# THE NCAR-OSU YOPP-SH DATA IMPACT STUDY: UPDATE

Jordan G. Powers[1], Kevin W. Manning[1], and
David H. Bromwich[2]

[1]Mesoscale and Microscale Meteorology Laboratory
National Center for Atmospheric Research
Boulder, Colorado, USA

[2]Department of Geography and Byrd Polar and Climate Research
Center
The Ohio State University
Columbus, Ohio , USA

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# Background

- **WMO Polar Prediction Project (PPP)** (2013–2022)

    - Goal: Promote research toward improved environmental prediction for the polar regions

    - Year of Polar Prediction: 2017–2019

- **YOPP Activity: YOPP–Southern Hemisphere (YOPP-SH)**

    - Focus: Observation & prediction in the high southern latitudes

    - **S**pecial **O**bserving **P**eriod (**SOP**): **November 2018–February 2019**

        - ✓ Extra radiosondes
        - ✓ Enhanced surface AWS platforms
        - ✓ Drifting buoys
        - ✓ Ship obs: Oceanic, atmospheric

# YOPP-SH SOP Data Impact Study

- **Methodology: Conduct Model Forecast Experiments Adding Observations and Varying Data Assimilation Approaches**

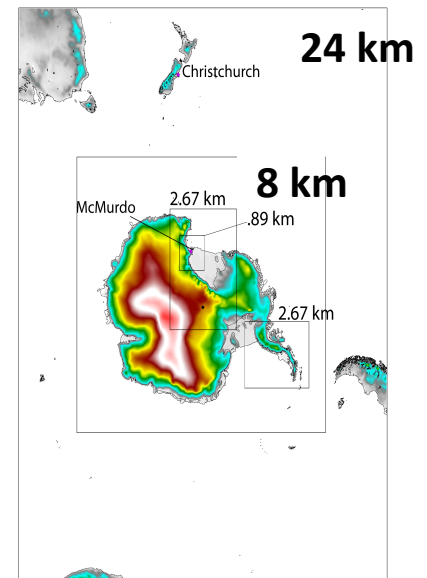   **1) Add YOPP-SH SOP soundings in model initialization**

   *Do the YOPP-SH obs improve the forecasts significantly?*

   **2) Test new data assimilation (DA) methods for AMPS**

   *Can different DA approaches improve polar prediction in AMPS?*

- **Framework:  AMPS WRF Domains**

   – 24-km (Southern Ocean) & 8-km (Antarctica) grids

# Forecast Setups: Observation Sets

**Standard Observations for AMPS WRF Forecasts**

- Surface AWS and station repts (METAR, SYNOP, etc)
- Radiosondes
- Ships, buoys, aircraft
- Satellite measurements: Winds, temps, etc.
- GPSRO

**Observation Sets for Experiments**

**1) STD Expts: Standard AMPS obs**

**2) STD + SOP Expts: Standard AMPS obs + SOP soundings**

Issue: Identification of the extra/non-regular soundings attributable to the SOP

# Extra YOPP-SH Soundings

*Thanks to: Steve Colwell, BAS!*

| Site | Launches | Site | Launches |
|------|----------|------|----------|
| Aboa | 35 | Macquarie | 57 |
| *Agulhas II* | 15 | *Mary Arctica* | 1 |
| *Almirante Maximiano* | 20 | *Mary Celeste** | 21 |
| Casey | 91 | Mawson | 61 |
| Concordia | 120 | Mirnyj | 93 |
| Davis | 167 | Neumayer | 257 |
| Dumont D'Urville | 191 | Polarstern | 118 |
| Escudero | 86 | Rothera | 26 |
| Halley | 63 | *Shirase* | 20 |
| Jang-Bogo | 86 | Syowa | 213 |
| King Sejong | 101 | WAIS | 29 |
| Mario Zucchelli | 74 | **Total** | **1945** |

Not included: Dome Fuji

*= WDK38HS

# Observation Acquisition: AMPS Data Sources During SOP

## i) GTS
- AMPS regular, real-time standard obs ingest source

## ii) NCEP BUFR
- BUFR= **B**inary **U**niversal **F**orm for the **R**epresentation of met data
- Not QC'd
- Sounding data: Full vertical resolution

## iii) NCEP GFS PrepBUFR
- Prepared BUFR: NCEP processed & QC'd BUFR
- Sounding data: Reduced vertical resolution

## iv) NCEP GDAS PrepBUFR
- Data from NCEP's **G**lobal **D**ata **A**ssimilation **S**ystem
- GDAS= DA system used by NCEP for GFS initialization
- Sounding data: Reduced vertical res
- Later cutoff time

# YOPP-SH SOP Sonde Data Monitored for AMPS

- **SOP Sonde AMPS Monitoring Page**

**www2.mmm.ucar.edu/rt/amps/status/prepbufr_raob_accounting.html**

89002 : 354 : NEUMAYER / GERMANY STTN
89009 : 211 : AMUNDSEN-SCOTT / U.S.A. STTN
89022 : 109 : HALLEY / U. KINGDOM STTN
89055 : 014 : BASE MARAMBIO(CENTRO MET. ANTARTICO) / A
89056 : 081 : CENTRO MET. ANTARTICO PDTE. EDUARDO FREI
89062 : 102 : ROTHERA POINT / U. KINGDOM STTN
89532 : 209 : SYOWA / JAPAN STTN
89564 : 111 : MAWSON / AUSTRALIA STTN
89571 : 224 : DAVIS / AUSTRALIA STTN
89573 : 000 : ZHONGSHAN WEATHER OFFICE / CHINA STTN
89592 : 208 : MIRNYJ / RUSSIAN FEDERATION STTN
89611 : 230 : CASEY / AUSTRALIA STTN
89625 : 230 : CONCORDIA / ITALY STTN
89642 : 288 : DUMONT D'URVILLE / FRANCE STTN
89662 : 233 : BASE BAIA TERRA NOVA / ITALY STTN
89664 : 215 : MCMURDO / U.S.A. STTN
89859 : 000 : JANG BOGO (KOREA)
94998 : 323 : MACQUARIE ISLAND / AUSTRALIA (ADDITIONAL
DBLK : 176 : Polarstern
HTXUH4H : 001 : HTXUH4H
JSNJ : 000 : SHIRASE
MOBIL : 000 : DOME FUJI / JAPAN STTN
WDK38HS : 021 : WDK38HS
WSD : 008 : WAIS DIVIDE

**SOP Sonde Sites/ Platforms**

NB: Not all sites launched through the duration of the SOP.

# Ex: Radiosonde Data– 15 Jan 2019

## Reports Received
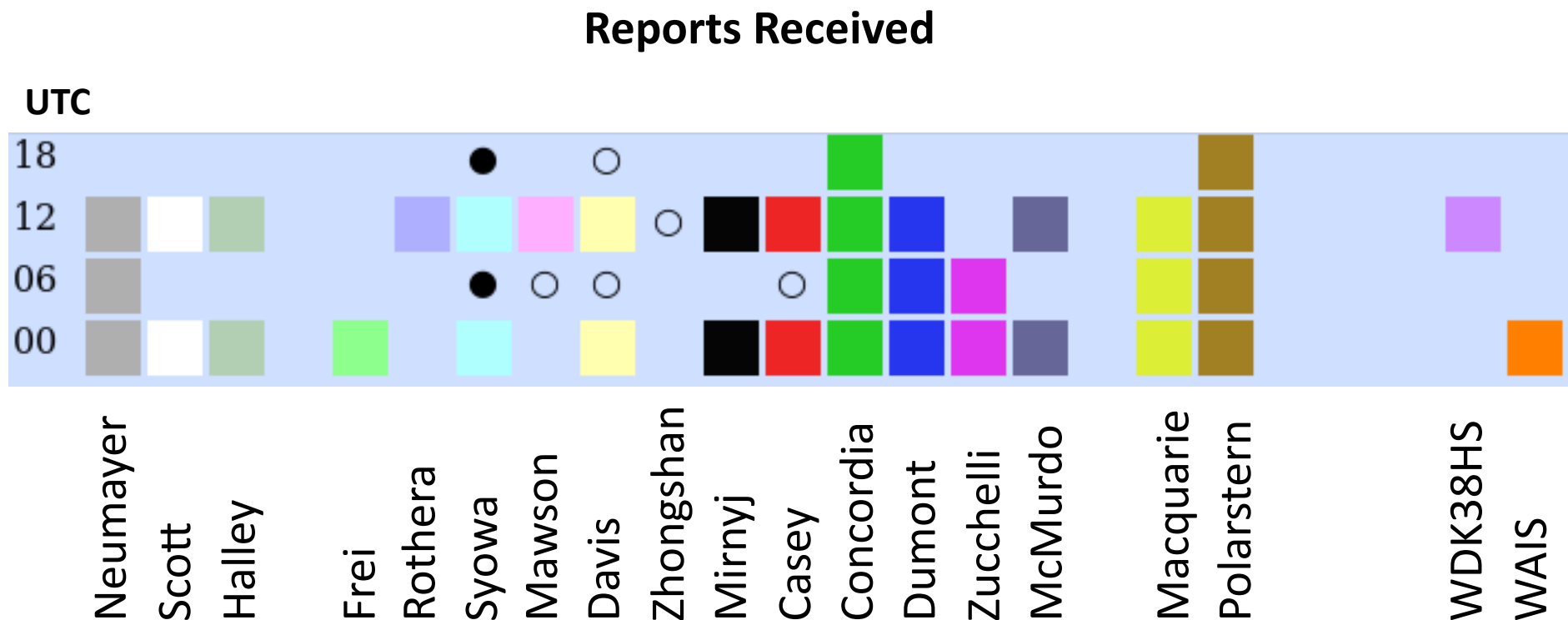


○ ●: Source of data from NCEP

○ Report in low-level BUFR files but not in PREPBUFR files
● Report in GDAS PREPBUFR file but not in GFS PREPBUFR file

# WRF FORECAST EXPERIMENTS

- **Period Forecasts**

  – 72-h forecasts initialized 0000 & 1200 UTC each day

  *15–30 November 2018*     (spring)

  *1– 15 January 2019*     (mid-summer)

  *1–15 February 2019*     (late summer)

- **Event Forecasts**

  – Cases of significant/noteworthy weather

  ◆ *Major low impacting Ross Is.*     *3–4 Dec 2018*

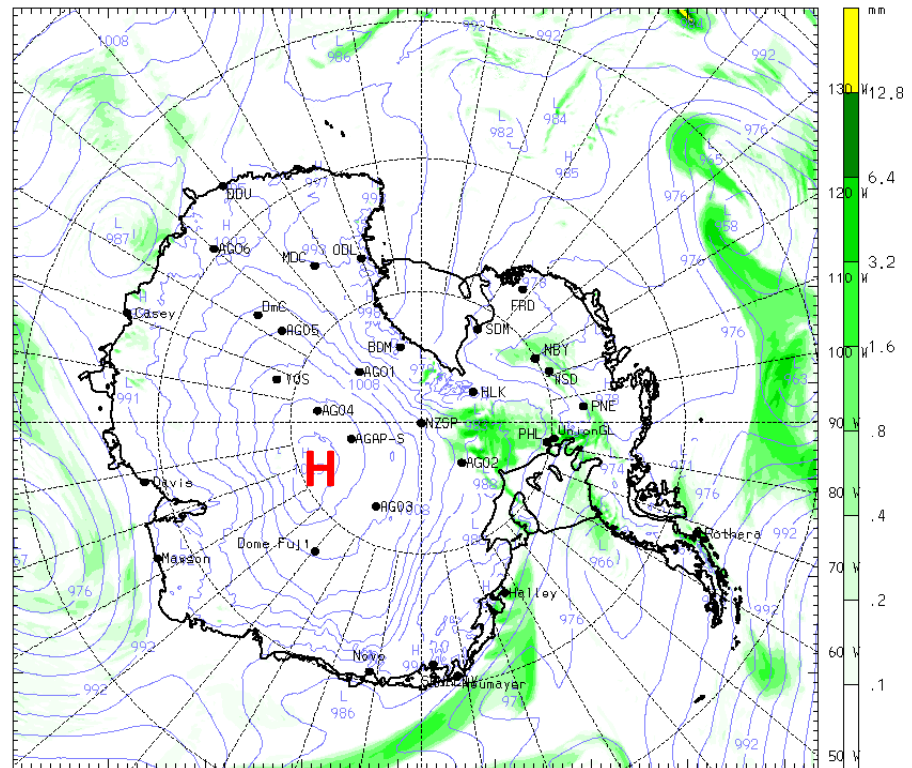  ◆ *Unusual ridge/flow over continent*     *18–22 Dec 2018*

  ◆ *Log fog/cloud period at WAIS*     *8–9 Jan 2019*
      *causing flight aborts*

# Case Study: Continent-Wide Ridge 18–22 Dec 2018

– Upper-level ridge: Flow crossing continent from QML to Ross Sea
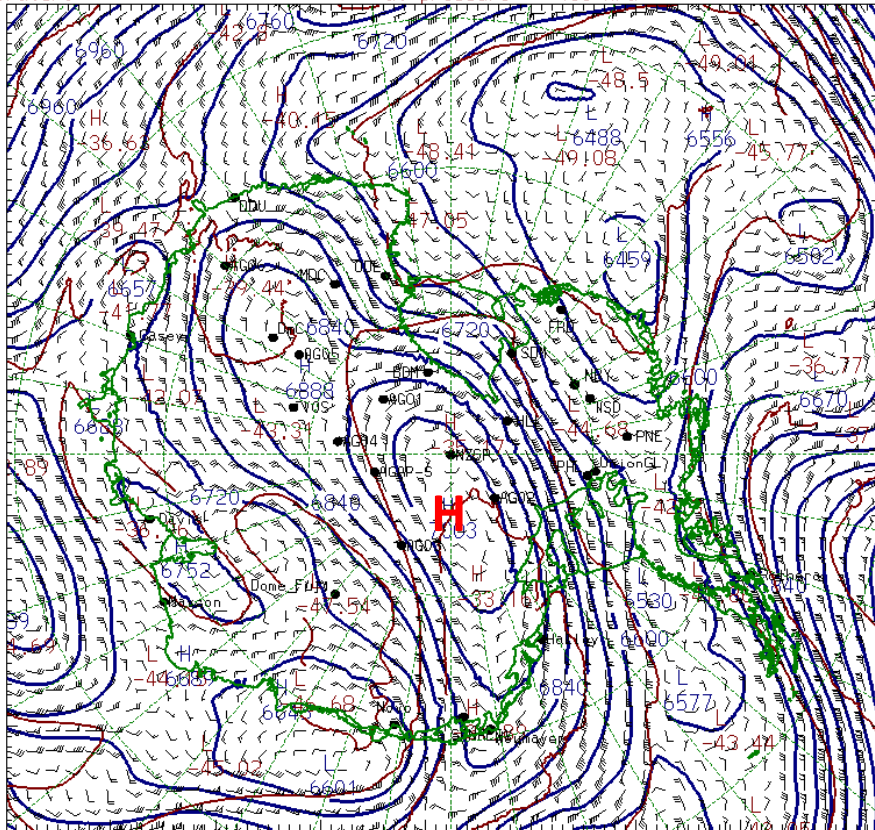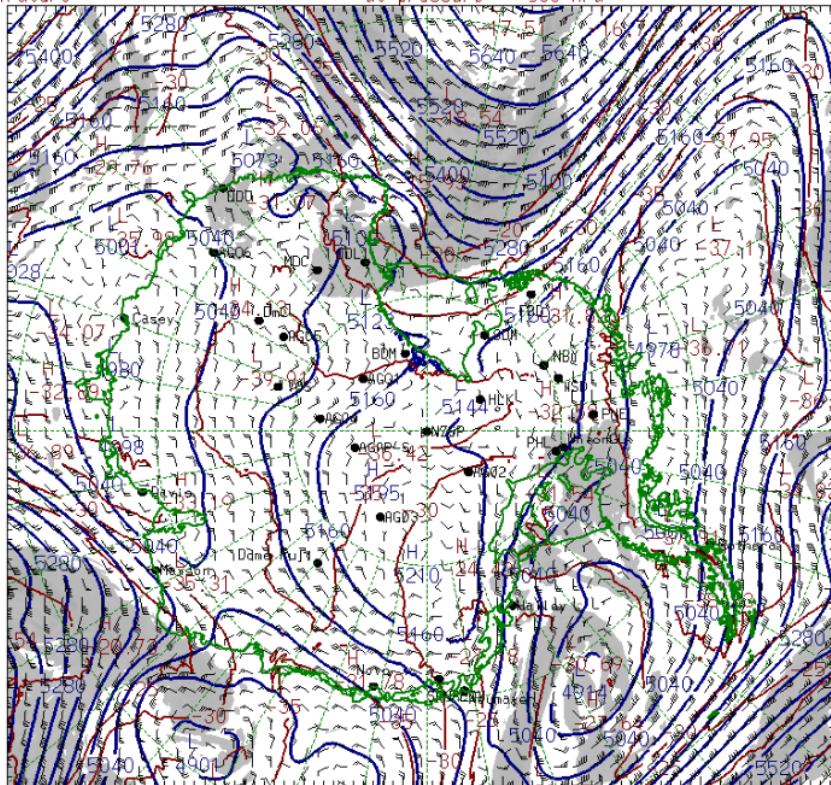


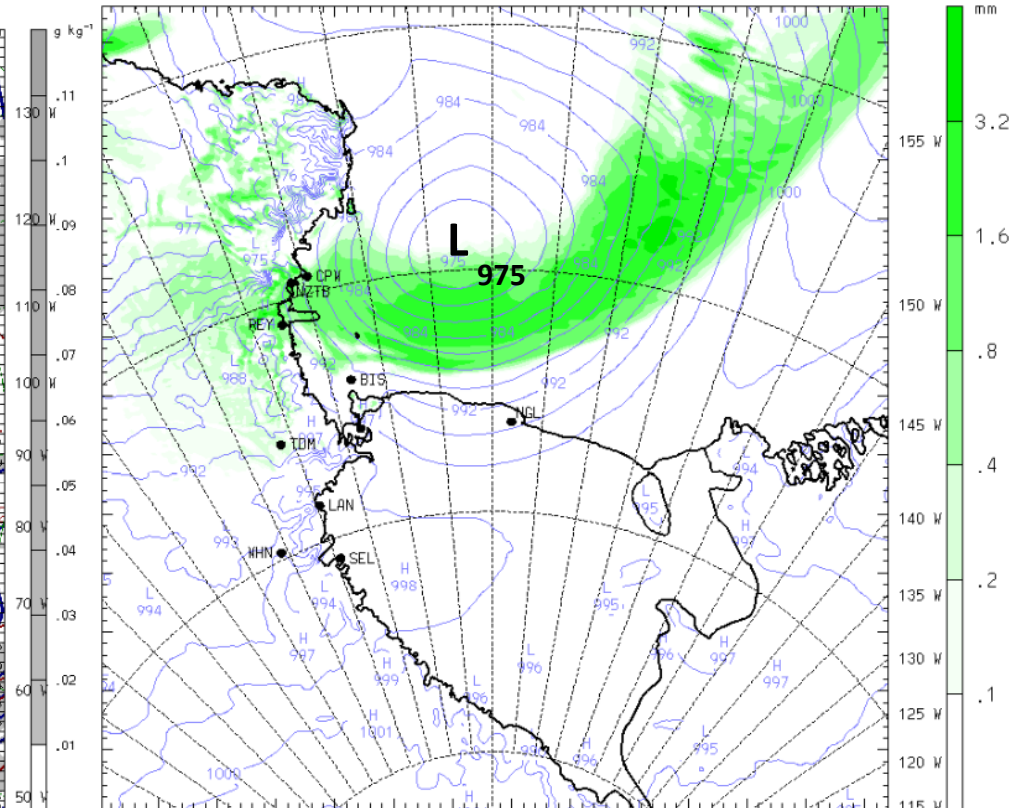400 mb analysis 00 UTC 20 Dec 2018
(Height interval= 60 m)



SLP/Precip 00 UTC 20 Dec 2018
72h AMPS WRF fcst

# Case Study: Low Impacting McMurdo 3–4 Dec 2018

– Deep, strong low moving into Ross Sea from NW
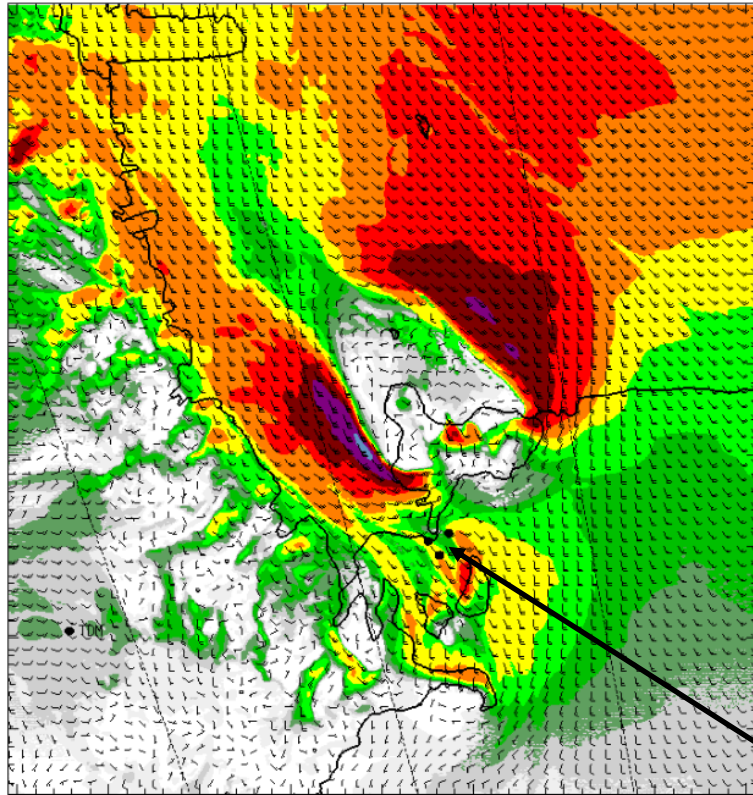– Strong winds and precip in Ross Is. region: Flight cancellations



**500 mb analysis 00 UTC 4 Dec 2018**
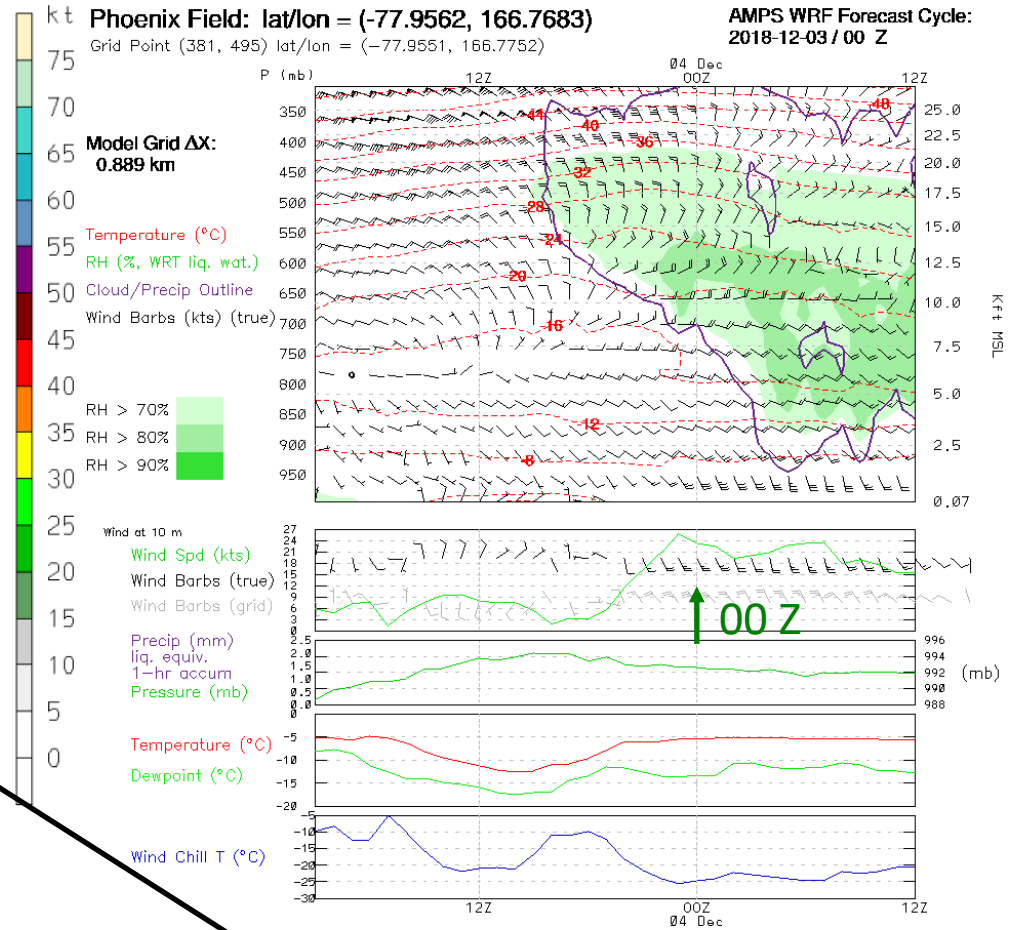**Height interval= 60 m**
**Cloud shaded**

**SLP/Precip  00 UTC 4 Dec**
**24h AMPS WRF fcst**

# Case Study: Low Impacting McMurdo 3–4 Dec 2018



Sfc wind gusts (kt) 00 UTC 4 Dec
24h AMPS WRF fcst

Phoenix Field Meteogram
00 UTC 3 Dec 2018 init

# DA Experiment Methodology: Varied System Inputs from Different Forecast Ensembles

- **AMPS WRF DA: Hybrid Ensemble/3D-Variational DA  (3DEnVar)**

  – Key system component: **Background Error (BE) covariances**

  – BE input types to 3DEnVar: (1) Static and **(2) Ensemble**



*The 2 ensembles to be run come into play here.*

**WRF Model forecast generation path**
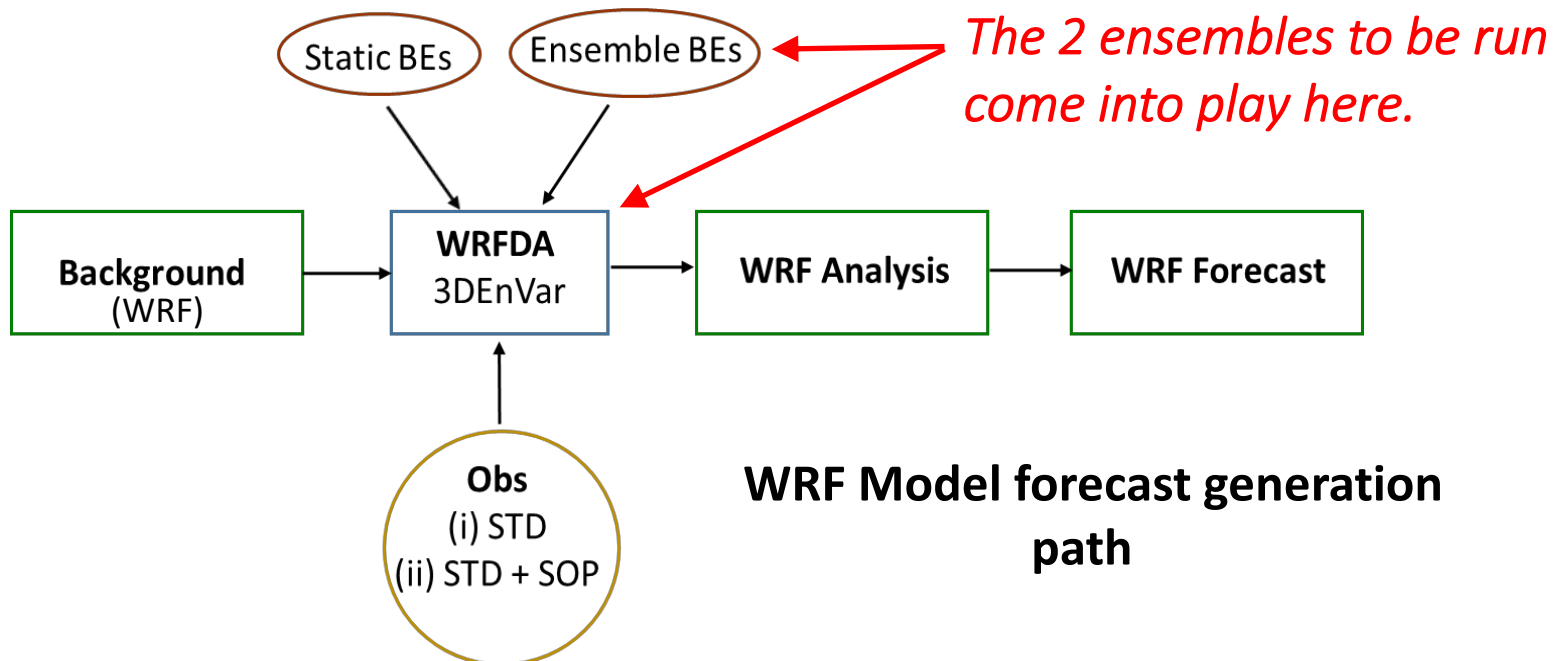
# Approach to DA Experiment Ensemble Input

**Run 2 WRF Ensembles ⇨ 2 Ensemble BE Sets ⇨**
**2 DA Setups ⇨ 2 Different Forecast Analyses**

- ENSEMBLE 1

  Input: GFS Global Ensemble Forecasting System (GEFS)
  output used to initialize WRF ensemble

- ENSEMBLE 2

  Input: Cycled WRF members w/member reanalysis via DA
  using the **DART** data assimilation system

  **DART = Data Assimilation Research Testbed**

  NCAR community system for *ensemble* data assimilation:
  **Ensemble Kalman Filter (EnKF) technique**

# DA Approach Development and Testing

- **Testing of Cycled WRF Ensemble Completed**

    – Cycled WRF ensemble created and tested
        Period: 1 Nov 2017– 10 Dec 2017

    – WRF w/6-h cycling with DART DA

    *Results:*    ✓ *Cycled system stable*

    ✓ *No forecast problems*

- **DART Configuration and Testing**

    – System applied to Antarctica: Code modified for WRF polar
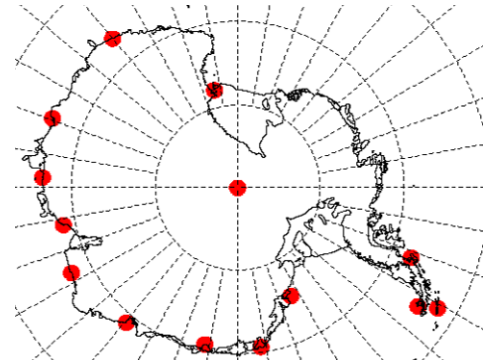        stereographic grid projections

    *Results:*    ✓ *Error reductions in analyses*

    ✓ *Behavior reasonable*
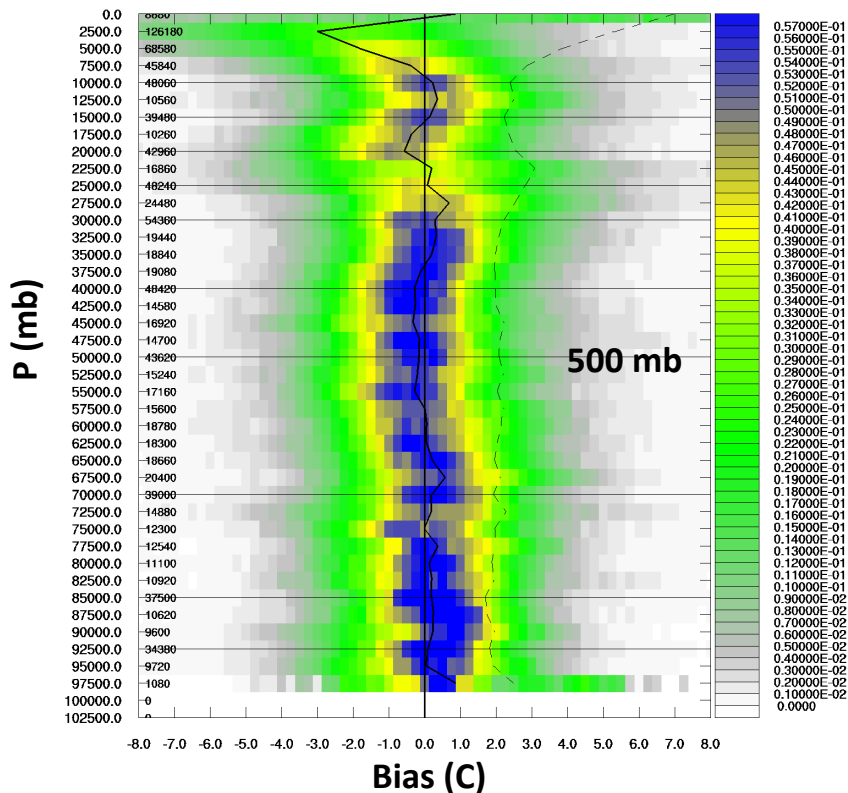
# Testing of DART: T Biases at RAOB Sites

**Prior Bias= Background – Obs**   *Before* **DART DA**

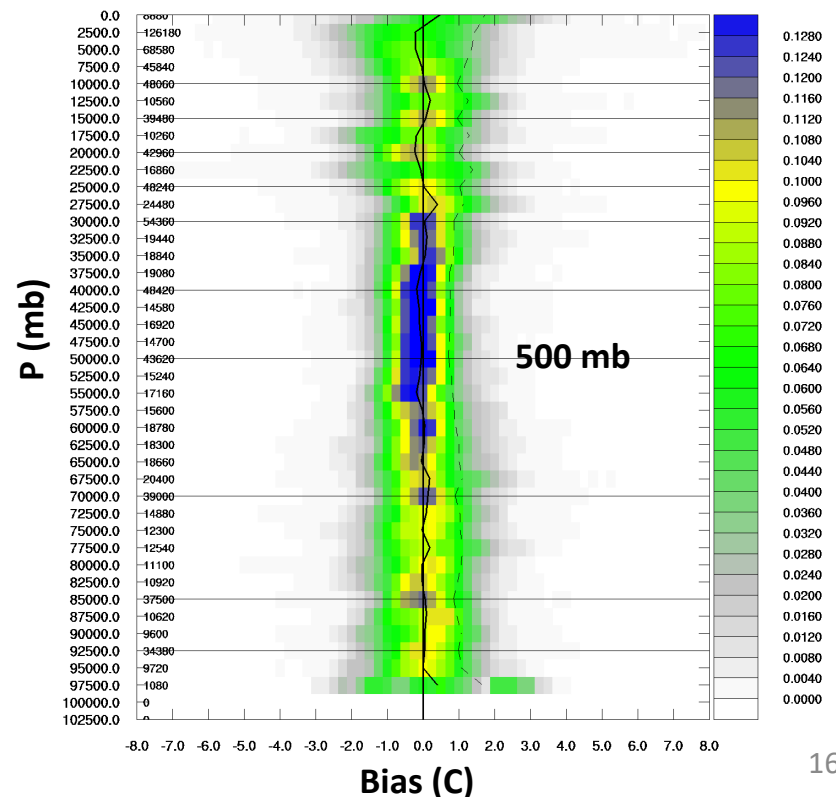**Posterior Bias= Analysis – Obs**   *After* **DART DA**

Test Period: 1 Nov 2017–10 Dec 2017



## T Bias Frequencies-- Prior



## T Bias Frequencies-- Posterior

# Summary: YOPP-SH Data Impact Study Update

- **Experiment, Case, and Data Preparation**

    – Target events/periods selected and case analyses begun

    – Data preparation

        ✓ Soundings compiled, formatted, and catalogued

        ✓ Sounding acquisition: "Thanks" to community (esp. BAS) on the efforts to collect and provide!

- **DA and Ensemble Systems Setup**

    – AMPS WRF cycling: Cycled system prepared, tested, stable

    – DART development

        ✓ Successfully applied for WRF over Antarctica

        ✓ Testing/tuning: Performance reasonable

    *Experimental runs to begin soon!*