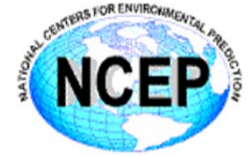# Aviation, Convection, Energy and Fire-Weather Ensemble Products in NCEP's Regional Ensemble Forecast Systems

Binbin Zhou[1,2], Jun Du[2], and Geoff DiMego[2]

1. I.M. System Group
2. EMC/NCEP/NWS/NOAA

❑ **Goal**

~ Support and provide ensemble guidance to aviation and other special weather predictions

❑　**3 NCEP regional ensemble forecast systems:**

❖ **SREF** (~16 km, 21 members)

~ Multi-model/multi-physics/IC breeding (7 ARW+7 NMM +7 NMMB)

~ Conventional and aviation weather ensemble

~ 4 runs/day, 3hr output out to 87 forecast hours

~ Over CONUS, Alaska, Hawaii

❖ **N. America Rapid Refresh Ensemble** (NARRE-TL,10mbr, ~13km)

~ 2 model *Time-Lagged* (4 NAM + 6 RAP)

~ Specific for aviation/convection ensemble

~ Hourly run, hourly output, total 12 forecast hours

~ Over CONUS and Alaska

❖ **NCEP Convection Allowing Scale Ensemble** (NCASE, 18mbr, ~ 4 km)

~ 4 model *Time-Lagged* (4 NAMnest + 4 HRRR + 5 WRF-NMMB + 5 WRF-ARW)

~ Specific for aviation, severe storm, fire weather and energy (wind) ensemble

~ Still experimental, 6 runs/day, hourly output, total 12 forecast hours

~ Over CONUS

❖ Time-lagged Ensemble

~ Collect existing/previous cycle files as members to build simple ensemble

~ How many members can be collected depends on Ttime-Lag window size and forecast length

~ *Un-equal member weight = 1 - age (hr)/ 30*

Cycles: C1   C2   C3 C4 C5 C6 C7

Time-Lag window
~ 30 hr

Forecast time window
~12 hr

4
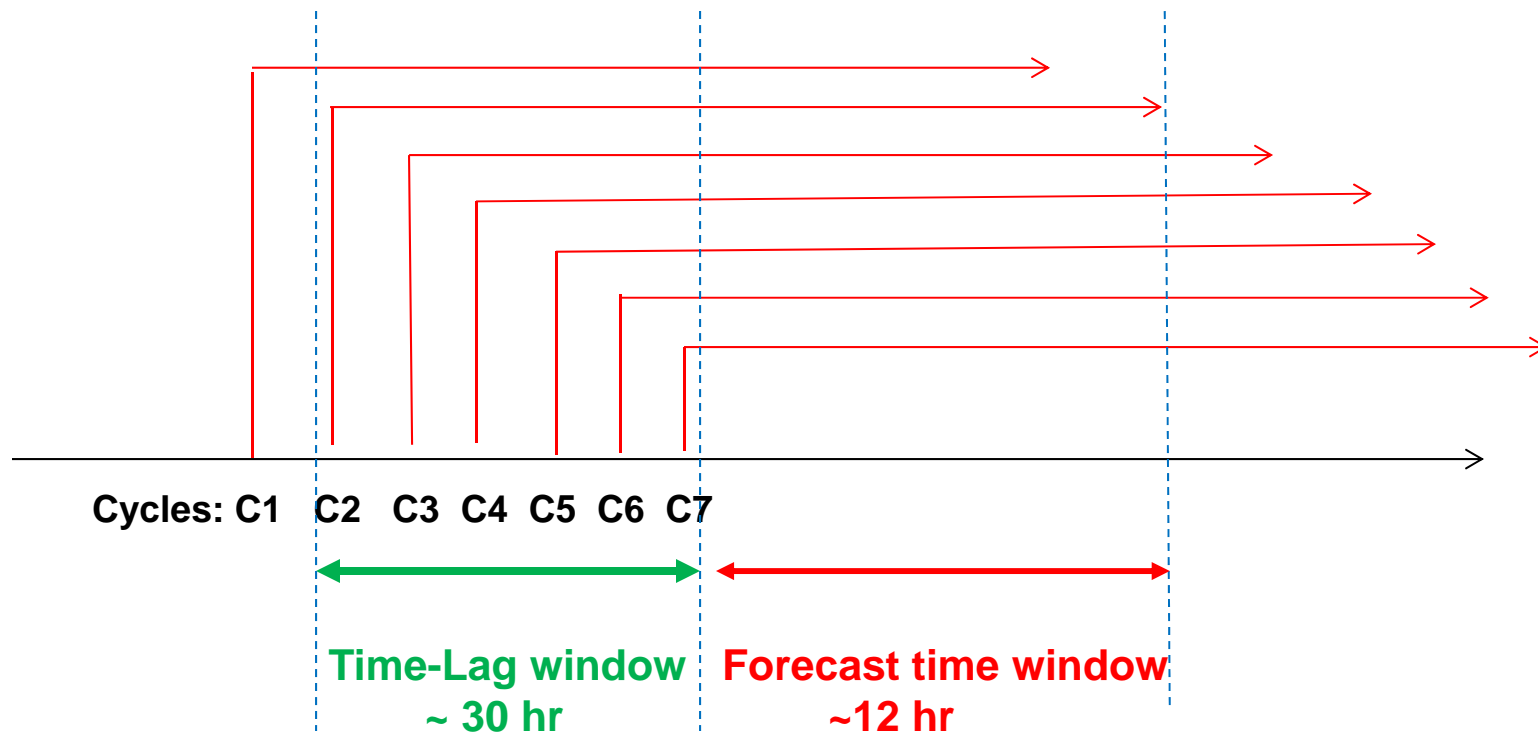
❖ Aviation ensemble products list

| Field	Ensemble product	SREF	NARRE-TL	NCASE
Ceiling	Mean/spread/prob of 6 height thresholds	Y	Y	Y
Visibility	Mean/spread/prob of 6 VIS thresholds	Y	Y	Y
Low level wind shear	Mean/spread/occurrence probability	Y	Y	Y
Surface wind	Mean/spread/prob 3 speed thresholds	Y	Y	Y
Fog	Probability of dense fog and light fog	Y	Y	N
Precipitation type	Prob of rain, snow, freezing rain	Y	Y	Y
Accumulate Precip	Prob of 1, 3 and 6hr accumulated precip	Y	Y	Y
Icing	Occurrence prob on 8 Flight levels (FLs)	Y	Y	Y
Turbulence (CAT)	3 severity occurrence Prob on 9 FLs	Y	Y	Y
Freezing height	Mean/spread	Y	Y	N
Jet stream	Prob on 3 heights & 3 speed thresholds	Y	Y	N
Radar reflectivity	Probability of 5 thresholds of dBZ	Y	Y	Y
Echo-top	Probability of 5 height thresholds	Y	N	Y
Mountain obscuration	Probability (to be added)			

■ TAF products   ■ En-route products

Storm/convection, fire-weather, energy (wind) ensemble products list

Field	Ensemble product	SREF	NARRE-TL	NCASE
Convection	Probability	N	Y	Y
Lightning	Probability	Y	Y	N
Dry lightning	Probability	Y	Y	N
Severe thunderstorm	Probability	Y	Y	N
Max updraft helicity	Prob for certain thresholds	N	N	Y
Max down & updraft speed	Prob for certain thresholds	N	N	Y
Max 1km AGL radar reflectivity	> 40 dBZ probability	N	N	Y
Radar composite reflectivity	> 40 dBZ probability	N	N	Y
Max 10m wind	> 30 knots probability	N	N	Y
Fire weather	Probability of Hainse index	N	N	Y
Fire weather	Probability of Fosberg index	Y	N	N
80 m wind speed (for energy sector)	Mean/spread/probability	N	N	Y
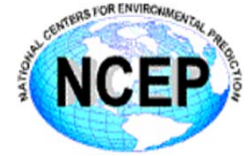
❑ Ensemble Product Generation Procedure

❖ All regional ensemble products are produced from one unified
   Ensemble Product Generator

   ~ One code is used in all 3 systems (different domains, grids, etc)
      Same product in 3 ensemble systems uses same code
      If one product is upgraded, changed in all 3 systems

   ~ Flexible to add/remove new/old products
      Just modify a product name table

   ~ Code management efficient
      Code upgrade/develop/maintain

❖ Some product algorithms

Product	Algorithm (reference)
CAT	Diagnostic method of Ellrod (1992)
Icing	Simple diagnostic method of S. Silberberg (AWC)
Low level wind shear	Diagnosis (NWS 2004)
Ceiling	Definition of NWS (2004)
Flight condition	LIFR, IFR, MVFR, VFR (FMH-1, 1995)
Fog	Diagnostic method (Zhou and Ferrier 2008)
Convection	Diagnostic method of S. Weygrandt (GSD)
Dry/Lightning, Severe-thunderstorm	Diagnostic methods of D. Bright (AWC)
Hainse,Fosberg index	Diagnosis of Hainse and Fosberg

❖ **Products displayed on 3 NCEP web pages**

~ Maintained by EMC/personal, not by NCO

~ GRIB1/GRIB2 files in NCEP/NOMADS

~ Forecasters use web products to find uncertainty, and forecast consistence info
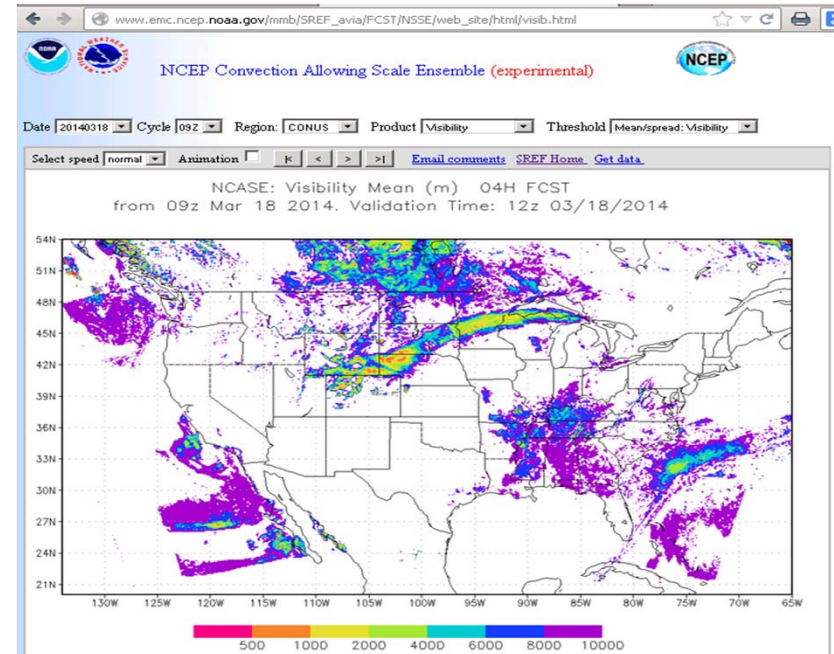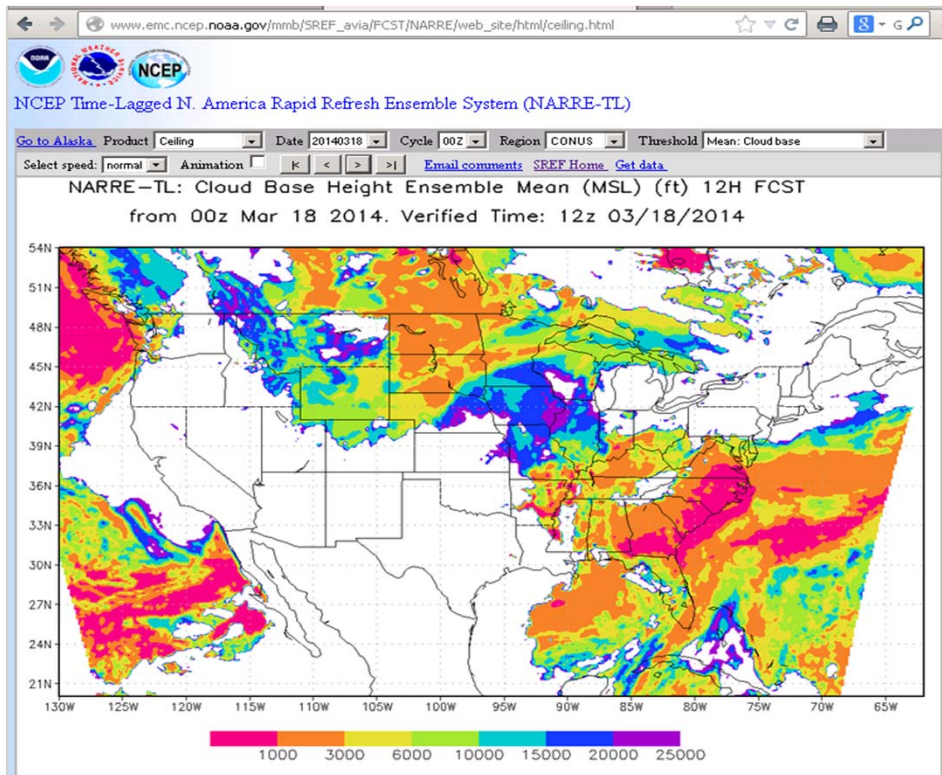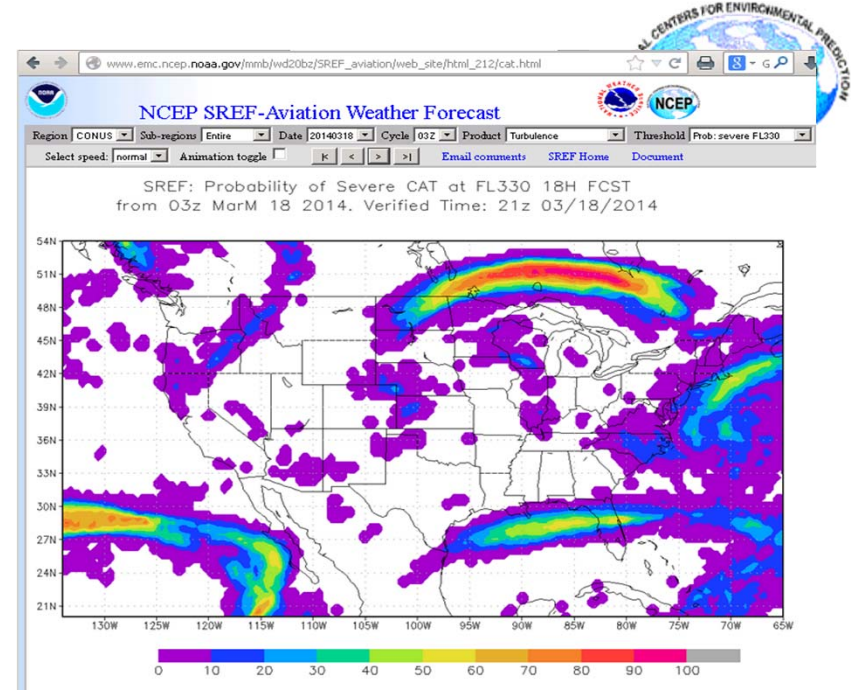
❑ **Verification/Evaluation**

❖ Limited objective grid-to-grid and grid-to-point verifications

~ Reflectivity

~ Echo-top

~ Visibility

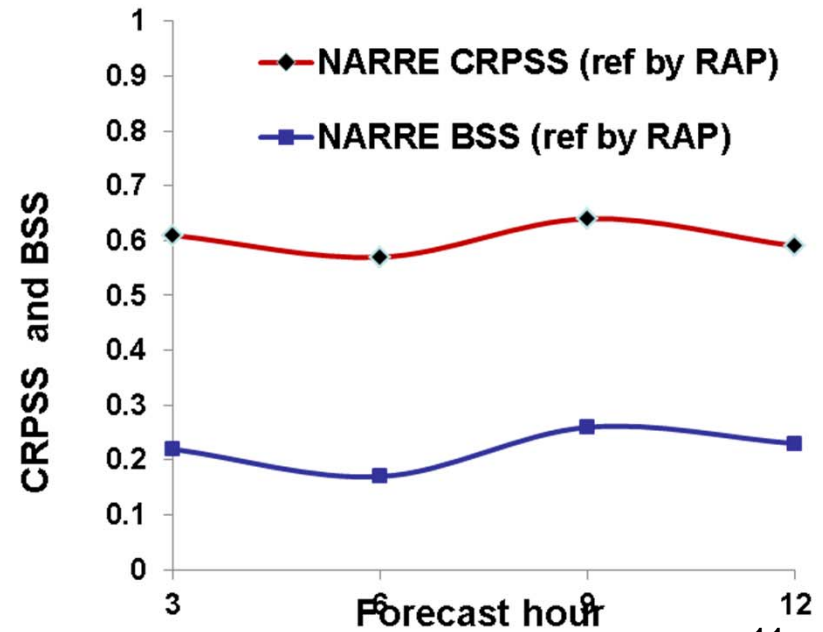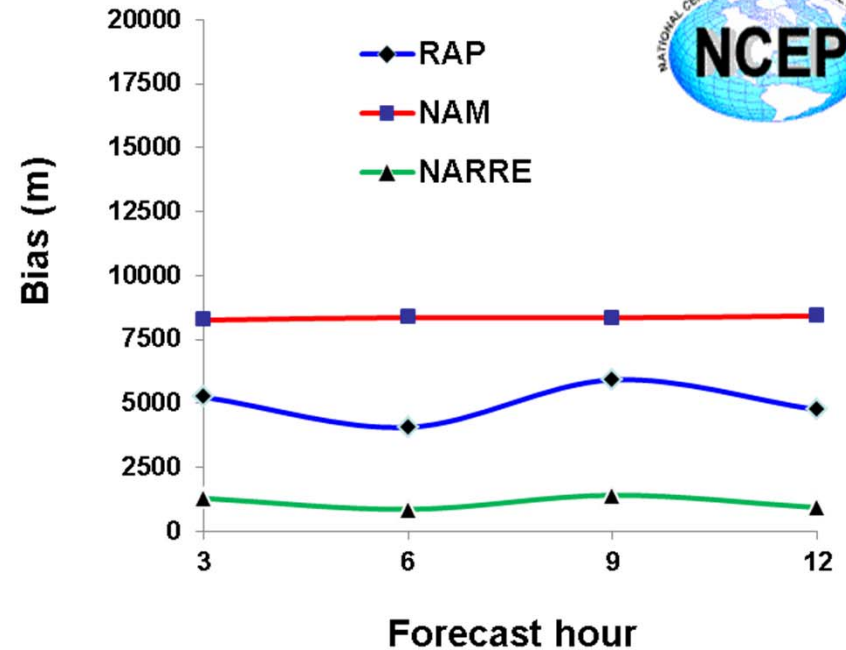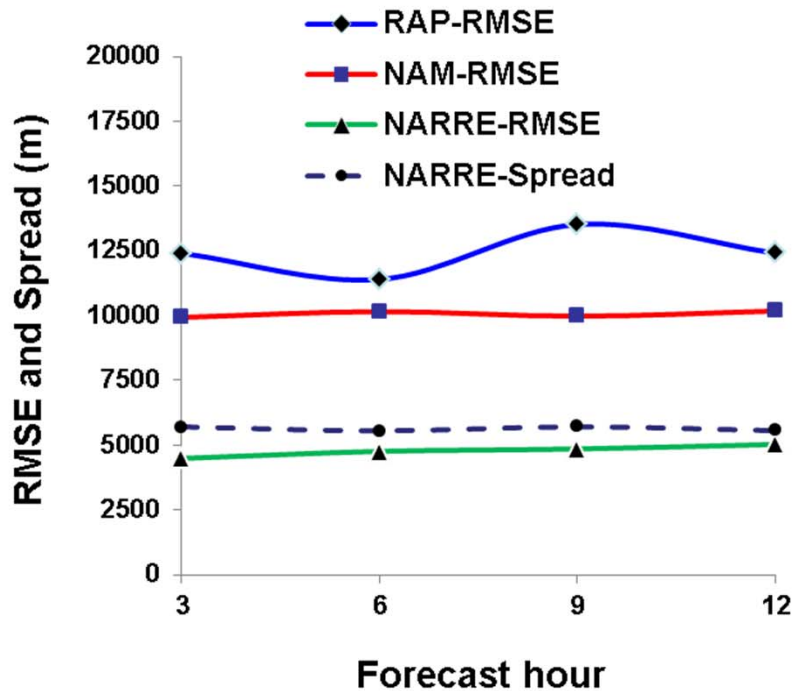~ Fog

~Icing

❖ Many users voluntarily evaluate them locally

WFO forecasters (East Region, CR, SR, AWC, etc)

~ Compare with other model forecasts in severe weather events

~ Feedbacks/comments

~ Help us to enhance/improve the products

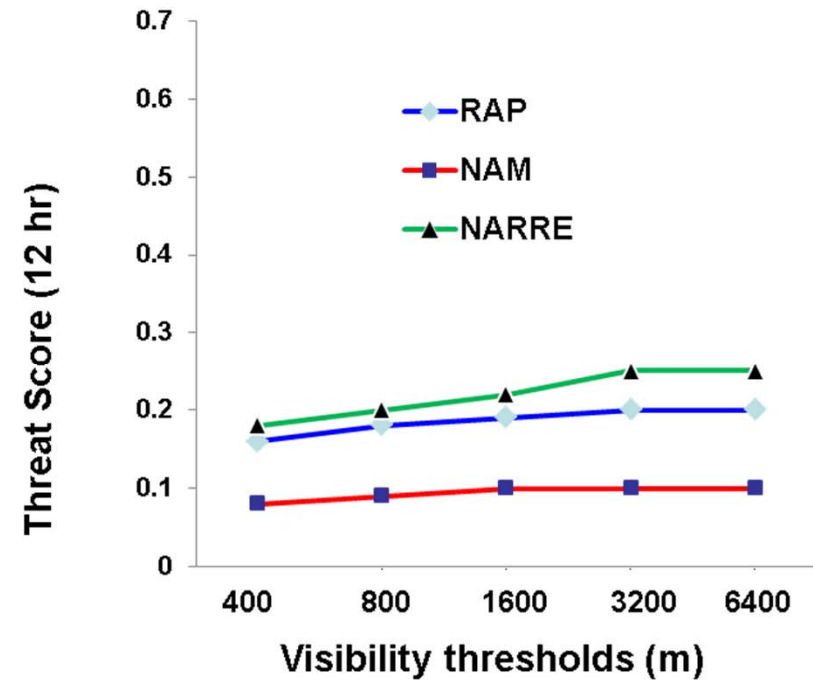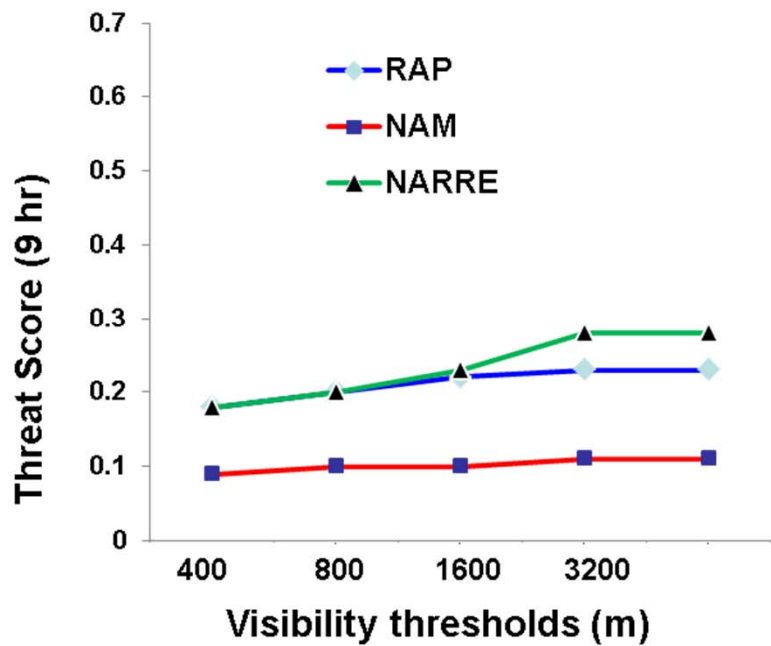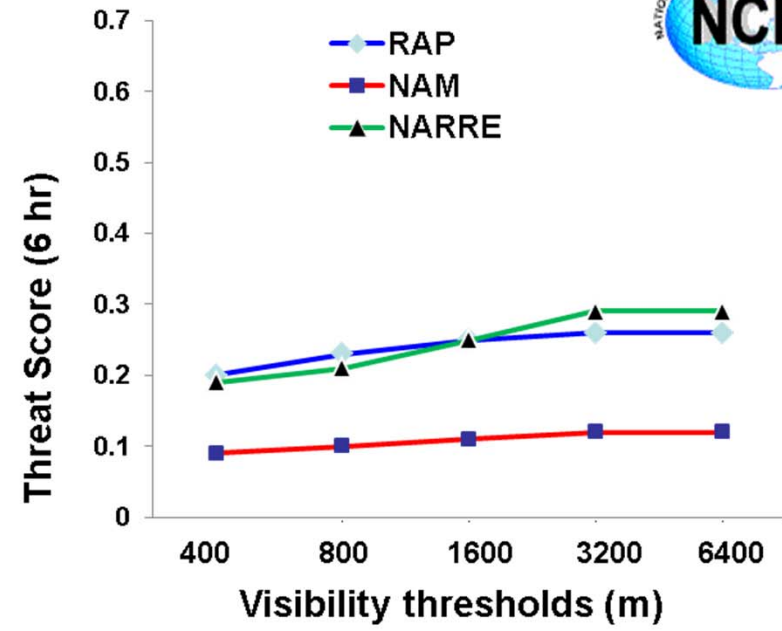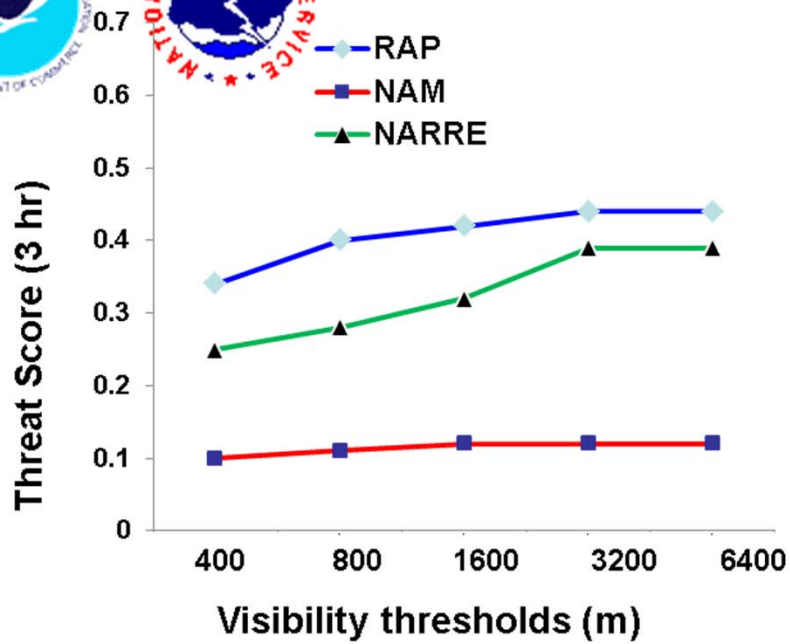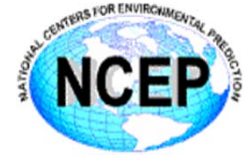**NARRE-TL Visibility Evaluation**

Grid-to-Grid verification against ADDS data
Sep 14, 2012 ~ Dec 31, 2012

11

❖ **NARRE-TL Visibility Evaluation**

❑ **Future work**

❖　NARRE-TL will be upgraded (RAP is upgraded from V1 to V2)

~ RAP-V2 is developed by GSD and will be soon implemented at NCEP

~ Parallel NARRE-TL with RAP-v2 has been tested by NCO and ready to go

❖　NCASE will be upgraded

~ NCEP's new hi-res window WRFs

~ Add extra members from AFWA WRF runs to NCASE

AFWA WRF run's GRIB2 files decoding still has problem at NCEP

❖　Products upgrade

~ Add new products? upon users' request

~ Using new method? Depend on computer resoures

❖　More verification/evaluations

~ If observation/analysis data are available (e.g. ADDS, RTMA, NESDIS)
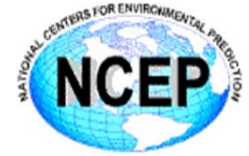
❑ **Summary**

❖ Aviation, convection, wind-energy and fire weather regional ensemble products are generated from SREF, NARRE-TL and NCASE ensemble forecast systems and displayed in a near-operational way

❖ These ensemble products provide uncertainty and consistence info for single model predictions

❖ WFO forecasters are routinely using NCEP's web pages to obtain these ensemble products for their local forecasting

❖ Evaluations are still limited; Some products were objectively verified by EMC, and evaluated by WFO forecasters voluntarily as well

❖ Objective verifications and evaluations show their values and skills

❖ Continuously develop, upgrade and maintain these 3 systems, products and continuously provide technical support to users