Results of a test ensemble of human perturbed simulations for severe weather forecasting

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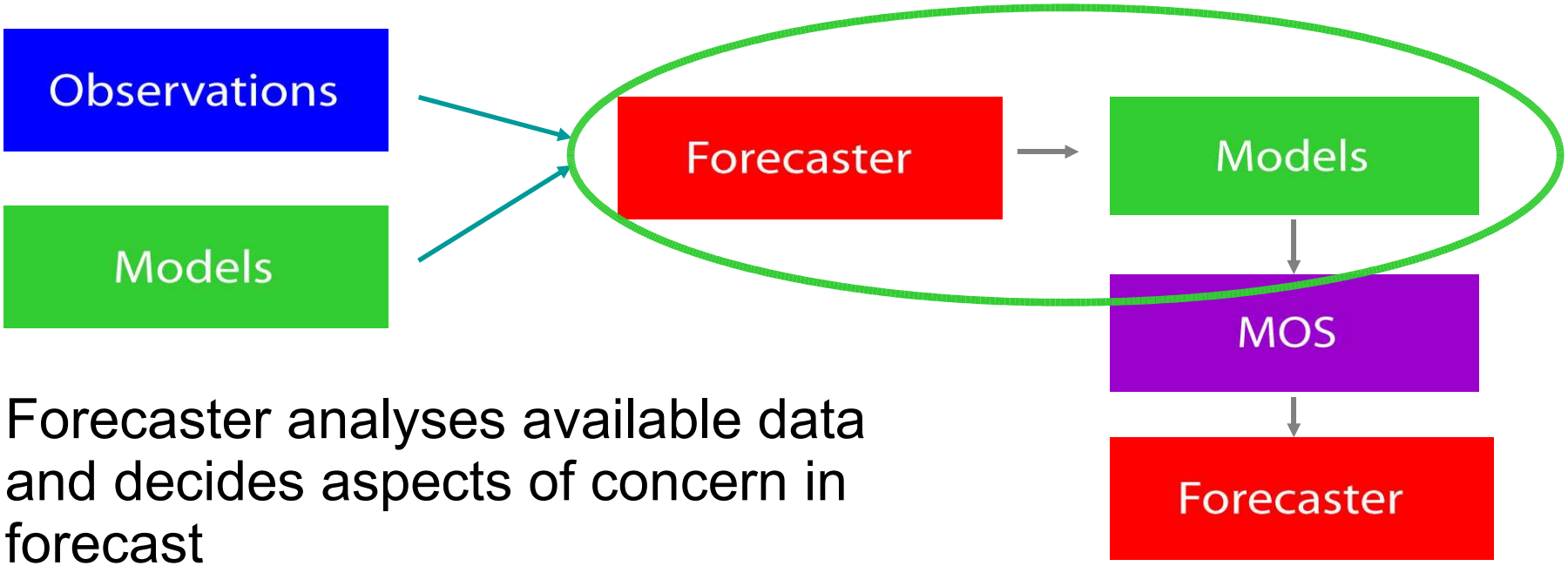
Motivation and Background

- Is the human intervention valuable in adapting short-range numerical forecasts of severe weather on a daily basis?
- Can the adjoint model help in the design of such human-driven system?
- The NOAA SPC/NSSL Spring program 2003 explored the use of Short-Range Ensemble Systems in Operational Severe Weather Forecasting. In particular:
  - SP03 SUBEXPERIMENT: Consisted in testing an ensemble of human perturbed simulations using and adjoint model.

This poster presents the generation process and verification of that experimental ensemble.

Tomorrow's Forecast Process?

Forecaster interacts with models
to create an ***adapted*** numerical forecast



Forecaster analyses available data and decides aspects of concern in forecast

Better guidance to public

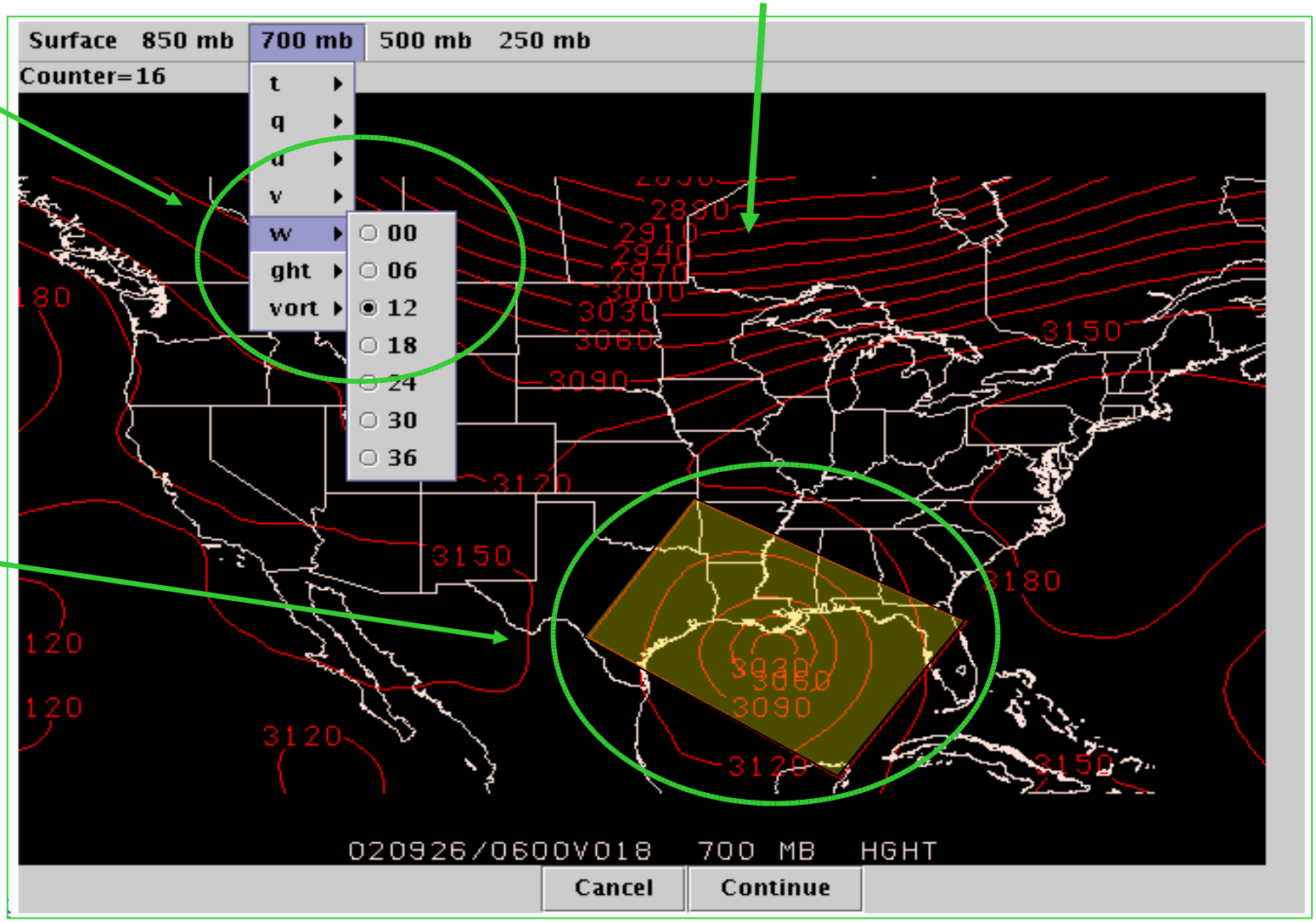
The inclusion of the forecaster in the process allows to customize the numerical forecasting system to focus on the forecasting aspect of interest for the day

Ensemble design

Deterministic forecast (Eta 12z)

Forecaster chooses level, field, and time of concern

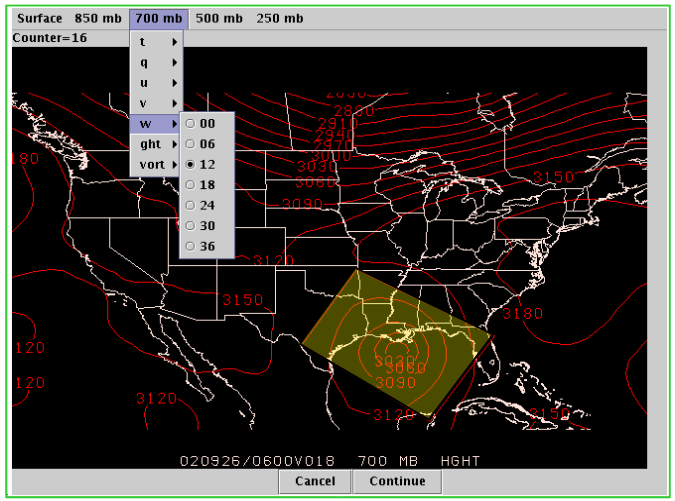
A box is drawn around interest area



For the case of severe weather, the forecaster was asked to highlight 16 structures of concern in the Day2 forecast from a deterministic model

Ensemble design

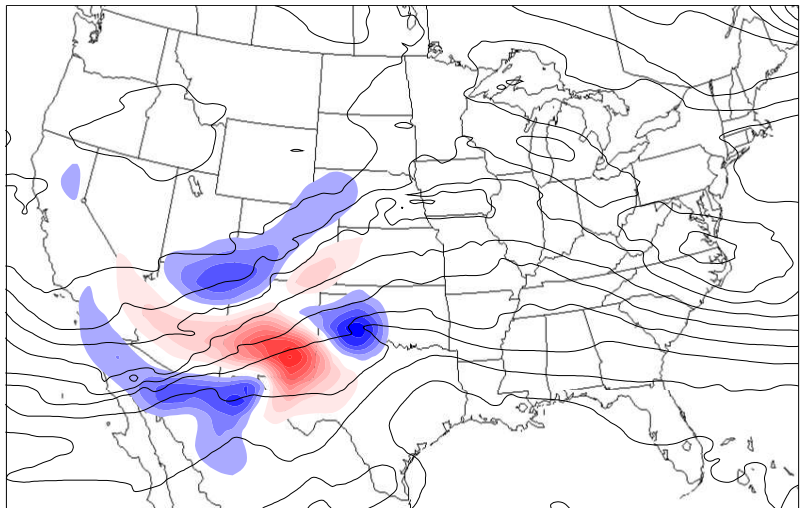
Regions/Structures of concern



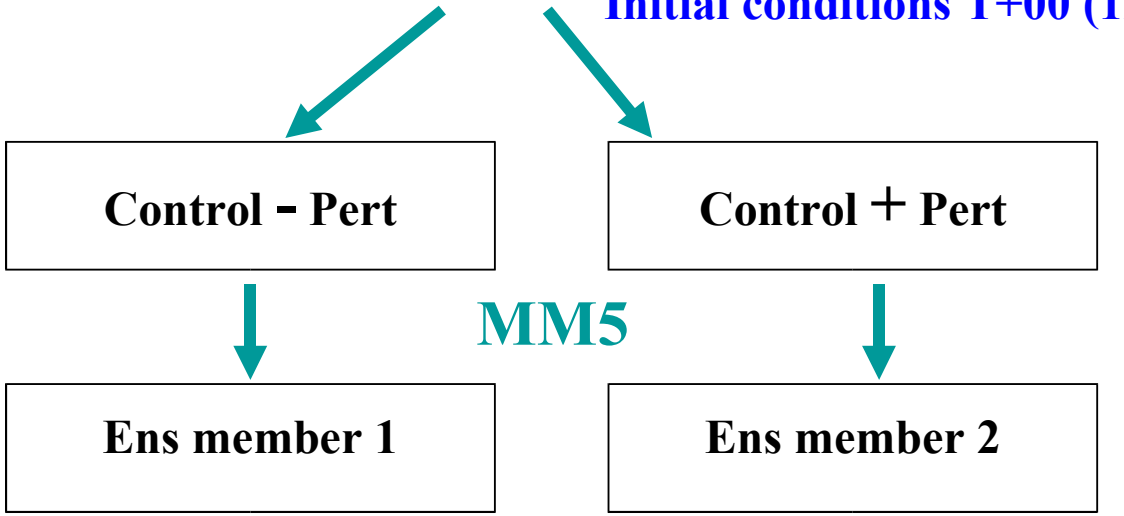
Time T+HH

MM5 Adjoint

Sensitivities



Initial conditions T+00 (12z)



For each structure of concern, an adjoint run is initialized and the sensitivity fields are derived. A pair of opposite perturbations are added to the control run to generate the corresponding ensemble members

Experimental ensemble design

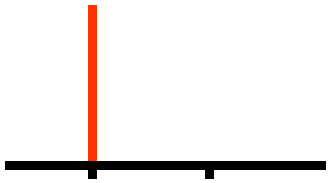
Forecasting system main features:

- 16 structures of concern per day, 2 perts each
- MM5 Adjoint modeling system
- IC perturbations to: U, V and T fields
- 32 MM5V3 runs 12z + 48 h
  2 nested domains: 90, 30km
- Experiment period: Apr 28 – Jun 06 2003

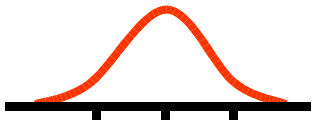
Comparison and Verification datasets

Observations:

- SPC severe weather reports database
- Reports-derived Practically Perfect Prog:



Reports



PPP

The PPP is the most skillfull probabilistic *prediction* under certain rules of smoothness and continuity of the forecast field when the observations are already known.

- NCEP Stage IV precipitation data

Forecasts:

- Experimental MM5 ADJ Ensemble
- NCEP SREF Ensemble (10 members, only 11 “SP03 days” available)
- Operational Eta
- SPC SP03 Day2 Outlook

All fields remapped to the 30 km MM5 grid

Probability of severe

Severe weather is not a model field so the probability of severe is calculated from model output as:

- A model is considered to forecast severe weather in a gridbox during a 24 h period if:
  - Supercell Composite Parameter >= 1
  - Convective rain > 0

Simultaneously,

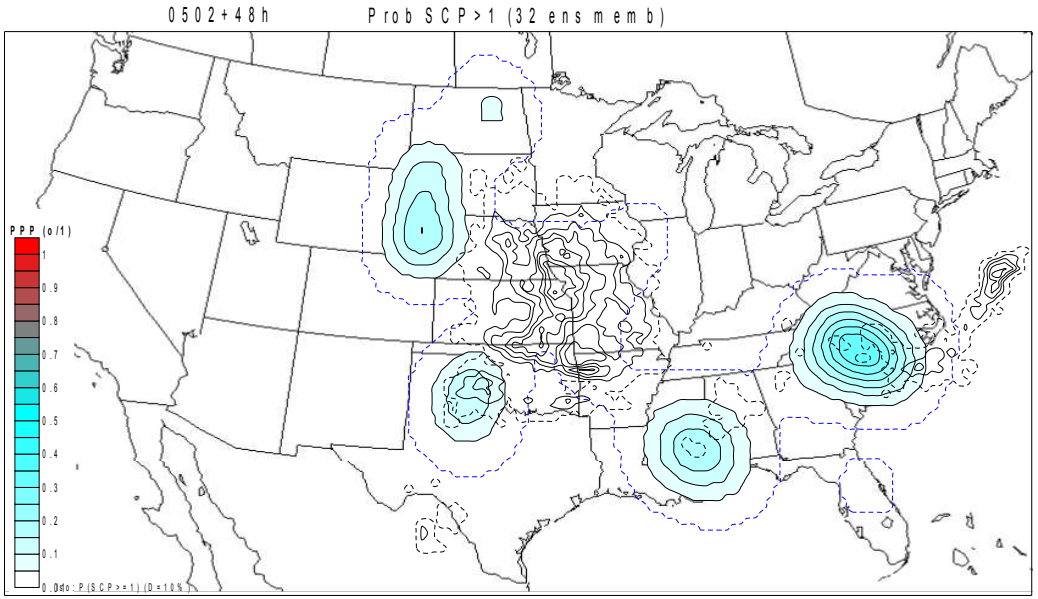
anytime during period

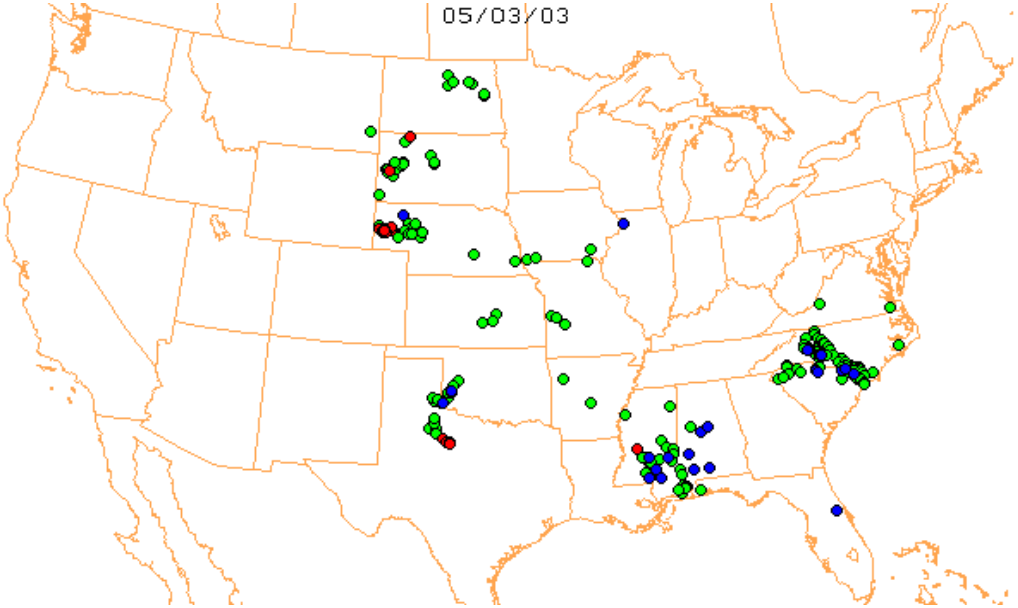
- Probability of severe in a gridbox during 24 h:

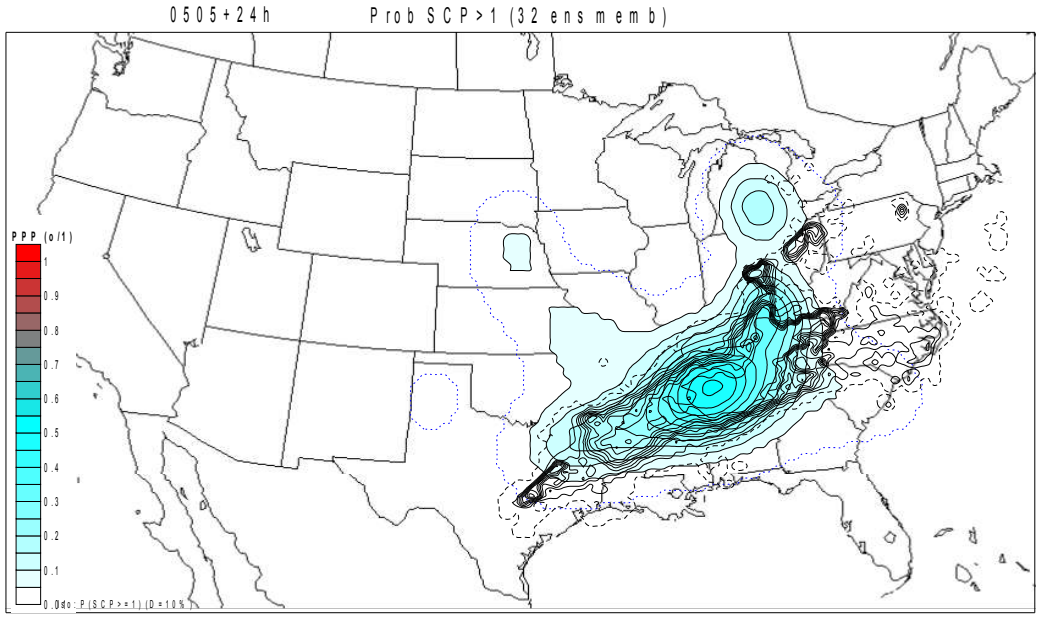
$$P = \frac{\#memb\ fcsting\ \ severe}{\#memb}$$

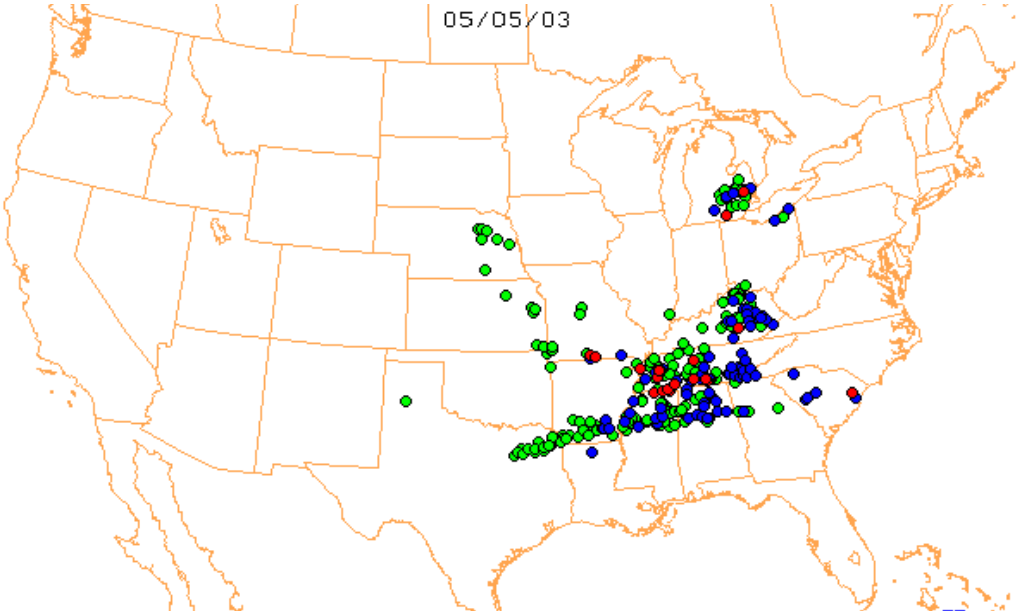
Probability of severe

- Examples 5 and 3 May 2003:

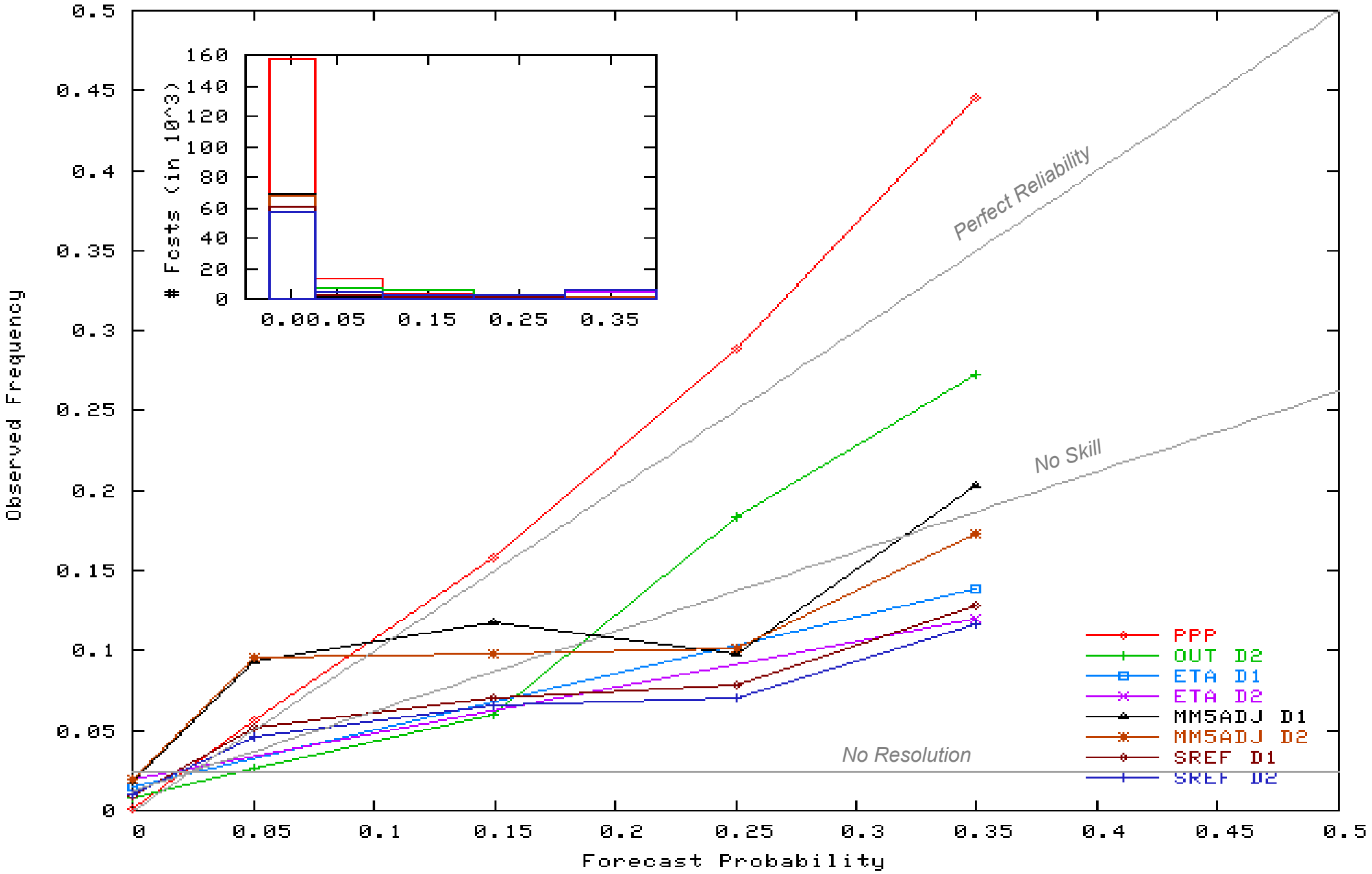




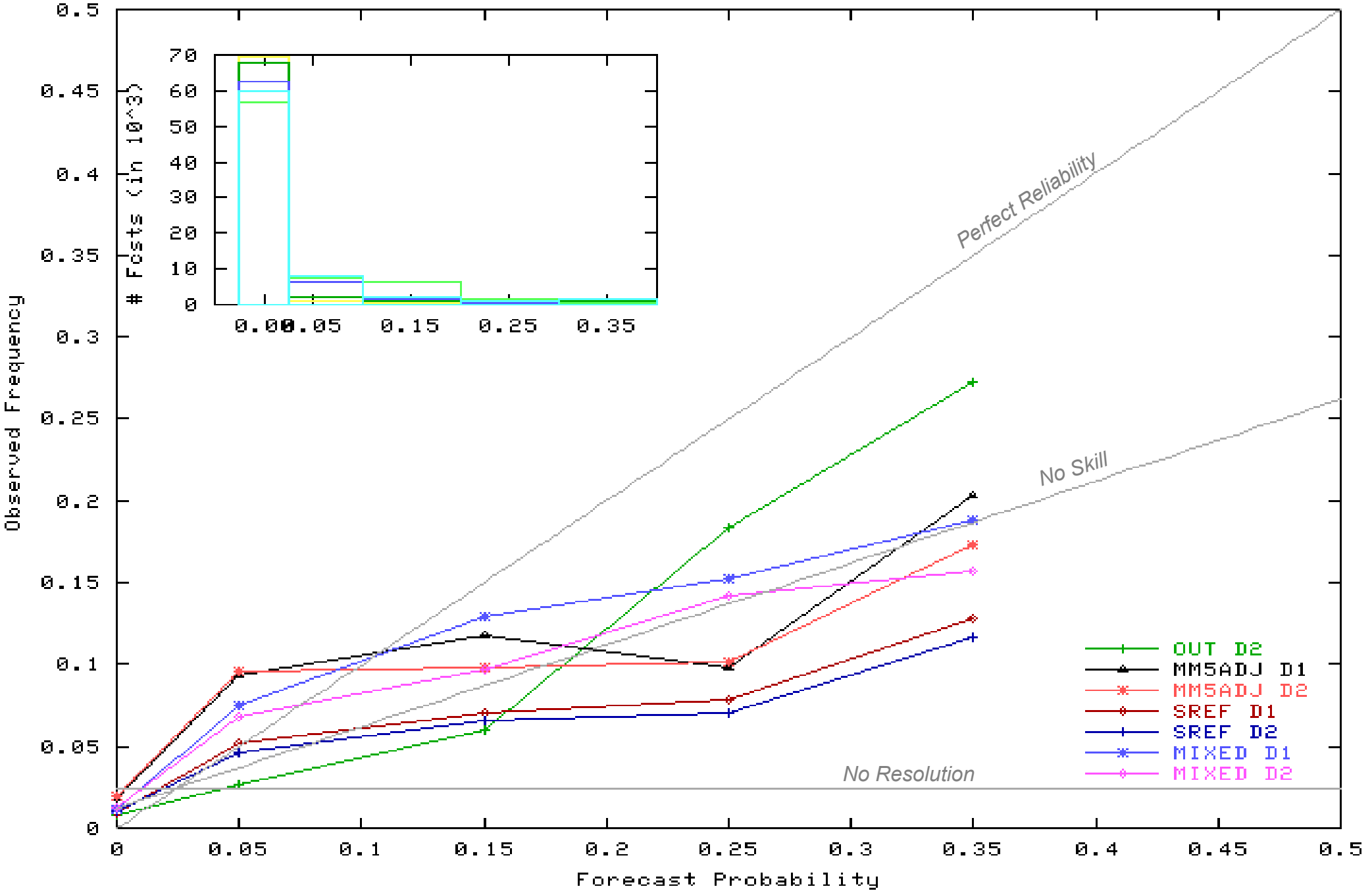




Severe reports verification

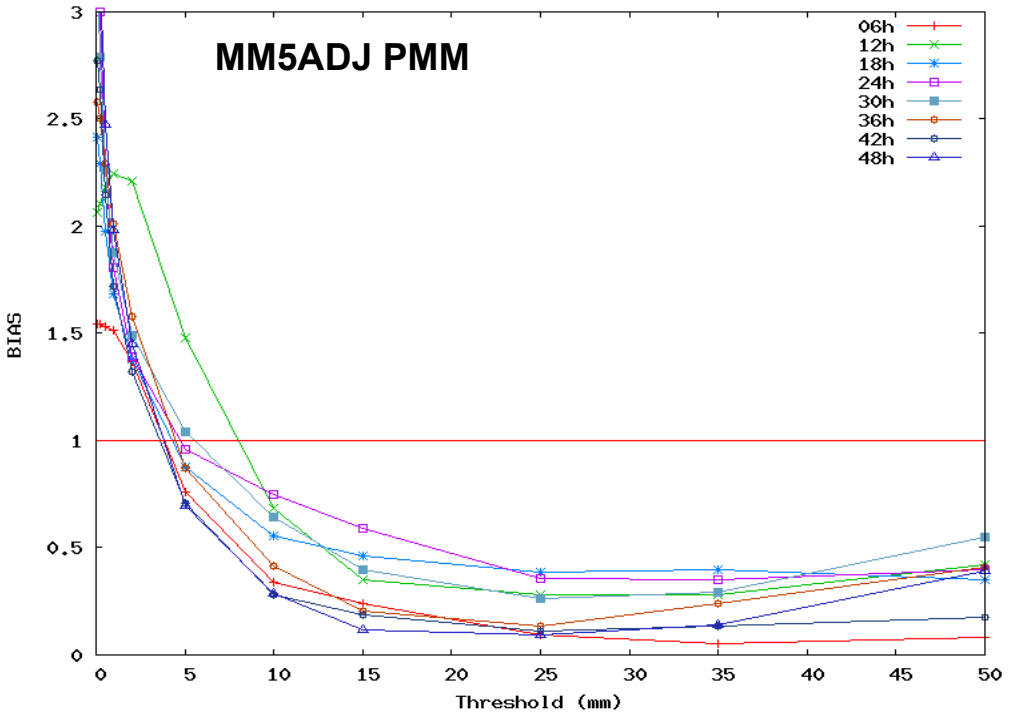


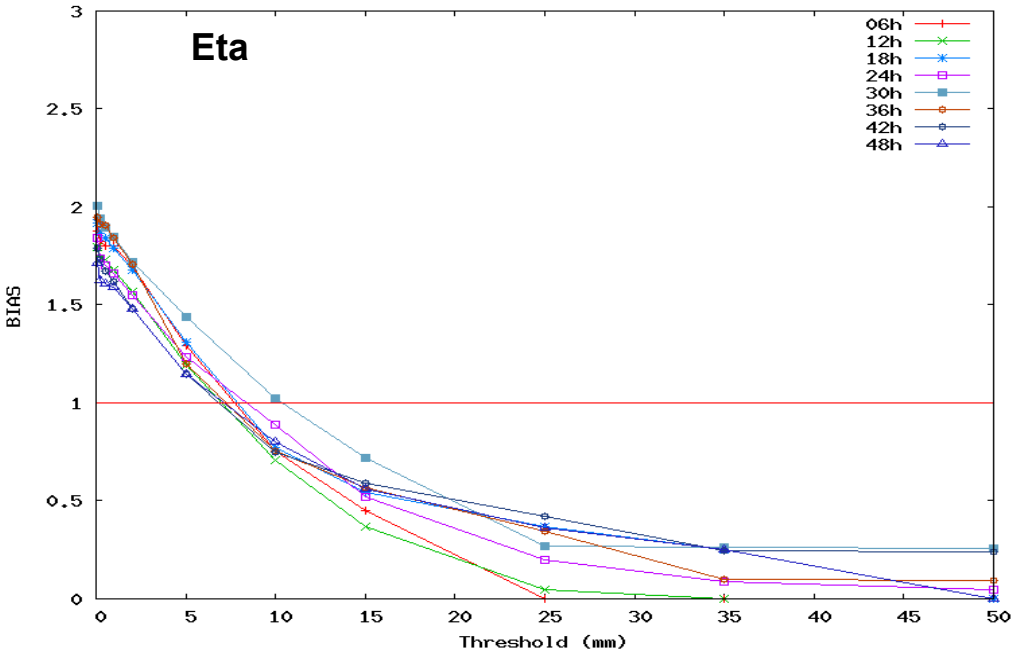
Mixed (MM5-SREF) configuration

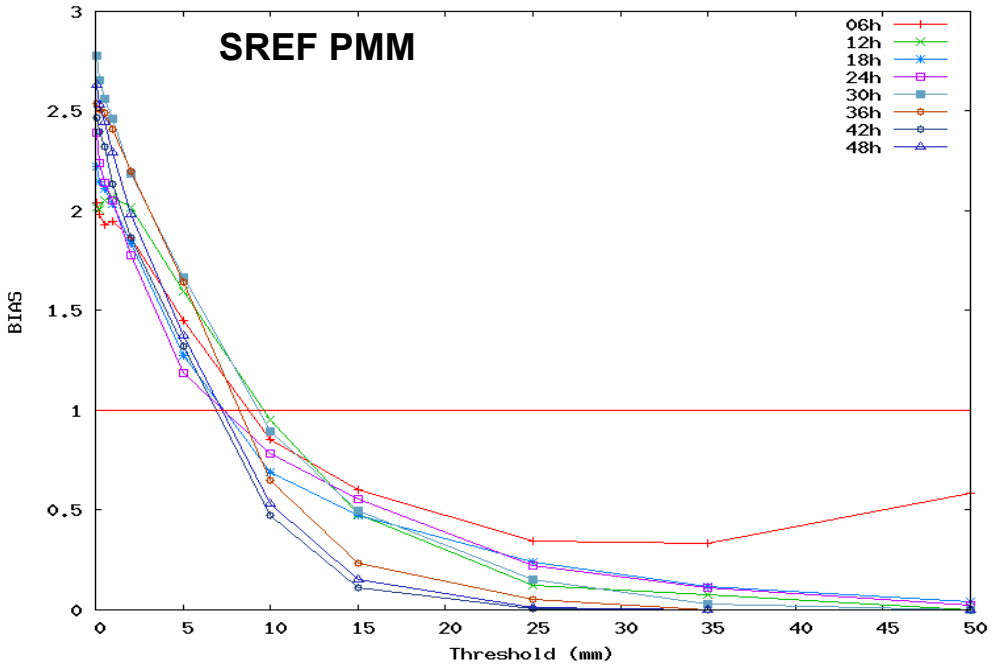


Precipitation BIAS

$$\mathrm{BIAS} = \frac{\#F}{\#O}$$



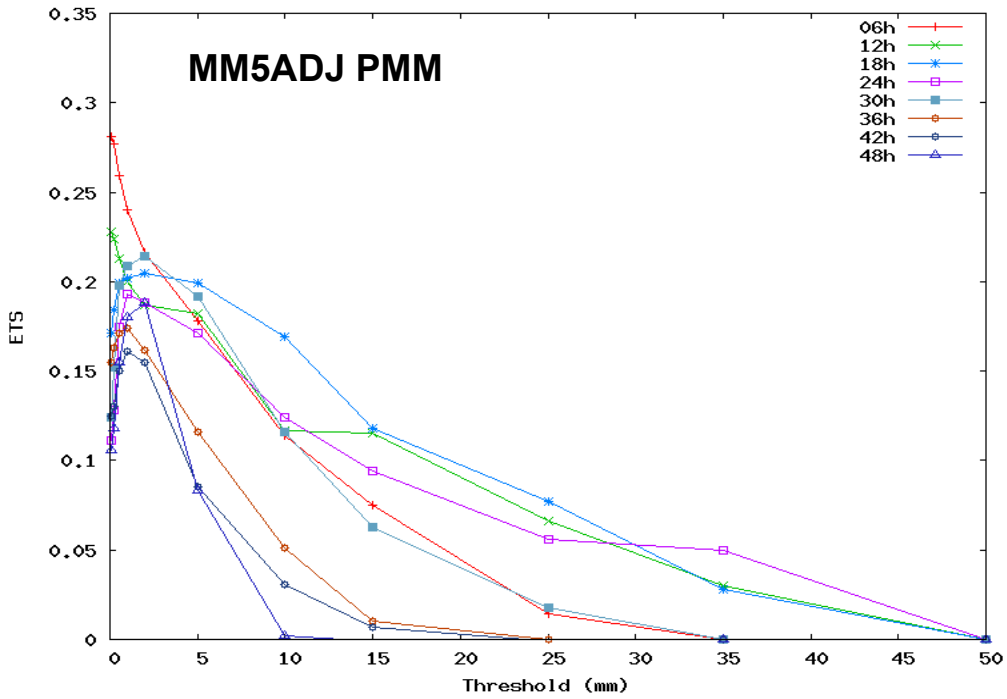


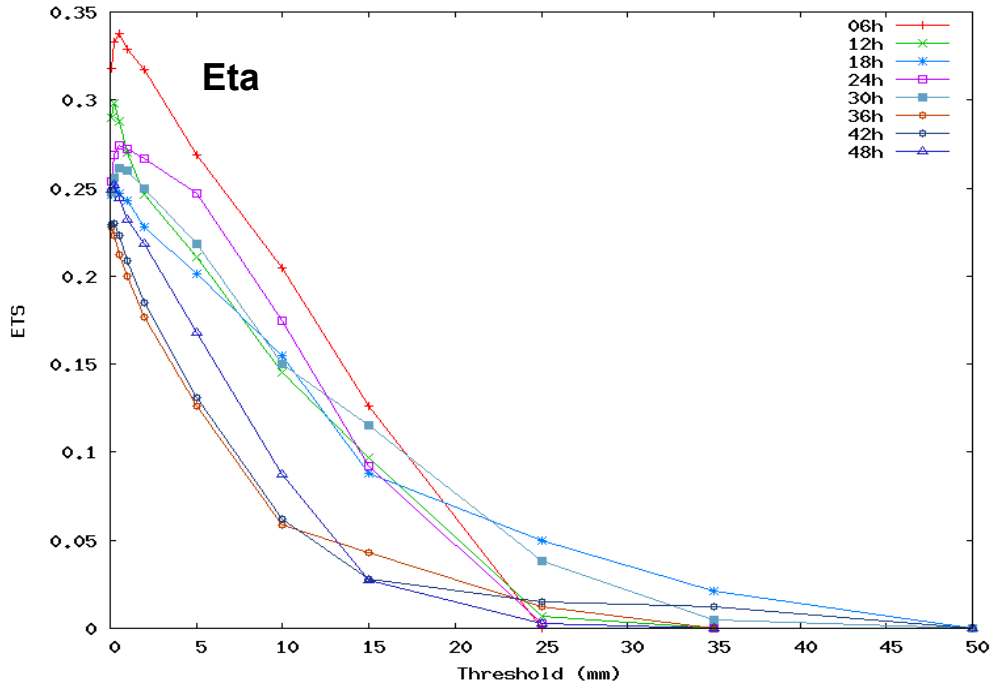


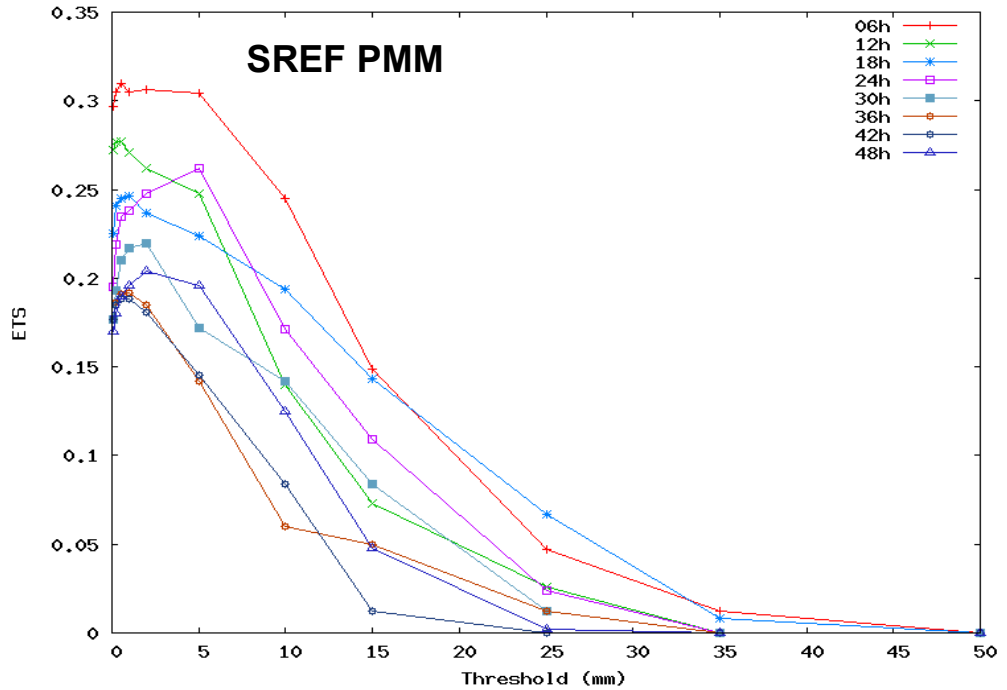
Equitable Threat Score

$$\mathrm{ETS} = \frac{\#C - E}{\#F + \#O - \#C - E}$$

$$\text{with} \quad E = \frac{\#F\,\#O}{\#T}$$







Pre-conclusions

➔ Forecasting system test hampered:

- *Single model:* No model uncertainty considered
- No training/experience: Forecasters driving the system had no previous experience with the system.
- Not well tested perturbation: types and amplitude. Optimal perturbation type may also adapt to the situation of the day

still…

➔ Human involvement in routinely adapting forecast systems to the needs of the day has value in the short-range forecasting of severe weather

➔ The adjoint model provides the opportunity to intuitively include the areas of concern of the day subjectively diagnosed by the forecaster into the forecast process

➔ Verification results show that MM5ADJ ensemble provides:

- ➔ Better probabilistic forecast of severe events, specially at high confidence categories
- ➔ Better BIAS and ETS scores for intense (>25mm/6h) precipitations

➔ For non-extreme events (low confidence severe or low precipitation thresholds) the system is less robust than the SREF and Eta forecasts