Real-time Sensitivity Analysis During MPEX

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Overview

- Hypothesis: Initial condition errors in specific locations limit the prediction of convection
- It is not always clear where is the optimal location for initial condition changes
- Can be determined via ensemble-based sensitivity analysis
- Interest in MPEX is understanding the dynamics of how IC errors translate into forecast errors

Ensemble Sensitivity

$$\frac{\partial J_e}{\partial x_j} \equiv cov(\delta J, \delta \mathbf{x}_{o,j})\mathbf{D}_j^{-1} = \frac{cov(\mathbf{J}, \mathbf{X}_j)}{var(\mathbf{X}_j)}$$

Ancell and Hakim 2007, Torn and Hakim 2008

- Ensemble-based method of computing the sensitivity to the initial conditions
- Above equation is linear regression based on ensemble:
  - Dependent variable is ensemble estimate forecast metric
    - 850 hPa circulation for 200 km radius circle
  - Independent variable is an element of state vector
- Can also obtain confidence bounds on sensitivity value

MPEX Activities

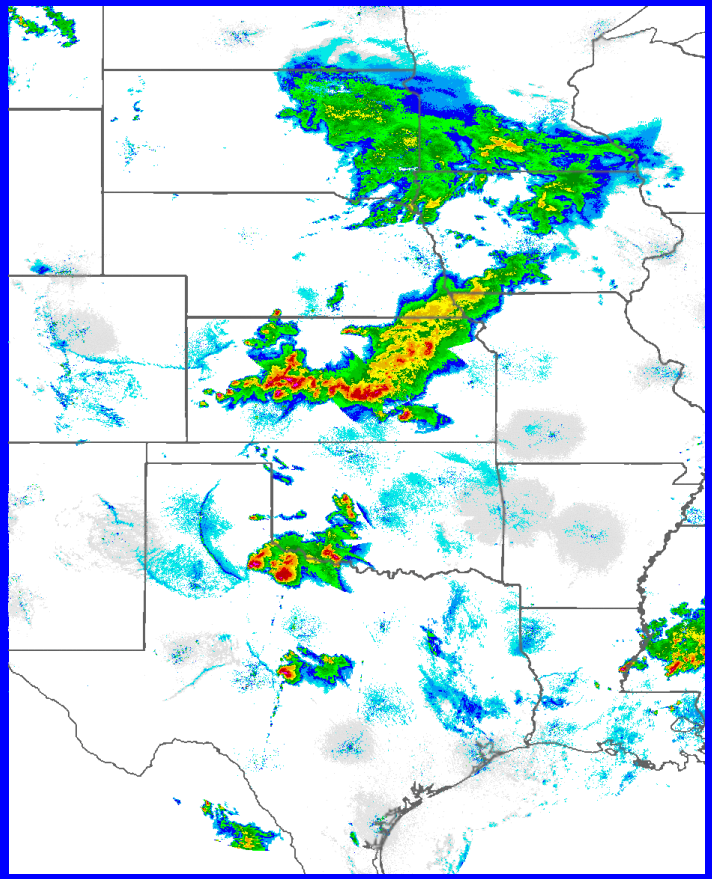
- Compute real-time forecast sensitivities using ensemble forecasts produced at NCAR (see Glen's talk)
- Regions of large sensitivity can provide guidance on where to fly GV during the next morning.
- Sensitivity determined either through gradient, or composites of members with large metric vs. small metric values

Forecast Sensitivity

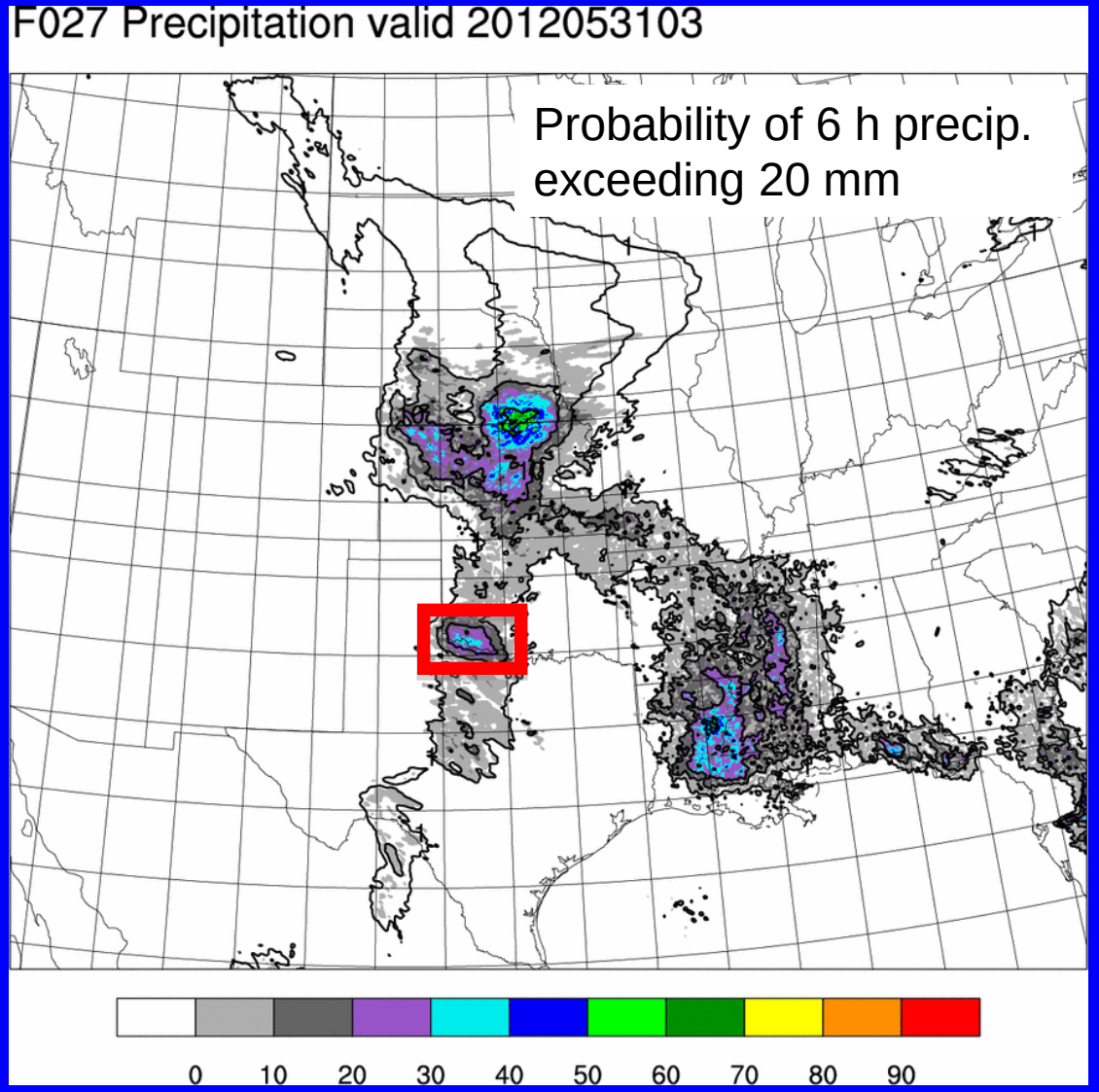
- Forecast Metrics:
  - Precipitation averaged over time period and horizontal location
  - Area of simulated reflectivity exceeding 35 dBZ in area
  - Skewness of reflectivity over area
  - SUGGESTIONS???
- Fields to compute sensitivity to:
  - Low-level θ_e
  - Low-level stability
  - mid-level moisture
  - Upper-level features (PV, Vorticity, height)
  - Vertical Wind Shear
  - SUGGESTIONS???

Example Case

Forecast Initialized
0000 UTC 30 May 2012



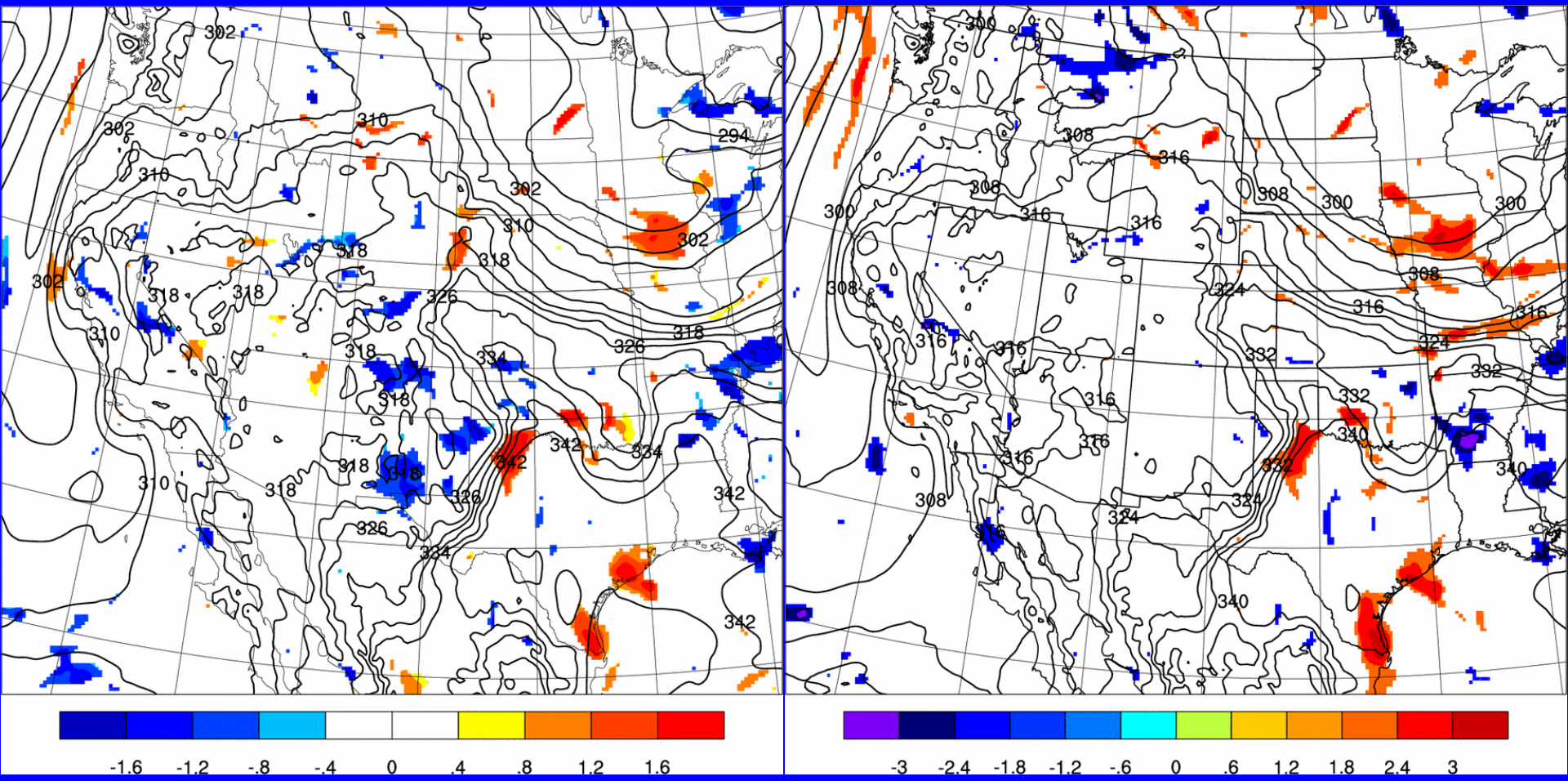
Observed reflectivity on 0000 UTC 31 May 2012



Sensitivity Example

Difference Between High/Low Precip. Fcst

Sensitivity to 12 h forecast

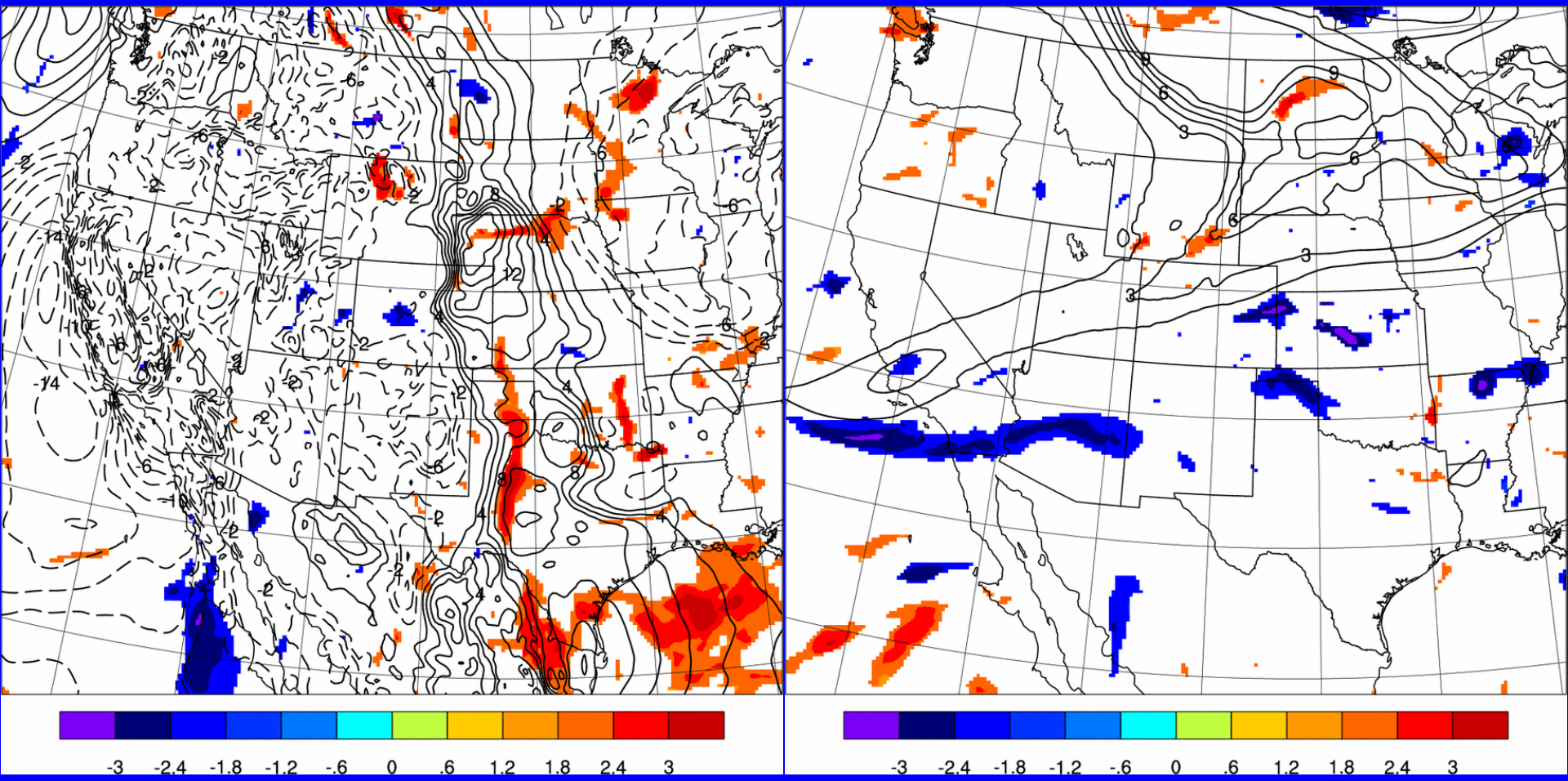


12 h forecast of theta-e < 1 km AGL

Sensitivity Cont.

< 1 km AGL meridional wind sensitivity

330 K PV Sensitivity



Potential Operations Timeline

- Need to determine sensitivity prior to daily planning meeting
- Instead of computing sensitivity to IC, will do sensitivity to earlier forecast lead time.
  - Likely sensitivity of 36 h forecast to ~22 h forecast.