

WORLD METEOROLOGICAL ORGANIZATION

WWRP POLAR PREDICTION PROJECT (WWRP-PPP) YEAR OF POLAR PREDICTION PLANNING MEETINGS

ARCTIC OBSERVATIONS

05-07 SEPTEMBER 2016

YOPP MODELLING COMPONENT

07-09 SEPTEMBER 2016

EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS
(ECMWF)

SHINFIELD PARK, READING RG2 9AX, UNITED KINGDOM



(back row, from left) Manfred Wendisch, Thomas Haiden, Matthew Shupe, Chawn Harlow, Jo Browse, Doug Wallace, Timo Vihma, Ian Renfrew, Linus Magnusson, Trond Iversen, Jun Inoue, Sarah Keeley, Vito Vitale, Dean Lockett, Robert Grumbine, Qizhen Sun, Greg Smith, Congwen Zhu, Alexander Makshtas, Yongqi Gao, Helge Goessling, Edward Blanchard-Wrigglesworth.

(front row, from left) Stein Sandven, Amy Solomon, Laurent Brodeau, Ed Blockley, John Methven, Andrey Proshutinsky, Guylaine Canut, Joo-Hong Kim, Marion Maturilli, Steffen Tietsche, Vanessa Aellen, Michael Karcher, Tuukka Petäjä, Renee Tatusko, Pablo Clemente-Colon, Peter Bauer, Thomas Jung, Paolo Ruti, Richard Swinbank, Axel Schweiger, Xiangdong Zhang, Harald Schyberg, Guðrún Nina Petersen, Karin Margretha H. Larsen, Cristiana Stan, Anja Sommerfeld, Gunilla Svensson, Neil Barton, Markus Rex, Mikhail Tolstykh, Kirstin Werner, Winfried Hoke, Eric Bazile, Matthieu Chevallier, Jonathan Day, Steffen Olsen (Photo: Simon Witter, ECMWF)

Arctic Observations

Welcome and purpose of the meeting

Peter Bauer opened the meeting and welcomed the participants to ECMWF. He outlined recent advances in medium-range predictive skill, and pointed out the need for improved observations and understanding in polar regions. **Helge Goessling** gave a welcome on behalf of the PPP Steering Group and the International Coordination Office; Thomas Jung, leader of the project, would be joining the meeting on Tuesday. **Paolo Ruti** welcomed participants on behalf of WMO, and highlighted the need to provide good services to people living and working in polar regions. **Ian Renfrew**, who chaired the initial part meeting, outlined the agenda and purpose of the meeting.

Overview Presentations

Helge Goessling gave an introduction to the Polar Prediction Project (PPP) and the Year of Polar Prediction (YOPP). PPP is a major component of the WMO GIPPS (Global Integrated Polar Prediction System), with a mission to "promote cooperative international research enabling development of improved weather and environmental prediction services for the polar regions, on time scales from hours to seasonal". YOPP is the main flagship project of PPP intended to "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". An updated version of the YOPP Implementation Plan has just been published. The focus of these meetings is to plan for the rapidly approaching YOPP core period that will run from mid-2017 to mid-2019. This meeting focuses on Arctic Observations, and is immediately followed by a meeting on Modelling. A third meeting, to develop the YOPP data strategy, will be held in Oslo in November.

Sarah Keeley discussed observation requirements from a forecasting perspective. Timely delivery of observations is essential; data need to be distributed via the GTS. There are some major gaps in observation coverage, leading to large analysis uncertainties. To enable observations to be used for model development, we need to understand observations' representativeness and validity. YOPP observations will be invaluable for developing modelling of coupled processes. **Jun Inoue** showed results from ARCROSE, which demonstrated positive impacts of additional observations. In the JAMSTEC ensemble reanalysis, the use of IABP Arctic buoy data significantly reduced the analysis uncertainties in the lower troposphere. Additional radiosondes had a broader impact, extending into mid latitudes, as demonstrated by several case studies of forecasts of Arctic storms.

Paolo Ruti gave an overview of the history of WMO research programmes leading up to PPP. PPP is one of three core WWRP research projects that were started following the THORPEX programme. Polar and high mountains are together one of the WMO strategic priorities for 2016-2019. He stressed that YOPP needs to develop a well-structured plan for special and intensive observing periods, so that letters can be written soon to WMO Permanent Representatives to request additional observations. **Ian Renfrew** confirmed

the need to firm up plans, including mobile systems, and extra observations from existing sites. This needs to be coordinated with modelling work, including coupled models and process studies. Our working assumption has been two Special Observing Periods (SOPs): early summer to late autumn 2018, and early 2019, but we also need to consider MOSAiC, which is not now planned for deployment until September 2019.

Contributing Projects

Two talks outlined observations components of two Horizon 2020 projects. **Stein Sandven** described the Integrated Arctic Observing System (INTAROS), which is focused on the need to satisfy a wide range of users, include polar prediction, climate and various user communities. Its scope covers ocean and sea ice, land, as well as atmospheric observations. Work Package 2 (WP2), the exploitation of existing observing systems, will be the main focus for the first two years. WP3 is intended to fill gaps in current in-situ observations, including enhancement of existing sites, while WP4 will build up community observing programmes. **Peter Bauer** described APPLICATE, which is a project focused on modelling and observing system design. WP4 is focused on Arctic observing system development, including studies of the value of observations using data denial experiments, forecast sensitivity to observations and ensemble reliability diagnostics.

The morning session concluded with a talk by **Manfred Wendisch** on (AC)³ – a German project on Arctic Amplification. The aim is to understand the processes that are leading to much larger surface warming in the Arctic than in other regions. The project includes four clusters: cluster A – Energy Fluxes in the Arctic boundary layer; cluster B – Water Vapour, Clouds and Aerosols; cluster C – Surface Atmosphere Interactions; and cluster D – Atmospheric Circulation and Transport.

Matthew Shupe gave talk on observations from MOSAiC. MOSAiC will cover a wide range of science areas including: boundary layer, energy and momentum fluxes, coupled atmosphere-ice-ocean processes, clouds, aerosol, radiation, ozone, ecosystem and biogeochemistry. RV Polarstern will house the central observatory, including an ice camp within walking distance. Additional measurements will be made from a distributed network, up to around 40 km from the ship. There will be links to larger scales, using UAVs and coordination with aircraft campaigns. The ship (supported by AWI) and some of the observations are funded, and there is opportunity for others to join and contribute to the research and funding. Matthew also gave a brief presentation on ICECAPS – a supersite on top of the Greenland ice sheet focused on detailed cloud-atmosphere-surface process studies.

Tuuka Petäjä gave an overview of the Pan-Eurasian Experiment (PEEX) – a network of 400 researchers from 20 different countries, with a focus on Boreal and Arctic Environment. PEEX has a common interest with YOPP on filling gaps in data coverage, especially aerosol data. **Jo Browse** introduced PACES – a new international initiative to coordinate work on air pollution in the Arctic. There are two working groups: one on improving predictive

capabilities and the second on Arctic pollution and society. **Doug Wallace** described MEOPAR, which is a Canadian project on Arctic environmental change and human activity. Its aim is to increase resilience to new hazards and vulnerabilities that result from altered risks. The first cycle of the project is nearing completion, and, provided funding is confirmed, the second cycle will include ocean observations, forecasting and coastal resilience. Partnered calls will help leverage additional funding.

Helge Goessling gave an overview of the YOPP endorsement process, and then summarized several endorsed projects that are contributing to the YOPP observation component, but not covered elsewhere in the meeting. For researchers, YOPP endorsement increases the visibility of research activities, and should help researchers with funding applications. Endorsement helps YOPP by providing knowledge of, relevant plans and helps coordination between different activities.

International organizations, committees and observational plans

Sandy Starkweather described the International Arctic Systems for Observing the Atmosphere (IASOA), which is an IPY legacy project about studies of transport into and out of the Arctic. During IPY, the emphasis was on building capacity, but the focus is now more of data and science. IASOA has illustrated the value of data portals to gather together data from different sites, and data from different instruments at the same site. **Pablo Clemente-Colon** gave a talk covering ice data collected by the US National Ice Center (NIC), covered by three projects: IABP, IICWG and PSTG. The International Ice-Chart Working Group (IICWG) has developed sea ice and snow products based on a range of sensors, with human input. Sea-ice thickness is difficult to derive – “the holy grail”. The International Arctic Buoy Program (IABP) reveals the circulation in the Canadian Arctic, with some additional deployment south of the Bering Strait. The WMO Polar Space Task Group (PSTG) is supporting YOPP by developing a polar prediction strategy. They expect to produce polar mosaics, based on Sentinel data, every three days. **Helge Goessling** gave a presentation on Argo on behalf of **Brigit Klein**. Argo would like feedback from YOPP on where best to deploy floats. In the final presentation, **Ian Renfrew** described the Iceland-Greenland Seas project (IGP). This is a multi-national project to study the formation of dense waters via atmosphere-ocean coupling from both an observational and modelling perspective. A field campaign is planned for March 2018, involving aircraft, ships and additional observations from land and sea.

ACTION: All to give views on Argo questions to ICO, for Helge to pass on.

In the general discussion, it was agreed that it is vital that observations get onto the GTS, and that it needs to be confirmed that observations are successfully getting through to forecast centres. It was also confirmed that pressure measurements from the sea surface would be valuable, so long as errors are well characterised. Additional data, including surface temperatures, ice concentrations and clouds are also useful – even if they cannot be assimilated, they are likely to be useful for validation.

ACTION: ICO to contact ECMWF to agree how to provide confirmation that observations that are put on the GTS are getting through.

Vanessa Aellen of the GEO secretariat gave an overview of the Group on Earth Observations (GEO) and their Cold Regions Programme (GEOCRI). GEOCRI is part of the water resources management societal benefit area (SBA), and aims to build a global network to exchange information and support efforts of scientists and decision makers. **Carla Cardinali** gave a presentation on the Data Assimilation and Observing Systems (DAOS) working group. DAOS was established during THORPEX, but is now a WWRP working group, providing guidance on data assimilation issues, and promoting activities to make better use of observations. Analysis and reanalysis for the Arctic are limited by both observation systems and model deficiencies. In situ observations are mainly limited to populated areas. Polar-orbiting satellites provide good coverage, but can be difficult to exploit due to lack of contrast between cold surface and lower troposphere temperatures. Limited knowledge of model processes leads to poor background error covariance information for data assimilation.

National and International Plans and Enhancements to the Operational Observing Network

Trond Iversen presented possible extensions to Norway's Arctic observations during YOPP. A YOPP call from the Research Council Norway is expected before summer 2017. The Norwegian observations network extends rather far north, and enhancements to the conventional network are being considered. The Barents Sea MetOcean and Sea Ice Network could be extended (in time) to cover YOPP. Observationally based research at the University of Bergen, on boundary layer and orographic effects could also contribute to YOPP. **Alexander Makshtas** presented Russian plans. There is a rich dataset of observations from drifting stations that could help with YOPP preparations. The ice base at Cape Baranov is a potential new member of IASOA and YOPP participant. There is also a new Russian scientific centre in Svalbard (Barentsburg). The Russian Aircraft laboratory will be available during YOPP – contact is Mikhail Strunin. **Renee Tatusko** gave an overview of the USA contributions. There is a large observation network in the Alaska region, but not all owned by the National Weather Service (NWS). Measurements will also be made of the Chukchi Sea: currents within 200 km of the shore measured by radar, and NOAA aircraft measuring ocean temperature and meteorological data. Small UAVs could also be launched from land or ship. There are also several observation-based Arctic research projects. **Helge Goessling** presented plans for Denmark and Greenland on behalf of **Steffen Olsen**. There are many operational long-term observations sites, mostly around the coast, and a DMI observatory at Thule air base. DMI is considering augmentation of radiosondes to support YOPP.

Japanese plans were presented by **Jun Inoue**. The Japanese flagship project is Arctic Challenge for Sustainability (ArCS). Several autumn cruises are planned for RV Mirai. There will be four radiosonde launches a day, with data

transmitted to the GTS. RV Mirai data will be available from the DARWIN data server at JAMSTEC. **Joo-Hong Kim** presented South Korean plans. The Korea Polar Research Institute runs an Arctic station at Dasan (Ny Alesund) and a research ship IBRV Araon. Cruises are planned for each autumn during YOPP, and all meteorological instruments have been updated in preparation for YOPP. **Qizhen Sun** (NMEFC) described Chinese plans, including cruise observations from the icebreaker Xuelong, drifting observations over the sea ice and land-based observations from Svalbard. The CHINARE 2018 project will contribute to YOPP with a focus on surface properties, energy fluxes, boundary layer, and snow and sea ice. There is a plan for future high frequency (10 minute) observations of atmosphere-ice-ocean interactions.

Timo Vihma presented plans from Finland. The Finnish Meteorological Institute (FMI) will participate in the RV Polarstern cruise to the Fram Strait in June 2017, with a focus on stable boundary layers. FMI will assess the benefit of assimilating UAV data, as a possible supplement to radiosonde sounding data. Intensive radiosonde campaigns at Sodankylä can be timed to link with SOPs. They also plan a range of snow and sea ice observations in the Arctic. FMI coordinates COST Action ES1404 to harmonise European snow monitoring. **Chawn Harlow** outlined the Met Office contributions to YOPP. They will run a FAAM aircraft campaign MACSSIMIZE (Measurements of Arctic Cloud, Snow and Sea Ice nearby the Marginal Ice Zone), with aircraft deployments to St Johns, Newfoundland and Fairbanks, Alaska. Deployments of one and two weeks are planned, but these could be extended with additional outside support. **Marion Maturilli** described German plans for MIDO (Multidisciplinary Ice-based Distributed Observatory); these include monitoring key parameters in the Arctic and Antarctic oceans and the use of drifting observatories. The German programme also includes the (AC)³ project, RV Polarstern and the AWIPEV research base in Ny Alesund (Svalbard). The latter is part of GRUAN, the high-quality GCOS Reference Upper Air Network. **Guylaine Canut** outlined French plans for intercomparison campaigns and polar remote sensing activities. A snow bidirectional reflectance distribution function (BDRF) model has been included in RTTOV v11. They contribute to GABLS4 intercomparison of models in extremely stable conditions in the Antarctic, using observations from the Concordia station. **Guðrún Nína Petersen** described plans from the Icelandic Meteorological Office (IMO). There are over 300 weather stations in Iceland, including two radiosonde stations. IMO receives TAMDAR measurements from Icelandair aircrafts. IMO has a strong interest in orographic effects: barrier winds, gap winds, downslope wind storms, etc., are all part of “normal” weather in Iceland.

Vito Vitale described Italian contributions to YOPP. They have long-term Arctic activities based at Ny Alesund (Svalbard) and Thule station (Greenland). At Ny Alesund there is a 33 m observation tower, plus an aerosol laboratory 450 m up a mountain; they also hope to add an ice buoy. An additional potential activity for YOPP is observation of sea-ice distribution using the CosmoSkyMed constellation. **Karen Margetha Larsen** described the Faroe Islands contribution to Blue Action. They monitor ocean currents near the Faroes to get improved estimates of the heat transport towards the

Arctic to support climate modelling. **Stella Melo** and **Paul Joe** outlined Canadian plans. There are two ECCO supersites, at Iqaluit (coastal) and Whitehorse (quite mountainous). They plan an enhanced gridded snow dataset for YOPP. They have a proposal to carry out a range of Convair 580 aircraft campaigns (not yet funded). There is a potential contribution of enhanced observations, including more frequent sondes, ocean profiling and additional observations from Iqaluit and Whitehorse, subject to funding. **Michael Tjernström** described the Swedish project Arctic Climate Across Scales (ACAS). ACAS covers both modelling and observations, though it is not yet funded. There are three work packages: Large Scale Interactions and Natural Variability; Cloud Aerosols and Interactions; and Surface Energy Budget. There are two infrastructure packages: numerical modelling using large eddy simulations and new observations, from the icebreaker Oden.

Special and Intensive Observing Periods

The Arctic Observation meeting was concluded by an extended discussion session, with the main aim of agreeing to a framework of special and intensive observation periods for YOPP. **Helge Goessling** introduced the session by recapping previous discussions of this topic. The general plan was to have one SOP (SOP_NH1) in summer-autumn 2018, plus another (SOP-NH2) in winter to early spring 2019. We should aim for around five months of SOPs in total, since it was reckoned that would be an affordable amount of additional radiosonde launches. **Peter Bauer** commented that for Data Assimilation observation impact experiments, periods of at least a month or two are needed. **Sarah Keeley** said that two months is a minimum for ocean experiments. **Matthew Shupe** asked how best to coordinate the additional MOSAiC observations with YOPP, since MOSAiC takes place after the core period. After some discussion, there was a general consensus to consider a third SOP (with additional radiosonde launches) during the MOSAiC period, perhaps January-February 2020. **Ian Renfrew** pointed out that intensive observation activities did not have to coincide with the SOPs. It was agreed that IOPs could be defined around observation campaigns, not necessarily within the radiosonde SOPs.

The general conclusion was that the following SOPs (i.e. enhanced radiosonde observation periods) should be defined:

- July-September 2018
- February-March 2019
- February 2020 (for MOSAiC)

This proposal needs to be discussed further at the modelling meeting. [After discussion at the modelling meeting, the Feb-Mar 2019 period was brought forward to Feb-Mar **2018**.]

Ian Renfrew asked what we should be requesting from the Polar Satellite Task Group (PSTG). **Pablo Clemente-Colon** proposed requesting the polar sea-ice mosaic. **Peter Bauer** said that we need to focus on a small number of things that could make a big difference. Sea-ice thickness was agreed to be a

priority – this could potentially be produced using a combination of measurements.

Thomas Jung wrapped up the meeting, summarising what had been achieved, and looked forward to the modelling meeting, starting with a joint session the following morning. He also reminded everyone about the data planning workshop to be held in Oslo on 10-11 November.

Joint Session: Arctic Observations and Modelling component

Welcome

Thomas Jung welcomed everyone to the joint meeting. In his opening remarks, he noted that there was a realisation several years ago that there was a need for a project on polar prediction, with its main focus on the Year of Polar Prediction (YOPP). The split between observational and modelling meetings was mainly for logistical reasons, but this joint session brings everyone together. **Paolo Ruti** welcomed the participants on behalf of WMO, and emphasised the strong WMO interest in polar prediction. **Peter Bauer** welcomed everyone on behalf of ECMWF. While ECMWF has a big research department, the main concern is improving the predictive skill of the forecast. Polar prediction is an important part of this, and aligns well with the strategy of bringing together a range of earth system components in the models.

Joint Session

Ian Renfrew summarised the observation meeting for the benefit of new arrivals. He showed a spreadsheet compiled by Helge Goessling that summarised the observational activities, which need to be coordinated and connected with modelling activities. He outlined the plans for Arctic SOPs that had been proposed the previous day: one in July-September 2018, one in February-March 2019 and a third coordinated with MOSAiC. He also showed a summary of YOPP endorsed projects. **John Methven** gave a talk about the NAWDEX campaign, which was about to take place (16 Sept – 16 October). The main focus of NAWDEX is on studying diabatic processes that influence jet stream dynamics. NAWDEX will provide valuable experience to help with planning YOPP. Five aircrafts will provide measurements for NAWDEX, including three based in Iceland. EUMETNET has funded 250 extra radiosonde launches, and Canada is also providing additional radiosonde data.

Peter Bauer introduced the YOPP modelling component. He reminded the audience that our ultimate aim is to improve operational Numerical Weather Predictions (NWP) for polar regions. We need to make best use of observations for model evaluation, providing initial conditions and climate modelling. In order to improve model physics, coupling processes and large-scale linkages, we need to employ a range of process-oriented diagnostics. Three broad categories of modelling datasets are envisaged: YOPP core, supplementary and experimental datasets. The former will include a “YOPP dataset”, with high frequency model output and tendencies, along with several reanalysis datasets. These will be supplemented by reference data from S2S, TIGGE and other archives. Thirdly, there will be a broad range of experimental modelling dataset. Peter finished his talk by showing some very recent results from the first ECMWF global forecast with a 1.25 km resolution – what we might look forward to in five to ten years.

Next there were three short talks summarizing three European Horizon 2020 projects. **Stein Sandven** introduced INTAROS, whose overall objective is to develop an efficient integrated Arctic Observing System. This will be achieved by extending, improving, and unifying the current observing system. Although the emphasis will be on marine data, atmosphere, ocean and sea ice are all

included. **Thomas Jung** introduced APPLICATE. The linked rings on the project logo symbolise to bring together weather and climate, observations and models, and higher and lower latitudes. Advanced observation-based metrics and diagnostics will be used to inform model developments. Selected activities include: YOPP high-resolution reanalyses, coupled single-column modelling and data denial experiments. **Steffen Olsen** introduced Blue Action, which has the overarching objective to improve our ability to describe, model and predict Arctic climate change and its wider impact. Specific objectives include: improve long-range forecast skill and range; quantifying the impact of recent changes; improving the description of key processes; optimising observing systems; and reducing and evaluating uncertainty. The project will have a focus on stakeholder involvement, transferring knowledge and fostering their capacity to adapt and respond to climate change.

Matthew Shupe gave an overview of MOSAiC, focusing mainly on modelling aspects. MOSAiC observations will support detailed process studies, including coupling processes. This will lead to improved weather, climate, and sea-ice forecasting models. MOSAiC will include multi-scale nodes around a central facility, allowing evaluation of heterogeneity within a typical model grid box. MOSAiC will need operational support to help plan the installation phase, on-going drift forecasting, and weather forecasting. A range of associated modelling studies is planned including: Large eddy simulations (LES) and mesoscale atmospheric models; 3D chemical and biological ecosystem models; regional model intercomparisons; experimental sea-ice forecasts; and data assimilation.

Discussion

The joint meeting concluded with an extended discussion session. **Thomas Jung** said that the MOSAiC “drifting grid box “ gives a very useful perspective. **Peter Bauer** commented that we need to make a concerted plan to employ a hierarchy of models: LES, mesoscale, regional and global. There was some discussion of data policy; although this is still under development, **Markus Rex** said that there would be a presumption that data would be open, as far as possible.

The prospects for additional observations are encouraging. EUMETNET support is the key to funding additional observations from Greenland. Plans for field campaigns are good, although measurements of ocean-atmosphere-sea ice coupling are falling short. There was a discussion of the prospects for additional buoy deployments, including ocean buoys on ice-free oceans. **Timo Vihma** noted a risk of insufficient attention on the terrestrial Arctic, though **Thomas Jung** said that would be included in APPLICATE. Thomas also noted that YOPP will also include some novel observation types, including UAVs. **Peter Bauer** commented that there is a lot of data from previous campaigns that could be used to help with planning for YOPP – others commented that time may be too short to make good use of them.

Thomas Jung asked for suggestions to improve communication. The ICO will soon be producing a YOPP newsletter. It was also pointed out that H2020 and

other large projects generally include communication specialists. **Jo Browse** said that having someone to lead and coordinate data is important to the project. Thomas agreed the need for a data champion. It is not a simple job, since we need to set up the database structure so that it is useful to the wider community.

It was recognised that there was a need to bring experts together in specialist “task forces”, e.g., to coordinate aircraft campaigns. There should also be future specialist workshops – the ICO would be willing to provide support. **Thomas Jung** proposed holding a similar joint planning meeting in about a year’s time, perhaps jointly with MOSAiC. He also reminded people about the data planning meeting in November before formally closing the joint session.

Modelling Component

Opening

Thomas Jung welcomed those who were staying on for the planning meeting on YOPP modelling, and outlined the agenda and purpose of the meeting.

Core datasets

Peter Bauer opened his talk with a reminder of the three broad dataset categories; his talk was on the ECMWF contributions to the YOPP core datasets. The first contribution is a “**YOPP dataset**” that would follow the example of the dataset that ECMWF previously produced to support YOTC (Year of Tropical Convection). It will be a dataset produced from the operational NWP system containing many more fields than the standard output, including physical tendencies. The exact content is to be agreed. Since the data will be global, they will also be useful for other studies beyond YOPP. ECMWF are committed to producing the data for the two-year core period, though Peter was hopeful that it could be extended to cover MOSAiC, too. ECMWF also plans to supply **global coupled reanalyses** covering YOPP. This is likely to be an extension of the CERA-SAT dataset, which is funded by an EU-funded FP7 project. However, the funding does not cover the YOPP period. Peter also advertised that operational ECMWF output can also be provided to support research projects, including YOPP field campaigns, provided a licence is applied for well in advance.

Ian Renfrew gave a talk on the **Arctic System Reanalysis (ASR)**, on behalf of **Dave Bromwich**. ASR currently covers the greater Arctic region for the period 2000-2012. There are two versions: ASR v1 uses a 30 km grid, and the new (about to be released) ASR v2 uses a 15 km grid. Both use a 71-level configuration of the Polar WRF model, with 3-hour temporal resolution. Results show that the higher resolution topography of ASR v2 lead to more detailed flow than, for example, ERA-Interim, confirming that a resolution of 10-15 km is needed to pick up mesoscale details. To support YOPP, it is proposed to run ASR v3, with improved representation of topographic forcing and ability to resolve fine-scale structure of synoptic cyclones and polar lows. The desired grid length is 5 km, with the first model level at 2 m. It is proposed to adopt hybrid ensemble data assimilation and use the NCAR community land model, with high-resolution daily sea-surface temperatures.

Xiangdong Zhang described the CBHAR (Chukchi-Beaufort Seas High-resolution Atmospheric Reanalysis) dataset. CBHAR has been run for 1979-2009 using a 10 km configuration of WRF. For YOPP, it is hoped to extend CBHAR to real time. It is also proposed to run a new high-resolution regional reanalysis for the Pacific Arctic (HARPA).

Supplementary Datasets

Richard Swinbank gave a presentation on TIGGE. The TIGGE dataset comprises operational ensemble forecasts from the leading global NWP centres, stored every six hours in GRIB2 format. The data are available for research after a 48-hour delay. TIGGE has now been running for almost ten

years. Although it was set up as part of the THORPEX, which finished at the end of 2014, TIGGE will be continued for at least five further years, covering the YOPP core period. Further information and links to the data portals are available via <http://tigge.ecmwf.int>. **Frederic Vitart** gave a talk on the Subseasonal to Seasonal (S2S) dataset, which was established as part of the WWRP S2S project. The S2S data portal at ECMWF was opened in May 2015, followed by the CMA portal in November 2015. Data are stored every 24 hours on a common 1.5° grid. The dataset includes both ensemble forecast data and hindcasts. Although many of the same centres provide data for both TIGGE and S2S, the model versions are generally different. It is planned that data from all eleven providers will be available by the end of 2016. It is also planned to add ocean and sea ice variables in netcdf format. For further information, see <http://s2s.ecmwf.int>.

Dave Bromwich gave a talk of the Antarctic Mesoscale Prediction System (AMPS). The primary goal of AMPS is to provide NWP support to the US Antarctic Program (USAP). AMPS has been providing real time forecasts since 2000, with many updates. AMPS is based on the Polar WRF model using a 30 km grid and embedded high-resolution domains, with highest resolution 1.1 km over Ross Island. The higher resolution configurations reveal strong katabatic flows, and have also been used for investigations of small-scale cyclones. Dave also gave a brief overview of YOPP plans for the Southern Hemisphere; further details are available from <http://polarmet.osu.edu/YOPP-SH/> .

Greg Smith described the GODAE OceanView (GOV) sea-ice forecast intercomparison. This project compares sea-ice forecasts provided by several different centres, using a common set of reference observations (AMSR-2 sea ice concentration data). Results have highlighted strengths and weaknesses in various systems. Greg then talked about the proposed development of a WMO Arctic Polar Regional Climate Centre, which would fill the current Arctic gap in RCC coverage. The Polar RCC will be the lead centre for multi-model ensembles of long-range forecasts, and will produce a range of regional products. **Matthieu Chevallier** described the Ocean Reanalysis Intercomparison Project ORA-IP. This project gives insight into the ocean analysis uncertainties and ocean variability. Matthieu showed a range of comparisons of ORA-IP results for the Arctic. In systems without sea-ice assimilation, concentrations tend to be over-estimated. Velocity biases are sensitive to model tuning. Comparisons of sea-ice thickness and volume show similar patterns in different models, though large biases. There is potential for a range of new studies with these data.

Richard Swinbank presented a proposal for YOPP modelling experiments to include a core set of standard output fields, to facilitate comparison of model results. The proposed core set of output is based on the set of fields stored in TIGGE and S2S, with some additional ocean and sea-ice parameters. One issue is that TIGGE does not currently include surface stress data; their addition was supported by feedback from several participants, Richard is looking into getting those fields added to TIGGE output.

ACTION: All to give feedback to Richard Swinbank on the proposed list of core model output fields, circulated before the meeting.

YOPP-Endorsed Projects

Helge Goessling gave an overview of the YOPP-endorsement process, and a brief summary of YOPP-endorsed modelling projects that are not covered by other presentations.

Experimental Modelling Activities

Thomas Jung described the modelling activities included in the APPLICATE project. The numerical experimentation plan is focused on determining the impact of model enhancements on process representation and systematic errors. Ensemble experiments will elucidate linkages between the Arctic and lower latitudes in both, atmosphere and ocean. Other experiments will cover Arctic observing systems developments. Further experiments will be directed at improving the representation of processes, including boundary layer, cloud, snow and sea-ice modelling. One key question is “what do we need from the observations to make the most of this project?” **Steffen Olsen** described modelling activities of the Blue-Action project. Those modelling activities are covered by four work packages: WP1 – Improving Long-Range Prediction of Risks of Hazardous Weather and Climate Events; WP2 – Drivers of Arctic Changes; WP3 – Linkages of Arctic Change to Lower Latitudes; WP4 – Enhancing the Capacity of Seasonal to Decadal Predictions. A fifth work package will synthesise results from WP1-4 into products relevant to stakeholders, e.g., climate services for fisheries, tourism and mineral extraction.

Andrey Proshutinsky gave an overview of the Forum for Arctic Modelling and Observation Synthesis (FAMOS). The aim of FAMOS is to enhance collaboration between Arctic marine and sea-ice modellers, theoreticians and observationalists. FAMOS has just had its funding extended for three more years. It will continue to cover such topics as freshwater dynamics, sea-ice processes and internal solitary waves. These activities will be coordinated with YOPP. **John Methven** described NAWDEX modelling activities. Most of the worst European forecast busts share a common precursor of systematic errors in model representation of Rossby Wave propagation that are attributable to diabatic processes. A range of modelling studies, informed by aircraft observations, will be used to study the issues, including process studies and data denial experiments. See the NAWDEX [wiki page](#) of the “waviestoweather” project. **Cristiana Stan** outlined the “Year of Tropics-Midlatitude Interactions and Teleconnections”, which is part of the S2S teleconnections subproject. YTMIT involves using observations, forecasts and applications, diagnostics, theory and modelling to understand the nature of tropical-mid-latitude teleconnections.

Gunilla Svensson gave an overview talk on process modelling. A process model is a model that can simulate a process, e.g. LES (large eddy simulation), or resolve a process in detail. The aim is to study, describe and understand processes so that they can be represented in “model physics” parameterizations. The GABLS (GEWEX Atmospheric Boundary Layer

Study) has revealed the sensitivity of global forecasts to boundary layer processes. Larcform 1 focused on transport over sea ice in winter, and the model representation air mass transformation – this is linked to the “Grey Zone” project. ARCMIP (Arctic Regional Climate Model Intercomparison Project) experiments using SHEBA data showed that different models have very different behaviours. There are several proposals for coordinated parameterization studies during YOPP.

Xiangdong Zhang showed examples of predictions of several Arctic storms. There seems to be a trend of increasing storm activity over the Arctic. A modelling study of a long-lasting storm in September 2010 revealed that a barotropic structure dominated throughout its lifetime. Downward intrusion of low polar vortex from the stratospheric vortex plays an important role in maintaining the storm. **Ed Blanchard** gave a presentation on the Sea Ice Prediction Network (ISPN) Sea Ice Outlook (SIO). There have been more than 500 submissions (over nine years) of September sea ice in the Arctic, based on June-August initial data. The skill has been less than expected – and dynamical models are equally unsuccessful. In order to help understand this, different models were initialised on 1st May with the same data. There was a lot of inter-model spread, with no consistency in regional anomalies. The results showed that bias correction is important to get the best from model predictions. **Francois Massonnet** gave a brief presentation on SOSIE (Southern Ocean Sea Ice Experiment), a proposal to extend SIO to the Antarctic. **Axel Schweiger** described experimental short term drift and ice edge forecasts. The motivation is to acquire high resolution satellite data covering drifting buoys when the area covered by the image is very small (~10 km across). Sea-ice drift is largely driven by wind. Compared to using climate drift, the probability of the data being on target increases from 60% to 95%. Ice drift is an observationally well-constrained parameter, and we should make better use of these data to improve models. **Helge Goessling** described the proposed YOPP/MOSAiC drift forecast experiment. There are two motivations: first, to describe where to deploy RV Polarstern and second, to provide drift forecasts during the experiment. A first step is to request forecast trajectories starting 1st June through September – either single or ensemble forecasts, though ensembles of trajectories would be more useful.

Harald Schyberg described planned Met Norway contributions to YOPP. The AROME-Arctic model will provide convective-scale (2.5 km) predictions for the Arctic north of Norway. They plan “Big Brother” experiments to quantify the value of high-resolution limited area models. Other contributions include the GLAMEPS multi-model pan-European EPS, and development of a coupled atmosphere ocean sea-ice forecast system. **Steffen Tietsche** described developments at ECMWF. Prognostic sea ice is being introduced in the medium-range and monthly ensembles. ECMWF will contribute sea-ice forecasts to the SPICE project on space-based observations for detecting and forecasting extremes in sea-ice cover. **Eric Bazile** and **Matthieu Chevallier** covered Meteo-France modelling plans; their NWP includes the global ARPEGE model and the high-resolution AROME. For YOPP, they are intending to run an ARPEGE configuration with a stretched-grid pole near Dome C in Antarctic, implement an Arctic configuration of AROME with a 1.3

km grid and a smaller AROME domain covering Dome C. Simulations with the CNRM-CM6 model will contribute to CMIP6, while the MF-S2S model contributes to the S2S database and will be used for case studies contributing to YOPP. The output data for YOPP should be similar to that produced for CMIP6 as far as the same coupled models are concerned.

Greg Smith outlined the modelling plans of Environment Canada (EC). There will be a regional coupled high-resolution atmosphere-ice-ocean prediction system (HRDPS-RIOPS) comprising 2.5 km GEM and 3-8 km NEMO-CICE. The Global coupled global medium-range deterministic system (GDPS-GIOPS) could produce reference data for YOPP. Monthly global ice-ocean GIOPS ensembles are run once a week (forced by atmospheric GEPS, not two-way coupled). There is also a seasonal forecasting system CanSIPS, using the new GEM-NEMO-CICE coupled model. EC also plans to run a range of atmospheric, sea ice and ocean data assimilation experiments. **Bob Grumbine** outlined USA modelling plans for YOPP. NOAA will use the RASM-ESRL regional coupled model for short-term coupled forecast. The US Navy will use the HYCOM hybrid coordinate ocean model with CICE for the Arctic cap. NCEP runs an operational drift model, with resolution up to a 25 km grid. The NWS/NGGPS mesoscale coupled global air-sea-ice demonstration system ranges from days to weeks ahead. **Mikhail Tolstykh** described Russian activities. As part of the COSMO consortium, Russia will run the COSMO-RU_ARCT model for two nested domains, the outer (6.6 km) covering Polar Europe and North Asia, and the inner domain (2.2 km) the Barents and Kara seas. This will be mainly use for studies of polar mesocyclones. They will also run a global Semi-Lagrangian (SL-AV) model, using different configurations for medium-range and seasonal forecasting, contributing to the S2S project. It will also be run with ocean and sea ice, using their own coupled design. **Ed Blockley** outlined the UK Met Office contribution to YOPP modelling. The UK Earth system model comprising atmosphere, land, ocean and sea ice component models, which are updated regularly. Modelling studies will focus on sea ice, boundary layer and clouds, feeding through to future model development. Experiments with a convective-scale (1-4 km) suite will be run in conjunction with the FAAM aircraft campaign. **Jun Inoue** described the modelling aspects of the Japanese flagship project ArCS. There will be an experimental ensemble reanalysis, using the AFES-LETKF ensemble data assimilation system. For YOPP, there are plans to upgrade the ALEDAS data assimilation system and explore the output of short terms sea ice forecasts, to understand the role of atmospheric predictability on those forecasts.

Gunilla Svensson gave an overview of Swedish contributions to YOPP, many of which are part of the APPLICATE and INTAROS projects. In addition, there are Swedish contributions to ARCPATH (Arctic Climate Predictions) and GREENICE (on the impact of future cryospheric changes). Technical development of the AOSCM of IFS/EC-Earth has now been completed. Model results will be compared with observations from the Ice-Atmosphere-Arctic Ocean Observing System IAOS, MOSAiC and the Swedish Icebreaker Oden. Further development is planned under the APPLICATE project. **Frank Kauker** introduced the YOPP-endorsed project 'Arctic Earth Observation

Impact Assessment' (A+5) that is funded through ESA's Support To Sciences Element and addresses the combination of Earth Observation (EO) data streams with a numerical model of the Arctic sea ice-ocean system using quantitative network design (QND) techniques. Exemplarily, results of a QND study performed in the framework of the EU-Integrated Project ACCESS were presented. The study quantified the impact of ice and snow observations made from two synthetic flight transects typical for NASA's operation "IceBridge". He concluded that this was a useful objective technique to assess the benefit of Arctic observations, which would best be carried out jointly by observation and modelling experts.

Model Assessment

Thomas Haiden gave a talk on forecast verification for YOPP. The Joint Working Group on Forecast Verification Research (JWGFVR) has recently produced a report on Polar Verification (the final version will be published shortly). WMO/CBS has developed a set of standards for atmospheric forecast verification – which could be extended for PPP. He also outlined the benefit user-oriented verification (linking with PPP-SERA) and recent developments of spatial verification methods. To minimise technical verification issues, model and observation data need to be available in consistent formats – this would enable baseline verification to CBS-type standards. **Linus Magnusson** described the use of model diagnostics – this work will contribute to APPLICATE. He showed that tendencies from different physics scheme can be used to study the causes of model biases. Another approach is to study the reliability budget of an ensemble data assimilation scheme – this can highlight biases and other types of error. Similar diagnostic techniques can also be applied to coupled models. In discussion, both Thomas Jung and Peter Bauer strongly supported applying these approaches in the Arctic. Strong investment in developing diagnostic techniques makes an invaluable contribution to model development.

Model Output Data

Thomas Jung outlined the YOPP data strategy. The aim is to allow wide access to observational model and forecast data. It is planned to set up a data portal, with consistent meta data and pointers to online locations from where data may be retrieved. All appropriate data should be made available through GTS/WIS, using the WMO standards, including BUFR format. We need to identify a set of data centres (e.g., PANGEA) that are willing to archive YOPP data. The Oslo workshop will help us work out data management requirements. We also need to identify a "champion" to progress YOPP data management.

In subsequent discussion, **Peter Bauer** recommended leaving NWP data where they are – the YOPP data portal should link to the NWP data archives. There was some discussion of data standards. Most researchers will be working with NetCDF, but the NetCDF CF standard is sometimes interpreted inconsistently. Although GRIB2 is more consistent, some of the variables used by YOPP are not included in the GRIB2 standard. **Ed Blockley** and others recommended that YOPP follows the CMIP6 standards, especially for

subseasonal-to-seasonal predictions. **Bob Grumbine** noted that it can be hard to write BUFR data – and asked for common tools to be provided.

Experimental Modelling Activities – Discussion

Thomas Jung opened an extended discussion of planned modelling activities. He asked people to address three key questions:

- What is holding us back?
- What are the game changers?
- What do we need to do to make progress?

Greg Smith opened the discussion on sea ice and coupled modelling. He pointed out that, at the moment, the Canadian ice service makes very little use of model data. Ice pressure would be a useful product, but is not really looked at by modellers. It was also pointed out that there is a lot of data available (e.g. from IPY) which has not been well exploited. There was a discussion of how best to deploy ice buoys - they need to be deployed in advance of intensive observing periods. **Ed Blockley** also noted the value of marine mammal data. It was agreed that we need a further workshop, bringing together observation and model specialists, to discuss the use of observations for model validation, and modelling studies using observation data. **Linus Magnusson** noted that we are held back by not having a reliable (observing) system available 24/7 all year. **Sarah Keeley** said that we need a better understanding of coupling processes in order to construct good observation operators. **Xiangdong Zhang** highlighted the need for ocean, as well as atmosphere, profile information.

Gunilla Svensson introduced the discussion on atmospheric modelling and process studies. Observation and process studies are close together, but Ian Renfrew commented that it can be hard to scale up aircraft observations of (for example) surface fluxes to the grid scale. **Thomas Jung** noted that MOSAiC could be a game changer. **Helge Goessling** also noted that smaller drifters are also valuable. Thomas Jung also noted the benefit of bringing together different modelling communities, with different models, insights and expertise. **Peter Bauer** said that we need model formulations that work across a range of scales. **Linus Magnusson** noted the benefit of comparing high and low model resolutions. **Gunilla Svensson** pointed out that we need to consider the season – different processes are important at different times. There was agreement that spring and summer would be an interesting time. **Thomas Jung** remarked that it was not easy to study processes from model output. It was agreed that the tendency information in the YOTC dataset was invaluable, and would be for YOPP. It would also be very helpful to have this information from more than one model. **Thomas Jung** suggested that we set up a task group of representatives from operational centres to help coordinate preparations and operational support for YOPP.

Thomas Jung chaired the discussion on predictability studies. He asked the question: what is holding us back on predicting sea ice? In the short-range, we know that wind and ocean currents are key, but for subseasonal and longer predictions, the mechanisms are less clear. Apparently small, or

unobserved, differences can have a big effect. **Greg Smith** said that many models are clearly not representing fast ice – there are potentially missing processes. Greg also commented that preconditioning was important. It would be better to have Summer SOP after a winter SOP, rather than the other way round. There was general agreement that it would be better to have an SOP in early 2018, although the shorter notice period would be challenging. It would also be useful to have two years between this SOP and the MOSAiC SOP, to allow lessons to be learned. **Paolo Ruti** highlighted the urgency of making this decision. **Trond Iversen** raised the issue that we need to understand the origins of uncertainty. We need to understand uncertainties – when systems are more or less predictable. Coupled modelling should include the necessary range of physical processes. **Amy Solomon** pointed out that limited area models are useful to understand causes and effects. The TIGGE framework is useful for comparing and contrasting model forecasts. **Xiangdong Zhang** noted that land surface processes also need to be taken into account.

Peter Bauer led the discussion on observing system design (as opposed to individual observations). Our aim is to make recommendations to WMO and national met services. There was some discussion of possible observation targeting in the Arctic, but it was pointed out a study by the DAOS working group showed rather limited benefits. Both data denial experiments and FSO techniques can be used to assess the benefit of different observation types – results from the two techniques can be complementary. There was some discussion of the use of Observing System Simulation Experiments (OSSE) to identify how to fill gaps in the observing system, but the consensus was that this technique is expensive and can be problematic. **Frank Kauker** also reminded people about the QND technique. **Peter Bauer** noted that confidence is increased if similar conclusions are reached across a range of models and systems. Another urgent question is: what specific requests should **Thomas Jung** make at the PSTG meeting next week? Sea ice thickness is clearly a priority. **Patricia de Rosnay** asked if there was any prospect of measurements of snow on sea ice.

Thomas Jung opened the discussion on teleconnections and linkages. This will be discussed more at the US CLIVAR meeting in the new year, but it was worth discussing what is holding us back, gaps and priorities. **Steffen Olsen** and others raised the need to consider ocean linkages, not just the atmosphere. **Linus Magnusson** noted that N Europe is on the edge of the Arctic – we need sharper tools than those used to study linkages with low latitudes. Thomas also suggested a task group on this topic.

Future Plans

Richard Swinbank opened this session by outlining plans to develop a YOPP modelling plan document. This would be structured to describe the YOPP core and supplementary datasets, then the other modelling work following the themes just discussed, and also covering plans for the YOPP consolidation phase. He aims to have a draft modelling plan ready for discussion at the steering group meeting next February.

Thomas Jung then set out other plans. First, he highlighted the need to set up task groups to push forward specific areas, including:

- Coordination of operational centres' contribution
- Coordination of airborne observations
- PPP-SERA is already a task team covering socio-economic aspects
- Data task force and champion(s)
- Outreach task team (already working on video and preparing for the launch).

Second, Thomas highlighted the need to run another set of workshops in about a year, bringing together observationalists and modellers for a longer period, and including data champions. **Dave Bromwich** said that YOPP-SH needs to be involved in these workshops. **Xiangdong Zhang** also recommended to bring observation and modellers together immediately after intensive observing periods to exchange ideas. To enhance communications, a YOPP newsletter is planned. This is an opportunity for two-way communication – not just news from the ICO. The polar prediction mailing list now has over 500 subscribers.

There was agreement that we need a formal process to endorse institutional plans to support YOPP, either by extending the current YOPP project endorsement scheme, or introducing a complementary 'institutional' scheme. It was also agreed that we need an urgent commitment from Met services to support the YOPP SOPs with additional radiosondes. The SOPs need confirmation as a matter of urgency, so that Paolo Ruti can write the letter to request support from PRs. **Bob Grumbine** also pointed out that if additional NWP data were needed, that would also need a long lead-time to set up. The proposed NH SOP dates, after bringing forward the "late winter" SOP to 2018 are:

- February-March 2018
- July-September 2018
- February 2020 (for MOSAiC).

Wrap-up and Closure

Thomas Jung wrapped up the meeting by summarising the main meeting outcomes. Paolo Ruti thanked Thomas and the ICO for organizing the meeting, and ECMWF for hosting the meeting. Thomas also thanked all the participants, the ICO and ECMWF, and Peter thanked all the ECMWF staff members who had helped with the organization and contributed to the meeting.

Annex 1: Agenda Arctic Observation Workshop

WWRP Polar Prediction Project (WWRP-PPP)

YOPP Planning Arctic Observations

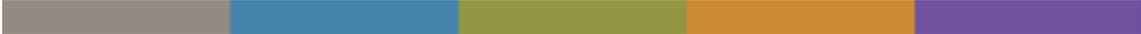
5–7 September 2016

Monday 5 September		
08:30-09:00	Registration	
Welcome and purpose of the meeting		
09:00-09:10	Welcome and opening	Peter Bauer (ECMWF) Helge Goessling (AWI) Paolo Ruti (WMO)
09:10-09:30	Agenda and purpose of the meeting	Ian Renfrew (Univ. East Anglia)
Overview Presentations		
09:30-09:50	General update on YOPP	Helge Goessling (AWI)
09:50-10:10	Observational requirements from a forecasting perspective	Sarah Keeley (ECMWF)
10:10-10:30	The impacts of additional observations on Arctic weather and sea ice forecasts	Jun Inoue (NIPR)
10:30-11:00	<i>Coffee break</i>	
11:00-11:20	Contributions from WMO	Paolo Ruti (WMO)
11:20-11:40	The YOPP Arctic Observational Component	Ian Renfrew (Univ. East Anglia)
Contributing Projects I		
11:40-12:10	Horizon2020 INTAROS	Stein Sandven (NERSC)
12:10-12:30	Horizon2020 APPLICATE	Peter Bauer (ECMWF)
12:30-12:50	(AC)³ - A German Transregional Collaborative Research Center on Arctic Amplification: Overview and possible contributions to YOPP	Manfred Wendisch (Univ. Leipzig)
12:50-13:00	Discussion	
13:00-14:15	<i>Lunch break</i>	

Contributing Projects II		
14:15-14:35	MOSAic and ICECAPS	Matthew Shupe (NOAA)
14:35-14:50	PEEX and PACES	Tuukka Petäjä (Univ. Helsinki) and Jo Browse (Univ. Exeter)
14:50-15:05	MEOPAR	Doug Wallace (Dalhousie Univ.)
15:05-15:15	The Iceland-Greenland Seas Project	Ian Renfrew (Univ. East Anglia)
15:15-15:45	<i>Coffee break</i>	
Contributing Projects III		
15:45-16:05	YOPP-Endorsed projects	Helge Goessling (AWI)
International Organizations, Committees, and Observational Plans I		
16:05-16:20	IASOA	Sandy Starkweather (NOAA)
16:20-17:00	IABP, IICWG and PSTG	Pablo Clemente-Colon (NOAA)
17:00-17:05	Argo	Birgit Klein, pp Helge Goessling (AWI)
17:05-18:00	Open discussion	
18:00-19:30	<i>Drinks reception</i>	
Tuesday 6 September		
International Organizations, Committees, and Observational Plans II		
09:00-09:15	Overview of Group on Earth Observation (GEO) and the Cold Region Programme (GEOCRP)	Vanessa Aellen (GEO)
09:15-09:30	DAOS	Carla Cardinali (remote; ECMWF)
National and Institutional Plans and Enhancements to the Operational Observing Network I		
09:30-09:45	Norway	Trond Iversen (Met.No)
09:45-10:00	Russia - possible contributions of Roshydromet to YOPP	Alexander Makshtas (Arctic and Antarctic Research Institute)
10:00-10:20	USA - NOAA, ONR, NSF Transportable Array Network, and Alaska long-term monitoring	Renee Tatusko (NOAA)
10:20-10:30	Denmark and Greenland	Steffen Olsen, pp Helge Goessling (AWI)
10:30-11:00	<i>Coffee break</i>	
National and Institutional Plans and Enhancements to the Operational Observing Network II		
11:00-11:15	Japan	Jun Inoue (NIPR)
11:15-11:30	Korea	Joo-Hong Kim (Korean Polar Research Institute)
11:30-11:45	China	Qizhen Sun (National Marine Environmental Forecasting Center)
11:45-12:00	Finland - FMI activities	Timo Vihma (FMI)

12:00-12:15	UK – Met Office field campaigns	Chawn Harlow (Met Office)
12:15-12:30	Germany	Marion Maturilli (AWI)
12:30-12:45	France - Météo-France	Guylaine Canut (Météo France)
12:45-13:00	Iceland	Guðrún Nína Petersen (Icelandic Meteorological Office)
13:00-14:15	Lunch break	
National and Institutional Plans and Enhancements to the Operational Observing Network III		
14:15-14:30	Italy	Vito Vitale (ISAC CNR)
14:30-14:45	Faroe Islands and Blue-Action Observations	Karin Margretha Larsen (Faroe Marine Research Institute)
14:45-15:00	Canada	Stella Melo (remote; Environment and Climate Change Canada)
15:00-15:15	Sweden - ACAS	Michael Tjernström (remote; Bolin Centre for Climate Research/ Stockholm University)
15:15-15:45	Coffee break	
Special and Intensive Observing Periods		
15:45-16:00	Introduction	Helge Goessling (AWI)
16:00-17:15	<p>Discussion</p> <ul style="list-style-type: none"> • Fix timings of Intensive Observing Periods (IOPs) for official WMO letter asking for extra observations during YOPP • Try to identify comprehensive reference stations before mid-2019 • Discuss satellite aspects for input to upcoming PSTG meeting • Miscellaneous 	Lead by: Ian Renfrew (Univ. East Anglia)
17:15-17:30	Wrap-up of YOPP Arctic Observations Planning Meeting	Ian Renfrew (Univ. East Anglia)
Wednesday 7 September		
08:30-09:00	Registration	(new arrivals only)
Welcome to the Joint Session Arctic Observation and The YOPP Modelling Component		
09:00-09:05	PPP	Thomas Jung (AWI)
09:05-09:10	WMO	Paolo Ruti (WMO)
09:10-09:15	Local host and practical arrangements	Peter Bauer (ECMWF)
09:15-09:20	Agenda and purpose of the joint session	Thomas Jung (AWI)
Joint Session I		
09:20-09:50	YOPP Arctic Observations - overview and meeting summary	Ian Renfrew (Univ. East Anglia)
09:50-10:00	The NAWDEX observing system	John Methven (Univ. Reading)
10:00-10:20	Overview of YOPP Modelling Component	Peter Bauer (ECMWF)

10:20-10:30	Group photo in the courtyard (Picture: Simon Witter, ECMWF)	
10:30-11:00	<i>Coffee break</i>	
Joint Session II - brief overview of H2020 contributions to YOPP		
11:00-11:10	INTAROS	Stein Sandven (NERSC)
11:10-11:20	APPLICATE	Thomas Jung (AWI)
11:20-11:30	Blue-Action	Steffen Olsen (DMI)
11:30-11:50	MOSAIC and YOPP	Matthew Shupe (NOAA)
Discussion		
11:50-12:45	Discussion of predefined questions – e.g., Intensive Observing Periods (IOPs), use of operational forecast data for field campaigns, experience with GFDex (and T-NAWDEX, etc.), links with MOSAiC	All
Wrap-up of Joint Session and closure		
12:45-13:00	Summary and next steps	Thomas Jung (AWI)
13:00-14:15	<i>Lunch break</i>	



WWRP Polar Prediction Project (WWRP-PPP)

YOPP Planning : Arctic Observations

5–7 September 2016

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WWRP Polar Prediction Project (WWRP-PPP) YOPP Planning Modelling Component 7-9 September 2016

Wednesday 7 September		
08:30-09:00	Registration	(new arrivals only)
Welcome to the Joint Session Arctic Observation and The YOPP Modelling Component		
09:00-09:05	PPP	Thomas Jung (AWI)
09:05-09:10	WMO	Paolo Ruti (WMO)
09:10-09:15	Local host and practical arrangements	Peter Bauer (ECMWF)
09:15-09:20	Agenda and purpose of the joint session	Thomas Jung (AWI)
Joint Session I		
09:20-09:50	YOPP Arctic Observations - overview and meeting summary	Ian Renfrew (Univ. East Anglia)
09:50-10:00	The NAWDEX observing system	John Methven (Univ. Reading)
10:00-10:20	Overview of YOPP Modelling Component	Peter Bauer (ECMWF)
10:20-10:30	Group photo in the courtyard (Picture: Simon Witter, ECMWF)	
10:30-11:00	<i>Coffee break</i>	
Joint Session II - brief overview of H2020 contributions to YOPP		
11:00-11:10	INTAROS	Stein Sandven (NERSC)
11:10-11:20	APPLICATE	Thomas Jung (AWI)
11:20-11:30	Blue-Action	Steffen Olsen (DMI)
11:30-11:50	MOSAIC and YOPP	Matthew Shupe (NOAA)

Discussion		
11:50-12:45	Discussion of predefined questions – e.g., Intensive Observing Periods (IOPs), use of operational forecast data for field campaigns, experience with GFDex (and T-NAWDDEX, etc.), links with MOSAiC	All
Wrap-up of Joint Session and closure		
12:45-13:00	Summary and next steps	Thomas Jung (AWI)
13:00-14:15	<i>Lunch break</i>	
Opening YOPP Modelling Planning Meeting		
14:15-14:20	Brief welcome	Thomas Jung (AWI) Peter Bauer (ECMWF)
Core Datasets		
14:20-14:45	YOPP dataset and reanalysis by ECMWF	Peter Bauer (ECMWF)
14:45-15:05	Arctic system reanalysis v3	Ian Renfrew (Univ. East Anglia)
15:05-15:15	CBHAR: High-resolution reanalysis for the Pacific Arctic	Xiangdong Zhang (International Arctic Research Center)
15:15-15:45	<i>Coffee break</i>	
Supplementary Datasets and YOPP requirements		
15:45-16:00	TIGGE: Global ensemble forecast data	Richard Swinbank (WMO consultant to PPP)
16:00-16:15	The S2S database	Frederic Vitart (ECMWF)
16:15-16:30	AMPS (Southern Hemisphere)	Dave Bromwich (remote; Byrd Polar and Climate Research Center)
16:30-16:50	GODAE OceanView (GOV) sea-ice forecast data and polar RCC	Greg Smith (Environment and Climate Change Canada)
16:50-17:10	Sea-ice/ocean reanalyses	Matthieu Chevallier (Météo-France)
17:00-17:25	Common/core set of model output fields	Richard Swinbank (WMO consultant to PPP)
YOPP-Endorsed Projects		
17:25-17:45	Overview of endorsed projects and their modelling contributions	Helge Goessling (AWI)
Thursday 8 September		
Experimental Modelling Activities I		
09:00-09:20	APPLICATE modelling activities	Thomas Jung (AWI)
09:20-09:40	Blue-Action modelling activities	Steffen Olsen (DMI)

09:40-10:00	FAMOS: 2016-2019 plans and activities	Andrey Proshutinsky (Woods Hole Oceanographic Institution)
10:00-10:15	NAWDEX modelling activities	John Methven (Univ. Reading)
10:15-10:30	The Year of the Tropics - Midlatitude Interactions and Teleconnections (YTMIT)	Cristiana Stan (George Mason University)
10:30-11:00	<i>Coffee break</i>	
Experimental Modelling Activities II		
11:00-11:15	Overview of process modelling	Gunilla Svensson (UnivStockholm)
11:15-11:30	High-resolution modelling of storms: physical process studies	Xiangdong Zhang (International Arctic Research Center)
11:30-11:40	Lessons from multi-model experiments in the sea ice prediction network	Ed Blanchard (Univ Washington)
11:40-11:45	Southern Ocean Sea Ice Experiment	François Massonnet
11:45-12:00	Sea-ice drift and edge forecasts	Axel Schweiger (Univ Washington)
12:00-12:05	YOPP/MOSAIc drift forecast experiment	Helge Goessling (AWI)
12:05-12:15	Sea ice predictability studies at ECMWF	Steffen Tietsche (ECMWF)
12:15-12:30	Norway	Harald Schyberg (Met.No)
12:30-12:45	Canada	Greg Smith (Environment and Climate Change Canada)
12:45-13:00	France	Eric Bazile (Météo-France)
13:00-14:15	<i>Lunch break</i>	
Experimental Modelling Activities III		
14:15-14:30	USA	Bob Grumbine (NOAA)
14:30-14:45	Russia	Mikhail Tolstykh (Hydrometcentre of Russia)
14:45-15:00	UK	Ed Blockley (Met Office)
15:00-15:15	Japan	Jun Inoue (NIPR)
15:15-15:45	<i>Coffee break</i>	
Experimental Modelling Activities IV		
15:45-15:55	Sweden	Gunilla Svensson (UnivStockholm)
15:55-16:10	Arctic earth observation impact assessment	Frank Kauker (AWI)
Model Assessment		
16:10-16:30	Forecast verification	Thomas Haiden (ECMWF)
16:30-16:50	Forecast system diagnosis	Linus Magnusson (ECMWF)
16:50-17:00	Discussion	
Model Output Data		
17:00-17:15	YOPP data strategy	Thomas Jung (AWI)

17:15-17:30	YOPP legacy - data hubs and discussion of model data issues	Thomas Jung (AWI)
Friday 9 September		
Experimental Modelling Activities - Discussion		
Thematic Discussion of Proposed Modelling Activities and Gap Analysis [discussion chairs for each theme are listed]		
08:30-09:00	Coupled modelling and sea-ice	Greg Smith (Environment and Climate Change Canada)
09:00-09:30	Atmospheric modelling and process studies	Gunilla Svensson (Univ Stockholm)
09:30-10:00	Predictability studies	Thomas Jung (AWI)
10:00-10:30	Observing system design	Peter Bauer (ECMWF)
10:30-11:00	<i>Coffee break</i>	
11:00-11:15	Teleconnections and linkages	Thomas Jung (AWI)
Future Plans		
11:15-11:25	Development of YOPP modelling plan	Richard Swinbank (WMO consultant to PPP)
11:25-11:45	Science legacy of YOPP - workshops, education and outreach, PPP-SERA aspects, special issues	Thomas Jung (AWI)
Wrap-up and closure		
11:45-12:00	Review meeting outcomes and actions	Thomas Jung (AWI)



WWRP Polar Prediction Project (WWRP-PPP)

YOPP Planning : Modelling Component

7–9 September 2016

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