Ensemble Products and Training

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Motivation

- **Ensembles are about probabilities and probabilities facilitate making good decisions**

- Products
  - *What we have and what we need*
  - *High Impact events: Climate and forecast data*
    - *R-Climate and M-Climate products*
    - *Toward Extreme forecast Indices→ EFI and Threats images*

- Training
  - What we have and what we need
  - Need for EFI related training.

# EC EFI 4,9, 18 March valid 14 March 2012
Probability of above normal mean 2m temperatures

Sunday 04 March 2012 00UTC @ECMWF VT: Wed 14 Mar 2012 00UTC - Mon 19 Mar 2012 00UTC 240-360h
Extreme forecast index for: 2m mean temperature
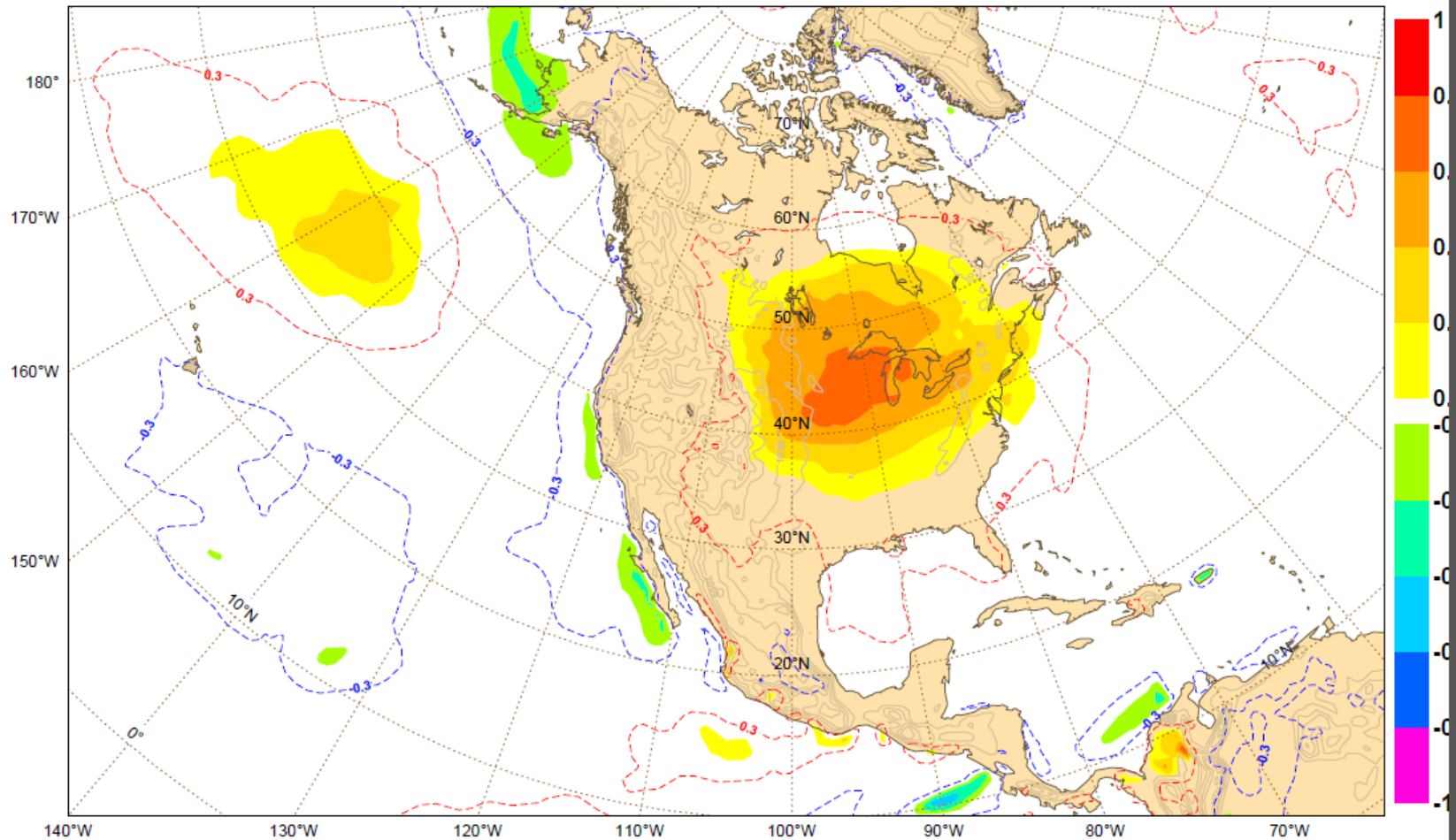
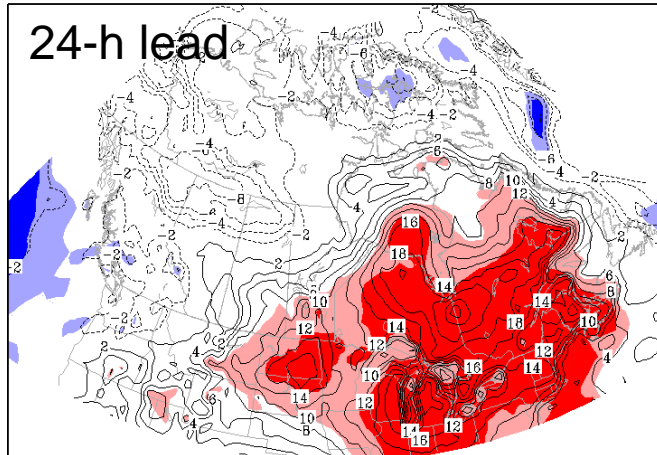# EFI For Record high and high minimum temperatures

Sunday 18 March 2012 00UTC @ECMWF VT: Sun 18 Mar 2012 00UTC - Mon 19 Mar 2012 00UTC 0-24h
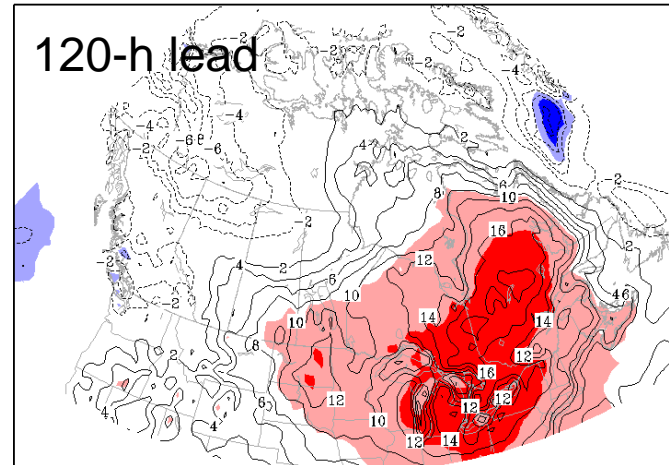Extreme forecast index for: 2m maximum temperature
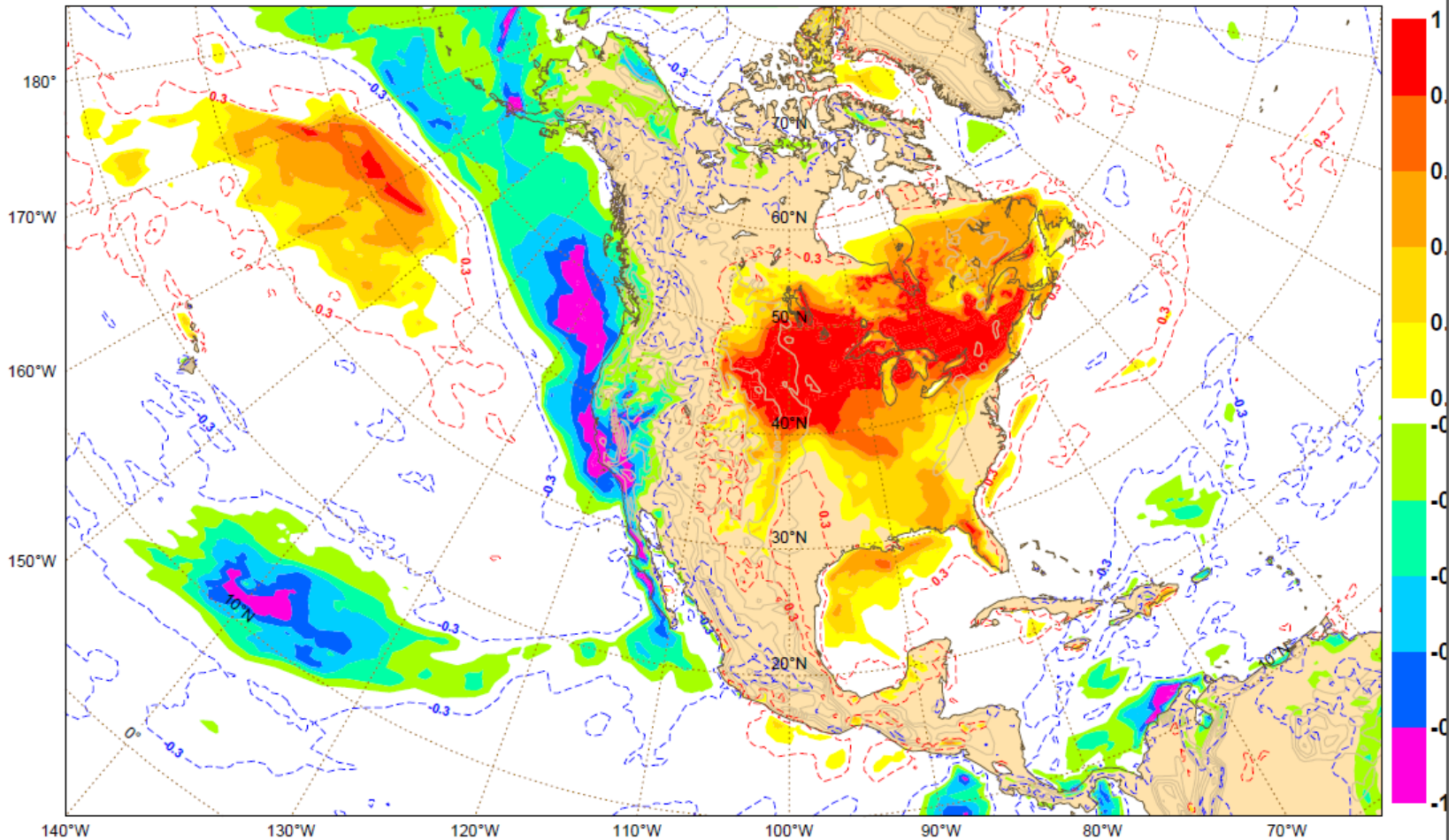
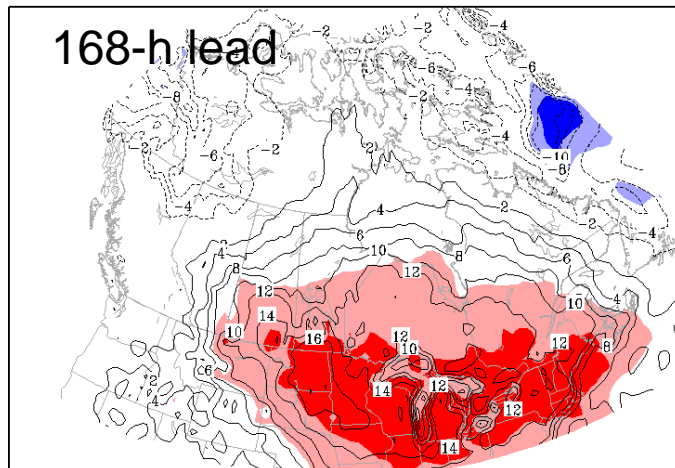# MSC-CMC EFI March Heat
Hai Lin MSC-CMC

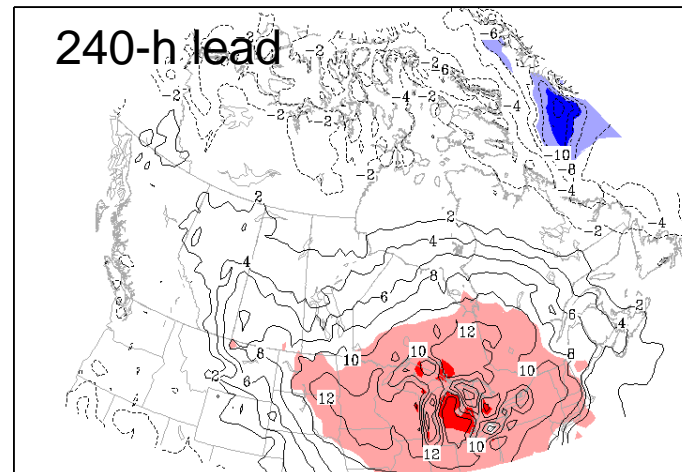T2m anomaly and T2m EFI: 2012032100 024 — 24-h lead

T2m anomaly and T2m EFI: 2012031700 120 — 120-h lead

T2m anomaly and T2m EFI: 2012031500 168 — 168-h lead

T2m anomaly and T2m EFI: 2012031200 240 — 240-h lead

Data, images and credits

- EC EFI Products
  - Thomas Petroliagis

- MSC-CMC EFI products
  - Hai Lin MSC-CMC

- NCEP GEFS
  - Locally produced in real-time

Extreme Forecast Indices

- **Development of an Extreme Forecast Index**
  - Hai Lin→CMC Preliminary results showed March 2012 case MSC-CMC GEPS

- **Two EFI Types**
  - R-Climate → Re-analysis
  - M-Climate → Ensemble climate based

- **Why**
  - Alert forecasters to critical weather→
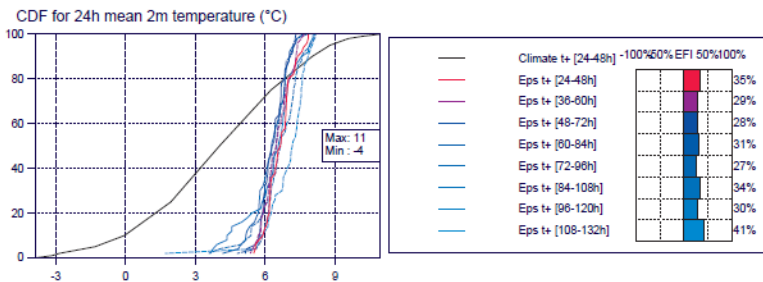
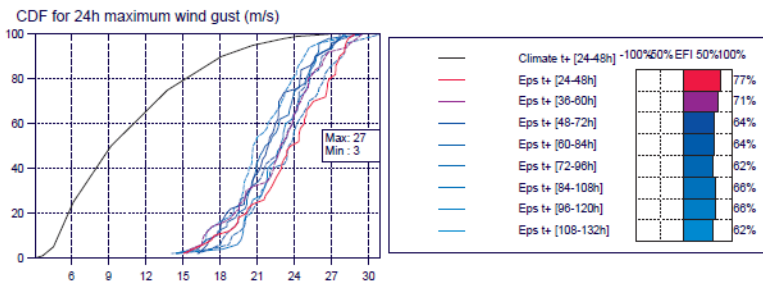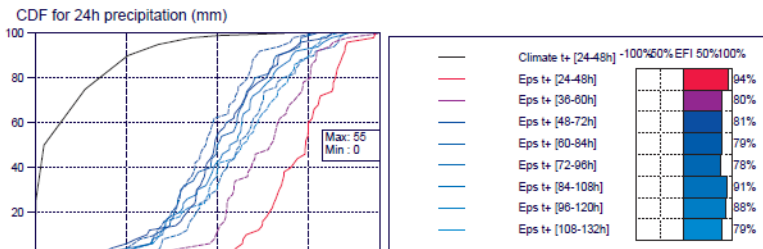# EFI, Threats, and Forecasters

- **Highlight critical forecast**
  - issues fast and *extremely easily*
  - *Early warnings & alarm signals to forecaster*
  - *Threats based on key parameters by type*

- **A suite can be designed**
  - For a range of problems and have been
  - High wind threat, excessive rain, snow, and temperature extremes of all kinds

- **This is a paradigm shift**

Point Data with CDF
Western US snow/ice wind event 20-21 January 2012

Forecast and M-Climate cumulative distribution functions with EFI values at 43.4°N/123.43°W
valid for 24 hours from Thursday 19 January 2012 00 UTC to Friday 20 January 2012 00 UTC

CDF for 24h precipitation (mm)

	-100%50% EFI 50%100%	
Climate t+ [24-48h]		
Eps t+ [24-48h]		94%
Eps t+ [36-60h]		80%
Eps t+ [48-72h]		81%
Eps t+ [60-84h]		79%
Eps t+ [72-96h]		78%
Eps t+ [84-108h]		91%
Eps t+ [96-120h]		88%
Eps t+ [108-132h]		79%

Max: 55
Min : 0

CDF for 24h maximum wind gust (m/s)

	-100%50% EFI 50%100%	
Climate t+ [24-48h]		
Eps t+ [24-48h]		77%
Eps t+ [36-60h]		71%
Eps t+ [48-72h]		64%
Eps t+ [60-84h]		64%
Eps t+ [72-96h]		62%
Eps t+ [84-108h]		66%
Eps t+ [96-120h]		66%
Eps t+ [108-132h]		62%

Max: 27
Min : 3

CDF for 24h mean 2m temperature (°C)

	-100%50% EFI 50%100%	
Climate t+ [24-48h]		
Eps t+ [24-48h]		35%
Eps t+ [36-60h]		29%
Eps t+ [48-72h]		28%
Eps t+ [60-84h]		31%
Eps t+ [72-96h]		27%
Eps t+ [84-108h]		34%
Eps t+ [96-120h]		30%
Eps t+ [108-132h]		41%

Max: 11
Min : -4

Max:
Min: 24-48h M-Climate extrema

M-Climate: this stands for "Model Climate". It is a
function of lead time, date (+/- ~15 days), and model
version. It is derived by rerunning a 5 member
ensemble, over the last 18 years, once a week (450
realisations). M-Climate is always from the same
model version as the displayed EPS data. On this
page only the 24-48h lead M-Climate is displayed.

ECMWF

Magics++ 2.8.1

- CDF shows precipitation and wind gust skewed to the right of internal M-Climate values

- This event featured heavy snow, ice (Seattle) and high winds in western USA

NAEFS

Forecaster related probabilities

- Get at high probability high impact weather
  - Quickly identify pattern and areas under the threat by weather type
  - Facilitates focusing on critical weather

- Partially uses traditional forecaster paradigms
  - Synoptic Patterns and anomalies (**Synoptic Part**)
  - A range of AI applications
  - high probability of long duration events→ confidence
    - Anticipate prolonged rainfall event
    - Anticipate droughts and heat episodes

- Comes with built in probabilities

Output required

- Probabilities of key forecast parameters
  - Traditional threshold exceedance concepts
  - Synoptic anomalies of key features
- Probabilities of key standardized anomalies
  - Exceeding key thresholds
  - Relate back to key forecast problems
    - Floods, heat waves, cold outbreaks, snow storms,
    - Severe outbreaks
  - Could be accomplished for visibility and ceilings.

Synoptic Probabilistic Case
January Record Warmth

- Pattern to EFI

- R-Climate for Pattern

- Leverage Hai Lin$\rightarrow$ EFI to tie in
  - Images from MSC-CMC shown here

- Case: **Warm Early North American Winter 2012: Western Warmth 2-5 January 2012**

Verifying 850 hPa temperatures 0000 UTC 1-6 January 2012
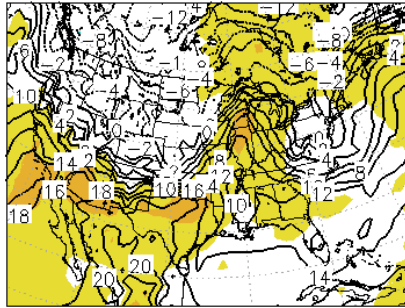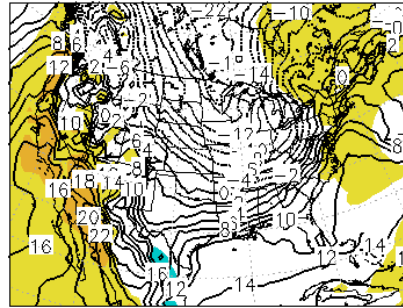
NAEFS
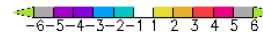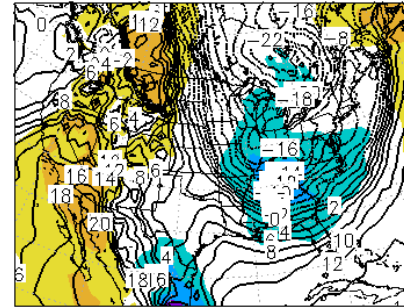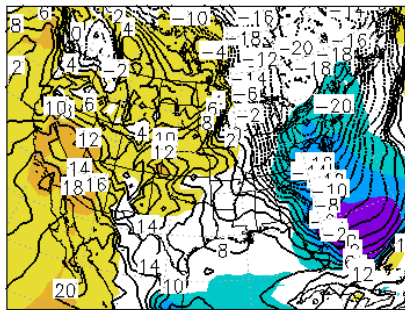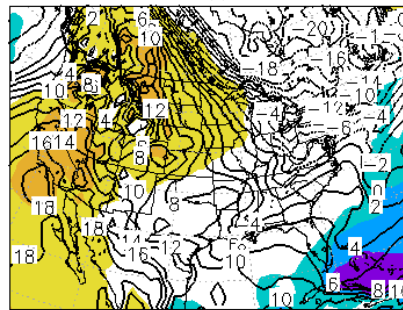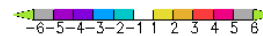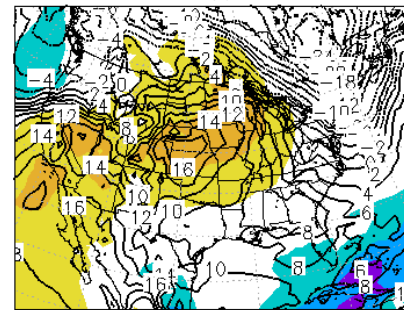
GEFS Forecasts 500 hPa and 850 hPa temperatures

a. 12Z01JAN2012 GEFS Valid 12Z04JAN2012 (Wed) 500hPa hgtprs(ens)
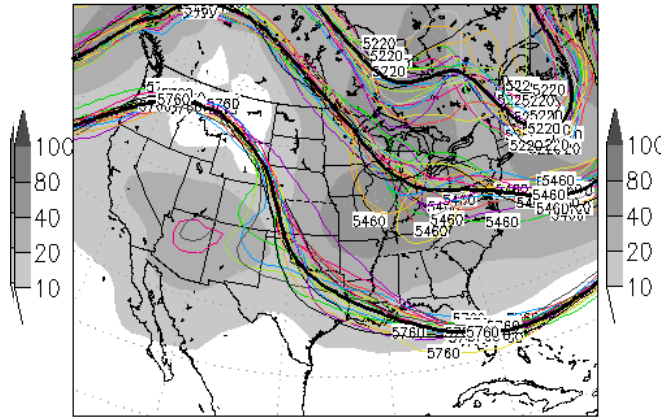
a. 12Z01JAN2012 GEFSPARA Valid 12Z04JAN2012 (Wed) 500hPa hgtprs(meso)

Ensemble Components:

b. GEFS Consensus Forecast (contour) & Normalized Anomaly shaded)

b. GEFSPARA Consensus Forecast (contour) & Normalized Anomaly shaded)
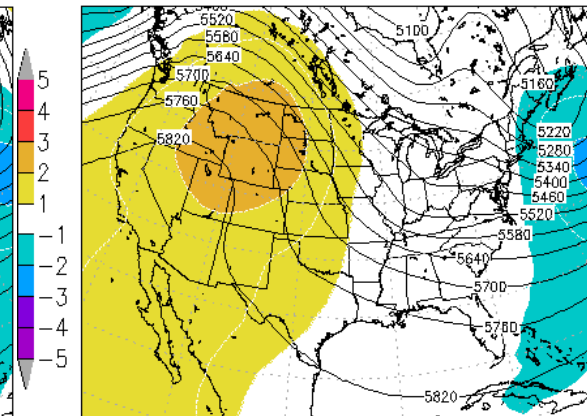
R-Climate Threats
Pattern with warm episodes

a. 12Z31DEC2011 GEFS Valid 00Z06JAN2012(Fri)
500 hgtprs exceed 1.5SD
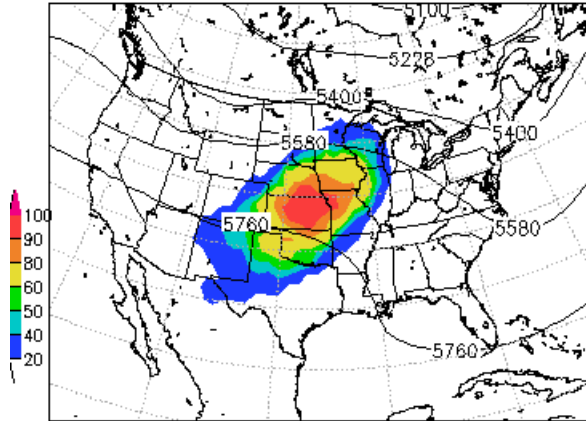
b. 12Z31DEC2011 GEFS Valid 00Z06JAN2012(Fri)
850 tmpprs exceed 2.5SD
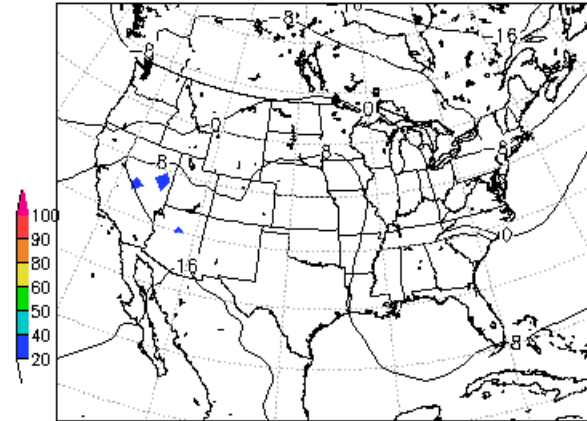
c. 12Z31DEC2011 GEFS Valid 00Z06JAN2012(Fri)
1000 pwatclm exceed 2.0SD
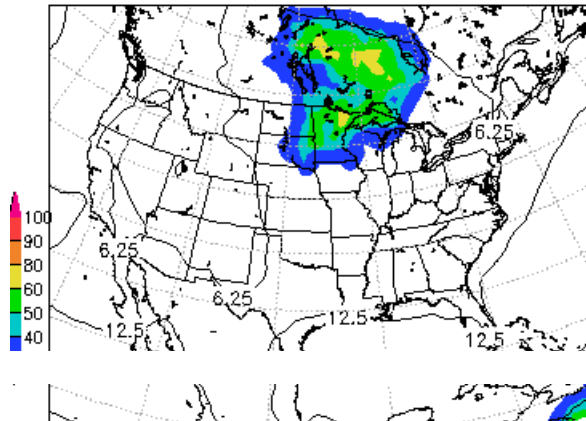
d. 12Z31DEC2011 GEFS Valid 00Z06JAN2012(Fri)
sfc tmp2m exceed 2.5SD

text.

5/5/2012

NAEFS 2012
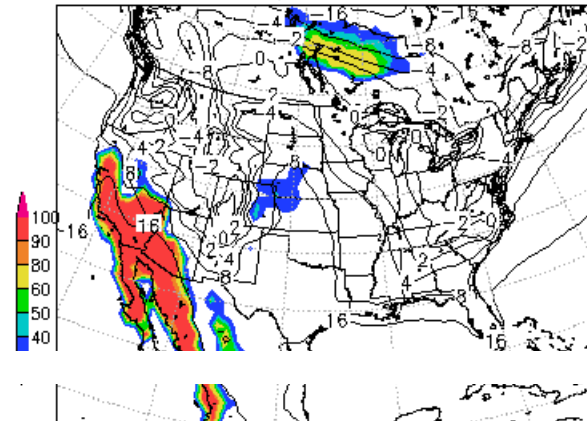
MSC-CMC EFI 7PM 5 January
Hai Lin's talks

T2m anomaly and T2m EFI: 2011122700 240
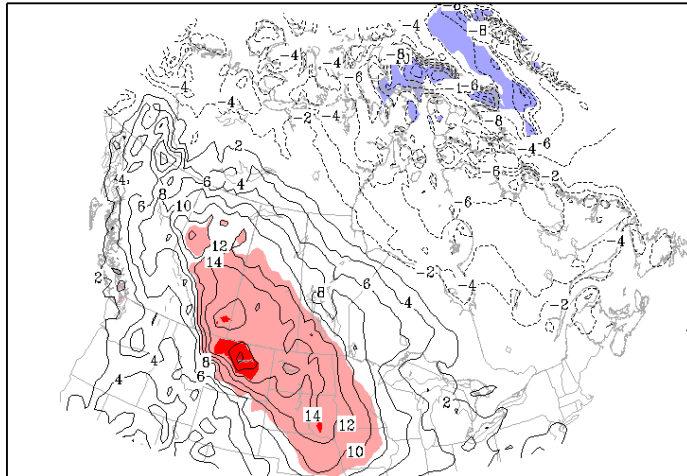
T2m anomaly and T2m EFI: 2011122800 216
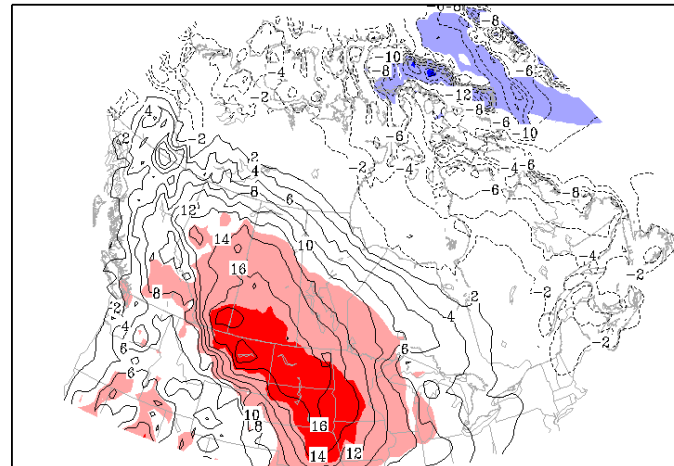
T2m anomaly and T2m EFI: 2011122900 192
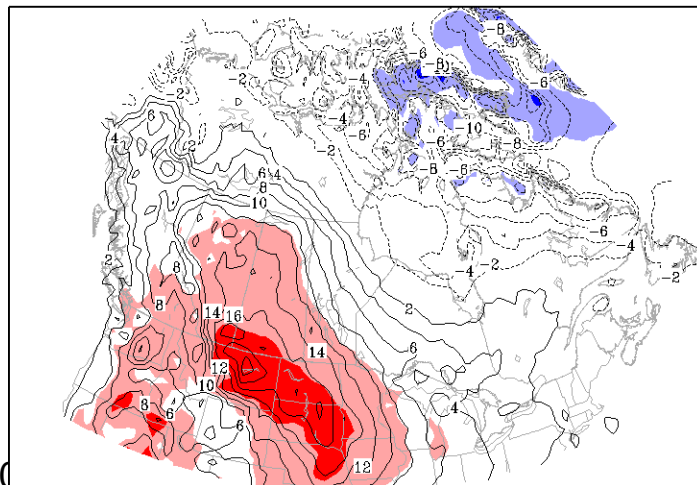
T2m anomaly and T2m EFI: 2011123000 168

MSC-CMC EFI

T2m CDF near Carman, Manitoba 20120106 00Z

Legend:
- 24h lead clim
- 120h lead clim
- 240h lead clim
- 24h lead fct
- 120h lead fct
- 240h lead fct

Y-axis: Probability not to exceed threshold

X-axis: Threshold T2m (C)

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NAEFS 2012
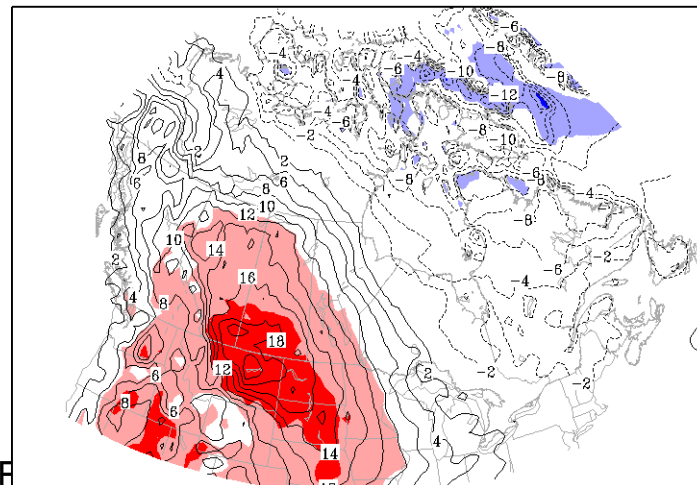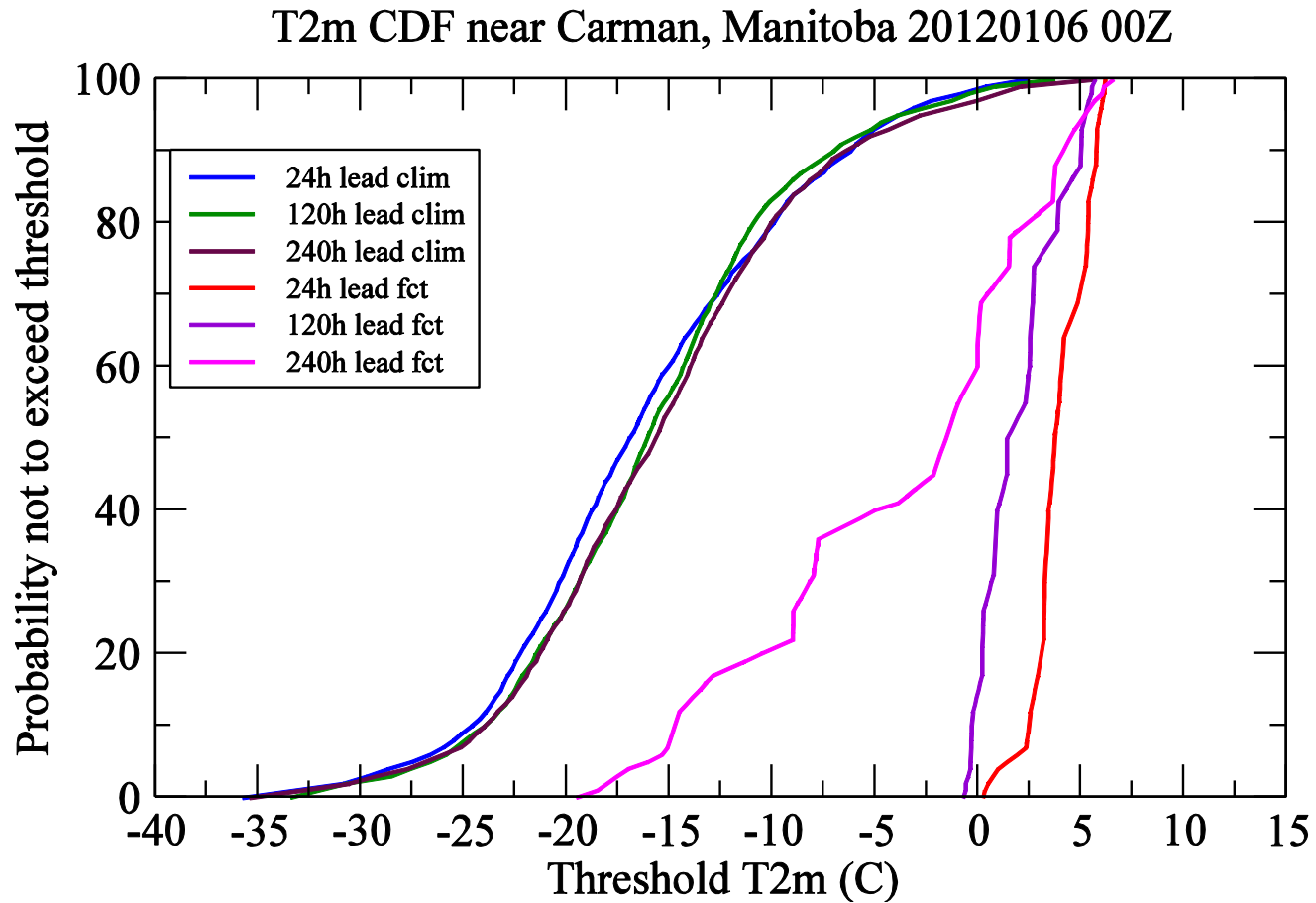
US Record Highs 4 & 5 January 2012

Record High Temperatures for January 4, 2012

NAEFS 2012
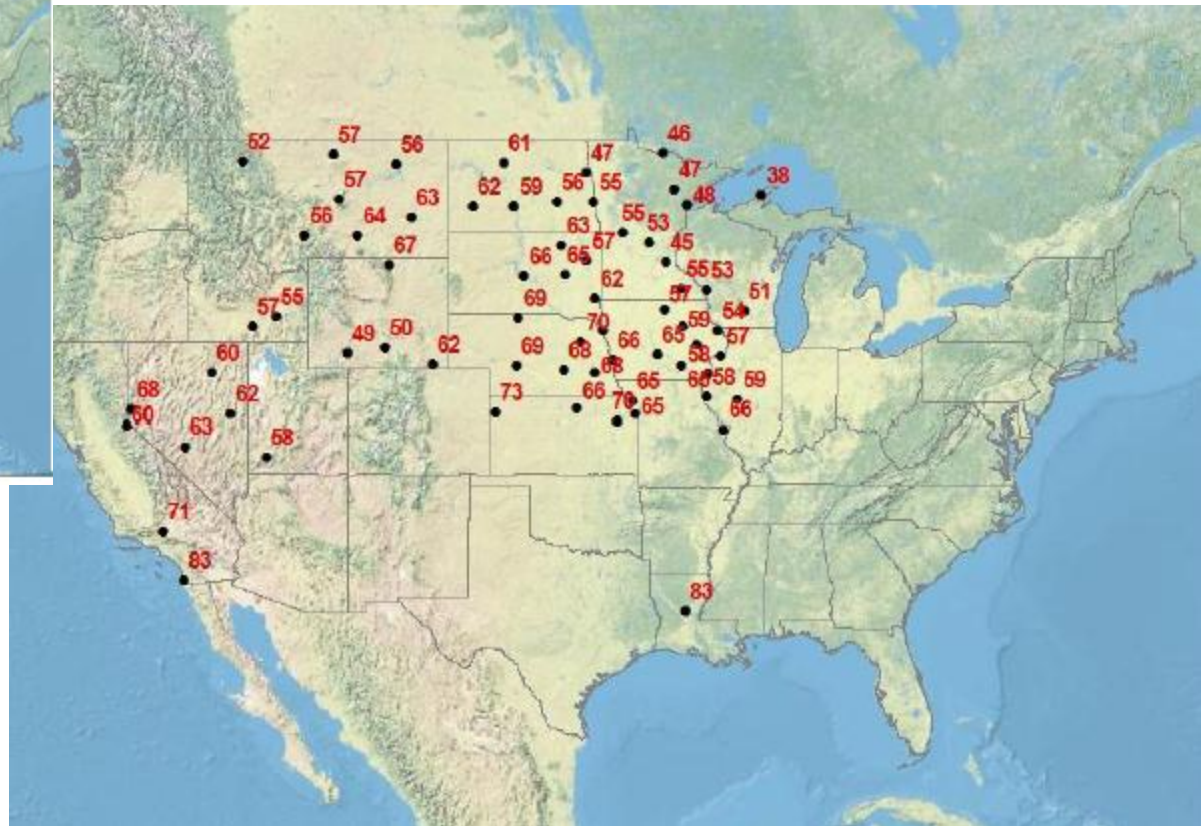
EFI and R-Climate

- Synoptic Pattern favoring high probability warm episode

- MSC-CMC EFI alarm for M-Climate based record high temperatures

- Confidence in high end temperature event

- More examples:
  - Record Winds NW US January 2012
  - Scottish wind storm December 2012

Two Types of Events

- **Short duration events**:
  - 27-28 April Severe weather event
  - Heavy rain, flash flood events and snow storms
  - Considerable effort has been placed here
    - EPS output 3 or 6 hour intervals for most fields

- **Longer duration or Persistent events**
  - Repetitive or persistent heavy rains→
    - think Pakistan July 2010
    - Mid-Mississippi Valley 2011
  - Russian Heat wave and drought

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NUOPES

GEFS 24-hour anomalies 0000 5-6 January 2012

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Scottish wind event December 2011

Forecast and M-Climate cumulative distribution functions with EFI values at 56.27°N/3.47°W valid for 24 hours from Thursday 8 December 2011 00 UTC to Friday 9 December 2011 00 UTC

- EFI northern Scotland

- 10m wind gusts all skewed above the M-Climate 10m wind gusts from multiple runs

- Some heavy rain in upper CDF plot too.

EC EFI Plainview Wind EFI

Thursday 8 December 2011 00UTC ©ECMWF Extreme forecast index t+000-024 VT: Thursday 8 December 2011 00UTC - Friday 9 December 2011 00UTC
Surface: 10 metre wind gust index

Wednesday 7 December 2011 00UTC ©ECMWF Extreme forecast index t+024-048 VT: Thursday 8 December 2011 00UTC - Friday 9 December 2011 00UTC
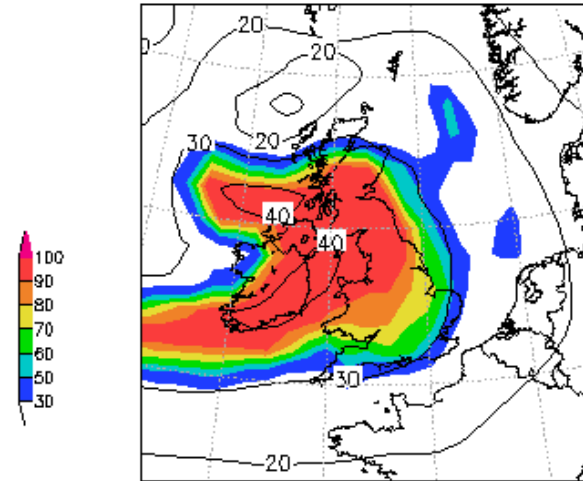Surface: 10 metre wind gust index
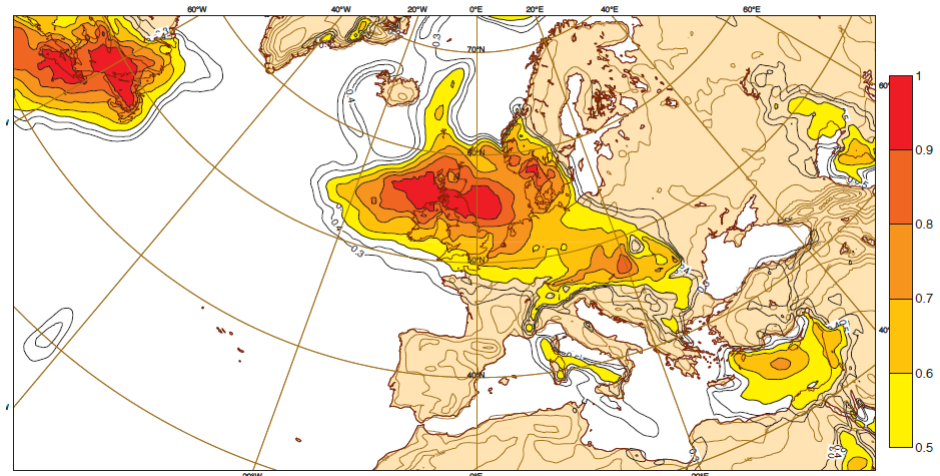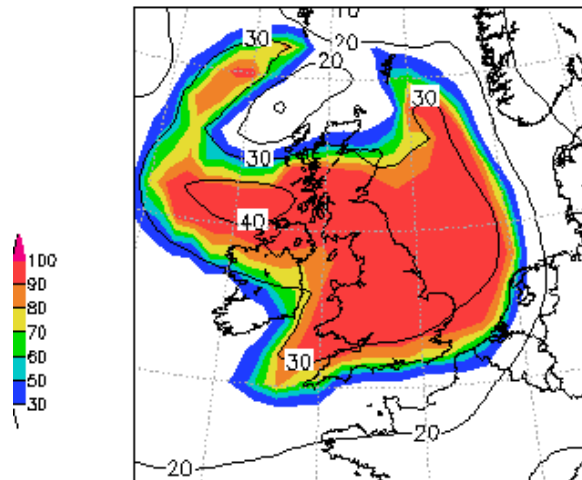
GEFS Threats for Synoptic wind Pattern R-Climate based
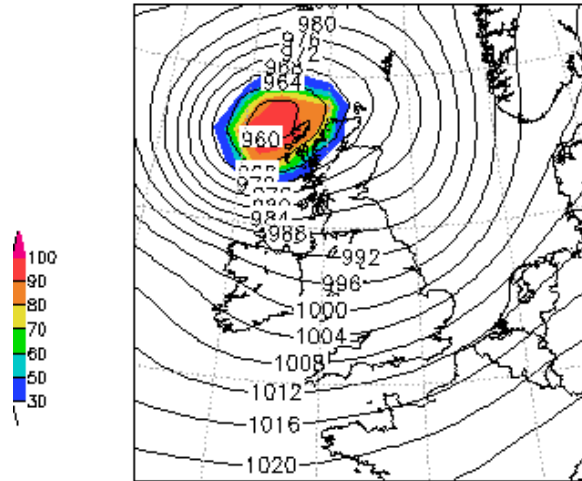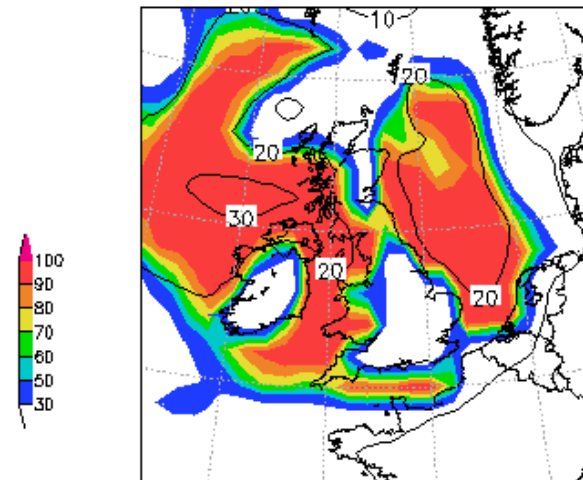
Wind gust verifications

Windspeeds in knots (kts)
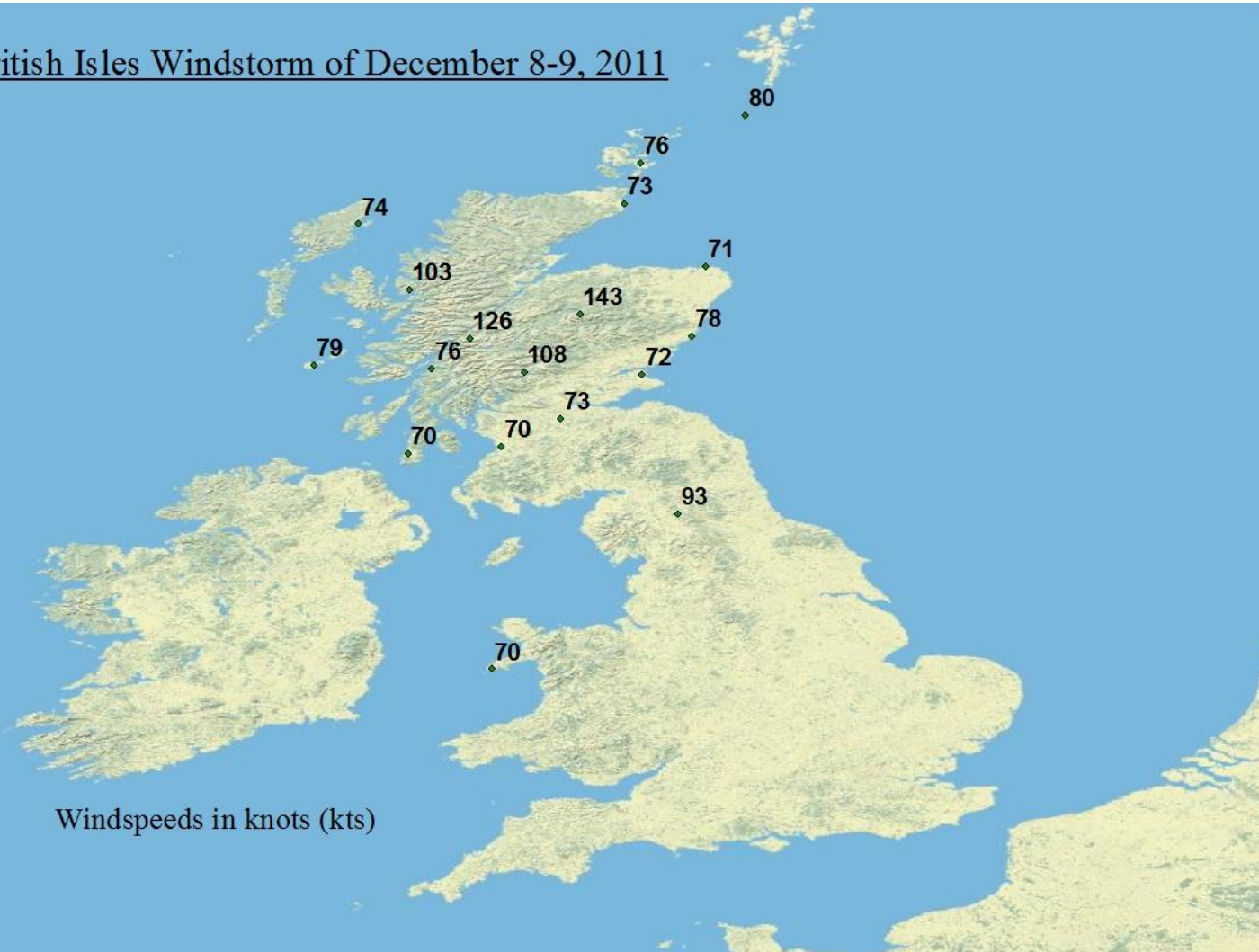
EFS Training

- COMET and Commerce Learning site

- Two courses related to High Impact Weather shown

- Developed High Impact Weather Course-Pennsylvania State University

- Training Needs

Basic use of anomalies

Commerce Learning Site and WDTB

Training Needs

- ## Moving towards Threats/EFI
  - Synoptic Probabilistic Forecasting Methods
    - Less diagnosis and more high probability pattern and high probability alarms by weather types
    - Good for synoptic scale events and larger
    - Some value mesoscale events

- ## Using
  - Threats/alarm/EFI maps relying on probabilities
  - Using CDFs at a point

New Zealand Flood

- Synoptic Probabilistic Approach to Flood

- High probability heavy rain in NCEP GEFS

- Synoptic R-Climate Anomalies show threat

- ECWMF EFI for M-Climate Heavy Rainfall

- Forecaster has probabilities & confidence
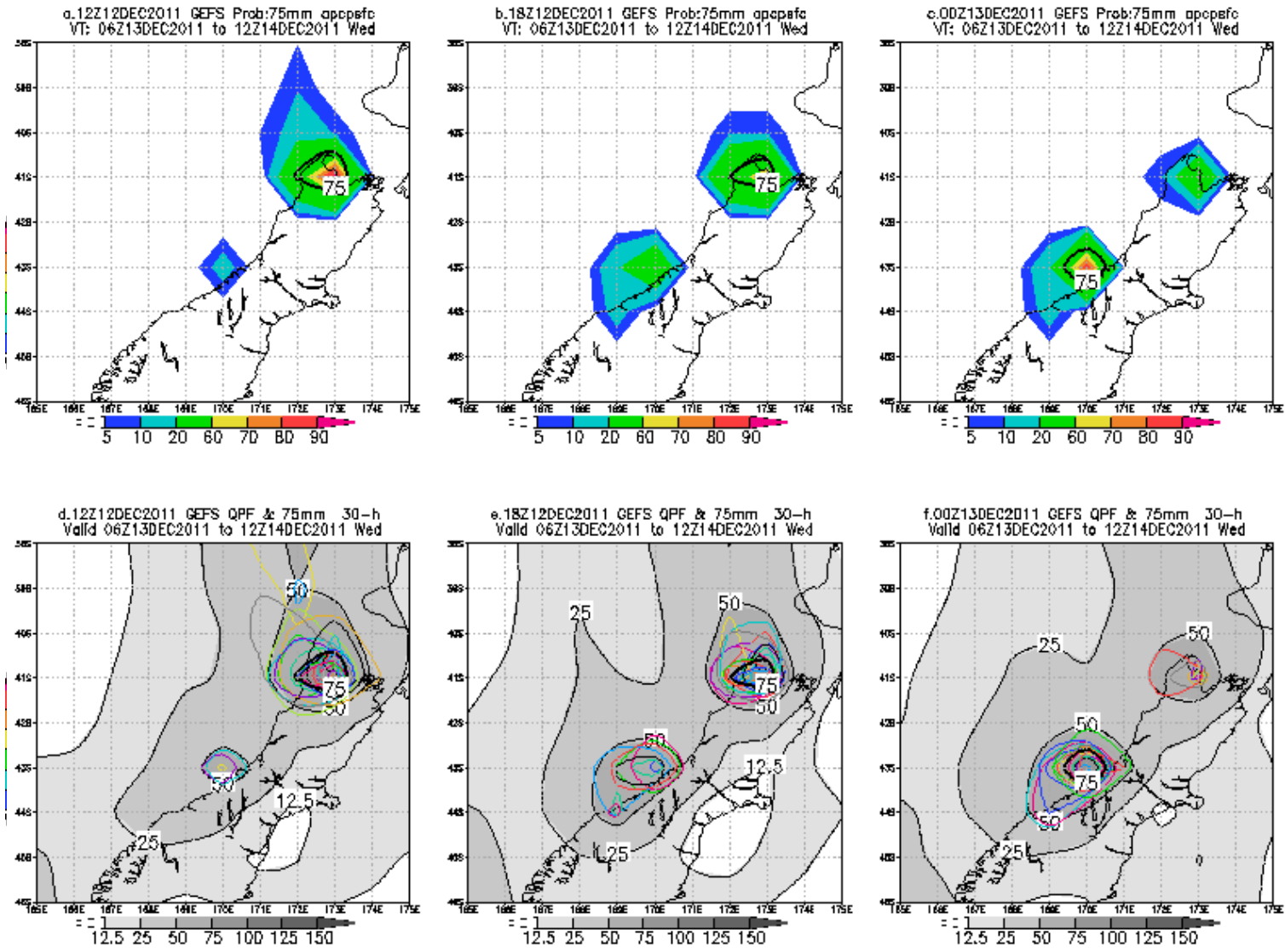 - *Better input for decision support*

Figure 12. NCEP 75km GEFS forecasts of QPF from forecasts initialized at a & d) 1200 UTC 12 December 2011, b &d) 1800 UTC 12 December 2011, and c &f) 0000 UTC 13 December 2011. Upper panels show each cycles mean 75 mm contour and the probability of exceeding 75 mm or more of QPF. The lower panels show the ensemble mean QPF and each member 75 mm contour. Return to text.

Figure 13. European Center BPF for heavy rainfall from ensembles forecasts initialized (top) 1200 UTC 10

5/5/2

Conclusions/Summary

Ensembles are about probabilities and probabilities facilitate making good decisions

- We looked at products via case examples
  - *What we have and what we need*
  - *High Impact events: Climate and forecast data*
    - *R-Climate and M-Climate products*
    - *Toward Extreme forecast Indices→ EFI and Threats images*

- Training
  - What we have and what we need
  - Need for EFI and Synoptic Threats
    - Reading using and leveraging alarm/EFI maps
    - Leveraging probabilities
    - Synoptic Probabilistic Forecasting