# Pressure Signatures of Extreme Weather Events Deduced from EarthScope's USArray Network

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Project Objectives

- Improve access for the atmospheric science community to both real-time and archived pressure observations
  - Project Website: http://meso1.chpc.utah.edu/usarray
  - MesoWest: http://mesowest.utah.edu
  - MesoWest data distributed to NWS Western Region, MADIS, and other NOAA entities
- Develop and analyze climatologies of pressure perturbations and signatures at each observing site
- Examine pressure perturbations and perturbation gradients in the context of local, mesoscale, and synoptic-scale flows
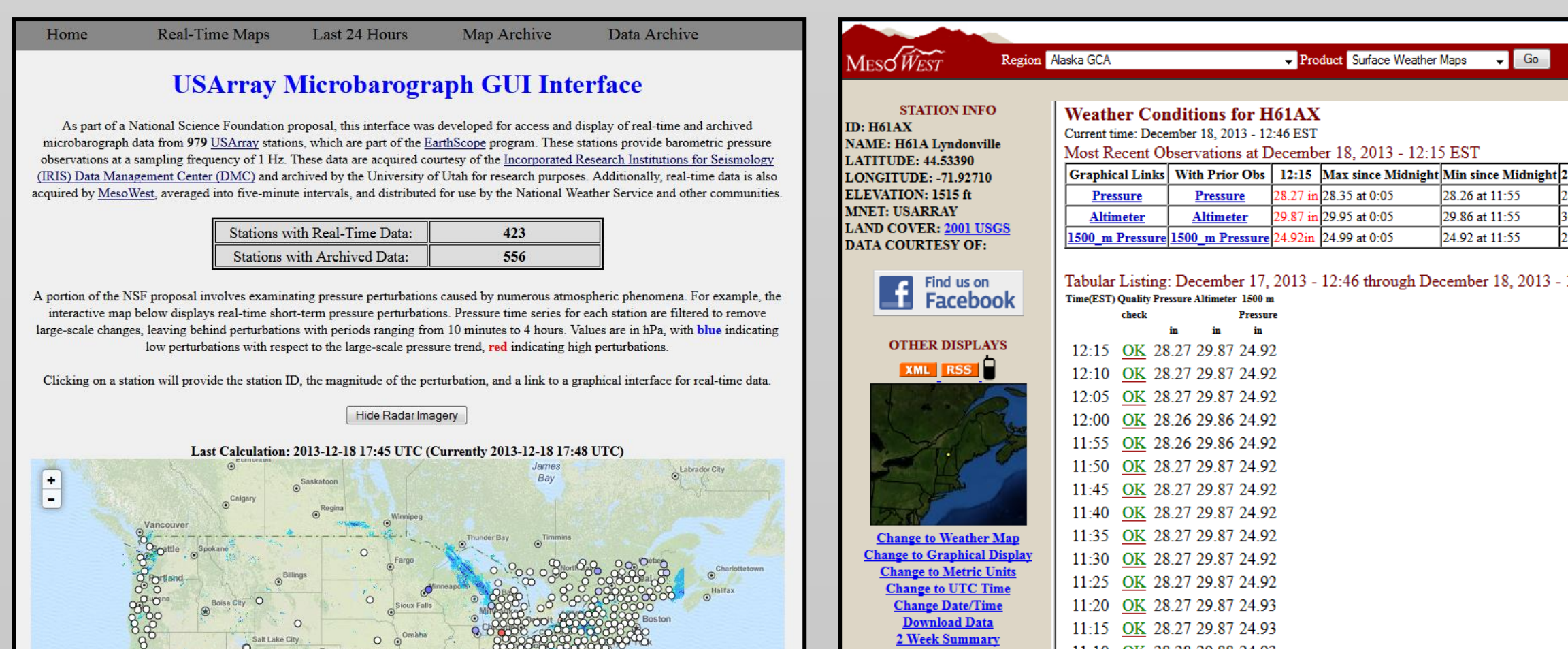
What is the USArray?

- Network of over 400 seismic stations traversing the CONUS as part of an EarthScope project to study seismic activity
- Stations outfitted with microbarometers beginning in 2010
- Barometric pressure reported at 1 Hz sampling rate
- Locations semi-uniformly spaced ~70 km apart (quasi-grid)
- Stations report for ~1.5-2 years then moved to new location

USArray Station Deployment (Updated 8 Jan 2014)
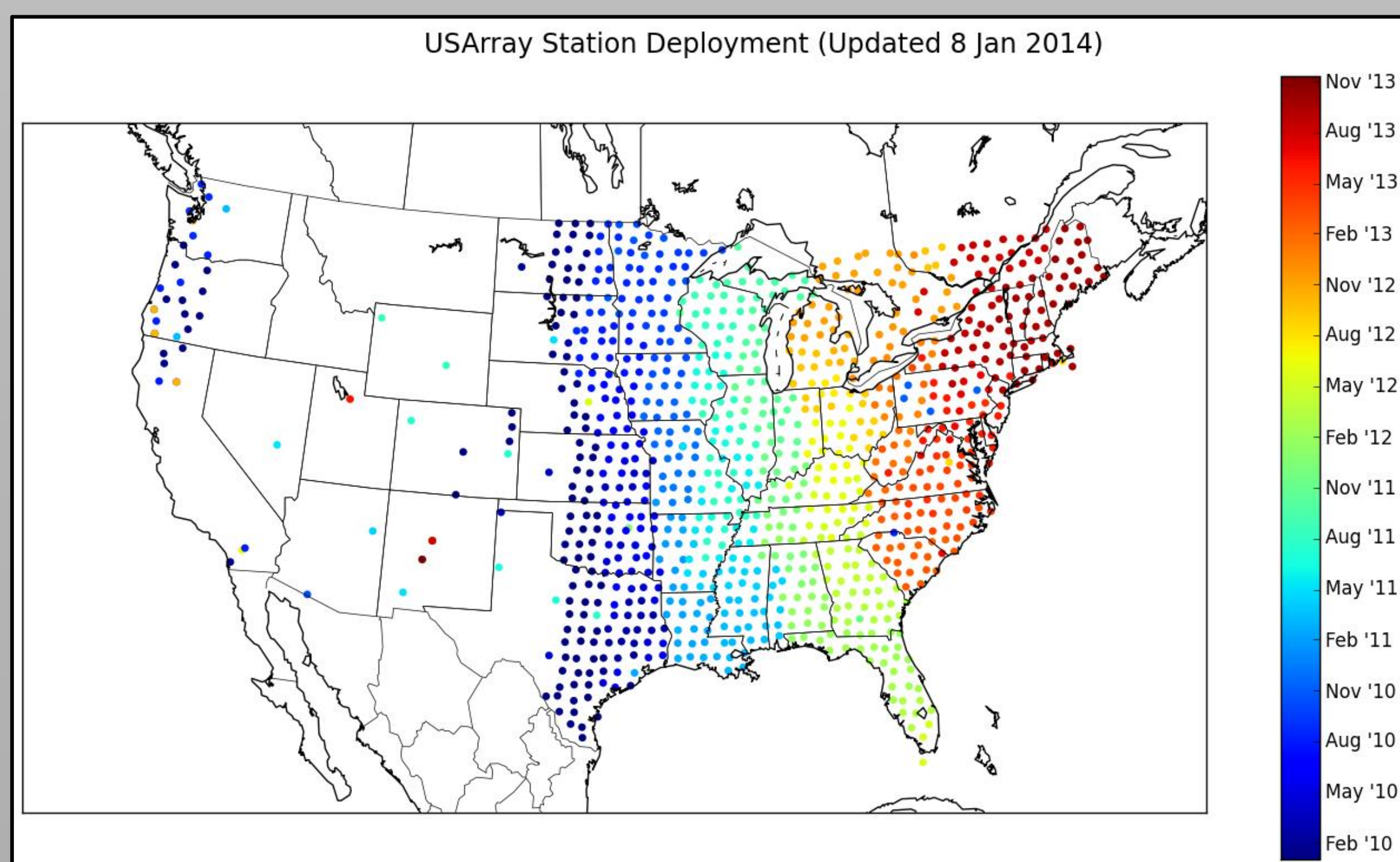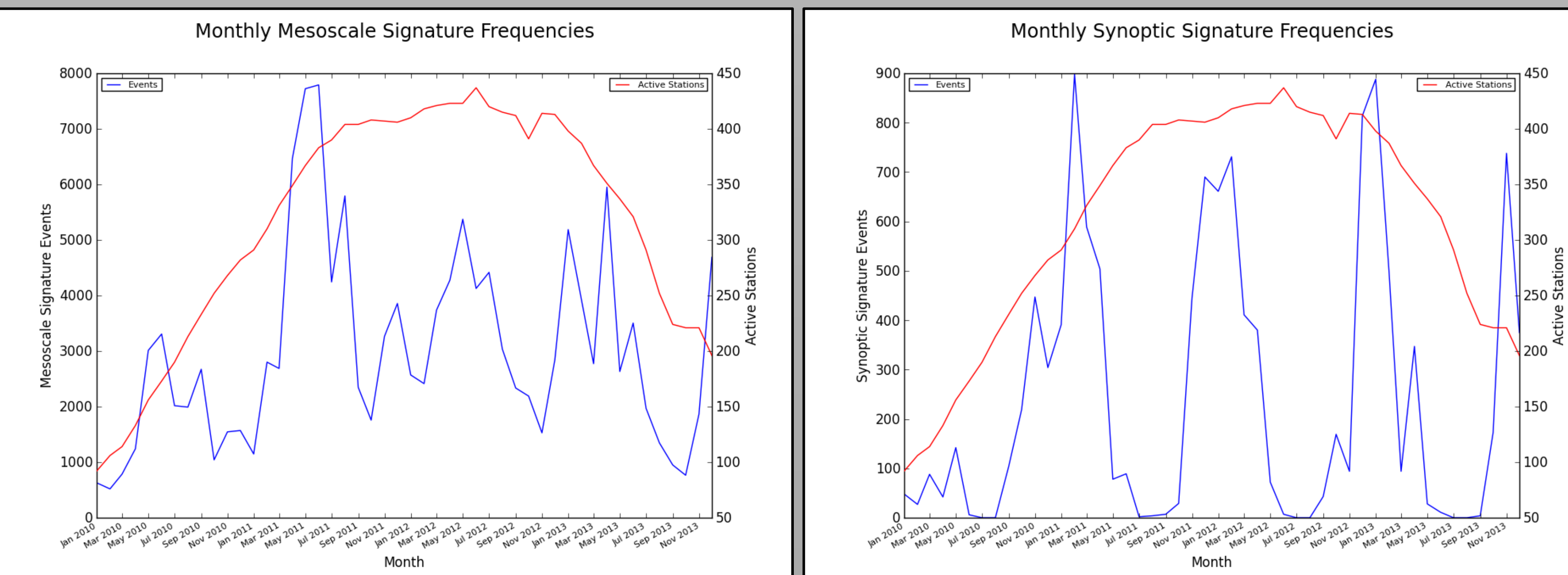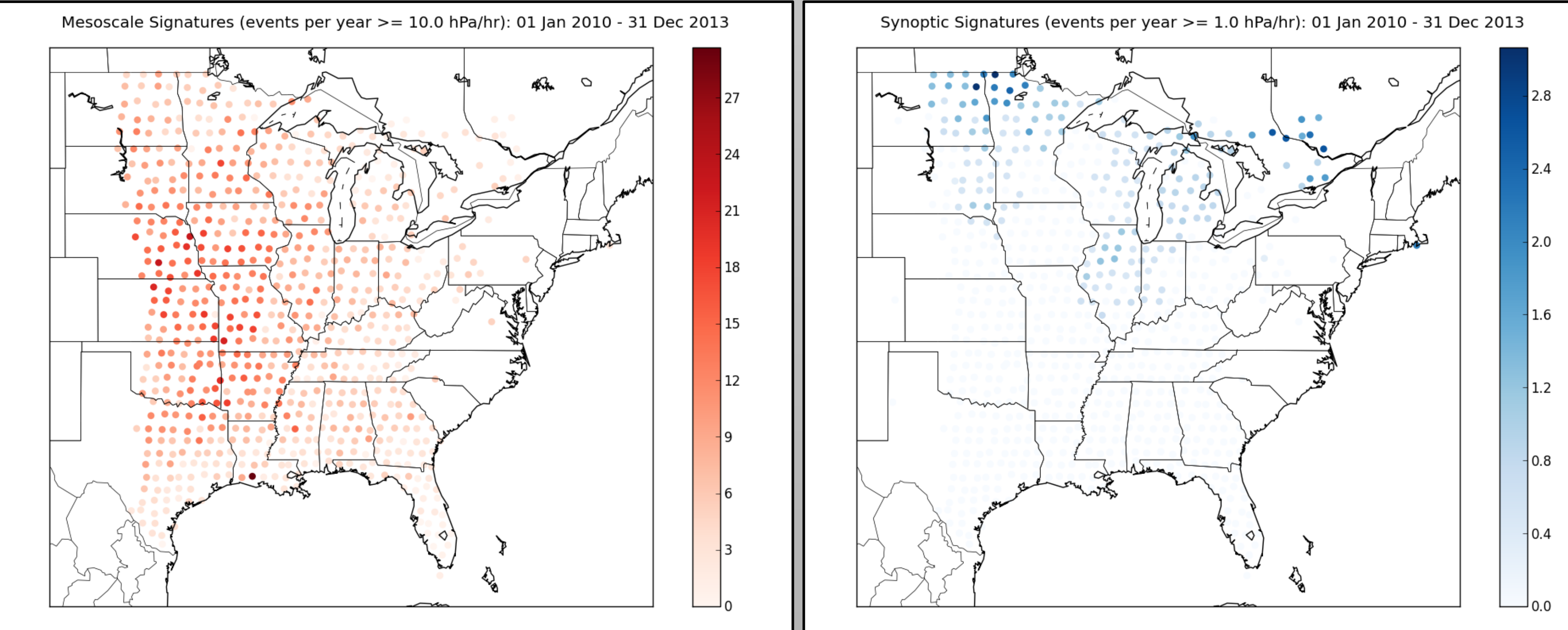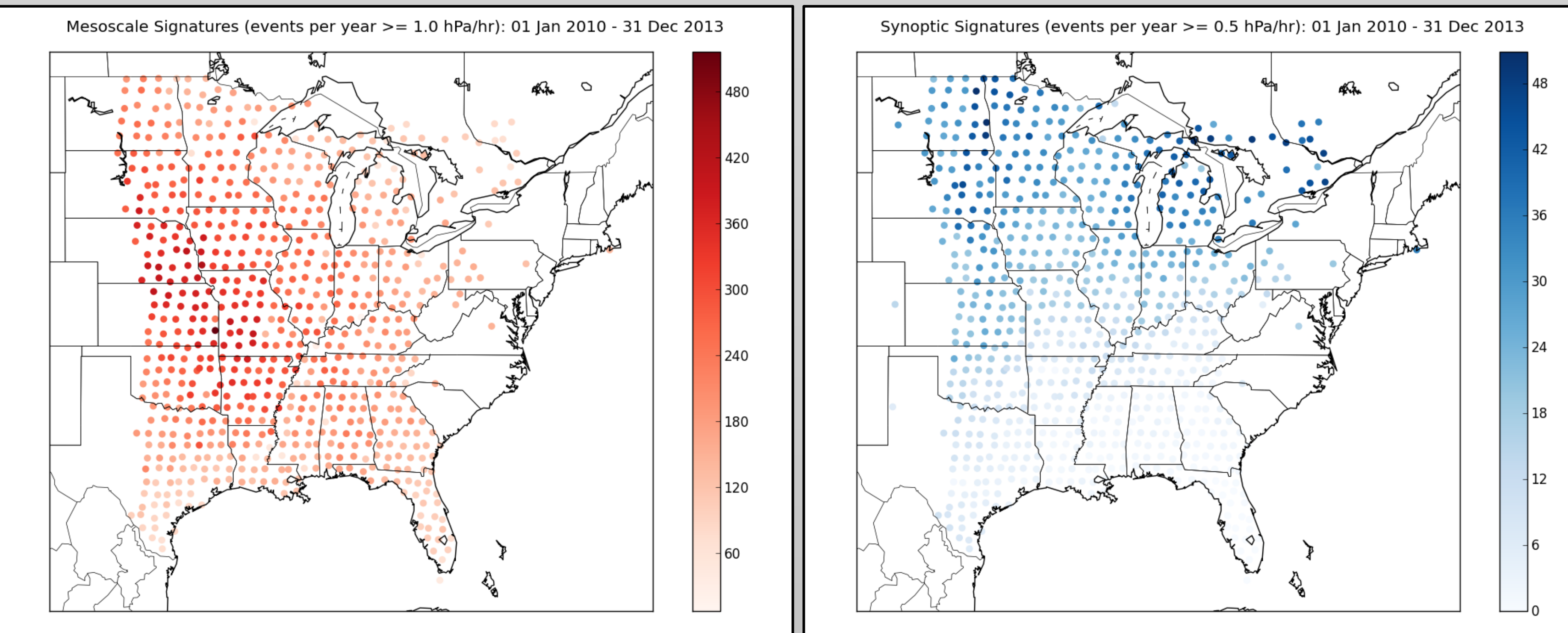
Data Storage and Quality Control

- Data stored in compressed HDF5 format via PyTables
- QC/QA Procedures applied to identify missing and spurious data periods (e.g. large discrete pressure fluctuations)
- Quantitative Statistics from 1 Jan 2010 – 31 Dec 2013
  - Individual observations collected: **46,086,051,637**
  - Average station uptime: **98.29%**
  - Average station data retainment (post-QC): **96.48%**
  - Disk space consumed by time-series archive: **~58 GB**

For more information, please attend the following presentation:
Paper 2.4: Using Python to Store, Display, and Analyze Pressure Observations from Earthscope's USArray Network
4th Python Symposium – Monday 2/3/14 at 5:00 PM Rm. C302

Pressure Signature Detection Algorithm

1) Acquire pressure time series for a station and downsample to 1 observation per minute (faster speed)
2) Compute perturbation time series by executing 2nd-order Butterworth band-pass filters on sampled data
   a. **Mesoscale Filtering:** retain wave periods between 10 minutes – 4 hours
   b. **Synoptic Scale Filtering:** retain wave periods between 30 hours – 5 days
3) Determine pressure signatures by identifying local extrema in the perturbation time series
4) Store all relevant information for each signature in PyTables HDF5 format

Frequency of Pressure Signature Events

Mesoscale Signatures (events per year >= 1.0 hPa/hr): 01 Jan 2010 - 31 Dec 2013

Synoptic Signatures (events per year >= 0.5 hPa/hr): 01 Jan 2010 - 31 Dec 2013

Mesoscale Signatures (events per year >= 10.0 hPa/hr): 01 Jan 2010 - 31 Dec 2013

Synoptic Signatures (events per year >= 1.0 hPa/hr): 01 Jan 2010 - 31 Dec 2013

Monthly Mesoscale Signature Frequencies

Monthly Synoptic Signature Frequencies

- Majority of strong mesoscale events located in the central latitudes of the CONUS
  - Maxima location consistent for varying choices of pressure rate magnitude (e.g. 1 versus 10 hPa/hr)
  - Maxima located over east-central Great Plains in part to strong convective year in 2011
- Frequency of strong synoptic events increases with latitude
- Occurrence of synoptic events exceeding 24 hPa/day (1 hPa/hr) relatively small over region studied
- Strong seasonality in both mesoscale and synoptic event occurrences, coincident with active convective seasons and seasonal positioning of the polar jet stream

Extreme Event Examples

- 26-27 Jun 2011 MCS Event
- 300+ Wind Damage Reports
- Station O37A: 8.33 hPa rise in 13 minutes (38.45 hPa/hr)

Valid: 2011-06-27 04:20 UTC
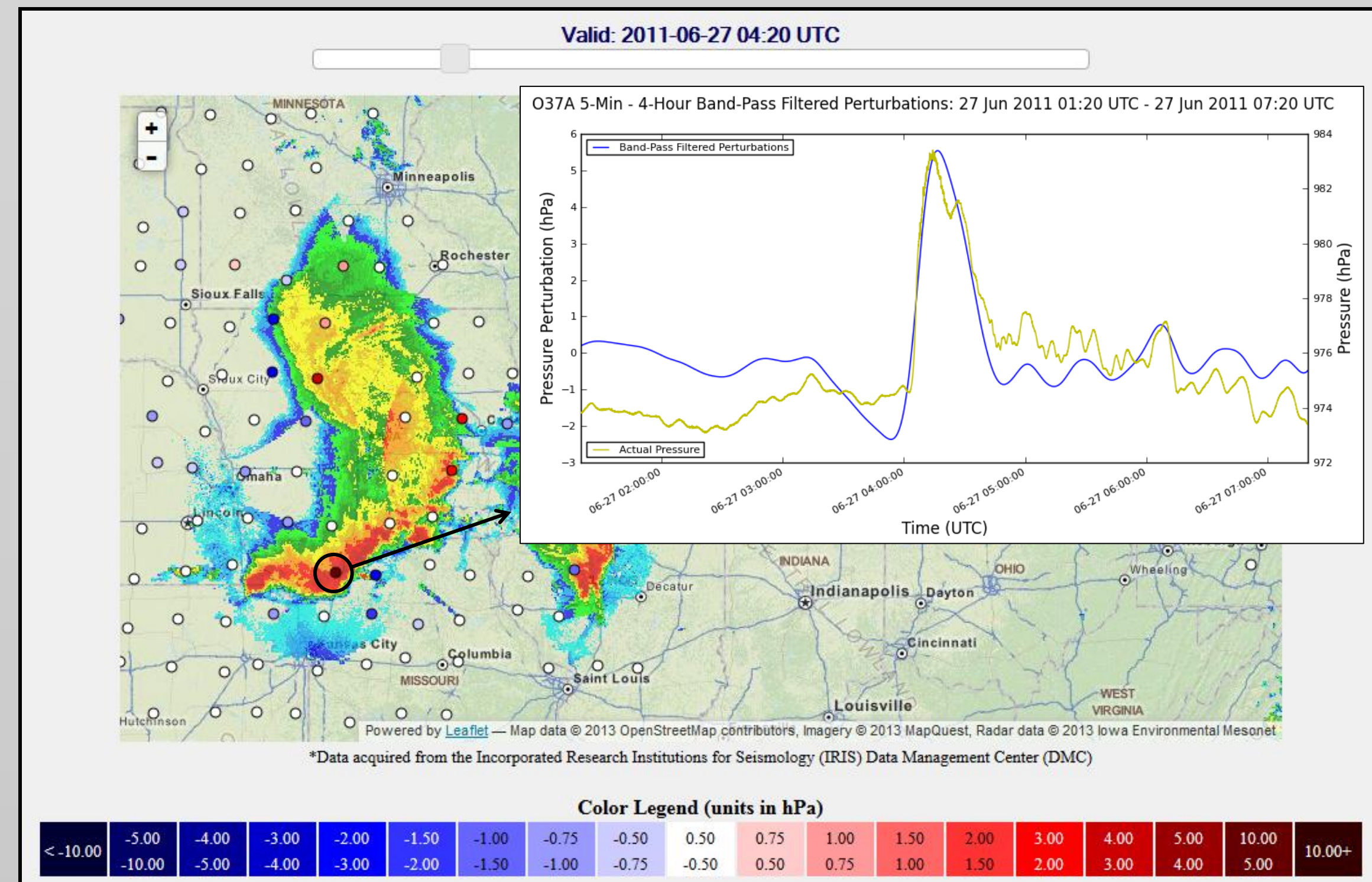
- 19-20 Dec 2012 Midwest Blizzard
- Numerous stations indicated pressure tendencies greater than 1 hPa/hr ahead of the strengthening system

Valid: 2012-12-20 11:20 UTC
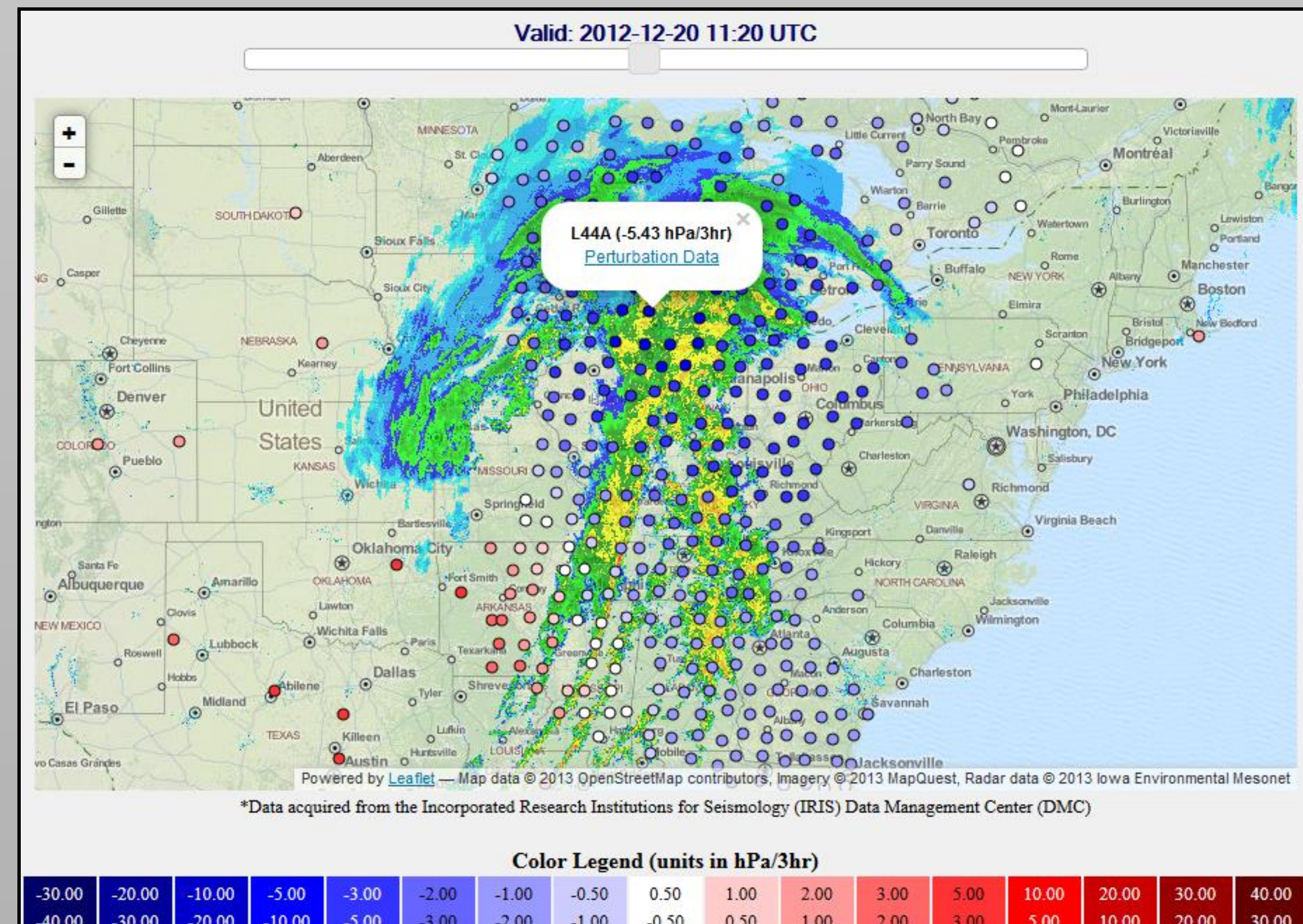
Future Work

- Continue active research, archival, and dissemination of real-time pressure data to MesoWest/MADIS
- Continue perturbation frequency analyses for stations along the east coast that were installed in mid to late 2013
- Develop and conduct methods to analyze perturbation pressure gradients from real-time and archived data
- Continue development of web interface to visualize results

Acknowledgements