11B.1

Detection of Mesoscale Pressure Perturbations with Five Minute Gridded Analyses

Alexander A. Jacques, John D. Horel, and Erik T. Crosman
Dept. of Atmospheric Sciences, University of Utah

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Outline

- Motivation
- Surface Pressure Datasets
  - Observations: US Transportable Array
  - Background: NOAA RTMA Grids
- 5-Minute Analysis and Perturbation Detection Methods
- Perturbation Case Examples
- Spring/Summer 2011 Perturbation Statistics
- Conclusions and Discussion

Motivation

- Large mesoscale pressure perturbations from various phenomena (e.g., MCS, gravity waves, etc.) can produce numerous impacts:
  - Surface wind fluctuations (potentially damaging winds)
  - Precipitation generation/suppression

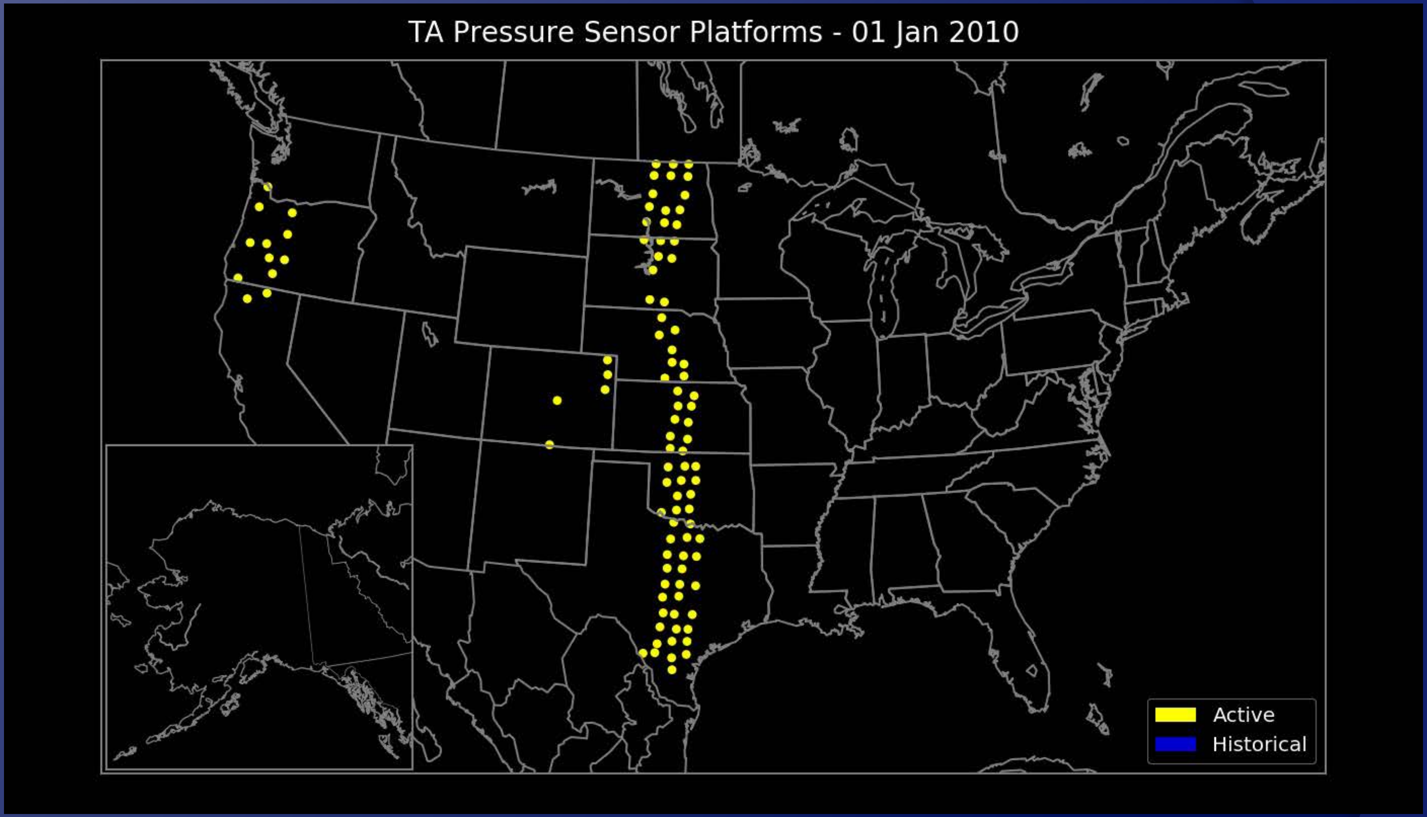
- Surface observations: good temporal resolution, less spatial
- Gridded datasets: good spatial resolution, less temporal

- Research demonstrates ability to effectively combine observations and gridded datasets to form a set of high temporal, high spatial analysis grids adequate for detecting prominent mesoscale pressure perturbation features

- Potential use for real-time operational detection of prominent mesoscale perturbations (e.g. strong inertial gravity waves)

USArray Transportable Array (TA)

- Temporary deployment of ~400 seismic platforms (~70 km spacing)



- 1 Hz Pressure Data Archive: NCAR RDA Repositories

Jacques, A. A., J. D. Horel, E. T. Crosman, and F. L. Vernon, 2016: EarthScope USArray Transportable Array (TA) Surface Pressure Observations Sampled at 1 Hz Frequency. Research Data Archive at the National Center for Atmospheric Research, Computational and Information Systems Laboratory, Boulder, Colorado, USA. **doi:10.5065/D6028PRS**

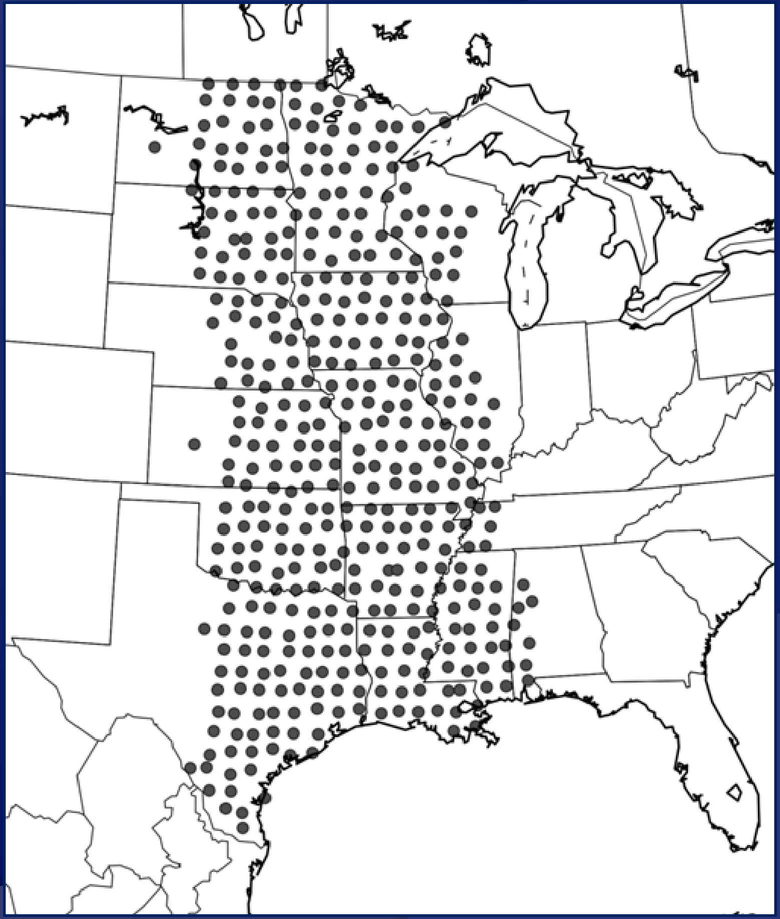
USArray Transportable Array (TA)

- Jacques et al. (2015, MWR) identified prominent mesoscale activity over TA domain but did not assess spatial characteristics of the detected perturbation features

- TA spatial resolution (~ 70 km) too coarse to adequately describe mesoscale spatial characteristics

- Therefore, an additional resource was required to improve upon spatial resolution

TA Deployment : 1 Mar – 31 Aug 2011

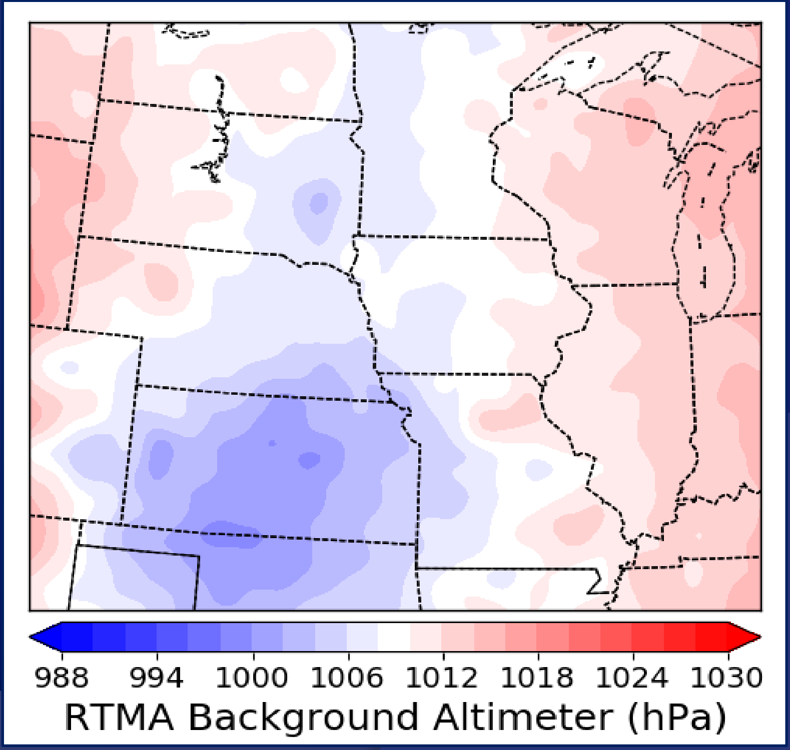


Analysis Background Grids

- NOAA Real Time Mesoscale Analysis (RTMA) Surface Pressure

- 13 km RUC 1 h forecasts interpolated to 5 km across CONUS
  - *Today: HRRR used instead of RUC, 2.5 km instead of 5 km*
  - Conventional observations incorporated to nudge resultant analysis grids

- Grids serve as a background "first guess" surface pressure field which could be nudged using the TA observations



Analysis Creation and Feature Detection

- Grids interpolated (obs subsampled) to 5 min intervals
- Datasets converted to 5 min pressure tendency
- Background grid tendency adjusted using obs via U. of Utah Two Dimensional Variational Analysis (UU2DVAR) to create final grids
- Final analysis grids converted back to surface pressure
- Analyses band-pass filtered (10 min – 12 h) to isolate mesoscale

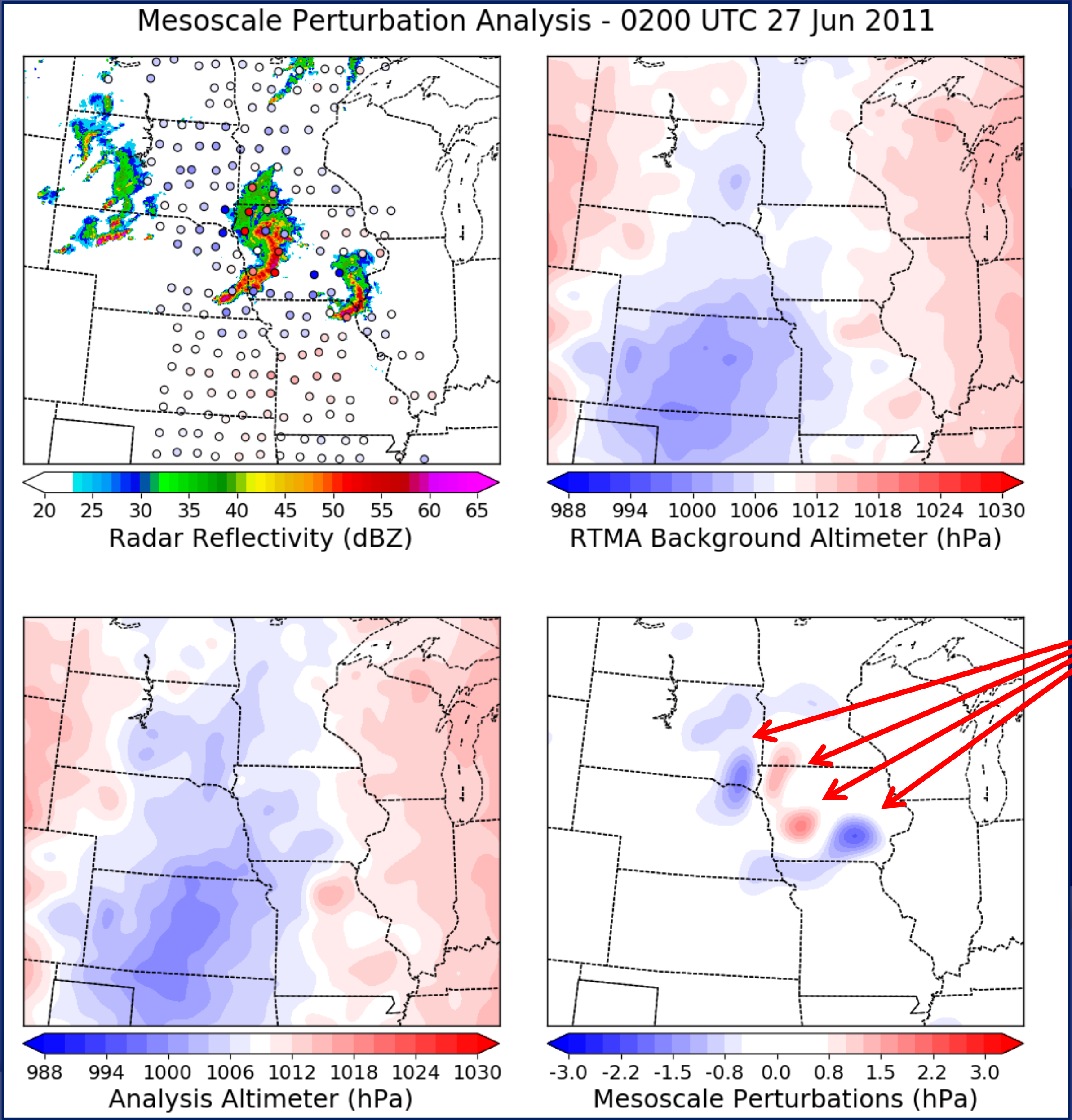
Interpolated RTMA "Background" Grids + **TA Observations** → **Final "Analysis" Grids**

- Prominent mesoscale perturbations detected using analysis grids
  - Absolute perturbation magnitude ≥ 1 hPa
  - Detected lifetime ≥ 1 h
  - Areal extent ≥ 10,000 km^2

Example of Analysis Grid Creation

Radar + TA Mesoscale (10 min - 12h) Perturbations (points using bottom-right color bar)

RTMA "Background"



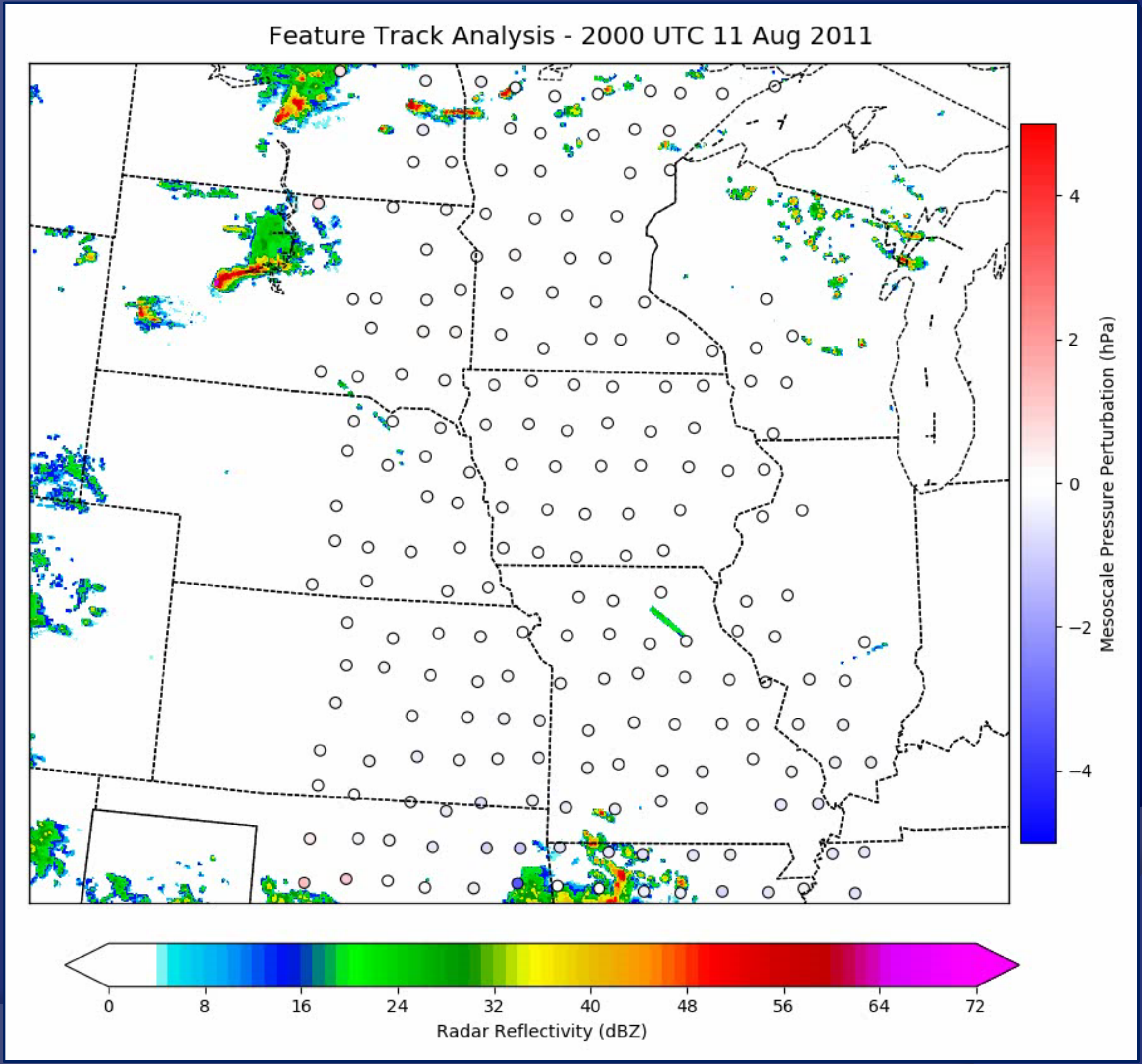
Features to be assessed

Analysis Pressure Grid

10min - 12h Mesoscale Perturbations

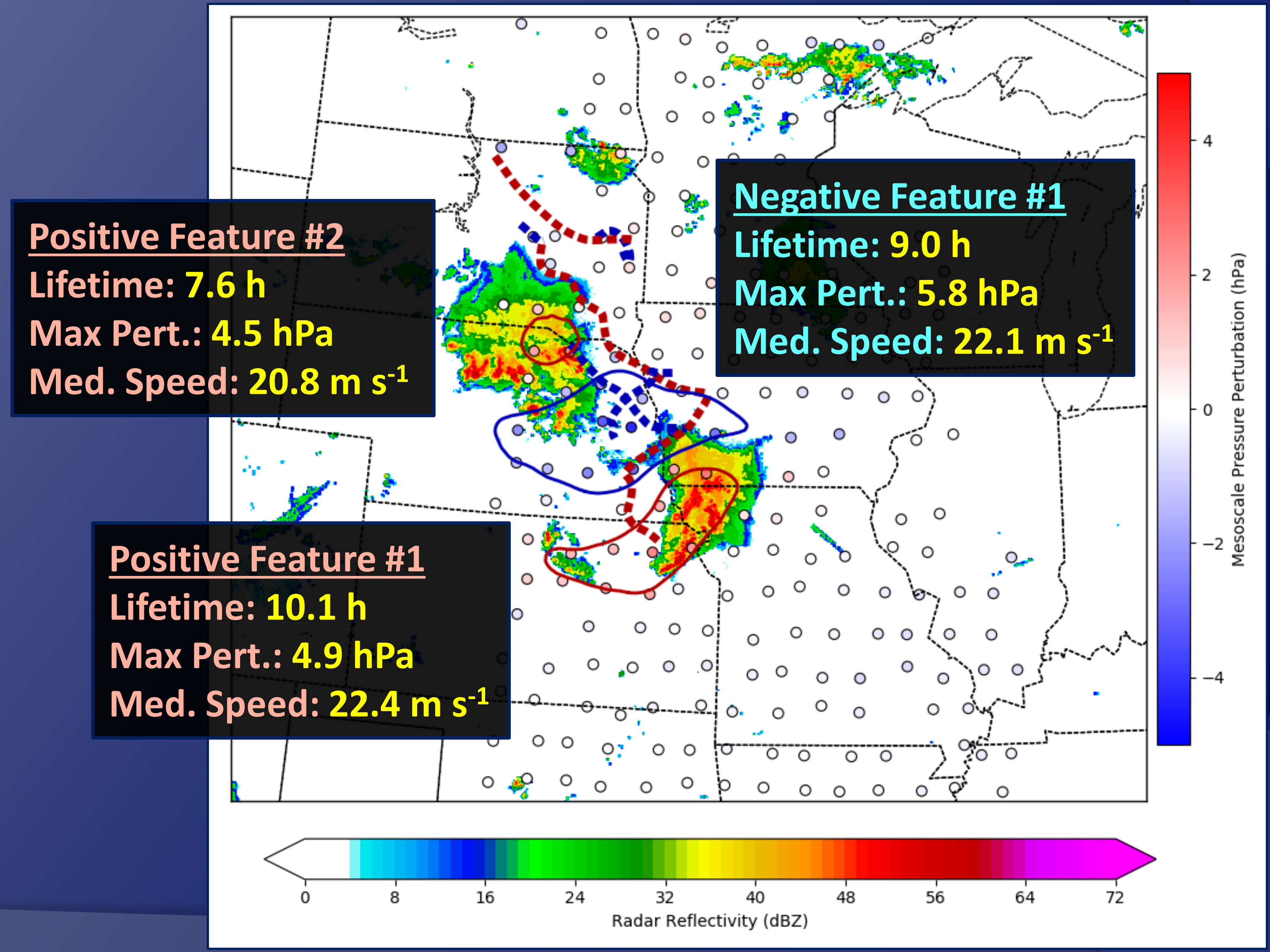
Case Study I: 11-12 Aug 2011

- Radar, TA mesoscale perturbations (markers - **red** positive, **blue** negative), contoured features (solid) and tracks (dashed lines)



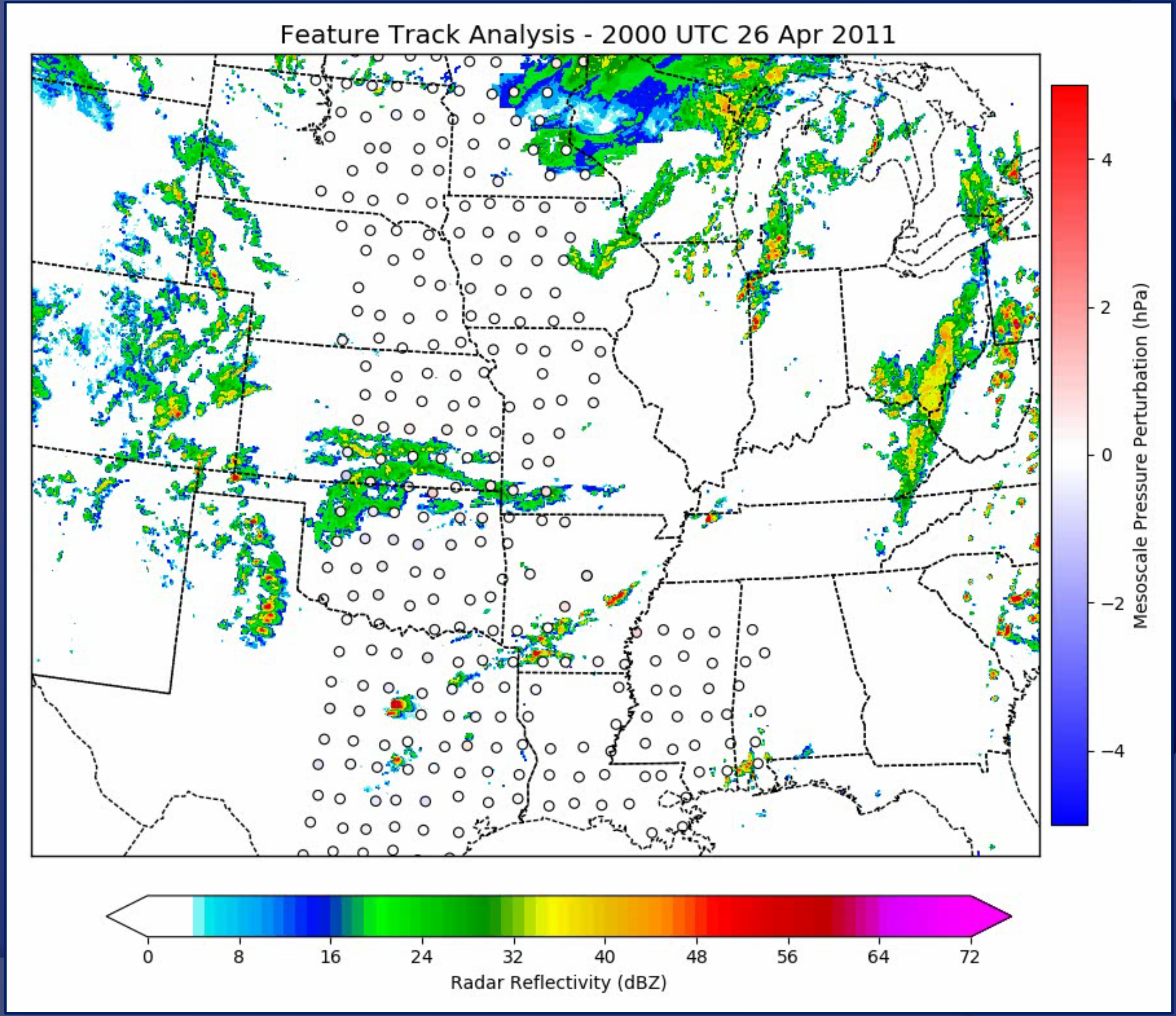
Case Study I: 11-12 Aug 2011

- 0900 UTC 12 Aug 2011 – Analysis Grid and Detected Features



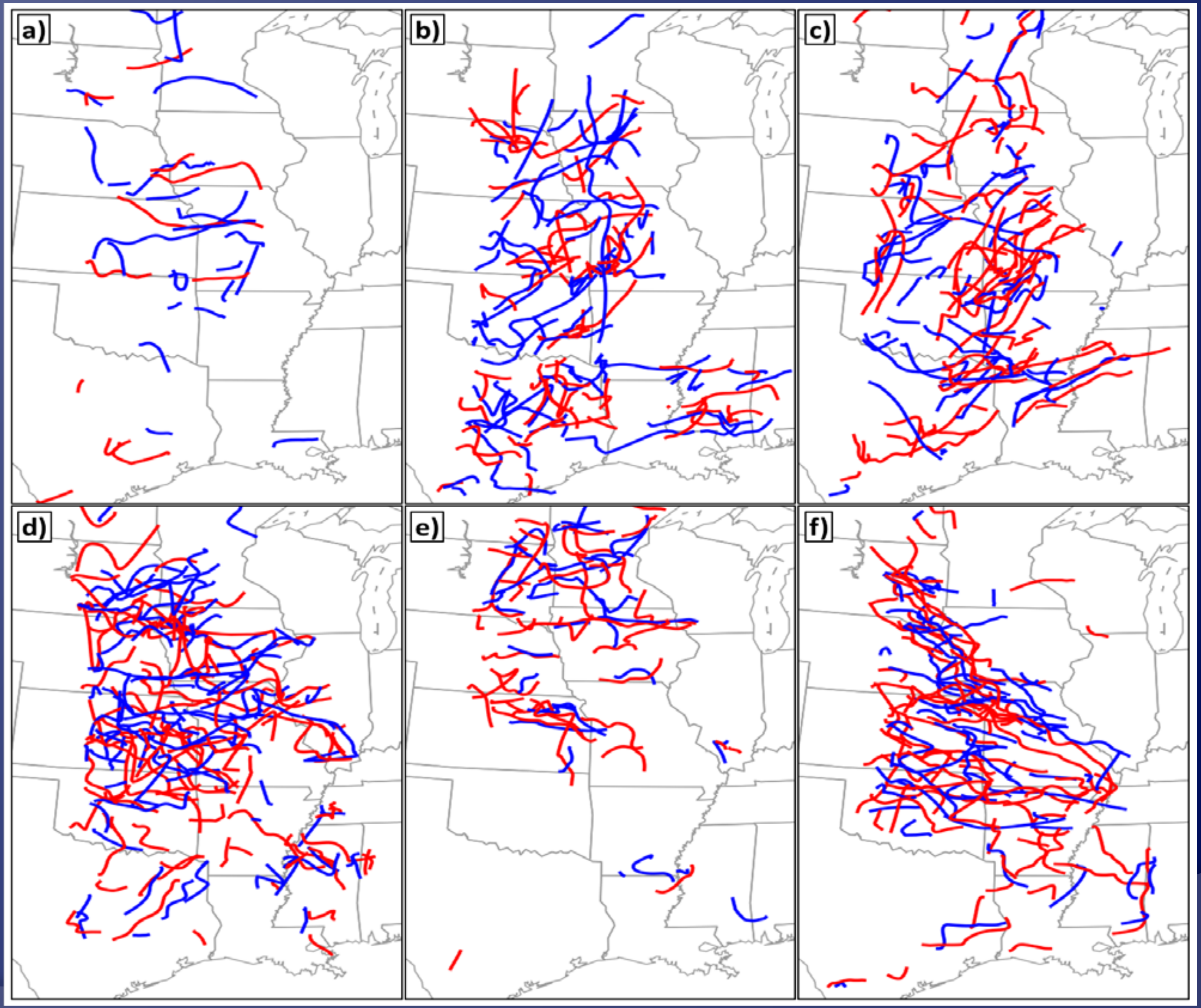
Case Study II: 26-27 Apr 2011

- Radar, TA mesoscale perturbations (markers - **red** positive, **blue** negative), contoured features (solid) and tracks (dashed lines)



2011 Mesoscale Feature Summaries

- Seasonal shifts in feature development region and track preference



Spring (MAM: Figs. a-c)

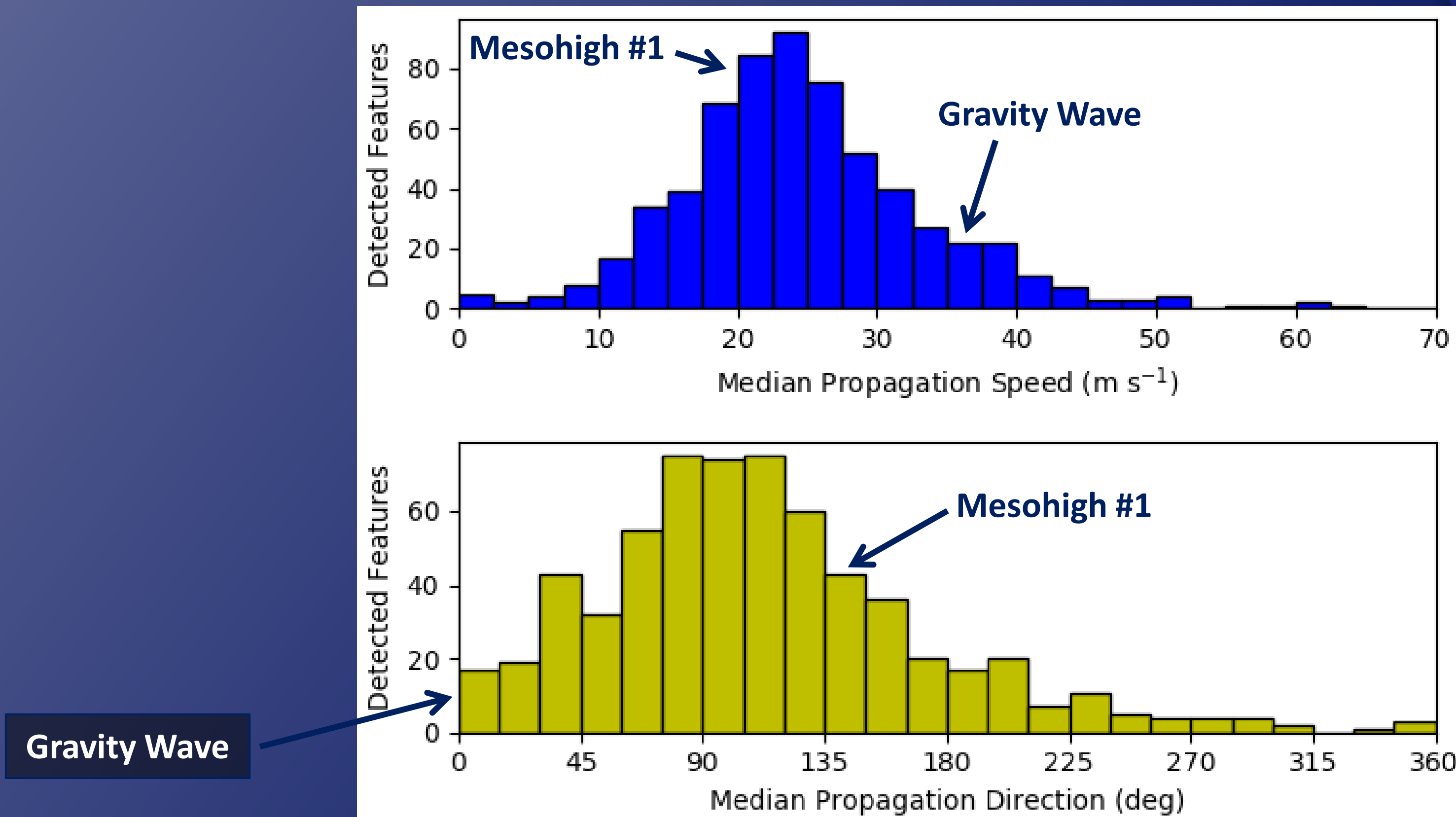
- Majority form in south/central Plains
- Primarily move in east-northeast direction

Summer (JJA: Figs. d-f)

- Majority form in north/central Plains
- Primarily move in east-southeast direction

2011 Mesoscale Feature Summaries

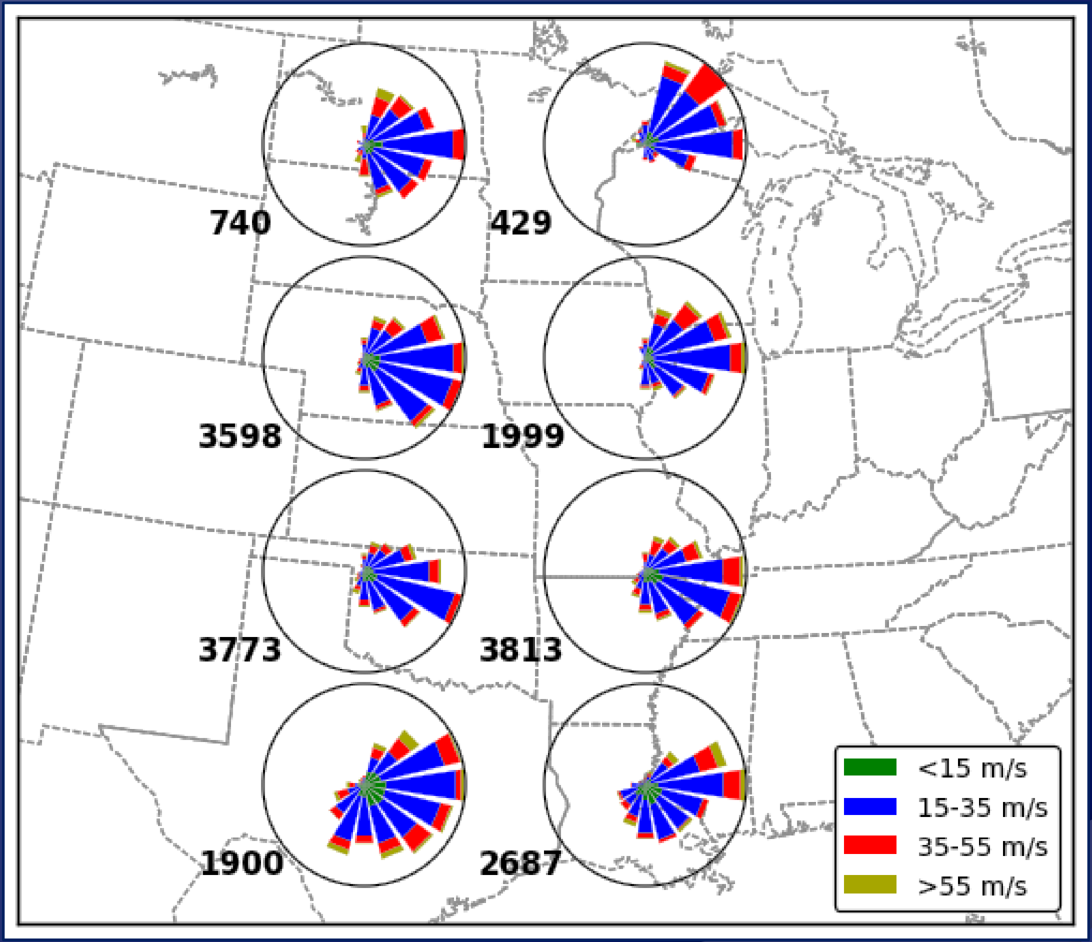
- Feature Median **Speeds** and **Directions**



- **Majority of detected features (76.1%) moved within 15-35 m s^{-1} bounds previous climatologies had assessed as "typical" speeds**
- Preferred propagation directions match feature track assessments

2011 Mesoscale Feature Summaries

- Feature movement properties were assessed every 5 minutes and are summed up regionally via these rose plots for 1 Mar – 31 Aug

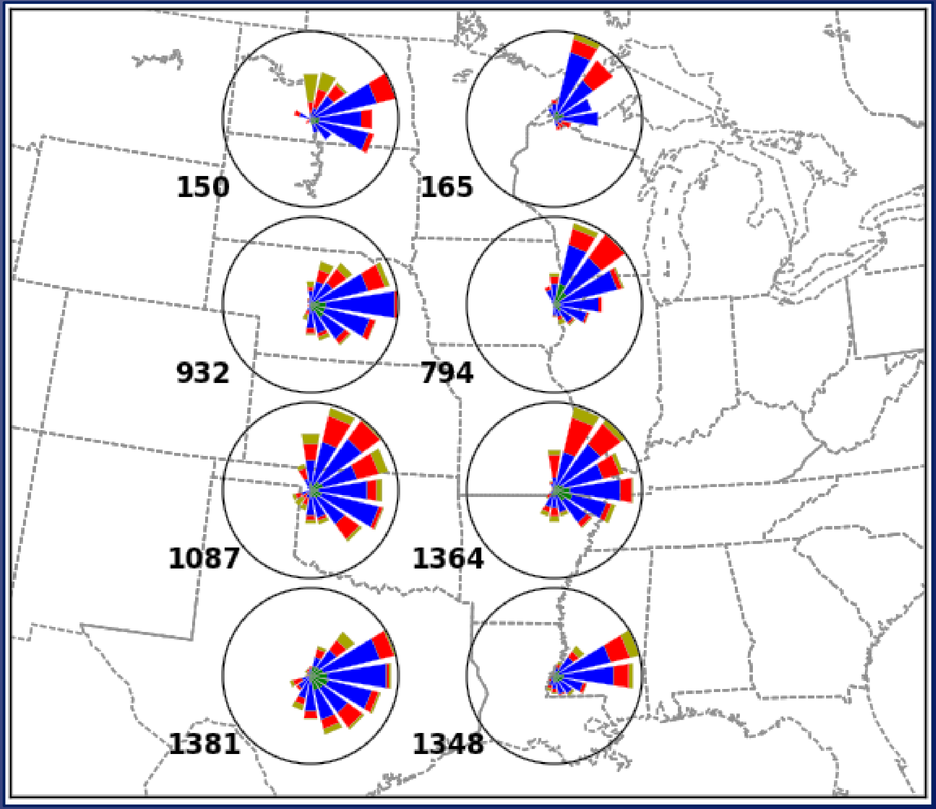


- Feature movement within 15-35 m s^{-1} is the most frequent

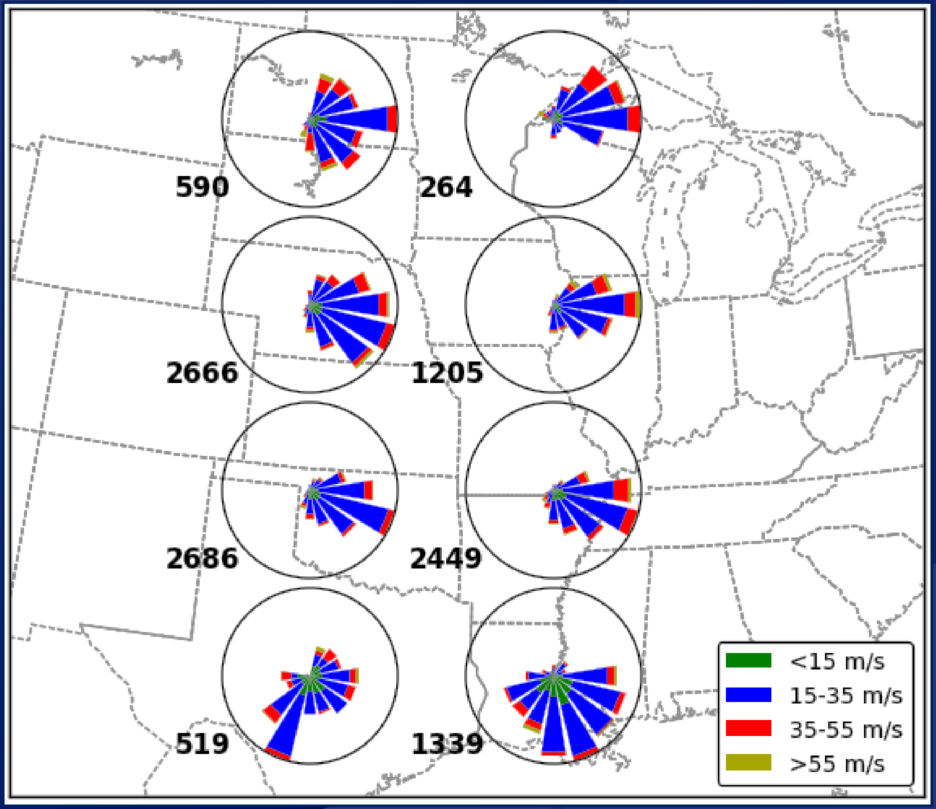
2011 Mesoscale Feature Summaries

- Noticeable shift in preferred direction of movement for features from spring to summer seasons

Spring (MAM) 2011



Summer (JJA) 2011



Conclusions

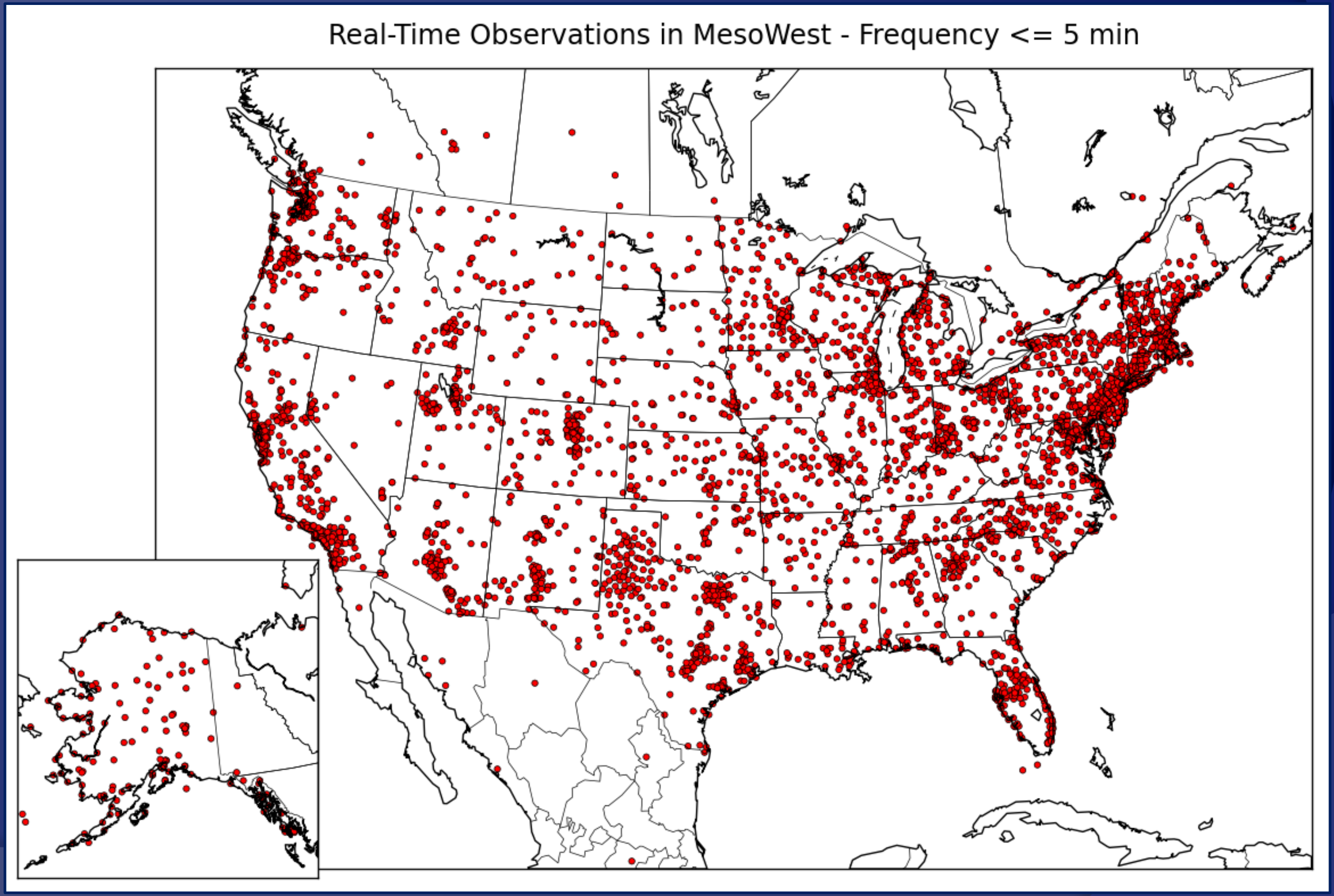
- Results demonstrate ability to effectively combine observations and grids in a cohesive manner (5 km, 5 min) such that less assumptions were required to assess mesoscale features

- Spatial review of 1+ hPa mesoscale features (1 Mar – 31 Aug 2011)
  - 72.9% lasted less than 3 h
  - 70.5% less than 40,000 km^2
  - 76.1% median speed 15-35 $m\ s^{-1}$

- Seasonal reviews of feature speeds, directions, and tracks support typical climatological shift of flow patterns over central US which influence mesoscale feature development and movement

Mesonet Obs for Operational Detection?

- Operational Perturbation/Gravity Wave Detection: can it be done?
  - Assessed before (e.g., Koch and Saleeby 2001) but issues getting better than hourly data and processing efficiently
  - Today: more resources, more sampling, better dissemination



Acknowledgments and References

Submitted Manuscripts:

Jacques, A. A., J. D. Horel, E. T. Crosman, and F. L. Vernon, 2017: Tracking Mesoscale Pressure Perturbations Using the USArray Transportable Array. *Monthly Weather Review*, accepted pending revisions.

Published Manuscripts:

Jacques, A. A., J. D. Horel, E. T. Crosman, and F. L. Vernon, 2015: Central and Eastern United States Surface Pressure Variations Derived from the USArray Network. *Monthly Weather Review*, **143**, 1472-1493, doi:10.1175/MWR-D-14-00274.1.

Jacques, A. A., J. D. Horel, E. T. Crosman, F. Vernon, and J. Tytell, 2016: The Earthscope US Transportable Array 1 Hz Surface Pressure Dataset. *Geoscience Data Journal*, **3**, 29-36, doi:10.1002/gdj3.37.

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