AFWA Ensemble Products & Training

Mr. Horner
Chief, Scientific Services
A3N

Approved for Public Release – Distribution Unlimited

Aim High...Fly, Fight, Win

Purpose

- **Highlight examples of ensemble products and ensemble training materials available from the Air Force Weather Agency (AFWA)**

Overview

- **Current Operational Status**

- **Products**

- **Performance**

- **Training Materials**

- **Way-Ahead**

Current Operational Status

- **AFWA Declared Ensembles Operational in 2012**
- **Air Force Weather Ensemble Prediction Suite (AFWEPS)**
  - **Global Ensemble Prediction Suite (GEPS)**
  - **Mesoscale Ensemble Prediction Suite (MEPS)**
- **Available Products**
  - **Point Ensemble Probabilities**
  - **Potential Error Plots**
  - **Probability Plots**
  - **Precipitation Plots**
  - **Meteograms**
  - **Stamp Charts**
  - **Severe Plots**

MEPS 4-Panel Turb Probabilities
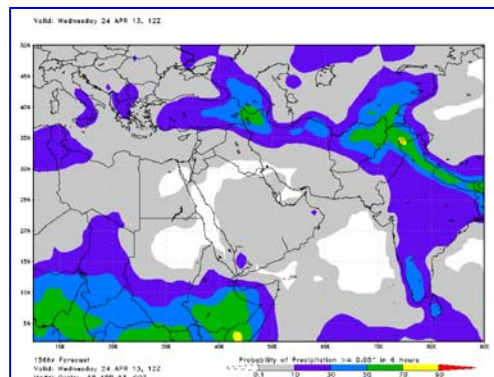
GEPS Precip Probability
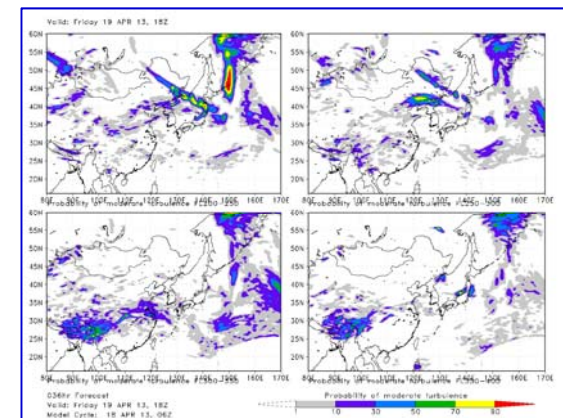
Current Operational Status

- **Global Ensemble Prediction Suite (GEPS)**
  - **Combination of GFS, GEM, and NOGAPS ensembles**
  - **Post-processed at AFWA (62 total members)**
  - **1° resolution; 240 hour forecast**
  - **00/12Z cycles daily (available t+10 hours)**

- **Mesoscale Ensemble Prediction Suite (MEPS)**
  - **10 members of WRF-ARW with diverse physics configurations and initial conditions**
  - **Initial conditions are deterministic UM, GFS, and GEM**
  - **20 km hemispheric and tropical stripe domains to 144 hours run at 06Z/18Z with inline dust module**
  - **4 km domains once per day to 72 or 84 hours**
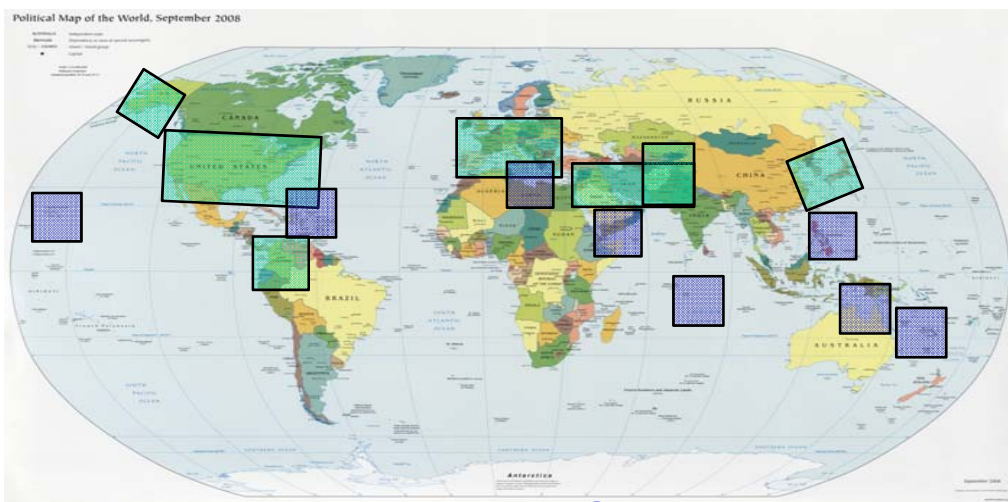
MEPS

4km MEPS Windows
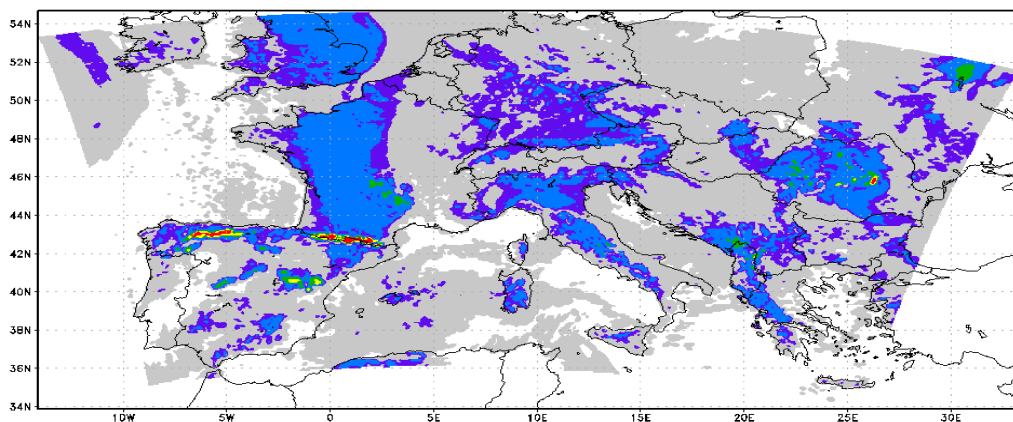
4 km MEPS visibility product

- **4km MEPS Domains**
  - **Green – static fixed windows**
  - **Blue – relocatable windows**
    - JTWC uses to track tropical storms
    - Air Force Weather's Operational Weather Squadrons coordinate window movements to address a variety of natural and manmade contingencies

■ 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	USGS	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)

Point Ensemble Probabilities (PEP)
4 km MEPS

U.S. AIR FORCE

WASHINGTON/NATL	38.8500 lat	-77.0333 lon	18 meters elevation
MODEL BOX INFO	38.8559 lat	-77.0287 lon	10 meters elevation
4 km MEPS OCT 27/12Z	SAT 27		

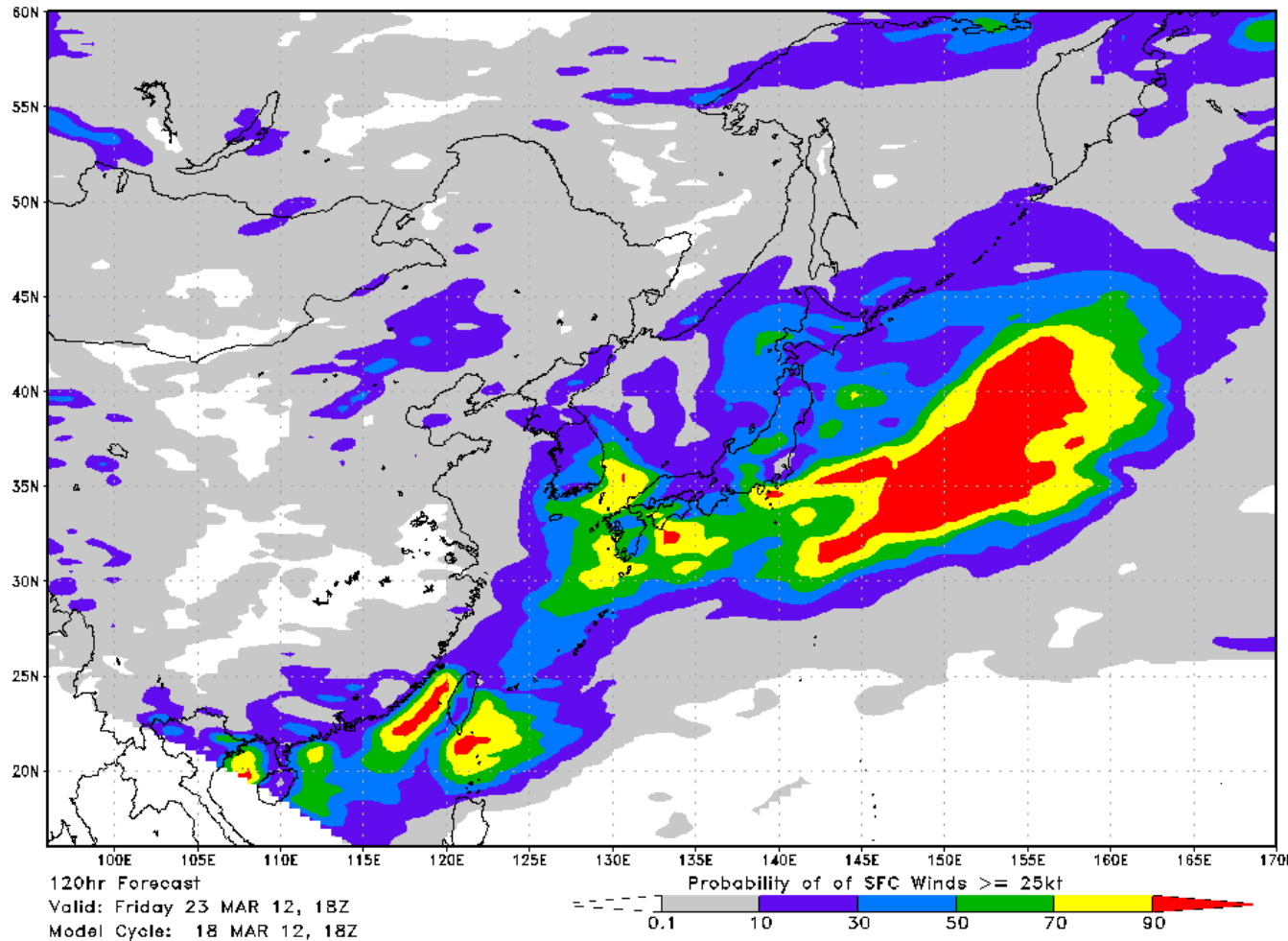| | SAT 27 | | | | | | SUN 28 | | | | | | | | | | | | | | | | | | | | | | | | MON 29 | | | | | | | | | | | | | | | | | | | | | | | | | TUE 30 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Surface winds** | 18 | 19 | 20 | 21 | 22 | 23 | 0Z | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0Z | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0Z | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 |
| Winds GT 25 KT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 6 | 6 | 4 | 3 | 4 | 9 | 12 | 16 | 27 | 27 | 31 | 34 | 34 | 25 | 21 | 25 | 32 | 33 | | 37 | 44 | 47 | 52 | 56 | 53 | 50 | 59 | 62 | 63 | 73 | 83 | 84 | 90 | 92 | 94 | 87 | 93 | 96 | 98 | 97 | 96 | 93 | 88 | | 89 | 91 | 88 | 86 | 87 | 81 | 77 | 63 | 66 | 61 | 57 | 49 | 42 |
| Winds GT 35 KT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 1 | 1 | 2 | | 7 | 7 | 7 | 8 | 14 | 15 | 17 | 25 | 27 | 29 | 37 | 42 | 46 | 50 | 54 | 54 | 56 | 53 | 62 | 57 | 58 | 53 | 57 | 54 | | 45 | 43 | 41 | 38 | 23 | 17 | 15 | 11 | 10 | 5 | 3 | 3 | 3 | | | | | |
| Winds GT 50 KT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 5 | 4 | 5 | 3 | 5 | 11 | 15 | 9 | 8 | 11 | 13 | 15 | 17 | 15 | 14 | 15 | 10 | 8 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| Winds GT 65 KT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LLWS GT 30 KT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 6 | 4 | 3 | 4 | 14 | 25 | 25 | 29 | 6 | 28 | 23 | 52 | 57 | 59 | 69 | 65 | 34 | 30 | 35 | 47 | 51 | 50 | 49 | 54 | 75 | 76 | 79 | 82 | 78 | 78 | 83 | 92 | 86 | 76 | 74 | 76 | 65 | 53 | 55 | 45 | 39 | 29 | 27 | 26 | 17 | 15 | 7 | 4 | 2 | 2 | | | | |
| **Precipitation** | 18 | 19 | 20 | 21 | 22 | 23 | 0Z | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0Z | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0Z | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 |
| Prcp GT 0.05IN in 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 11 | 12 | 11 | 10 | 9 | 29 | 47 | 63 | 69 | 70 | 73 | 76 | 79 | 81 | 87 | 89 | 89 | 89 | 88 | 87 | 88 | 89 | 90 | 90 | 91 | 92 | 93 | 94 | 94 | 96 | 97 | 98 | 98 | 99 | 99 | 98 | 97 | 95 | 94 | 94 | 92 | 93 | 93 | 94 | 93 | 93 | 93 | 93 | 93 | 92 | 91 | 90 | 91 | 91 | | |
| Prcp GT 2IN in 12 | -99 | -99 | -99 | -99 | -99 | -99 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 10 | 16 | 17 | 34 | 38 | 41 | 43 | 45 | 54 | 57 | 58 | 53 | 52 | 53 | 56 | 58 | 61 | 64 | 67 | 82 | 83 | 76 | 77 | 71 | 74 | 70 | 66 | 65 | 59 | 58 | 55 | 48 | 34 | 31 | 30 | 29 | 28 | 16 | 8 | | | | |
| FRZR GT 0.01IN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SN GT 0.1IN in 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 17 | 18 | 18 | 18 | 18 | 26 | 29 |
| SN GT 2IN in 12 | -99 | -99 | -99 | -99 | -99 | -99 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 7 | 10 | 11 | | |
| SN GT 6IN in 24 | -99 | -99 | -99 | -99 | -99 | -99 | -99 | -99 | -99 | -99 | -99 | -99 | -99 | -99 | -99 | -99 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 4 | 15 | 23 |
| **Thunderstorms** | 18 | 19 | 20 | 21 | 22 | 23 | 0Z | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0Z | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0Z | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 |
| Lgt in 20 NM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 7 | 11 | 9 | 9 | 12 | 10 | 11 | 12 | 7 | 6 | 6 | 6 | 0 | 5 | 9 | 12 | 23 | 25 | 27 | 19 | 19 | 18 | 17 | 14 | 12 | 11 | 12 | 17 | 15 | 13 | 8 | 12 | 15 | 14 | 20 | | 14 | 20 | 10 | 12 | 14 | 9 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 in hail in 20 NM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 in hail in 20 NM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tornado in 20 NM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Cig + Vis** | 18 | 19 | 20 | 21 | 22 | 23 | 0Z | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0Z | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0Z | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 |
| Vis lt 5 miles | 2 | 2 | 2 | 3 | 4 | 4 | 5 | 4 | 6 | 7 | 8 | 7 | 6 | 5 | 6 | 7 | 7 | 6 | 8 | 11 | 16 | 28 | 26 | 44 | 50 | 66 | 68 | 66 | 66 | 64 | 66 | 74 | 67 | 76 | 82 | 73 | 73 | 73 | 75 | 77 | 81 | 94 | 94 | 94 | 91 | 91 | 97 | 84 | 74 | 79 | 85 | 79 | 67 | 71 | 69 | 63 | 49 | 44 | 46 | 37 | 45 | 39 | 40 | 33 | 46 | 52 | 41 |
| Vis lt 3 miles | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 4 | 10 | 18 | 18 | 34 | 44 | 46 | 51 | 48 | 47 | 46 | 40 | 46 | 55 | 54 | 55 | 50 | 48 | 47 | 40 | 63 | 65 | 71 | 67 | 66 | 75 | 64 | 62 | 67 | 61 | 46 | 37 | 47 | 41 | 38 | 31 | 22 | 26 | 13 | 30 | 24 | 18 | 18 | 29 | 35 | 31 | | | |
| Vis lt 1 mile | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 11 | 10 | 11 | 12 | 14 | 15 | 23 | 19 | | | | | | | | | | | | | | | |
| Cig lt 3000 ft | 7 | 16 | 14 | 30 | 25 | 28 | 32 | 18 | 27 | 23 | 20 | 21 | 26 | 29 | 22 | 30 | 38 | 38 | 43 | 42 | 28 | 38 | 45 | 52 | 57 | 77 | 72 | 74 | 75 | 74 | 81 | 79 | 79 | 79 | 85 | 80 | 82 | 77 | 76 | 80 | 81 | 94 | 94 | 94 | 91 | 91 | 97 | 84 | 79 | 82 | 89 | 83 | 70 | 79 | 74 | 70 | 61 | 56 | 58 | 53 | 59 | 54 | 52 | 51 | 62 | 71 | 63 |
| Cig lt 1000 ft | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 4 | 10 | 19 | 18 | 34 | 44 | 46 | 51 | 48 | 47 | 46 | 40 | 46 | 55 | 54 | 55 | 50 | 48 | 47 | 40 | 63 | 65 | 71 | 67 | 66 | 75 | 64 | 62 | 67 | 61 | 47 | 38 | 47 | 42 | 38 | 32 | 24 | 28 | 16 | 32 | 26 | 20 | 19 | 32 | 38 | 37 | | | |
| Cig lt 500 ft | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 3 | 1 | 1 | 1 | 0 | 5 | 0 | 2 | 0 | 0 | 3 | 7 | 0 | 2 | 2 | 4 | 3 | 0 | 5 | 7 | 4 | 5 | 2 | 6 | 4 | 0 | 2 | 1 | 11 | 10 | 10 | 12 | 14 | 15 | 23 | 19 | | | | | | | | | |
| **Others** | 18 | 19 | 20 | 21 | 22 | 23 | 0Z | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0Z | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0Z | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 |
| Mean Temp (F) | 65 | 66 | 65 | 64 | 64 | 63 | 62 | 62 | 61 | 60 | 60 | 59 | 59 | 58 | 57 | 57 | 56 | 56 | 56 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 54 | 54 | 54 | 54 | 54 | 53 | 53 | 53 | 53 | 52 | 52 | 52 | 51 | 51 | 51 | 50 | 50 | 50 | 50 | 49 | 49 | 48 | 48 | 48 | 47 | 47 | 46 | 46 | 45 | 45 | 44 | 44 | 43 | 43 | 42 | 41 | 41 | 40 | 40 |
| Mean Wind Spd (kt) | 9 | 9 | 10 | 10 | 10 | 9 | 9 | 10 | 10 | 11 | 11 | 11 | 13 | 12 | 12 | 12 | 13 | 13 | 14 | 15 | 15 | 14 | 15 | 15 | 15 | 14 | 14 | 15 | 15 | 15 | 16 | 16 | 17 | 17 | 18 | 18 | 19 | 20 | 20 | 22 | 23 | 24 | 25 | 26 | 25 | 25 | 25 | 26 | 26 | 27 | 26 | 26 | 26 | | 24 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 18 | 17 | 17 | 16 | 15 |
| >80% Cld cvr | 15 | 28 | 36 | 42 | 42 | 51 | 46 | 25 | 42 | 45 | 47 | 53 | 45 | 59 | 70 | 63 | 67 | 64 | 61 | 51 | 49 | 40 | 52 | 52 | 58 | 77 | 72 | 74 | 75 | 74 | 82 | 79 | 79 | 79 | 85 | 80 | 82 | 77 | 76 | 80 | 81 | 94 | 94 | 94 | 94 | 91 | 97 | 91 | 91 | 93 | 90 | 93 | 90 | 85 | 84 | 75 | 77 | 68 | 65 | 62 | 60 | 62 | 60 | 51 | 62 | 71 | 63 |

POINT ENSEMBLE PROBABILITY™

- A number of variables of significance are plotted for a single station, and color-coded to draw attention to the time periods of higher risk (i.e., where probabilities are notable)

- In the future, decision makers will ideally be able to color-code their own probability thresholds.

Aim High...Fly, Fight, Win

Probability Plots

Valid: Friday 23 MAR 12, 18Z

120hr Forecast
Valid: Friday 23 MAR 12, 18Z
Model Cycle: 18 MAR 12, 18Z

Probability of of SFC Winds >= 25kt

- Ensemble member outputs are combined to create probabilities by counting how many members are above and below the threshold of significance (e.g., surface winds >= 25 kts).

- Probabilities can be used both to improve deterministic forecasts and also to alert decision makers to the level of weather risk depending on their sensitivity to various types of weather.

Aim High…Fly, Fight, Win

9

Convection-Allowing

Valid: Wednesday 21 MAR 12, 15Z
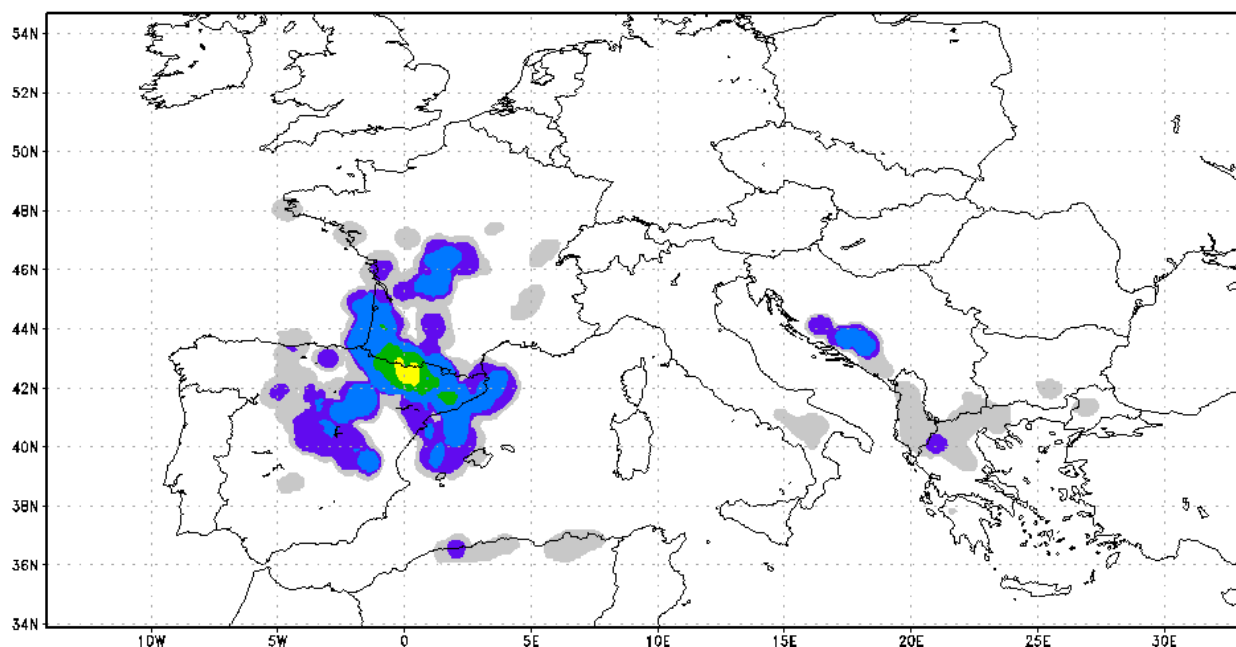
051hr Forecast
Valid: Wednesday 21 MAR 12, 15Z
Model Cycle: 19 MAR 12, 12Z

Probability of lightning within 20NM

0.2   5   10   25   40   70
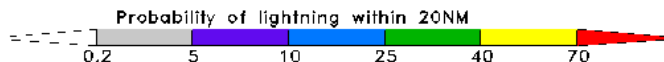
- 4 km domains are convection-allowing, meaning updrafts and downdrafts are explicitly predicted rather than parameterized.

- This allows for more precise prediction of convective impacts from lightning, wind, hail, tornadoes, and precipitation.

- However, owing to the complex nature of convection, convective features generated in 4 km domains may be spurious even though they "look" realistic.

U.S. AIR FORCE

Valid: Monday 19 MAR 12, 03Z

009hr Forecast
Valid: Monday 19 MAR 12, 03Z
Model Cycle: 18 MAR 12, 18Z

Probability of 2m Visibility <= 1 mile

0.1   5   10   30   50   70
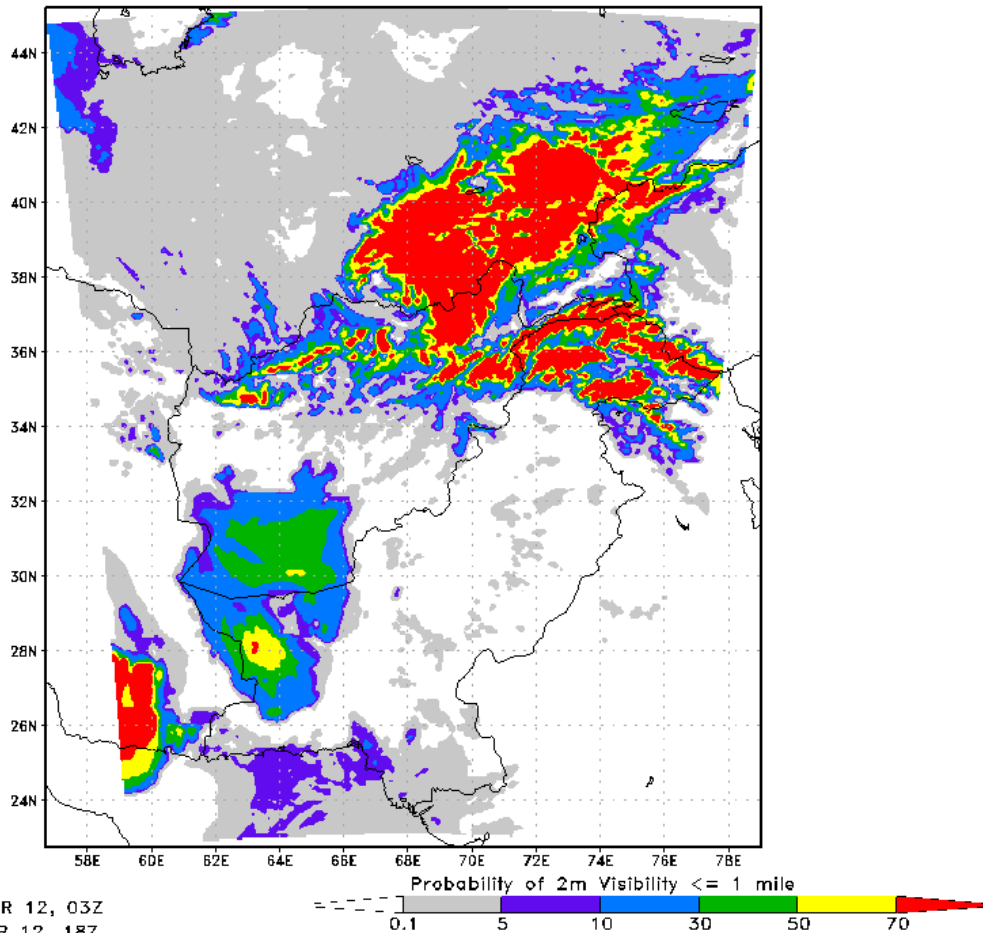
- In certain domains, dust is lofted and advected as part of the model (WRF-Chem) to improve dust forecasts.

- In the visibility restriction product shown here, snow/precipitation related restrictions are present in the north with dust related restrictions in the south.

Precipitation Accumulation

Valid: Tuesday 20 MAR 12, 00Z
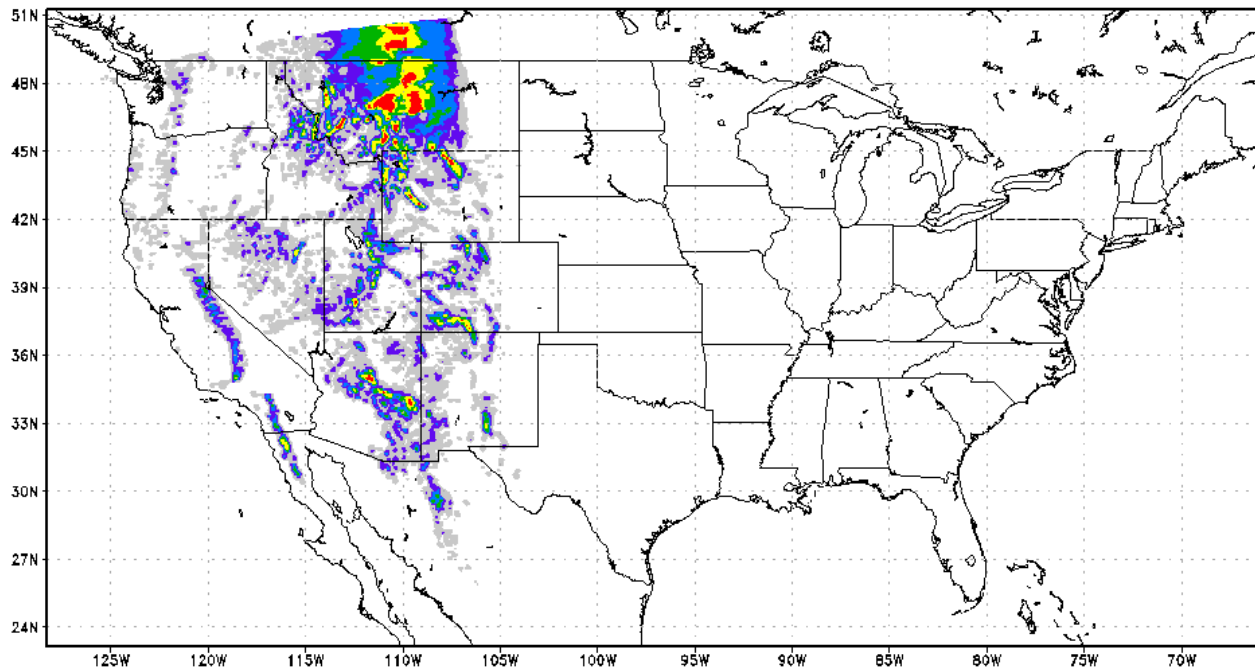
024hr Forecast
Valid: Tuesday 20 MAR 12, 00Z
Model Cycle: 19 MAR 12, 00Z

Probability of Snow >= 6.0" in 24 hours

0.1   10   30   50   70   90
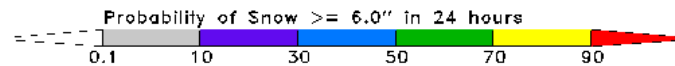
- Probabilities of precipitation for different amounts and time periods.

- Standard warning criteria (e.g., 2 inches of rain or snow in 12 hours) plus many others (e.g., 6 or more inches of snow in 24 hours).

Aim High…Fly, Fight, Win

Summary Charts

JF3MSP Quick Look Weather Threat Probability Run: 2012072000 valid: 048 hrs at: 2012072200
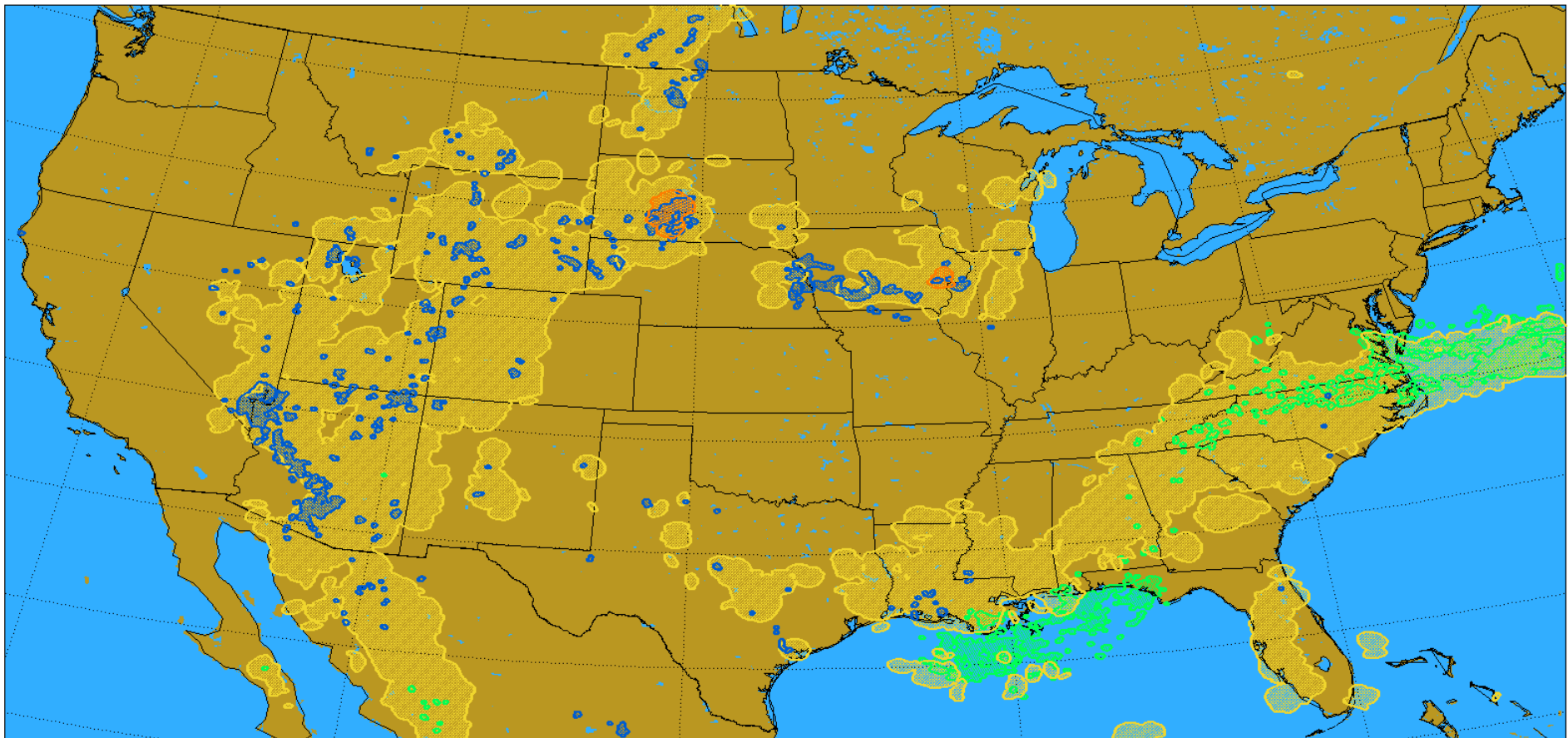
| ● P(RA gt 2 inch/12 hrs) >20% | ● P(SN gt 2 inch/12 hrs) >20% | ● P(FZRN gt 0.01 inch) >20% |
| ● P(Tornado in 20 NM) >5% | ● P(Hail gt 1 inch in 20 NM) >10% | ● P(Gust gt 50 knots) >10% | ● P(LGT in 20 NM) >20% |

- ▪ Hourly chart from the 4 km MEPS showing multiple weather threats on one map.

Summary Charts

Severe Probabilities for the 36-60 hour period after 2012072000

Wind Gusts gt 50 kts

Tornado within 20 NM

Lightning

Hail > 1 inch within 20 NM

| 1 | 3 | 5 | 10 | 20 | 30 | 40 | 50 | 75 |
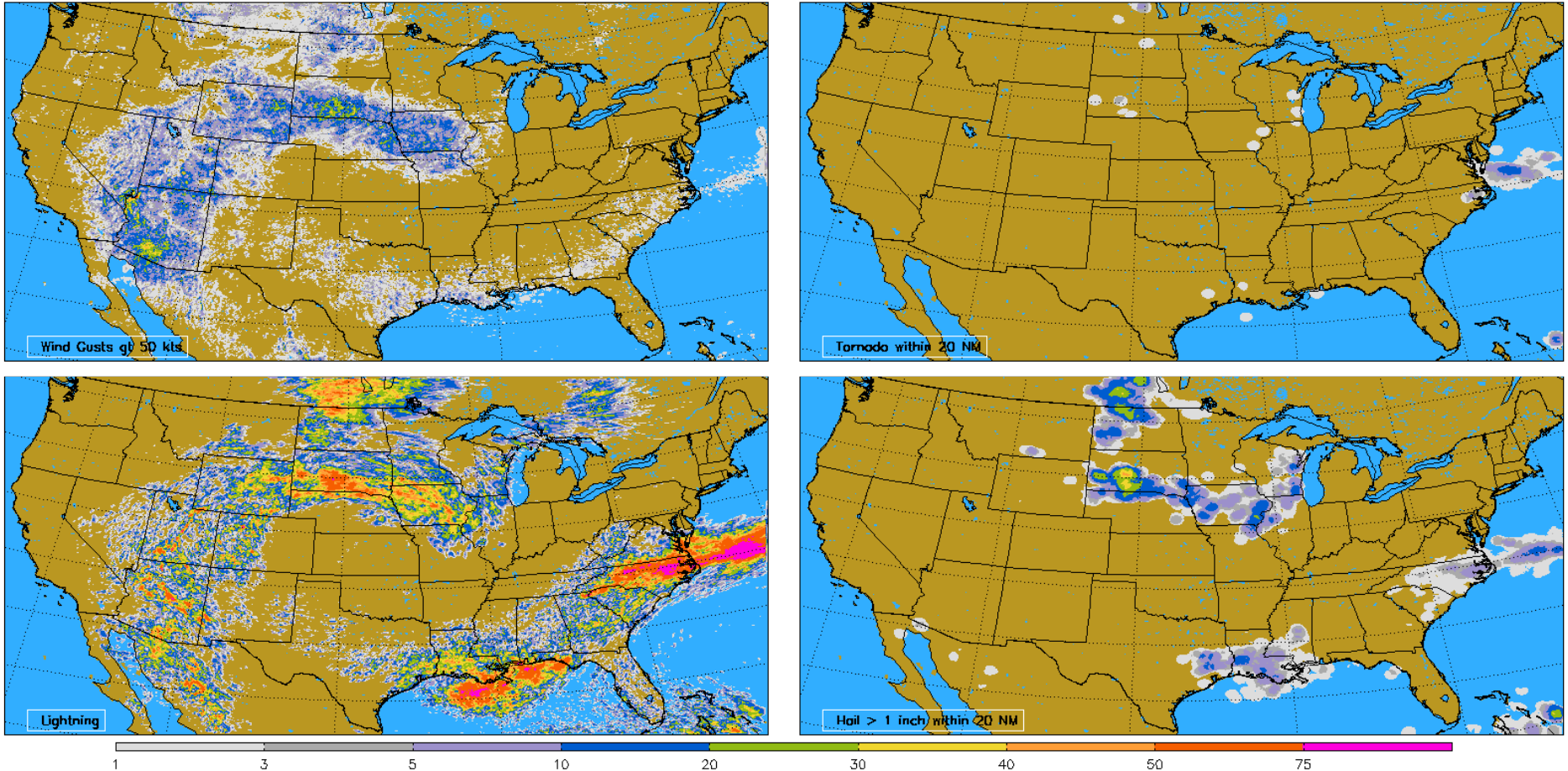
- Summaries to help discern where severe threats will be located in a given 24-hour period.

Output

- **GEPS and MEPS products are available on AFW-WEBS:**
  https://weather.af.mil/AFW_WEBS/viewer/MapModule.php
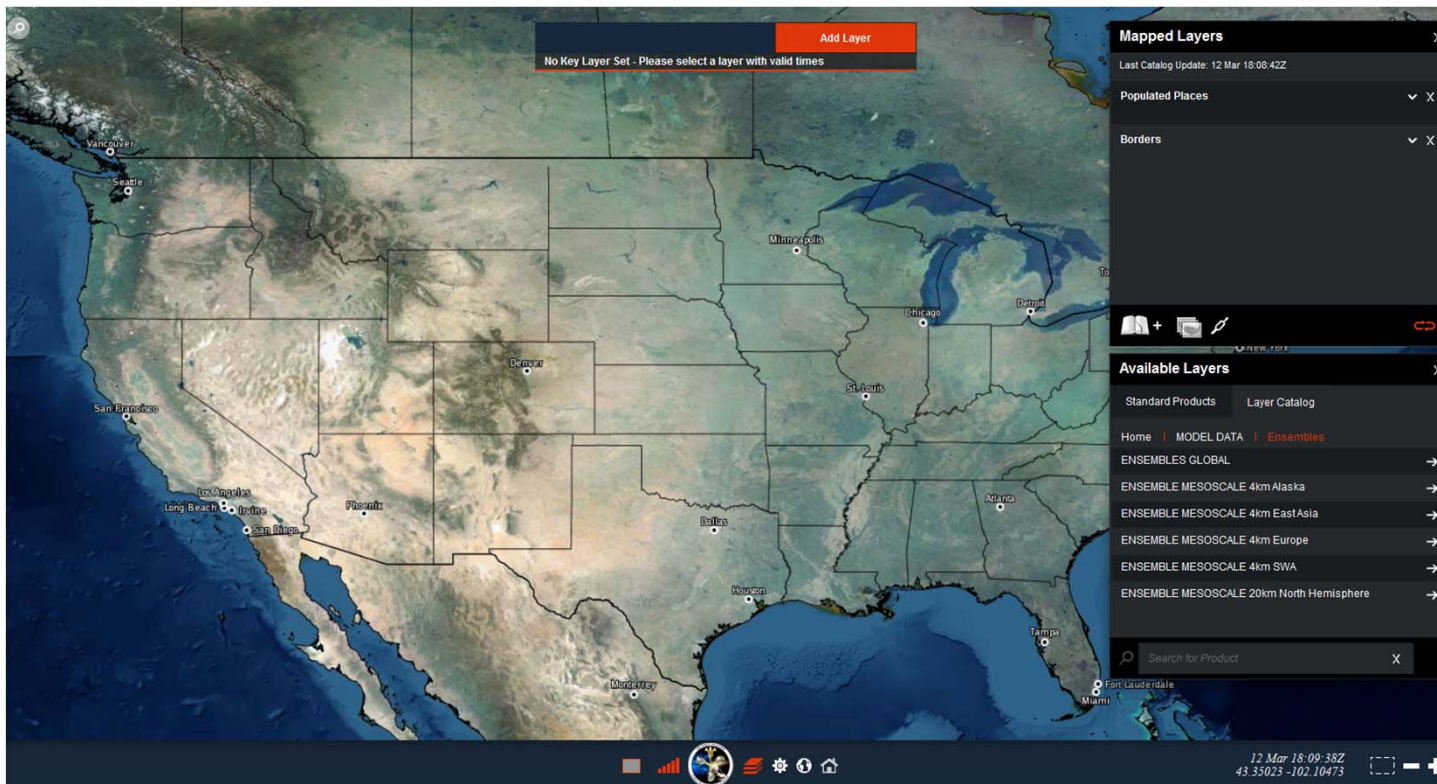
Select "Layer Catalog → Model Data → Ensembles" in the menu on the bottom right.

Output

https://weather.af.mil/confluence/display/AFWWEBSTBT/Ensembles+Main+Page

For PEP bulletins, use map or enter ICAO. Note: only stations with ICAO are created.

Output

https://weather.af.mil/confluence/display/AFWWEBSTBT/Ensembles+Main+Page

User can navigate between model, region, and product suite for output of choice.

Statistical Verification
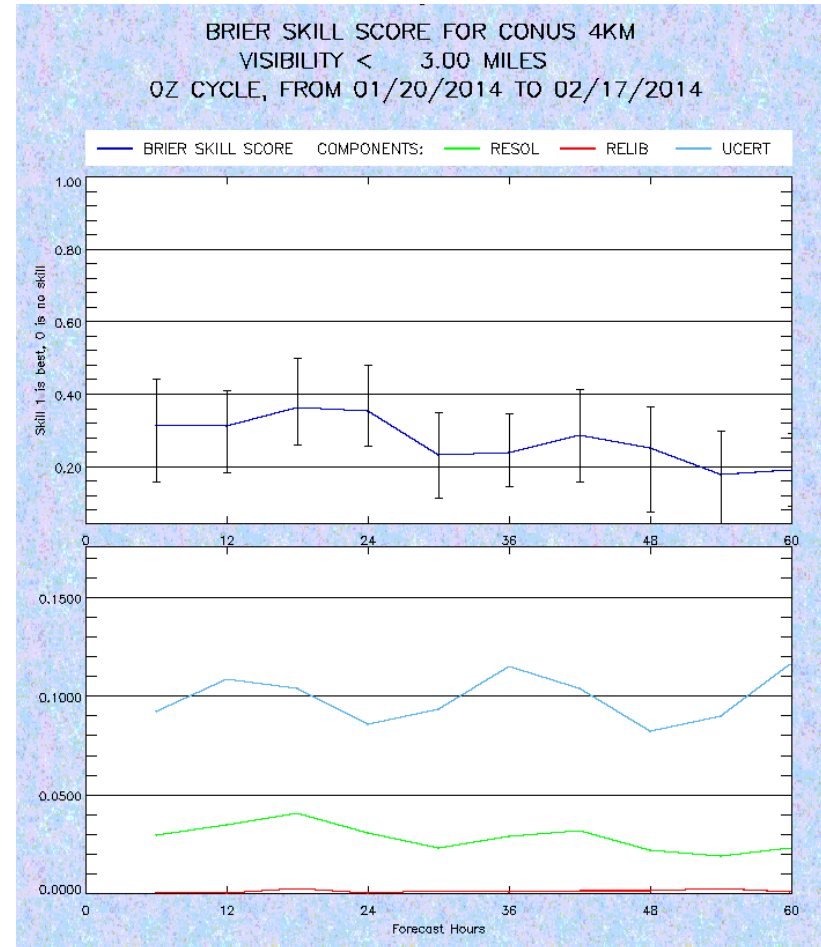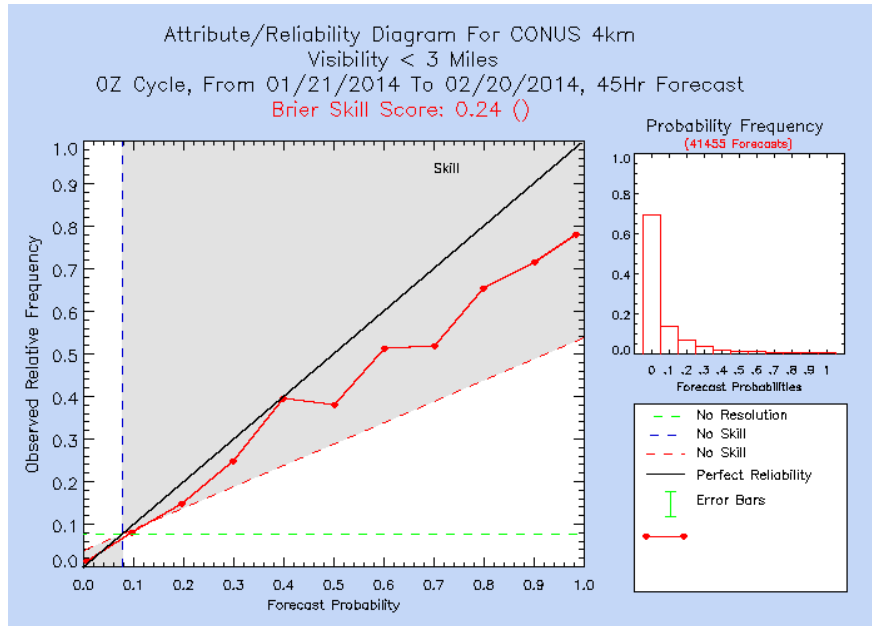
Aim High...Fly, Fight, Win

U.S. AIR FORCE

0043Z surface obs

000m Forecast
Valid: Tuesday 30 OCT 12, 00Z
Model Cycle: 27 OCT 12, 12Z
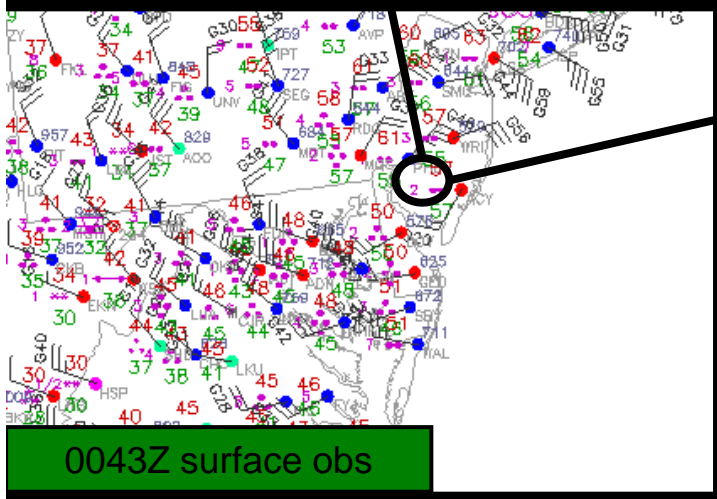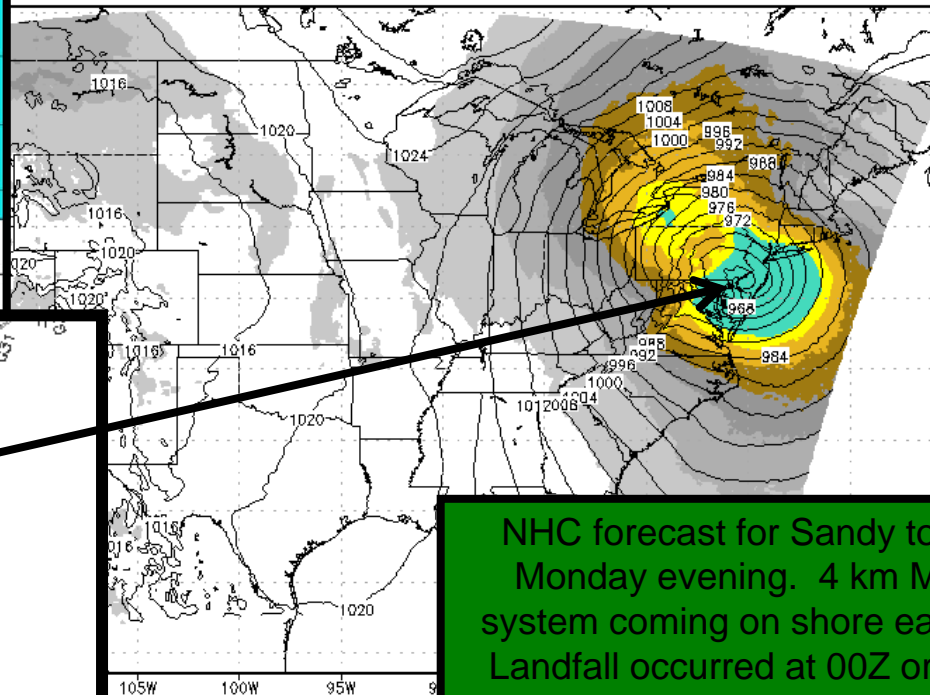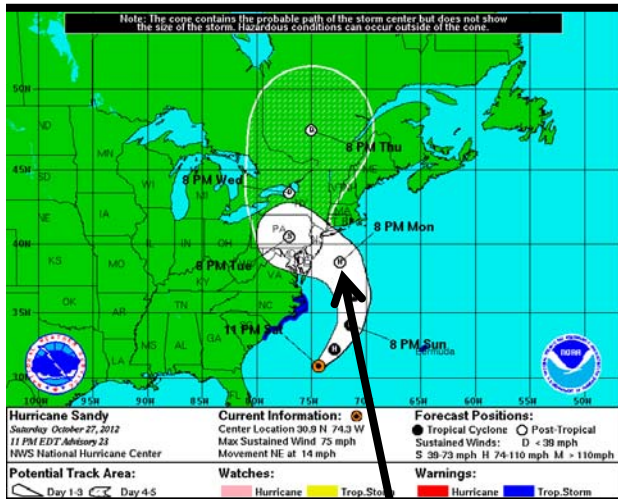
NHC forecast for Sandy to still be offshore on Monday evening. 4 km MEPS mean shows system coming on shore early Monday evening. Landfall occurred at 00Z or 8:00 PM local time.

MSLP Potential Error (+/-) in hPa (95% CI)

Mean MSLP (hPa)

Valid: Friday 29 JUN 12, 21Z

4 km MEPS 21-hour forecast

81 knots Marengo @ 2216

70 knots Fairfield @ 2134

NEXLAB-College of DuPage

SPC Storm Reports for 06/29/12

NEXRAD 1KM MOSAIC 29 JUN 12 20:54

021hr Forecast
Valid: Friday 29 JUN 12, 21Z
Model Cycle: 29 JUN 12, 00Z

Probability of 10m Winds >= 65kt

0.1   2   5   10   30   50   70

36-hour PEP 20 Feb 2013

KSZL—MEPS shows heavy snow threat from 14Z-21Z (obs 13Z-19Z). Thunder also forecast and observed.

U.S. AIR FORCE

WHITEMAN AFB	38.7167 lat	-93.5333 lon	265 meters elevation		
MODEL BOX INFO	38.7054 lat	-93.5417 lon	262 meters elevation		

4 km MEPS FEB 20/12Z

	WED 20						THR 21																								FRI 22																								SAT 23												
Surface winds	18	19	20	21	22	23	0Z	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0Z	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0Z	01	02	03	04	05	06	07	08	09	10	11	12
Winds GT 25 KT	0	0	0	0	0	0	0	0	0	1	0	1	1	1	5	11	26	42	41	13	21	68	63	57	61	47	59	69	69	53	43	20	4	1	1	0	0	0	3	3	3	6	6	3	1	2	4	6	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Winds GT 35 KT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	11	15	11	3	2	2	10	9	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Winds GT 50 KT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Winds GT 65 KT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LLWS GT 30 KT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	22	31	36	61	77	57	49	31	3	17	16	13	10	6	3	1	2	0	2	1	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	1	0	1	0	0	0	0	0
Precipitation	18	19	20	21	22	23	0Z	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0Z	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0Z	01	02	03	04	05	06	07	08	09	10	11	12
Prcp GT 0.05IN in 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	81	96	96	97	97	98	97	96	98	96	97	96	94	91	62	52	37	21	11	12	7	4	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prcp GT 2IN in 12	-99	-99	-99	-99	-99	-99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	11	12	13	13	13	15	13	14	14	12	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FRZR GT 0.01IN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SN GT 0.1IN in 6	0	0	0	0	0	0	0	0	0	0	1	2	3	5	7	11	70	82	91	95	97	97	96	93	89	92	92	91	94	97	99	99	97	98	94	86	83	83	68	62	55	42	42	35	18	16	14	4	3	5	3	2	1	2	2	8	10	8	6	6	4	2	2				
SN GT 2IN in 12	-99	-99	-99	-99	-99	-99	0	0	0	0	0	0	0	0	0	0	14	57	87	93	96	96	96	96	96	96	97	97	95	92	80	71	63	37	16	10	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SN GT 6IN in 24	-99	-99	-99	-99	-99	-99	-99	-99	-99	-99	-99	-99	-99	-99	-99	-99	-99	0	0	12	52	82	88	92	92	92	92	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	94	91	75	66	40	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thunderstorms	18	19	20	21	22	23	0Z	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0Z	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0Z	01	02	03	04	05	06	07	08	09	10	11	12
Lgt in 20 NM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	60	63	59	47	39	24	18	7	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 in hail in 20 NM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 in hail in 20 NM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tornado in 20 NM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cig + Vis	18	19	20	21	22	23	0Z	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0Z	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0Z	01	02	03	04	05	06	07	08	09	10	11	12
Vis lt 5 miles	1	0	5	6	5	3	2	3	6	3	6	6	6	5	5	5	4	3	4	8	69	99	99	99	99	99	96	95	99	81	99	81	91	90	80	69	77	84	77	72	64	43	31	24	14	21	9	10	6	5	5	5	6	18	34	31	23	24	26	24	28	29	30	29	26	28	27
Vis lt 3 miles	0	0	3	3	3	1	1	2	4	1	4	4	3	3	3	2	2	1	1	0	69	95	99	99	99	99	90	89	95	77	92	66	86	82	46	51	52	62	48	47	19	14	13	7	4	3	3	2	2	2	2	1	10	20	20	14	15	16	13	17	18	19	18	16	17	17	
Vis lt 1 mile	0	0	1	2	2	0	0	0	2	0	2	2	1	1	1	0	1	0	62	89	99	99	99	96	89	79	45	42	37	20	22	13	6	10	11	16	15	15	15	4	2	2	1	0	0	0	0	0	0	0	0	0	0	3	7	7	5	5	4	6	6	6	5	4	5	5	
Cig lt 3000 ft	3	4	6	6	6	7	2	3	6	4	7	7	7	6	6	4	5	8	70	99	99	99	99	99	96	95	99	86	99	87	95	95	81	81	85	87	80	77	70	56	47	42	38	36	28	32	26	24	27	26	25	32	40	38	37	36	35	33	34	33	32	32	29	29	27		
Cig lt 1000 ft	0	0	3	3	3	1	1	2	4	1	4	4	3	3	3	2	3	3	69	95	99	99	99	99	91	90	95	78	92	69	88	84	53	64	59	66	55	53	54	28	26	22	23	16	12	14	10	9	9	8	9	16	24	22	18	18	19	17	20	20	21	21	18	18	17		
Cig lt 500 ft	0	0	1	2	2	0	0	0	2	0	2	2	1	1	1	0	1	0	62	89	99	99	99	96	89	79	45	42	37	20	22	13	6	10	11	16	15	15	15	4	2	2	1	0	0	0	0	0	0	0	0	0	0	3	7	7	5	5	5	4	6	6	6	5	4	5	5
Others	18	19	20	21	22	23	0Z	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0Z	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0Z	01	02	03	04	05	06	07	08	09	10	11	12
Mean Temp (F)	26	27	28	29	29	28	28	28	27	27	27	27	27	27	27	26	26	26	26	24	23	23	23	24	24	25	26	27	27	28	28	29	30	30	31	32	32	32	30	28	25	22	21	21	21	23	23	24	24	24	23	21	17	16	15	15	15	12	11	10	9	8	8				
Mean Wind Spd (kt)	7	9	8	9	10	9	8	10	10	11	11	11	12	13	14	15	16	16	14	14	18	18	17	16	17	18	18	17	16	13	11	9	9	9	9	10	10	12	12	11	11	12	12	13	13	12	12	10	10	9	8	8	8	7	7	7	7	7	7	7	7	6					
>80% Cld cvr	99	99	99	95	67	67	63	65	72	68	70	78	84	79	75	66	74	93	99	100	100	100	100	100	100	100	98	99	100	99	99	99	96	93	92	93	95	87	96	77	65	68	63	66	59	53	56	53	52	51	48	47	50	46	46	51	47	52	51	47	43	42	43	44	47	52	
Pollution Trapping(1=LO,5=HI)	4	4	4	4	3	4	4	3	3	3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	3	3	3	3	4	4	3	2	3	3	2	2	2	2	2	2	2	3	3	4	4	4	4	5	5	5	5	5	5	5	5	5			

Point Ensemble Probability

Despite highly confident forecast of significant weather impacts, base was open as normal for the day. Just after everyone arrived, 3 inch/hr snowfall was observed in the morning with 10 inches total in a 6 hour period. Base closed after snow fell, compounding problems.

Other bases in the local area closed early based on forecast (one the night before, and two just before the weather arrived).

Aim High...Fly, Fight, Win

13 Apr 00Z 4km MEPS
24-hour tornado probability valid 12Z 14 Apr - 12Z 15 Apr

Aim High...Fly, Fight, Win

AFWEPS Information

- **Detailed AFWEPS information is also available on AFW-WEBS Confluence:**
  - **https://weather.af.mil/confluence/pages/viewpage.action?pageId=11766859**

- **For additional AFWEPS information, the AFWA POC is Mr. Evan Kuchera**
  - **DSN: 271-3724, COMM: (402) 294-3724**
  - **E-mail: evan.kuchera@offutt.af.mil**

Training Materials

- **Available on the Air Force Weather Knowledge Center (AFWKC):**

    1. *AFW Transition to Stochastic Weather Prediction*
    2. *AFWA Introduction to ORM in AFW*
    3. *AFW Introduction to Ensemble Verification Techniques*
    4. *COMET Introduction to Ensemble Prediction*
    5. *COMET Ensemble Forecasting Explained*
    6. *Glossary of Ensemble Forecasting Terms*
    7. *WTS: Models – GEPS*
    8. *WTS: Models – MEPS*
    9. *Use/Misuse of Ensemble Stamp Charts*

Training Materials

- **Accessing the Air Force Weather Knowledge Center (AFWKC)**
  - **Go to:**
    https://afwkc.csd.disa.mil/kc/login/login.asp?kc_ident=kc0002

Way-Ahead

- **Policy**
  - AFW policy does not strongly sanction the use of ensembles
  - Official policy documents may be revised (e.g., AFMAN 15-129, Volume 1, "Air and Space Weather Operations – Characterization")
    - New verbiage will need to be coordinated/approved by the AFWA Staff and Air Staff

- **Operations**
  - Collect and report feedback from users
  - Revise training material and policy as necessary based on user feedback

Way-Ahead

- **AFW-WEBS will enable users to manually select variables, thresholds, and time increments of choice**
  - **Can tailor the probabilities to specific mission needs**
  - **For instance, probability of surface winds greater than 50 knots OR visibility less than 1 mile OR ceiling less than 1000 feet OR lightning for aircraft ops**
  - **Also, probability of 2 inches of snow in 3 hours, 12 hours, 53 hours, XX hours, etc.**

- **Contingency 4 km MEPS domains**
  - **Appointed user can request to change the area of the domain from cycle to cycle to meet mission or weather needs**

- **Gridded data availability via subscription**
  - **Test datasets available now by request to 16 WS/WXN**

- **Develop multi-model regional ensembles (e.g., fold US Navy mesoscale model members into AFWA's MEPS)**