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Implementation Decision Briefing

Short Range Ensemble Forecast (SREF) Version 6.1.3 (initially "bug fix" evolves into an interim package)

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Correct / improve initial conditions:

- a) replace GFS land states with NDAS land states in NMM & ARW members;
- b) rewrite NDAS land states in NMMB to fix a bug in NPS related to lake ice;
- c) correct inadvertent use of global initial conditions with use of RAP for ARW members
- Fix bugs in NOAH LSM:
- a) eliminate negative soil moisture fractions for NMM and ARW members;
- b) eliminate "urban swamp" (causing too cold surface temperature over urban regions during heat wave periods) for NMMB members
- Improve cloud ceiling
- a) correct GFS physics in 2 NMMB members to produce compatible cloud & ceiling guidance with the rest of SREF members;
- b) fix post-processor to remove use of snow in diagnosing cloud base height
- Correct a mapping bug (eastward shift) in NMM member's pressure-grib output files.
- Code improvements: (a) p vs log(p), (b) NetCDF I/O for NMM and ARW

Changes



part II: New or improved products



- Add 4 winter weather variables:
- a) low-level Rime Factor of 21 members;
- b) snow depth of 21 members;
- c) % of frozen precipitation of 21 members;
- d) water equivalent accumulated snow of 7 ARW members
- Add 2m temperature and 3-hourly accumulated precipitation of 21 SREF
 members from the 32km North American domain (grid 221) into AWIPS
- Modify the clustering algorithm to "preserve" time-continuity within a cluster over each of the three preselected forecast periods (00-39hr, 42-63hr, 66-87hr)
- Add more sites in SREF bufr sounding output by unifying the SREF bufr station list with that used in RAP and coming NAM.
- Use model-lowest level fields for T2m, Q2m, U10, V10, Td2m, RH2m at f00 for NMMB





 Since the original intention is to fix bugs and there is no major model change (except for ARW), overall performance should be similar between prod and para SREFs. ARW members are expected to have the largest changes.







Surface wet and cold biases of certain areas in some cases (SPC concern)





GFS (wetter)











NDAS (drier)

























May 16 case: Initial 2m-Td of NMM CTL much better initialization after the land states replacement







ATMOSA

May 16 case: 2m Td difference (opl – test) (09z) too-high 2m Td reduced after the land states replacement in early hours (also see the stats later) but reduces with time

NMM ctl



NOAR



9 hr 2m-Td of NMM CTL: signal lost with time

OPS









Initial 2m-Td of NMM (from GFS/GEFS) vs. ARW (from RAP) members (09z, May 14, 2013)

ND ATMOSA NOAA





ARW











NMM



09z 200













Much improved initialization



130514/0900 ALL OR

15-HR PARA 09z SREF DEW PT FCSTS



















Despite better initialization, EM members quickly turn moist



May 16 case: Surface CAPE difference (opl – test) (09z) too-high surface CAPE reduced after the land states replacement in early forecast



NMM ctl

ARW ctl







2m T



Warm season (July 15- Aug. 31, 2013) Cold season (Oct. 1 – Feb. 28, 2014)



NMM 2m T: reduction in total error for both warm and cold seasons, No reduction or similar in bias.



RMSE of 2m T for ARW_ctl (Prod vs. Para, 2013-2014, 09z cycle)



Warm season (July 15 – Aug. 31)

Cold season (Oct. 1 – Feb. 28, 2014)



ARW 2m T: reduction in total error in warm season and similar in cold season. No reduction or similar in bias.

Ranked Probabilistic Skill Score (RPSS) of 2m T (Prod vs. Para, 2013-2014, 09z cycle)





SREF 2m T probabilistic forecasts: More skillful in warm season and similar in cold season





Warm season (July 15 – Aug. 31, 2013) Cold season (Oct 1 – Feb 28, 2014)



SREF 2m T: Slightly smaller spread or more cold bias





2m Td



RMSE of 2m Td for NMM_ctl (Prod vs. Para, 2013-2014, 09z cycle)





NMM 2m Td: Slight reduction (increase) in total error in warm (cold) seasons. No reduction or similar in bias.





Warm season (July 15- Aug. 31)

Cold season (Oct. 1 – Feb 28)



ARW 2m Td: similar or slight reduction (increase) in total error in warm (cold) season. No reduction or similar in bias.





Warm season (July 15- Aug. 31, 2013)

Cold season (Oct. 1 – Feb 28, 2014)



SREF 2m Td probabilistic forecasts: More skillful in both warm season and cold seasons.



SREF 2m Td: Slightly smaller spread or more cold or drier in bias







Precipitation, winter weather and fog forecasts







PJ 48-AR PCP 20140120 212 F5





Contragamment of COMMERC

NOAF

Case 1: too wet

15z Jan. 20, 2014







OPS EM



| 0.01 | | 0.25 | | 0.75 | | 1.50 | | 2. 50 | | 3. 50 | | 5.00 | |
|------|--|------|--|------|--|------|--|-------|--|-------|--|------|--|
| | | | | | | | | | | | | | |

PROD SREF ARW members are all too wet



Note: some erroneous low totals near DCA/BWI skewing analysis







20140120



20140120 212 F 5 1



15z Jan. 20, 2014

PARA EM









48-HR PCP

20140120 212 51

| | 0.01 | 0.25 | 0.75 | 1.50 | 2. 50 | 3. 50 | 5.00 |
|---|------|------|------|------|-------|-------|------|
| 1 | | | | | | | |

PARA SREF ARW members are corrected in the right direction





Why: similar in NMMB, positive contribution from NMM's eastward-shift correction, and main contribution from ARW



15z 2/11 PROD SREF EM







15z 2/11 PARA SREF EM





















All para ARW members are wetter and shifted to NW





- I think the event last week was a good event for the SREF-PARA
- I suspect convection and the two phasing waves were critical in this event. As the southern low cut-off it developed a new area of QPF and enhanced it. I recall using the SREF/SREF PARA and it was clear there were to be 2 slugs and the PARA had heavy snow in 09Z 10 Feb run, we expanded our Watch and added an advisory 2-3 counties farther west due to this.



Case 3: Snow probability forecasts from AWC Winter Weather experiment





ANALYZED 24-HR SNOW ENDING 00 UTC 20140214



32-KM SREFP MEAN 24-HR SNOW ENDING 00 UTC 20140214







EG_THT_SCF

ETS

BIAS

Precipitation Verification (slight improvement in light precipitation): SREF mean (Feb. 5 – Mar 4, 2014)

NO ATMOSPHERE TO AMOSPHERE TO

STAT=FH0 PARAM=APCP/24 FH0UR=27+39+51+63+75+87 V_RGN=G212/RFC VYMDH=201402050D00-201403042300 CI ALPHA=0.050



STAT=FH0 PARAM=APCP/24 FHOUR=27+39+51+63+75+87 V_RGN=G212/RFC VYMDH=201402050000-201403042300 CI ALPHA=0.050



THRESHOLD (INCHES)



Precipitation Verification (slight improvement in all 3 models): subgroup means (Feb 5 – Mar 4, 2014)





WRF_ARW

STAT=FH0 PARAM=APCP/24 FHOUR=27+39+51+63+75+87 V_RGN=6212/RFC VYMDH=201402050000-201403042300



STAT=FH0 PARAM=APCP/24 FHOUR=27+39+51+63+75+87 V_RGN=G212/RFC VYMDH=201402050000-201403042300



THRESHOLD (INCHES)





Why: similar in NMMB and NMM but much improved in some ARW members











Lake Ice → Lake Effect snow (WPC concern)



NMMB member lacks of "Lake-Effect" snow







Lake Ice on Jan. 5, 2014







← lake ice in model (before)



← lake ice in model (after)





















Cloud ceiling height issue (over snow and two NMMB_GFS members) (AWC concern)



Fix of "touching ground cloud-ceiling height over snowing area"



Before

After



100 200 300 500 700 800 1000 2000 3000 5000 7000 9000110001500020000

Produced by JUN DU. EMC/NCEP/NOAA

100 200 300 500 700 800 1000 2000 3000 5000 7000 9000110001500020000 Produced by JUN DU, EMC/NCEP/NOAA



Before: two NMMB_GFS members look very different from other members (significant low bias in ceiling height)



DOM_AK Ceiling (m) 21H fast fram DBZ 25 JUL 2013 (mem 1) yeilfied time: 05z, 07/27/2013



DOM_AK Cellsy (m) 21H fast fram DBZ 25 JD, 2113 (mem 4) yeitfied time: 05z, 07/27/2013



DOM_AK Ceiling (m) 21H fast from 092 25 JUL 2013 (mem 7) veilfied time: 05z, 07/27/2013



DOM_AK Ceiling (m) 21H fast from D92 25 JUL 2013 (mem 2) yeitfied time: 052, 07/27/2013



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DOM_AK Ceiling (m) 21H fast fram B92 25 JUL 2013 (mem 8) yeithed times 057, 07/27/2013



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DOM_AK Celling (m) 21H fcst from 892 25 JUL 2013 (mem 3) verified time: 052, 07/27/2013



DOM_AK Ceiling (m) 21H fast from B92 25 JUL 2013 (mem 6) verified time: 052, 07/27/2013



DOM_AK Ceiling (m) 21H fest from B92 25 JUL 2013 (mem 9) veilfied times 057, 07/27/2013



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After: two NMMB_GFS members look more like other members (low bias much reduced but still exists!)



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D3H_AK Ceiling (m) 21H fast from 892 30 JUL 2013 (mem 9) veilfied time: 05z, 07/31/2013





Consistent with the AWC's evaluation result in SREF Flight Rule Distribution Comparison (Steven Lack)



(Look at Feb 1-28 2014; East Coast North Region with a good mixture of precipitation types)

(1) ARW members decrease the occurrence of LIFR closer to that of the observed distribution. Rain is also fairly similar. Good improvement over current operational version.

(2) NMM parallel has an overemphasis on IFR conditions in the parallel version during snow, and a little too much LIFR during rain, but much better over the current operational version.

(3) MMB members show an improvement as well, however the P2 and N2 solutions still stick out as being much different in the operational and parallel versions. This is similar to NMM results with slightly too much IFR in snow and LIFR in rain.







Urban Swamp Problem



Eric Rogers' rerun with the fix: impact concentrated in major metropolitan areas





(a) Before

2-M TEMP OPSNEST 21H FCST VALID 21Z 20 JUL 2013



-40-38-32-28-24-20-18-12-8 -4 0 4 8 12 15 20 24 28 32 36 40 44

(b) After

2-M TEMP TESTNEST 21H FCST VALID 21Z 20 JUL 2013



^{-40-38-32-28-24-20-18-12-8 -4 0 4 8 12 16 20 24 28 32 36 40 44}







Eastward shift bug



Before: grid-eastward shifting issue prdgen weights in nmm







Before: grid-eastward shifting issue prdgen weights in nmm











4 winter weather variables have been added for WPC:

- a) low-level Rime Factor;
- b) snow depth;
- c) percentage of frozen precipitation; and
- d) water equivalent accumulated snow depth.



Snowfall with "regular" 2mT-based and "Rime Factor-based" SLR (Rime Factor is normally lower in values) AZOMTA DA

NOAA









Make-up of "Time-continuity" in clusters (WPC concern)



old clustering



moves backward



new clustering



500MB Z-VORT nmm_ctl_x 51H FCST VALID 12Z 16 SEP 2013





old clustering

500MB Z-VORT nmm_ctl 60H FCST VALID 21Z 16 SEP 2013



new clustering

500MB Z-VORT nmm_ctl_x 60H FCST VALID 21Z 16 SEP 2013



moves too fast



500MB Z-VORT nmm_ctl_x 63H FCST VALID 00Z 17 SEP 2013





old clustering

500MB Z-VORT nmm_ctl 81H FCST VALID 18Z 17 SEP 2013



new clustering

500MB Z-VORT nmm_ctl_x 81H FCST VALID 18Z 17 SEP 2013



no continuity at all



500MB Z-VORT nmm_ctl_x 84H FCST VALID 21Z 17 SEP 2013









 Using model lowest level fields to fill in the 2m and 10m fields at f00 in NMMB members





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CDM_US 2m-Temp (F) 0DH fost from D9Z 31 dBL 2013 (mem 10) vertiled date: 09Z, 07/31/2013

Im-Temp (F) 00H fost from 09Z 31 JUL 2013 (mem 1) verified time: 08Z, 07/31/2013



CON_US 2m-Temp (F) 00H fost from 09Z 31 JUL 2013 (mem 6) welfied time 09Z 07/31/2013



CDH_US 2m-Temp (F) 0DH fast from D9Z 31 JUL 2013 (mem 11) verified time: 092, 07/31/2013



CDH_US 2m-Temp (F) 0DH fost from D9Z 31 JUL 2013 (mem 16) verified time: 082, 07/31/2013



CON_US 2m-Temp (F) 00H fast from 09Z 31 JUL 2013 (mem 3) withed time 09Z, 07/31/2013



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CDM_US 2m-Temp (F) 00H fast from D9Z 31 dUL 2013 (mem 18) vertilad time: 09Z, 07/31/2013



CON_US 2m-Temp (F) 00H fost from 09Z 31 JUL 2013 (mem 4) witted take 09Z, 07/31/2013



CON_US 2m-Temp (F) 00H fcst from 09Z 31 JUL 2013 (mem 9) validad time 09Z 07/31/2013



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CDM_US 2m-Temp (F) 00H fast from D9Z 31 JUL 2013 (mem 19) verified dime: 08Z, 07/31/2013





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CDM_US 2m-Temp (F) 00H fast from D9Z 31 JUL 2013 (mem 20) vertilad time: 092, 07/31/2013



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CDM_US 2m-Temp (F) 00H fast from D9Z 31 JUL 2013 (mem 17) verified time: 09Z, 07/31/2013

CON_US 2m-Temp (F) 00H fest from 08Z 31 JUL 2013 (mem 2) witted time 08Z, 07/31/2013

CON_US 2m-Temp (F) 00H fcst from 09Z 31 JUL 2013 (mem 7) withed time 09Z, 07/31/2013

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COM_US 2m-Temp (F) 00H fest from 21Z 19 DEC 2013 (mem 1) verified time: 21z, 12/19/2013



22 40 50 40 70 40 40 Product of the state that The Party Party

COM_US 2m-Temp (F) 00H fost from 21Z 19 DEC 2013 (mem 6) verified time: 21z, 12/19/2013



52 40 54 90 78 90 40

COM_US 2m-Temp (F) 00H fcst from 212 19 DEC 2013 (mem 11) verified time: 212, 12/19/2013



22 40 50 40 70 40 40 PRODUCED DE LOS DOL ENCONCERCIÓN

COM_US 2m-Temp (F) 00H fcst from 212 19 DEC 2013 (mem 16) verified time: 212, 12/19/2013



Produced by JUN DJ. Dec/hctP/hcka

COM_US 2m-Temp (F) 00% fost from 21Z 19 DEC 2013 (mem 3) verified time: 21z, 12/19/2013



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51 +0 50 +0 70 #e .00

22 40 50 10 70 50 90

50 20 N 40 50 40 N 40 00

Produced in July DO. Dec./MERP./MOAR

Produced by JUN DOL ENCOURTING

COM_US 2m-Temp (F) 00H fast from 212 19 DEC 2013 (mem 7) verified time: 212, 12/19/2013

COM_US 2m-Temp (7) 00H fcst from 21Z 19 DEC 2013 (mem 12) verified time: 21z, 12/19/2013

COM_US 2m-Temp (F) 00H fcst from 21Z 19 DEC 2013 (mem 17) verified time: 21z, 12/19/2013

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at - 30 - 20 - 10





52 40 56 90 78 80 90

COM_US 2m-Temp (F) 00H fcst from 212 19 DEC 2013 (mem 13) verified time: 212, 12/19/2013



22 40 50 40 70 40 40 Produced by JOS DO, The Children Children

COM_US 2m-Temp (F) 00H fcst from 21Z 19 DEC 2013 (mem 18) verified time: 21z, 12/19/2013



Produced by 20% DU. ENC/h02P/m044

COM_US 2m-Temp (F) 00H fcst from 21Z 19 DEC 2013 (mem 4) verified time: 21z, 12/19/2013



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COM_US 2m-Temp (F) 00H fcst from 212 19 DEC 2013 (mem 9) verified time: 21z, 12/19/2013



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COM_US 2m-Temp (F) 00H fost from 21Z 19 DEC 2013 (mem 19) verified time: 21z, 12/19/2013



Produced by JUS DO. ENCANCER/NOAK

COM_US 2m-Temp (F) 00% fost from 21Z 19 DEC 2013 (mem 5) verified time: 21z, 12/19/2013



40 50 40 70 80 90

COM_US 2m-Temp (F) 00H fest from 212 19 DEC 2013 (mem 10) verified time: 212, 12/19/2013



22 40 50 10 70 10 10 41 -30 -31 -15 8

COM_US 2m-Temp (F) 00H fcst from 21Z 19 DEC 2013 (mem 15) verified time: 21z, 12/19/2013



22 40 50 40 70 40 40 at -50 -21 -19 Produced by JON DO. ENCINCERTING

COM_US 2m-Temp (F) 00H fcst from 212 19 DEC 2013 (mem 20) verified time: 212, 12/19/2013



32 40 54 90 Produced by 200 bit Decided 517







- T2m and 3h-apcp of 21 SREF members were added to 32km NA domain (g221) into AWIPS (Eastern region request for RFC hydro ensemble via NCO)
- SREF bufr sounding sites change (AWC request etc.):
 68 sites added
 - 3 sites removed
 - 7 sites replaced by a nearby site
- Code improvements: (a) p vs log(p), tiny change in result, (b) NetCDF I/O for NMM and ARW, identical result – ARW model code more reliable and NMM/ARW runs resource saving.





1. Replacing GFS/GEFS IC with RAP IC as well as replacing GFS land surface initial states with NDAS ones improve moist and cold bias in initial time and early forecasts, but the impact reduces with time for both ARW and NMM.

For NMM, the total error in T2m and Td2m is reduced especially in warm season;

For ARW, total error of T2m and Td2m is slightly reduced in warm season but opposite in cold season, while no improvement is seen in their biases in domain averaged statistics;

Probabilistic forecasts of 2mT and 2m Td are generally improved in both warm and cold seasons for both NMM and ARW;

Spread is slightly reduced due to ARW members;

2. Cases show impressive improvements in precipitation forecasts, winter weather and dense fog forecasts especially for ARW members, statistics shows similar or slight improvement in precipitation forecasts;

Summary 2





3. Significant improvements in ceiling forecasts over snow;

4. Many new user-requested variables have been added: individual member 2m and precipitation to AWIPS, 4 winter-weather variables, extra bufr sites, f00 fields at 2m and 10m levels in NMMB;

5. Improved clustering (time continuity) requested by WPC;

6. Many bugs have been fixed leading to important improvements in various detail aspects:

- (a) eastward shift in NMM,
- (b) lake ice in NMMB,
- (c) NOAH LSM for urban swamp in NMMB,
- (d) NOAH LSM for negative soil moisture fractions for NMM and ARW;

7. Improvement in codes to be more reliable and resource saving:
(a) log(p) → p in ARW;

(b) NetCDF I/O in NMM and ARW (save 10 min).



- ARW spread is too small as well as having a spread shock at 3hr (root cause is IC discontinuity due to the RAP domain being smaller than SREF, so we cannot simply increase IC perturbation size);
- 2. Too large in winter weather ptype area of ARW members (a fix is ready);
- 3. Low bias of two NMMB_GFS members ceiling height;
- 4. Cold bias in NMM and ARW models. Since IC and land states have been taken care of, indicating the problem might in physics;
- 5. Investigate March 3rd case why warmer and further north solution.





Backups

| Member (Model) | IC | IC perturb | physics | | | | | | | Land surface | | |
|-------------------|------|---------------|--------------------|---------------------|------|------|-----|--------------------------|------------|--------------|---------|----------|
| | | | conv | mp | lw | SW | pbl | Sfc layer | stochastic | model | initial | perturb. |
| nmmb_ctl | NDAS | BV | BMJ | FER | GFDL | GFDL | MYJ | MYJ | no | NOAH | NAM | no |
| nmmb_n1 | | | | | | | | | | | | |
| nmmb_p1 | | | | | | | | | | | | |
| nmmb_n2 | | | SAS | GFS | GFDL | GFDL | GFS | MYJ | no | NOAH | | |
| nmmb_p2 | | | | | | | | | | | | |
| nmmb_n3 | | | BMJ | WSM6 | GFDL | GFDL | MYJ | MYJ | | NOAH | | |
| nmmb_p3 | | | | | | | | | | | | |
| nmm_ctl | GFS | BV+ET R | BMJ | FER (new Eta) | GFDL | GFDL | MYJ | M_Obuhov (Janjic Eta) | no | NOAH | NAM | no |
| nmm_n1 | | | | | | | | | | | | |
| nmm_p1 | | | | | | | | | | | | |
| nmm_n2 | | | SAS | FER (new Eta) | GFDL | GFDL | MYJ | M_Ouhov (janjic Eta) | no | NOAH | | |
| nmm_p2 | | | | | | | | | | | | |
| nmm_n3 | | | KF (new Eta) | FER (new Eta) | GFDL | GFDL | MYJ | M_obuhov (janjic Eta) | no | NOAH | | |
| nmm_p3 | | | | | | | | | | | | |
| arw_ctl | RAP | BV | KF (new Eta) | FER (new Eta) | GFDL | GFDL | MYJ | M_obuhov (Janjic Eta) | no | NOAH | NAM | no |
| arw_n1 | | | | | | | | | | | | |
| arw_p1 | | | | | | | | | | | | |
| arw_n2 | | | BMJ | FER (new Eta) | GFDL | GFDL | MYJ | M_obuhov (Janjic Eta) | no | NOAH | | |
| arw_p2 | | | | | | | | | | | | |
| arw_n3 | | | BMJ | FER (new eta) | GFDL | GFDL | MYJ | M_Obuhov (Janjic Eta) | no | NOAH | | |
| arw_p3 | | | | | | | | | | | | |

2-M TEMP em_ctl 87H FCST VALID 00Z 14 JAN 2014

2-M TEMP em_ctIT 87H FCST VALID 00Z 14 JAN 2014



+0-30-32-28-24-20-10-12-8 -+ 0 + 8 12 16 20 2+ 28 32 36 40 ++

SLP,3-H APCP em_ctl 84H FCST VALID 21Z 13 JAN 2014



SLP and 3h-apcp at F84hr 🛋

VISIBILITY (KM) em_ctl 87H FCST VALID 00Z 14 JAN 2014





VISIBILITY (KM) em_ctIT 87H FCST VALID 00Z 14 JAN 2014



Little impact of hypsometric change In ARW from 2 (logP) To 1 (P)



T2m at F87hr

SLP,3-H APCP em_ctlT 84H FCST VALID 21Z 13 JAN 2014





surface visibility at f87hr