Further Plans of the Year of Polar Prediction in the Southern Hemisphere (YOPP-SH) and Completion of the Polar Prediction Project

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Summary

This IP summarises recent activities undertaken in the Antarctic region as part of the World Weather Research Programme (WWRP) of the World Meteorological Organization's (WMO) Polar Prediction Project (PPP).

PPP formally concluded on 31 December 2022 but activities in three key areas (Year of Polar Prediction in the Southern Hemisphere (YOPP-SH), the Model Intercomparison and Improvement Project (MIIP) and the PPP Societal and Environmental Research Applications group (PPP-SERA)) will continue during 2023. The WWRP is finalising approvals for a follow-on project currently known as the *Polar Coupled Analysis and Prediction Services* which is expected to commence in 2024.

Introduction

PPP coordinated international research with the main goal of significantly improving weather and sea-ice prediction capabilities in the polar regions, on time scales from hours to seasonal. It is part of the World Weather Research Programme (WWRP) of WMO, with close links to its sister programme, the WMO/IOC-UNESCO/ISC World Climate Research Programme (WCRP). SCAR has been a partner and supportive of PPP activities over the last ten years.

The YOPP included Special Observing Periods (SOP) and Targeted Observing Periods (TOPS) in the Arctic and Antarctic to increase the number of atmospheric and oceanographic observations. Extra radiosondes were launched from polar meteorological stations, and additional buoys were deployed from research vessels. The additional data enables improved representation of polar key processes in uncoupled and coupled models used for high-quality prediction in polar regions.

Winter Antarctic Special Observing Period (SOP) in 2022

The second YOPP-SH SOP from mid-April to the end of August 2022 coincided with the rapid expansion of the Antarctic sea-ice cover. The goal of this winter SOP was to improve forecast capabilities during the non-summer months as nations contemplate expanding to year-round scientific field investigations. In recognition of limited personnel and resources at this time of year, the TOP approach was adopted and included seven intensive observing periods during the overall structure of the SOP, each ranging from 5 to 10 days in duration.

Four of these TOPS were Pan-Antarctic and three were regional TOPS, with two focused on the East Antarctica/Ross Sea and one on the Antarctic Peninsula. The scientific focus was on major oceanic cyclones, atmospheric rivers and related events. The primary additional observations were extra radiosonde ascents (totalling 1100 during the 7 TOPS, see Fig. 1) although additional instrumentation was added at many stations, particularly in the Antarctic Peninsula to aid in the investigation of the atmospheric-river events.

A manuscript for the Bulletin of the American Meteorological Society is being prepared that describes the TOPS. With support from the U.S. National Science Foundation, The Ohio State University and the National Center for Atmospheric Research are performing data-denial experiments with the Antarctic Mesoscale Prediction System (AMPS) to explore the forecast improvement resulting from the extra radiosondes launched during the TOPS. In addition, more advanced data assimilation is being tested in the AMPS system, and the best microphysics scheme to capture the atmospheric river events is under investigation.

***Sea-ice prediction in the Antarctic***

One of the flagship activities of YOPP-SH is the Sea Ice Prediction Network South ([SIPN South](https://fmassonn.github.io/sipn-south.github.io/)), which was initiated in 2017 and has run without interruption since then. SIPN South was launched due to the increasing need for sea-ice information in the Southern Ocean, the existence of predictability mechanisms for summer sea ice recently suggested in the scientific literature, and the lack of knowledge regarding the skill of state-of-the-art operational forecasts at the seasonal time scale.

In the five years, SIPN South received more than 3000 forecasts of sea-ice area and concentrations from 21 unique groups representing five continents, many of which were ensembles. Forecasts conducted for the 2022-2023 summer season (Figure 2) are currently being analysed but the early results shown below reveal a continued overestimate of Antarctic sea-ice area, at least at the beginning of the forecast period. Notably, the minimum extent during February 2023 was a record low for the satellite era that started in 1979 (<https://nsidc.org/news-analyses/news-stories/antarctic-sea-ice-settles-record-low-2023>). A scientific paper (Massonnet et al. 2023) describes the skill of contemporary dynamical models and statistical models in predicting summer Antarctic sea ice at the global and regional scales. SIPN South will continue for the next few years, and a pending evaluation of model predictions during the sea-ice growth season was conducted during the SOP of May-August 2022 that had the embedded TOPs.

Gráfico, Gráfico radial

Descripción generada automáticamente

***Figure 1.*** *Stations (red dots) releasing extra radiosondes during the YOPP-SH winter Targeted Observing Periods in 2022. Numbers given for each station explained at bottom left of the figure.*

Chart, histogram

Description automatically generated

***Figure 2:*** *Forecasts of total Antarctic sea-ice area for the 2022-2023 melting season (submitted before 1st December 2022) contributed by 17 groups. Verifying observations are in black.*

***YOPP-SH TOP Outreach***

Facebook, Twitter and Instagram social media sites were established and maintained by the Polar Meteorology Group of the Byrd Polar and Climate Research Center at Ohio State University during the TOPS. Videos and pictures obtained from the participants in the TOPS at the research stations were regularly posted:

<https://www.facebook.com/YOPPSHOSUPolar?ref=page_internal>

<https://mobile.twitter.com/YOPPSHOSUPolar>

https://www.instagram.com/yoppshosu/

A video publicizing the TOPS was prepared by the Byrd Polar and Climate Research Center and is available here: <https://vimeo.com/784878087>

YOPP-SH Data Archival

With funding provided by the U.S. National Science Foundation, the Antarctic Meteorological Research and Data Center (AMRDC) is the official data center for YOPP-SH. All YOPP-SH data sets it holds can be found here: [https://amrdcdata.ssec.wisc.edu/group/year-of-polar-prediction-in-the-southern-hemisphere](https://urldefense.com/v3/__https:/amrdcdata.ssec.wisc.edu/group/year-of-polar-prediction-in-the-southern-hemisphere__;!!KGKeukY!w_wgtF7-ZP7q9lsF5sn9arXoGOsEWhsG4ZS6SK03j_mMAyNIvZp3IvjygPFJE-lBlK0Ee102KPA1dwpu8l72$). These include the radiosonde observations from the winter TOPS and all data sets have digital object identifier (doi) numbers.

***Meetings***

**YOPP-SH Community**

The seventh YOPP-SH meeting was a hybrid meeting held on 6August 2022 at the Pyle Centre at the University of Wisconsin, Madison. The meeting was organized by the Byrd Polar and Climate Research Center and was aligned with the annual Workshop on Antarctic Meteorology and Climate (WAMC, 4 and 5 August 2022). During the meeting the first results from the TOPs were discussed. The presentations are available online (<https://polarmet.osu.edu/YOPP-SH_2022/>) as is a meeting report (Wang et al. 2022; <https://polarmet.osu.edu/YOPP-SH_2022/BPCRC_tech_report_2022-001.pdf>), and a scientific article summarising the WAMC and the YOPP-SH meeting is presently under review (Tomanek et al., 2023).

**YOPP Final Summit**

The YOPP Final Summit (<https://yoppfinalsummit.com/>) took place in Montreal, Canada, 29 August - 1 September 2022, and brought together the polar prediction community – from operational centres, academia, environment services, polar prediction users and northern communities. The Summit showcased the successes of YOPP and included Science-to-Service sessions where key users described their engagement with environmental predictions. The YOPP-SH efforts provided an important contribution to the Summit.

The successes of YOPP from the Summit presentations included:

* a better understanding of the impact of key polar measurements (radiosondes and space-based instruments such as microwave radiometers), and recent advancements in the current NWP observing system, achieved through coordinated OSEs in both polar regions (e.g., Sandu et al 2021);
* enhanced understanding of the linkages between Arctic and mid-latitude weather (e.g., Day et al 2019);
* advancements in the atmosphere-ocean-sea ice and atmosphere-land-cryosphere coupling in NWP, and in assessing and recognizing the added value of coupling in Earth System Models (e.g., Bauer et al 2016);
* deployment of tailored polar observation campaigns to address yet unresolved polar processes (e.g., Renfrew et al 2022);
* progress in verification and forecasting techniques for sea-ice, including a novel headline score (e.g., Goessling and Jung, 2018);
* advances in process understanding and process-based evaluation with the establishment of the YOPPsiteMIP framework and tools (Svensson 2020);
* better understanding of emerging societal and stakeholder needs in the Arctic and Antarctic (e.g., Dawson et al 2017); and
* innovative transdisciplinary methodologies for co-producing salient information services for various user groups (Jeuring and Lamers 2021).

The YOPP Final Summit identified a number of areas worthy of prioritized research in the area of environmental prediction and services for the polar regions:

* coupled atmosphere, sea-ice and ocean models with an emphasis on advanced parameterisations and enhanced resolution at which critical phenomena start to be resolved (e.g., ocean eddies);
* improved definition and representation of stable boundary layer processes, including mixed-phase clouds and aerosols; incorporation of wave-ice-ocean interactions;
* radiance assimilation over sea ice, land ice, and ice sheets
* understanding of linkages between polar regions and lower latitudes from a prediction perspective;
* exploring the limits of predictability of the atmosphere-cryosphere-ocean system;
* an examination of the observational representativeness over land, sea ice and ocean; better representation of the hydrological cycle; and,
* transdisciplinary work with social scientists around the use of forecasting services and operational decision-making.

The discussions around the Science and Service sessions identified that, whilst good progress had been made in identifying key user groups and their needs, more effort is needed to expand research around identifying the range of information needs of a greater diversity of user groups as well as tailoring services to their needs.

**Societal and Environmental Research Applications (SERA)**

The PPP-SERA group are currently compiling a review paper for the journal “Weather, Climate and Society” that synthesises the work done over the last few years on the use of WWIC information. Some key themes that will be explored in the review paper include:

* user requirements
* service reliability
* barriers to use
* mismatch between services and user needs
* the importance of experience and local knowledge
* community-based monitoring
* planning and decision-making
* safety and risk
* education and training
* search and rescue

The group will further discuss the legacies of the PPP for users of WWIC in the conclusion.

A WWRP/PPP-SERA workshop held in Hobart, Australia, 17-19 April 2023, is expected to help to formulate a strategy for the next polar research project of the WWRP, proposed to begin in 2024 that takes into consideration social-science aspects and establishes strong connections with stakeholders in order to move towards co-production.

***Acknowledgement***

The Polar Prediction Project has been a ten-year effort of the WMO’s World Weather Research Programme and has been very successful, in part due to the enormous support provided to the project by many partner organisations and support of the Antarctic Treaty partners. WMO would like to thank those contributors and acknowledge their support.

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