

# 2<sup>d</sup> Weather Group

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## AFWA Ensemble Prediction System



**Mr. Evan Kuchera  
HQ AFWA  
2 WXG/WEA**



# Philosophy



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- **There are five characteristics of a good forecast:**
  - **Timely (Available before decision is made)**
  - **Communicative (information is easy to understand)**
  - **Focused (directly impacts the decision)**
  - **Useful (not something already known)**
  - **Reliable (information is correct)**
  
- **Ensembles are great for addressing the last two bullets, but the first three must be kept in mind**



# Overview



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- **Purpose:** *To discuss the AFWA transition from a prototype (JEFS) to an operational (AFWEPS) ensemble prediction system*
- **AFWA is exploring how ensembles can best be exploited to improve DoD forecast processes and warfighter decision making**
  - Diverse global and mesoscale models
  - Probabilistic algorithms/techniques for “high impact” variables
  - Concise, warfighter-focused products
  - Emphasis on training and outreach



# Mesoscale Ensemble

40 km Northern Hemisphere



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## ■ Pre-processing

- GFS ensemble from six hours earlier is used for initial/lateral boundary conditions (NOGAPS soon)

## ■ Model configuration

- 10 independent model configurations with varying physics and lower boundary conditions (land surface, SSTs) run at 06/18Z to 132 hours
- The table lists different physics packages used by each member



Member	Physics Packages						Stamp Placement
	Surface	PBL	Cumulus	Micro-physics	Longwave Radiation	Shortwave Radiation	
1 (3)	Thermal	MRF	Grell	WSM3	CAM	Dudhia	Top Center
2 (4)	Thermal	YSU	Grell	Ferrier	CAM	CAM	Bottom Right
3 (5)	Thermal	MYJ	KF	WSM6	RRTM	CAM	Bottom Left
4 (9)	Noah	MRF	KF	Lin	RRTM	CAM	Middle Right
5 (10)	Noah	YSU	KF	WSM5	RRTM	Dudhia	Large Control
6 (11)	Noah	MYJ	Grell	WSM5	RRTM	Dudhia	Top Right
7 (15)	RUC	YSU	BM	Lin	CAM	Dudhia	Bottom Center
8 (16)	RUC	MYJ	KF	Ferrier	RRTM	Dudhia	Middle Left
9 (17)	RUC	YSU	BM	Ferrier	RRTM	CAM	Top Right
10 (18)	RUC	YSU	Grell	WSM6	CAM	CAM	Middle Center

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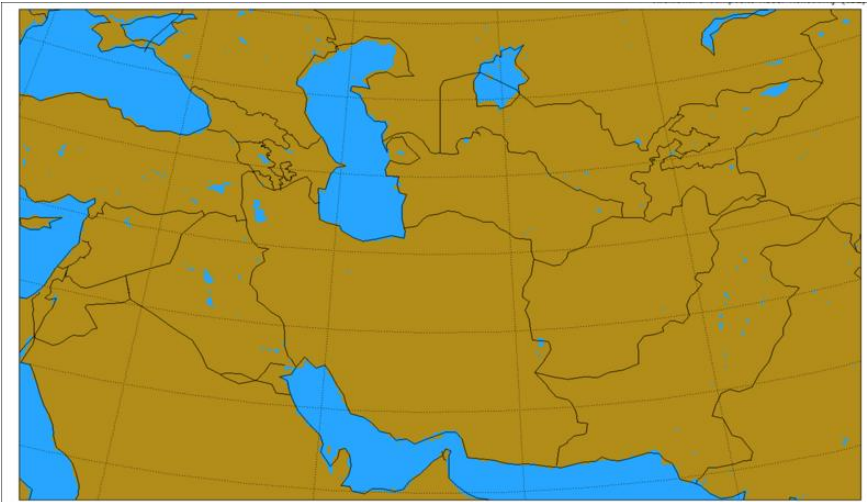
# Mesoscale Ensemble

12 km CONUS/SWA/EAST ASIA



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- Pre-processing
  - IC/LBC from 40 km NHEMI (also SREF for CONUS domain)
- Model configuration same as NHEMI
- Hourly output to 48 hours on 12 km domains





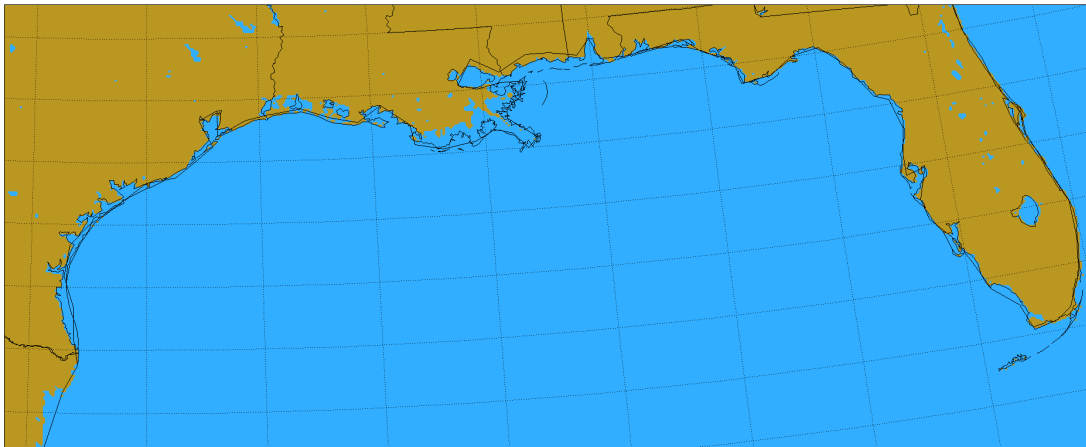
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# Mesoscale Ensemble

4 km SWA/CONUS



- Run as nests of the 12 km domains to 24 hours
- CONUS is a floater that we move around with the seasons



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# Post-Processing

## High Impact Weather



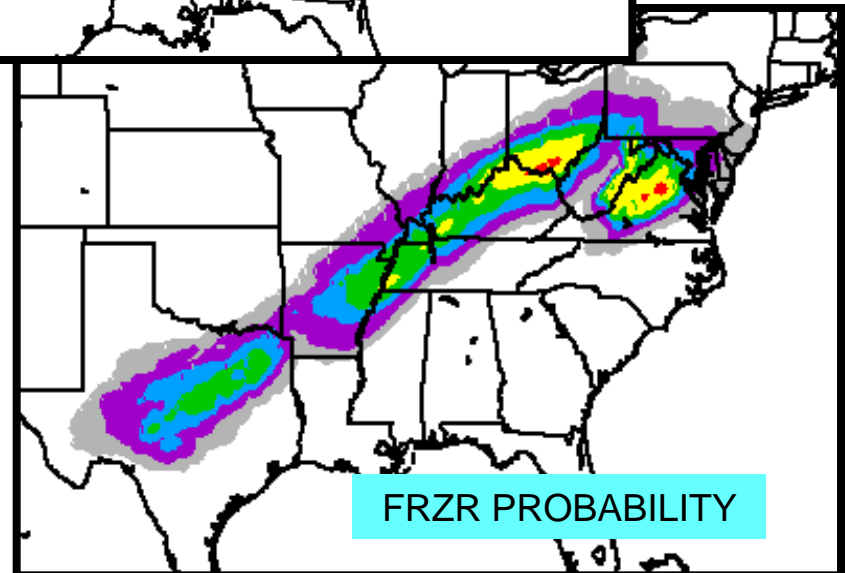
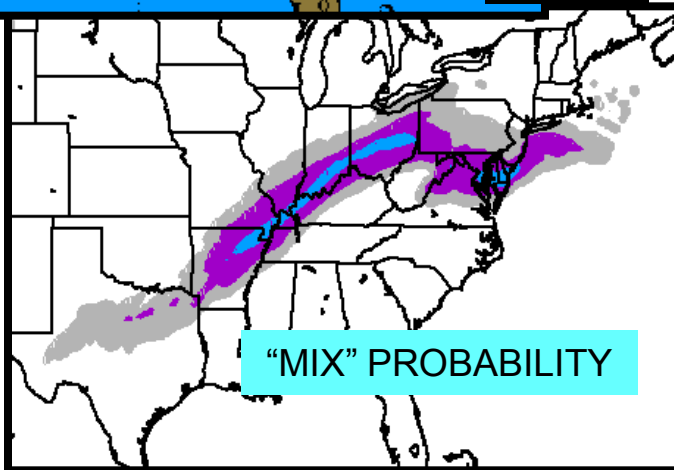
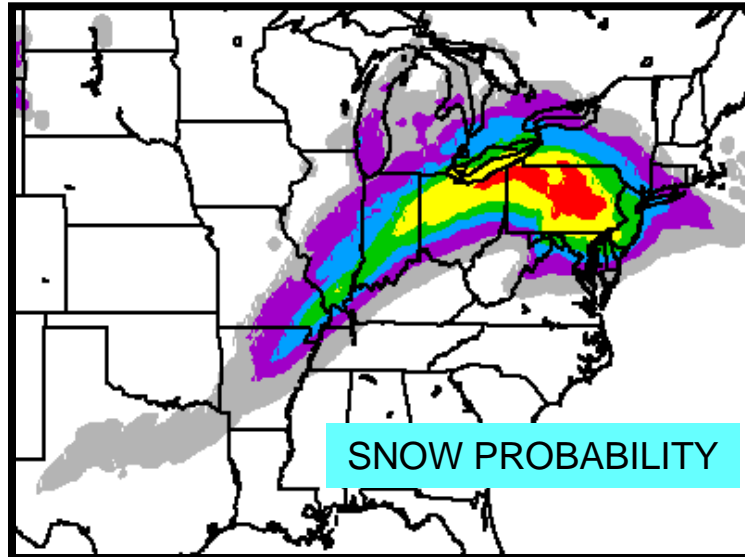
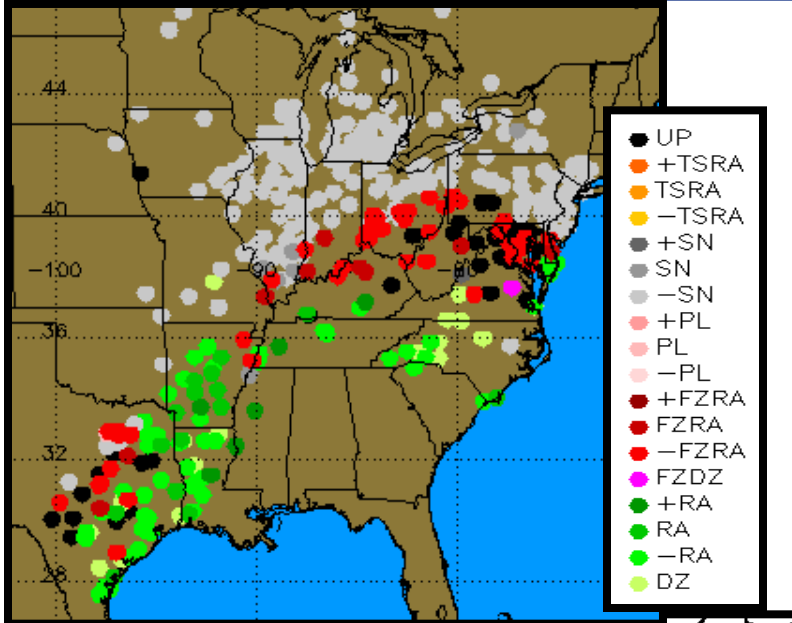
- Main focus of post-processing efforts is on probabilistic assessment of “high-impact” weather
- Specialized applications for dust and cloud forecasting
- Physics-based probabilistic (i.e. diagnosis uncertainty) algorithms for lightning, visibility, precipitation type, and surface wind gust
- Deterministic (i.e. no diagnosis uncertainty) algorithms used for snow accumulation, icing, turbulence
- Other diagnostics (joint probability of instability/shear for severe weather, surface winds/snowfall for blizzard conditions)



# 30 hour ice storm forecast



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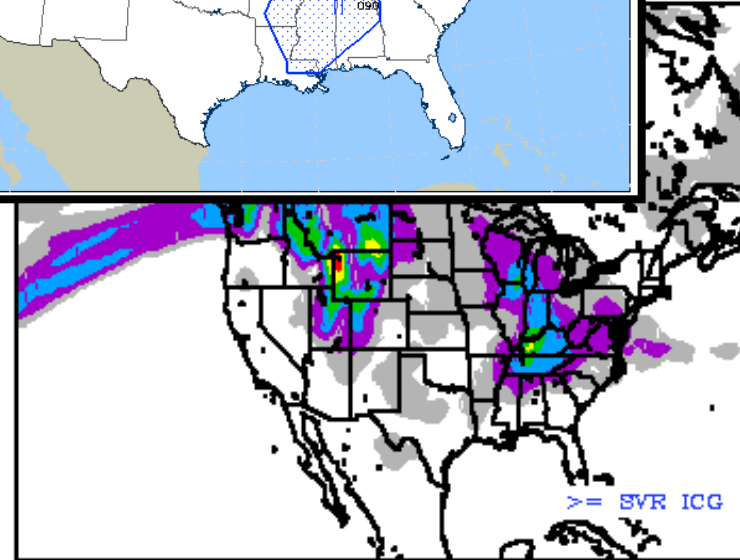
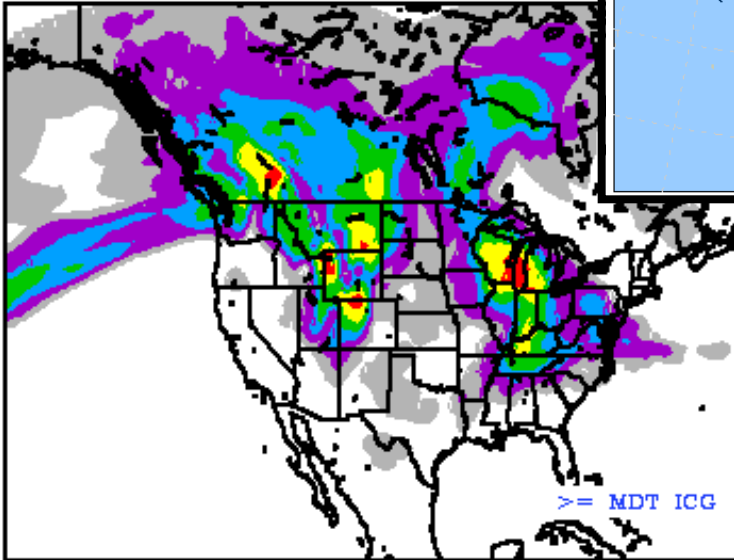
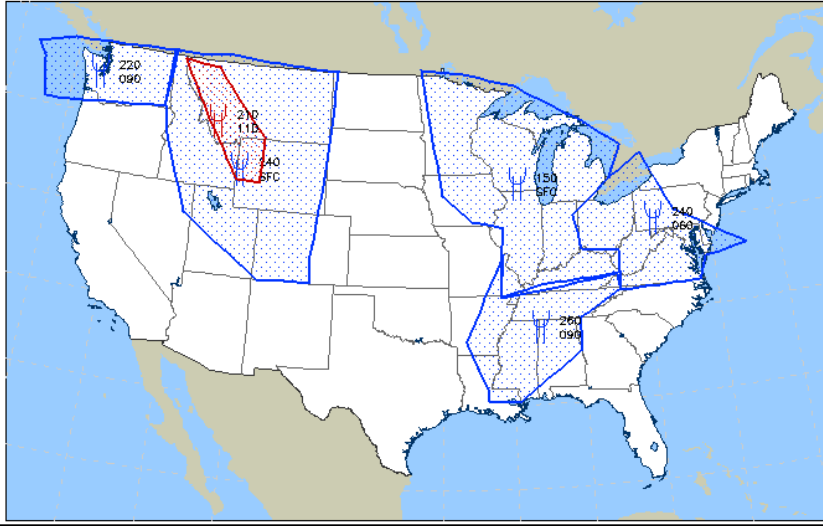
# Forecast Example: 51 hour icing forecast



Icing AIRMETs (blue) and SIGMETs (red)

chart created at 1557 UTC Wed 12 Nov 2008

AIRMETs valid until 2100z/12<sup>th</sup>, SIGMETs expire at or before 1855z/12<sup>th</sup>



51hr Forecast  
Valid: 12 NOV 08, 15Z  
Model Cycle: 10 NOV 08, 12Z

Percent Probability of Icing at 700mb



Prototype Software, Non-

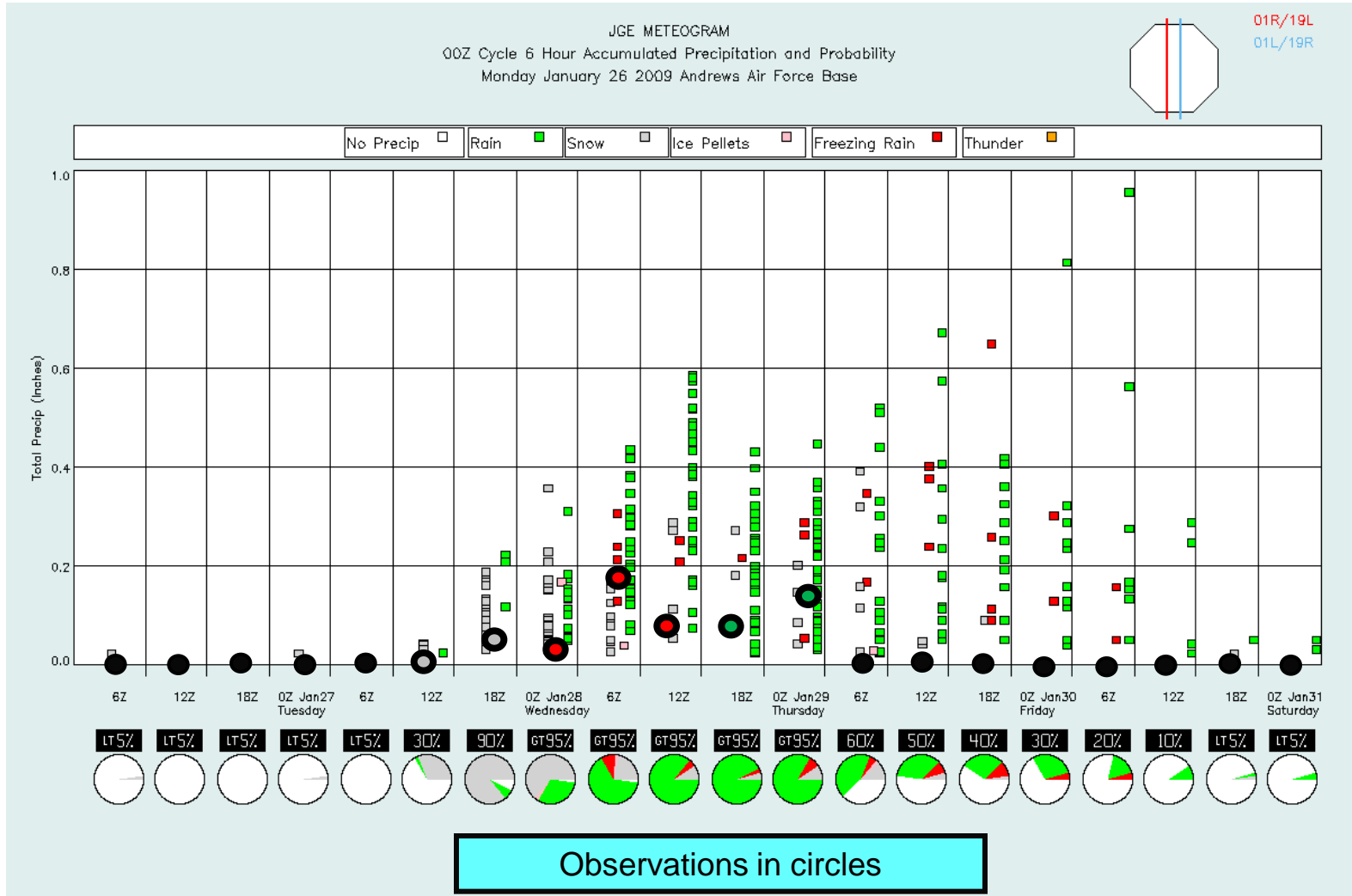
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# Precipitation Meteogram



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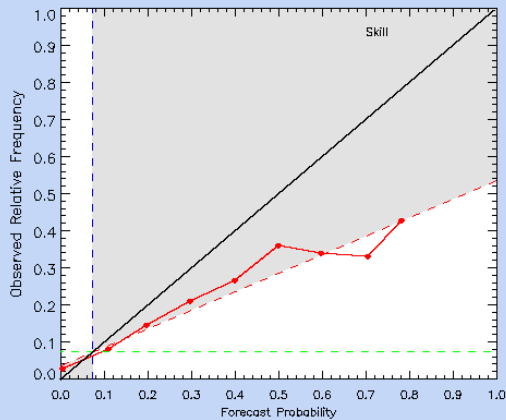


# Objective Verification

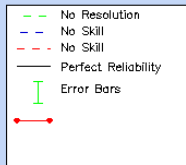
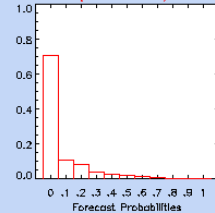


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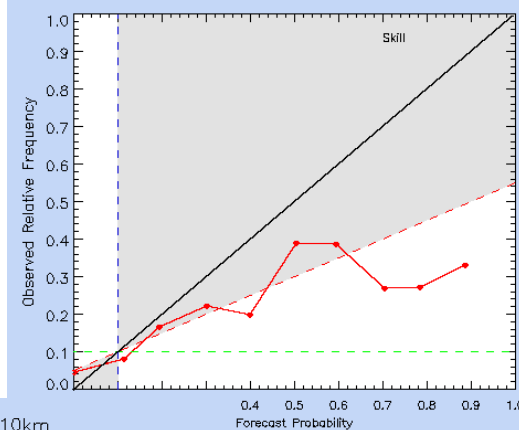
Attribute/Reliability Diagram For CONUS 10km  
Precipitation Accumulation > 0.25 Inches  
OZ Cycle, From 07/12/2009 To 08/11/2009, 48Hr Forecast  
Brier Skill Score: 0.11 ( )



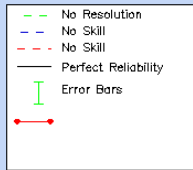
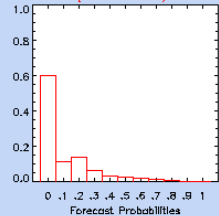
Probability Frequency  
(3844 Forecasts)



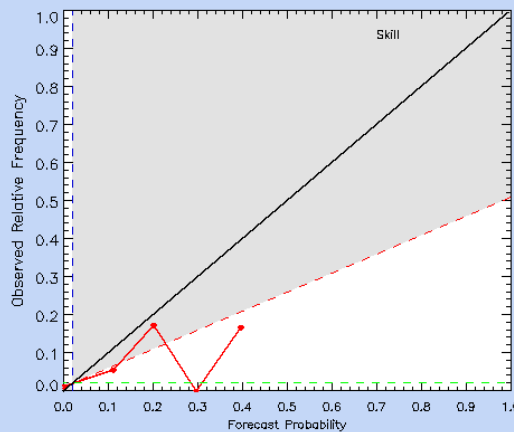
Attribute/Reliability Diagram For Korea 10km  
Precipitation Accumulation > 0.25 Inches  
OZ Cycle, From 07/12/2009 To 08/11/2009, 48Hr Forecast  
Brier Skill Score: 0.10 ( )



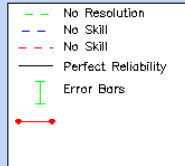
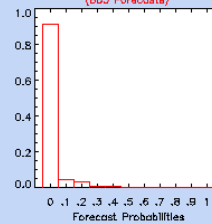
Probability Frequency  
(2275 Forecasts)



Attribute/Reliability Diagram For South West Asia 10km  
Precipitation Accumulation > 0.25 Inches  
6Z Cycle, From 07/12/2009 To 08/11/2009, 48Hr Forecast  
Brier Skill Score: 0.01 ( )



Probability Frequency  
(883 Forecasts)





# Way Ahead



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## ■ Near Term:

- Establish operational flow of “full” NOGAPS and NCEP SREF ensembles to allow initialization of mesoscale members (~12 km)
- Explore ETKF on NHEMI (or global) mesoscale domain
- Explore new techniques for model physics diversity
- Continue refining ensemble forecast techniques on high-impact forecast variables (clouds, dust, surface winds, precipitation, visibility, icing, turbulence)
- Continue close relationships with forecasters to further cement ensemble presence “in the field”
- Explore stronger relationships with “decision makers” who can benefit from stochastic information



# Way Ahead



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## ■ Medium Term:

- Work to establish agreements on operational data flows of raw ensemble model output from as many centers as possible
- Go “operational” with basic mesoscale ensemble
  - Hopefully multi-center with Navy and NOAA
- Develop sophisticated software to allow interrogation of full raw ensemble and user selected decision thresholds
  - Likely “reach-back” capability due to large volumes of ensemble data
- Implement standardized training programs



# Way Ahead



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## ■ Long Term:

- Leverage techniques for initial condition generation found most effective (4DVAR/ENKF/Hybrids/etc)
- Design new model physics to fully represent uncertainties in sub-grid scale processes
- Entrain advancements in land surface and aerosol modeling
- Increase membership and resolution as computing resources allow