Recent Results from USArray TA

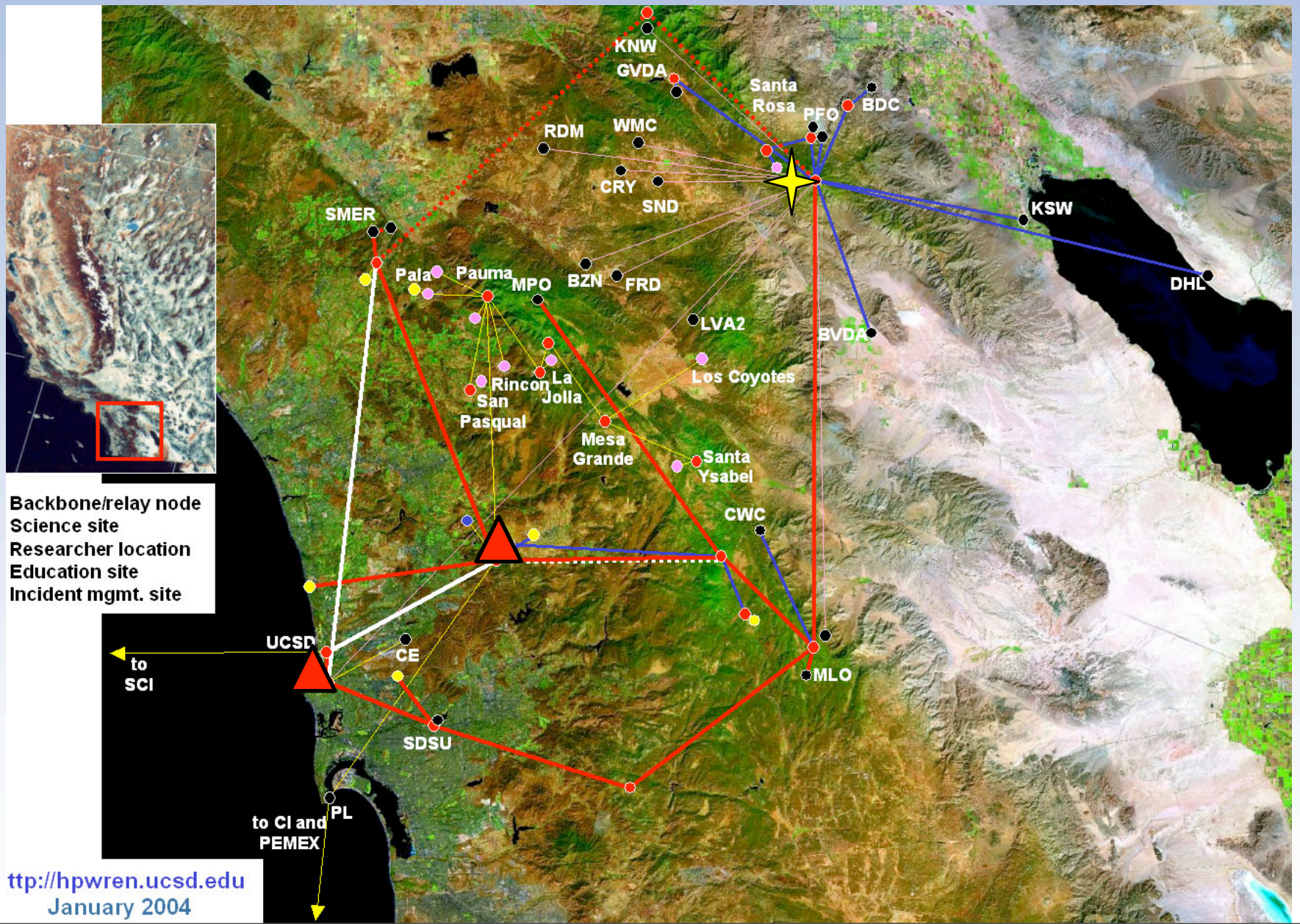
Frank Vernon

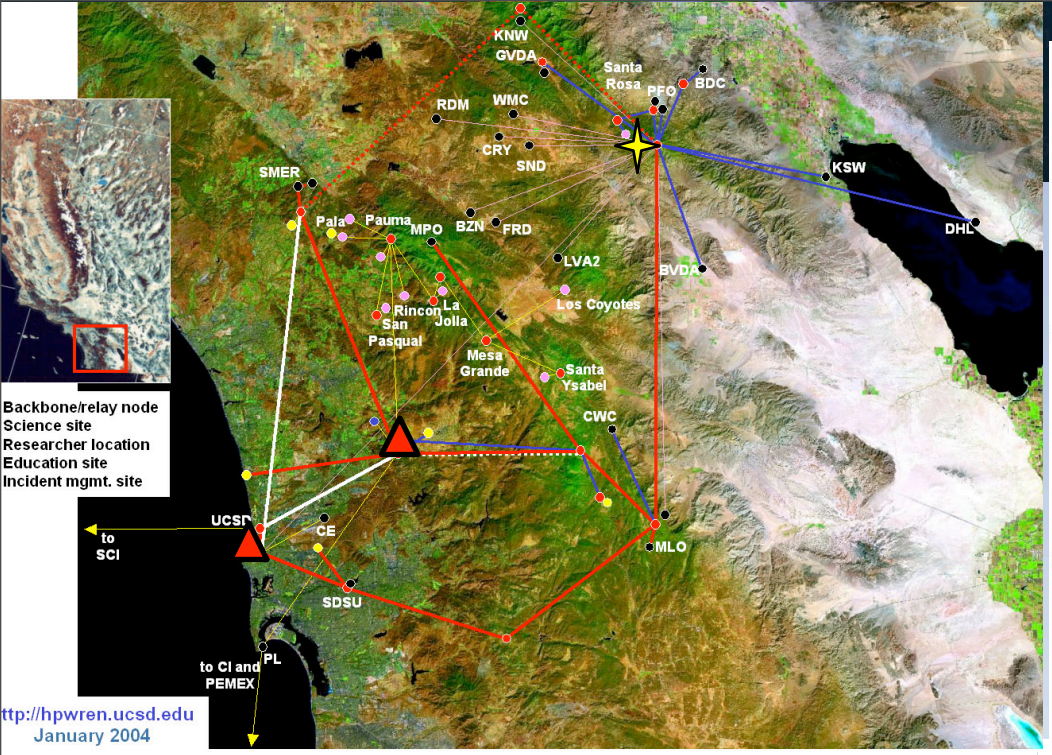
Quanterra/Antelope User Group Meeting

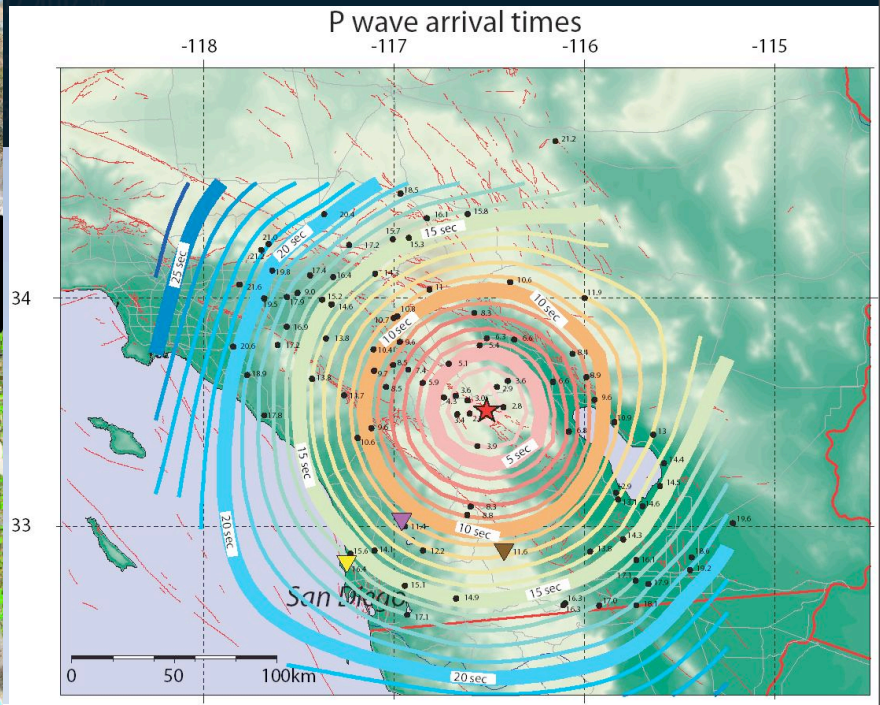
12 March 2009

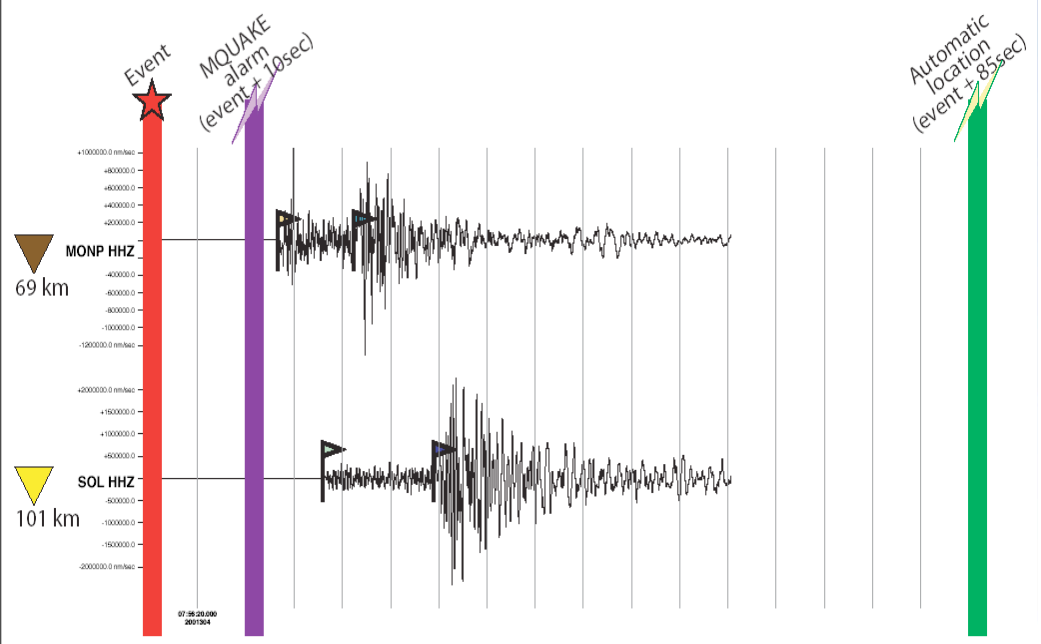
Data Latency Characteristics Observed by the EarthScope USArray Transportable Array

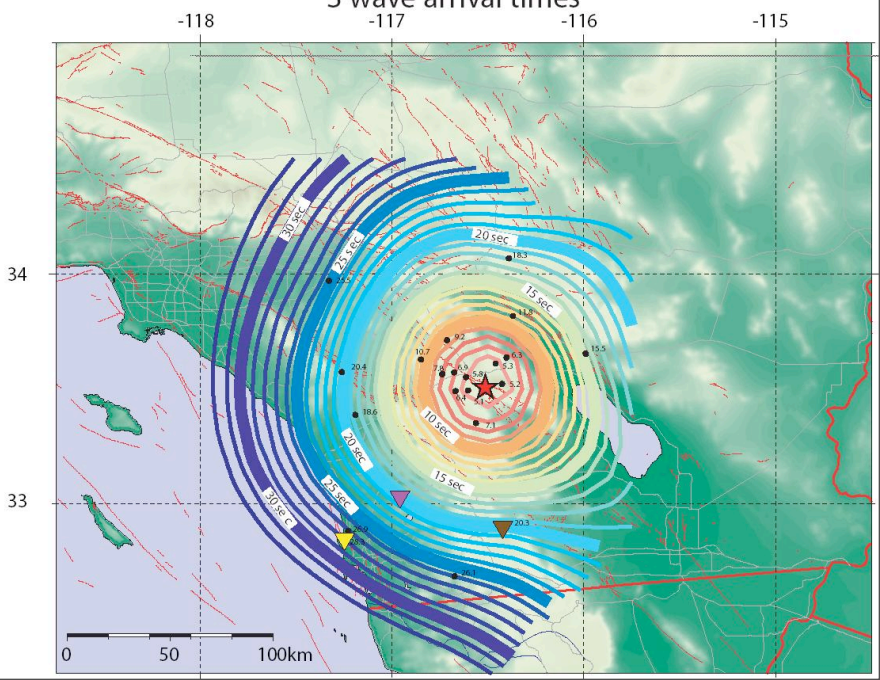
Early Warning




KNW
GVDA
Santa Rosa
PFO
BDC
RDM
WMC
CRY
SND
KSW
SMER
DHL
Pala
Pauma
MPO
BZN
FRD
LVA2
BVDA
Los Coyotes
Rincon
San Pasqual
La Jolla
Mesa Grande
Santa Ysabel
CWC
UCSD
to SCI
CE
MLO
SDSU
PL
to CI and PEMEX
Backbone/relay node
Science site
Researcher location
Education site
Incident mgmt. site
ttp://hpwren.ucsd.edu
January 2004


P wave arrival times
-118
-117
-116
-115
34
33
0
50
100km

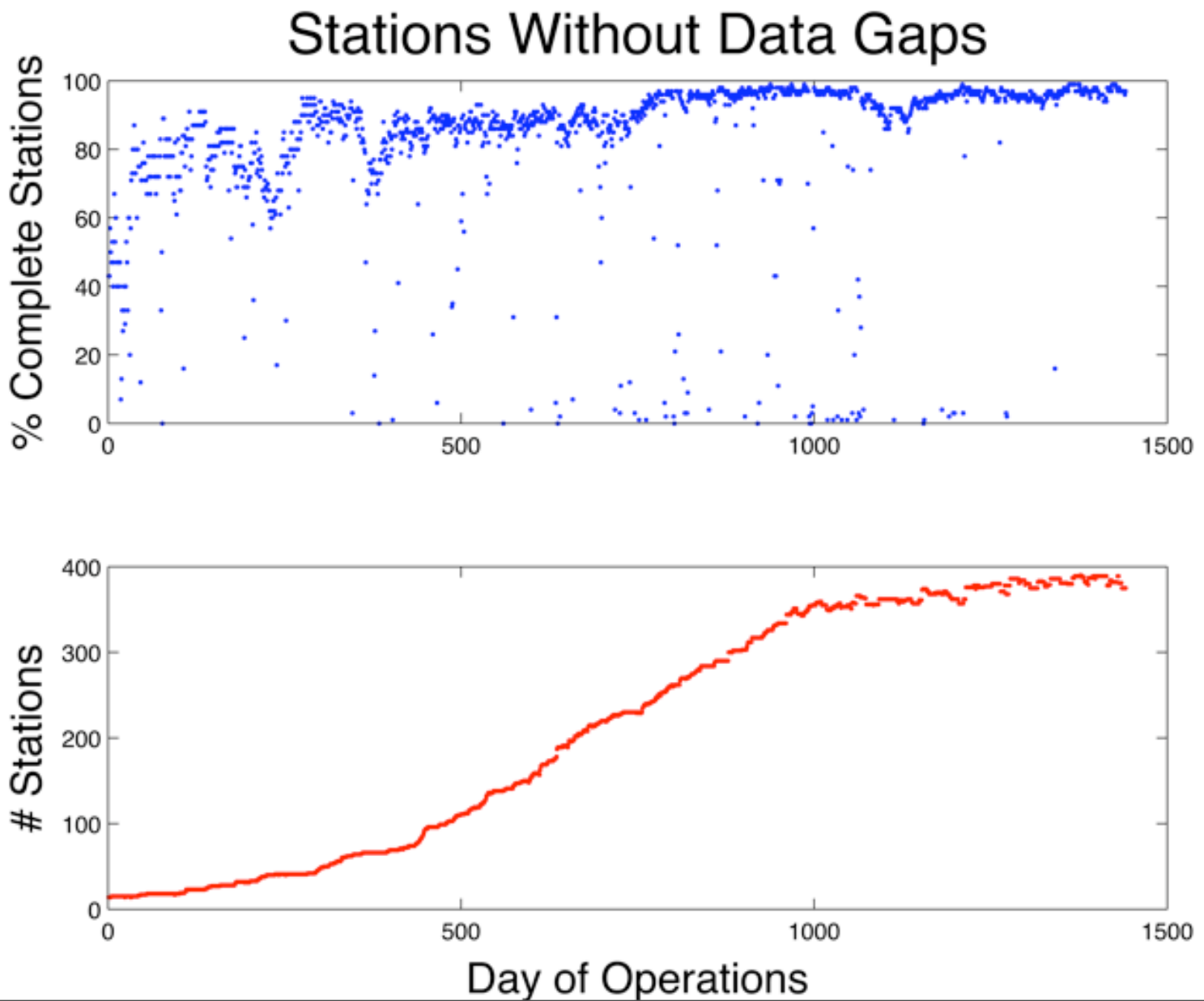

Event
MQUAKE alarm (event + 10sec)
Automatic location (event + 85sec)
MONP HHZ
69 km
SOL HHZ
101 km


S wave arrival times
-118
-117
-116
-115
34
33
0
50
100km

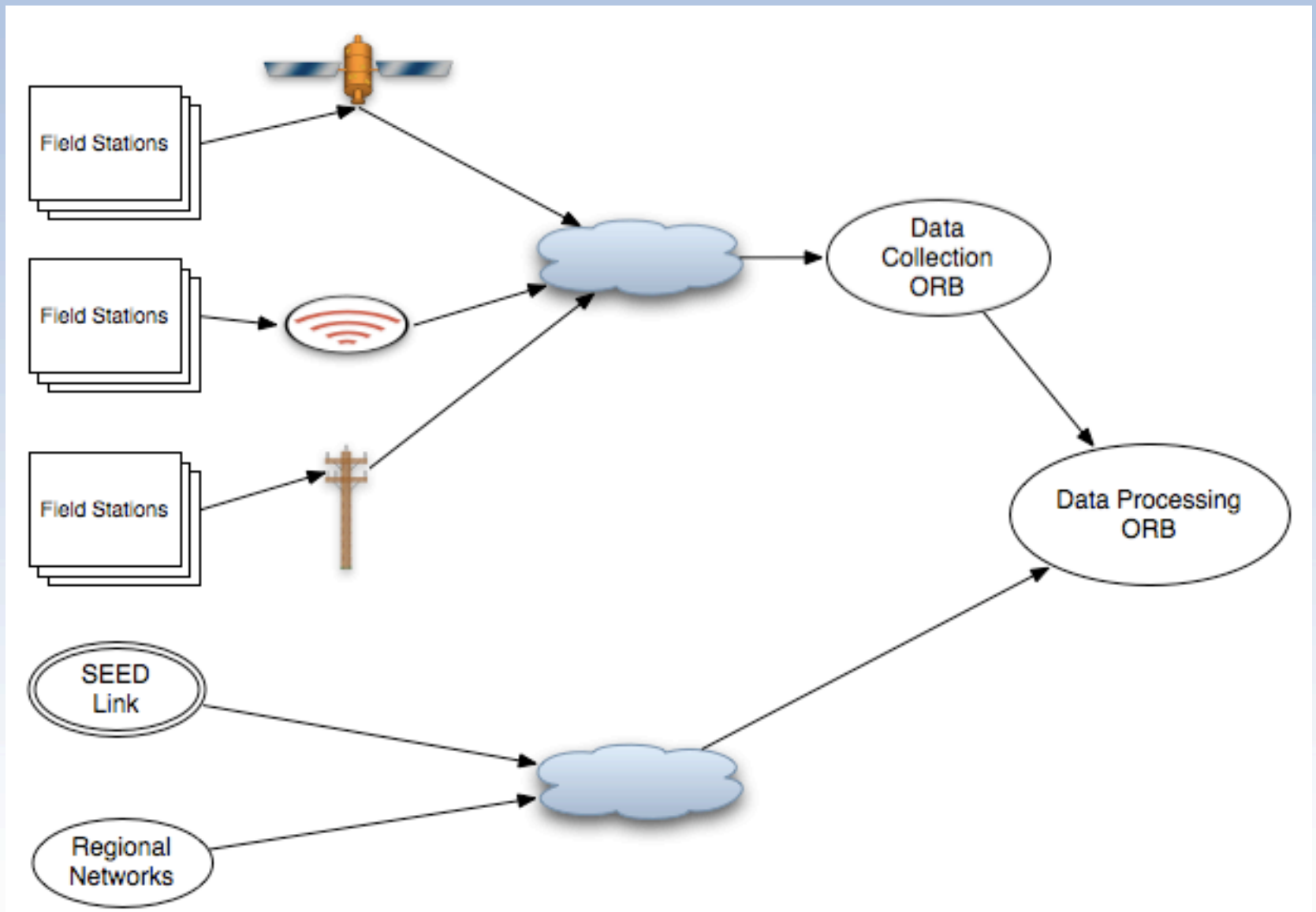
Essential Elements

- Quality of Data
  - Information Quality
    - Calibrated Waveforms
    - Accurate Parametric Data
  - Clock Quality
    - Location error
    - Warning accuracy
- Availability of Data
  - Completeness
    - Gaps in data
  - Latency

TA Gap Analysis



TA Data Flow


Field Stations
Field Stations
Field Stations
Data
Collection
ORB
Data Processing
ORB
SEED
Link
Regional
Networks

Modularity in Communications

- Cellular Modem
- AC VSAT or BB provider
- Solar VSAT

Communication Variety

- 44% Cell modems,
  - 80% Verizon (CDMA)
  - 20% Cingular EDGE (GPRS / GSM)
- 44% VSAT systems,
  - All Wild Blue
- 7% Broadband providors
  - 4 DSL, 1 Cable, 2 WiFi
- 6% Internet via Host
  - Usually research campus

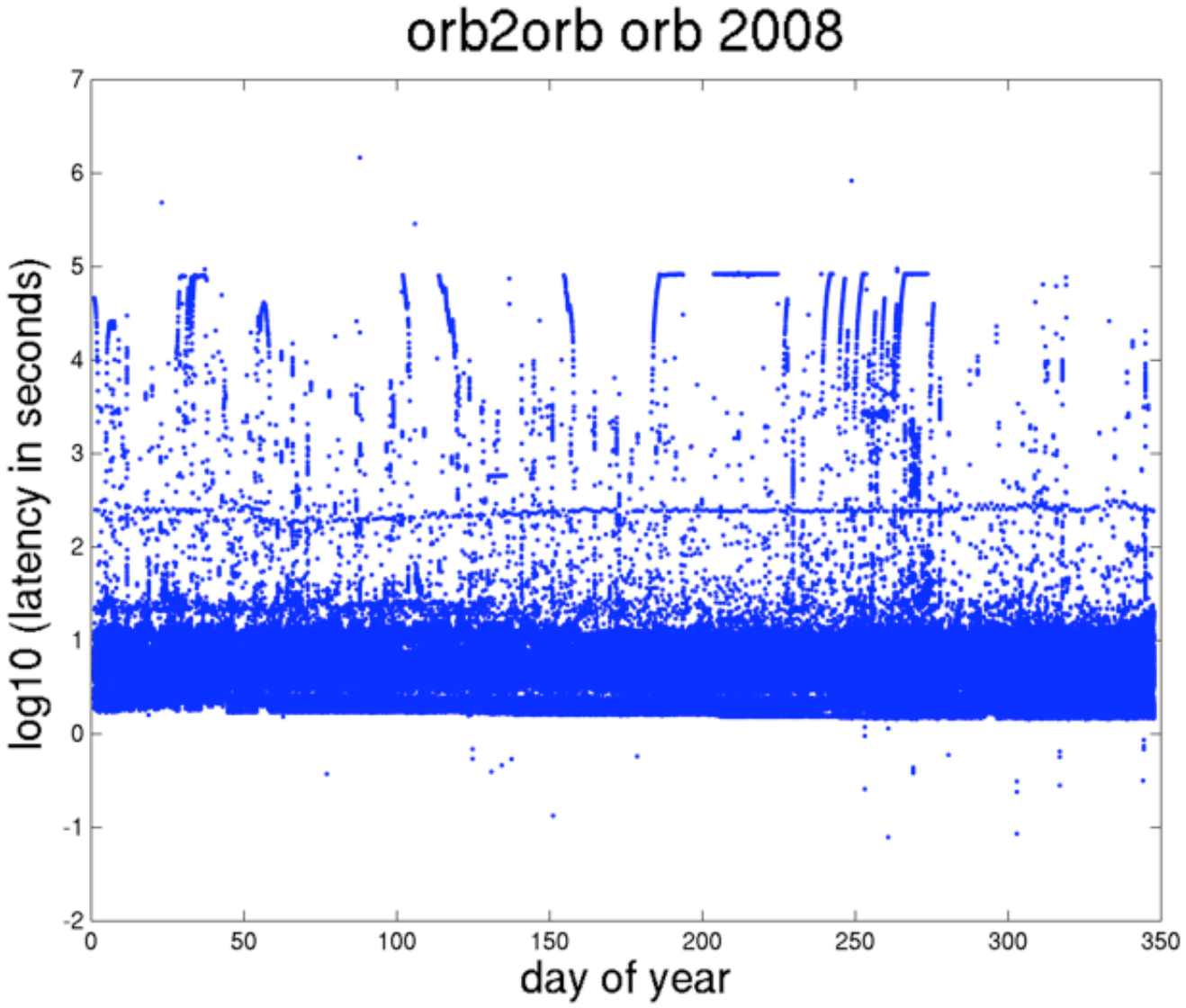
Latency Measurements

- Defined as the difference between the time of the last sample in a packet and the time the packet available
- Measurements interval
  - 2005 - 2007 May 11 5 minute intervals
  - 2007 May 11 - present Hourly
- Measurements
  - mean latency
  - minimum latency
  - maximum latency
  - standard deviation
- 78 10^6 Observations

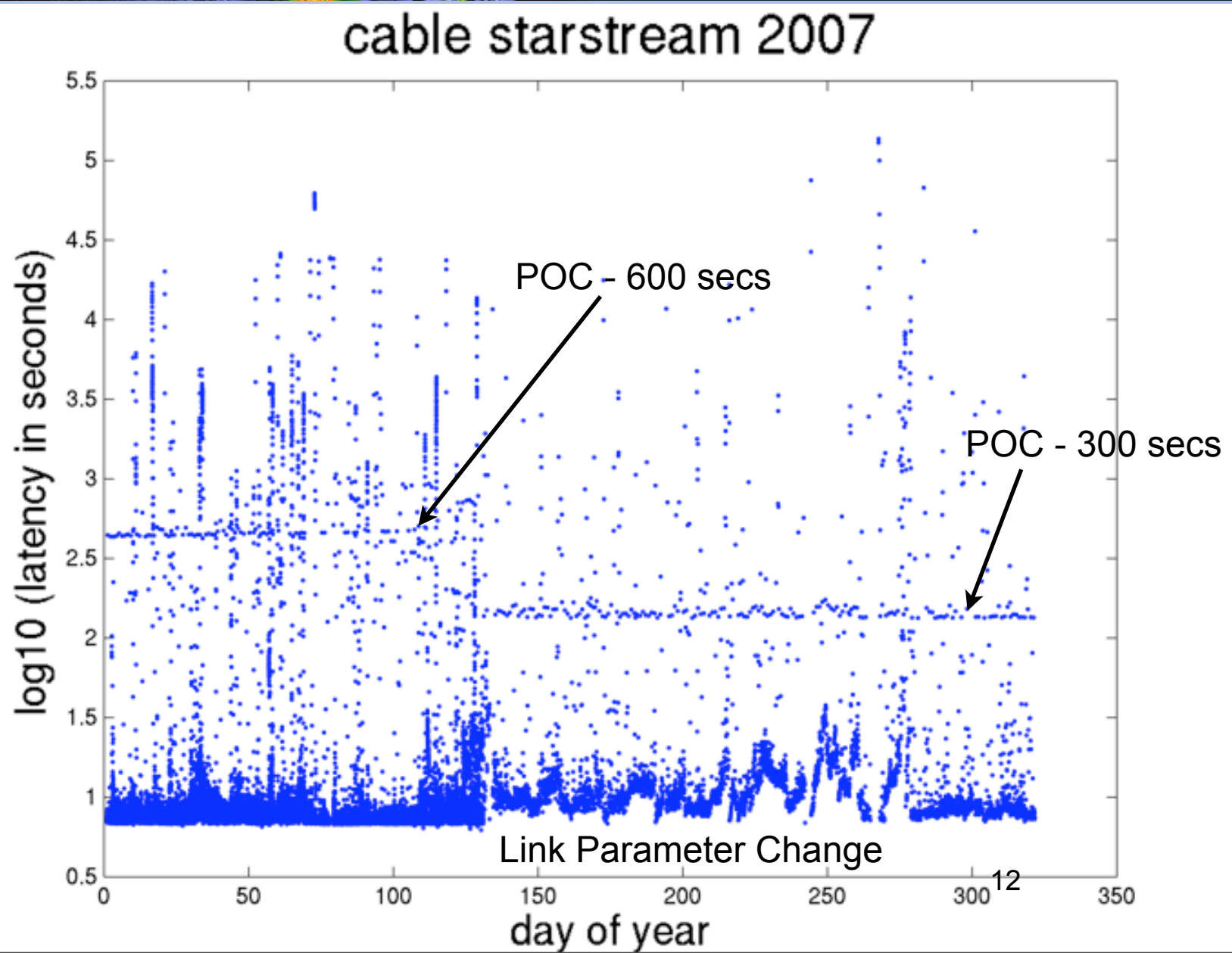
Status: RT Latency

Regional network contributed stations using orb2orb transport

Consistent over 4 years of operations

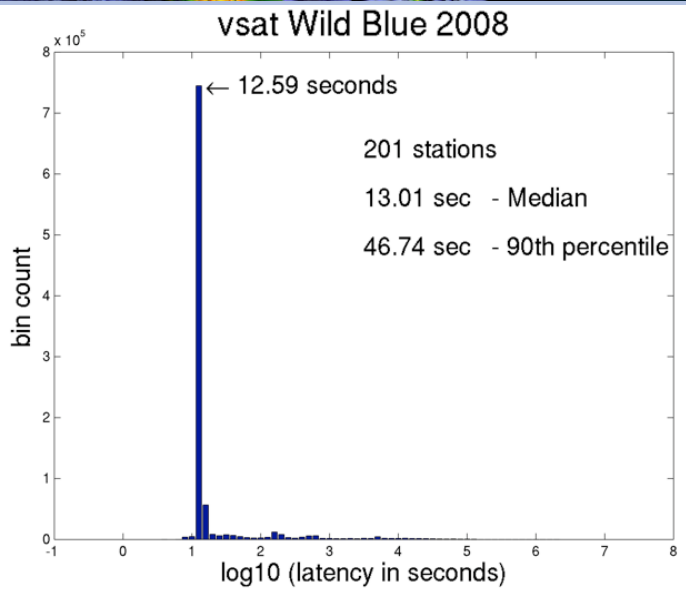


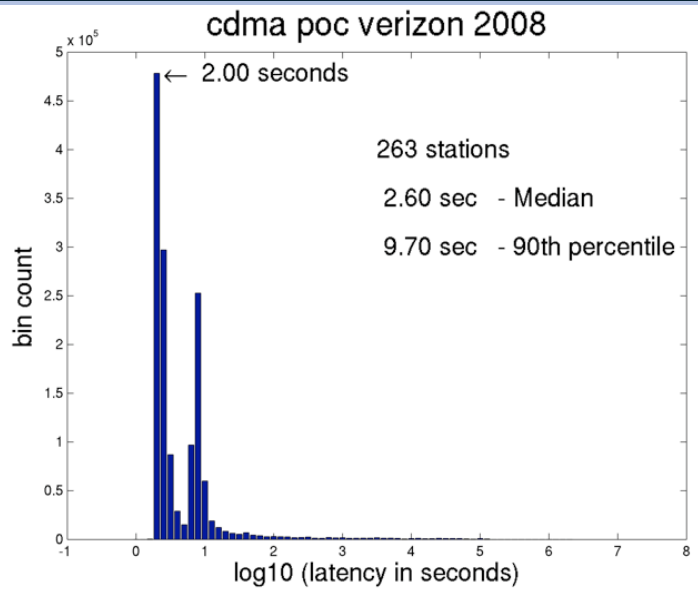
Status: RT Latency Mean

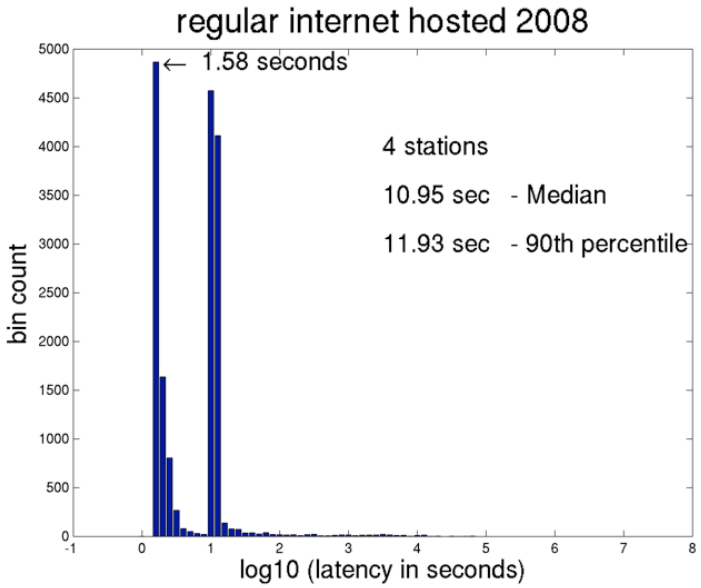


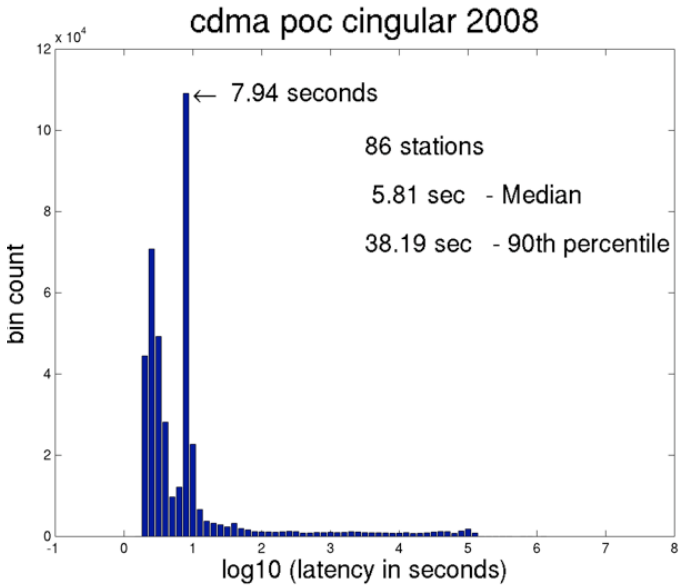
Status: RT Latency Mean

Direct datalogger connection



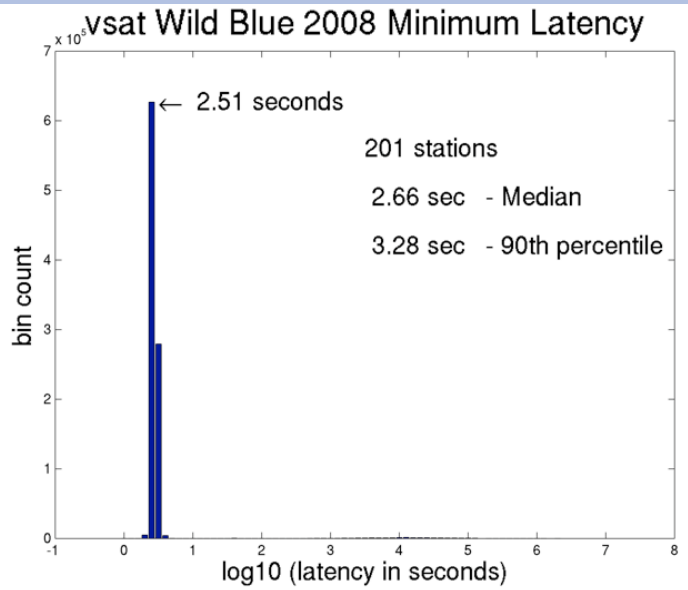


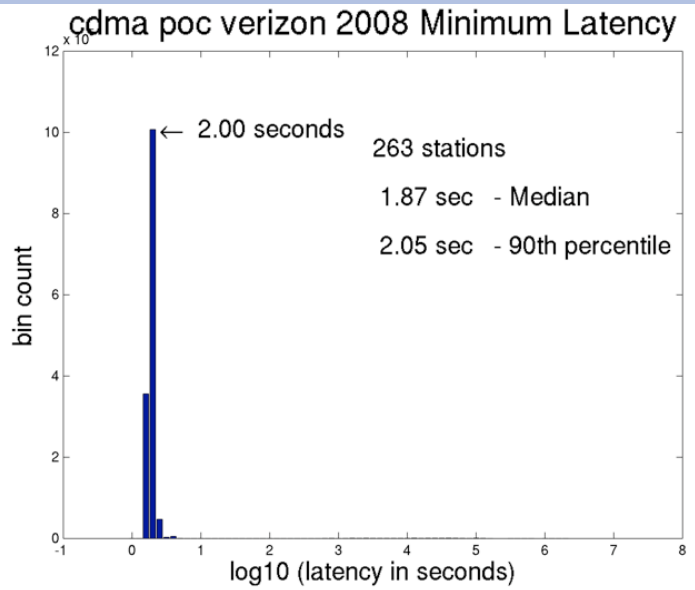


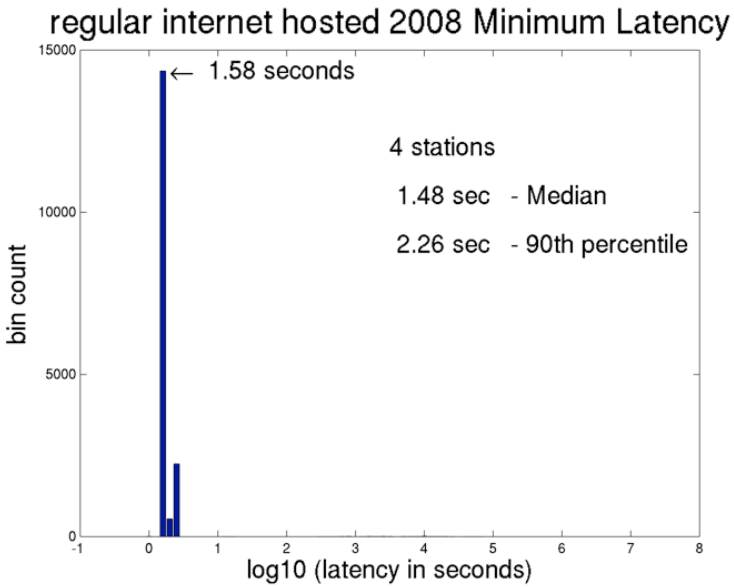


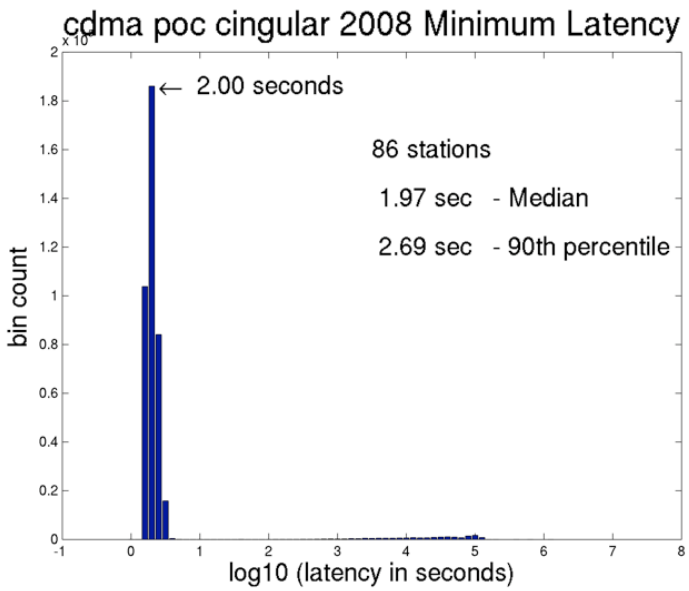
Status: RT Latency Min

Direct datalogger connection



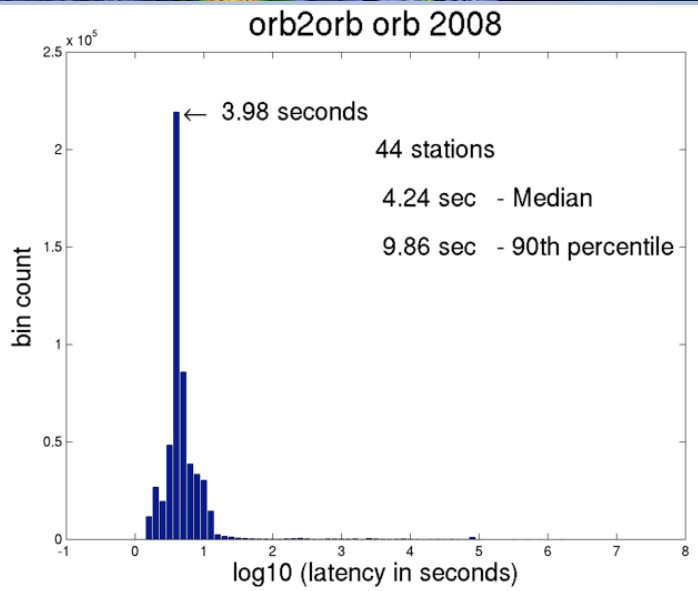


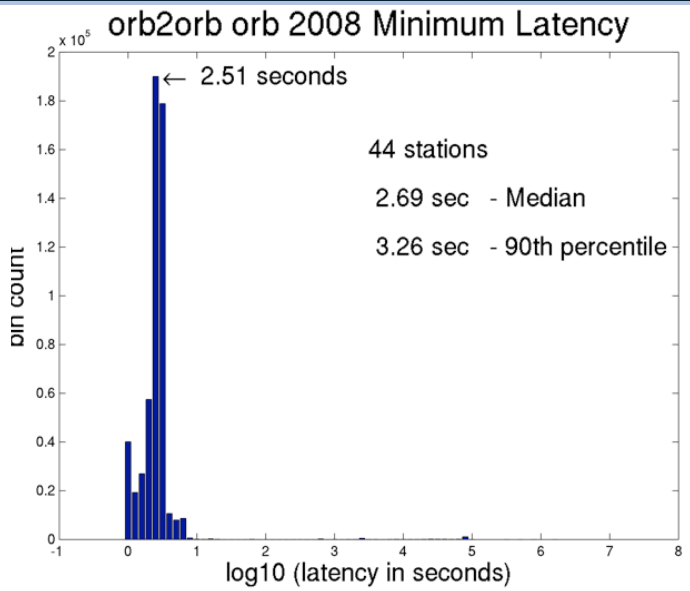


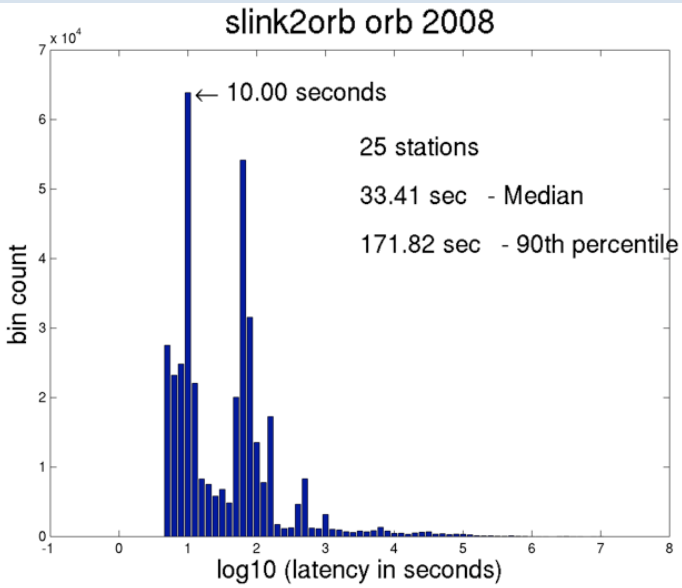


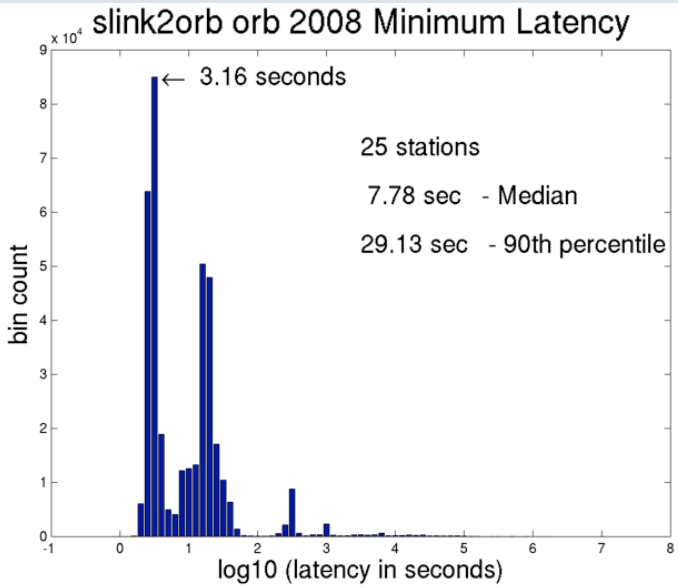
Status: RT Latency

Direct data server connection







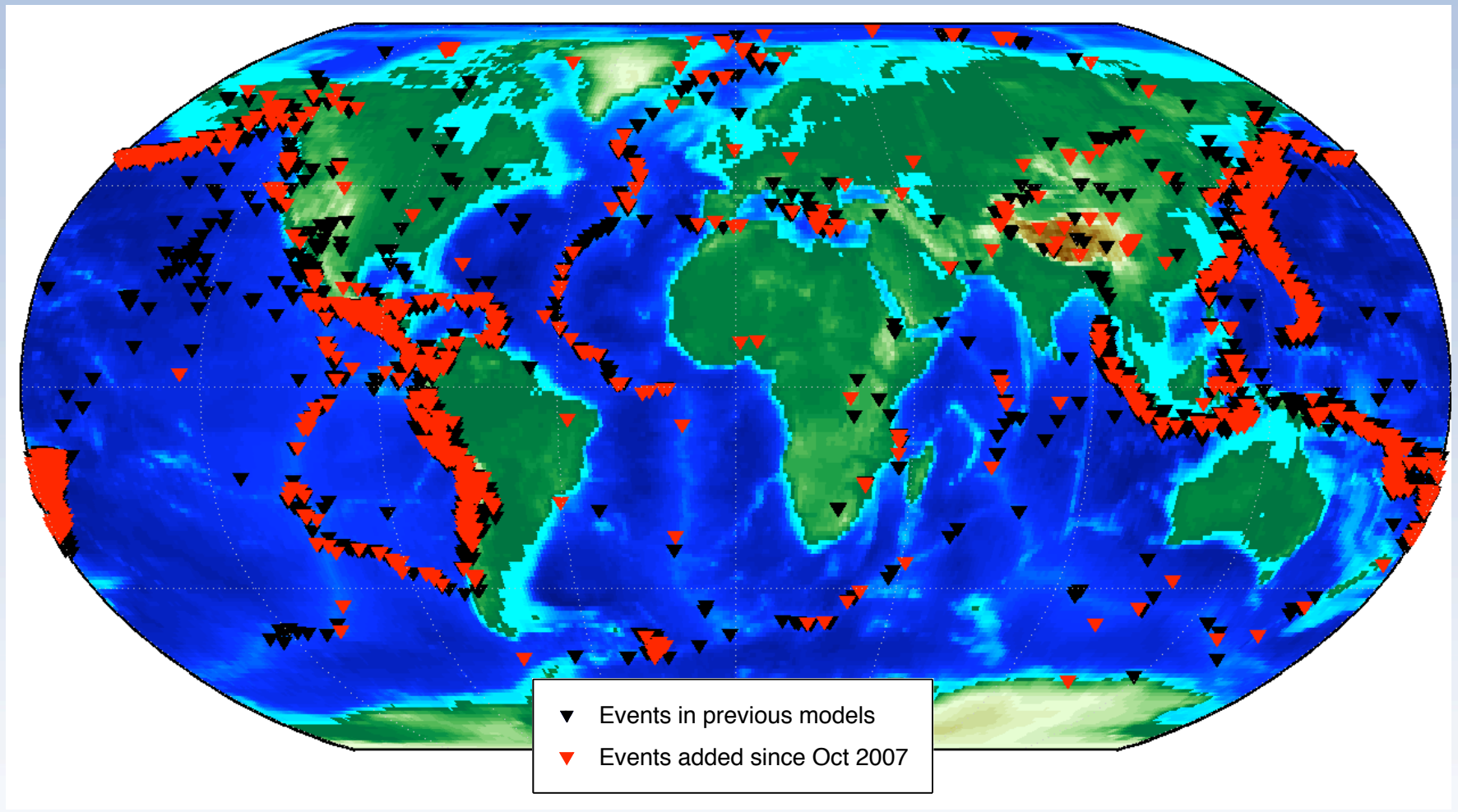


Conclusions

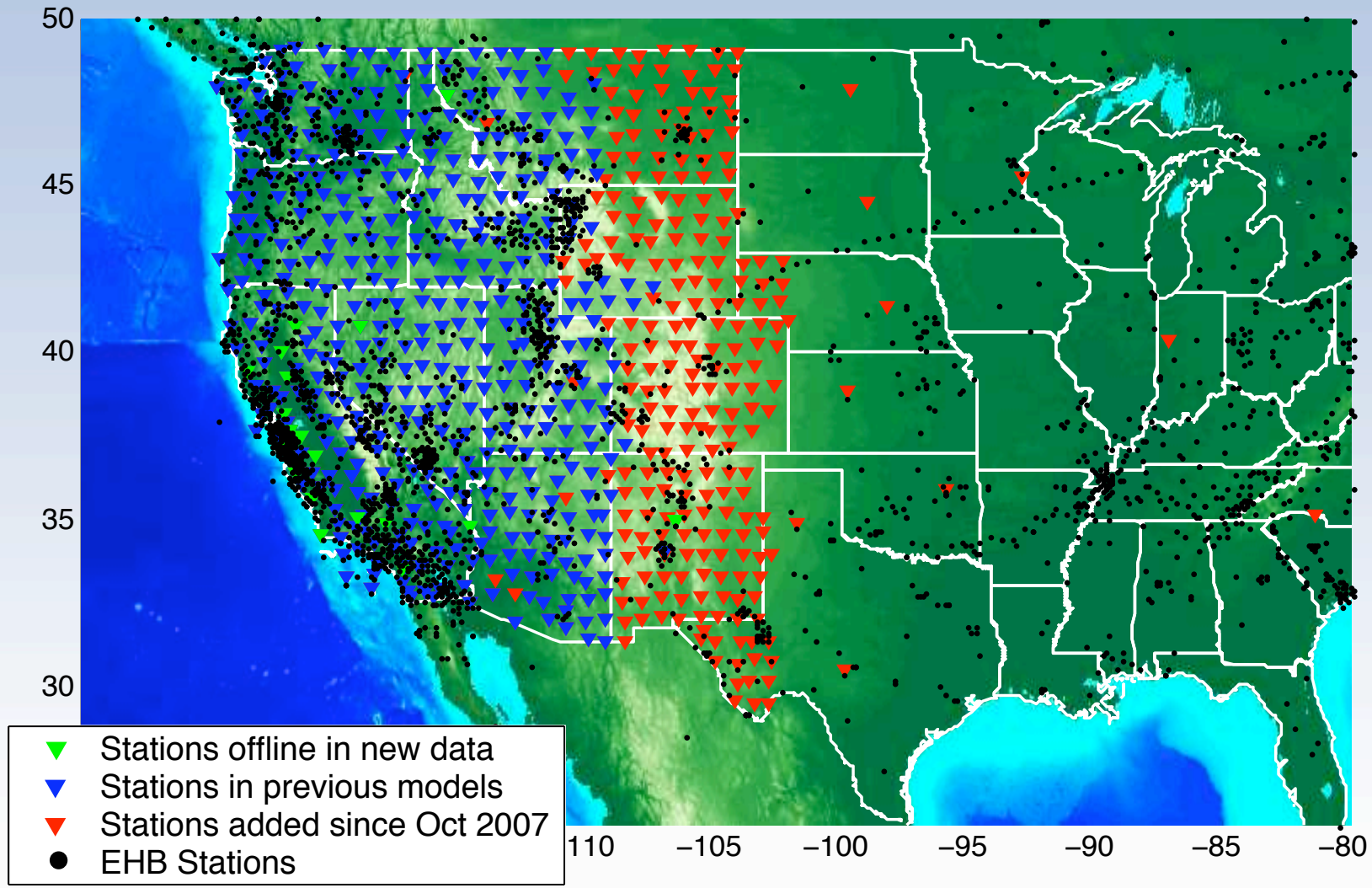
- Requirements
  - Data Quality
  - Clock Quality
  - Data Completeness
  - Data Latency
- Data latency results
  - Cell phones ~ 2 seconds
  - Satellite ~ 3 seconds
  - Observatory ~ 3 seconds

Observations and Results from Seismic Data

Tomography



Tomography


50
45
40
35
30
−110
−105
−100
−95
−90
−85
−80
Stations offline in new data
Stations in previous models
Stations added since Oct 2007
EHB Stations

Tomography

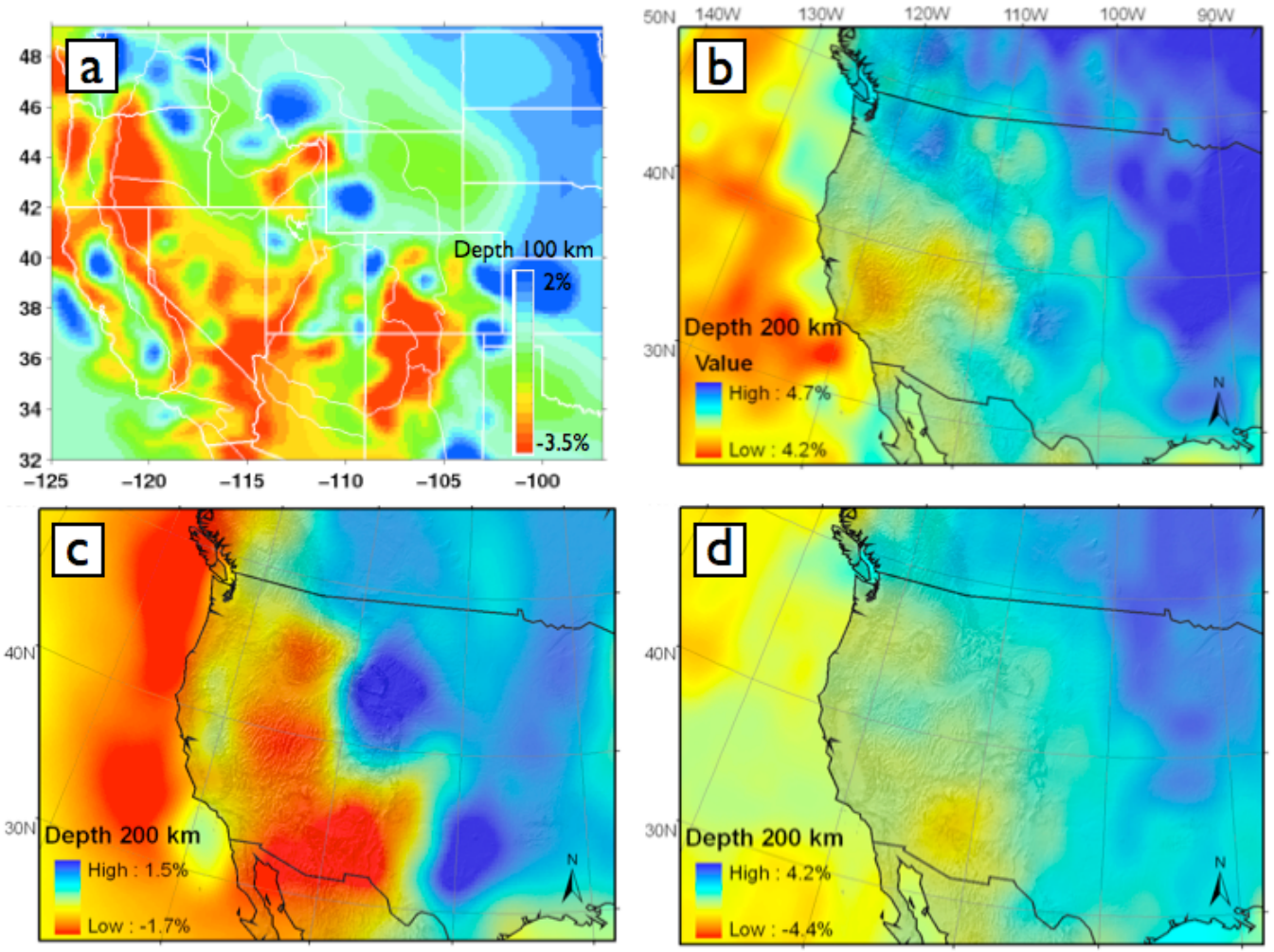
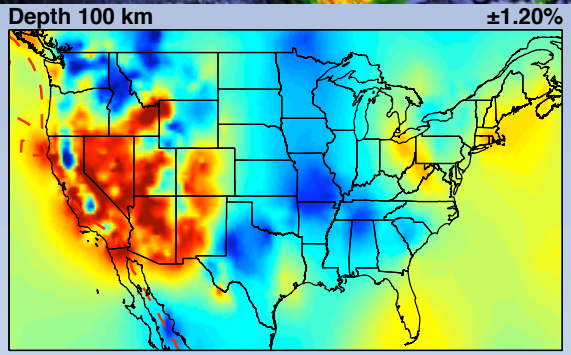
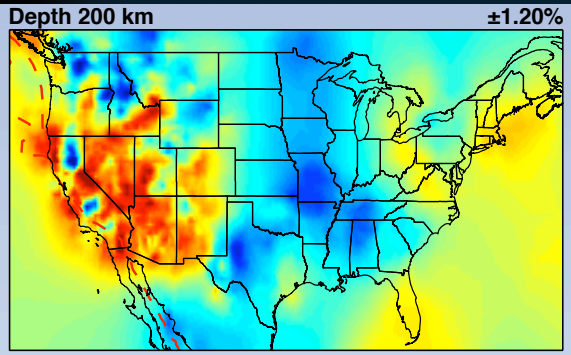
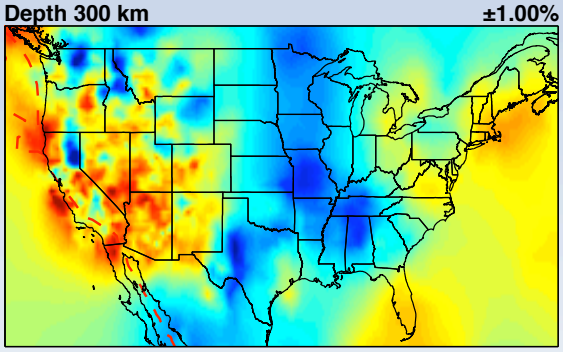


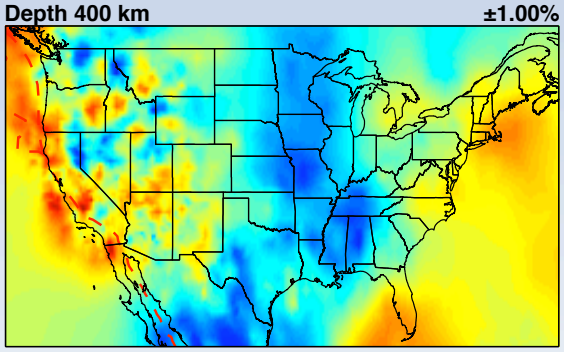
Figure 1. *a.) Model made by piecing together local tomography studies from Humphreys and Dueker, 1994 and inverting with global data set (Dueker et al. 2001). b.) Global S-wave model from surface wave diffraction (Ritzwoller et al. 2002) c.) Global P-wave model using finite frequency kernels (Montelli, et al. 2004). d.) Global S-wave travel-time model (Grand 2002).*

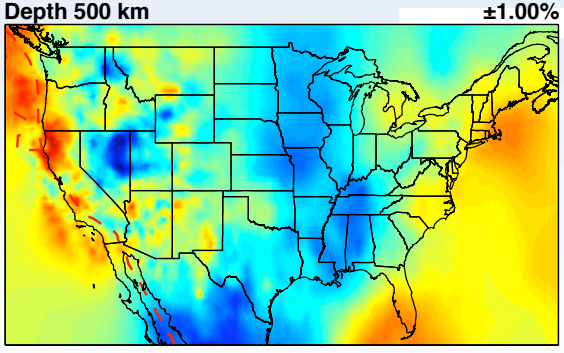
Tomography

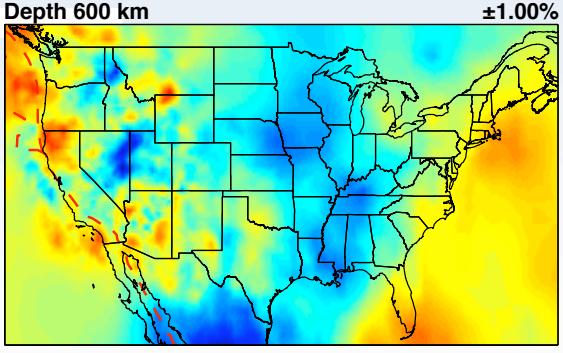

Depth 100 km
±1.20%


Depth 200 km
±1.20%


Depth 300 km
±1.00%


Depth 400 km
±1.00%


Depth 500 km
±1.00%


Depth 600 km
±1.00%

Animation of Wenchuan China Earthquake

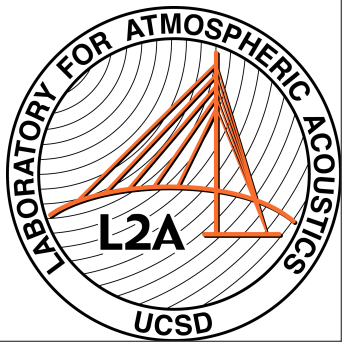
Robert Woodward
IRIS

www.earthscope.org

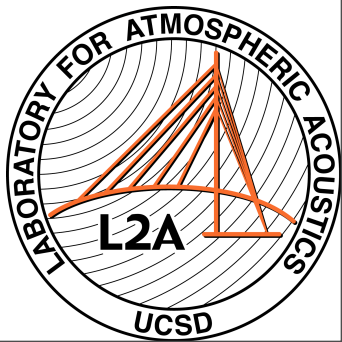
The Feb 19, 2008 bolide study

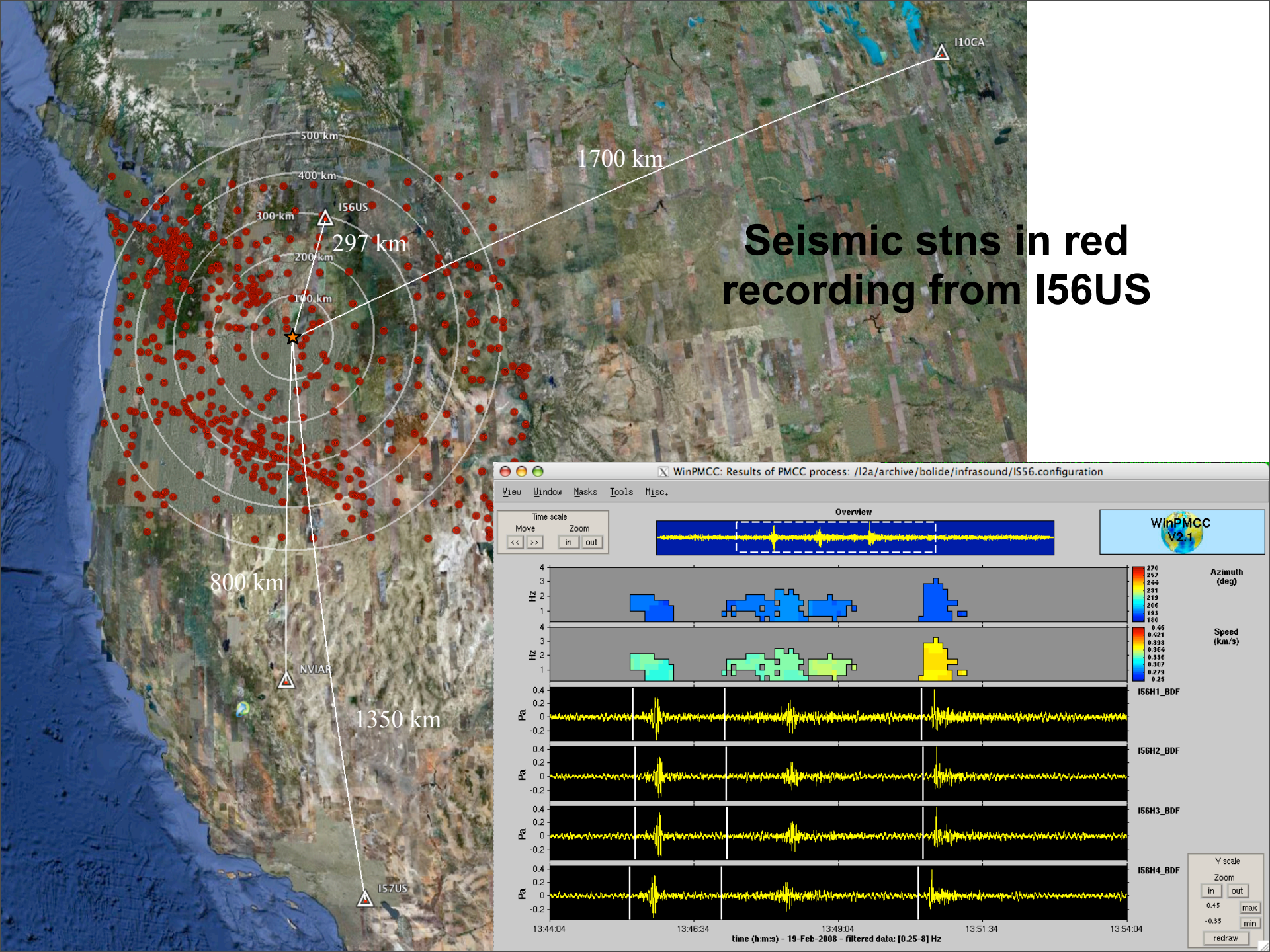
some preliminary results/comments

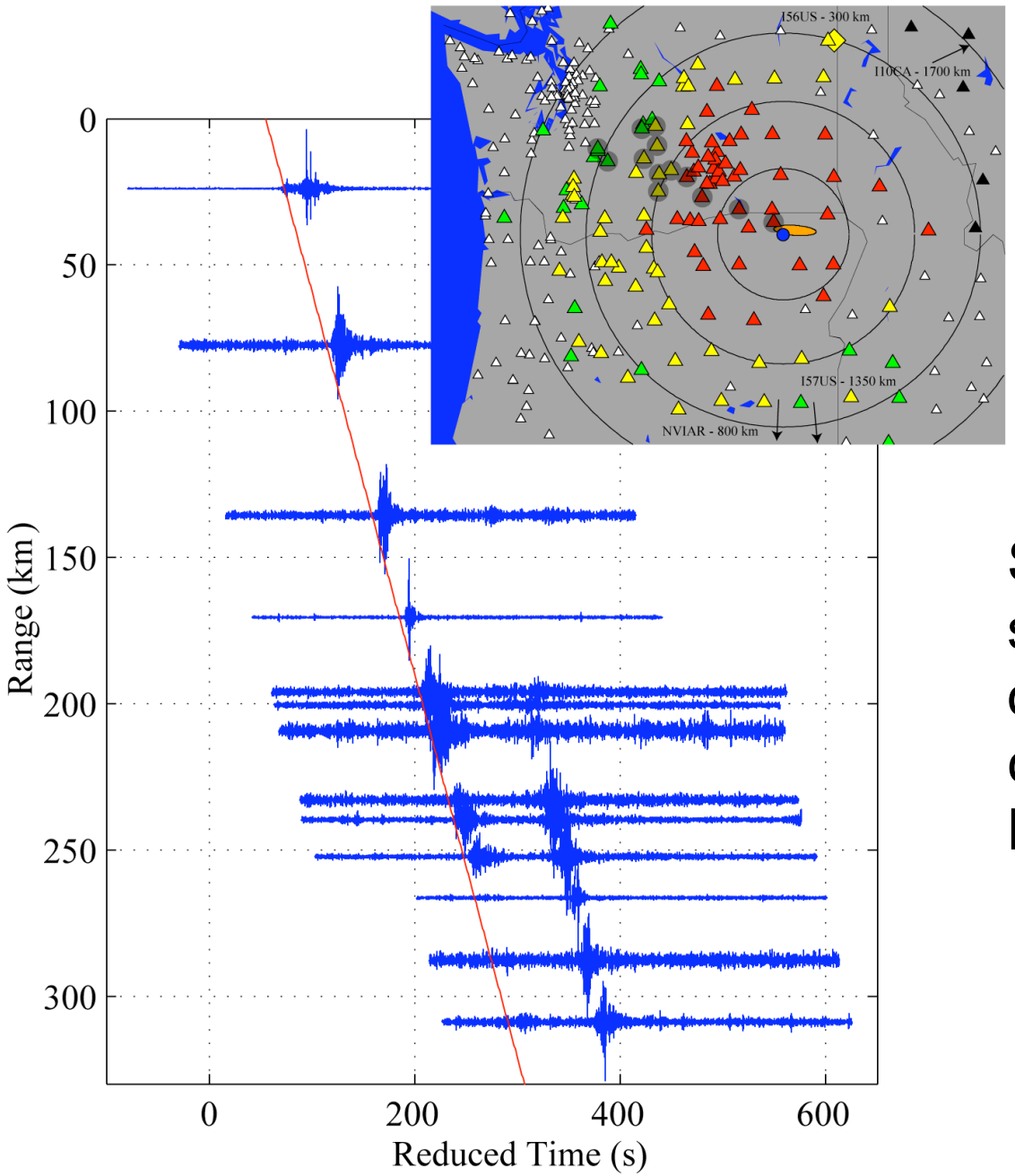
Dr. Michael Hedlin
Dr. Kristoffer Walker



- A bolide burst above NE Oregon at 05:30 AM local time on Feb 19, 2008
- The event was recorded by 4 infrasound arrays and several hundred seismic stations in the USArray and regional networks
- The seismic stations reveal how infrasound signals vary with range and azimuth
- Celerity (horizontal distance traveled/travel time) vs range plots may shed light on propagation paths and provide useful information about atmospheric structure




I10CA
1700 km
500 km
400 km
300 km
I56US
297 km
200 km
100 km
Seismic stns in red
recording from I56US
800 km
NVIAR
1350 km
I57US
WinPMCC: Results of PMCC process: /I2a/archive/bolide/infrasound/IS56.configuration
View
Window
Masks
Tools
Misc.
Time scale
Move
Zoom
Overview
WinPMCC
V2.1
Azimuth
(deg)
Speed
(km/s)
I56H1_BDF
I56H2_BDF
I56H3_BDF
I56H4_BDF
Hz
Pa
Y scale
Zoom
max
min
redraw
13:44:04
13:46:34
13:49:04
13:51:34
13:54:04
time (h:m:s) - 19-Feb-2008 - filtered data: [0.25-8] Hz



Sample record section to west of event, Z components Bp 0.8-3.0 Hz

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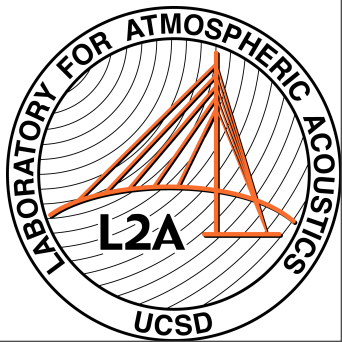
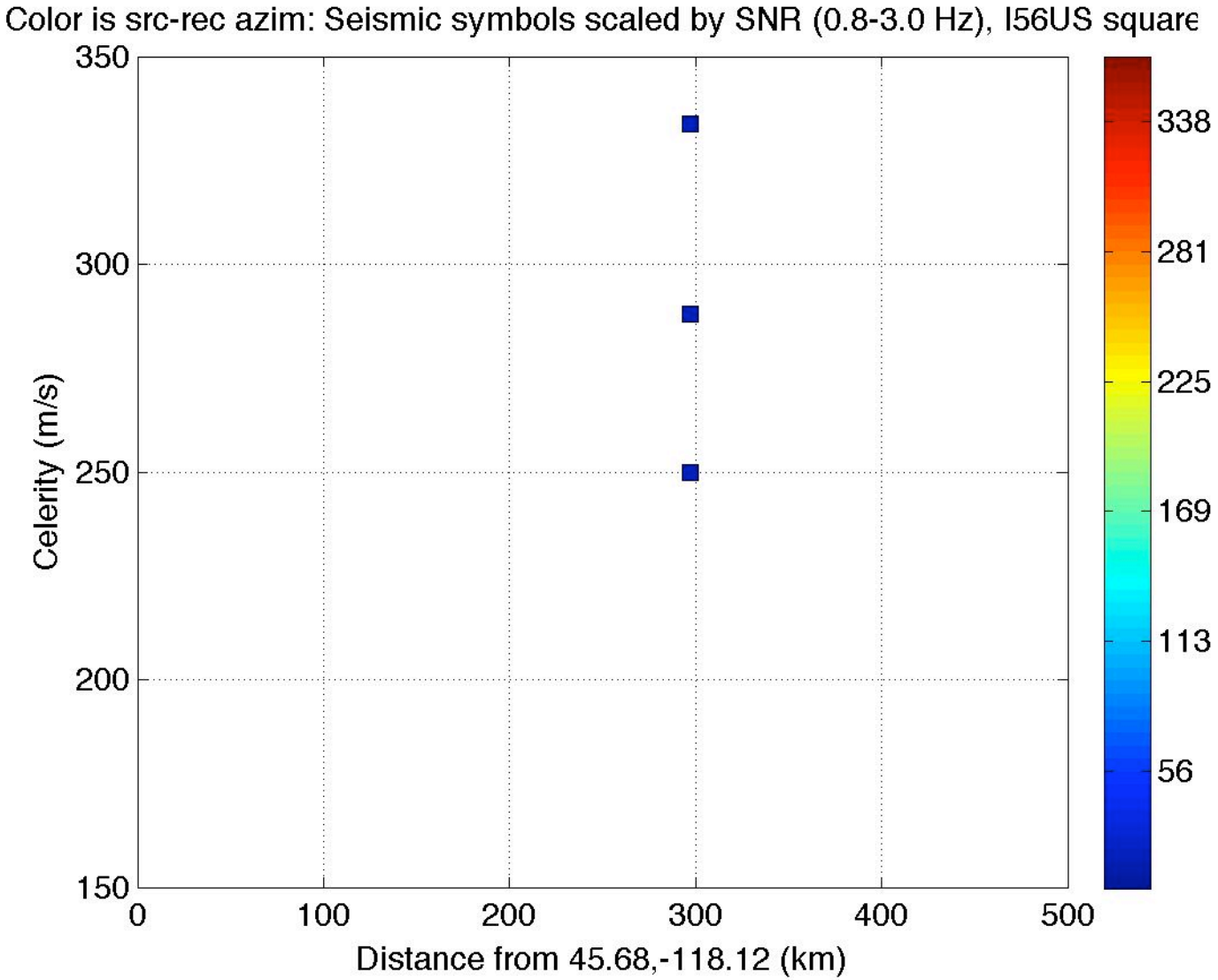
Celerity vs range plots



Just I56US


Color is src-rec azim: Seismic symbols scaled by SNR (0.8-3.0 Hz), I56US square
Celerity (m/s)
350
300
250
200
150
0
100
200
300
400
500
Distance from 45.68,-118.12 (km)
338
281
225
169
113
56

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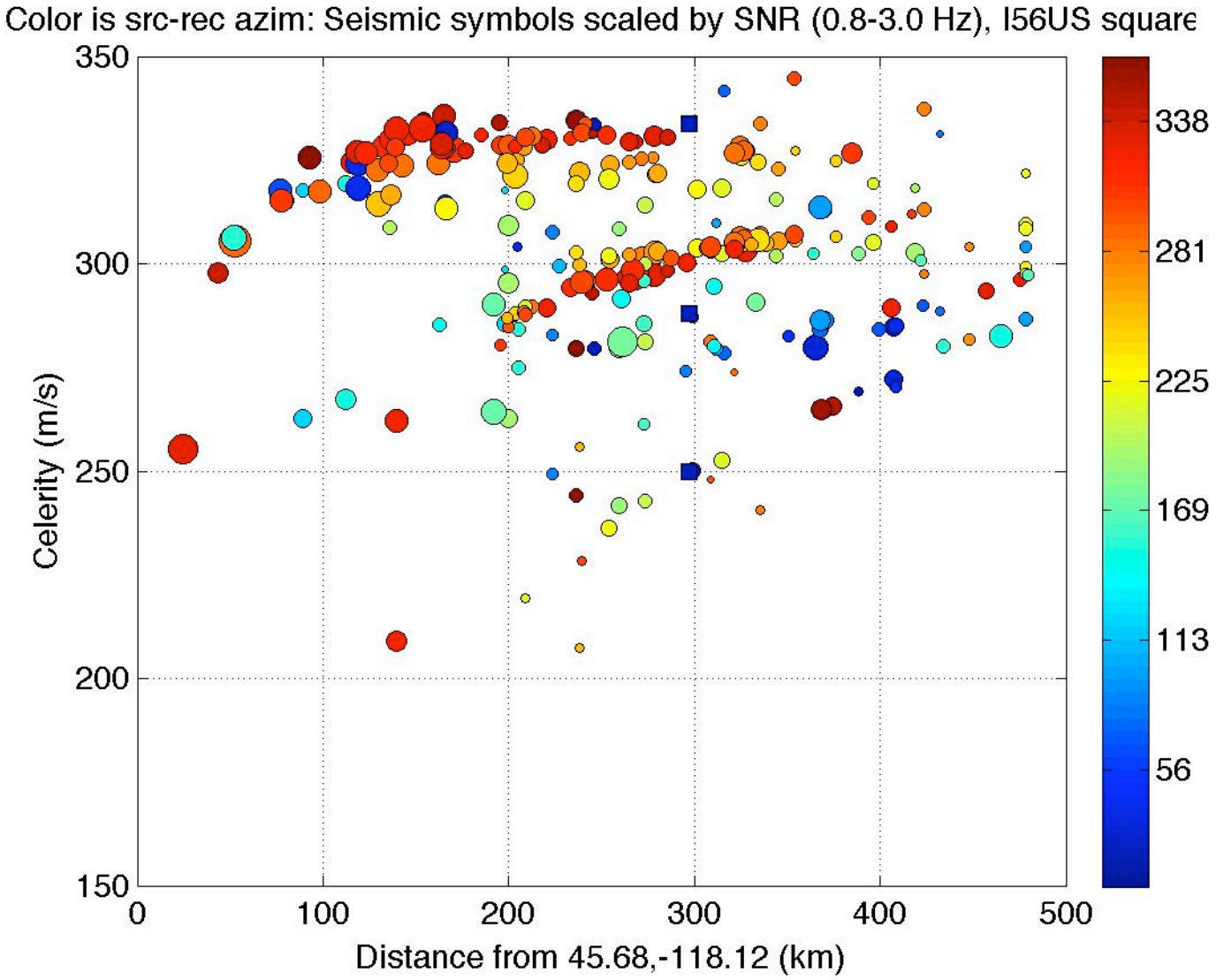
I56US with picks from open dataset



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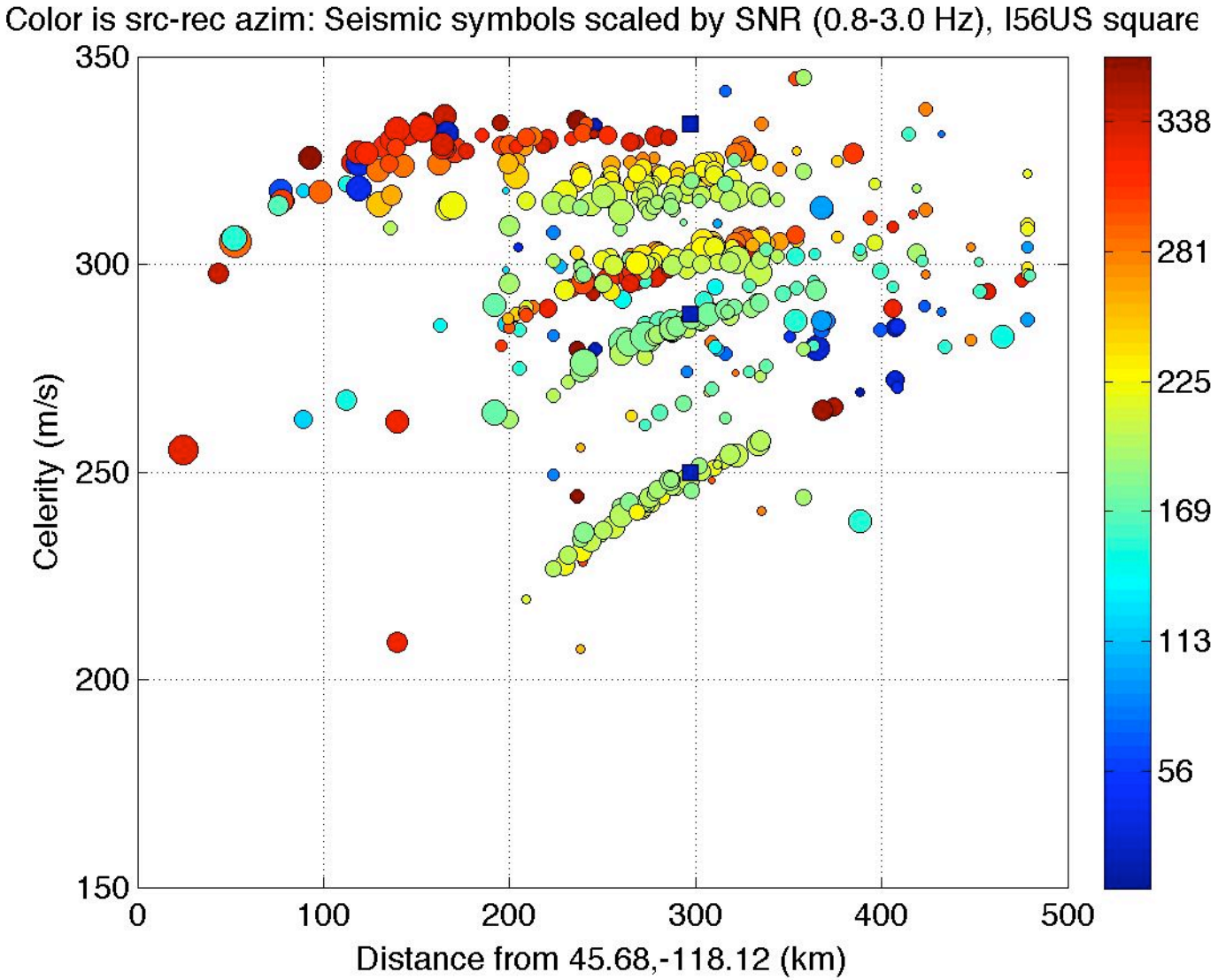
I56US with picks from open dataset + Fouch dataset



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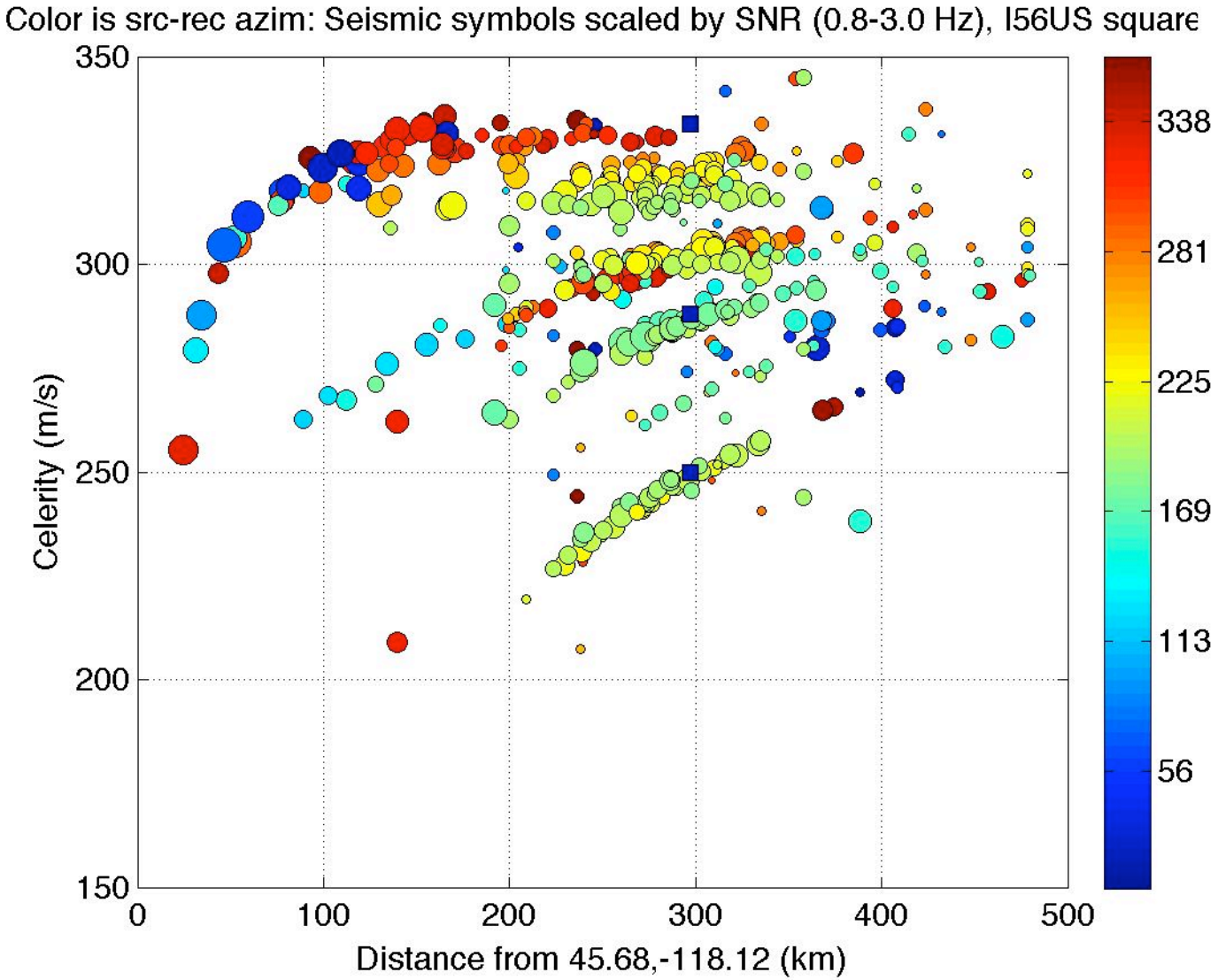
I56US with picks from open dataset + Fouch and Humphreys datasets



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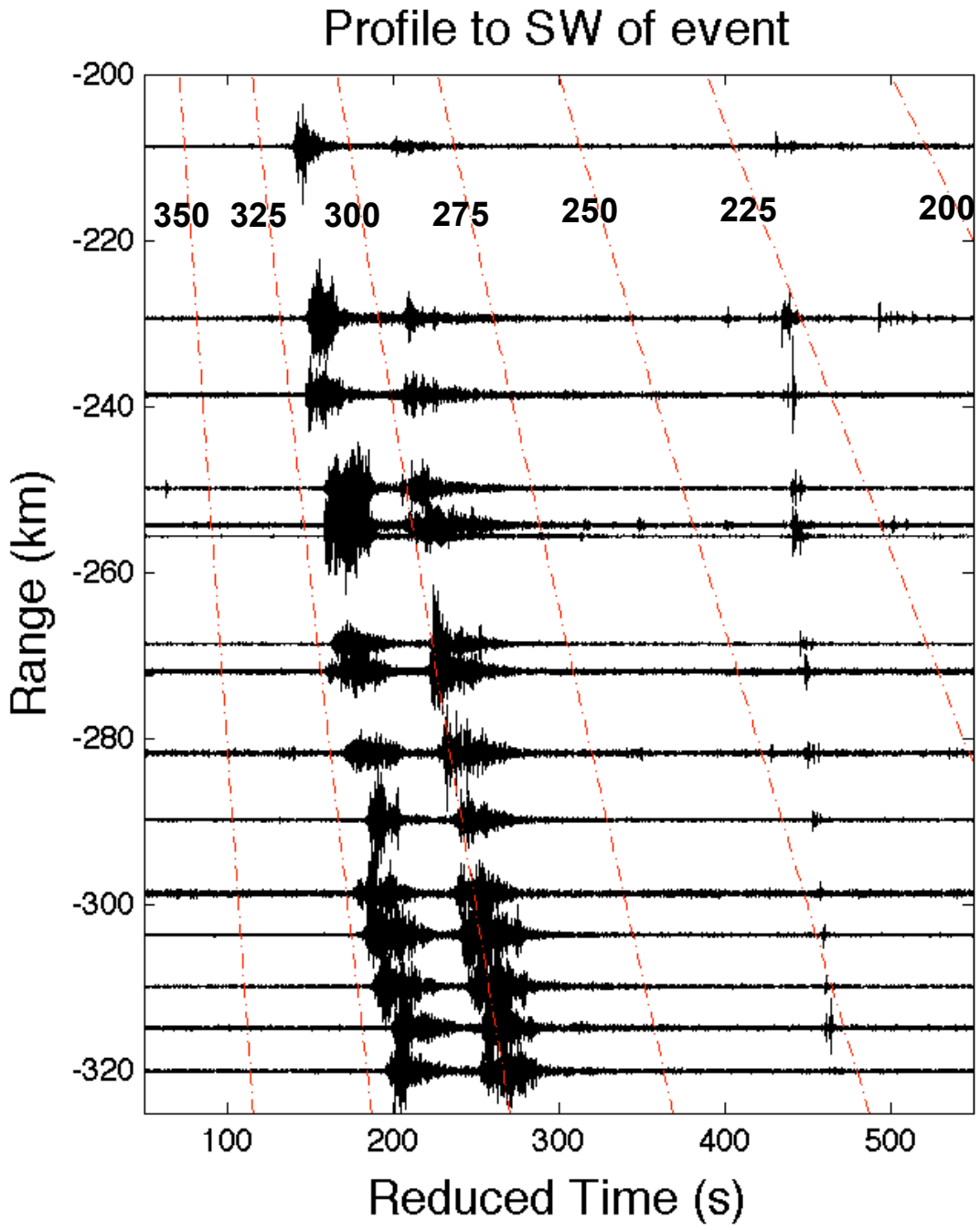
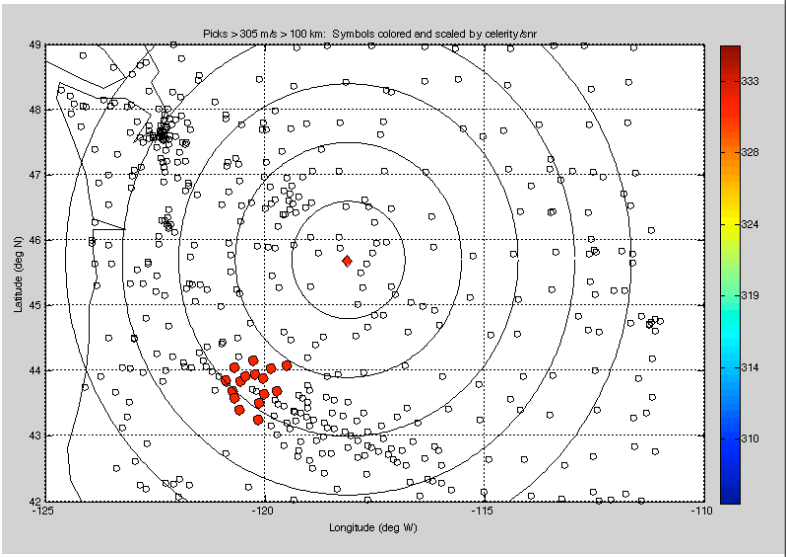


Profile to SW of event

Note third branch



Misc. points

- Interpretation of these picks is in the early stages. We plan to model propagation from the event to solidify our interpretation of the branches of signals.
- The seismic dataset is likely to give us an unprecedented look at the propagation of infrasound energy through the atmosphere out to several hundred km from the source
- Although these slow-moving signals are valuable to infrasound researchers they also hint at high-frequency noise due to atmospheric processes that is likely common on seismic channels

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