

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

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and

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AFWA Configuration Testing

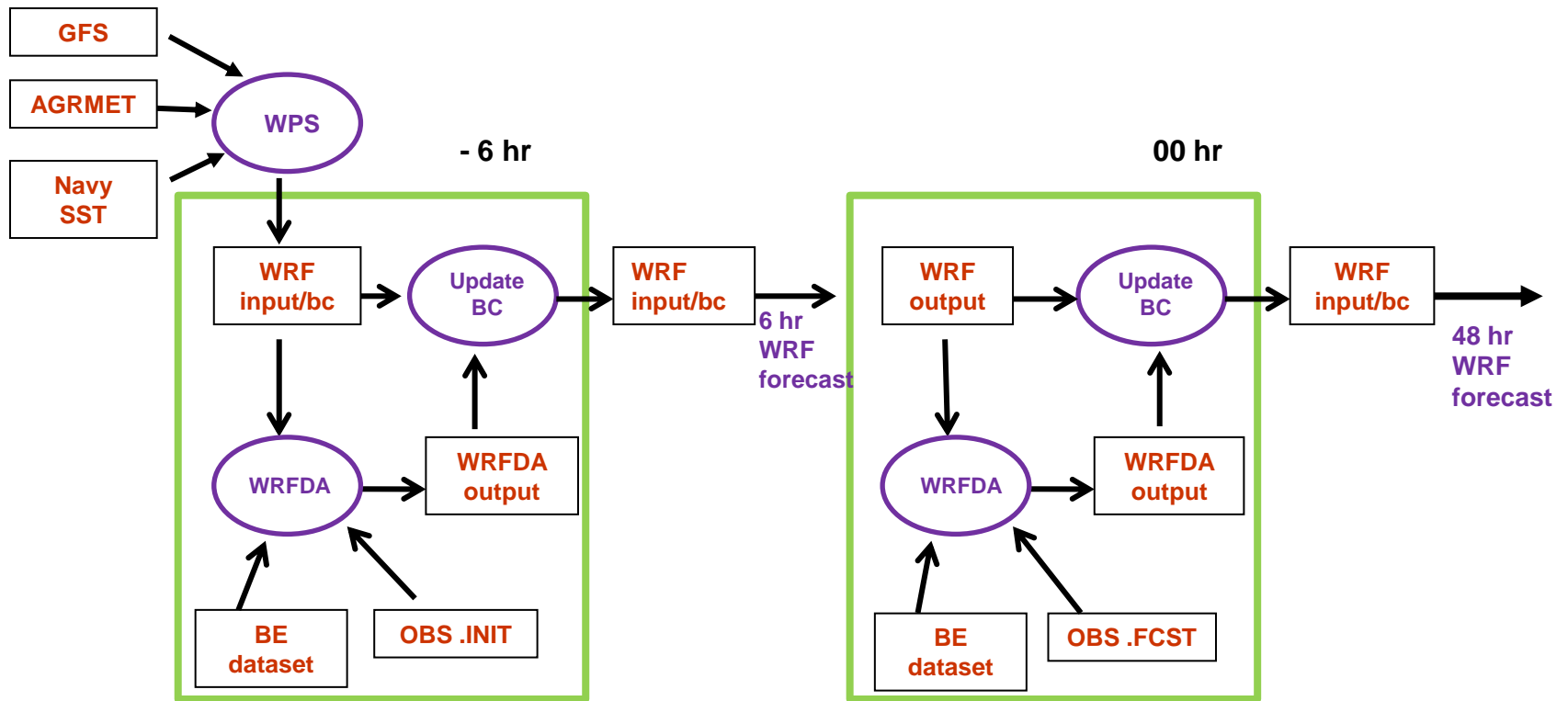
DTC 2012 AFWA testing and evaluation

- 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

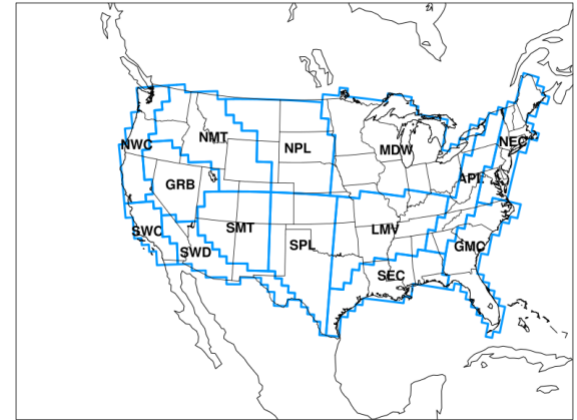


Seasonal BE were generated from 2-week-long cold-start runs

Flowchart of the 6-hr "warm start" spin-up

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



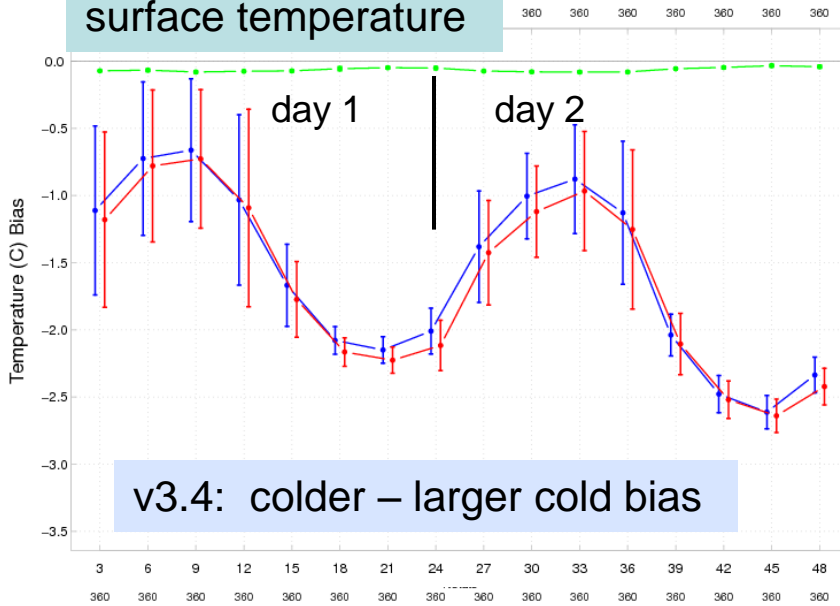
Evaluation Matrix

- **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)

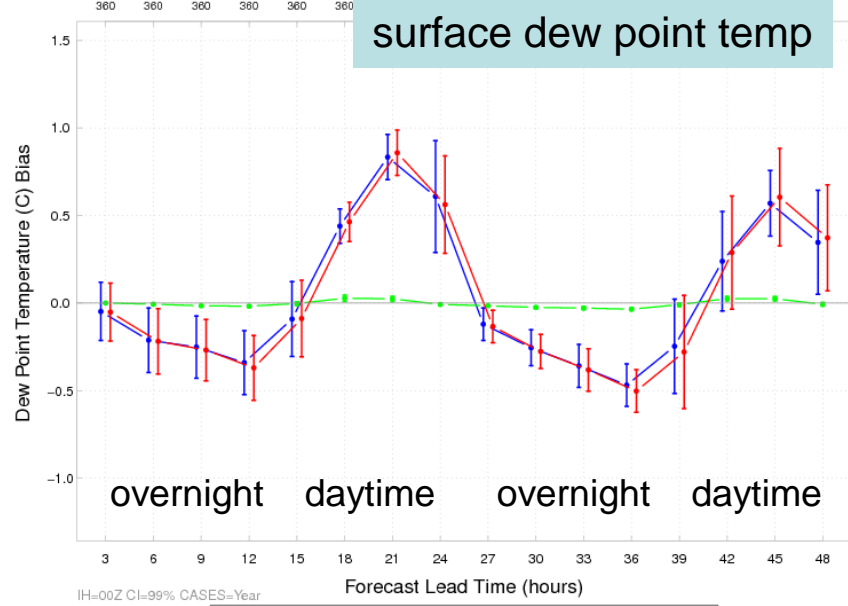
Surface Verification: Bias v3.4 - v3.3.1

00 UTC initialization

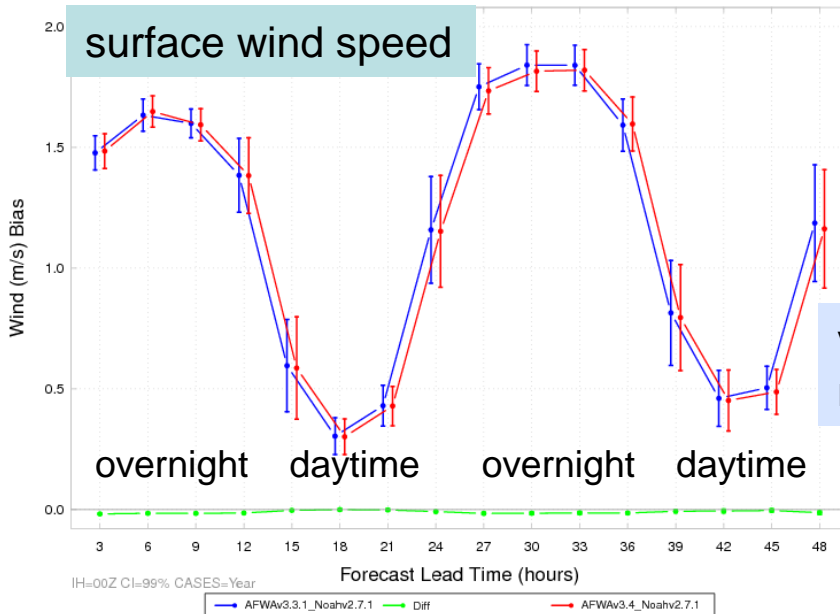
surface temperature



surface dew point temp



surface wind speed



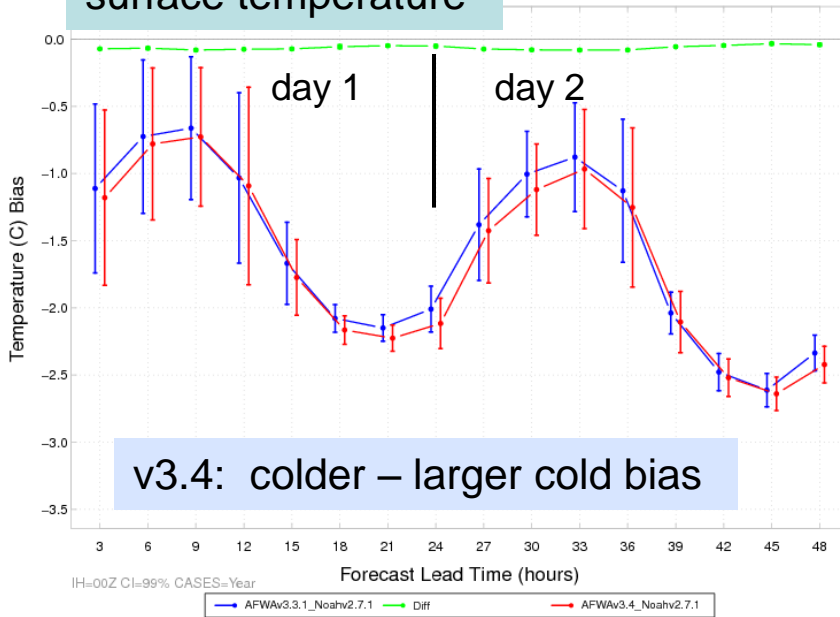
v3.4: colder during cold-bias hours, warmer during warm-bias hours – larger bias

v3.4: smaller high bias; no differences are PS

Surface Verification: Bias v3.4 - v3.3.1

00 UTC initialization

surface temperature



A bug was found last week in the Prepbufr datasets used for verification, which may have exaggerated the cold temperature bias, especially for summer.

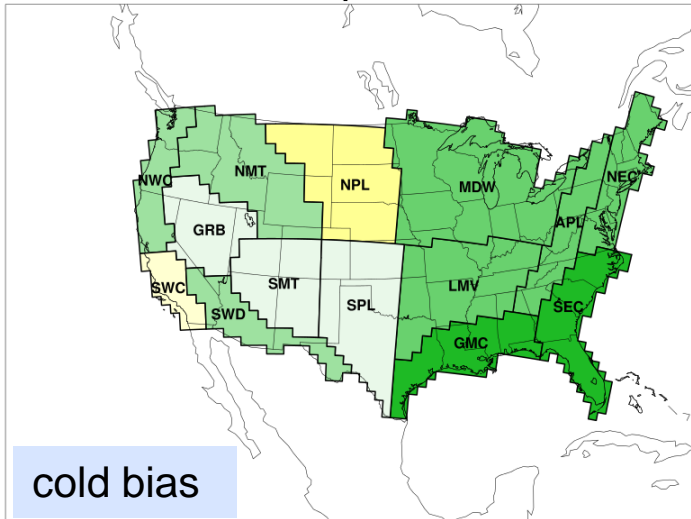
Surface Temperature: Bias

WRF v3.3.1

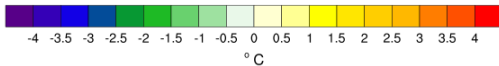
00 UTC 12 h forecast

00 UTC 48 h forecast

Median Temperature Bias

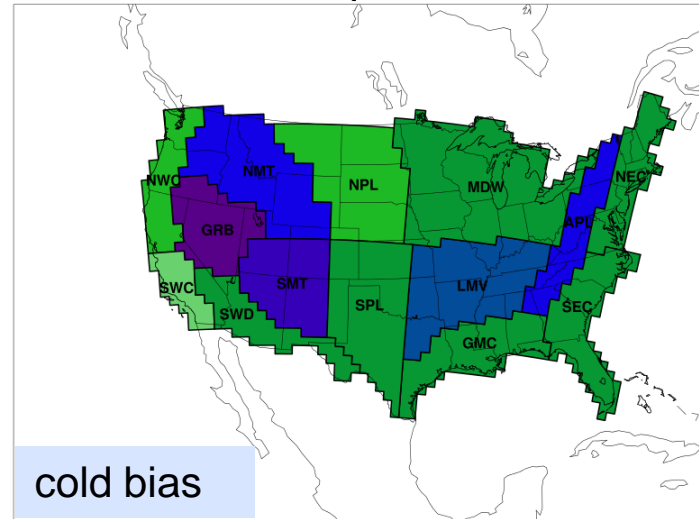


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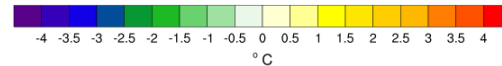


valid at 12 UTC

Median Temperature Bias



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



valid at 00 UTC

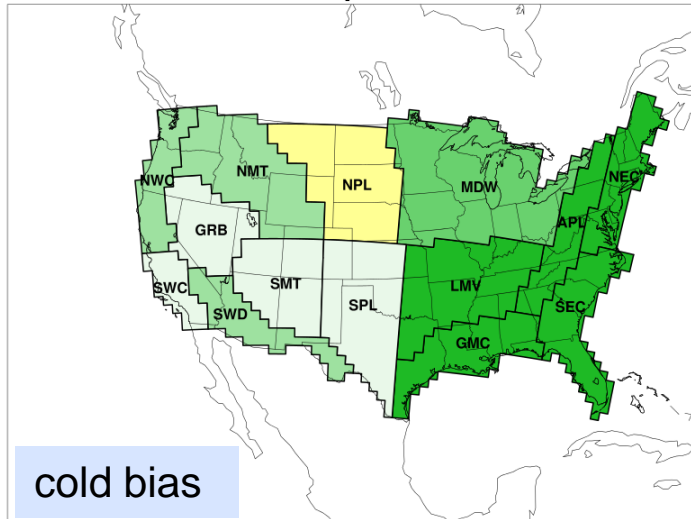
Surface Temperature: Bias

WRF v3.4

00 UTC 12 h forecast

00 UTC 48 h forecast

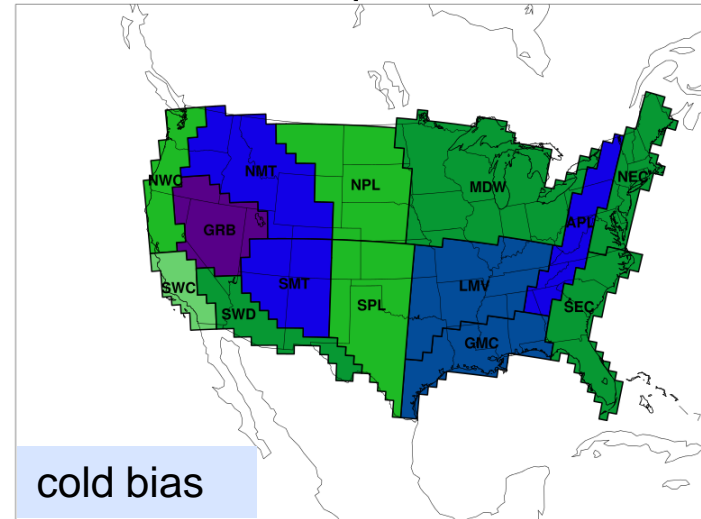
Median Temperature Bias



Config=AFWAv3.4_Noahv2.7.1 Season=Year Init=00Z Fcst Hr=12h

valid at 12 UTC

Median Temperature Bias



Config=AFWAv3.4_Noahv2.7.1 Season=Year Init=00Z Fcst Hr=48h

valid at 00 UTC

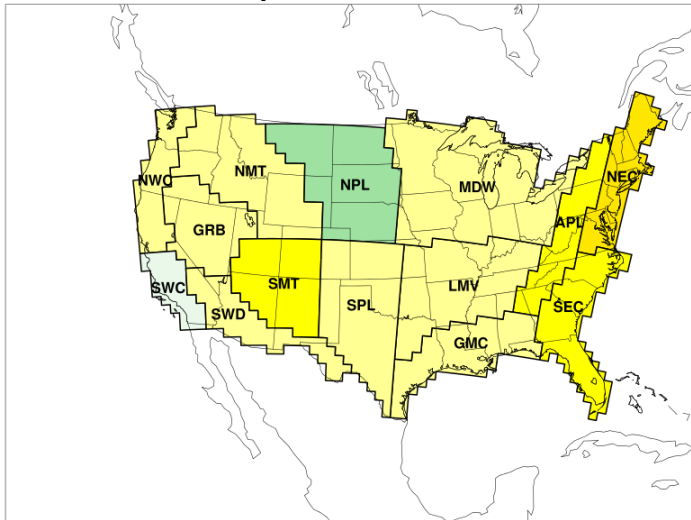
Surface Temperature: Bias

$$|v3.4| - |v3.3.1|$$

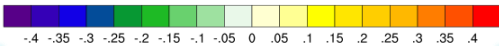
00 UTC 12 h forecast

00 UTC 48 h forecast

Median Temperature Bias - Difference



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

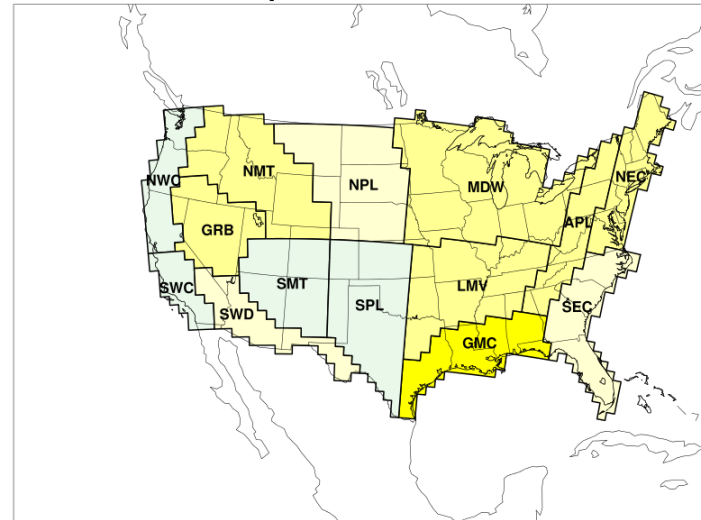


v3.4 better

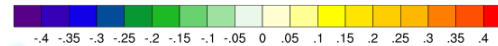
v3.3.1 better

valid at 12 UTC

Median Temperature Bias - Difference



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



v3.4 better

v3.3.1 better

valid at 00 UTC

Surface Dew Point: Bias

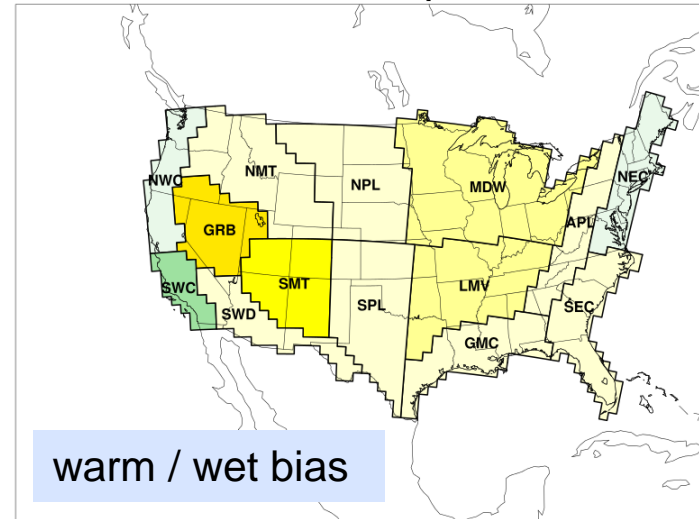
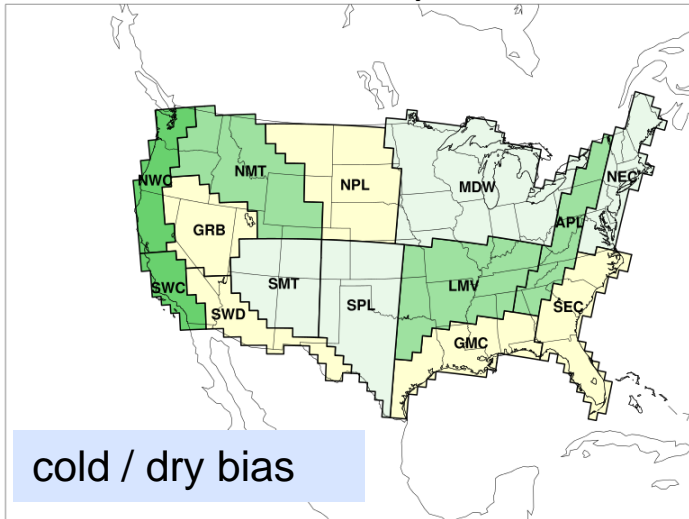
WRF v3.3.1

00 UTC 12 h forecast

00 UTC 48 h forecast

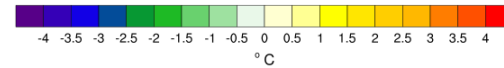
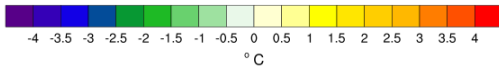
Median Dew Point Temperature Bias

Median Dew Point Temperature Bias



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

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



valid at 12 UTC

valid at 00 UTC

Surface Dew Point: Bias

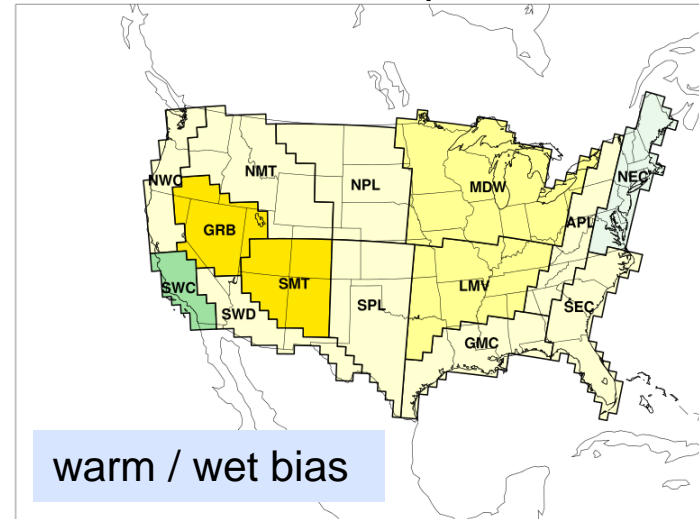
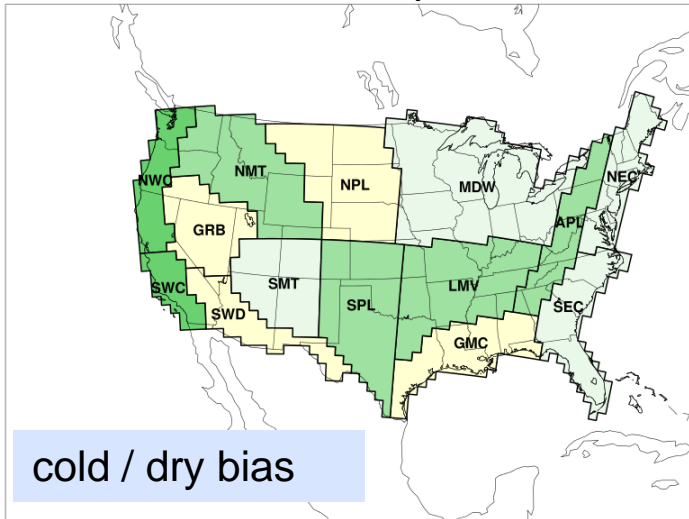
WRF v3.4

00 UTC 12 h forecast

00 UTC 48 h forecast

Median Dew Point Temperature Bias

Median Dew Point Temperature Bias



Config=AFWAv3.4_Noahv2.7.1 Season=Year Init=00Z Fcst Hr=12h

Config=AFWAv3.4_Noahv2.7.1 Season=Year Init=00Z Fcst Hr=48h

valid at 12 UTC

valid at 00 UTC

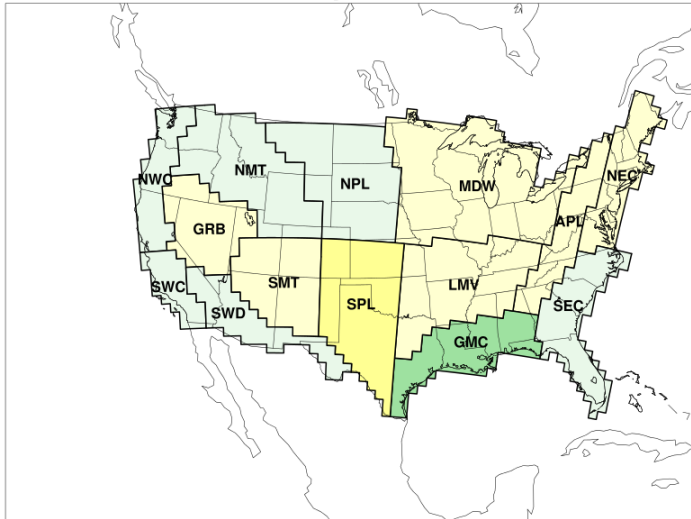
Surface Dew Point: Bias

$|v3.4| - |v3.3.1|$

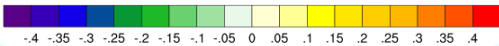
00 UTC 12 h forecast

00 UTC 48 h forecast

Median Dew Point Temperature Bias - Difference



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

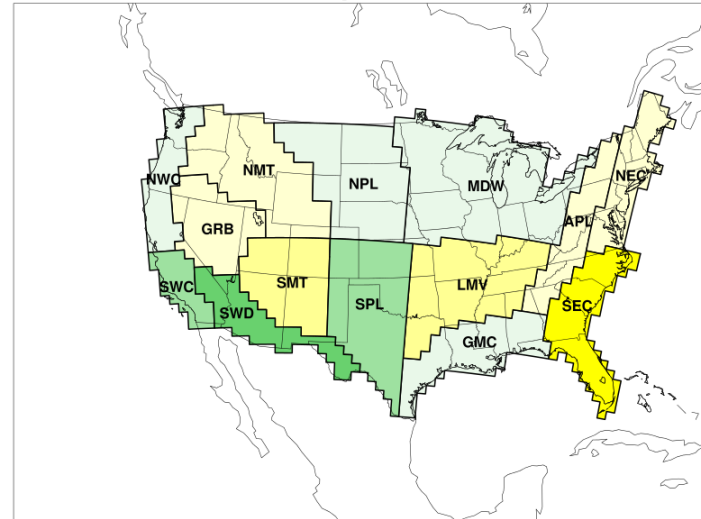


v3.4 better

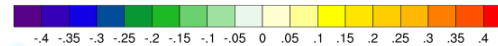
v3.3.1 better

valid at 12 UTC

Median Dew Point Temperature Bias - Difference



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



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

Surface Temperature		f03	f06	f09	f12	f15	f18	f21	f24	f27	f30	f33	f36	f39	f42	f45	f48		
00 UTC	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	
		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	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	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	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*	--	--
12 UTC	Bias	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*	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	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	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*	v3.3.1*

SS (light shading) and PS (dark shading)

Surface Dew Point: Bias v3.4 vs v3.3.1

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

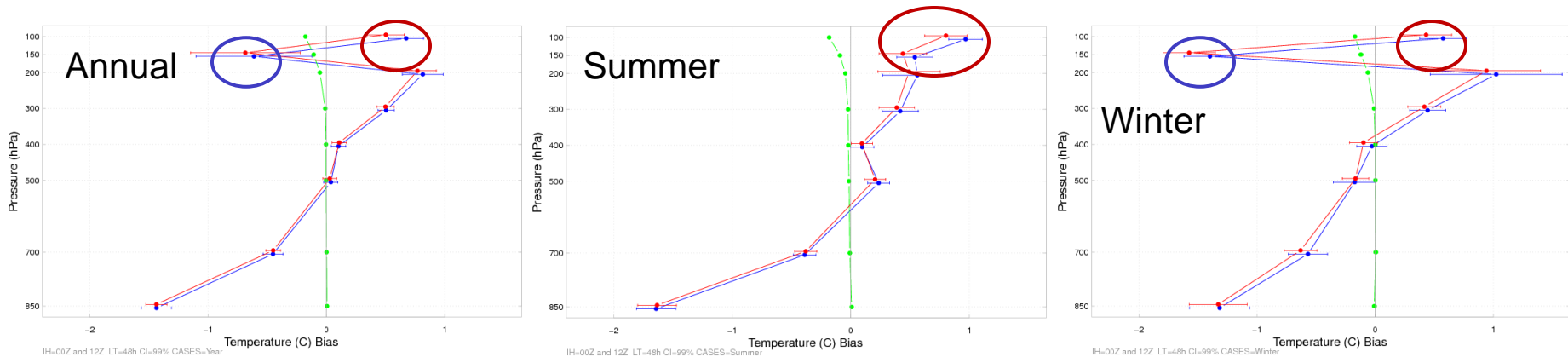
		Surface Dew Point Temperature																	
		f03	f06	f09	f12	f15	f18	f21	f24	f27	f30	f33	f36	f39	f42	f45	f48		
00 UTC	Bias	00 UTC Initializations	Annual	--	v3.3.1	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	SS	v3.3.1	v3.3.1	v3.3.1	--	v3.3.1	v3.3.1	--	
			Summer	--	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	v3.3.1	--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

SS (light shading) and PS (dark shading)

Upper Air Temperature: v3.4 vs v3.3.1

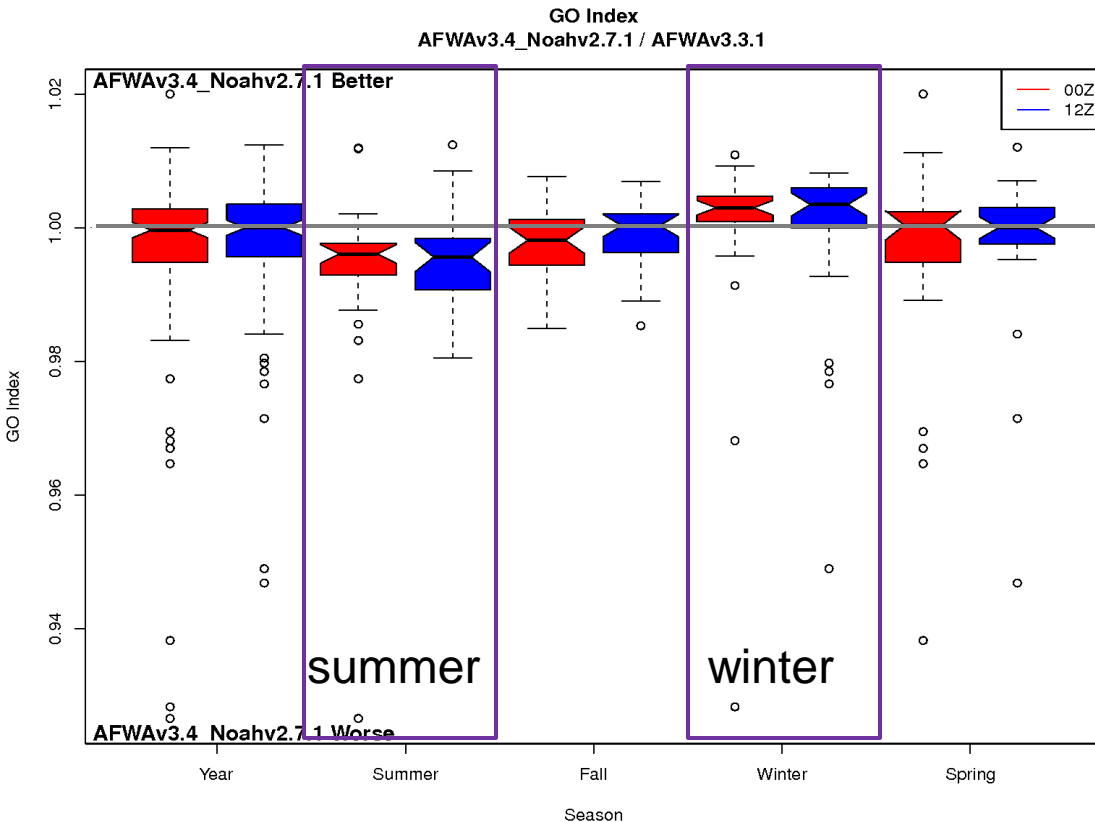
pair-wise differences for **RMSE and bias** by initialization time, lead time, and season

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*



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

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

v3.4

v3.3.1

THANK YOU!