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**MEETING OF THE CBS (DPFS) EXPERT TEAM  
ON OPERATIONAL WEATHER AND  
FORECASTING PROCESS AND SUPPORT**

Agenda item: 5.1

MONTREAL, CANADA  
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ENGLISH ONLY

## **NCEP Global Ensemble Forecast System**

*(Submitted by Yuejian Zhu)*

### **Summary and purpose of document**

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This document provides updates for NCEP Global Ensemble Forecast System (GEFS), post products, data access for the public, future plans, and related applications.

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### **Action Proposed**

The meeting is invited to note the information in the document.

**Annex:** Table 2.1: The changes of NCEP Global Ensemble Forecast System (GEFS)

## **THE NCEP GLOBAL ENSEMBLE FORECAST SYSTEM (GEFS)**

### **2.0 Introduction**

NCEP's Global Ensemble Forecast System (GEFS) has been in operation since December 1992, using the NCEP Global Forecast System (GFS) model for integration and Breeding Vector (BV) technique to generate perturbations in the initial conditions. After the Aug. 25, 2005 implementation, GEFS runs four times per day (0000, 0600, 1200 and 1800 UTC) out to 16 days. At each time, 10 (5 pairs) perturbed members are initialized using BV method, cycling every 6 hours. If tropical cyclones are present in the initial conditions, a tropical storm relocation (TSR) technique is applied to each ensemble member to adjust the initial central location to the observed location (see: Liu and et al., 2006). An extended BV method with Ensemble Transform and Rescaling (BV-ETR; Wei and et al., 2008) was implemented operationally in 2006. In early 2010, GEFS included model uncertainty using the Stochastic Total Tendency Perturbation (STTP) algorithm (see: Hou and et al., 2012). Starting in December 2015, GEFS initial condition perturbations are selected from the operational hybrid Global Data Assimilation System (GDAS) 80-member Ensemble Kalman Filter (EnKF; Whitaker and et al., 2008) 6-h forecast and include tropical storm relocation and centralization of the initial perturbations (see: Zhou and et al., 2016).

### **2.2 Recent Changes in Configuration (Feb. 2012 and Dec. 2015)**

User can refer to NCEP Global Ensemble Forecast system implementation log for details:

[http://www.emc.ncep.noaa.gov/gmb/ens/ens\\_imp\\_news.html](http://www.emc.ncep.noaa.gov/gmb/ens/ens_imp_news.html)

#### **2.2.1 Horizontal and Vertical Resolutions:**

In the Dec. 2015 implementation, the horizontal resolution has increased to T<sub>L</sub>574 (about 34km on equator) for 0-192 hours and T<sub>L</sub>372 (about 55km) for 192-384 hours. The vertical resolution has also increased from 42 to 64 hybrid levels for all forecast hours.

#### **2.2.2 Membership:**

The number of perturbed members remains unchanged (20 members + ensemble control) for all four forecast cycles.

#### **2.2.3 Generation of the Initial Perturbations:**

Initial perturbations are generated from the EnKF component of GDAS. GEFS uses the 6-h 80-member ensemble forecast instead of the EnKF analysis due to timing constraints within the NCEP production suite (Zhou and et al., 2016).

#### **2.2.4 Representation of Model Related Uncertainty:**

In Feb. 2010, a Stochastic Total Tendency Perturbation scheme was implemented to represent uncertainties associated with the forecast model. STTP is based on the hypothesis that tendencies of the ensemble perturbations provide a representative sample of the random total model errors (see: Hou and et al. 2012). In the latest Dec. 2015 upgrade, an additional tuning process is applied for lower latitudes (tropical area) and no perturbation is applied for tropical surface pressure (Zhou and et al., 2016).

**Table 2.1: The changes of NCEP Global Ensemble Forecast System (GEFS)**

Version	Date	Initial Uncertainty	TS Relocation	Model Uncertainty	Resolution	Forecast length	Ensemble members	Daily Frequency
V1.0	1992.12	Breeding Vector (BV)	None	None	T62L18	12	2+	00UTC
V2.0	1994.3				T62L18	16	10+1(00UTC) 4+1(12UTC)	00,12UTC
V3.0	2000.6				T126L28 (0-2.5) T62L28 (2.5-16)			
V4.0	2001.1				T126 (0-3.5) T62L28 (3.5-16)			
V5.0	2004.3				T126L28 (0-7.5) T62L28 (7.5-16)	10+1	00,06,12, 18UTC	
V6.0	2005.8							
V7.0	2006.5	T126L28	14+1					
V8.0	2007.3	BV + Ensemble Transform with Rescaling (BV- ETR)	Tropical Storm Relocation (TSR)	Stochastic Total Tendency Perturbation (STTP)	T190L28	20+1		
V9.0	2010.2				T254L42 (0-8) T190L42 (8-16)			
V10.0	2012.2							
V11.0	2015.12				TL574L64 (0-8) TL382L64 (8-16)			
		EnKF (f06)						

## 2.3 Post Processing Products

### 2.3.1 Global products at 1x1 degree resolution:

A set of probabilistic forecasts of 10%, 50%, 90%, ensemble mean, mode and spread have been generated daily for 50 bias corrected variables.

### 2.3.2 CONUS products at 2.5x2.5km resolution

A set of probabilistic forecast of 10%, 50%, 90%, ensemble mean, mode and spread have been generated daily for 10 surface variables.

### 2.3.3 Alaska Region products at 3x3km resolution

A set of probabilistic forecast of 10%, 50%, 90%, ensemble mean, mode and spread have been generated daily for 10 surface variables.

### 2.3.4 Products Access

All NCEP ensemble,, CMC global ensemble, FNMOC global ensemble, and North American Ensemble Forecasting System (NAEFS) ensemble products can be accessed publically through:

NCEP ftp - <ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/gens/prod/>

and

NCEP NOMADS - <http://nomads.ncep.noaa.gov/>

## 2.4 GEFS Future Plan

NCEP GEFS will be upgraded in 2018 to a new GFS model version that includes upgraded model physics.

### 2.4.1 Horizontal and Vertical Resolutions:

The horizontal resolution will most likely increase to 34km (TL574) for the full day 0-16 forecast and retain its current 64 hybrid vertical levels.

#### **2.4.2 Membership:**

The number of perturbed members will most likely double from 20 to 40 perturbed members with an ensemble control forecast for all four forecast cycles.

#### **2.4.3 Generation of the Initial Perturbations:**

The initial perturbations will continue to be directly generated from the EnKF component of GDAS with tropical storm relocation and centralization of the initial perturbations.

#### **2.4.4 Representation of Model Related Uncertainty:**

GEFS will plan to replace STTP with the Stochastic Kinetic Energy Backscatter Scheme (SKEBS; Shutts 2005), Stochastically Perturbed Parameterization Tendencies (SPPT; Palmer et al. 2009), and Stochastic Humidity Perturbation (SHUM) to represent model uncertainty.

#### **2.4.5 Week 3&4 forecast:**

GEFS is planning to extend the forecast out to 35 days to cover the sub-seasonal forecast period.

### **2.5 Ensemble User Workshop:**

#### **2.5.1 Summary**

The NCEP ensemble users workshop is scheduled for every other year. The 6<sup>th</sup> NCEP ensemble users workshop was held in College Park, Maryland in March 2014. The 7<sup>th</sup> NCEP ensemble users workshop is scheduled in College Park, Maryland from June 13-15 2016. The workshop covers all ensemble systems including global, regional, storm-scale, climate and ocean-wave. The presentations and discussions focus on the system configurations, models, post-processing, probabilistic products, product distribution, user feedback, verifications and international collaborations.

#### **2.5.2 Training**

There was a half-day ensemble training session during the last ensemble users workshop led by the NUOPC (National Unified Operational Prediction Capability) project office. The leading presenters were from the NWS, US Navy and Air Force, and UCAR/COMET.

#### **2.5.3 Participants**

About 100 scientists attended last ensemble users workshop. The participants were from model developmental centers, NCEP service centers, NWS regions (and WFO), NWS OHD and OST, NOAA OAR, Navy and Air Force, the research community and private sectors, and international centers (MSC, ECMWF, CMA, etc.).

#### **2.5.4 Information Access**

All presentations (with discussions) were posted on the web-site for public access:

[http://www.emc.ncep.noaa.gov/gmb/ens/WkShopOct13/6th\\_User\\_workshop.shtml](http://www.emc.ncep.noaa.gov/gmb/ens/WkShopOct13/6th_User_workshop.shtml)

### **2.6 Reference(s) for GEFS, NAEFS and post process:**

Cui, B., Z. Toth, Y. Zhu and D. Hou, 2012: Bias Correction For Global Ensemble Forecast, *Weather and Forecasting*, Vol. 27 396-410

Cui, B., Y. Zhu, Z. Toth and D. Hou, 2016: Development of Statistical Post-processor for NAEFS Submitted to *Weather and Forecasting* (in process)

Guan, H., B. Cui, Y. Zhu, 2015: Improvement of Statistical Postprocessing Using GEFS Reforecast Information, *Weather and Forecasting*, Vol. 30, 841-854

Hou, D., Z. Toth, Y. Zhu, W. Yang and R. Wobus, 2012: "A Stochastic Total Tendency Perturbation Scheme Representing Model- Related Uncertainties in the NCEP Global Ensemble Forecast System" Submitted to *Tellus-A*

Hou, D., M. Charles, Y. Luo, Z. Toth, Y. Zhu, R. Krzysztofowicz, Y. Lin, P. Xie, D-J. Seo, M. Pena and B. Cui, 2012: Climatology-Calibrated Precipitation Analysis at Fine Scales: Statistical

- Adjustment of STAGE IV towards CPC Gauge-Based Analysis, *Journal of Hydrometeorology* Vol. 15 2542-2557
- Liu, Q., S. J. Lord, N. Surgi, Y. Zhu, R. Wobus, Z. Toth and T. Marchok, 2006: Hurricane Relocation in Global Ensemble Forecast System, Preprints, 27th Conf. on Hurricanes and Tropical Meteorology, Monterey, CA, Amer. Meteor. Soc., P5.13.
- Ma, J., Y. Zhu, D. Wobus and P. Wang, 2012: An Effective Configuration of Ensemble Size and Horizontal Resolution for the NCEP GEFS, *Advance in Atmospheric Sciences*, Vol. 29, No. 4, 782-794
- Ma, J., Y. Zhu, D. Hou, X. Zhou and M. Pena, 2014: Ensemble Transform with 3D Rescaling Initialization Method, *Monthly Weather Review*, Vol. 142, 4053-4073
- Palmer, T. N., R. Buizza, F. Doblas-Reyes, T. Jung, M. Leutbecher, G. Shutts, M. Steinheimer, and A. Weisheimer, 2009: Stochastic Parametrization and Model Uncertainty. ECMWF Tech. Memo. 598, 44.
- Shutts, G., 2005: A kinetic energy backscatter algorithm for use in ensemble prediction systems. *Quart. J. Roy. Meteor. Soc.*, 131, 3079–3102.
- Toth, Z., and E. Kalnay, 1997: Ensemble forecasting at NCEP and the breeding method. *Mon. Wea. Rev.*, 125, 3297–3319.
- Wei, M., Z. Toth, R. Wobus, and Y. Zhu, 2008: Initial Perturbations Based on the Ensemble Transform (ET) Technique in the NCEP Global Operational Forecast System, *Tellus* 59A, 62-79
- Whitaker, Jeffrey S., Thomas M. Hamill, Xue Wei, Yucheng Song, Zoltan Toth, 2008: Ensemble Data Assimilation with the NCEP Global Forecast System. *Mon. Wea. Rev.*, 136, 463–482.
- Zhou, X., Y. Zhu, D. Hou, Y. Luo, J. Peng and R. Wobus, 2016: The NCEP Global Ensemble Forecast System with the EnKF Initialization. Submitted to MWR
- Zhu Y., and Y. Luo, 2014: Precipitation Calibration Based on Frequency Matching Method (FMM), *Weather and Forecasting*, Vol. 30, 1109-1124