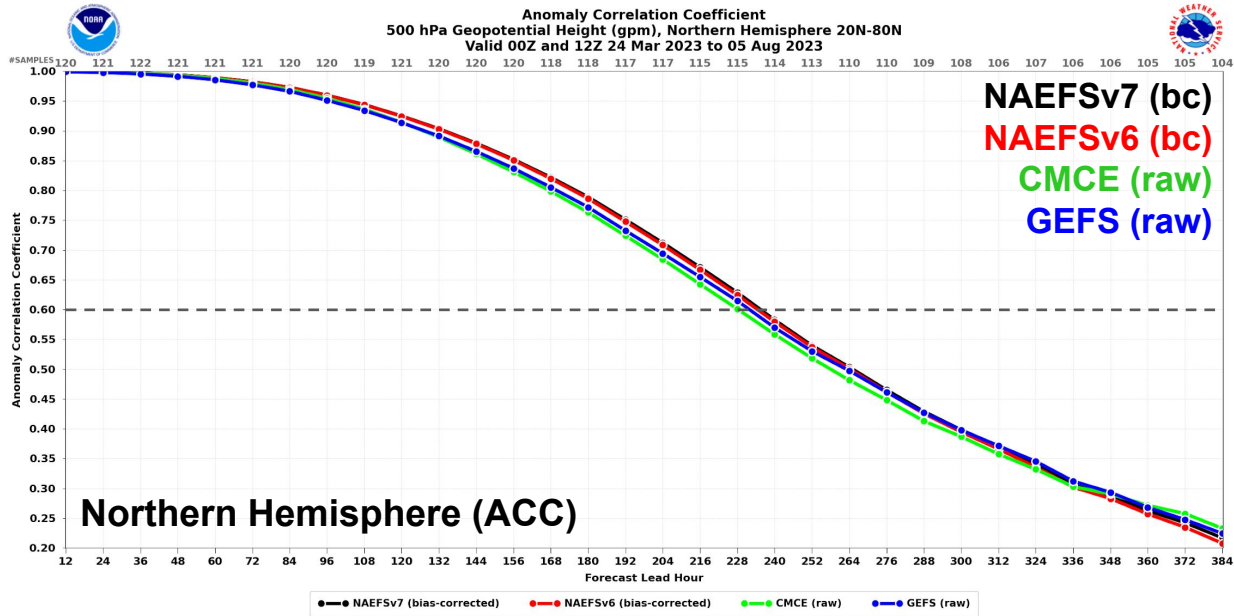




Recap of the NAEFSv7 Field Evaluation



Alicia Bentley and Geoff Manikin
Model Evaluation Group (MEG) Webinar
10 August 2023

Contributions from:
Bo Cui and Binbin Zhou



What is NAEFS?

- North American Ensemble Forecast System (NAEFS) version 1.0 became operational on May 30th, 2006
- NAEFS is run jointly by the U.S. National Weather Service and Meteorological Service of Canada to provide a large, bias-corrected global ensemble as part of a multi-national agreement between the U.S., Canada, and Mexico
- NAEFS is run four times a day (00Z, 06Z, 12Z, 18Z)
- Each run produces forecast files every 3 hours from F000 out to F192, and then every 6 hours out to F384





Where have you seen NAEFS forecasts?

Ensemble Situational Awareness: x +

satable.ncep.noaa.gov/naefs/

ENSEMBLE SITUATIONAL AWARENESS TABLE
NOAA / NATIONAL WEATHER SERVICE

[ECMWF ENS](#) [D\(prog\)/Dt](#) [Archive](#) [Verification](#) [Help](#)

Model Run: Aug 8, 2023 00Z | Table Region: North America | Plot Region: North America | Output: NAEFS Standardized Anomaly | [View Table](#)

WFO North America Table Aug 8, 2023 00Z Run

| | | How to navigate: | | | | | | | | | | |
|-----|----------|------------------|------|-----|------|------|-----|------|------|-----|-----|---|
| | | Z | T | U | V | WSP | SLP | Q | PW | MT | | |
| 0 | Tue 8th | 00Z | 4.8 | 6.6 | 5.4 | 5.5 | 6.4 | 3.2 | -4.6 | 3.7 | 6.9 | On the main table: Click a field (e.g., 'Z') to switch to a sub-table with data for each vertical level. Click a value (e.g., '2.8') to plot a multi-panel image for that time and field at all levels. |
| | | 06Z | 5.1 | 6.4 | -6.6 | 4.8 | 7.8 | 3.8 | -4.8 | 3.6 | 5.7 | |
| | | 12Z | 4.8 | 6.6 | -6.6 | 4.9 | 6.7 | 3.5 | -5.2 | 3.9 | 5.2 | |
| 24 | Wed 9th | 18Z | 5.0 | 7.0 | -6.0 | 5.0 | 6.4 | 3.8 | -4.7 | 3.7 | 5.6 | On a sub-table: Click a value (e.g., '2.8') to plot an image for that hour, field and level. Click a level (e.g., '500') to loop images for that field and level at all forecast hours. |
| | | 00Z | 4.9 | 6.5 | -6.0 | 4.7 | 6.6 | 3.6 | -4.7 | 3.5 | 5.7 | |
| | | 06Z | 5.1 | 7.1 | -6.8 | 4.6 | 7.2 | 3.9 | -4.8 | 3.4 | 5.1 | |
| 30 | Thu 10th | 12Z | 4.7 | 6.4 | -6.0 | 4.8 | 6.4 | -3.7 | -4.7 | 3.3 | 4.5 | For a different table: Select the desired Model Run, Table/Plot Region, and Output Type from the drop-down menus above, and click View Table |
| | | 18Z | 4.6 | 5.6 | -5.4 | 4.6 | 6.0 | -3.5 | -4.1 | 3.3 | 5.0 | |
| | | 00Z | 4.5 | 5.7 | -5.2 | 3.9 | 6.3 | -3.5 | -4.1 | 3.2 | 7.1 | |
| 54 | Fri 11th | 06Z | 4.2 | 5.8 | -5.3 | 3.4 | 6.4 | -3.7 | -3.9 | 3.1 | 6.9 | The NAEFS Ensemble: A 52-member ensemble consisting of 31 GEFS ensemble members and 21 Canadian (GEPS) members. The GEFS has 30 perturbed members and a control member. The GEPS has 20 perturbed members and a control member. Although the GEFS and GEPS are run at native resolutions of 25 and 39 km, respectively, the NAEFS is distributed on a 1x1-degree grid. |
| | | 12Z | -4.1 | 5.8 | -5.2 | 3.2 | 6.3 | -3.9 | -3.9 | 3.0 | 5.5 | |
| | | 18Z | -3.8 | 5.8 | -4.7 | 3.1 | 5.5 | -3.5 | -3.6 | 3.2 | 5.3 | |
| 66 | Sat 12th | 00Z | 3.6 | 5.5 | -4.3 | -3.3 | 4.9 | -3.3 | -3.9 | 3.2 | 3.9 | NAEFS Standardized Anomaly: How different is the model forecast from the climatological mean? Compares the NAEFS ensemble mean forecast to a 3-week running mean and standard deviation derived from the 1979-2009 Climate Forecast System Reanalysis. Standardized anomaly = (NAEFS_forecast - CFSR_climatology_mean) / (CFSR_climatology_standard_deviation) |
| | | 06Z | 3.6 | 5.5 | -4.3 | -3.3 | 4.9 | -3.4 | -4.0 | 3.0 | 4.3 | |
| | | 12Z | 3.6 | 5.2 | -4.0 | -3.1 | 4.5 | -3.3 | -3.8 | 2.9 | 4.0 | |
| 84 | Sun 13th | 18Z | 3.6 | 5.4 | 3.4 | -3.0 | 3.9 | -3.0 | -3.5 | 2.6 | 4.1 | NAEFS Percentile (Recommended): Where would the model forecast fall with respect to climatology? Example: MAX at 00Z indicates that values in the current NAEFS forecast are greater than all 00Z values in the CFSR climatology for a 3-week period centered on the valid day. Forecasters are encouraged to focus on "MAX" and "MIN" values, indicating that the ensemble is forecasting an event that would fall outside the 1979-2009 climatology for this time of year |
| | | 00Z | 3.6 | 5.2 | 3.3 | -2.9 | 3.4 | -2.8 | -3.5 | 2.7 | 3.9 | |
| | | 06Z | 3.7 | 5.1 | 3.2 | -2.6 | 3.2 | -2.8 | 3.8 | 2.4 | 4.2 | |
| 108 | Mon 14th | 12Z | 3.7 | 4.8 | 3.2 | -2.5 | 2.8 | -2.7 | 3.8 | 2.4 | 4.5 | NAEFS Return Interval: How often do these forecast values show up in the climatology? Specifically, how often were the CFSR values (in a 3-week period centered on the valid time) more extreme than values in the NAEFS forecast. Example: a return interval of 5 on Feb 15th means that roughly every 5 years, there is a day in mid-February when values in the current forecast were met or exceeded. Another example: "outside CFSR climate" for temperature means that none of the mid-February reanalyses were this warm between 1979 and 2009. |
| | | 18Z | 3.6 | 4.9 | 2.9 | -2.6 | 2.8 | -2.6 | 3.3 | 2.7 | 4.5 | |
| | | 00Z | 3.4 | 4.4 | 2.8 | -2.5 | 2.6 | -2.3 | 3.3 | 2.8 | 4.2 | |
| 126 | Tue 15th | 06Z | 3.4 | 4.6 | 2.7 | -2.7 | 2.6 | 2.2 | -3.1 | 2.6 | 3.8 | NAEFS Probabilities: How many of the ensemble members produce "extreme" values? Indicates the fraction of NAEFS members with values either higher or lower than any CFSR reanalysis (in a 3-week period centered on the valid time). 60% probability of a min for MSLP on 00Z 15 Sept means that 60% of the NAEFS members have MSLP values lower than any 00Z, mid-September reanalysis. We use the word "extreme" loosely because these are rarely all-time highs or lows -- they're just outside the 1979-2009 climatology for this time of year |
| | | 12Z | 3.2 | 4.5 | 2.8 | -2.6 | 2.7 | -1.8 | -2.8 | 2.4 | 3.7 | |
| | | 18Z | 3.0 | 5.1 | 2.5 | -2.4 | 2.7 | 2.0 | -3.1 | 2.3 | 3.2 | |
| 144 | Wed 16th | 00Z | 2.9 | 5.1 | 2.5 | -2.3 | 2.7 | -2.3 | 3.5 | 2.7 | 2.9 | GEFS Model Climate: How does this forecast compare to past forecasts? Same calculations as for the NAEFS outputs, but in this case the GEFS ensemble mean is compared to the GEFSv12 reforecast climatology (2000-2019). The current forecast is placed in the context of reforecasts with |
| | | 06Z | 2.7 | 4.9 | -2.5 | -2.0 | 2.6 | -2.4 | 2.7 | 2.8 | 2.8 | |
| | | 12Z | 2.7 | 4.8 | 2.2 | -1.9 | 2.5 | -2.0 | 2.6 | 2.8 | 2.5 | |
| 162 | Thu 17th | 18Z | 2.6 | 4.8 | 2.3 | 2.0 | 2.3 | -2.1 | 3.0 | 2.5 | 2.1 | |
| | | 00Z | 2.6 | 4.2 | 2.6 | 1.8 | 2.4 | -2.6 | 3.7 | 2.2 | 2.1 | |
| | | 06Z | 2.7 | 3.8 | 2.6 | 1.8 | 2.4 | -2.1 | 2.7 | 2.6 | 2.0 | |
| 180 | Fri 18th | 12Z | 2.6 | 3.6 | 2.5 | -1.9 | 2.5 | -2.0 | 2.7 | 2.4 | 2.0 | |
| | | 18Z | 2.7 | 3.8 | 2.6 | -1.8 | 2.4 | -1.9 | 2.9 | 2.1 | 1.8 | |

Ensemble Situational Awareness Table maintained by WPC



Where have you seen NAEFS forecasts?

Ensemble Situational Awareness: x +

satable.ncep.noaa.gov/naefs/#

ENSEMBLE SITUATIONAL AWARENESS TABLE
NOAA / NATIONAL WEATHER SERVICE

ECMWF ENS D(prog)/Dt Archive Verification Help

Model Run: Table Region: Plot Region: Output: Fcst Hr: 18 Valid: Tue Aug 8 2:00 PM EDT

Aug 8, 2023 00Z North America North America NAEFS Standardized Anomaly View Table

| WFO North America Table | | Aug 8, 2023 00Z Run | | | | | | | | | |
|-------------------------|----------|---------------------|------|-----|------|------|-----|------|------|-----|-----|
| | | Z | T | U | V | WSP | SLP | Q | PW | IVI | |
| 0 | Tue 8th | 00Z | 4.8 | 6.6 | 5.4 | 5.5 | 6.4 | 3.2 | -4.6 | 3.7 | 6.9 |
| 6 | | 06Z | 5.1 | 6.4 | -6.6 | 4.8 | 7.8 | 3.8 | -4.8 | 3.6 | 5.7 |
| 12 | | 12Z | 4.8 | 6.6 | -6.6 | 4.9 | 6.7 | 3.5 | -5.2 | 3.9 | 5.2 |
| 18 | | 18Z | 5.0 | 7.0 | -6.0 | 5.0 | 6.4 | 3.8 | -4.7 | 3.7 | 5.6 |
| 24 | | 00Z | 4.9 | 6.5 | -6.0 | 4.7 | 6.6 | 3.6 | -4.7 | 3.5 | 5.7 |
| 30 | Wed 9th | 06Z | 5.1 | 7.1 | -6.8 | 4.6 | 7.2 | 3.9 | -4.8 | 3.4 | 5.1 |
| 36 | | 12Z | 4.7 | 6.4 | -6.0 | 4.8 | 6.4 | -3.7 | -4.7 | 3.3 | 4.5 |
| 42 | | 18Z | 4.6 | 5.6 | -5.4 | 4.6 | 6.0 | -3.5 | -4.1 | 3.3 | 5.9 |
| 48 | Thu 10th | 00Z | 4.5 | 5.7 | -5.2 | 3.9 | 6.3 | -3.5 | -4.1 | 3.2 | 7.1 |
| 54 | | 06Z | 4.2 | 5.8 | -5.3 | 3.4 | 6.4 | -3.7 | -3.9 | 3.1 | 6.9 |
| 60 | | 12Z | -4.1 | 5.8 | -5.2 | 3.2 | 6.3 | -3.9 | -3.9 | 3.0 | 5.5 |
| 66 | | 18Z | -3.8 | 5.8 | -4.7 | 3.1 | 5.5 | -3.5 | -3.6 | 3.2 | 5.3 |
| 72 | Fri 11th | 00Z | 3.6 | 5.5 | -4.3 | -3.3 | 4.9 | -3.3 | -3.9 | 3.2 | 3.9 |
| 78 | | 06Z | 3.6 | 5.5 | -4.3 | -3.3 | 4.9 | -3.4 | -4.0 | 3.0 | 4.3 |
| 84 | | 12Z | 3.6 | 5.2 | -4.0 | -3.1 | 4.5 | -3.3 | -3.8 | 2.9 | 4.0 |
| 90 | | 18Z | 3.6 | 5.4 | -3.4 | -3.0 | 3.9 | -3.0 | -3.5 | 2.6 | 4.1 |
| 96 | Sat 12th | 00Z | 3.6 | 5.2 | -3.3 | -2.9 | 3.4 | -2.8 | -3.5 | 2.7 | 3.9 |
| 102 | | 06Z | 3.7 | 5.1 | -3.2 | -2.6 | 3.2 | -2.8 | -3.6 | 2.4 | 4.2 |
| 108 | | 12Z | 3.7 | 4.8 | -3.2 | -2.5 | 2.8 | -2.7 | -3.8 | 2.4 | 4.5 |
| 114 | | 18Z | 3.6 | 4.9 | -2.9 | -2.6 | 2.8 | -2.6 | -3.3 | 2.7 | 4.5 |
| 120 | Sun 13th | 00Z | 3.4 | 4.4 | -2.8 | -2.5 | 2.6 | -2.3 | -3.3 | 2.8 | 4.2 |
| 126 | | 06Z | 3.4 | 4.6 | -2.7 | -2.7 | 2.6 | 2.2 | -3.1 | 2.6 | 3.8 |
| 132 | | 12Z | 3.2 | 4.5 | -2.8 | -2.6 | 2.7 | -1.8 | -2.8 | 2.4 | 3.7 |
| 138 | | 18Z | 3.0 | 5.1 | -2.5 | -2.4 | 2.7 | 2.0 | -3.1 | 2.3 | 3.2 |
| 144 | Mon 14th | 00Z | 2.9 | 5.1 | -2.5 | -2.3 | 2.7 | -2.3 | -3.5 | 2.7 | 2.9 |
| 150 | | 06Z | 2.7 | 4.9 | -2.5 | -2.0 | 2.6 | -2.4 | -2.7 | 2.8 | 2.6 |
| 156 | | 12Z | 2.7 | 4.8 | -2.2 | 1.9 | 2.5 | -2.0 | -2.6 | 2.8 | 2.5 |
| 162 | | 18Z | 2.6 | 4.8 | -2.3 | 2.0 | 2.3 | -2.1 | -3.0 | 2.5 | 2.1 |
| 168 | Tue 15th | 00Z | 2.6 | 4.2 | -2.6 | 1.8 | 2.4 | -2.6 | -3.7 | 2.2 | 2.1 |
| 174 | | 06Z | 2.7 | 3.8 | -2.6 | 1.8 | 2.4 | -2.1 | -2.7 | 2.6 | 2.0 |
| 180 | | 12Z | 2.6 | 3.6 | -2.5 | -1.9 | 2.5 | -2.0 | -2.7 | 2.4 | 2.0 |
| 186 | | 18Z | 2.7 | 3.8 | -2.6 | -1.8 | 2.4 | -1.9 | -2.9 | 2.1 | 1.8 |

NAEFS Mean MSLP (hPa) and Standardized Anomaly
 HOUR 018 - VALID 18:00 UTC Tue Aug 08 2023

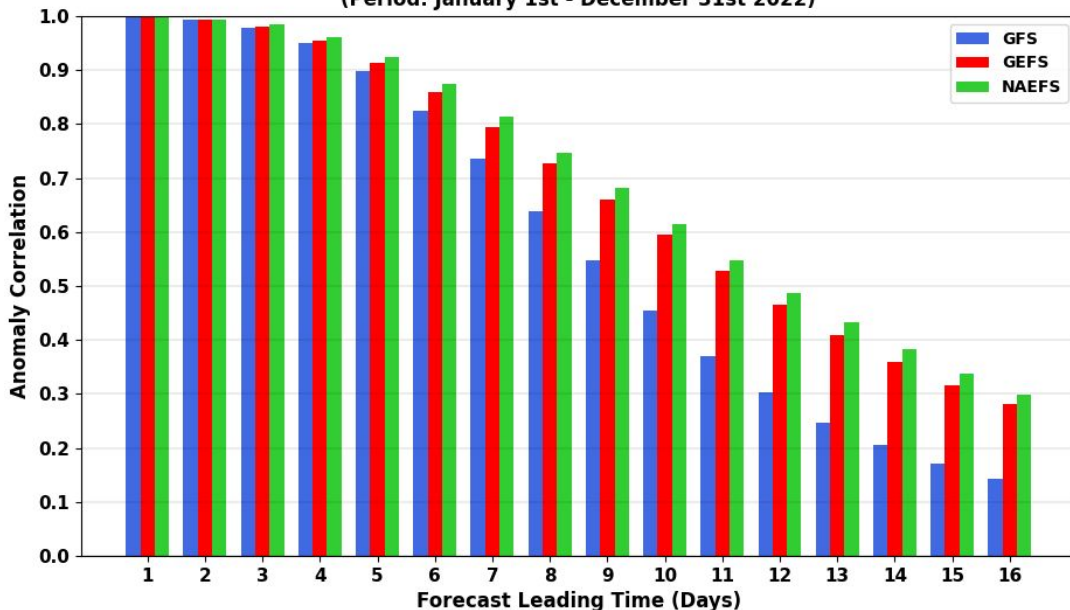
Relative to the 29-Jul to 19-Aug 1979-2009 CFSR climatology

Ensemble Situational Awareness Table maintained by WPC



What are the benefits of using NAEFS?

NH Anomaly Correlation for 500hPa Height
(Period: January 1st - December 31st 2022)



GFSv16 = Deterministic

GEFSv12 = Ensemble
(31 members)

NAEFSv6 = Ensemble
(42 members)

- **GFSv16** is a deterministic global model that had “useful skill” (i.e., ACC score ≥ 0.6) out to ~8.4 days in 2022
- **GEFSv12** is a global ensemble (31 members) that had “useful skill” out to ~9.9 days in 2022
- **NAEFSv6** is a **bias-corrected** global ensemble (42 members) that had “useful skill” out to ~10.2 days in 2022



NAEFS Bias Correction

| Parameter | Level | Total: 51 |
|--------------|---|-----------|
| HGT | 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 hPa | 10 |
| TMP | 2m, 2mMax, 2mMin; 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 hPa | 13 |
| UGRD | 10m; 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 hPa | 11 |
| VGRD | 10m; 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 hPa | 11 |
| VVEL | 850 hPa | 1 |
| PRES | Surface | 1 |
| PRMSL | Pressure Reduced to Mean Sea Level | 1 |
| WIND | 10m | 1 |
| DPT | 2m | 1 |
| RH | 2m | 1 |



Changes in the NAEFSv7 Upgrade

- Increased ensemble membership from 42 to 52 members by including the 10 GEFS members that were added during the GEFSv12 upgrade
 - NAEFSv6 = 21 GEFS + 21 CMCE
 - NAEFSv7 = 31 GEFS + 21 CMCE
- Updated calibration of parameters to account for new GEFS members
- Updated GEFS bias-corrected precipitation from 21 to 31 members (The Meteorological Service of Canada does not send us bias-corrected precipitation forecasts, so “NAEFS” precipitation = bias-corrected GEFS)
- We expect NAEFSv7 to be as good as or slightly better than NAEFSv6



Recap of the NAEFSv7 Field Evaluation

- Assess the statistical performance of the NAEFSv7 parallel
- Provide a few examples of bias-corrected precipitation forecasts
- Review the comments and recommendations from NWS Centers/Regions
- Share a summary and outline next steps

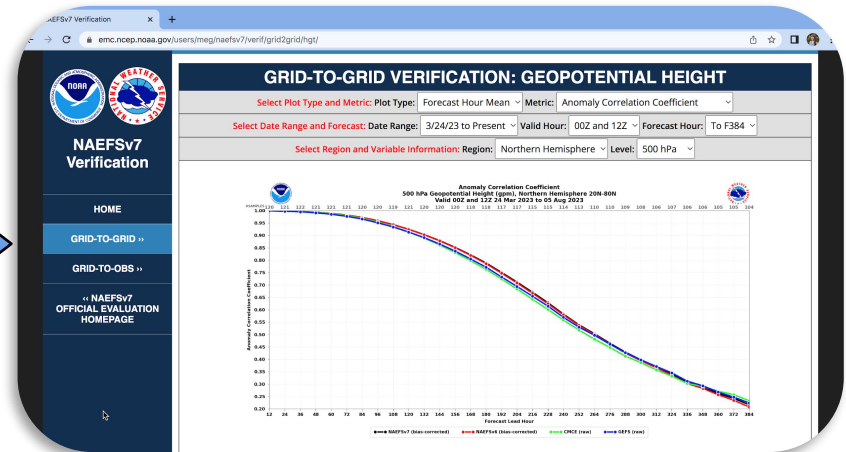
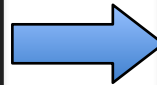
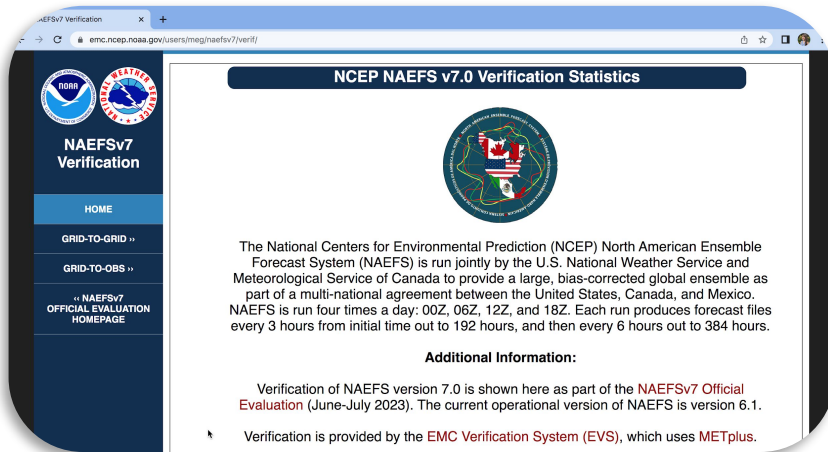
NAEFSv7 Official Evaluation Webpage

<https://www.emc.ncep.noaa.gov/users/meg/naefsv7>



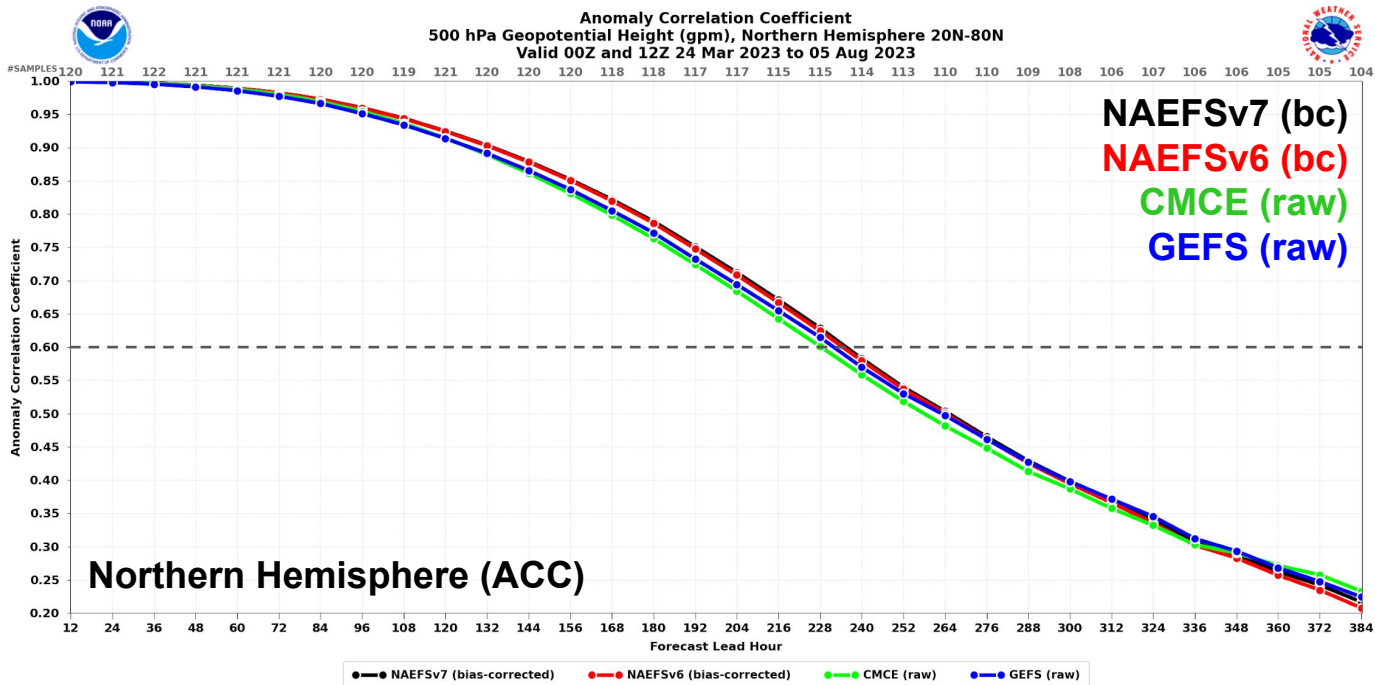
Statistical Performance of NAEFSv7 Parallel

- Statistics and verification graphics for the NAEFSv7 Official Evaluation were produced using the METplus-based EMC Verification System (EVS)
- Verification graphics showing the NAEFSv7 parallel, NAEFSv6, GEFS, and CMCE (3/24/23–8/5/23) can be found here: [NAEFSv7 verif. webpage](#)





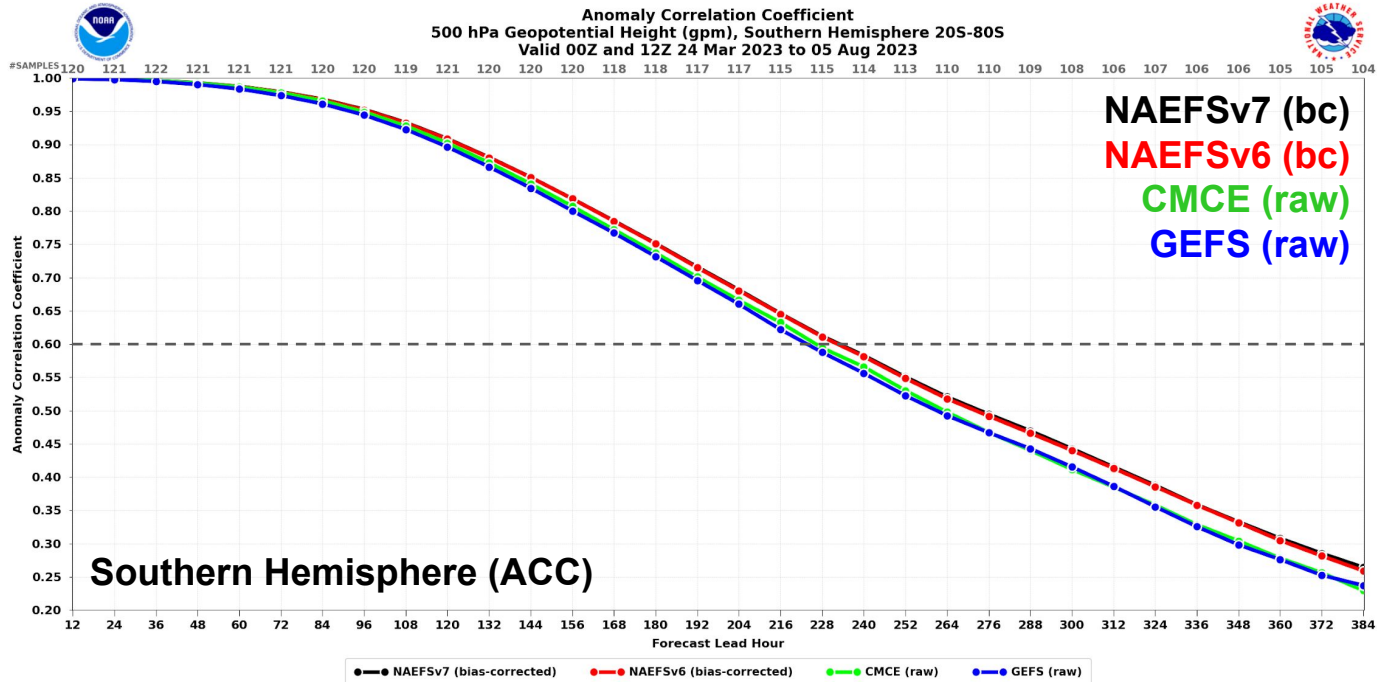
NAEFSv7: 500-hPa Geopotential Height



- **NAEFSv7** and **NAEFSv6** were very similar at Days 1–6; NAEFSv7 had slightly higher ACC at Days 7–11
- Bias-corrected **NAEFSv7** performed better than its raw **GEFS** and **CMCE** inputs (benefit of bias-correction)
- **NAEFSv7** had “useful skill” (i.e., ACC score ≥ 0.6) for the longest of the models compared (out to ~9.83 days)



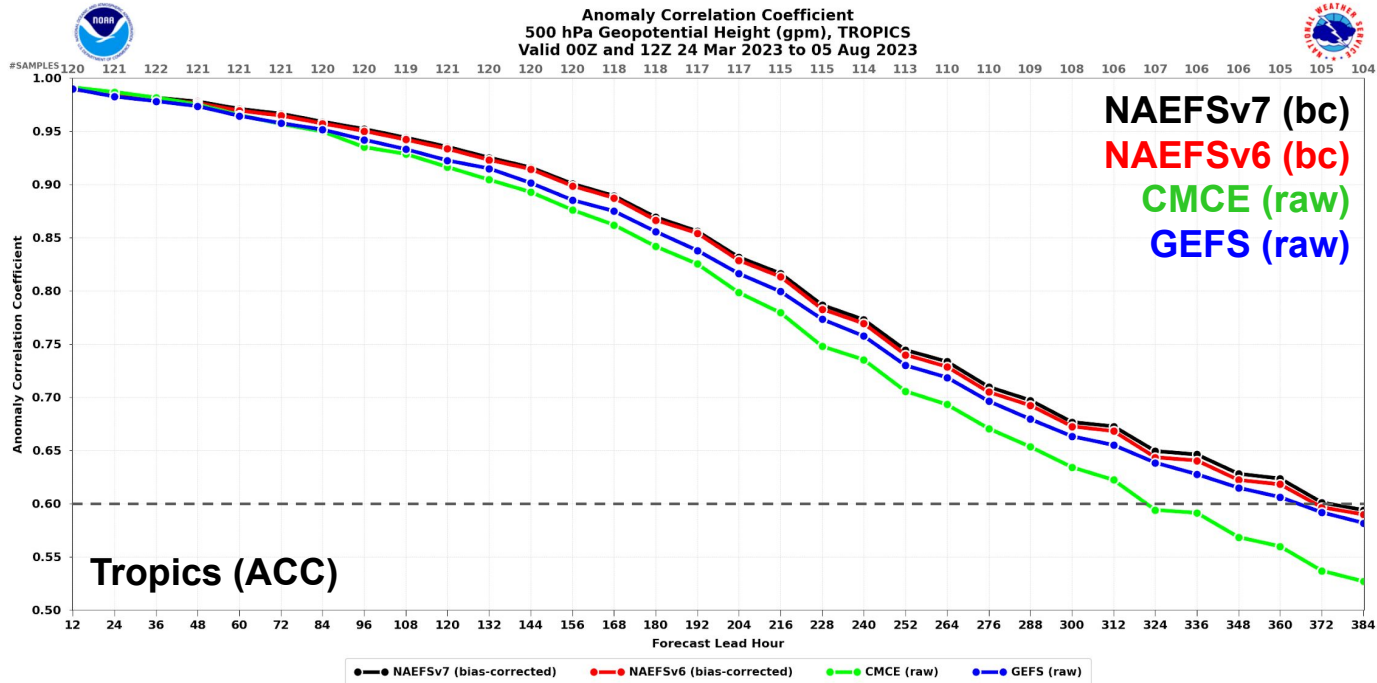
NAEFSv7: 500-hPa Geopotential Height



- **NAEFSv7** and **NAEFSv6** were very similar at Days 1–10; NAEFSv7 had slightly higher ACC at Days 11–13
- Bias-corrected **NAEFSv7** performed better than its raw **GEFS** and **CMCE** inputs (benefit of bias-correction)
- **NAEFSv7** had “useful skill” (i.e., ACC score ≥ 0.6) for slightly longer than **NAEFSv6** (out to ~9.75 days)



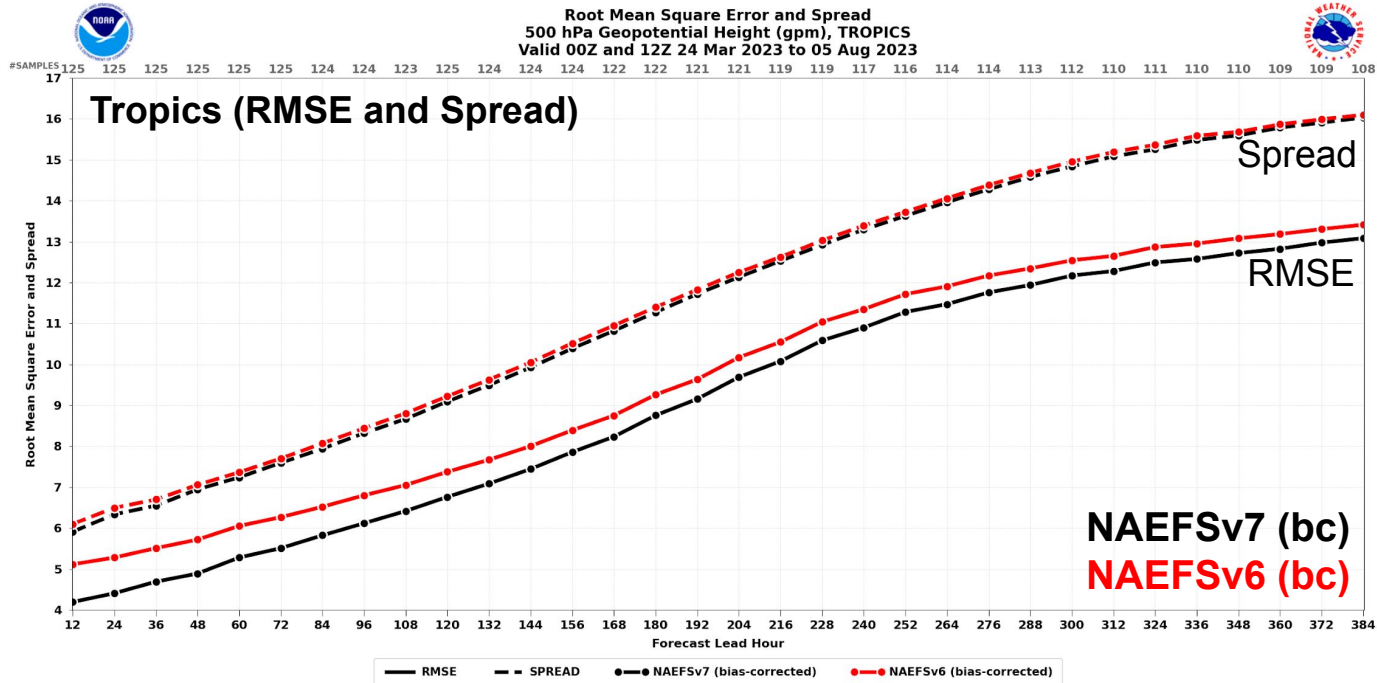
NAEFSv7: 500-hPa Geopotential Height



- **NAEFSv7** had slightly higher ACC than **NAEFSv6** in the tropics at almost all forecast lead times (Days 1–16)
- Bias-corrected **NAEFSv7** performed better than its raw **GEFS** and **CMCE** inputs (benefit of bias-correction)



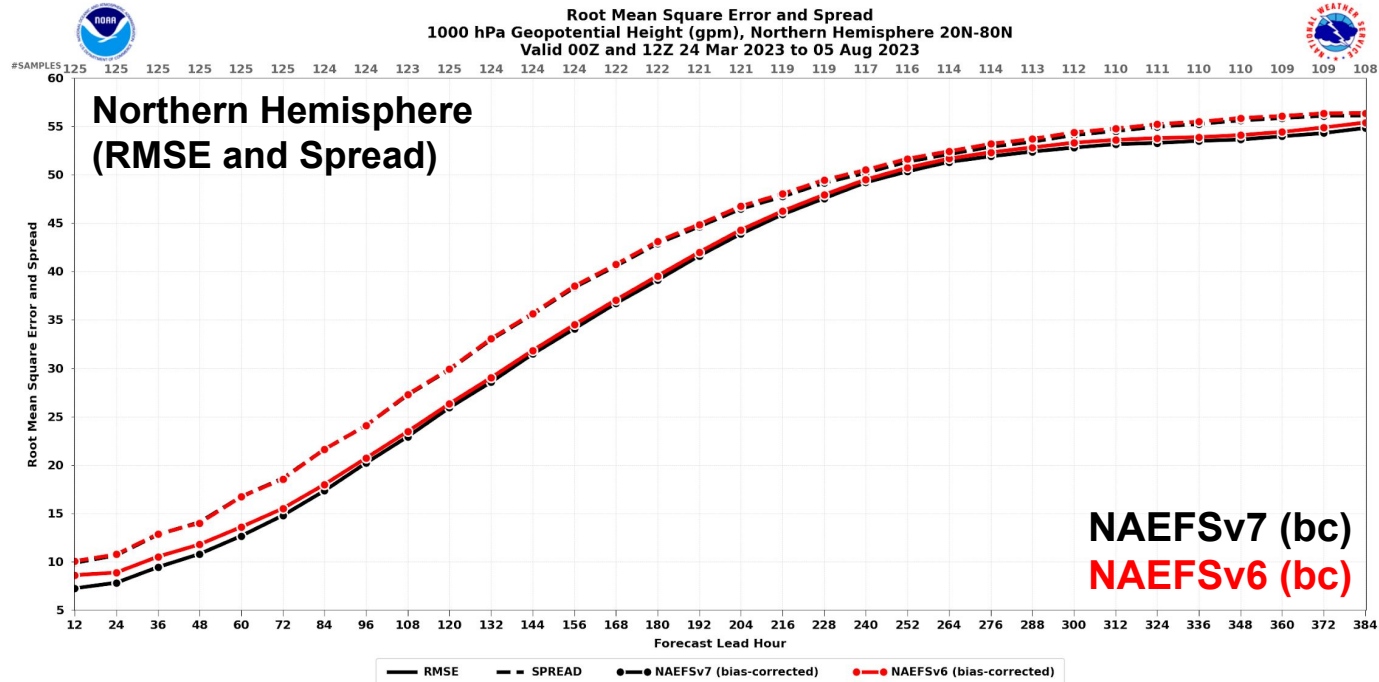
NAEFSv7: 500-hPa Geopotential Height



- **NAEFSv7** had slightly higher ACC than **NAEFSv6** in the tropics at almost all forecast lead times (Days 1–16)
- Bias-corrected **NAEFSv7** performed better than its raw **GEFS** and **CMCE** inputs (benefit of bias-correction)
- **NAEFSv7** had lower RMSE than **NAEFSv6** and very similar ensemble spread at all forecast lead times



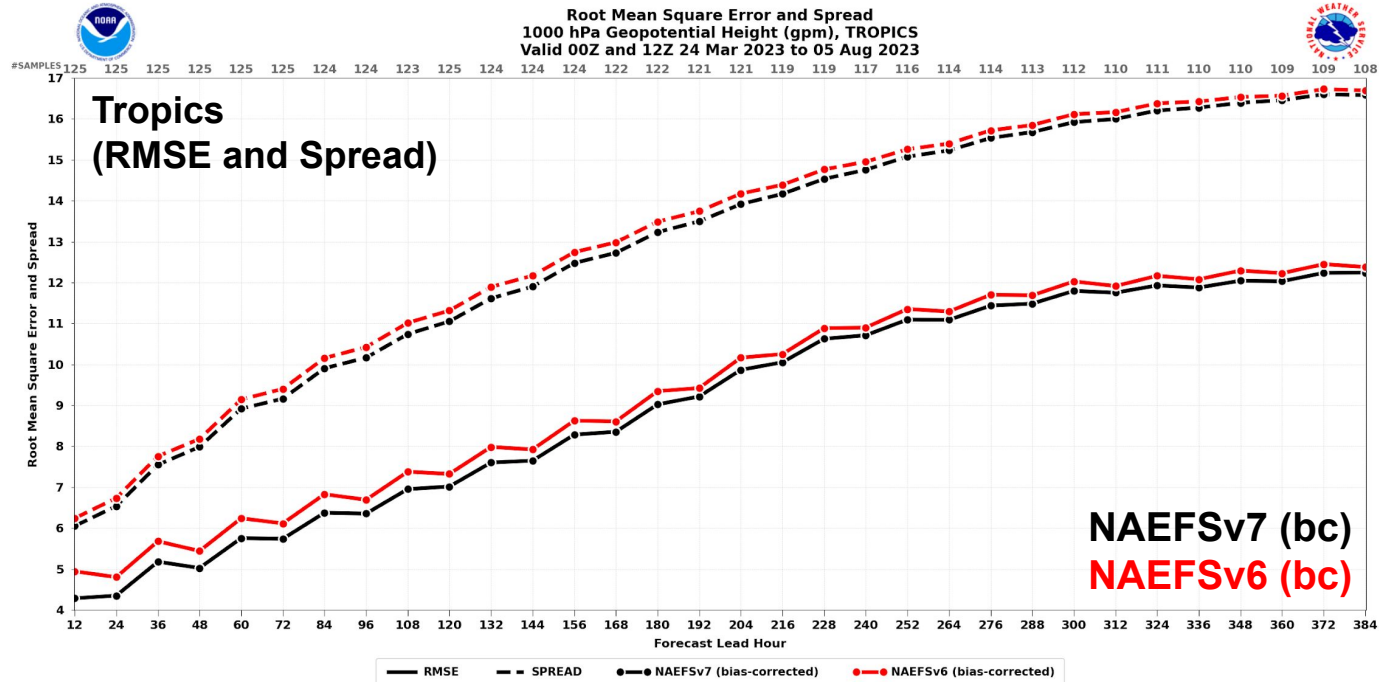
NAEFSv7: 1000-hPa Geopotential Height



- In the NH, **NAEFSv7** had lower RMSE than **NAEFSv6** at Days 1–3 and slightly lower RMSE at Days 4–16
- In the SH, **NAEFSv7** was very similar to **NAEFSv6** in both RMSE and spread values (not shown)



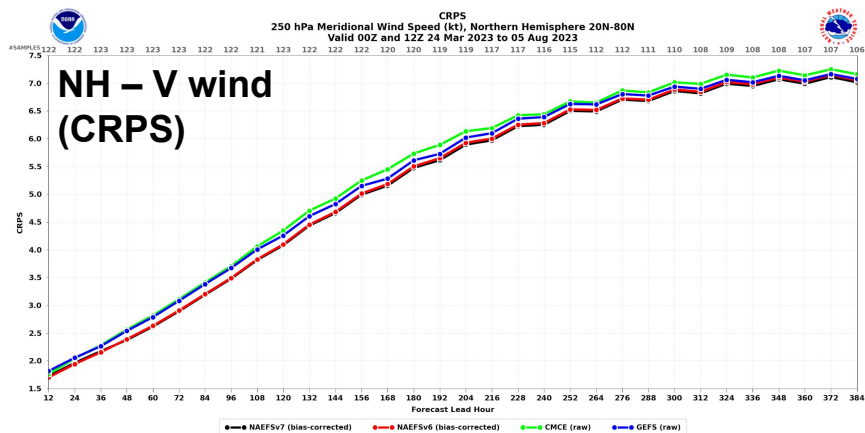
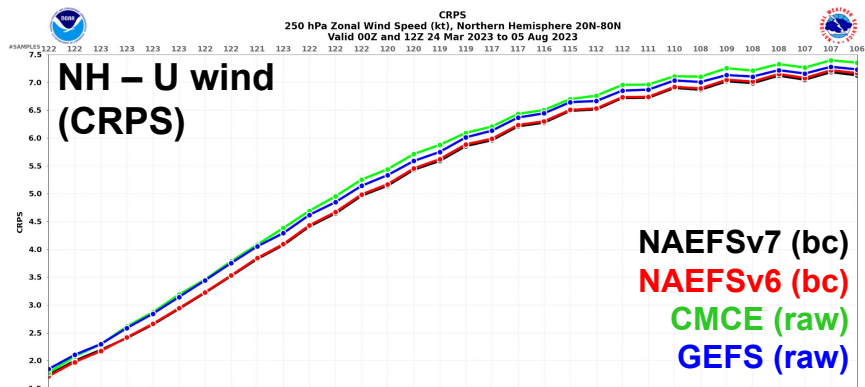
NAEFSv7: 1000-hPa Geopotential Height



- In the NH, **NAEFSv7** had lower RMSE than **NAEFSv6** at Days 1–3 and slightly lower RMSE at Days 4–16
- In the SH, **NAEFSv7** was very similar to **NAEFSv6** in both RMSE and spread values (not shown)
- In the tropics, **NAEFSv7** had lower RMSE than **NAEFSv6** and less ensemble spread at all forecast lead times



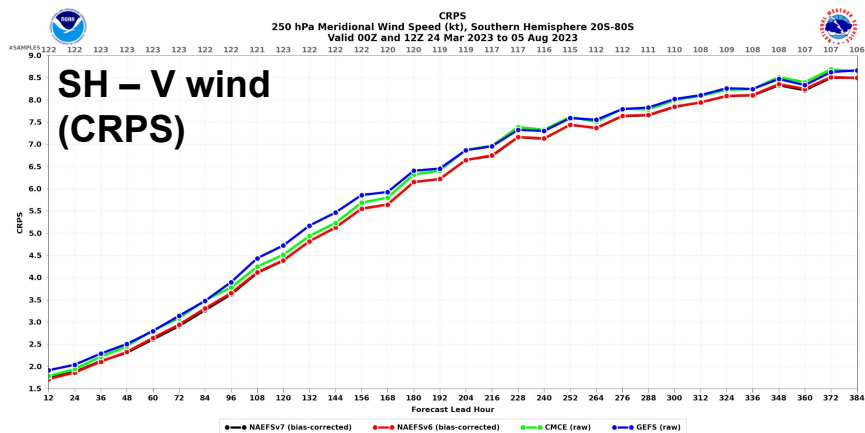
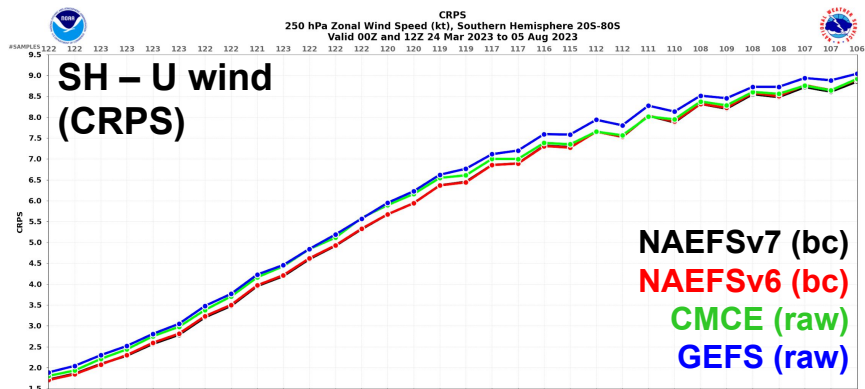
NAEFSv7: 250-hPa U and V Winds



- Continuous Ranked Probability Score (CRPS) measures the accuracy of a set of probabilistic forecasts (the lower the CRPS, the better)
- **NAEFSv7** had slightly lower CRPS than **NAEFSv6** in the Northern Hemisphere (NH), and both have lower CRPS than raw inputs (**GEFS/CMCE**)



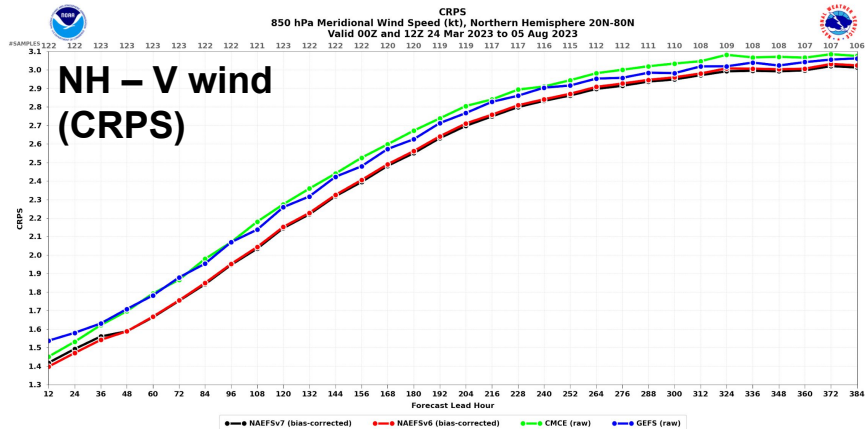
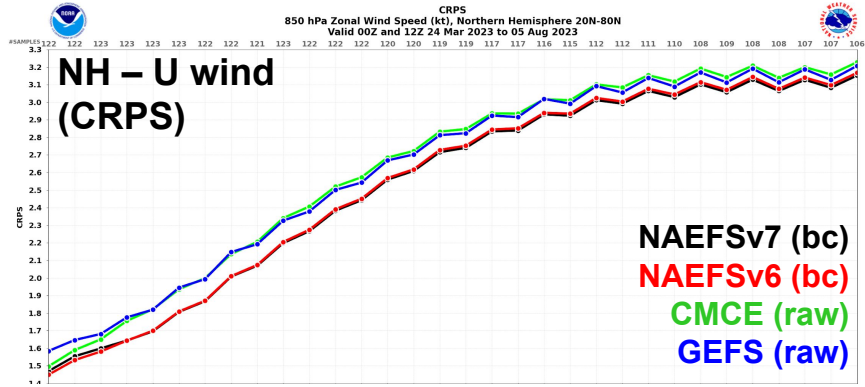
NAEFSv7: 250-hPa U and V Winds



- Continuous Ranked Probability Score (CRPS) measures the accuracy of a set of probabilistic forecasts (the lower the CRPS, the better)
- NAEFSv7 had slightly lower CRPS than NAEFSv6 in the Northern Hemisphere (NH), and both have lower CRPS than raw inputs (GEFS/CMCE)
- NAEFSv7 and NAEFSv6 had very similar CRPS in the Southern Hemisphere (SH)
- NAEFSv7 and NAEFSv6 had very similar CRPS in the Tropics as well (not shown)



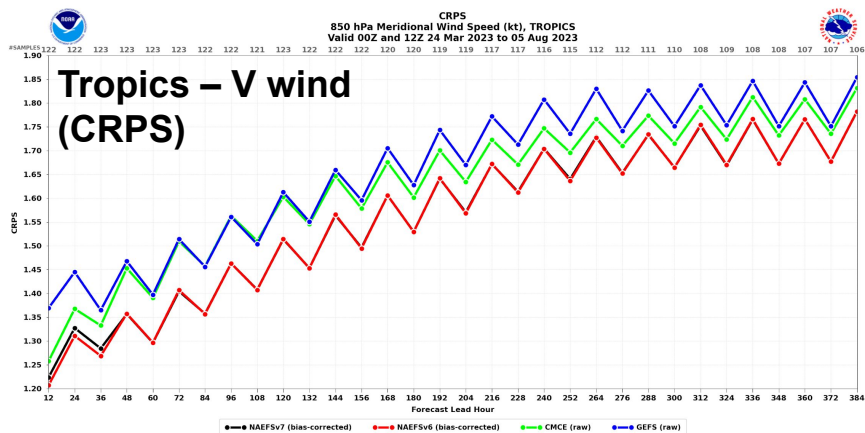
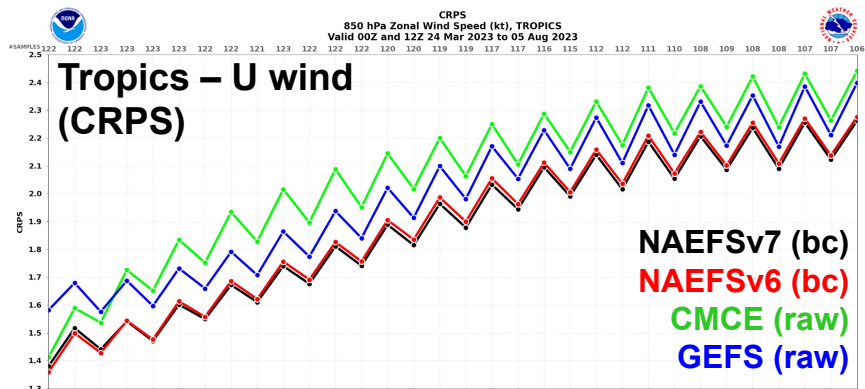
NAEFSv7: 850-hPa U and V Winds



- Continuous Ranked Probability Score (CRPS) measures the accuracy of a set of probabilistic forecasts (the lower the CRPS, the better)
- NAEFSv7 had slightly lower CRPS than NAEFSv6 in the NH, and both have lower CRPS than raw inputs (GEFS/CMCE)
- NAEFSv7 and NAEFSv6 had very similar CRPS in the SH (not shown)



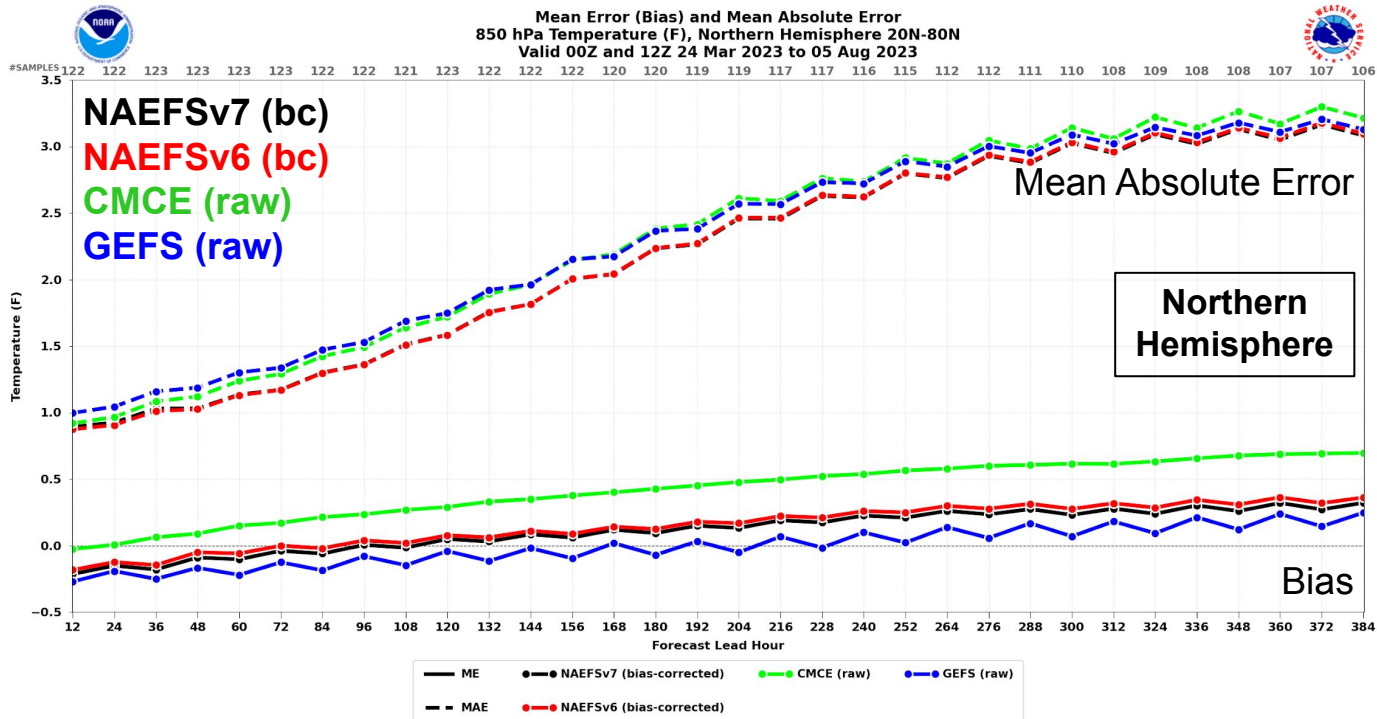
NAEFSv7: 850-hPa U and V Winds



- Continuous Ranked Probability Score (CRPS) measures the accuracy of a set of probabilistic forecasts (the lower the CRPS, the better)
- NAEFSv7 had slightly lower CRPS than NAEFSv6 in the NH, and both have lower CRPS than raw inputs (GEFS/CMCE)
- NAEFSv7 and NAEFSv6 had very similar CRPS in the SH (not shown)
- NAEFSv7 had slightly lower CRPS than NAEFSv6 in the Tropics for U (zonal) wind, with similar values for V (meridional) wind



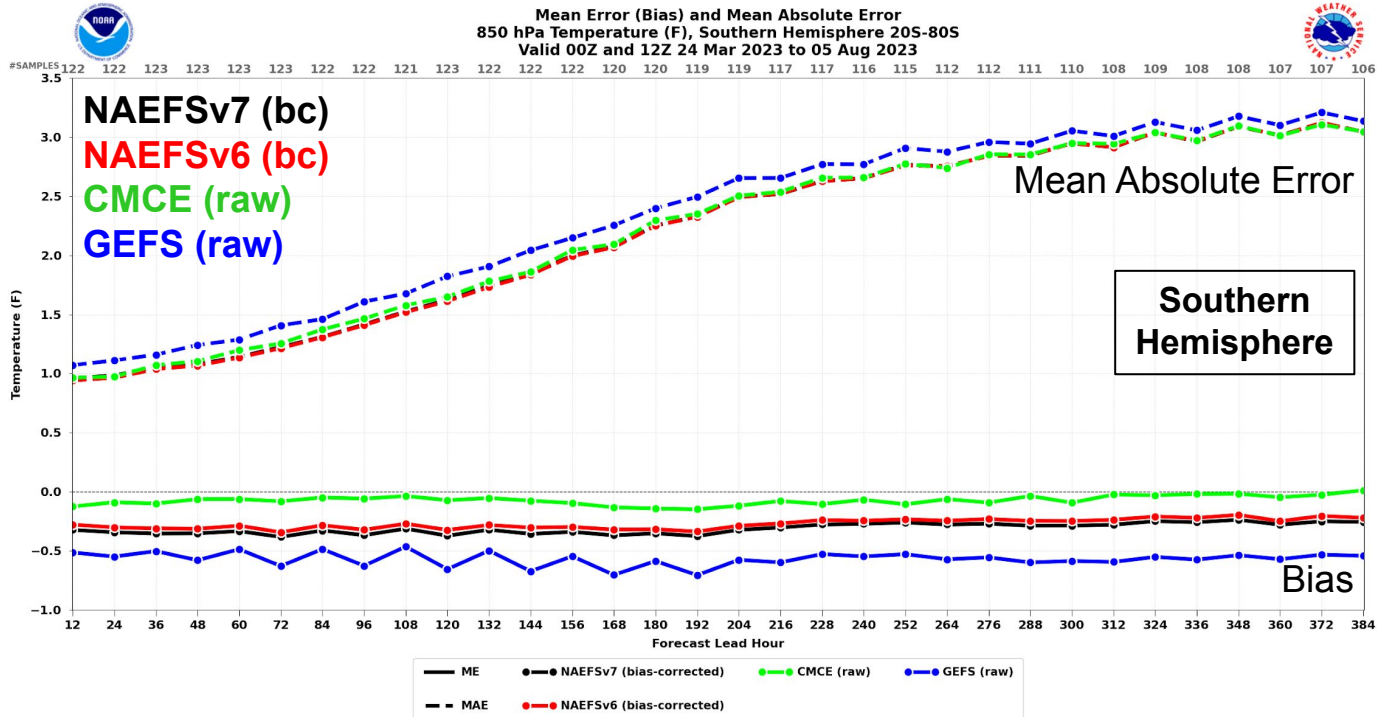
NAEFSv7: 850-hPa Temperature



- **NAEFSv7** had slightly less of an 850-hPa temperature warm bias than **NAEFSv6** during Days 4–16 over the NH and Mean Absolute Error (MAE) values that were comparable to **NAEFSv6** during all forecast lead times



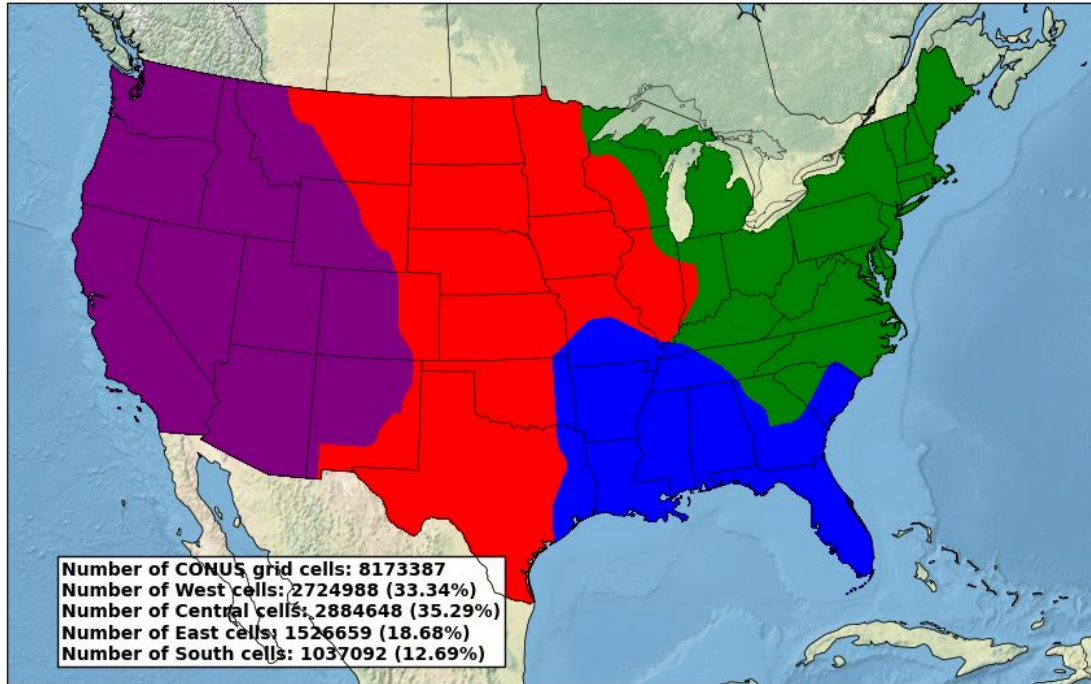
NAEFSv7: 850-hPa Temperature



- **NAEFSv7** had slightly less of an 850-hPa temperature warm bias than **NAEFSv6** during Days 4–16 over the NH and Mean Absolute Error (MAE) values that were comparable to **NAEFSv6** during all forecast lead times
- **NAEFSv7** had a slightly larger 850-hPa temperature cold bias than **NAEFSv6** over the SH at Days 1–16



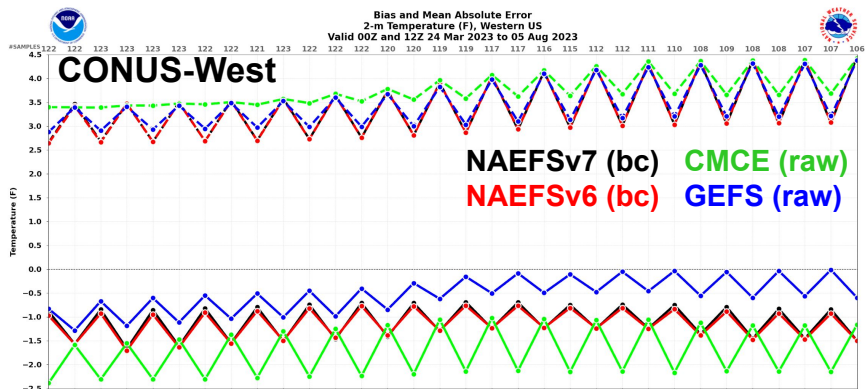
NAEFSv7: 2-m Temp. and 10-m U/V Winds



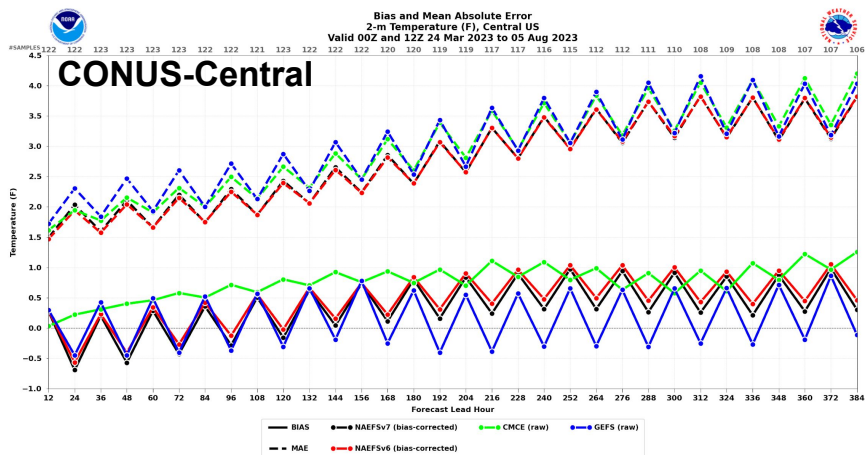
- A meaningful examination of near-surface parameters (e.g., 2-m temperature, 10-m wind) requires that the CONUS be separated into four sub-regions (West, Central, East, and South) and that Alaska is its own region
- The plot above shows the four CONUS sub-regions, created by combining similar Bukovsky Regions ([see link](#))

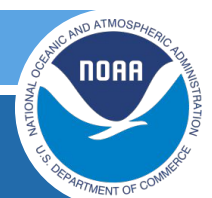


NAEFSv7: 2-m Temperature

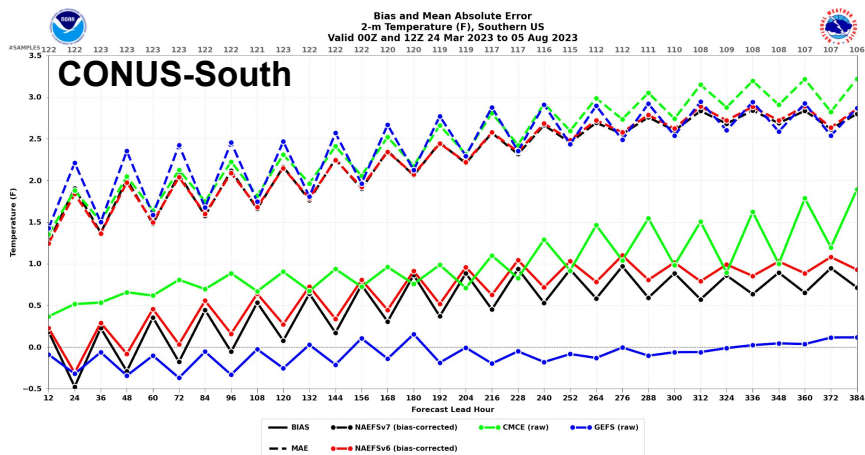
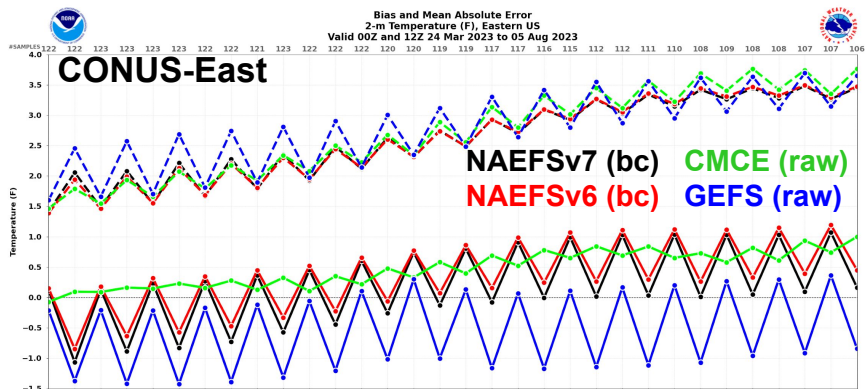


- **NAEFSv7** had a comparable cold bias to **NAEFSv6** over CONUS-West at all lead times
- **NAEFSv7** had slightly less of a warm bias than **NAEFSv6** over CONUS-Central at Days 5–16





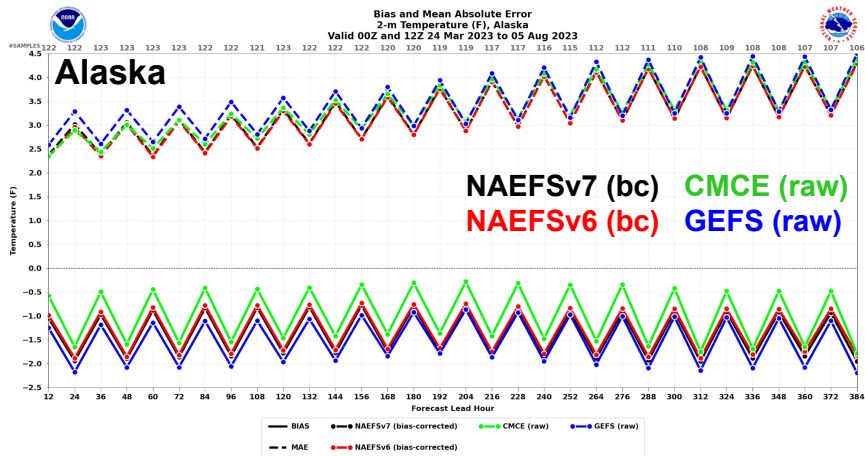
NAEFSv7: 2-m Temperature



- **NAEFSv7** had a comparable cold bias to **NAEFSv6** over CONUS-West at all lead times
- **NAEFSv7** had slightly less of a warm bias than **NAEFSv6** over CONUS-Central at Days 5–16
- **NAEFSv7** had slightly more of a cold bias than **NAEFSv6** over CONUS-East at Days 1–4 and slightly less of a warm bias at Days 8–16
- **NAEFSv7** had slightly less of a warm bias than **NAEFSv6** over CONUS-South at Days 4–16



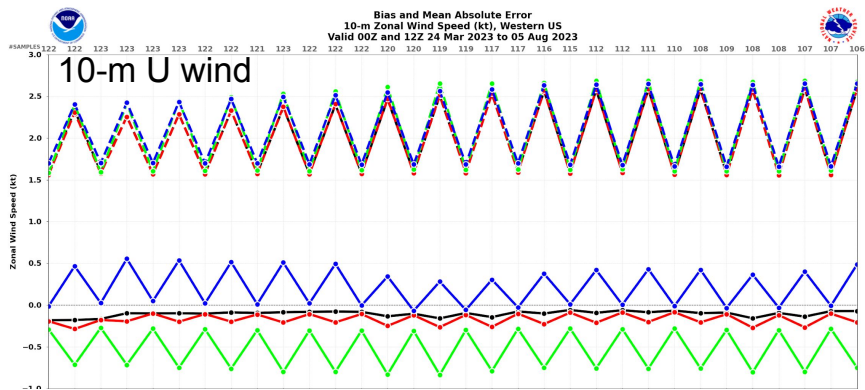
NAEFSv7: 2-m Temperature



- **NAEFSv7** had a comparable cold bias to **NAEFSv6** over CONUS-West at all lead times
- **NAEFSv7** had slightly less of a warm bias than **NAEFSv6** over CONUS-Central at Days 5–16
- **NAEFSv7** had slightly more of a cold bias than **NAEFSv6** over CONUS-East at Days 1–4 and slightly less of a warm bias at Days 8–16
- **NAEFSv7** had slightly less of a warm bias than **NAEFSv6** over CONUS-South at Days 4–16
- **NAEFSv7** had a comparable cold bias to **NAEFSv6** over Alaska at all lead times

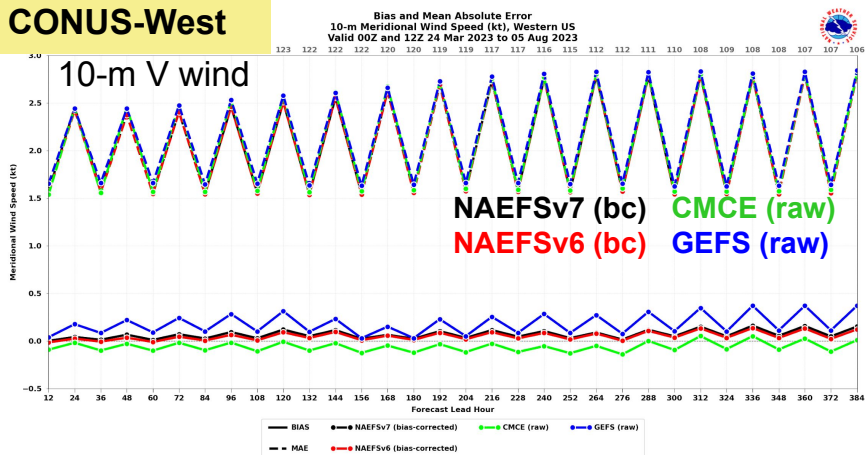


NAEFSv7: 10-m U and V Winds



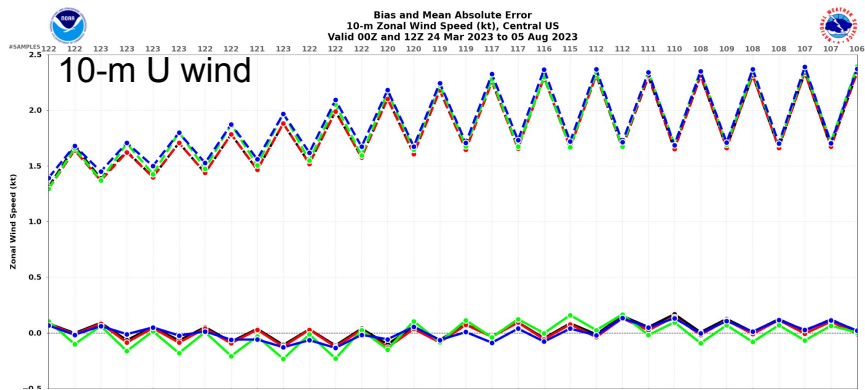
- **NAEFSv7** had slightly less of a low 10-m U wind-speed bias than **NAEFSv6** and a comparable high 10-m V wind-speed bias over CONUS-West at all lead times

CONUS-West

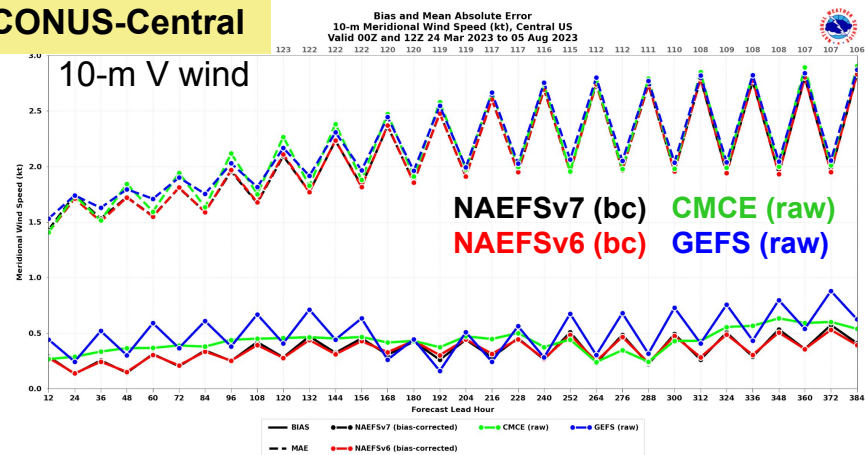




NAEFSv7: 10-m U and V Winds



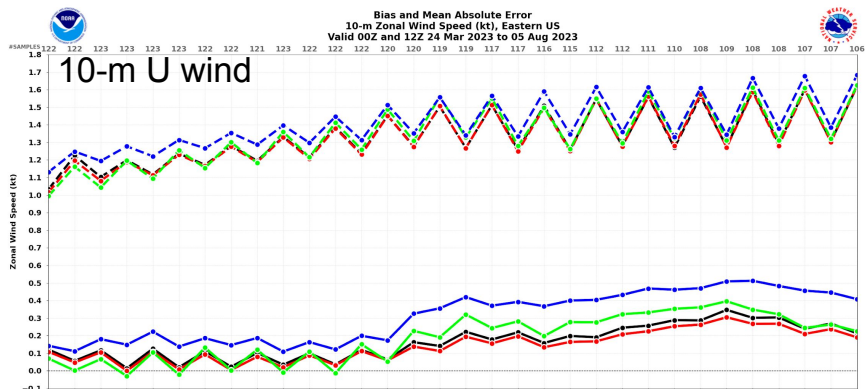
CONUS-Central



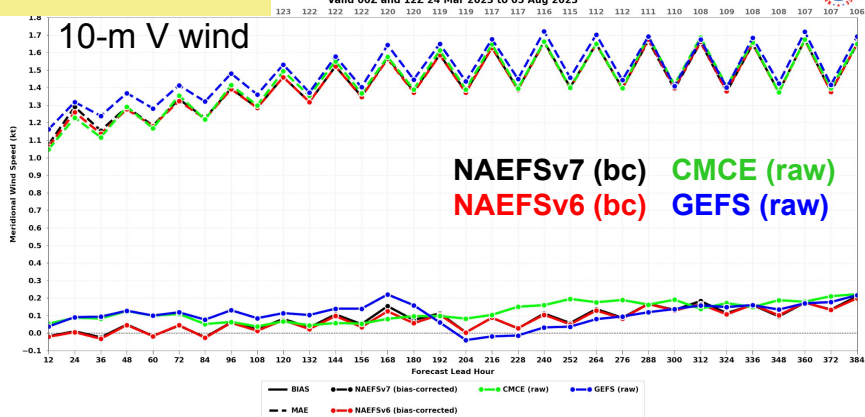
- **NAEFSv7** had slightly less of a low 10-m U wind-speed bias than **NAEFSv6** and a comparable high 10-m V wind-speed bias over CONUS-West at all lead times
- **NAEFSv7** had comparable 10-m U and V wind-speed biases to **NAEFSv6** over CONUS-Central at all lead times (no 10-m U wind-speed bias and high V wind-speed bias)



NAEFSv7: 10-m U and V Winds



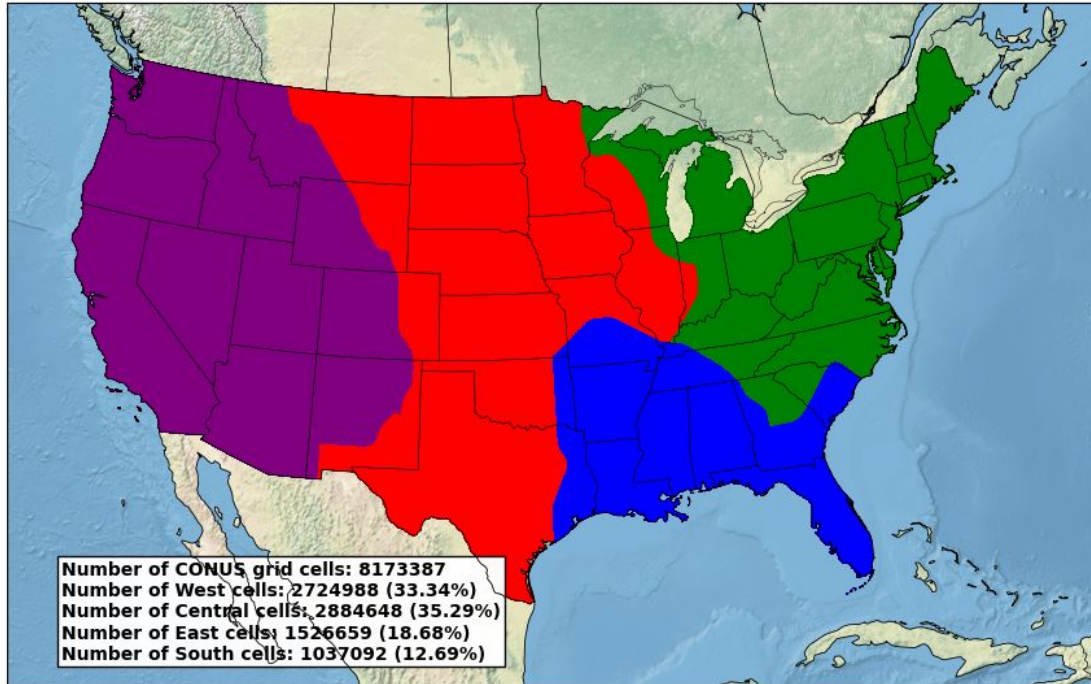
CONUS-East



- **NAEFSv7** had slightly less of a low 10-m U wind-speed bias than **NAEFSv6** and a comparable high 10-m V wind-speed bias over CONUS-West at all lead times
- **NAEFSv7** had comparable 10-m U and V wind-speed biases to **NAEFSv6** over CONUS-Central at all lead times (no 10-m U wind-speed bias and high V wind-speed bias)
- **NAEFSv7** had slightly more of a high 10-m U wind-speed bias than **NAEFSv6** at Days 7–16 and a comparable high 10-m V wind-speed bias over CONUS-East at Days 1–16



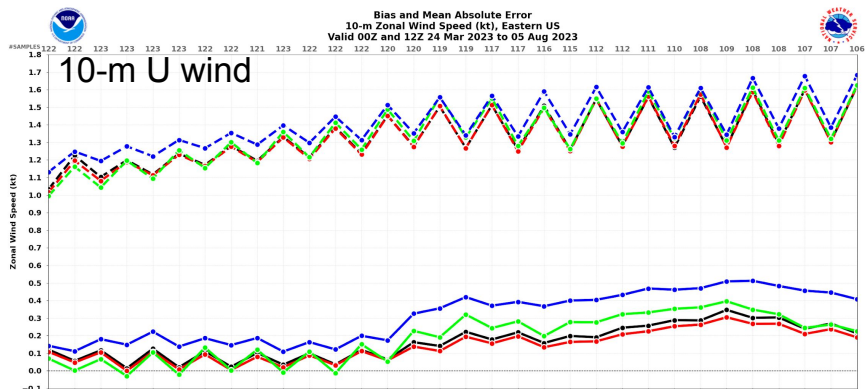
NAEFSv7: 2-m Temp. and 10-m U/V Winds



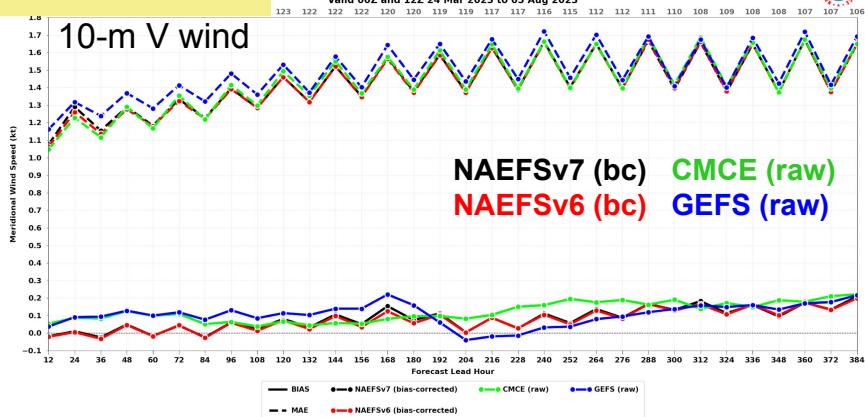
- A meaningful examination of near-surface parameters (e.g., 2-m temperature, 10-m wind) requires that the CONUS be separated into four sub-regions (West, Central, East, and South) and that Alaska is its own region
- The plot above shows the four CONUS sub-regions, created by combining similar Bukovsky Regions ([see link](#))



NAEFSv7: 10-m U and V Winds



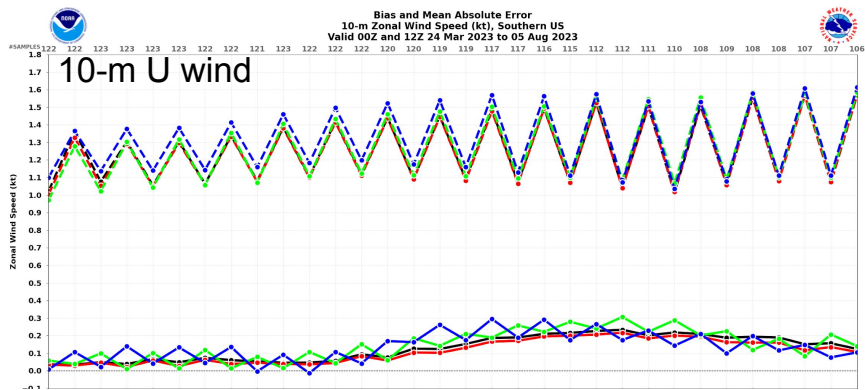
CONUS-East



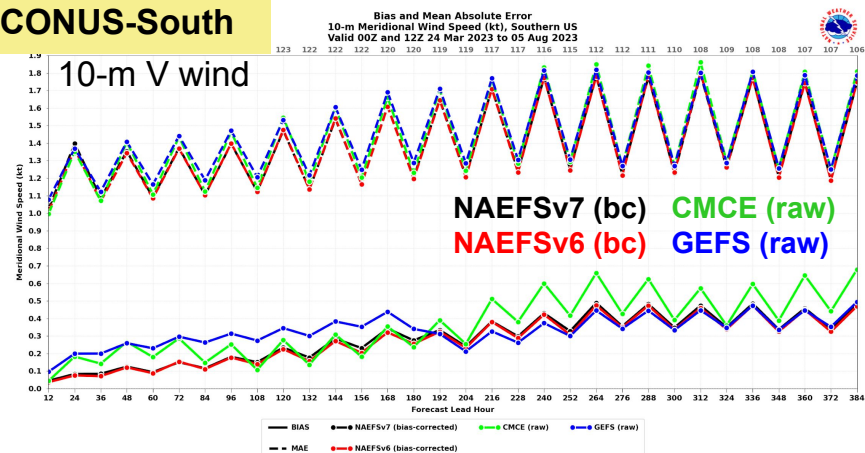
- **NAEFSv7** had slightly less of a low 10-m U wind-speed bias than **NAEFSv6** and a comparable high 10-m V wind-speed bias over CONUS-West at all lead times
- **NAEFSv7** had comparable 10-m U and V wind-speed biases to **NAEFSv6** over CONUS-Central at all lead times (no 10-m U wind-speed bias and high V wind-speed bias)
- **NAEFSv7** had slightly more of a high 10-m U wind-speed bias than **NAEFSv6** at Days 7–16 and a comparable high 10-m V wind-speed bias over CONUS-East at Days 1–16



NAEFSv7: 10-m U and V Winds



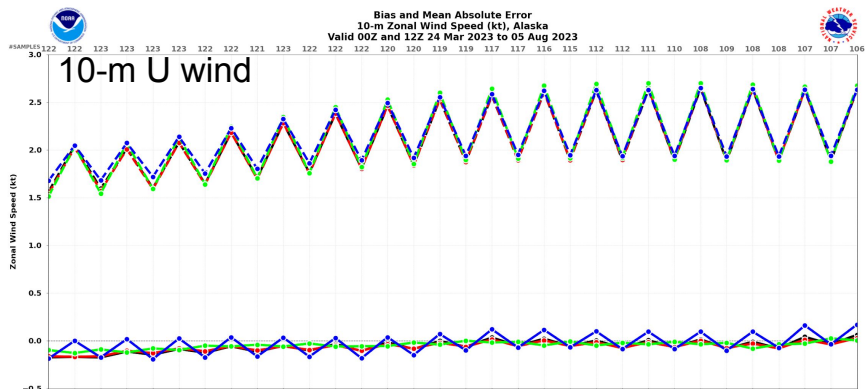
CONUS-South



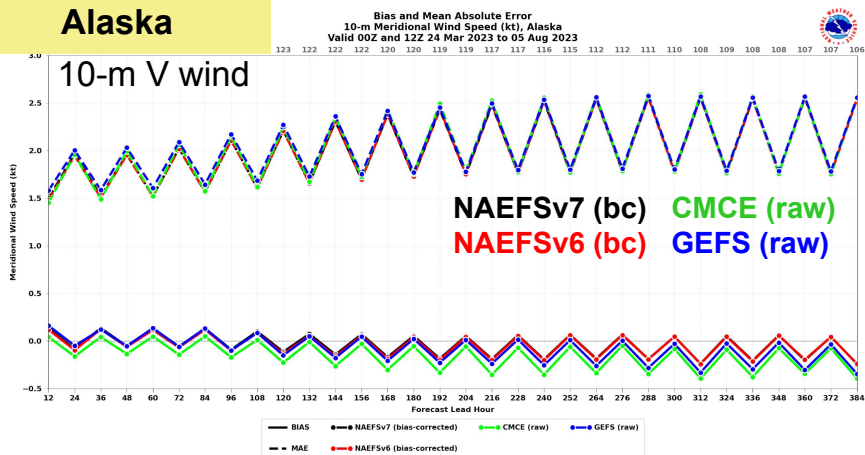
- **NAEFSv7** had slightly less of a low 10-m U wind-speed bias than **NAEFSv6** and a comparable high 10-m V wind-speed bias over CONUS-West at all lead times
- **NAEFSv7** had comparable 10-m U and V wind-speed biases to **NAEFSv6** over CONUS-Central at all lead times (no 10-m U wind-speed bias and high V wind-speed bias)
- **NAEFSv7** had slightly more of a high 10-m U wind-speed bias than **NAEFSv6** at Days 7–16 and a comparable high 10-m V wind-speed bias over CONUS-East at Days 1–16
- **NAEFSv7** had comparable high 10-m U and V wind-speed biases to **NAEFSv6** over CONUS-South at all lead times



NAEFSv7: 10-m U and V Winds



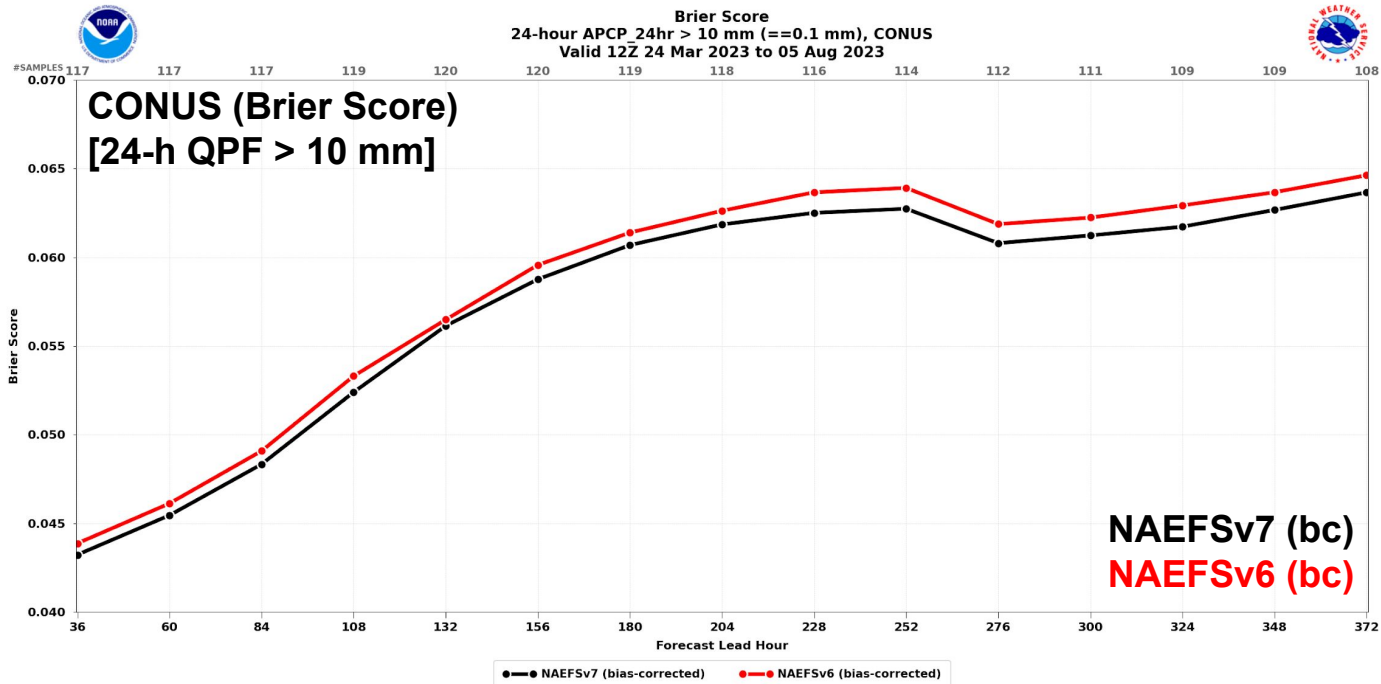
Alaska



- **NAEFSv7** had slightly less of a low 10-m U wind-speed bias than **NAEFSv6** and a comparable high 10-m V wind-speed bias over CONUS-West at all lead times
- **NAEFSv7** had comparable 10-m U and V wind-speed biases to **NAEFSv6** over CONUS-Central at all lead times (no 10-m U wind-speed bias and high V wind-speed bias)
- **NAEFSv7** had slightly more of a high 10-m U wind-speed bias than **NAEFSv6** at Days 7–16 and a comparable high 10-m V wind-speed bias over CONUS-East at Days 1–16
- **NAEFSv7** had comparable high 10-m U and V wind-speed biases to **NAEFSv6** over CONUS-South at all lead times
- **NAEFSv7** had comparable 10-m U and V wind-speed biases to **NAEFSv6** over Alaska at all lead times



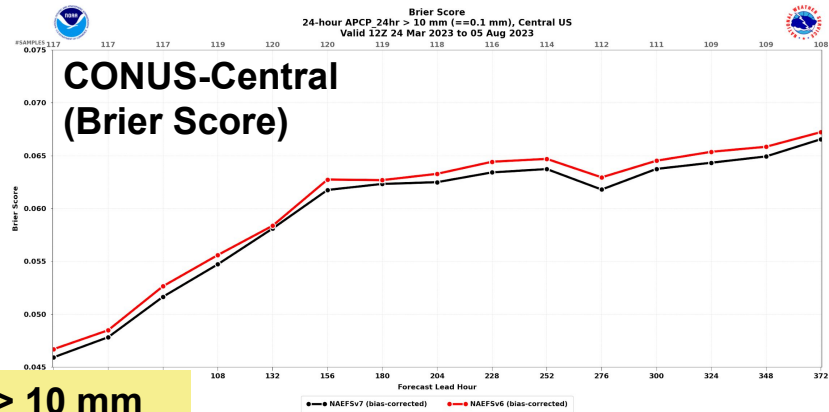
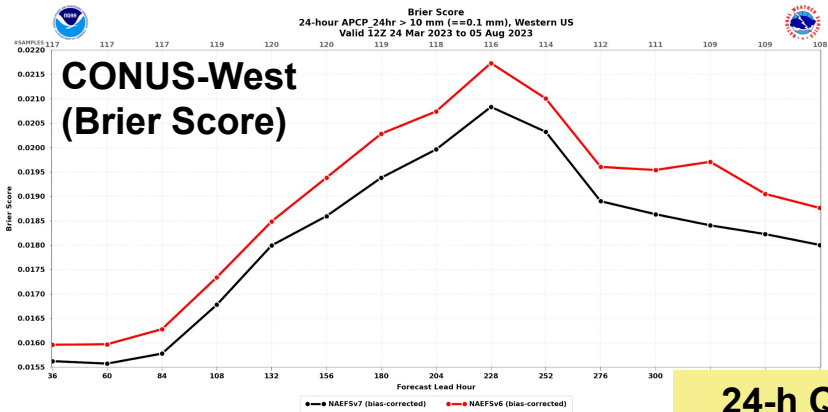
NAEFSv7: Precipitation



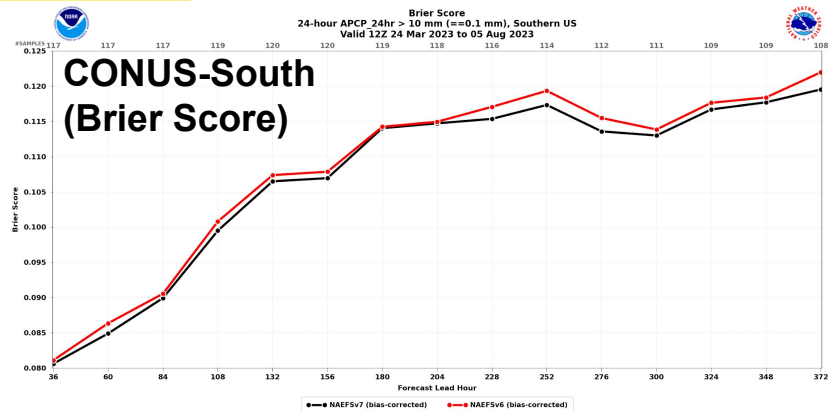
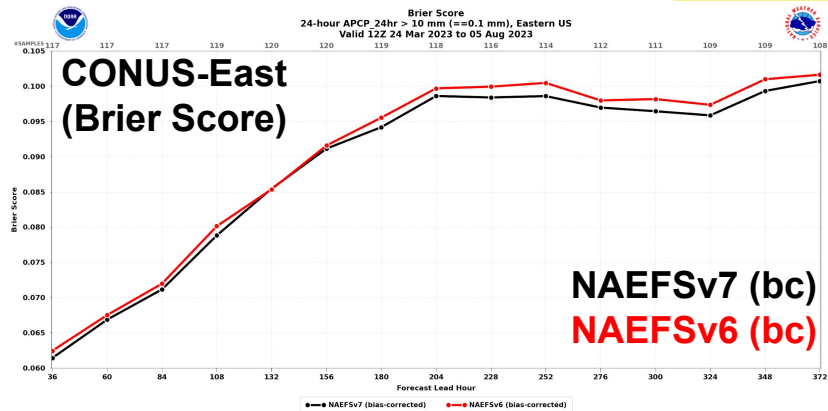
- Of the parameters evaluated, bias-corrected 24-h precipitation showed the most improvement in **NAEFSv7**
- Brier Scores for various 24-h QPF thresholds (>1, 5, 10, 25, 50 mm) were notably better in **NAEFSv7**
- Brier Scores were also notably better in **NAEFSv7** in all four CONUS sub-regions (West, Central, East, South)



NAEFSv7: Precipitation



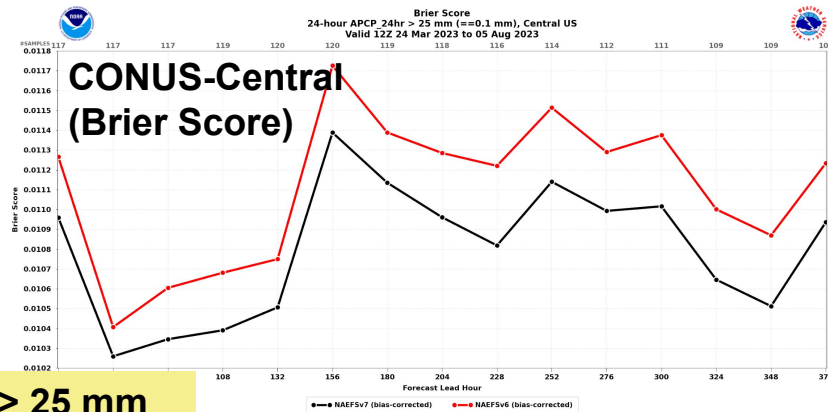
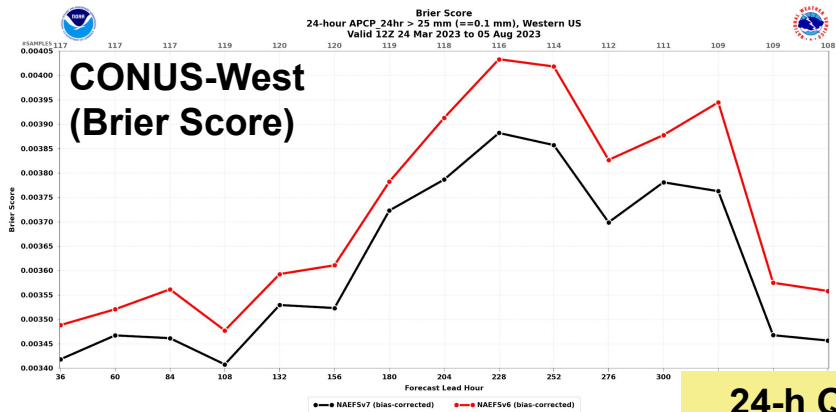
24-h QPF > 10 mm



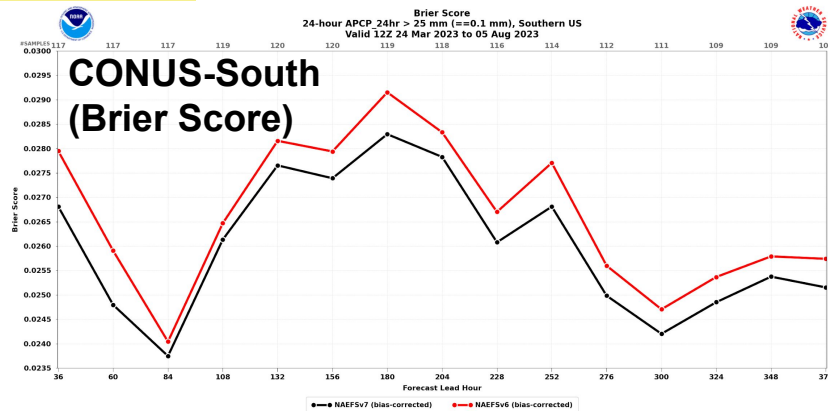
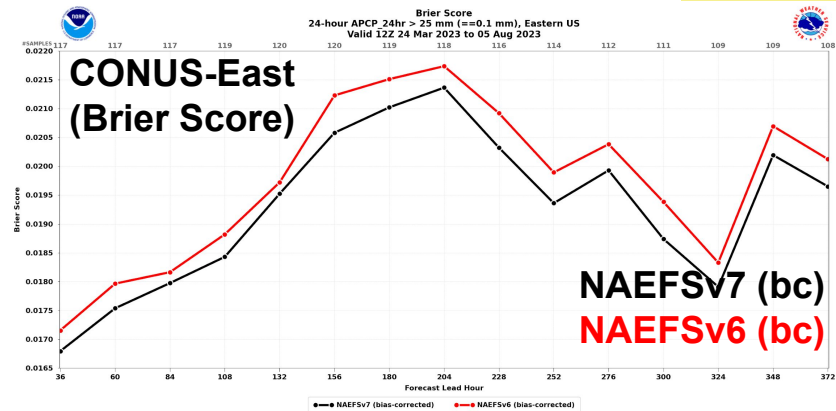
NAEFSv7 (bc)
NAEFSv6 (bc)



NAEFSv7: Precipitation



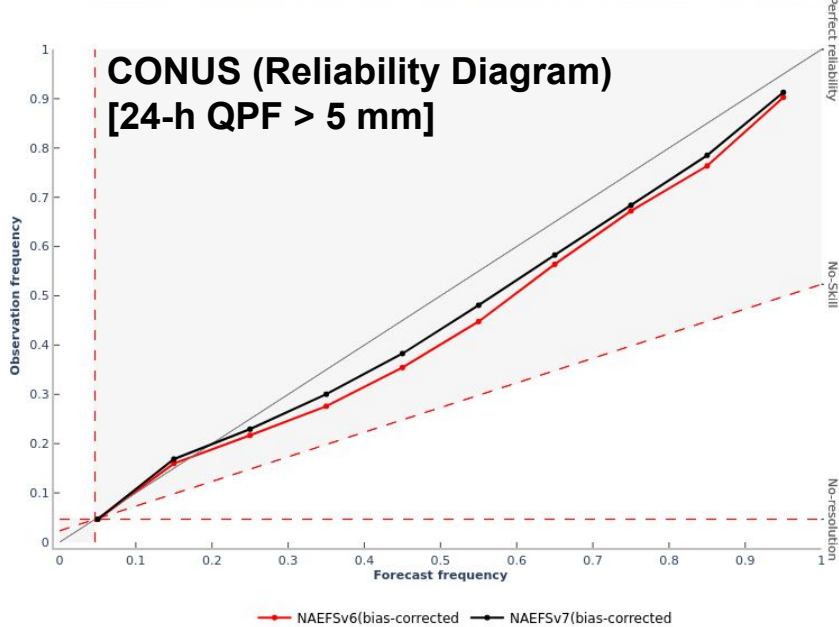
24-h QPF > 25 mm



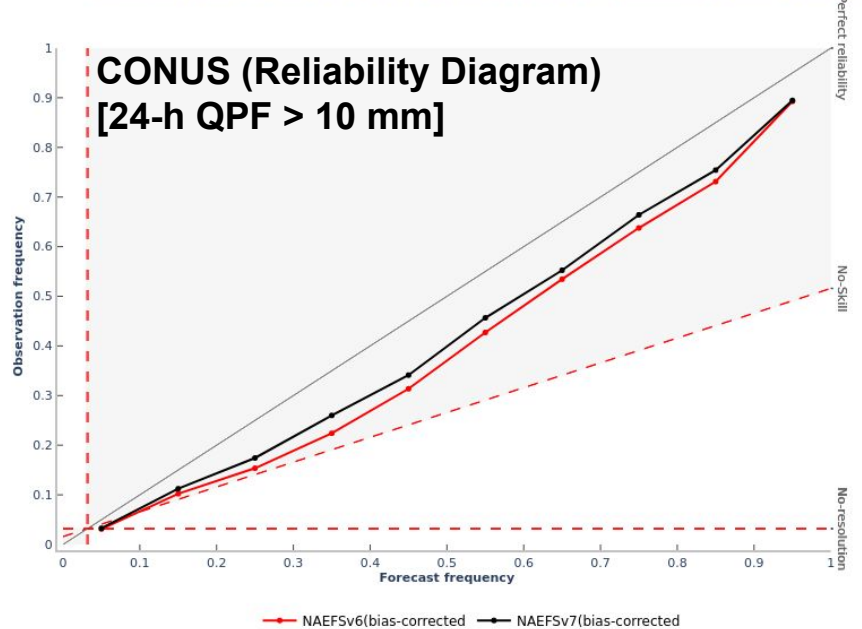


NAEFSv7: Precipitation

Reliability-diagram for APCP24 > 5 mm, 20230325 ~ 20230804 over CONUS



Reliability-diagram for APCP24 > 10 mm, 20230325 ~ 20230804 over CONUS



- Reliability Diagrams of 24-h QPF at different thresholds (>1, >5, >10, >25, >50 mm) all showed improvement in **NAEFSv7**, where improvement is indicated by a line being closer to the diagonal “perfect reliability line”
- **NAEFSv7** bias-corrected 24-h QPF even had some skill at >50 mm, whereas **NAEFSv6** did not (not shown)



Summary of NAEFSv7 Verification Statistics

| Parameter | Remarks | Improvement | Neutral | Degradation |
|----------------------|--|-------------|---------|-------------|
| | | | | |
| 500-hPa Geo. Height | Comparable in the NH and SH; slight improvement in the tropics at all forecast lead times | | | |
| 1000-hPa Geo. Height | Slight improvement in the NH in the short range; comparable in the SH; slight improvement in the tropics at all forecast lead times | | | |
| 250-hPa U/V Winds | Slight improvement in the NH at all lead times; comparable in the SH and tropics | | | |
| 850-hPa U/V Winds | Slight improvement in the NH at all lead times; comparable in the SH; slight improvement in U wind in the tropics with comparable V wind | | | |
| 850-hPa Temperature | Slight improvement in the NH warm bias at all lead times; slightly larger cold bias in the SH; comparable in the tropics | | | |
| 2-m Temperature | Comparable over CONUS-West and Alaska; slight decrease in the warm bias over CONUS-Central/East/South at longer lead times; slight increase in the cold bias over CONUS-East at shorter lead times | | | |
| 10-m U/V Winds | Comparable over CONUS-Central, CONUS-South, and Alaska; slight improvement in U wind low bias over CONUS-West; slight increase U wind high bias over CONUS-East | | | |
| 24-h Precipitation | Improvement over all CONUS sub-regions and thresholds, modest skill at >50 mm; comparable frequency bias for most CONUS sub-regions | | | |



Recap of the NAEFSv7 Field Evaluation

- Assess the statistical performance of the NAEFSv7 parallel
- Provide a few examples of bias-corrected precipitation forecasts
- Review the comments and recommendations from NWS Centers/Regions
- Share a summary and outline next steps

NAEFSv7 Official Evaluation Webpage

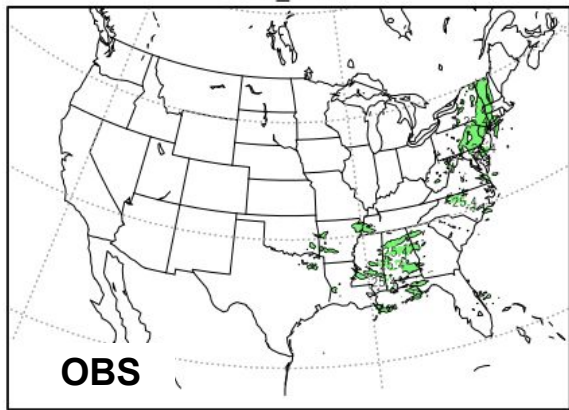
<https://www.emc.ncep.noaa.gov/users/meg/naefsv7>



QPF Case Example: VT Flooding

**DAY 2-3 PROB of
24h QPF > 1"**

OBS_CCPA

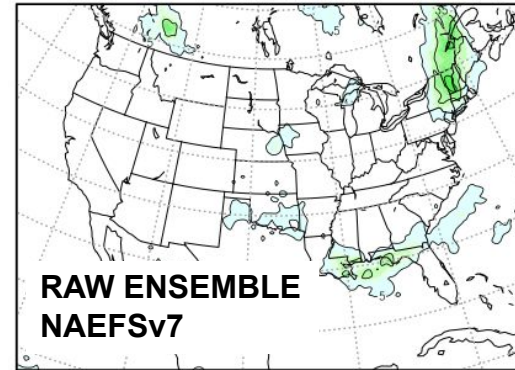


QPF images courtesy of Bo Cui

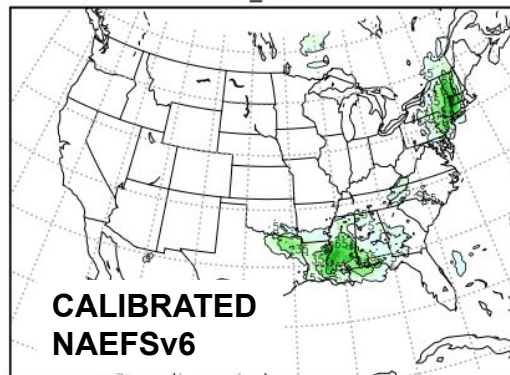
RAW



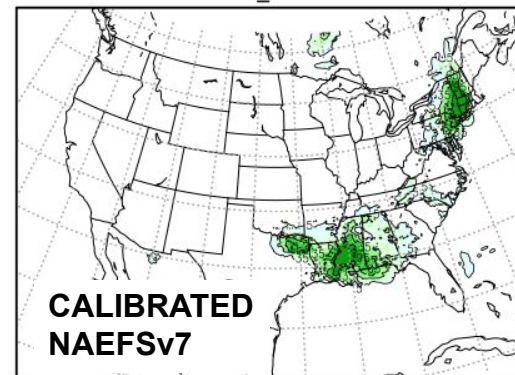
RAW



CAL_bc+ds



CAL_bc+ds

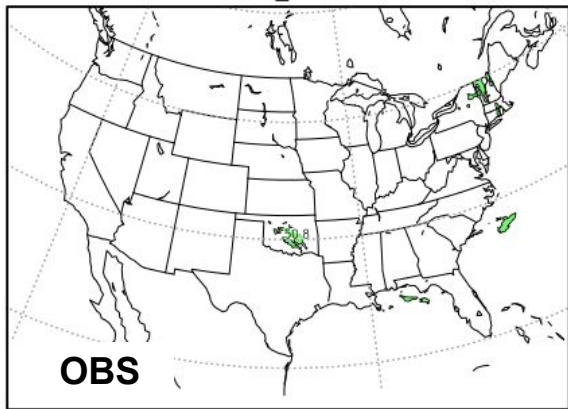




QPF Case Example: VT Flooding

**DAY 2-3 PROB of
24h QPF > 2"**

OBS_CCPA

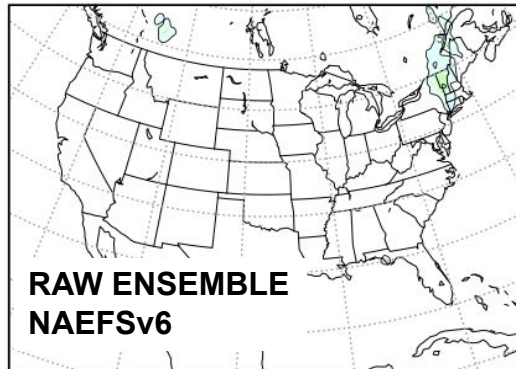


OBS



QPF images courtesy of Bo Cui

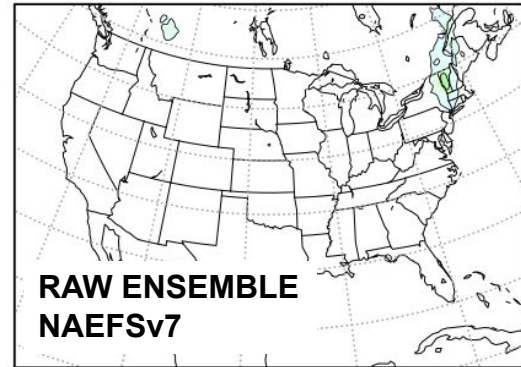
RAW



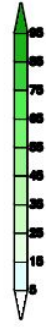
RAW ENSEMBLE
NAEFSv6



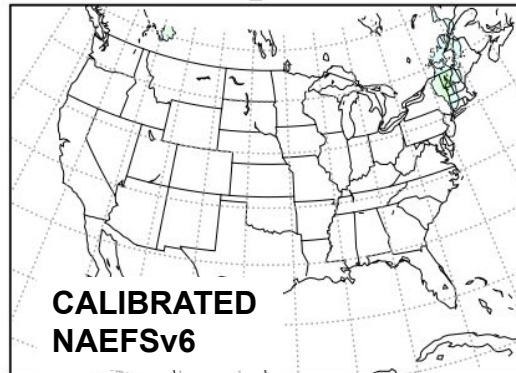
RAW



RAW ENSEMBLE
NAEFSv7



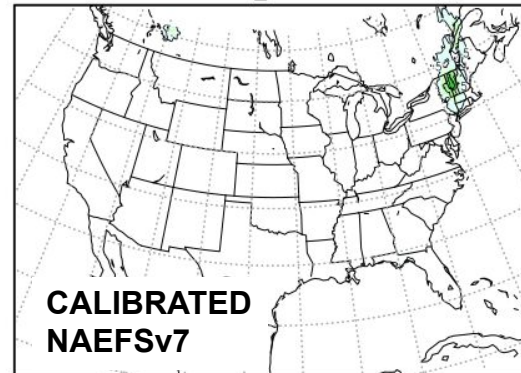
CAL_bc+ds



CALIBRATED
NAEFSv6



CAL_bc+ds



CALIBRATED
NAEFSv7

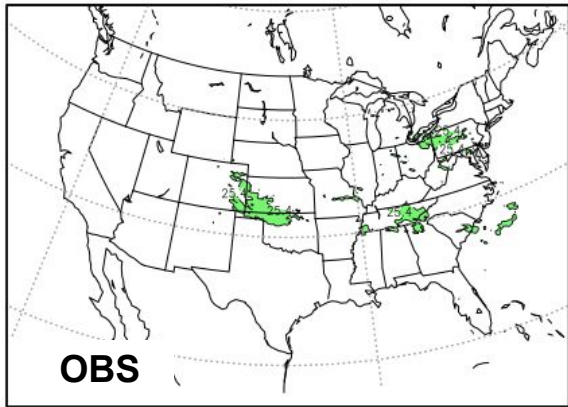




QPF Case Example: High Plains MCS

**DAY 3-4 PROB of
24h QPF > 1"**

OBS_CCPA

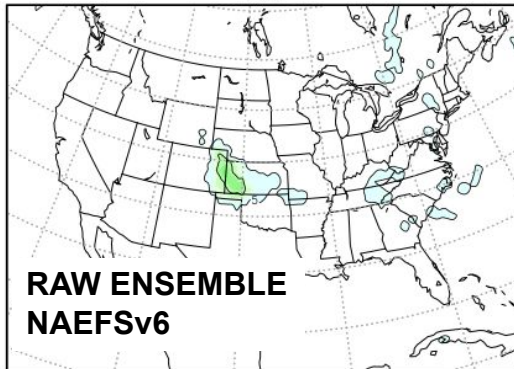


OBS

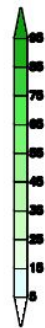


QPF images courtesy of Bo Cui

RAW



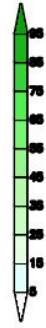
RAW ENSEMBLE
NAEFSv6



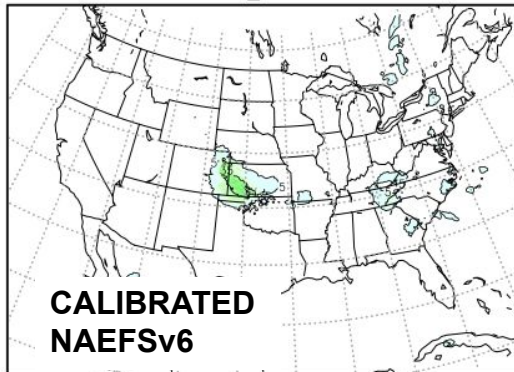
RAW



RAW ENSEMBLE
NAEFSv7



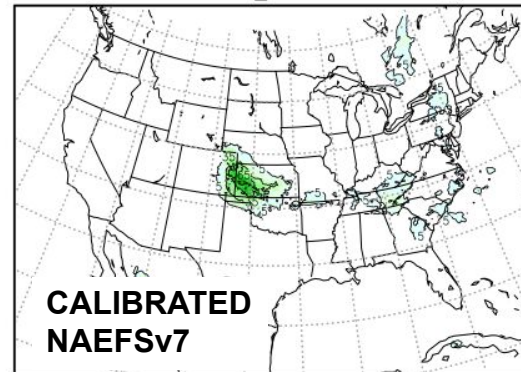
CAL_bc+ds



CALIBRATED
NAEFSv6



CAL_bc+ds



CALIBRATED
NAEFSv7





Recap of the NAEFSv7 Field Evaluation

- Assess the statistical performance of the NAEFSv7 parallel
- Provide a few examples of bias-corrected precipitation forecasts
- Review the comments and recommendations from NWS Centers/Regions
- Share a summary and outline next steps

NAEFSv7 Official Evaluation Webpage

<https://www.emc.ncep.noaa.gov/users/meg/naefsv7>



NAEFSv7 Field Evaluation

Information that users were asked to provide:

- What are your overall impressions of NAEFSv7 relative to NAEFSv6?
- What is your recommendation?

The questions were kept simple due to the limited scope of the proposed upgrade.

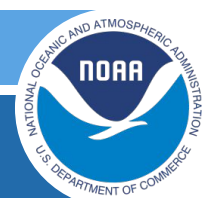
Evaluations were requested from each NWS Region, as well as WPC and CPC. Eastern Region and CPC were unable to participate due to resource limitations.

Thank you to all who submitted formal recommendations and to those who provided subjective feedback during the evaluation period!



NWS Southern Region

- Reliability for very light QPF is slightly worse in the CONUS-South in NAEFSv7
- Overall, though, it seemed like the QPF was slightly improved in NAEFSv7
- Bigger diurnal swings in 2m temperature ACC in the South compared to some other regions, but this is similar to NAEFSv6
- Would have liked to have seen forecast images
- **Supports implementation of NAEFSv7**



NCEP Weather Prediction Center (WPC)

- Differences in the stats between NAEFSv6 and NAEFSv7 were overall minor
 - Biggest differences were in QPF
- Noted some improvement in 500-hPa ACC over the Tropics, as well as lower RMSE
- Better reliability and Brier Score in NAEFSv7 for 24-h QPF for 5, 10, 25 mm thresholds
- Some improvement in the warm bias in NAEFSv7 over the Central/Southern/Eastern CONUS in the medium-to-long range, but the cool bias is slightly worse
- Overall, NAEFSv7 offers limited improvement but certainly doesn't degrade the forecast
- Supports implementation of NAEFSv7



NWS Western Region

- Some small improvements and some small areas of degradation
- Mostly very similar performance due to small scope of changes
- Would like to have seen forecast images, especially from a real-time parallel
- **Supports implementation of NAEFSv7**



NWS Alaska Region

- Based on the limited amount of data available, NAEFSv7 performs very similarly to NAEFSv6
- **Supports implementation of NAEFSv7**



NWS Central Region

- Based on the verification statistics, it was difficult to find any characteristics of NAEFSv7 that reflected vast improvement over the current operational NAEFS
- Some improvement in NAEFSv7, relative to v6, at Day 8 and beyond
 - **The two systems were overall indistinguishable on Days 1–7**
- Slight edge for NAEFSv6 on precip bias scores
- It is a challenge to assess an upgrade with only verification statistics
 - **Would have much preferred to have at least a short period of forecast graphics available for v6/v7 comparisons**
- **Neutral regarding proposed implementation of NAEFSv7**



NWS Pacific Region

- Based on the provided verification statistics, it appears NAEFSv7 performs similarly to NAEFSv6
- **Supports implementation of NAEFSv7**



Overall Impressions of NAEFSv7

| Center/Region | Recommendation | Key Remarks |
|---------------------------------|----------------|--|
| Southern Region | Implement | Few overall differences, but NAEFSv7 slightly better. Slightly worse for small precip thresholds, but perhaps slightly better overall for precip. |
| Weather Prediction Center (WPC) | Implement | Differences in objective verification overall pretty minor. Some improvement in 500-hPa heights over Tropics. Better QPF Brier Scores and reliability for 5, 10, 25 mm thresholds. Some improvement in longer-range warm bias for East, South, and Central. Cool bias slightly worse at shorter forecast ranges. |
| Alaska Region | Implement | Performance is overall very similar between NAEFSv6 and v7. |

Improvement

Neutral

Degradation



Overall Impressions of NAEFSv7

| Center/Region | Recommendation | Key Remarks |
|----------------|----------------|---|
| Western Region | Implement | Some small improvements, some slight degradation. Very similar overall performance, as expected due to the small scope of the changes. |
| Central Region | Neutral | Tough to find any vast improvement with NAEFSv7. Some slight improvement at Day 8 and beyond. Slight edge for NAEFSv6 with precip bias. |
| Pacific Region | Implement | NAEFSv7 performs very similarly to NAEFSv6. |

Improvement

Neutral

Degradation



Recap of the NAEFSv7 Field Evaluation

- Assess the statistical performance of the NAEFSv7 parallel
- Provide a few examples of bias-corrected precipitation forecasts
- Review the comments and recommendations from NWS Centers/Regions
- Share a summary and outline next steps

NAEFSv7 Official Evaluation Webpage

<https://www.emc.ncep.noaa.gov/users/meg/naefsv7>



Overall Impressions (MEG and Evaluators)

- Some slight improvement in NAEFSv7 relative to NAEFSv6, especially for the majority of precipitation stats
- Overall, NAEFSv7 performed very similarly to NAEFSv6
- The similar performance of NAEFSv7 is not surprising given the limited scope of the changes – the primary purpose of this upgrade is the utilize all 31 GEFS members in NAEFS (which were added in GEFSv12, but not included yet)
- Evaluators support the proposed NAEFSv7 upgrade



NAEFSv7 Next Steps

EMC Science briefing: 8/22/23

NCEP Director briefing: 8/25/23

Code handoff to NCO: 9/1/23

NCO 30-day IT test: 10/30/23–11/28/23

Implementation date: ~11/28/23



NAEFSv7 Official Evaluation Webpage

<https://www.emc.ncep.noaa.gov/users/meg/naefsv7>