WWRP Polar Precition Project: Year of Polar Prediction

An Initiative of the World Meteorological Organization to Improve Weather and Sea ice Forecasts in Polar Regions

Gunilla Svensson

Stockholm University, Sweden

Member of the WWRP PPP Steering Group

Photo: Michael Tjernström

YOPP YEAR OF POLAR PREDICTION

WORLD METEOROLOGICAL ORGANIZATION

WWRP WORLD WEATHER RESEARCH PROGRAMME

AWI

The Year of Polar Prediction

Mission: Enable a significant improvement in environmental prediction capabilities for the polar regions and beyond, by coordinating a period of intensive observing, modelling, verification, user-engagement and education activities.

Launch of PPP
(2011)

Preparation Phase
(2013-17)

Core Phase
(2017-2019)

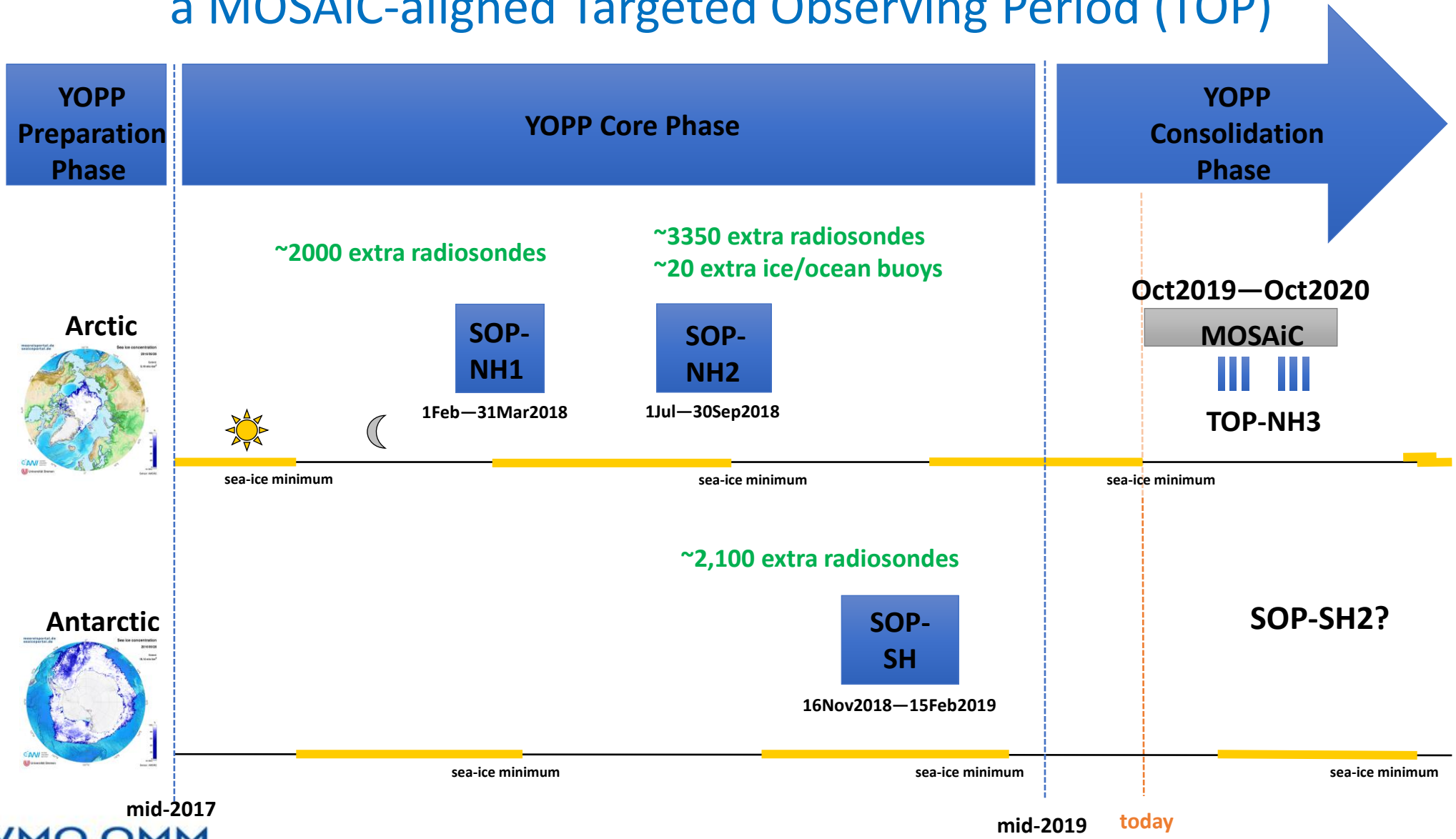
Consolidation Phase
(2019-2022)

YOPPsiteMIP

MOSAiC
International
Arctic Drift
Expedition

WMO OMM

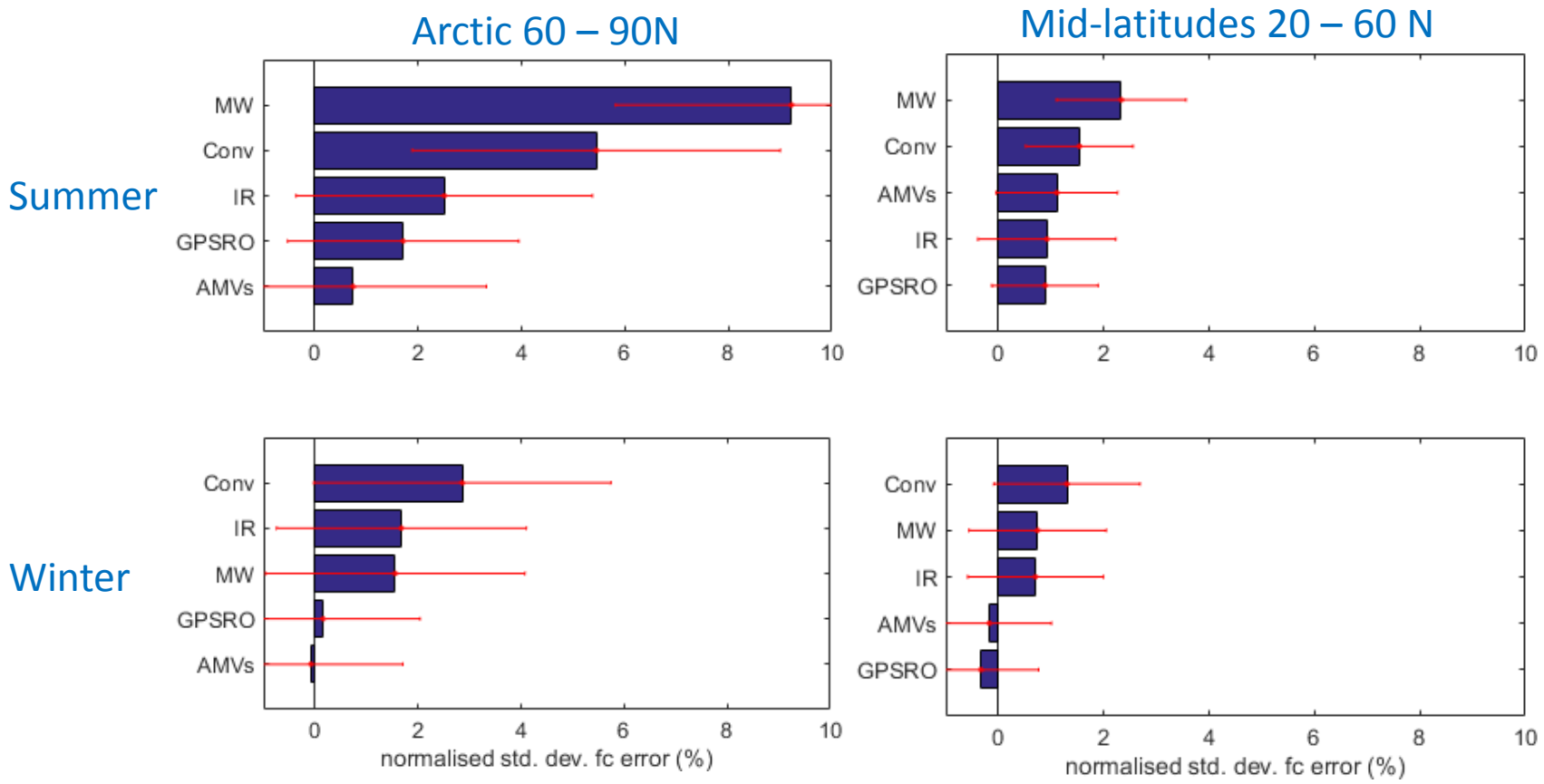
YOPP: Special Observing Periods (SOPs) and a MOSAiC-aligned Targeted Observing Period (TOP)



WMO OMM

YOPP Core Phase – Selected Highlights

Observing System Experiments, Day 3, Z500



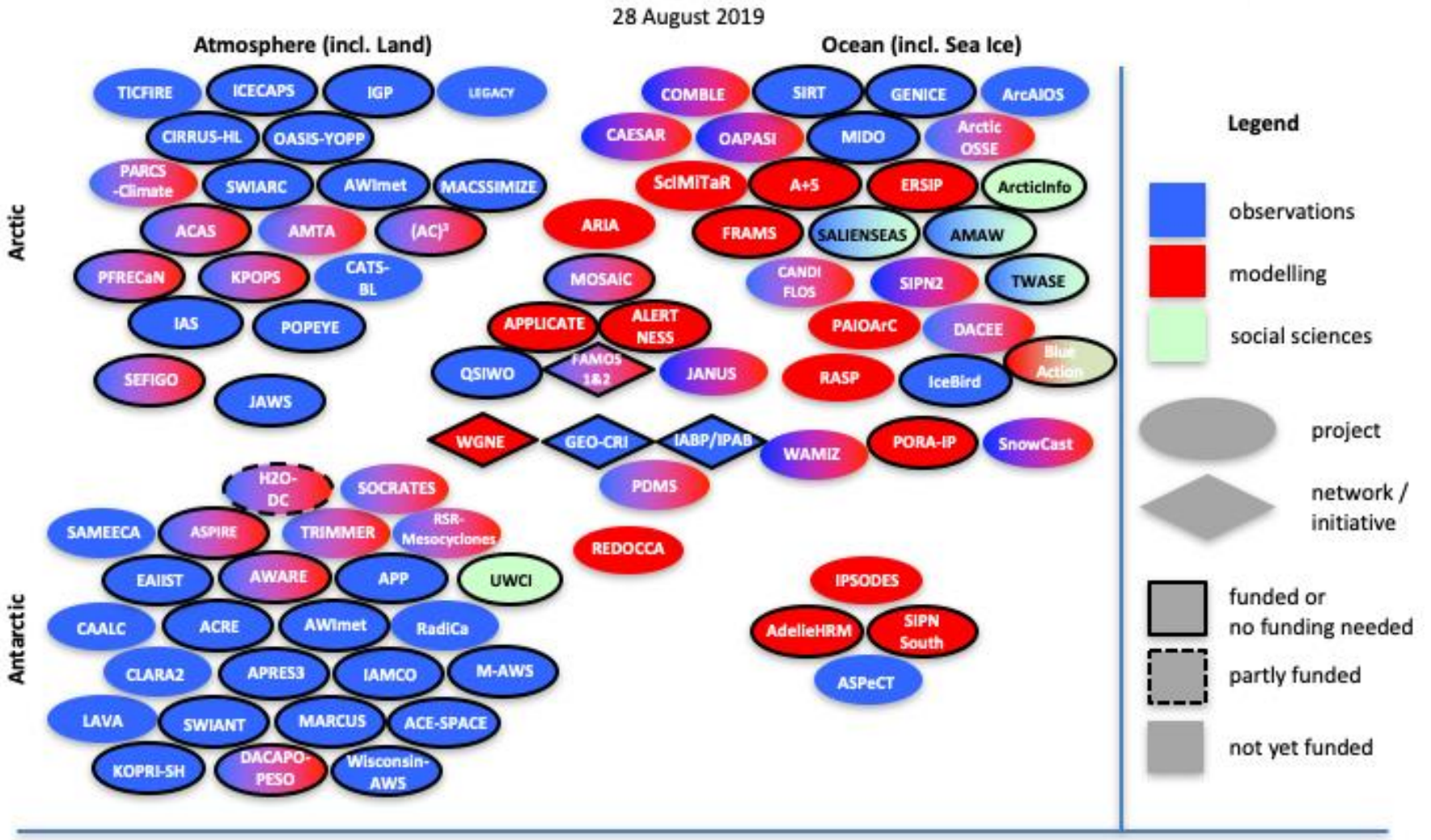
Summer:
- Microwave
- Conventional

Winter:
- Conventional
- Overall less impact, likely due to assimilation problems

Lawrence et al., 2019 QJRMS

YOPP Core Phase – Selected Highlights

85 projects endorsed by YOPP

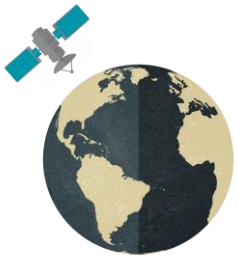


Six institutional endorsements

Met NO | ARC MFC | GFI | ECCC | USNIC | UK Met Office

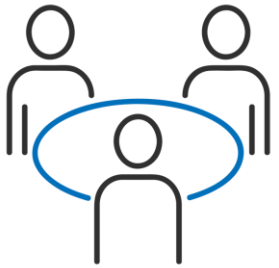
WMO OMM

The YOPP Consolidation Phase – Elements



Consolidating YOPP research

From research to operations and services



YOPP coordination Task Teams

Communication and outreach

Creating a YOPP legacy

Determining success

WMO OMM

YOPP Consolidation phase: Process Task Team

Gunilla Svensson (Stockholm University)

Barbara Casati, ECCC; James Doyle, NRL; Jun Inoue, National Institute of Polar Research; Steffen M. Olsen, DMI; Felix Pithan, AWI; Ian Renfrew, University of East Anglia, Thomas Spengler, Bergen University; Taneil Uttal, NOAA; Timo Vihma, FMI; Manfred Wendisch, Leipzig University and Matt Shupe, University of Colorado/NOAA

WMO OMM

YOPP Consolidation phase: Process Task Team

Gunilla Svensson (Stockholm University)

Barbara Casati, ECCC; James Doyle, NRL; Jun Inoue, National Institute of Polar Research; Steffen M. Olsen, DMI; Felix Pithan, AWI; Ian Renfrew, University of East Anglia, Thomas Spengler, Bergen University; Taneil Uttal, NOAA; Timo Vihma, FMI; Manfred Wendisch, Leipzig University and Matt Shupe, University of Colorado/NOAA

WMO OMM

YOPPsiteMIP

YOPP & MOSAiC

YOPPsiteMIP
The Year of Polar Prediction supersite Model Intercomparison Project

Gunilla Svensson (Stockholm University)

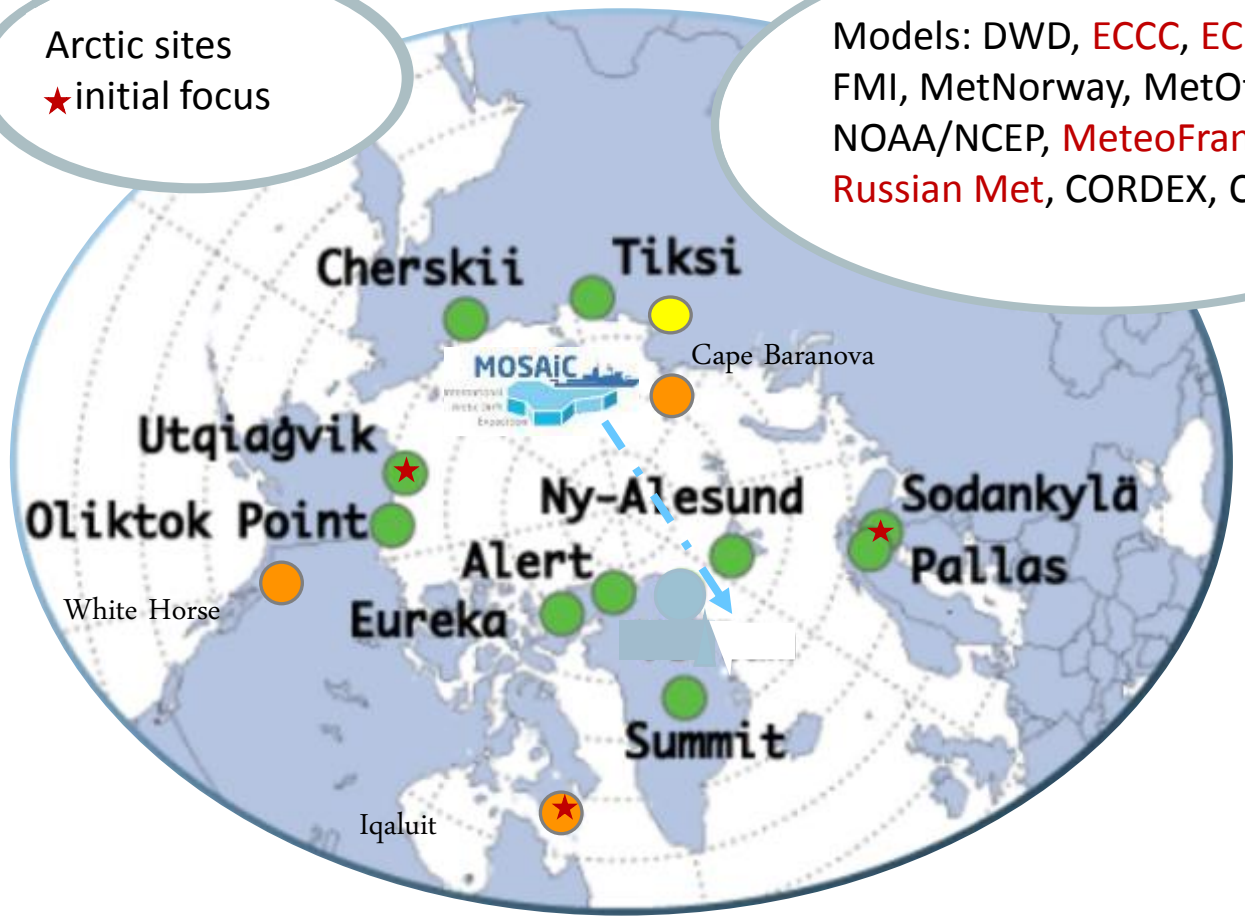
Taneil Uttal (NOAA), Barbara Casati (ECCC), Jonny Day (ECMWF), Siri Jodha S. Khalsa (NSIDC)
+ data handling experts, observationalist and modellers

WMO OMM

YOPPsiteMIP

Arctic sites
★initial focus

Models: DWD, ECCC, ECMWF, FMI, MetNorway, MetOffice, NOAA/NCEP, MeteoFrance, Russian Met, CORDEX, CESM, …



- IASOA (International Arctic Systems for Observing the Atmosphere)
- ECCC supersites – soon members of IASOA
- Cape Baranova – soon member of IASOA
- MOSAiC drifting station

In addition: Antarctic, Arctic Ocean and Third Pole sites

Supersites: Suites of instruments measuring variables that lead to *process understanding*

Models: *High frequency* column output on *model levels* at supersites

MIP: Developed *Format and Semantics* used for both models and observations promoting *multi-model* and *multi-site* ***process evaluation***

Data: Available through the ***YOPP Data Portal*** (yopp.met.no)

Targeted processes: low-level clouds (including phase), stable boundary layers, atmosphere/snow interactions over land and sea ice, coupling procedures (variables and frequencies), ocean mixing, …

WMO OMM

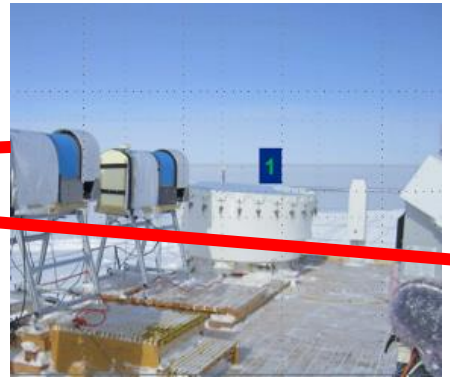
YOPPsiteMIP data

- **Processes** is the target – time step data on model levels, including tendencies and corresponding high-resolution observational data
- **NetCDF** format – to bridge between NWP, Climate and academia
- Inspiration from GASS, CFMIP … but taking it a step further to make sure the correct **terminology** and **conventions** are used and declared
- Model and observational files created in the same way i.e. we are using a Merged Data File Specification (**MDFS**) schema with a **Python** tool kit for creation of Merged Observatory Data Files (MODF) and Merged Model Data Files (MMDF)
- **Published** data sets (with DOI) **open access** (and FAIR) via the YOPP data portal https://yopp.met.no
- **Atmosphere**, ocean, sea-ice, land, …
- A **workshop** is planned (April 2020 in Boulder) on how-to create files

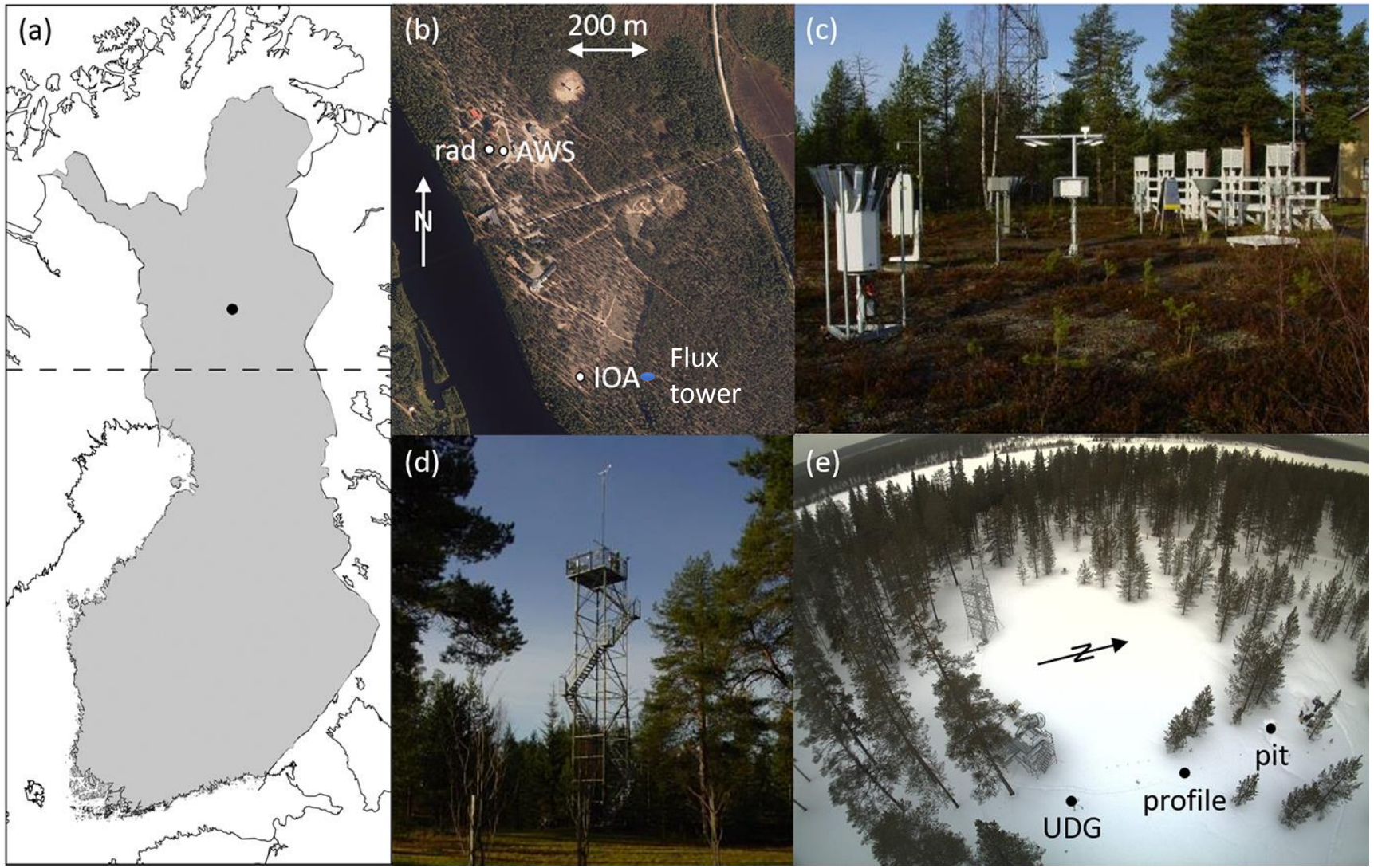
The IASOA Merged Observatory Data Files (MODF)

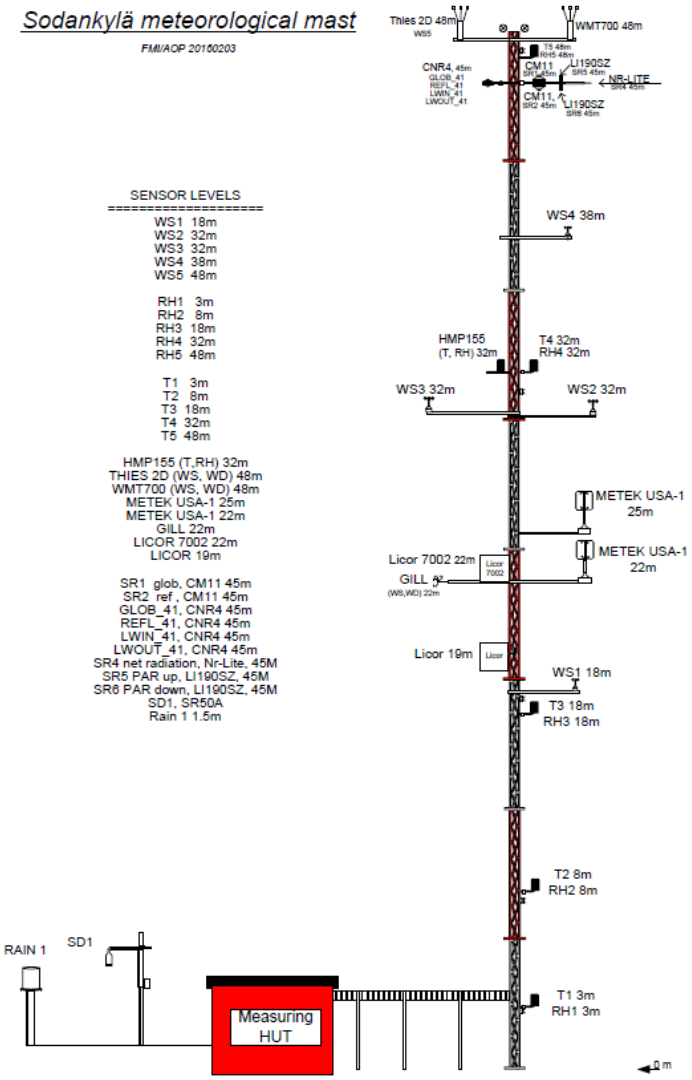
In support to YOPPsiteMIP, IASOA aims to provide a unified file format with standardized quality controls and data processing, which includes all measurements from all sensor, for each observatory.

```
netcdf sodankyla_ecmwf_ifs_2017050100 {
dimensions:
        time = UNLIMITED ; // (576 currently)
        lon = 1 ;
        lat = 1 ;
        level = 137 ;
        half_level = 138 ;
        soillevel = 4 ;
        tiles = 9 ;
variables:
        double lat(lat) ;
                lat:long_name = "latitude" ;
                lat:units = "degrees_north" ;
        double lon(lon) ;
                lon:long_name = "longitude" ;
                lon:units = "degrees_east" ;
        float time(time) ;
                time:long_name = "verification time" ;
                time:calendar = "standard" ;
                time:units = "hours since 2017-05-01 00:00:00" ;
        double soillevel(soillevel) ;
                soillevel:_FillValue = 9.96920996838687e+36 ;
        double zg(time, lat, lon, level) ;
                zg:long_name = "Geopotential height" ;
                zg:units = "m" ;
                zg:_FillValue = 9.96920996838687e+36 ;
        double pfull(time, lat, lon, level) ;
                pfull:long_name = "Pressure on full levels" ;
                pfull:units = "Pa" ;
                pfull:_FillValue = 9.96920996838687e+36 ;
        double ta(time, lat, lon, level) ;
                ta:long_name = "Temperature" ;
                ta:units = "K" ;
                ta:_FillValue = 9.96920996838687e+36 ;
        double ua(time, lat, lon, level) ;
                ua:long_name = "Eastward wind component" ;
                ua:units = "m/s" ;
                ua:_FillValue = 9.96920996838687e+36 ;
        double va(time, lat, lon, level) ;
                va:long_name = "Northward wind component" ;
                va:units = "m/s" ;
                va:_FillValue = 9.96920996838687e+36 ;
        double hus(time, lat, lon, level) ;
                hus:long_name = "Specific humidity" ;
                hus:units = "kg/kg" ;
                hus:_FillValue = 9.96920996838687e+36 ;
        double hur(time, lat, lon, level) ;
                hur:long_name = "Relative humidity" ;
                hur:units = "%" ;
                hur:_FillValue = 9.96920996838687e+36 ;
        double cl(time, lat, lon, level) ;
```



Sodankylä site



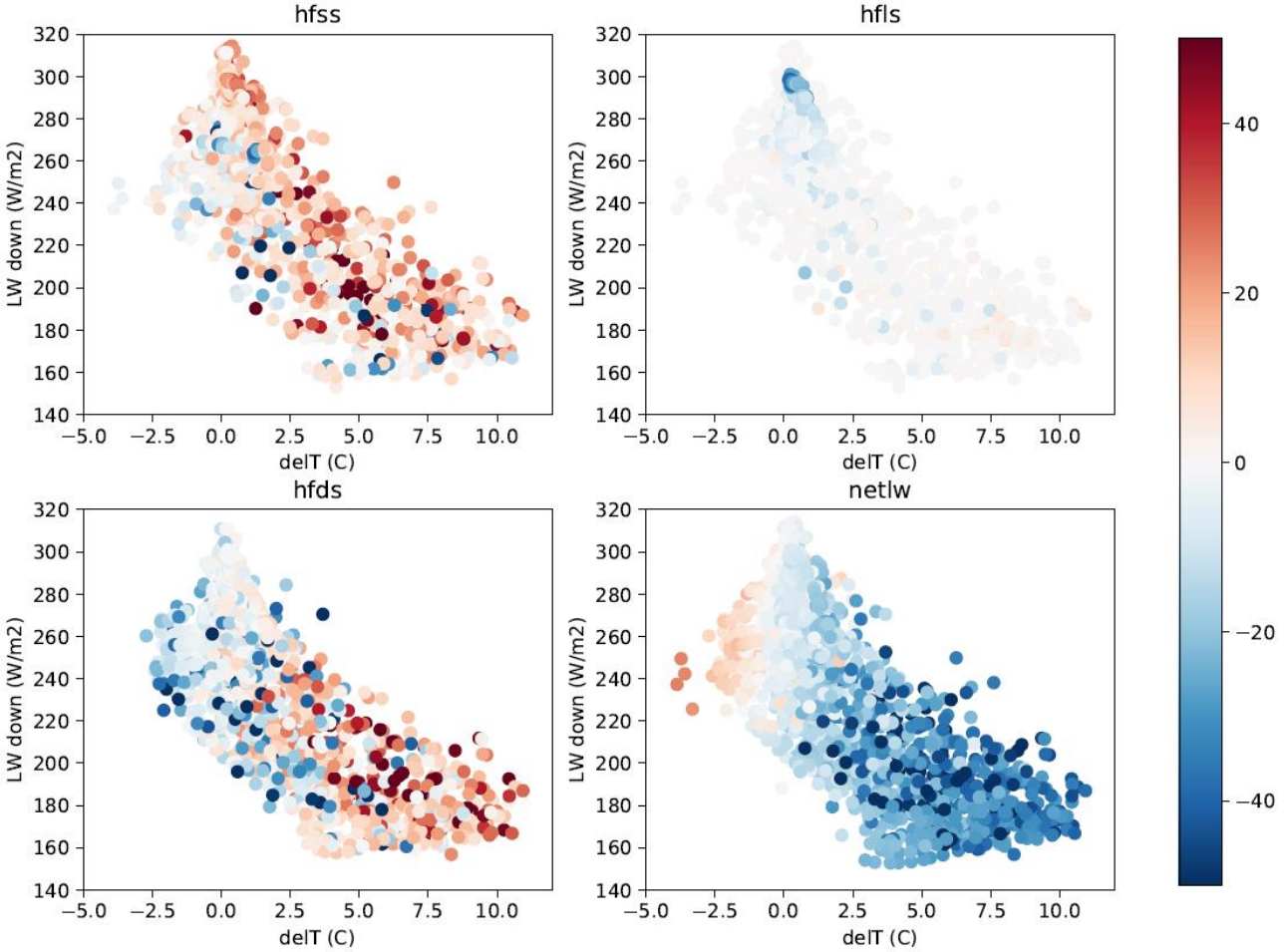


Essery et al. (2016), Kangas et al. (2016)

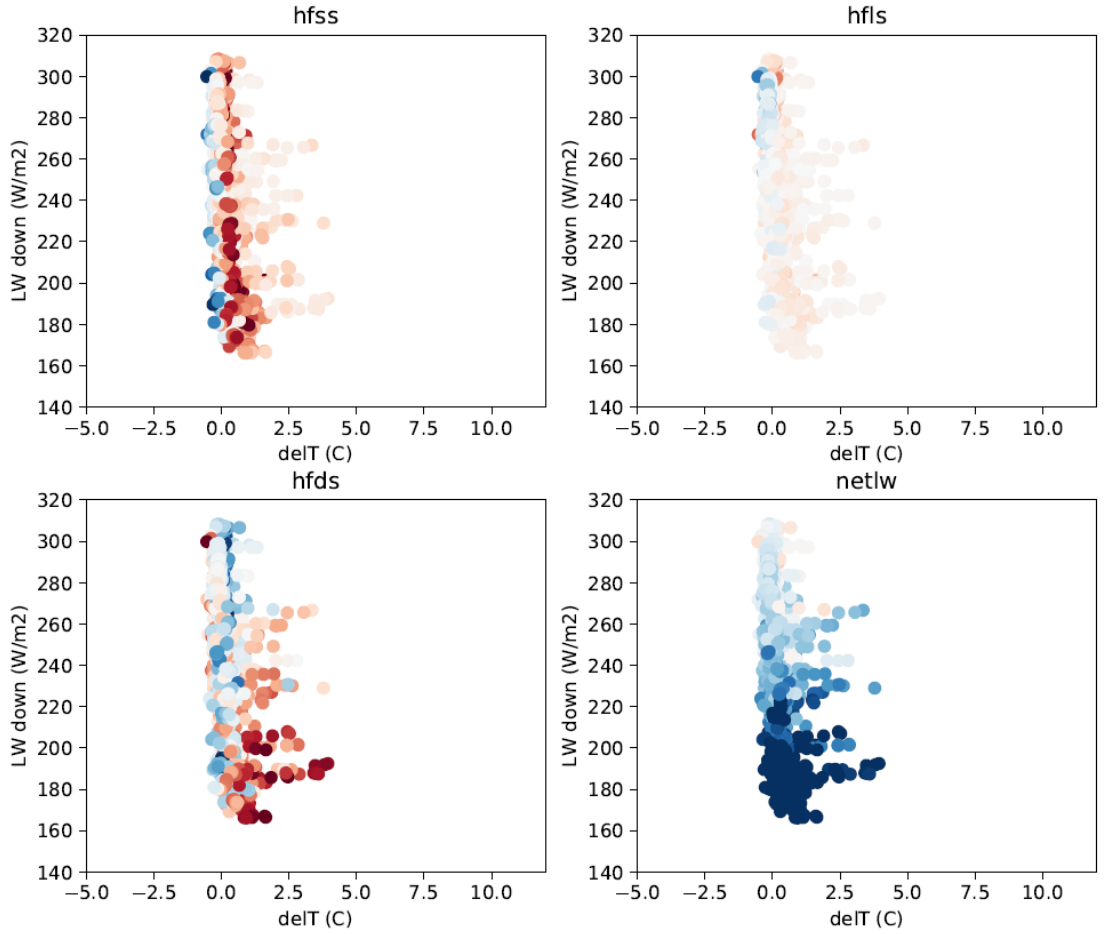
WMO OMM

Process evaluation, Sodankylä

Observations



IFS

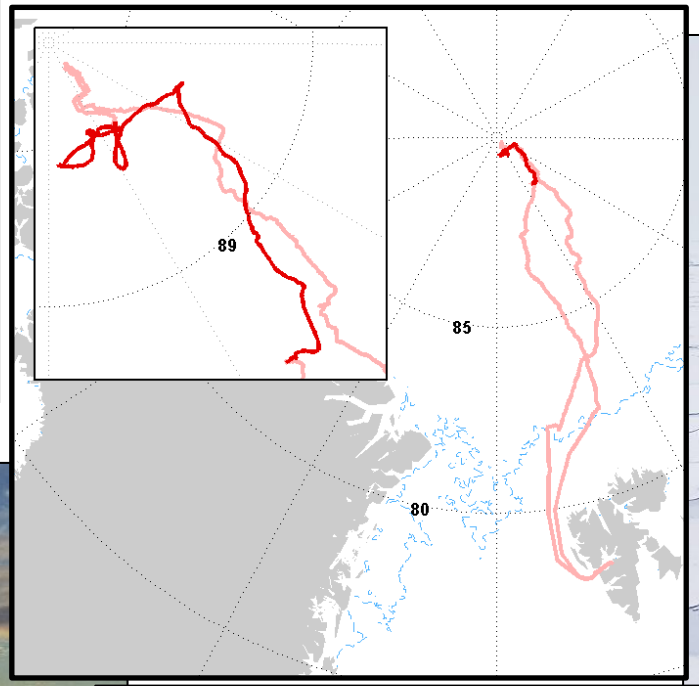


Courtesy Jonny Day
ECMWF

WMO OMM

Arctic Ocean 2018

1 August – 21 September



YOPP endorsed project during SOP-NH2

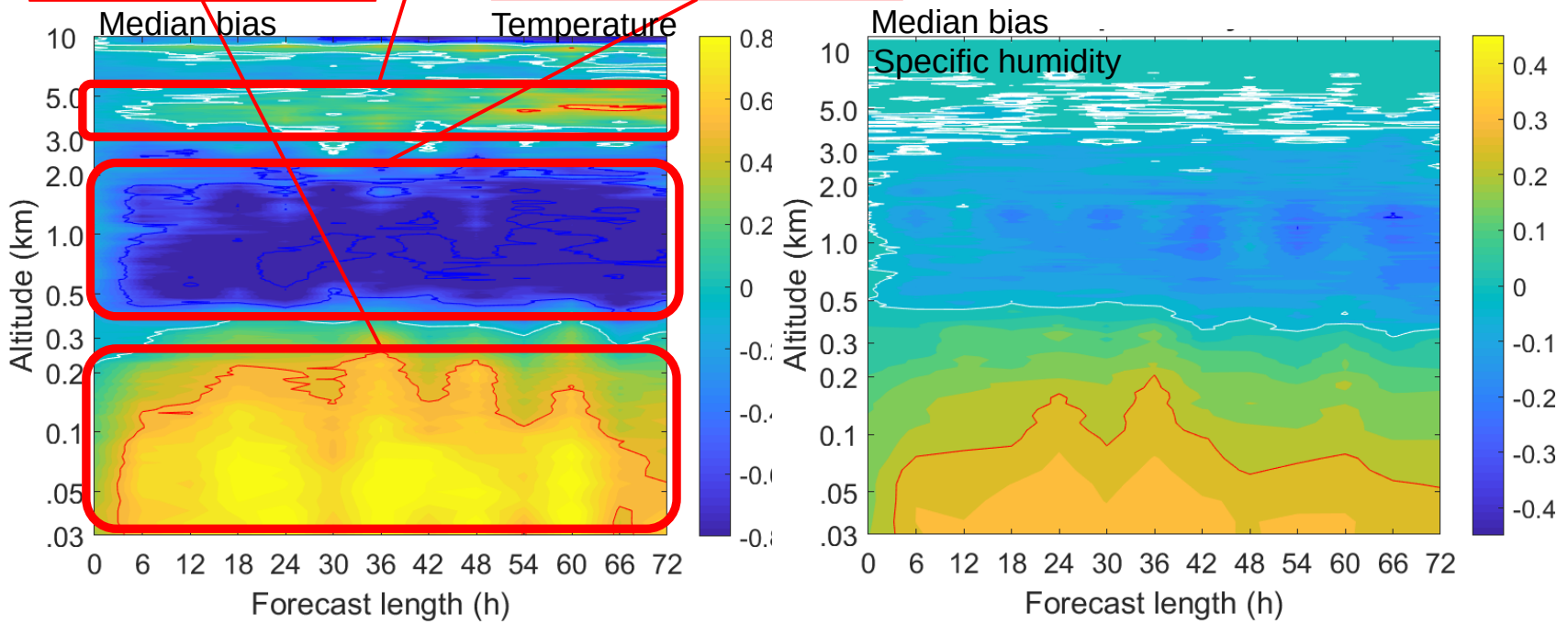
WMO OMM

AO2018: Forecast evaluation of vertical thermodynamic structure

Middle troposphere warm bias, ~0.5 °C 3 to 6 km

Boundary layer warm bias, ~1 °C below ~300 m

Lower free troposphere cold bias, ~-1 °C 0.5 to 3 km

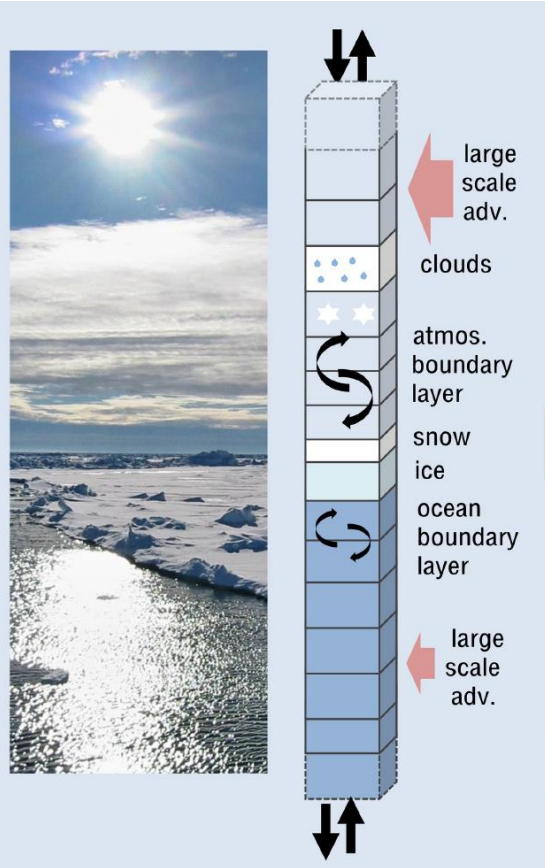


Tjernström et al, in preparation

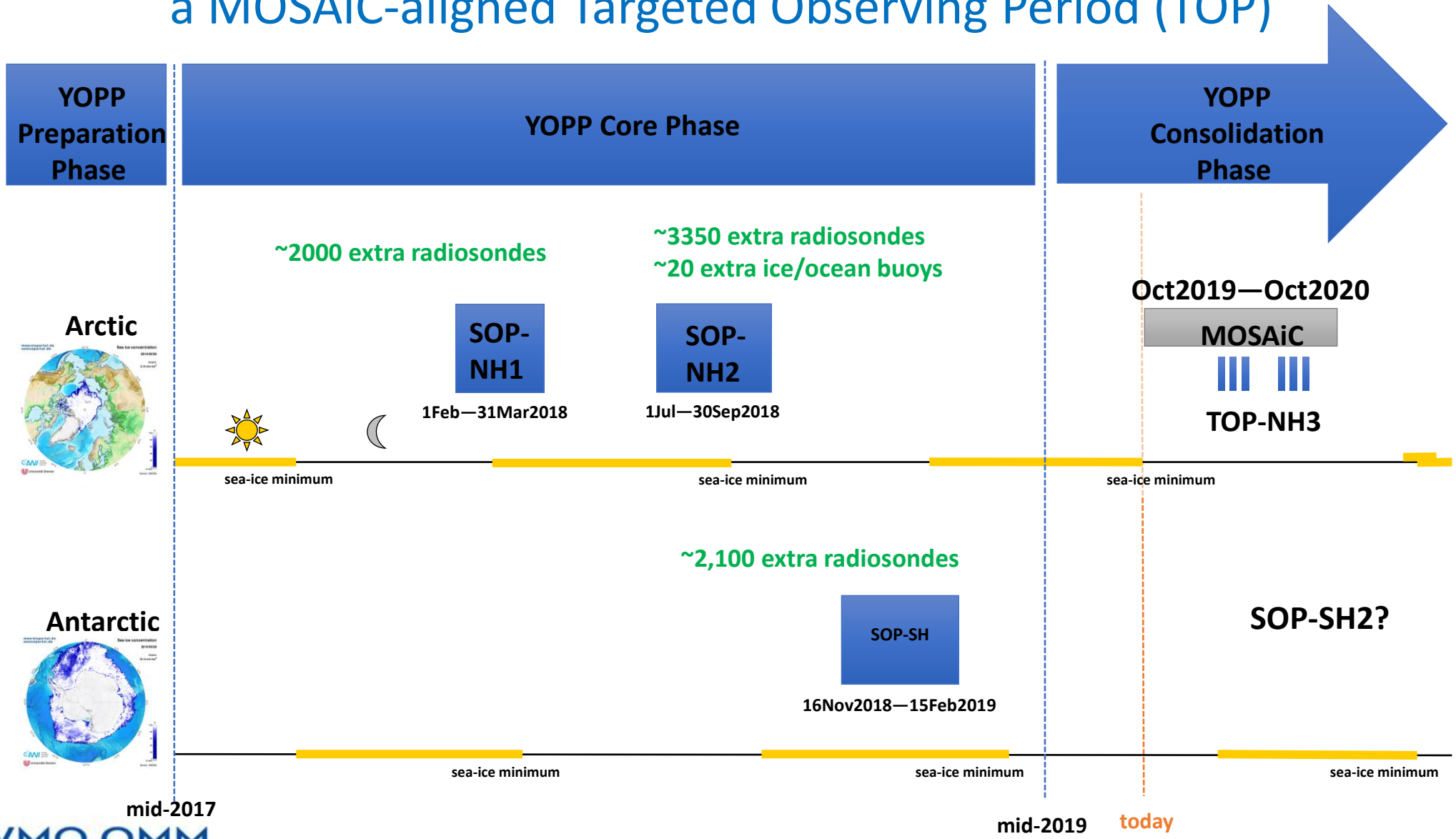
WMO OMM

YOPPsiteMIP data

- **Process evaluation diagnostics** that is being developed using the MODF and MMDF files for one model at one site can easily be expanded to several sites and/or other models
- A **site** can be an existing supersite or data from a research cruise as AO2018
- NWP are increasingly being coupled with the ocean and sea ice, additional processes to be evaluated



YOPP: Special Observing Periods (SOPs) and a MOSAiC-aligned Targeted Observing Period (TOP)



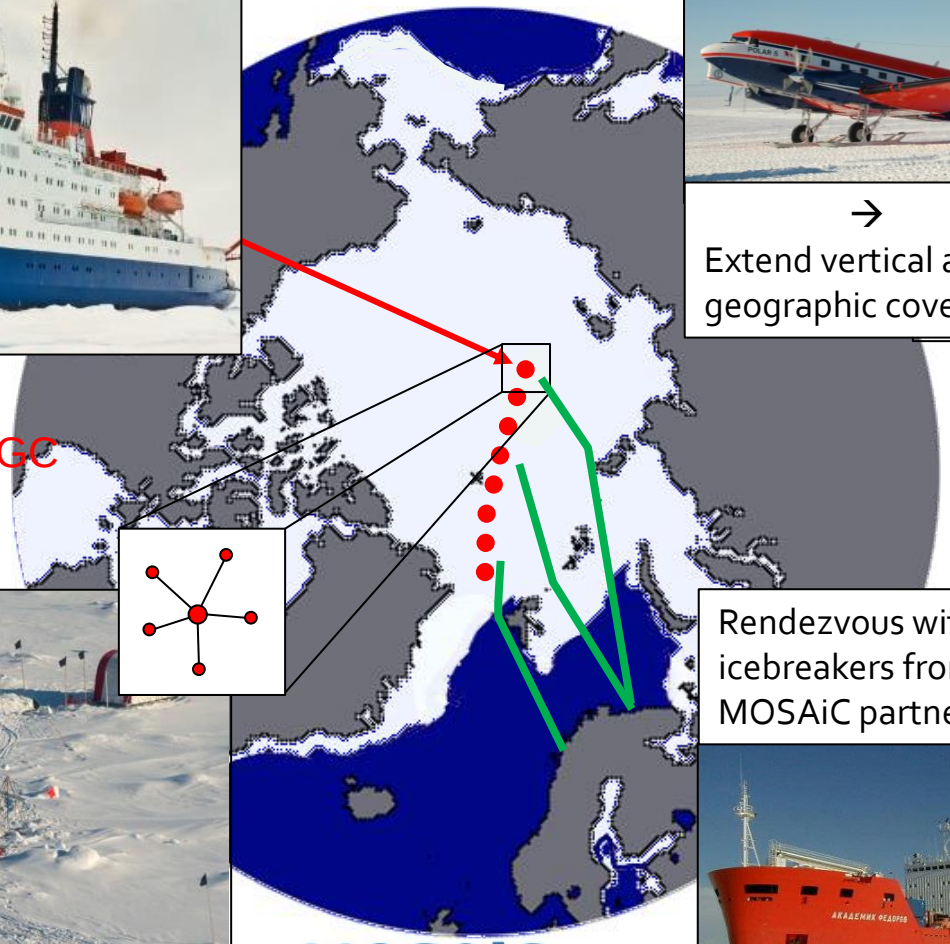
WMO OMM

A Year in the Arctic

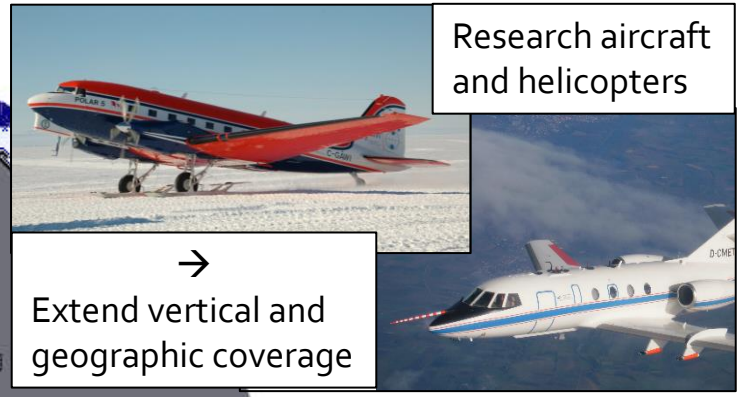
September 2019 – October 2020

Central Observatory:
RV Polarstern

Coupled observations
Atmos-Ice-Ocean-Eco-BGC



Research aircraft and helicopters



→ Extend vertical and geographic coverage

Distributed network

Autonomous systems, buoys,UAS, AUV

Rendezvous with icebreakers from MOSAiC partners

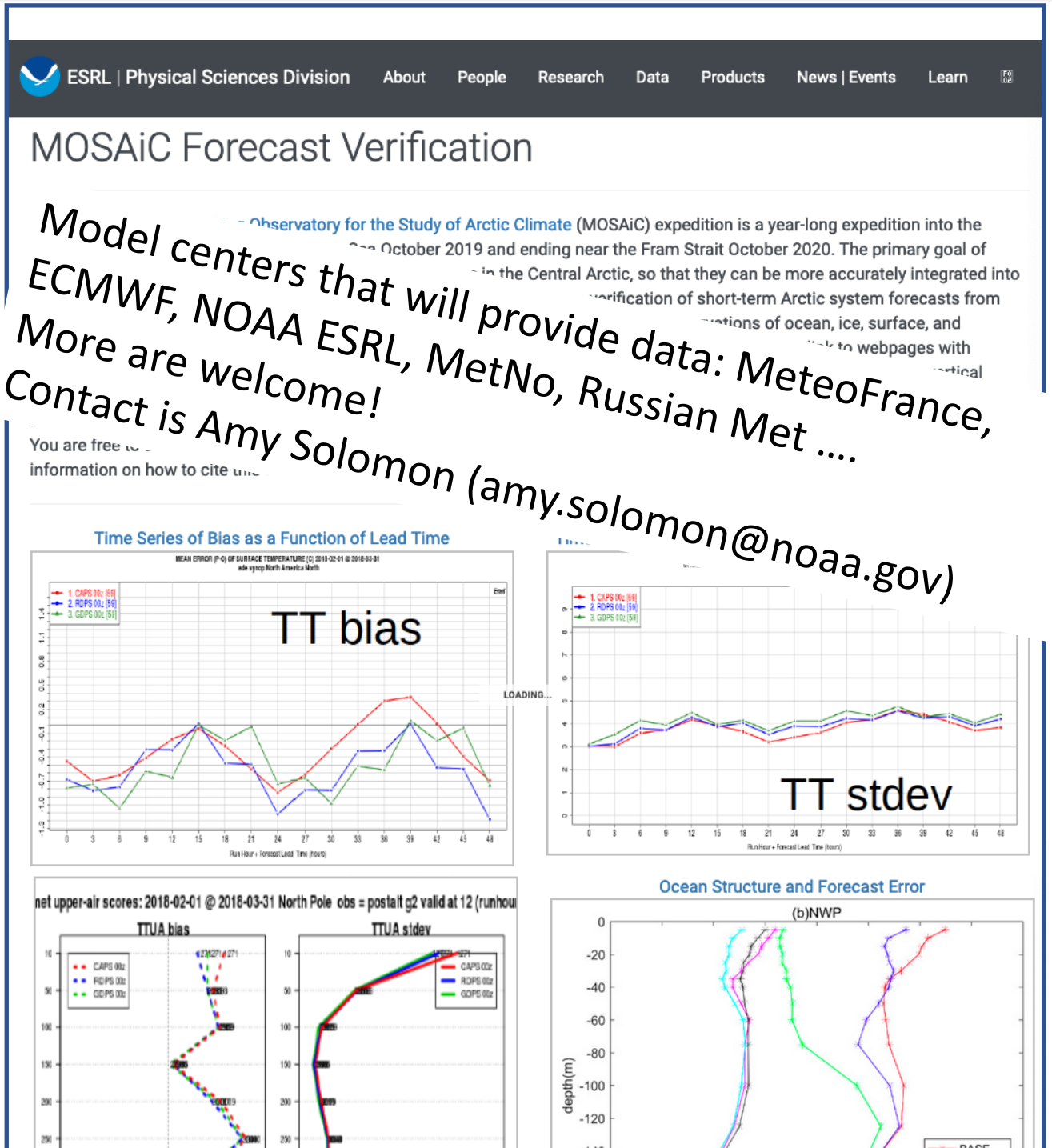
→ Broader geographic coverage & supply

MOSAiC
International Arctic Drift Expedition

WMO OMM

MMDF files that are created for the MOSAiC site and uploaded at the YOPP data portal will be presented in near-real time at a dedicated website

Will be launched when MOSAiC observations are coming on GTS!

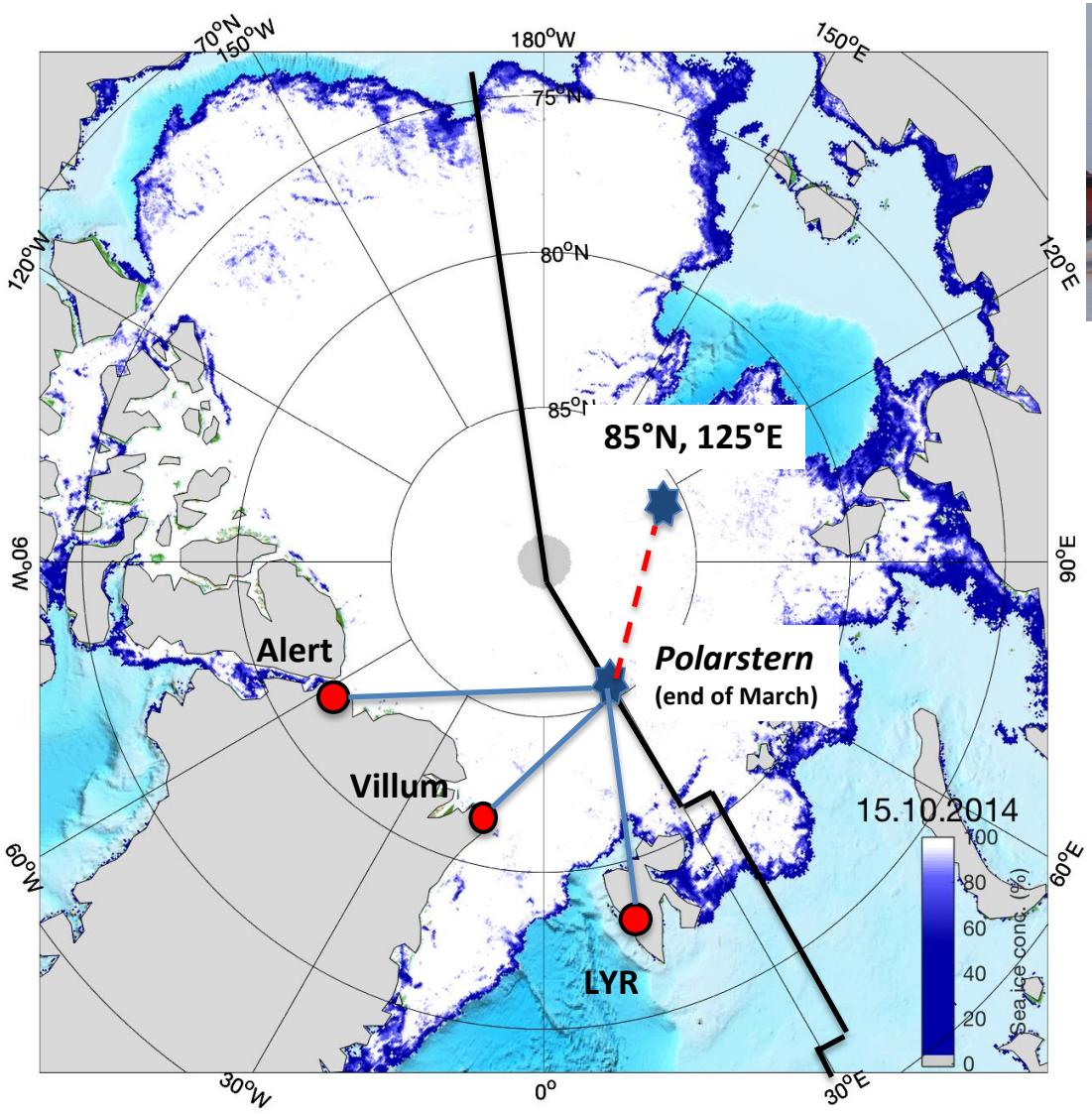


WMO OMM

YOPP and MOSAiC

- MODF will be created for **MOSAiC** data after each leg (approx. 2 months) when more process evaluation will be performed
- **MIP** periods will be identified during the year after each leg for extra modeling
- **Targeted Observation Periods** (TOPs), preferably at the time of aircraft observations, will be identified and requests of additional soundings may be issued
- Airmass transformations – Warm air intrusions and cold air outbreaks are in focus

AWI AIRCRAFT OPERATION



Atmosphere (Polar 5 & 6)

SPRING (160 h)

16 March – 07 April 2020

SUMMER (100 h)

28 August – 15 September 2020

Sea Ice & Snow (Polar 5)

SPRING (80 h)

24 April – 15 May 2020

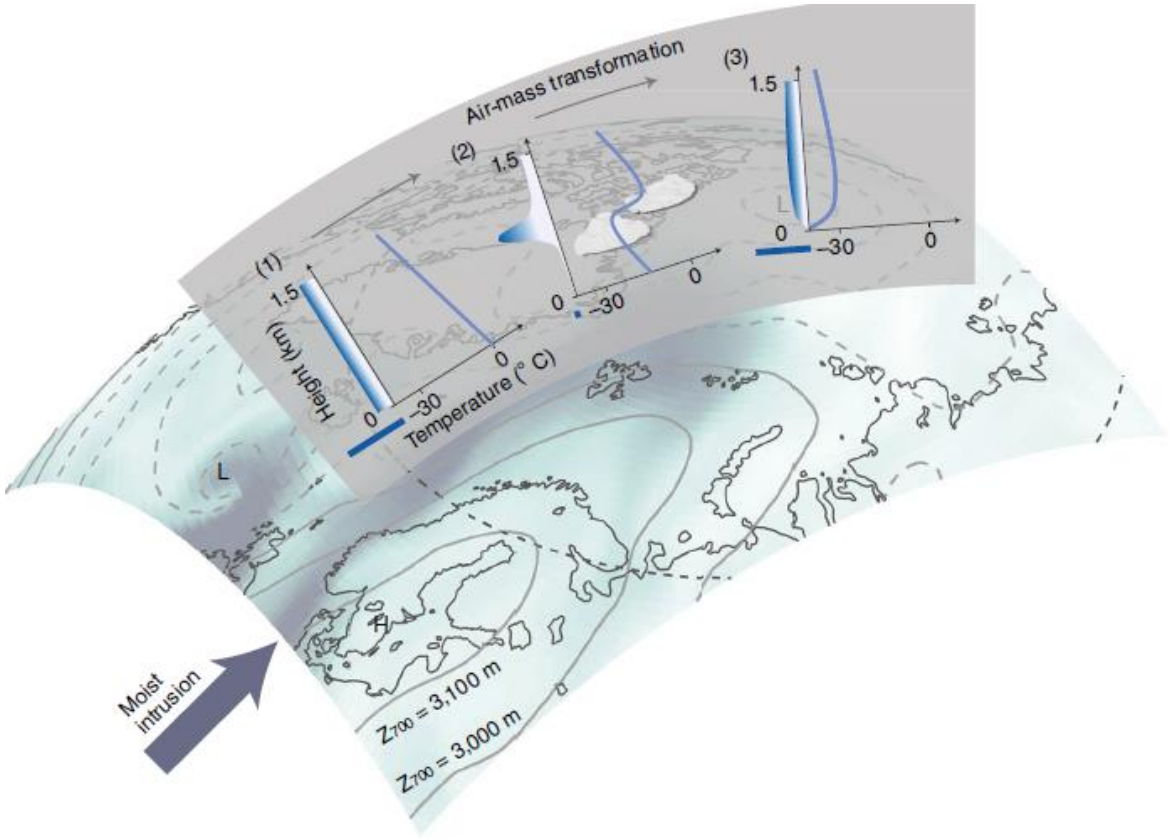
SUMMER (50 h)

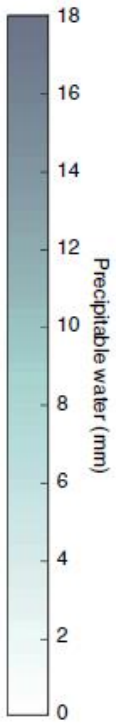
31 July – 17 August 2020

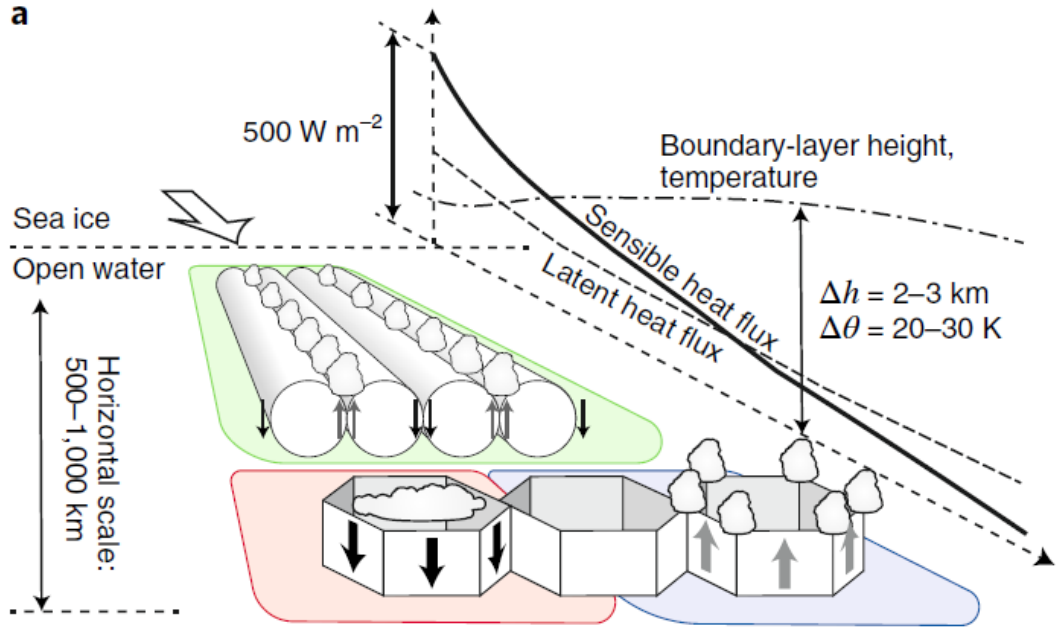
Total flight hours, including Ferry- and Test flights: 500 h

Science focus of the TOPs: Airmass transformation

Warm-air advection & cold-air outbreak, Lagrangian perspective







Pithan, F., G. Svensson, R. Caballero, D. Chechin, T.W. Cronin, A.M.L. Ekman, R. Neggers, M.D. Shupe, A. Solomon, M. Tjernström, and M. Wendisch, 2018: Role of air-mass transformations in exchange between the Arctic and mid-latitudes, Nature Geoscience, [doi:10.1038/s41561-018-0234-1](doi:10.1038/s41561-018-0234-1)

WMO OMM

Questions?
Comments?