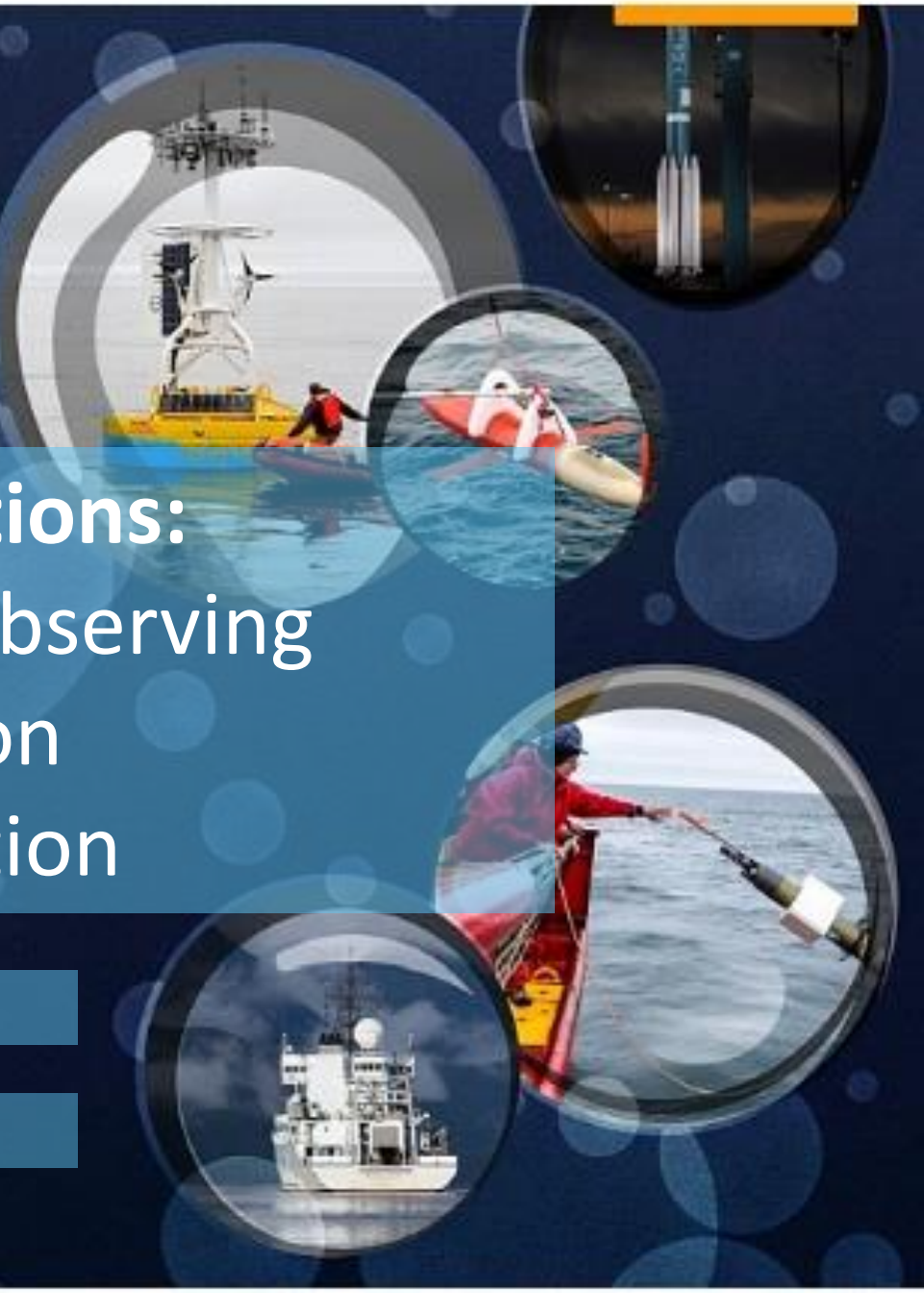
OCEAN OBS '19

AN OCEAN OF OPPORTUNITY
September 16-20, 2019

ceanPredict '19
GODAE OceanView Symposium 2019



Polar Ocean Observations: A Critical Gap in the Observing System and its effect on Environmental Prediction

A white paper contribution to OceanObs`19

Gregory Smith (ECCC) and co-authors

White paper coauthors

Under review in Frontiers in Marine Science

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Related OceanObs`19 white papers

Under review in Frontiers in Marine Science

- **Fujii** et al**:** Observing System Evaluation Based on Ocean Data Assimilation and Prediction Systems: On-going Challenges and Future Vision for Designing/Supporting Ocean Observational Networks
- **Davidson** et al: Synergies in Operational Oceanography: The intrinsic need for Sustained Ocean Observations
- **Stewart** et al.: The Canadian Integrated Ocean Observing System (CIOOS)
- **Howe** et al: Observing the Ocean Acoustically
- **Janzen** et al: Real-Time Observing Capabilities for Remote Coastal Regions for Informing Nowcasts and Forecasts
- **Lee** et al: A framework for the development, design and implementation of a sustained Arctic Ocean Observing System

Special session organized at OceanObs’19 on polar observations

The Growing Need for Polar Environmental Predictions

Polar amplification of climate change

Photo from Llodys report

Oil spill in ice: Is the OceanPredict community ready?

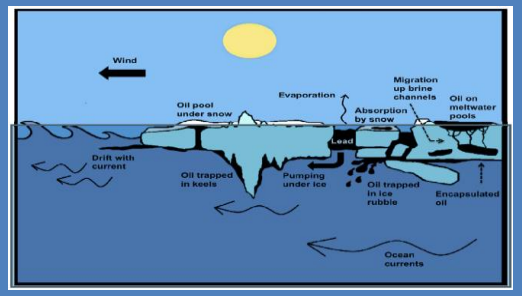
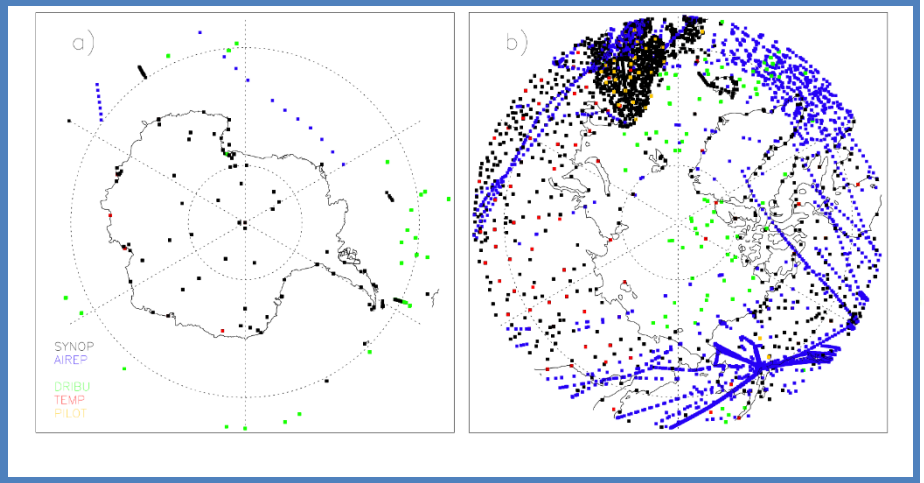


Photo by Chilean Navy/Reuters

- Increase in maritime traffic and exploitation of marine resources in the Arctic
- Predictive power of traditional knowledge is breaking down
- Support for Antarctic operations and understanding of ice shelf stability
- Jung et al. (BAMS, 2016)

Gap in Observational Coverage

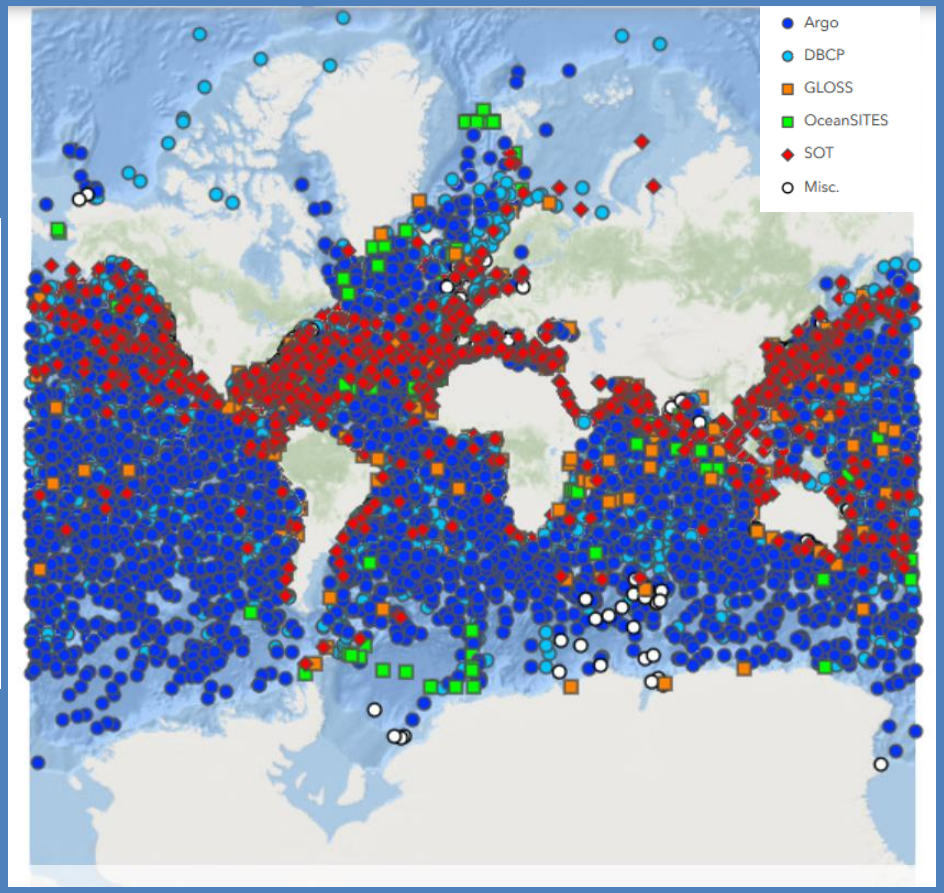
Atmosphere



Synop, AIREP, DRIBU, TEMP and PILOT

Polar data coverage of conventional observations in the ECMWF operational analysis on 1 January 2012

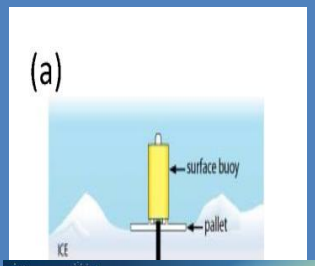
Ocean



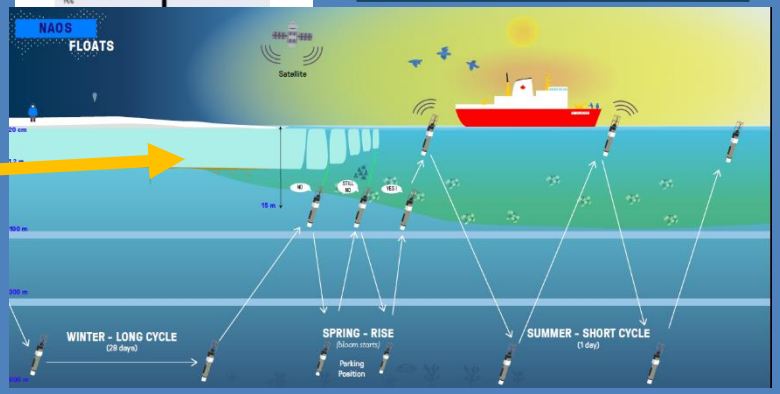
Observation coverage for May 2, 2019
From JCOMMOPS

Real-time in situ observations

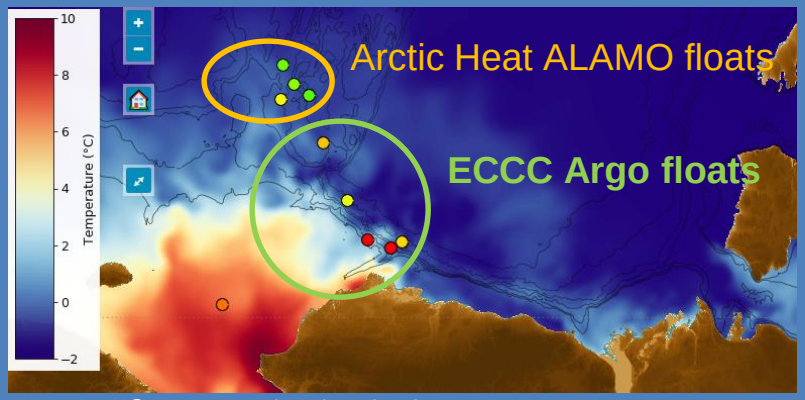
- Ice-tethered profilers
  - e.g. IAOOS, WHOI ITP



- Under-ice profiling floats
  - Various projects in Southern Ocean: SOCCOM, SOCLIM, RemOcean, SOCCO
  - Send data during ice-free season
  - RAFOS floats allow triangulation of position
  - Ice-sensing algorithm for Arctic becoming more mature
    - NAOS PRO-ICE floats (Takuvik)



- Other autonomous marine systems
  - ALAMO floats, Saildrones, Gliders
  - Exploit longer periods of ice-free conditions

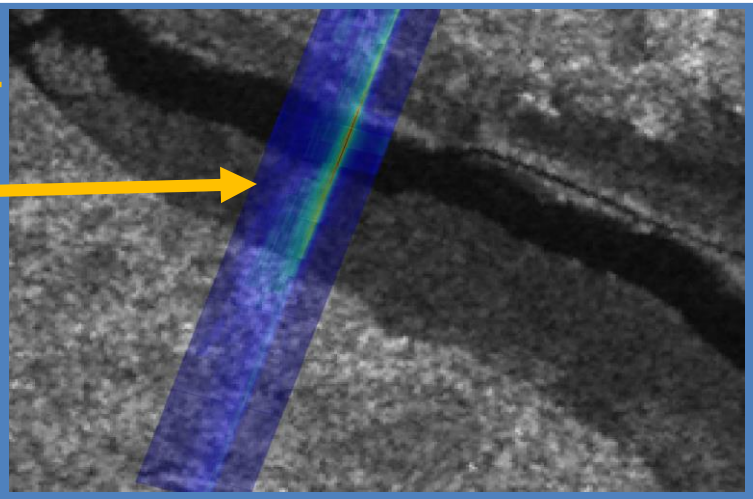


Beaufort and Chukchi Seas, 28 Sept 2018

Satellite-based observations of polar oceans acquired for more than 4 decades

Many issues still remain…

- SSH required to constrain sfc currents, but…
  - Limited coverage poleward of 82°N
  - Ice detection still a challenge. Use SAR data?
  - Improved geophysical corrections required (tides)
  - SWOT, SKIM missions may provide innovations
- Significant spread in sea ice concentration retrievals
  - Surface melt a problem for passive microwave
- Observing ice thickness a challenge
  - Advances from altimetry (Cryosat2) and L-band radiometers (SMOS, SMAP). Soon IceSat2.
  - Cryorad mission may provide radiometer obs for thicker ice
- SST retrievals challenging in polar regions
  - Abnormally dry conditions, clear-sky detection, ice detection
  - In situ data required for calibration is lacking
  - Potential issue of continuity for microwave imagers

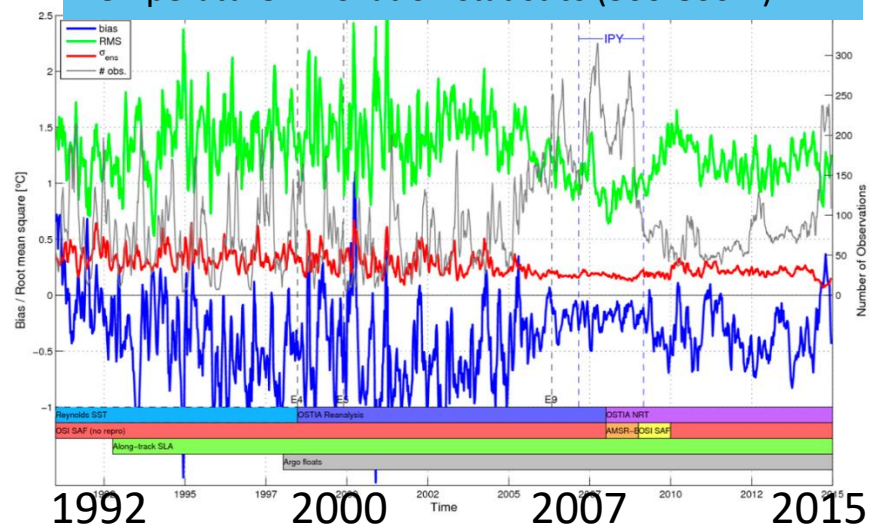


Collocation of one Sentinel-1 SAR image and Sentinel-3 altimeter waveforms over a lead in the Arctic Ocean

Observation impact on quality of analyses

- Understanding observation impacts is fundamental for modelling and observing system design
  - Coupled model data assimilation issues
  - Representation of physical processes
  - Assessing model performance
  - Maximize observing efforts
- Strong need for further OSE, OSSE and Network design

Temperature innovation statistics (300-800m)



TOPAZ4 Reanalysis Statistics over the Arctic.

Avg Innovations, RMS innov., Ens. Spread, #obs

- Significant change in statistics during IPY

International Projects

Various international efforts contribute to coordinate and support the vast and complex polar observing networks

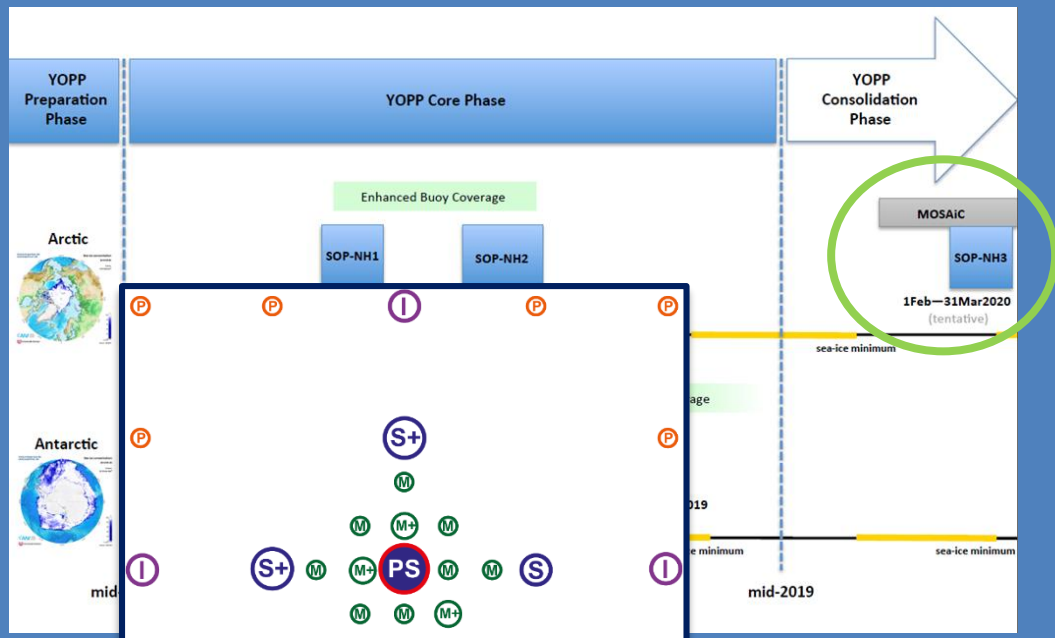
- E.g. IAOOS, FRAMS, NorArgo, SODA, INTAROS, EMODNET

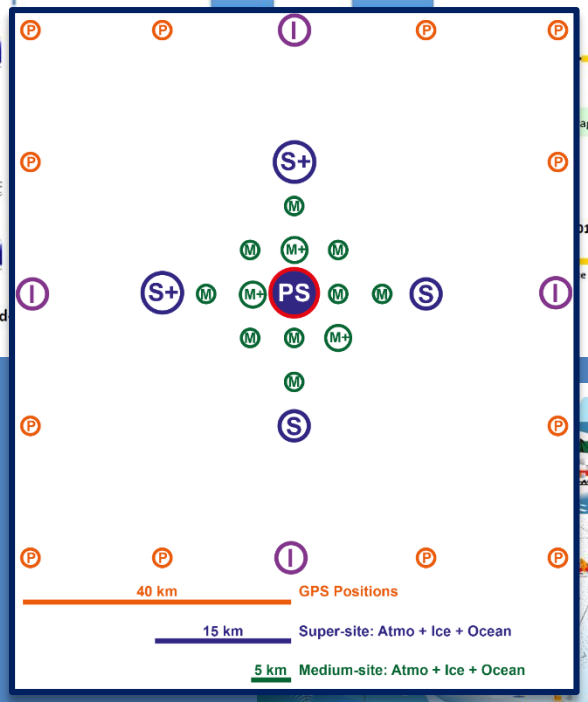
Southern Ocean Observing System

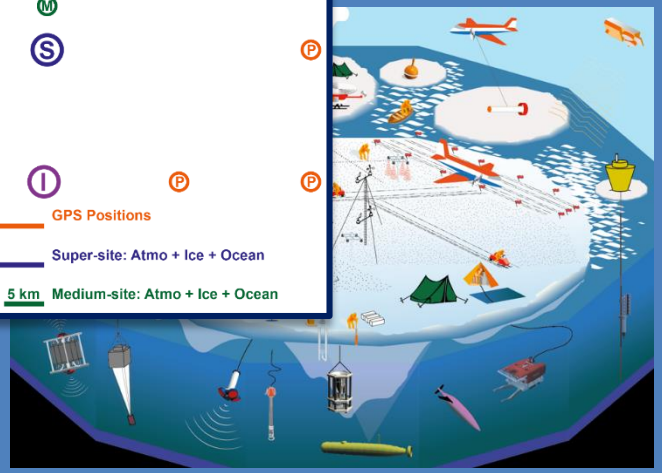
- Supported by SCOR and SCAR

SAON initiative (IASC) emerged from AOSs

- Arctic Region Global Ocean Observing System (ARGOOS) has been proposed







Year of Polar Prediction (YOPP)

- Period of intense observation and modelling in polar regions
- Opportunity/challenge for Ocean Prediction
  - How best to capitalize on YOPP observational and modelling datasets?

MOSAiC

- Over-wintering of Polarstern icebreaker
- Intensive observatory:
  - buoys, ice-tethered profilers, remote meteorology stations, underwater drifters, unmanned aerial systems, aircraft

Recommendations (1 / 2)

- Deploy and support operationally an Arctic network of ice-borne measurement systems
  - Adapt technologies developed in Arctic for use in Antarctic as well
- Re-evaluate observing system design to account for changing patterns of ice-cover
  - Use of open-water observing systems (e.g. Argo and gliders) in seasonally ice-free areas
- Make better use of ships of opportunity, especially given increase in marine traffic in the Arctic
- Improve availability of near-real time in situ observations for calibration of remote sensing products.
  - Efforts involving multi-platform calibration are needed to improve remote sensing products
- Expand efforts for sea ice thickness use in environmental prediction
  - In particular, require products for southern ocean
- There is a need for high-resolution (km-scale) remotely-sensed snow and ice property data for both the Arctic and Southern Ocean with sufficient temporal resolution to address small-spatial scale features

Recommendations (2 / 2)

- Call for coordinated efforts (including QND, OSEs and OSSEs) to enhance the Arctic and Southern Ocean observing networks
  - In particular, require OSEs using real-time prediction systems and multi-system exercises
- Require collocated information about the state of the atmosphere, sea ice and ocean, to be used for improving interfacial fluxes (esp. covariance measurements)
- Open access to real-time data is a critical capability for improved sea-ice and weather forecasting and other environmental prediction needs
  - Prioritize real-time dissemination of in-situ observations in polar regions to global data assembly centers
- International collaboration will continue to be key for facilitating deployment of polar ocean instrument systems, including the fielding of drifting and anchored buoys, floats and gliders and free, rapid dissemination of the resulting data

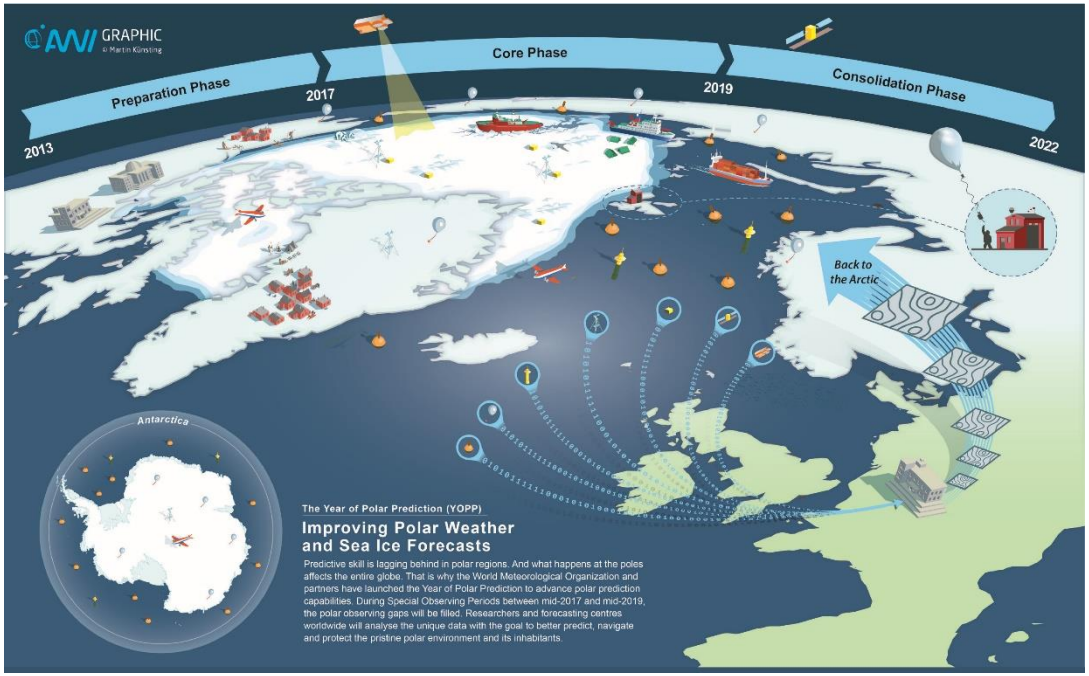
Outlook

- The relative remoteness and harsh environmental conditions over polar regions will always hinder efforts to provide adequate observations for polar prediction.
- Over recent years, we have seen improvements in observing technology and capabilities that create new possibilities for how to construct and maintain the polar ocean observing system.
- The technologies make an adequate polar ocean observing system feasible, but the question remains, are they worth the cost?

Important role for OceanPredict to play in answering this question

YOPP Final Summit 2022 provides opportunity to demonstrate importance of polar observations for Environmental Prediction and inform observing system design.

YEAR OF POLAR PREDICTION



Coordinated by the World Meteorological Organization (WMO)

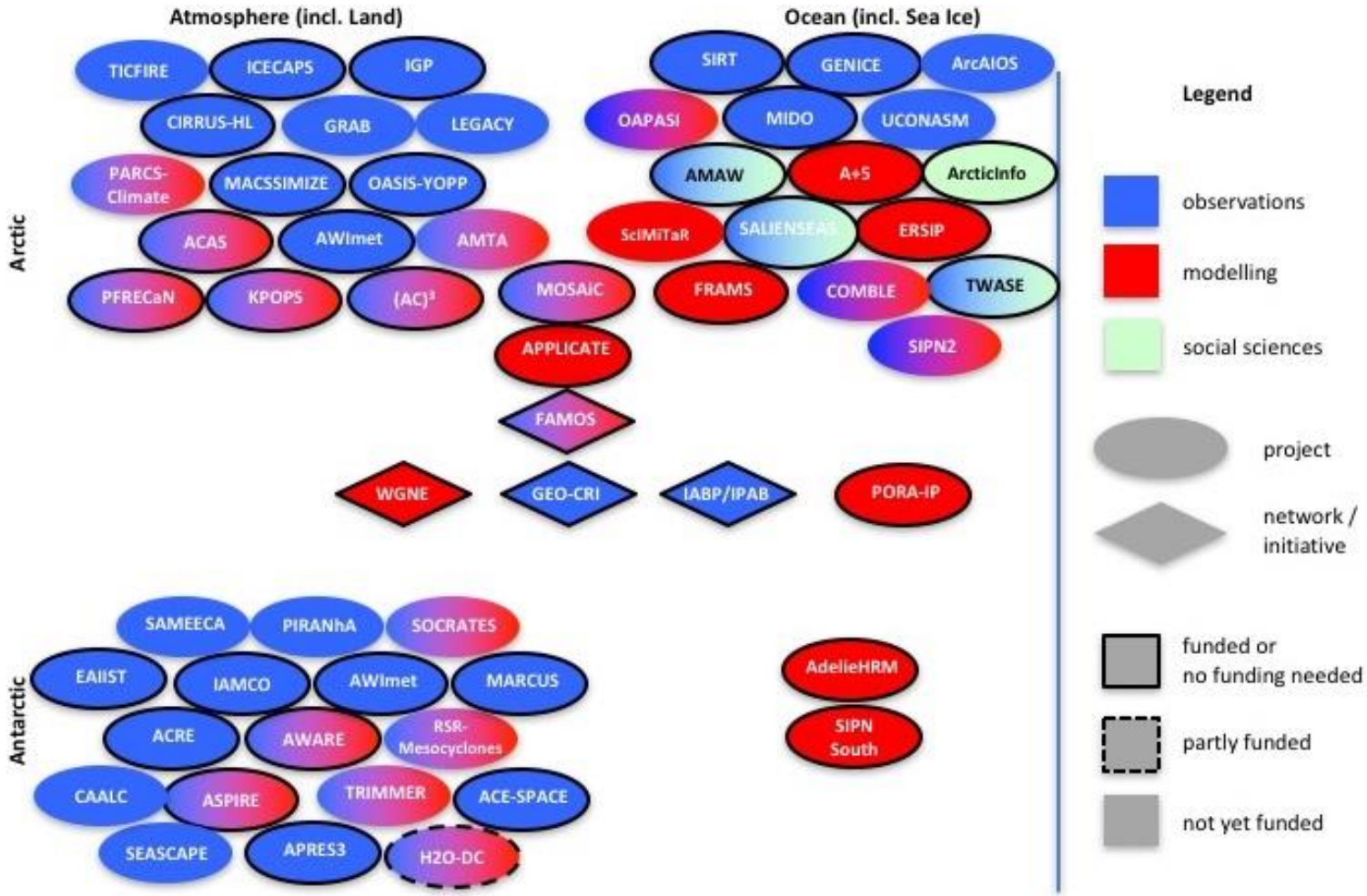
Period:
mid 2017– mid 2019
(Launch: 15th May 2017)

- **Goal: Improving predictions of weather and environmental conditions in polar regions and beyond**
- International collaboration between academia, operational forecasting centres, and stakeholders
- Improving the polar observing system, as well as weather and climate prediction models in polar regions

WMO OMM

www.polarprediction.net
@polarprediction

YOPP Endorsement



59 endorsed projects (28 August 2017)