



## 6<sup>th</sup> NCEP Ensemble User Workshop

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# Short Range Ensemble Forecast (SREF)

Jun Du, Geoff DiMego, Dusan Jovic, Binbin Zhou, Bo Yang and Brad Ferrier

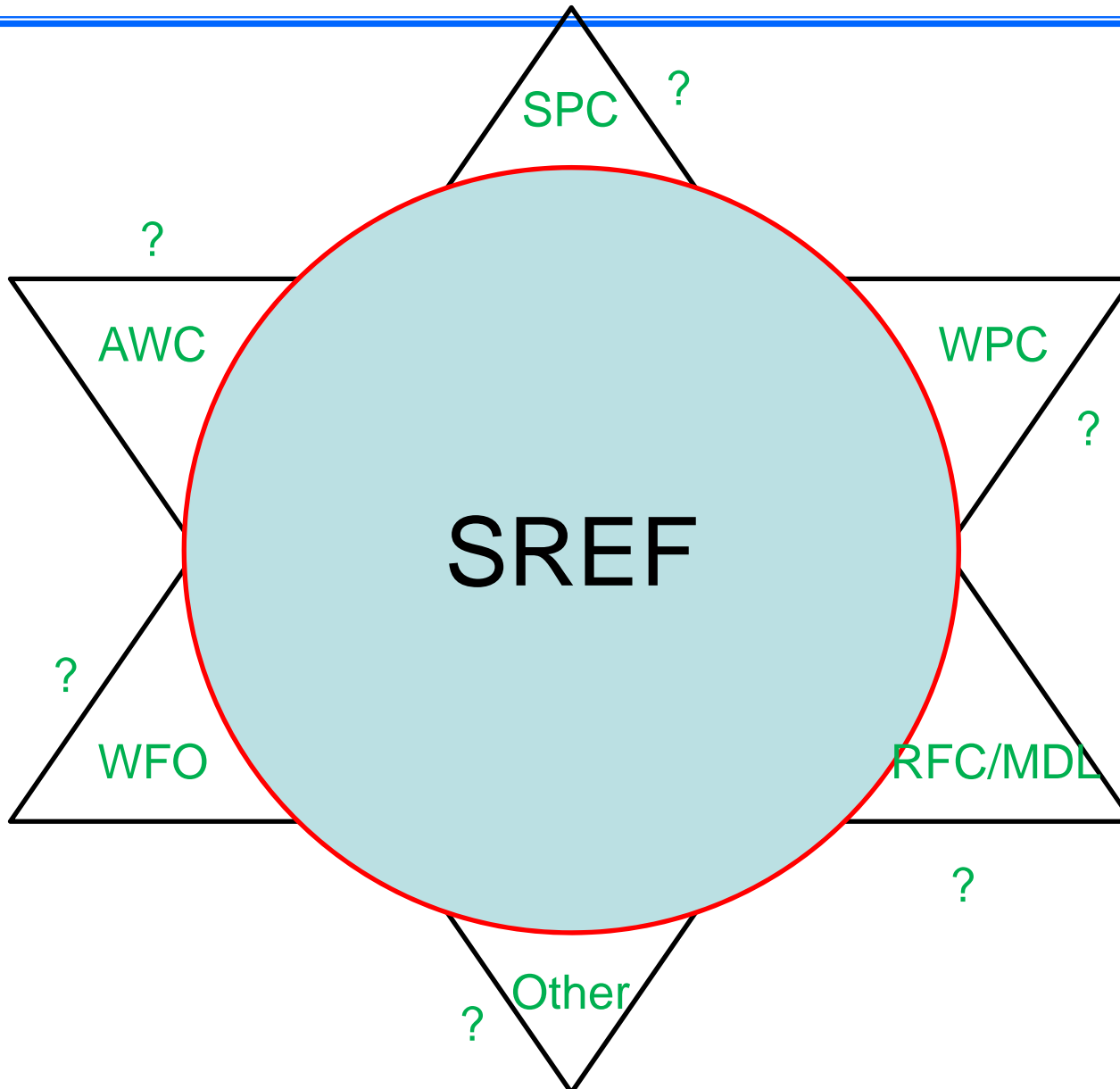
March 25-27, 2014

Du, J., G. DiMego, B. Zhou, D. Jovic, B. Ferrier, B. Yang, S. Benjamin, 2014: NCEP Regional Ensembles: Evolving toward hourly-updated convection-allowing scale and storm-scale predictions within a unified regional modeling system. *22nd Conf. on Numerical Weather Prediction and 26th Conf. on Weather Analysis and Forecasting*, Atlanta, GA, Amer. Meteor. Soc., Feb. 1-6, 2014, paper J1.4.



# What to expect from the workshop

(1) Users: tell EMC what the white areas are?

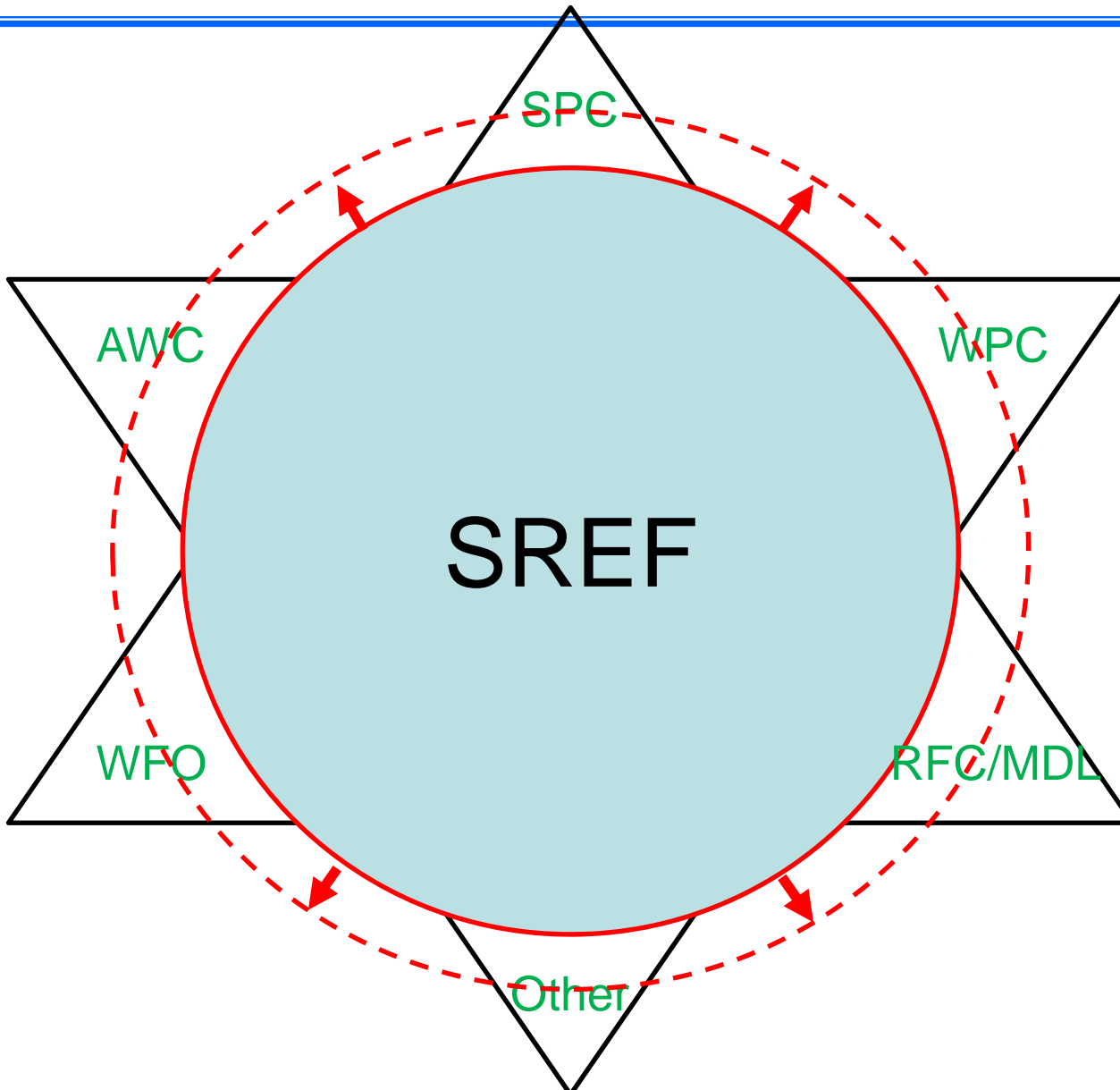




# What to expect from the workshop



(2) EMC: expand the SREF circle to cover more white areas





# Current SREF



- **Configuration**: 16km, 21 members, 0-87hr, North America domain, 4 cycles per day
- **IC uncertainty**: multi-analysis, Breeding and ETR perturbations, multi-LBCs
- **Physics uncertainty**: multi-model and multi-physics
- **Post-processing**: bias correction and downscaling
- **Products**: mean, spread, probability, percentiles, range, clusters
- **Users**: WPC, SPC, AWC, MDL, WFOs, RFCs, private companies and universities...





# SREF five-year plan (2014-2018)



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<b>FY</b>	<b><u>Model</u></b>	<b><u>Resolution</u></b>	<b><u>Membership</u></b>	<b>cycles</b>	<b>length</b>	<b>ICP</b>	<b>Stoch Phy</b>
2014	NMMB/NMM/ARW	16km (NA)	21	03/09/15/21	3.5 days	BV/ETR	no (my talk)
2015	NMMB/ARW	12km (NA)	22	03/09/15/21	3.5 days	BV/G-EnKF	yes? (my talk)
2016	NMMB/ARW	9km (NA)	22	hrly (1 <sup>st</sup> 24h)	3.5 days	R-EnKF	yes (Geoff's talk)
2018	NMMB/ARW	3km (CONUS)	22	hrly (1 <sup>st</sup> 24h)	3.5 days	R-EnKF	yes (Geoff's talk)



# SREF interim upgrade package will be implemented on March 26, 2014 (Tomorrow)



## Part I: Bug fix and improvements

- **Correct / improve initial conditions:**
  - a) replace GFS land states with NDAS land states in NMM & ARW members;
  - b) correct inadvertent use of global initial conditions with use of RAP for ARW members;
  - c) rewrite NDAS land states in NMMB to fix a bug in NPS related to lake ice.
- **Fix bugs in NOAH LSM:**
  - a) eliminate negative soil moisture fractions for NMM and ARW members;
  - b) eliminate “urban swamp” 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;
  - 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

## Part II: New 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 temp and 3-hrly accumulated precipitation** of 21 SREF members to AWIPS (221 grid)
- **Modify the clustering algorithm** to “make up” time-continuity within a cluster
- **Add more bufr sites**
- **Use model-lowest level fields for T2m, Q2m, U10, V10, Td2m, RH2m at f00 for NMMB**



## Known issues to improve in the FY15 upgrade: “A user-oriented development strategy”

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1. 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 much coverage of winter weather precipitation type in ARW members (a fix is ready);
3. Low bias for ceiling height in two of two NMMB\_GFS members;
4. Surface temperature cold bias in NMM and ARW models;
5. Wet bias in ARW;
6. Dry bias in NMMB.

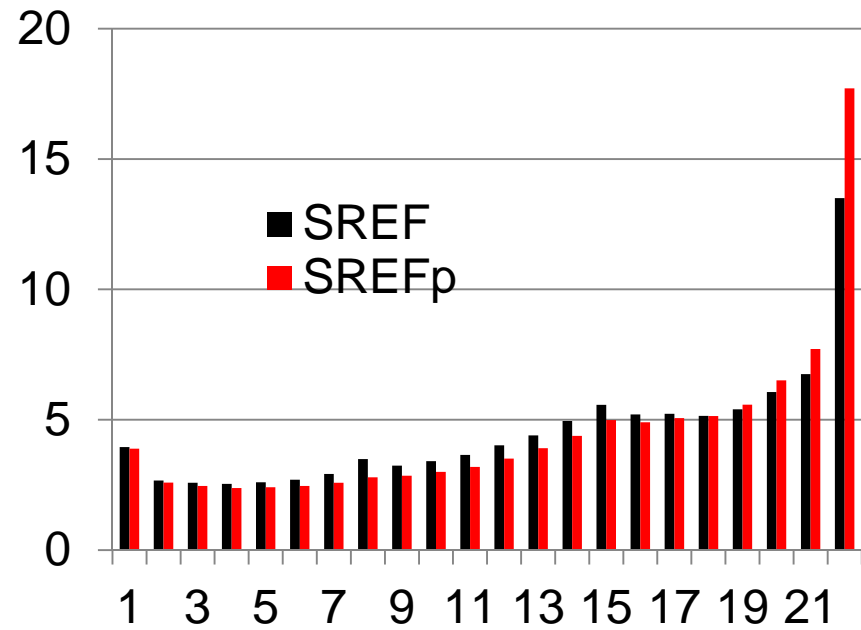
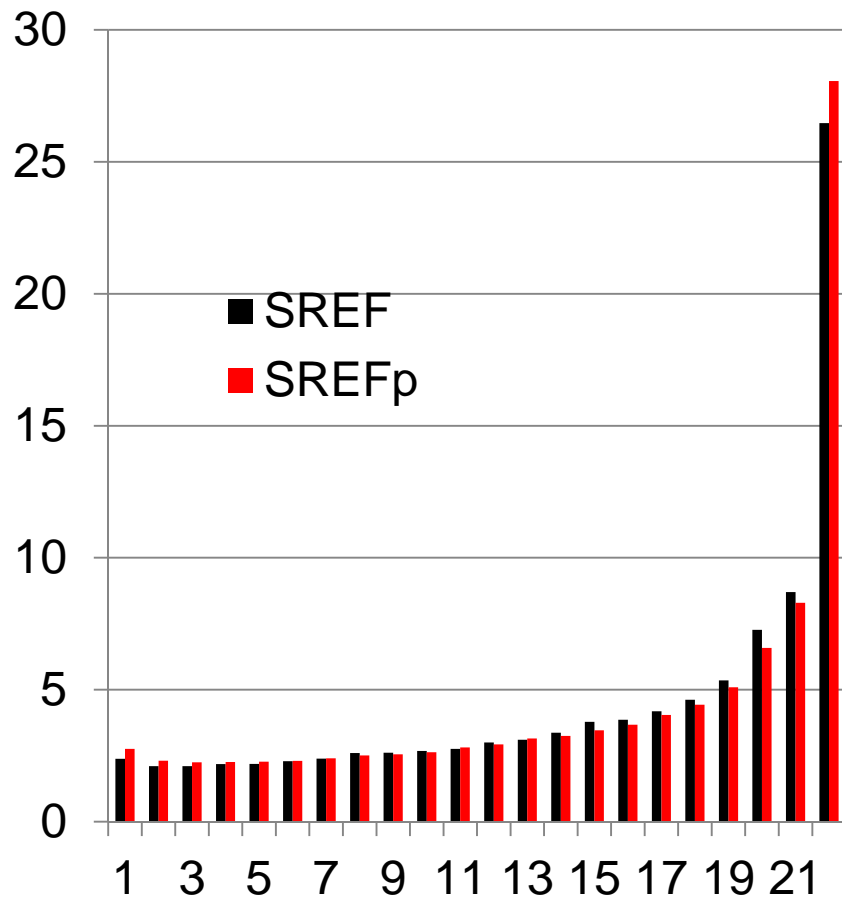




# Talagrand Distribution of T2m at F87h



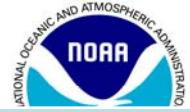
Warm season (July 15 – Aug. 31, 2013)    Cold season (Oct 1 – Feb 28, 2014)



SREF 2m T: Strong cold bias especially in warm season



# SREF's next major upgrade (2015)



Current SREF 2014	Upgrade SREF 2015 (to be decided)
<b>System</b>	
nmmb, wrf_arw, wrf_nmm	nmmb, wrf_arw
16km	~12km
35 levels	40 levels (same as hi-res window run)
21 members	22 members
limited diversity	more physics diversity
BV and ETR	Global EnKF perturbations for a few members
<b>Products</b>	
none	anomaly forecasts
simple ensemble mean (precipitation)	probability-matching ensemble mean (precipitation)
none	variables at 80m AGL, TKE, wind chill, heat index, wind gust, ...
<b>Downscaling</b>	
none	Tmax, Tmin, 2mTd, ... (same as NAEFS)
<b>Other</b>	
grib1	grib2 (likely)



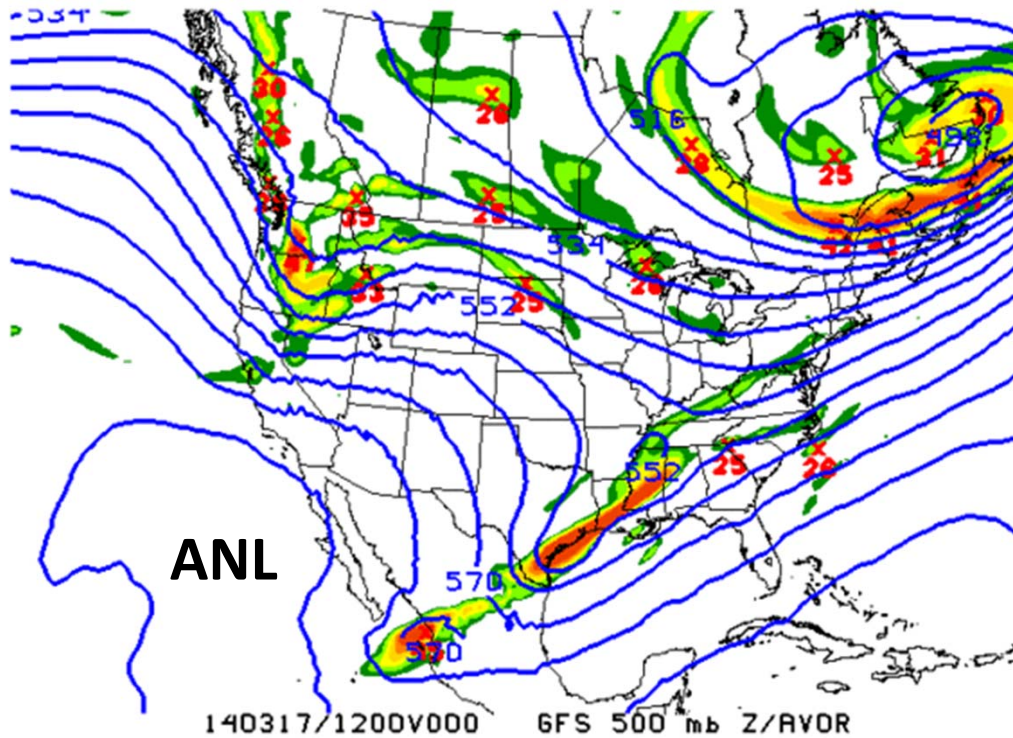
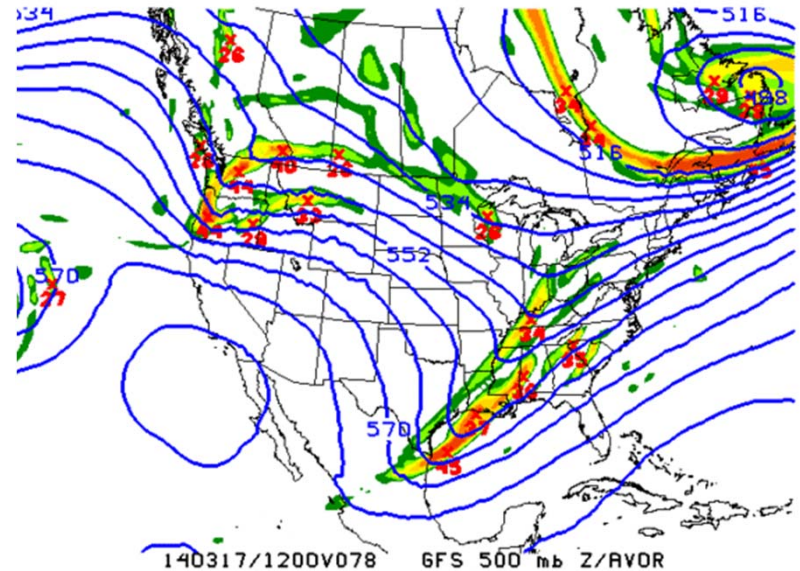
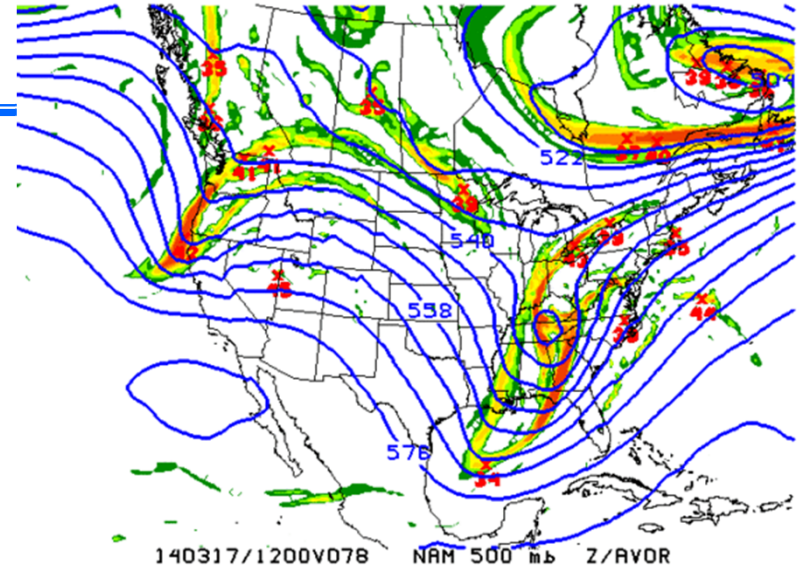
## Particular challenges in the FY15 package



- Lose diversity by eliminating NMM model core → more physics scheme diversity and adding stochastic physics to compensate?
- Strong impact by control IC analysis → mix use of 3 control analysis (NDAS, GDAS, RR)



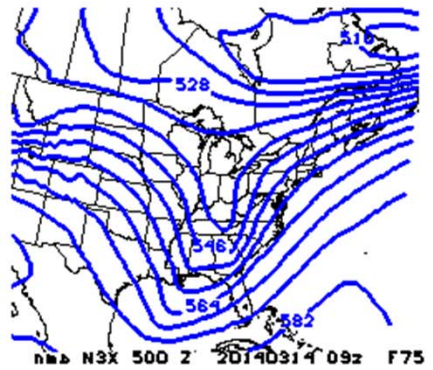
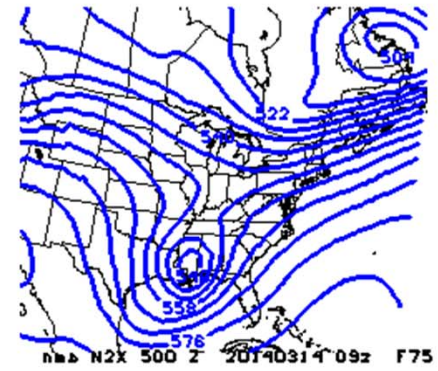
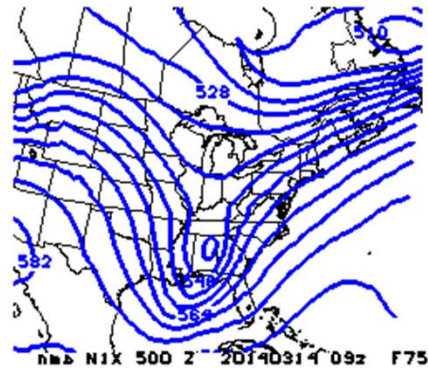
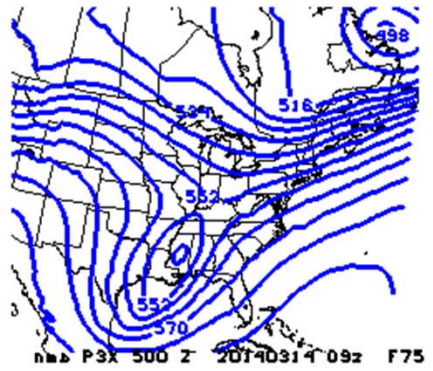
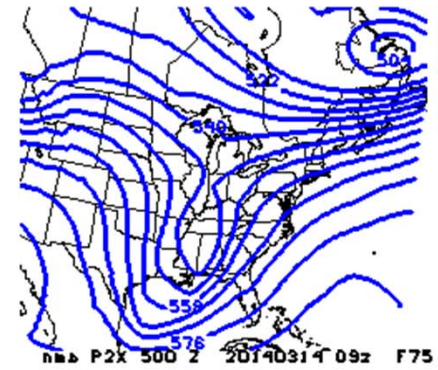
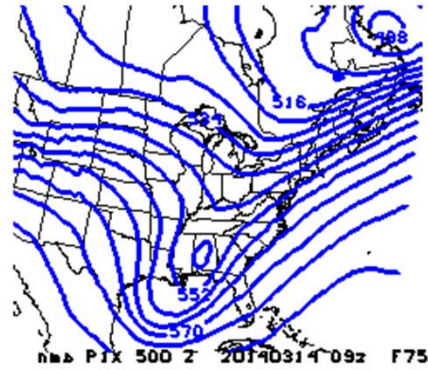
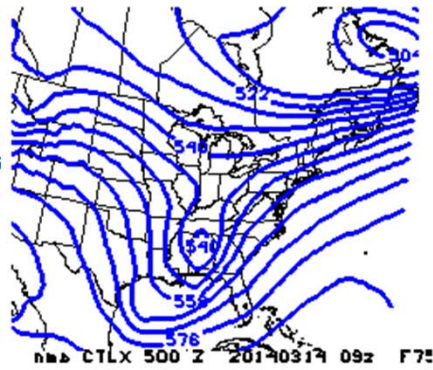
6z 3/14 NAM too deep  
and less tilted with trough  
(Geoff Manikin)



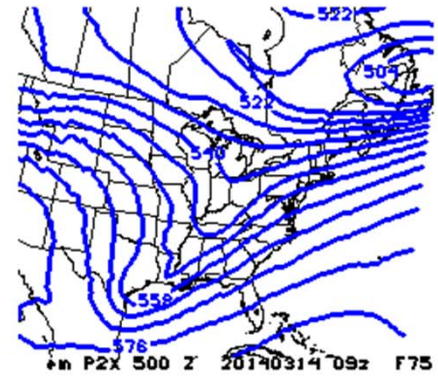
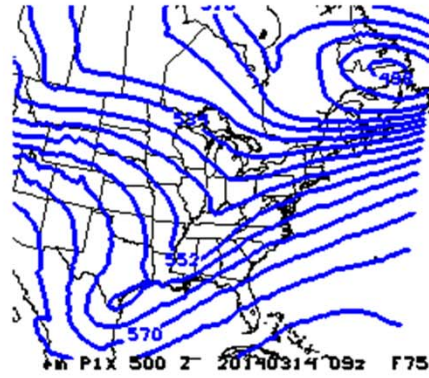
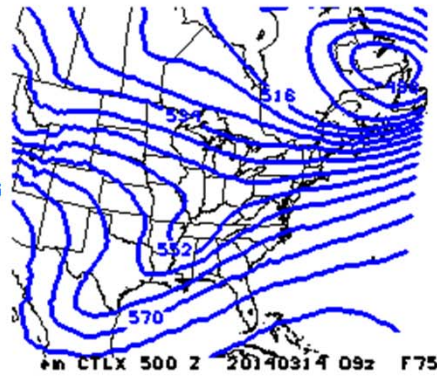
How will this affect 09z NMB SREF members?



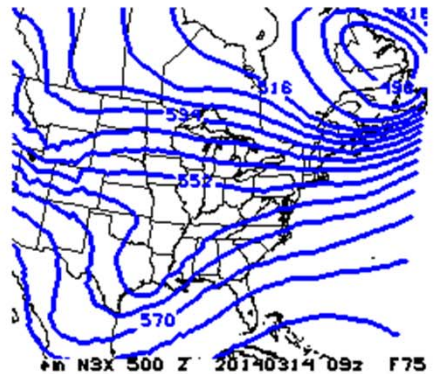
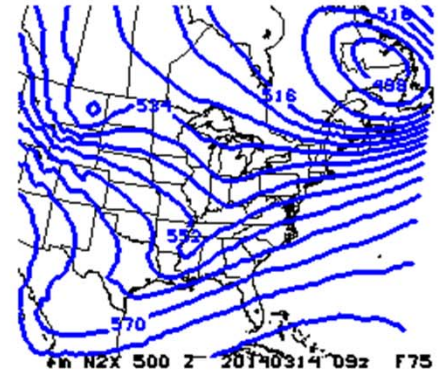
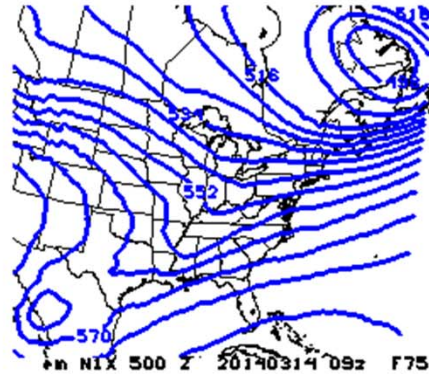
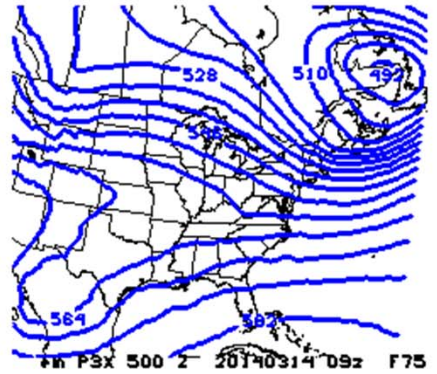
09z 3/14  
SREF  
NMB  
MEMBERS

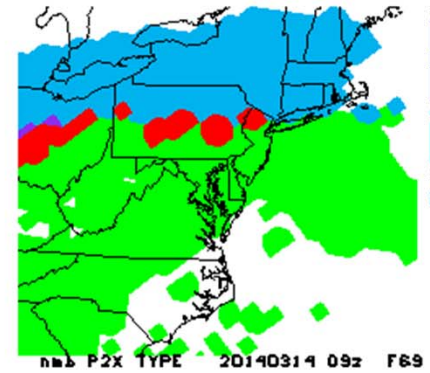
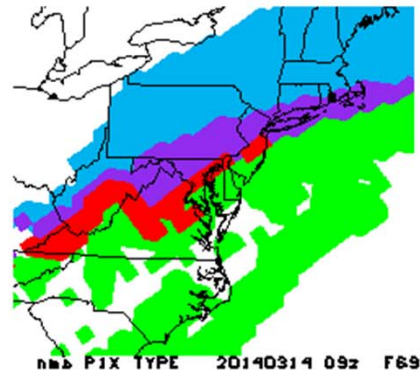
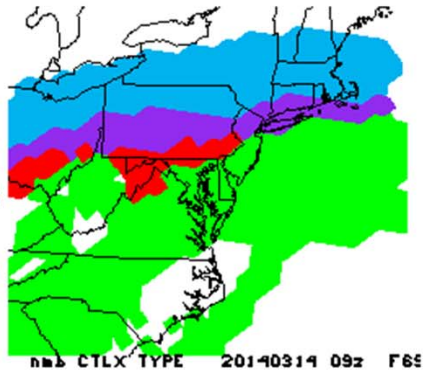


All NMB members,  
initialized by the NAM,  
have an amplified solution

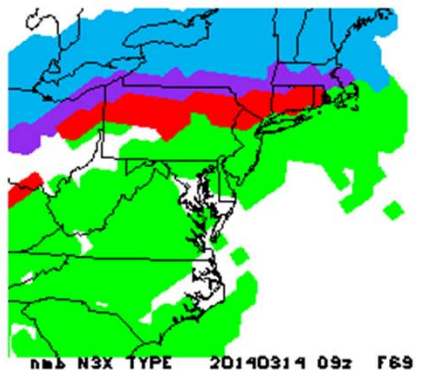
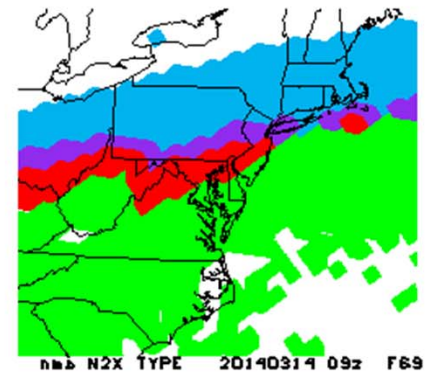
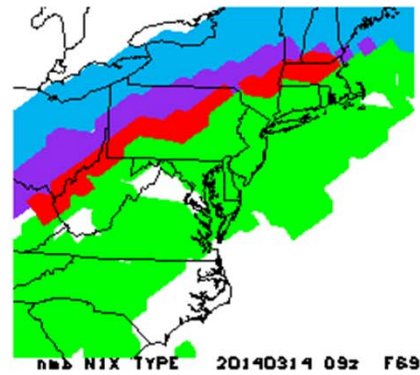
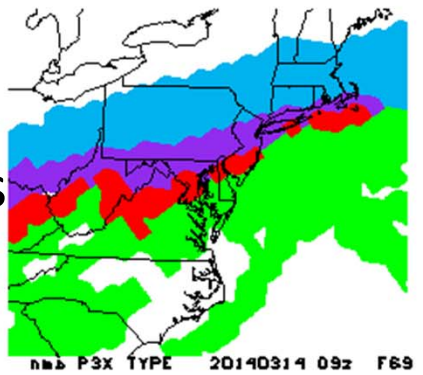


09z 3/14  
SREF ARW  
MEMBERS,  
Initialized by  
GFS-like RR





09z 3/14  
SREF NMB  
MEMBERS:  
warm air pushes  
to too north



No NMB member  
has snow

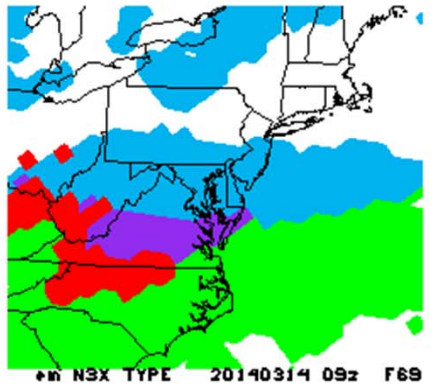
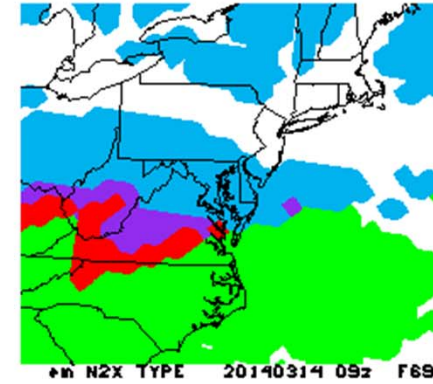
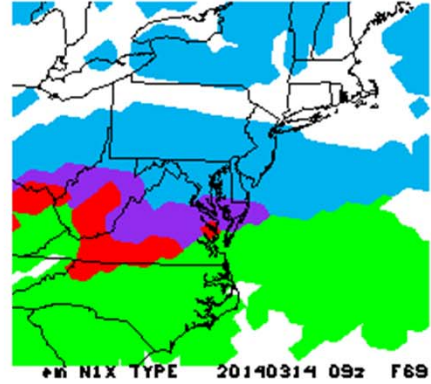
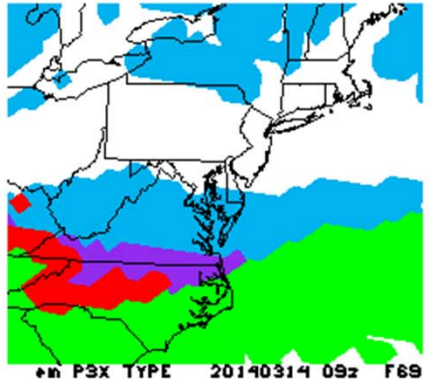
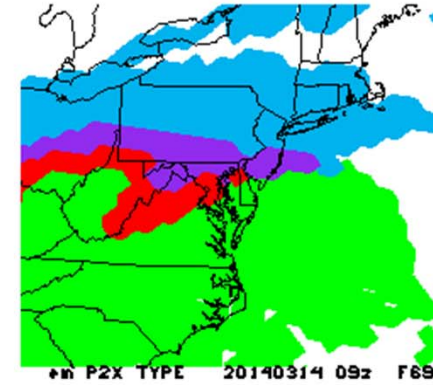
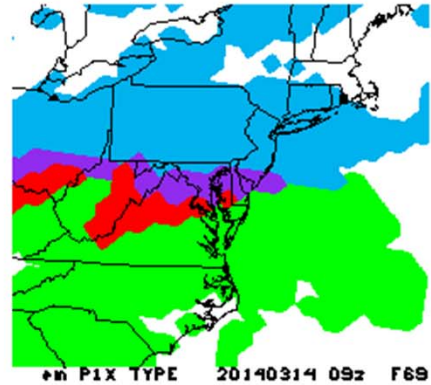
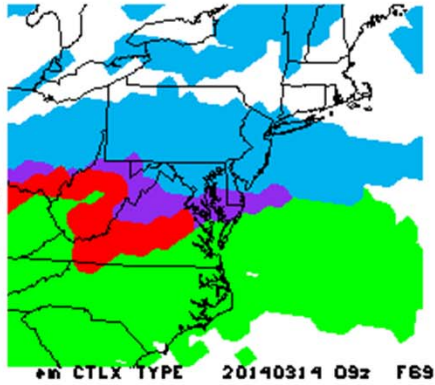


09z 3/14

SREF ARW

MEMBERS:

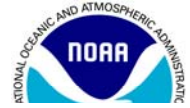
warm air not  
pulled as far  
north - snowier  
solutions for  
Mid-Atlantic







# Little snow in NMMB members

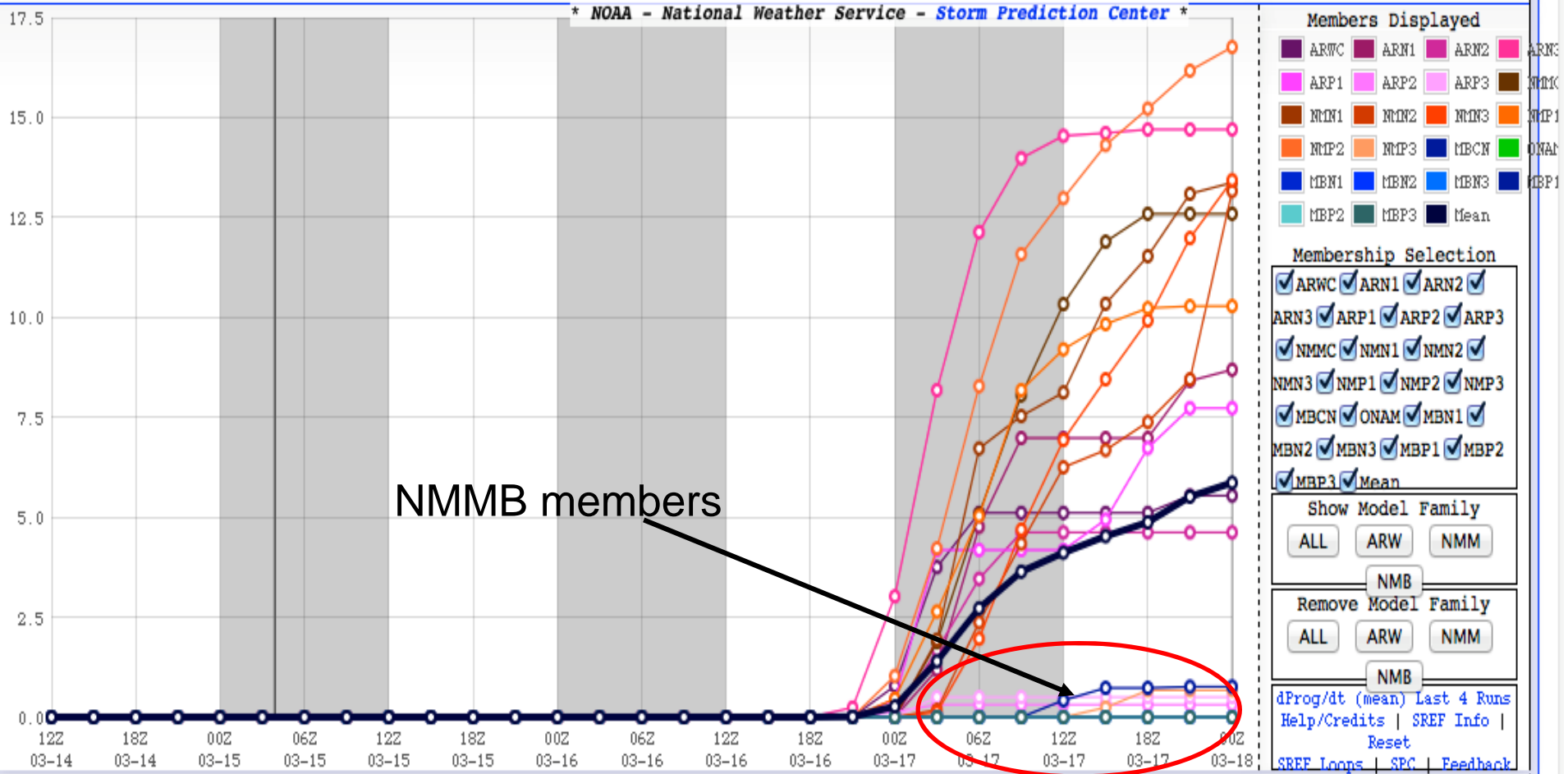


NCEP SREF plume for Total-SNO at DCA from 20140314/09 UTC run (data unavailable for some selections).

Change date: 20140314 and select runtime: 03 09 15 21 to view archived forecasts and verifying observations (TEMP, DWPT, RH, WIND).

Forecast Parameter Selection - Hover over buttons for more information.

- 3hrly-TMP
- 3hrly-DWP
- 3h-MUCAPE
- 3h-MLCAPE
- 3h-EFFSHR
- 3hrly-QPF
- Total-QPF
- 3hrly-SNO
- Total-SNO
- Ptype-POP
- 3hr-2mRH%
- 3h-10mWND



NCEP Mesoscale Ensembles Replace Regional Deterministic Guidance: current and future

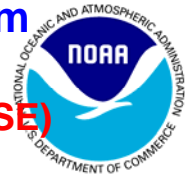
(see the next talk by Geoff DiMego)



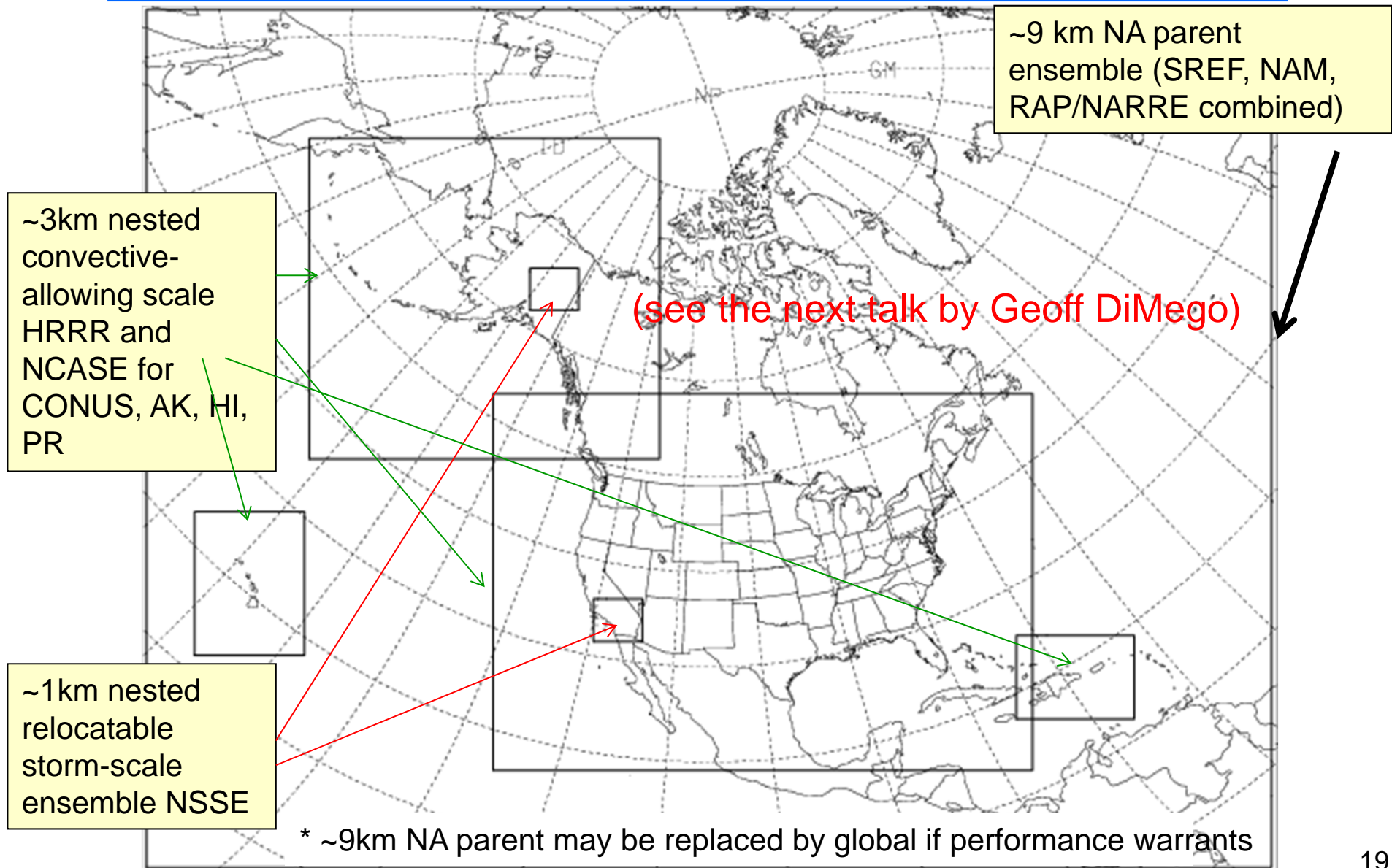
Current	~2015	~2018
<b>SREF continental scale</b>	<b>SREF continental scale</b>	<b>SREF continental scale</b>
WRF-ARW, -NMM, NMMB	WRF-ARW & NMMB	WRF-ARW & NMMB
7 each = 21 members 16 km	11 each = 22 members ~12 km	11 each = 22 members ~9 km (parent)
35 levels 6 hourly to 87 hr	40-60 levels 6 hourly to 87 hr NARRE run hourly to 18 hr	50-60 levels 6 hourly to 96 hr NARRE run hourly to 24 hr
<b>Convection-Allowing-Scale</b>	<b>Convection-Allowing-Scale</b>	<b>Convection-Allowing-Scale Ensemble (NCASE)</b>
Irregular suite of guidance 3-6km [HiResWindows & NAM nests] ~6 hourly to 48/60 hr for CONUS, Alaska, HI, PR	Single hourly 3 km HRRR & NAM nest run to 15 hr for CONUS Upgrade irregular suite to ~3 km 6 hourly to 48/60 hr for CONUS, Alaska, HI, PR	Ensemble HRRR (NCASE) Multiple hourly 3 km Run to 24 hr for 6 hourly extended to 60 hr for CONUS, Alaska, HI, PR
<b>Storm Scale</b>	<b>Storm Scale</b>	<b>Storm Scale Ensemble</b>
Single placeable sub-nest [fire weather run] 1.33-1.5 km Run 6 hourly to 36 hr	Single placeable/movable sub-nest 1-1.5 km Run 6 hourly to 36 hr	Storm-scale ensemble (SSE) Multiple placeable/movable sub-nests: ~1 km run hourly to 18 hr and run 6 hourly to 36 hr



# Strategic Plan: unified 2-model (NMMB, ARW) regional modeling system



Ensembles replace all regional deterministic guidance (SREF/NARRE/NCASE/NSSE)





## NARRE\_TL and NCASE\_TL (see Binbin Zhou's talk)



### **NARRE-TL (12km, 10 mem, multi-model)**

North America Rapid Refresh Ensemble – Time Lagged (implemented in May 1, 2012)

**10 weighted time-lagged (multi-model) members from:**

- 6 NCEP's operational RAP members (12km)
- 4 operational NAM members (12km)

**Forecast hours:**

12 hours (hourly update)

**Output grids:**

CONUS and Alaska

**Products:**

Aviation, convection

[http://www.emc.ncep.noaa.gov/mmb/SREF\\_avia/FCST/NARRE/web\\_site/html/icing.html](http://www.emc.ncep.noaa.gov/mmb/SREF_avia/FCST/NARRE/web_site/html/icing.html)

### **NCASE-TL (4-5km, 20 mem, multi-model)**

**NCEP Storm-Scale Ensemble - Time Lagged (experimental)**

**20 weighted time-lagged (multi-model) members from:**

- NCEP 4km NAM nest (NMMB),
- NCEP 4km Hi-ResWindow (ARW and NMM),
- EMC 5km SPC WRF-NMM run
- GSD 4km HRRR (ARW) runs

**Forecast hours:**

12 hours (3 hourly update)

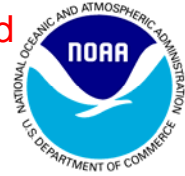
**Output grids:**

CONUS

**Products:**

Convection, aviation, fire weather and energy (wind).

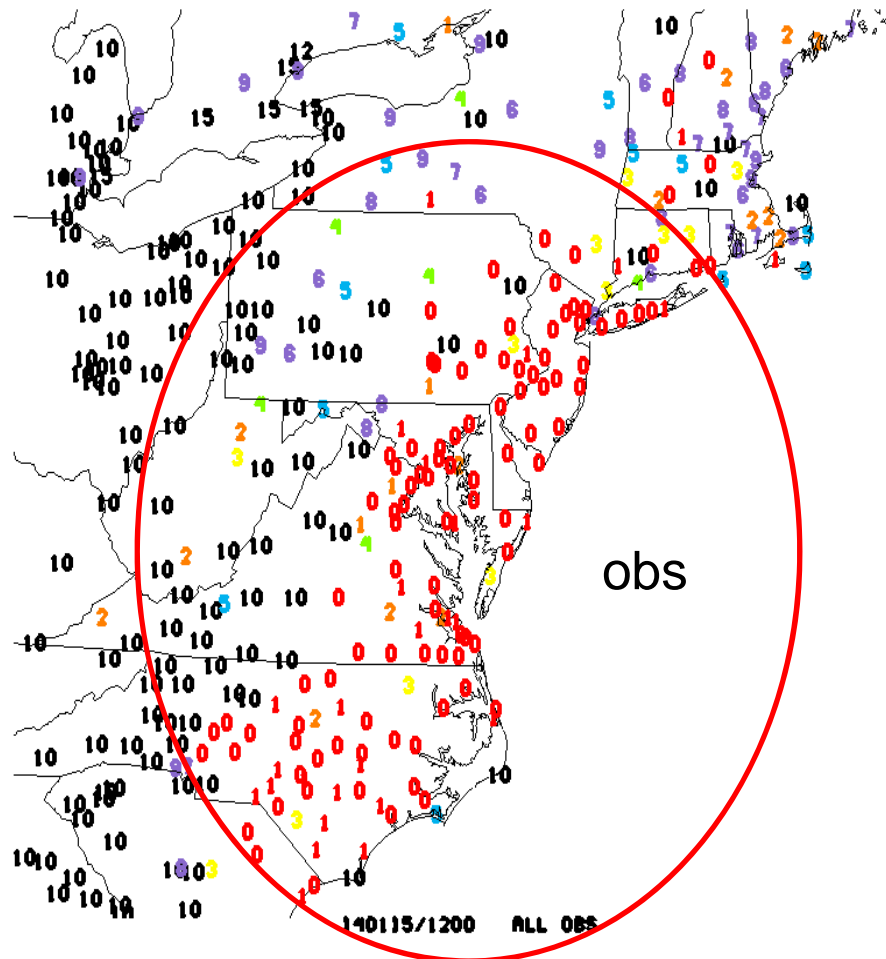
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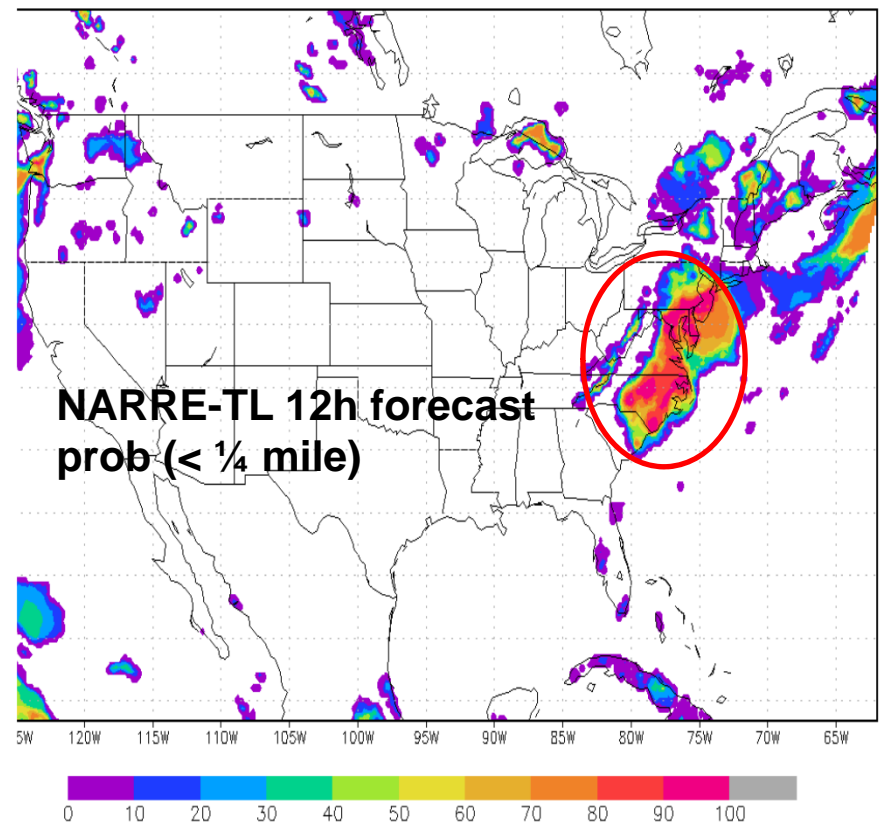
Positive feedbacks from WFOs about NARRE-TL:

- (1) Dense fog is difficult to forecast as we all know. The Rapid Refresh Ensemble did very well with tonight's event - much better than traditional MOS. ... Jeff
- (2) This product performed really well again tonight. As early as the 02z run, it showed the dense FG over PHL/NJ expanding N/NE into NYC/LI between 10-11z which matched satellite trends and the synoptic setup. Allowed for more confidence in the TAFs as there was big model discrepancy...NAM was also on the money, while GFS was out to lunch and completely dry in the low-levels. Adrienne referenced it in her AFD.

Jan. 15, 2014 (night-morning): Dense fog event in the east coast



NARRE-TL: Probability of visibility <math>< 1/4 \text{ mile}</math> 12H FCST from 00z Jan 15 2014. Verified Time: 12z 01/15/2014





# Summary



- NCEP operational SREF is a North America, 16km, 21-member, multi-analysis, multi-model and multi-physics regional ensemble prediction system, which is an integral part of U.S. NWP modeling system by providing useful and critical info to forecasters in their daily weather forecasting. It is planned to be upgraded to ~12km system in 2015.
- Convection-allowing scale (~3km NCASE or HRRRE) and storm-scale (~1km SSE) ensembles are planned to be implemented in about 5 years at NCEP. Prior to real NARRE and NCASE, NARRE-TL (12km) and NCASE-TL (4-5km) have been developed as their prelude to meet users' needs. Note, SSE might take longer due to technical challenges.
- Mesoscale ensembles will replace all regional deterministic guidance by strategically developing a unified regional modeling system at NCEP.
- Seeking more feedbacks from service centers during our system upgrade