NAEFS upgrade (v6)

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Environmental Modeling Center
NCEP/NWS/NOAA
August 22/23 2016

Scopes (NAEFSv6.0)

- Add new bias corrected NAEFS/GEFS 0.5*0.5 degree products
  - **Needs full coordination with EMC, NCO and CMC for data exchange**
  - **GEFS 0.5d data structure for public access will be modified (TIN)**

- New multi-model products
  - Using RBMP to process three bias corrected ensembles UNOPC (NCEP+CMC (NAEFS) + **FNMOC**) at 1*1 degree resolution globally
    - **FNMOC 0.5*0.5 degree data is not available (consider later)**
  - Various new methodologies (include reforecast) have been applied to improve NAEFS/NUOPC bias correction, 2nd moment adjustment, downscaling products.

- Add precipitation products - bias correction and downscaling

- Add RMOP products for WPC/CPC and users (add EFI and ANF images as well)

New Products From NAEFS v6 Upgrade

- NCEP/GEFS (4 cycles/per day)
  - 0.5d bias corrected forecasts (3 hourly for day 8, new pgrb2ap5_bc)
  - 0.5d anomaly forecast (new pgrb2ap5_an)
  - 0.5d bias corrected prcp (prcp_gb2)
  - 2.5km bias corrected and downscaled prcp for CONUS (new ndgd_prcp_gb2)
  - 0.5d RMOP, ANF and EFI(data and images?)
- CMC (2 cycles/per day)
  - 0.5d raw GEFS forecast (/dcom)
  - 0.5d bias corrected forecast (/dcom)
- NAEFS (2 cycles/per day)
  - 0.5d probabilistic forecasts (new pgrb2ap5_bc)
  - 0.5d anomaly forecast (new pgrb2ap5_an)

New Products From NAEFS v6 Upgrade

- NCEP/GEFS (4 cycles/per day) – reference (EnKF puts to ftp: 120GB per cycle)
  - 0.5d bias corrected forecasts (3 hourly for day 8, new pgrb2ap5_bc) – **70GB (day)**
  - 0.5d anomaly forecast (new pgrb2ap5_an) - **2GB (day)**
  - 0.5d bias corrected prcp (prcp_gb2)
  - 2.5km bias corrected and downscaled prcp for CONUS (new ndgd_prcp_gb2)
  - 0.5d RMOP, ANF and EFI(data and images?)
- CMC (2 cycles/per day)
  - 0.5d raw GEFS forecast (/dcom) – **52GB (day)**
  - 0.5d bias corrected forecast (/dcom) - **33GB (day)**
- NAEFS (2 cycles/per day)
  - 0.5d probabilistic forecasts (new pgrb2ap5_bc) – **10GB (day)**
  - 0.5d anomaly forecast (new pgrb2ap5_an) – **1.0 GB (day)**
- Fix files for calibration (daily climatology of bias)
  - 1.0d resolution, 54 variables, 96 lead-time, 4 times per day
  - File size of one day – 1.152GB
  - Files size for one year – **420GB**

Scope #1: NAEFS main products at 0.5d globally

NAEFS Global Grid Exchange Variables for 1.0d

Update: June 2013

Variables	Levels and Categories	Total 80
GHT	Surface, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 hPa	11
TMP	2m, 2mMax, 2mMin, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 hPa	13
RH	2m, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 hPa	11
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
PRES	Surface, PRMSL	2
PRCP	APCP, CRAIN, CSNOW, CFRZR, CICEP	5
FLUX (surface)	LHTFL, SHTFL, DSWRF, DLWRF, USWRF, ULWRF	6
FLUX (top)	ULWRF (OLR)	1
PWAT	Total precipitable water at atmospheric column	1
TCDC	Total cloud cover at atmospheric column	1
CAPE	Convective available potential energy, Convective Inhibition	2
SOIL/SNOW	SOILW(0-10cm) , TMP(0-10cm down), WEASD(water equiv. of accum. Snow depth), SNOD(surface)	4
Other	850 hPa vertical velocity	1
Notes	Current NAEFS grids at 1*1 degree	

NAEFS Global Grid Exchange Variables for 0.5d

Update: August 8 2016

Variables	Levels and Categories	Total 86/43
GHT	Surface, 10, 50, 100, 200, 250, 300, 500, 700, 850, 925, 1000 hPa	12/(5)
TMP	2m, 2mMax, 2mMin, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 hPa	13/(6)
RH	2m, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 hPa	11/(4)
UGRD	10m, 10, 50, 100, 200, 250, 300, 400, 500, 700, 850, 925, 1000 hPa	13/(8)
VGRD	10m, 10, 50, 100, 200, 250, 300, 400, 500, 700, 850, 925, 1000 hPa	13/(8)
PRES	Surface, PRMSL	2/(2)
PRCP	APCP, CRAIN, CSNOW, CFRZR, CICEP	5/(5)
FLUX (surface)	LHTFL, SHTFL, DSWRF, DLWRF, USWRF, ULWRF	6/(0)
FLUX (top)	ULWRF (OLR)	1/(0)
PWAT	Total precipitable water at atmospheric column	1/(1)
TCDC	Total cloud cover at atmospheric column	1/(1)
CAPE	Convective available potential energy, Convective Inhibition	2/(2)
SOIL/SNOW	SOILW(0-10cm) , TMP(0-10cm down), WEASD(water equiv. of accum. Snow depth), SNOD(surface)	4/(0)
Other	850 hPa vertical velocity, Ice thickness (ICETK)	2/(1)
Notes	Current NAEFS grids at 1*1 degree New 0.5 degree fields already exchanged at 1 degree New 0.5 degree added from users request	

File Size Estimates, GB

Option #	1.0 days	1.0@3 days	0.5 days	0.5@3 days	1.0 size	0.5 size	Total size
0	16				5.6	0	5.6
1	16		8	5	5.6	7.2	12.8
2	16		8	8	5.6	8.8	14.4
3	16	5	8	5	7.2	7.2	14.4
4	16	8	8	8	8.3	8.8	17.1
5	16		10	5	5.6	8.3	13.9
6	16		10	10	5.6	11.0	16.6
7			16	5		22.5	22.5
8			**16**	**8**		**25.6**	**25.6**
9			16	10		27.7	27.7

Option #8 is proposed for implementation in 2017 (discussed at task team #1)

0.5 degree NAEFS data exchange to NCEP implementation (agenda)

Date	Activity	NCEP	CMC	Note
7/21/2016	Initiated discussion with NCO	Yes		
8/15/2016	Request NCO to archive GEFS 0.5d to 2-y run-history	prod		Approved: 7/25/2016
8/15/2016*[1]	Deliver codes (1st) to NCO for re-organizing pgrb2ap5 and pgrb2bp5	EMC		NCO needs to start set up NAEFS test mode
9/15/2016 (?)	Start to exchange raw data	NCO dev	Y	CMC approved
10/1/2016	Deliver codes (2nd) to NCO for generating bias corrected data	EMC		
11/1/2016	Start to exchange bias corrected data	NCO dev	Y	CMC approved
12/10/2016	EMC/NCO CCB	Yes		Pending on approving
12/15/2016	Deliver codes (final) to NCO for implementation	EMC		
1/10/2017	Issue TIN	NCO		
1/15/2017	Real-time parallel (evaluation)	NCO		
2/25/2017	Briefing to NCEP director	NCO/EMC		
3/4/2017	Implementation	NCO		

*[1]: delayed due to upstream master files availability, need extra GEFS upgrade (updated on 08/17/2016)

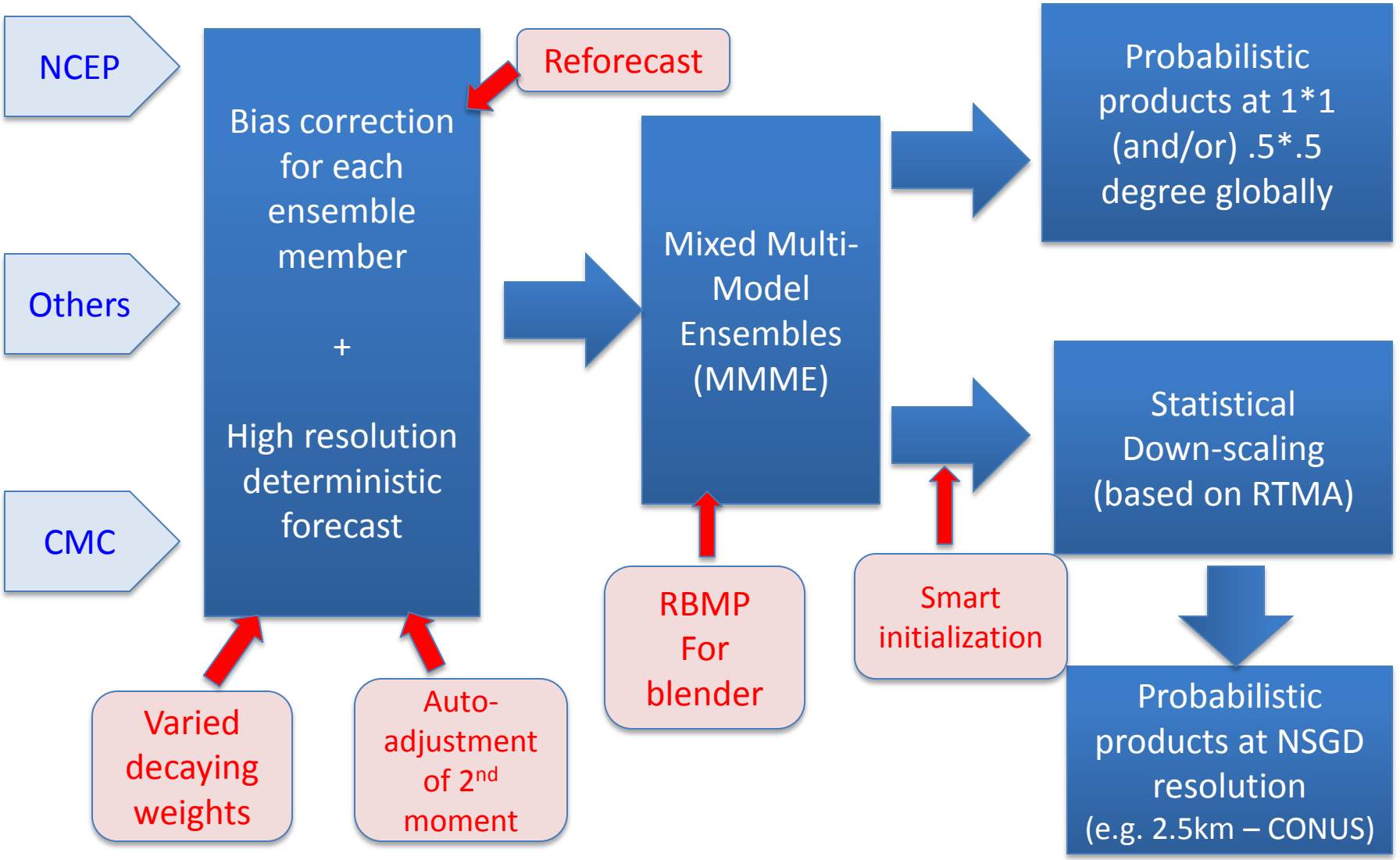
NAEFS bias corrected variables

Last upgrade: March 29 2016 - (bias correction)

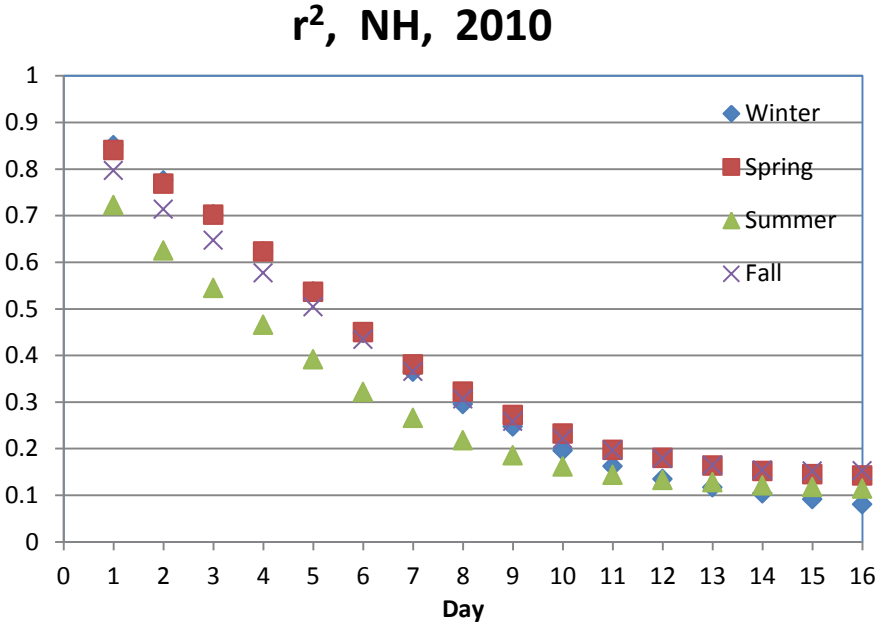
Variables	pgrba_bc file	Total 52
GHT	10, 50, 100, 200, 250, 500, 700, 850, 925, 1000hPa	10
TMP	2m, 2mMax, 2mMin, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000hPa	13
UGRD	10m, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000hPa	11
VGRD	10m, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000hPa	11
VVEL	850hPa	1
PRES	Surface, PRMSL	2
FLUX (top)	ULWRF (toa - OLR)	1
Td and RH	2m (April 8 2014)	2
TCDC	Total cloud cover (March 29 2016)	1
Notes	CMC do not apply last two upgrades yet FNMOC do not apply last upgrade yet	

Scope #2: Improving NAEFS SPP at 0.5d globally

Improving NAEFS Statistical Post-Processing System



Using reforecast to improve current bias corrected product



r could be estimated by linear regression from joint samples, the joint sample mean could be generated from decaying average (*Kalman Filter* average) for easy forward.

Bias corrected forecast: The new (or bias corrected) forecast (***F)*** will be generated by applying decaying average bias (***B***) and reforecast bias (***b***) to current raw forecast (***f***) for each lead time, at each grid point, and each parameter.

$$F_{i,j}^{m} = f_{i,j}^{m} + (r_{i,j}^{2} - 1) \cdot b_{i,j} - r_{i,j}^{2} B_{i,j}$$

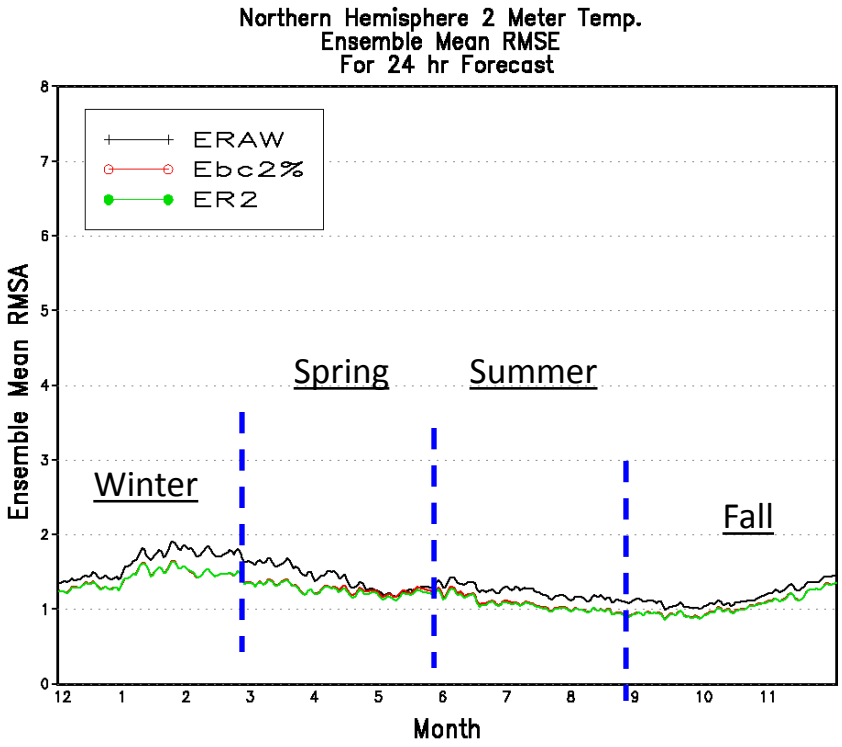
bias corrected forecast

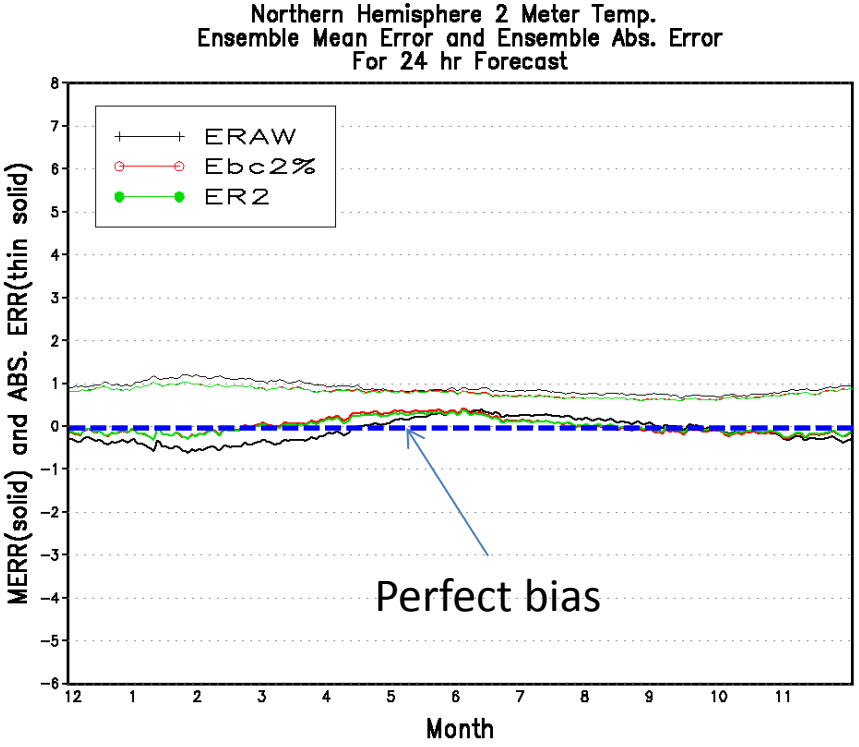
raw forecast

reforecast bias

decaying average bias

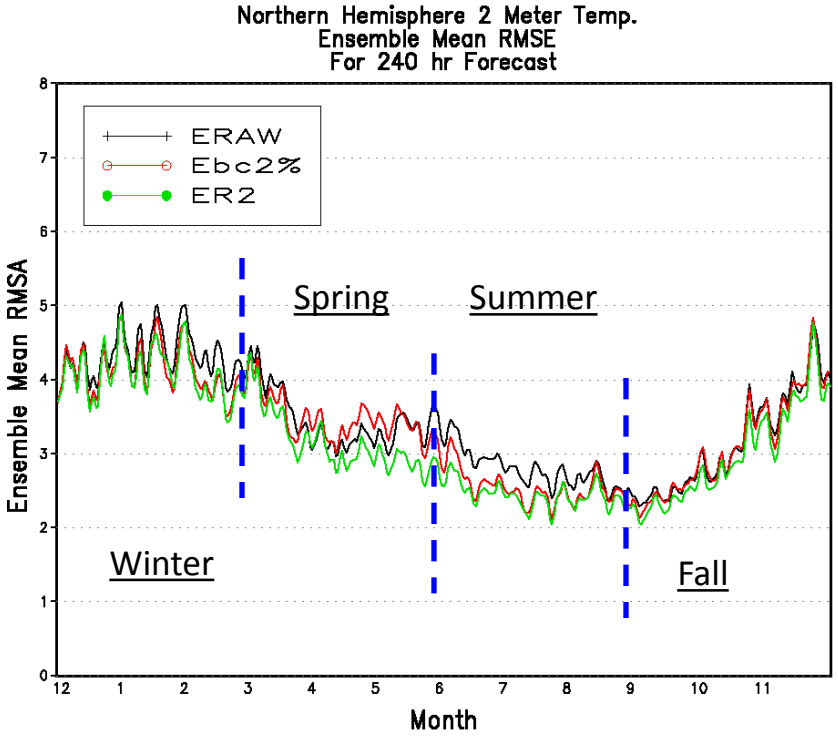
Using reforecast to improve current bias corrected product (24-hr forecast, 2010)

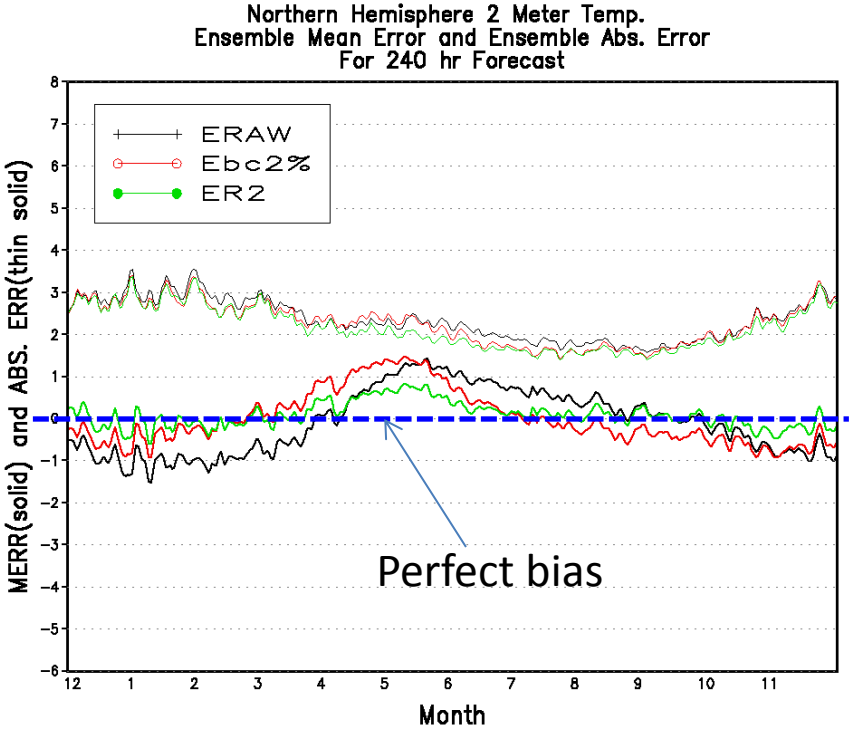




Ref: Guan, H., B. Cui and Y. Zhu, 2015: "Improvement of Statistical Post-processing Using GEFS Reforecast Information" *Weather and Forecasting*, Vol. 30, 841-854

Using reforecast to improve current bias corrected product (240-hr forecast, 2010)





Scope #3: NAEFS precipitation calibration at 0.5d globally

Precipitation Calibration for the NCEP Global Ensemble Forecast System

NCEP GFS/GEFS precipitation forecast products

Raw forecast- model direct output

6h-QPF/PQPF–
High Reso. GFS
Low Reso. GEFS/CTL
20 GEFS ensembles:
0.5 deg, globally

Calibrated products - 1st Post-processing

Bias corrected
6h&24h-QPF/PQPF –
High Reso. GFS
Low Reso. GEFS/CTL
20 GEFS ensembles:
0.5 deg, globally

More reliable

Downscaled products – 2nd Post-processing

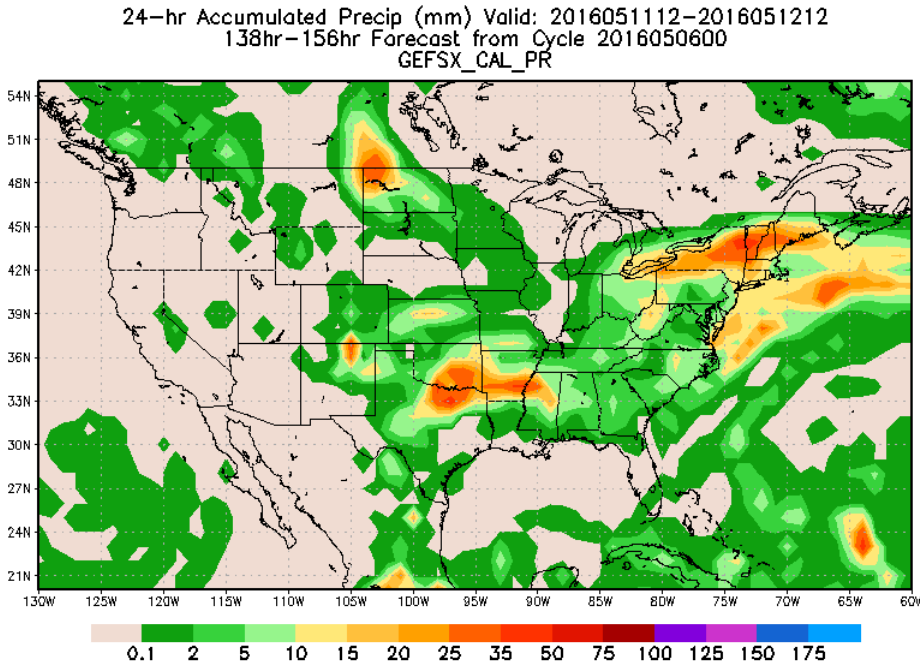
Downscaled
24h-QPF/PQPF –
High Reso. GFS
Low Reso. GEFS/CTL
20 GEFS ensembles:
2.5KM, NDGD, CONUS

Much finer

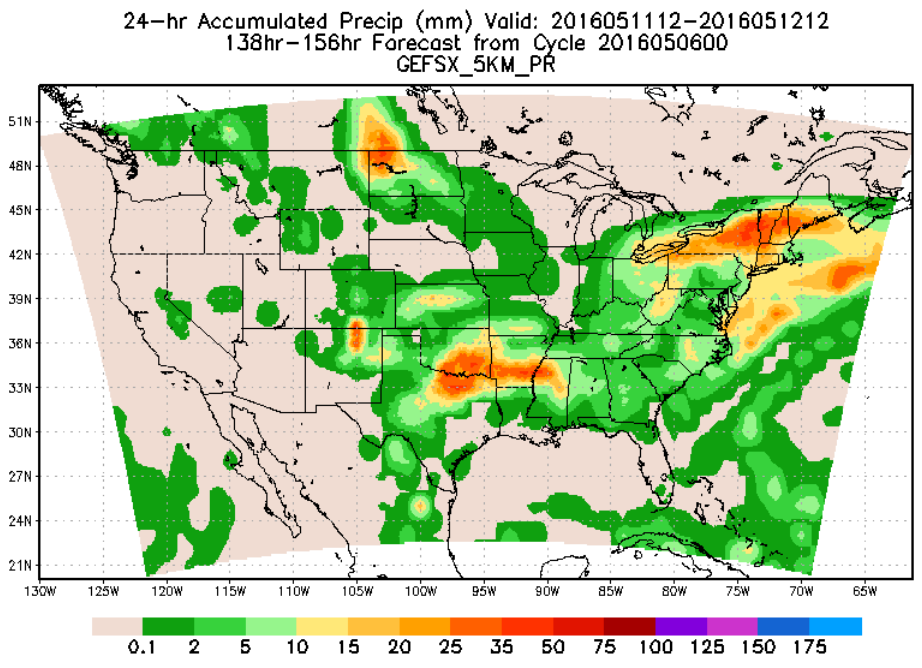
Ref: Zhu, Y, and Y. Luo, 2015: "Precipitation Calibration Based on Frequency Matching Method (FMM)". *Weather and Forecasting*, Vol. 30, 1109-1124

Example of proposed products

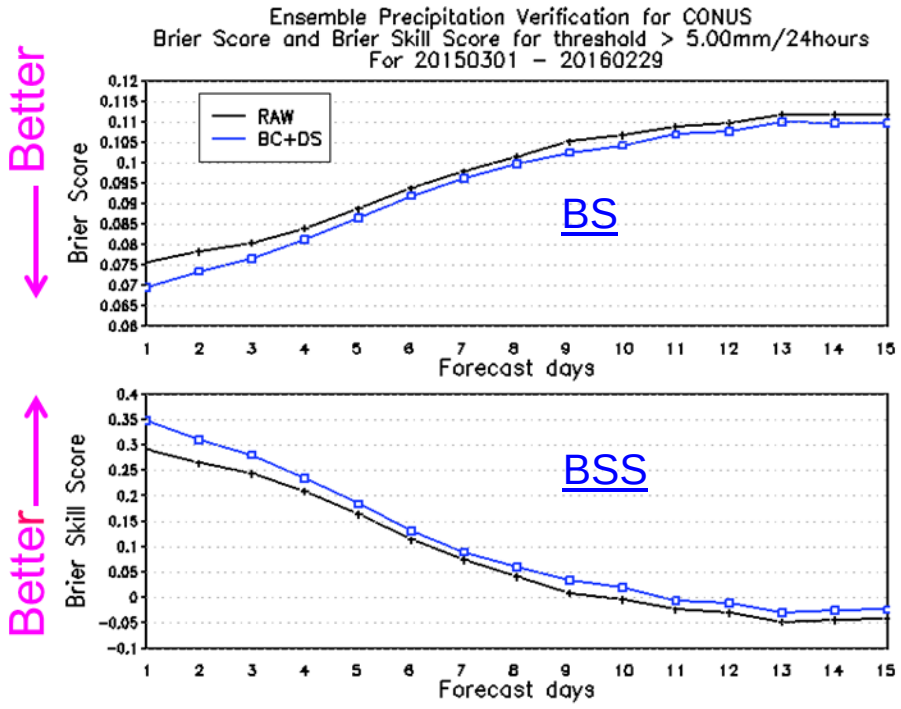
1 deg calibrated QPF

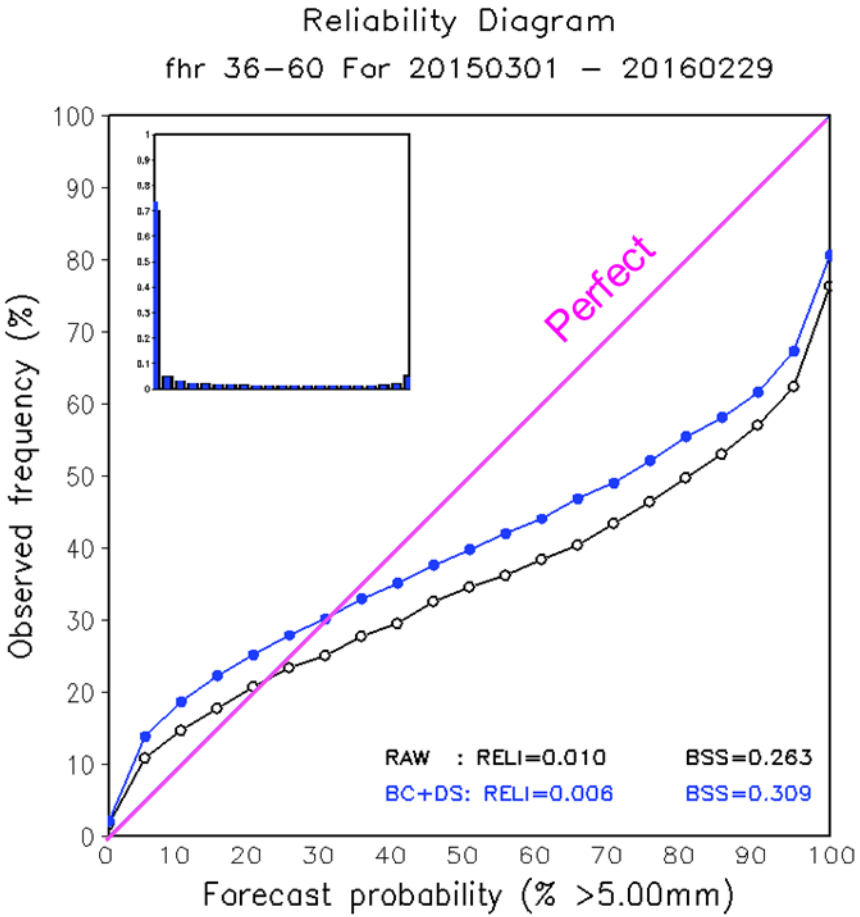


5km downscaled QPF



Evaluation of precipitation calibration and downscaling





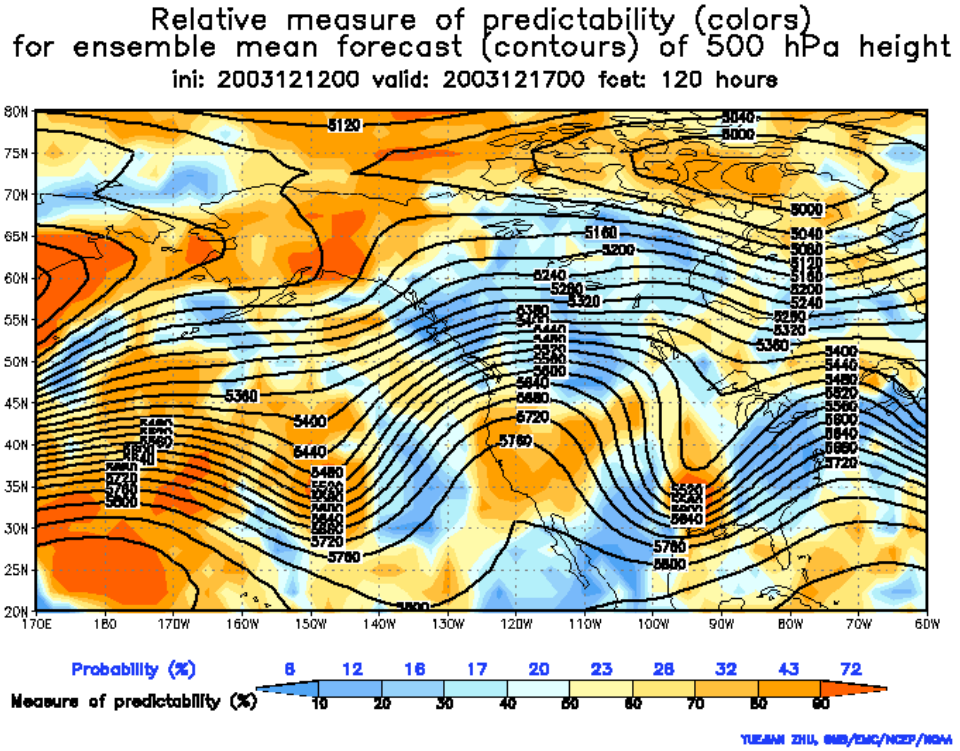
Scope #4: New NAEFS products (Images: RMOP, ANF and EFI)

The Relative Measure of Predictability (RMOP)

Application of theory

RMOP & Ensemble Forecast of 500-hPa Height

- Contours: ensemble mean forecast
- Shading: RMOP of the ensemble mean at each grid point over the previous 30 days
- Blue numbers: verification information from historical average



Shading at 90%: at least 9 of 10 ensemble forecasts in the past 30 days fall in the same "bin" as the ensemble mean than the present forecast. In this case, the trough in the eastern US is 90% predictable relative to ensemble forecasts in the past 30 days.

The blue numbers over each box represents the percentage that a forecast with the given degree of predictability has verified over the past 30 days. Here, over the 90% predictability box, only 72% of the forecasts with 90% relative predictability at 120 hours have verified in the same climatological bin as the observed 500-hPa height at 120 hours over the past 30 days of ensemble forecast. Note that in general, the values are generally lower than the RMOP numbers below the bar. This is because:

The underlying forecast model is imperfect
The initial conditions are imprecise, and
The atmosphere behaves chaotically

Ref: Toth. Z., Y. Zhu and T. Marchok, 2001: "The Use of Ensembles to Identify Forecasts with Small and Large Uncertainty" *Weather and Forecasting*, Vol. 16, 436-477

We can expect verification percentages to decrease with

Increasing forecast lead time, during warm season, and during relatively unpredictable regimes in all season

Definition of Extreme Events

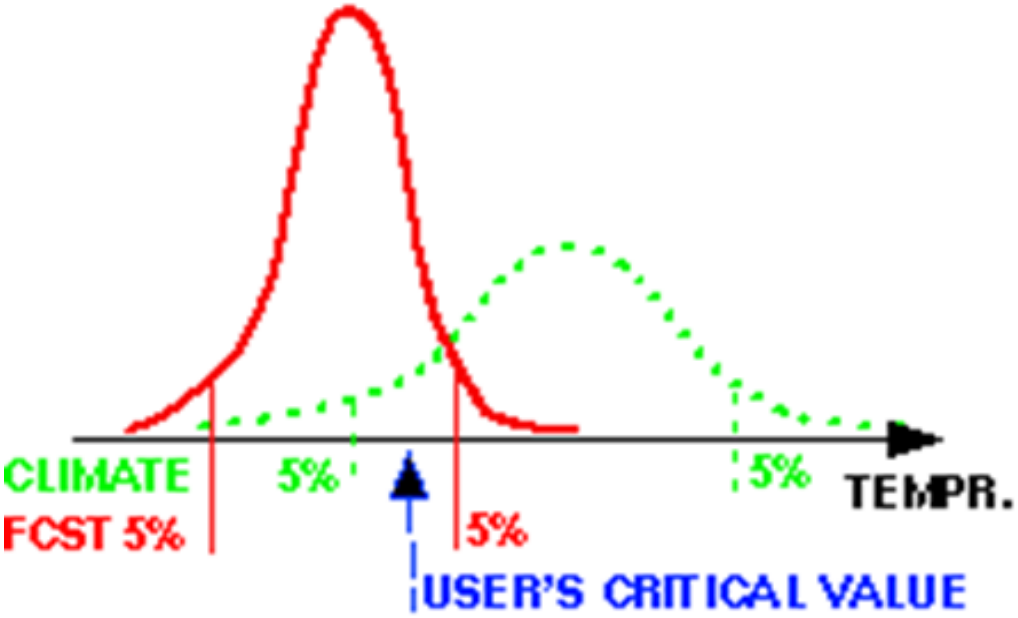


Fig. 1. Schematic indicating climatological (continuous), forecast (dotted) and user specific (dashed) extreme events.

Climatological (forecast) extreme is the tails of corresponding distribution for a particular variable, time, and place.

Extreme Weather Forecast Methods

– Anomaly Forecast (ANF)

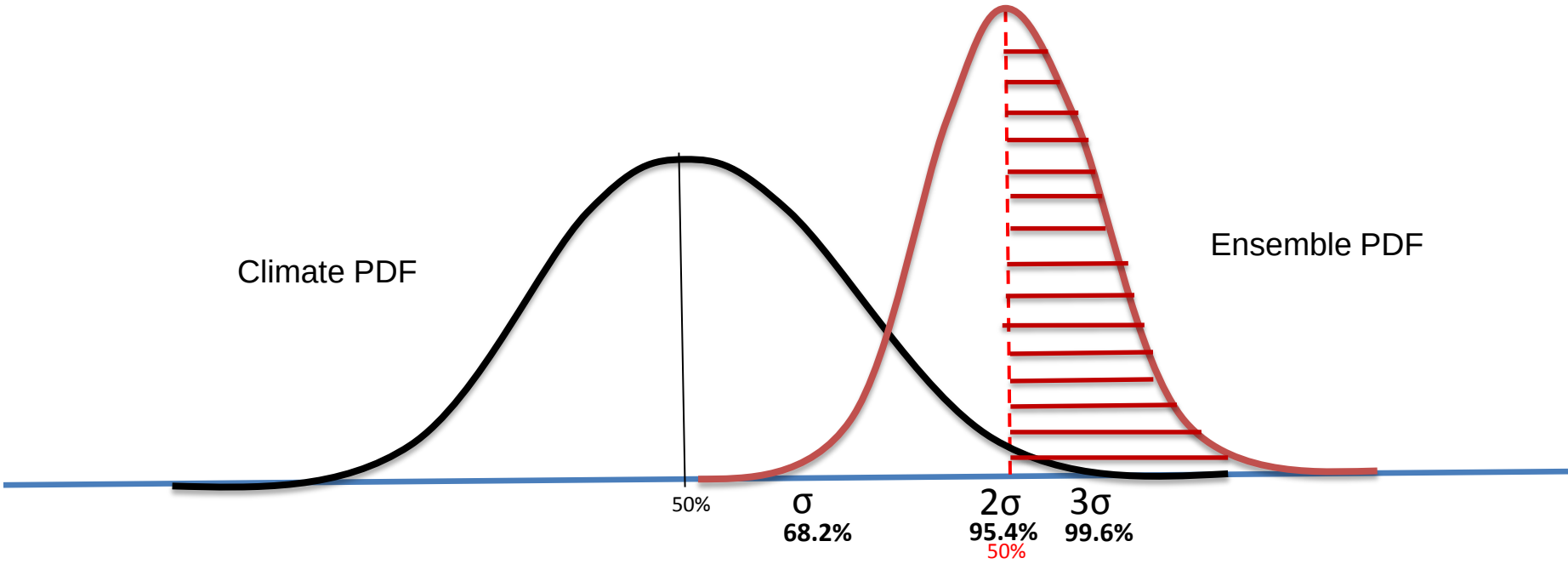
EMC/NCEP since 2006

– Extreme Forecast Index (EFI)

CMC, ECMWF, and ESRL/OAR

Ref: Guan, H. and Y. Zhu, 2016:
"Development of verification methodology for extreme weather forecasts"
Submitted to *Weather and Forecasting* (June 2016)

Anomaly Forecast (ANF)



Schematics diagram for anomaly forecast (PDF)

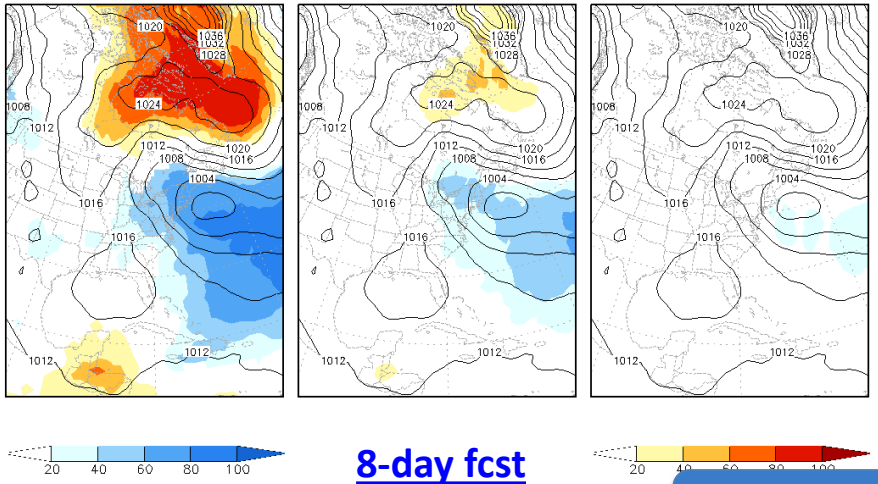
Definitions for Anomaly Forecast

Percentage of ensemble forecast (shaded area) which exceeds climate threshold (for example: 2σ) (NCEP/ NAFES product)

Anomaly forecast

Sea Level Pressure (PRMSL), 192-hour forecast
Ini. time:2012102300 Valid time:2012103100
Contour-mean forecast; Shaded-forecast anomalies

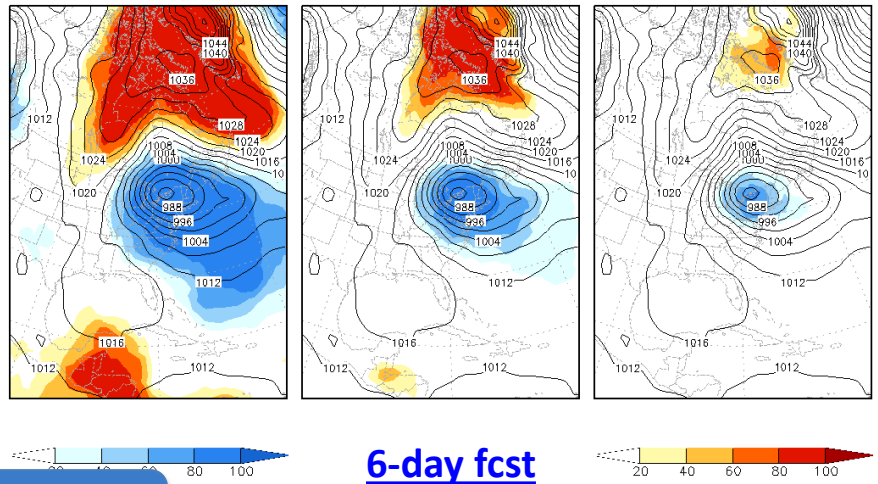
σ 2σ 3σ



8-day fcst

Sea Level Pressure (PRMSL), 144-hour forecast
Ini. time:2012102500 Valid time:2012103100
Contour-mean forecast; Shaded-forecast anomalies

one stdv two stdv three stdv



6-day fcst

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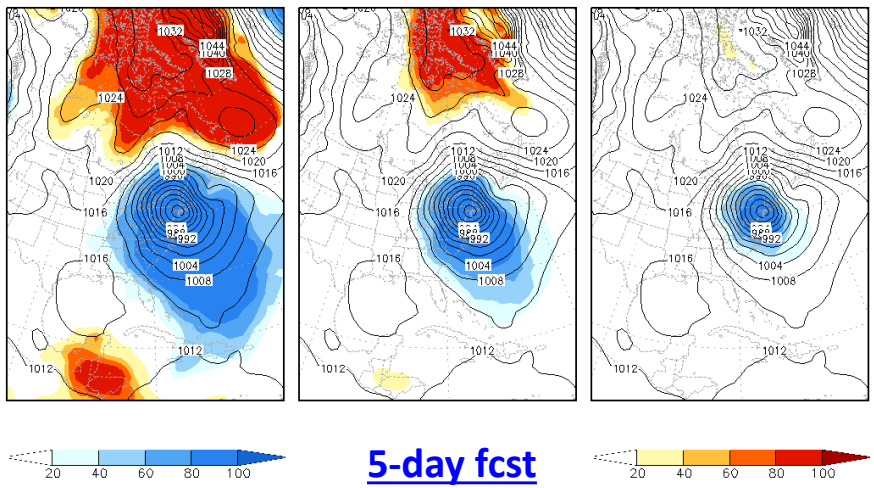
Hurricane Sandy

Sea Level Pressure (PRMSL), 120-hour forecast
Ini. time:2012102600 Valid time:2012103100
Contour-mean forecast; Shaded-forecast anomalies

one stdv two stdv three stdv

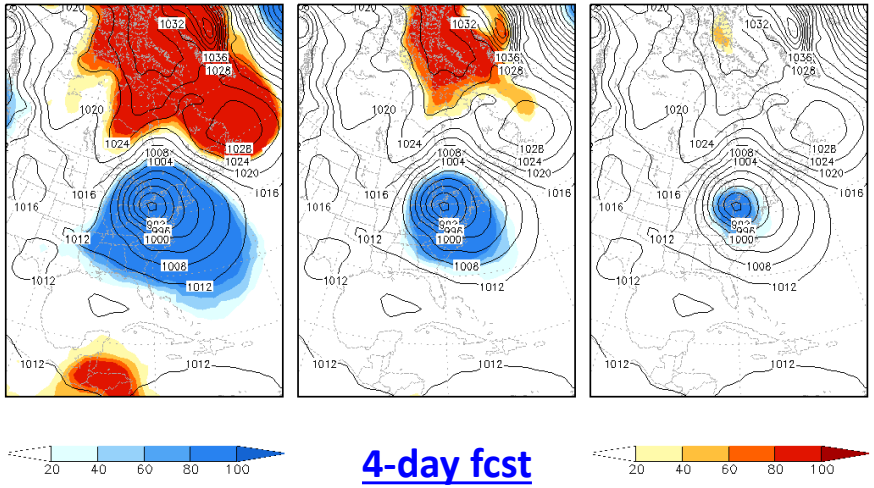


5-day fcst

YUEJIAN ZHU, GCWMB/EMC/NCEP/NOAA

Sea Level Pressure (PRMSL), 96-hour forecast
Ini. time:2012102700 Valid time:2012103100
Contour-mean forecast; Shaded-forecast anomalies

one stdv two stdv three stdv

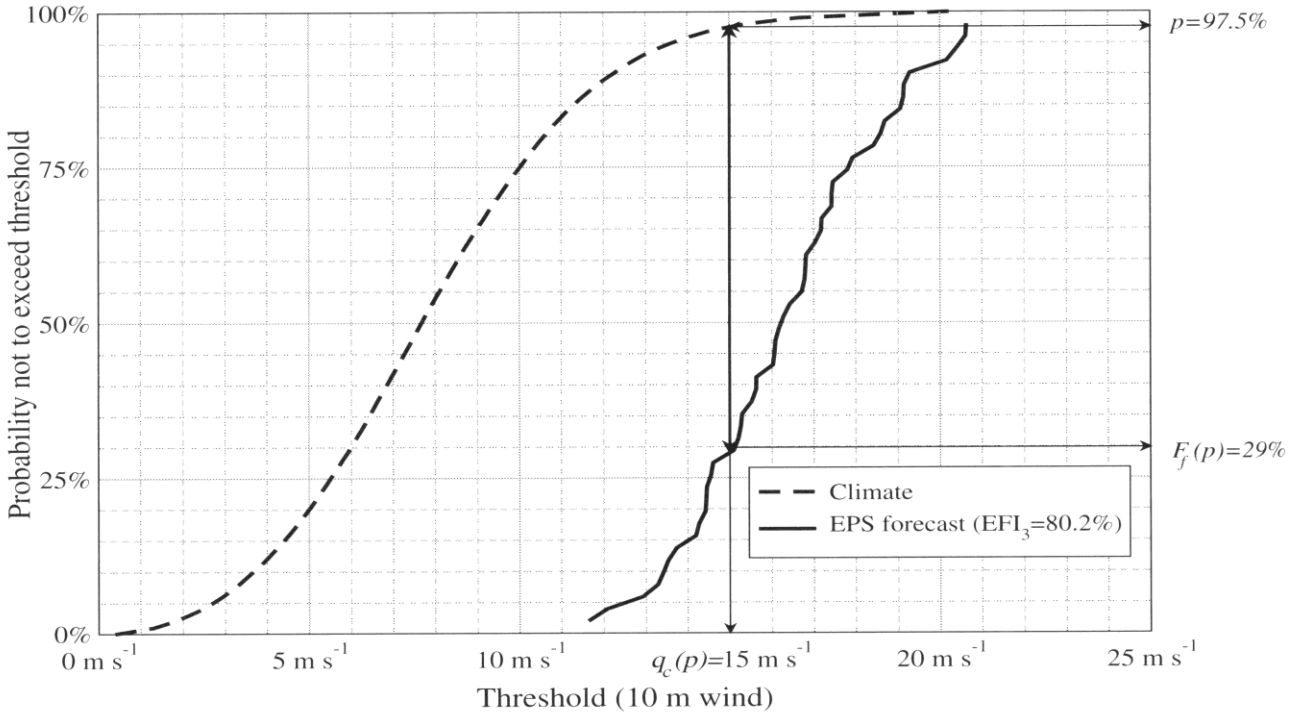


4-day fcst

YUEJIAN ZHU, GCWMB/EMC/NCEP/NOAA

Extreme Forecast Index (EFI)

(Lalaurette, 2003)



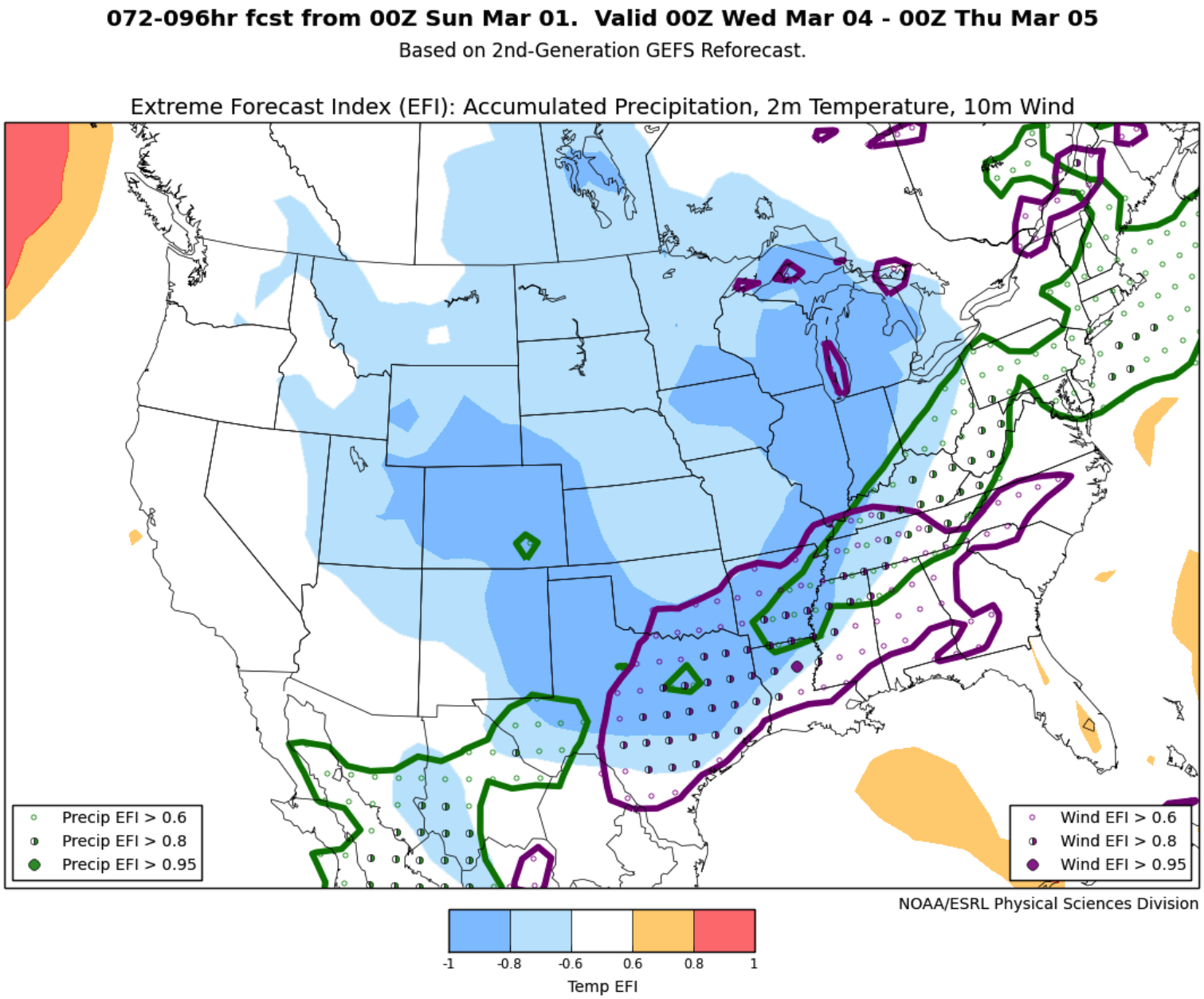
The EFI is a measure of the difference between the model climatological forecast distribution and the current ensemble forecast distribution.

CDF: cumulative distribution function

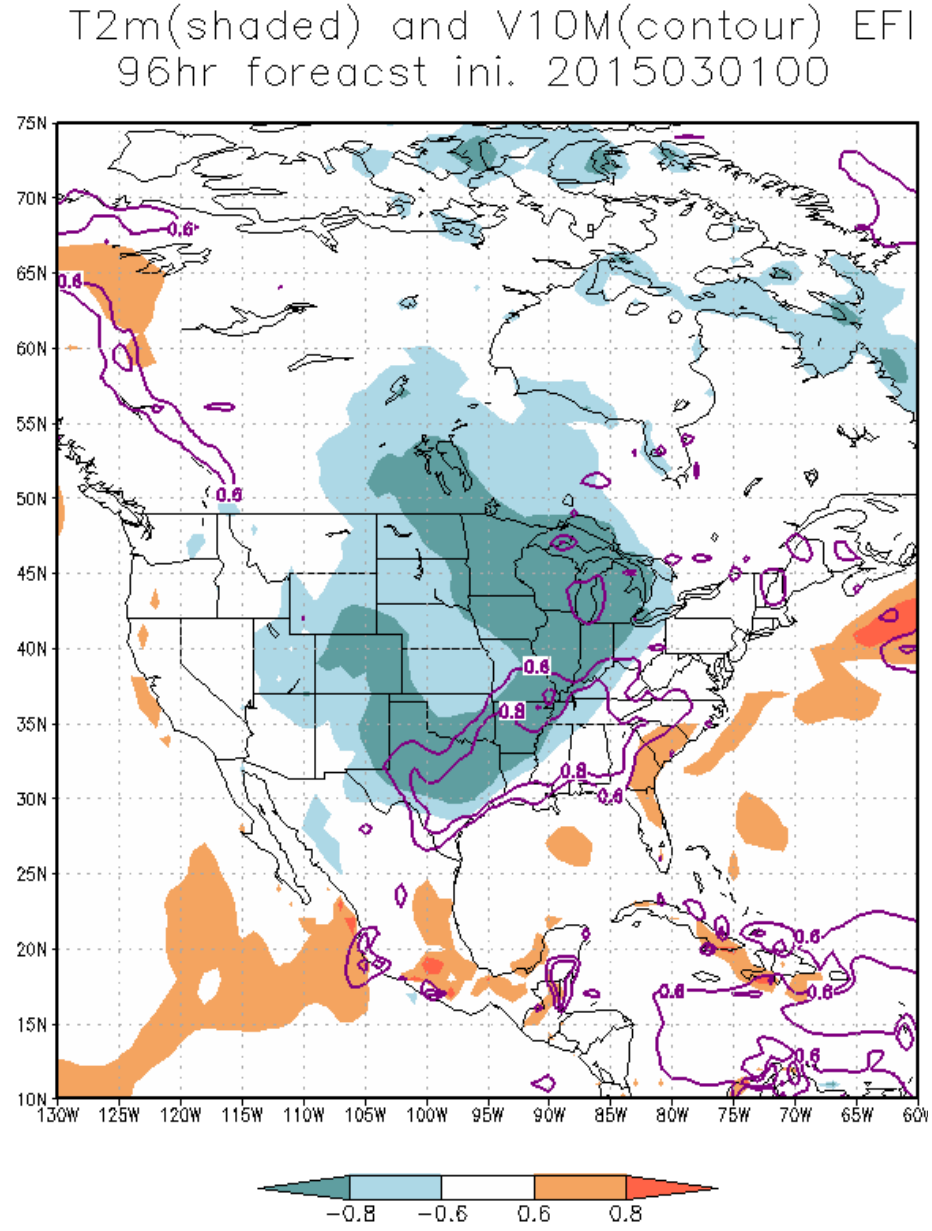
Modified Equation
(Zsooter 2006)

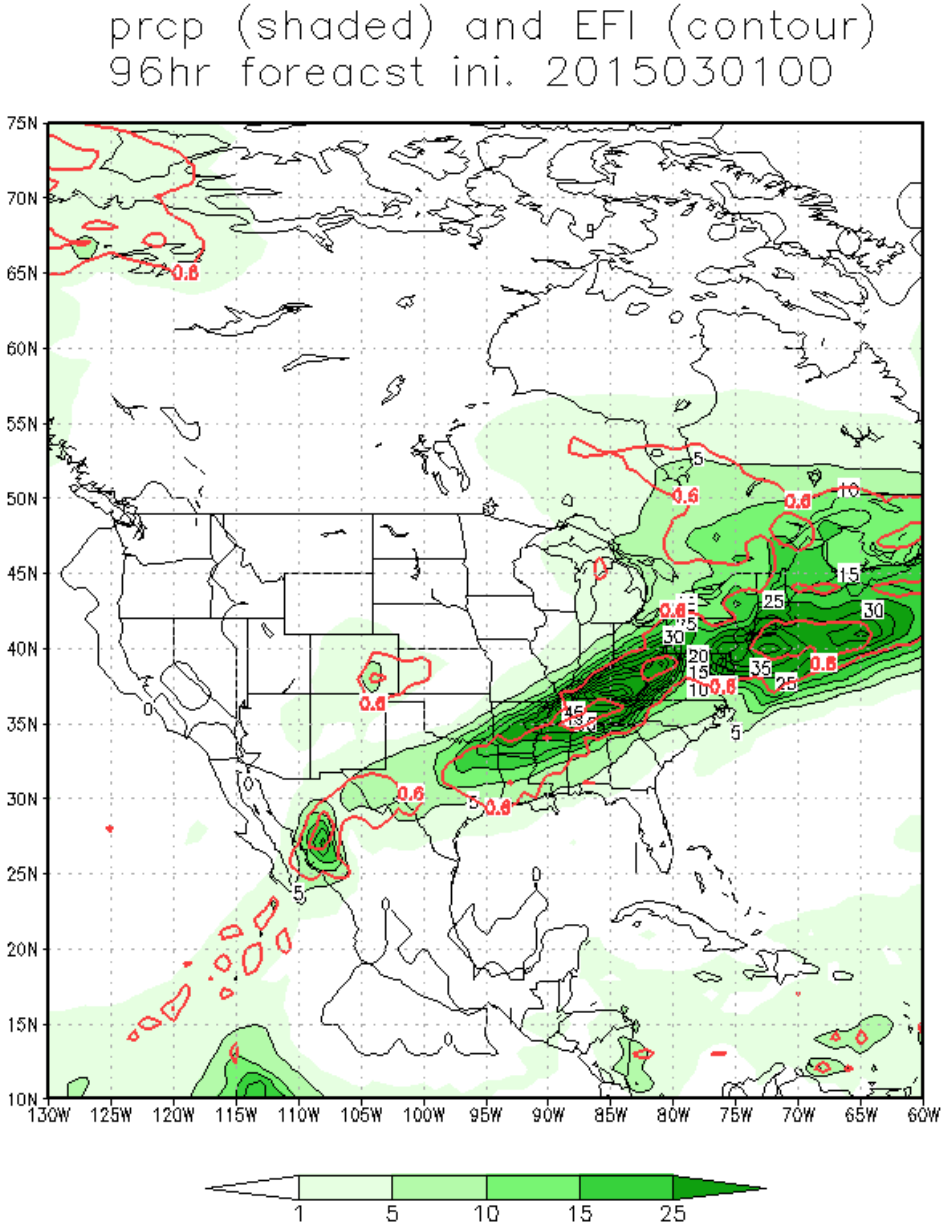
$$EFI = \frac{2}{\pi}\int_0^1 \frac{p - F_f(p)}{\sqrt{p(1-p)}}\,dp$$

Operational GEFS based EFI (ref: 25 years refcst – ESRL)



Parallel GEFS based EFI (ref: 18 years refcst – EMC)





Resource of changes

- Current:
  - Length of process – last 2+ hours
  - How many nodes? - 30 nodes (peak)
  - Start time / end time – +6:00 - +8:00
  - Disk storage per cycle
    - 17GB (pgrb2ap5)
    - 6.4GB (pgrb2a)
    - 10GB (pgrb2a_bc for GEFS and CMC)
    - 4GB (pgrb2a_an for GEFS and CMC)
- Future:
  - Length of process – last 2+ hours
  - How many nodes? – 60 nodes (peak)
  - Start time / end time – +6:00 - +8:00 (? Need more tests on CRAY)
  - Disk storage per cycle (99GB more per cycle)
    - 6.4GB (pgrb2a), 5GB (pgrb2a_bc), 2GB (pgrb2a_an)
    - 28GB (pgrb2ap5, redistributed variables)
    - 44GB (pgrb2ap5_bc, new for GEFS and CMC)
    - 24GB (pgrb2ap5_an, new for GEFS and CMC)
    - 2GB (pecp_gb2, ndgd_prcp_gb2, new for precipitation)

Input/Output Changes

- Current:
  - Input & Output : 1x1 degree global fields

- Future:
  - Input - 0.5d global ensemble data
    - NCEP (re-organized pgrb2ap5) and CMC
    - Raw and bias corrected forecast
  - Output – 0.5d global ensemble data
    - NCEP
      - reorganized pgrb2ap5 (raw) and pgrb2bp5 (raw) for public (TIN)
      - new pgrb2ap5_bc for public replace pgrb2a_bc (TIN)
      - prcp_gb2 for 0.5d bias corrected prcp (TIN)
      - new ndgd_prcp_gb2 for 0.5d bias corrected and downscaled prcp
      - ensstat (???)
    - CMC
      - 0.5d raw GEFS forecast for public replace pgrb2a (TIN)
      - 0.5d bias corrected forecast for public (new)
    - NAEFS
      - new pgrb2ap5_bc & pgrb2ap5_an to replace pgrb2a_bc & pgrb2a_an (TIN)

NAEFS (V6.0) Upgrade

Project Status as of 8/22/2016

G Project Information and Highlights

Lead: Yuejian Zhu and Bo Cui, EMC, Steven Earle, NCO

Scope:

- Add new bias corrected NAEFS/GEFS 0.5*0.5 degree products (new)
- New multi-model products
  - Using RBMP to process three bias corrected ensembles UNOPC (NCEP+CMC (NAEFS) + FNMOC) at 1*1 degree resolution globally (???)
  - Using RTMA as proxy of truth, downscale 1*1 degree products to extend-CONUS 2.5km & Alaska 3km (done)
  - Various new methodologies (include reforecast) have been applied to improve NAEFS/NUOPC bias correction, 2nd moment adjustment, downscaling products.
- Add precipitation products - bias correction and downscaling. (new)
- Add RMOP, ANF and EFI product images for WPC/CPC and users (new)
- Add downscaling products for other regions (Hawaii, Puerto Rico, Guan) (take out)
- GRIB II (encoding/decoding directly) for:
  - All new/exist products

Expected Benefits:

- Higher resolution NAEFS products globally
- For WPC, regions, CPC and Partner of North American

Y Scheduling

Milestone (NCEP)	Date	Status
Initial coordination with SPA team	1/15/2016 →4/15 ->7/21	done
EMC testing complete/ EMC CCB approval	2/1/2016 – 3/1 →6/1-> 9/1 -> 12/10	
Final Code Delivered to NCO	2/1/2016 →2/15 -> 3/15 →6/15 -> 9/15 -> 12/15	
Technical Information Notice Issued	3/1/2016 →3/15 →8/1	
SPA begins prep work for 30 day test	2/2/2016 →2/16 →3/16 →6/20	
30-day evaluation begins	2/29/2016 →3/14 →5/16 →8/15	
30-day evaluation ends	3/29/2016 →4/13 →6/15 →9/13	
IT testing ends	3/15/2016 →3/31 →6/1 →9/13	
Management Briefing	3/25/2016 →4/22 →6/24 →9/23	
Operational Implementation	3/29/2016 →4/26 →6/28 →9/27	

Y Issues/Risks

Issues:

Code delivery delayed due to delay in NAEFS v5 implementation

Risks:

1) Data exchange of 0.5 degree data (raw and bias corrected) with CMC

Mitigation:

I1 – delay schedule

R1 – adjust scopes (adding new items)

G Finances

Associated Costs:

Funding Sources: EMC Base and **NAEFS/NUOPC project**: T2O 24 Man-months NCO Base: 2 man-months for implementation, 1 man-month annually for maintenance

R	Management Attention Required	Y	Potential Management Attention Needed	G	On Target

Background!!!

0.5 degree NAEFS data exchange to NCEP implementation (agenda)

Date	Activity	NCEP	CMC	Note
7/21/2016	Initiated discussion with NCO	Yes		
8/15/2016	Request NCO to archive GEFS 0.5d to 2-y run-history	prod		Approved: 7/25/2016
8/15/2016*1	Deliver codes (1st) to NCO for re-organizing pgrb2ap5 and pgrb2bp5	EMC		NCO needs to start set up NAEFS test mode
9/30/2016	Start to exchange raw data	NCO dev	Y	CMC approved
10/15/2016	Deliver codes (2nd) to NCO for generating bias corrected data	EMC		
11/15/2016	Start to exchange bias corrected data	NCO dev	Y	CMC approved
1/10/2017	EMC/NCO CCB	Yes		Pending on approving
1/15/2017	Deliver codes (final) to NCO for implementation	EMC		
2/10/2017	Issue TIN	NCO		
2/15/2017	Real-time parallel (evaluation)	NCO		
3/25/2017	Briefing to NCEP director	NCO/EMC		
4/4/2017	Implementation	NCO		

*1: delayed due to upstream master files availability, need extra GEFS upgrade (updated on 08/17/2016)

```
[Yuejian.Zhu@g10a2 pgrb2a_an]$ wgrib2 gep20.t00z.pgrb2a_anf24
1:0:d=2016081600:HGT:1000 mb:24 hour fcst:ENS=+20
2:76241:d=2016081600:HGT:700 mb:24 hour fcst:ENS=+20
3:146842:d=2016081600:HGT:500 mb:24 hour fcst:ENS=+20
4:212879:d=2016081600:HGT:250 mb:24 hour fcst:ENS=+20
5:265934:d=2016081600:UGRD:850 mb:24 hour fcst:ENS=+20
6:368170:d=2016081600:UGRD:500 mb:24 hour fcst:ENS=+20
7:461139:d=2016081600:UGRD:250 mb:24 hour fcst:ENS=+20
8:521340:d=2016081600:VGRD:850 mb:24 hour fcst:ENS=+20
9:625042:d=2016081600:VGRD:500 mb:24 hour fcst:ENS=+20
10:720656:d=2016081600:VGRD:250 mb:24 hour fcst:ENS=+20
11:783115:d=2016081600:TMP:850 mb:24 hour fcst:ENS=+20
12:856522:d=2016081600:TMP:500 mb:24 hour fcst:ENS=+20
13:922944:d=2016081600:TMP:250 mb:24 hour fcst:ENS=+20
14:985418:d=2016081600:TMAX:2 m above ground:18-24 hour max fcst:ENS=+20
15:1061386:d=2016081600:TMIN:2 m above ground:18-24 hour min fcst:ENS=+20
16:1140432:d=2016081600:PRMSL:mean sea level:24 hour fcst:ENS=+20
17:1177787:d=2016081600:UGRD:10 m above ground:24 hour fcst:ENS=+20
18:1283467:d=2016081600:VGRD:10 m above ground:24 hour fcst:ENS=+20
19:1389625:d=2016081600:TMP:2 m above ground:24 hour fcst:ENS=+20
[Yuejian.Zhu@g10a2 pgrb2a_an]$
```

prcp_gb2 files: full cycles, 61 files per cycle.
gepqpf.${cyc}z.pgrb2_24hf${FHR}: 24 hour raw PQPFs at 1 degree resolution. 13 thresholds (0.254, 1, 1.27, 2.54, 5, 6.35, 10, 12.7, 20, 25.4, 50.8, 101.6, 152.4mm/day) are selected.
cyc: 00, 06, 12, 18
FHR: for 00z-00z, FHR=24-384, every 24 intervals, total 16 days; for 06z-06z, FHR=30-366, every 24 intervals, total 15 days; for 12z-12z, FHR=36-372, every 24 intervals, total 15 days; for 18z-18z, FHR=42-378, every 24 intervals, total 15 days.

ensstat files: 00z only

1. enspost.t00z.prcp_24hbc.grib2 :

24 hour bias-corrected QPFs, 2.5 degree resolution, 24 hour interval, mm/day.
Two sets of 24 hour accumulations are selected: 00z-00z, Hi reso control out to 8days and Low-reso control+20members out to 16 days; 12z-12z, Hi reso control out to 180 hour and Low-reso control+20members out to 372 hour (15days).

2. ensstat.t00z.pqpf_24hbc.grib2

24 hour bias-corrected PQPFs, 2.5 degree resolution, 24 hour interval, ten thresholds (0.254, 2.54, 6.35, 12.7, 25.4, 50.8, 1, 5, 10, 25mm/day) are selected.
Two sets of 24 hour accumulations are selected: 00z-00z, out to 16 days; 12z-12z, out to 372 hour (15days).

3. ensstat.t00z.pqpf_24h.grib2

Same as 2 but for 24 hour raw PQPFs, not sent out to the public.

NAEFS bias corrected variables

Last upgrade: March 29 2016 - (bias correction)

Variables	pgrba_bc file	Total 51
GHT	10, 50, 100, 200, 250, 500, 700, 850, 925, 1000hPa	10 (4)
TMP	2m, 2mMax, 2mMin, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000hPa	13 (6)
UGRD	10m, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000hPa	11 (4)
VGRD	10m, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000hPa	11 (4)
VVEL	850hPa	1
PRES	Surface, PRMSL	2 (1)
FLUX (top)	ULWRF (toa - OLR)	1
Td and RH	2m (April 8 2014)	2
TCDC	Total cloud cover (March 29 2016)	1
Notes	CMC and FNMOC do not apply last two upgrades yet 19 variables for anomaly forecast	

37

NAEFS downscaling parameters and products

Update: March 29 2016 (NDGD resolutions)

Variables	Domains	Resolutions	Total 10/10
Surface Pressure	CONUS/Alaska	2.5km/3km	1/1
2-m temperature	CONUS/Alaska	2.5km/3km	1/1
10-m U component	CONUS/Alaska	2.5km/3km	1/1
10-m V component	CONUS/Alaska	2.5km/3km	1/1
2-m maximum T	CONUS/Alaska	2.5km/3km	1/1
2-m minimum T	CONUS/Alaska	2.5km/3km	1/1
10-m wind speed	CONUS/Alaska	2.5km/3km	1/1
10-m wind direction	CONUS/Alaska	2.5km/3km	1/1
2-m dew-point T	CONUS/Alaska	2.5km/3km	1/1
2-m relative humidity	CONUS/Alaska	2.5km/3km	1/1
Total cloud cover?			
Wind Gust?			
Significant wave height			

Downscaled products are generated from 1*1 degree probabilistic fcst globally
Products include ensemble mean, spread, 10%, 50%, 90% and mode

NCEP Anomaly Forecast

- There are two (three) products we have produced right now:
  - The value from normal (50% of climatology) of ensemble mean
  - Percentile of climatology for each ensemble members
- Anomaly forecast maps
  - Anomaly for 10%, 50% and 90% probabilistic forecast
- Probabilistic anomaly forecast
  - Probability of exceeding one standard deviation of climatology
  - Probability of exceeding two standard deviations of climatology
  - Probability of exceeding three standard deviations of climatology

COMPUTATION OF CLIMATE ANOMALIES