Dynamic and Statistical Analyses of Alaskan Surface Pressure Perturbations Using the USArray Network

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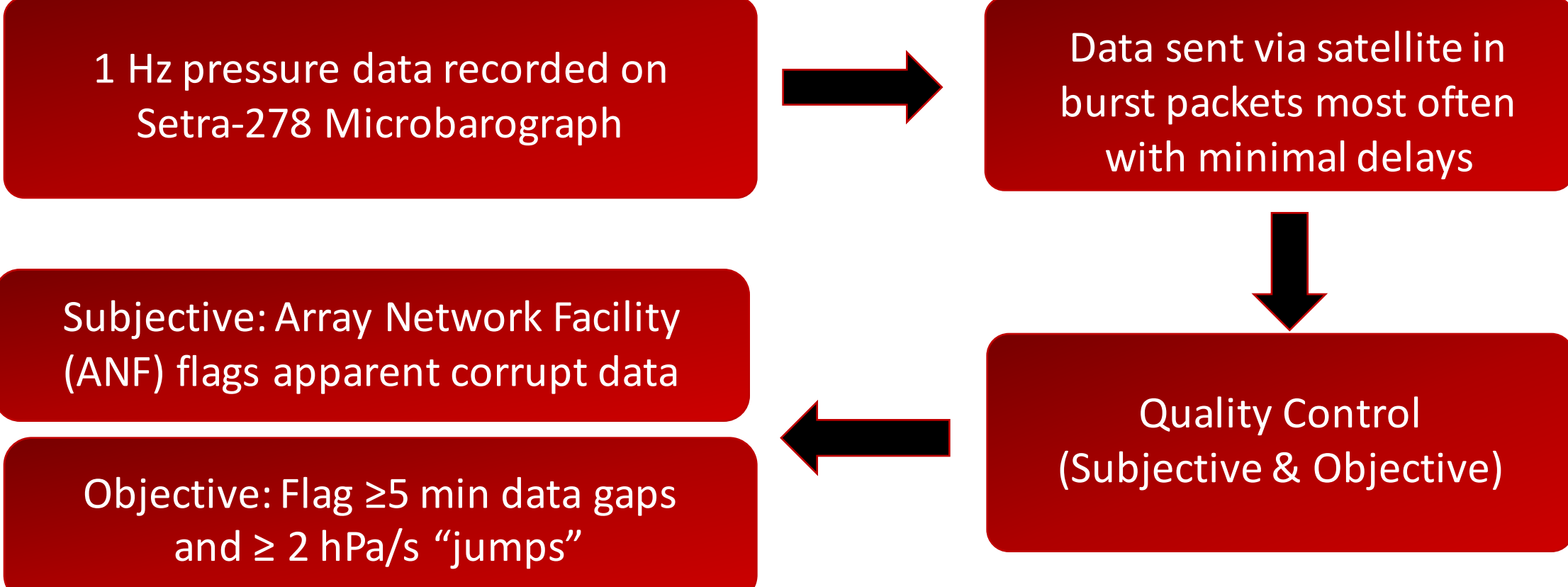
Background and Motivation

- The USArray is a component of the National Science Foundation's EarthScope Initiative; a platform for high-resolution monitoring of seismic activity
  - Atmospheric pressure sensors added to the USArray have been shown by Jacques et al. (2015, 2016) and Tytell et al. (2016) to provide unique high frequency (1 Hz) observations of atmospheric phenomena in eastern CONUS
- USArray instrumentation now being redeployed in Alaska/Yukon through the year 2018 that will lead to several years of high temporal resolution pressure data in **undersampled** areas of **high-latitiude, complex terrain**.

Goal:
1. Determine the frequency and causes of large pressure perturbations across Alaska on multiple temporal scales
2. Focus specifically on common phenomena such as gravity wave and downslope wind events
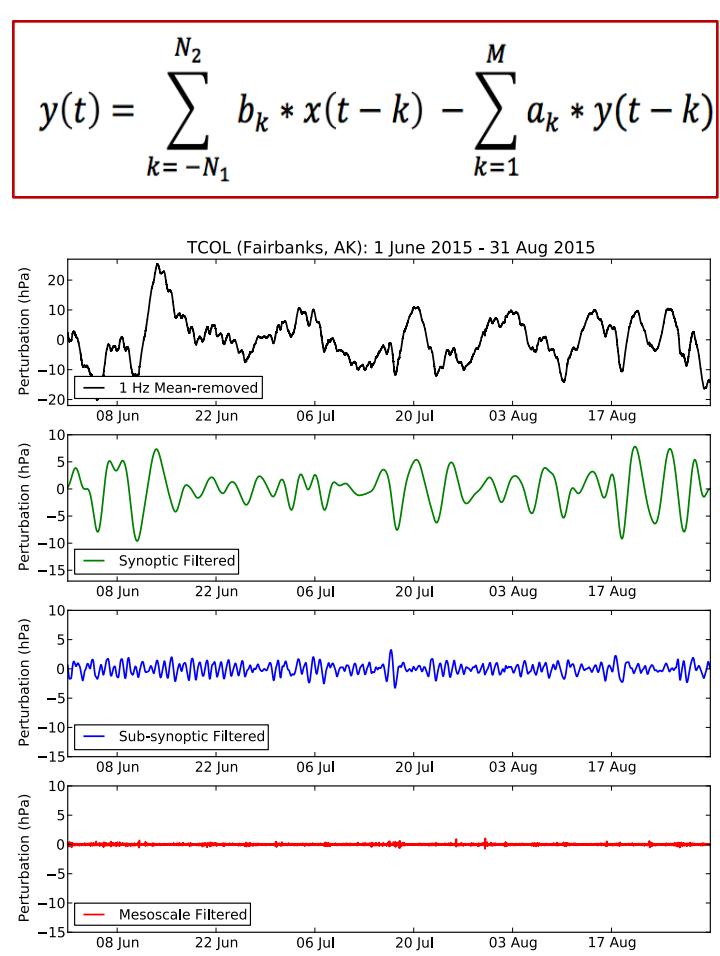
Data and Methodology
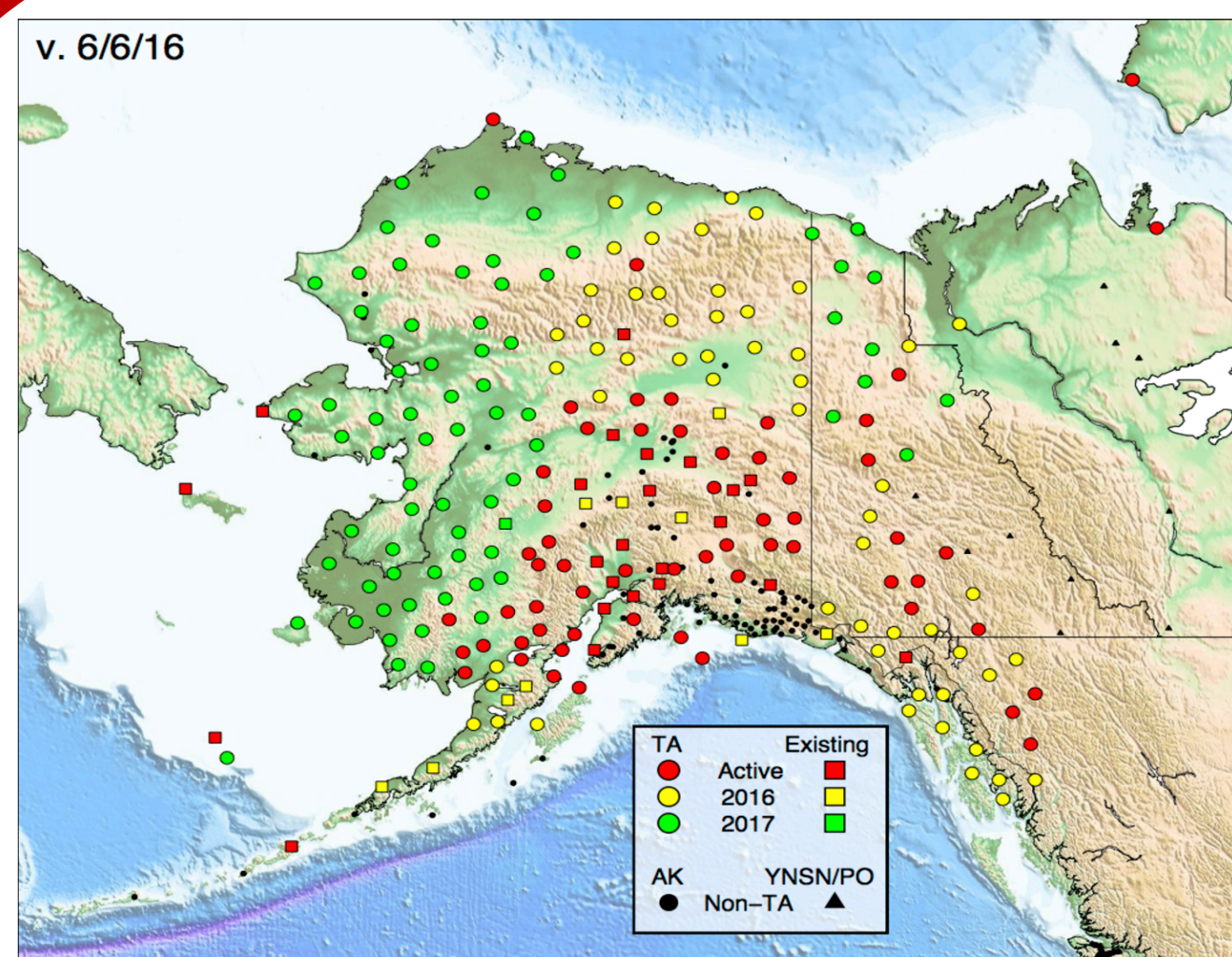
Projected station deployment schedule and locations for USArray Alaska's Transportable Array, denoted by circles on the map.

Image: usarray.org

1 Hz pressure data recorded on Setra-278 Microbarograph → Data sent via satellite in burst packets most often with minimal delays

Subjective: Array Network Facility (ANF) flags apparent corrupt data

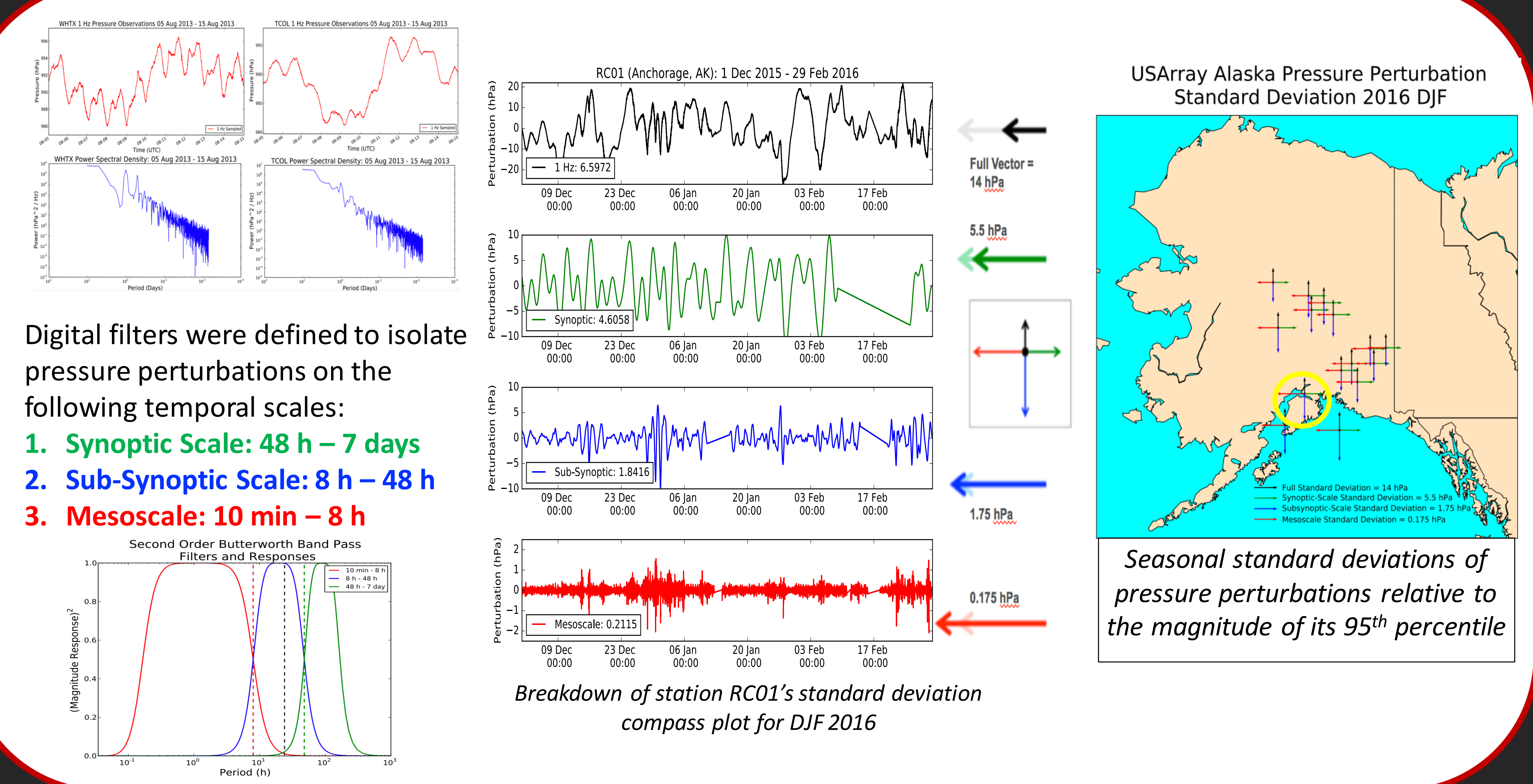Objective: Flag ≥5 min data gaps and ≥ 2 hPa/s "jumps" ← Quality Control (Subjective & Objective)

QC'd data are down-sampled and processed using a second-order Butterworth (digital) bandpass filter in order to isolate pressure perturbation signals.
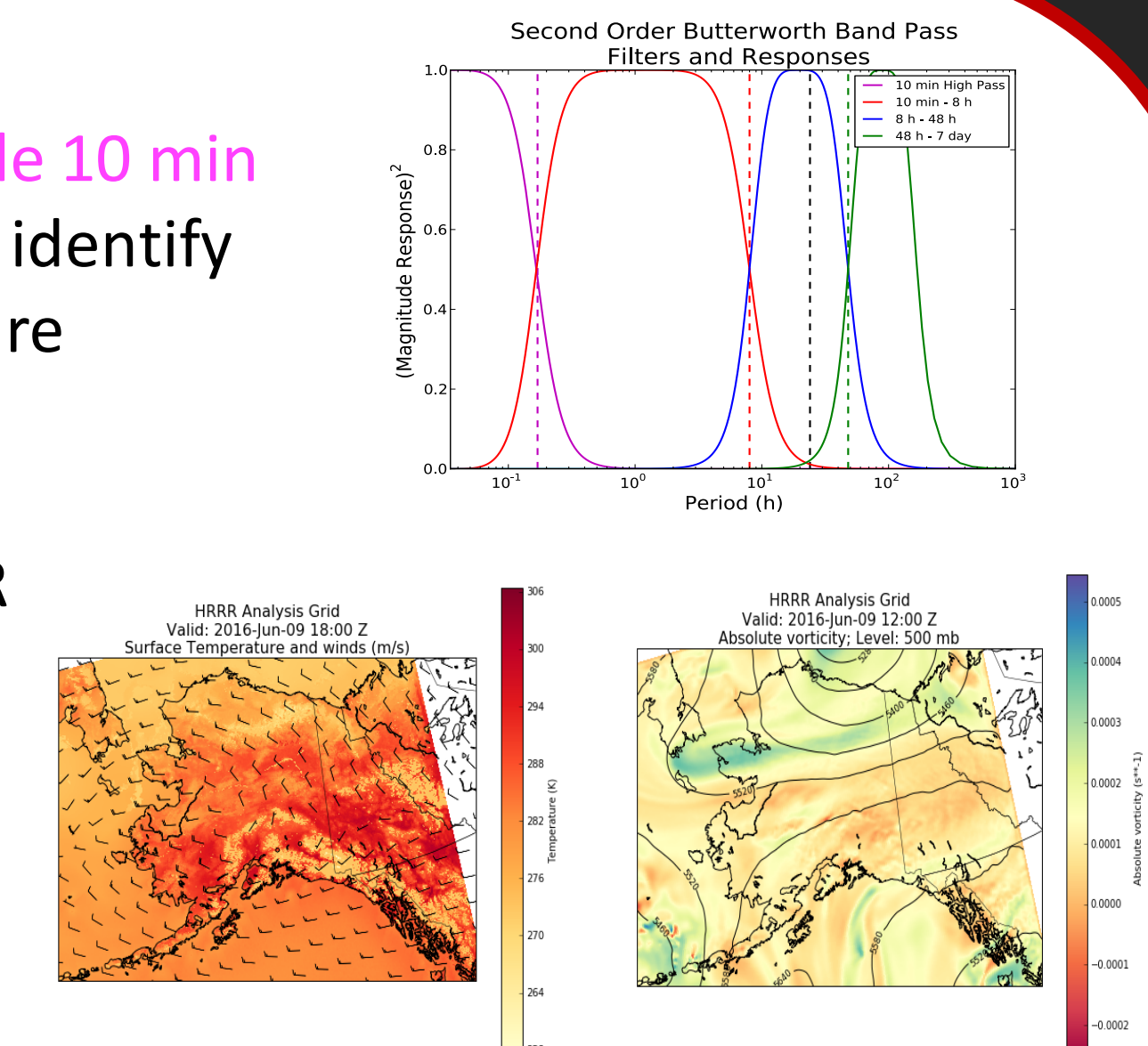
$$y(t) = \sum_{k=N_1} b_k * x(t-k) - \sum_{k=1}^{M} a_k * y(t-k)$$

Archived data through 2015 available via:
http://rda.ucar.edu/datasets/ds386.0/

Real time data available at:
http://meso1.chpc.utah.edu/usarray/

Results: Statistical Analyses

Digital filters were defined to isolate pressure perturbations on the following temporal scales:
1. **Synoptic Scale: 48 h – 7 days**
2. **Sub-Synoptic Scale: 8 h – 48 h**
3. **Mesoscale: 10 min – 8 h**

Full Vector = 14 hPa
5.5 hPa
1.75 hPa
0.175 hPa

USArray Alaska Pressure Perturbation Standard Deviation 2016 DJF

Seasonal standard deviations of pressure perturbations relative to the magnitude of its 95th percentile

Breakdown of station RC01's standard deviation compass plot for DJF 2016

Results: Case Study – 30 December, 2015

Downslope Wind Event – Anchorage, Alaska

RC01 (Anchorage, AK)	December 30 12 Z December 31 00 Z
ΔP = P@Anchorage – P@Cordova	13.2 mb 7.11 mb
850 mb mean wind speed and dir	12 m/s; 135° 16 m/s; 145°
Stability: 700-850 mb	3.1° C/km 7.5° C/km
Stability: 500-700 mb	3.1° C/km 7.5° C/km

Event met criteria specified by NWS Anchorage for downslope winds. A station at McHugh Creek recorded a wind gust of 98 mph at 5:10 am (14:10 UTC), as well as a 91 mph report near Golden View Middle School at 6:01 am (15:01 UTC). Both are located in Anchorage.

USArray Alaska – Date of first data received

Chinook Wind Event – Tanana Valley, Alaska

- Sub-synoptic perturbation coincided with pressure drop.
- Low to mid-level veering winds from the SSE to SSW off the Alaska range.
- Above normal temperatures with southerly wind.
- Low relative humidity.
- Stable layer at crest level.

- Simultaneous events reflected by sub-synoptic perturbations at nearby USArray stations.

Time series data obtained from MesoWest

Ongoing Work

1. Implement a **microscale 10 min** high pass filter to help identify mountain wave pressure features

2. Use Experimental HRRR Alaska analysis and forecasts grids for case studies and to initialize WRF simulations of particular events

Jacques, A. A., J. D. Horel, E. T. Crosman, and F. L. Vernon, 2015: Central and Eastern US Surface Pressure Variations Derived from the USArray Network *Mon. Wea. Rev.*, **143**, 1472-1493.

Jacques, A. A., J. D. Horel, E. T. Crosman, F. L. Vernon, and J. Tytell, 2016: The Earthscope US Transportable Array 1 Hz Surface Pressure Dataset. *In press: Geoscience Data Journal*.

Tytell, J., F. Vernon, M. Hedlin, C. de Groot Hedlin, J. Reyes, B. Busby, K. Hafner, and J. Eakins, 2016: The USArray Transportable Array as a Platform for Weather Observation and Research. *Bull. Amer. Meteor. Soc.*, **97**.