Inter-comparison of AFWA Operational Configurations using WRFv3.3.1 and WRFv3.4

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Research Applications Laboratory (RAL)
and
Developmental Testbed Center (DTC)
AFWA Configuration Testing

**DTC 2012 AFWA testing and evaluation**

- Impact assessment of WRF-ARW version upgrade (WRFv3.3.1/WRFv3.4)
- Performance assessment of two land surface input data sets (LIS2.7.1/LIS3.3)

*in a functionally similar operational environment*

- Data assimilation (WRFDA 3DVAR) and 6-hr warm start
- AFWA operational input datasets
- AFWA operational namelist options
AFWA Configuration Testing

Flowchart of the 6-hr “warm start” spin-up

Seasonal BE were generated from 2-week-long cold-start runs
Experimental Design

- **End-to-end system:** WPS, WRFDA, WRF, UPP, and MET

- **Test Period:** 1 July 2011 – 29 June 2012
  - 48-h warm start forecasts
  - initialized every 36 h (244 cases)

- **Domain:** single 15-km CONUS grid
  - 56 vertical levels

- **Numerical experiments:**
  - WRFDAv3.3.1 + WRFv3.3.1 w/ LoBCs from LIS w/ Noahv2.7.1
  - WRFDAv3.4 + WRFv3.4 w/ LoBCs from LIS w/ Noahv2.7.1
  - WRFDAv3.4 + WRFv3.4 w/ LoBCs from LIS w/ Noahv3.3
Evaluation Matrix

- **Surface and Upper Air** [(BC)RMSE, bias]
  - Temperature, Dew Point Temperature, Wind speed

- **Precipitation** (Gilbert skill score, frequency bias)
  - 3-h and 24-h accumulations (vs. Stage II analysis)

- **GO Index**
  - weighted RMSE across variables, domain and lead time

- **Statistical Assessment**
  - confidence intervals (CI) at the 99% level
  - statistical significance (SS) and practical significance (PS)
Surface Verification: Bias v3.4 - v3.3.1

00 UTC initialization

Surface temperature

- v3.4: colder – larger cold bias

Surface dew point temp

- v3.4: colder during cold-bias hours, warmer during warm-bias hours – larger bias

Surface wind speed

- v3.4: smaller high bias; no differences are PS
A bug was found last week in the Prepbufr datasets used for verification, which may have exaggerated the cold temperature bias, especially for summer.
Surface Temperature: Bias

WRF v3.3.1

00 UTC 12 h forecast

00 UTC 48 h forecast

Median Temperature Bias

valid at 12 UTC

cold bias

valid at 00 UTC

cold bias
Surface Temperature: Bias

WRF v3.4

00 UTC 12 h forecast

00 UTC 48 h forecast

Median Temperature Bias

cold bias

valid at 12 UTC

valid at 00 UTC
Surface Temperature: Bias

|v3.4| – |v3.3.1|

00 UTC 12 h forecast

v3.4 better
valid at 12 UTC

00 UTC 48 h forecast

v3.4 better
valid at 00 UTC

v3.3.1 better
Surface Dew Point: Bias

WRF v3.3.1

00 UTC 12 h forecast

00 UTC 48 h forecast

Median Dew Point Temperature Bias

cold / dry bias

warm / wet bias

valid at 12 UTC

valid at 00 UTC
Surface Dew Point: Bias

WRF v3.4

00 UTC 12 h forecast

00 UTC 48 h forecast

Median Dew Point Temperature Bias

cold / dry bias
valid at 12 UTC

warm / wet bias
valid at 00 UTC

valid at 00 UTC
Surface Dew Point: Bias

|v3.4| – |v3.3.1|

00 UTC 12 h forecast

00 UTC 48 h forecast

Median Dew Point Temperature Bias - Difference

v3.4 better
v3.3.1 better
valid at 12 UTC

v3.4 better
v3.3.1 better
valid at 00 UTC
### Surface Temperature: Bias v3.4 vs v3.3.1

pair-wise differences for **bias** by initialization time, lead time, and season

<table>
<thead>
<tr>
<th>Surface Temperature</th>
<th>f03</th>
<th>f06</th>
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**SS (light shading)** and **PS (dark shading)**

**DTC**
Developmental Testbed Center
Surface Dew Point: Bias v3.4 vs v3.3.1

pair-wise differences for bias by initialization time, lead time, and season

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SS (light shading) and PS (dark shading)
Upper Air Temperature: v3.4 vs v3.3.1

pair-wise differences for **RMSE and bias** by initialization time, lead time, and season

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<th>Upper Air Temperature</th>
<th>Annual</th>
<th>Summer</th>
<th>Fall</th>
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**RMSE**

- v3.4 temp is generally colder – smaller warm bias at upper levels except 150 mb
GO Index: v3.4 vs v3.3.1

- v3.3.1 more skillful during summer
- v3.4 more skillful during winter
- comparative for annual, spring and fall
- outlier cases: v3.3.1 better than v3.4

N<1 baseline configuration has higher skill
N>1 comparison configuration has higher skill.
Summary of Results

• Most PS pair-wise differences are noted in temperature and dew point temperature bias
  – Surface temperature and dew point: WRFv3.3.1 is generally favored.
  – Upper air temperature: Mixed results dependent on vertical levels.

• No PS pair-wise differences are noted in wind speed. The SS differences favor WRFv3.4.

• No SS differences are noted in precipitation skills.

• GO Index: WRFv3.3.1 is more skillful during summer, and WRFv3.4 is more skillful during winter
THANK YOU!

http://www.dtcenter.org/config/