Verification of the National Blend of Models

97th AMS Annual Meeting

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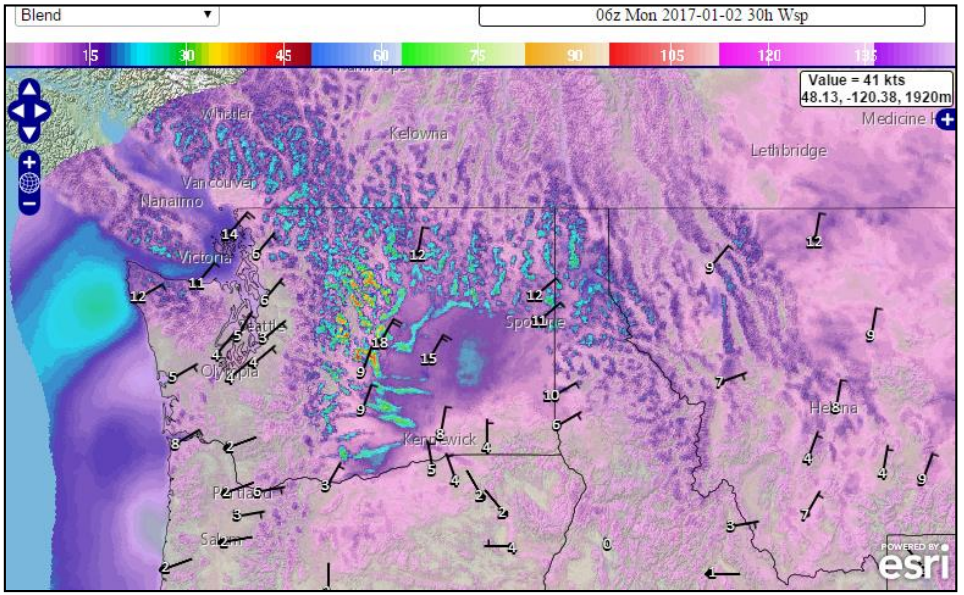
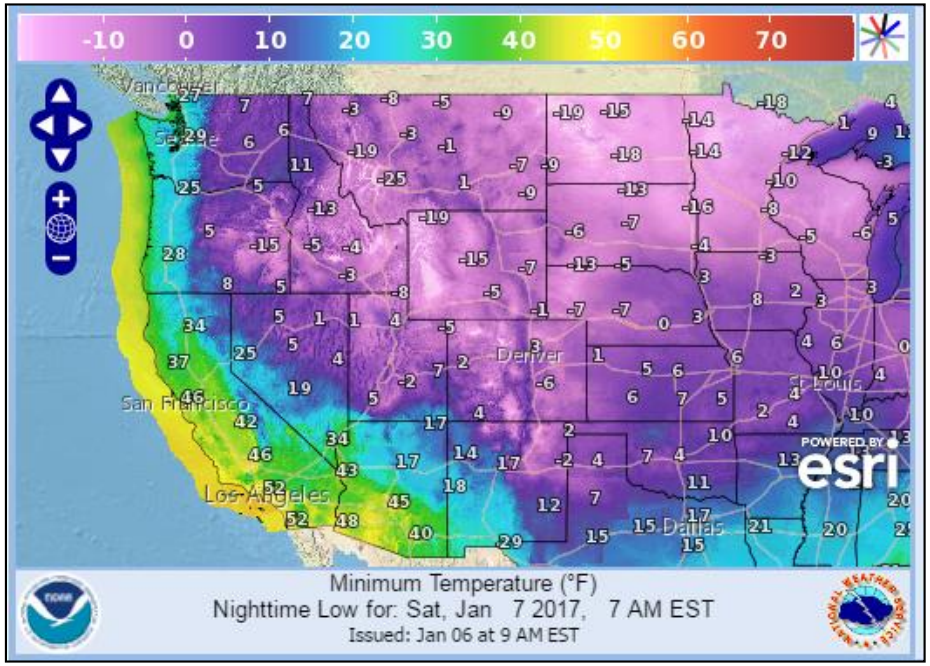
National Blend of Models



- Developed to provide nationally consistent and skillful suite of calibrated forecast guidance
- A blend of NWS and non-NWS deterministic, ensemble, and statistically post-processed output
- Intended as forecast guidance for NWS forecasters as they prepare the NDFD

National Digital Forecast Database

- Official NWS forecasts produced by NWS forecasters on fine-resolution grid
- MDL routinely evaluates NDFD and compares skill to guidance (e.g., NBM, WPC, GMOS)
- Verification performed both on grids and at stations



Data

- **NBM v1.0 became operational 1/6/2016**
  - CONUS only
  - Max/Min Temperature; Temperature; Dewpoint; Wind Direction, Speed, and Gust; Sky Cover; Relative Humidity; Apparent Temperature
  - Wind Speed not bias-corrected
- **NBM v2.0 became operational 11/15/2016**
  - Added QPF06 and PoP12, extended to 264 hours, added OCONUS
  - Parallel data available for several months before implementation
  - Added 2 versions of the NAM for all elements except MaxT/MinT
  - All inputs except EKDMOS are bias-corrected for Wind Speed
- **This study shows Surface Temperature and Wind Speed verification for CONUS**

Component Verification

- **NBM v2.0 vs. its Bias-Corrected Components**
  July 2016 – November 2016

  All sources are 00Z model cycle time

  - ☆ **CMCE**: Canadian Meteorological Centre Ensemble
  - ● **EKDMOS**: Ensemble Kernel Density MOS from NAEFS (only for temperature)
  - ◆ **GEFS**: Global Ensemble Forecast System
  - ⬟ **GFS**: Global Forecast System
  - ■ **GMOS**: Gridded Model Output Statistics

Not shown in this study: 2 versions of NAM

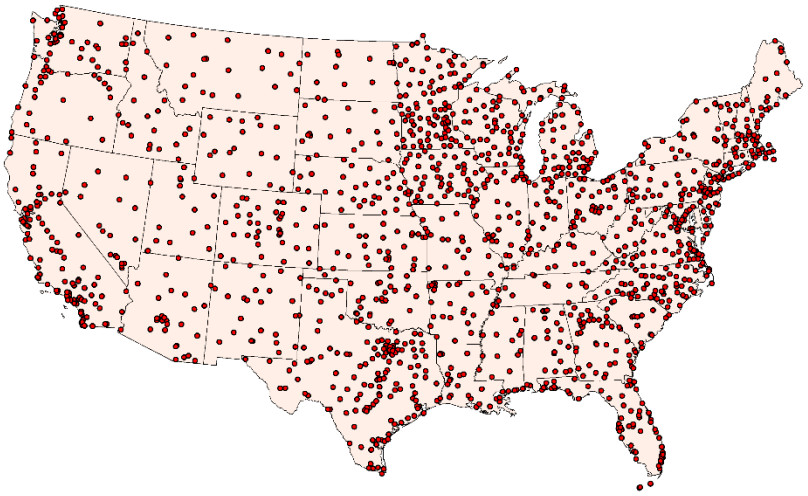
Forecast Verification

- **00Z NDFD issuance vs. available guidance**
  July 2016-October 2016

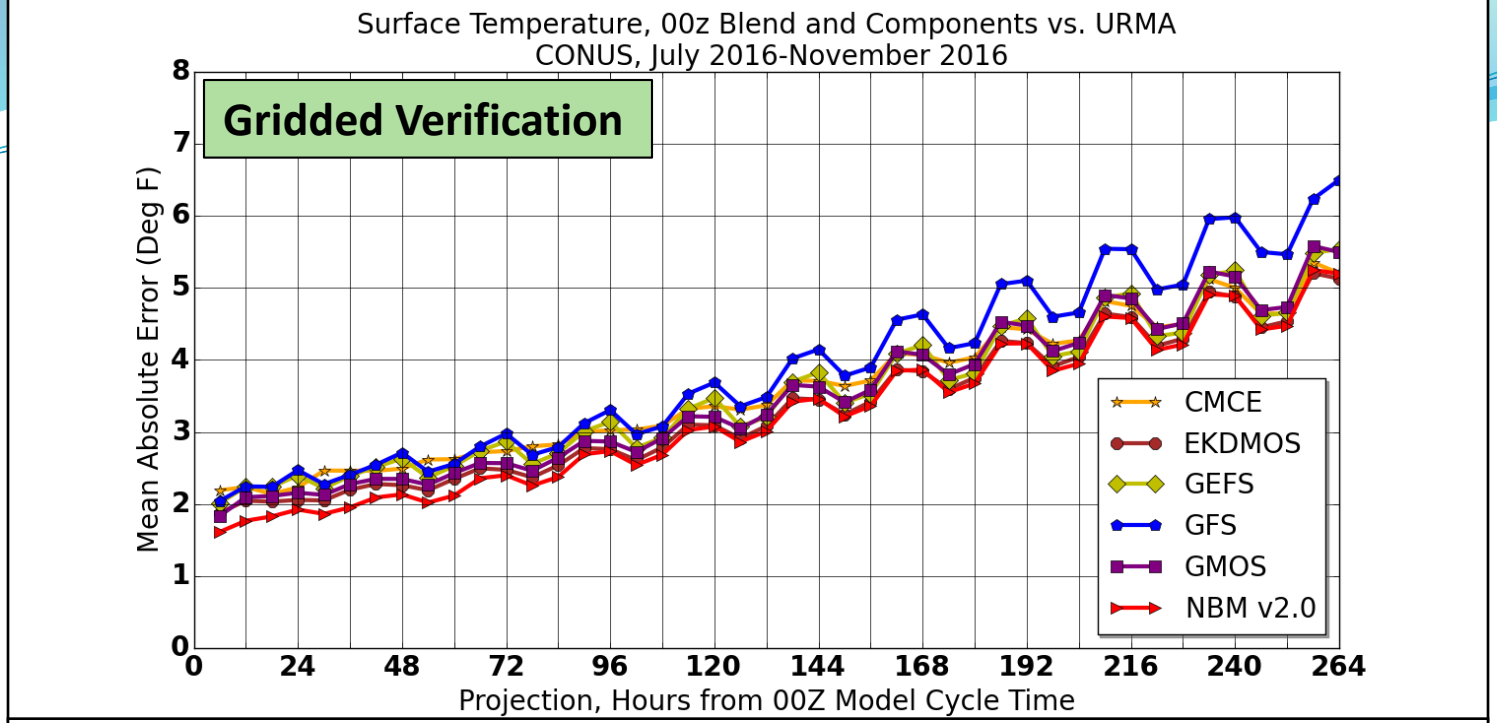
Source	Reference Time	Available
★ pcNBM v2.0	Prior day 00Z model cycle	0900Z
● WPC	Prior day 12Z reference time	1500Z
▶ NBM v2.0	Prior day 12Z model cycle	2100Z
◆ NBM v1.0	Prior day 12Z model cycle	2330Z

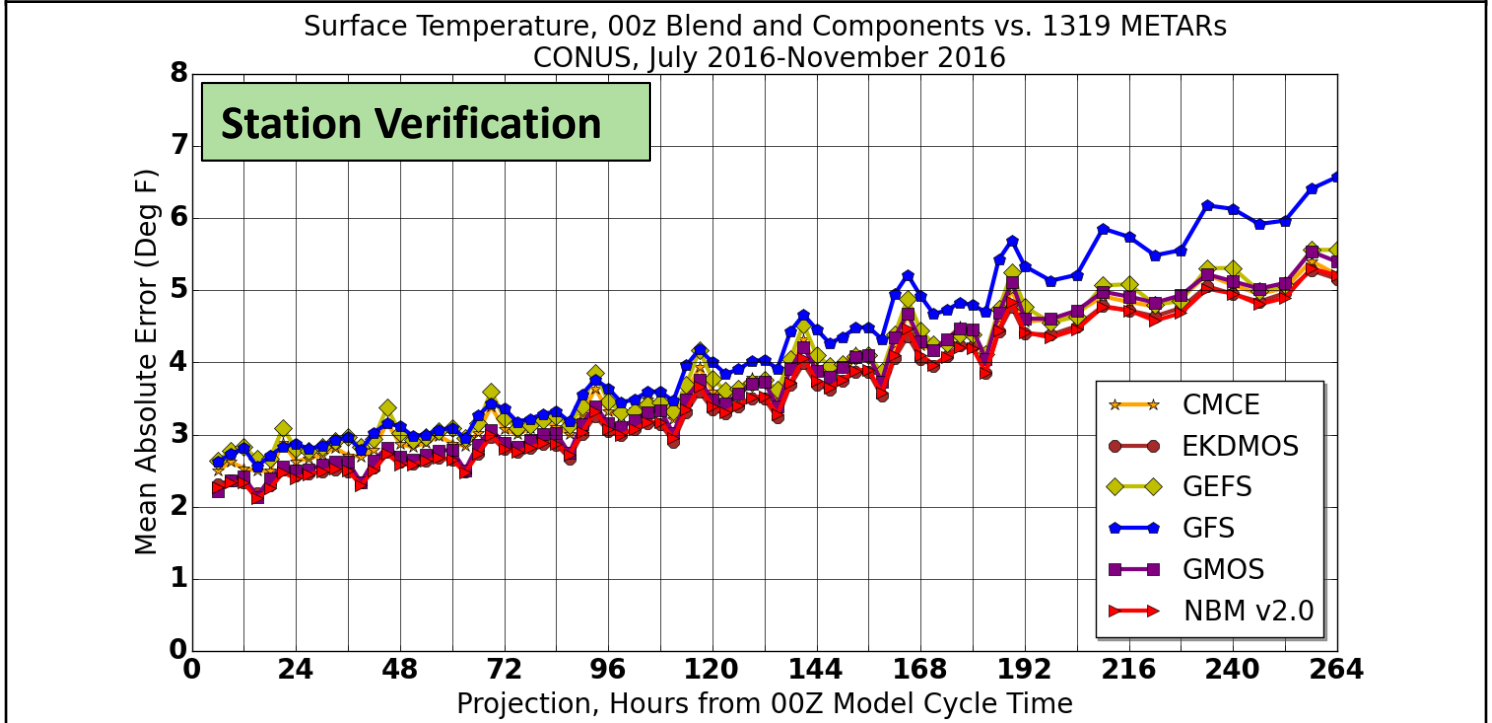
Observations

- **Gridded "truth": UnRestricted Mesoscale Analysis (URMA)**
  - Run 6 hours after Real Time Mesoscale Analysis (RTMA) in order to incorporate observations that arrive too late for the RTMA
- **Station "truth": METAR observations at 1319 stations**
  - Gridded forecasts are interpolated to points using a modified nearest neighbor technique



1319 METAR stations


Surface Temperature, 00z Blend and Components vs. URMA
CONUS, July 2016-November 2016
Gridded Verification
Mean Absolute Error (Deg F)
Projection, Hours from 00Z Model Cycle Time
CMCE
EKDMOS
GEFS
GFS
GMOS
NBM v2.0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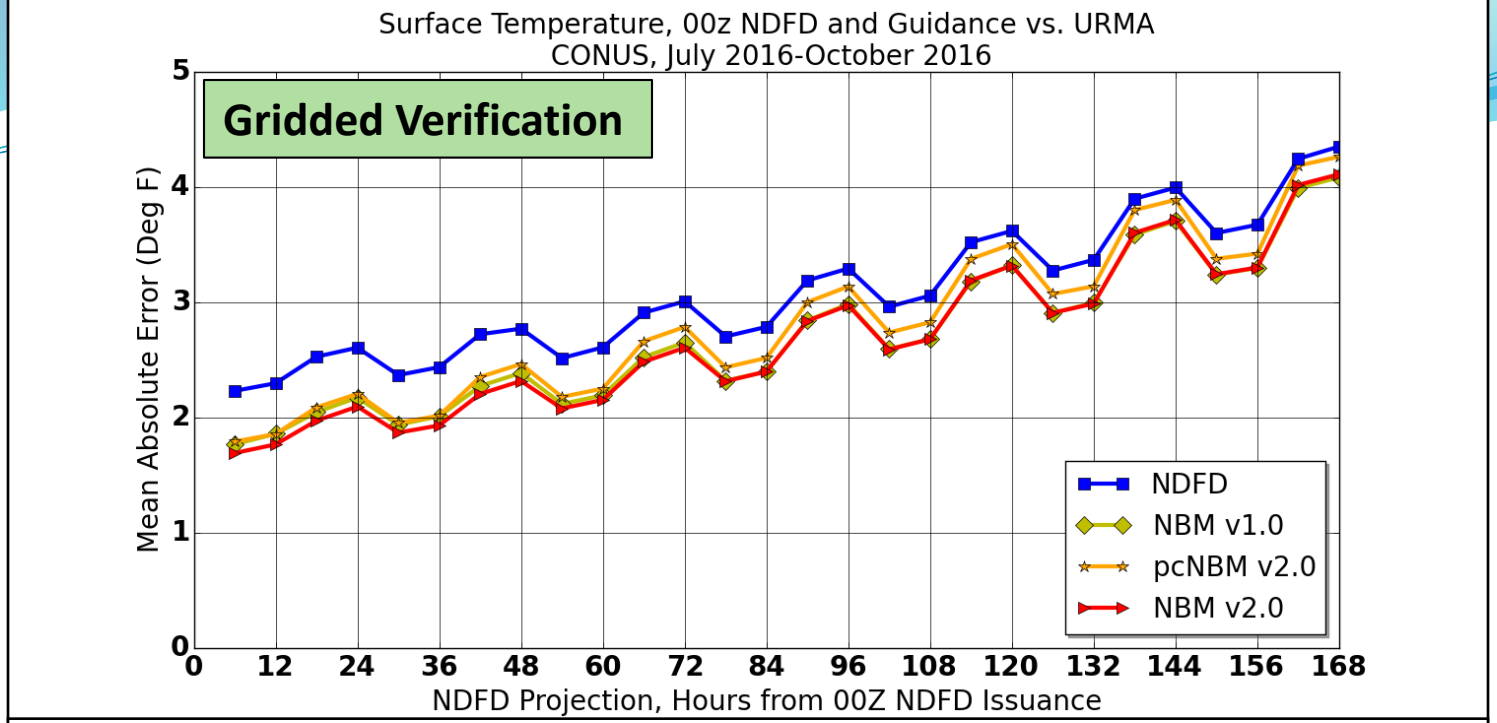
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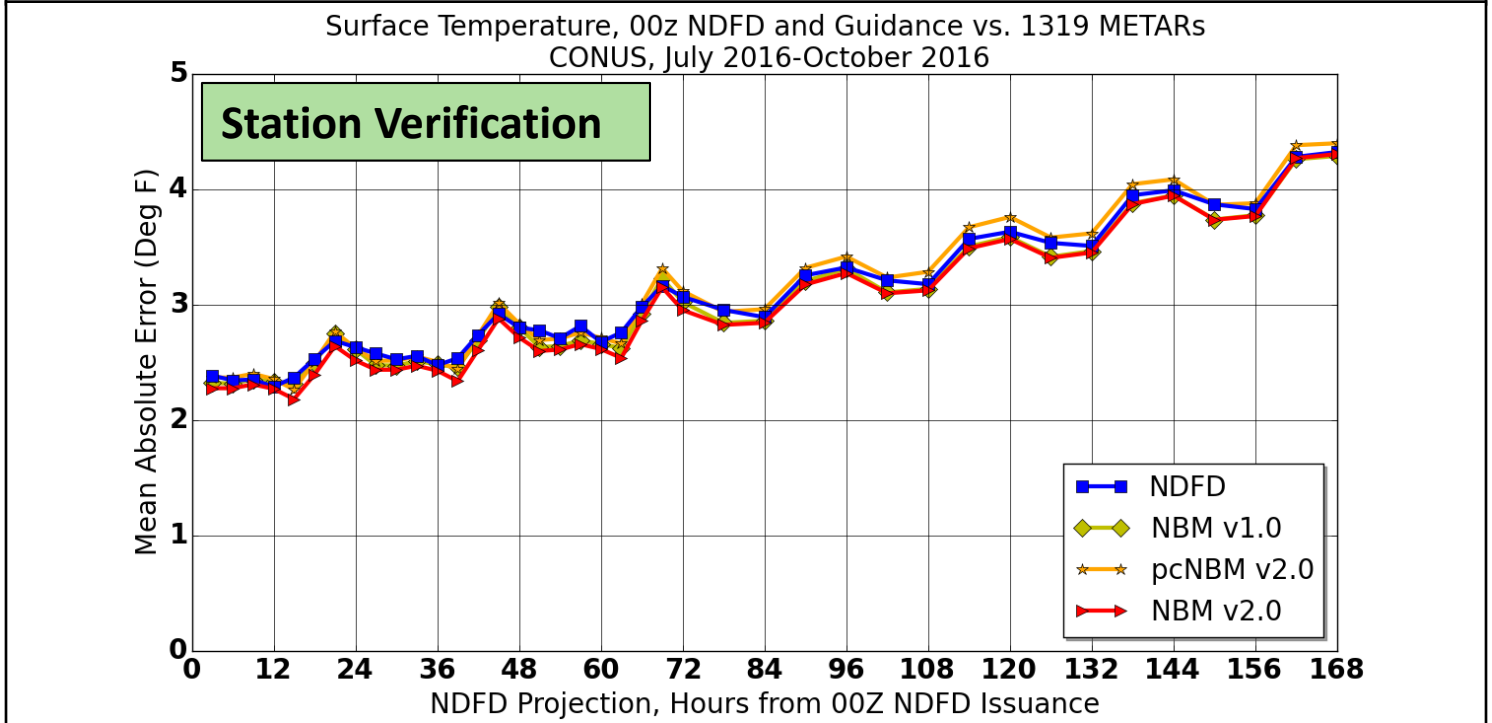
Mean Absolute Error (Deg F)
NDFD Projection, Hours from 00Z NDFD Issuance
NDFD
NBM v1.0
pcNBM v2.0
NBM v2.0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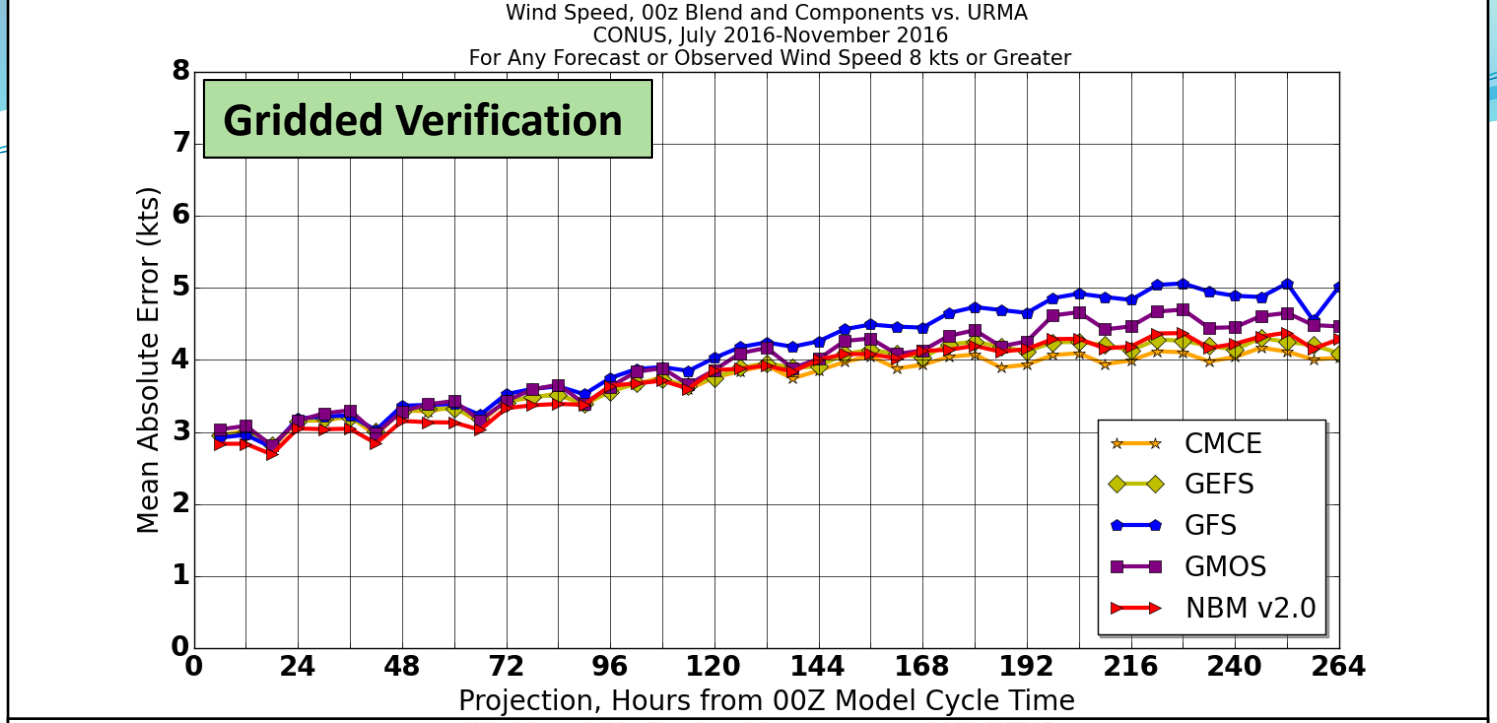
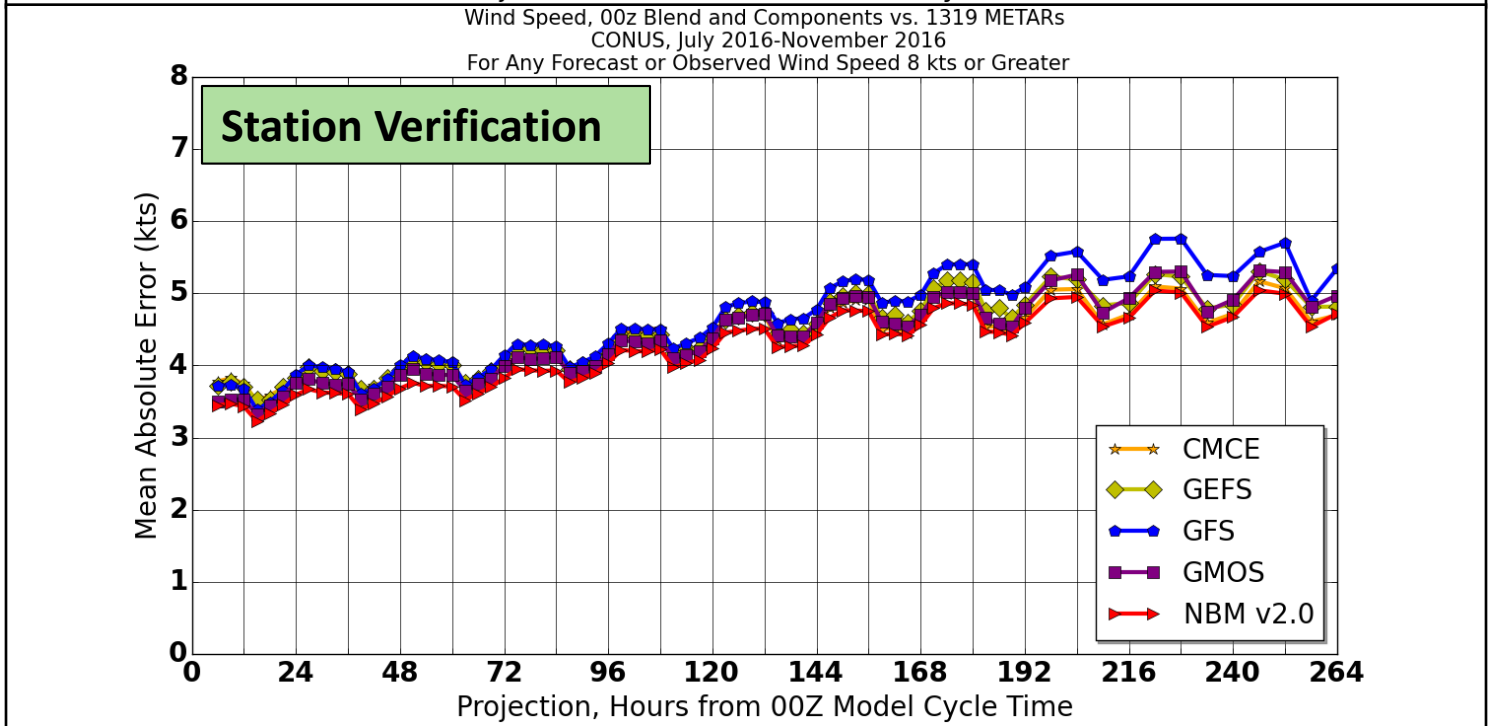
NBM v1.0
pcNBM v2.0
NBM v2.0

Results - Temperature

- NBM v2.0 improves on its bias-corrected components
  - Day 4 NBM forecast is as skillful as Day 2 BC GFS forecast
- NBM v2.0 and components verify better against URMA than METARs
  - These are bias-corrected against the URMA
- NBM v2.0 is an improvement over NBM v1.0
- NBM skill is comparable to NDFD
  - NDFD verifies equally well against URMA and METARs
  - NBM appears better than NDFD when verified against URMA


Wind Speed, 00z Blend and Components vs. URMA
CONUS, July 2016-November 2016
For Any Forecast or Observed Wind Speed 8 kts or Greater
Gridded Verification
Mean Absolute Error (kts)
Projection, Hours from 00Z Model Cycle Time
CMCE
GEFS
GFS
GMOS
NBM v2.0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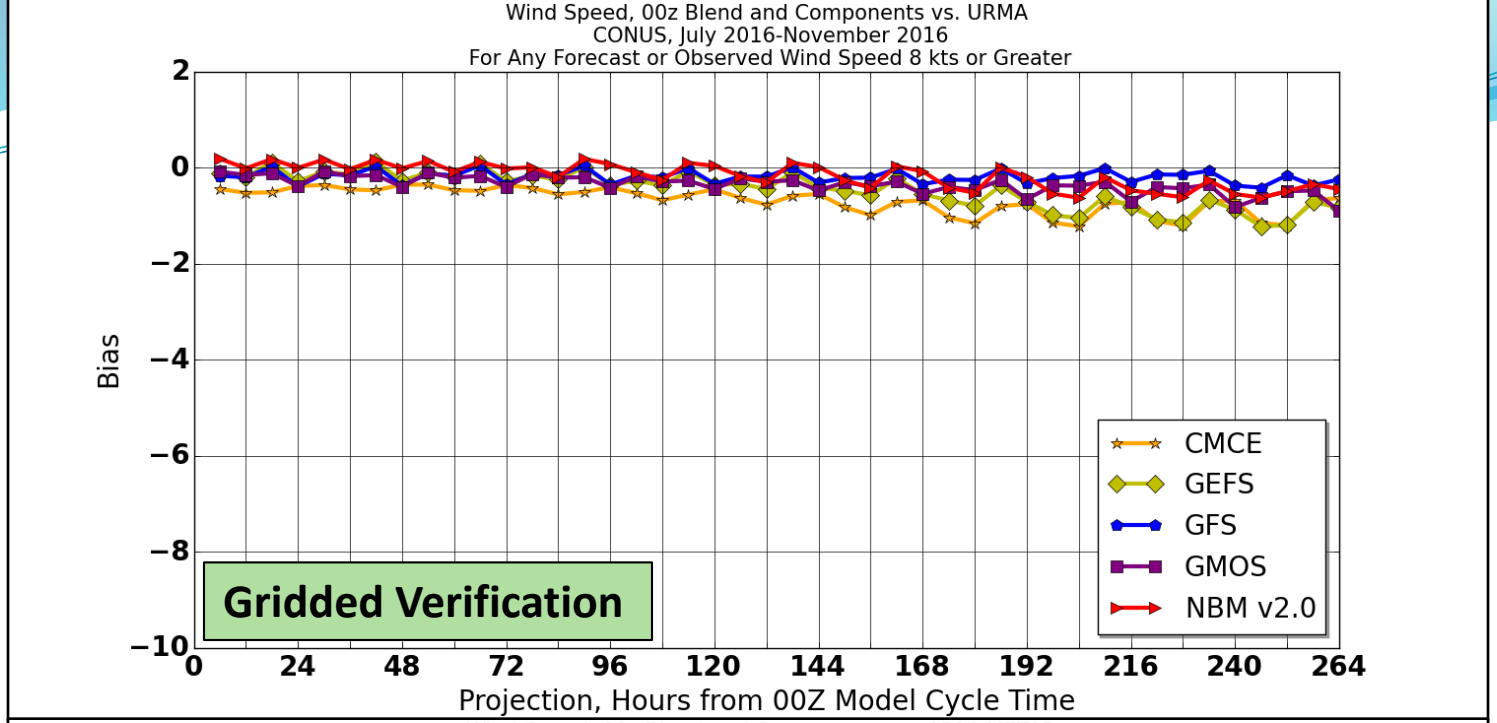
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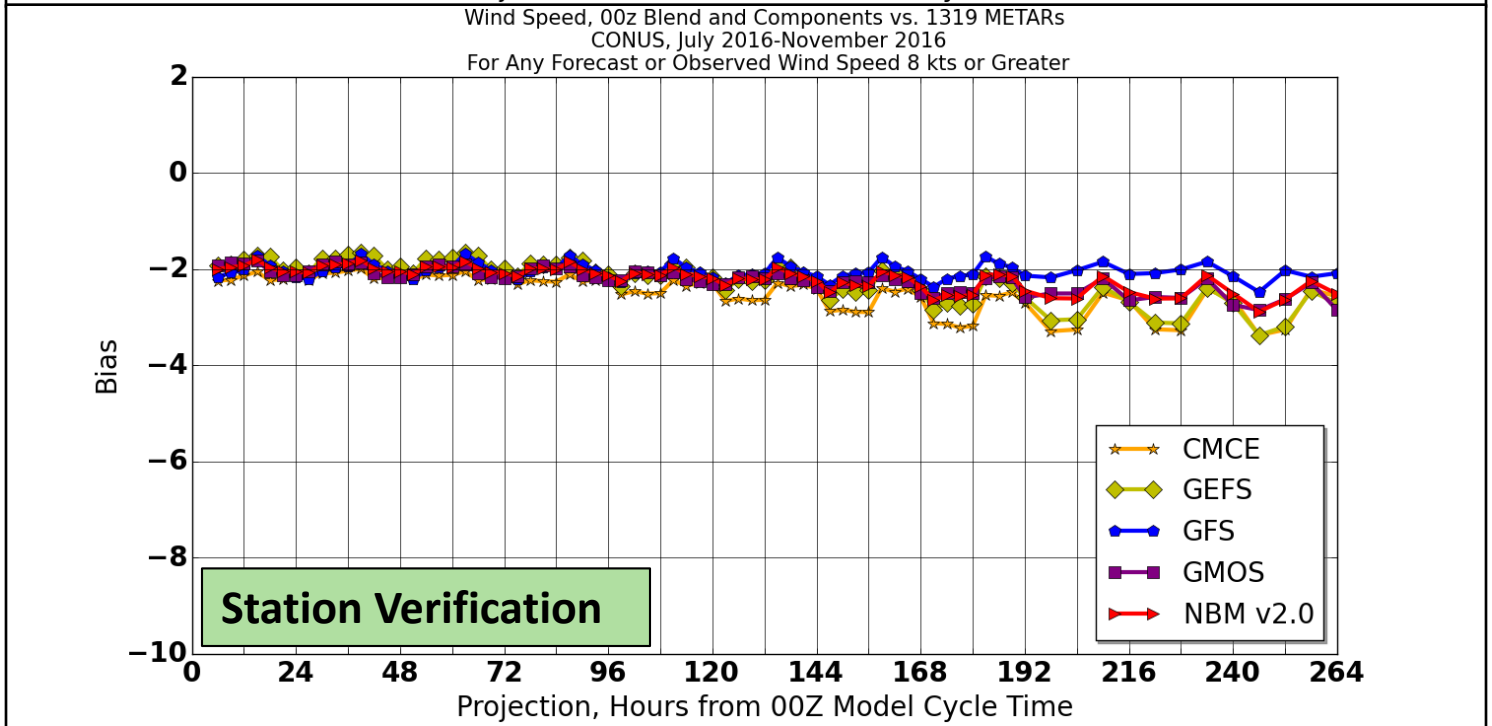
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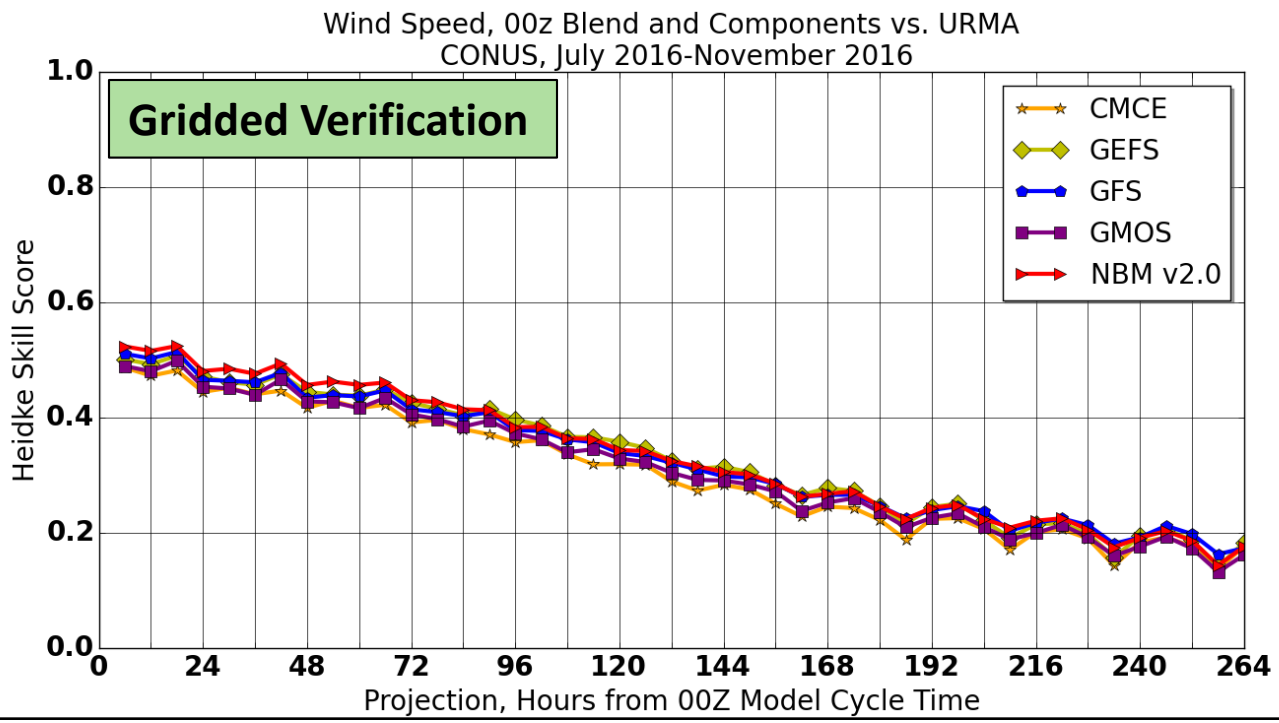
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GMOS
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Heidke Skill Score
1.0
0.8
0.6
0.4
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48
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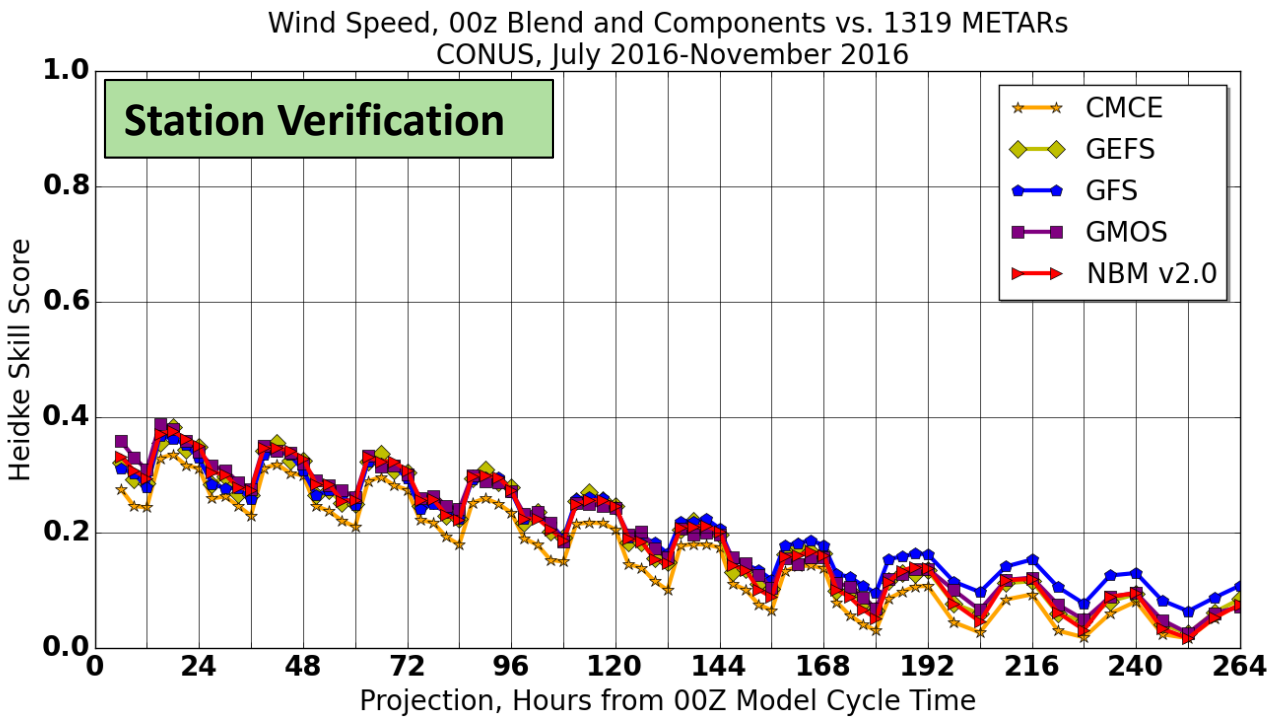
96
120
144
168
192
216
240
264
Projection, Hours from 00Z Model Cycle Time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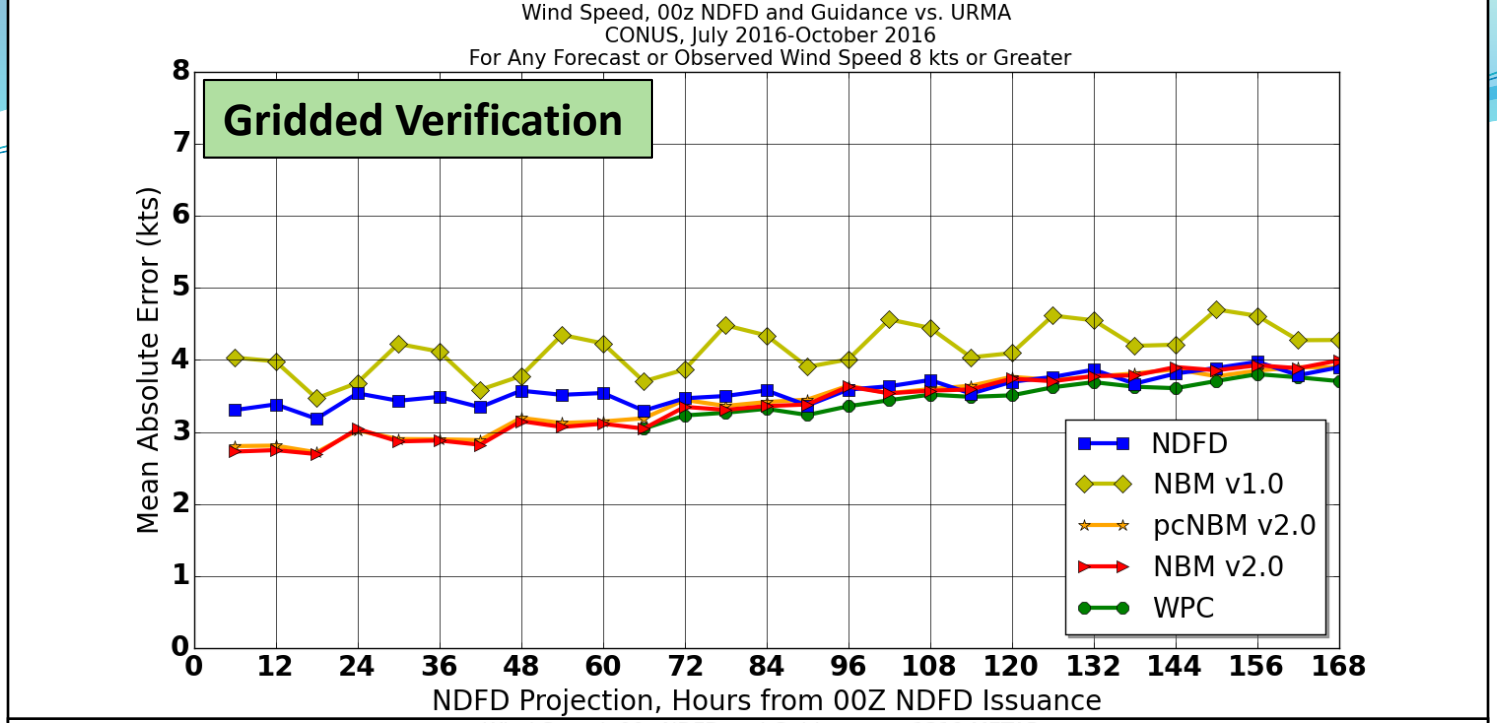
Projection, Hours from 00Z Model Cycle Time

Results – Wind Speed Components

- In grids, NBM is best (lowest MAE) in days 1-5; CMCE/GEFS are better in days 6-11. At stations, NBM is best at all projections
- All systems underforecast, but NBM v2.0 is better than components due to bias correction to URMA
- Projections with most cases (verifying around 21Z) have lower MAEs and are less biased than projections with fewer cases.
  - GFS and NBM tend to have more cases than CMCE and GEFS in days 6-11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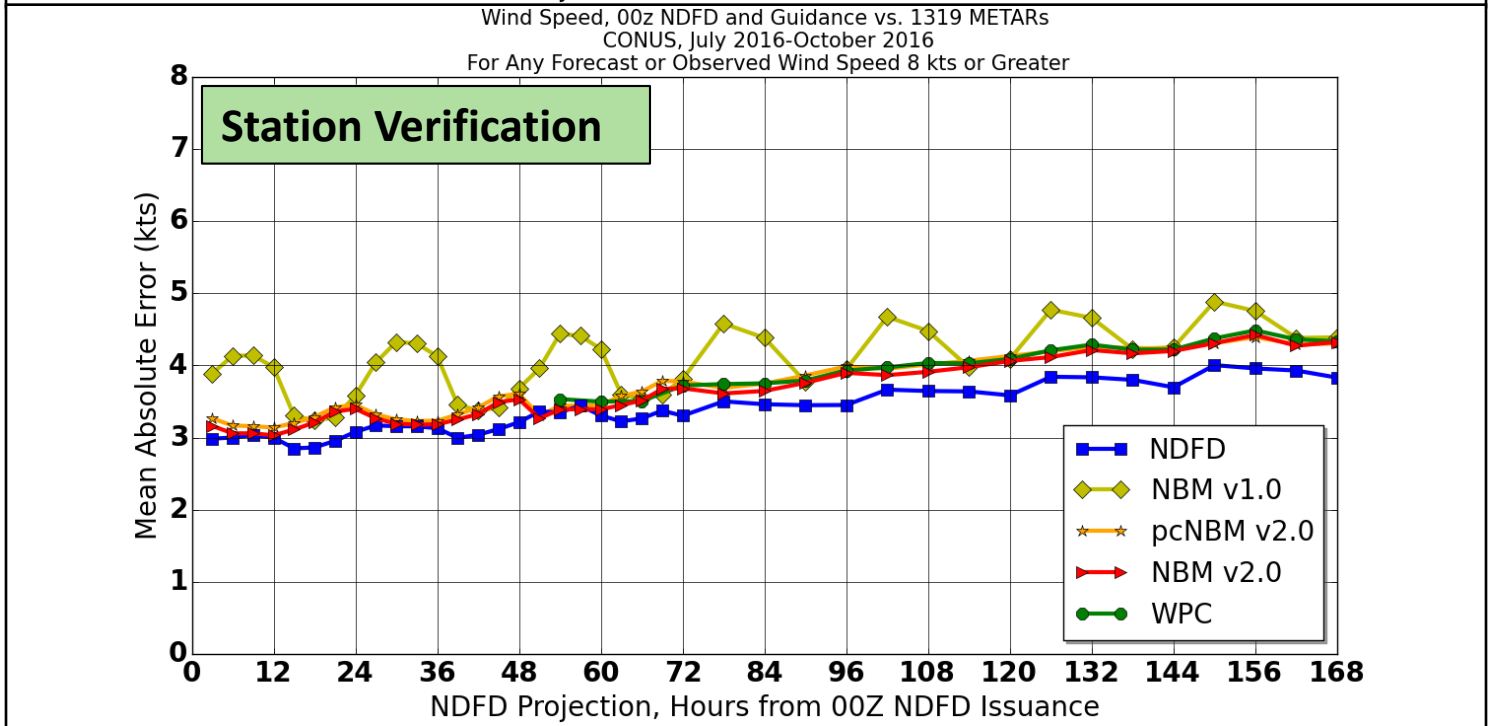
NDFD
NBM v1.0
pcNBM v2.0
NBM v2.0
WPC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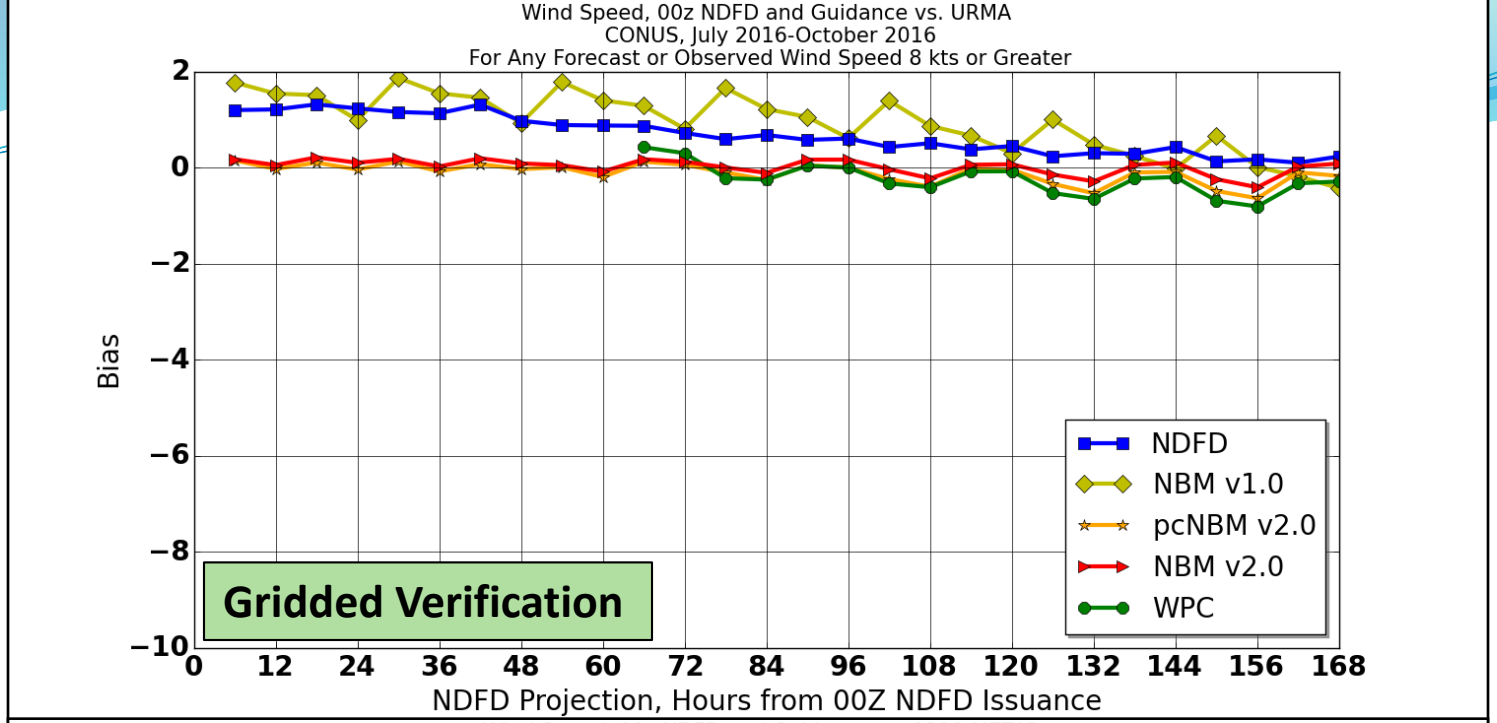
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Bias
2
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0
12
24
36
48
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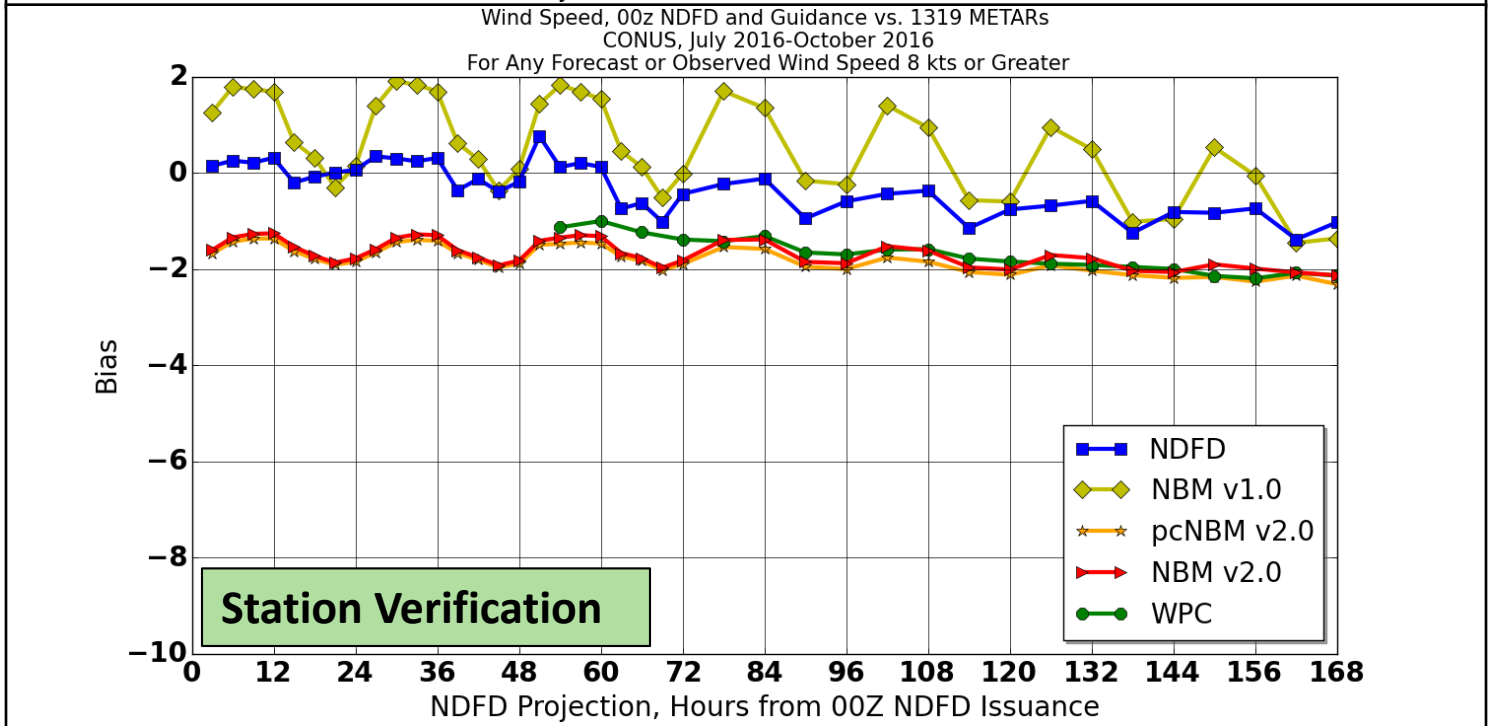
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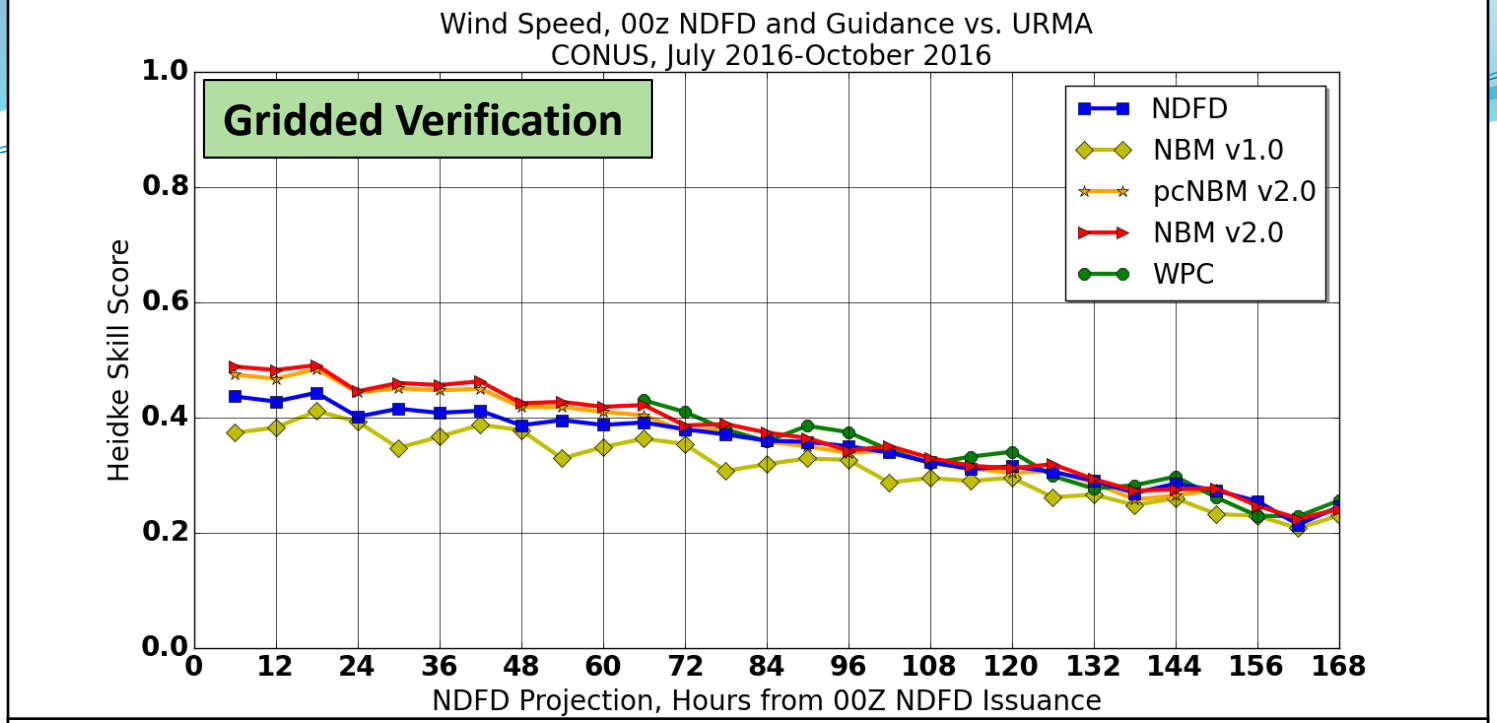
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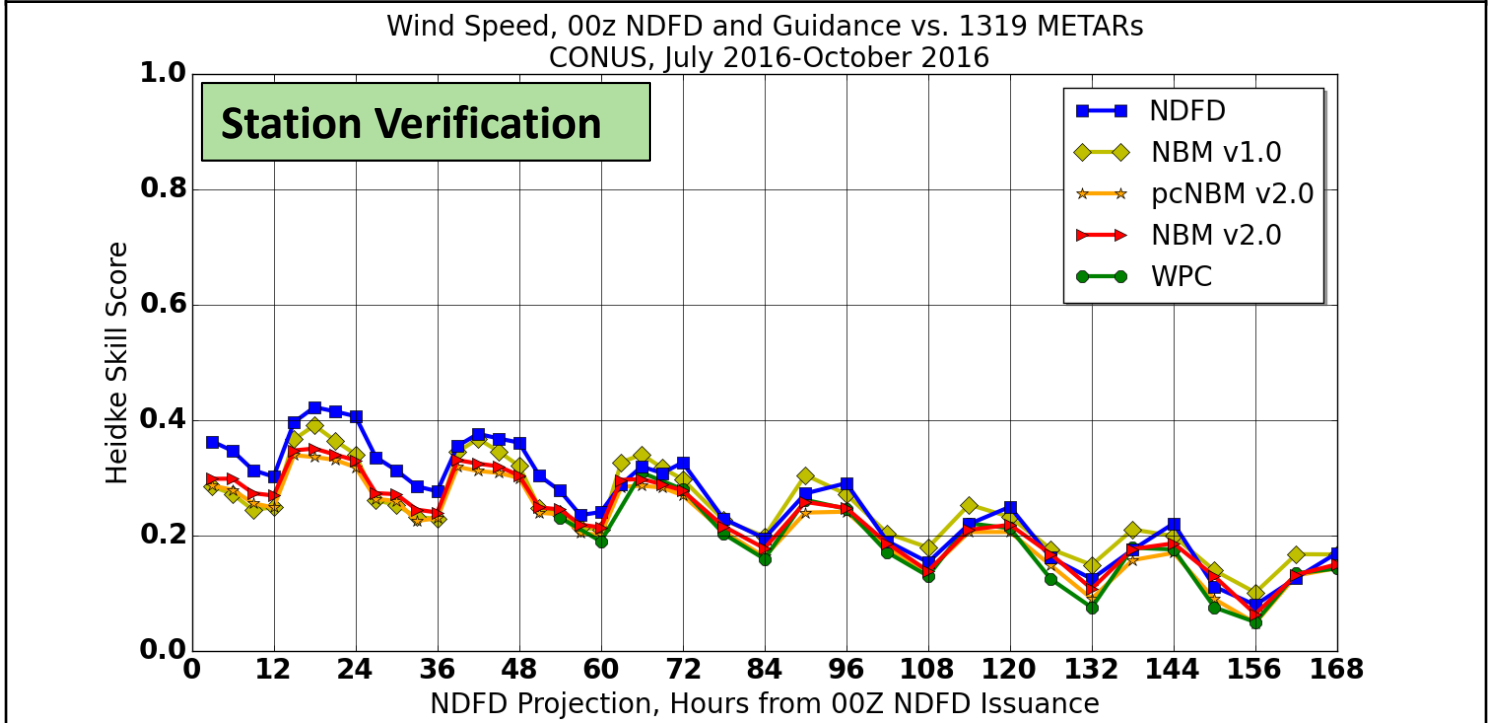
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Results – Wind Speed Forecasts

- NBM v2.0 is an improvement over NBM v1.0
  - NBM v1.0 was not bias-corrected and performs poorly
- NBM v2.0 verifies better against URMA than METARs
- NBM v2.0 MAE is comparable to NDFD and WPC
- A negative bias is apparent in the station verification for most forecast systems
  - Forecast systems with consistent negative bias do well with MAE but do poorly with Heidke skill.

Conclusions

- Post-processing model output adds value
  - Blended guidance outperforms its components
- NBM v2.0 is an improvement on v1.0
  - NBM v3.0 currently under development: available summer 2017
- NBM is tuned to URMA so it verifies well on grids, but it also performs well at stations
- NBM is expected to serve as valuable guidance to NWS forecasters