

# 16<sup>th</sup> Weather Squadron

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*Fly - Fight - Win*



## Air Force Weather Ensembles

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# Overview



- Air Force Weather Operational Ensembles
- Probabilistic diagnostics
- Interactive data interrogation
  
- <https://weather.af.mil/confluence/display/AFWWEBSTBT/Ensembles+Main+Page>
  - Operational products, configuration information, case studies, etc
  - Password protected—contact me for access info



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# *AFW Operational Ensembles*



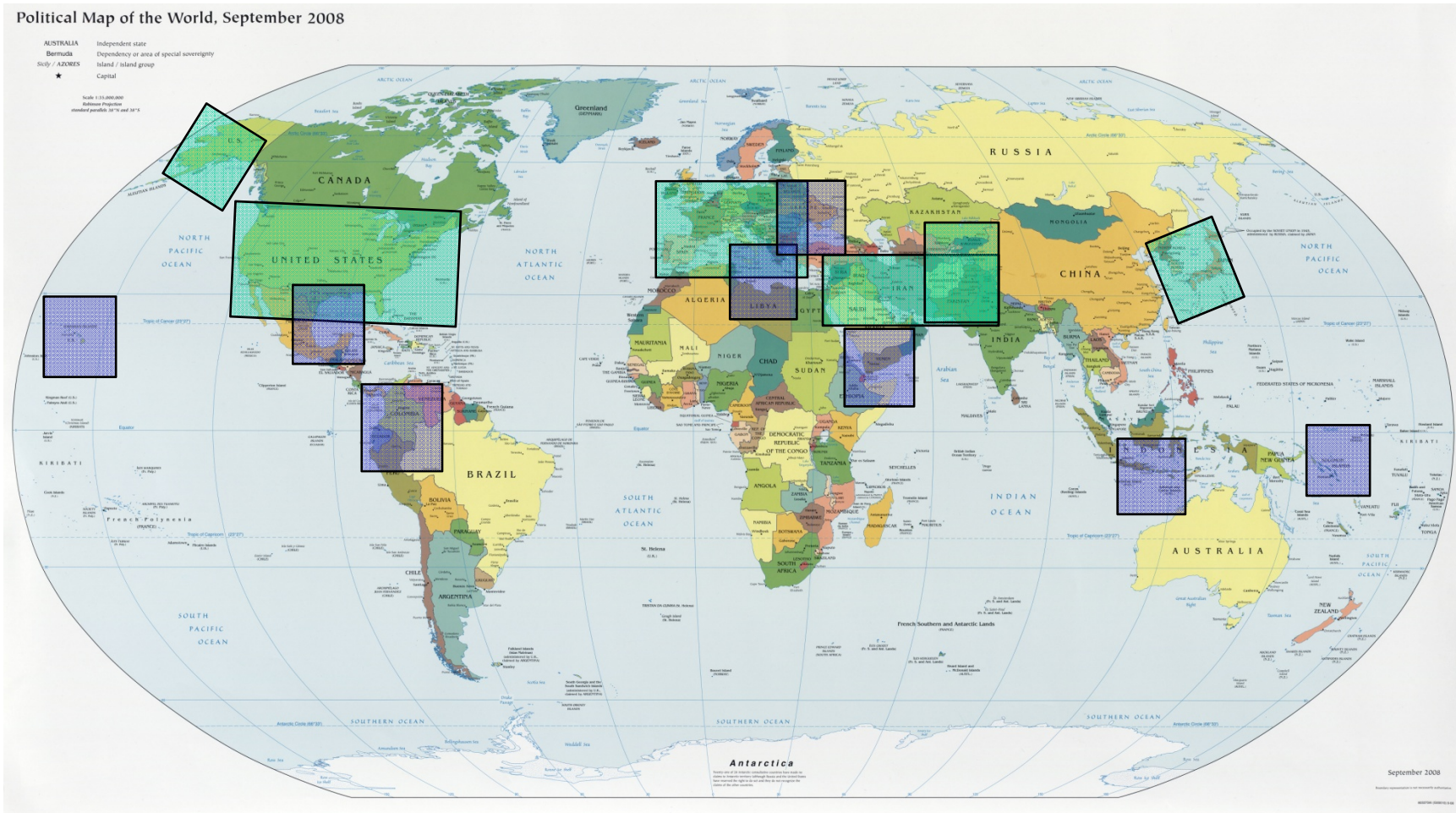
- **Goals for operational ensembles**
  - Reliable, sharp prediction of mission-impact phenomena
  - Tailored products: both quick-look AND detailed
  - Timely!
- **Global Ensemble Prediction Suite (GEPS)**
  - 62 members from NCEP, CMC, FNMOC
- **Mesoscale Ensemble Prediction Suite (MEPS)**
  - 10 members of WRF-ARW with diverse initial conditions and physics
  - 144 hour “global” at ~20 km, 72 hour regional at 4 km
    - MAJCOMs own keys to re-locatable domains



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# 4 km MEPS domains

Green—static; Blue—relocatable (positions subject to change)  
Each domain runs to 72 hours once per day (CONUS 2X/day)



\*(Current as of March 2014)

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# AFW Operational Ensembles



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## ■ Physics configurations

Mem	Atmos IC/LBC	Land IC	Snow/SST IC	LU	Surface	LEVS	LEV2	SW-Rad	LW-Rad	PBL	DSR	Microphysics	Hail	CCN	Cumulus (20 km only)
1	UM	LIS	UM	USGS	NOAH	27	0.990	Dudhia	RRTM	ACM2	GNX	WDM6	1	5E+08	BMJ
2	GFS	LIS	GFS	USGS	NOAH	27	0.995	Dudhia	RRTM	BouLac	DRI	Morrison	1	1E+08	Tiedtke
3	GEM	LIS	GEM	USGS	NOAH	24	0.990	Goddard	Goddard	YSU	GNX	WDM6	0	1E+09	New SAS
4	GEM	UM	GEM	USGS	NOAH	21	0.995	Goddard	Goddard	BouLac	DRI	Morrison	1	1E+09	BMJ
5	UM	UM	UM	USGS	NOAH	21	0.985	CAM	CAM	YSU	GNX	Thompson	N/A	N/A	Tiedtke
6	GFS	LIS	GFS	USGS	PX	24	0.990	Dudhia	RRTM	ACM2	DRI	WDM6	1	1E+08	Tiedtke
7	GEM	UM	GEM	USGS	PX	24	0.985	Dudhia	RRTM	BouLac	GNX	Thompson	N/A	N/A	New SAS
8	GFS	LIS	GFS	USGS	PX	24	0.995	CAM	CAM	ACM2	DRI	Morrison	0	1E+08	BMJ
9	UM	UM	UM	USGS	PX	27	0.985	CAM	CAM	YSU	GNX	WDM6	0	5E+08	BMJ
10	GFS	UM	GFS	USGS	PX	21	0.990	Goddard	Goddard	ACM2	DRI	Thompson	N/A	N/A	New SAS

- No data assimilation, most recently available global model output is interpolated to the domain
- 21-27 vertical levels—does not seem to degrade quality, saves on cost (Aligo, et. al., 2008)

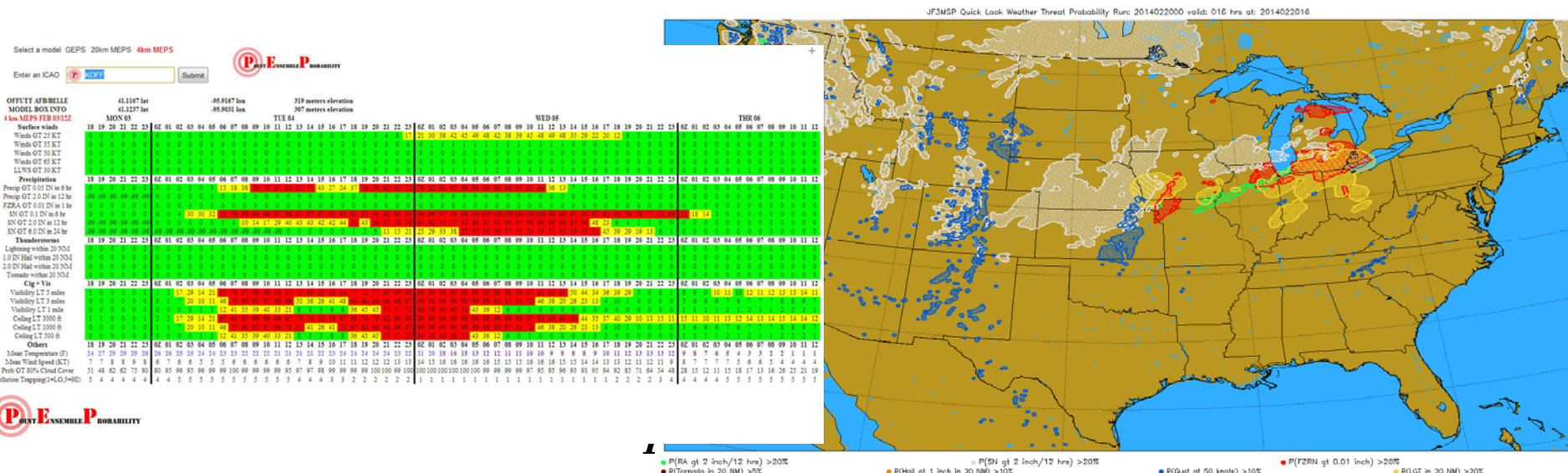
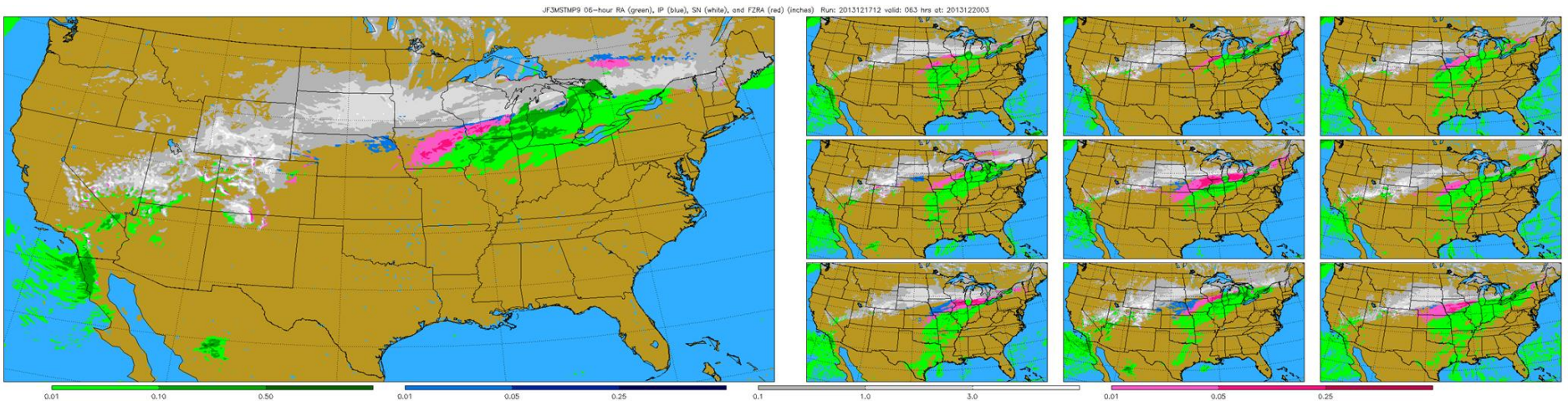


# AFW Operational Ensembles



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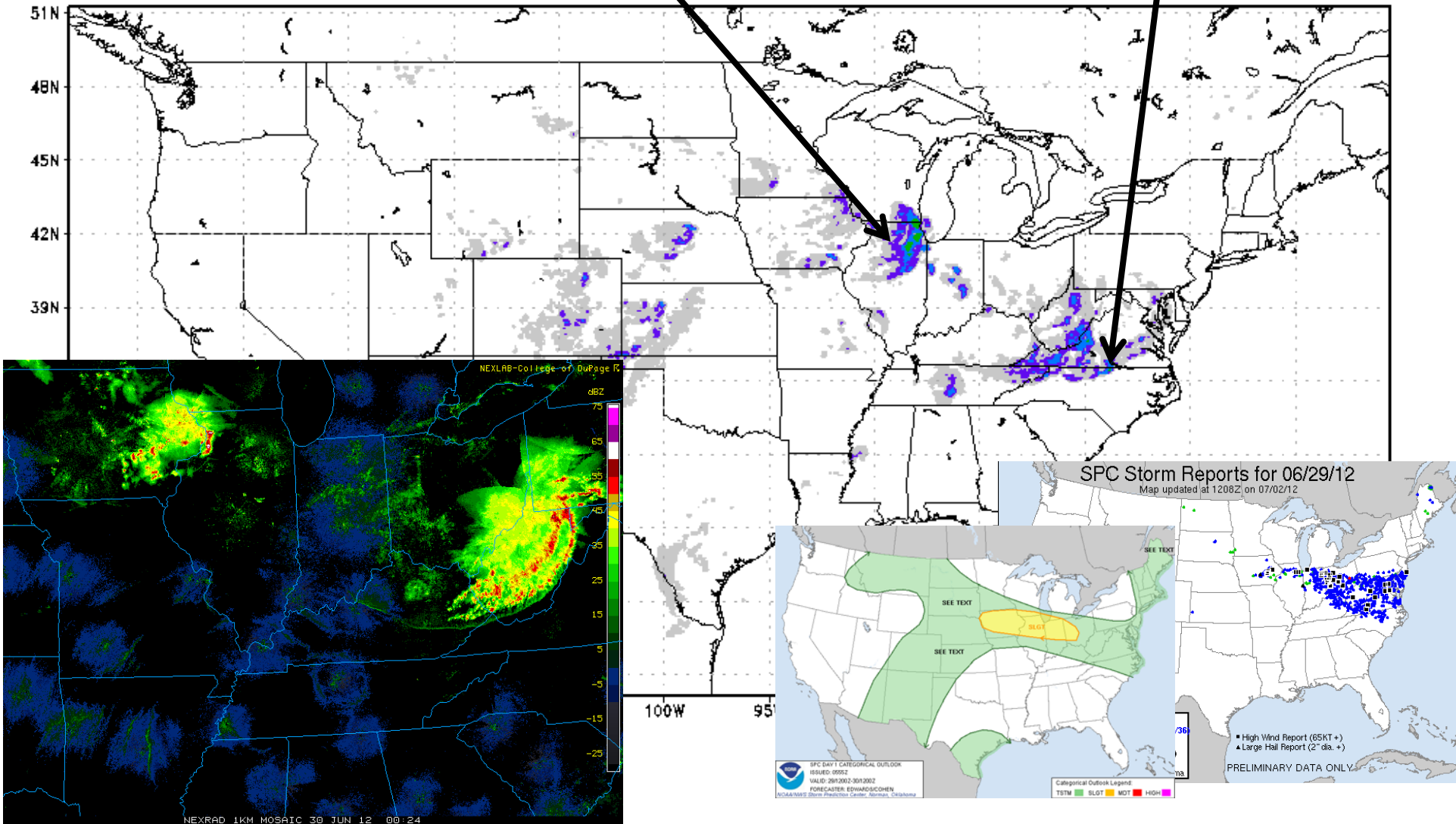
## Product Examples



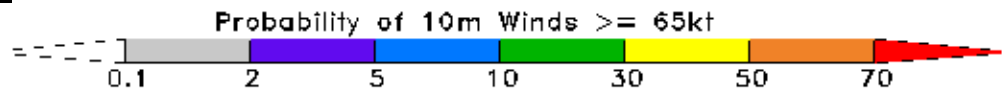
Valid: Saturday 30 JUN 12, 00Z

65 knots Dixon @ 0105

75 knots Nelson @ 0120



024hr Forecast  
Valid: Saturday 30 JUN 12, 00Z  
Model Cycle: 29 JUN 12, 00Z





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# *Probabilistic Diagnostics*



- **Purpose of diagnostics: Access data from the model for “algorithmic post-processing” while it is available in memory**
  - **Reduces I/O load**
  - **Enables tracking of maxima/minima**
  - **Enables variable temporal output cadence**
  - **Given model code parallelization, is generally cheap**
- **Targeted variables**
  - **Simulated clouds/satellite and radar**
  - **Clear and rime aircraft icing**
  - **Precipitation Type/snowfall**
  - **Surface visibility (fog/precip/dust)**
  - **Severe weather (lightning/hail/tornado/winds)**
- **All diagnostics within community WRF framework**





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# Probabilistic Diagnostics



## ■ Algorithms

- Many variables of importance to users are “sub-grid”
- Uncertainties in occurrence/frequency require algorithms to ensure reliable prediction

## ■ Limited ensemble members

- Only having 10 members means the PDF is poorly sampled even if the ensemble is perfect

## ■ Weibull distribution

- Three variables to describe:
  - Shape, scale, shift
  - Flexibility to make different distributions (Gaussian-like, exponential, etc)
  - Can put a curve on grid-scale data (i.e. precipitation) and on sub-grid data (i.e. lightning frequency)

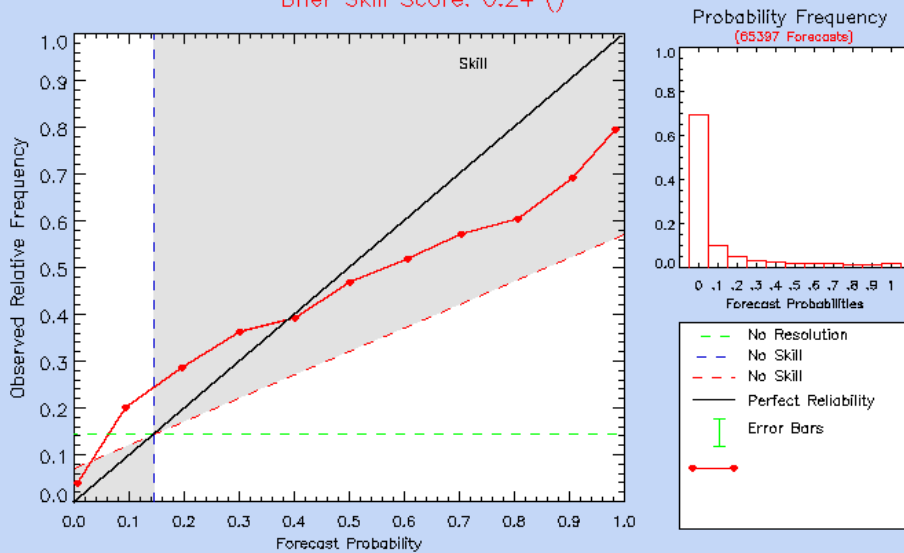


# Probabilistic Diagnostics



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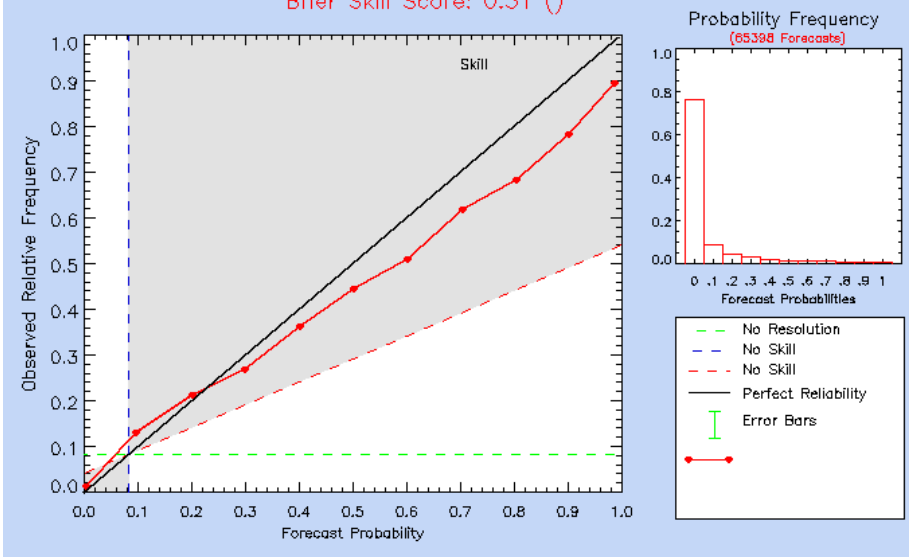
Attribute/Reliability Diagram For CONUS 4km  
Wind Speed Sustained > 15 Knots  
OZ Cycle, From 01/20/2014 To 02/19/2014, 48Hr Forecast  
Brier Skill Score: 0.24 ( )



No weibull modifications, uses uniform ranks to determine thresholds

Weibull for wind gusts:  
  
Shift: sustained wind speed  
Scale: (sustained wind speed)<sup>0.75</sup>  
Shape: 3 (gaussian-like)

Attribute/Reliability Diagram For CONUS 4km  
Wind Speed Gusts > 25 Knots  
OZ Cycle, From 01/20/2014 To 02/19/2014, 48Hr Forecast  
Brier Skill Score: 0.31 ( )





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# *Interactive data*



- **AF missions and platforms have unique criteria**
  - **Impractical to pre-stage all possible criteria**
  - **Need to develop tools to allow users to set their own**
- **Sophisticated missions need raw data to reason with**
  - **Example: Precision airdrop program**
    - **Each model realization of wind profile will lead to a different landing point for a re-supply package dropped from an aircraft**
    - **Risk assessments can be made given expected errors and times of lower/higher confidence**
  - **Example: Long-haul flights**
    - **Optimal flight-level winds; hazard avoidance**
    - **Potential to save \$2-12 million annually per AFIT MS thesis**





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# Summary



- **Air Force Weather is executing operational ensemble prediction systems**
  - **Timely, storm-scale products tailored to mission needs**
- **Finalizing probabilistic diagnostics**
  - **Within model code for efficiency, quality, flexibility**
  - **Improved characterization of certainty**
- **Interactive data interrogation**
  - **Provide users the ability to tailor probabilistic data to the mission**
  - **Improved risk assessment and \$\$\$ saved**