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The 17th Workshop on Antarctic Meteorology and Climate and 7th Year of Polar Prediction in the Southern Hemisphere Meeting

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• **Meeting Summary** •

The 17th Workshop on Antarctic Meteorology and Climate and 7th Year of Polar Prediction in the Southern Hemisphere Meeting

Anastasia J. TOMANEK*[1,2], Matthew A. LAZZARA[1,3], David E. MIKOLAJCZYK[1], Taylor P. NORTON[1,2], Isabella I. ONSI[1,2], David H. BROMWICH[4], and Mariana F. LITELL[4]

[1]*Antarctic Meteorological Research and Data Center*, *Space Science*, *and Engineering Center*, *University of Wisconsin-Madison*, *Madison*, *WI* 53706, *USA*

[2]*Department of Atmospheric Sciences*, *University of Wisconsin-Madison*, *Madison*, *WI* 53706, *USA*

[3]*Department of Physical Sciences*, *School of Engineering*, *Science*, *and Mathematics*, *Madison Area Technical College*, *Madison*, *WI* 53704, *USA*

[4]*Polar Meteorology Group*, *Byrd Polar & Climate Research Center*, *The Ohio State University*, *Columbus*, *OH* 43210, *USA*

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1. Overview

August 2022 marked the 17th Workshop on Antarctic Meteorology and Climate (WAMC) which was held in a hybrid format at the Pyle Center at the University of Wisconsin-Madison (UW-Madison) in Madison, WI, USA. The workshop is the first partial in-person gathering since the 14th WAMC (Lazzara et al., 2018) as the 15th WAMC was canceled due to the COVID-19 pandemic, and the 16th WAMC (Bromwich et al., 2022) was purely online. Global members of the Antarctic meteorological community gathered at this meeting to present and discuss weather-related topics encompassing scientific research and support operations within Antarctic meteorology and climate. These conversations aimed to share and discuss results, future developments, and build collaborative plans. The WAMC attracted over 40 attendees from over 10 countries (Fig. 1). Following the WAMC, the 7th International Year of Polar Prediction-Southern Hemisphere (YOPP-SH) workshop was held on Saturday, 6 August. This meeting was also in hybrid format, attended by over 15 in the research community, many of whom were present for the WAMC. YOPP-SH integrated presentations and discussions regarding the recent Special Observing Period and its embedded Targeted Observing Period (TOPs). Both meetings were held just before the American Meteorological Society (AMS) Collective Meeting, which included the Polar Meteorology and Oceanography meeting, at Monona Terrace in Madison, WI.

2. Automatic Weather Station Networks

2.1. *Status*

After welcoming statements, the session began with Automatic Weather Station (AWS) presentations from the Antarctic Meteorology Research and Data Center (AMRDC) and the British Antarctic Survey (BAS). The main goal was to highlight and map the previous field season, observing equipment, operational applications, and upcoming field season goals.

Representatives Lee WELLHOUSE and Dave MIKOLAJCZYK from UW-Madison summarized their 2021–22 field season and accomplishments on the Ross Ice Shelf, which included the raising of AWS instrumentation due to accumulation, addressing instrumentation failures, and troubleshooting data transmission issues. Their deployment to West Antarctica was canceled due to COVID-19 and logistic conflicts. This impacted the recovery of the Austin and Kathie AWSs, which are no

* Corresponding author: Anastasia J. TOMANEK
Email: ajtomanek@wisc.edu

longer transmitting given their location in high accumulation zones. Since both AWS are suspected to be completely buried, digging them out to recover and raise the instrumentation is impossible. Full replacement AWSs will need to be installed.

The upcoming field season, 2022–23, for the UW-Madison AWS network (Fig. 2) will consist of two separate projects and deployments. The deployment of group 1 will be in the early season based out of McMurdo to focus on Cape Hallett and Alexander Tall Tower while completing standard service work. Group 2 will prioritize West Antarctica to recover Austin and Kathie while completing the West Antarctic Tall Tower installation. Both groups will continue tests on the polar climate and weather stations (PCWS), a joint project between UW-Madison and Madison Area Technical College while raising

Fig. 1. In-person attendees at the 17th WAMC workshop pose with online attendees.

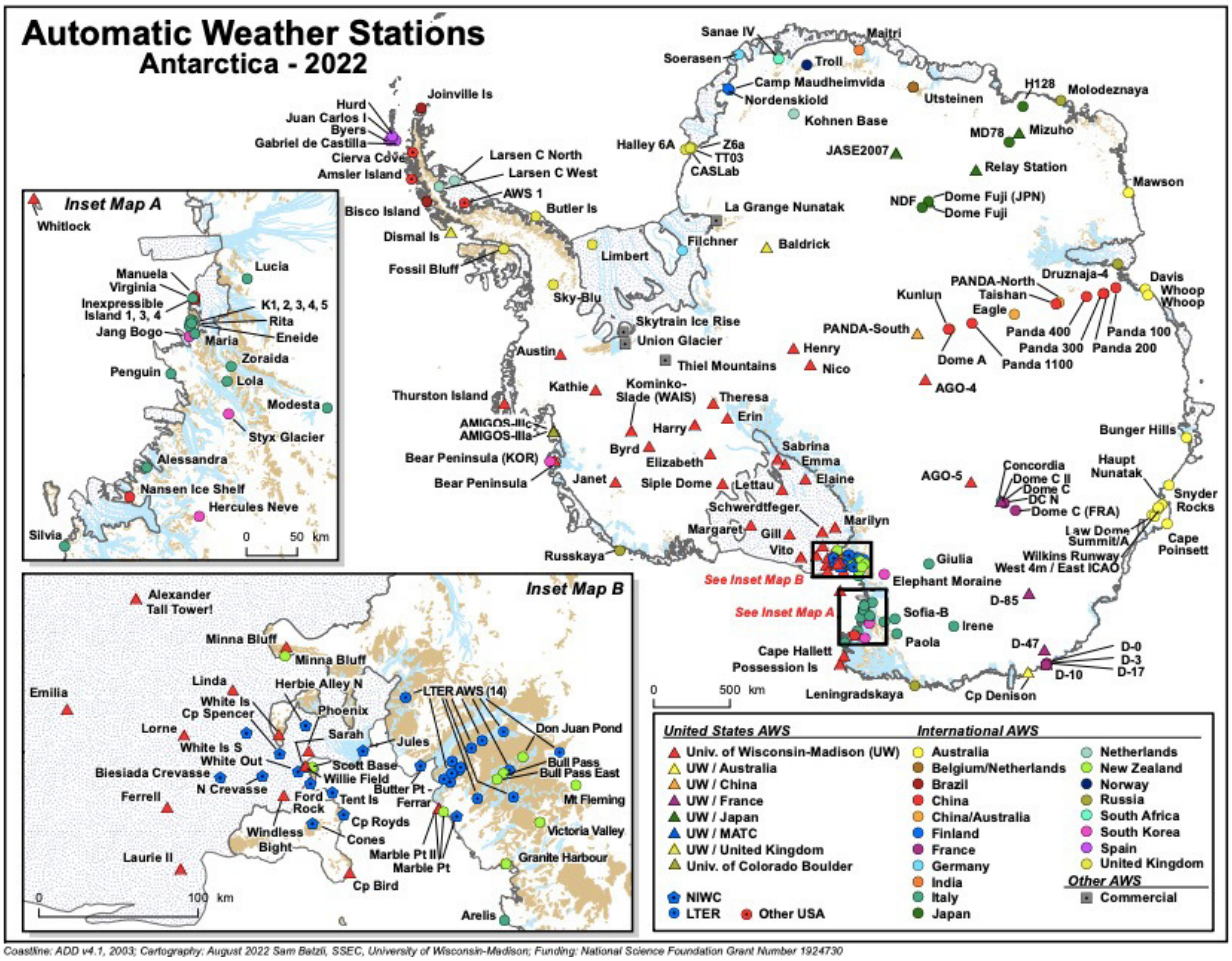

Fig. 2. 2022 Antarctica AWS network map.

and servicing stations behind schedule due to COVID-19.

Mairi SIMMS from the British Antarctic Survey (BAS) highlighted eight AWSs in the Peninsula and Halley Research Station region along with two further along the Larsen C Ice Shelf shared with the University of Utrecht. The primary importance of their work was the replacement of old masts constructed with a heavy and time-consuming metal framework which required training and kits on hand. New pole masts utilize a telescopic pole system which does not require training, in addition to it being lighter and quicker to raise while deployed. Raising the new masts is still needed, but all the instruments can remain secured while the cables are replaced. Many attendees are looking forward to reviews on this structural change in future field seasons as they may influence other structural choices moving forward.

2.2. *McMurdo operations*

Providing an overview of the United States Program Meteorological Services, Art CAYETTE from the Naval Information Warfare Center (NIWC), Atlantic-Polar Programs (NPP), informed attendees on the previous and upcoming status of McMurdo operations since the interrupted field season in 2020–21. During this season, a decrease in operation abilities resulted in the reduction of staff numbers to fit the pace and safety measures implemented during the pandemic. Restrictive measures remained for 2021–22, as only required operations and projects were conducted while special care continued to avoid COVID-19 exposure on the continent. The milestone of full operations and staff for the 2022–23 field season is expected as project operations resume toward the pre-pandemic rate.

Given the reduction of project operations in previous years, the International Organization for Standardization (ISO)/ World Meteorological Organization's (WMO's) quality assurance program goals for the data during this time were a topic of precedence. Though performance numbers remained high during the previous season, the sampling of measures could not be compared to the achievements of previous seasons. The comparison of this season to the previous two will be excluded to prevent influencing past and future performance measures. Instead, the recommended goals were to not only analyze the statistical characteristics of the data but also to learn to identify strengths and weaknesses in models which can be improved upon moving forward.

2.3. *Discussion*

The leading discussion of the workshop centered around various AWSs and functionality based on the current network operations and reviewed practices from other operations. Since the Sabrina and Emma stations are geographically close to each other, and that Sabrina has a longer data record, it was agreed that Emma could be removed. Stations Marilyn, Elaine, and Schwerdtfeger will be transitioned to NIWC while keeping the same names and continuing under the quality control of UW-Madison. Locations of interest for more observations included the Megadunes region in East Antarctica, the eastern side of the Peninsula, and sea ice regions through sources such as ship instrumentation, given it cannot be done through AWS.

3. Antarctic forecasting and operational services

Forecasting and operational service discussions covered a variety of approaches to improve forecasting in the Antarctic region. As observations are central to forecasting, there was an overlap in interest regarding national data availability, reliability, and observation expansion to support weather monitoring and numerical modeling. Among the highlighted topics was the critical importance of weather data during events and in post-analysis to enhance forecasting capabilities and advance warnings for accuracy and safety measures.

3.1. *Challenges*

The primary challenges of weather forecasting for the region were identified to be the scarcity of data and meteorological complexity. Satellite communication and internet bandwidth/access are limited in the Antarctic region, inhibiting the planning of logistical operations given their dependence on weather conditions. Alvaro SCARDILLI from the Argentinian Servicio de Hidrografía Naval (SHN) discussed forecasting mesoscale cyclogenetic events over the Antarctic Peninsula and their impact on maritime operations which addressed the lack of accuracy here compared to the rest of the world. This difficulty stems from limited observed data, noting that the models do not fully represent the complex topography and do not sufficiently account for the effect and variability of the sea ice field. The northern Antarctic Peninsula was an area of interest given the high number of official operations at sea and the recent influx of tourist activity. Tourism alone directly instigates safety concerns as the variability and detail of sea ice trends may not be known to those on incoming tourist ships. The weather in this region is highly variable, as it is susceptible to extreme cyclone events along with strong topographic and temperature contrasts which can occur throughout the year, making it difficult to forecast weather for this region.

Current limitations specified for forecasting capabilities are archival space for satellite data, which often cannot be processed until after the season concludes. Given the need for AMPS to be more accessible to forecasters in the maritime community, it is important to consider the file size which can be accessed in the more remote areas. By reducing the file sizes of

data, they will be easier to download for access as well as for information presented in future talks.

3.2. *Planning and outcomes*

The generation of mesoscale systems across the peninsula is known to be caused by the thermal contrast between the cold air from the continent and warmer maritime temperatures in conjunction with anticyclonic circulations. These ingredients produce favorable conditions for the genesis of mesoscale systems north of the peninsula.

Joey SNARSKI from the Naval Information Warfare Center (NIWC) and Atlantic–Polar Programs (NPP) discussed collaborations with the scientific community using tools such as the Soumi-National Polar-orbiting Partnership (S-NPP) satellite have been productive in developing new forecasting utilities for the region, a vital need due to the extreme and highly variable weather conditions. To increase the ability for satellite data archiving, which currently cannot happen until after the season has concluded, Charleston aims to increase capacity to retain 3–6 months of data so case study information and imagery can be stored and readily accessible. This will be an increase from the currently available 48 hours. File formatting is also being evaluated to maintain formatting after deletion. Training capabilities are provided for forecasters to better understand the local effects of the continent. As such, the data maintained for case studies will be an integral tool for analysis during training, providing unique scenarios to help trainees predict weather in near-real-time which they may not be able to experience in person. More collaboration with the research community is being requested for these efforts, and AMRDC would be willing to partake in the future.

Targeted Observing Periods (TOPs) are a part of the Year of Polar Prediction – Southern Hemisphere (YOPP-SH) and are used to improve forecasting skill in the Antarctic through the deployment of additional radiosondes. The past winter observing period occurred from 15 April to 31 August of 2022, with TOPs focusing on the East Antarctica-Ross Sea and Peninsula regions. So far, six TOPs have been conducted, doubling the routine observing schedule with an extra 30–35 radiosondes per day. Forecasts from NIWC have been of great assistance, using six-day predictions of impacted regions and 10-day outlooks. Additionally, various institutions provided cloud water measurement observations via Anasonde launches. As the TOPs indicate, more access and forms of numerical data may be key to improving the accuracy and promptness of forecasts highlighting the conditions and risks during these weather events.

4. Antarctic numerical modeling systems

Numerical modeling over Antarctica and the high southern latitudes is a primary focus at the WAMC. The workshop covered numerical modeling and forecasting systems for the Antarctic in addition to referencing studies utilizing them. A severe weather case study of Half Moon Island from Arthur SCARDILLI demonstrated model access importance as a system that brought increased winds, snowfall, and visibility inundated the island in January 2015. The main effect of the event was its impact on ships, as emergency departures and groundings were necessary to safely navigate rapidly deteriorating conditions. More reliable accessibility to forecasters in the maritime community is necessary during these events to reach well-rounded forecasting conclusions.

Kevin MANNING from the National Center for Atmospheric Research (NCAR) provided an update on the Antarctic Mesoscale Prediction System (AMPS) operated at NCAR. This provides the community with real-time data of the whole continent with smaller areas at higher resolutions which helps to account for terrain. The potential for an enhanced AMPS ensemble has been introduced, but it will depend on the capabilities remaining on the new supercomputer "Derecho" anticipated to begin processing in April 2023. Based on conducted experiments, observational biases inherent to the model were addressed while refinement is anticipated with the Model for Prediction Across Scales (MPAS). A full transition to MPAS is anticipated within the next 3–5 years while the WRF data continues to be archived, though the archetypical structure for MPAS is still unclear.

The McMurdo Building 165 Observation System automation data tool was produced to access current and historical weather data while on the United States Antarctic Program (USAP) network. The system is currently producing 3- and 6-hour synoptic and intermediate observations to help feed results into and through the Global Telecommunication System (GTS), which increases data reporting to global weather models. Future automation goals are to present a higher level of complexity with new tools such as radar analysis and fusion decision-makers. Checks are being looked at with the help of AMRDC to validate AMPS products and analyze the biased behaviors of the model. Discussions also included new actions which could improve the status of the system.

The Consortium of Small-Scale Modeling in Climate Mode (CCLM) regional model is a non-hydrostatic sea ice model with a tile approach that takes historical data from 2000–15 to predict the future climate of 2036–50. Historical model runs were compared with ERA5 data to elucidate observed higher wind speeds at various topographies, higher temperatures toward the middle of the continent, and locations that contain higher sea ice concentrations. The analysis focused on the climate change signal of low-level jets (LLJs) and boundary layer characteristics. Throughout testing for validation and biases, the climate change signal produced an end-of-century increase for both wind and temperature over areas of sea ice retreat.

5. Observation applications and research

Antarctic meteorology and climate research are integral to the WAMC, so the prioritization of highlighting current research spanning a variety of topics and observation methods was at the core of the meeting. Observation methods spanned satellite remote sensing, in-situ observations, data re-analysis, and model output.

5.1. *Outcomes*

The investigation of clouds from both ground and satellite observations demonstrates the potential impact on pilot flight safety and the association between atmospheric rivers and precipitation magnitude. Jeff FOURNIER from NIWC Polar Programs presented on the use of ceilometers to forecast cloud ceilings by sending pulses of light with a laser and calculating its scatter detection and pulse emissions. This was used on the continent but only produced usable data when clouds were overhead. When unavailable, cloud ceilings were estimated by observers. These observations are essential for Visual Flight Rules (VFR), as accurate forecasting is needed to determine flight conditions. Different conditional parameters alter the instrumentation and training needed to execute the flight. Determining cloud ceilings is challenging when clouds are not directly above the instrument because observations from space are then used, which have performance issues related to the poor thermal contrast of the clouds and the cold surface. This causes shallow clouds to lack sufficient contrast. Visible Infrared Imaging Radiometer Suite (VIIRS; found on S-NPP and later satellites) Channel-4 offers improved imagery contrast plotted with grayscale conveying cold values in darker shades. Reflected sunlight will still influence the brightness temperature, but there is an improved differentiation between layers of clouds. Plans to grow the database over the next few summers are in action to refine forecast guidelines.

From Hosei University in Japan, Kazue SUZUKI presented on the satellite detection of atmospheric rivers which featured clouds bringing heavy snow to the Antarctic that can be identified using imaging associated with Atmospheric Rivers (AR) during snowfall. Data collected were obtained using the National Oceanic and Atmospheric Administration (NOAA) satellite series (NOAA-19 and earlier) and the Advanced Very High-Resolution Radiometer (AVHRR) observations. SUZUKI noted that biases in the satellite analysis can occur from high albedo and sea ice around the continent. Associated snow depths were collected at the Syowa station in 2009 to compare with the imagery. The AR events selected were based on cloud conditions over the station and their persistence over long distances. The results associated 7 of the 28 total blizzard events with ARs based on imaging features that occurred during class A blizzards.

Foehn warmings over the Antarctic Peninsula were shown to be amplified by atmospheric rivers by Penny ROWE from NorthWest Research Associates. An example was shown using ice-shelf break-up and surface melting examined and measured at King George Island. Warm and dry downslope winds, known as Foehn winds, initiate cloud clearing on the leeward side of the mountain range contributing to warming. In 2022, warming spots were identified on the lee side of James Ross Island where cloud clearing occurred, while the upward side featured low-level blocking. Average temperatures within the Foehn window increased by about 3°C in 24 hours while the wind speed increased by 16 m s^{-1} in 12 hours. Cloud and radiation observations demonstrated that depending on the time of day, cooling could be seen in the shortwave radiation signature, while warming is evident in the longwave spectrum. Sensible heat flux proved to be important at night, but during the day the shortwave radiation was greater. Challenges arose owing to the diurnal cycle and how the peak varies geographically. Proposed solutions included calculating energy budgets to include both day and night, conducting more observations on the leeward side of Marambio, and calculating surface energy balance components in other cases.

The National Institute of Polar Research (NIPR) evaluated the eruption of Tonga on 15 January 2022, through surface waves captured by the AWS network of the Japan Meteorological Agency. Naohiko HIRASAWA presented on how impacts of eruptions on the global atmosphere are rare, which is why records were saved for this event. Time series of surface pressure anomalies indicated two shock waves from the near side and two from the far side of Tonga. Wave packets consisted of positive-negative-positive pressure anomalies with 9 and 27 hours between waves, giving them a cyclic period of 36 hours. Analysis of the first wave revealed its relationship to associated altered meteorological elements as the wave passed over the Antarctic ice sheet using AWS data. This analysis showed that topography influenced the behavior of the wave and was an integral part of its dynamics.

6. Antarctic community and data sources

The utilization of virtual data sources and community connections have evolved as resources of interest for the WMO. During the meeting, the new data repository hosted by the AMRDC and the evolution of the Polar Technology Conference to the Polar Technology Community were addressed.

6.1. *The AMRDC Repository*

The AMRDC Repository (https://amrdcdata.ssec.wisc.edu), as presented by Matthew LAZZARA, is a new resource that provides archiving, preservation, access, and metadata authoring services from Antarctic meteorological data, managing

data from submission to end-user retrieval. The repository hosts data collected by the AMRDC and AWS projects in addition to datasets deposited by other investigators. Datasets can be accepted from accredited organizations and researchers in the Antarctic meteorology and climatology field to be made accessible to the larger research community for open-access use. Data types and forms that can be found on the site include raw observational data, imagery, and processed datasets through interfaces such as interactive maps, keyword searches, and Digital Object Identifiers (DOI). Google Analytics have been implemented to track site interaction of the product for better guidance of the project moving forward between the AMRDC and National Science Foundation (NSF). Features are continually being added to the repository including forecasts and contributions from Prince Elizabeth Station in East Antarctica. Future development aims to include YOPP-SH radiosonde observations, AMRC historical holdings, data visualizations, external links, and USAP observations from stations, ships, and field camps. With the release of the repository, the File Transfer Protocol (FTP) will no longer be supported and is projected to end between 2023 and 2024. Data inquiries must be accessed through the web link to the new site moving forward.

6.2. *Polar technology community*

Conversations at Stanford University led to the formation of the Polar Technology Conference which convened from 2005–16 with the goal of linking experts in polar science and technology development covering a range of disciplines. Mark Seefeldt from the University of Colorado-Boulder (CU) noted that disruptions due to funding and planning personnel halted further meetings until 2020, which were held at CU. The conclusion of the event brought to light lessons that would guide future endeavors to benefit the community. The Polar Technology Community (PTC) has evolved to its current form through the pooling of ideas and experience, partnering with the technology industry, and utilizing discussions within the community to expand opportunities across disciplines. This change not only aligns with their vision more accurately but also better associates funding efforts.

The revised vision seeks to engage and facilitate ideas and experiences between stakeholders, geographical regions, and the international community through the investigation of common applications. An in-person workshop will be held every 18–24 months which will consist of oral and poster sessions, panels, breakout groups, peer-coaching sessions, trainings for common needs, and integration with industry providers and vendors. In the interim, the community online forum will provide monthly to bi-monthly webinars and resources to connect the field with best practices and guidance based on the participants in the community.

7. The 7th Workshop on Year of Polar Prediction – Southern Hemisphere (YOPP-SH)

The 7th Year of Polar Prediction in the Southern Hemisphere (YOPP-SH) workshop immediately followed the 17th Workshop on Antarctic Meteorology and Climate on Saturday 6 August 2022 at the same venue in a hybrid format — both in-person and virtual. Seven presentations related to the winter 2022 TOP, along with results from the summer Special Observing Periods (SOP; 2018–19 austral summer) were presented. David BROMWICH started with an overview of the project and its achievements, especially for the recently concluded winter SOP (see Fig. 3). Vito Vitale summarized the numerous Italian contributions to YOPP-SH as a whole. He summarized contributions to the winter TOP including additional radiosonde ascents from Concordia and Jan Bogo stations; supercooled liquid water sondes were also launched from those sites as well as from Marambio. Francois MASSONNET provided an update on the progress of the Sea Ice Prediction Network-South (SIPN-South) and its activities during the winter Special Observing Period. SIPN-South's goal is to document and understand the forecasts of Antarctic sea ice extent primarily during austral summer, which now has expanded to the austral winter. Naohiko HIRASAWA outlined Japanese activities during the winter TOP, focusing on the greatly enhanced radiosonde program at Syowa station. Jorge CARRASCO used satellite imagery during the winter TOP that was acquired by the University of Wisconsin to investigate extreme polar lows over the Southern Ocean. Kevin MANNING discussed the NSF-funded project involving Ohio State University (OSU, lead) and the National Center for Atmospheric Research (NCAR) to investigate the forecast impact of all the additional radiosonde ascents released during the seven TOPs. A new 4DVAR data assimilation approach is also being tested and the microphysics parameterizations for mixed-phase clouds are being refined. Finally, Keith HINES outlined his recent work with simulating Antarctic mixed-phase coastal clouds under cold conditions as a prelude for the mixed-phase cloud investigations under warm conditions to be undertaken as part of the OSU-NCAR project described above.

The workshop then discussed three topics. The first considered whether the Antarctic Meteorological Research and Data Center (AMRDC) at the University of Wisconsin could be the YOPP-SH data repository. The first aspect considered was the best approach for assembling a high-resolution dataset of radiosonde ascents, regular and additional, Anasphere sondes, surface observations, and model data sets. The next discussion turned to the best way to make these datasets available to the community. The conclusion was that an AMRDC link for download with a registration process would be ideal. The next aspect addressed the need to collect the metadata from all Antarctic stations. Vito Vitale is preparing a guide for metadata and is training personnel to use this information. Concerning the Atmospheric River (AR) output for the winter SOP prepared by the Scripps Center for Western Water and Climate Extremes (CW3E), Jerry ZOU is working on an archive for AMRDC

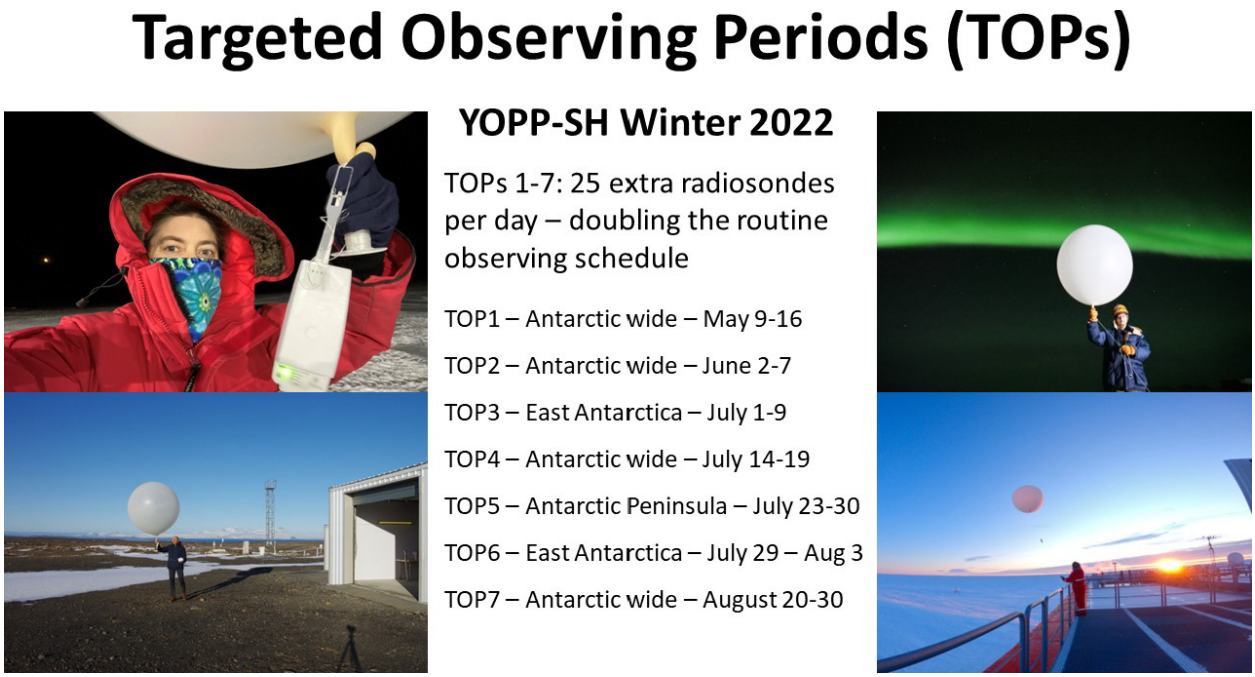

Fig. 3. YOPP-SH TOPs throughout the winter 2022 season.

by backing up plots and analyses. Art Cayette's forecast discussions for the TOPs are being added to the AMRDC archive as well. Group forecast discussions to initiate the TOPs are available in the Slack app and all videos and pictures sent from the stations are stored in a Dropbox account and posted on the social media accounts set up by the Byrd Polar and Climate Research Center. The last topic discussed in this section was that microwave rain radar (MRR) processed data, radiation measurements, and Micropulse Lidar (MPL) data should also be included in the AMRDC archive.

The second discussion concerned the lessons learned from the YOPP-SH TOPs. The deliberations focused on whether the enhanced radiosonde program could continue. Due to limited personnel and the increasing costs of helium, there are some uncertainties. However, YOPP-SH has proven how valuable the extra radiosondes are, so it is improbable that they will stop completely. The Jang Bogo and Concordia stations are good candidates for additional radiosonde ascents during winter; however, it is best to start an enhanced program in summer to demonstrate feasibility and value. Another focus of these deliberations was to evaluate other data collection approaches and even new technology approaches such as wind profilers and ground-based GPS (Global Positioning System) meteorology observations. To summarize, it is also important to know how to use the new data sets in forecast models, and whether they can be made available in a timely fashion.

The last discussion addressed the future of YOPP-SH beyond its expiration in 2024 based on World Meteorological Organization (WMO)-World Weather Research Programme (WWRP) Plans for 2024–27 and the proposed Polar Coupled Analysis, Prediction, and Services (PCAPS) effort. It was mentioned that new future projects need to be defined, focusing on the southern and northern hemisphere polar regions with attention to Indigenous communities and improving coupled models for weather impacts in the increasingly ice-free Arctic (and Antarctic). Specifically, much more emphasis on PCAPS is needed for Antarctica because, among many reasons, local forecast improvements impact the midlatitudes and tropics.

8. Workshop outcomes

This workshop had several key outcomes and action items. The COVID-19 pandemic has clearly impacted fieldwork in the Antarctic, especially in maintaining the AWS network. Explorations into potentially improving field techniques may hold promise in the future (e.g., newer tower and maintenance methods). The AWS network will evolve in the coming years to remove, when possible, sites that are no longer needed and difficult to support. New installations to support improvements in weather forecasting and climate modeling are possible in the near future. As always, more observations, from the surface or satellite, are desired to improve Antarctic weather forecasting. Numerical models such as AMPS aid significantly in forecast operations, despite challenges in representing topography. Additionally, with limited communications always at the forefront of operating in Antarctica, it is essential to have numerical model products available in additional formats and transmitted in a manageable file size to help forecasters and decision-makers. The future of Antarctic numerical modeling remains bright, with newer systems being developed (e.g., MPAS) while well-established systems (e.g., AMPS) remain a vital community standard. Case studies and research investigations at the workshop revealed the importance of both models

and observations. This workshop highlighted how atmospheric rivers are an important feature in Antarctic weather as are clouds in impacting aviation operations. The YOPP-SH TOP revealed the value of additional radiosonde observations to improve numerical weather prediction performance. The AMRDC is evolving to be an indispensable archive and data repository for the Antarctic meteorological community, including collections of unique YOPP-SH forecast datasets, radiosonde observations, and routine and campaign meteorological data, just to name a few. As seen from the Polar Technology Community and the YOPP-SH TOP campaign, the Antarctic is a collaborative community, seeking to address essential questions on Antarctic meteorology and climate, for the benefit of all.

The diversity of topics and participants has brought the WAMC to the forefront in the Antarctic community as well as the WMO. Future meetings will have the opportunity to bring new research topics to the community while continuing discussions on existing topics such as the status and evolution of the AWS network. Numerical modeling will remain a key focus of this workshop in the future and will be an important forum to update the community on the future of numerical modeling systems. The WMO has taken a keen interest in this venue, as it offers the opportunity to engage with participants on developing issues including the implementation of the WMO Information System 2.0, the WMO Integrated Global Observing System (WIGOS), PCAPS, and the Antarctic Regional Climate Center. The heart of this workshop will forever remain a venue to promote collaboration and cooperation for meteorology and climate activities in Antarctica.

9. Workshop materials

All presentations and extended abstracts from the WAMC workshop can be accessed through the AMRDC website under the "Meetings" tab (http://amrc.ssec.wisc.edu/meetings/meeting2022/). Presentations from the YOPP-SH Workshop and a workshop report outlining the discussion are available at: https://polarmet.osu.edu/YOPP-SH_2022/.

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