Infrasound Case Studies

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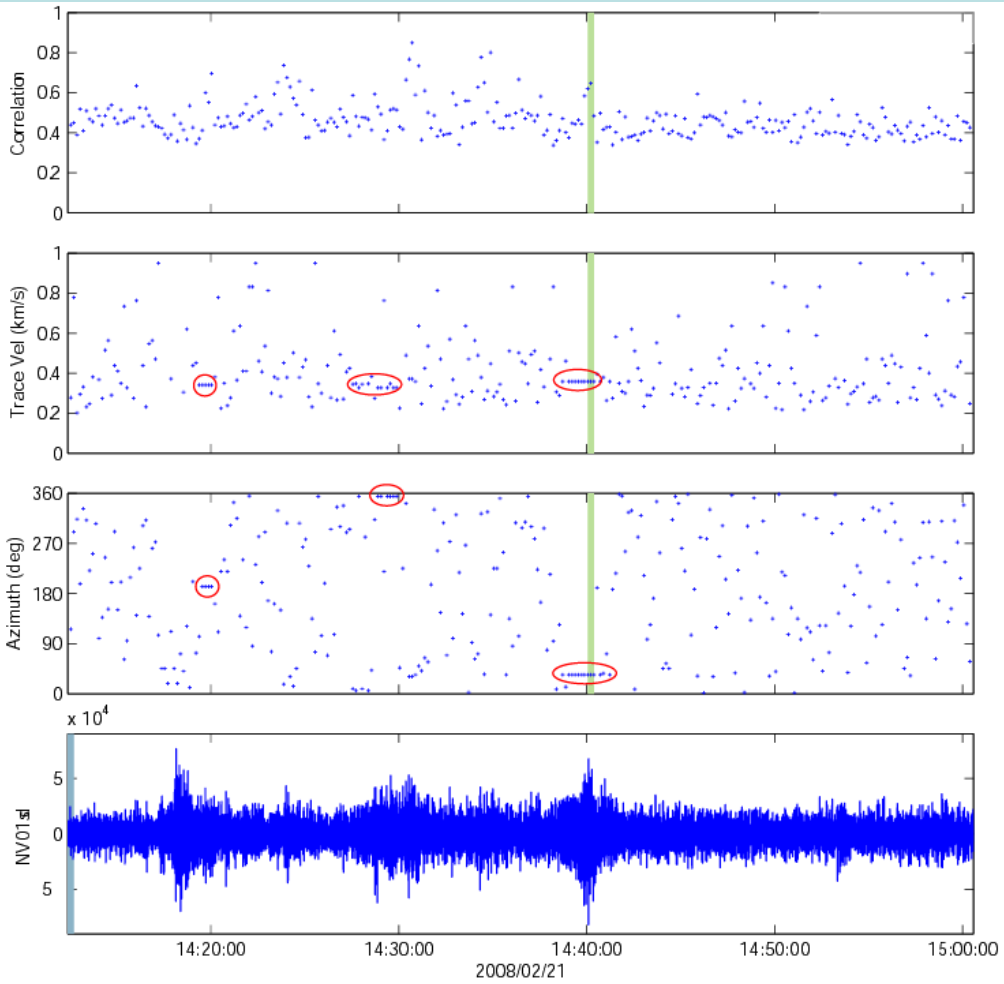
Case 1

- A magnitude 6.0 earthquake located near Wells NV USA at a distance of 422 Km. from IMS station PS47 caused 3 different infrasound arrivals at the NVIAR infrasound array colocated with PS47.

Infratool Detector Results



Window Parameters		Pass Band Parameters		Slowness Parameters		Windowed Values & S.D.		
Duration (s)	20.0	Low frequency (Hz)	0.5	Max. Slown. (s/deg)	400.0	Corr.	0.566	0.114
Overlap (%)	50.0	High frequency (Hz)	3.0	# of Slown.	40	Fstat	4.546	2.515
Number of windows	288	Order (integer)	2			Vel.	0.358	0.000
						Az.	34.216	0.000


Wells
Earthquake
Intermediate arrival source
NVIAR Array
Early infrasound arrival source
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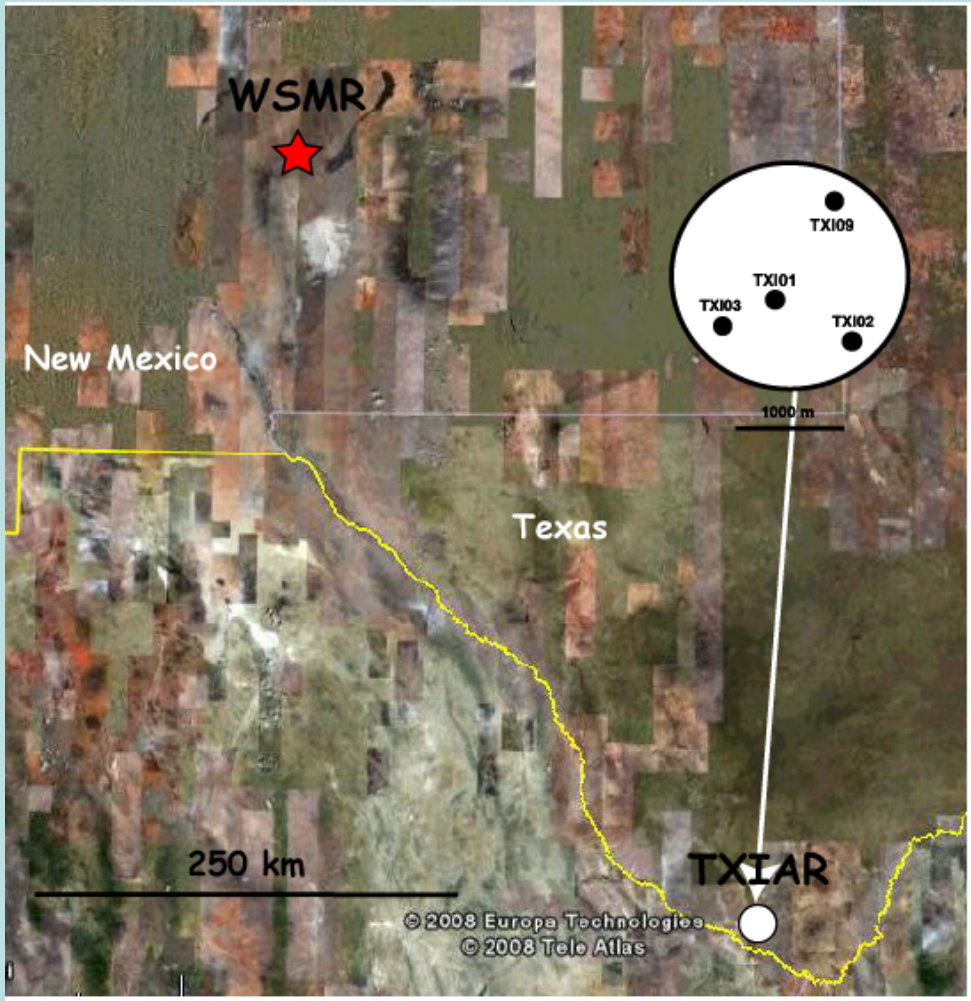
Conclusions (Earthquake Infrasound)

- Through an iterative process of combining Rayleigh wave travel times with infrasound travel times and a known azimuth, it can be shown that one single earthquake can cause multiple infrasound sources in a region.

Case 2
Dispersed infrasound

- Dispersed infrasound signals were observed on November 19, 1997 at TXIAR and September 9-12, 2007 at FALN and NVIAR
- The source/receiver distance was 546 km for TXIAR, 157 km for FALN and 36 km for NVIAR
- The signals exhibited dispersion between 0.2-1 Hz (for TXIAR) and 1 – 2 Hz (for NVIAR and FALN)


WSMR
TXI09
TXI01
TXI03
TXI02
New Mexico
1000 m
Texas
250 km
TXIAR
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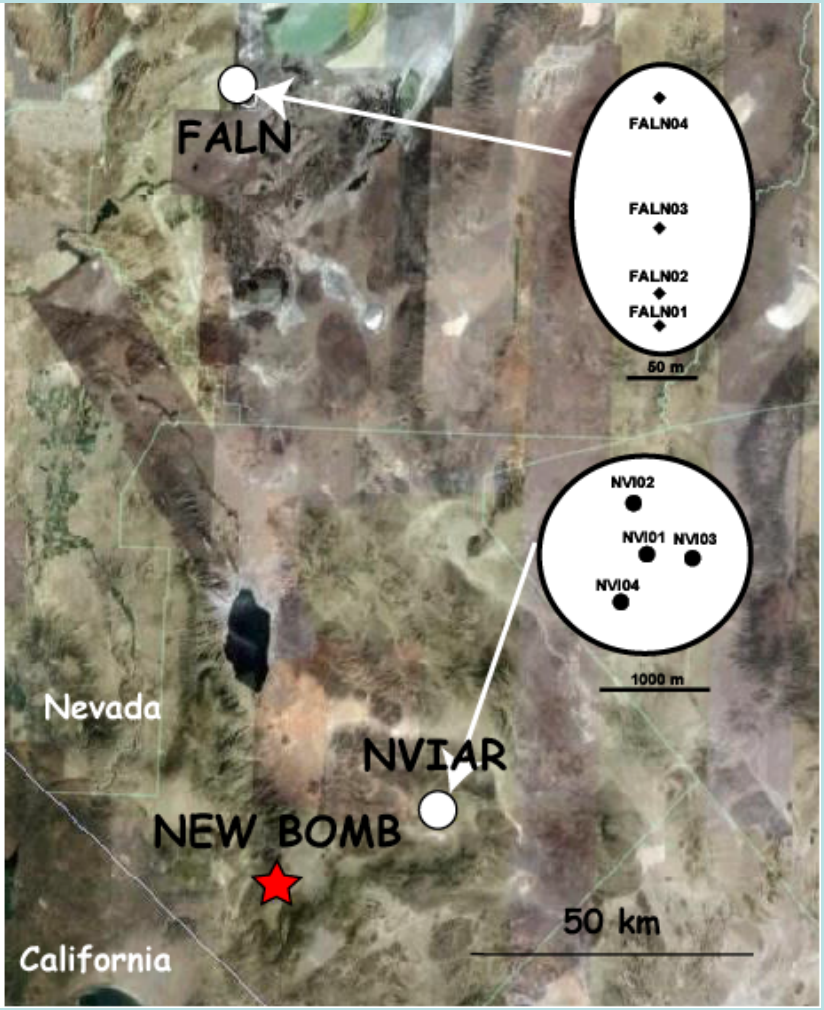
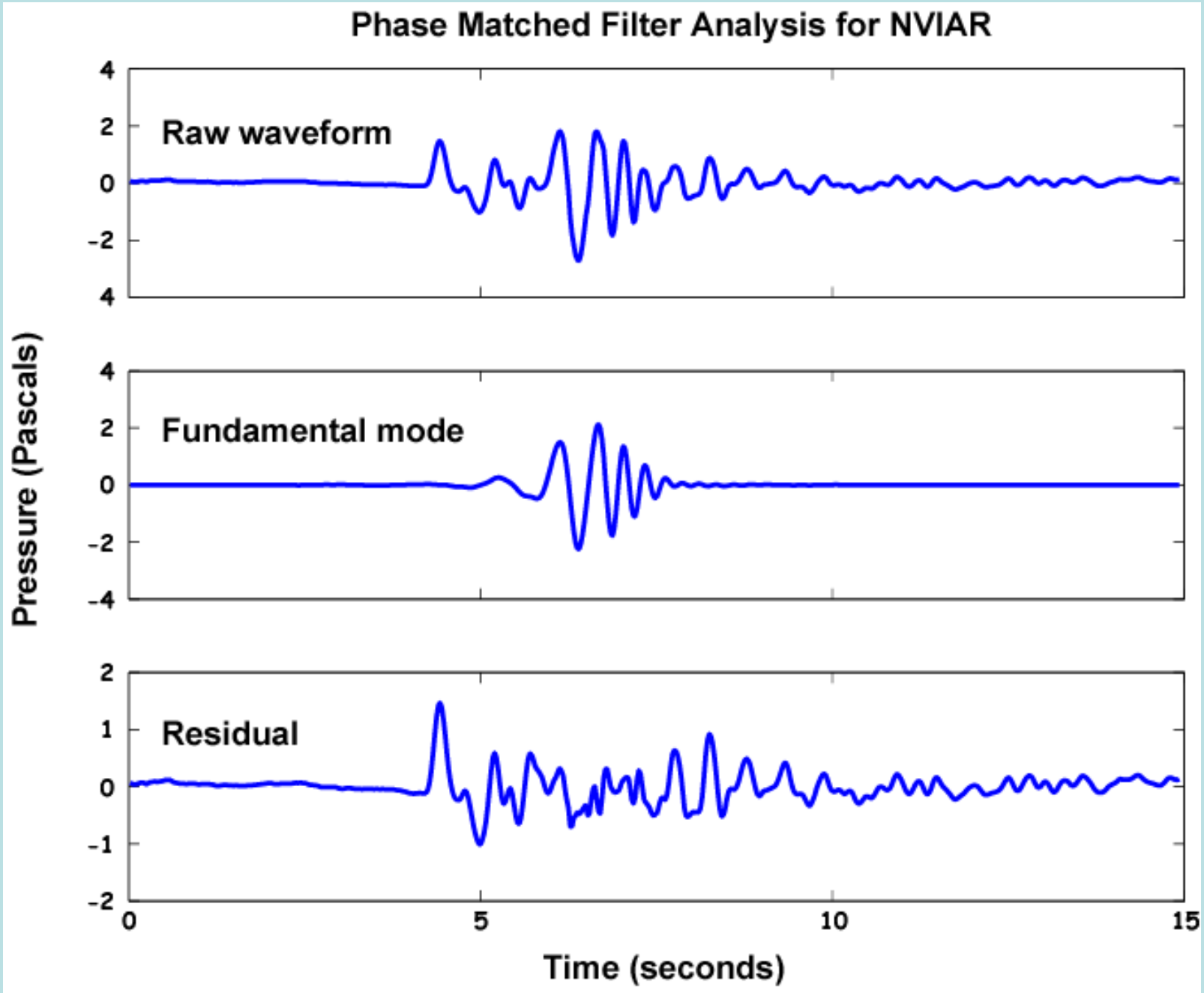
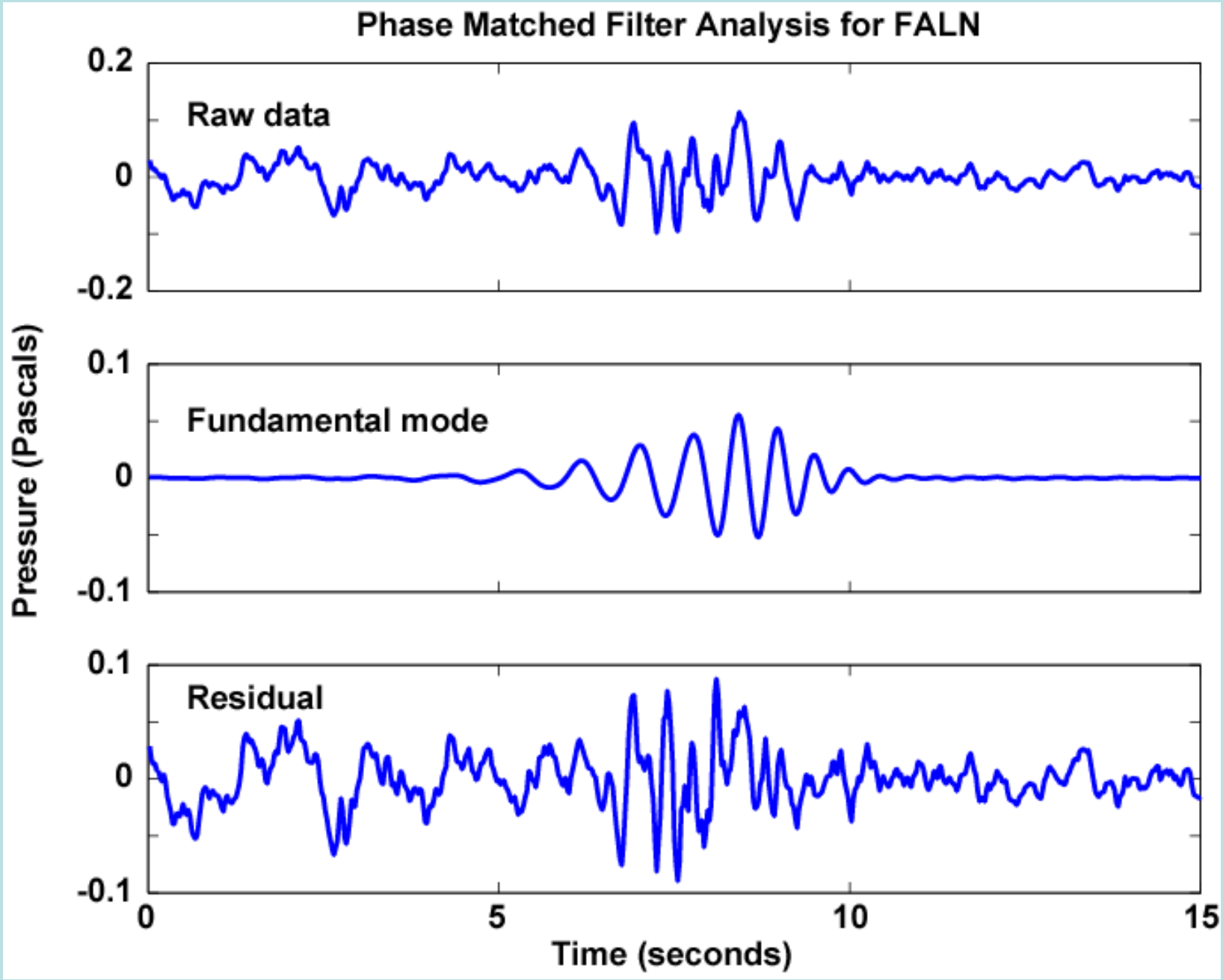
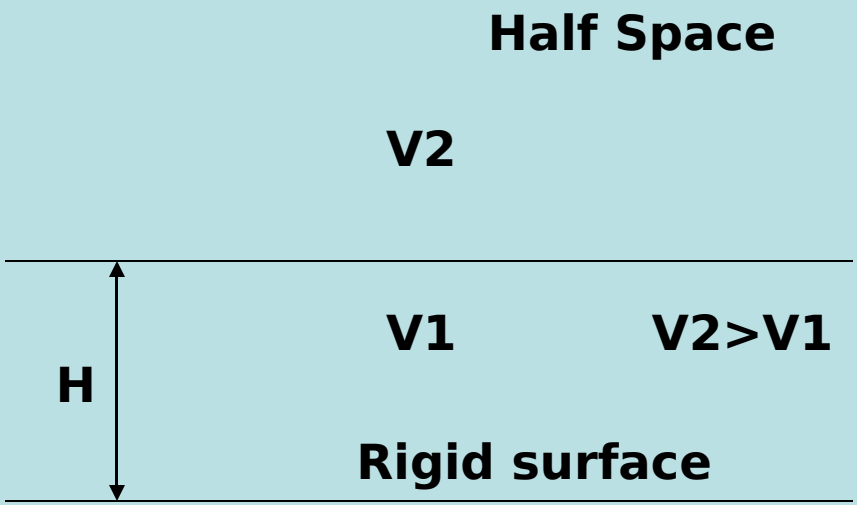

FALN
FALN04
FALN03
FALN02
FALN01
50 m
NVI02
NVI01
NVI03
NVI04
1000 m
Nevada
NVIAR
NEW BOMB
50 km
California

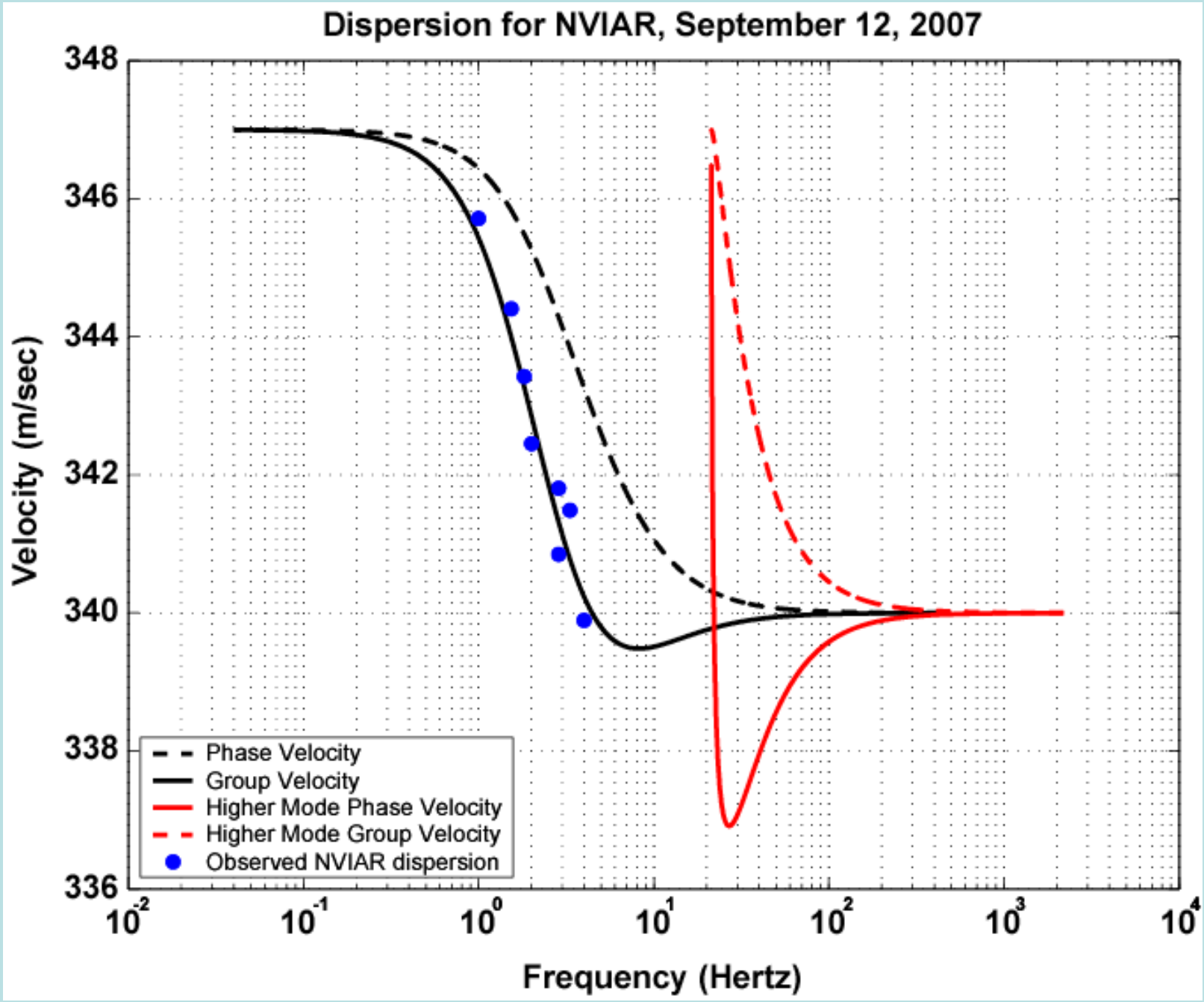

Phase Matched Filter Analysis for NVIAR
Raw waveform
Fundamental mode
Residual
Pressure (Pascals)
Time (seconds)
4
2
0
-2
4
4
2
0
-2
-4
2
1
0
-1
-2
0
5
10
15

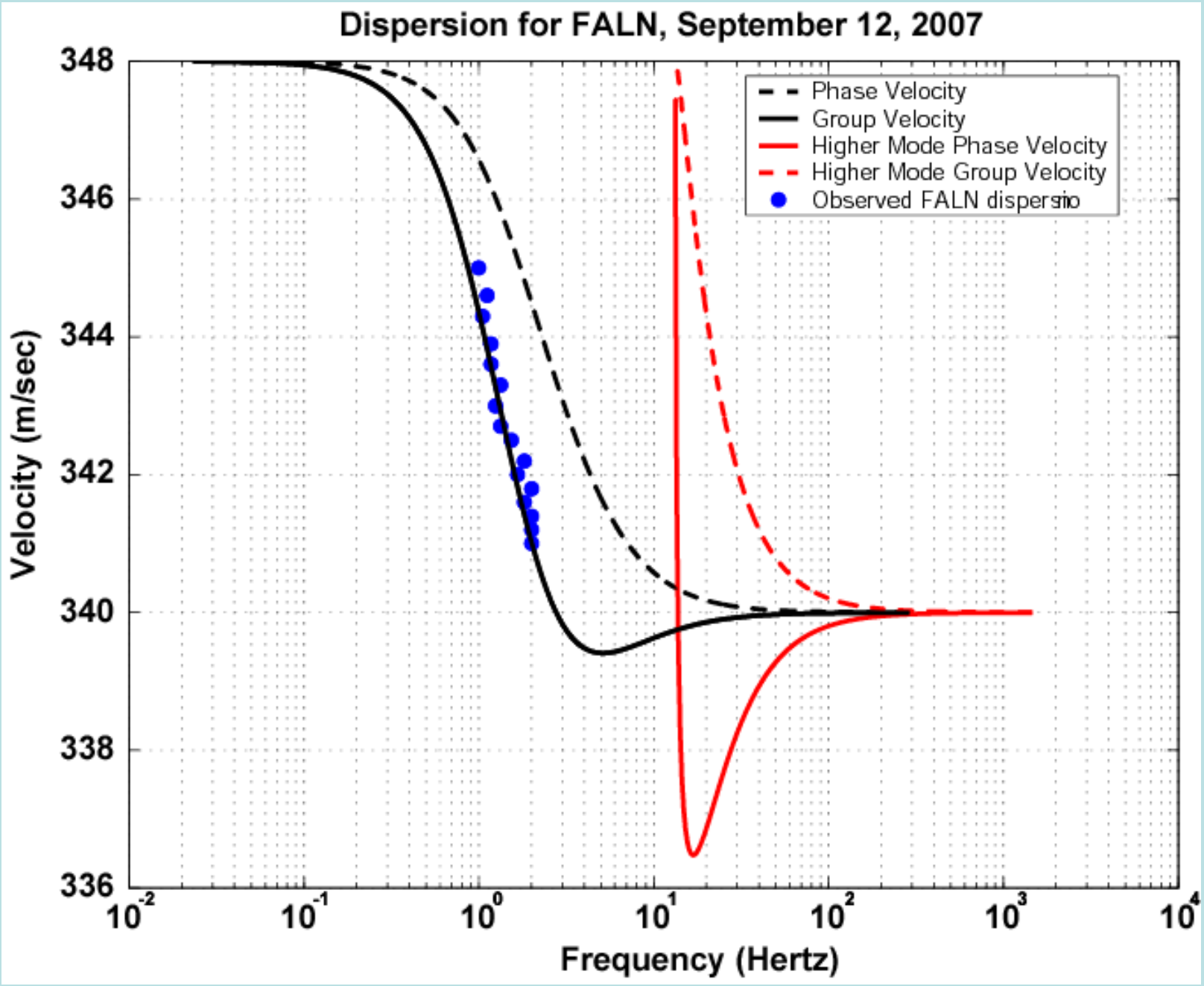

Phase Matched Filter Analysis for FALN
Raw data
Fundamental mode
Residual
Pressure (Pascals)
Time (seconds)
0.2
0
-0.2
0.1
0
-0.1
0.1
0
-0.1
0
5
10
15

Modeling

- **We modeled the dispersed infrasound as low velocity waveguides**
- **Model composed of a low velocity layer overlain by a half space**
- **Boundary conditions: rigid boundary at surface of the earth; continuity of stresses (pressure) and displacements at the interface and the displacements must vanish in the half space, away from the interface**

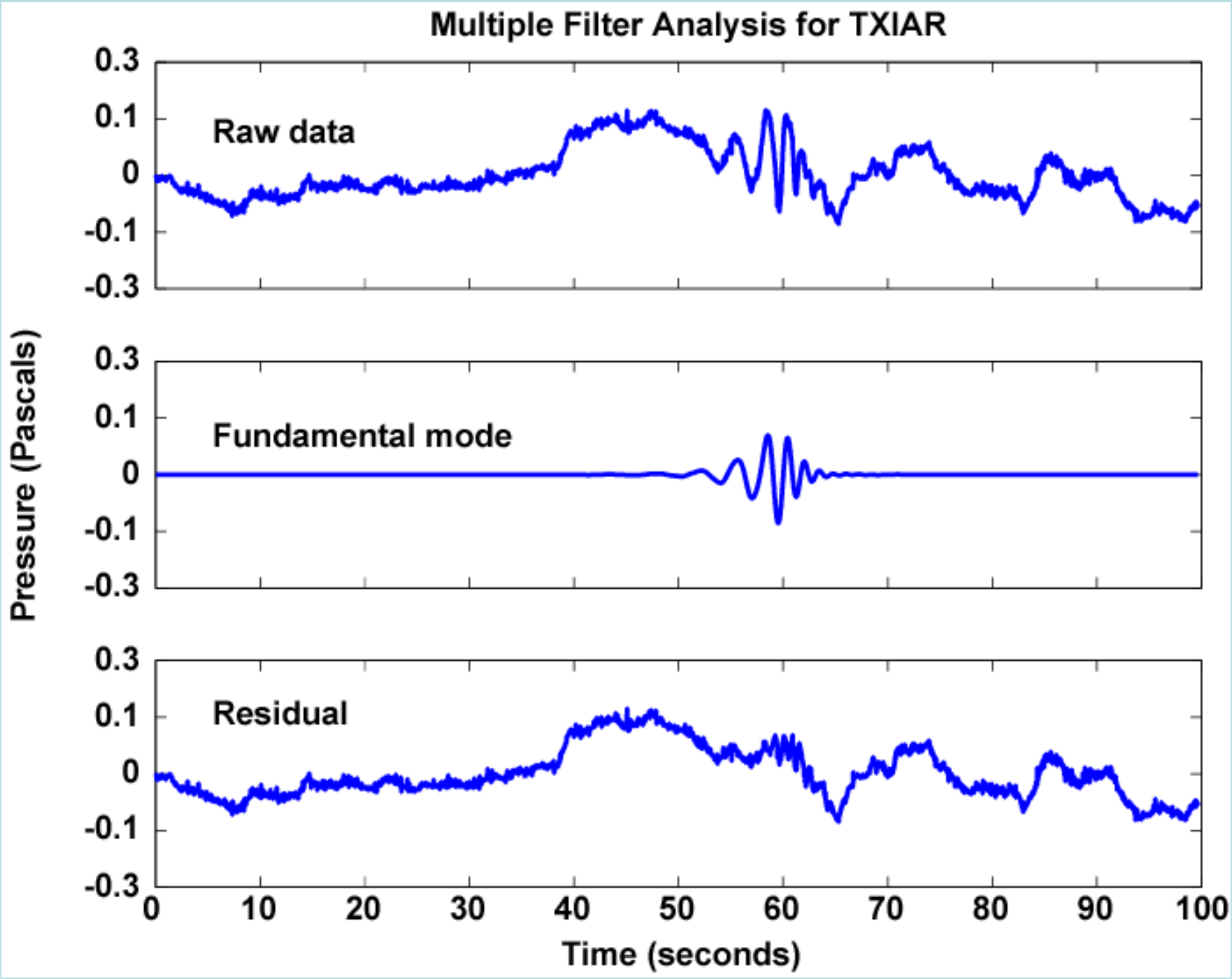


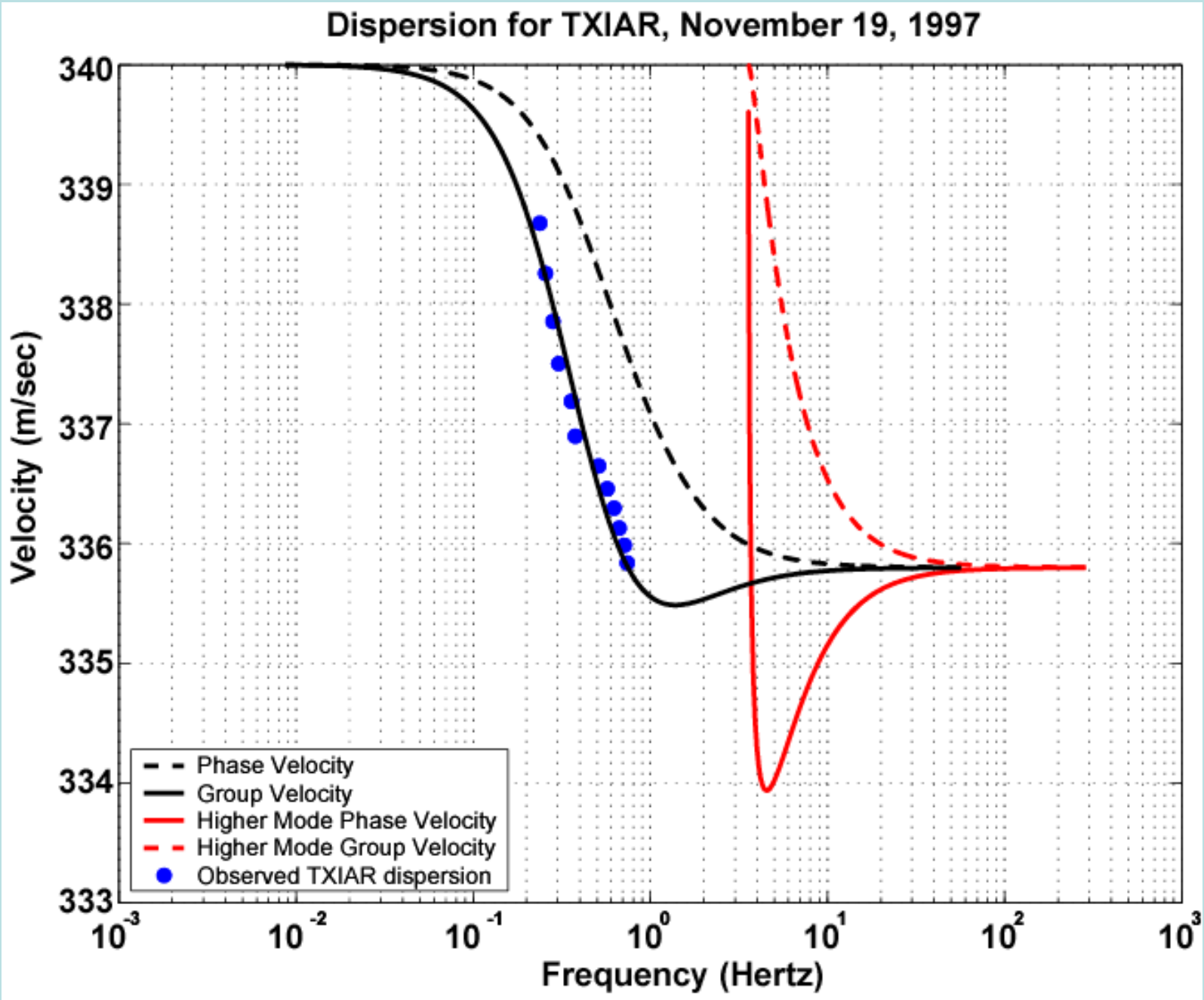

Dispersion for NVIAR, September 12, 2007
Velocity (m/sec)
Frequency (Hertz)
348
346
344
342
340
338
336
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
Phase Velocity
Group Velocity
Higher Mode Phase Velocity
Higher Mode Group Velocity
Observed NVIAR dispersion


Dispersion for FALN, September 12, 2007
Phase Velocity
Group Velocity
Higher Mode Phase Velocity
Higher Mode Group Velocity
Observed FALN dispersion
Velocity (m/sec)
Frequency (Hertz)
348
346
344
342
340
338
336
10^-2
10^-1
10^0
10^1
10^2
10^3
10^4

Model

	TXIAR	NVIAR	FALN
Layer thickness	600	80	120
Frequency	0.2 – 1	1 - 2	1 - 2
Velocity	335.8 - 340	340 - 347	340 – 348
Distance	546	36	157
Phase Velocity	341	354	352
Celerity	339	348	345


Multiple Filter Analysis for TXIAR
Raw data
Fundamental mode
Residual
Pressure (Pascals)
Time (seconds)
0.3
0.1
0
-0.1
-0.3
0
10
20
30
40
50
60
70
80
90
100


Dispersion for TXIAR, November 19, 1997
Velocity (m/sec)
340
339
338
337
336
335
334
333
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
Frequency (Hertz)
Phase Velocity
Group Velocity
Higher Mode Phase Velocity
Higher Mode Group Velocity
Observed TXIAR dispersion


Source Location
Ciudad Juarez
ElPaso
TX01
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62 km
Pointer lat 30.306624° lon -104.044420°
Streaming 100%
Eye alt 191.92 km

Conclusions (Dispersion)

- **We observed signals at TXIAR, NVIAR and FALN that traveled in boundary layer waveguides as well as later arrivals that were determined to be stratospheric returns. The trapped signals displayed obvious dispersion while the stratospheric returns did not. The later arrivals exhibited lower celerities and higher phase velocities than the dispersed signals.**

Conclusions (Dispersion)

- Dispersed infrasound signals can be modeled successfully as acoustic energy propagating in a low velocity surface waveguide.
- The thickness of modeled waveguides are on the order of hundreds of meters.
- The observed dispersed infrasound signals have celerity values comparable to their phase velocities.