SAND2016-11091C

# Infrasonic Observations of the 13 kt South Atlantic Bolide of 06-Feb-2016

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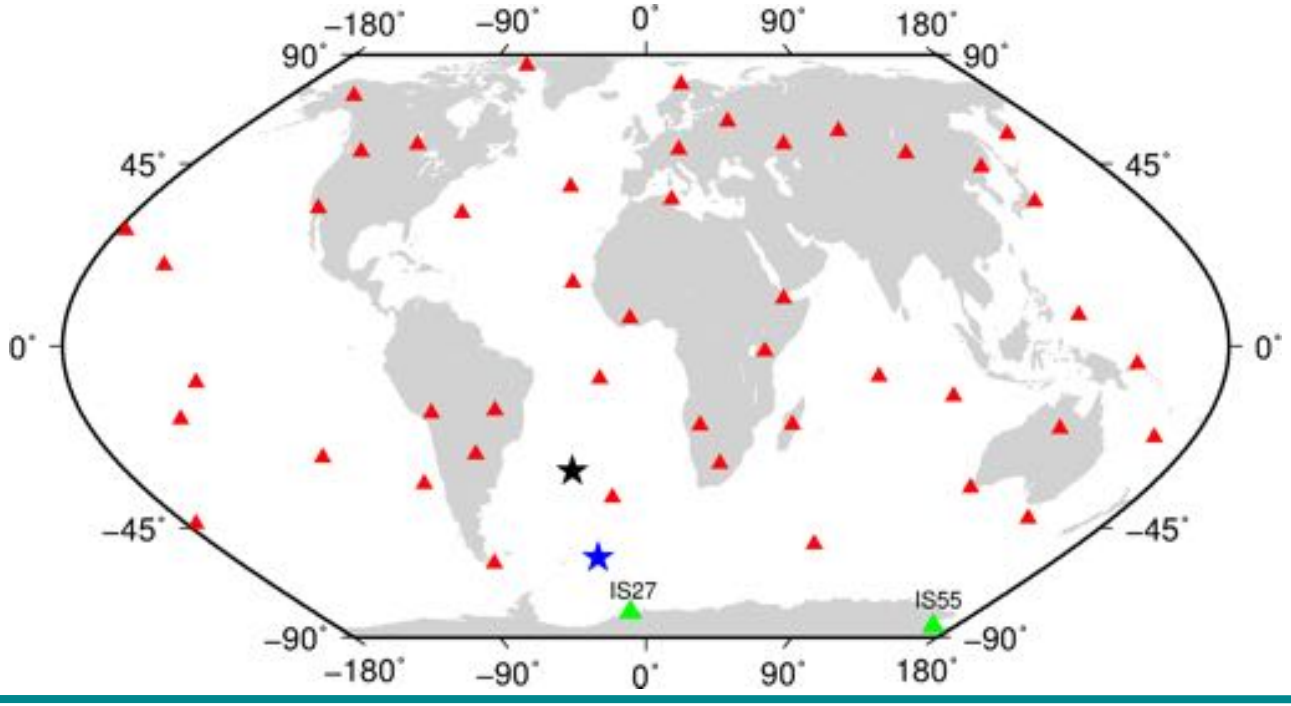
# Overview – 13 kt bolide event

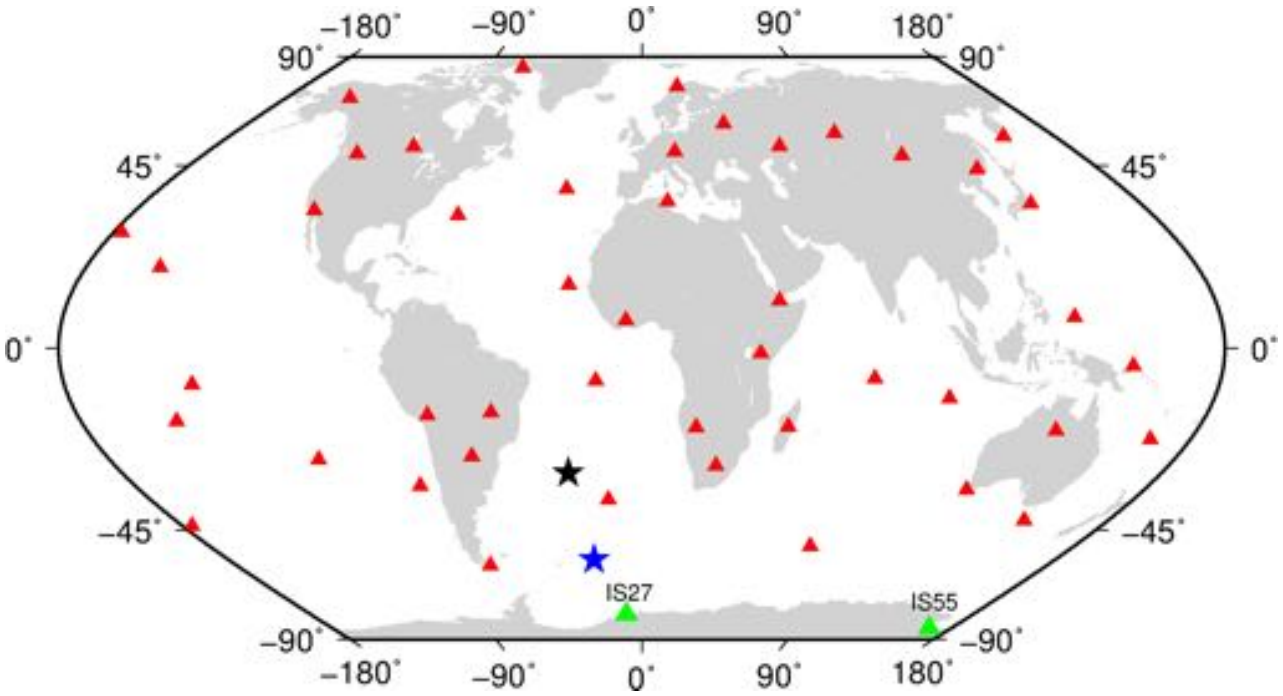
- South Atlantic Bolide 13:55:09 06-Feb-2016 at 31 km altitude and total impact energy, **13 kt**
  http://neo.jpl.nasa.gov/fireballs/

- Only **2** IMS station detections associated, IS27 (4609 km) and IS55 (7977 km), both in Antarctica. (Range from NASA loc.)



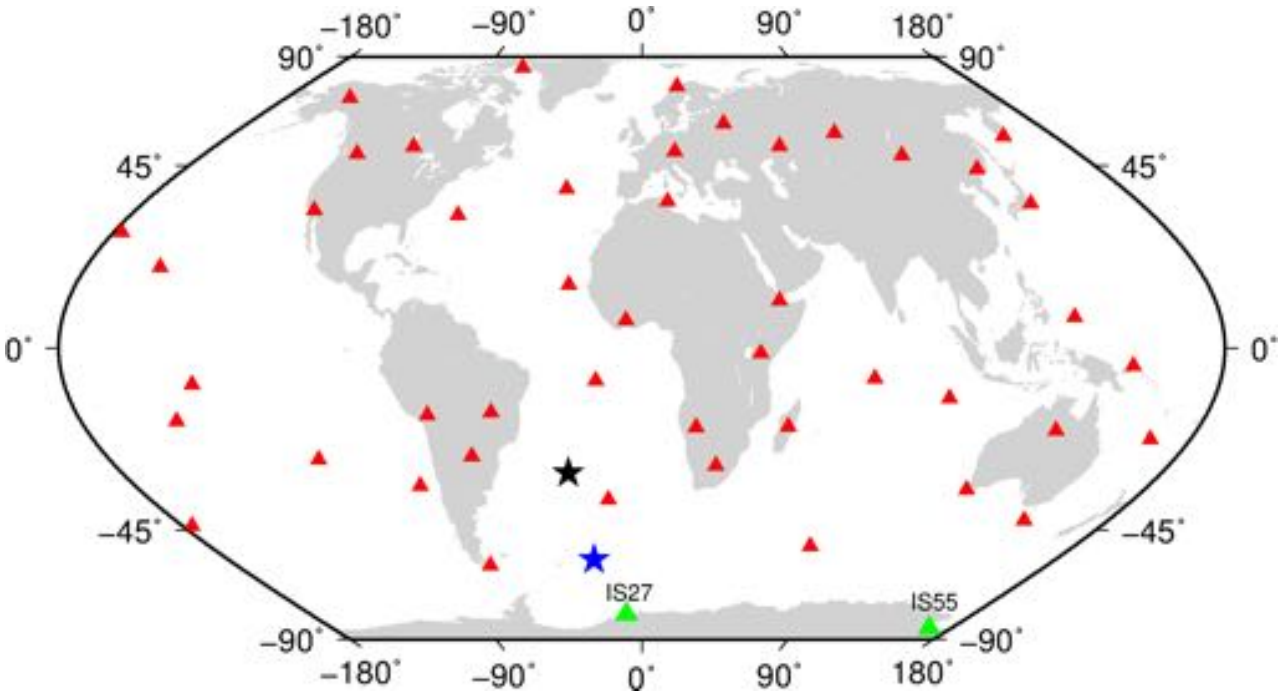
# Overview – automatic detections, SEL3?

- Automatic detections at IS27 and IS55 associated to form LEB event
- The IS55 detection originally associated with a different event in SEL3
- The IS27 detection was not automatically associated with an event



# Overview – LEB vs. NASA

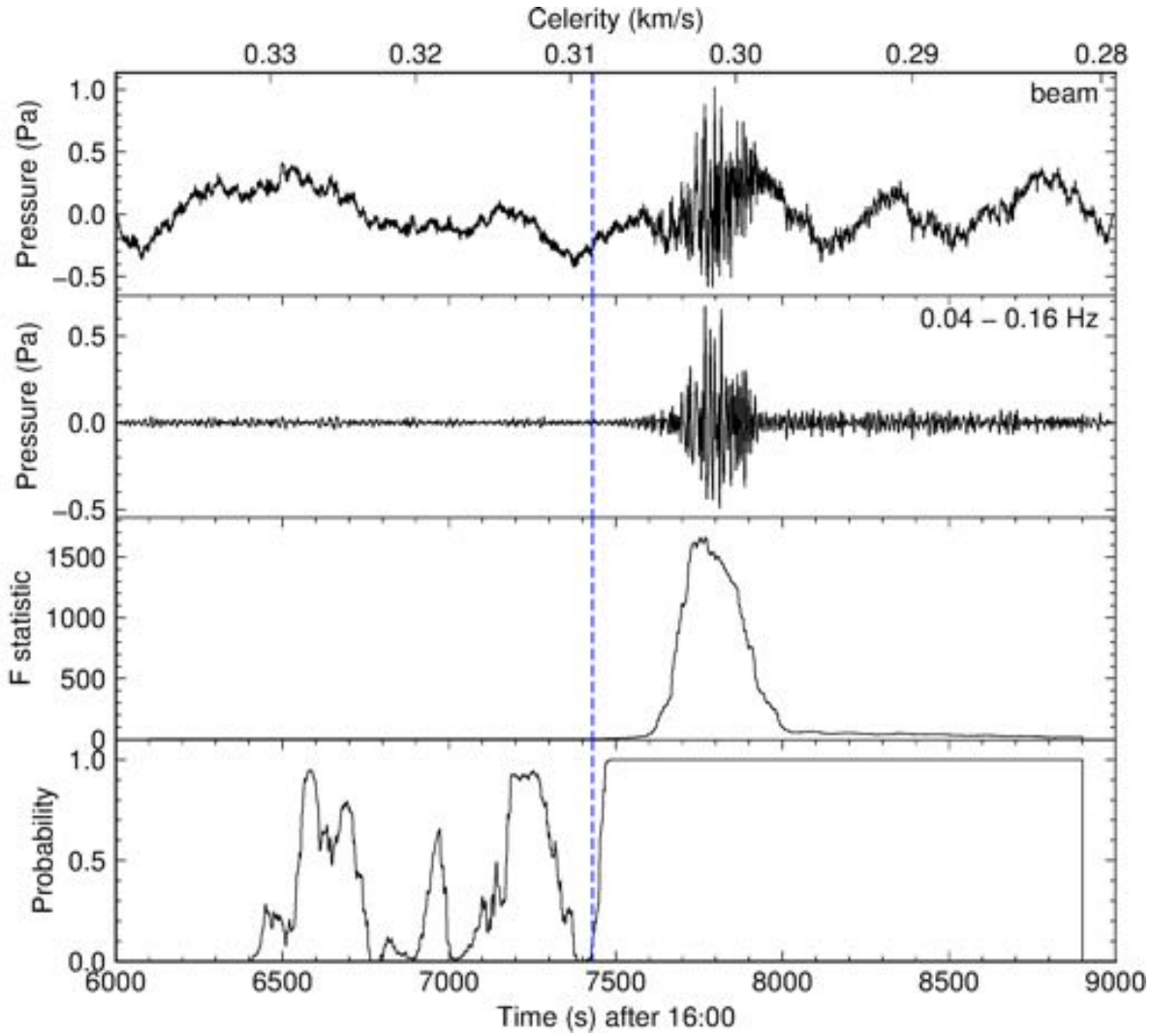
- LEB - O.T. 16:12:48 Location 52.9326°S 20.8802°W
- NASA – O.T. 13:55:09 Location 30.4°S 25.5°W

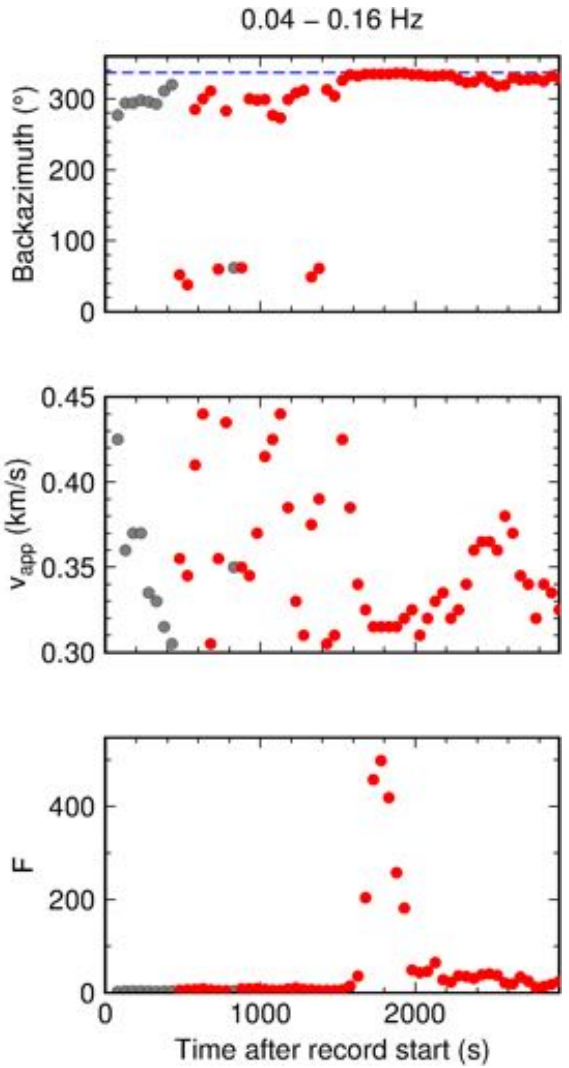


# Aims and motivating questions

- Re-analyse data at surrounding stations – is there a 3rd arrival detected anywhere? (The minimum criteria for an REB event is 3 station detections).
- Why is there no signal at the closest station to the bolide, IS49 (1426 km)?
- Use propagation modelling to understand the distribution of observations.
- Are the South Atlantic stations fit for purpose? Previous lack of observations for the Chelyabinsk meteorite in this region (Le Pichon et al., 2013).
- Are other bolides observed in the South Atlantic?

# LEB - IS27 (4608 km from NASA location)

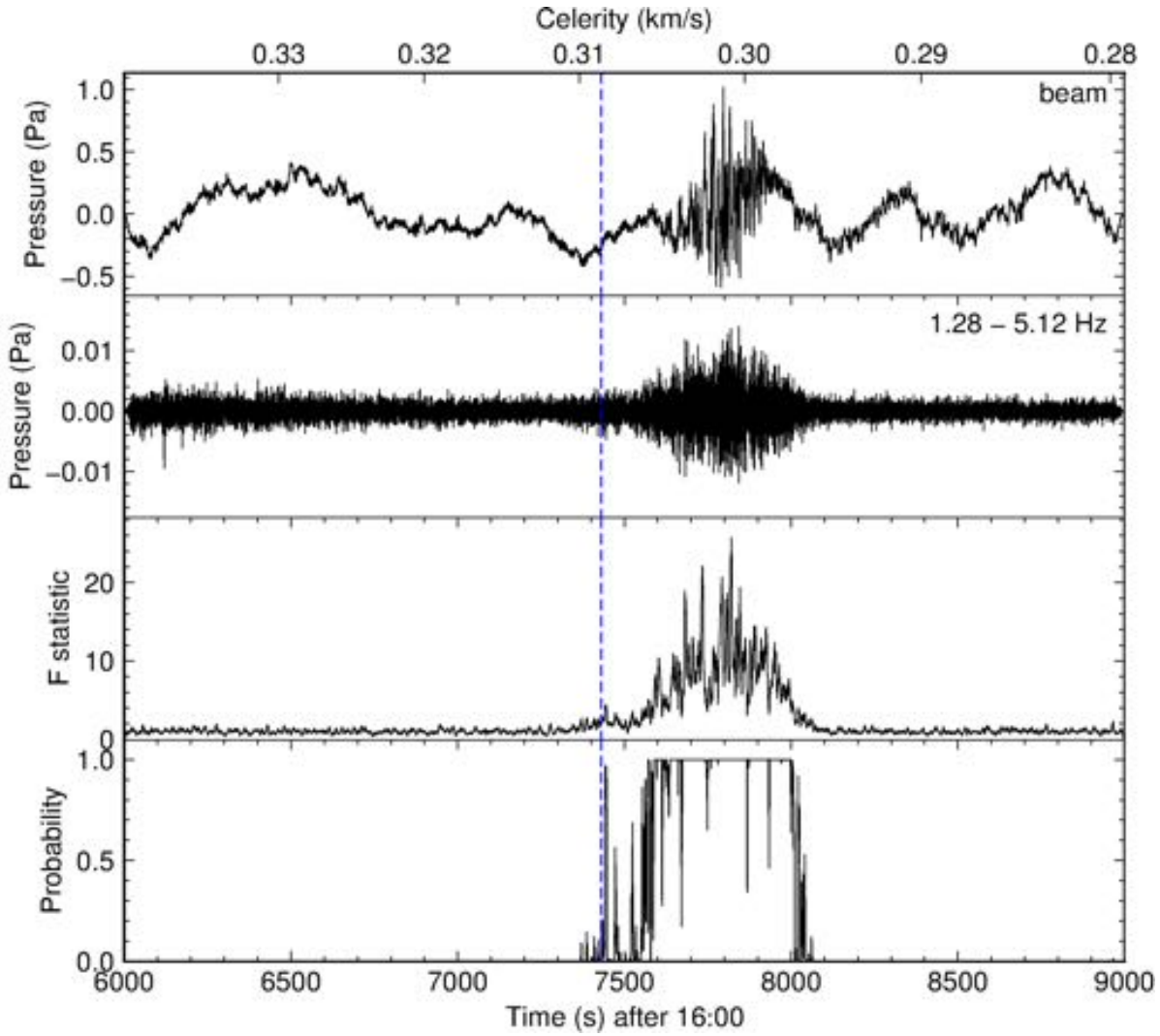


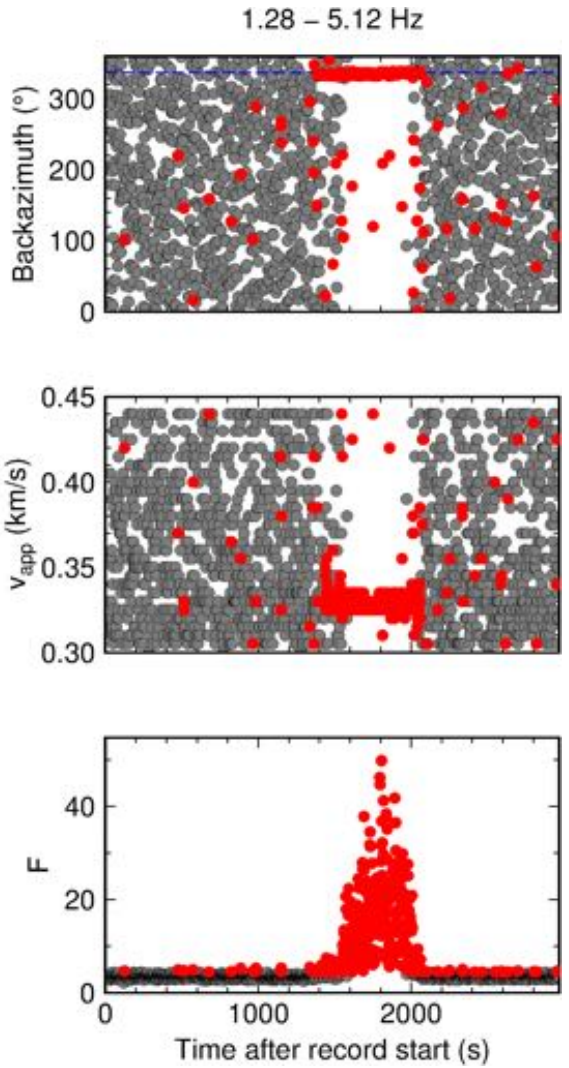




IDC detection time, 18:03:50

95% probability of a signal for SNR = 1.5

# LEB - IS27 (4608 km from NASA location)

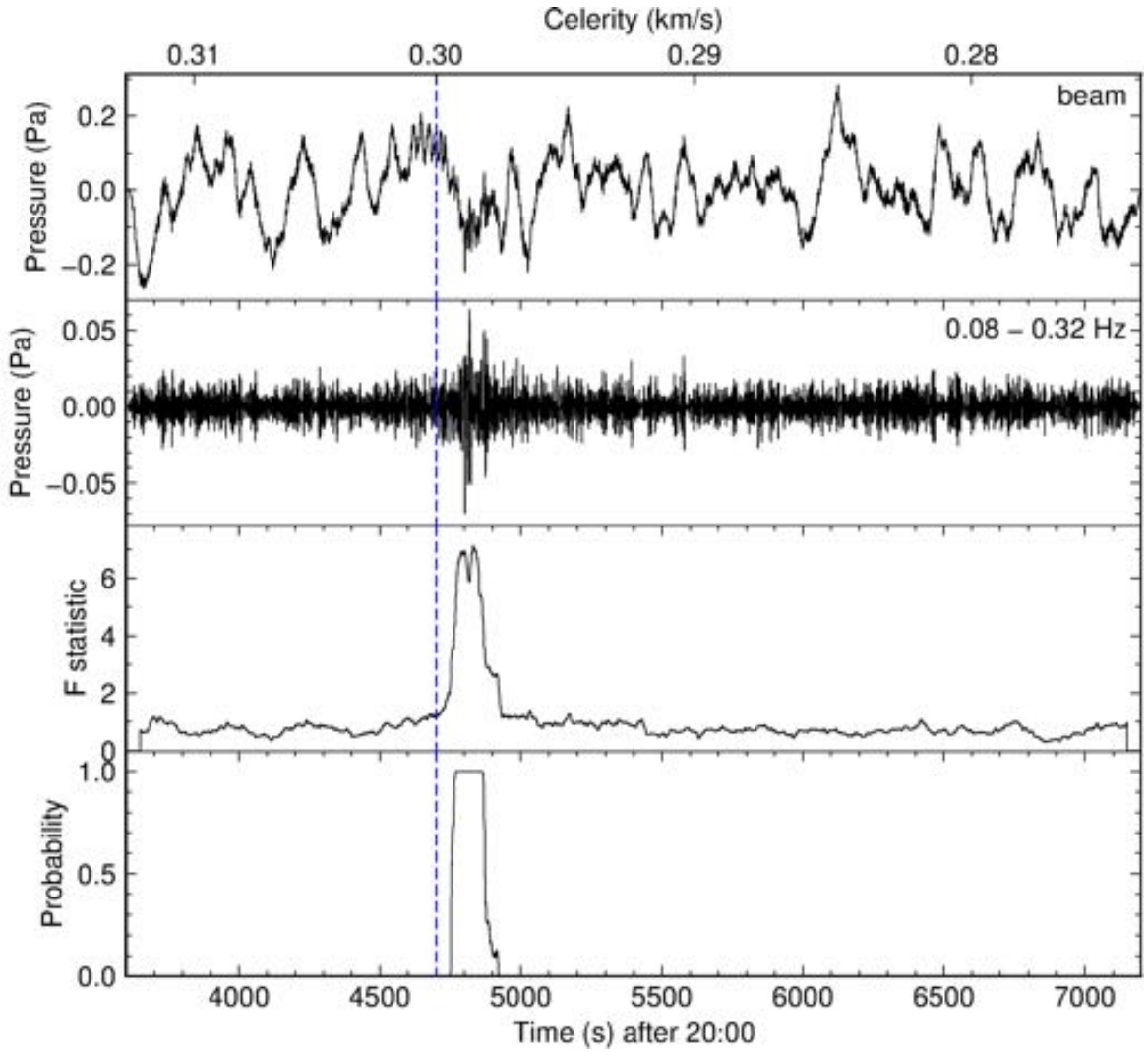


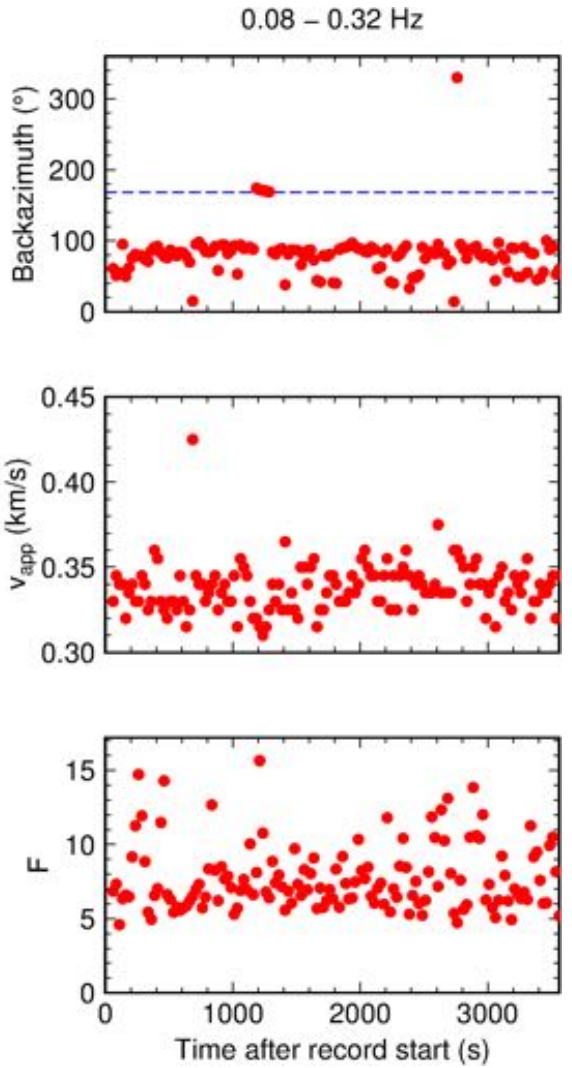




IDC detection time, 18:03:50

95% probability of a signal for SNR = 1.5

# LEB - IS55 (7977 km from NASA location)

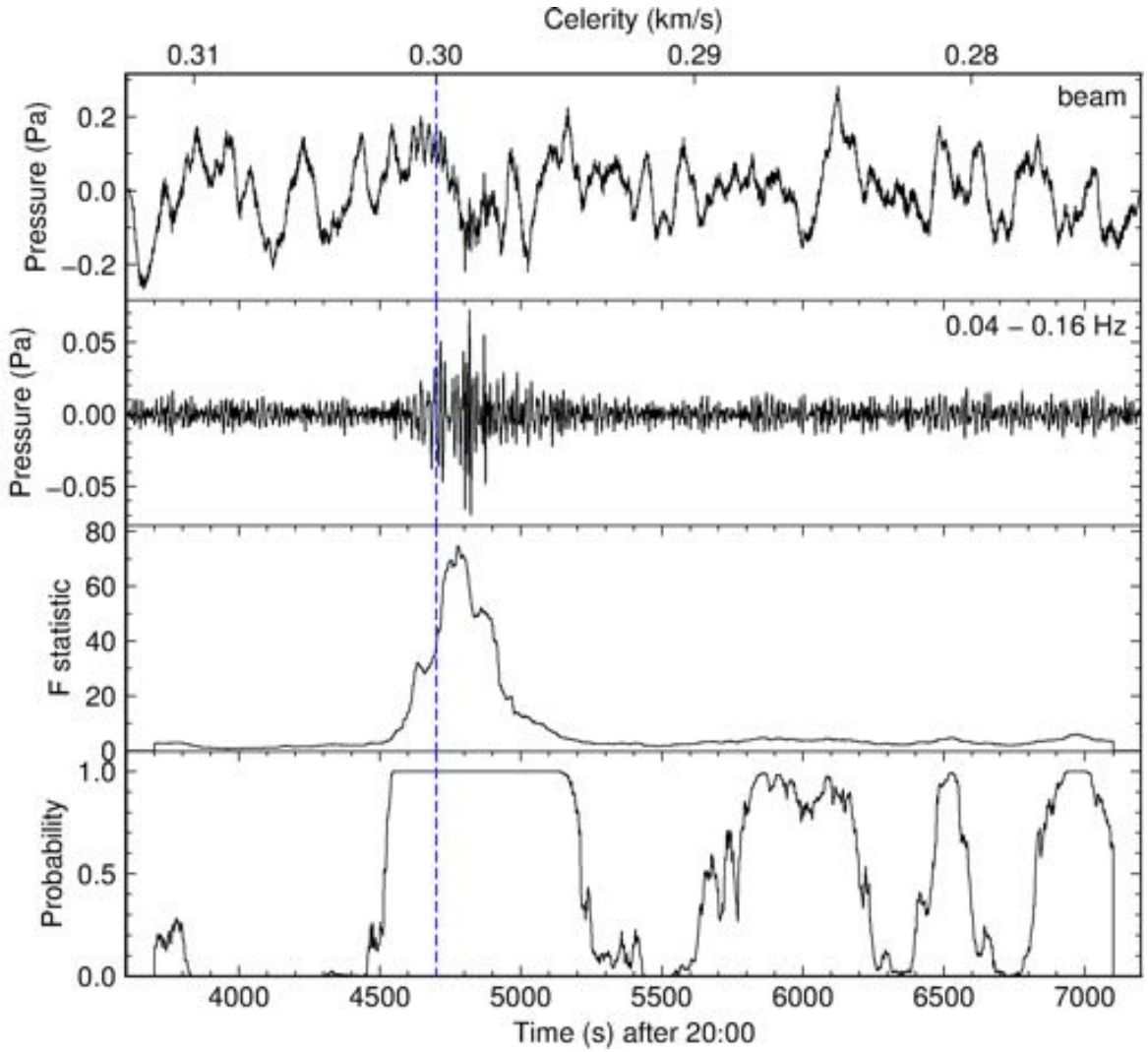


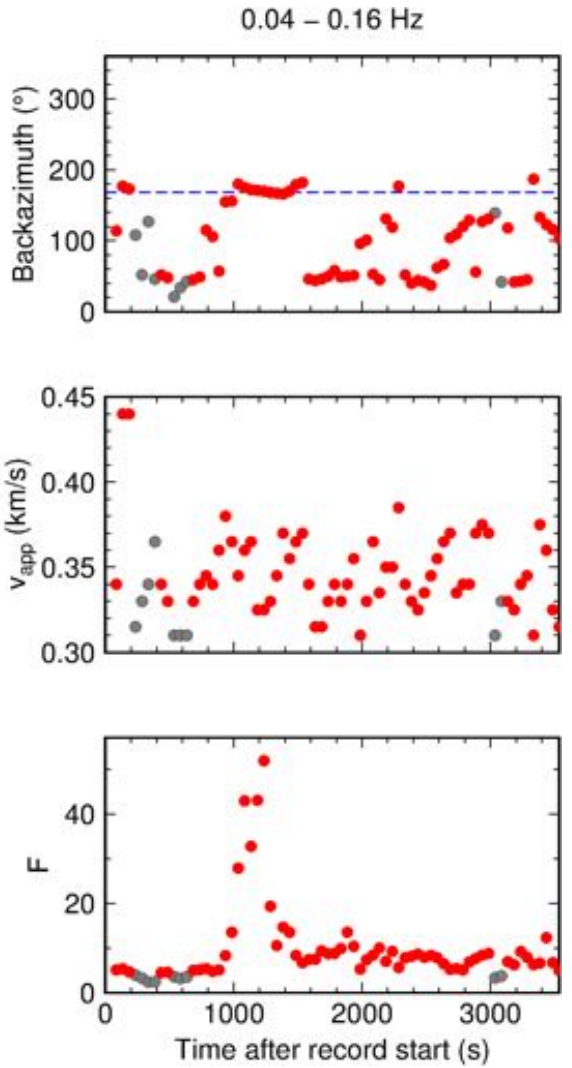




IDC detection time, 21:18:20

95% probability of a signal for SNR = 1.5

# LEB - IS55 (7977 km from NASA location)

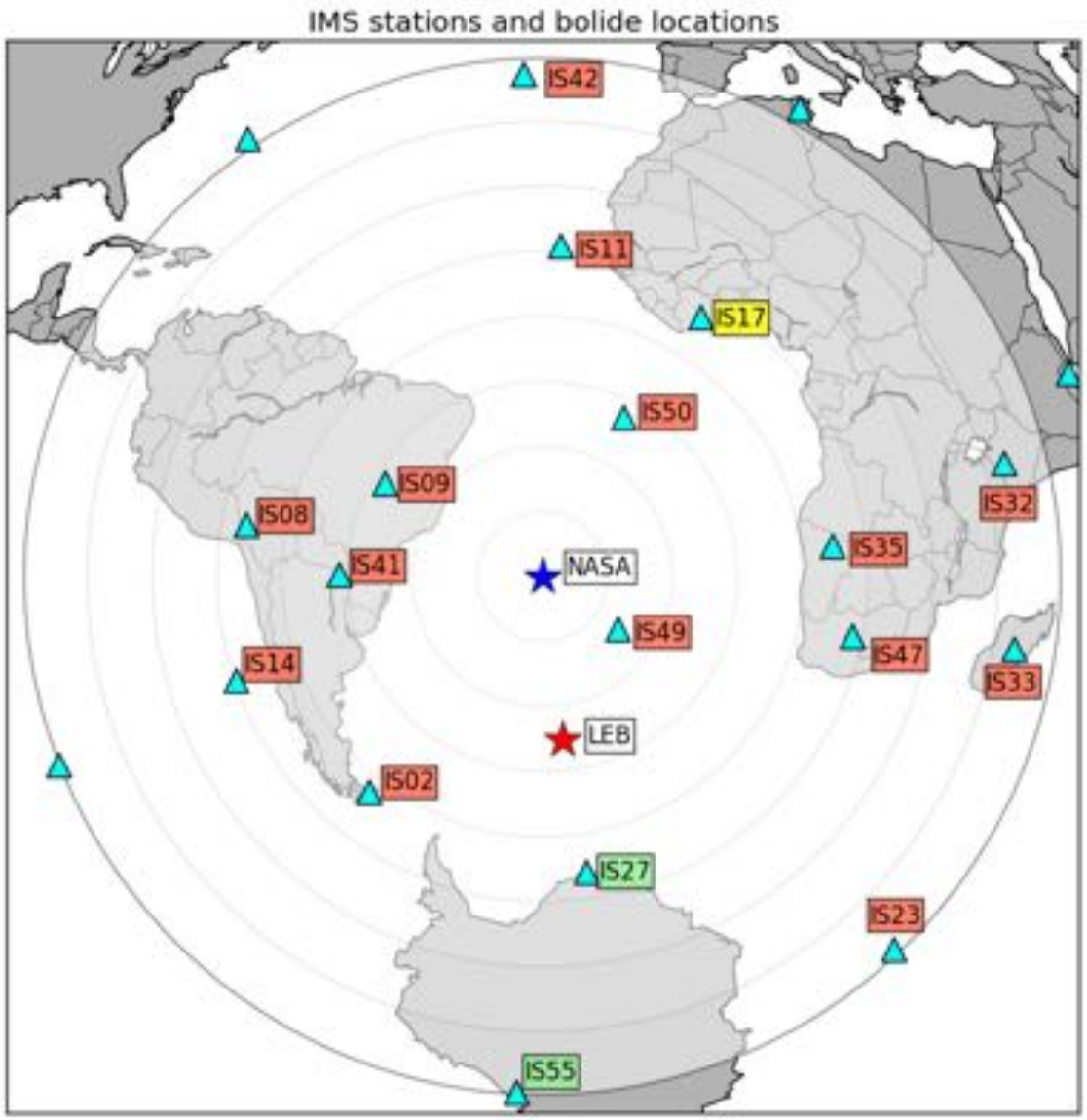



IDC detection time, 21:18:20

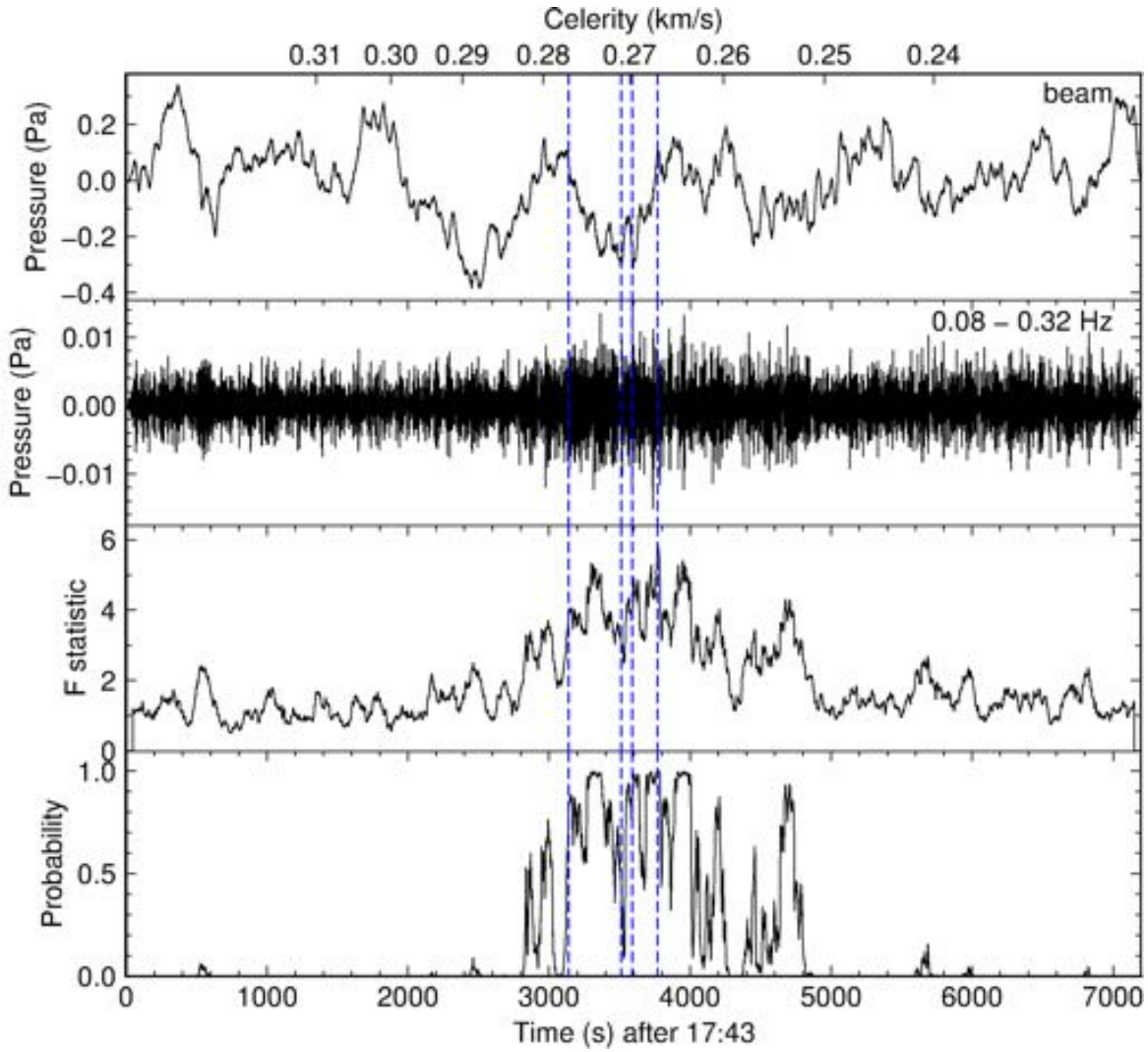
95% probability of a signal for SNR = 1.5

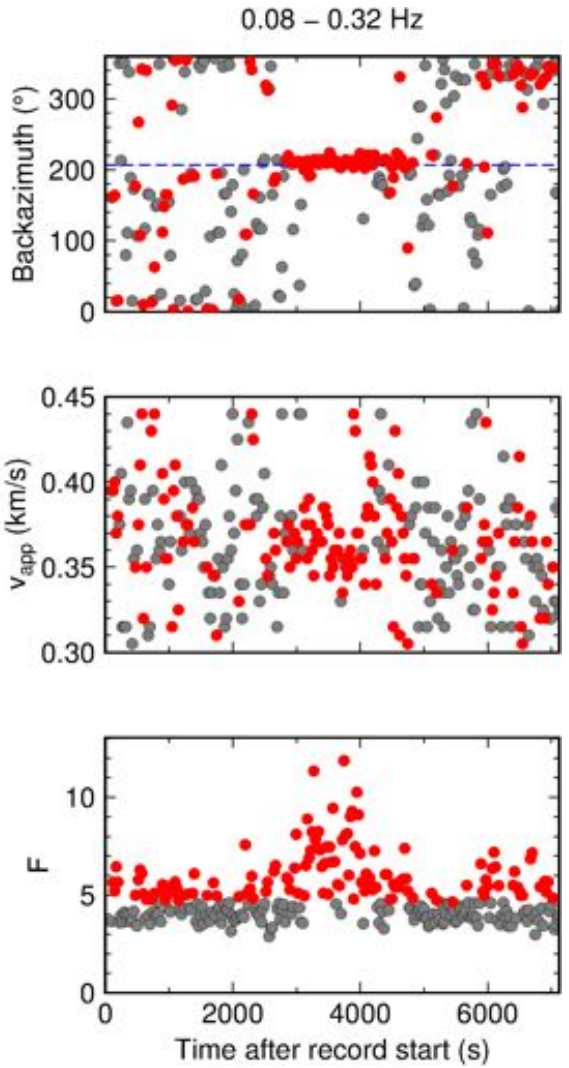
# Data re-analysis - stations




Red – no signal
Green – signal
Yellow – signal?

# IS17 (4656 km from NASA location)




IDC detections

95% probability of a signal for SNR = 1.5

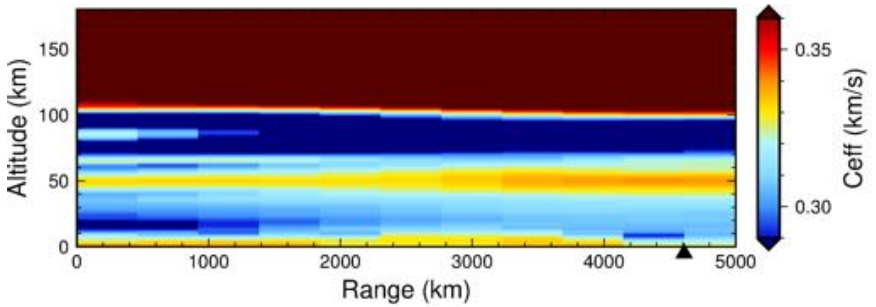
# IS17 (4656 km from NASA location)

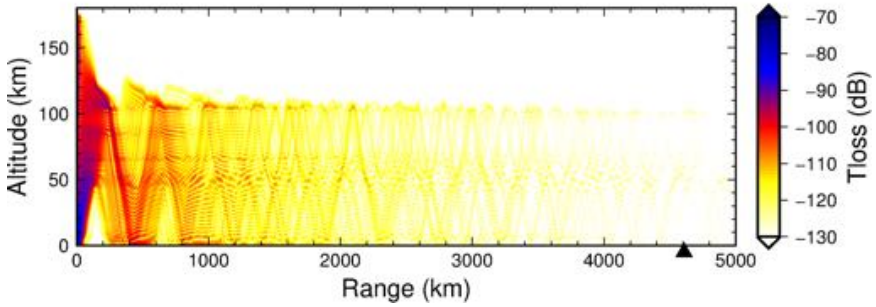
- 98 IDC automatic detections at IS17 on this day
- Only the 4 detections shown are consistent with the predicted arrival back azimuth
- Propagation in this direction is not anticipated for a ground-based source at this time of year

# Range-dependent PE modelling - IS27

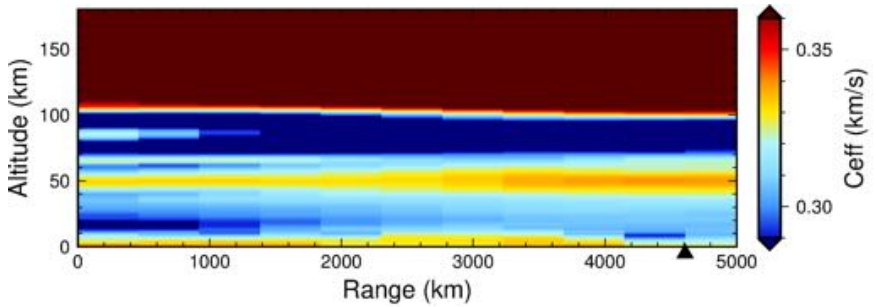
- Effective sound speed, 2D transmission loss magnitude; 0.1 Hz, using G2S profiles.

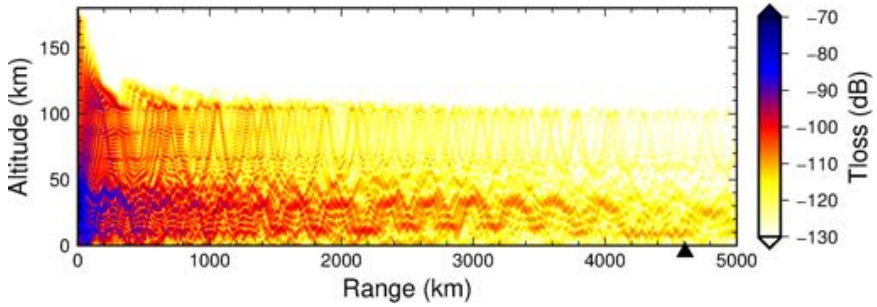
Ground source




Elevated source (31 km)



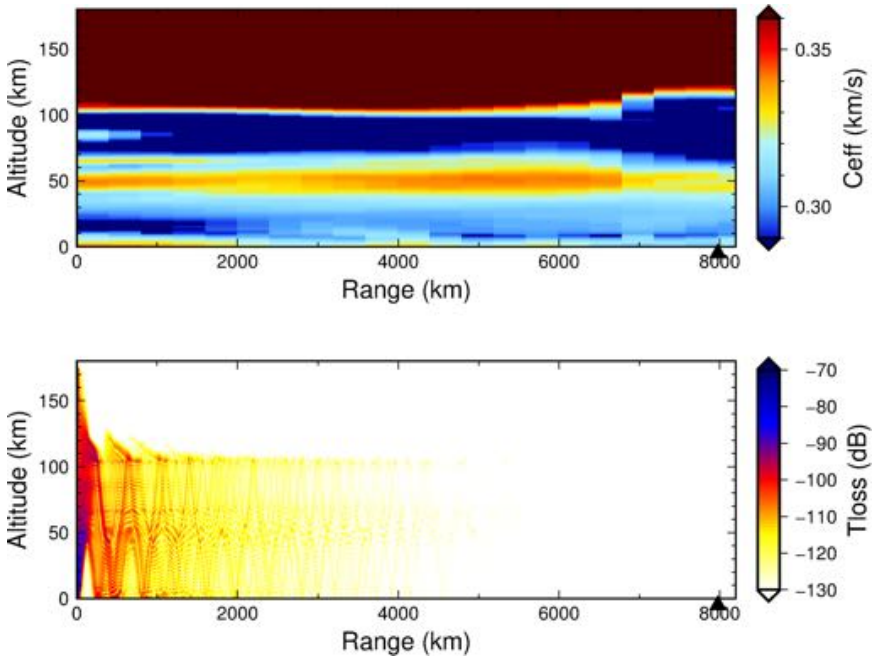




IS27 Azimuth from source, 171.5°

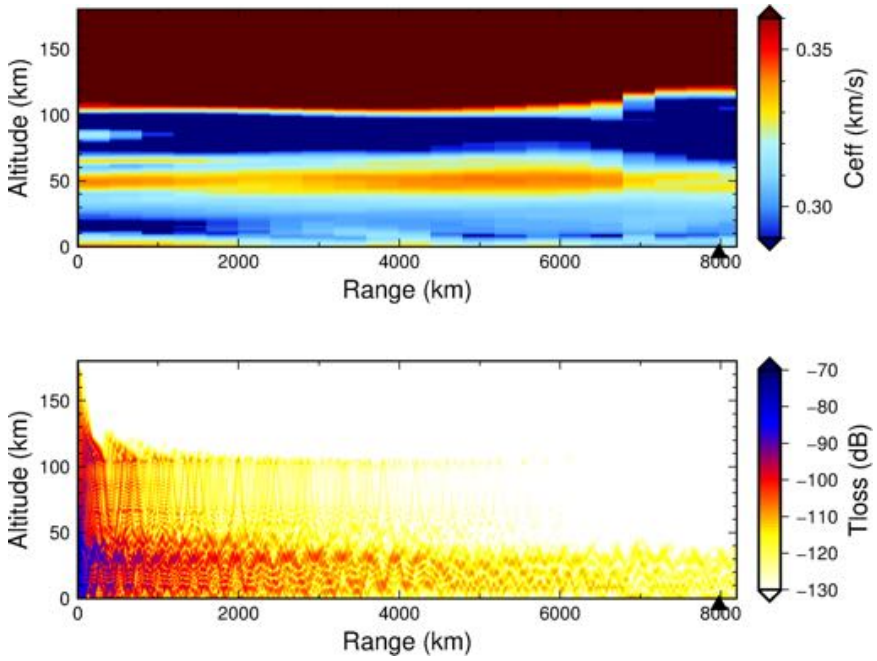
# Range-dependent PE modelling - IS55

- Effective sound speed, 2D transmission loss magnitude; 0.1 Hz, using G2S profiles.

Ground source




Elevated source (31 km)

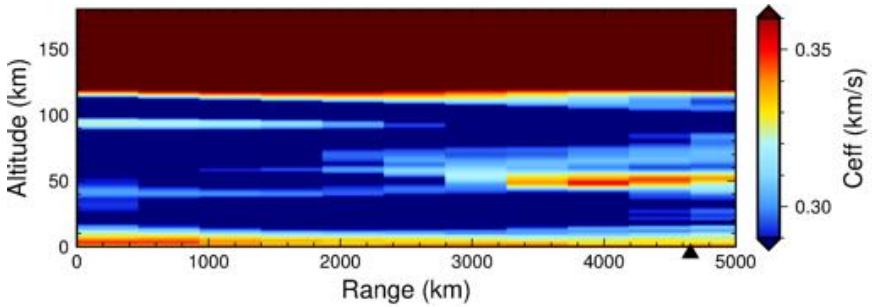


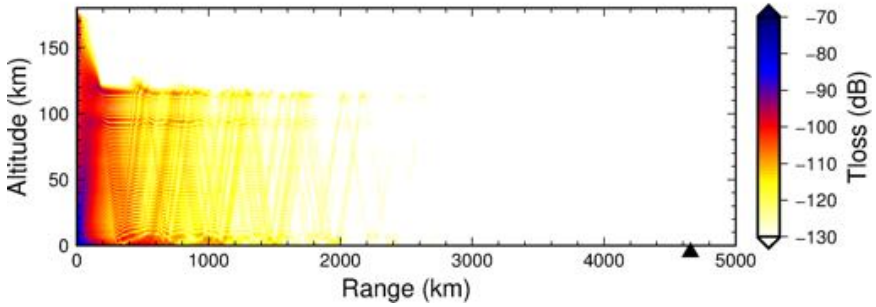

IS55 Azimuth from source, 182.9°

# Range-dependent PE modelling - IS17

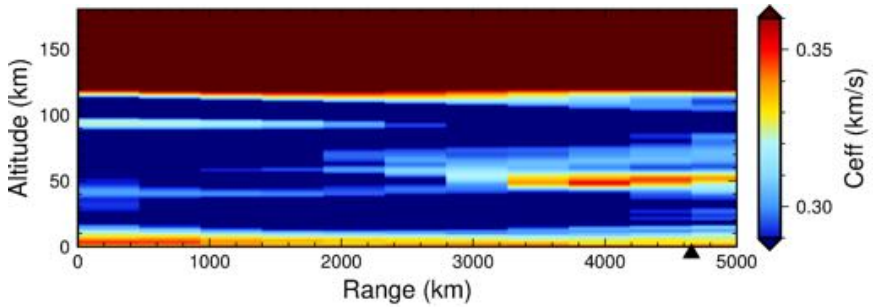
- Effective sound speed, 2D transmission loss magnitude; 0.1 Hz, using G2S profiles.

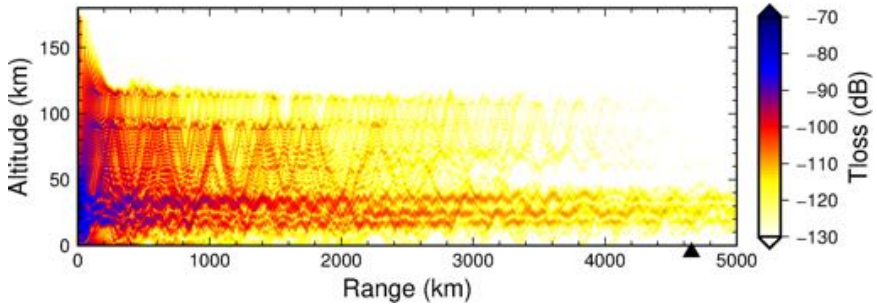
Ground source




Elevated source (31 km)



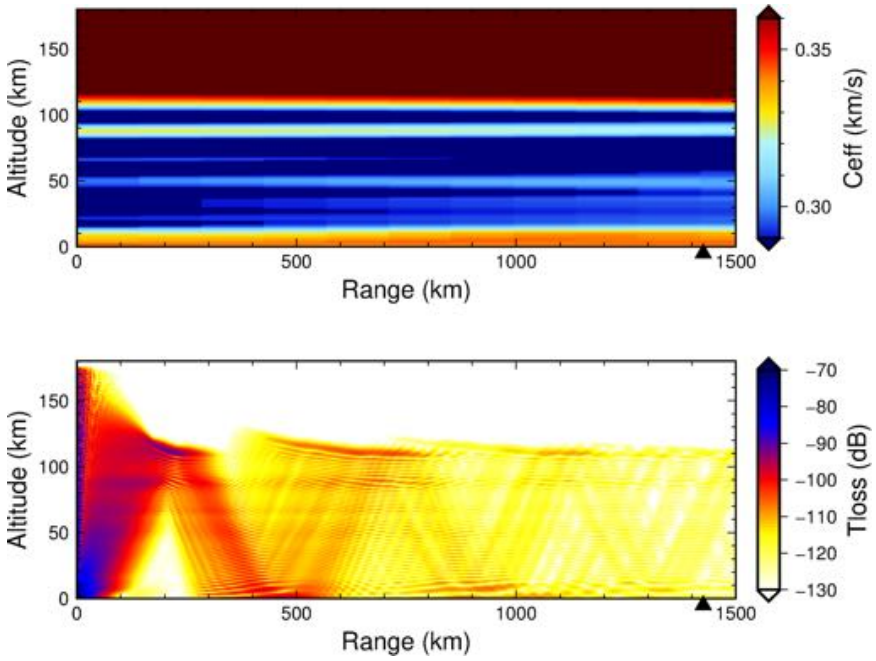




IS17 Azimuth from source, 31.7°

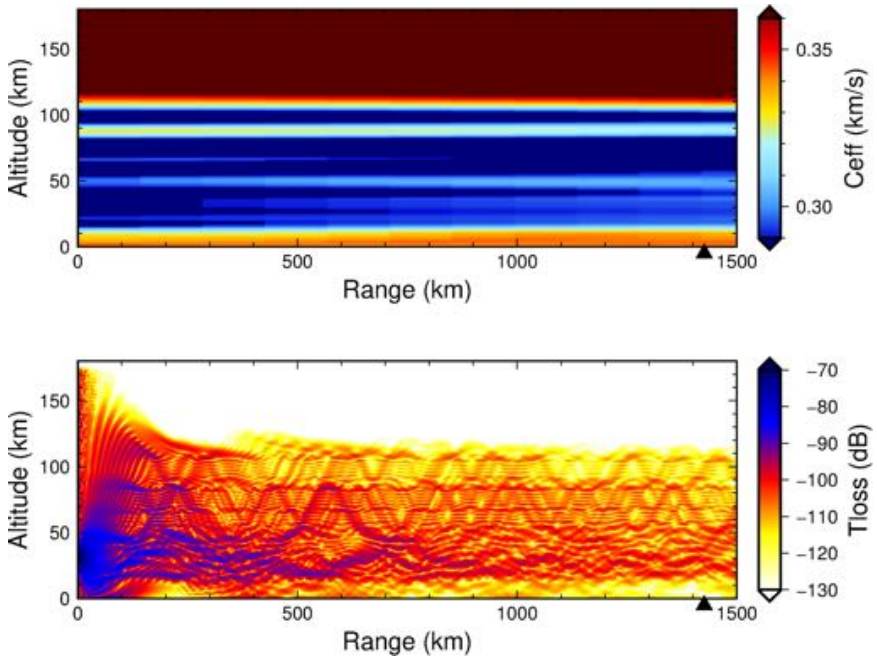
# Range-dependent PE modelling - IS49

- Effective sound speed, 2D transmission loss magnitude; 0.1 Hz, using G2S profiles.

Ground source




Elevated source (31 km)

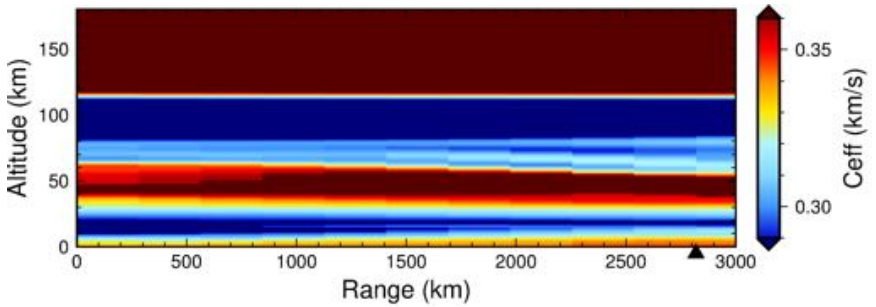



IS49 Azimuth from source, 124.9°

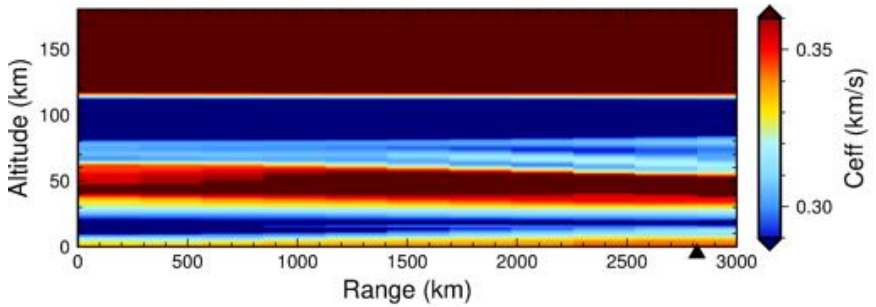
# Range-dependent PE modelling - IS09

- Effective sound speed, 2D transmission loss magnitude; 0.1 Hz, using G2S profiles.

Ground source




Elevated source (31 km)




IS09 Azimuth from source, 300.4°

# Summary so far

- The 13 kt bolide was observed at 3 IMS stations, fulfilling the REB event criterion and allowing for an improved location estimate.

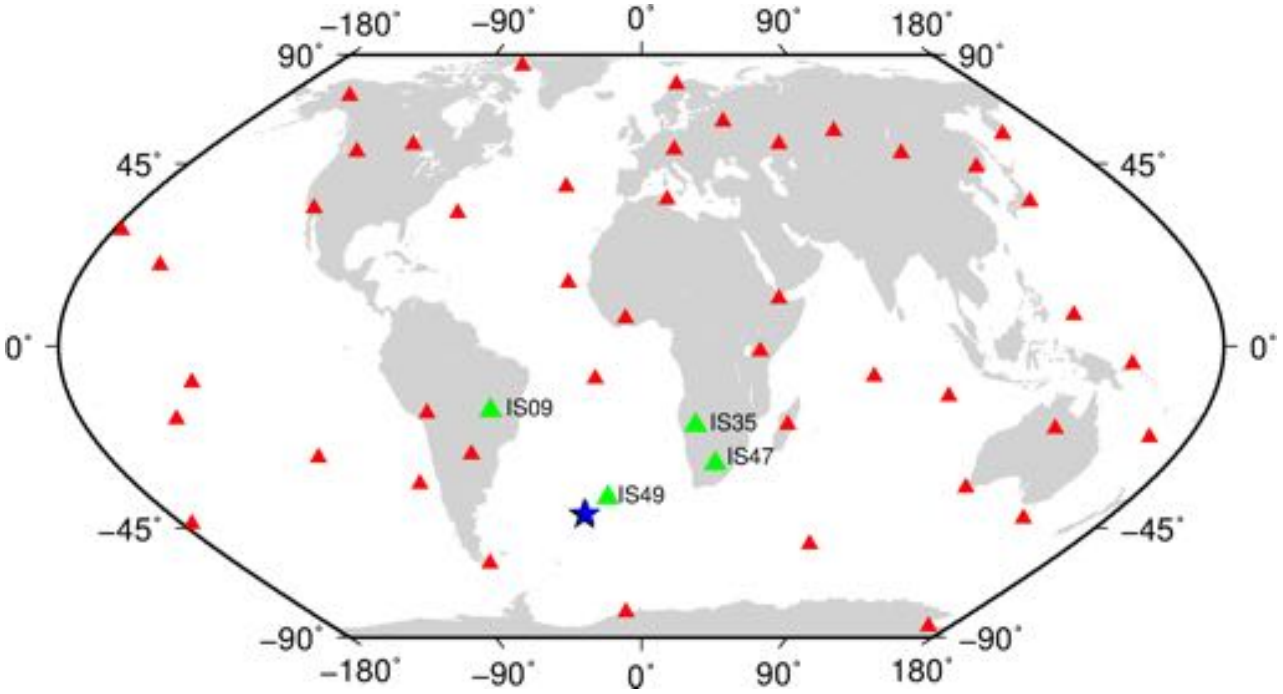
- An elevated source allows energy to propagate out to greater distances than a ground-based source.

- The modelling supports observations at IS27, IS55 and IS17
- However, the modelling does not simply explain the lack of observations at IS49 and IS09.

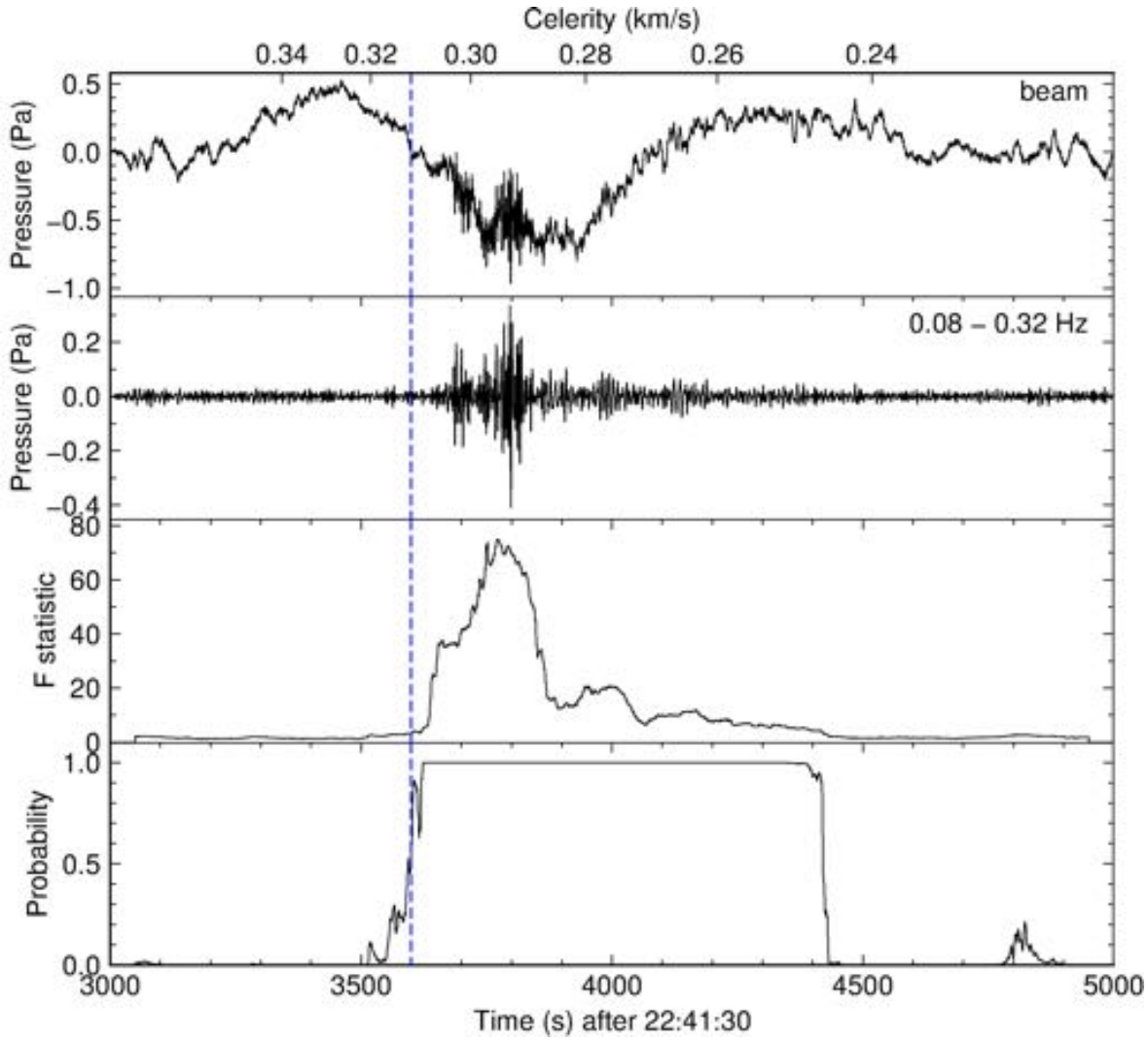
# REB bolide event, South Atlantic

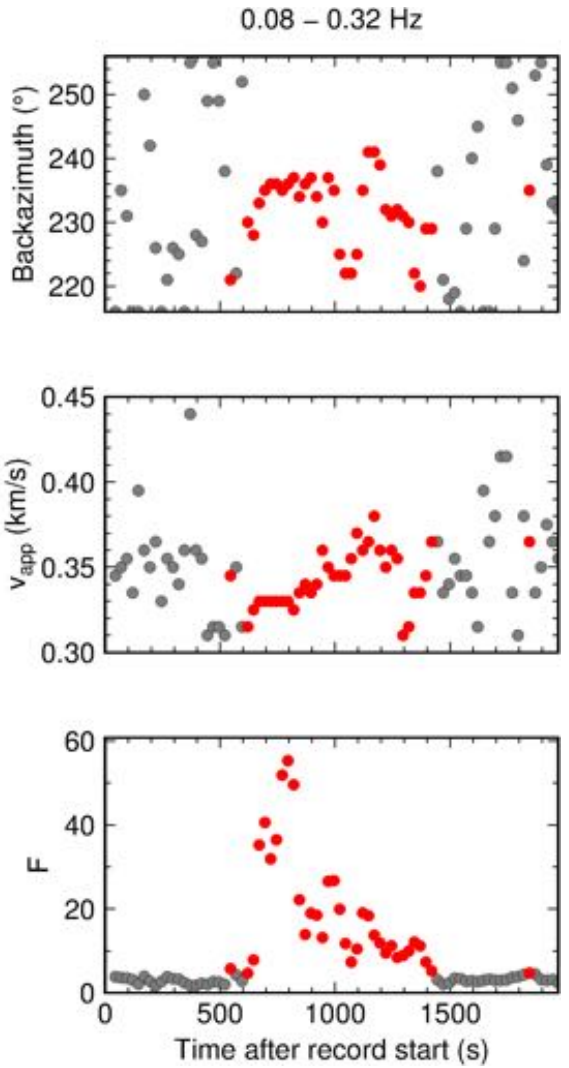
- South Atlantic Bolide 22:50:12 03-Oct-2012 at unknown km altitude and total impact energy, 0.75 **kt**
  http://neo.jpl.nasa.gov/fireballs/

- 4 IMS station detections associated, IS49 (989 km), IS09 (3809 km), IS35 (4472 km) and IS47 (4470 km).



# IS49 (989 km from NASA location)

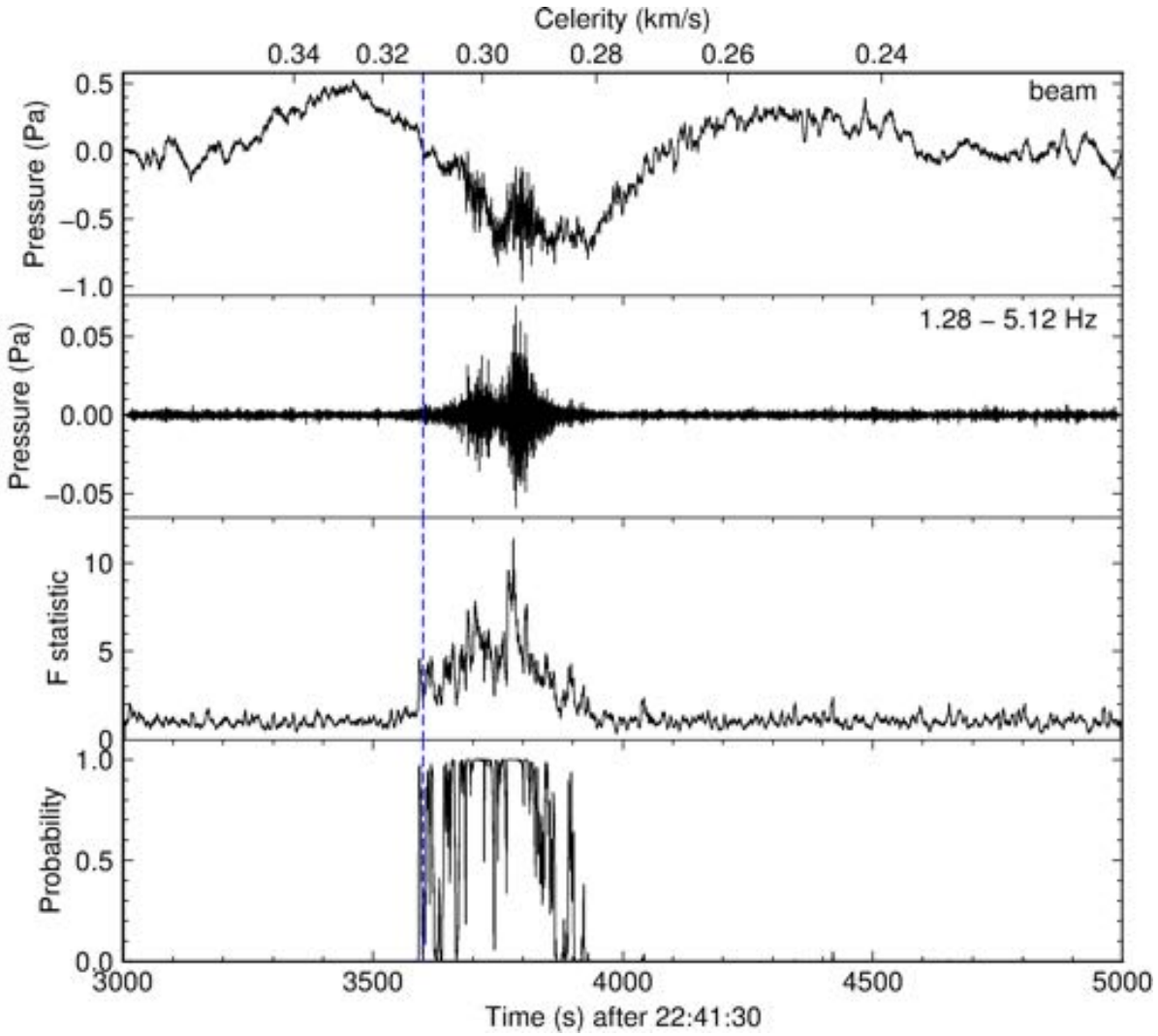


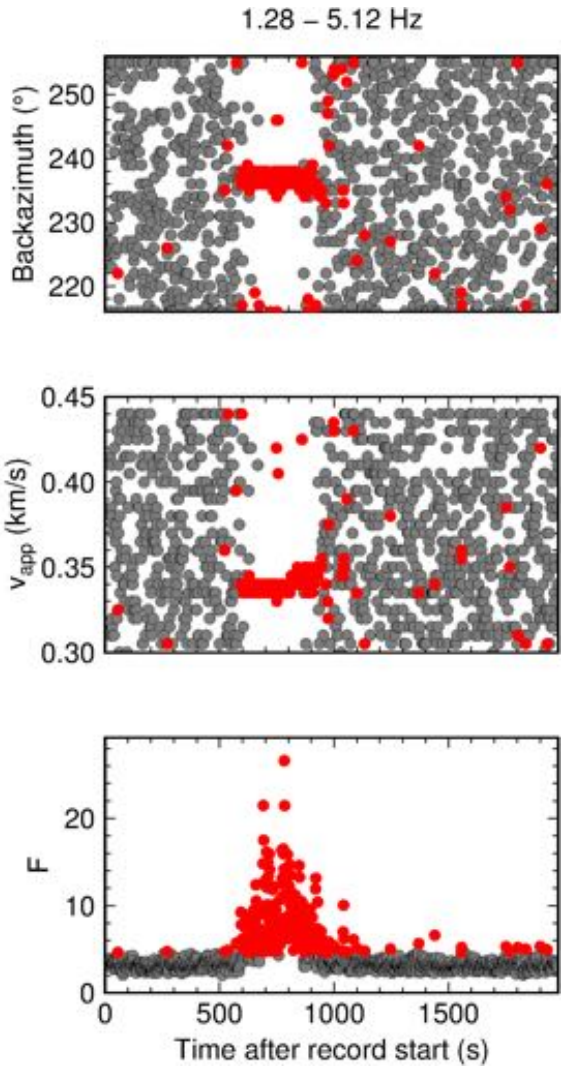




IDC detection time, 23:41:30

95% probability of a signal for SNR = 1.5

# IS49 (989 km from NASA location)

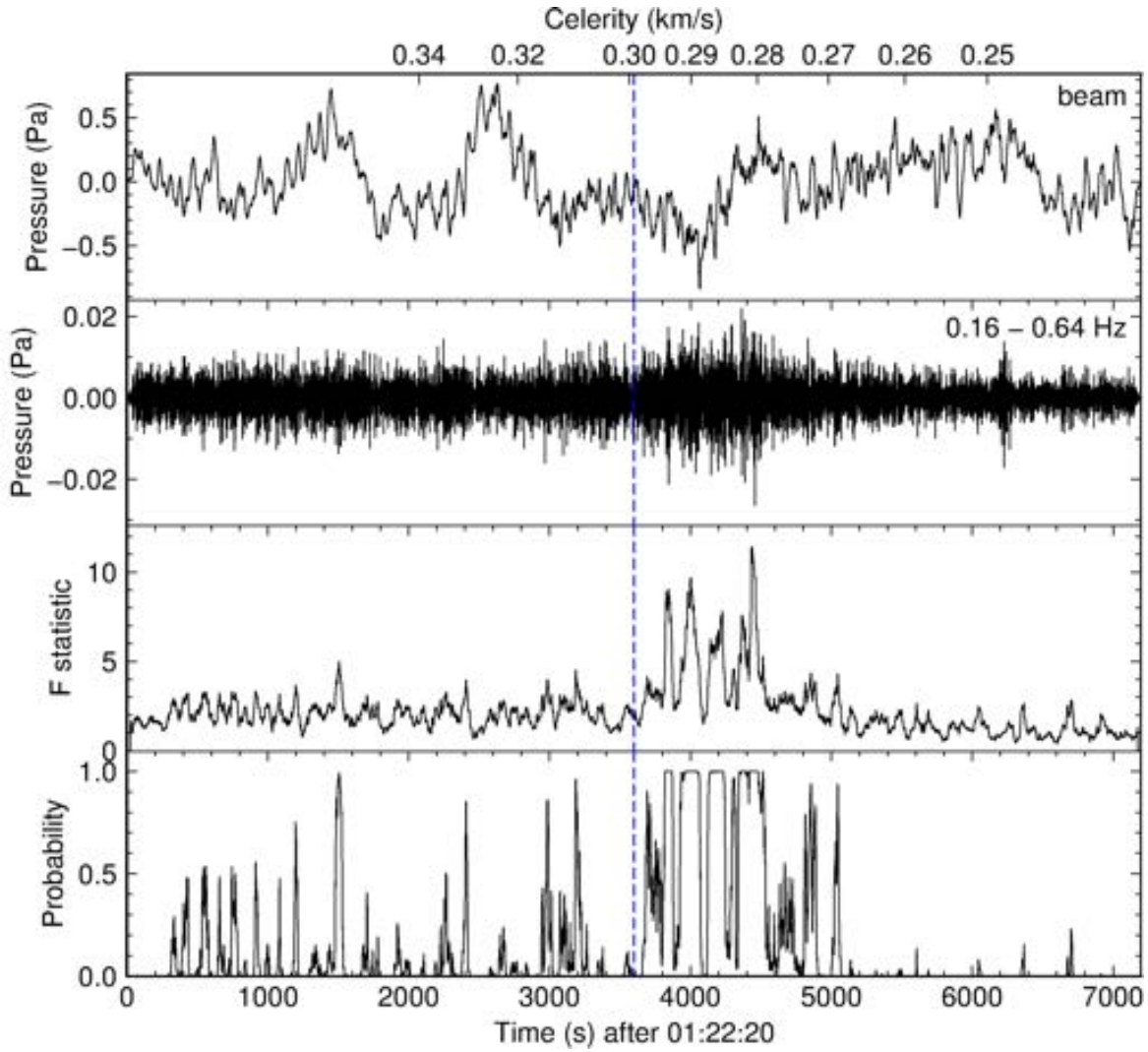


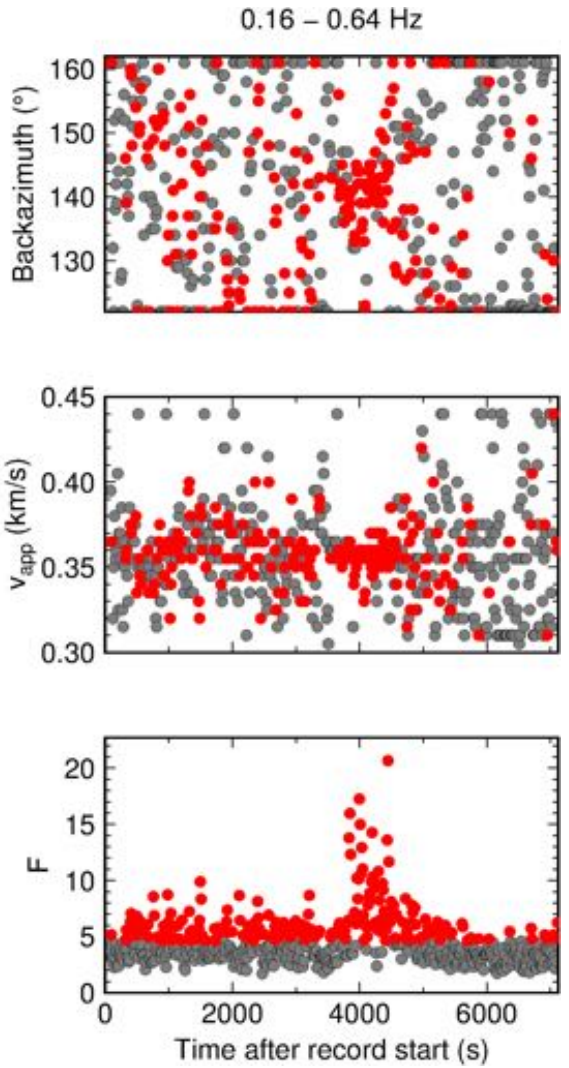




IDC detection time, 23:41:30

95% probability of a signal for SNR = 1.5

# IS09 (3809 km from NASA location)

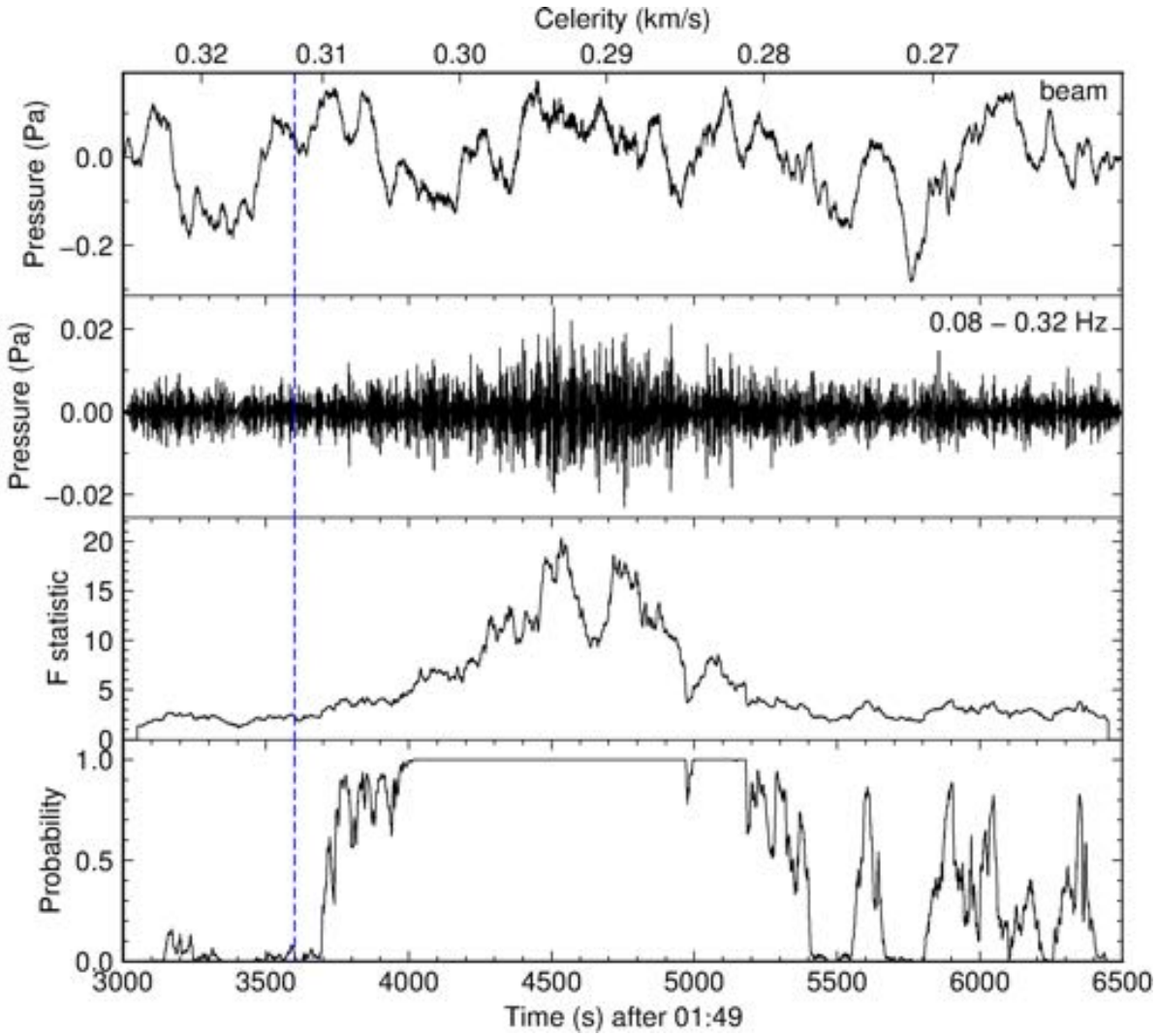


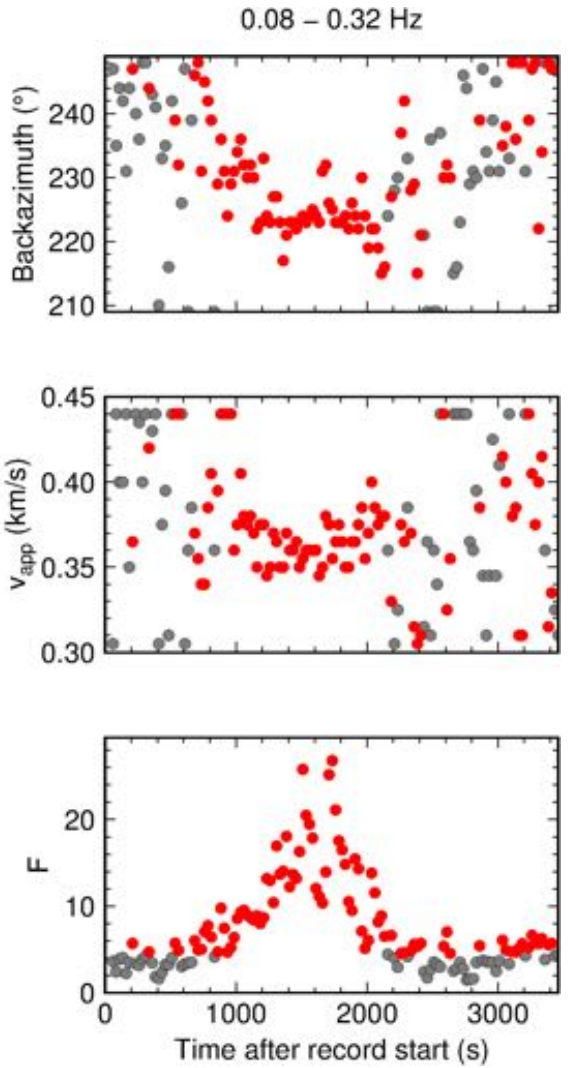




IDC detection time, 02:22:20

95% probability of a signal for SNR = 1.5

# IS35 (4472 km from NASA location)



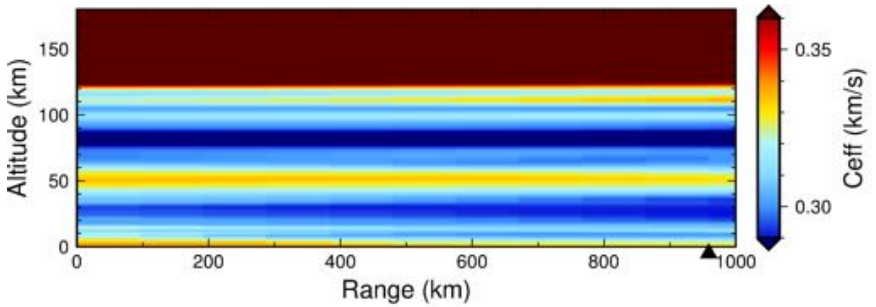

IDC detection time, 02:49:00

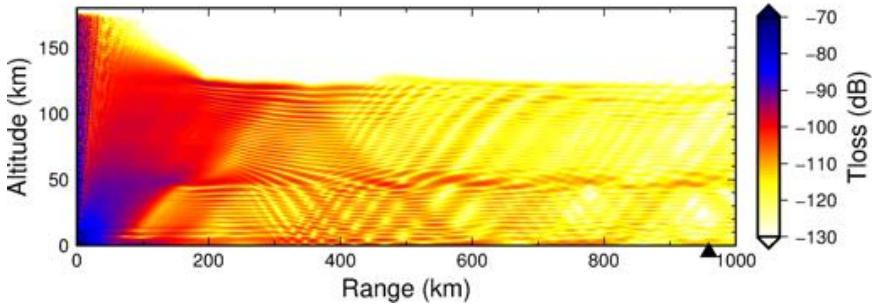
95% probability of a signal for SNR = 1.5

# Range-dependent PE modelling - IS49

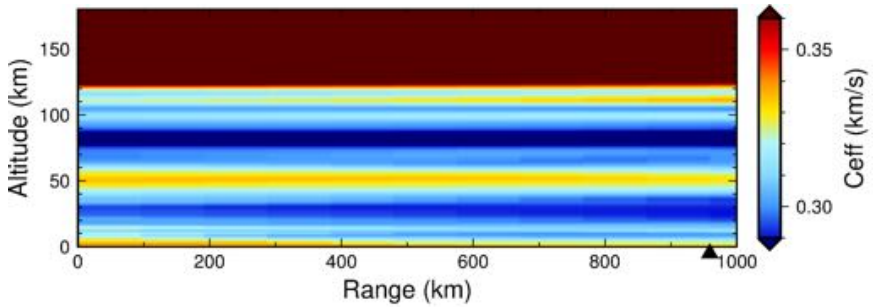
- Effective sound speed, 2D transmission loss magnitude; 0.1 Hz, using G2S profiles.

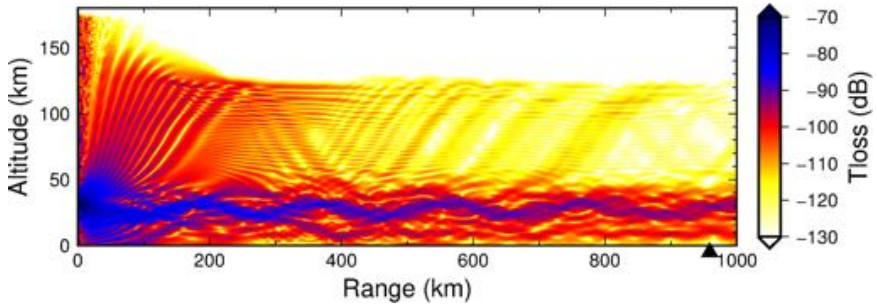
Ground source




Elevated source (31 km)



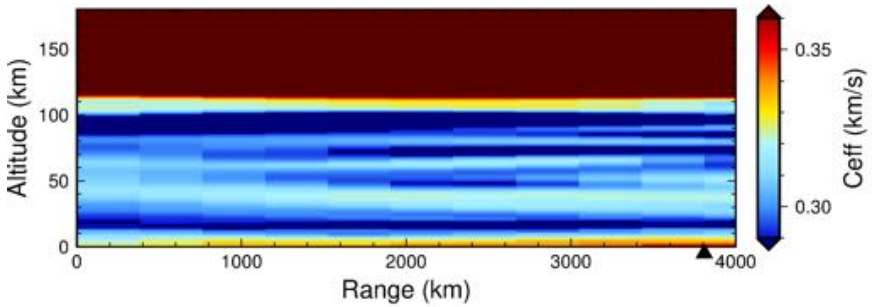



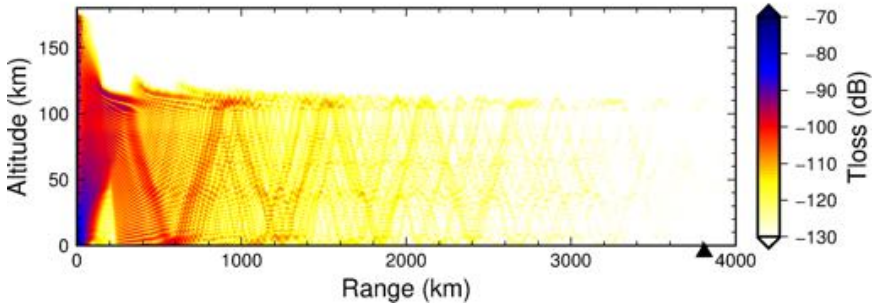

IS49 Azimuth from source, 62.4°

# Range-dependent PE modelling - IS09

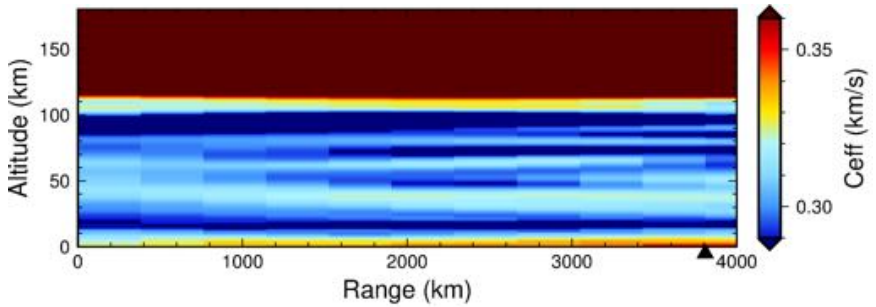
- Effective sound speed, 2D transmission loss magnitude; 0.1 Hz, using G2S profiles.

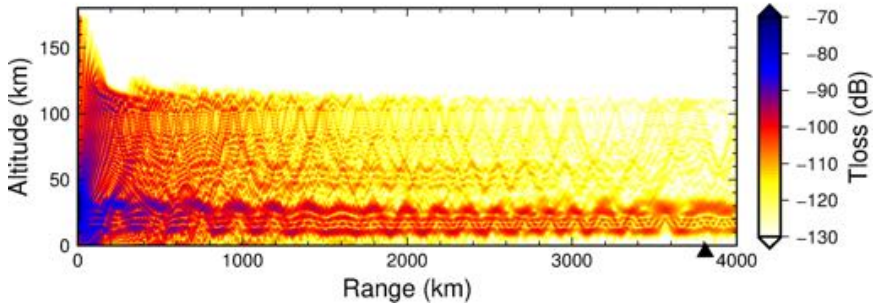
Ground source




Elevated source (31 km)



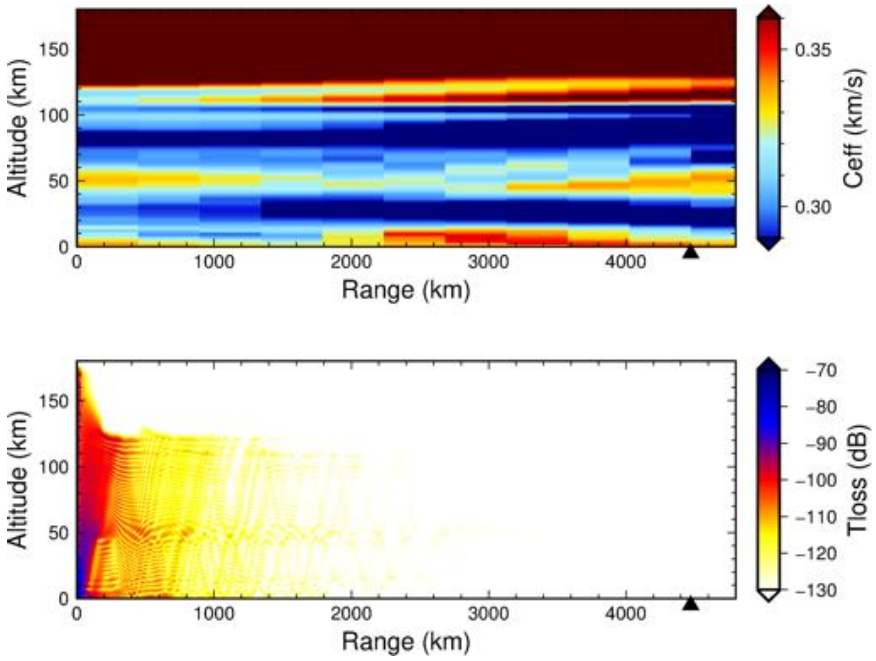




IS09 Azimuth from source, 311.1°

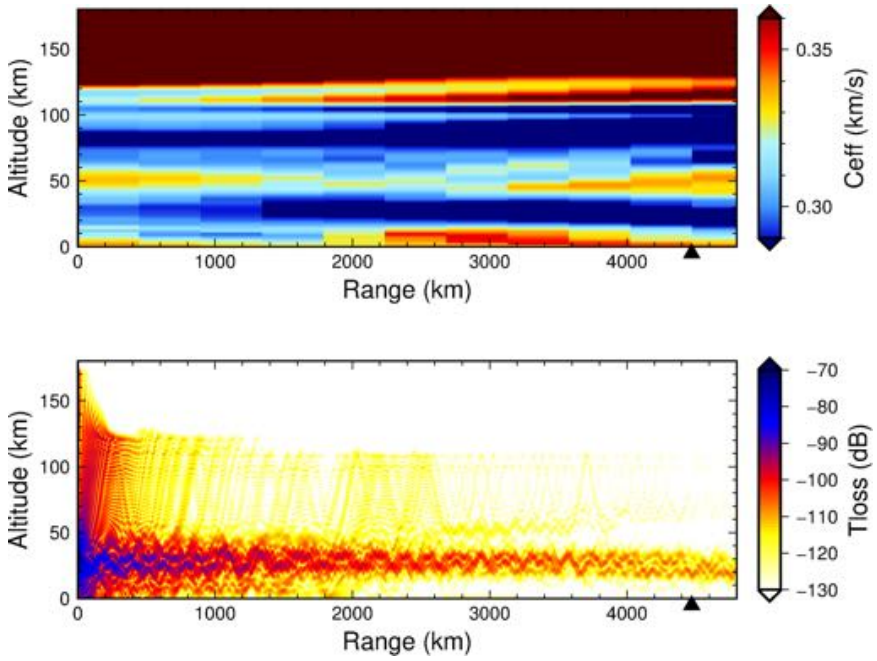
# Range-dependent PE modelling - IS35

- Effective sound speed, 2D transmission loss magnitude; 0.1 Hz, using G2S profiles.

Ground source




Elevated source (31 km)

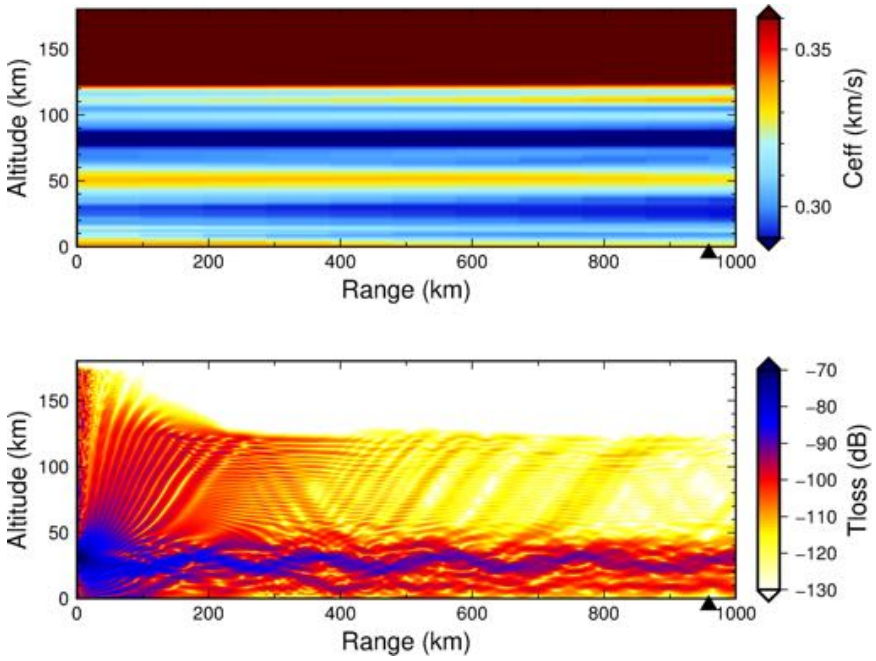



IS35 Azimuth from source, 68.6°

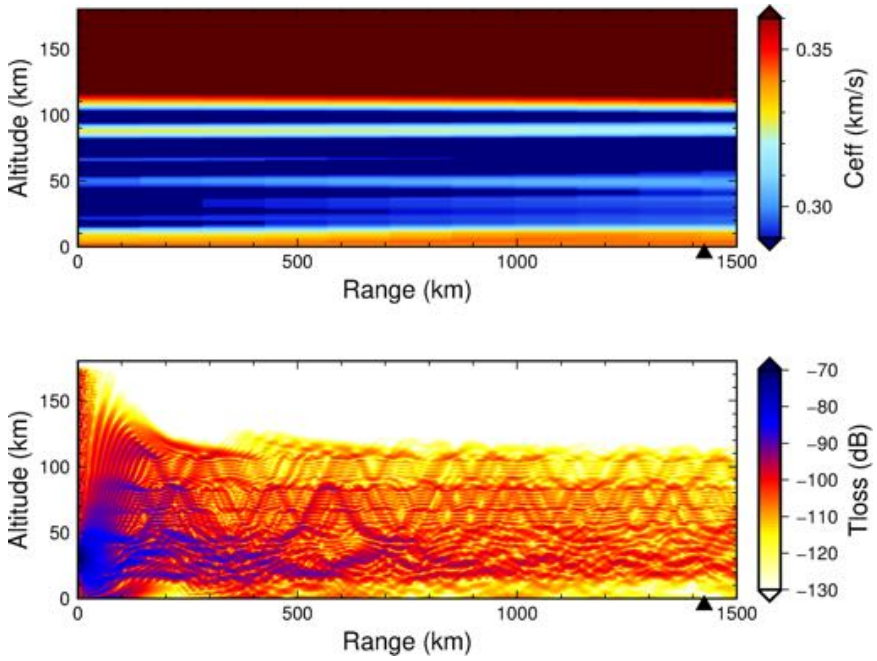
# IS49 event comparison - elevated

- Effective sound speed, 2D transmission loss magnitude; 0.1 Hz, using G2S profiles.

2012




2016




IS49 Azimuth from source, 62.4° (2012), 124.9° (2016)

# Summary

- 2 different bolides from the South Atlantic region studied, 13 kt in LEB and 0.75 kt in REB
- Observed a third arrival for the 2016-Feb-06 bolide at IS17, in addition to the IDC observations at IS27 and IS55
- Confirmed 3 of the 4 REB observations for the 2012 bolide
- Propagation modelling shows that for an elevated source, energy propagates to greater distances, increasing the likelihood of observations both at greater distances and bi-directionally
- Further work is needed to fully understand the observational distributions
- This work has implications for measures of network performance

# Acknowledgements

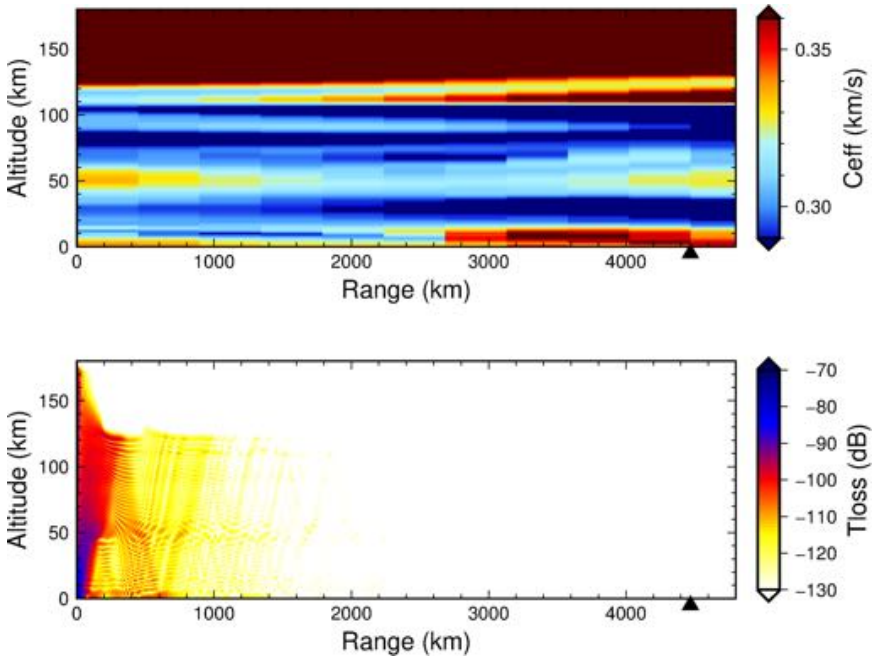

- We would like to thank Doug Drob for the G2S atmospheric specifications

- Modelling was performed using ncpaprop 1.3.17, NCPA Infrasound Propagation Modelling Package

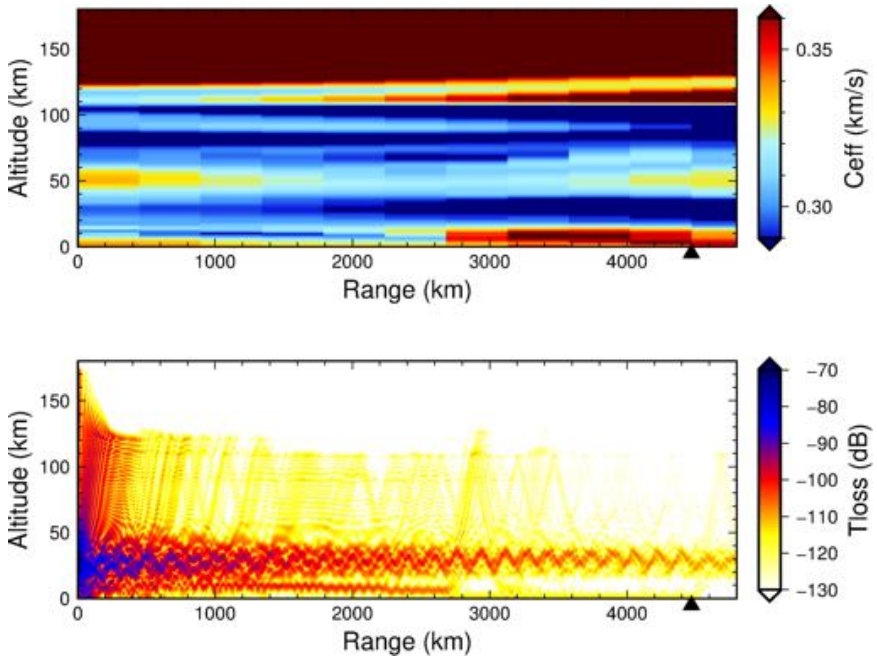
# Range-dependent PE modelling - IS47

- Effective sound speed, 2D transmission loss magnitude; 0.1 Hz, using G2S profiles.

Ground source




Elevated source (31 km)

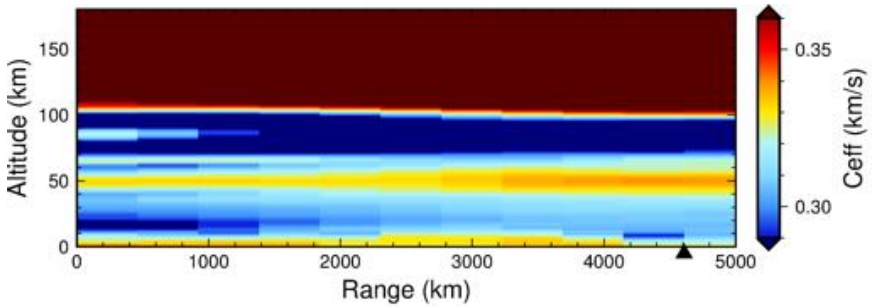


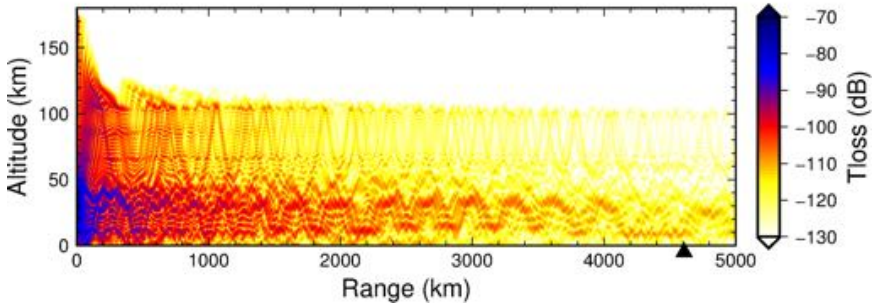

IS47 Azimuth from source, 86.8°

# PE modelling, elevated source - IS27

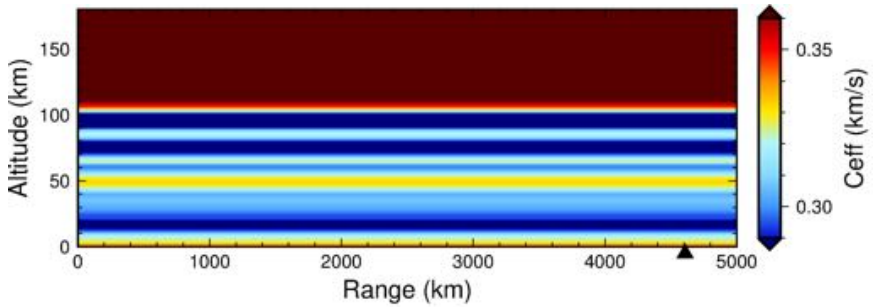
- Effective sound speed, 2D transmission loss magnitude; 0.1 Hz, using G2S profiles.

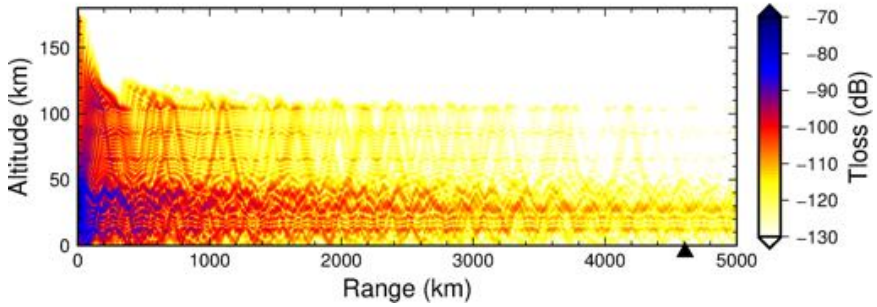
Range dependent




Range independent

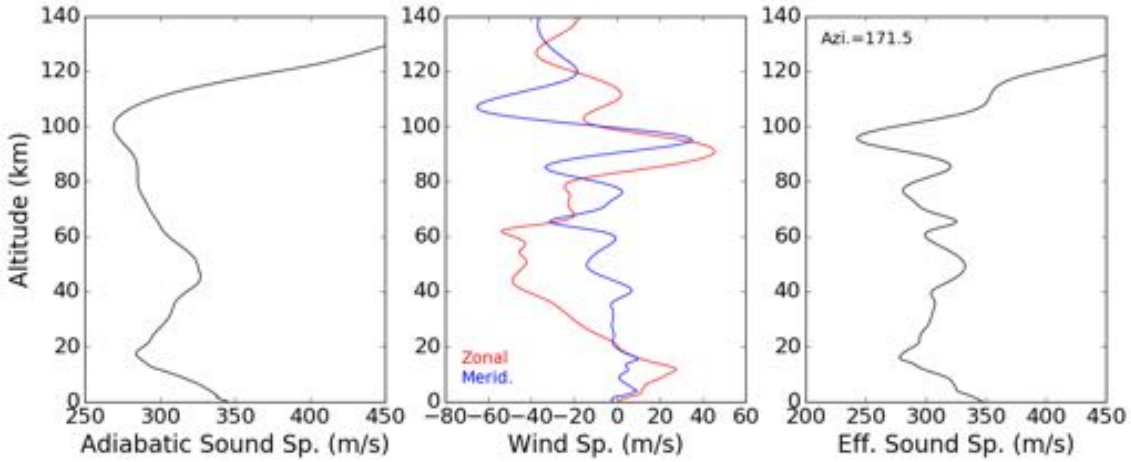


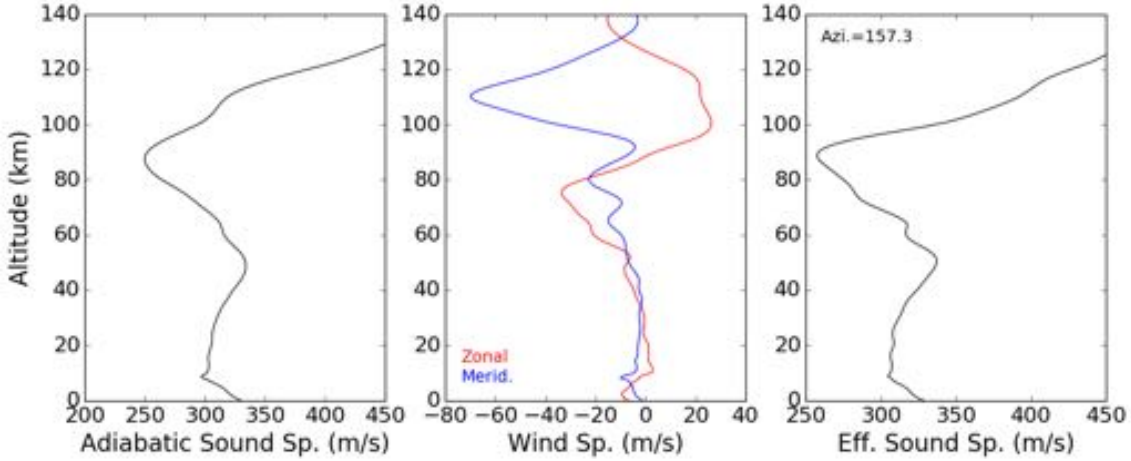

IS27 Azimuth from source, 171.5°

# 1-D G2S Profiles IS27 2016 event

Source location

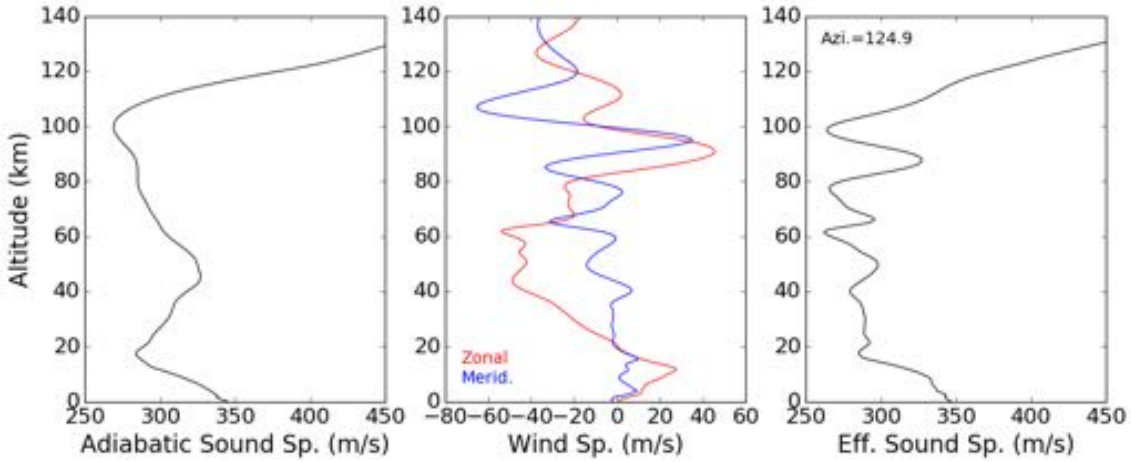



Station location



# 1-D G2S Profiles IS49 2016 event

Source location




Station location