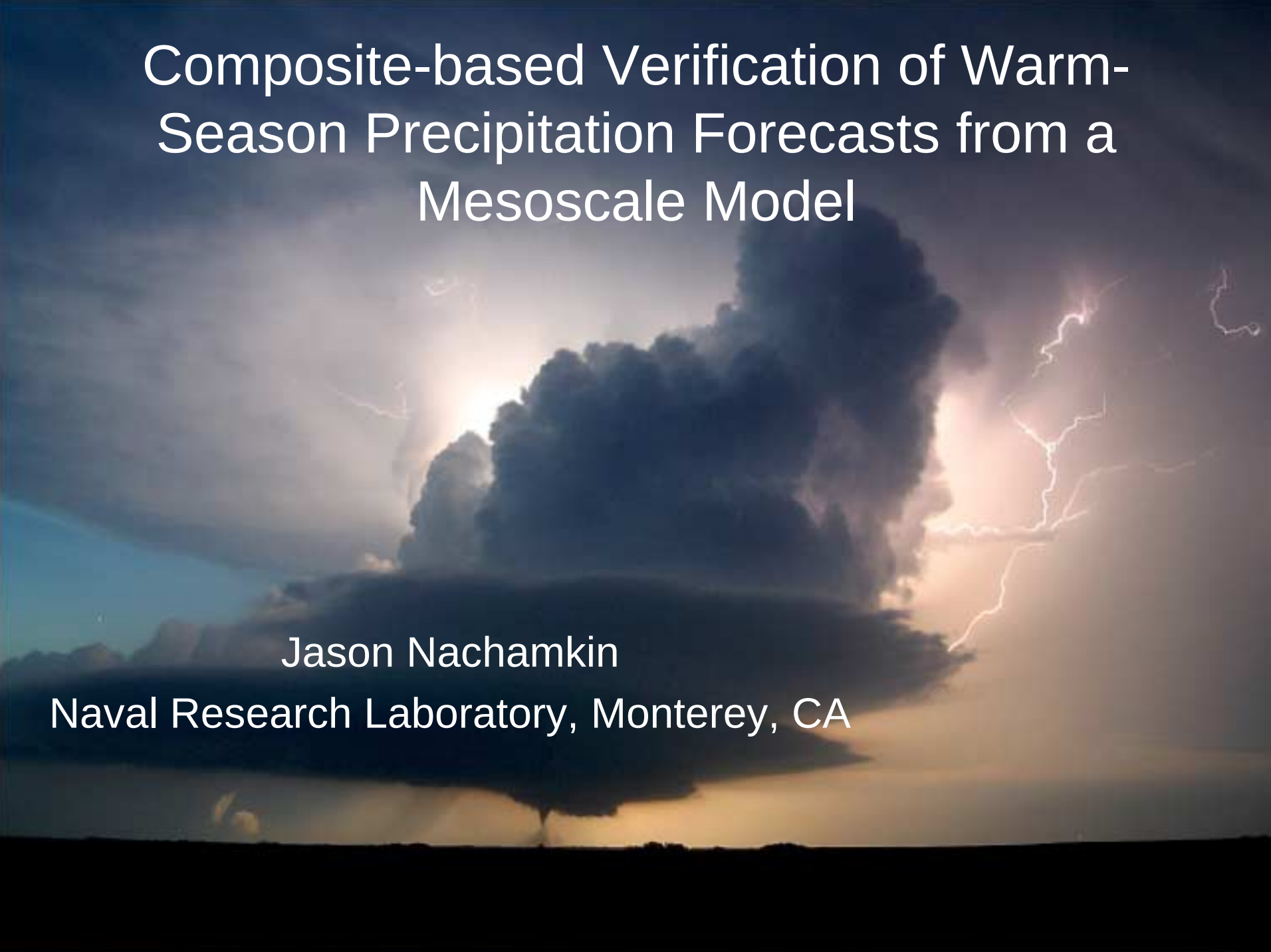
Composite-based Verification of Warm-Season Precipitation Forecasts from a Mesoscale Model



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Variability

$$\mathbf{MSE} = (\text{bias})^2 + (S_f)^2 + (S_o)^2 - 2S_fS_or_{fo}$$ (Murphy 1988)

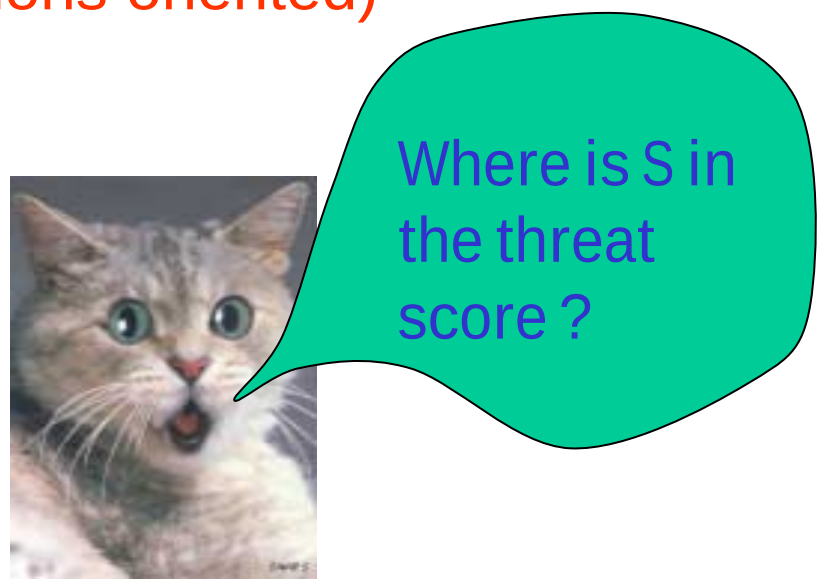
Large

Small

The nature of high-resolution forecasts leads to poor scores!!!

Composite Sampling

- Collect a narrowly defined, specific sample of events (reduces S)
- Summarize as much of the forecast space as possible (increases S)
- Verify directly in terms of the forecast and observed variables (distributions oriented)
  - Helps track S
  - Results are easily databased
  - Useful diagnostic tool



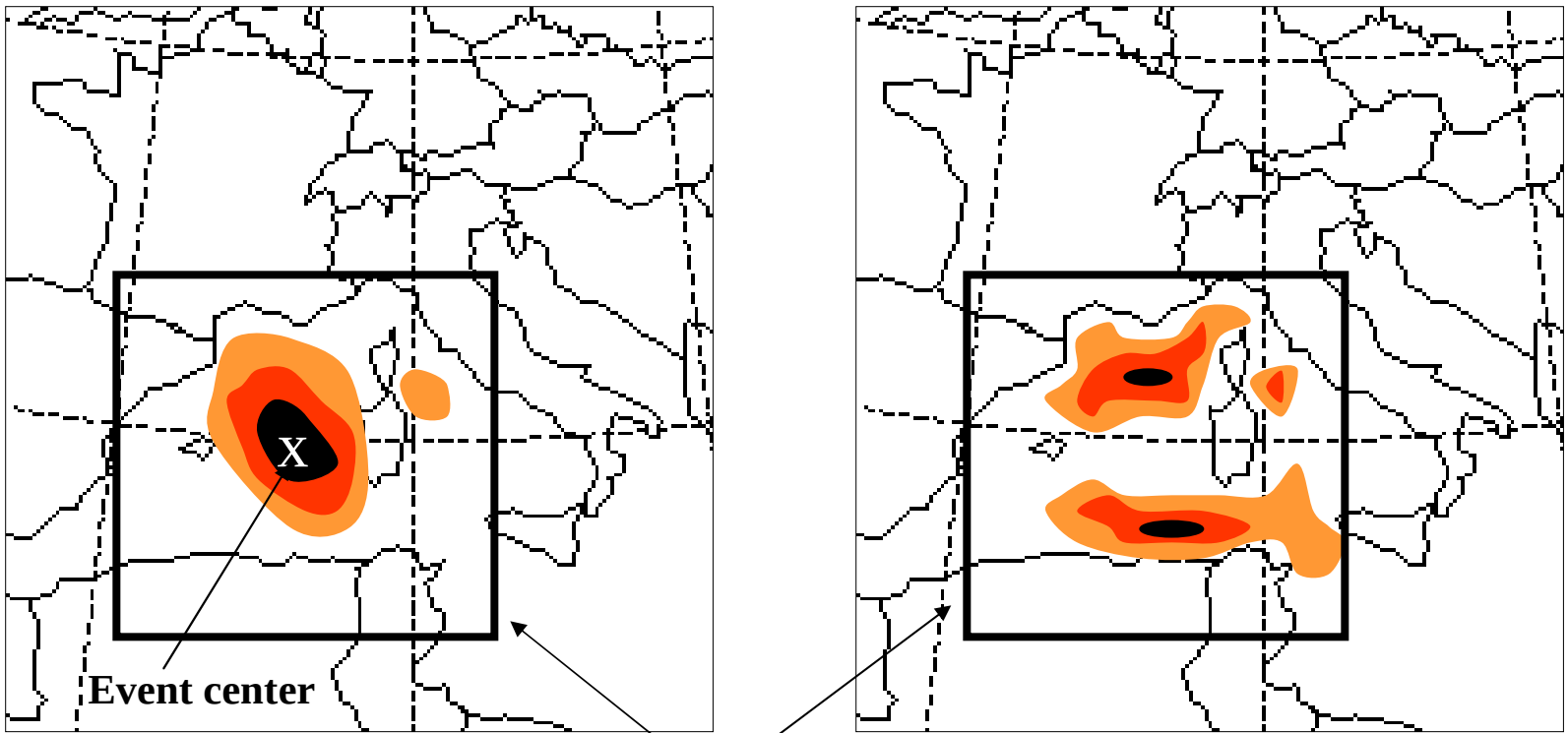
Composite Verification Method

- Identify events of interest in the forecasts
  - Rainfall greater than 25 mm
  - Event contains between 50 and 500 grid points
- Define a kernel and collect coordinated samples
  - Square box
  - 31x31 grid points (837x837 km for 27 km grid)
- Compare forecast PDF to observed PDF
- Repeat process for observed events

Collecting the Samples

Forecast event

Observations

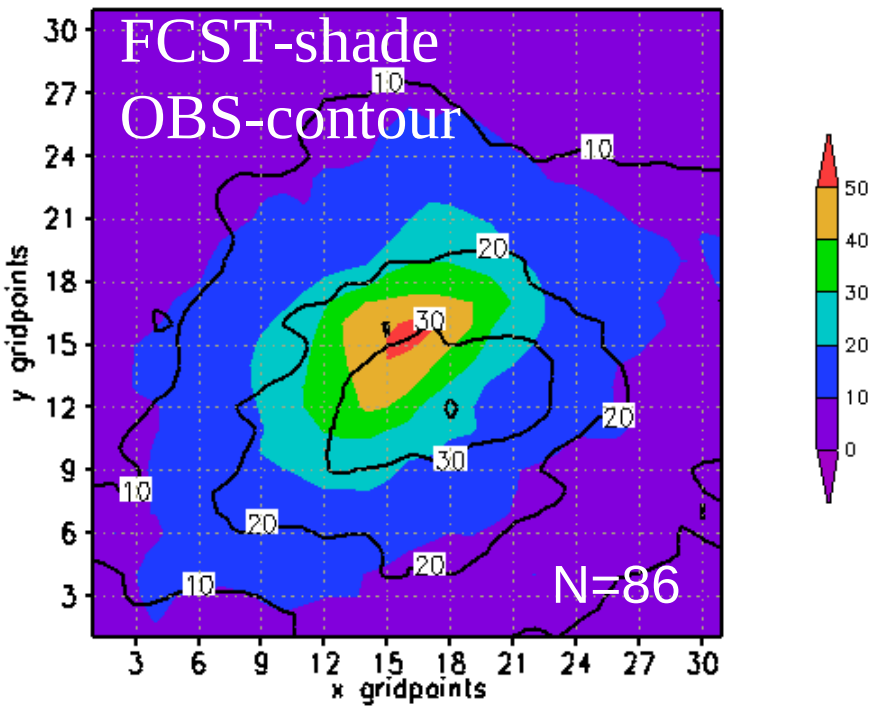


CONUS Precipitation Study

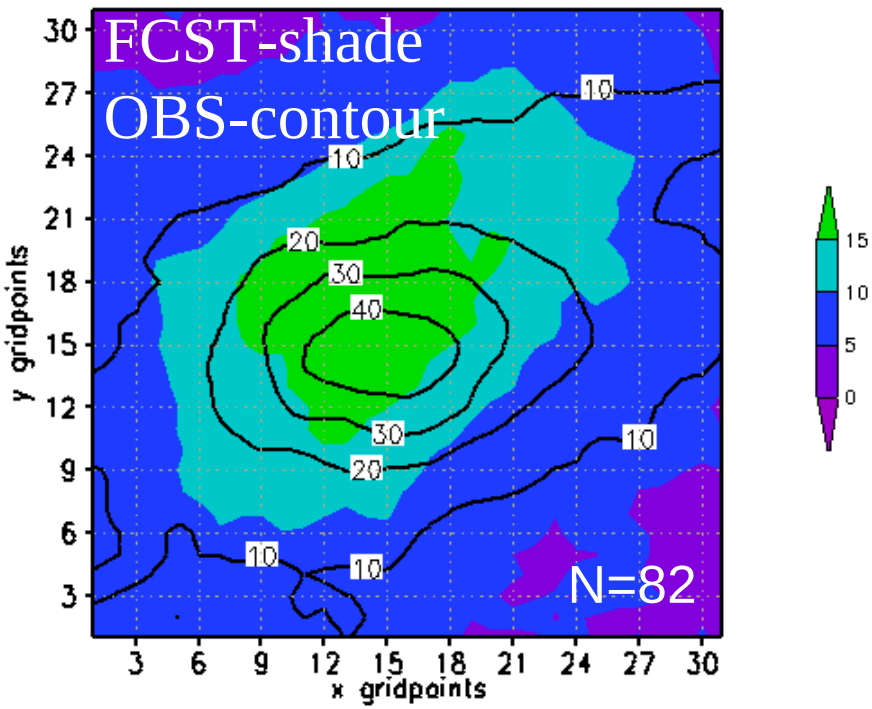
- All 24-hour forecasts from 15 April – 7 September
- COAMPS^{TM} operational forecasts
  - 27 km horizontal grid spacing
  - Nonhydrostatic
  - Kain-Fritsch cumulus parameterization
  - Rutledge&Hobbs microphysics with graupel (Schmidt)
  - MVOI data assimilation, 6-hour update frequency
- Verification data: River Forecast Center 4 km rain gauge analysis remapped to model grid

Kernel Grid-Average Precipitation

Average rain (mm) given an event was predicted (24-hr FC)

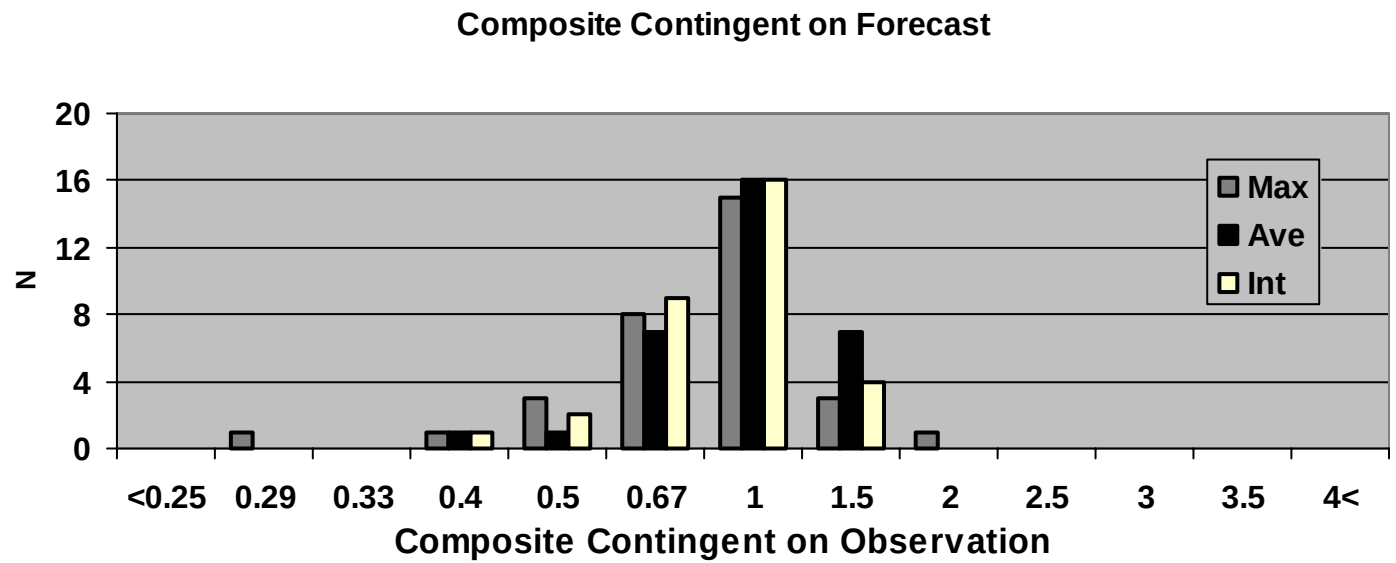


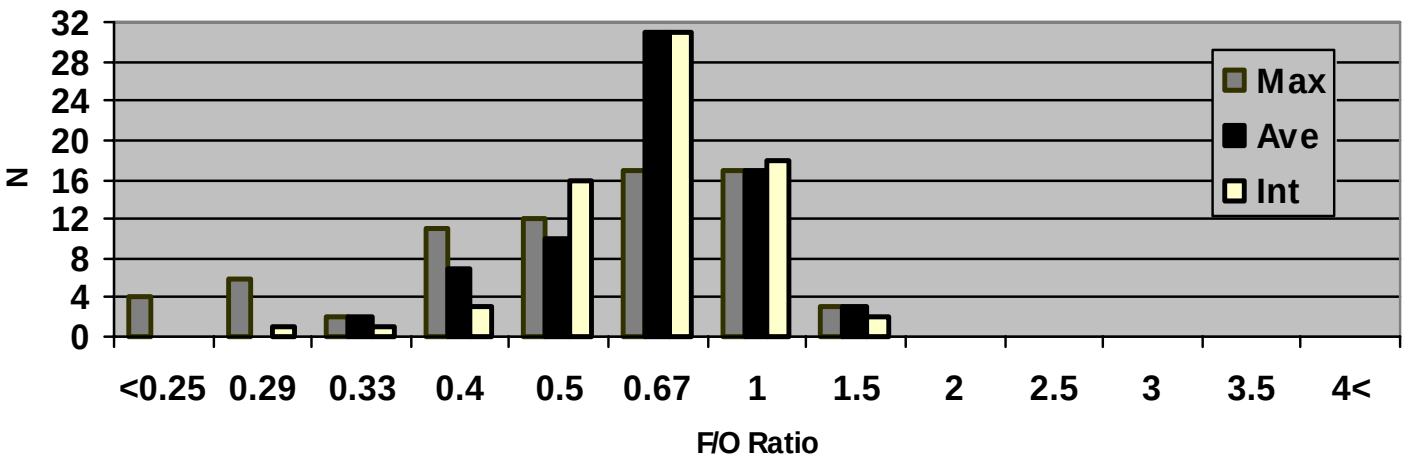
Average rain (mm) given an event was observed



Model-predicted events are phase-shifted, and the model has a significant under-estimation problem when an event is observed.

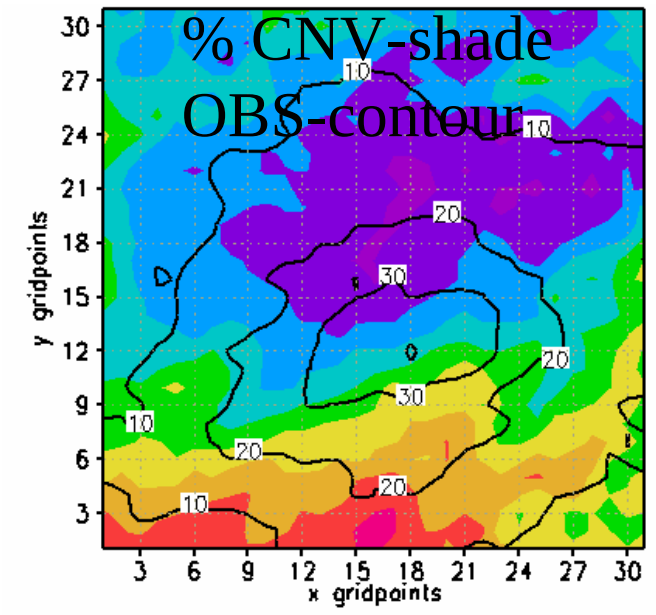
Daily Forecast Frequencies



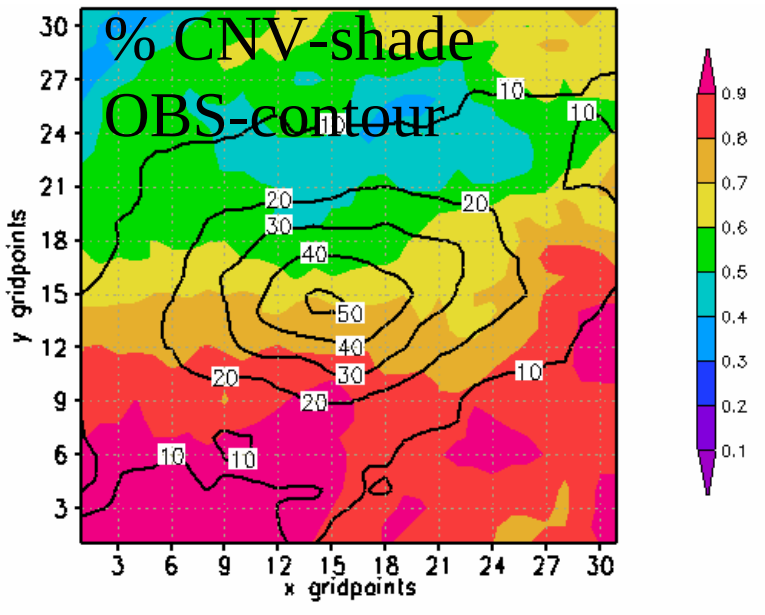


Percentage of Parameterized Precipitation

All 24-h forecast events



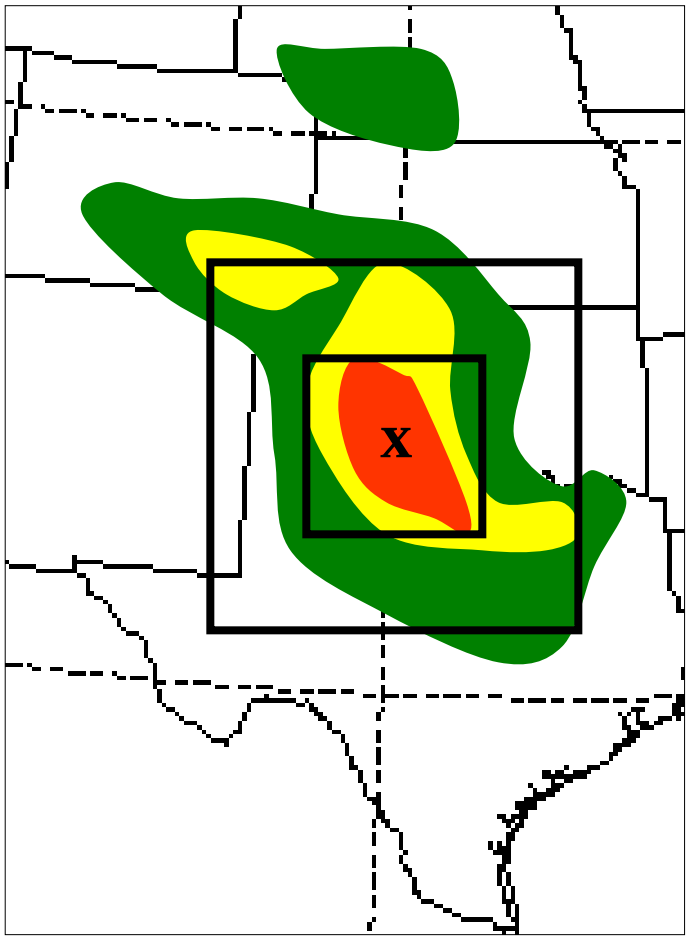
Missed events (obs events with grid mean FC < 0.8 OB)



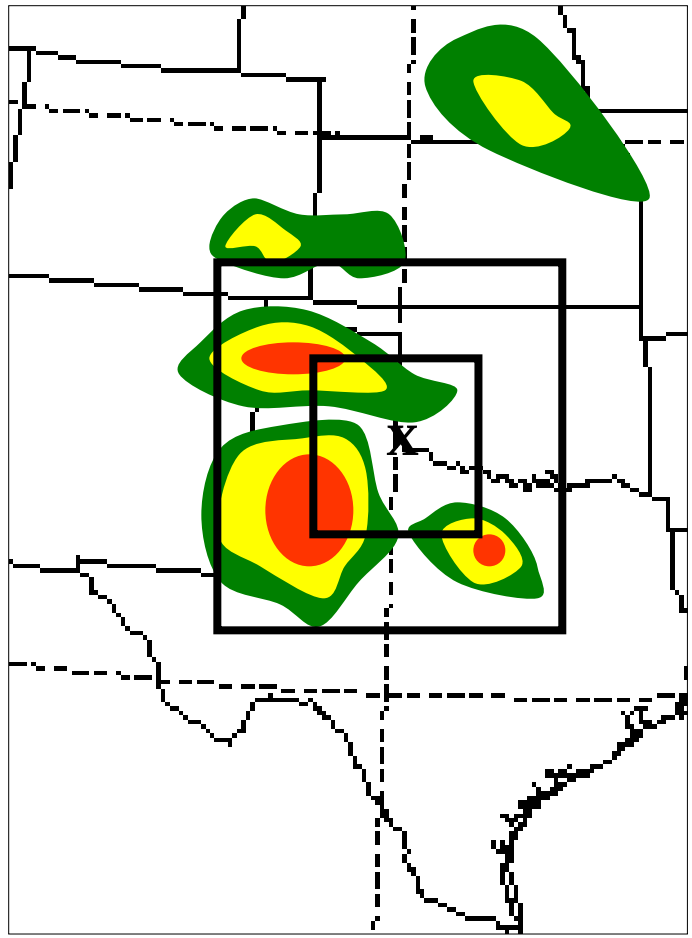
- Missed events contain high percentages of parameterized precipitation
- North-south gradient related to phase shift in FCST events

Quantifying Error

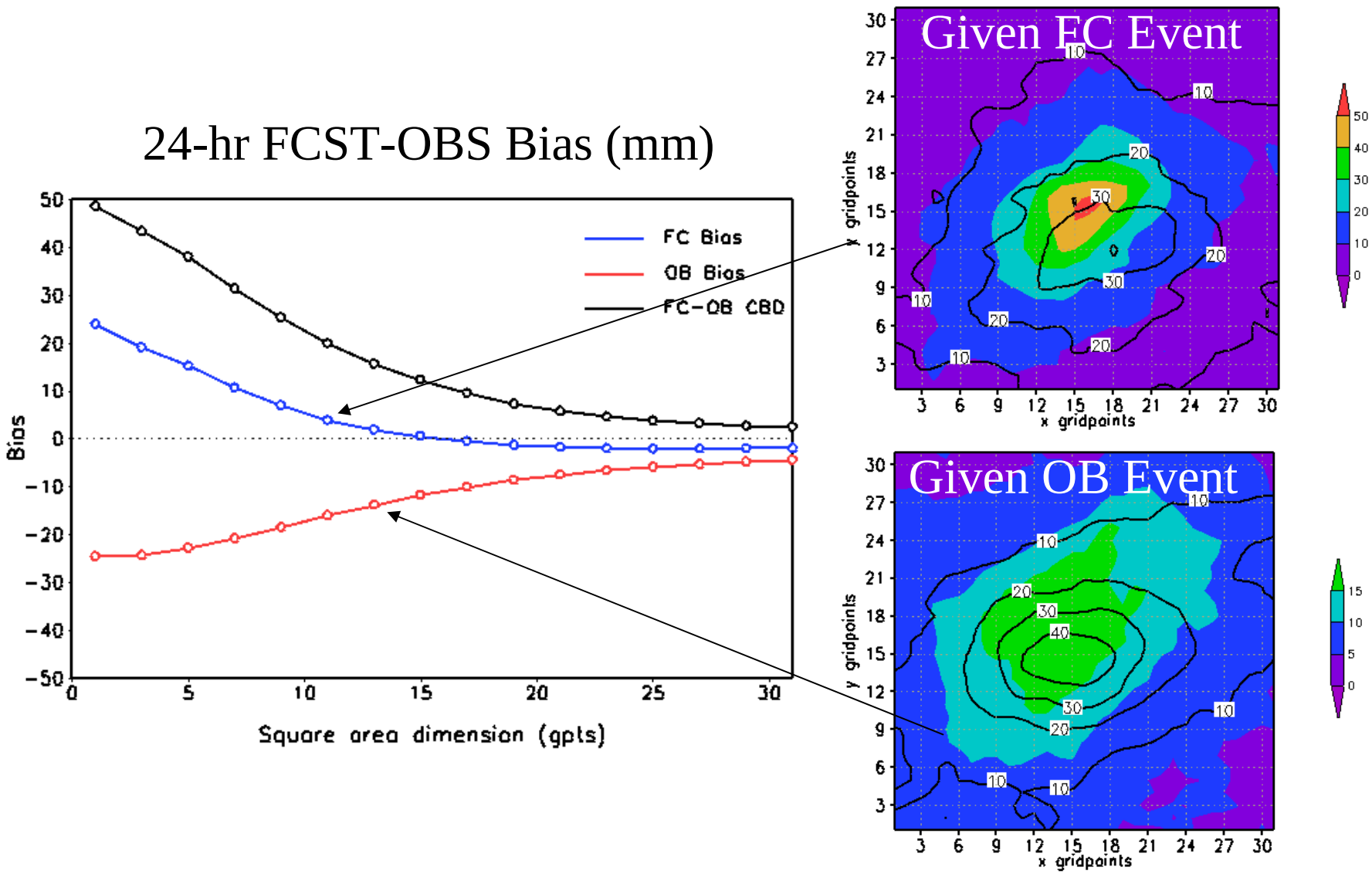
Forecast



Observations



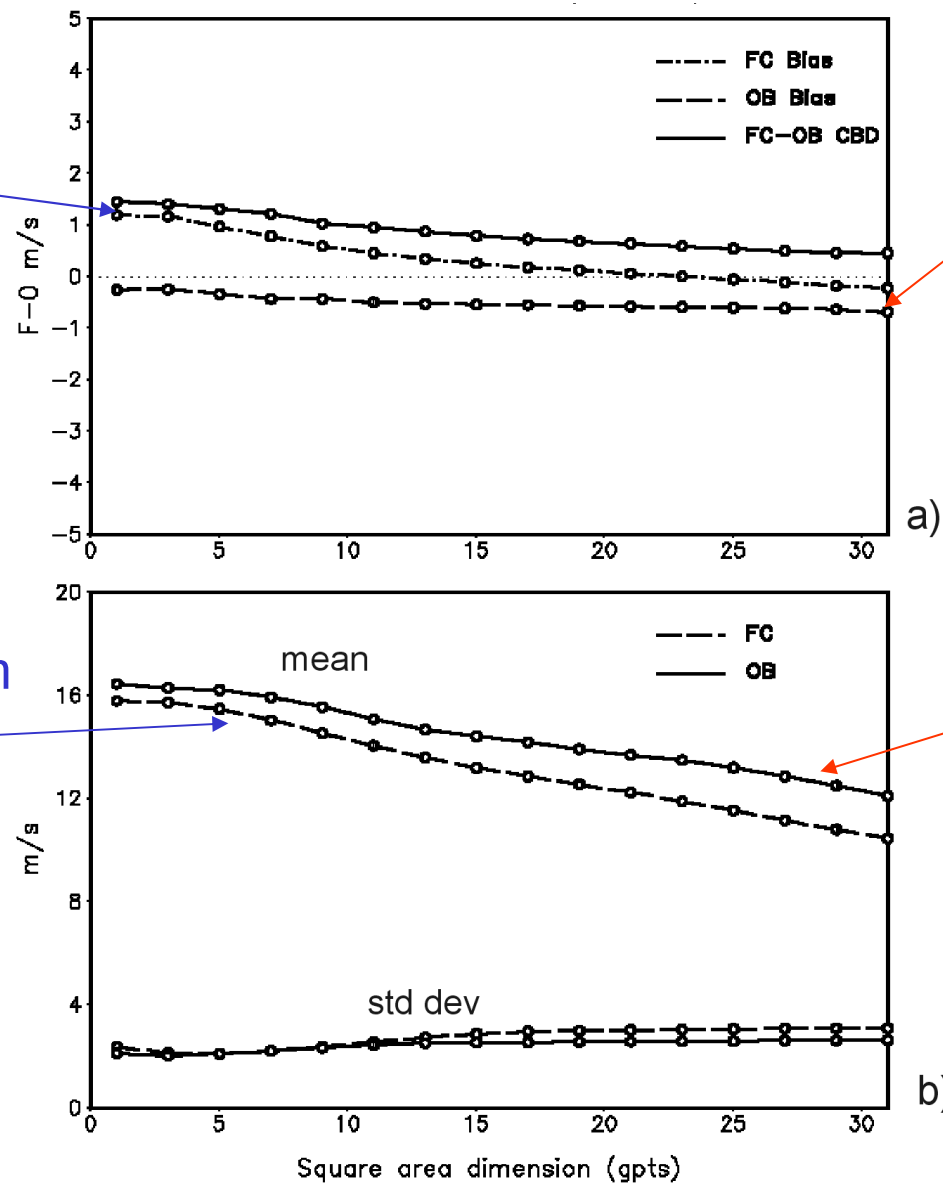
Multi-scale Sample Bias



Mistral Statistics

Given an event is predicted

Given an event is observed

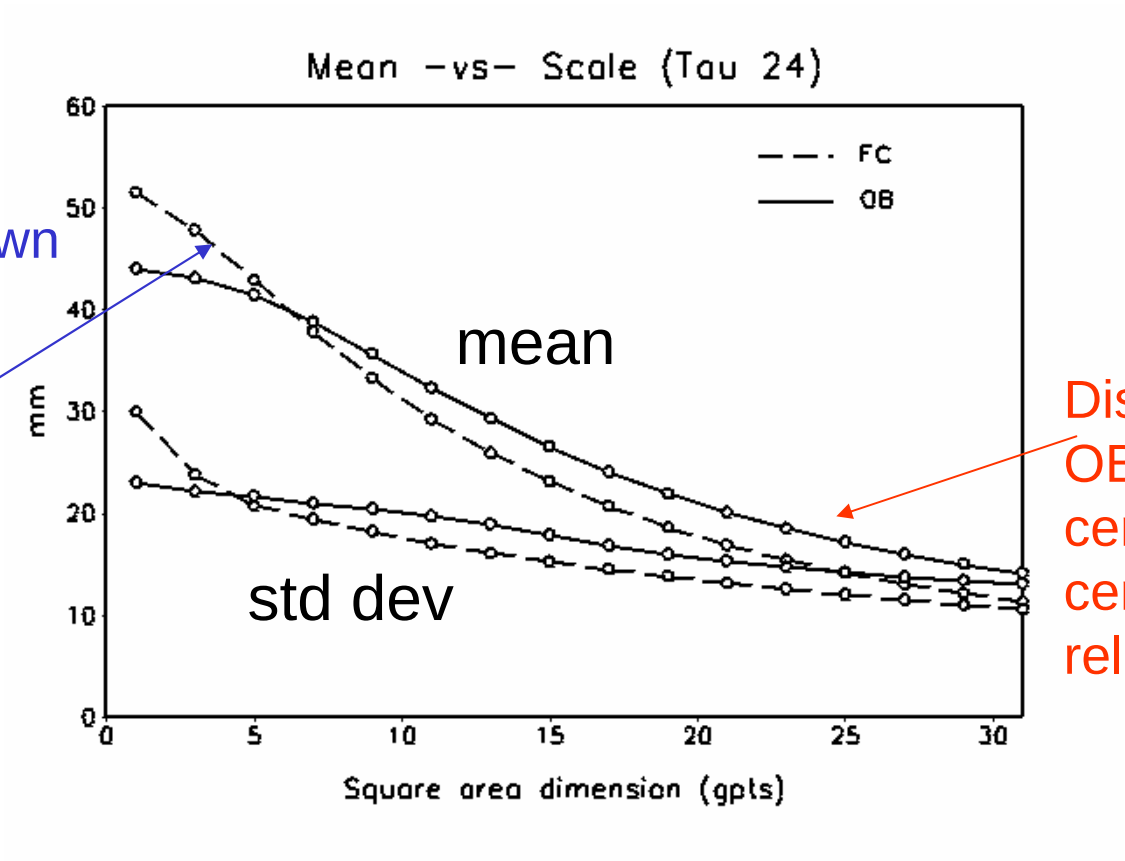


Dist of all known FCST events centered at center of relative grid

Dist of all known OBS events centered at center of relative grid

Precipitation Event Statistics

Dist of all known FCST events centered at center of relative grid

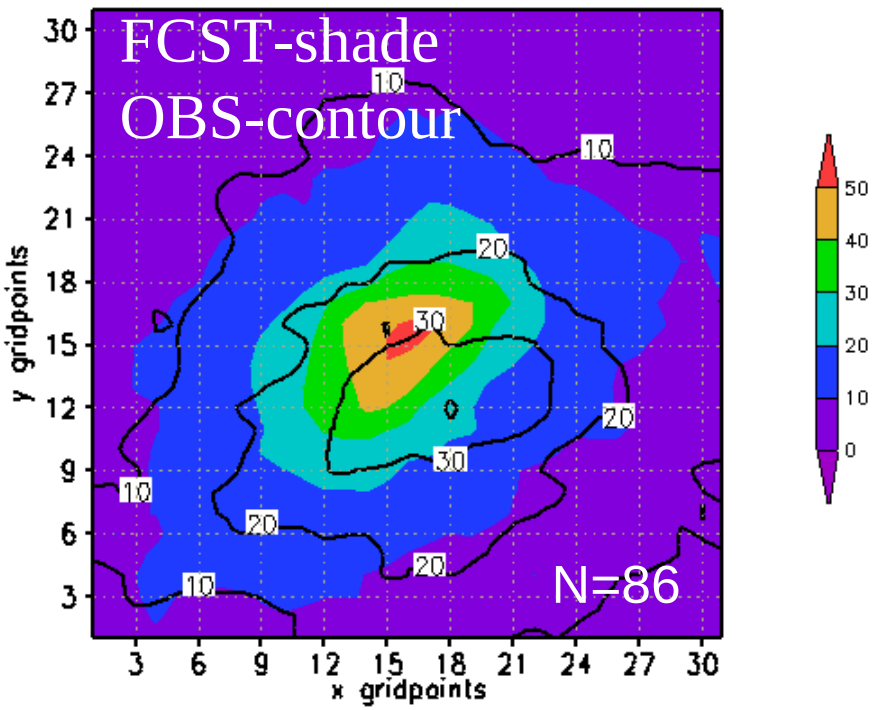


Dist of all known OBS events centered at center of relative grid

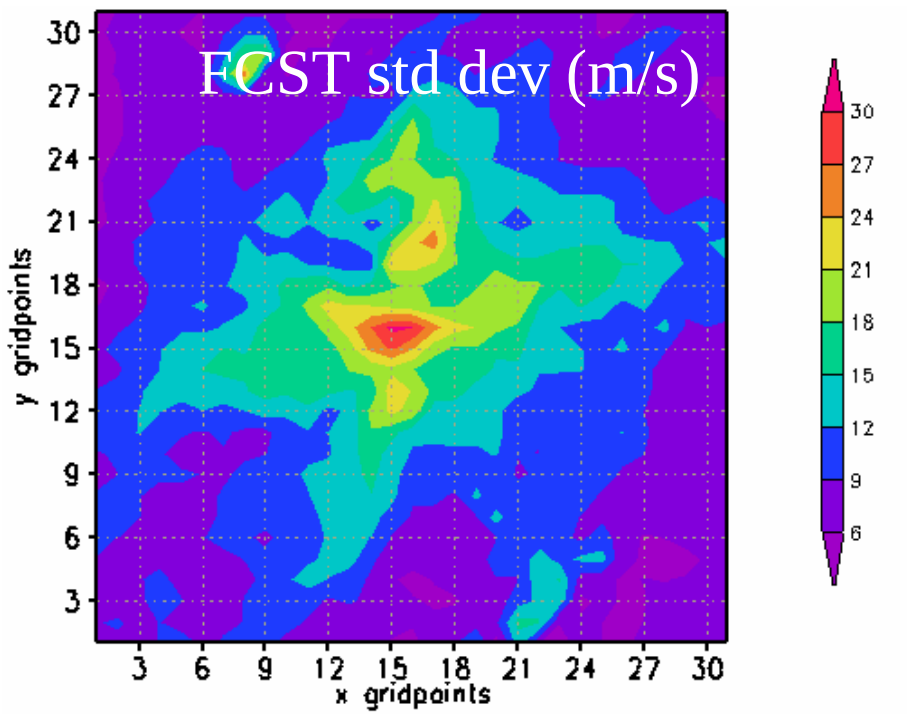
- Signal-to-noise ratio smaller for precipitation forecasts
- Variability does not decrease despite event superposition

Interpreting the Scores

Average rain (mm) given an event was predicted



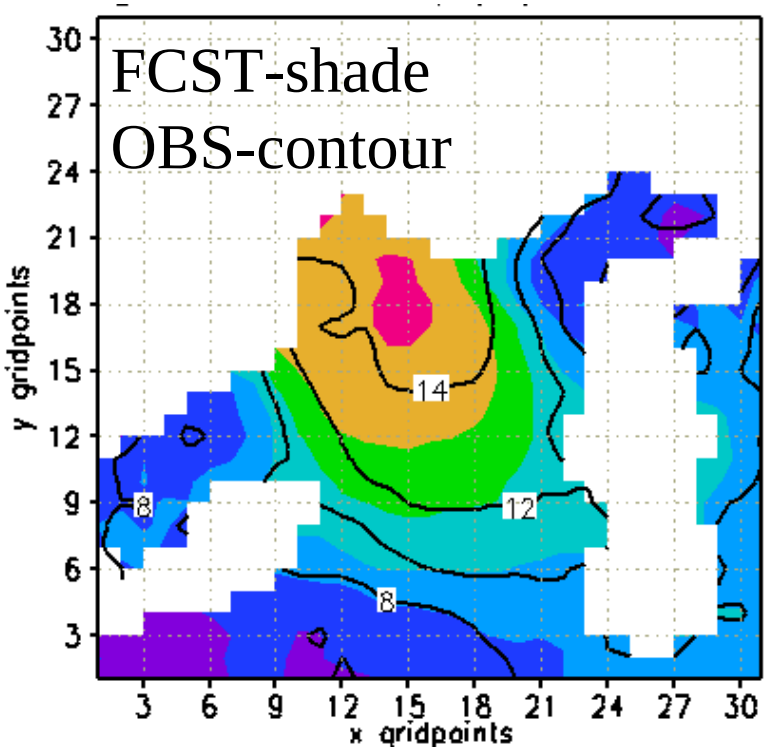
Standard deviation (mm) given an event was predicted



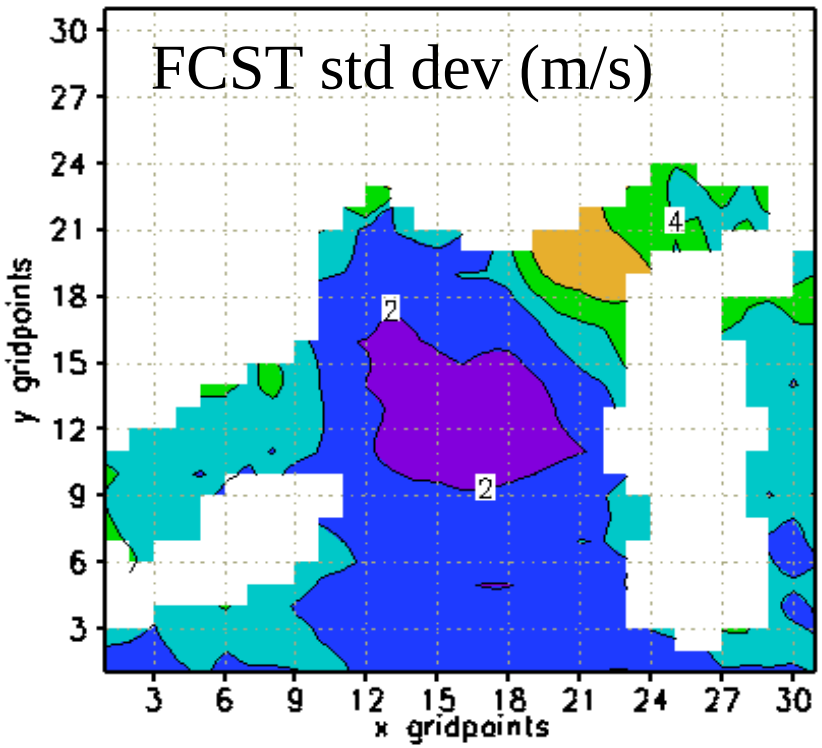
- Standard deviations increase towards event center
- Every event is different

Mistral Speed Distribution

Average wind (m/s) given an event was predicted (18-hr FC)



Forecast standard deviation (m/s) (18-hr FC)



- Standard deviations decrease towards event center
- Less variability between events

Conclusions

- The composite method is a simple way to directly verify meteorological variables.
- Data are easily databased.
- The sample paradox suggests multiple scales should be verified.
  - Small sample grids sensitive, scores saturate easily
  - Large grids less sensitive but scores less precise
- Future work should focus on probabilistic statistics based on attributes.