Investigating Seasonal and Regional Differences of the WRF-ARW HIRES Window Physics Suite

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Introduction

A baseline Reference Configuration utilizing the Weather Research and Forecasting (WRF) model Advanced Research WRF (ARW) core High-Resolution Window (HIRESW) physics suite being run operationally at the National Centers for Environmental Prediction (NCEP) was extensively tested by the Developmental Testbed Center (DTC). This presentation will focus on evaluating the seasonal and regional differences of surface variables.

Experimental Design

Code

End-to-end forecast system consisted of the WRF Preprocessing System ***(WPS) v3.4.1***, ***WRF v3.4.1+*** (tag from Nov 2012), Unified Post Processor ***(UPP) v2.0***, and Model Evaluation Tools ***(MET) v4.0***

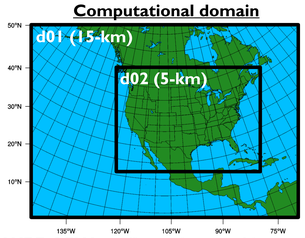
Retrospective forecasts

Forecasts were initialized every ***36 hours*** from ***1 July 2011 through 30 June 2012*** and run out to ***48 hours***

Model Configuration

- 15-km and 5-km 2-way nested domain
  - Parent domain was chosen to minimize effects of lateral boundary condition propagation into the area of interest
  - Inner domain was defined to limit the impacts of complex terrain at the boundaries and covers the CONUS region in order to capture complex terrain, plains and coastal regions

Computational domain



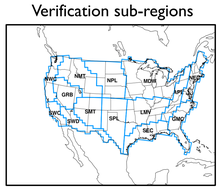
WRF-ARW configuration used in testing

Physics Suite	HIRESW Configuration
Microphysics	WRF Single-Moment 3
Radiation (SW/LW)	Dudhia/RRTM
Surface Layer	Monin-Obukhov similarity theory
Land Surface Model	Noah
PBL	Yonsei University
Convection	Kain-Fritsch

Model Verification

- **Verification statistics** are stratified temporally and spatially; spatial aggregations included *CONUS, CONUS-East, CONUS-West* and *14 sub-regions*
- **Grid-to-point** verification for *surface* and *upper-air temperature, dew point temperature,* and *winds*
  - *Bias-corrected root-mean-squared error (BCRMSE)* and *bias*
- **Grid-to-grid** verification for *3-h* and *24-h QPF*
  - *Gilbert Skill Score* and *frequency bias*
- **Confidence intervals** (CIs) computed at the 99% level

Verification sub-regions



Summary and Future Activities

- Over the CONUS, regardless of initialization or seasonal aggregation, ***all forecast lead times have a cold bias***, intensifying at times valid near 00 UTC
- ***Dew point temp*** bias displayed ***higher values around times valid at 00 UTC*** and ***lower bias values at times around 12 UTC***; higher dew point temp bias was seen in interior regions, while coastal regions tended to have lower dew point temp biases
- Over the CONUS, regardless of initialization or seasonal aggregation, most ***all forecast lead times have a high wind speed bias***, with largest biases for valid times around 06 – 09 UTC
- In the coming weeks, configuration descriptions, executive summaries, graphics, documentation, and a full suite of verification results will be available on the project's webpage: http://www.dtcenter.org/config

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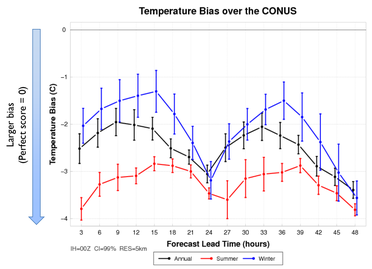
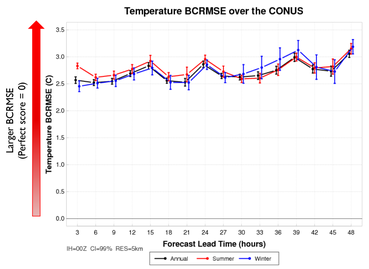
Verification Results

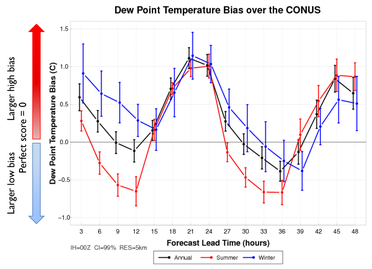
Aggregations by forecast lead time

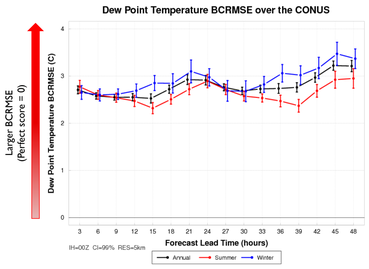




Surface temperature evaluation

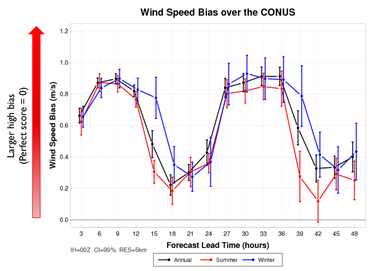
- ***Temperature bias***: for both 00 and 12 UTC initializations over the CONUS domain, all temporal aggregations display a cold bias (fall and spring not shown)
- Diurnal signal in temperature bias: strongest cold biases at hours valid between 00 – 03 UTC; smaller cold biases at times valid between 09 – 15 UTC
- Compared to all temporal aggregations, summer has a stronger cold bias
- ***Temperature BCRMSE***: in general, seasonal aggregations display similar results, with peaks in error at times valid at 00 and 15 UTC

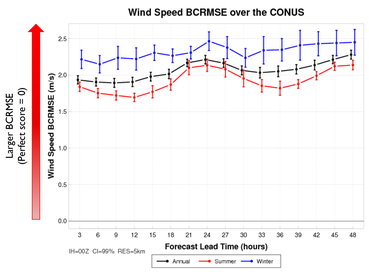




Surface Dew point temperature evaluation

- ***Dew point temp bias***: diurnal signal evident in all temporal aggregations (fall and spring not shown), with lower bias values at times valid between 03 – 12 UTC and higher bias values at times valid between 18 – 00 UTC
- At times valid between 03 – 12 UTC large seasonal spread in dew point temp bias, with the summer aggregation having lower bias
- ***Dew point temp BCRMSE***: Seasonal spread in errors at the 12 to 21-h and 33 to 48-h forecast lead times, where summer aggregation typically has lower BCRMSE





Surface wind speed evaluation

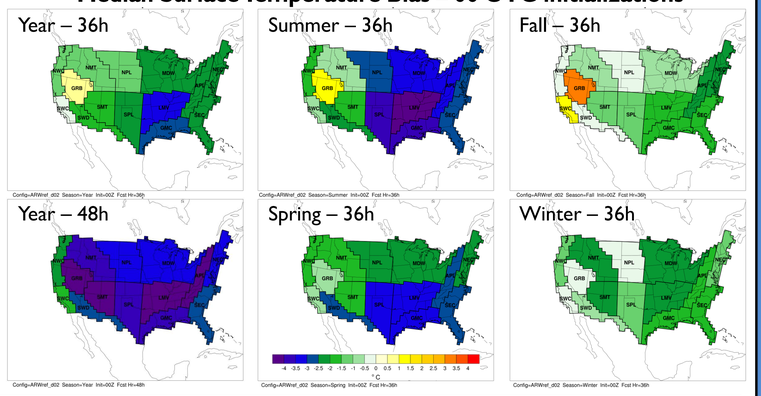
- ***Wind speed bias***: for both 00 and 12 UTC initializations over the CONUS domain, all temporal aggregations display a high wind bias (fall and spring not shown)
- Diurnal signal in wind speed bias: highest biases at hours valid between 03 – 12 UTC; lower biases at times valid between 18 – 00 UTC
- ***Wind Speed BCRMSE***: at a majority of forecast lead times, summer has the lowest BCRMSE values while winter displays the largest errors
- All seasonal aggregations have peak values of BCRMSE at times valid near 00 UTC

Regional differences by season

Seasonal differences in surface temperature

- Forecast times valid at 12 UTC: cold bias in most regions, with strongest southeast
- Forecast times valid at 00 UTC: cold bias intensifies for most all regions
- Strong cold bias for summer & spring at 12 UTC valid times over Eastern CONUS
- GRB has a magnified diurnal signal in bias

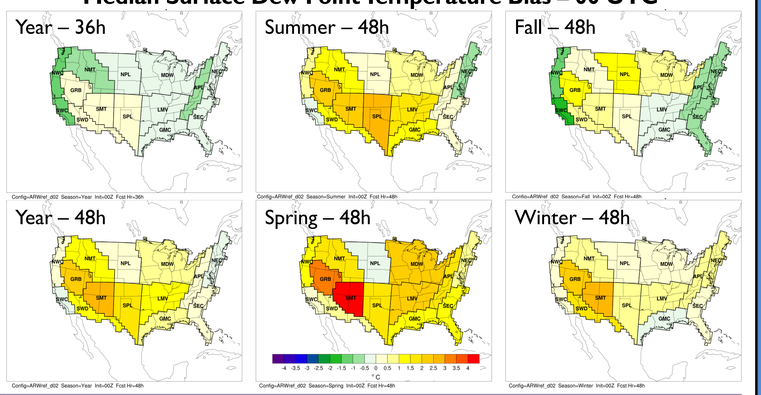
Median Surface Temperature Bias – 00 UTC initializations



Seasonal differences in surface dew point temperature

- All seasons have diurnal trend with higher bias values around times valid at 00 UTC and lower bias values at times around 12 UTC
- Higher bias values at times valid near 00 UTC in the interior regions of the CONUS, specifically GRB, SMT, Southern Plains, and MDW regions
- Lower biases seen in coastal regions; magnified in fall & times valid around 12 UTC

Median Surface Dew Point Temperature Bias – 00 UTC



Seasonal differences in surface wind speed

- All seasons display diurnal trend with higher bias near times valid at 12 UTC and lower bias at times near 00 UTC
- In general, lower magnitude of biases in the Western CONUS

Median Surface Wind Speed Bias – 00 UTC initializations