

Statistical Down-Scaling for Alaska Region

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Acknowledgements

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Overview

Statistical Down-Scaling Techniques for Alaska

- Variable: surface pressure, 2-m temperature, 10-meter wind component
 - work well using current operational technique for CONUS
- Variable: Tmax and Tmin
 - Choose proper period definition in code/scripts
 - Modification for definition changed July, 2009
- Variable: wind speed and direction
 - Problem exist in utility “copygb” for wind direction
 - Solution to avoid interpolation of wind speed
 - Not bed, difficult for wind direction improvement
- Variable: 2m dew point temp and 2m relative humidity
 - Discussed in meeting June, 2009
 - How to improve methods, future inclusion

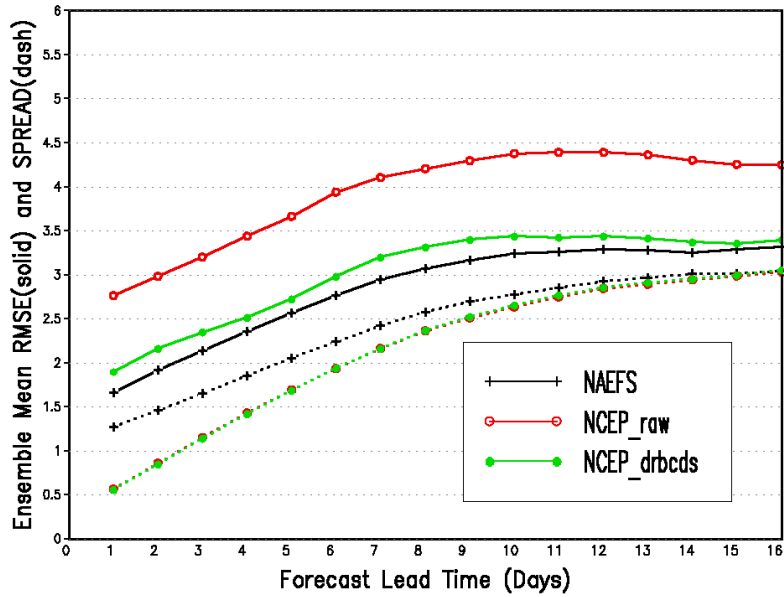
Alaska Verification

- Next images show some verification for Tmax, Tmin, wind direction/speed
- First a few key points:
 - Statistical down-scaling data adds value
 - Bias correction alone is of value
 - Bias correction with downscaling adds significant value to the forecasts
 - NAEFS is better than lone GEFS
 - More members is better

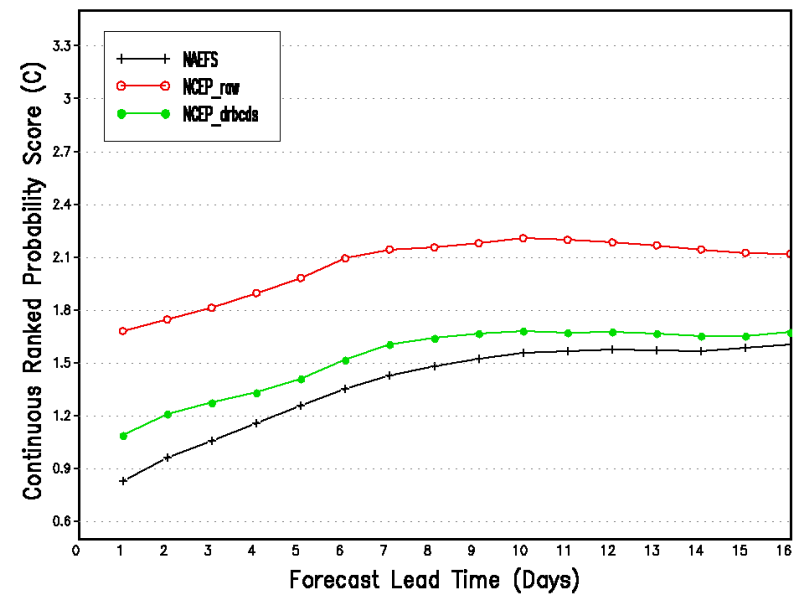
Statistical downscaling for NAEFS forecast

- Proxy for truth
 - *RTMA* at 5km resolution
 - Variables (surface pressure, 2-m temperature, and 10-meter wind)
- Downscaling vector
 - Interpolate GDAS analysis to 5km resolution
 - Compare difference between interpolated GDAS and RTMA
 - Apply *decaying weight* to accumulate this difference – *downscaling vector*
- Downscaled forecast
 - Interpolate bias corrected 1*1 degree NAEFS to 5km resolution
 - Add the downscaling vector to interpolated NAEFS forecast
- Application
 - Ensemble mean, mode, 10%, 50%(median) and 90% forecasts

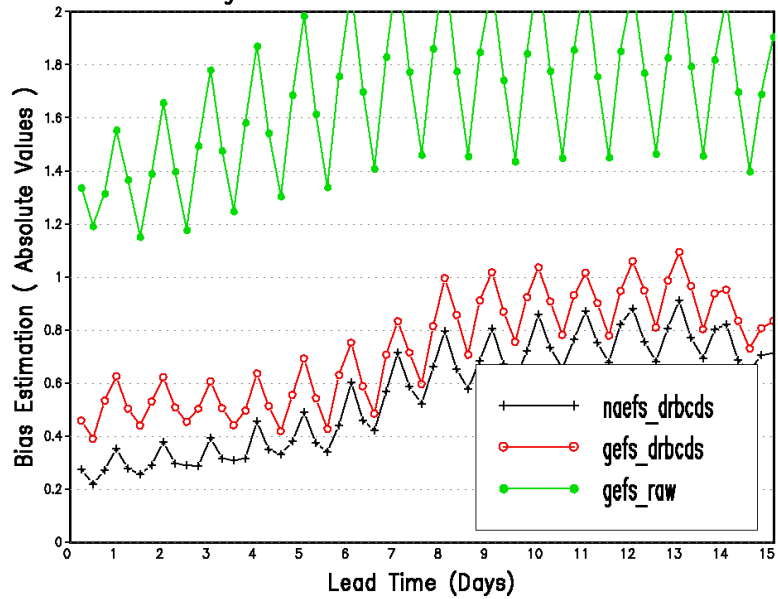
NAEFS NDGD Probabilistic 2m Temperature
Forecast Verification For 2009051800 – 2009073100



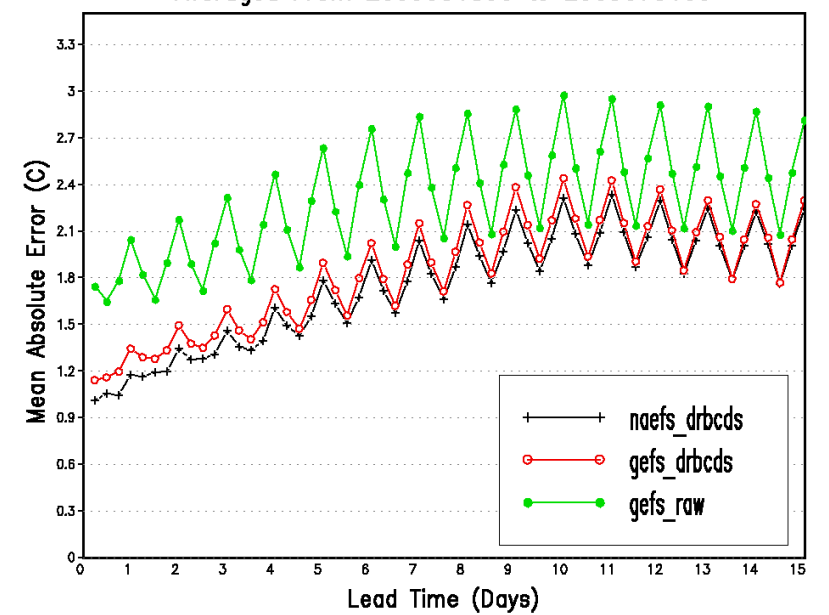
NAEFS NDGD Probabilistic 2m Temperature
Forecast Verification For 2009051800 – 2009073100



RTMA Alaska Region 2m Temperature
Averaged From 2009051800 to 2009073100



RTMA Alaska Region 2m Temperature
Averaged From 2009051800 to 2009073100



Process to Downscale Tmax & Tmin for Alaska

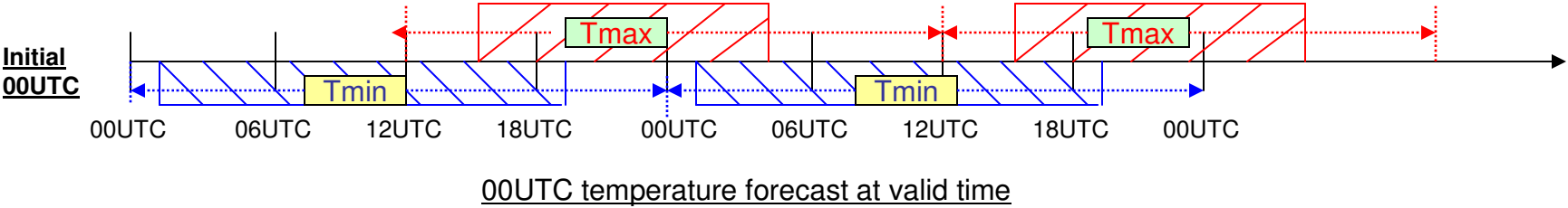
- Based on $1^{\circ} \times 1^{\circ}$ 6-hr bias corrected Tmax/Tmin and down-scaling vectors (DV) for T2m at each 6-hr cycle
 - Definition of Tmax/Tmin for Alaska region
 - Tmax period: 13UTC (5am-local) – 04UTC (8pm-local) – local daylight time
 - Tmin period: 01UTC (5pm-local) – 19UTC (11am-local) – local daylight time
 - Definition of approximated period for Tmax/Tmin for giving initial cycle
 - Mean DV of T2m for 6-hr period: weighted average of two instantaneous DVs
 - Interpolating bias corr. 6-hr Tmax/Tmin ($1^{\circ} \times 1^{\circ}$) to 6km NDGD grid for Alaska
- Downscaling detailed process
 - Apply mean DV to each grid point, each ens. member, and each 6-hr lead-time period, to produce down-scaled Tmax and Tmin for each 6-hr lead-time period
 - Find out highest Tmax and lowest Tmin for approximated period
 - For different grid points, different ens. members, highest Tmax could be in different 6-hr period, the same for lowest Tmin
 - Only one down-scaled Tmax and Tmin for every 24-hr. fcst, up to 384 hours
- Calculate the Tmax/Tmin statistical outputs: mean, spread, mode, 10%, 50% and 90% based on above step

EFFECTIVE 1200UTC JULY 28 2009, DEFINITIONS OF MAX T AND MIN T FOR ALASKA REGION
CHANGE FROM: MAX T 7:00 AM - 7:00 PM LST, MIN T 7:00 PM - 8:00 AM LST
TO: MAX T 5:00 AM - 8:00 PM LST, MIN T 5:00 PM - 11:00 AM LST

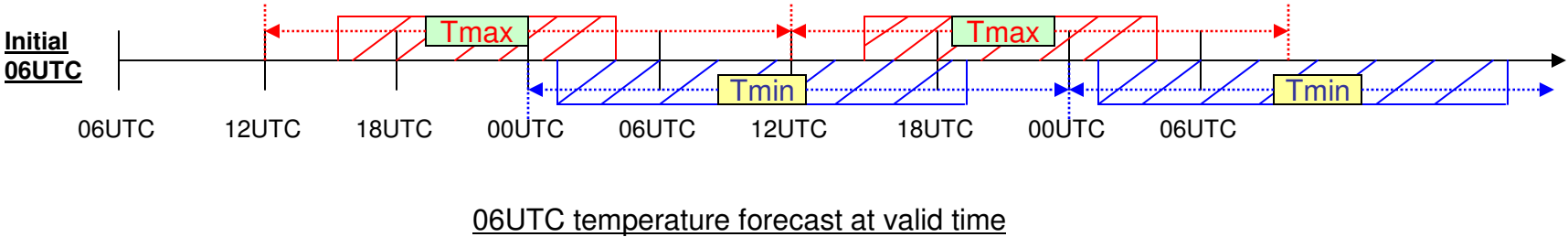
Tmax and Tmin calculations for Alaska region (2009)

Alaska Daylight Time : Tmax period: 13UTC (5am-local) – 04UTC (8pm-local) – local daylight time
 Tmin period: 01UTC (5pm-local) –19UTC (11am-local) – local daylight time

OUTPUT: Tmax: f18(no), f24(no), f30(no), **f36(yes:12-36hrs)**, f42(no),f48(no), f54(no), **f60(yes:36-60hrs)**,
 (00UTC) Tmin: f06(no), f12(no), f18(no), **f24(yes:0-24hrs)**, f30(no), f36(no), f42(no), **f48(yes:24-48hrs)**,

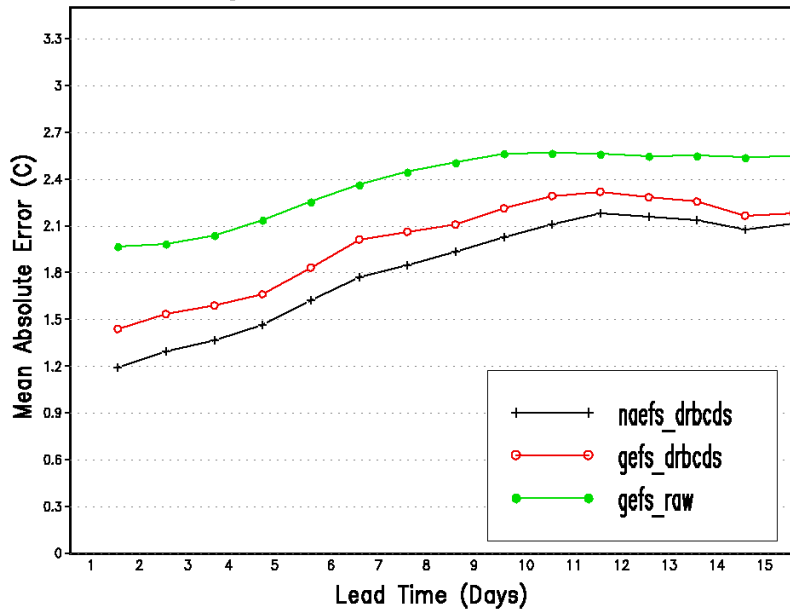


OUTPUT: Tmax: f12(no), f18(no), f24(no), **f30(yes:06-30hrs)**, f36(no), f42(no), f48(no), **f54(yes:30-54hrs)**,
 (06UTC) Tmin: f24(no), f30(no), f36(no), **f42(yes:18-42hrs)**, f48(no), f54(no), f60(no), **f66(yes:42-66hrs)**,

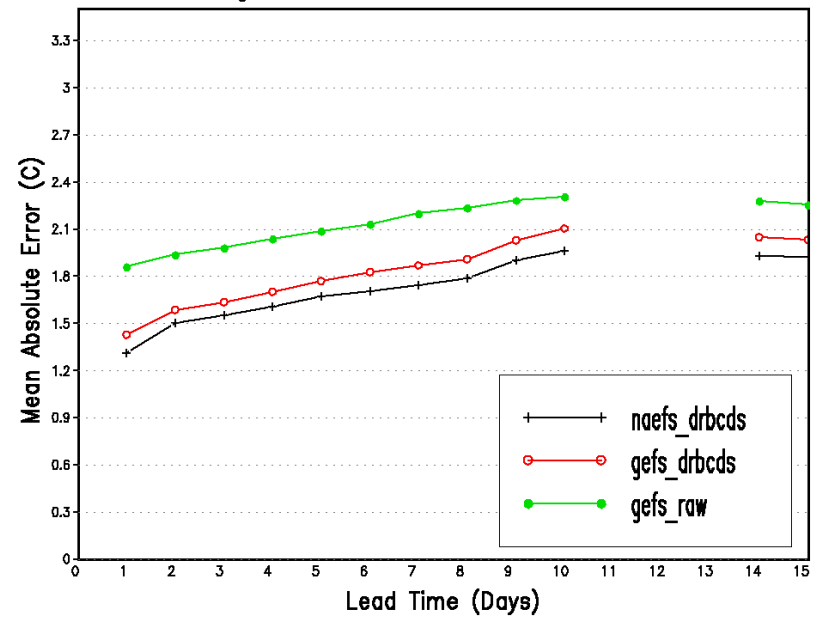


Alaska Standard Time : Tmax period: 14UTC (5am-local) – 05UTC (8pm-local)
 Tmin period: 02UTC (5pm-local) – 20UTC (11am-local)

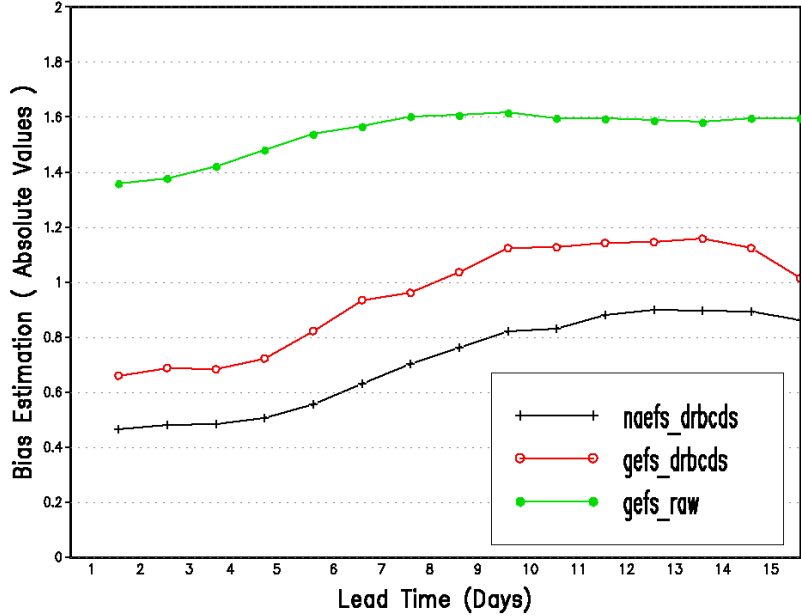
RTMA Alaska Region 2m Tmax
Averaged From 2009051800 to 2009073100



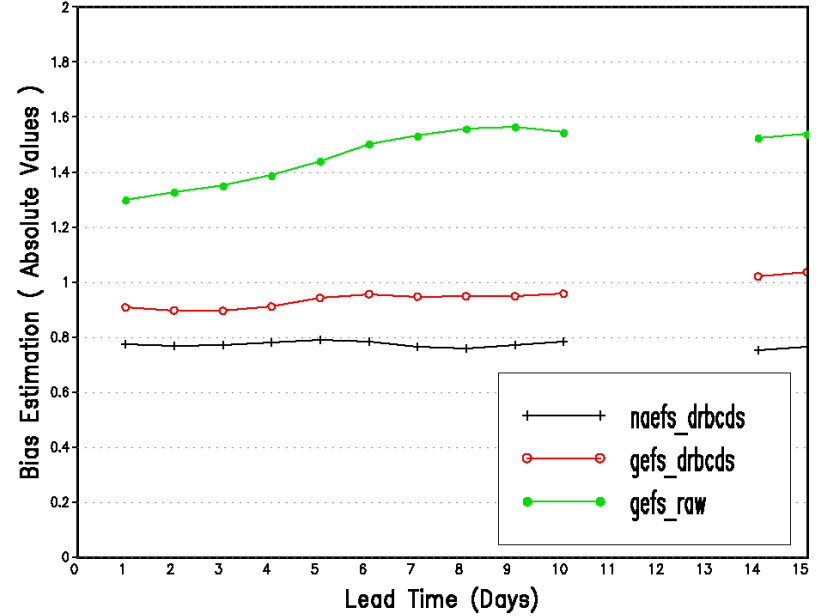
RTMA Alaska Region 2m Tmin
Averaged From 2009051800 to 2009073100



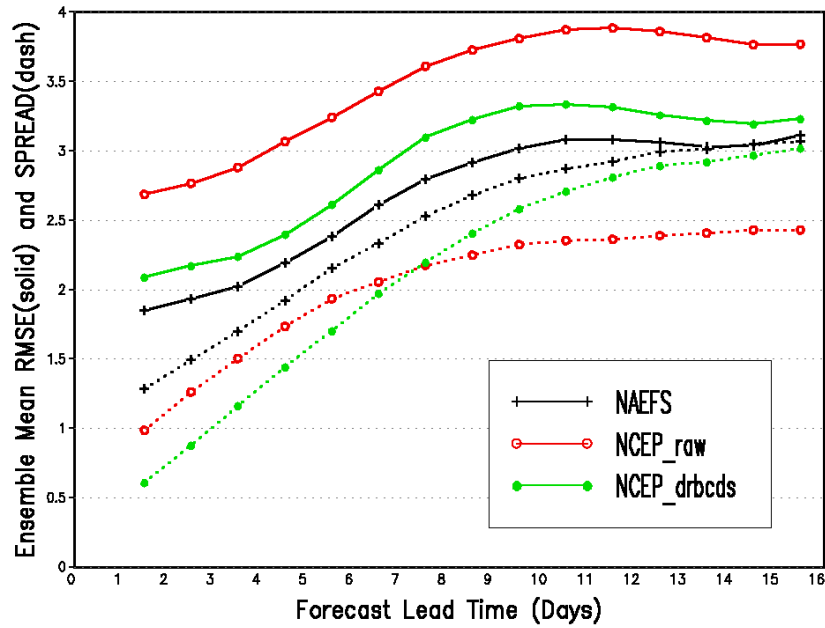
RTMA Alaska Region 2m Tmax
Averaged From 2009051800 to 2009073100



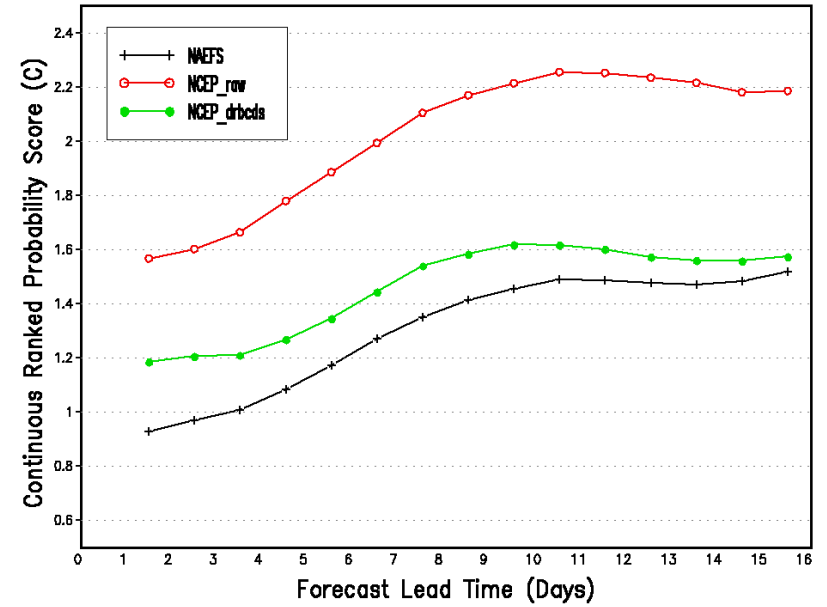
RTMA Alaska Region 2m Tmin
Averaged From 2009051800 to 2009073100



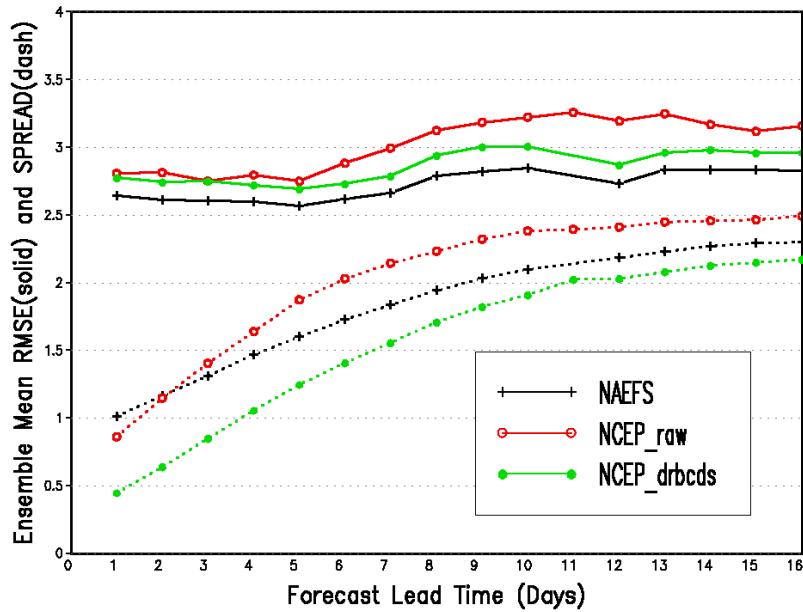
NAEFS NDGD Probabilistic Max Temperature
Forecast Verification For 2009051800 – 2009073100



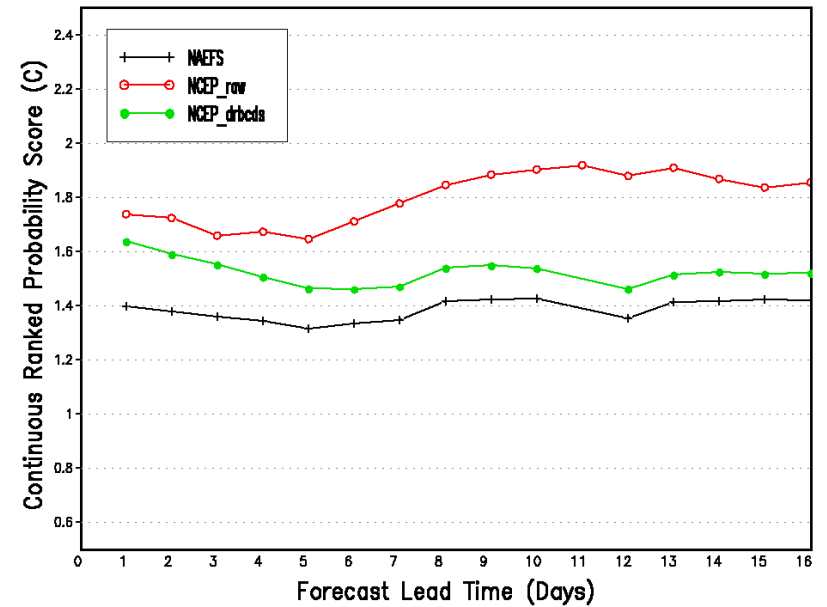
NAEFS NDGD Probabilistic Max Temperature
Forecast Verification For 2009051800 – 2009073100



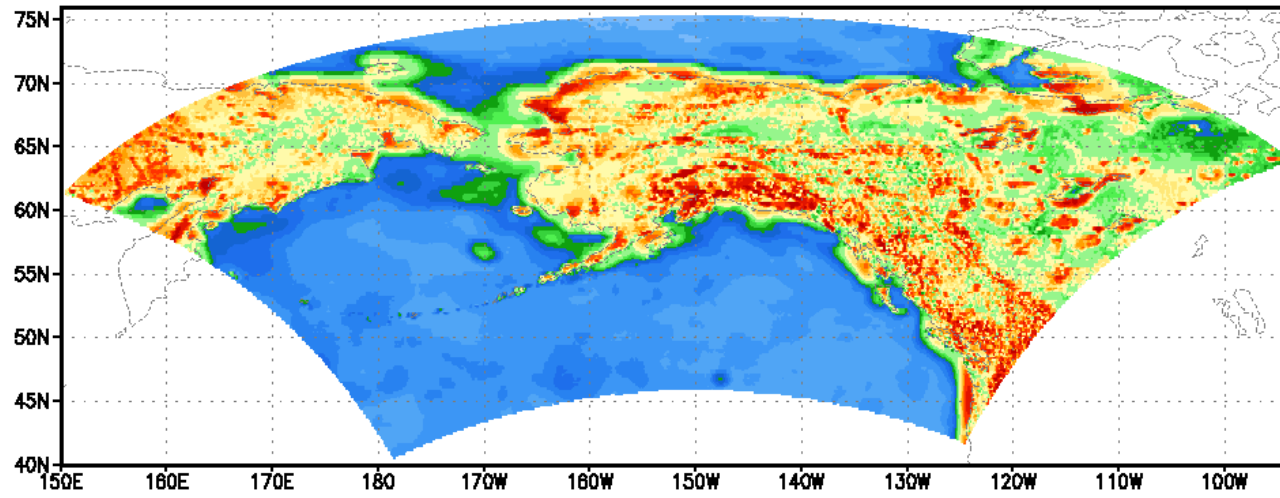
NAEFS NDGD Probabilistic Min Temperature
Forecast Verification For 2009051800 – 2009073100



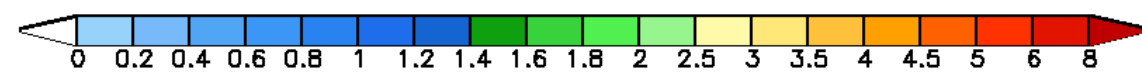
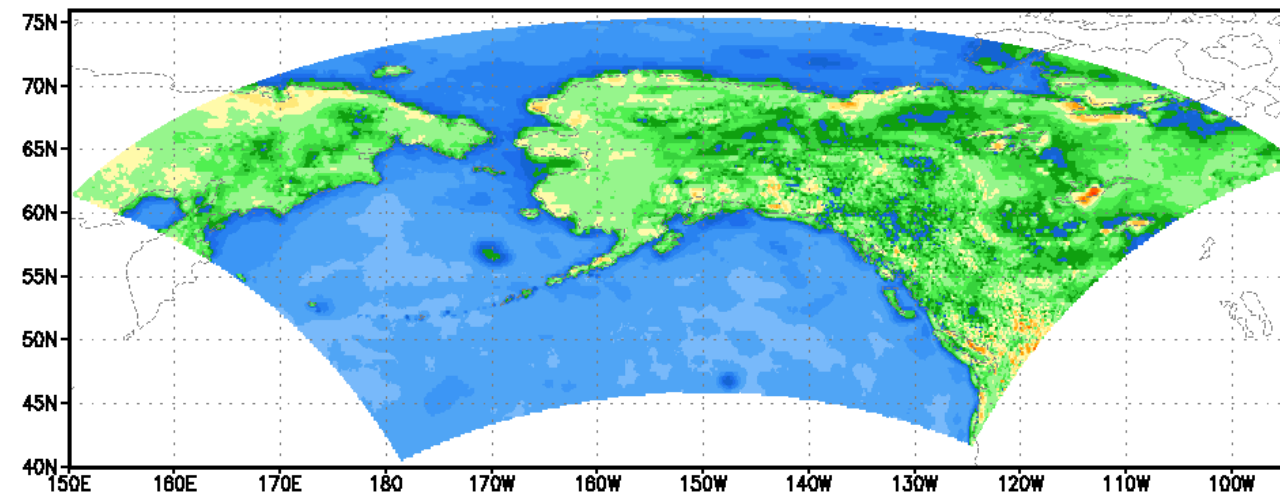
NAEFS NDGD Probabilistic Min Temperature
Forecast Verification For 2009051800 – 2009073100



**ALASKA GEFS Raw Ens. Mean Absolute Error w.r.t RTMA
2m Tmax (shaded, K)
Averaged From: 2009051800 to 2009073100 (36 h)**



**ALASKA NAEFS Ens. Mean Absolute Error w.r.t RTMA
2m Tmax (shaded, K)
Averaged From: 2009051800 to 2009073100 (36 h)**



Process to Statistically Downscale Wind Speed and Direction

Old Method

- Based on $1^\circ \times 1^\circ$ 10m U and V
 - Compute 10m wind speed & direction forecasts
 - Combine bias corrected NCEP/CMC 10m wind speed & direction to generate the mean, spread, mode, 10%, 50% and 90% forecasts
- Downscaling process
 - Apply “copygb” utility to interpolate wind speed & direction (both forecasts and analysis) from 1 degree to 6km grid
 - Get downscaling vectors (DV) for wind speed & direction at each 6-hr cycle
 - Apply DV to the mean, mode, 10%, 50% and 90% forecasts to produce down-scaled wind speed & direction for each 6-hr lead-time period

Question: “copygb” work properly for wind direction? For example, interpolation between 6° and 350° ?

Current Method

- No action for data on 1 degree, whole process based and completed on 6km grid 10m U and V
- Downscaling process
 - Apply “copygb” utility to interpolate 10m U and V for NCEP/CMC each ensemble member
 - Apply DV to produce down-scaled 10m U and V for each member and compute itsm wind speed & direction for each member
 - Combine NCEP/CMC 10m wind speed & direction to generate the mean, spread, mode, 10%, 50% and 90% forecasts
- No change for wind speed & direction calculation, no change for probabilistic wind direction calculation

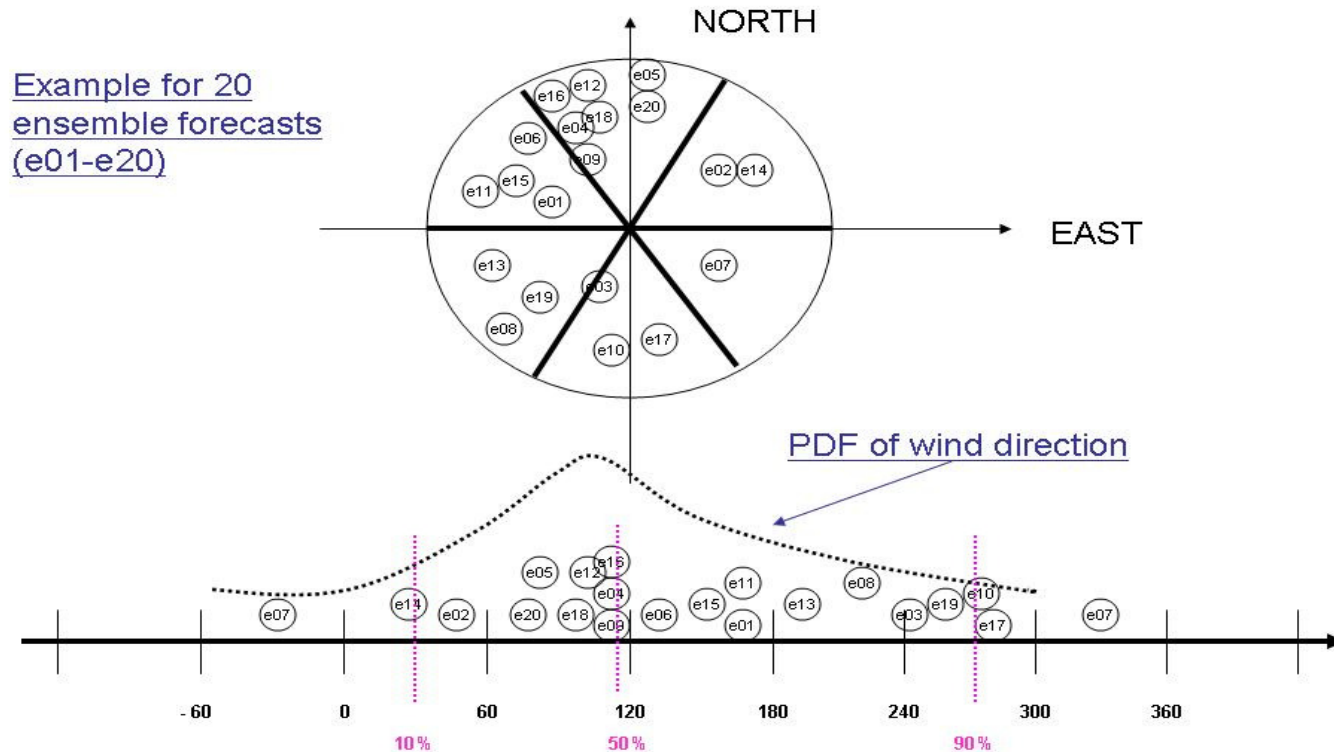
Process to Statistically Downscale Wind

- Wind speed & direction calculation based on 1*1 degree bias corr. u10m & v10m

$$W_s = \sqrt{u^2 + v^2}$$
$$W_d = \text{sign}(u \cdot v) \cdot \arctan\left|\frac{u}{v}\right| + d_p \quad \text{where } d_p = \begin{cases} 0, & \text{if } u \leq 0, v < 0 \\ 180, & \text{if } u < 0, v \geq 0 \\ 180, & \text{if } u \geq 0, v > 0 \\ 360, & \text{if } u > 0, v \leq 0 \end{cases}$$

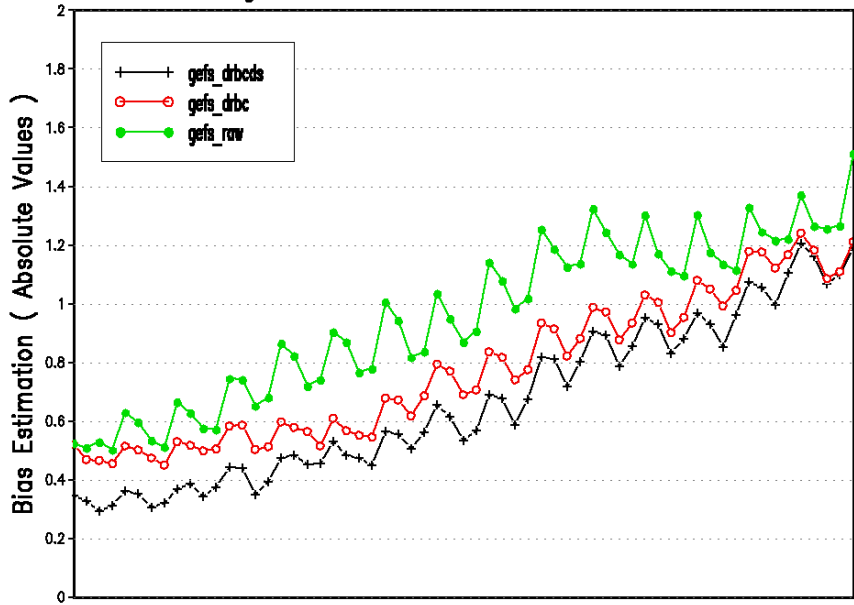
Probabilistic Wind Direction Calculation

The Distribution of Ensemble Wind Directions

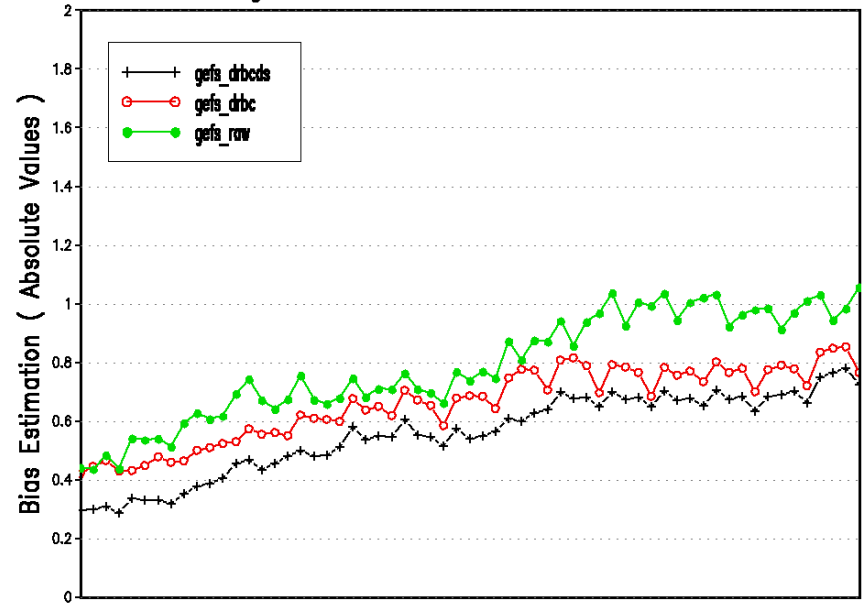


- Divide (0,360) into 6 units, choose the closed 2 units where Wdir data (equal weight currently, different weight by wind speed as a option ?) fall most
- Rearrange the data to allow 2 units in the middle of the distribution
- Set a 60 degree window, move the window through the 2 units, mode is the center of the window with the most members
- Calculate the average wind direction using 6 units data
- Calculate probability 10%, 50% and 90%, mode and spread by using full data
- Adjust wind direction phase in [0,360]

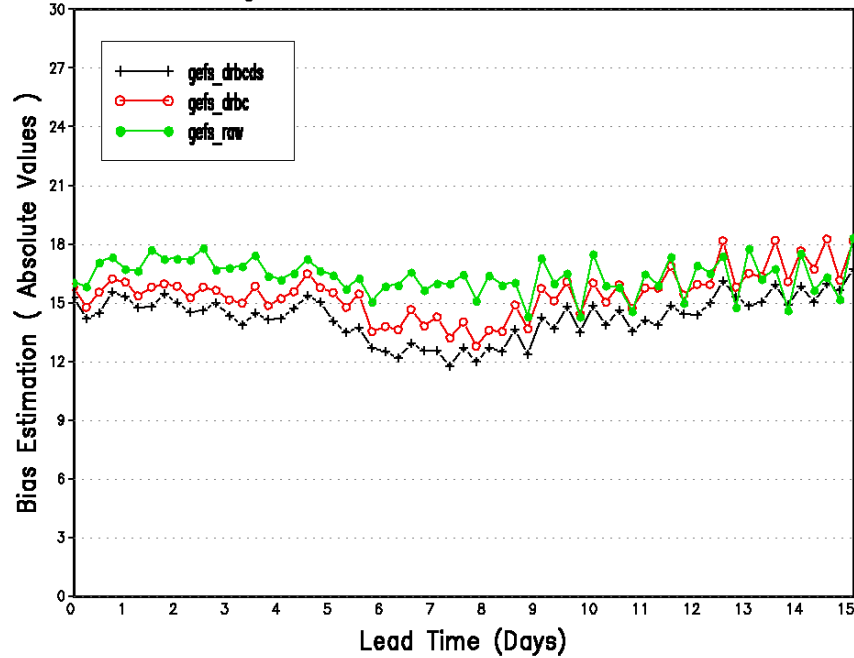
RTMA Alaska Region 10m U Component
Averaged From 2009051800 to 2009073100



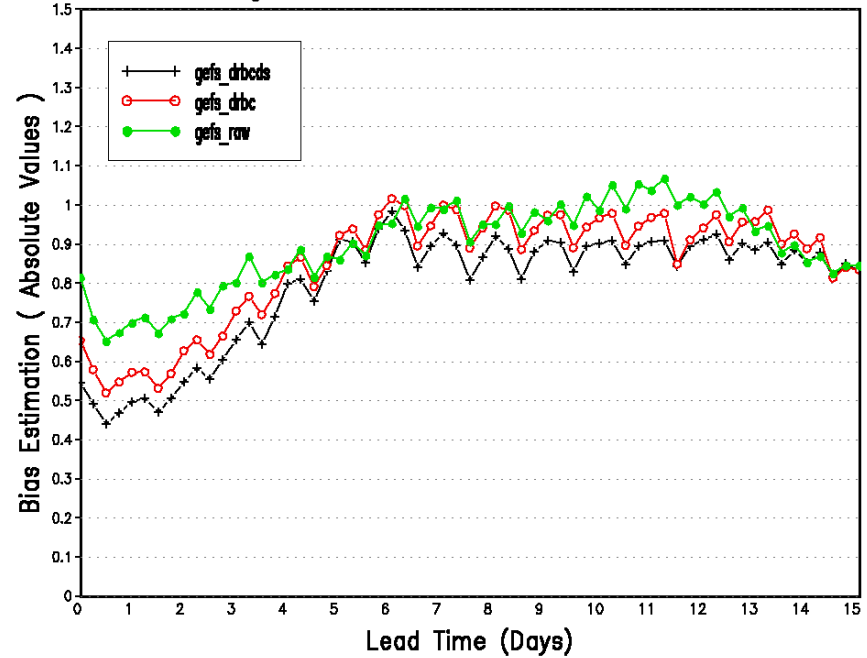
RTMA Alaska Region 10m V Component
Averaged From 2009051800 to 2009073100



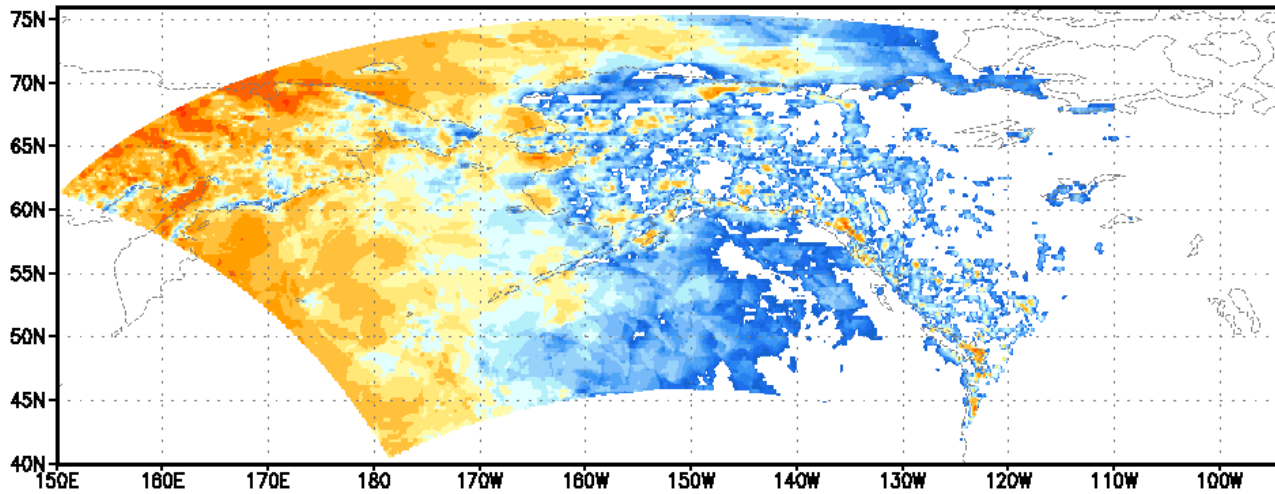
RTMA Alaska Region 10m Wind Direction
Averaged From 2009051800 to 2009073100



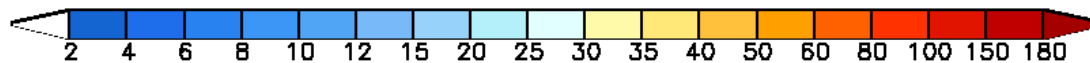
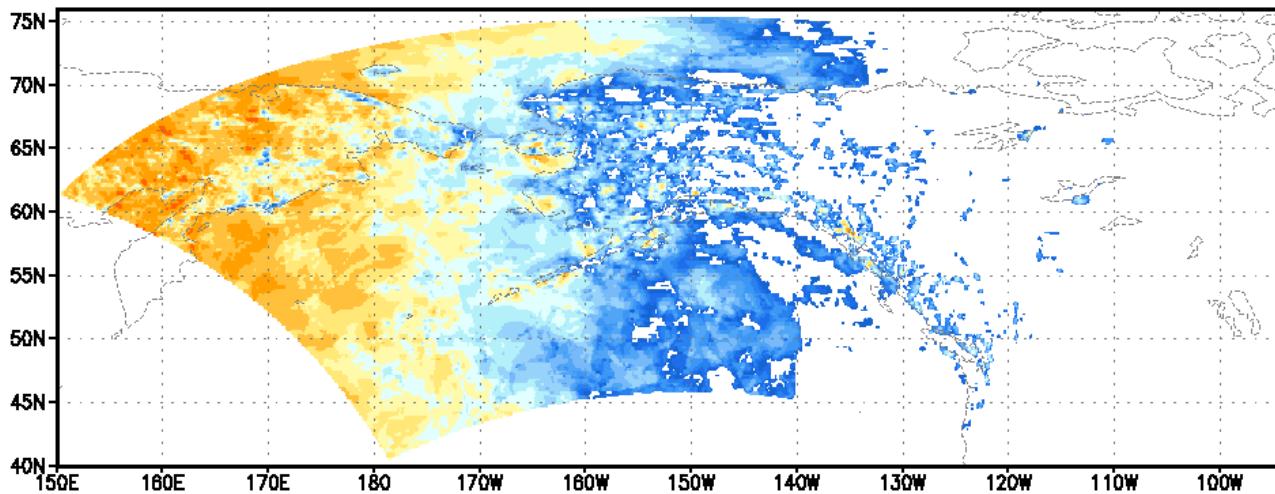
RTMA Alaska Region 10m Wind Speed
Averaged From 2009051800 to 2009073100



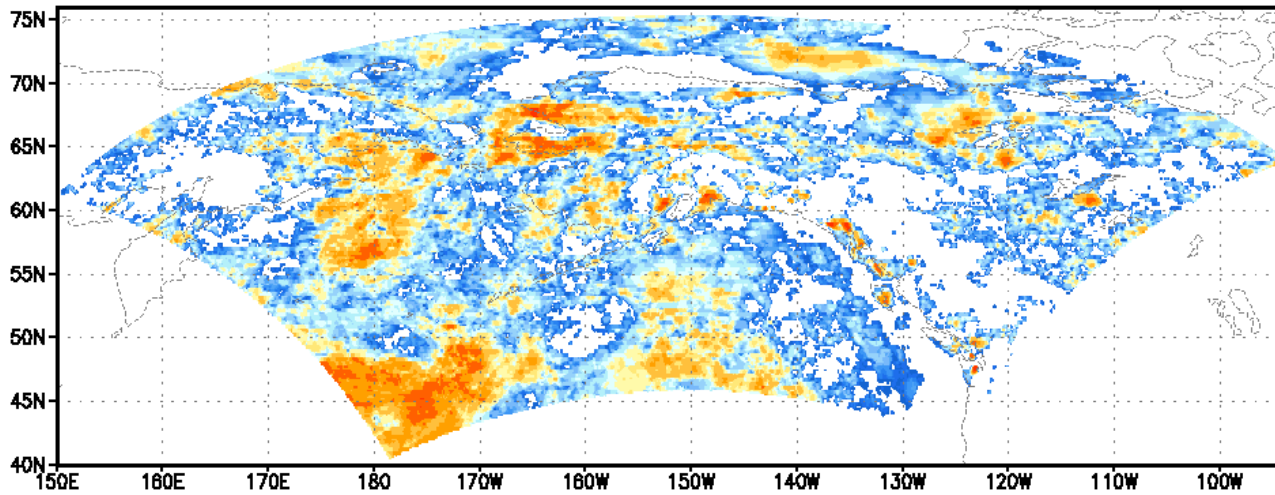
ALASKA GEFS Raw Ens. Mean Forecast Error w.r.t RTMA
Wind Direction (shaded, Degree)
Averaged From: 2009051800 to 2009073100 (36 h)



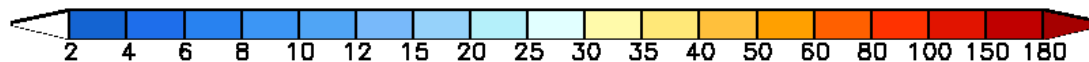
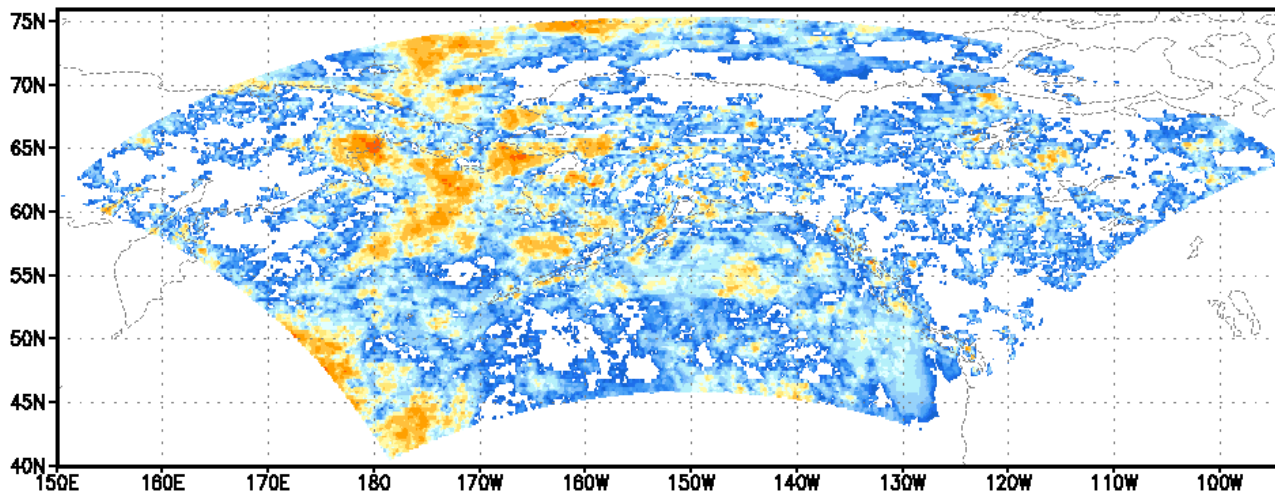
ALASKA GEFS Bias Corrected Downscaled Ens. Mean Forecast Error w.r.t RTMA
Wind Direction (shaded, Degree)
Averaged From: 2009051800 to 2009073100 (36 h)



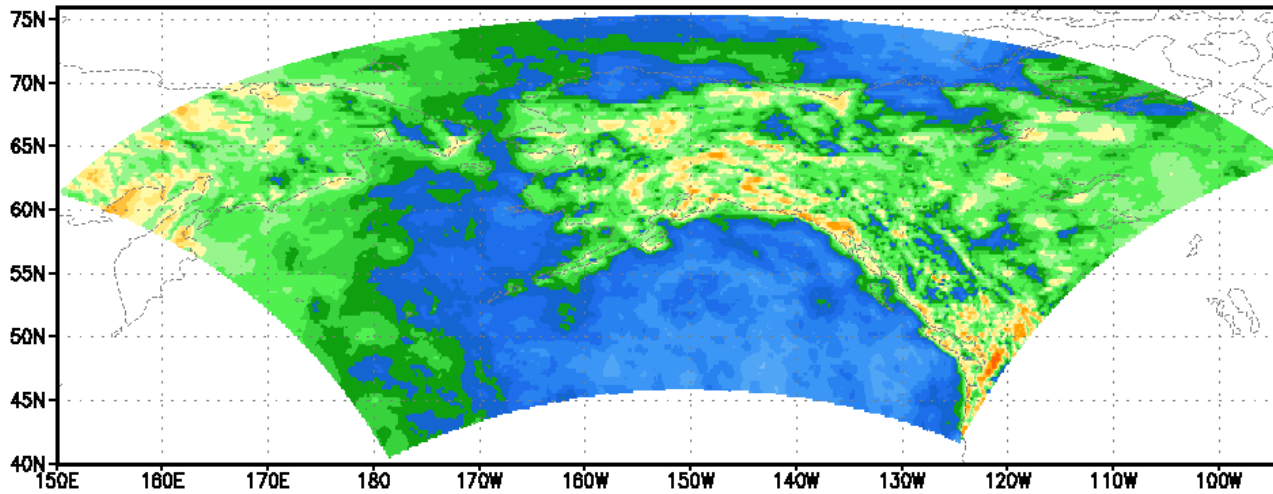
ALASKA GEFS Raw Ens. Mean Forecast Error w.r.t RTMA
Wind Direction (shaded, Degree)
Averaged From: 2009051800 to 2009073100 (360 h)



ALASKA GEFS Bias Corrected Downscaled Ens. Mean Forecast Error w.r.t RTMA
Wind Direction (shaded, Degree)
Averaged From: 2009051800 to 2009073100 (360 h)



**ALASKA GEFS Raw Ens. Mean Absolute Error w.r.t RTMA
Wind Direction (shaded, Degree)
Averaged From: 2009051800 to 2009073100 (36 h)**



**ALASKA GEFS Bias Corrected Downscaled Ens. Mean Absolute Error w.r.t RTMA
Wind Direction (shaded, Degree)
Averaged From: 2009051800 to 2009073100 (36 h)**

