THE AMPS YOPP-SH SOP DATA IMPACT STUDY

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YOPP-SH SOP Data Impact Study

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

• Methodology: Analyze forecasts using SOP data with varying data assimilation approaches

• AMPS: Antarctic Mesoscale Prediction System
  – Main model: WRF
  – Primary grids for YOPP-SH simulations: *

*24-km

*8-km
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• Goal 1: Determine effects on model forecasts of enhanced southern hemisphere observations
  – Do the SOP obs improve forecasts? Over individual forecast events or subseasonal periods?
    → Demonstrate potential value of 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 Polar Prediction Project (PPP) goal of improving polar NWP
• **Background: Current AMPS Setup**

  – **AMPS Ensemble WRF Forecasts**
    - 15-member WRF ensemble (24-km/8-km grids only)
      1. Provides ensemble guidance for USAP forecasters
      2. Generates background error information for the
data assimilation for the main WRF forecasts
    - Member backgrounds: NCEP **Global Ensemble Forecast System**
      (GEFS)
  
  – **AMPS Main WRF Forecasts**: Backgrounds from
    NCEP **GFS** (Global Forecast System) analyses

Note: YOPP-SH experiments—Cycled WRF forecasts for backgrounds
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• **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 \textbf{two versions of flow-dependent BEs for use in the DA}

– Create 2 new, larger ensembles for expts: \textasciitilde 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 \textbf{DART— Data Assimilation Research Testbed}
DA Procedure Experiments

**WRF Ensemble for BE Generation**

- **GEFS member 1 analysis**
- **GEFS member 2 analysis**

- **Forecast model (WRF)**
  - Forecast model (WRF) initialized from GEFS
  - Ensemble forecasts used to generate BEs for the DA for the experiment forecasts

- **6-h WRF model forecast member 1**
- **6-h WRF model forecast member 2**

- **Ensemble BEs**
  - 6-h WRF model forecasts initialized from GEFS analyses provide BEs for hybrid analyses

- **Static BEs**

- **Hybrid background**

- **WRFDA hybrid**
  - Hybrid analysis initializes 5-day forecast at 0000 and 1200 UTC

- **Hybrid analysis**

- **Full fcst for verification**

- **Main WRF Forecasts**
  - 6-h WRF forecast for new background

- **The hybrid analysis initializes a short-term (6-h) deterministic forecast that becomes the background for the next hybrid DA cycle.**

- **DA BE Variation 1**
  - WRF ensemble members initialized from GEFS
  - Ensemble fcsts used to generate BEs for the DA for the experiment fcsts
DA Procedure Experiments

**WRF Ensemble for BE Generation**

- 6-hr fcsts for member backgrounds

**Forecast model (WRF)**

- ens mem 1 background (WRF)
- ens mem 2 background (WRF)

**DART EnKF**

- ens mem 1 analysis
- ens mem 2 analysis

**Main WRF Forecasts**

- Static BEs
- Ensemble BEs

**WRFDA hybrid**

- Hybrid background

**Hybrid analysis**

- Hybrid analysis initializes 5-day forecast at 0000 and 1200 UTC

**WRF fcst for verification**

- The hybrid analysis initializes a short-term (6-h) deterministic forecast that becomes the background for the next hybrid DA cycle.

**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

**DART uses an EnKF approach for DA in initializing cycled WRF ensemble members**
SOP DATA WRF FORECAST EXPERIMENTS: 2 TYPES

• Period Forecasts
  – 2-week periods
    \[\text{November 2018} \quad (\text{spring})\]
    \[\text{Early January 2019} \quad (\text{mid-summer})\]
    \[\text{February 2019} \quad (\text{late summer})\]
  – 24-km/8-km forecast grid used
  – 2 forecasts/day: ≥72 hrs

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

• Study: Examine Impact of YOPP-SH SOP Data on Antarctic Weather Forecasts

• Forecast Experiments
  – Ingest of standard obs vs. extra YOPP-SH SOP data
  – Variation of DA approaches
  – Forecasts/evaluations
    (i) Subseasonal period forecasts
    (ii) Case studies

• Goals
  • Determine forecast value of extra Southern Hemisphere obs
  • Identify improvements for DA in AMPS