16th Weather Squadron

Fly - Fight - Win

Air Force Weather Ensembles

Evan Kuchera
Fine Scale and Ensemble Models
16WS/WXN

U.S. AIR FORCE

- **NCAR developed WRF-ARW based ensemble framework for AFWA (2007-08)**
  - **Software (Tom Henderson, Julie Schramm, Dave Gill) and science (Chris Snyder, Josh Hacker, So-Young Ha, Judith Berner)**
  - **Perturb initial conditions, physics, land/sea surface within WRF**

- **AFWA continues to test and refine techniques in real-time "prototype" environment**
  - **Convective-scale and aerosol ensembles**
 - **Operational implementation early 2011**

Purpose-example

■ Precision Airdrop

- ■ **Currently, must fly pre-mission over drop area and take a measurement of winds—model too inaccurate on average**

- ■ **With ensembles, can see if measurement needs to be taken based on uncertainty *that day***

- ■ **EX→ 85% of simulated drops for 19 March 2010 land in acceptable range—acceptable risk to skip pre-mission—cost savings and improved safety**

200 meters
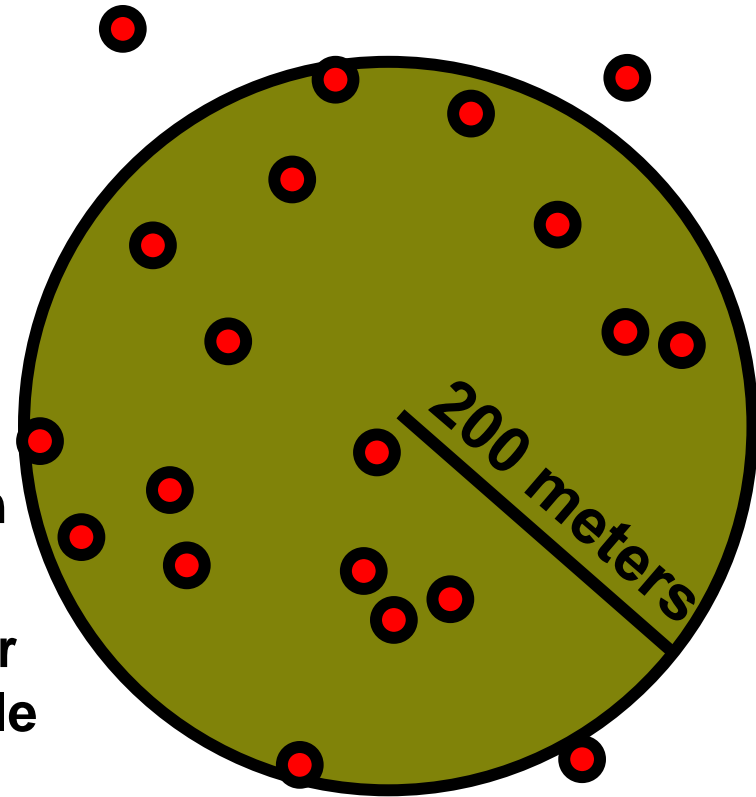
Mesoscale Ensemble

40 km Northern Hemisphere (NHEMI)

- **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 (NCAR)	Surface	PBL	Cumulus	Microphysics	Longwave	Shortwave
1 (3)	Thermal	QNSE	BMJ	Thompson (WSM3)	RRTM	Dudhia
2 (4)	Thermal	YSU	Grell 3-D	Ferrier	RRTM	CAM
3 (5)	Thermal	MYJ	KF	WSM6 (WSM5)	RRTM	Goddard
4 (9)	Noah	MYNN	KF	Lin (WSM3)	RRTM	CAM
5 (10)	Noah	YSU	KF	WSM5	RRTM	Dudhia
6 (11)	Noah	MYJ	Grell 3-D	Goddard (WSM3)	CAM	Goddard
7 (15)	RUC	QNSE	BMJ	WSM5	CAM	Dudhia
8 (16)	RUC	MYJ	KF	Ferrier	RRTM	Goddard
9 (17)	RUC	MYNN	BMJ	Ferrier	RRTM	CAM
10 (18)	RUC	YSU	Grell 3-D	Thompson (WSM3)	CAM	Dudhia

Mesoscale Ensemble

12 km CONUS/SWA/EAST ASIA

- **Pre-processing**
  - **IC/LBC from 40 km NHEMI (also SREF for CONUS domain)**

- **Model configuration same as NHEMI**
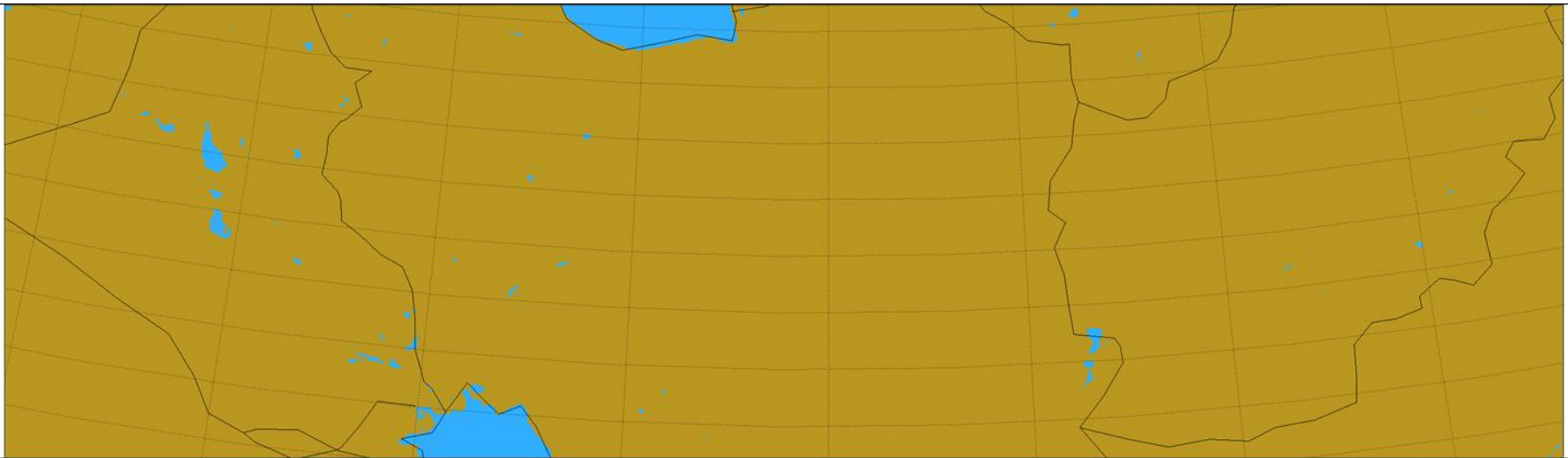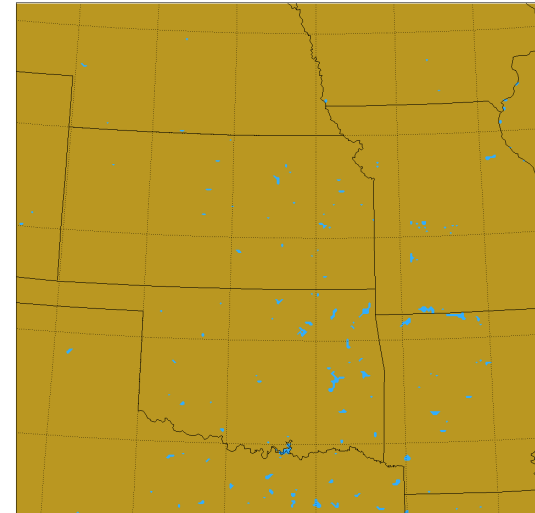
- **Hourly output to 48 hours on 12 km domains**

Mesoscale Ensemble

4 km SWA/CONUS

- **Run as nests of the 12 km domains to 24 hours**

- **CONUS floats by entering a center lat/lon at a website (software does the rest)**

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Available products for global (GEPS) and mesoscale (MEPS):

Precipitation Amount
Precipitation Type
Snow Amount
Cloud Cover
Lightning
Hail
Dust Lofting
Severe Weather
Blizzard
Surface Wind Gust
Ceiling/Visibility
Wind Chill
Thermal Stress
Smoke Trapping
Haboob Threat

Realtime verification also available on webpage

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4 km SWA ensemble

12 Apr 2010 Iraq

U.S. AIR FORCE

IR satellite loop from 09-18Z
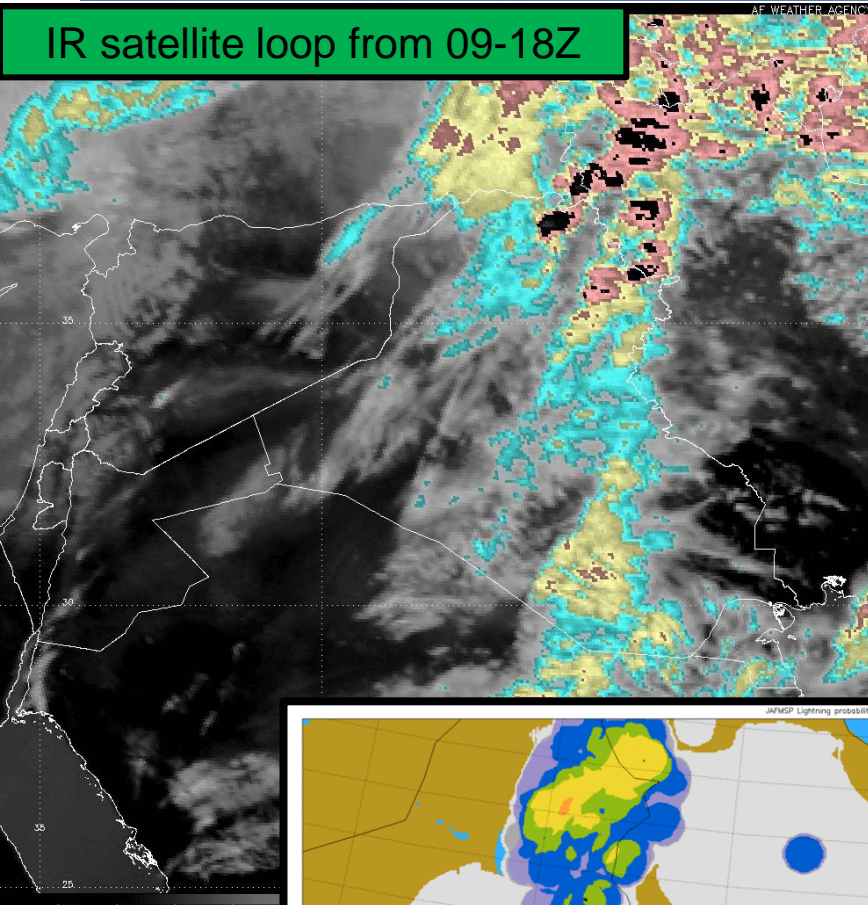
50 knot wind gust probability at 19Z
58 knots observed at 1911Z
Black contour=where individual ensemble
member forecasted 40 knots sustained
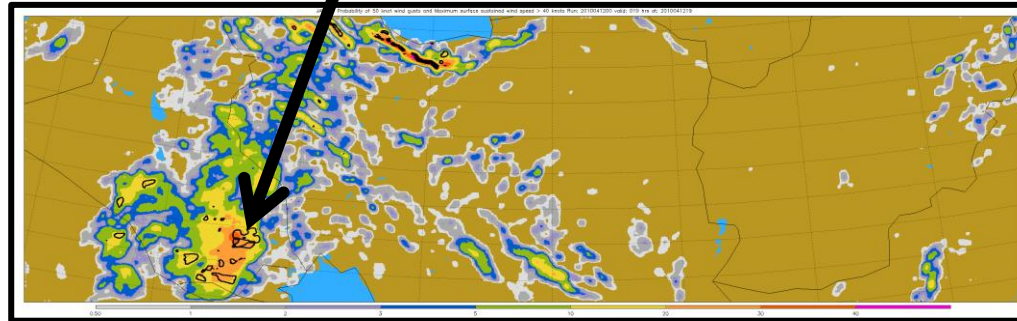
Lightning probability loop from 09-18Z
00Z 12 Apr 2010 ensemble run
Black contours=where individual ensemble
member forecasted intense lightning
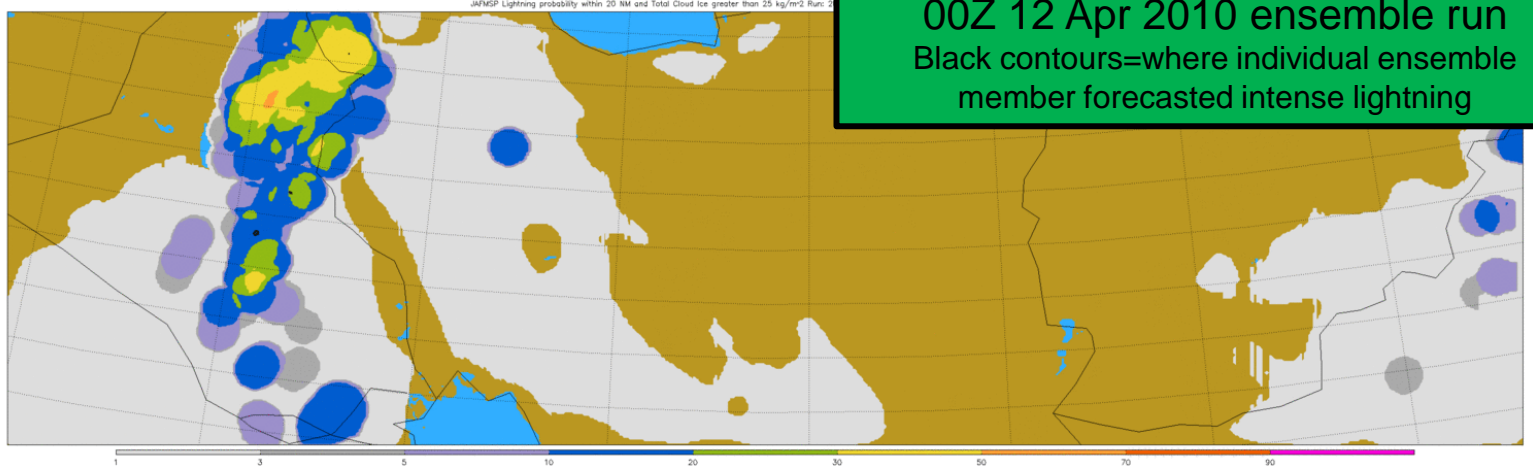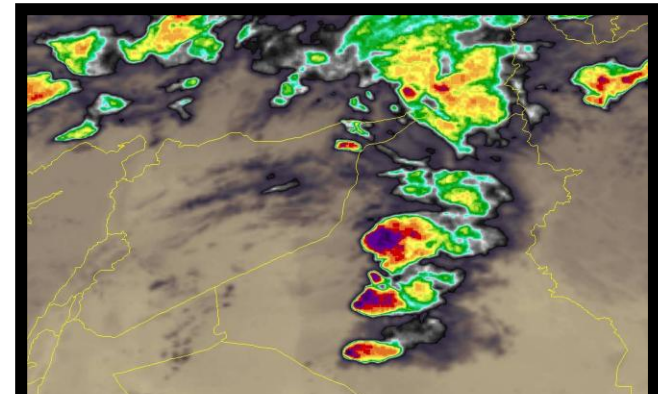
4 km SWA ensemble
27 Apr 2010 Iraq

"One thing to take away from this was the success of the Ensembles"

28 OWS storm review for 27 April thunderstorm event

Keys to forecast success

o Convective scale ensemble members (4 km)
o Direct diagnosis of supercells in WRF (updraft helicity)
o Good ensemble agreement (high forecast confidence)
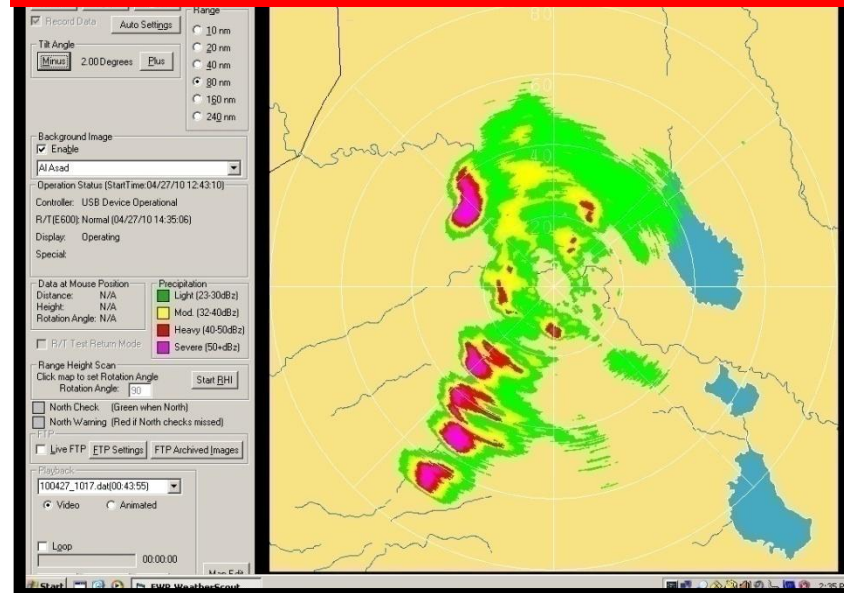

15Z satellite and radar

Probability of a supercell within 20NM
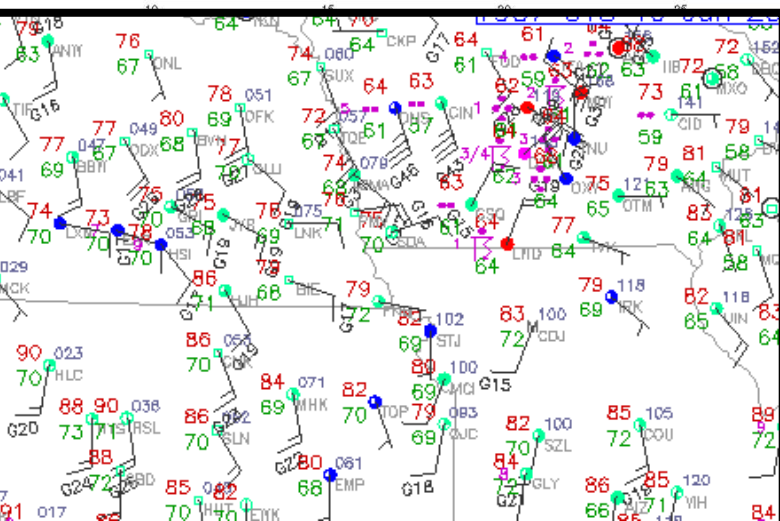
0.2   2   5   10   25   50
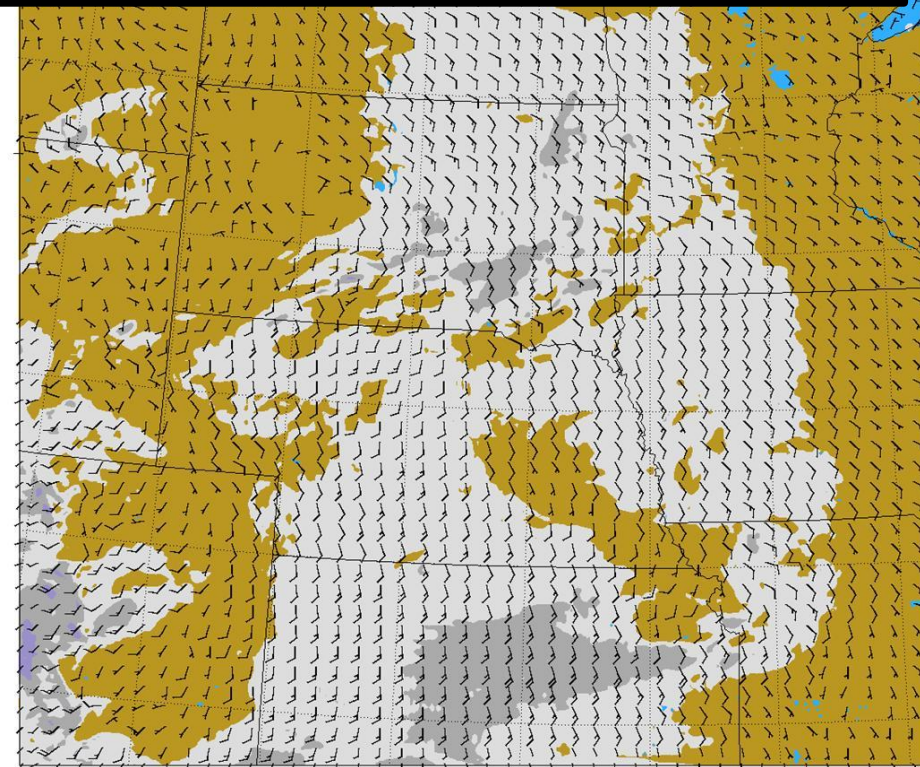
15 hour supercell forecast
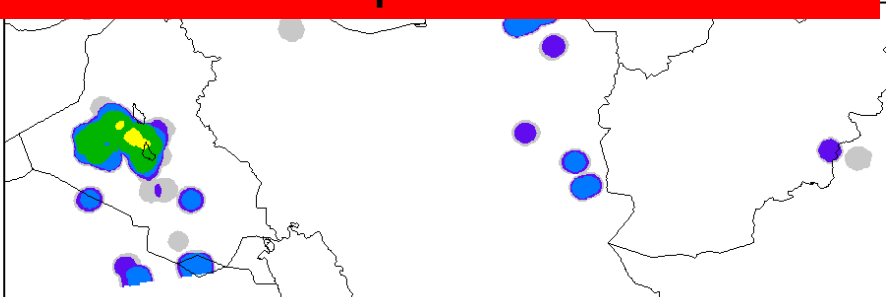
Prototype Software Only

10 June 2010
Wake low from MCS—24 hour forecast
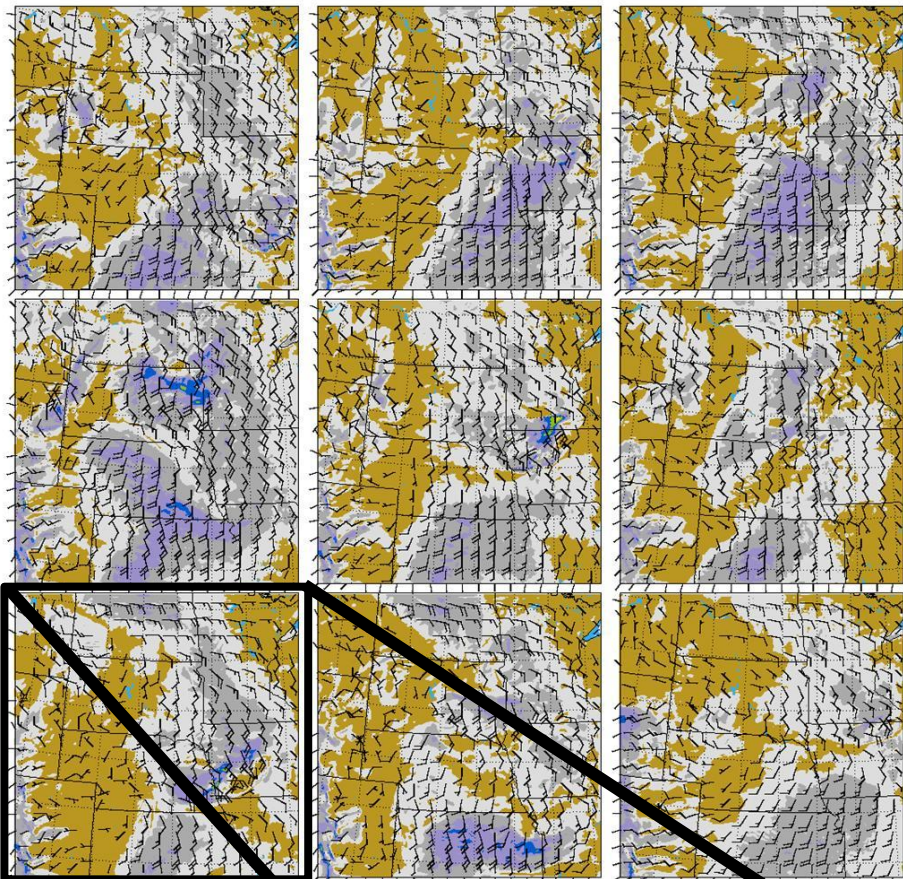
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Statistical Verification
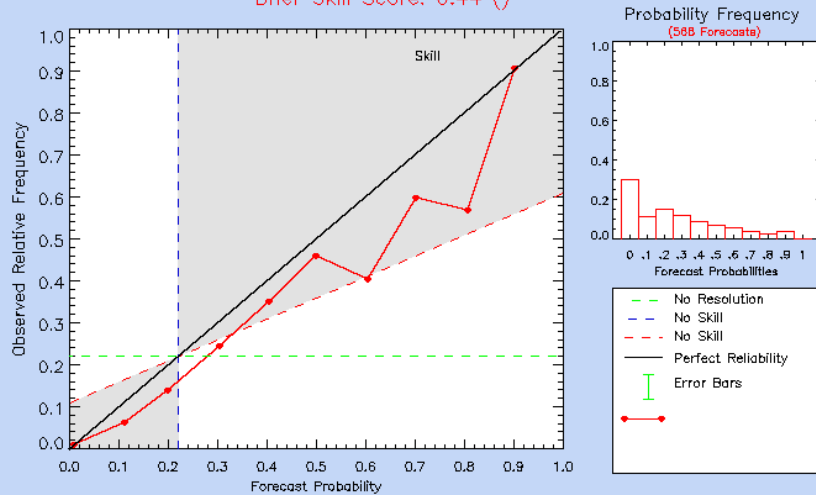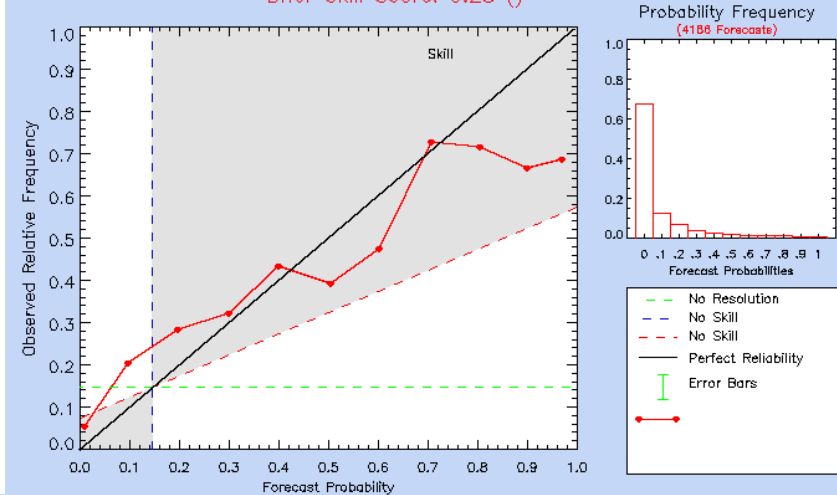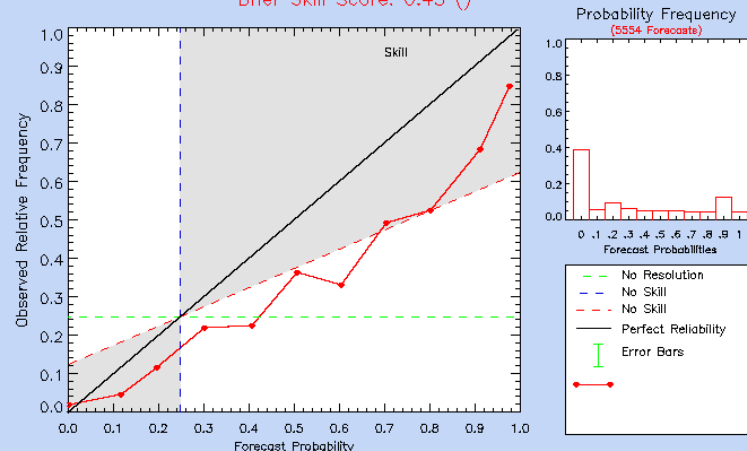
Ongoing efforts

- **2010 initiatives**
  - **Dust forecasting using WRF-CHEM, geological process-based dust source regions, and convection resolving ensembles in SWA (Jones and Creighton)**
  - **Severe weather diagnostics from convection resolving models with a customer-moveable domain over CONUS (Rentschler)**
  - **Physics-based and statistical techniques to forecast cloud coverage, ceiling, and visibility (Wilson)**
  - **Training and outreach, moving toward operational implementation**
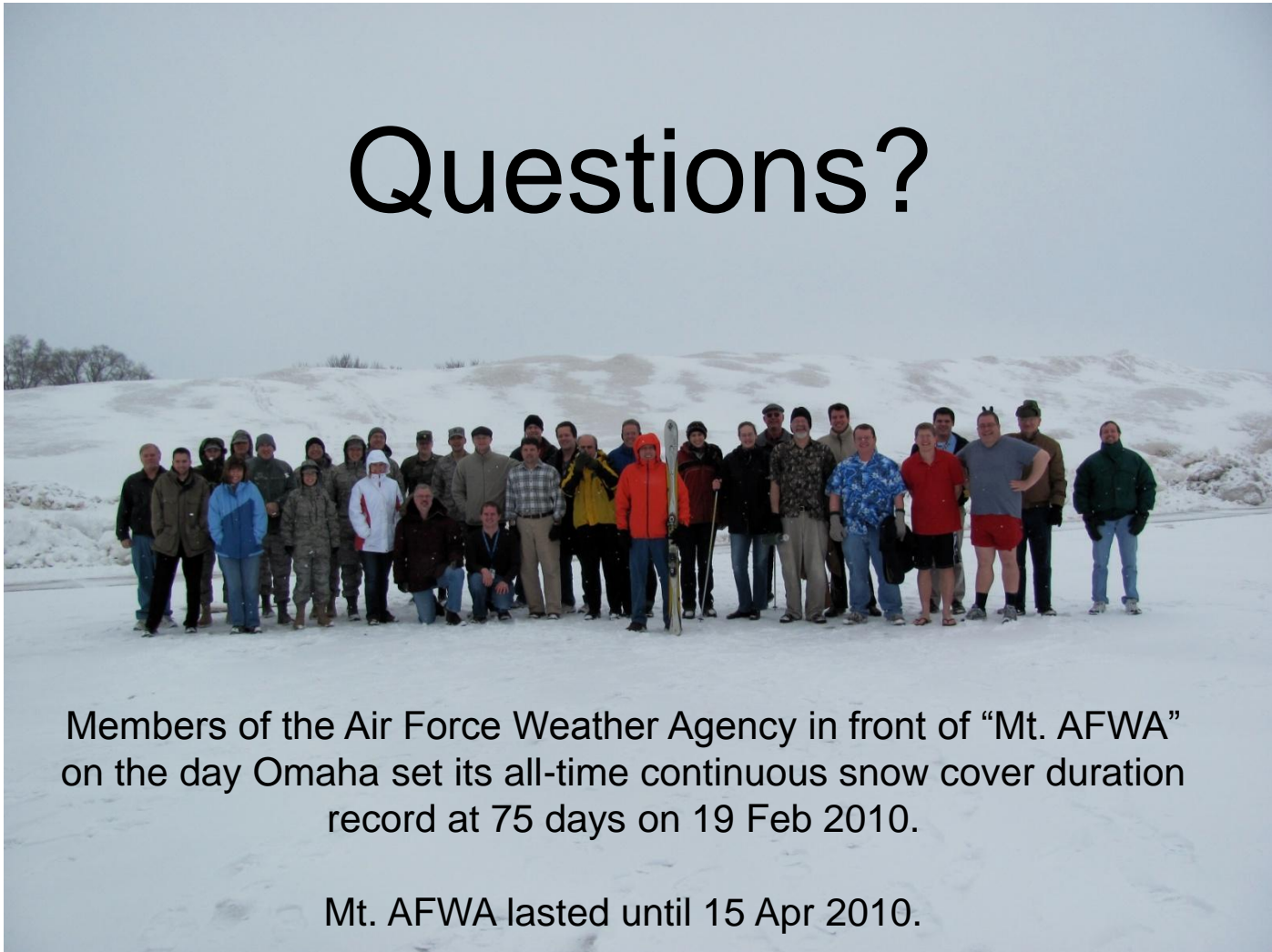   - **Product development key—summarize voluminous information**

Thank You!

Questions?

Members of the Air Force Weather Agency in front of "Mt. AFWA" on the day Omaha set its all-time continuous snow cover duration record at 75 days on 19 Feb 2010.

Mt. AFWA lasted until 15 Apr 2010.