376 - Forecast Impact of Additional Radiosonde Ascents During the Year of Polar Prediction – Southern Hemisphere (YOPP-SH) Winter Campaign

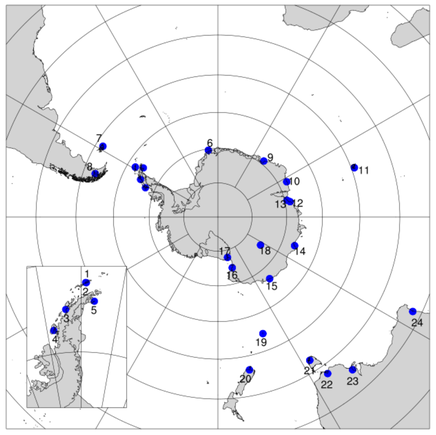
David H. Bromwich[1,2], Jordan G. Powers[3], Mariana Fontolan Litell[1,2], Kevin W. Manning[3] and Sheng-Hung Wang[1]

[1]Polar Meteorology Group, Byrd Polar and Climate Research Center, The Ohio State University, Columbus, OH, USA
[2]Atmospheric Sciences Program, Department of Geography, The Ohio State University, Columbus, OH, USA
[3]NSF National Center for Atmospheric Research, Boulder, CO, USA

Byrd Polar and Climate Research Center
Polar Meteorology Group
The Ohio State University

INTRODUCTION

- Existing polar prediction capabilities require improvement, especially for the Southern Ocean.
- The Year of Polar Prediction in the Southern Hemisphere (YOPP-SH) aims to improve the weather forecasts for Antarctica and the Southern Ocean.
- The project is centered around the winter Special Observing Period (SOP) that spanned April 15 - August 31, 2022.
- During the SOP, seven Targeted Observing Periods (TOPs) featured extra radiosonde launches to capture intense weather events, such as major oceanic cyclones and atmospheric rivers.
- To quantify the benefits of the additional soundings during the TOPs, statistical analyses on Polar Weather Research and Forecast (PWRF) forecast runs were executed.



Stations participating in the winter YOPP-SH, releasing extra radiosondes. On the bottom left, a map with focus on the Peninsula. Station names by number listed in the Table 1.

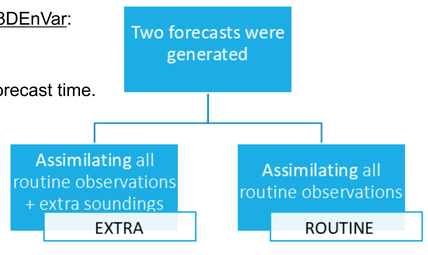
Table 1. Stations that participated in the winter YOPP-SH

NUMBER	STATION NAME
1	King Sejong
2	Escudero
3	Vernadsky
4	Rothera
5	Marambio
6	Neumayer
7	Mount Pleasant
8	Punta Arenas
9	Syowa
10	Mawson
11	Kerguelen
12	Davis
13	Zhongshan
14	Casey
15	Dumont d'Urville
16	Jang Bogo
17	McMurdo
18	Concordia
19	Macquarie
20	Invercargill
21	Hobart
22	Melbourne
23	Adelaide
24	Perth

DATA and METHODS

- NSF NCAR performed forecast experiments using the Weather Research and Forecasting (WRF) model setup in the Antarctic Mesoscale Prediction System (AMPS) framework.
- For the model initial conditions, the observations were assimilated using both 3-Dimensional Ensemble Variational data assimilation (3DEnVar) and Multi-Resolution Incremental 4DVAR (MRI-4DVAR).
- Forecast errors were calculated against ECMWF reanalysis version 5 (ERA5) that is a close approximation to reality.
- Statistical analysis employed: Mean Absolute Error and Student's t–test of the significance of the MAE (for whole domain and south of 60°S).

11 WRF forecasts were generated using 3DEnVar:
- Starting on June 2, 2022 at 1200UTC.
- Ending on June 7, 2022 at 1200UTC.
- With 12-hour intervals between each forecast time.
- Each run for 5 forecast days.



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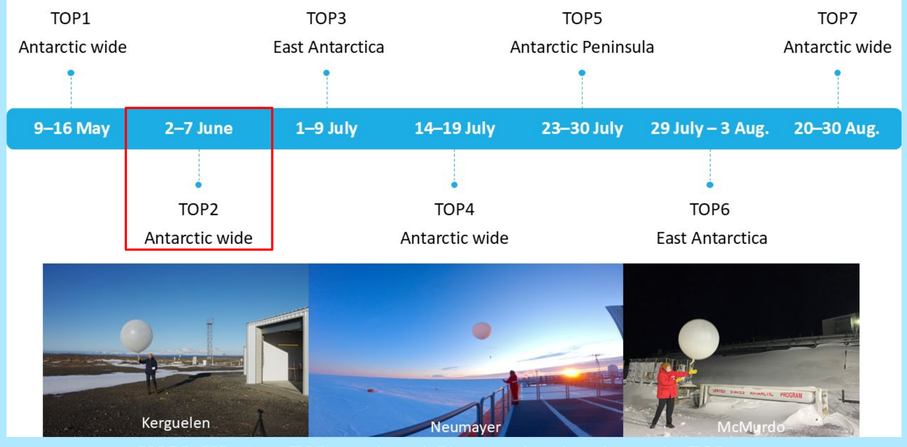
WHY IS ENHANCING THE REPRESENTATION OF THE SOUTHERN OCEAN WEATHER IMPORTANT?

- **Importance for climate change studies:** More observational data improves the representation of physical processes in the climate models. This strengthens their ability to project long-term trends and assess the impacts of climate change.
- **Importance for the Southern Ocean and Antarctica:** Additional atmospheric observations over this region of the globe improve forecasts which further safe and efficient logistical operations, assist in the safeguard of personnel in the stations, and facilitate equipment maintenance.
- **Enhancing forecast models:** Better understanding of the Antarctic atmosphere significantly improves the forecast accuracy for the southern mid-latitudes as well.

Increasing observational data is a key for better forecasting skill for the continent!

TOP experiments with the winter YOPP-SH extra radiosondes show a significant enhancement in the forecasts that employ the extra soundings.

Targeted Observing Periods (TOPs)



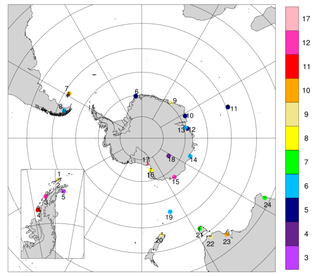
YOPP-SH winter TOPs conducted. Photographs taken during the TOPs.

REFERENCES
- Bromwich, D. H, I. V. Gorodetskaya, S., M. Fontolan Litell, et al., 2024: Winter Targeted Observing Periods during the Year of Polar Prediction in the Southern Hemisphere (YOPP-SH). *Bull. Amer. Meteor. Soc.*, **105**, E1662–E1684, https://doi.org/10.1175/BAMS-D-22-0249.1.
- Bromwich, D. H., J. G. Powers, K. W. Manning, X. Zou, 2022: Antarctic data impact experiments with Polar WRF During the YOPP-SH summer special observing period. *Q. J. R. Meteorol. Soc.*, **148**, 2194–2218, https://doi.org/10.1002/qj.4298.

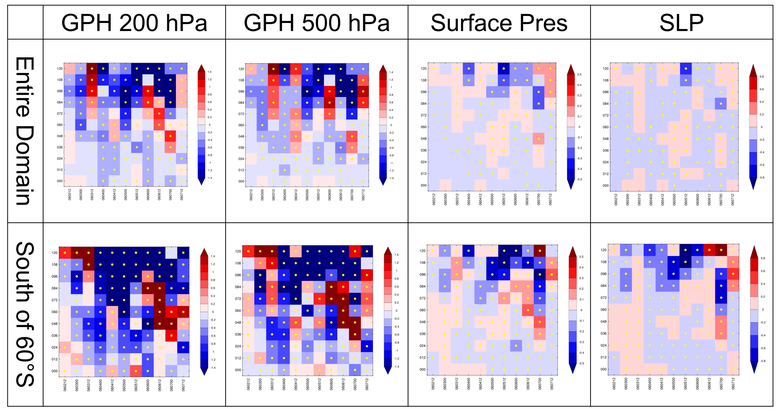
RESULTS FOR TOP2

- TOP2: June 2-7, 2022.
- Around 32 extra soundings/day.
- Key Events: Atmospheric Rivers at the Peninsula and Queen Maud Land.
- Results for the TOP2 experiments with observations assimilated using 3DEnVar.

Total number of additional soundings by station during TOP2 (colors). The information for each location number can be found in Table 1.

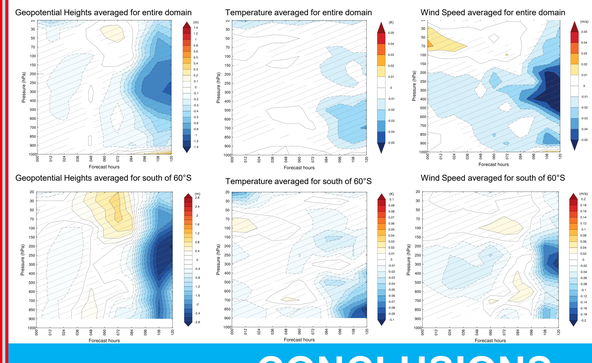


MAE difference (MAE [Extra-ERA5] – MAE [Routine-ERA5]) for each forecast and forecast lead time
Blue = Extra better **Red** = Routine better (Yellow dots: significance > 95%)



For most times, there is enhancement in the forecast with the extra radiosondes. This is particularly pronounced when averaged for regions south of 60°S.

MAE difference (MAE [Extra-ERA5] – MAE [Routine-ERA5]) averaged for each forecast hour
Blue = Extra better **Red** = Routine better (Hatching: significance >95%)



For TOP 2, a significant improvement in forecast accuracy is observed, especially in the later forecast hours (after 72 hours) south of 60°S.

CONCLUSIONS

- The need for improvement in Antarctic weather forecast is imperative but challenging due to several limitations such as the shortage of observations for assimilation.
- Overall, the results of the TOP experiments with the winter YOPP-SH extra radiosondes demonstrate a major improvement in forecast accuracy, particularly for south of 60°S and later forecast hours.
- Analyses are continuing to verify the impact of additional soundings for all seven TOPs.