# Section 2: New ensemble forecasts
From hybrid GFS and GEFS bias corrected forecasts

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EMC has experimentally summary by combined GFS bias corrected forecast and GEFS bias corrected forecast for the forecast lead-time up to 180 hours. The description of the method is as following:

1). GFS bias corrected forecast: Please see documentation Section 1.
2). GEFS bias corrected forecast: Implemented by May 30 2006.
3). Hybrid GFS and GEFS bias corrected forecasts:
   a). Why do we need hybrid? Because GFS performances consistently better than lower resolution (ensemble control at T126L28 resolution) forecast for short lead-time, the example from one-year statistics shows the GFS takes the advantage up to 120 hours (see figure below and reference from Zhu, 2005):
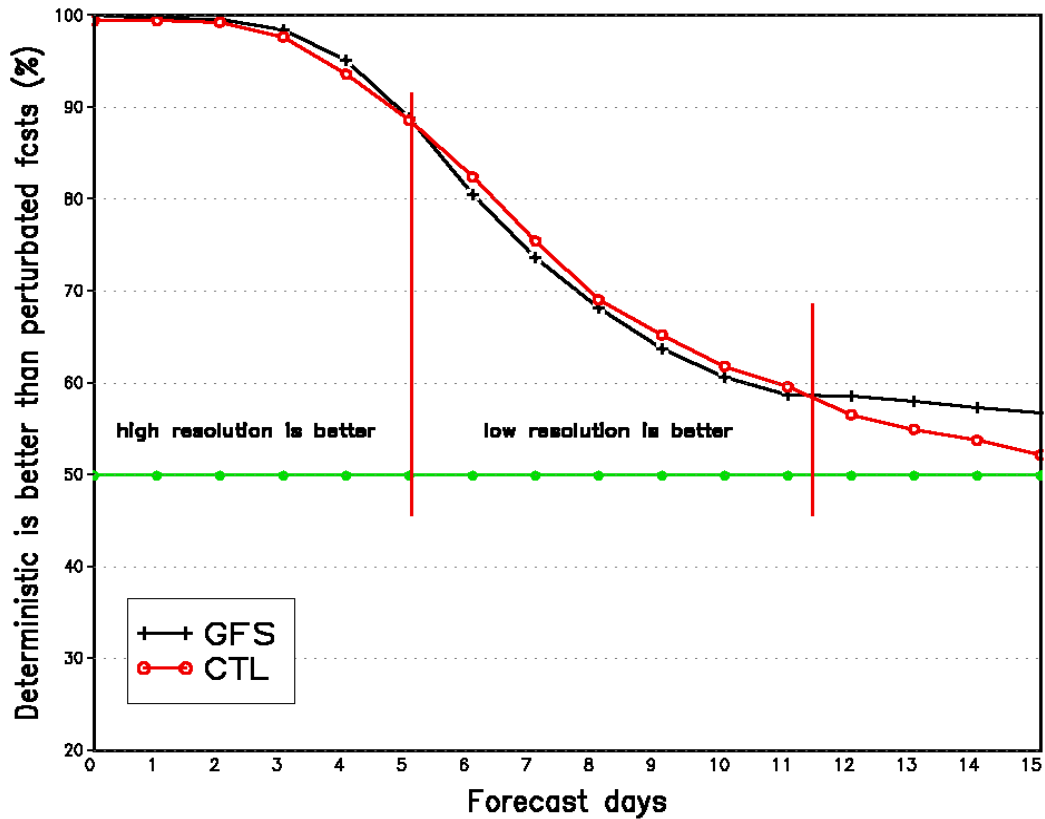
b). In order to combine GFS bias corrected forecasts and GEFS bias corrected forecasts for the first 180 hours, a cosine weighting function has been used to weight GFS and ensemble control (CTL at T126L28 resolution), to have highest weights for GFS at short lead time, to have it smoother or continues to ensemble forecast when the lead-time close to 180 hours. Here is the formula for each ensemble forecast:

$$f_i^*(t) = f_{gfs}(t) \cdot w_{gfs}(t) + f_{ctl}(t)w_{ctl}(t) + (f_i(t) - f_{ctl}(t)) \qquad (i=1,2,\ldots n)$$

Where

$$w_{gfs}(t) = \frac{\cos(t)+1}{2} \quad \text{and} \quad w_{ctl}(t) = 1 - w_{gfs}(t) \quad (t \text{ represents forecast hours from 0 to 180 })$$

And figure shows weighting function with lead time.
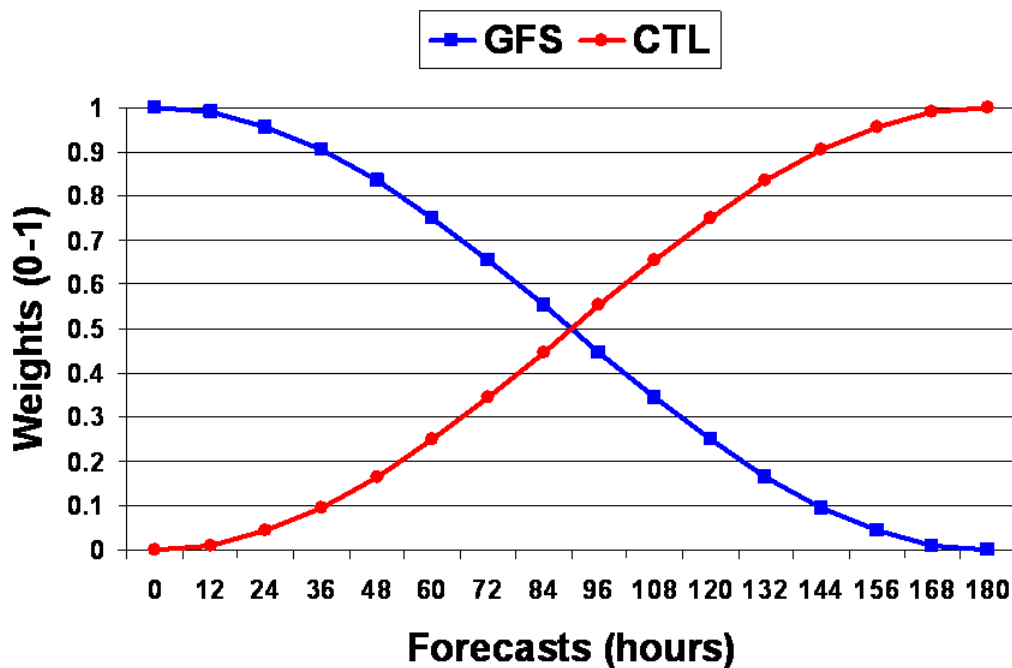
4). Performance: The performance is estimated by applying above method for both raw and bias corrected forecast from GFS, ensemble control and ensembles. The improvement depends on the variables. For example, there is significant improvement for Northern Hemisphere 2-meter temperature by applying this method (top figure below). E14s is for raw forecast skill, E14hb is for hybrid forecast skill, and E14sb is for bias corrected forecast during 3 month period. Bottom figure shows one month statistics while comparing E14s, E14sb with E14hbbc which is hybrid bias corrected GFS and ensembles.

Northern Hemisphere 2 Meter Temp.
ROC area (0-1)
Average For 20070301 - 20070510
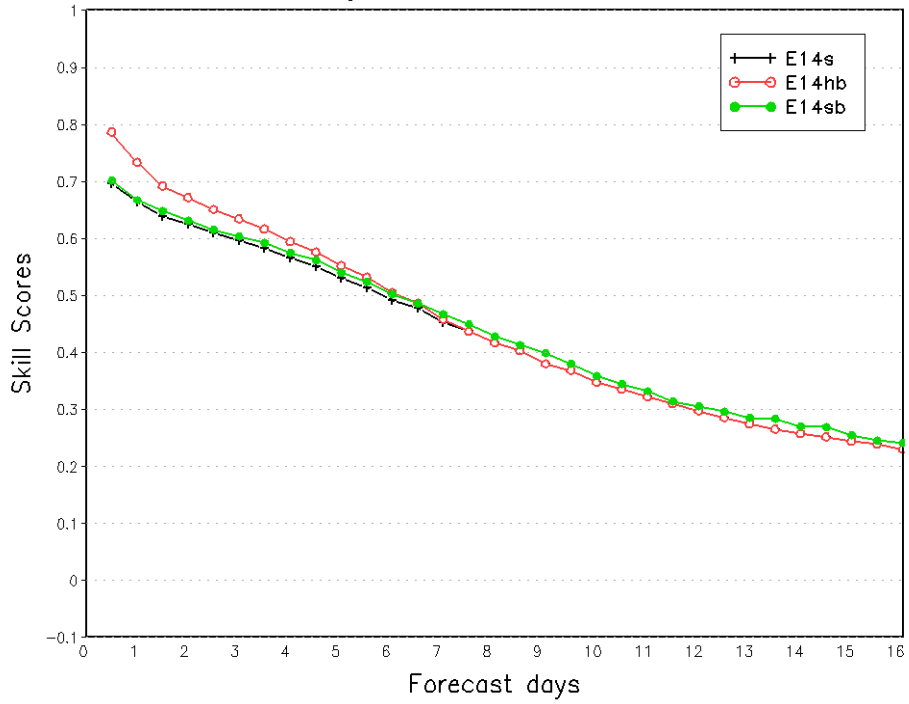
Northern Hemisphere 2 Meter Temp.
ROC area (0-1)
Average For 20070513 - 20070615