

Tracking WRF performance: How do the three most recent versions compare?

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National Center for Atmospheric Research/Research Applications Laboratory
and Developmental Testbed Center

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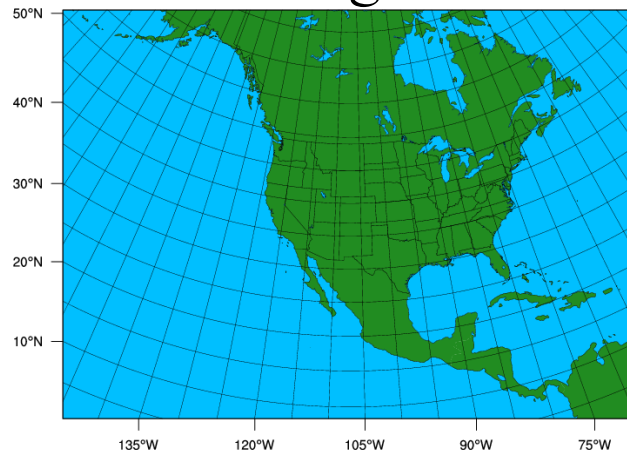
Introduction

- Developmental Testbed Center (DTC) testing philosophy:
 - Conduct comprehensive testing and evaluation, including extensive objective verification
 - Provide a neutral and unbiased assessment
- WRF version testing:
 - Continually evolving code base
 - Prior to a release, WRF code run through large number of regression tests; however, extensive testing to evaluate forecast skill is not widely addressed
 - Modifications to address a specific issue may impact other aspects
- Is WRF improving? neutral? degrading? → Hard question to answer!
 - Highly configurable, many options - depends on the user's needs
 - *This presentation will outline the forecast performance of one specific configuration for three most recent WRF releases*



WRF Version Testing and Evaluation (T&E)

- **End-to-end system:** WPS, WRF, UPP, and MET
- **Test Period:** Summer 1 July 2011 – 30 September 2011
Winter 1 January 2012 – 31 March 2012
- **Simulations:** 48-h cold start forecasts initialized every 36 h (116 total cases) (focus on 00 UTC cases)
- **Domain:** 15-km N. America grid



WRF Version T&E, Cont.

- **Physics Suite:**

Microphysics	WRF Single-Moment 5 scheme
Radiation SW and LW	Dudhia/RRTM schemes
Surface Layer	Monin-Obukhov similarity theory
Land-Surface Model	Noah
Planetary Boundary Layer	Yonsei University scheme
Convection	Kain-Fritsch scheme

- **Evaluation:**

- Surface and Upper-air BCRMSE, Bias
 - Temperature, Dew Point Temperature, Winds
- Pair-wise differences (v3.4-v3.4.1, v3.4.1-v3.5, v3.4-v3.5)
- Statistical/Practical Significance

Verification Regions



Version T&E Results

WRFv3.4

WRFv3.4.1

WRFv3.5

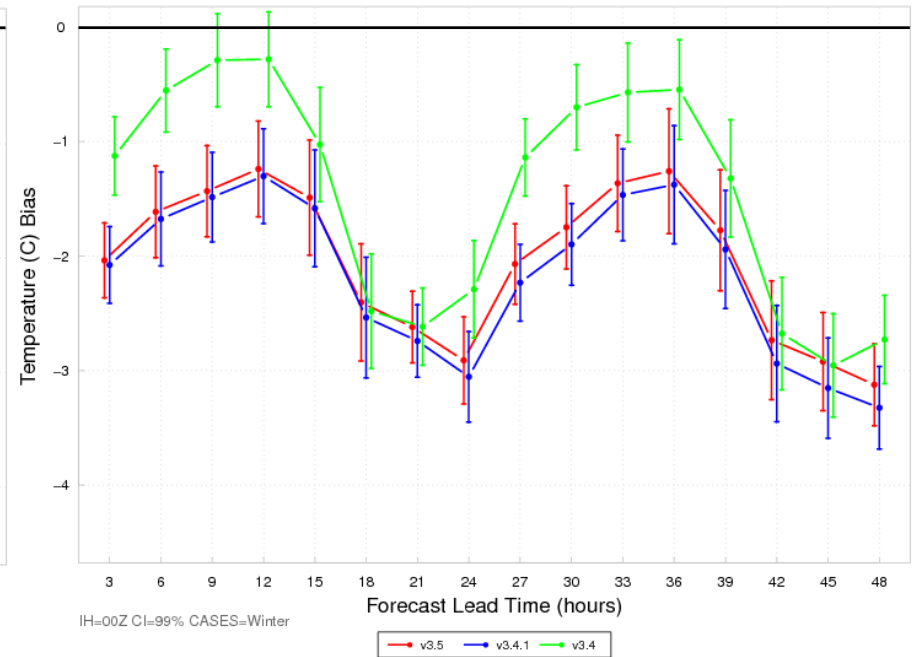
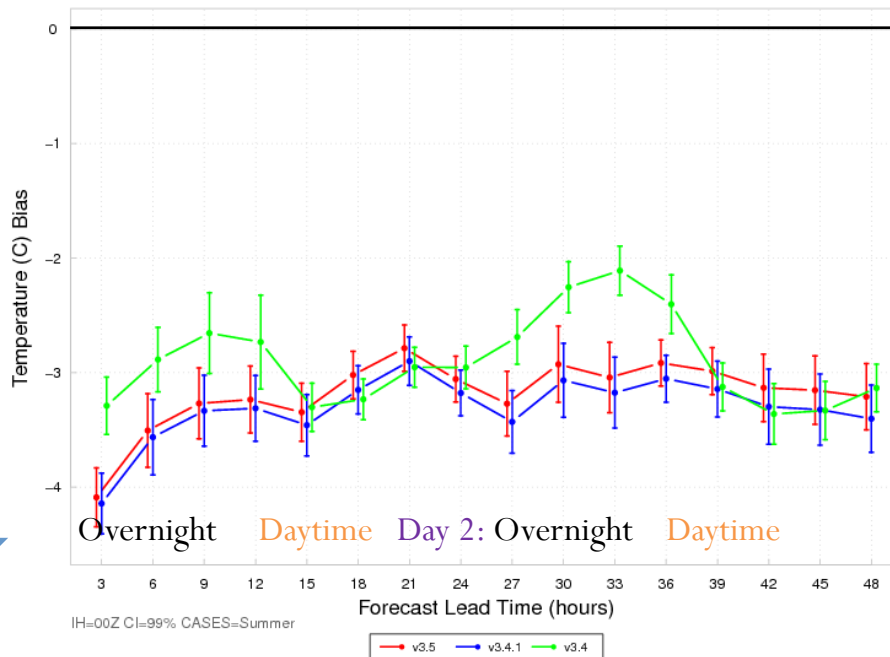
CONUS Sfc Temp Bias - Time Series

00 UTC Initializations

Summer

Winter

Larger cold bias



WRFv3.4

WRFv3.4.1

WRFv3.5



CONUS Sfc Temp Bias - Pair-wise Diffs

00 UTC Initializations

Day 2:

Valid:

12 UTC

00 UTC

12 UTC

00 UTC

Overnight

Daytime

Overnight

Daytime

Lead Time	f03	f06	f09	f12	f15	f18	f21	f24	f27	f30	f33	f36	f39	f42	f45	f48
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v3.4 -
v3.4.1

Aggregated	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 *
Summer	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4.1	v3.4.1	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	--	--	--	v3.4 *
Winter	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 *

v3.4.1
- v3.5

Aggregated	v3.5	v3.5	v3.5	v3.5	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *
Summer	v3.5	v3.5	v3.5	v3.5	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *
Winter	v3.5	v3.5	v3.5	v3.5	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *

v3.4 -
v3.5

Aggregated	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.5 *	v3.5 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	--	v3.5 *	v3.5 *	v3.4 *
Summer	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.5	v3.5 *	v3.5 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.5 *	v3.5 *	v3.5 *	--
Winter	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	--	--	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4 *	--	--	v3.4yy *

Practical Significance: v3.4 Better v3.5 Better



Sfc Temp Bias - By Region

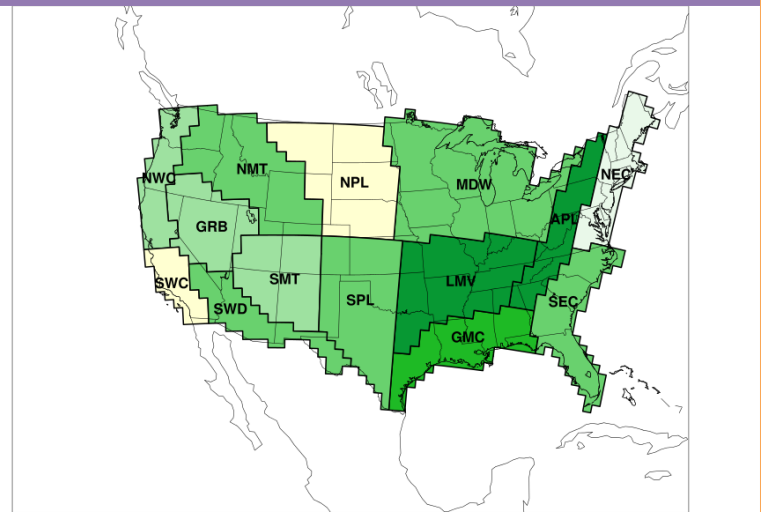
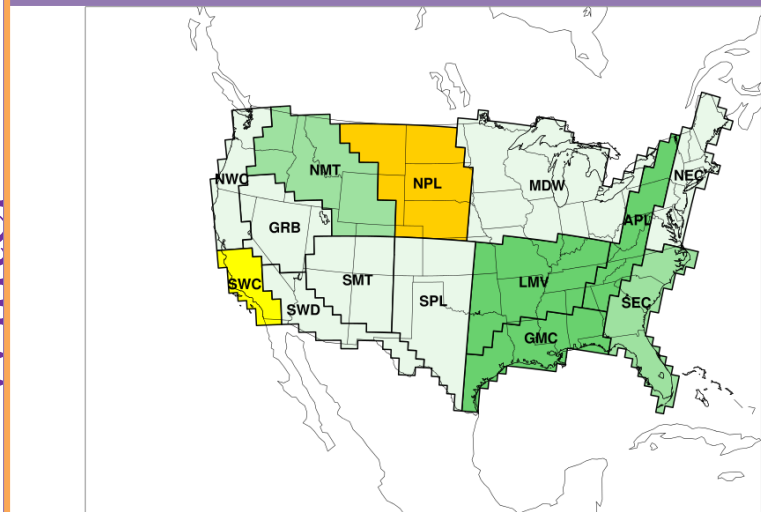
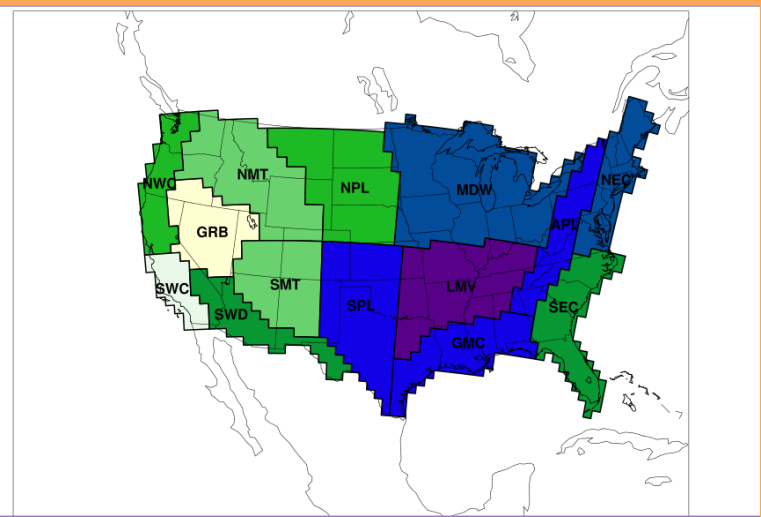
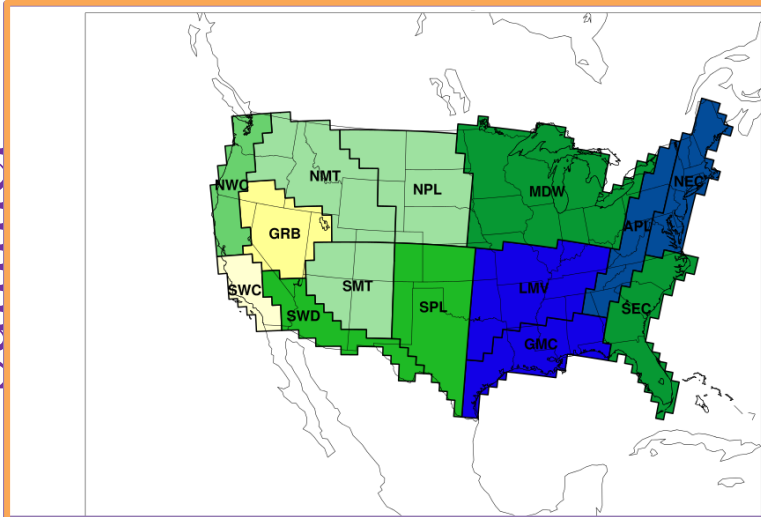
00 UTC Initializations; Lead Time=36h (Valid 12 UTC)

v3.4

v3.5

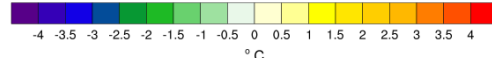
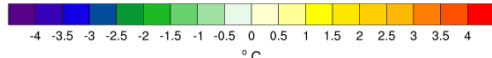
Summer

Winter



Contig=AFWAOC WRFv3.4_d01 Season=Winter Init=00Z Fcst Hr=36h

Contig=AFWAOC WRFv3.5_d01 Season=Winter Init=00Z Fcst Hr=36h



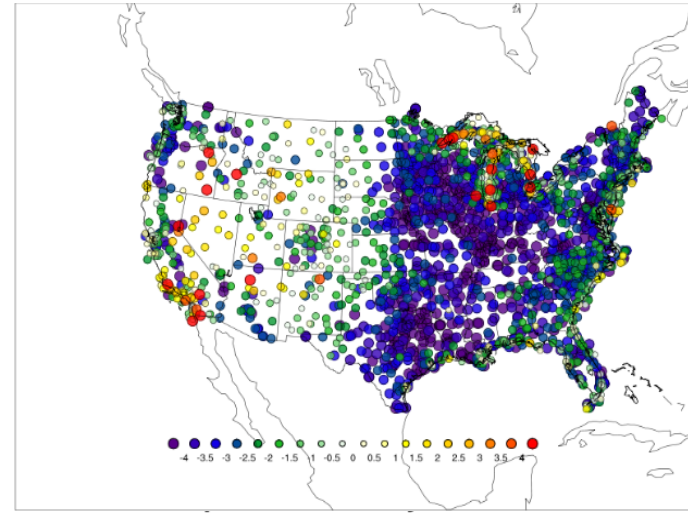
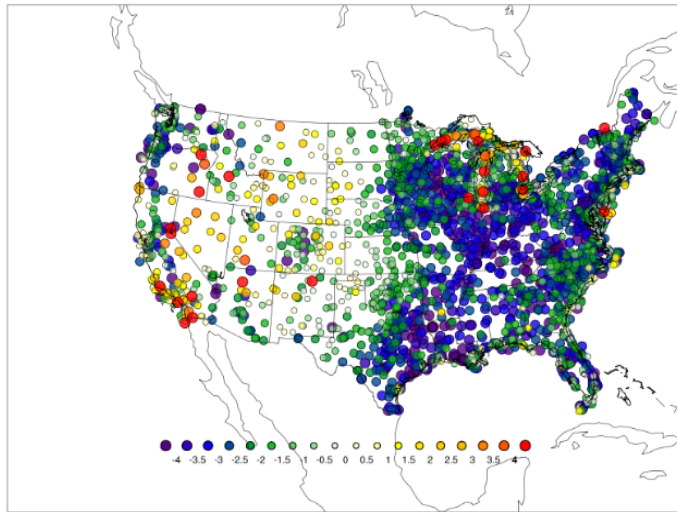
Sfc Temp Bias – By Observation Station

00 UTC Initializations; Lead Time=36h (Valid 12 UTC)

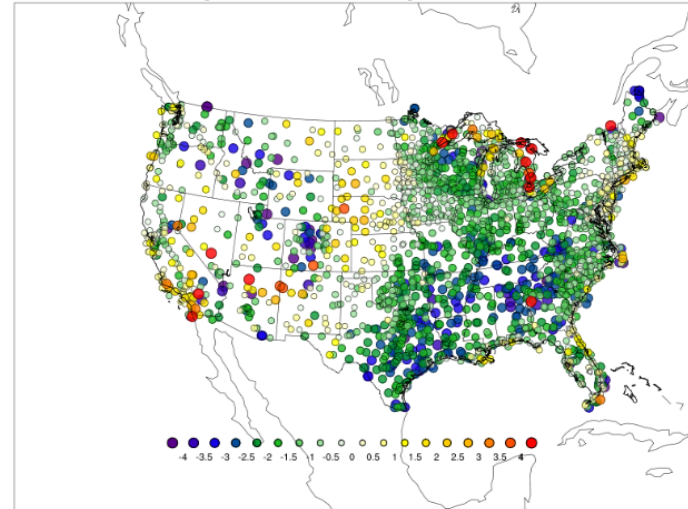
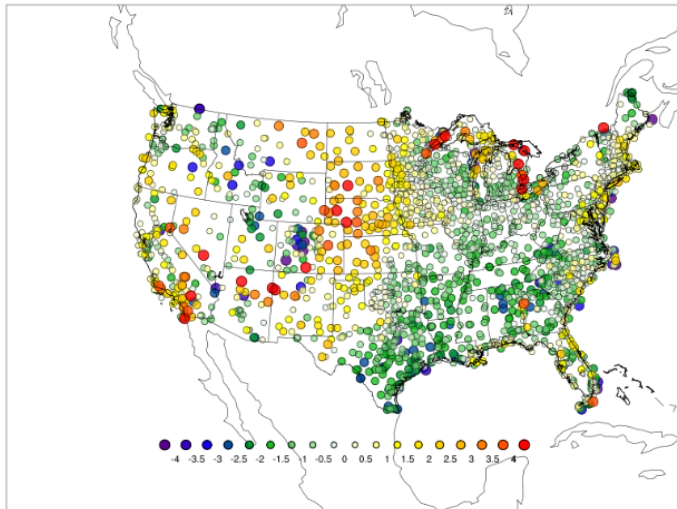
v3.4

v3.5

Summer



Winter

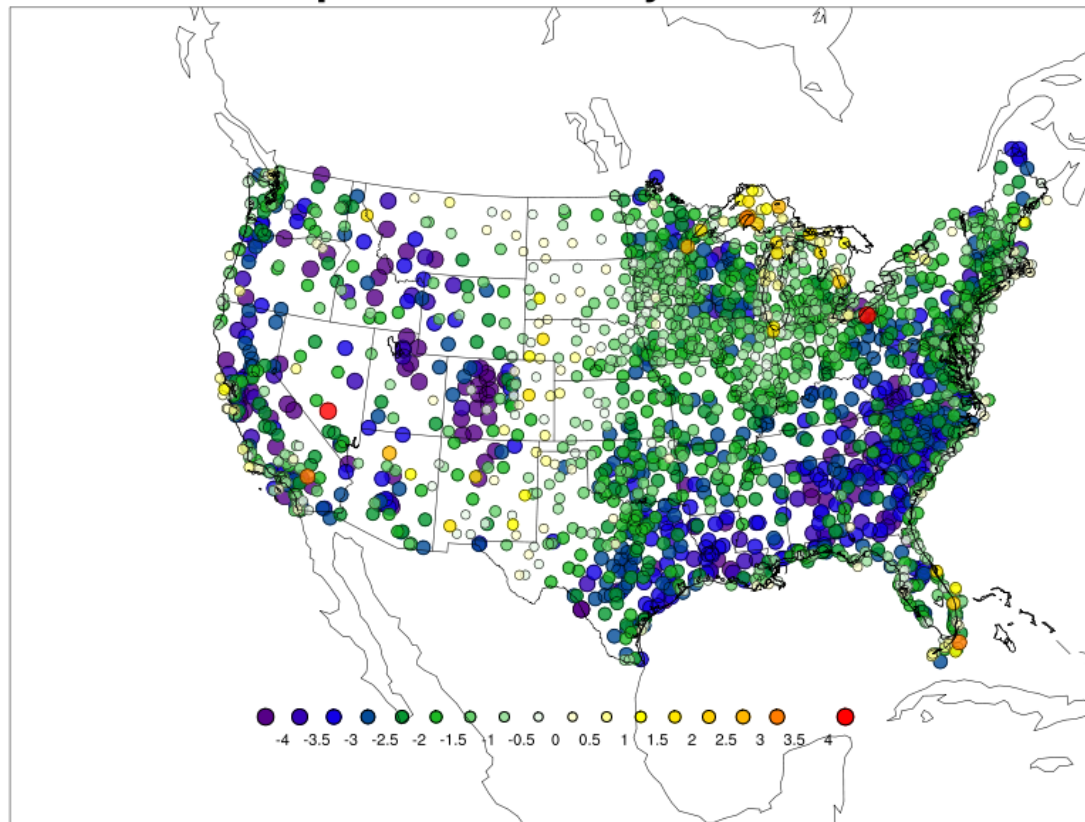


Sfc Temp Bias – By Observation Station

00 UTC Initializations; Lead Time 03-48h, every 3h

Winter

Temperature Bias by Station ID



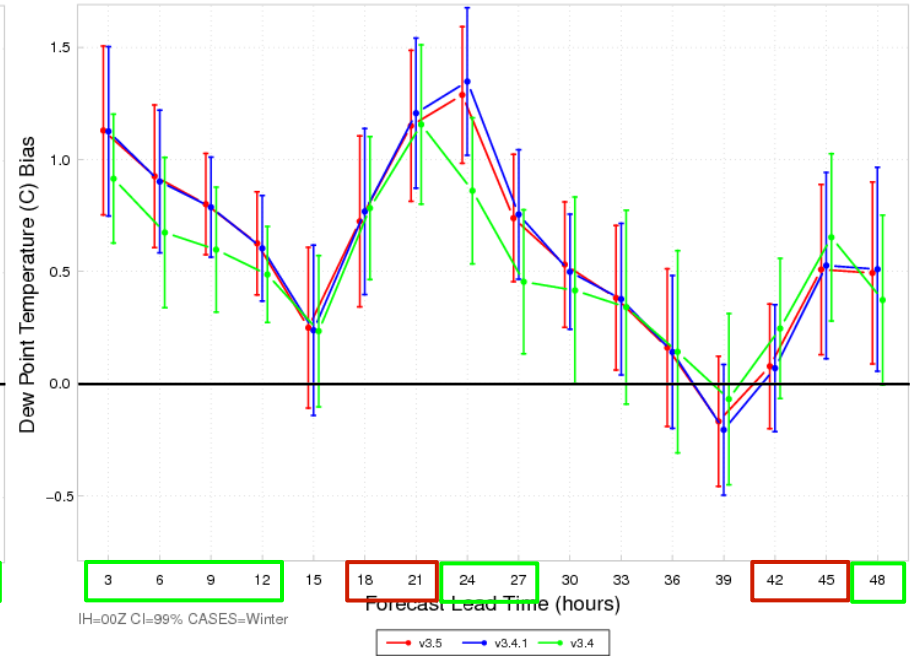
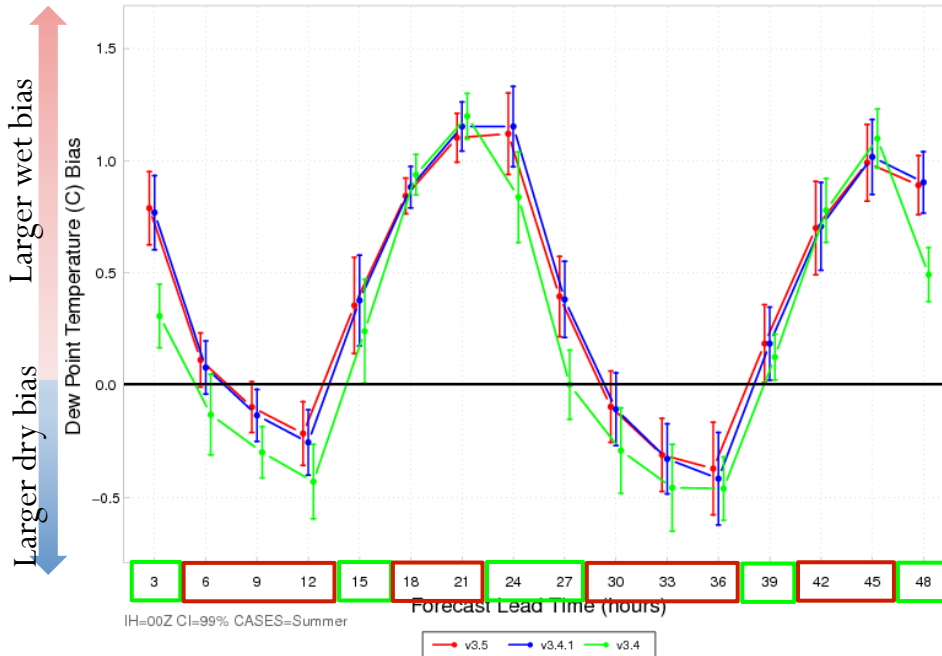
Config=AFWAOC_WRFv3.5 Season=WINTER Init=00UTC Fcst Hr=03h

CONUS Sfc Dew Point Bias - Time Series

00 UTC Initializations

Summer

Winter



WRFv3.4

WRFv3.4.1

WRFv3.5

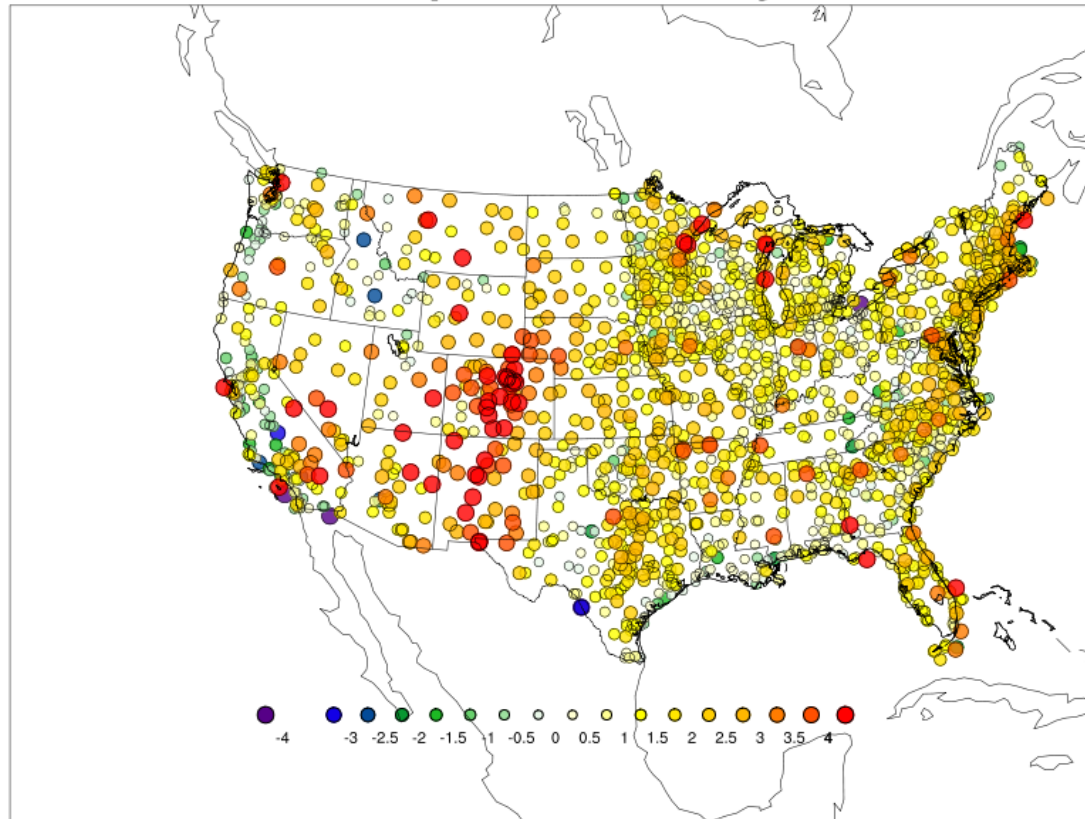
Lead Time	f03	f06	f09	f12	f15	f18	f21	f24	f27	f30	f33	f36	f39	f42	f45	f48
Aggregated	v3.4 *	v3.4 *	v3.4 *	v3.4 *	v3.4	v3.5 *	v3.5 *	v3.4 *	v3.4 *	v3.4 *	v3.5 *	v3.5 *	--	v3.5 *	v3.5 *	v3.4 *
Summer	v3.4 *	v3.5 *	v3.5 *	v3.5 *	v3.4 *	v3.5 *	v3.5 *	v3.4 *	v3.4 *	v3.5 *	v3.5 *	v3.5 *	v3.4 *	v3.5 *	v3.5 *	v3.4 *
Winter	v3.4 *	v3.4 *	v3.4 *	v3.4 *	--	v3.5 *	v3.5 *	v3.4 *	v3.4 *	--	--	--	--	v3.5 *	v3.5 *	v3.4 *

Sfc Dew Point Bias – By Observation Station

00 UTC Initializations; Lead Time 03-48h, every 3h

Winter

Dew Point Temperature Bias by Station ID



Config=AFWAOC_WRFv3.5 Season=WINTER Init=00UTC Fcst Hr=03h

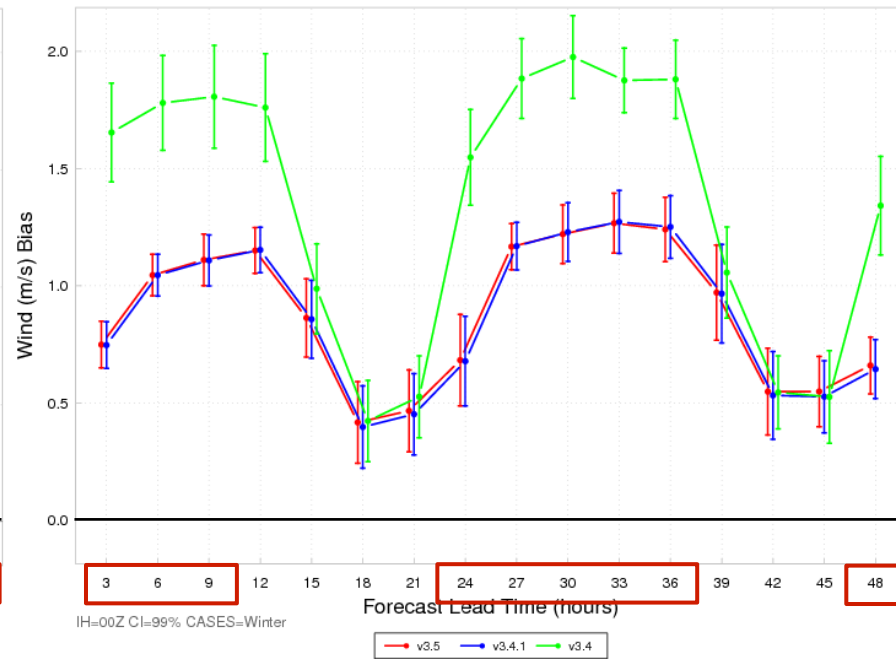
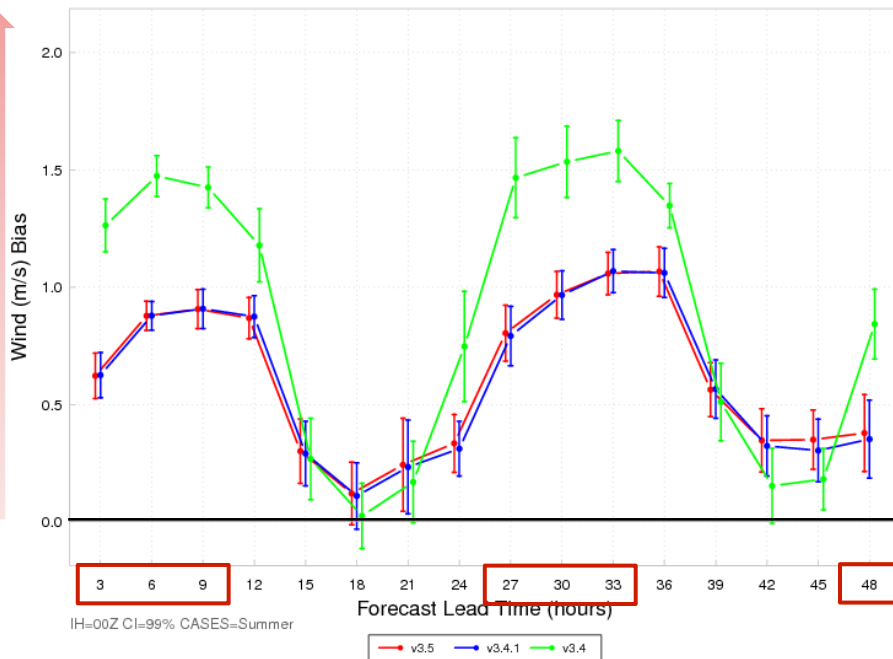
CONUS Sfc Wind Bias - Time Series

00 UTC Initializations

Summer

Winter

Larger high bias



WRFv3.4

WRFv3.4.1

WRFv3.5

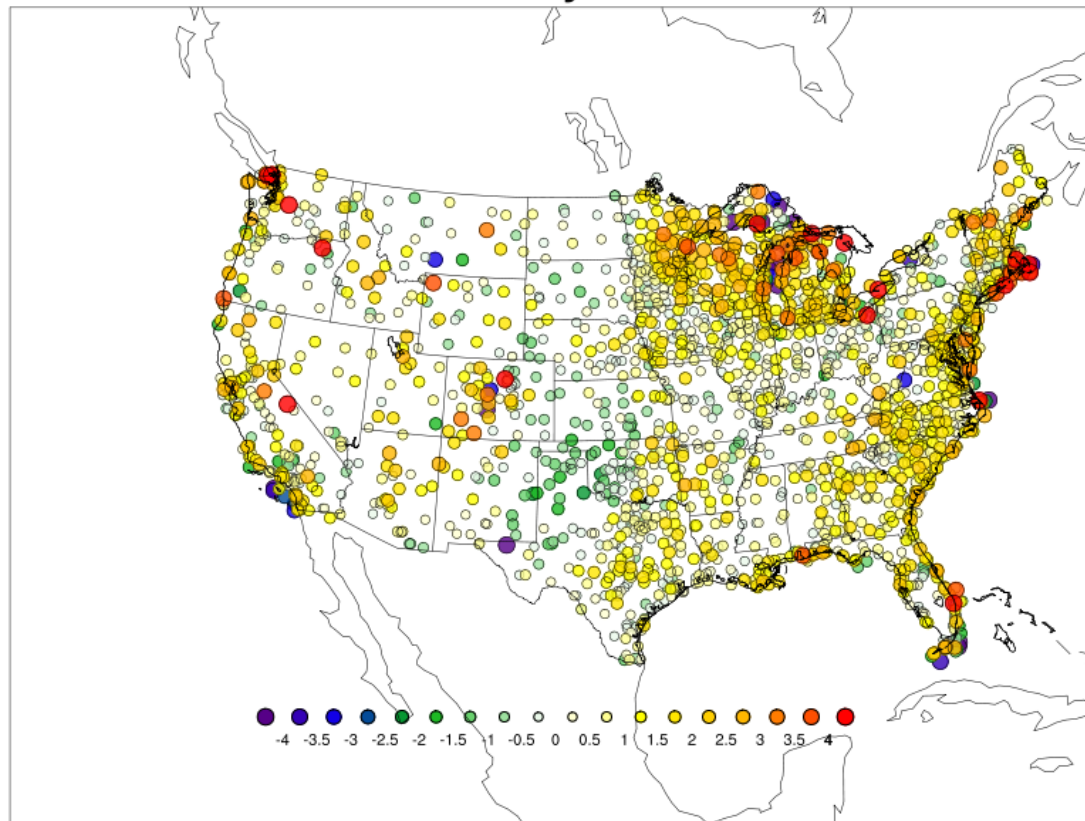
Lead Time	f03	f06	f09	f12	f15	f18	f21	f24	f27	f30	f33	f36	f39	f42	f45	f48
Aggregated	v3.5 *	v3.5 *	v3.5 *	v3.5 *	--	v3.4	v3.4	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5	--	v3.4	v3.4	v3.5 *
Summer	v3.5 *	v3.5 *	v3.5 *	v3.5	--	v3.4	v3.4	v3.5	v3.5 *	v3.5 *	v3.5 *	v3.5	v3.4	v3.4	v3.4	v3.5 *
Winter	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5	--	--	v3.5 *	v3.5 *	v3.5 *	v3.5 *	v3.5 *	--	v3.4	v3.4	v3.5 *

Sfc Wind Bias – By Observation Station

00 UTC Initializations; Lead Time 03-48h, every 3h

Winter

Wind Bias by Station ID



Config=AFWAOC_WRFv3.5 Season=WINTER Init=00UTC Fcst Hr=03h

Summary

- Surface Temperature
 - Strongest cold bias during the daytime hours; exception Central Plains between 09 - 12 UTC
 - *Cold bias intensified significantly with v3.5*
- Surface Dew Point Temperature
 - Largest moist bias during the daytime hours; exception SE Coast, TX and CA between 12-15 UTC
 - *Better performer depends on valid time*
- Surface Wind
 - Largest high bias during the overnight hours; exception Central Plains between 18-00 UTC
 - *High bias improved significantly with v3.5*



Questions?

Thanks!

www.dtcenter.org/eval

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