YOPP YEAR OF POLAR PREDICTION

AWI PPP WORLD METEOROLOGICAL ORGANIZATION

International Coordination Office (ICO) of the Polar Prediction Project

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Newsletter #14

Apr. 2020

PolarPredictNews

Photo: Stefan Hendricks/Alfred Wegener Institute

Six months into the MOSAiC drift campaign, RV Polarstern and its crew and scientists have explored uncharted territory by acquiring a comprehensive climate data set during a whole winter season in the central Arctic. Next up is to capture how the Arctic transforms around the onset of the melt season and into the summer. But the progression towards Fram Strait, the gate to the Nordic Seas and the North Atlantic, has been rapid - more rapid than expected. Together with the extraordinary logistical challenges posed by the COVID-19 pandemic, this renders the fate of MOSAiC during spring and summer uncertain. In this issue's lead article (p.5), scientists shed light on how the drift of the ship is continuously being forecast, and how accurate the forecasts have turned out to be until now.

International Coordination Office (ICO) of the Polar Prediction Project

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Content

The Year of Polar Prediction (YOPP) is a major international activity that has been initiated by the World Meteorological Organization as a key component of the Polar Prediction Project (PPP). The overarching goal of YOPP is to significantly advance our environmental prediction capabilities for the polar regions and beyond. As an internationally coordinated period of intensive observing, modelling, prediction, verification, user-engagement, and education activities which involves various stakeholders, YOPP contributes to the knowledge base needed to manage the opportunities and risks that come with polar climate change.

Editorial

Dear Colleagues,

Since the last issue of PolarPredictNews has been published, the world has changed due to the COVID-19 pandemic. Like many other activities, the pandemic will have an influence on PPP and YOPP. However, when it comes to the planning for the YOPP Consolidation Phase, we are fortunate that the PPP Steering Group managed to have its annual meeting in Bremerhaven just a couple of weeks before international travel was impacted. A summary of this meeting and the associated science workshop can be found in this issue.

Work in PPP and YOPP has also continued in support of the MOSAiC expedition. In this issue, for example, Helge Goessling and colleagues report on the first outcomes from SIDFEx which provides novel insights into the predictability of sea-ice drift in the Arctic. Furthermore, the first YOPP Targeted Observing Period (TOP) took place, providing additional radiosondes during two intrusions of warm and moist air masses from mid-latitudes that reached the MOSAiC camp in mid-April. I am sure that these events will keep the scientific community busy for years to come. Furthermore, I would like to draw your attention to the drawings by Thomas Rackow and Friederike Krüger. Spread throughout this issue, they nicely illustrate the instruments that have been deployed around RV Polarstern during the first leg of the MOSAiC expedition.

I would also take the opportunity to thank Mikhail Tolstykh and Matthieu Chevallier for their outstanding contributions to PPP and YOPP. Both recently stepped down as PPP Steering Group members. At the same time, it is my pleasure to welcome the new members Qizhen Sun, Clare Eayrs and Eric Bazile.

Finally, I would like to thank the ICO for developing what I consider a very appealing new design of PolarPredictNews.

Happy reading & stay healthy
Thomas Jung

Photo: Martina Buchholz/AWI

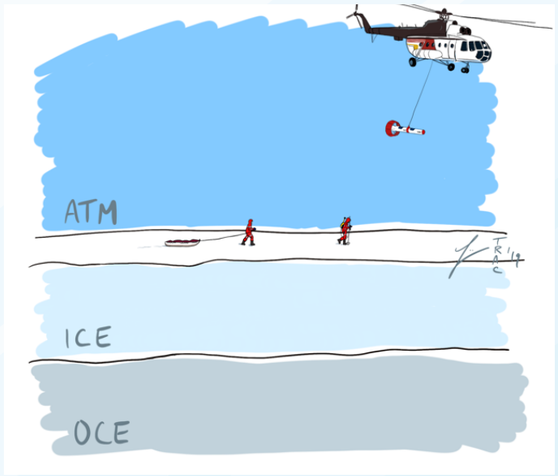
FEATURED IN THIS ISSUE:

The (Drawn) Distributed Network

by Thomas Rackow, Alfred Wegener Institute and Friederike Krueger, IGS Bothfeld School, Hanover

A collection of drawings of the instruments that have been deployed around RV Polarstern during the first leg of the MOSAiC expedition is now available and is featured in this issue of *PolarPredictNews*. These cartoons are a great way of engaging children and the wider public in polar science.

For the last five months, the research icebreaker RV Polarstern has been moored to an ice floe in the Central Arctic Ocean (Krumpen et al., 2020, see this issue) to drift for a year with the Arctic sea ice. Measurements taken during polar night and polar day from fall 2019 to fall 2020 will significantly increase the knowledge on environmental processes in the Central Arctic that have not been observed up to this point in detail. In addition to Polarstern's Central Observatory, a network of heavy scientific equipment has been set up on various ice floes surrounding the ship within a radius of up to approximately fifty kilometres. Measurements from around the central vessel's location allow to extend the data sets generated during MOSAiC and to put the MOSAiC outcome into a large-scale spatial and temporal context. The so-called Distributed Network of instruments around Polarstern covers approximately the size of a grid box in current



***RV Polarstern** and **RV Akademik Fedorov** had their rendez-vous in fall 2019 in the central Arctic when the Distributed Network of instruments was set up around Polarstern.*

climate models (an area comparable in size to the New York metropolitan area), yielding important information for complex climate processes that cannot yet be explicitly resolved in these models.

While photos can look very technical in presentations, digital drawings can help in making things clear and simple for an audience. The teacher Friederike Krüger and the climate modeller Thomas Rackow joined the MOSAiC Leg 1a aboard the supporting Russian icebreaking vessel Akademik Fedorov. They have now published cartoons of various instruments that are part of the Distributed Network set up by participants of the MOSAiC School in fall 2019 (Krueger and Rackow, 2020). "These drawings are an excellent way to address a wider audience, including school kids", says Friederike Krüger who teaches Geography and German Language in Hanover, Germany. The drawings which you can also find in this issue can be used freely for science communication, outreach, and scientific talks.

See also *EGU's Cryoblog*
Krueger, F., & Rackow, T. 2020. The (Drawn) Distributed Network Around Polarstern, MOSAiC Expedition, Zenodo. *http://doi.org/10.5281/zenodo.3696853*

*Sea ice thickness: The distance to the sea ice underside can be measured by the **electromagnetic (EM) sensor** in the sled, or with an **EM-Bird** towed to the helicopter. While the sled is sitting directy on the ice surface and its measured EM distance to the ice/water interface corresponds to the ice thickness, the EM-Bird measures the height above the surface with a laser altimeter.*

01

A Stone's Throw Away from the North Pole

*by Helge Goessling, Alfred Wegener Institute (AWI), Axel Schweiger, University of Washington, Seattle, Thomas Krumpen, AWI, and SIDFEx Team**

Preface

The article reprinted here was originally published two months ago at AWI's Sea Ice Portal. At the time, we first looked at how our earlier SIDFEx drift forecasts for the MOSAiC expedition had performed, and then ventured to present a real-time forecast for the next 3.5 months, that is, until early June. We stated that „there is a 30% probability that the latitude of 88.5987°N reached on Sunday, 23 February 2020 will be surpassed". Now we can say that this record has indeed not been broken, and it is extremely unlikely that it will over the course of the remaining drift. Instead, the camp has made exceptionally fast progress towards Fram Strait, driven by persistent wind anomlies associated with what is known as the positive phase of the Arctic Oscillation.

Towards the end of April, the ship has already almost passed 84°N, which is even slightly faster than the fastest of all trajectories comprising the SIDFEx consensus forecast presented in Fig. 2. It is difficult to tell whether our forecast has failed in this regard because of systematic errors, or whether we might still consider the outcome consistent with the uncertainties captured by our forecast ensemble. In any case, while MOSAiC logistics have already become extremely challenging due to the COVID-19 pandemic, the faster-than-expected drift possibly implies even more challenges ahead. If the camp shall remain on stable ice until autumn, a relocation to the north might become necessary at some point. Up-to-date observations and forecasts, including from SIDFEx, will be an important element to guide decisions during the weeks and months ahead. (hfg)

(24 February 2020) **Four months into the MOSAiC drift campaign, the North Pole is less than 160 kilometres away. Current predictions by international forecast centres and researchers, collected and evaluated by the *Sea Ice Drift Forecast Experiment* (SIDFEx), suggest that there is a chance that the drift will take the expedition even further North. However, the tight grip of the westward Transpolar Drift stream makes it unlikely that the ship will pass the North Pole in the direction of North America. There is other good news: The probability to get pushed into the open ocean before October 2020 is still not more than 10-15%.**

On Sunday, 23 February 2020, the MOSAiC expedition on board the icebreaker RV Polarstern reached 88.5987°N, besting the northernmost point of Fridjof Nansen's expedition 125 years ago by more than two degrees of latitude. While Nansen's goal was to reach the North Pole, MOSAiC's science plan has no specific interest in this target. Nevertheless, being so close, the question how close to the pole MOSAiC will get is on the mind of participants and observers at home. Is the camp destined for a continuation of its straight course toward the Fram Strait, named after Nansen's ship, or could the expedition still pass the pole on the "other side", across the date line?

Drift Forecasts are Essential for Expedition Planning

When planning the route for his 1893 expedition to reach the North Pole, Nansen had little to go by other than a few pieces of debris from the shipwrecked Jaennette that had been found off the south-west coast of Greenland. After more than a century of research and innovation, planning and execution of science missions such as MOSAiC can now draw on millions of Earth observations and complex weather and climate models running on supercomputers that simulate the evolution of our environment based on the laws of physics. The planning for the MOSAiC drift, in particular where and when to start, relied on satellite observations of Arctic sea-ice drift from the previous two decades. This historical information provided a sense of what one might expect for the 2019-2020 period. Many months before a planned mission, such climatological information so far remains the best planning tool. This is because modern forecast systems that simulate the ice motion have difficulty adding much skill beyond several weeks forecast lead time. The chaotic nature of the atmosphere makes the winds that drive the ice motion largely unpredictable beyond some point.

However, when it comes to the drift over the next days to weeks, real-time information from modern forecast systems can sharpen the prediction significantly. These

*The SIDFEx Team is listed at the bottom of the SIDFEx website.

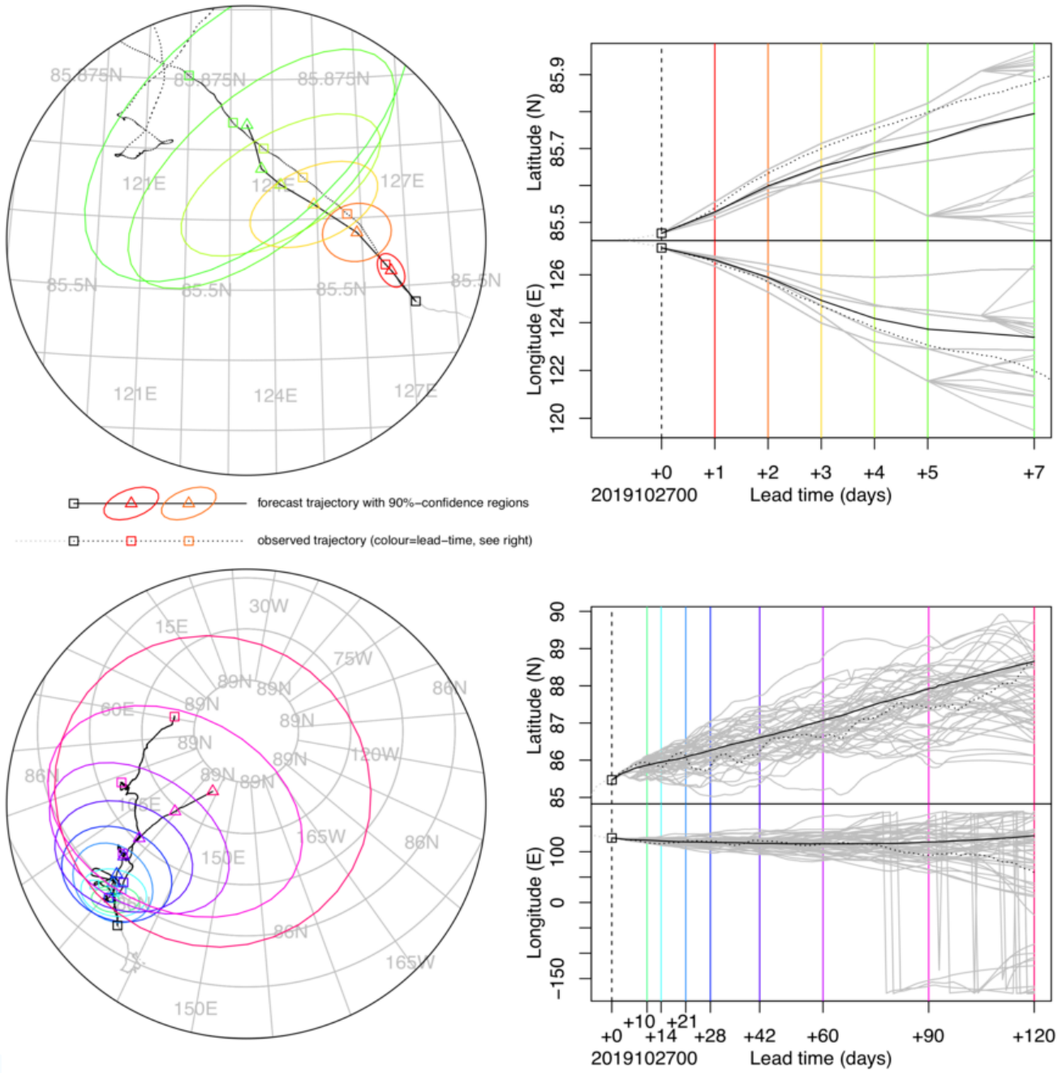
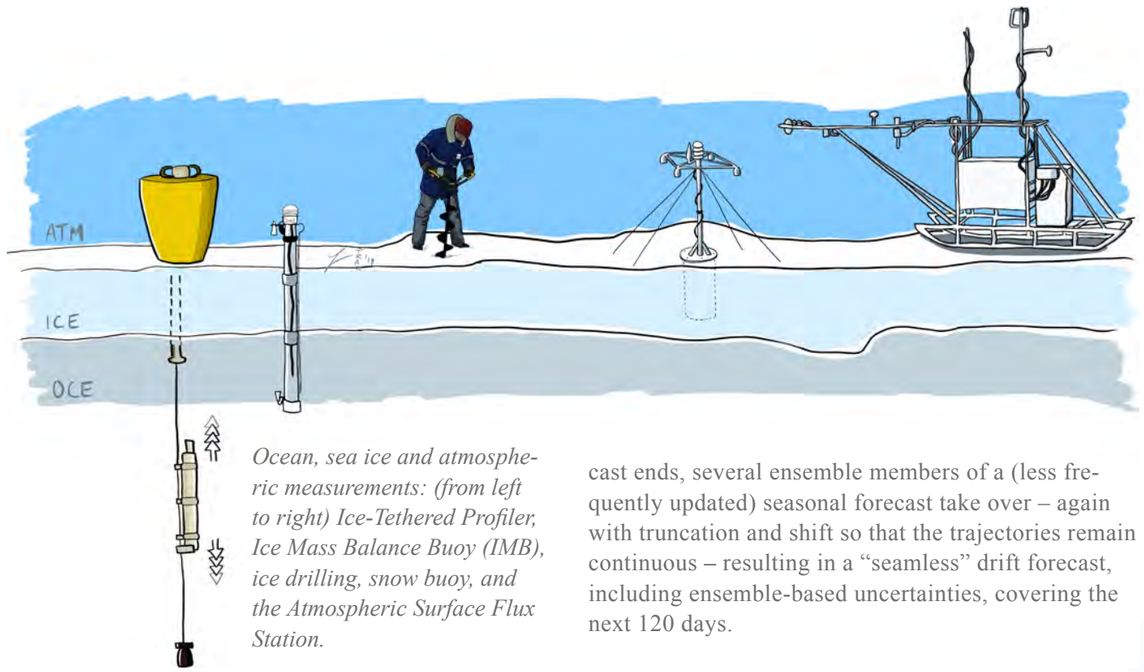


Figure 1. Short (top) and long term (bottom) SIDFEx consensus forecast issued 27 October 2019 at 00:00 UTC. Ellipses in the left column denote 90%-confidence regions, obtained from 2-dimensional normal distributions fitted to the point clouds corresponding to the respective lead time (colours as indicated in the time series graphs). Time series graphs (right) show latitude and longitude for forecasts and observed trajectories for different forecast lead times (source: SIDFEx).



Ocean, sea ice and atmospheric measurements: (from left to right) Ice-Tethered Profiler, Ice Mass Balance Buoy (IMB), ice drilling, snow buoy, and the Atmospheric Surface Flux Station.

forecasts are useful for mission planning and for applications such as the ordering of high-resolution satellite images of targets moving with the ice. Assessing how well these systems work, how to improve them, and how to best integrate them with historical information to generate seamless forecasts from days to months, is the main motivation for the Sea Ice Drift Forecast Experiment (SIDFEx), an initiative of the Year of Polar Prediction (YOPP). Instead of providing forecasts based on a single system, SIDFEx is bringing together forecasts from more than a dozen models from many countries, to increase accuracy and to characterize forecast uncertainty.

Forecast Method

After two years of preparations and testing with buoy data provided by the *International Arctic Buoy Program* (IABP), SIDFEx now provides a consensus forecast for MOSAiC that is updated every six hours. The first part of each consensus forecast is constructed from several short-term forecast systems (listed in the weblinks below) that cover lead times up to ten days. Those systems involve weather forecasts that "know" about the current atmospheric situation. Unfortunately, due to logistical hurdles, even these forecasts are typically already one day "old" when the SIDFEx consensus forecast is constructed and therefore do not take advantage of the most recent (known) position information. To fix this, the outdated part of each short-term trajectory is truncated and the remaining part is shifted so that the location at the initial time of the consensus forecast matches the observed location. Moreover, at the time when the trajectory of each short-term forecast ends, several ensemble members of a (less frequently updated) seasonal forecast take over – again with truncation and shift so that the trajectories remain continuous – resulting in a "seamless" drift forecast, including ensemble-based uncertainties, covering the next 120 days.

Results

Comparing the observed drift path to the consensus forecast issued 120 days ago reveals that the northward progress of the MOSAiC site unfolded as expected, whereas the site was carried further westward than expected on average (Fig. 1, bottom). However, the actual position remained within the estimated 90%-confidence bounds of the forecast, which also holds for the short-term part of the forecast (Fig. 1, top). Consistent with the satellite-derived climatological-forecasts, the SIDFEx forecasts issued during the first one or two months of the campaign indicated a similar likelihood to pass the North Pole on the Atlantic side, across the Greenwich meridian (0 Deg Longitude), or on the Pacific side, across the Date Line (180 Deg Longitude). However, progress of the drift through the ice has shifted the odds significantly in favour of a passing across the Greenwich meridian. In fact, not a single one of the individual trajectories of the most recent individual extended-range forecasts crosses the Date Line, although some miss it only by a very small margin (Fig. 2, left). That margin becomes broader when current short-term forecasts, indicating a further westward drift with increasing southward component for the next few days, are taken into account, as it is the case in the SIDFEx consensus forecast (Fig. 2, right).

So, what does this mean for how far north MOSAiC will still go, and when will this point be reached? According to the SIDFEx consensus forecast (Fig. 2, right), there is a 30% probability that the latitude of 88.5987°N reached on Sunday, 1 March 2020 will

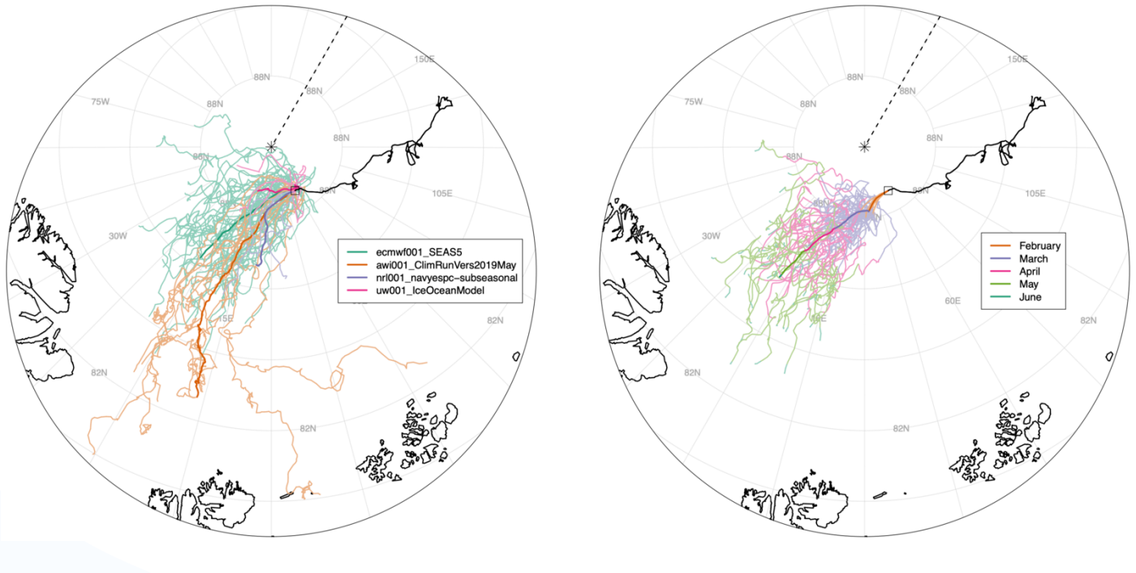


Figure 2. left: SIDFEx forecasts from four extended-range systems/methods, truncated and shifted to be valid from 24 February 2020 at 00:00 UTC. The "awi001_ClimRunVers2019May" forecast ensemble is based on satellite-derived drift of past years, whereas the remaining forecast ensembles are based on dynamical models. The different systems/methods provide different lead-time ranges, which explains the systematic differences of the trajectory lengths. Right: The SIDFEx consensus forecast issued at the same time, with colour indicating the calendar month. In contrast to the standard graphical product shown in Fig. 1, this plot shows individual ensemble members instead of ellipses to represent the uncertainties. Note that the current version of the consensus forecast uses only the "ecmwf001_SEAS5" forecasts to extend the short-term forecasts (source: SIDFEx).

be surpassed. A northernmost latitude beyond 89°N appears possible, too, although only one of the 51 trajectories reaches so much to the north. Concerning the time when the record latitude will be attained, anything between 23 March 2020 and May 2020 seems possible.

Drifting Out of the Pack Ice Earlier? Probably Not

Finally, does the faster-than-expected westward drift have implications for a possible earlier end of the campaign by drifting out of the pack ice earlier than planned? The theoretical chance of this happening makes scientists and mission planners look with interest at the progress of the ship. The SIDFEx consensus forecast does not reach far enough ahead, but the most recent satellite-derived climatological forecast (Fig. 2, brown curves) does. And it has some relieving news for those that hope to complete the full year of MOSAiC measurements: The probability to get pushed into the open ocean before October 2020 is still not more than 10-15%.

Scientists always caution that absolute certainty in forecasts is not attainable. However, it would be a surprise if the MOSAiC drift would take a turn and still make it across the Date Line; too strong is the grip of the Transpolar Drift Stream. Those people on board Polarstern should enjoy the proximity to Nansen's goal while they can, because forecasts call for a southward course soon.

Further information

Latest real-time consensus forecast

SIDFEx webtool

SIDFEx website

02

The MOSAiC Near Real-Time Verification Project

by Amy Solomon, NOAA Earth System Research Laboratory, CIRES & University of Colorado

A project led by NOAA/CIRES evaluates fully-coupled short-term forecasts with observations taken during MOSAiC in near real-time, with the ultimate goal of identifying biases in the representation of surface-boundary layer-cloud feedbacks that limit the skill of weather and sea-ice forecasts.

The MOSAiC Near Real-Time Verification (MOSAiC-NRV) project has been designed to evaluate the skill of fully-coupled short-term forecasts at the RV Polarstern location after each leg of the MOSAiC campaign, i.e. approximately every two to three months during the one-year ice drift campaign. Short-term forecasts of weather and sea ice are used in this project to identify potential errors in the representation of surface-boundary layer-cloud feedbacks that cause biases in climate model projections of Arctic climate change. The diagnostics that involve multiple models operated by different national weather services will focus on a process-based evaluation of the coupled Earth system to detect systematic biases that limit the ability to produce reliable forecasts of weather and sea-ice conditions in the Arctic. Field measurements of snow and sea-ice characteristics (from ice mass balance buoys IMB), the atmospheric structure (from weather balloon radio soundings), cloud characteristics (based on radar/lidar measurements), and surface energy fluxes (from four separate surface flux stations) will be used in the evaluation to compare model output with actual observations.

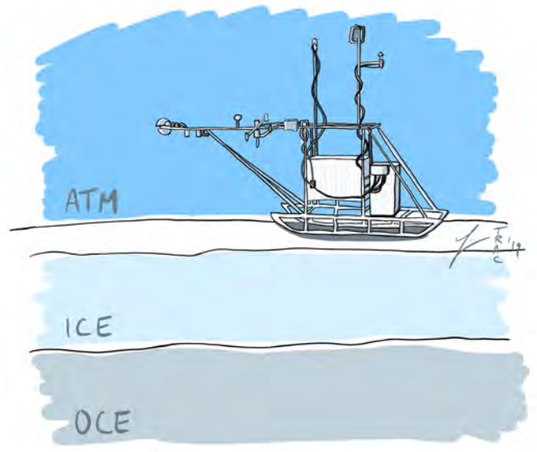
Your Contribution of Model Output to the MOSAiC-NRV Project

The MOSAiC-NRV project is based on the *YOPPSiteMIP* activity (see *documentation on YOPPSiteMIP*). Therefore, contributors of model output are kindly requested to use the YOPPsiteMIP protocol so that field definitions and units are consistent for files from the different modelling centers. Since the model output for MOSAiC-NRV is provided for the MOSAiC ice floe as a moving target, most modelling centers need to extract fields from archived files, which limits both the time resolution of the model output and the available fields. For this reason, model output up to six-hourly and a subset of the YOPPsiteMIP variables are requested. The YOPPsiteMIP list of requested variables can be found *here* with the subset of fields requested for the MOSAiC-NRV project highlighted in yellow. Contributors are asked to please provide as many of the highlighted fields as possible. The model output should be submitted within a month after the end of each leg. For example, provide the model output for leg 2 by the end of March so a telecon can be scheduled shortly thereafter.

Please contact Amy Solomon (see email below) for any questions or concerns, or if help is needed in formatting the model output using the YOPPsiteMIP protocol. All model files will be archived on the *YOPP Data Portal* operated by Met Norway.

A preliminary evaluation of five models (four forecast models and the climate reanalysis dataset ERA5) with Polarstern radio soundings and flux station data is available at *https://www.esrl.noaa.gov/psd/people/amy.solomon/MOSAiC_NRV.html*. This webpage will be updated when more observations are available and after more models have been submitted. Separate pages will be created for each leg of the campaign. In a teleconference shortly after each leg, the performance of the models, current and future diagnostics and potential case studies will be discussed. A recent presentation on MOSAiC-NRV by Amy Solomon can be found *here*.

For any questions, contact Amy Solomon *amy.solomon@noaa.gov*



*The **Atmospheric Surface Flux Station**, also known as the „met sled" measures surface energy budgets between the snow/ice surface and the atmosphere.*

03

Start of Arctic YOPP Targeted Observing Periods

by Kirstin Werner, Alfred Wegener Institute (AWI), Gunilla Svensson, Stockholm University, and Thomas Jung, AWI

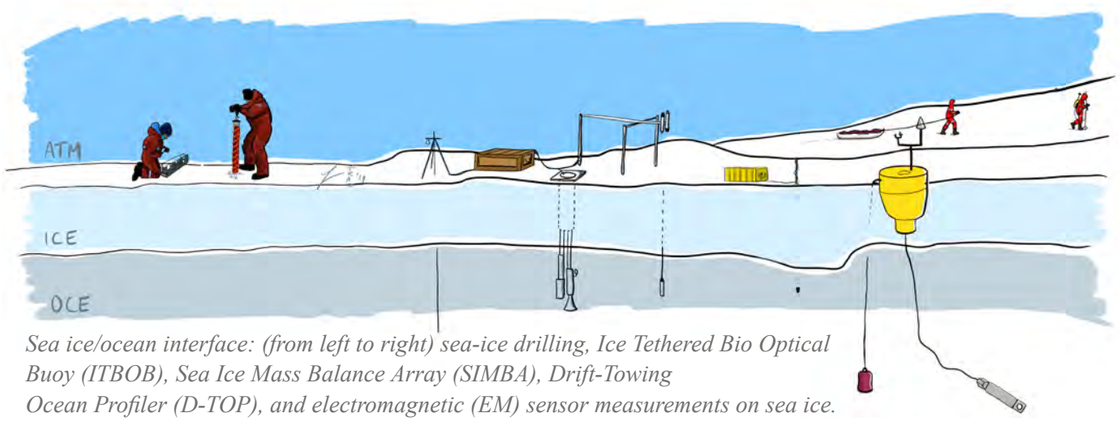
In support of the MOSAiC one-year ice drift, additional weather balloons will be launched during episodes of strong interactions between the Arctic and the mid-latitudes in spring and summer 2020. These so-called YOPP Targeted Observing Periods, or TOPs, will help to better understand cold-air outbreaks from the pole and warm air intrusions coming from the mid-latitudes.

In September 2019, the MOSAiC (Multidisciplinary Drifting Observatory for the Study of Arctic Climate) project (*www.mosaic-expedition.org*) commenced. The resulting central Arctic Ocean MOSAiC observations in concert with the ongoing measurements at the surrounding Arctic terrestrial observatories will provide an unprecedented opportunity to document the intricacies of the entire Arctic system for one year.
Linkages between the Arctic's and mid-latitudes atmosphere are the focus of the upcoming YOPP Targeted Observing Periods, or TOPs. Starting from now and onwards into summer, TOPs will take place whenever the atmospheric circulation is favourable for strong interactions between the Arctic and mid-latitude atmosphere. During a TOP, the radiosonde launch frequency will be increased, similar to what happened during the Arctic Special Observing Periods (SOPs) in winter and summer 2018. The Targeted Observing Periods are different from SOPs, however, as extra observations will be taken for certain flow types only, that is when air masses are undergoing a strong transformation on their way into or out of the Arctic.

YOPP Special Observing Periods

The main objective of the earlier Arctic YOPP Special Observing Periods in 2018 was to assess the impact of increased frequency of observations on the prediction skill over the Northern Hemisphere. First results from observing system experiments (OSEs) suggest that on average this led to only minor improvement in prediction skill. There were, however, larger impacts during certain large-scale flow situations. Therefore, the PPP Steering Group decided at its tenth meeting in Helsinki in January 2019 to revise the concept for additional observations. Episodes of particularly strong Arctic-mid-latitude linkages and their associated air mass modifications are now targeted during what is called a TOP. Aligned with the MOSAiC campaign, this approach will further capitalize on the increasingly strong partnership that has been built between YOPP and the MOSAiC observing assets.

In order to prepare for the YOPP TOPs, the PPP Steering Group requested national weather centres to support on-demand radiosonde launches from Arctic meteorological stations during spring and summer 2020 to complement the MOSAiC Drifting Observatory radiosonde launches. Support was also requested from national centres and research institutions for a developing framework with regards to increase the data uptake that will be achieved through data management and coding strategies that facilitate coordinated process-based evaluation of Numerical Weather Prediction (NWP) output.



Sea ice/ocean interface: (from left to right) sea-ice drilling, Ice Tethered Bio Optical Buoy (ITBOB), Sea Ice Mass Balance Array (SIMBA), Drift-Towing Ocean Profiler (D-TOP), and electromagnetic (EM) sensor measurements on sea ice.

Targeted Observing Periods (TOPs)

The focus of the YOPP TOPs planned during the MOSAiC experiment is on increasing radiosonde frequency during episodes of strong interactions between the Arctic and mid-latitudes. The start of the TOPs was supposed to be aligned to an across-the Arctic aircraft campaign with AWI research aircraft Polar 5 and Polar 6 which unfortunately had to be cancelled due to the corona virus pandemic. Events will now be selected for targeted observations between March 2020 until melt season, based on the atmospheric flow situation, aiming at air masses expected to undergo significant transformation that will pass over (i) existing YOPP Supersites including the MOSAiC ice camp and (ii) the ARM mobile facility at Northern Norway and Bear Island that currently are supporting the Cold Air Outbreaks in the Marine Boundary Layer (COMBLE) project. Focus for the additional radiosonde launches is on the Atlantic sector of the Arctic, where the majority of warm air intrusions and cold air outbreaks occur. The YOPP Processes Task Team will closely monitor the atmospheric flow situation to request the targeted launch of additional radiosondes. Participating countries, institutions and stations will be notified of a TOP five days ahead of time with details of requested launches 24 to 48 hours ahead of time.

Development of Integrated Observation/Model Data Files

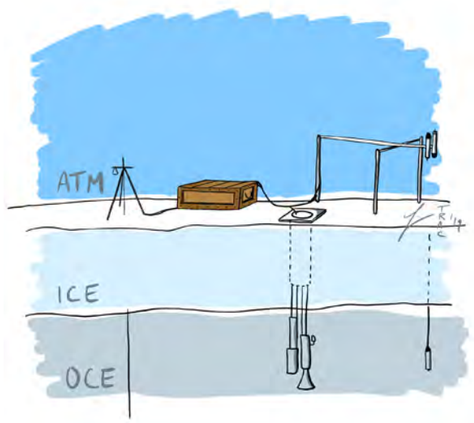
To support the TOPs, it will be important to facilitate the intercomparison of observations from densely instrumented observation sites with the high frequency model output in the immediate area around each of the identified supersites. This work is organized within the YOPP Supersite Model Intercomparison Project (*YOPPsiteMIP*). The intercomparison concept is based on developing a well-defined file format and compatible semantics applicable across models and observations.

TOP Twitter Challenge and Social Media

To engage with the Polar Prediction community, a Twitter challenge will accompany the Targeted Observing Periods. Aligned with the schedule of TOPs, the YOPP International Coordination Office will send out Twitter posts for engaging the community: For expected cold-air outbreaks, the community could be asked, for example, to guess on the coldest temperature at the AWIPEV Station/Svalbard, including when it will happen; for moist air intrusion, the community might be asked to guess the maximum temperature at the MOSAiC camp. There will be a reward for the winner of the challenge.

We would also like to widely share the stories related to the TOP measurements with the community, using our Twitter and Instagram accounts @polarprediction and through partners' social media channels. Therefore, participating stations are asked to share photos of radiosonde launches with the YOPP Office (send to: office@polarprediction.net) so material can be distributed via the @polarprediction social media accounts and through the PPP website (please do include copyright information, i.e. name of photographer).

See more information also on the *website of the YOPP Processes Task Team*.



*Extending the capabilities of traditional ice-mass-balance buoys, the **Ice Tethered Bio Optical Buoy** (ITBOB) has chlorophyll and CDOM fluorometers, oxygen optodes, CTD packages and light sensors attached to measure in, directly beneath, and 5 m below the sea ice.*

04

Options for Publishing YOPP Datasets

by SiriJodha S. Khalsa, National Snow and Ice Data Center, CIRES and University of Colorado

The Year of Polar Prediction (YOPP) encourages good data management practices among the YOPP-endorsed projects, and facilitates the documentation and discoverability of datasets through the YOPP Data Portal. This article aims at providing guidance on the options that researchers doing YOPP-related work have for publishing their data.

Data, in the form of observations and numerical simulations, is the foundation YOPP will build upon to achieve its objectives. The outputs of the research that is done using YOPP data also needs to be discoverable and accessible. In fact, most publishers now require that the data upon which a manuscript is based be openly accessible. Funding agencies are also now requiring that data generated through publicly funded research be made openly available for the purposes of reuse and reproducibility.

Publication of Research Data

The publication of research data, as a scholarly output in its own right, stems from several different drivers, among them are: 1) the desire of researchers to publish as many works as possible, 2) the desire of dataset creators to be given recognition for their work, and 3) the desire of repository managers to quantify the impact of the data in their archives [1]. This has led to the creation of numerous journals focusing solely on datasets, and in some instances also experimental setup, data collection and analysis methodologies.

YOPP DATA PORTAL
YEAR OF POLAR PREDICTION

Digital Object Identifier (DOI)

When publishing research results it is important that the data used in the study is properly cited. The *YOPP Data Portal* provides basic guidelines for citing data in publications. Data citations aid in reproducibility, provide credit to the people and institutions who were essential for the data production, aid in tracking the use and impact of a data set, increase potential for finding new collaborators, and help future users learn how others have used a data set [2]. Data citation is greatly aided by having a digital object identifier (DOI) assigned to the dataset. Many data repositories now have the capability of assigning DOIs to the datasets they curate.

Publishing a Data Paper

Publishing a data article is another method of obtaining a DOI. A data paper can supply details on the collection, processing, file structure and other aspects of a dataset without going into the specifics of the scientific analysis. Material that is often relegated to the "supplementary material" of a journal article can be expanded upon and made into a separate publication. This makes it possible to establish ownership of the dataset, especially if it is required to be made open immediately after collection, ahead of research results. The Joint Declaration of Data Citation Principles [3] states that

> **"Data citations should be accorded the same importance in the scholarly record as citations of other research objects such as publications."**

A data article should therefore subsequently be cited in every publication that makes use of the data.
Data is becoming viewed as part of a scholarly ecosystem, which also includes software for data management and analysis, and the workflows used in the research process. The ultimate aim, which the F.A.I.R. Principles are intended to support, is to enable machines to automatically find and use data to generate new knowledge [4].

The PPP ICO will advertise in its newsletter and website any published YOPP data articles. The YOPP Data Portal will display the citation for any data article describing data cataloged in the portal provided this information is included in the metadata that the portal harvests. Alternatively, if the metadata has been submitted to the YOPP Data Portal via the metadata collection form, the "Dataset citation" fields will need to be completed.

Contact: Siri Jodha Khalsa *sjsk@nsidc.org*

References

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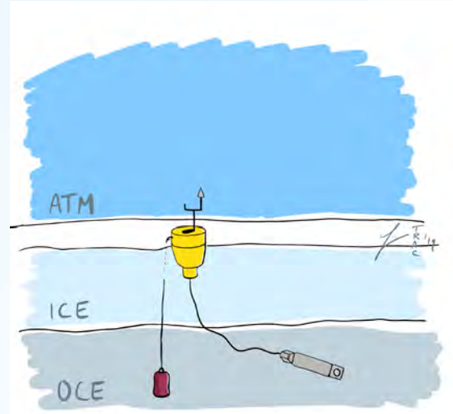
[3] Data Citation Synthesis Group (2014): Joint Declaration of Data Citation Principles, Martone M. (ed.) San Diego CA: FORCE11. Online resource. *https://doi.org/10.25490/a97f-egyk*

[4] Wilkinson, M., et al. The FAIR Guiding Principles for scientific data management and stewardship. Sci Data 3, 160018 (2016) *https://doi.org/10.1038/sdata.2016.18*



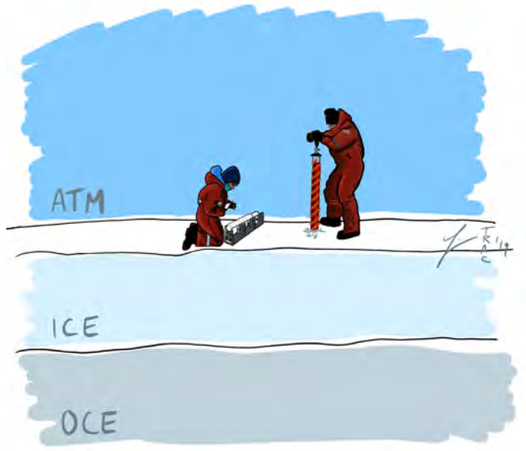
Drift-Towing Ocean Profilers *(D-TOP) collect atmospheric and hydrographic data from the upper layer of the ocean under the ice.*

05

New Sea Ice and Ocean Variables in S2S Forecast Database

by Lorenzo Zampieri, Alfred Wegener Institute and European Centre for Medium-Range Weather Forecasts

In Phase II of the Subseasonal-to-Seasonal (S2S) Prediction Project, nine new ocean and sea-ice variables have been introduced to its data base. Most of the S2S forecast systems now feature dynamical ice models and assimilate sea-ice and ocean observations.



The ***Kovacs Mark II coring system*** *retrieves 9 cm diameter ice cores up to 1 meter long. Sea-ice cores are studied for various biological, physical and chemical parameters such as stable or radiogenic isotope ratios, chlorophyll and organic matter, or ice-rafted debris – fine sand material picked up at the formation of the ice floe on the shallow Arctic shelves. In fact, sediments were found during the set-up of the Distributed Network, see also Krumpen et al. (2020) in this issue, p. 31.*

The Subseasonal-to-Seasonal (S2S) Prediction Project is an initiative endorsed by the World Meteorological Organization (WMO) that aims to improve our understanding of the Earth system predictability at the S2S timescale from 15 to 60 days into the future, with special emphasis on high-impact weather events. The main outcome of this project is the implementation of a database that collects forecasts from several Numerical Weather Prediction (NWP) centers and research institutions all over the world. These forecasts are produced with state-of-the-art probabilistic fully-coupled forecast models, meaning that the atmosphere, ocean, and sea-ice model components interact and allow to simulate the complex feedbacks in the Earth system. Furthermore, these models are run multiple times from slightly different initial conditions, generating an ensemble of forecasts that takes into account the uncertainties of observations, physical parameterizations

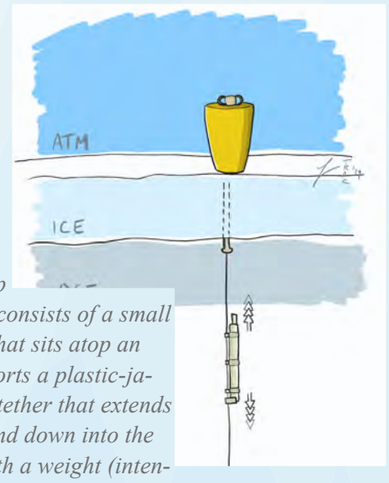
in the model, and the Earth system's chaotic nature. The S2S forecasts are available for an overall period of almost three decades, allowing us to draw robust conclusions and to develop a deep understanding of the system.

There are many beneficial aspects for the Polar Prediction community to explore the S2S database and to benefit from such a well-structured initiative. Firstly, there are good reasons to believe that the evolution of the sea ice, polar oceans, and snow on land could be predictable at the S2S timescale. Secondly, the description of the polar climate in the S2S forecast systems has grown in complexity since the start of the S2S initiative in November 2013. Most of the forecast systems now feature dynamical ice models and assimilate sea-ice and ocean observations. And finally, the focus of Phase II of the S2S Prediction Project has been broadened beyond the atmospheric domain, with the introduction of nine new ocean and sea-ice variables to the database. These include:

- Depth of 20°C isotherm
- Mean sea-level practical salinity in the upper 300 meters
- Mean sea-level potential temperature in the upper 300 meters
- Ocean mixed-layer thickness defined by sigma theta 0.01 kg/m3
- U-component of surface current
- V-component of surface current
- Sea-ice thickness
- Sea-surface height
- Sea-surface practical salinity

Since 1 January 2020, these new variables are archived in the *S2S database* in the GRIB2 format on a 1-degree latitude/longitude grid, they are openly available and ready to be investigated by the scientific community.

"The new variables will help researchers to explore the predictability of ocean and sea-ice conditions and to compare the representation of air, ocean and sea-ice interactions in different models," says Frederic Vitart, ECMWF scientist and co-chair of the S2S Prediction Project. Such additional information will increase our ability to understand and possibly correct the biases in models that so far limit the forecast skills in polar regions. At the same time, it casts light on still unknown or poorly understood predictability mechanisms, especially in polar regions. The implementation of the new ocean and sea-ice variables is thus an encouraging example of how the interaction between the S2S and the Polar Prediction communities improves our comprehension of the polar weather and climate. Additional information can be found on the *S2S Prediction Project* and *ECMWF* websites.



***Ice-Tethered Profilers** (ITP) sample the properties of the ice-covered Arctic Ocean at high vertical resolution over time periods of up to three years. It consists of a small surface capsule that sits atop an ice floe and supports a plastic-jacketed wire rope tether that extends through the ice and down into the ocean, ending with a weight (intended to keep the wire vertical). A cylindrical underwater instrument mounts on this tether and cycles vertically along it, carrying oceanographic sensors through the water column. Water property data are telemetered from the ITP to shore in near-real time.*

06

Mid-Latitude CO_2 Increase Amplifies Arctic Sea-Ice Decrease

by Aaron-Christoph Frehlich, Tido Semmler and Kirstin Werner, all Alfred Wegener Institute

A new modelling approach by the Alfred Wegener Institute indicates that increased CO_2 concentration in mid-latitudes enhances sea-ice melt in the Arctic. The study that investigates different CO_2 forcings over the Arctic and elsewhere has been recently published in the peer-reviewed journal Climate Dynamics.

Both field observations and model simulations depict a rise in Arctic surface temperatures, twice as high as the Northern Hemisphere mean temperature increase during the last thirty years. In order to better assess the different mechanisms that lead to the so-called Arctic Amplification, not only local Arctic processes need to be well-understood, but insightful knowledge on the atmospheric and ocean interactions between the Arctic and mid- and lower latitudes is crucial.

In a paper just published in Climate Dynamics by AWI scientists Tido Semmler, Felix Pithan and Thomas Jung a new modelling approach was applied where four times the CO_2 concentration of 1950 was assumed over different regions on Earth. "Quantifying the two-way influences between the Arctic and the mid-latitudes through regionally increased CO_2 concentrations is a physically consistent method" explains Tido Semmler who led the study. "In this way, not only the impacts of the Arctic on the mid-latitudes can be assessed, but also the other way around."

Sea ice is only present in polar regions and thus cannot be changed by experiments with a model's parameter outside the polar regions. In traditional idealized model simulations, sea ice is therefore being deleted from the model so that the impact of the polar region's sea-ice loss can be studied. This is also possible with the new method. But this time, the authors removed the sea ice through applying a CO_2 forcing over the Arctic, four times higher than the CO_2 concentration in 1950. As one would expect, the Arctic sea ice significantly decreased in the model.

Compared to traditional modelling studies, the new approach also allowed to quadruple 1950s' CO_2 concentrations for example over the mid-latitudes or any other desired region. Semmler and his team applied this quadrupled concentration of 1950s' CO_2 concentration over the Northern mid-latitudes, without changing Arctic CO_2 and without deleting sea-ice volume directly in the
model while
allowing changes in Arctic sea-ice volume through interactions in the climate system. "With the changing CO_2
concentrations, not only the impact from the Arctic to the mid-latitudes can be detected, but also those from any desired region to the Arctic, and results can be directly compared", explains Semmler of their new method. "It is therefore possible to disentangle influences that CO_2 changes have in different regions of the world".

The modelling experiments indicate that an increased CO_2 concentration in the Arctic will result only in minor influences in other regions of the world. In contrast, the study shows that increased CO_2 concentrations in the mid-latitudes lead to a significant decrease of Arctic sea ice. These model results are, however, idealized. In reality, the increased CO_2 concentrations added to one region would mix within several weeks with other regions worldwide so that consequences of increased CO_2 concentrations would be noticed everywhere. Nonetheless, the study shows another important mechanism of Arctic Amplification: the doubled effect of increased CO_2 concentrations from both inside and outside the Arctic leads to the amplified decrease of Arctic sea ice.

By utilizing the AWI.CM 1.1 climate model, which contributes to the Coupled Model Intercomparison Project phase 6 (CMIP6), this paper adds to the findings by Stuecker et al. (2018), who recently used the Community Earth System Model (CESM) 1.2 to apply the same approach. Based on their results, Semmler et al. suggest to employ this novel approach in as many and as different modelling experiments as possiblle in order to further elaborate on the regional impacts of CO_2 concentrations.

Semmler, T, Pithan, F., Jung, T. 2020. Quantifying two-way influences between the Arctic and mid-latitudes through regionally increased CO2 concentrations in coupled climate simulations. Climate Dynamics 54, 3307–3321. *https://doi.org/10.1007/s00382-020-05171-z*

07

New Episodes of the IcePod

by Kirstin Werner and Sara Pasqualetto, both Alfred Wegener Institute

Two new episodes of #TheIcePod, the official podcast for the Year of Polar Prediction, are available from Spotify and other podcast platforms.

The IcePod is the podcast about polar science and the people. Kirstin Werner and Sara Pasqualetto from the ICO talk to scientists and other colleagues involved in the Year of Polar Prediction and MOSAiC about their role and experience as participants of the largest Arctic expedition since Fridtjof Nansen's Fram expedition in 1893.

In Episode Two, Kirstin and Sara take a further look behind the scenes of the MOSAiC School. The master's student and professional photographer Thea Schneider was one of the lucky ones, namely one of the twenty early career scientists who went on board the Russian icebreaker Akademik Fedorov, which supported RV Polarstern in September 2019 in the Central Arctic. As they discussed the difficulties of assembling a sea-ice buoy without IKEA instructions, the audience learns what a smoking curl has to do with Arctic turbulences, and how lonesome you can (not) be as a vegetarian among Russian meat-eaters.

In the third episode, the Moon Episode of the IcePod, Kirstin and Sara talk to Stefan Hendricks, a sea-ice scientist at the Alfred Wegener Institute who joined the first leg of MOSAiC and worked along the Remote Sensing team on board Polarstern. What happens when lunar and solar tides are teaming up, and why Stefan prefers doing science rather than eating cake: this and more can be found on this lunar episode.
The IcePod is produced in collaboration with the Alfred Wegener Institute and *Radio Weser.TV*.

Find the new and all previous IcePod episodes e.g. on *Spotify*, *Apple Podcast*, *Castbox* or on our website *theicepodcast.home.blog*.

08

A Buoyant Success: A Review of the 'Adopt-a-Buoy' Programme

Original article from Meereisportal.de, modified by Aaron-Christoph Frehlich and Kirstin Werner, both Alfred Wegener Institute

The "Adopt-a-Buoy" project by sea-ice scientist Stefanie Arndt came to an end after two and a half years.

Involving kids in scientific endeavors and experiments is a very important way to connect to the outside of the science community. Ultimately, scientific research is conducted to better understand nature. Communicating your research to kids at school allows the next generations to experience the wonders of our planet as much as we, the older generations, were able to.

Sea-ice physicist Stefanie Arndt from the Alfred Wegener Institute in Bremerhaven had something like this in mind when she thought about a simple way to engage with potential future scientists. At an "Open Ship" exhibit on board the research icebreaker RV Polarstern in 2017, Steffi and her colleagues came up with the idea to invite kids to draw pictures which the scientists later on would attach to a sea-ice buoy to be deployed in the Arctic Ocean.

In her "polar Post Office" at the AWI in Bremerhaven, Germany, Stefanie Arndt collected more than sixty pictures drawn by children between 3 and 16 years old, sent in from all across Germany. As the original journey to the Arctic did not take place, Steffi took the artwork to the Antarctic instead where she joined a cruise in early 2018. "To avoid making them wait too long, the kids could already share the preparations I made for my upcoming expedition – and of course I always let them know where their pictures were," Steffi explains. On Meereisportal.de, Stefanie would post *regular updates on the status of her travel*. Between 11 and 26 February 2018, Steffi and her team deployed the autonomous measuring buoys at several sea-ice floes in the Antarctic, also contributing to the YOPP observational datasets generated from the Southern Ocean. As evidence, Steffi sent an adopt-a-buoy certificate – photographs of the kid's drawing attached to the buoy plus the buoy's lifetime story from its deployment until it stopped transmitting data were sent to the little artists. The kids provided tremendous positive feedback to the sea-ice scientists with even more questions raised.

Due to several natural incidents, such as major storms, the first buoy was lost in mid-March 2018. Eleven out of 13 other buoys followed until December of 2018. Fortunately, a snow buoy named 2018S59 and an ice mass balance buoy 2018M11continued transmitting well into 2019. In February 2019, when Stefanie Arndt came back to the Southern Ocean on board Polarstern, she was lucky to return to the snow buoy – never before it has been possible to revisit a buoy deployed in the Antarctic Ocean. Thereafter, the buoy drifted continuously north until its signal was lost at the end of April 2019.

Stefanie Arndt revisits the snow buoy # 2018S59 on 26 February 2019. Adorned with children's artwork, the buoy drifted for a year across the Weddell Sea in the Southern Ocean (photo: Stefanie Arndt).

The last "adopted" buoy lost signal on 27 November 2019 – one year, nine months and nine days after its deployment by Steffi and her colleagues. Prior to stopping data transmission in the marginal ice zone, this buoy had crossed the Weddell Sea and travelled more than 8,200 km in total.

Stefanie Arndt currently is on board the icebreaker RV Polarstern to lead the ICE Team of Leg 3 of the MOSAiC expedition. If you would like to know more about her current endeavor, check out the *Bonus Episode of the YOPP Podcast #The IcePod* where Stefanie Arndt talks about her preparations to join the MOSAiC campaign.

09

Fall Open Online Course by APPLICATE, APECS and YOPP

by Andrea Schneider and Gerlis Fugmann, both APECS

During Fall 2019, an open online course entitled "Advancing Predictive Capability of Northern Hemisphere Weather and Climate" was organized by the Association of Polar Early Career Scientists (APECS), the project APPLICATE (Advanced Prediction in Polar regions and beyond: modelling, observing system design and LInkages associated with a Changing Arctic climaTE) and the Year of Polar Prediction (YOPP).

Designed for early career researchers (e.g., Master's and PhD students, Postdocs) with a specific interest in Arctic weather and climate prediction and modelling, the course provided an overview of the state-of-the-art knowledge of Northern high-latitude weather and climate predictions.

Within eleven sessions, international experts provided their knowledge from September to December 2019 on a weekly basis to the participants. In total, 125 Master and PhD students as well as Postdocs from Europe, North and South America, Africa and Asia followed the webinars and challenged the lecturers with detailed questions. In preparation for each session, lecturers provided three to five top scientific papers from their field which fed into a comprehensive literature collection resulting from the course. The sessions were recorded and are available online via the *APECS vimeo channel*.

For more information, please see the *full article* on the APPLICATE website.

APPLICATE.eu
Advanced prediction in polar regions and beyond

YOPP YEAR OF POLAR PREDICTION

APECS Association of Polar Early Career Scientists

AWI

Co-funded by the Horizon 2020 programme of the European Union

UNIVERSITY OF TROMSØ

10

Version 3.0 of YOPP Implementation Plan

by Jeff Wilson, AWI Consultant, Kirstin Werner and Thomas Jung, both Afred Wegener Institute

A new version of the YOPP Implementation Plan is now available. This third version of the YOPP IP provides further details on the Polar Prediction Project (PPP) Consolidation Phase and outlines an approach for developing the legacy of PPP and YOPP.

The Consolidation Phase of the Polar Prediction Project started in July 2019 and is now in full swing. This final phase of an international effort to improve environmental predictions in polar regions and beyond will conclude at the end of 2022.

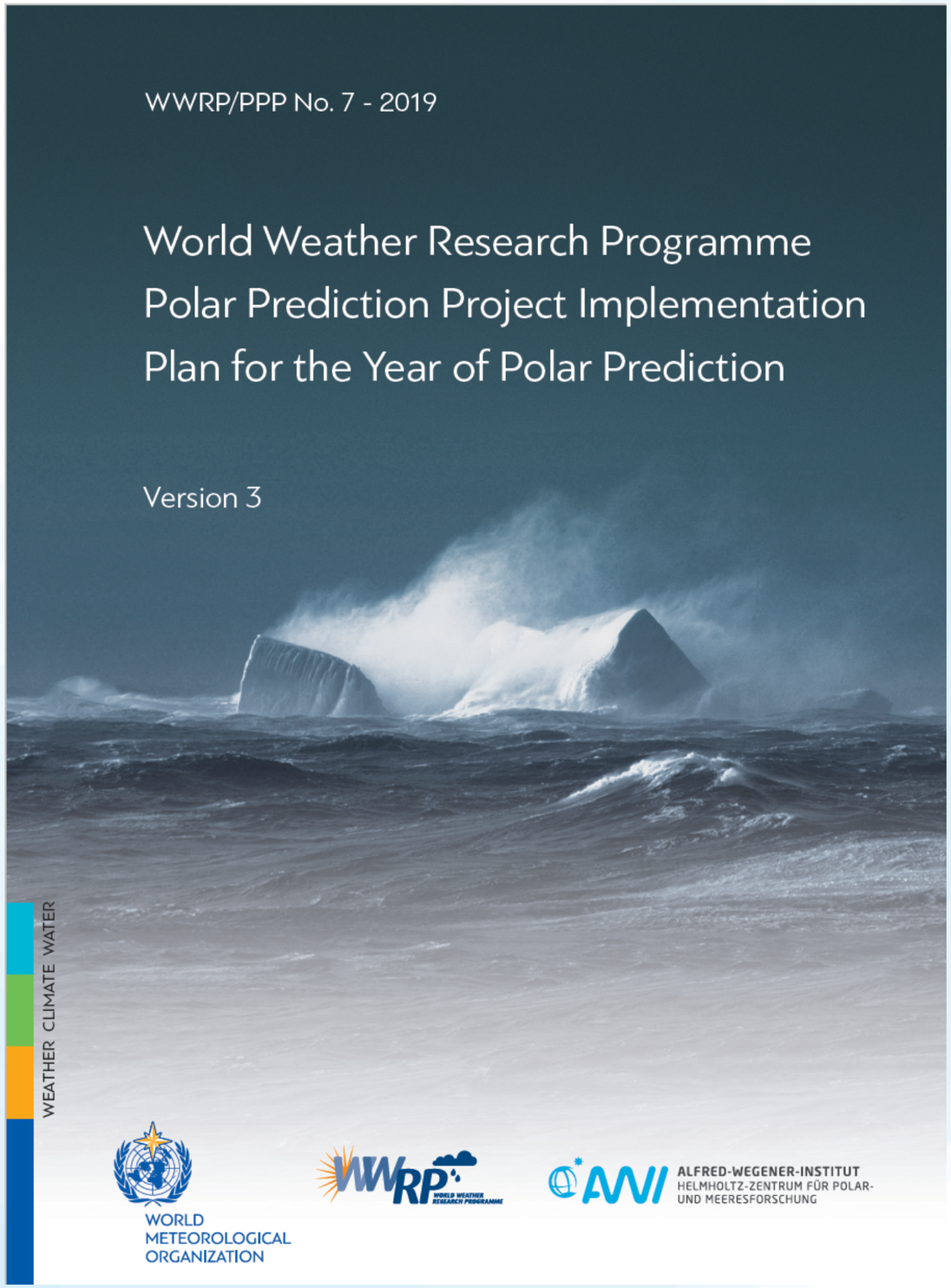
Details about the Consolidation Phase are now available from a third and final version of the YOPP Implementation Plan. Various activities that have been initiated during previous phases of PPP and YOPP will be continued during the Consolidation Phase. One example is data denial experiments, also called observing system experiments (OSEs). A number of modelling centres are coordinating to carry out OSEs to gain a better understanding of the impact of the additional observations during the three YOPP Special Observing Periods on prediction skill. A major effort during the Consolidation Phase will be using observation and model data from the three Special Observing Periods and the Arctic and Antarctic Targeted Observation Periods planned for early 2020 and during austral winter 2022, respectively, to gain a better understanding of the oceanographic, sea-ice and atmospheric processes in polar regions, particularly across the interfaces. To allow this research effort to progress, new data schemes have been developed to support the use of model and observational data.

In order to better prepare for the Consolidation Phase and what will be the legacies from PPP, the roles of the various PPP Task Teams, outlined in the new YOPP Implementation Plan, have been revised by the PPP Steering Group. Two new Task Teams have been formed while some of the earlier Task Teams were discontinued. Currently active Task Teams can be found *here*.

SAVE the DATE

A YOPP Final Summit will take place from 3 to 5 May 2022 in Montreal, Canada.

The new YOPP Implementation Plan is available on the *website*.



11

PPP Steering Group – Departures and Arrivals

by Aaron-Christoph Frehlich, Alfred Wegener Institute

During the eleventh Steering Group meeting (see also *13* this issue), held in February 2020 in Bremerhaven, Germany, three new members were elected to join the PPP Steering Group.

We are happy to welcome three new PPP Steering Group members who were elected at the recent PPP Steering Group meeting in Bremerhaven, Germany.

Qizhen Sun is an Associate Professor at the National Marine Environmental Forecasting Center (NMEFC) of China who is also responsible for the operational weather forecasts for the Chinese National Antarctic & Arctic Research Expedition (CHINARE). Together with Qinghua Yang, Qizhen will coordinate Chinese contributions to YOPP, with a special engagement in the Southern Hemisphere.

Clare Eayrs works at the New York University Abu Dhabi, United Arab Emirates as an ocean-ice scientist. Her long experience with the Association for Polar Early Career Scientists (APECS) makes her an excellent choice to take over the education parts for YOPP, having a leading role in the YOPP Communication, Outreach & Education Task Team.

From left to right: Qizhen Sun (photo: private), Clare Eayrs (photo: Center for Global Sea Level Change, NYUAD). Eric Bazile (photo: private). Matthieu Chevallier (photo: :private, Mikhail Tolstykh (photo: private).

Eric Bazile from Météo France has already been strongly engaged on the YOPP Southern Hemisphere Task Team as well as in a number of YOPP modelling activities. Eric also leads the GEWEX/GASS Atmospheric Boundary Layer Study *GABLS4* to study the strong stable boundary layer in the Antarctic. Eric basically takes over the PPP SG membership from earlier PPP SG member Matthieu Chevallier who in the meantime became the Director of the Marine Forecasting and Oceanography department at Météo France.

At the same time, we would like to thank our former PPP-SG members Matthieu Chevallier and Mikhail Tolstykh for their continuous efforts and contributions to PPP/YOPP.

Matthieu Chevallier joined the PPP-SG in 2014. With his expertise on sea-ice prediction and atmosphere-ice-ocean interactions, he has coordinated various Météo France contributions during the YOPP Core Phase and has been strongly involved in the YOPP Modelling Task Team and the YOPP-endorsed H2020 project APPLICATE.

Mikhail Tolstykh has been member of the PPP-SG since the early days of PPP. Since 2012, Mikhail has coordinated the Russian contributions to PPP/YOPP and contributed with his expertise in medium-range and seasonal forecasts as well as in climate prediction modelling. Past his official PPP-SG membership, he will continue to be around, e.g., to participate in several YOPP activities such as the YOPPsiteMIP initiative.

Learn more about the PPP Steering Group *here*.





12

Meeting Updates due to COVID-19 Pandemic

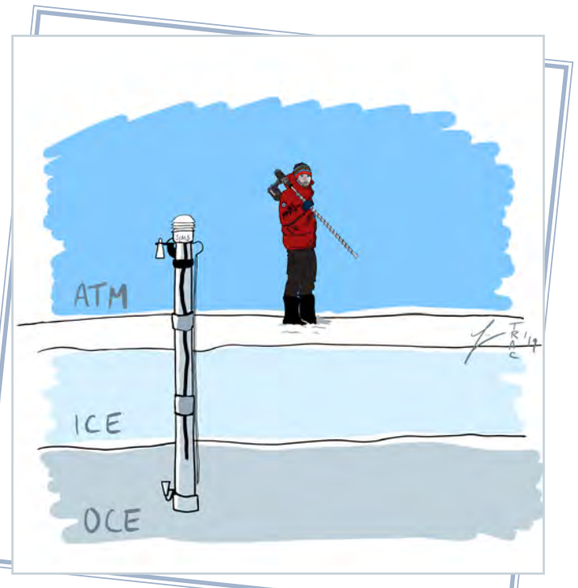
Polar Prediction Sessions at EGU2020: Sharing Geoscience Online (#shareEGU20)

by Aaron-Christoph Frehlich and Kirstin Werner, both Alfred Wegener Institute

The EGU 2020 management committee has decided to cancel this year's physical General Assembly in Vienna in order to minimize a growing COVID-19 outbreak. Nonetheless, scientific research and collaboration are of significant importance. It was therefore decided to hold this year's EGU as an online event instead, with a week-long series of activities from 3–8 May 2020.

To exchange knowledge and share results, the **joint YOPP-APPLICATE session "CL2.12 Exploiting Polar Observations to Improve Weather and Climate Predictions"** has been re-scheduled for a live chat on **Friday, 8 May, 14:00–15:45 CEST**. Activities and results from the YOPP and APPLICATE projects will be presented, as well as contributions from other projects and institutes that focus on how to best capitalize on existing and additional Arctic and Antarctic observations such as Copernicus to improve forecast initial states, verification, and model physics, and to optimize the future polar observing system. Further details of the session programme can be found *here*.

The session **CL4.15 on "Climate Variability and Prediction in High Latitudes"** is now scheduled as a live chat for **Friday, 8 May 2020, 10:45–12:30 CEST**. Here, mechanisms that control high-latitude climate variability and predictability at sub-seasonal to multi-decadal time-scales will be discussed. The session aims to discuss how a better understanding and better representation of the mechanisms that control high-latitude climate variability and predictability in both hemispheres at sub-seasonal to multi-decadal time-scales in past, recent and future climates can be achieved. Ongoing efforts to improve climate predictions at high latitudes at various time scales (as e.g. usage of additional observations for initialization, improved initialization methods, impact of higher resolution, improved parameterizations) and potential teleconnections of high latitude climate with lower latitude climate will also be discussed.
Further details of the session programme can be found *here*.



*The autonomous **Seasonal Ice Mass Balance Buoy (IMB)** is equipped with sensors to measure snow accumulation and ablation, ice growth and melt, and internal ice temperature, plus it has a satellite transmitter.*

Cancellation of 2020 YOPP-SH Meeting and Workshop on Antarctic Meteorology and Climate (WAMC) in Hobart, Tasmania

Due to the international updates related to COVID-19, the 15th Workshop on Antarctic Meteorology and Climate (WAMC) and the 5th YOPP in the Southern Hemisphere (YOPP-SH) meeting in Hobart, Tasmania from 29 to 31 July 2020 had to be cancelled. Those who planned on attending WAMC are invited to send a status report. These can be in the form of a short PowerPoint presentation, or as an extended abstract in the American Meteorological Society format. The reports can be sent to *tnorton2@wisc.edu* and *orendorf@wisc.edu* so they can be displayed on the *WAMC 2020 page*.

Cancellation of the PPP-SERA 2020 Annual Meeting and Open Session

The sixth annual *PPP-SERA* Task Team meeting including an Open Session to engage with users of polar forecast products which was supposed to be held from 20 to 24 April 2020 at the German Alfred Wegener Institute, Bremerhaven, had to be cancelled due to travel restrictions related to the Corona pandemic. Until their next annual meeting in 2021, the group will have regular online meetings.

Postponement of ICASS X and YOPP Session

Due to the COVID-19 pandemic, the 10th International Congress of Arctic Social Sciences (ICASS X) to be held in Arkhangelsk, Russia, from 15 to 20 June 2020 has been *postponed*. ICASS X will now take place in Arkhangelsk, Russia from **15 to 19 June 2021**. This includes a YOPP session on "Tailoring Environmental Forecasting Information and Services to Diverse Polar Needs" that was supposed to be co-convened by *PPP-SERA* co-chairs Machiel Lamers and Daniela Liggett.

Photo: CAPIRE-YOPP/Concordia Station

13

Polar Prediction Project Steering Group Meeting #11

by Jeff Wilson, AWI Consultant and Kirstin Werner, Alfred Wegener Institute

The eleventh meeting of the *Polar Prediction Project Steering Group* (PPP-SG) took place from 19 to 21 February 2020 at the Alfred Wegner Institute (AWI) in Bremerhaven, Germany.

The meeting was preceded by the *YOPP 2020 Science Workshop* where results from the Special Observing Period (SOP) activities as well as efforts that have commenced during the PPP Consolidation Phase activities were reported (see text item ***#14***).

The Wednesday morning session on 19 February started off with break-out group discussions where both, YOPP Science Workshop participants and PPP SG members jointly reviewed progress of individual YOPP Task Teams activities.

The eleventh PPP SG meeting formally started after lunch on the same day, 19 February. Specifically, the meeting focused upon reviewing progress during the YOPP Consolidation Phase – the final phase of the Polar Prediction Project that will conclude by end of 2022. During the discussion, options for the PPP evaluation were considered, plans for the Targeted Observing Periods aligned with MOSAiC in spring and summer 2020 (see ***#03*** this issue) were developed, and major activities such as the Final YOPP Summit were planned.

Following extensive discussion on the YOPP legacy, the PPP-SG recommended to hold a YOPP Legacy Scoping Workshop for looking at how to capitalize on PPP accomplishments in the years following 2022. PPP-SG noted excellent progress on PPP science activities in Numerical Experimentation, Verification, Sea Ice Forecasting, and the YOPPSiteMIP initiative to evaluate model performance at YOPP Supersites in the Northern and Southern Hemispheres. Also, the PPP-SG members agreed to extend the YOPP Southern Hemisphere effort (YOPP-SH) to the end of December 2024 due to the YOPP-SH Targeted Observing Periods (TOPs) potentially needing extra time for thorough planning. PPP-related education activities will be pursued alongside the Arctic Science Summit meeting in Lisbon in March 2021, during a PPP Spring School in Abisko, Sweden planned for March 2022, and around the YOPP Final Summit in May 2022. The YOPPSiteMIP effort was endorsed as a high-priority activity by PPP-SG as one of the lighthouse activities. PPP-SG also underlined the importance of the YOPP Data Portal for YOPPSiteMIP and other YOPP Legacy activities.

A YOPP Final Summit will be held from 2 to 5 May 2022 in Montreal, Canada, for which the overall concept and outline was endorsed by PPP SG.

The meeting report can be downloaded from *here*.

The PPP Steering Group came together for their eleventh annual session from 19 to 21 February 2020 at the Alfred Wegener Institute in Bremerhaven, Germany (photo: Sara Pasqualetto/AWI).

During the icebreaker reception at the German Maritime Museum, a panel discussion on 'Decision Making in the Polar Regions' took place with YOPP ICO director Kirstin Werner, expedition leader of the MOSAiC expedition Markus Rex, CEO of the start-up company Drift+Noise Lasse Rabenstein, and Polarstern Captains Thomas Wunderlich and Moritz Langhinrichs who all brought their experience and insights on working in the polar regions (photo: Nadine Wieters/AWI).

14

The YOPP Science Workshop 2020 – Polar Prediction in the Making

by Kirstin Werner and Sara Pasqualetto/both Alfred Wegener Institute, Jeff Wilson, AWI Consultant

About fifty international scientists and representatives from a number of major numerical weather prediction (NWP) centres came together from 17 to 19 February 2020 in Bremerhaven, Germany, to share scientific advances resulting from observational and modelling studies in the Arctic and Antarctic undertaken as part of the Polar Prediction Project. The Polar Prediction Project has the ultimate goal of improving environmental prediction and services in polar regions.

Currently, the polar regions are lacking observational data. The large observational gaps in the Arctic and Antarctic has implications for the accuracy of weather and sea-ice forecasts in the polar regions which is a topic of increasing interest for tourism, shipping and other industries. These industries are ready to expand their polar activities as a result of ongoing climate-related changes at high latitudes.

For two days in February, experts from international research institutes and operational forecasting centres convened at the Alfred Wegener Institute in Bremerhaven, Germany, to evaluate and discuss how additional observational data can help improving weather and sea-ice forecasts; how the representation of physical processes in a forecast model can be arranged to better reflect reality; and, how verification activities should implemented to assess the performance of the numerical models and the subsequent services.

Observing System Experiments

Of particular interest were the results from recent Observing System Experiments (OSEs) in the Northern Hemisphere which show that conventional observations have the highest impact during winter, which is partly due to shortcomings in assimilating microwave sounding data over snow and ice. In the summer months, the importance of microwave data predominated over the conventional observations which include radiosonde data. The additional radiosondes (increased frequency and coverage) released during the SOPs had a positive impact upon the forecasts with major impacts for particular weather events. This indicates that the current radiosonde network, when combined with satellite data, appears to capture the main atmospheric flow features. For particular weather events, additional radiosondes such as those deployed during SOPs can make a large difference. A Northern Hemisphere Targeted Observing Period (NH-TOP1), planned from March to April 2020 may provide further insight into this matter as well as provide more insight into the airmass transformation processes that cold air heading equatorward and warm air moving poleward undergo.

About fifty international scientists and experts involved in the Year of Polar Prediction convened at the German Alfred Wegener Institute for the YOPP 2020 Science Workshop (photo: Sara Pasqualetto/AWI).

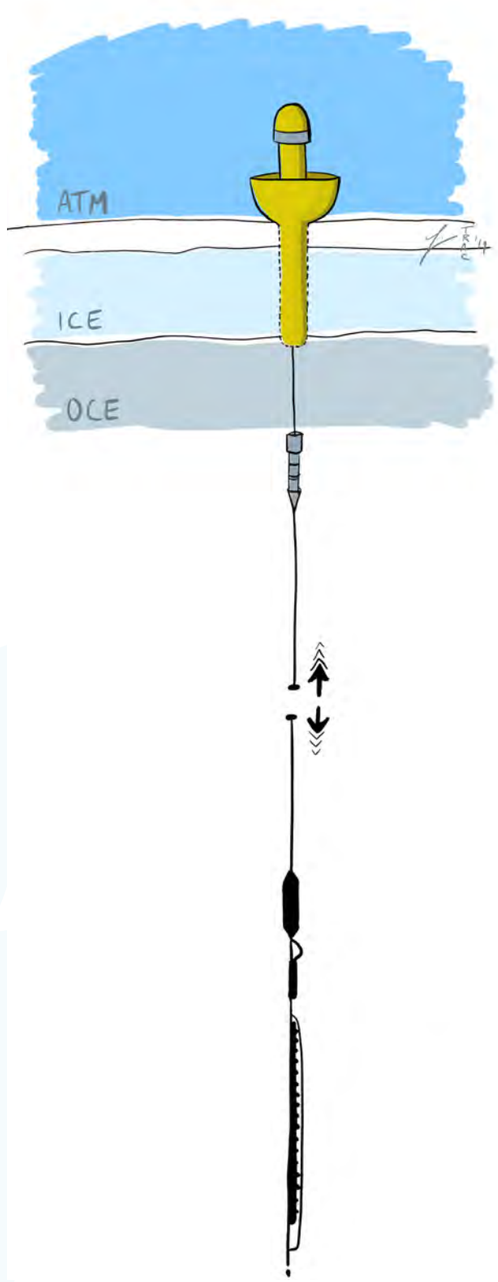
From Science to Services

One of the priorities for the final three years of YOPP will be to translate scientific advances of YOPP into operational products and services. Reaching users of forecasts in the polar regions and providing them with the capacity to safely "navigate" these areas will be an important part of the YOPP legacy. The users of polar weather and sea-ice forecasts were the focus of an evening event hosted at the German Maritime Museum on 17 February. A panel discussion chaired by ICO director Kirstin Werner explored aspects of the topic of "Decision-Making and Polar Prediction". The Panel was comprised of RV Polarstern captains Thomas Wunderlich and Moritz Langhinrichs, MOSAiC c oordinator Markus Rex, and managing director of the company Drift+Noise Lasse Rabenstein. The panel described what was needed to safely navigate a research vessel through sea ice, and which potential forecast services would support decision-making during polar operations in the future. Lasse Rabenstein summed up the discussion in the following statement: "With all the data we have, a lot is possible: but we have to make this data usable for those who are not researchers, who have other jobs and need this as an assistance for their decision-making".

The Science Workshop was followed by the 11th Polar Prediction Project (PPP) Steering Group meeting from 19 to 21 February 2020. Taking into account the discussions during the YOPP Science Workshop, the PPP Steering Group continued the strategic development of the Polar Prediction Project. A special focus was on the project's legacy and the key activities to be organized and carried out from now until the end of 2022 (see ***#13***).

All the participants provided invaluable contributions and contributed to fruitful discussions during the workshop. The agenda for the YOPP Science Workshop with links to presentations can be found *here*.

Photos from the evening event can be found on our *@polarprediction Instagram account*.



*The **Autonomous Ocean Flux Buoy** measures mixed ocean layer heat, salt and momentum fluxes and upper ocean velocity structure; it transmits data via Iridium satellite data transfer protocols.*

15

APPLICATE and PPP at the AAAS Annual Meeting

by Sara Pasqualetto, Alfred Wegener Institute

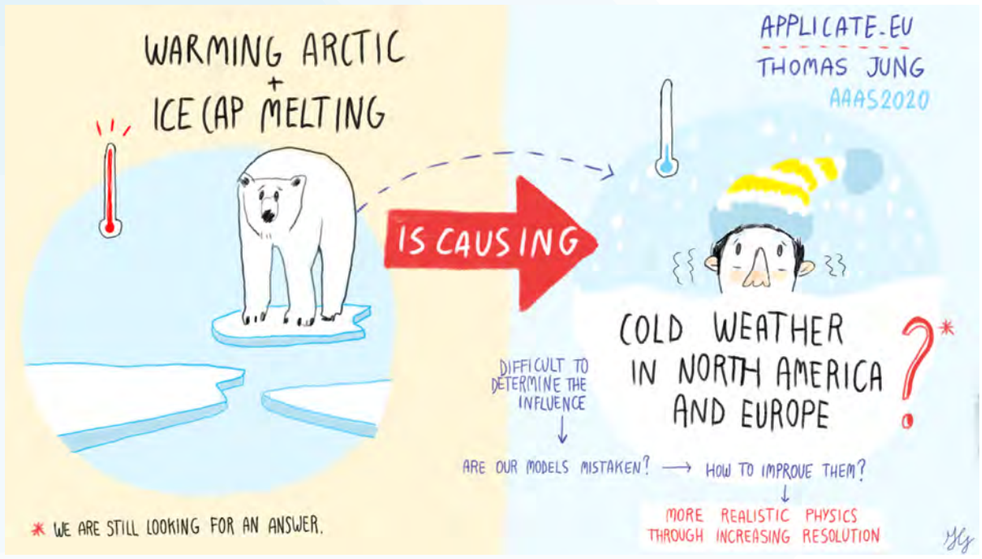
The *American Association for the Advancement of Science* (AAAS), the world's largest scientific society and publisher of the scientific journal Science, had its annual meeting in Seattle (WA) on 13-16 February 2020.

This has been one of the main science events of the year, gathering researchers, policymakers, industry and journalists to report and share cutting-edge advancements in science, engineering, and innovation, with star-guest Bill Gates delivering a presentation on Friday, 14 February 2020.

It is in this setting that the European Commission and the *Executive Agency for Small and Medium-sized Enterprises* (EASME) organized a session on "The Future of Earth's Climate: A World of Extremes?", held also on 14 February 2020. Here, APPLICATE Project Coordinator and Chair of the PPP Steering Group Thomas Jung is presenting on "Weather and Climate Extremes Caused by Rapid Warming of the Arctic", including results from the

Polar Amplification Model Intercomparison Project (PAMIP) and high-resolution simulations in the context of the YOPP-endorsed APPLICATE project. Thomas Jung presented alongside representatives from other modelling projects from the European H2020 Research Programme *PRIMAVERA* and *AtlantOS*.

Browse the complete programme and other sessions on the *meeting's website*.



Live drawing by Fiammetta Ghendini during Thomas Jung's APPLICATE presentation at AAAS in Seattle (www.riva-illustrations.com).

16

From Pole to Pole – The All-Atlantic Ocean Research Forum

by Sara Pasqualetto, Alfred Wegener Institute

On the 6 and 7 February 2020, the city of Brussels hosted the All-Atlantic Ocean Research Forum, an event organized by the European Commission to discuss strategies and cooperation in researching the Atlantic Ocean, from the Arctic to the Antarctic.

Representatives of institutes, projects, communities working on the Atlantic and addressing challenges and features of this environment met in the Belgian capital, to review the findings and recommendations stated in the latest IPCC Special Report on Oceans and Cryosphere as well as in the IPBES Global Assessment Report on Biodiversity and Ecosystem Services.

Since the signing of the *Galway Statement on Atlantic Ocean Cooperation* (EU - US - Canada) and the *Belém Statement on Atlantic Ocean Research and Innovation Cooperation* (EU - Brazil - South Africa) in 2017, many new projects and collaborations have been launched, which were showcased during the Research Forum as stories of development and impact in the Atlantic research and cooperation.

Discussions also involved the link between research with society, bringing together experts from all fields, ranging from science to industry to political leaders. The meeting was an important occasion to set a strategic direction for the All-Atlantic Ocean Research Alliance, particularly for how the Alliance will contribute on matters such as the *European Green Deal* and the *UN Decade of Ocean Science for Sustainable Development*.

You can read more on the Forum and the programme on the *website of the Forum*.

17
New Publications

Precise Medium-Range Forecast of Sea-Ice Distribution

Precise sea-ice and ocean current predictions are essential for passing through the Arctic Ocean. Uncertainties in short-term regional predictions (about five days) are still high, and therefore more efficient and accurate forecasting systems are needed. Liyanarachchi Waruna Arampath De Silva and colleagues performed an in-depth analysis of the real-time sea-ice forecasts generated for the first ever Arctic winter expedition (4 –25 November 2018) by RV MIRAI, an ice-strengthened Japanese research vessel. Although ice-strengthened, MIRAI still has to avoid extreme sea-ice conditions and is therefore in direct need of comprehensive and daily forecasts on sea-ice and ocean conditions. The authors compared the results of their ice-ocean coupled model with various other datasets and models. This studies' model is based on a new version of ice-POM developed by De Silva et al. (2015) – a coupled ice-ocean model specifically developed to assimilate ice-floe collisions and mesoscale-eddy activity in the marginal ice zone. IcePOM appears to be best when it comes to providing predictions on ice conditions with a lead time of ten days and a maximum ice-edge error of less than 16 km, if proper data on atmospheric forcing (provided by ECMWF high-resolution medium range forecasts) and ocean boundary conditions (provided by the ECCC RIOPS model) is available. This allows for a far more reliable and safe navigation in the Arctic Ocean compared to other models' predictions. IcePOM was also used during the MIRAI Arctic cruise in 2019 (see photo below) – one of PPP's contributions to providing real-time forecasts for field campaigns. *(acf/kw)*

De Silva, L.W.A., Inoue, J., Yamaguchi, H., Terui, T. 2020: Medium range sea ice prediction in support of Japanese research vessel MIRAI's expedition cruise in 2018. Polar Geography, doi: *10.1080/1088937X.2019.1707317*

RV MIRAI moving in the sea-ice area in mid October 2019 (photo: Jun Inoue/NIPR).

Comparison of Sea-Ice Deformation in Lead-Permitting Sea-Ice Simulations

High resolution sea-ice simulations show realistic lead distribution compared to satellite data. The Arctic sea-ice cover is formed by a mosaic of ice floes, which is fundamental for its interaction with the atmosphere and ocean in the Arctic climate system. Sea-ice models start to resolve floes and leads at very high resolution, but the evaluation of these features is challenging due to the chaotic nature of ice fracture. In this study, detection and tracking algorithms are used to extract deformation features (leads and pressure ridges) from model output and satellite data. Both spatial and temporal characteristics, such as densities, lengths, and persistence of deformation features, are evaluated. The good agreement with satellite observations paves the way for using these simulations to study interaction processes along leads and pressure ridges in high-resolution Arctic climate simulations. *(nh)*

Hutter, N., Losch, M. 2020: Feature-based comparison of sea ice deformation in lead-permitting sea ice simulations. The Cryosphere, 14, 93–113, doi: *10.5194/tc-14-93-2020*

Back to the Future: the MOSAiC Ice Floe

Tracking Polarstern's ice floe back in time reveals that it originated from the shallow Siberian shelf. This sediment-laden ice is becoming increasingly rare, with impacts for future primary production and biodiversity in the Central Arctic.
Using a combination of satellite imagery, reanalysis data, and a novel coupled thermodynamics-backtracking model, it was possible to extend the MOSAiC expedition back in time by following the MOSAiC ice floe to its place of origin: the Siberian shelf. Different to ice formed elsewhere, ice that originates from shallow waters can take up large amounts of climate relevant gases, sediments, pollutants and nutrients within a short time. However, this ice is becoming increasingly rare, as less and less ice survives the first summer. Given the ice floe's origin, which was confirmed by sediments found on-site, the MOSAiC project has the unique opportunity to study the role of shelf ice for the balance of climate relevant trace gases, primary production, and biodiversity in the Arctic Ocean. Record temperatures in summer and strong ice export in winter resulted in the longest ice-free summer period since reliable instrumental records began, shaping the exceptional ice conditions found on site at the start of the drift experiment. The ice thickness in September 2019 can be classified as exceptionally thin when compared to the last 26 years. In this sense, MOSAiC scientist have already experienced the "new normal" of Arctic conditions during the initial phase of MOSAiC, which might make future follow-up campaigns of this scale increasingly difficult. The MOSAiC expedition could thus be one of the last opportunites to study the important role of shelf ice for the Arctic biogeochemical cycle and ecosystem. *(tr)*

Krumpen, T., Birrien, F., Kauker, F., Rackow, T. et al Accepted for Review: The MOSAiC ice floe: sediment-laden survivor from the Siberian shelf. The Cryosphere Discussions, doi: *https://doi.org/10.5194/tc-2020-64*

18

YOPP-endorsed! - Nansen Legacy Project

Interview: Kirstin Werner, Alfred Wegener Institute

YOPP endorsement is available for projects, programmes and initiatives but also for institutions and operational centres that contribute to the Year of Polar Prediction's goals to improve weather and sea-ice forecasts in polar regions. More than eighty projects, programmes and initiatives already received project endorsement from YOPP.

The YOPP-endorsed Nansen Legacy is a Norwegian research project to facilitate a sustainable management of the northern Barents Sea and the adjacent Arctic Basin through the 21st century. Researchers from across all scientific disciplines jointly investigate the Arctic marine climate and ecosystem to better understand the ongoing rapid changes in the northern Barents Sea. The Norwegian research icebreaker "Kronprins Haakon" serves as the main research platform for the Nansen Legacy. The project runs from 2018 to 2023 and is funded by the Research Council of Norway and the Norwegian Ministry of Education and Research. We have spoken with the marine ecologist Marit Reigstad who manages the project together with her two co-leads Tor Eldevik (University of Bergen) and Sebastian Gerland (Norwegian Polar Institute). Marit has led several interdisciplinary projects and expeditions on Arctic marine ecosystems.

Prof. Reigstad, what is the Nansen Legacy project about?

M.R.: The Nansen Legacy project is an interdisciplinary research project on the climate and ecosystem of the northern Barents Sea and adjacent Arctic Basin, addressing the past, the present and the future.

Why did you call the project the "Nansen Legacy"?

M.R.: The Nansen Legacy project is inspired by the Norwegian natural researcher and humanist Fridtjof Nansen. His research was manifold and ground breaking. It included oceanography addressing how ocean currents connect across latitudes and how they

Photo: Joern Berger Nyvoll/UiT

impact fisheries, but also the innovation of scientific instruments like the Nansen bottle for water collection. 125 years ago, Nansen built the dedicated polar research vessel "Fram" for his polar expedition drifting across the Arctic Ocean. His ability to bring together teams of people with complementary skills to reach his
ambitious goals is also something we learn from. We hope that our investigations of the "new" Arctic Ocean will provide a legacy in terms of new knowledge and how we can collaborate to investigate complex research questions.

How big is the project?

M.R.: At present nearly 200 scientists are involved in the Nansen Legacy project. That includes > 50 recruits that will be our future generation of polar scientists.

The project is funded with 50% in-kind contributions from the participating institution, 25% from the Ministry of Education and Research, and 25% from the Research Council of Norway. Due to this funding organisation, the project partners are Norwegian, but we collaborate closely with several international research projects, including YOPP.

What are you and your team trying to achieve with the project?

M.R.: Our ambitions for the project include several layers. We will investigate the climate- and ecosystem in a more interdisciplinary way to build a knowledge base for a future sustainable management of the region. We will strengthen the collaboration between researchers from different disciplines and institutions in Norway to utilize expertise and infrastructure in a better way. We will contribute with region specific knowledge to the society and to a joint international effort in establishing a more holistic understanding of the Arctic Ocean.

After the project comes to an end – what wouldn't be there if there hadn't been any Nansen Legacy? Or: what will be the "Legacy" of the Nansen Legacy project?

M.R.: The legacy of the project is a new generation of polar researchers with interdisciplinary understanding and a unique national and international network. It is also a huge pool of data handled using the FAIR principles, collected using common protocols, that can be used by a larger science community. It is a more holistic understanding of how the climate and ecosystem interact, but also on how human activities impact the ecosystem. It is interest and knowledge to make better integrated Arctic Ocean studies and comparisons, including the international community.

How does Nansen Legacy contribute to the Year of Polar Prediction?

M.R.: The Nansen Legacy contribute to two essential parts of YOPP, with 1) model forecast and verification development, and 2) observations, as well as involvement in YOPP data management. The model work includes the development of a coupled kilometre-scale weather, ocean, ice and wave forecasting system for the European Arctic. Present results are that sea-ice leads and snow play an important role for sea ice in weather forecasting systems. A number of metrics have been explored to verify short-term sea-ice forecasts with specific focus on end-user needs. Observations include extensive measurements north of Svalbard in September 2018, with radiosondes, drift buoys, radiation and wave measurements in sea-ice and open water.

The project is in full motion at the moment. What has been most challenging for the project itself but also for you in your role as Project PI?

M.R.: The most challenging part has been to get such a large project up and running. The project participants had to find their place and familiarize with all new collaborators. This includes discussions on practicalities with sampling, agreement on methods to be used, routines for data handling, how to link the different models involved and criteria for evaluation, employment of all the new people, purchase of all the new equipment. We have also taken a brand-new ice breaking research vessel into use.

As a PI, I am first of all privileged to have such a great and dedicated research team in the project. That is a key to success, and enables us to find good solutions. I have also established a project office with excellent staff that helps to run the project. Challenges include practical issues like solutions and platforms for the communication and the interaction needed to keep such a huge and decentralised project functioning. It also involved handling of two cancelled cruises due to delays and required maintenance on the new vessel. But also to keep overarching goals up front to make sure that we develop the holistic and integrating perspectives we would like to.

How can the Polar Prediction Community follow the Nansen Legacy project?

M.R.: The Polar Prediction Community can follow us on our web page *www.nansenlegacy.org*, our blog on *www.sciencenorway.no*, and on Twitter *@nansenlegacy*. We will also make short announcements of data published on the YOPP Data Portal when data becomes available.

RV Kronprins Haakon and the ice camp during a Nansen Legacy cruise in August 2019 (credit: Christian Morel, http://christianmorel.net/NansenLegacy)

19 UPCOMING ONLINE EVENTS

3–8 May 2020
EGU2020 Sharing Geoscience Online (#share EGU20)

Polar Prediction Live Chats:

- **8 May 2020**
  10:45–12:30 CEST, 8:45–10:30 UTC
  CL4.15 Climate Variability and Prediction in High Latitudes

- **8 May 2020**
  14:00–15:45 CEST, 12:00–13:45 UTC
  CL2.12 Exploiting Polar Observations to Improve Weather and Climate Predictions (Joint APPLICATE-YOPP Session)

14 & 18 May 2020
17:00 UTC & 20:00 UTC
Arctic Futures 2050 Conference Report – Upcoming Community Webinars
organized by SEARCH: Study of Environmental Arctic Change

19–21 May 2020
6th APECS International Online Conference 2020
Opening Doors: Collaboration across knowledge systems

22 May 2020
12:00-13:00 AKDT, 20:00-21:00 UTC
May 2020 National Weather Service Alaska Climate Outlook Briefing
With Rick Thoman (PPP-SERA), Alaska Center for Climate Assessment & Policy (ACCAP)

04–05 June 2020
SIOS Online Conference on Remote Sensing in Svalbard
Abstract submission due by 24 May 2020

15–19 June 2020
Cryosphere Science with ICESAT-2 Remote Hackweek 2020
More information: *icesat@uw.edu*

AWI

International Coordination Office for Polar Prediction

Editorial responsibility: Kirstin Werner
Layout: Manon John

E-mail: office@polarprediction.net
Phone: +49 471 4831 1588

Address:
Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research
Bussestraße 24, 27570 Bremerhaven, Germany

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