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Analyses of Wind Gusts for the National Digital Guidance Database

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1. Introduction

The Localized Aviation MOS Program (LAMP; Ghirardelli and Glahn 2010) produces point forecasts for most of the weather variables contained in public and aviation forecasts, including 10-m sustained wind and gusts, for projections of 1 to 25 hours. The LAMP forecasts of sustained wind speed and u- and v-wind are produced by regression equations, in which the predictors in each station-specific equation are the same. Predictors come from the LAMP advective model, current observations, and Global Forecast System (GFS) MOS forecasts. Wind direction is computed from the two components. In order to increase the strong winds to near their observed frequency, the speed is "partially inflated" by subtracting the developmental sample mean, dividing the result by the multiple correlation coefficient (only) when the result is positive, and adding the mean back in.

LAMP forecasts are gridded to provide guidance for the grids produced at WFOs (Weather Forecast Office) that are inserted into the NDFD (National Digital Forecast Database). MDL uses the BCDG (Bergthorssen-Cressman-Doos-Glahn) method (Glahn et. al 2009; Glahn and Im 2011) for analysis of observations and LAMP forecasts. This successive correction method has had many modifications made to the original formulation proposed and used in the 1950's.

A gridded forecast is produced at each WFO that is a combination of wind speed and gusts—the maximum expected wind. When there is no gust forecast, the value is the sustained speed; when there is a gust forecast, the value is the gust. MDL has produced a gridded forecast that can be used as guidance for that specific product and will be putting it into the NDGD (National Digital Guidance Database).

The purpose of this presentation is to describe the gridding of the LAMP sustained wind and wind gust forecasts and also of observations over the NDFD area covering the conterminous United States.

2. Characteristics of the BCDG Analysis Scheme

For wind, six passes over the data are made, each producing an interim analysis. For each pass, each LAMP forecast has an effect on surrounding gridpoints within a radius of influence R. The total correction to a gridpoint on each pass is the average difference between the forecast and the current interim gridded value interpolated to the LAMP location, each difference weighted inversely by the distance between the station and the gridpoint and modified by a vertical change with elevation (VCE). The VCE is the difference between the 10-m forecast and the value interpolated from the GFS wind at the location of that point at the elevation of the gridpoint having the highest elevation to be affected by that station.

Radii of influence are specific to the data points. The radii for the first passes are computed so that each gridpoint will have sufficient stations correcting it. For the latter passes, the radii are based on the distances to the two closest stations to achieve detail. Ocean, land, and lakes are analyzed separately onto one grid.

3. Quality Control of Observations

The observations have been quality controlled when we access them from the NCEP "Buffer Tanks." We additionally quality control them by a two step process. First, on each analysis pass, we compute the difference between the observation and the value interpolated from the interim analysis. If the difference adjusted for elevation substantially exceeds a threshold (which varies by pass), then the observation is not used in that analysis pass, but can be used in subsequent passes. If the difference is close to the threshold, then the value in question is checked with its two closest neighbors. If at least one agrees, the report is used; if not, it is not used on this analysis pass. This process is the same as that used for temperature and dewpoint, which is explained in detail in Im and Glahn (2012).

4. Analysis of Observations

There are over 25,000 observing points that may report wind each hour. About 80% of these reports are from mesonets, which are many times of lower quality than those from the well sited and maintained METAR sites. For that reason, the weight given to the mesonet sites is about 21% of that given to METAR sites.

4. Analysis of Observations (Cont.)

With the ± 15-minute window of analysis time we use, only on the order of 10,000 of the sites may report at a particular hour. In order to maintain spatial continuity hour-to-hour, observations from the previous hour are also used for sites not reporting at analysis time. The receipt time for these observations can extend up until the run time, so many more reports are available, on the order of 12,000. The past observations are adjusted by the average change at surrounding stations reporting at both times. This accommodates the diurnal change that may have occurred.

MOS forecasts are used over water and Canada, adjusted to current observations. This produces more points to analyze, but most importantly begins continuity with LAMP analyses where MOS is used. Wind speed observations tossed are not used in the gust analysis.

5. Analysis of LAMP Forecasts

Observations are dense compared to LAMP forecasts (~1,500) and provide considerable detail. Much of this detail is real, and is carried into the LAMP analyses by augmenting the LAMP forecast points with observations, both on-time and 1-h old. An observation is adjusted by the average difference between surrounding LAMP forecasts and the observations at those same points. This adjustment compensates for diurnal and synoptic changes. The use of the observations is weighted by projection, being high (90%) at 1-hour and being low (10%) by projection 8. This adjustment cannot be made over water, because there are no LAMP points over water. Instead, the observations over water are adjusted by the MOS forecasts there. That gives detail that was present in the observations, and the trend is established by MOS. This weighting of observations by projection is in addition to the 21% weighting on mesonet observations.

There are no LAMP forecasts over water or Canada. MOS forecasts are used there, as well as at points over the U.S. Over land, the MOS forecasts are adjusted for the average difference between MOS and LAMP at surrounding stations. This adjustment cannot be made over water, because there are no LAMP water points and MOS is used unadjusted.

Because of the sparseness of data over the Great Lakes region, a few bogus points are inserted that are themselves a function of values at specific forecast points.

Observations tossed in analysis are not used in gridded LAMP analyses.

6. Postprocessing

Especially because of the spatial inhomogeneity of the data, the analysis needs to be smoothed. This is done over land with a special smoother that does not smooth the four gridpoints around a data point, but smoothes all other points, with more smoothing at larger distances from the closest station. This smoothing is also terrain dependent. After that, a two-gridlength, terrain-dependent smoother is applied.

Over the ocean, where the data are very sparse and of lesser quality, a smoother is used that smoothes over a circle of 50 gridlengths radius. Gridpoints are averaged by tracing a ray from each gridpoint in 16 points of the compass, but if land is encountered, the ray stops. This keeps winds over the ocean from materially affecting winds over bays, and vice versa.

After wind speed and wind gust analyses are completed, the gust analysis is checked gridpoint by gridpoint with the speed analysis, and the gust gridpoints are set to the maximum of the wind and gust analysis.

References

Ghirardelli, J. E., and B. Glahn, 2010: The Meteorological Development Laboratory's aviation weather prediction system. *Wea. Forecasting*, 25, 1027-1051.

Glahn, B., and J.-S. Im, 2011: Algorithms for effective objective analysis of surface weather variables, Preprints, *24th Conf. on Weather and Forecasting*, Seattle, WA, Amer. Meteor. Soc., 10A.4.

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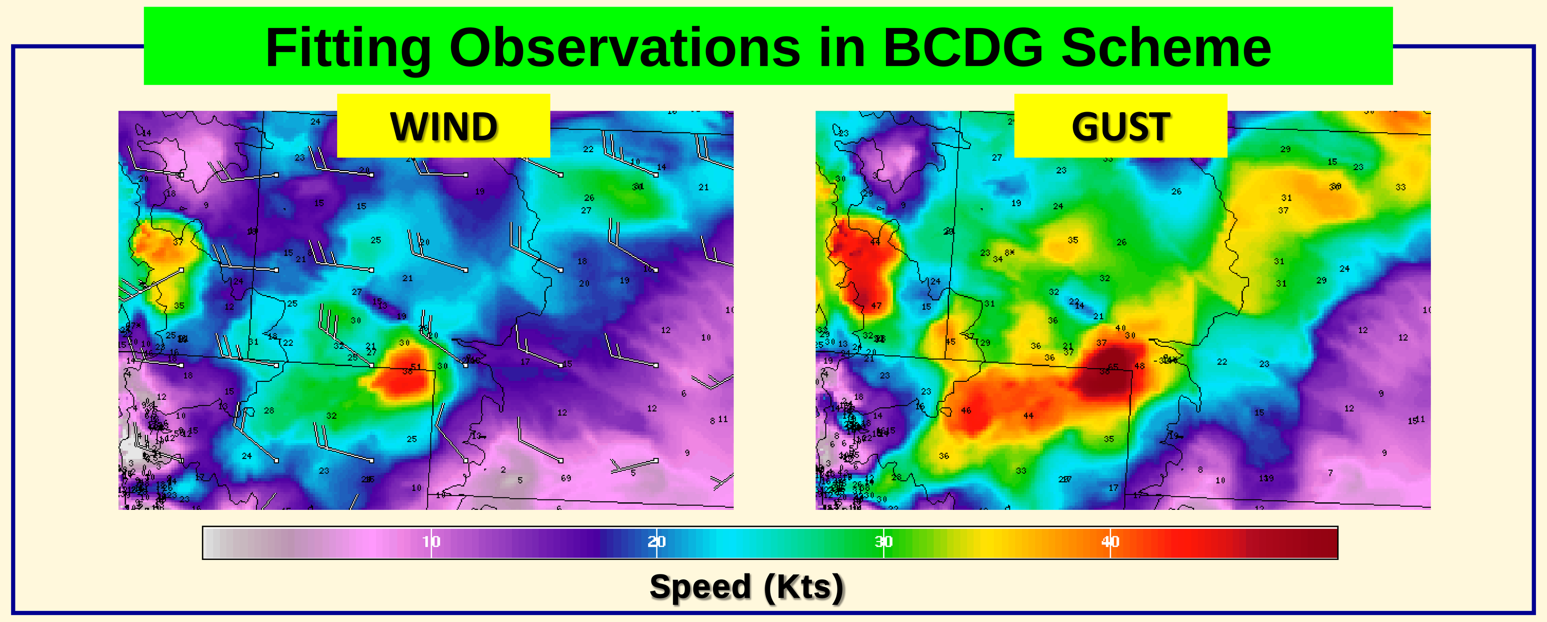
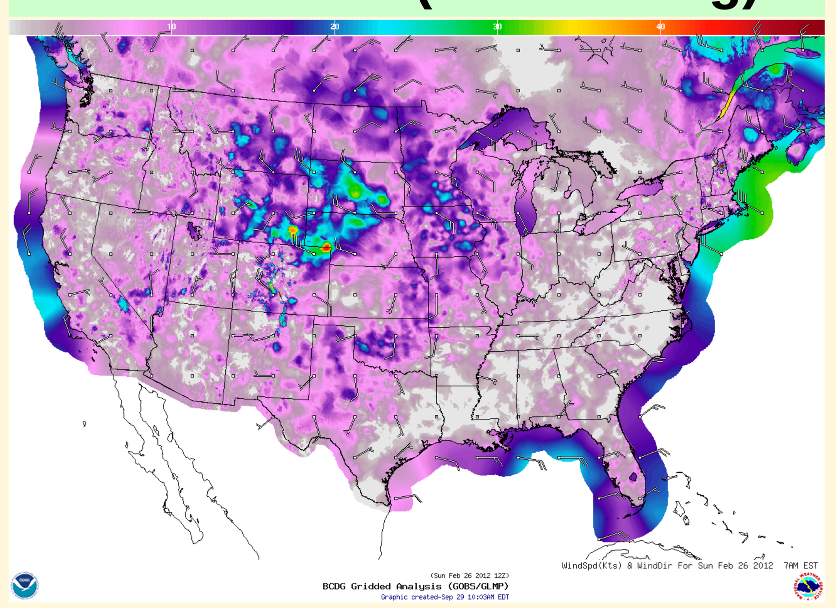
Im, J.-S., and B. Glahn, 2012: Objective analysis of hourly 2-m temperature and dewpoint observations at the Meteorological Development Laboratory. *Natl. Wea. Dig.*, 36(2), 103-114.

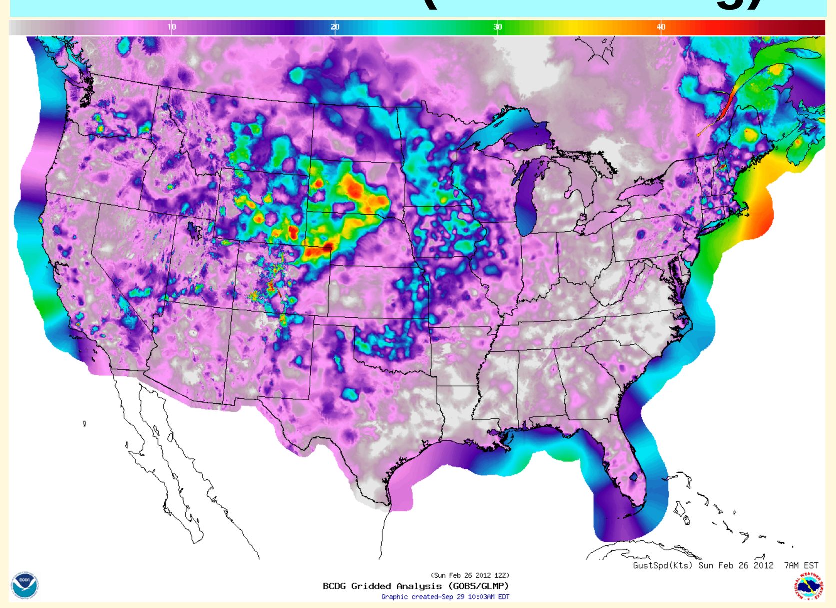
7. Results



GOBS WIND (Nowcasting)



GOBS GUST (Nowcasting)



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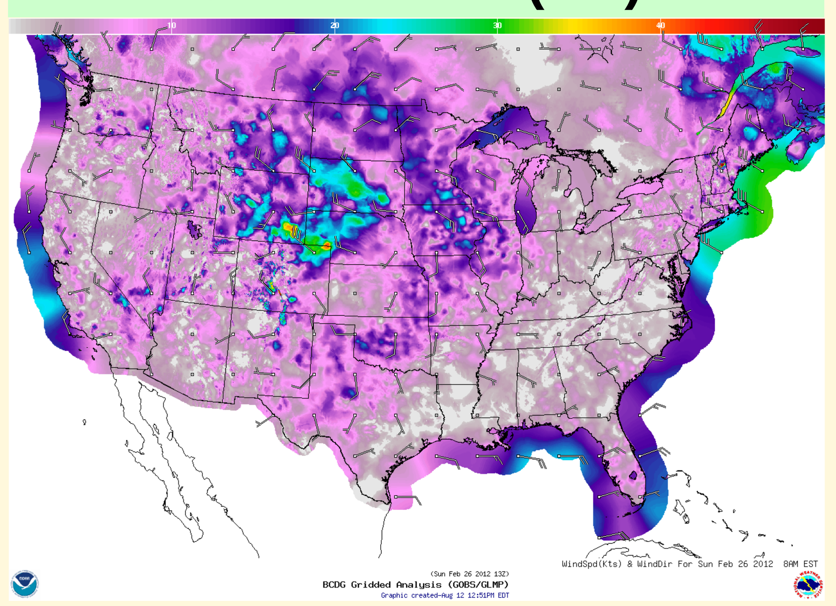
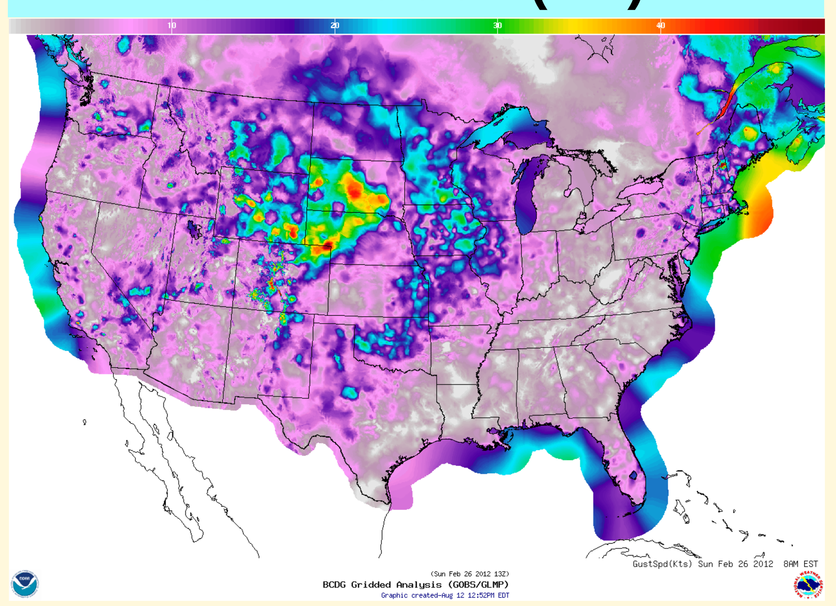


GLMP GUST (1 h)



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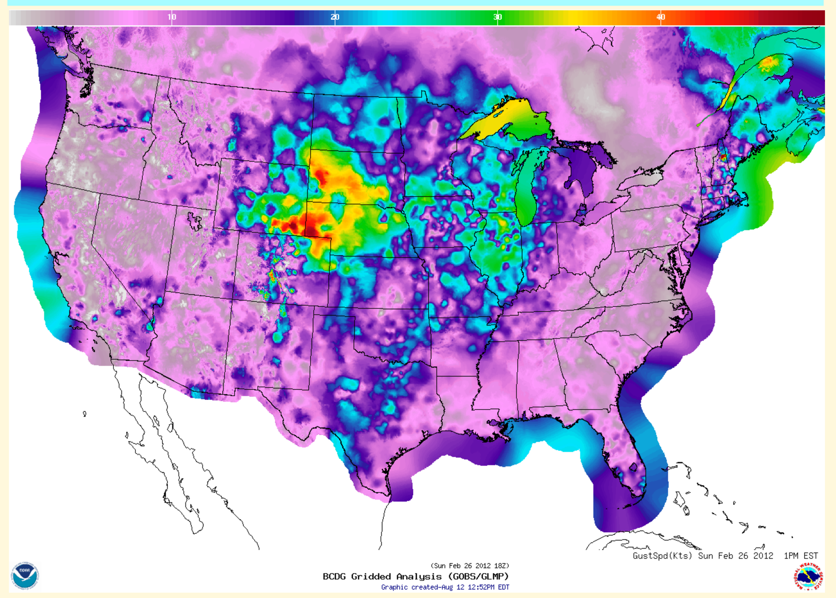
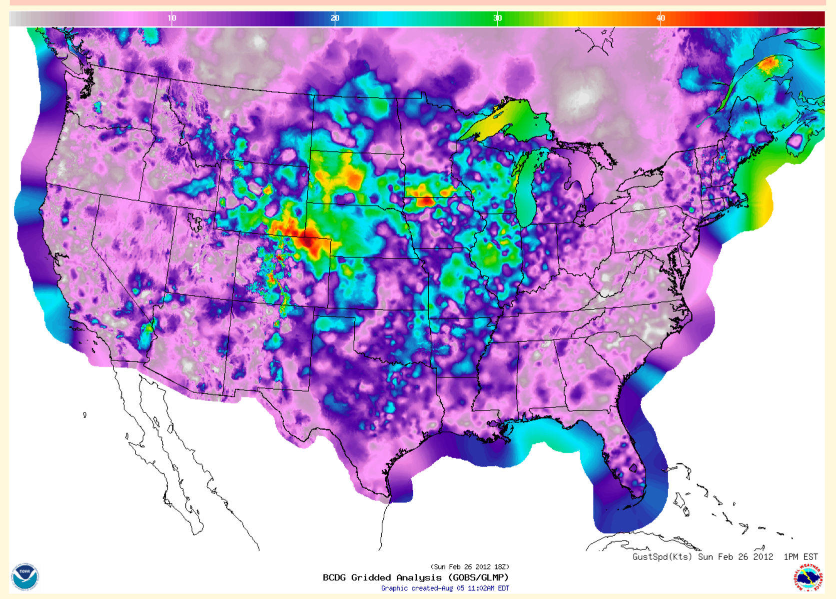


GOBS GUST (Verification for 6h)



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