7B.7   Inter-comparison of AFWA Operational Configurations using WRFv3.3.1 and WRFv3.4

Mei Xu, Jamie Wolff and Michelle Harrold

National Center for Atmospheric Research (NCAR)

Research Applications Laboratory (RAL)
and
Developmental Testbed Center (DTC)

**DTC**
Developmental Testbed Center

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

DTC
Developmental Testbed Center

AFWA Configuration Testing

Flowchart of the 6-hr "warm start" spin-up
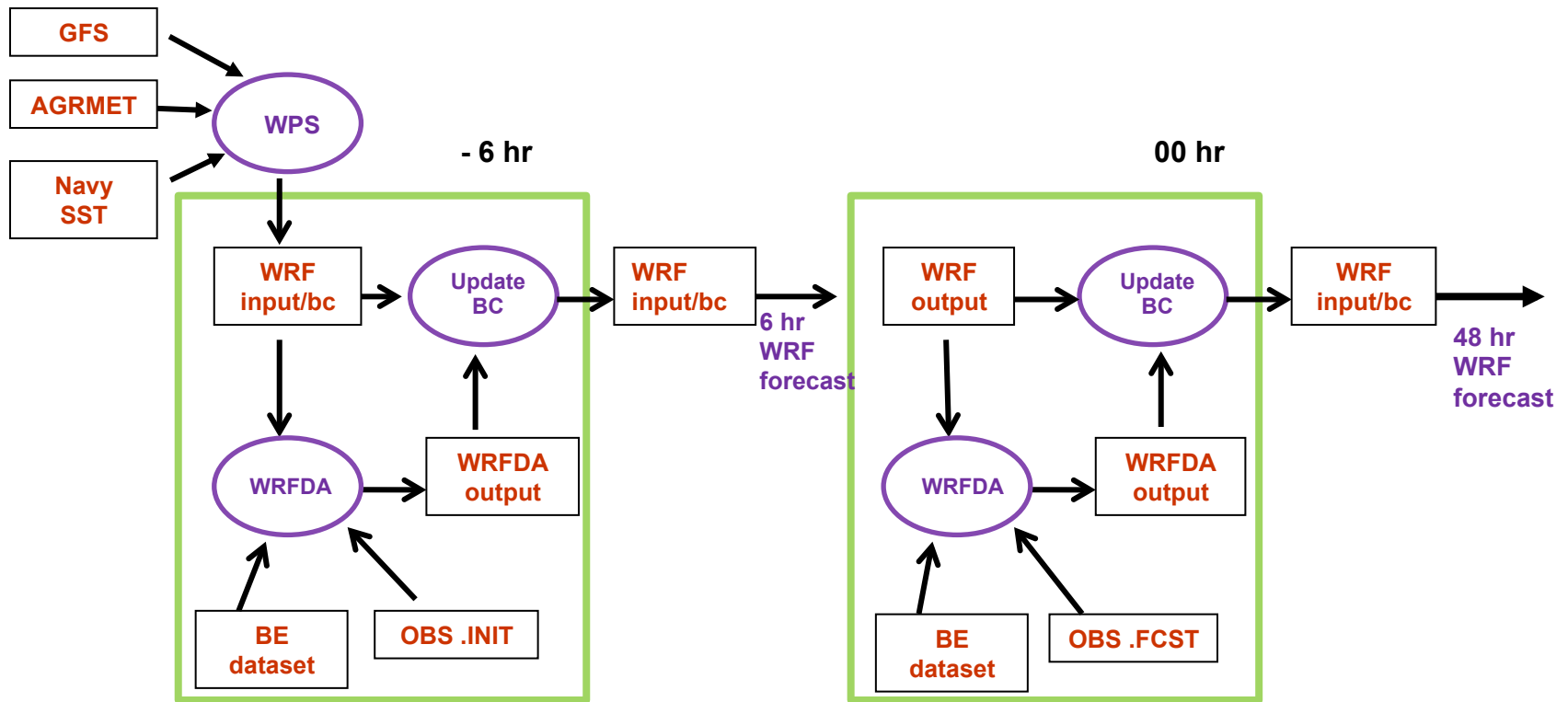
Seasonal BE were generated from 2-week-long cold-start runs

DTC
Developmental Testbed Center

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

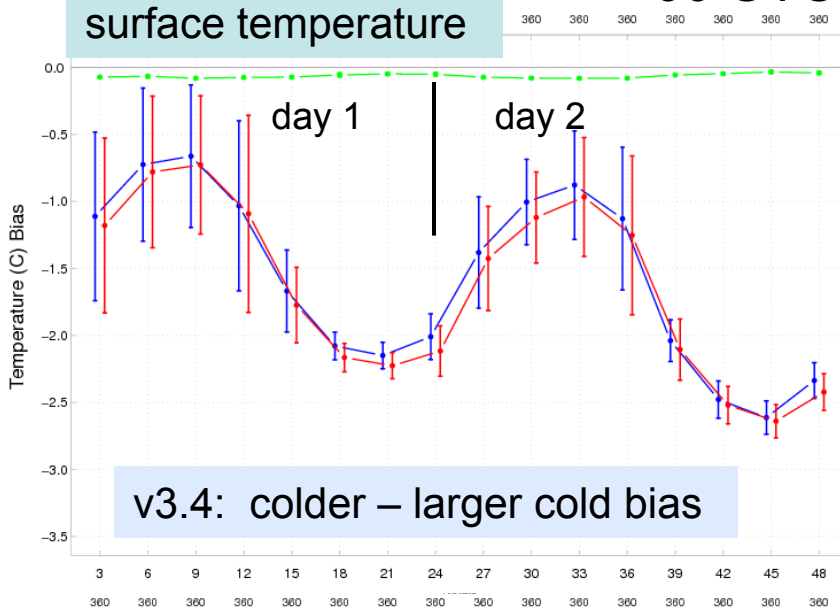   • WRFDAv3.4 + WRFv3.4 w/ LoBCs from LIS w/ Noahv3.3
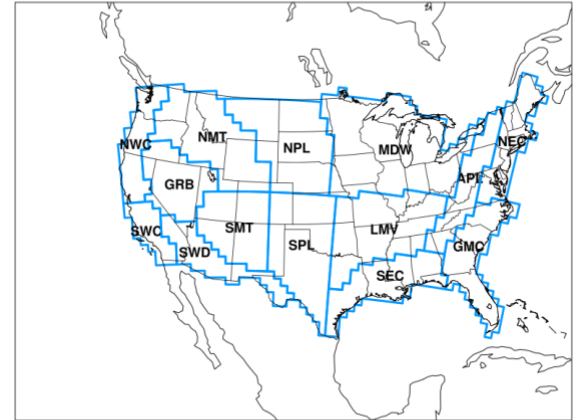
Evaluation Matrix

- **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)
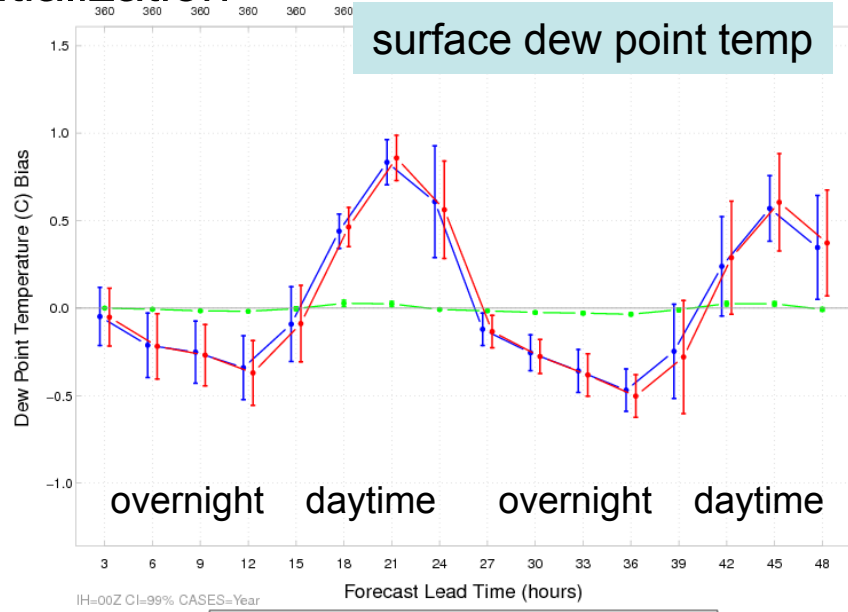
DTC
Developmental Testbed Center

Surface Verification: Bias v3.4 - v3.3.1

00 UTC initialization

surface temperature

day 1   day 2

v3.4: colder – larger cold bias

surface dew point temp

overnight   daytime   overnight   daytime

IH=00Z CI=99% CASES=Year

AFWAv3.3.1_Noahv2.7.1   Diff   AFWAv3.4_Noahv2.7.1

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

surface wind speed

overnight   daytime   overnight   daytime

IH=00Z CI=99% CASES=Year
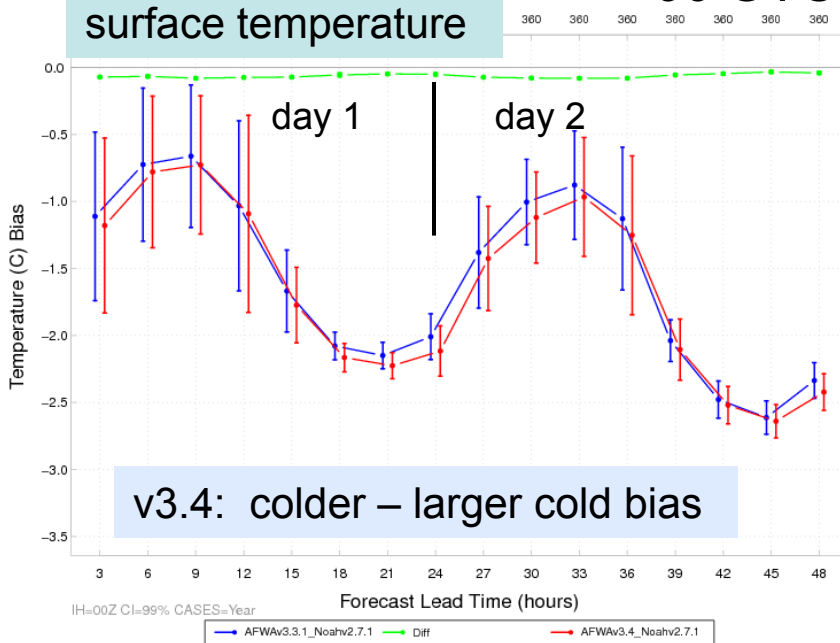
AFWAv3.3.1_Noahv2.7.1   Diff   AFWAv3.4_Noahv2.7.1
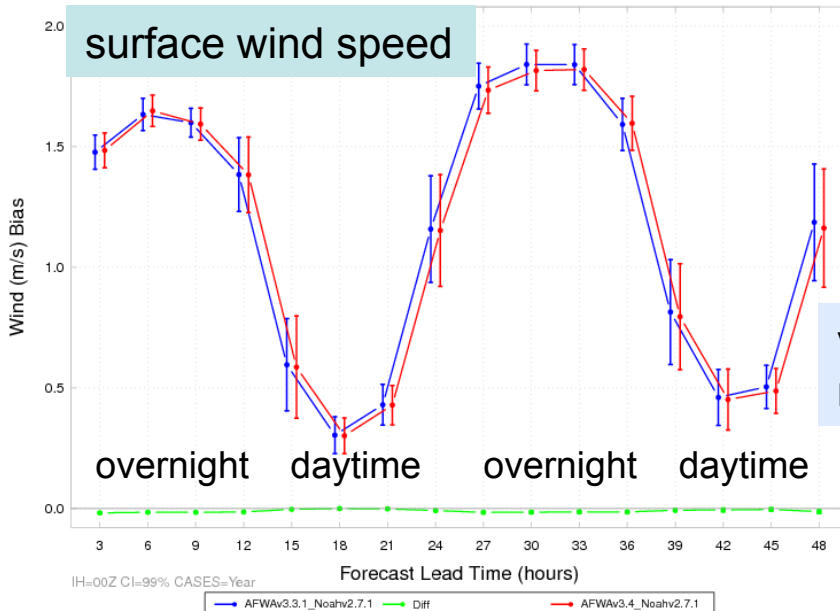
v3.4: smaller high bias; no differences are PS

Surface Verification: Bias v3.4 - v3.3.1

00 UTC initialization

surface temperature

day 1   day 2

v3.4: colder – larger cold bias

A bug was found last week in the Prepbufr datasets used for verification, which may have exaggerated the cold temperature bias, especially for summer.
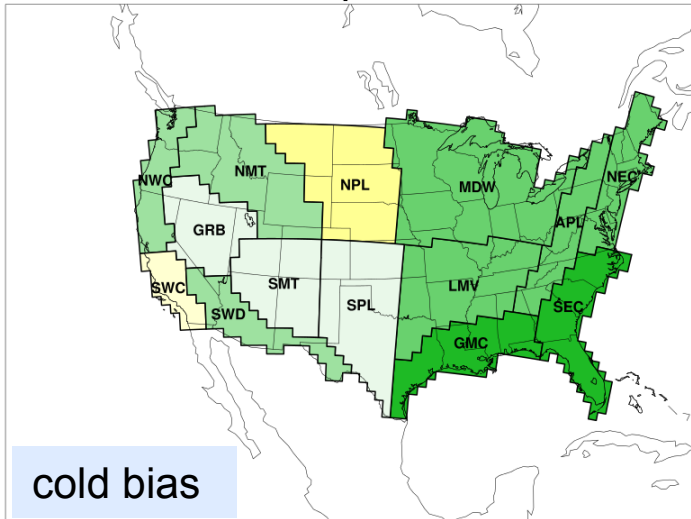
Surface Temperature: Bias
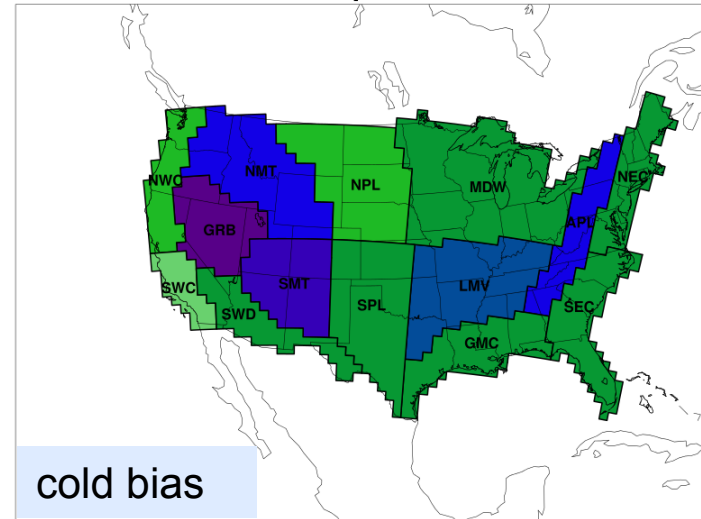
WRF v3.3.1

00 UTC 12 h forecast

00 UTC 48 h forecast

valid at 12 UTC

valid at 00 UTC

Surface Temperature: Bias

WRF v3.4

00 UTC 12 h forecast
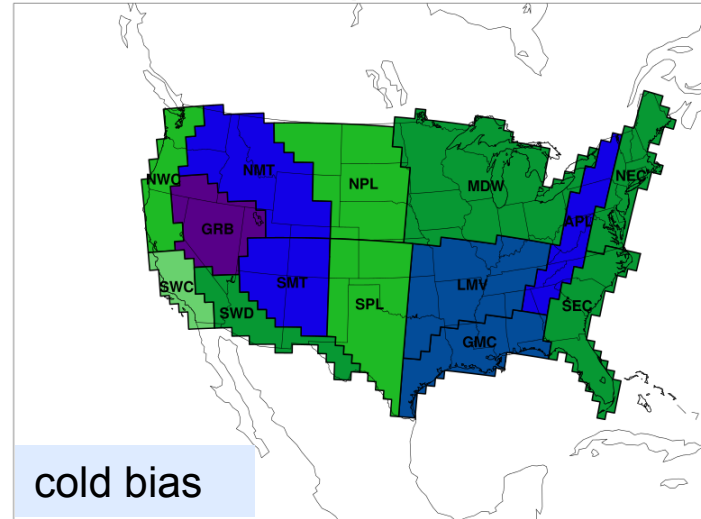
00 UTC 48 h forecast

valid at 12 UTC

valid at 00 UTC

Surface Temperature: Bias

|v3.4| – |v3.3.1|

00 UTC 12 h forecast

Median Temperature Bias - Difference

AFWAv3.4 - AFWAv3.3.1   Season=Year Init=00Z Fcst Hr=12h

-.4 -.35 -.3 -.25 -.2 -.15 -.1 -.05 0 .05 .1 .15 .2 .25 .3 .35 .4
°C

v3.4 better   v3.3.1 better

valid at 12 UTC

00 UTC 48 h forecast

Median Temperature Bias - Difference

AFWAv3.4 - AFWAv3.3.1   Season=Year Init=00Z Fcst Hr=48h

-.4 -.35 -.3 -.25 -.2 -.15 -.1 -.05 0 .05 .1 .15 .2 .25 .3 .35 .4
°C
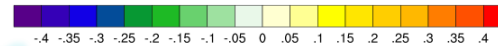
v3.4 better   v3.3.1 better

valid at 00 UTC

Surface Dew Point: Bias

WRF v3.3.1

00 UTC 12 h forecast

Median Dew Point Temperature Bias

cold / dry bias

Config=AFWAv3.3.1_Noahv2.7.1 Season=Year Init=00Z Fcst Hr=12h

°C

valid at 12 UTC

00 UTC 48 h forecast

Median Dew Point Temperature Bias

warm / wet bias

Config=AFWAv3.3.1_Noahv2.7.1 Season=Year Init=00Z Fcst Hr=48h

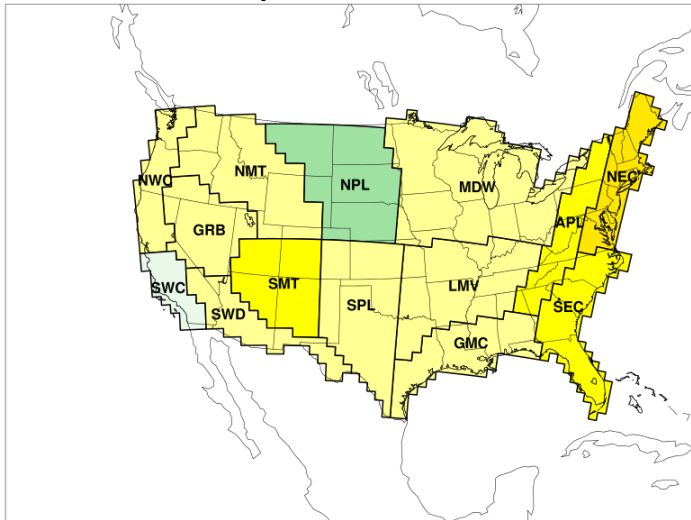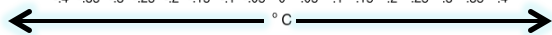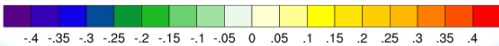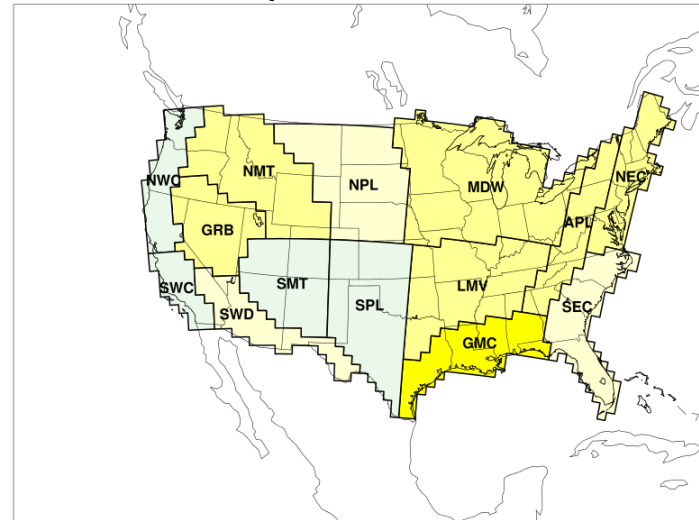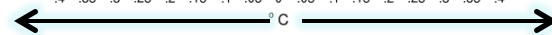°C
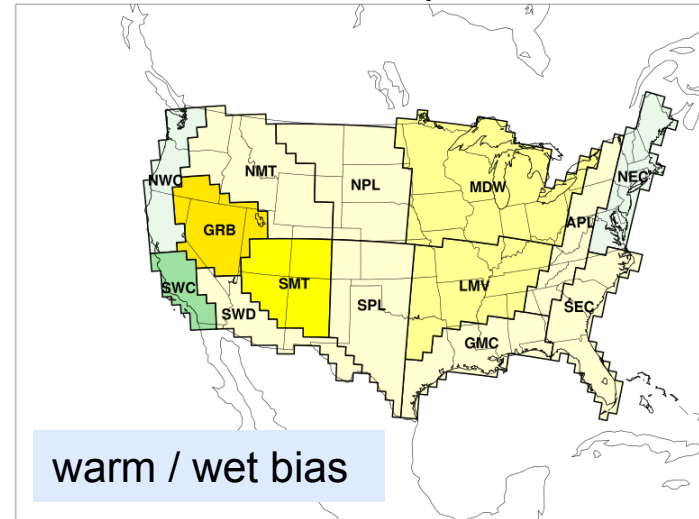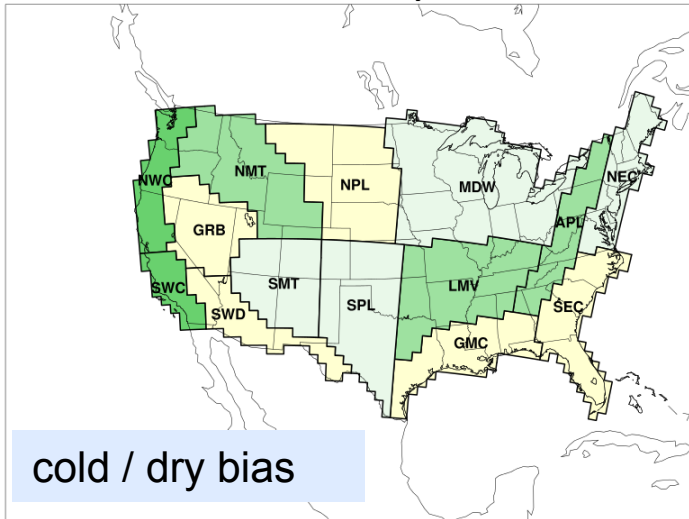
valid at 00 UTC

Surface Dew Point: Bias

WRF v3.4

00 UTC 12 h forecast
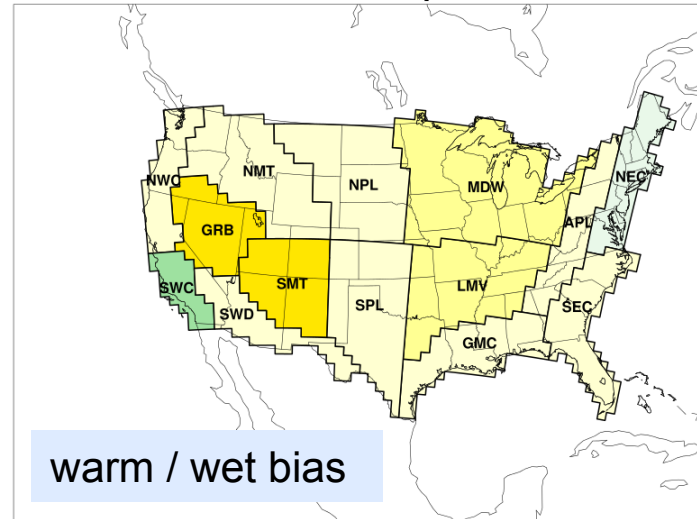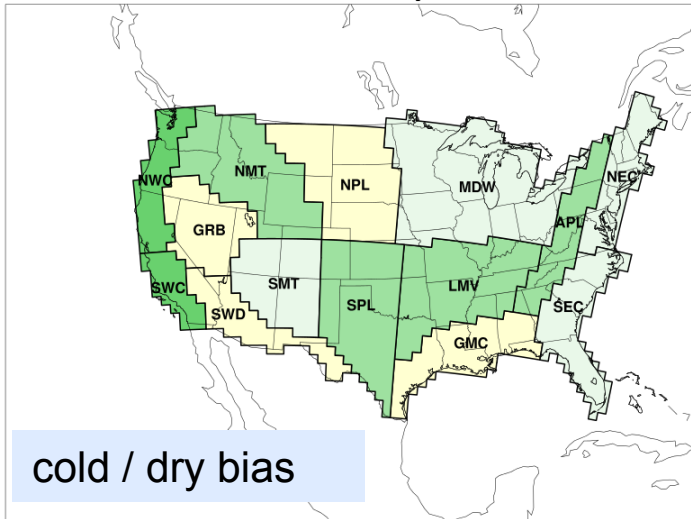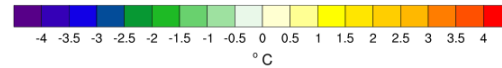
00 UTC 48 h forecast

valid at 12 UTC

valid at 00 UTC

Surface Dew Point: Bias

|v3.4| − |v3.3.1|

00 UTC 12 h forecast

v3.4 better   **v3.3.1 better**

valid at 12 UTC

00 UTC 48 h forecast

v3.4 better   **v3.3.1 better**

valid at 00 UTC

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

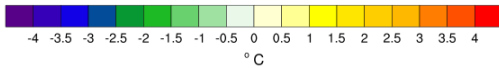| Surface Temperature			f03	f06	f09	f12	f15	f18	f21	f24	f27	f30	f33	f36	f39	f42	f45	f48
Bias	00 UTC Initializations	Annual	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1
		Summer	v3.3.1	v3.3.1	v3.3.1 *	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1 *	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1
		Fall	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1
		Winter	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1
		Spring	v3.3.1	v3.3.1	v3.3.1 *	v3.3.1 *	v3.3.1 *	v3.3.1 *	v3.3.1 *	--	v3.3.1 *	v3.3.1 *	v3.3.1 *	v3.3.1 *	v3.3.1 *	v3.3.1 *	--	--
	12 UTC Initializations	Annual	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1
		Summer	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1 *	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1 *	v3.3.1 *
		Fall	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1
		Winter	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1
		Spring	v3.3.1 *	v3.3.1	--	--	v3.3.1	v3.3.1	v3.3.1 *	v3.3.1	v3.3.1 *	v3.3.1 *	v3.3.1	v3.3.1	v3.3.1 *	v3.3.1 *	v3.3.1 *	v3.3.1 *

SS (light shading) and **PS (dark shading)**

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

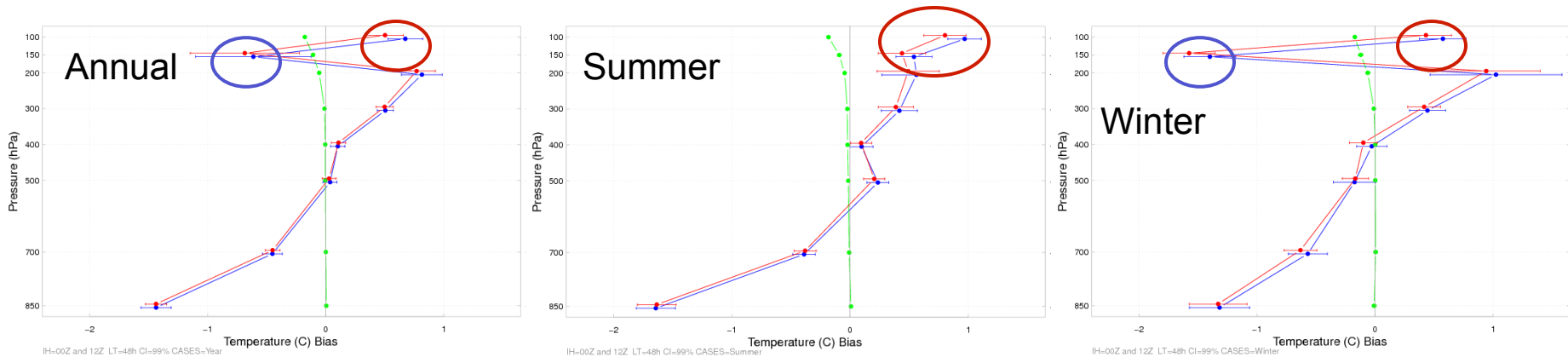| Surface Dew Point Temperature			f03	f06	f09	f12	f15	f18	f21	f24	f27	f30	f33	f36	f39	f42	f45	f48
Bias	**00 UTC Initializations**	Annual	--	v3.3.1	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	v3.4	v3.3.1	v3.3.1	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	--
		Summer	--	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	--
		Fall	--	--	v3.3.1	v3.3.1	v3.3.1	--	--	v3.3.1	--	v3.3.1	v3.3.1	v3.3.1	v3.3.1	--	--	--
		Winter	--	v3.4	v3.4	v3.4	v3.3.1	--	--	v3.4	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	--	--	--
		Spring	--	--	--	--	--	v3.3.1	v3.3.1	--	--	--	--	--	--	v3.3.1	v3.3.1	--
	12 UTC Initializations	Annual	--	v3.3.1	v3.3.1	--	v3.4	v3.3.1	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	v3.4	v3.3.1	v3.3.1	v3.3.1	v3.3.1
		Summer	v3.3.1	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	v3.3.1	v3.3.1
		Fall	v3.3.1	--	--	--	--	v3.3.1	v3.3.1	v3.3.1	v3.3.1	--	--	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1
		Winter	v3.3.1	v3.3.1	--	v3.4	v3.4	v3.4	v3.4	v3.3.1	v3.3.1	--	--	v3.4	--	--	v3.3.1	v3.3.1
		Spring	v3.3.1	v3.3.1 *	v3.3.1 *	--	--	--	--	--	--	v3.3.1 *	v3.3.1 *	--	--	--	--	--

**SS (light shading)** and **PS (dark shading)**

Developmental Testbed Center

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

Upper Air Temperature		Annual				Summer				Fall				Winter				Spring			
		f12	f24	f36	f48	f12	f24	f36	f48	f12	f24	f36	f48	f12	f24	f36	f48	f12	f24	f36	f48
RMSE	850	v3.3.1	v3.3.1	--	--	v3.3.1	--	--	--	v3.3.1	--	--	--	v3.3.1	v3.3.1	v3.3.1	--	--	--	--	--
	700	v3.3.1	--	--	--	v3.3.1	v3.3.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	500	--	v3.3.1	v3.3.1	v3.3.1	--	--	--	--	--	--	--	--	--	v3.3.1	v3.3.1	--	--	--	--	--
	400	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	300	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	--	v3.4	--	--	--	--	--	--	--	--	--	--	--
	200	v3.4	v3.4	v3.4	v3.4	v3.4	--	--	--	v3.4	v3.4	v3.4	v3.4	v3.4	--	v3.4	--	--	v3.4	v3.4	--
	150	--	v3.3.1	v3.3.1	v3.3.1	v3.4	v3.4	--	--	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	v3.3.1 *
	100	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4 *	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4
Bias	850	v3.3.1	v3.3.1	--	--	v3.3.1	--	--	--	--	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	v3.3.1	--	v3.3.1	--	--	--
	700	v3.3.1	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	--	--	--	--	--	v3.4
	500	v3.4	v3.4	v3.4	--	v3.4	v3.4	v3.4	v3.4	v3.3.1	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	--	--	--	v3.4	--	--
	400	v3.4	v3.4	v3.4	--	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	--	v3.4	v3.3.1	--	--	v3.4	v3.4	--	--
	300	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	--	v3.4	v3.4	v3.4	--	v3.4	v3.4	--	--
	200	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4	v3.4
	150	v3.3.1	v3.3.1	v3.3.1	v3.3.1 *	v3.4	v3.4	v3.4	v3.4 *	v3.3.1	v3.3.1 *	v3.3.1 *	v3.3.1 *	v3.3.1	v3.3.1 *	v3.3.1 *	v3.3.1 *	v3.3.1	v3.3.1 *	v3.3.1 *	v3.3.1 *
	100	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *

Annual

Summer

Winter

v3.4 temp is generally colder – smaller warm bias at upper levels except 150 mb

16

GO Index: v3.4 vs v3.3.1

GO Index
AFWAv3.4_Noahv2.7.1 / AFWAv3.3.1
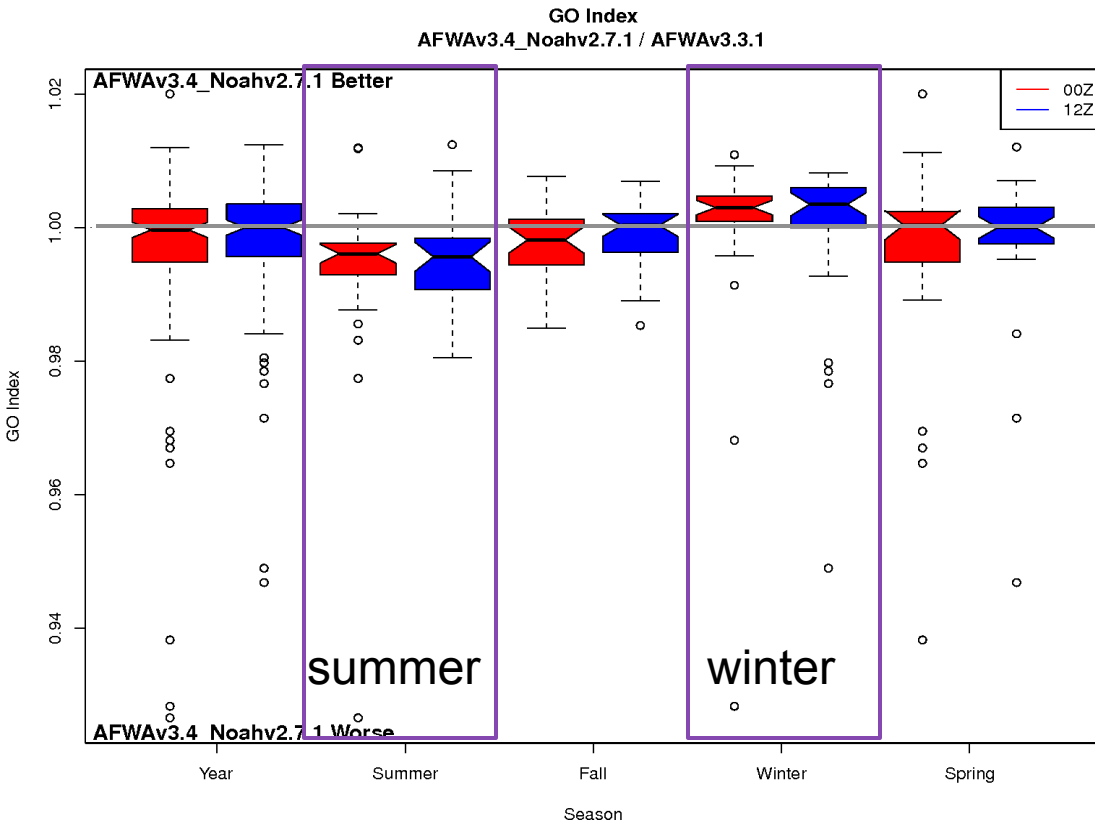
- v3.3.1 more skillful during summer

- 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

DTC

Developmental Testbed Center

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

THANK YOU!