DM 03-01.2004 - NOTICE OF INTENT TO CHANGE OPERATIONAL SHORT RANGE ENSEMBLE FORECAST (SREF) MODELING SYSTEM
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DATA MGT MESSAGE 04-03.XX

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SUBJECT NOTICE OF INTENT TO CHANGE NCEP SHORT RANGE ENSEMBLE FORECAST SYSTEM (SREF)

ADDITIONAL INFORMATION ABOUT THESE CHANGES WILL BE PROVIDED AS IT BECOMES AVAILABLE.

Brief Description of Changes:

- Increase horizontal resolution of all 15 ensemble members. Horizontal resolution increases from 48 km to between 32 km for Eta members and ~40 km for RSM members.
- Increase the frequency of Eta member physics calls from every 6th timestep to every other timestep to be more consistent with the operational Eta systems and to enhance the effects of physics in the ensemble system.
- Increase vertical resolution to 60 levels in the Eta members to be consistent with operational Eta systems.
- Upgrade Eta members to the same software version level as the 12 km North American Eta run (prior to 9 March 2004).
- Upgrade the Regional Spectral Model (RSM) with improved physics and computational schemes commensurate with current GFS.
- Enhance the SREF system physics diversity by running several members with different cloud physics and convective parameterization schemes.
- Improved scaled breeding technique based on the GFS technique.

A conference paper was written for the 2004 AMS annual meeting that describes a preliminary SREF enhanced diversity system tested last summer and provides evaluation statistics from the July 2003 physics diversity experiment. This paper can be found at:

http://wwwt.emc.ncep.noaa.gov/mmb/SREF-Docs/SREF_16thNWP2004.pdf

EMC is running a near real-time parallel that will be ready for your evaluation by April 2004. These parallel runs will be accessed at:

http://wwwt.emc.ncep.noaa.gov/mmb/SREF/PARA.html

The SREF production runs can be found in a format similar to the parallel runs at:

http://wwwt.emc.ncep.noaa.gov/mmb/SREF/SREF.html

Reasons for Changes:

Latest Parallel Change

The parallel SREF-X run during November 2003 through January 2004 was shown to have some members that performed unrealistically, especially during the cold season. This led to poorer accuracy, especially for qpf and some upper-level fields. The following problems were identified and corrected in the proposed parallel experiment:

- Over-dispersive forecasts led to unrealistic initial condition (IC) perturbations during the breeding cycle. *A scaled breeding system was installed to control the IC perturbations (see below).*
- 8 members were run with non-operational convective parameterizations combined with IC perturbations. The combined physics diversity and IC perturbations may have also contributed to the unrealistically high spread and poorer system accuracy. A test system that replaced 8 non-operational physics members with IC breeding to just 3 members with IC breeding showed too little spread. *The proposed system employs 6 non-operational physics members (2 each of Eta-SAT, Eta-Det, RSM-RAS, see table below). In the current configuration (as of March 2004), these members are also run with a single initial condition perturbation pair.*
- In the previous systems, 5 members did not produce convective precipitation outputs. However, they were tested to aid in the forecast of the pre-convective environment. The lack of convective precipitation from several members reduced the ensemble mean and probabilistic convective precipitation accuracies for this field when included in the probabilistic computations. *The proposed system now includes only 1 convective scheme (just 2 members), which currently does not diagnose convective precipitation (Eta-Kain-Fritsch-Full Detrainment).*

Additional Physics Diversity and Resolution

The SREF system was developed to provide a multiple regional model, short-range (0-3 days) ensemble prediction system that produces operationally relevant and useful guidance on the probability distribution of weather elements or events. The probabilistic information provided by SREF will help meet the NWS FY05 strategic goal of "providing probabilistic gridded products to the NWS/WFOs, service centers and other users".

In September 2003, NCEP added 5 Eta-KF (Kain-Fritsch convective parameterization)

members to the routine production and evaluation of a regional model based ensemble system and product suite (Du, et al., 2003). The system consisted of 5 ETA-KF, 5 Eta-BMJ (Betts-Miller-Janic convective parameterization) and 5 RSM multi-model members, for 15 total members at 48 km horizontal resolution. SREF is run twice per day (09z and 21z) out to 63hrs; with output available every 3hrs using regional bred initial state perturbations.

Previous studies have shown the importance of multi-physics ensemble forecasts in improving SREF diversity. This implementation incorporates additional physics diversity by running various convective and cloud microphysics parameterizations along with single pair breeding, to improve system diversity and forecast spread information, especially for quantitative precipitation forecasts. The table below summarizes the latest SREF-X configuration:

Model	**Convection**	**Microphysics**	**GFS ensemble 6hrly LBC**	**IC Breeding**
Eta-32	Betts-Miller-Janic (BMJ)	Operational Ferrier	Ctl, N1, P1	Ctl1 + 1 pair (N1, P1)
Eta-32	Kain-Fritsch (KF)	Operational Ferrier	Ctl, N2, P2	Ctl2+ N2, P2
RSM-40	Simple Arakawa Shubert (SAS)	Zhou GFS	Ctl, N1,P1	Ctl1 + N1, P1
RSM-40	Relaxed Arakawa-Shubert (RAS)	Zhou GFS	N2, P2	N2, P2
Eta-32	BMJ-SAT (Saturated moisture profiles)	Operational Ferrier	N1, P1	N3, P3
Eta-32	KF-DET (Full cloud detrainment)	Experimental Ferrier*	N2, P2	N4, P4

** Experimental Ferrier Microphysics are related to changes in parameters controlling the liquid water glaciation, ice nucleation, cloud formation, vapor deposition and cloud water collection by precipitation. More information on the various microphysics and convective parameterization can be found in Ferrier (2004) and Ferrier, et al. (2002).*

Improved Scaled Breeding Technique

This change was implemented to control the unrealistically high initial condition perturbations noted in the previous technique. The initial condition perturbations are now scaled by a factor inversely proportional to the difference between the previous run's 12-hour perturbed 850 mb temperature forecasts.

Upgraded Eta Model

This implementation of SREF will use a version of Eta implemented operationally in July 2003 (See NCEP/TPB, Ferrier et al., 2003):

http://www.emc.ncep.noaa.gov/mmb/tpb.spring03/tpb.htm.

A list of Eta changes is available at:

http://www.emc.ncep.noaa.gov/mmb/research/eta.log.html.

Upgraded RSM Model

For SREF, the hydrostatic version of the RSM will be implemented with upgraded Global Forecast System (GFS) physics and improved parallel processing. More information on the RSM upgrades can be found on the NCEP RSM page at:

http://wwwt.emc.ncep.noaa.gov/mmb/RSM/.

Preliminary results have shown that the addition of the 32 km improved physics diversity SREF system provides more accurate mean forecasts as well as ensemble diversity and more forecast spread in the SREF (See description of testing and statistical summaries, below).

- Model Products:

Output fields from the SREF post-processor are available for the following output grids on a 3-hourly basis out to 63 hrs:
- 40-km Lambert conformal grid over the CONUS (Grid 212).

Contingent upon available server resources, these grids will be accessible via anonymous ftp from the NCEP server. There are currently no SREF model outputs available on AWIPS.

Graphical plots of various SREF products from the combined 15 member 32 km system will be found at: http://wwwt.emc.ncep.noaa.gov/mmb/SREF/SREF.html.

Grib outputs of the 32 km SREF mean, spread and probabilistic output will be found at: ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/sref/prod/.

Ensemble mean BUFR outputs from the average of all SREF 32 km Eta members will be found at:
ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/sref/prod/.

The SREF system uses the Eta model product generator as of July 2003. Specific upgrades to model products are described below.

- *Use of Grib Extensions for Combined Probabilistic Outputs*

To improve output standardization, grib information from all SREF ensemble combined products (mean, spread and probabilistic fields) is being corrected to follow the NCEP standard for ensemble extensions. All probabilistic products will be contained in one file, rather than in 5 as previously done. This change was implemented in December 2003. A list of mean, spread and probabilistic products are available at: http://wwwt.emc.ncep.noaa.gov/mmb/SREF-Docs/.

- *Additional Grib Outputs for Individual Members*

In September 2003, at the request of NWS field forecasters and NCEP service centers, additional Grib outputs from each SREF Eta and RSM member and combined mean, spread and probabilistic products were added to the SREF Grib files. Additional cloud and convective fields were added to Eta member files to compute additional probabilistic products. For RSM members, additional convective fields and 2 m dew point temperature were added. In addition, the number of pressure levels was increased from 20 to 40 (at 25 mb intervals from 1000 mb to 25 mb). Updated on-line inventories of output grids from Eta are available at:
http://www.nco.ncep.noaa.gov/pmb/products/eta/.

Future implementations of AWIPS will carry additional SREF products. Currently, SREF graphical products are available at the NCEP SREF web page and ensemble probabilistic product files are available on the public NCEP ftp site.

- *Eta Ensemble Mean BUFR Outputs*

At the request of NWS field forecasters and NCEP service centers, ensemble mean BUFR output computed from all Eta SREF members were created and have been available since September 2003 at:
ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/sref/prod/.

A list of outputs from ensemble mean BUFR soundings is available at:
http://www.nws.noaa.gov/om/ord/iob/NOAAPORT/resources/noaaport_links.shtml.

Change Schedule:
Testing is ongoing since July 2003

Description of Testing:

Most of the individual components of this change package have been undergoing testing using EMC's 32-km SREF parallel system; details of these individual tests can be found on the EMC parallel web page. Since November 2003, the full package of changes has been undergoing real-time testing at 32 km resolution. The evolution of this parallel test is documented on the EMC SREF reference web page at:
http://wwwt.emc.ncep.noaa.gov/mmb/SREF-Docs.

Statistical Summaries:

Averaged time series of operational and preliminary experimental SREF forecasts vs analyses (MSLP, 850 mb wind, temperature, RH, 500 mb height, and 250 mb wind) verification statistics for July 2003 can be found in the paper by Du, et al. (2004) at: http://wwwt.emc.ncep.noaa.gov/mmb/SREF-Docs/SREF_16thNWP2004.pdf.

Comparison of some operational vs parallel SREF probabilistic products can be found at: http://wwwt.emc.ncep.noaa.gov/mmb/SREF/VERIFICATION_par_opr/.

Comparison of individual member plots vs observed daily precipitation can be found at: http://wwwt.emc.ncep.noaa.gov/mmb/SREF/VERIFICATION_32km_mbr/.

In addition, SREF forecasts are compared to the operational Eta-12 for July 2003 in Du, et al. (2004). For deterministic verification of ensemble mean and individual members vs observations, see: http://wwwt.emc.ncep.noaa.gov/mmb/SREF-Docs/verif/.

Additional probabilistic verification statistics will be posted on the SREF web page as they become available. See: http://wwwt.emc.ncep.noaa.gov/mmb/SREF/VERIFICATION_32km/new_html/system_48km_30day.html.

Anticipated Impact of Changes on Forecasts:

Based on both the daily observations of forecasts and the objective verification statistics, the changes described above will lead to improvements in member forecasts as described by Du , et al. 2004.

A common complaint received at the last two EMC Production Suite Reviews has been the lack of spread within the SREF model runs: i.e. all 5 RSM runs looked alike as did the Eta-BMJ runs. The new system provides physics diversity within each of the 3 model systems. During July 2003, the increased physics diversity system showed improved spread variance in surface and upper level fields as compared to the operational configuration at both 48 and 32 km. Improved spread was also observed in the precipitation forecasts. Therefore, this change was included in the SREF system change package because it is expected to improve model performance over all seasons.

Field evaluation:
Datasets and web pages were available for download and review.

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Future Changes:

The implementation of a four times/day SREF run with improved physics diversity in the NCEP SREF system will be tested. In addition, improved ensemble products with bias removal techniques, a common post-processed output in WRF-based format for all SREF members, and flow dependent breeding perturbation scaling are planned for implementation in the Fall of 2004. Basic SREF outputs are should become available in AWIPS in FY05.

References:

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