AMPS CONTRIBUTIONS TO THE YEAR OF POLAR PREDICTION–SOUTHERN HEMISPHERE (YOPP–SH)

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NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

THE OHIO STATE UNIVERSITY

AMPS

BACKGROUND

WORLD METEOROLOGICAL ORGANIZATION

- **WMO Polar Prediction Project (PPP)**
  - Goal: Promote international research toward improved weather and environmental prediction for the polar regions
  - Period: 2013–2022

- **PPP Activity: Year of Polar Prediction**
  - Period: 2017–2019
  - Elements: Intensive observing, modeling, verification, and educational activities

YOPP YEAR OF POLAR PREDICTION

BACKGROUND

- **Year of Polar Prediction–Southern Hemisphere (YOPP-SH)**
  - – Focus: Observation and prediction in the high southern latitudes
  - – **S**pecial **O**bserving **P**eriod (**SOP**): November 2018–February 2019

  SOP Observations

  - ✓ Extra radiosonde launches

    Ex: 4/day from Neumayer and Dumont D'Urville

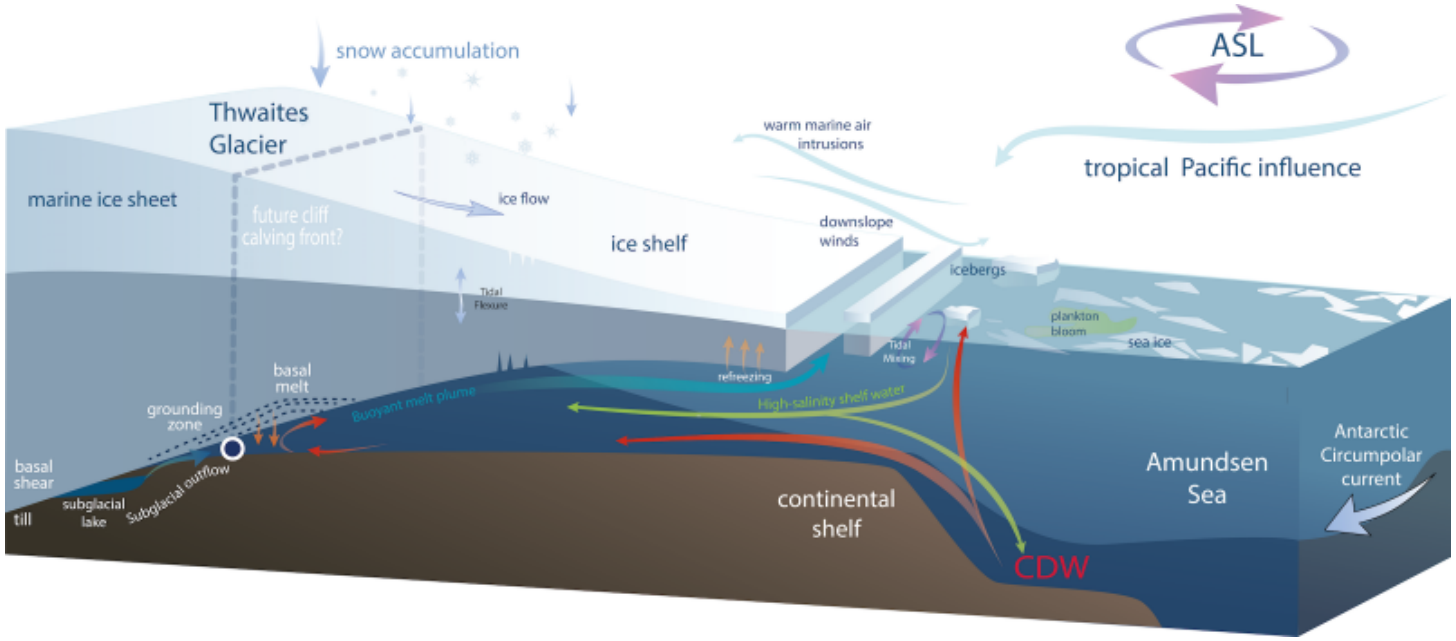
  - ✓ Deployment of enhanced surface AWS platforms
  - ✓ Additional Southern Ocean drifting buoys
  - ✓ Oceanic observations from ships

    Ex: Sondes, CTD (conductivity/temp/depth) measurements

AMPS-RELATED ACTIVITIES IN YOPP-SH

1) Regular AMPS Forecasts

2) Thwaites Glacier Study Support



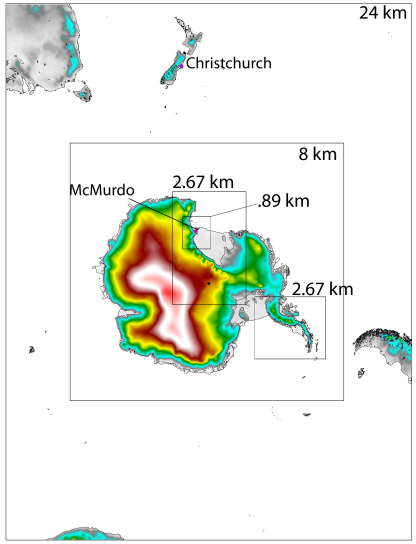
3) YOPP-SH Data Impact Study

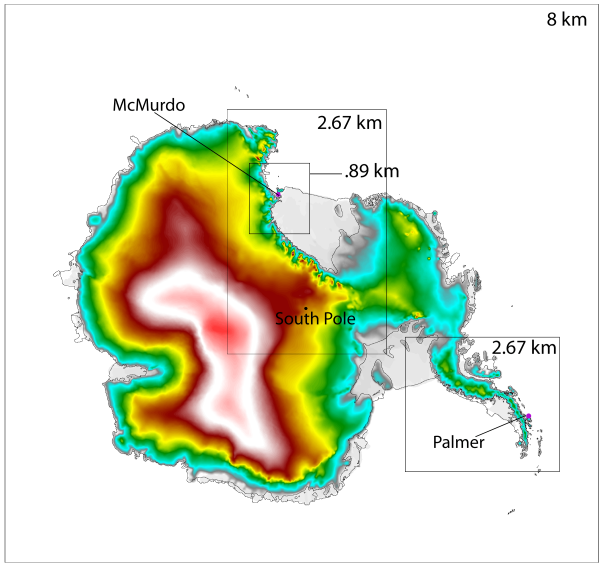
AMPS ACTIVITIES IN YOPP-SH

1) Regular AMPS Forecasts

– Models: Weather Research and Forecasting (WRF) Model
and Model for Prediction Across Scales (MPAS)

– WRF: 5 domains— 24 km / 8 km / 2.67 km / .89 km grid spacings





– WRF output archived and web-accessible for YOPP-SH studies

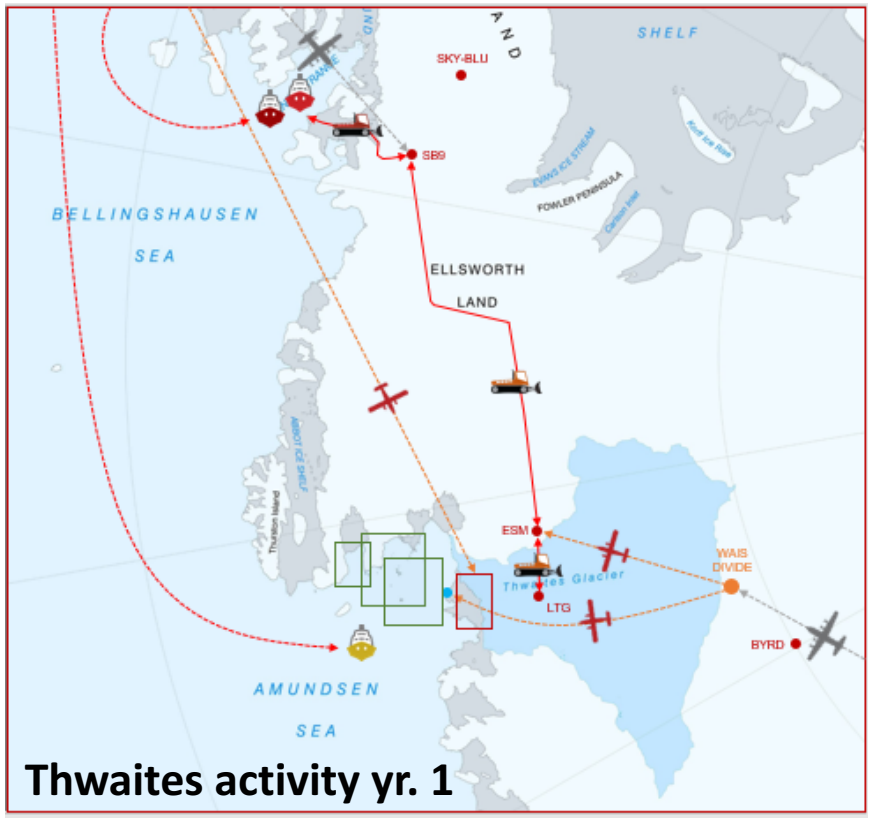
Earth System Grid/Climate Data Gateway at NCAR

https://www.earthsystemgrid.org/project/amps.html

2) Support for Thwaites Glacier Study

– Investigation of the unstable Thwaites Gl: NERC (UK) & NSF (US) sponsors

– Field campaigns (2018–2021): Measure ocean and currents, glacier dynamics, and marine sediments



Thwaites activity yr. 1

AMPS: Additional, higher-res WRF forecast grid for field periods

Ex: $\Delta x \leq 2.67$-km

https://thwaitesglacier.org/

3) YOPP-SH SOP Data Impact Study Using the AMPS Framework

– Collaboration: The Ohio State University BPCRC and Polar Meteorology Group and NCAR

– Support: NSF

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

– Components

(i) SOP obs acquisition and preparation

(ii) Configuration of model, forecasts, and data assimilation system

(iii) Model simulations

(iv) Experiment analyses

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NSF

YOPP-SH SOP DATA IMPACT STUDY

- **Goal 1: Determine effects on model forecasts of enhanced southern hemisphere observations**

  – Do the SOP obs improve forecasts? To what degree?

  – Over what timescales are the effects seen: Over subseasonal periods or in specific weather events?

  → Determine value in maintaining additional Southern Hemisphere high-latitude obs

- **Goal 2: Explore variations in data assimilation for WRF in AMPS for forecast improvement**

  – Can different data assimilation approaches for WRF yield AMPS forecast improvements?

  → Advance the PPP goal of improving polar NWP

- **Background: Current AMPS Setup**
  - **AMPS Ensemble WRF Forecasts**
    - 15-member WRF ensemble (24-km/8-km grids only)

      (i) Provides ensemble guidance for USAP forecasters

      (ii) Generates background error information for the data assimilation for the main WRF forecasts

    - Member backgrounds: NCEP **G**lobal **E**nsemble **F**orecast **S**ystem (GEFS)
  - **AMPS Main WRF Forecasts:** Backgrounds from NCEP **GFS** (Global Forecast System) analyses

Note: YOPP-SH experiments— Cycled WRF forecasts for backgrounds

YOPP-SH SOP DATA IMPACT STUDY

- **Approach:** WRF Antarctic forecasts (i) assimilating different data and (ii) applying different DA procedures

- **Experiment Variations**

1) Observations Ingested

(a) STD obs (standard AMPS operational)

STD obs: AWS, SYNOP, METAR, ships and buoys, radiosondes, aircraft obs, satellite winds, GPS radio occultations, satellite radiances

(b) STD obs + SOP obs

2) Data Assimilation (DA) Procedures Used

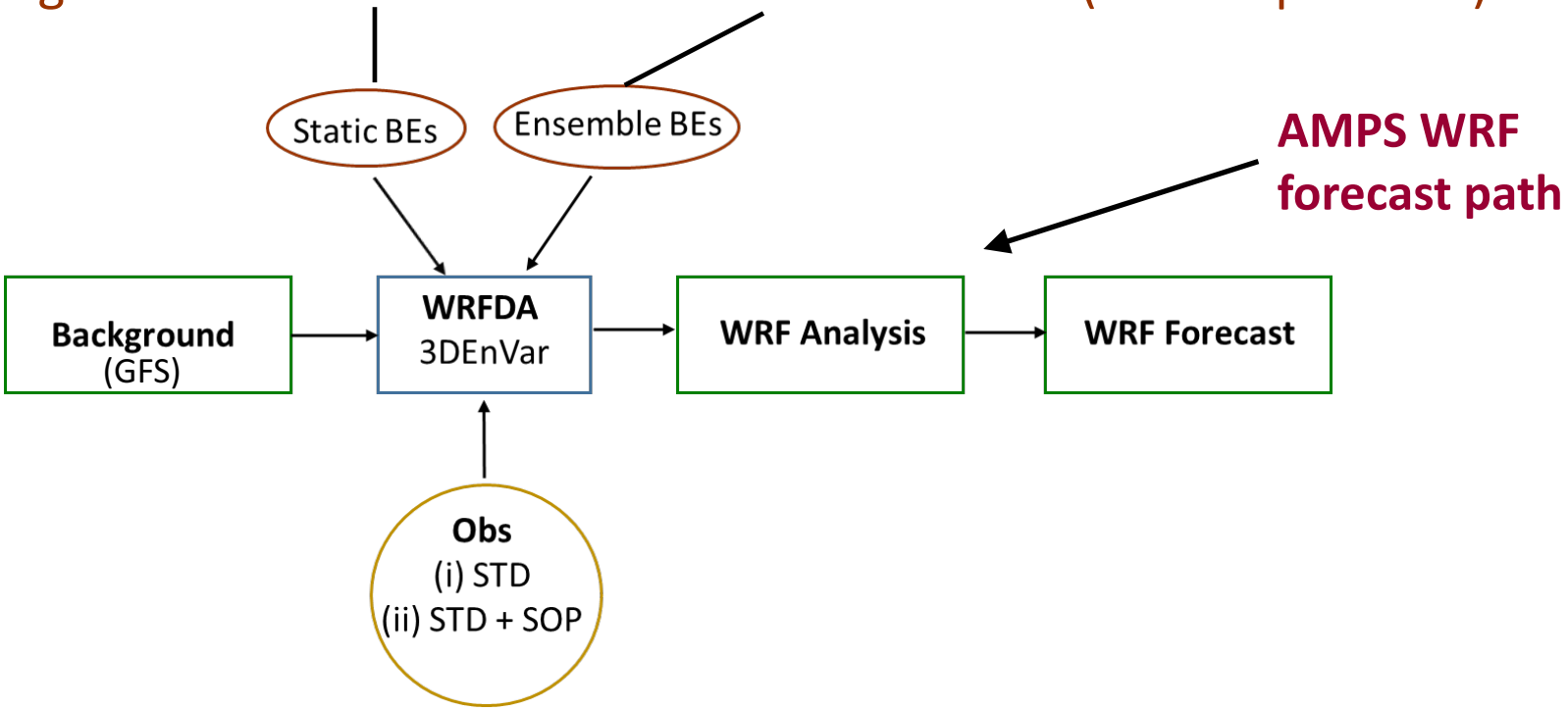
– Variation of the background error (BE) covariance inputs to the data assimilation package

DA Procedure Experiments

- **Current DA for WRF in AMPS:**
  Hybrid Ensemble/3-Dimensional Variational DA (3DEnVar)
  - 3DVAR w/ **background error covariances** (BEs) from two methods

(i) BEs from AMPS main fcsts using NMC method: **Static BEs**

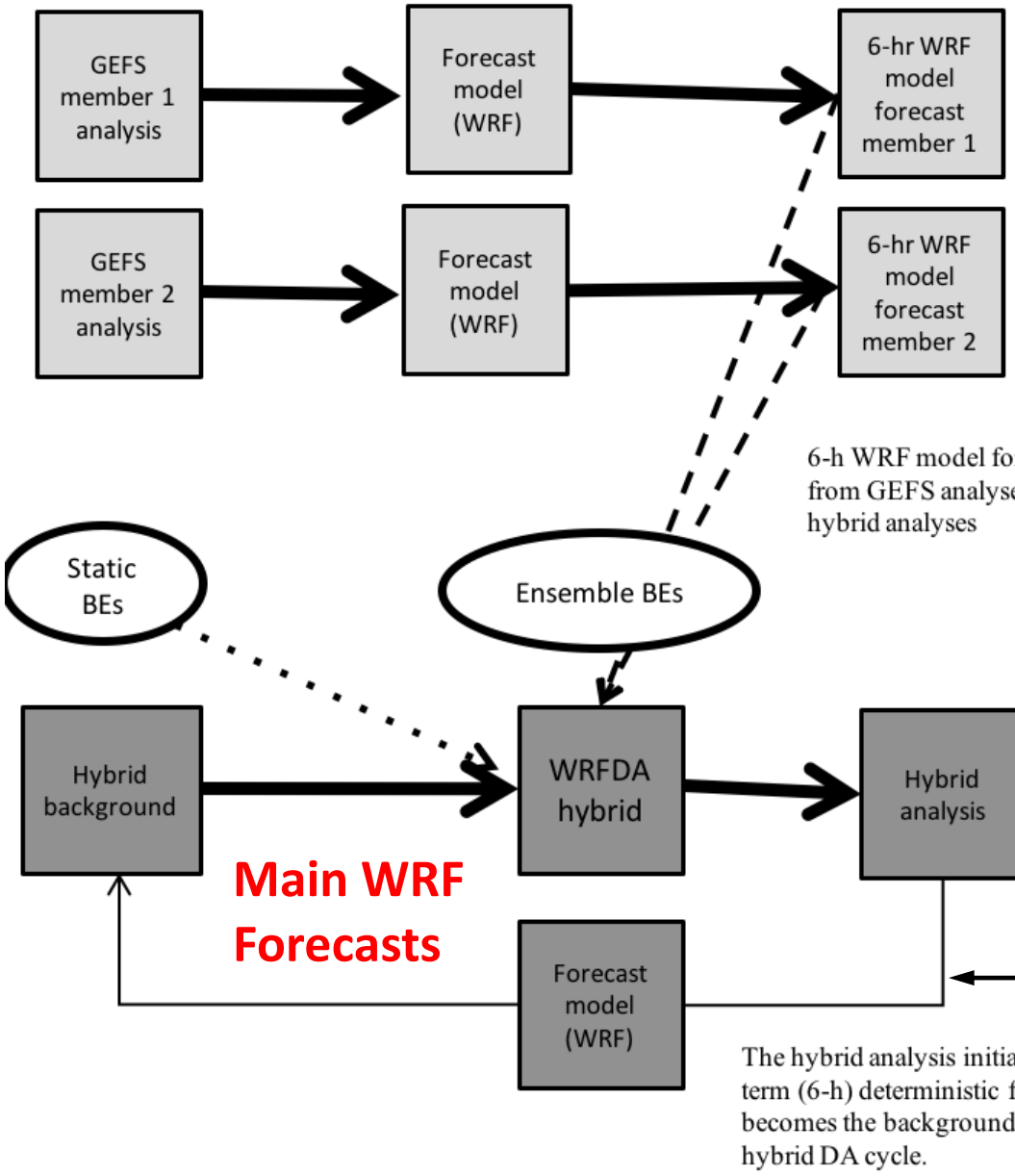
(ii) BEs from AMPS ensemble fcsts: **Ensemble BEs** (flow-dependent)



- **Experiments: WRF DA Variations Using New Ensembles**
  - Purpose: Generate **two versions of flow-dependent BEs** for use in the DA
  - Create 2 new, larger ensembles for expts: ~60 members each
    - ✓ BE covariances better estimated from larger ensembles
  - Ensemble differences: Member (a) backgrounds and (b) initializations
    - **Ensemble 1: GEFS backgrounds + no DA**
    - **Ensemble 2: Cycled WRF backgrounds + DA**

      DA method used: EnKF (Ensemble Kalman Filter) DA for initialization of members using **DART— Data Assimilation Research Testbed**

WRF Ensemble for BE Generation



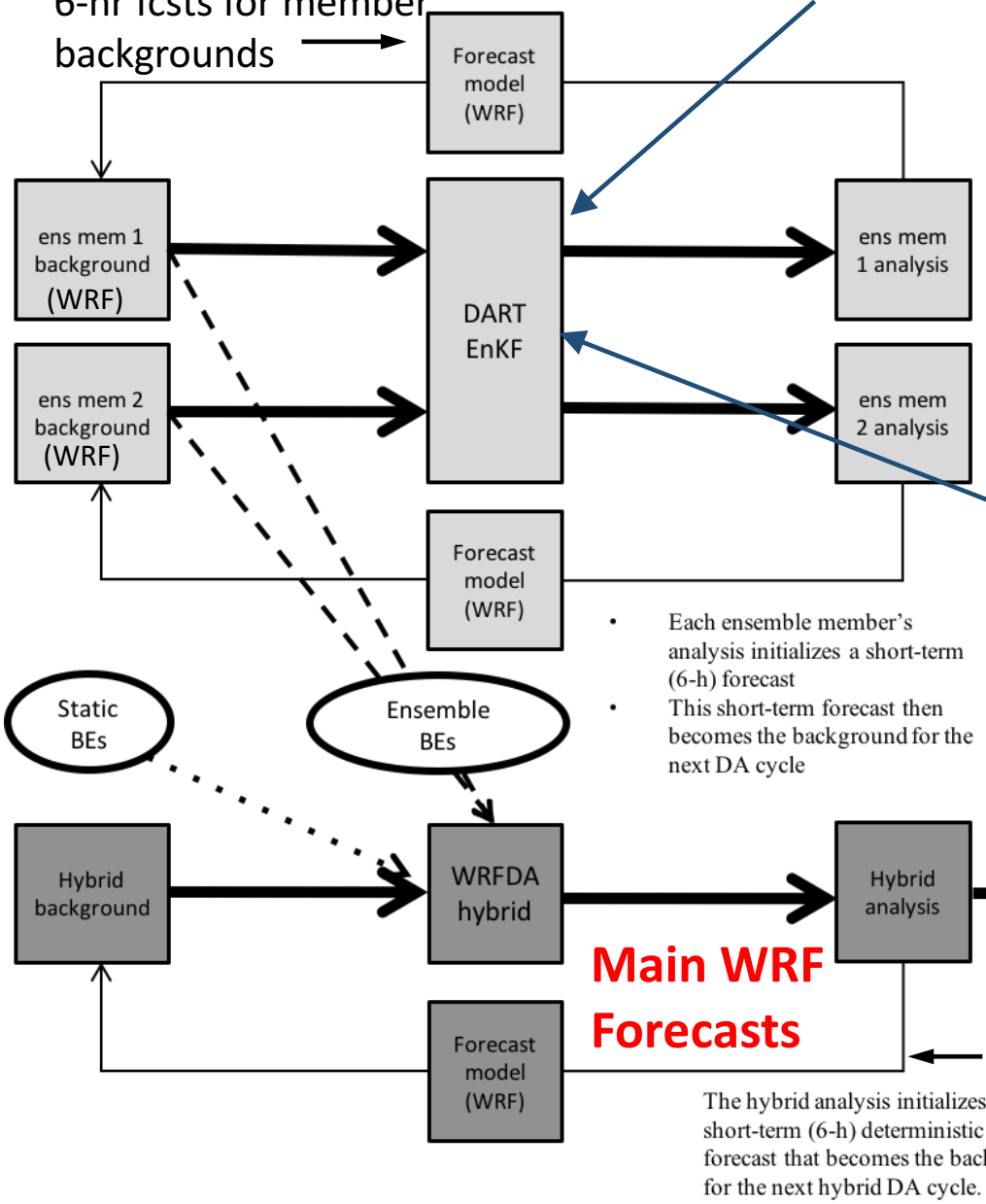
- **DA BE Variation 1**

– WRF ensemble members initialized from GEFS

– Ensemble fcsts used to generate BEs for the DA for the experiment fcsts

WRF Ensemble for BE Generation

DART uses an EnKF approach for DA in initializing cycled WRF ensemble members



- **DA BE Variation 2**

– Cycled WRF ensemble used to generate BEs for the DA for the experiment forecasts

– **Data Assimilation Research Testbed (DART)** used for DA for the ensemble members

SOP DATA WRF FORECAST EXPERIMENTS: 2 TYPES

- **Period Forecasts**
  - 2-week periods

    November 2018 (spring)

    Early January 2019 (mid-summer)

    February 2019 (late summer)

  - 24-km/8-km forecast grids used
  - 2 forecasts/day: ≥72 hrs

- **Event Forecasts**
  - Selected cases of significant weather affecting Palmer and McMurdo
  - Higher-resolution grids used: ≤2.67-km

SECONDARY DATA IMPACT TARGET: GLOBAL SOUTHERN OCEAN (GSO) ARRAY DATA

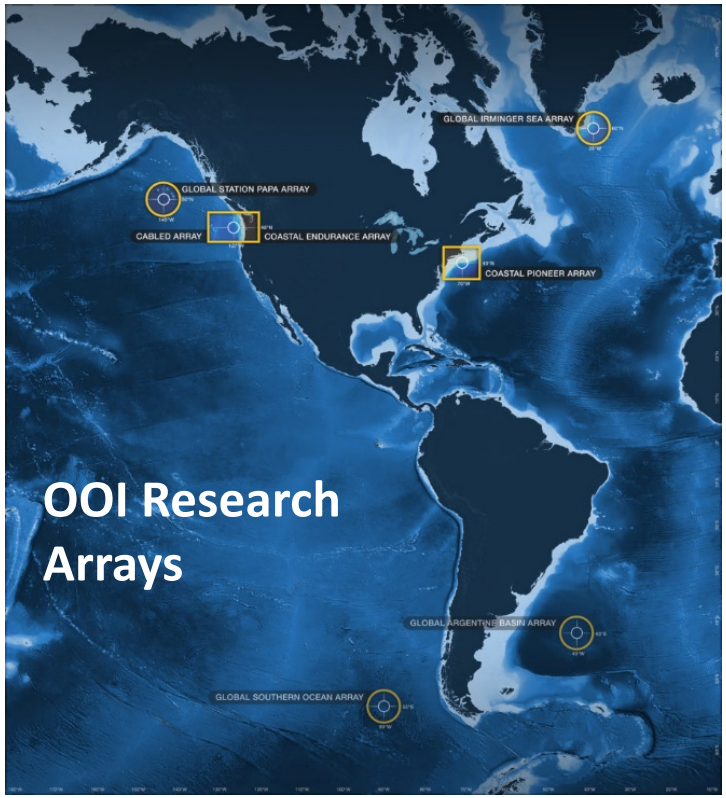
Resources permitting: Assess fcst impact of obs from the NSF Ocean Observatories Initiative (OOI) GSO array

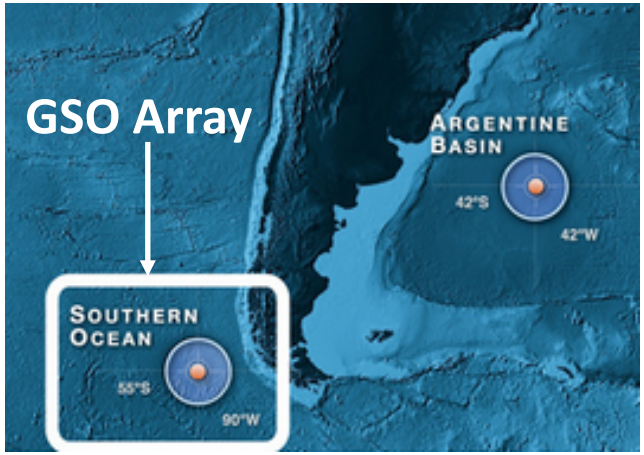
– GSO: 55°S 90°W

– OOI: Program to measure physical, chemical, geological, and biological properties and processes

– Data claimed to improve an ECMWF model forecast

Aim: Leverage the YOPP-SH study to assess the influence of the data from this NSF asset





SUMMARY

- **AMPS Contributions to YOPP-SH**

  (1) Continued AMPS forecasts and data archiving

  (2) Thwaites Gl. study support

  (3) SOP data impact study

- **YOPP-SH Data Impact Study**

  – Examine effects of SOP data on WRF Antarctic forecasts

  – Variation of data assimilation approaches in AMPS

  – Goals

    - **Determine forecast value of extra Southern Hemisphere obs**
    - **Identify improvements for DA in AMPS**