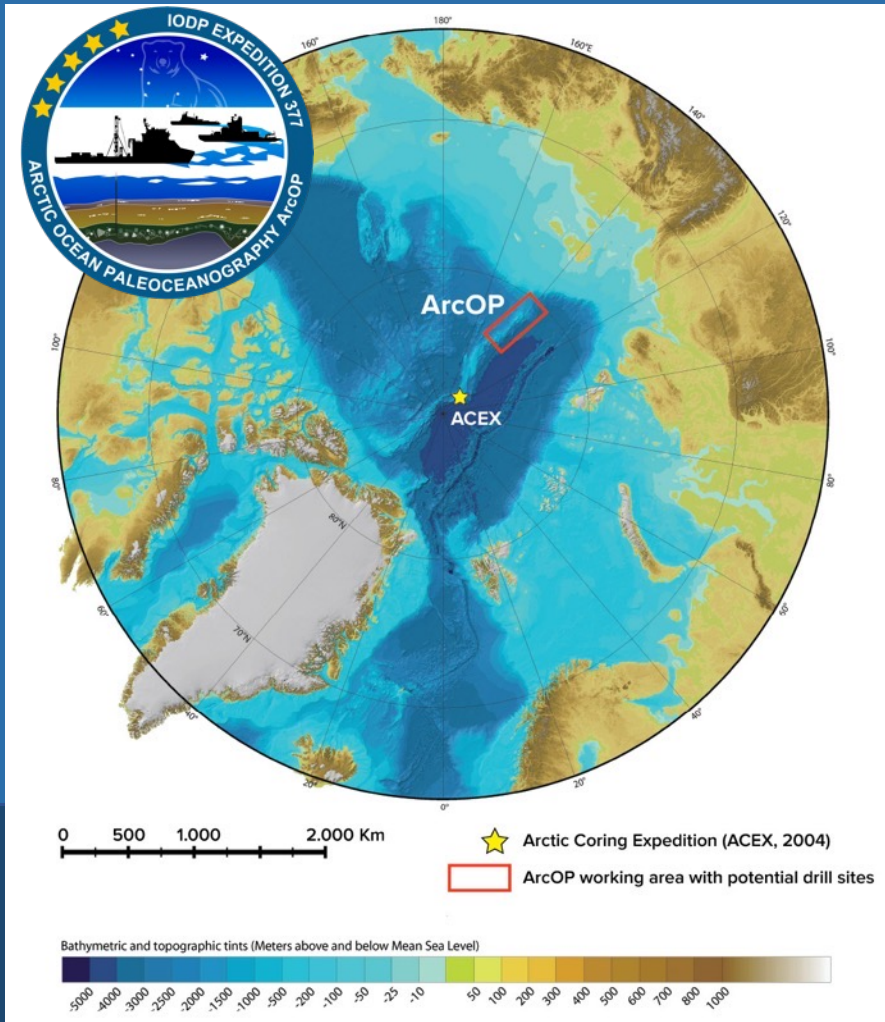


April 2022 Deployments

- 1 Cluster with...
 - 1 Light and Ice Mass Balance (LIMB) buoy
 - 1 Sidekick Webcam
 - 1 Ice Ball
 - Wooden Boat from www.floatboat.org
- 1 Pacific Gyre Ice Ball
- 2 APL/UW Ice Pelicans
- 3 Pacific Gyre Ice Trackers
- 4 UMD Trackers

International Ocean Drilling Program (IODP)

August – September 2022

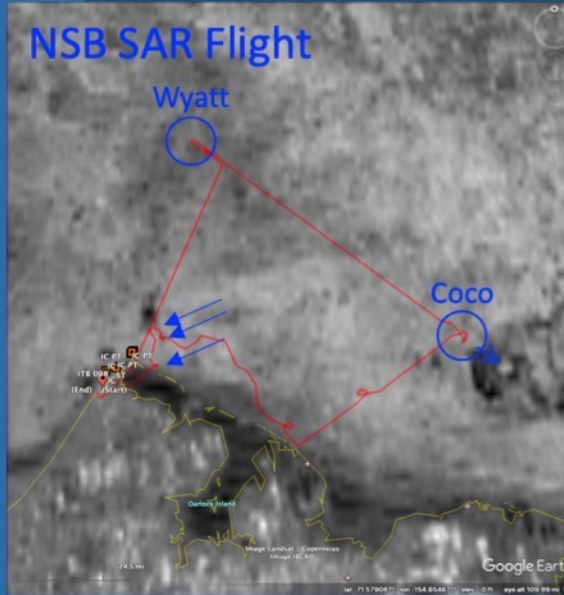


- Objective: 900m sediment core
- Chief Scientists:
 - Ruediger Stein
<ruediger.stein@awi.de>, and
 - Kristen St. John
<stjohnke@jmu.edu>.
- Buoys:
 - N Ice Ball
 - N SVP-B

Utqiagvik, Alaska Deployments March 2021

Ice Bergs and MY floes near Utqiagvik, Alaska

- As of May 25, 2021 ice bergs, MY floes, and landfast ice are not moving.
- Deployed 7 buoys at cluster of bergs north-northeast of NARL (bottom right).
- Deployed 5 buoys at loose cluster of bergs and MY floes north of Pt. Barrow (top right).
- Deployed 1 buoy on MY floe near Perch (NNW of NARL).
- Deployed 5 buoys at "Wyatt" (1 LIMB, 1 SK, 1 IP, 2 IC).
- Deployed 3 buoys at "Coco" (1 LIMB, 1 IB, 1 IC).
- Deployed 3 Ice Trackers on bergs in landfast ice east of Utqiagvik (blue arrows overlaid on Radarsat image in upper left).



END