CTBTO IMS CONTRIBUTION TO SDG:14 LIFE BELOW WATER INDIAN OCEAN

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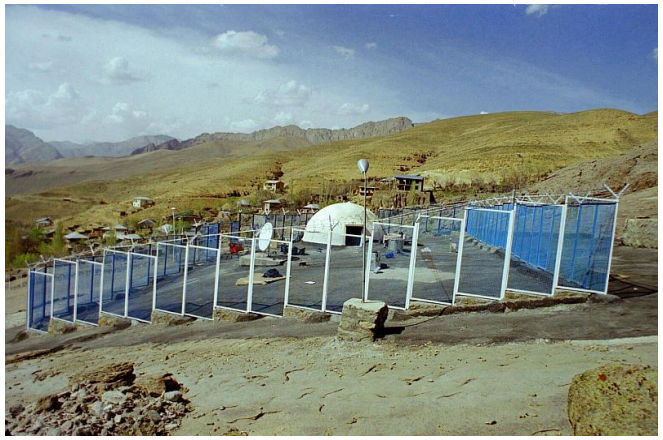
STUDY OBJECTIVES

- Analyze the Indian Ocean May-November-December, 2018 hydro acoustic data;
- Identify the source of events in the studied area;
- Interpret the result contribution SDG:14 Life below water.

INTRODUCTION

SEISMIC STATIONS

detect underground explosions



INFRASOUND STATIONS

detect events in the atmosphere

HYDROACOUSTIC STATIONS

underwater explosions

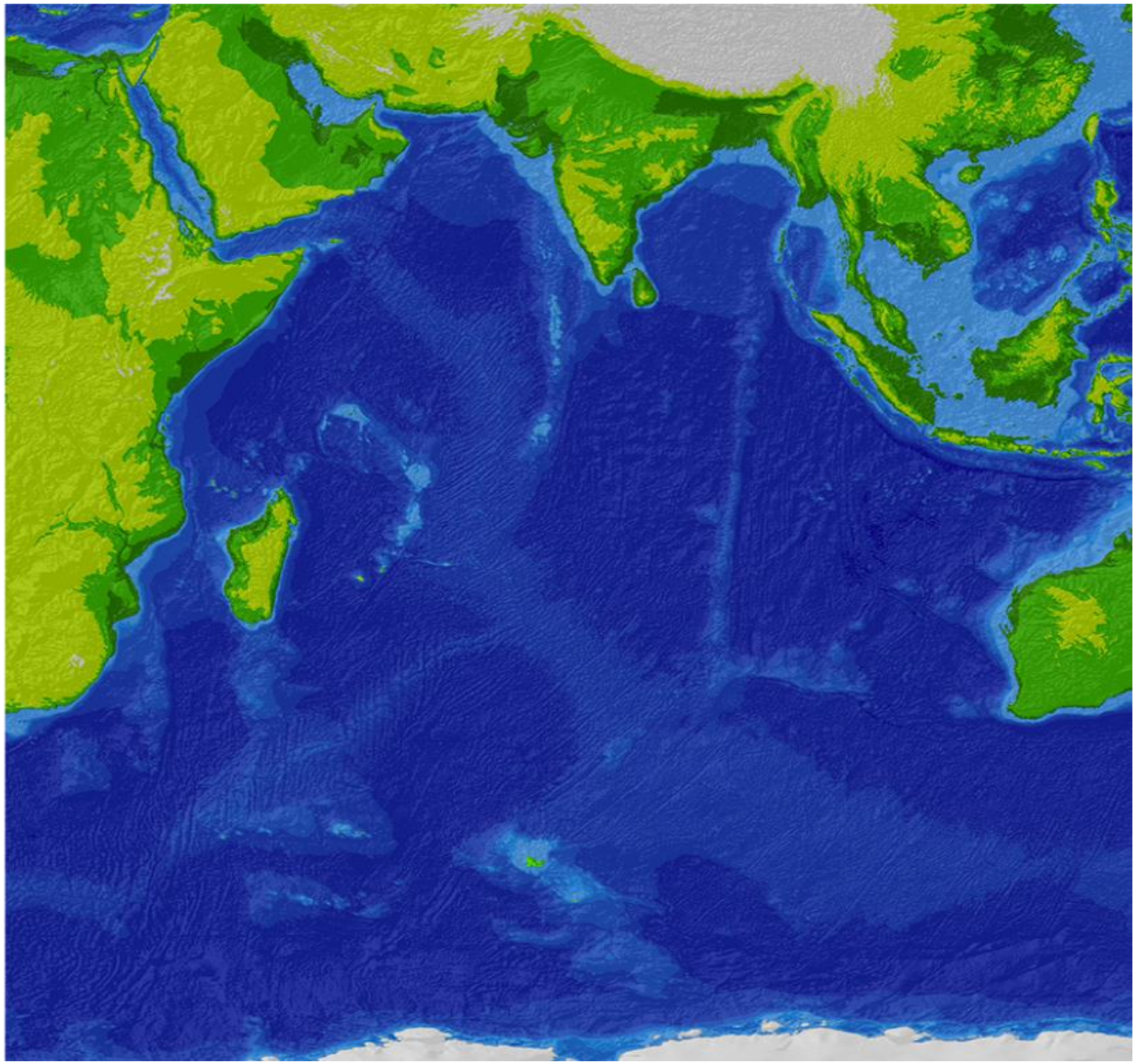
These technologies are combined with the radionuclide detection to justify the conduction of a nuclear test

- Hydro acoustic data can be used to obtain a better understanding of marine life.
- Particularly the Indian Ocean - the largest natural resources treasury in the region - affected by global warming. Its' actual environmental status is still undefined. (Roxy, M.K., 2014: The Curious Case of Indian Ocean Warming.).

AREA OF INTEREST

Indian Ocean

- third largest of the world's oceanic divisions, covering 70,560,000 km square.
- It is approximately 20% of the water on the Earth's surface.
- It is bounded by Asia on the north, on the west by Africa, on the east by Australia, and on the south by the Southern Ocean or, depending on definition, by Antarctica as shown in Figure 1. (source Wikipedia).



BACKGROUND: CTBT & SDG

Climate Action

Infrasound technology:

- register a host of other man-made and natural events on the Earth's surface.
- study of signals generated by the calving of icebergs, movements of glaciers, landslides and avalanches as indicators of climate change; (CTBTO)
- Hurricanes and tornadoes to assess the intensification of storm activity

Tsunami Warning

- The CTBTO has been providing real-time and continuous data on a test basis to four tsunami warning centres in Australia, Hawaii, Japan and Malaysia since March 2005 in collaboration with UNESCO. These data increase the ability of the centres to identify potentially tsunami-generating earthquakes as well as enabling them to provide vulnerable communities with faster warnings.

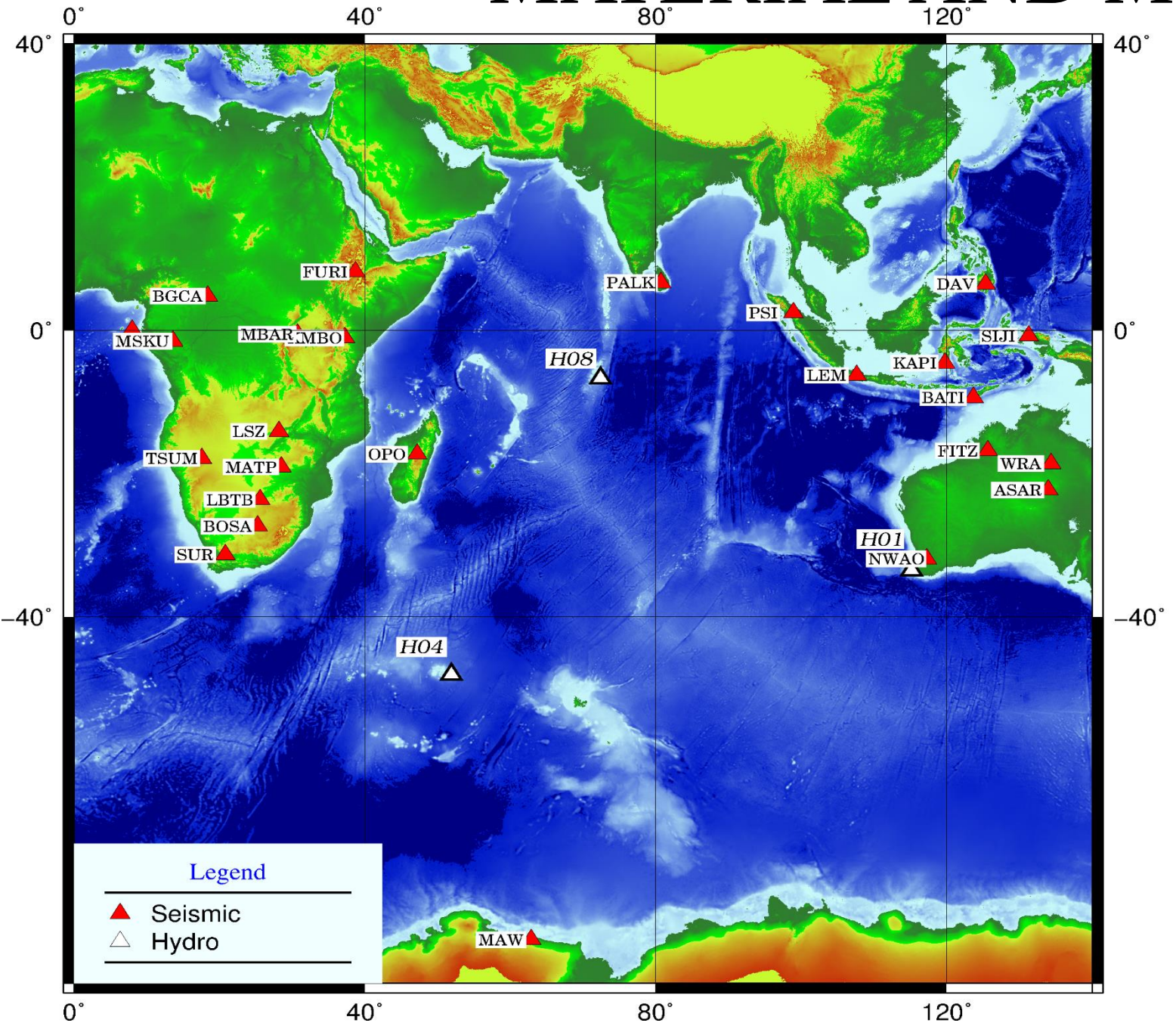
Volcano monitoring

- The CTBTO's infrasound stations register any large source of infrasound, anywhere on the planet.
- Infrasound is sound vibrations at very low frequencies. (volcanic eruptions or the breaking up of ice shelves,…)
- Applications on aviation and maritime safety (for underwater volcanoes).
- Member states receive this information so that they can warn their citizens. (CTBTO)

Life below water

- Hydroacoustic monitoring can be used to differentiate natural and man made signals.
- These activities or events may include
  - seismic profiling for oil exploration or
  - military exercises,
  - volcanic eruptions or underwater earthquakes. (CTBTO)
- Recently Hydroacoustic data is used to follow the whale's populations.

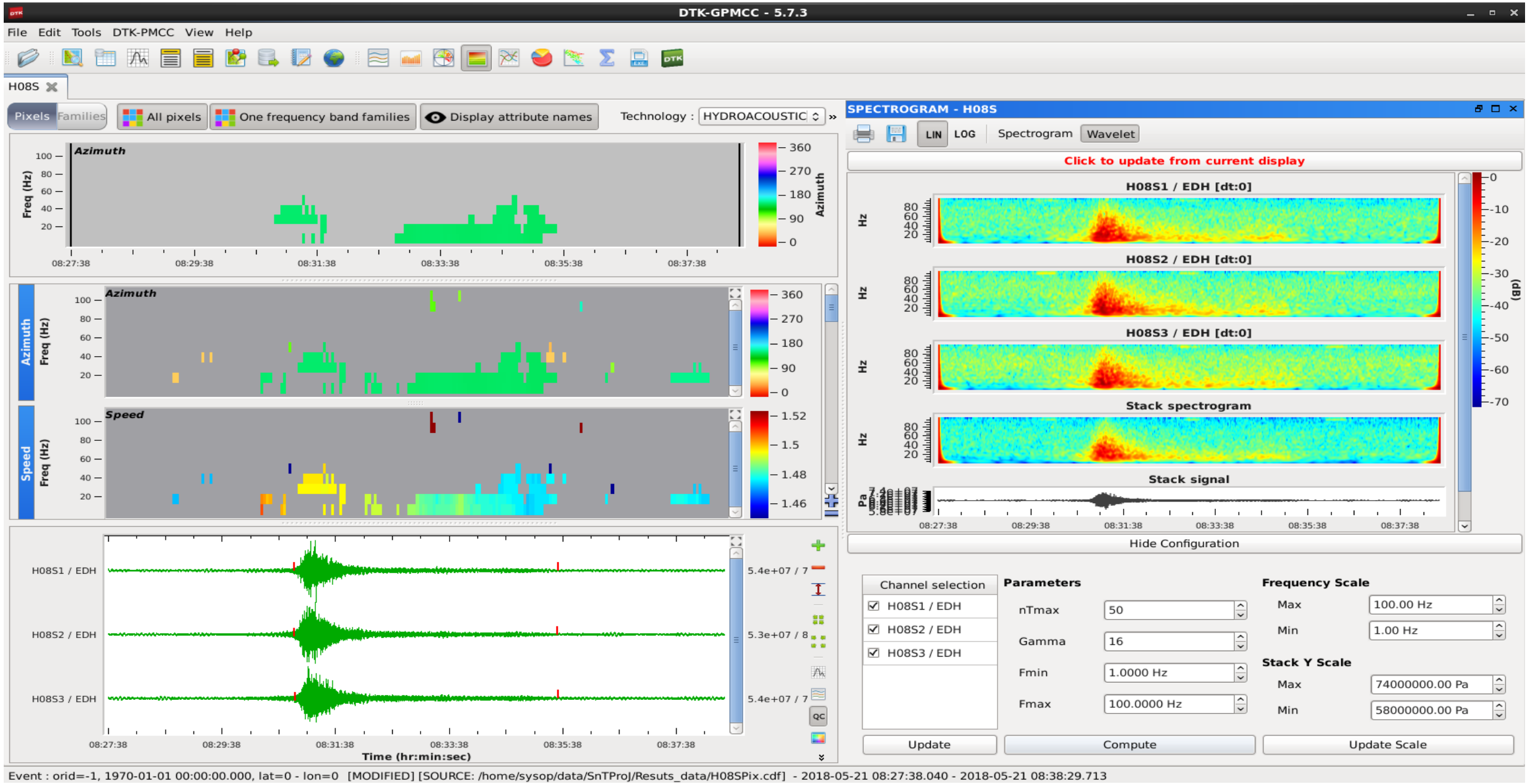
MATERIAL AND METHOD



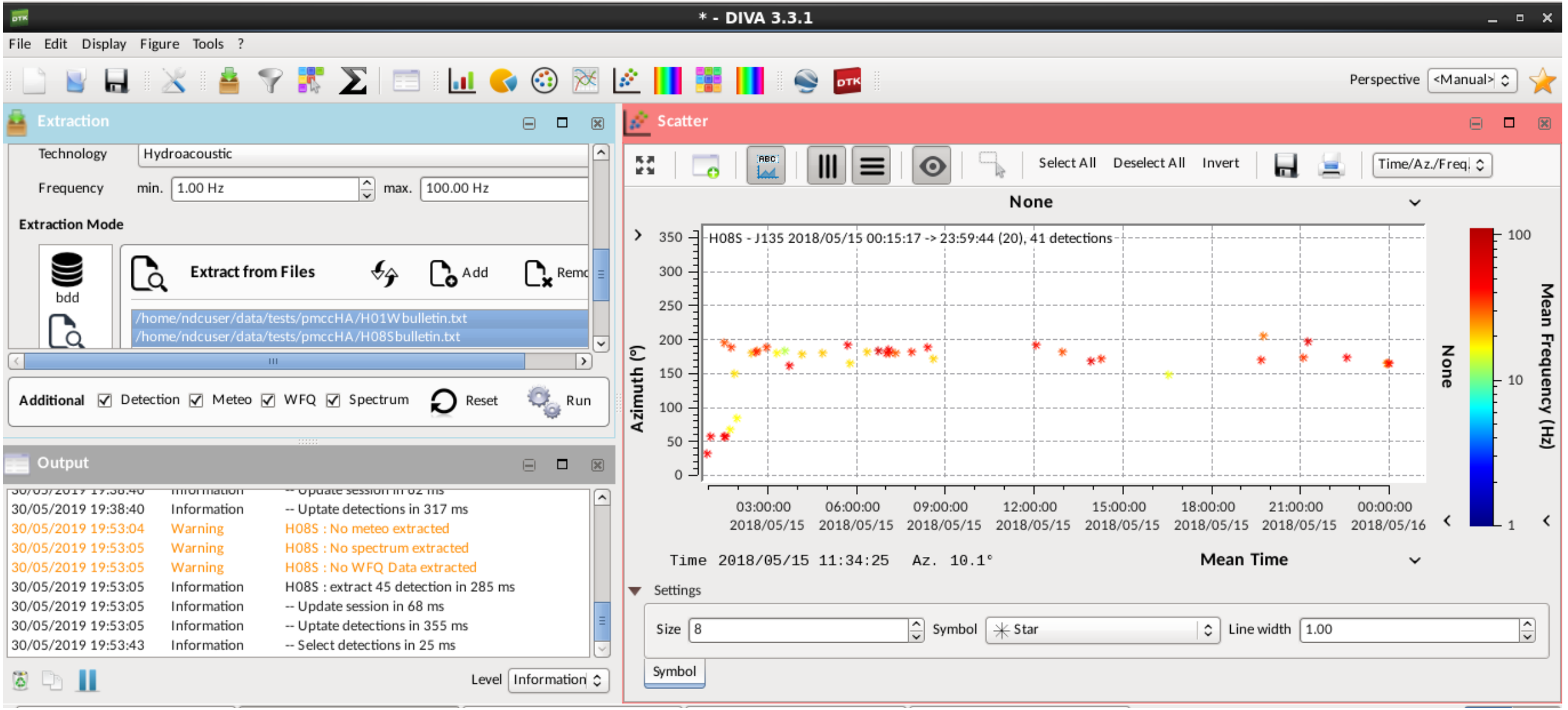
HYDROACOUSTIC Data

- **Data (waveform) are collected after request on the secure web portal of the CTBTO swp.ctbto.org.**
- **The IMS is composed of 11 Hydro acoustic stations monitoring the entire globe.**
- **Three of these stations are located in the Indian Ocean (figure).**
- **Water is a very good sound conductor so 11 stations are enough to monitor underwater explosions.**
- **At least three stations (white) are needed in order to locate an event, it is then necessary to combine the arrival from Hydroacoustic stations with Seismic stations (red)**

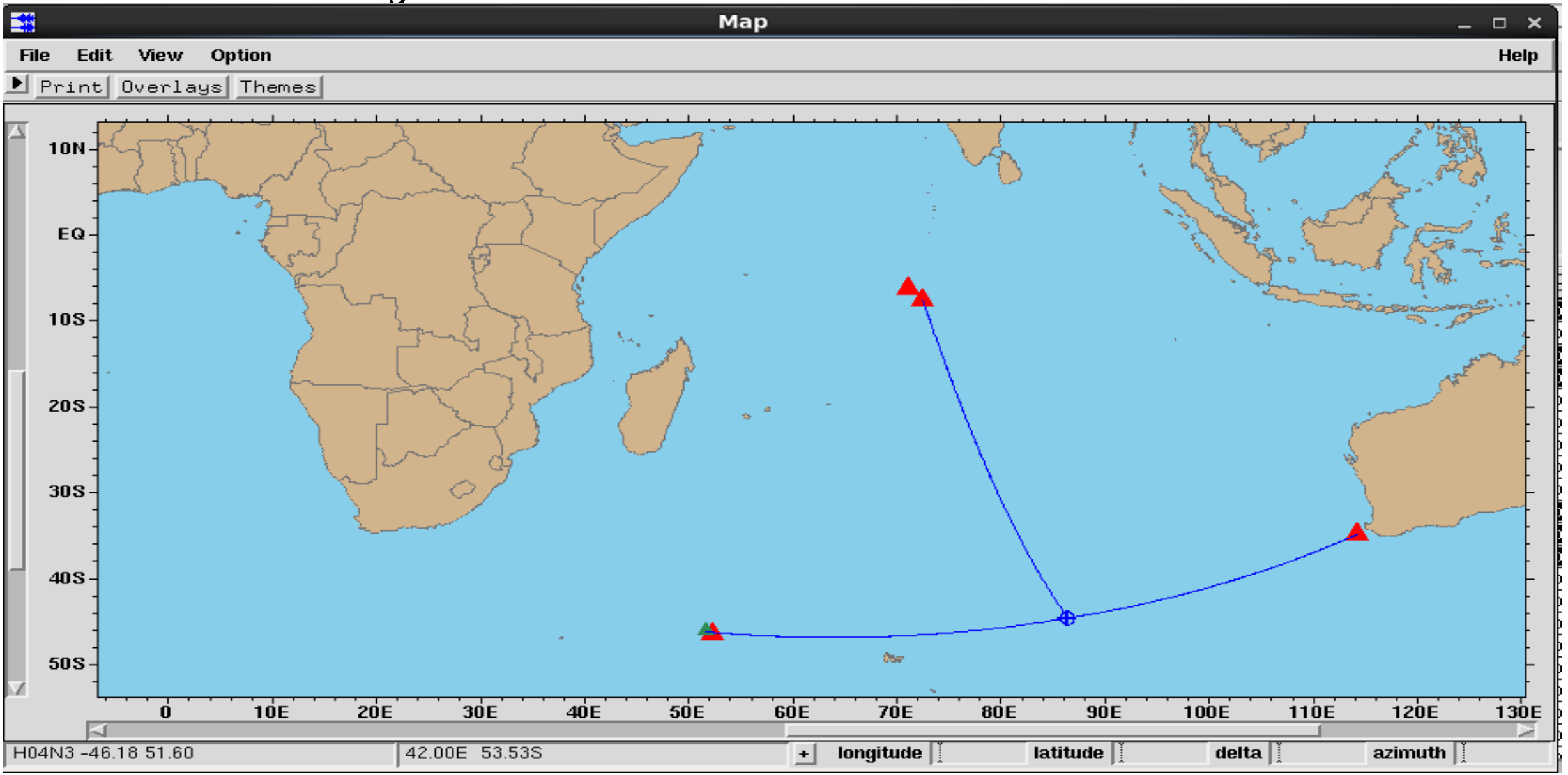
Event detection



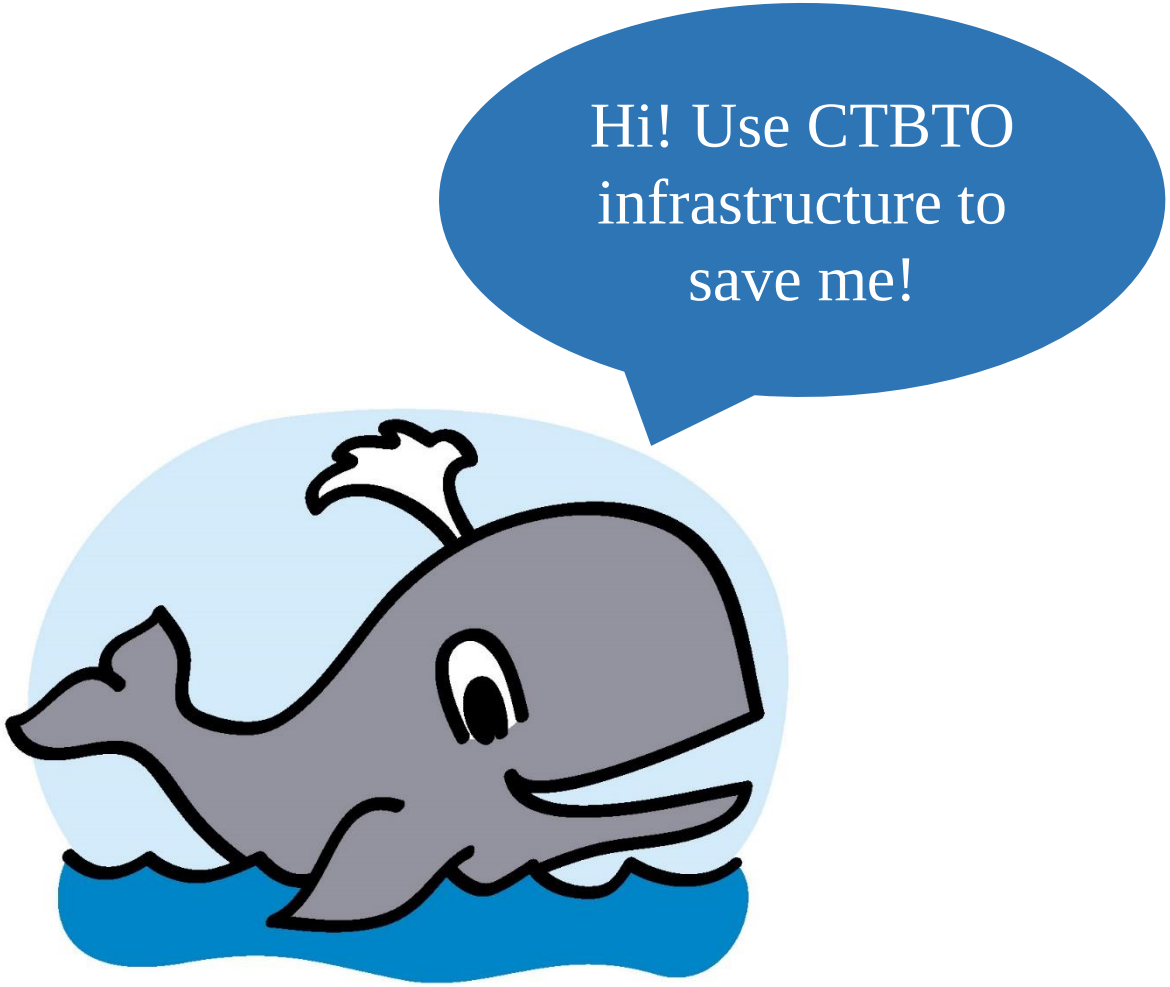
Visualization and analysis

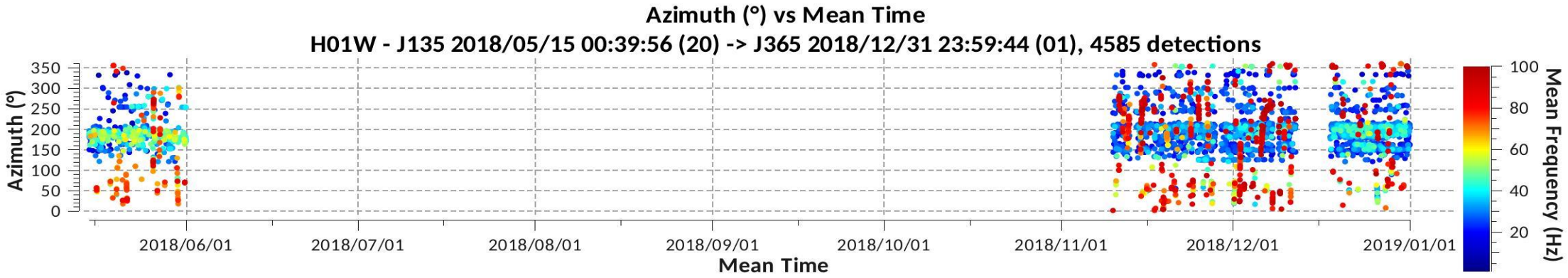


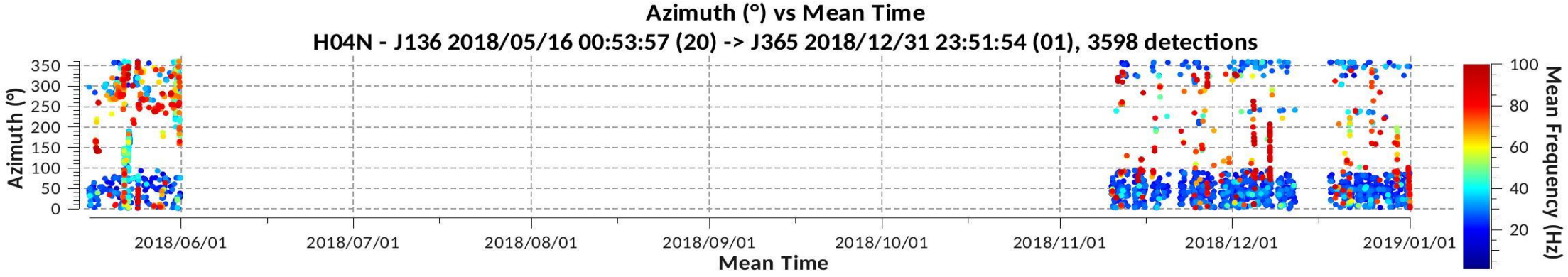
Hydroacoustic event locations

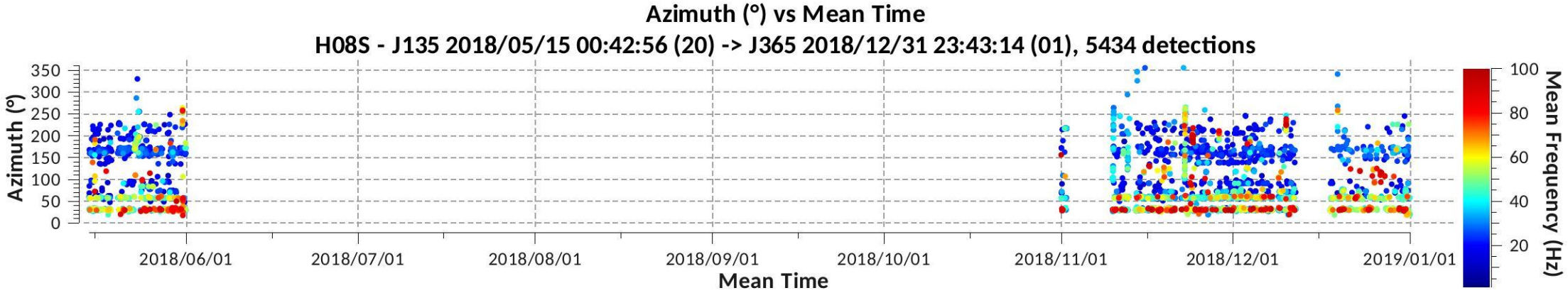


RESULTS




Azimuth (°) vs Mean Time
H01W - J135 2018/05/15 00:39:56 (20) -> J365 2018/12/31 23:59:44 (01), 4585 detections
Azimuth (°)
Mean Time
Mean Frequency (Hz)
2018/06/01
2018/07/01
2018/08/01
2018/09/01
2018/10/01
2018/11/01
2018/12/01
2019/01/01


Azimuth (°) vs Mean Time
H04N - J136 2018/05/16 00:53:57 (20) -> J365 2018/12/31 23:51:54 (01), 3598 detections
Azimuth (°)
Mean Time
Mean Frequency (Hz)
2018/06/01
2018/07/01
2018/08/01
2018/09/01
2018/10/01
2018/11/01
2018/12/01
2019/01/01


Azimuth (°) vs Mean Time
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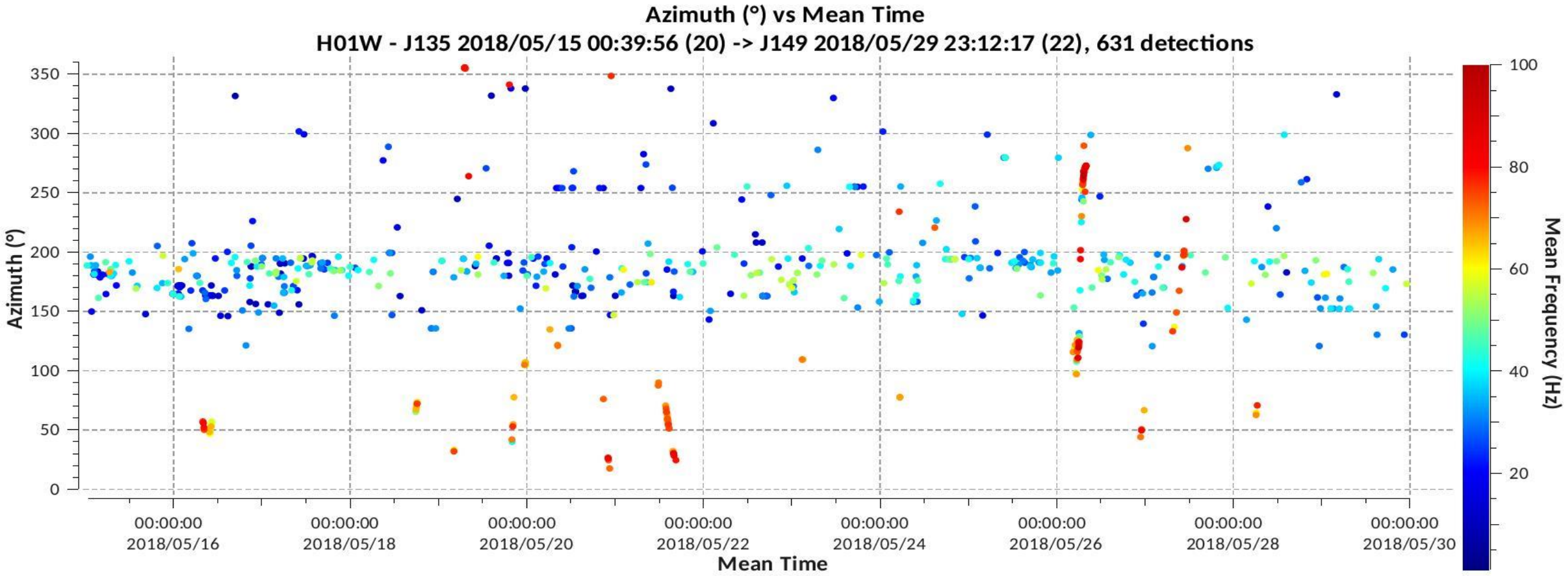
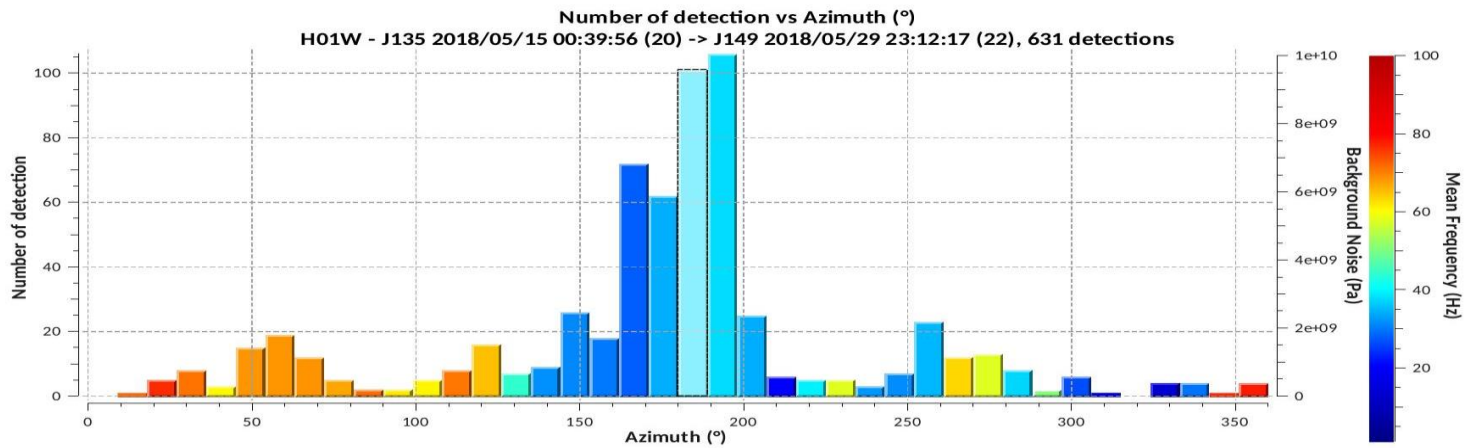
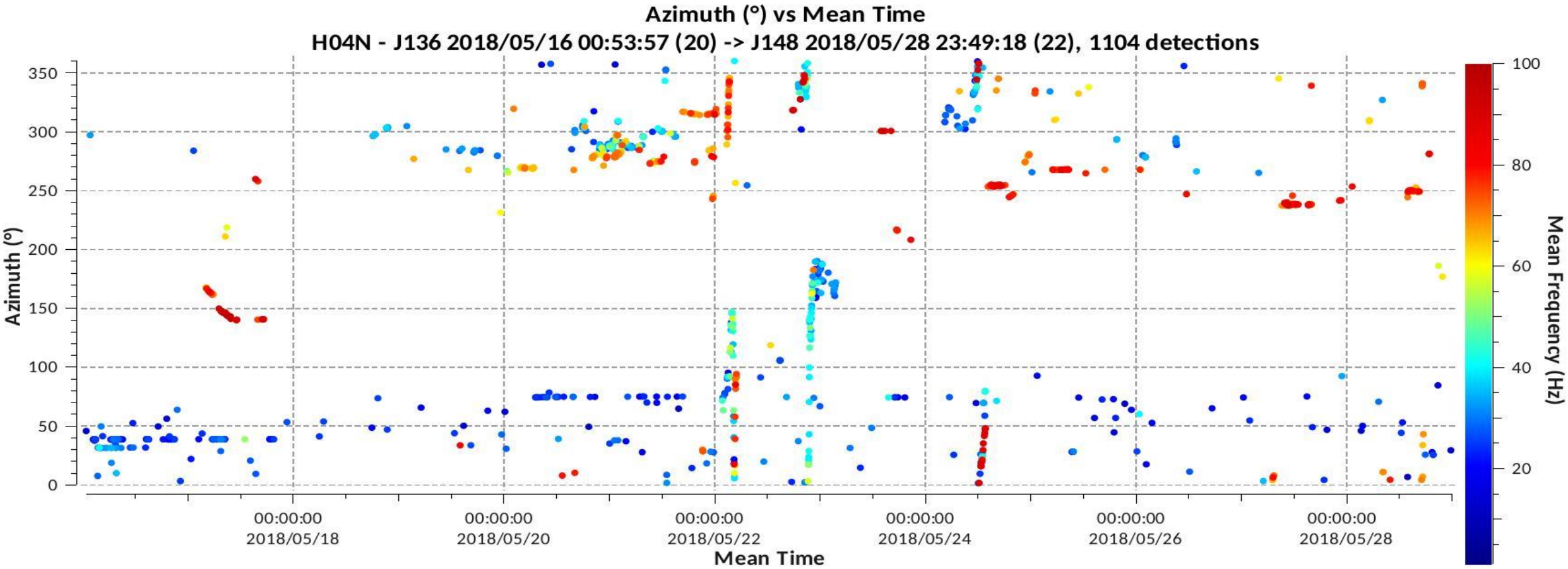
Azimuth (°)
Mean Time
Mean Frequency (Hz)
2018/06/01
2018/07/01
2018/08/01
2018/09/01
2018/10/01
2018/11/01
2018/12/01
2019/01/01



H01 detect events from Azimuth

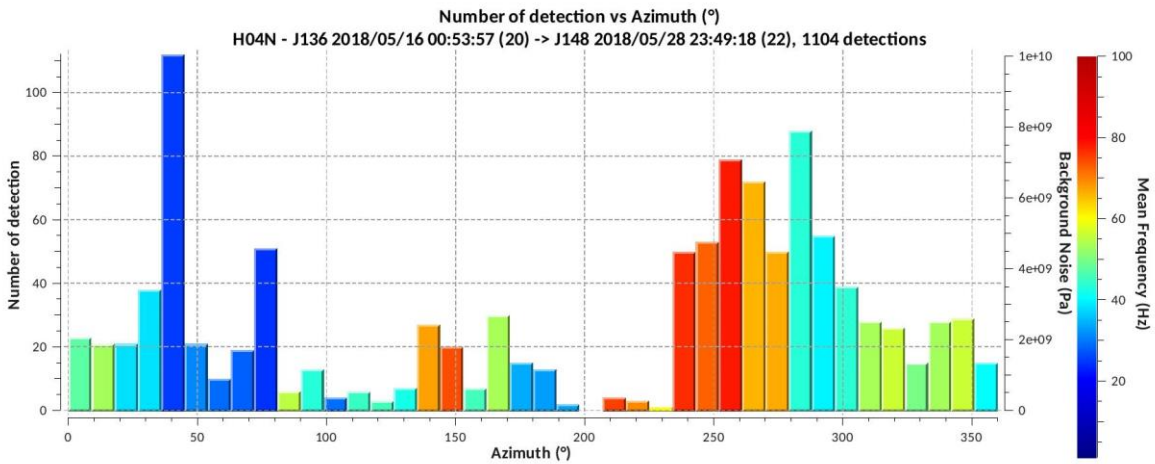
150 – 200

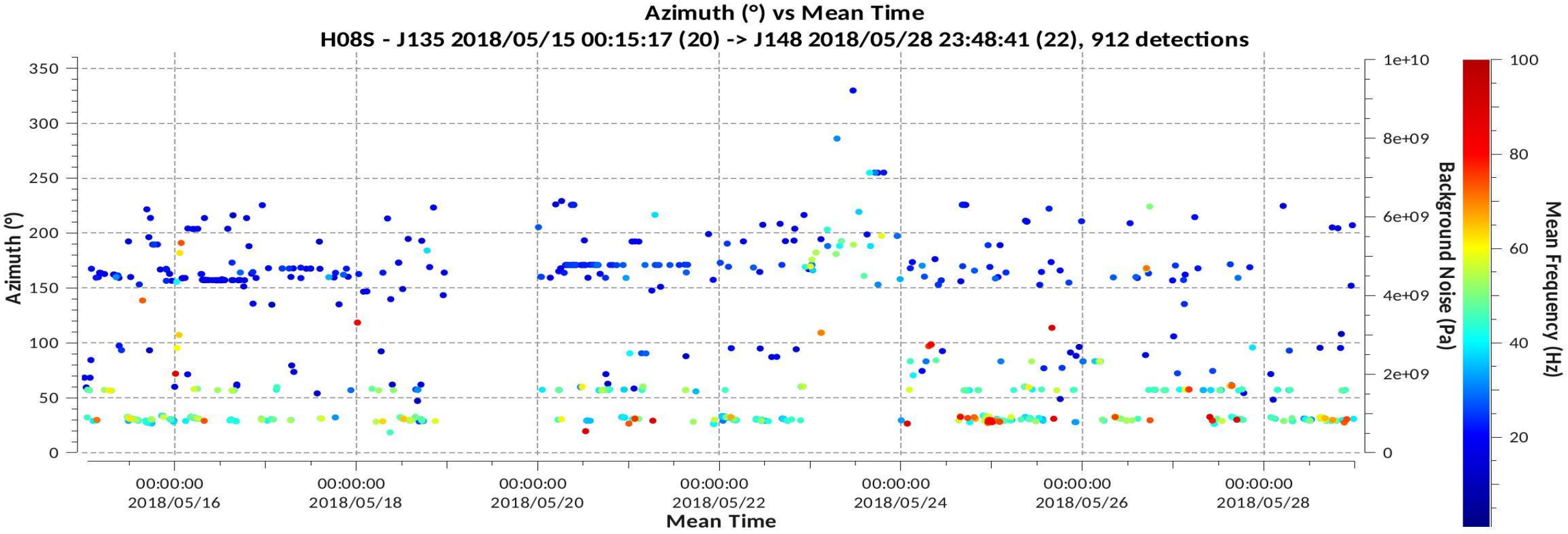




H04 detect events from Azimuth

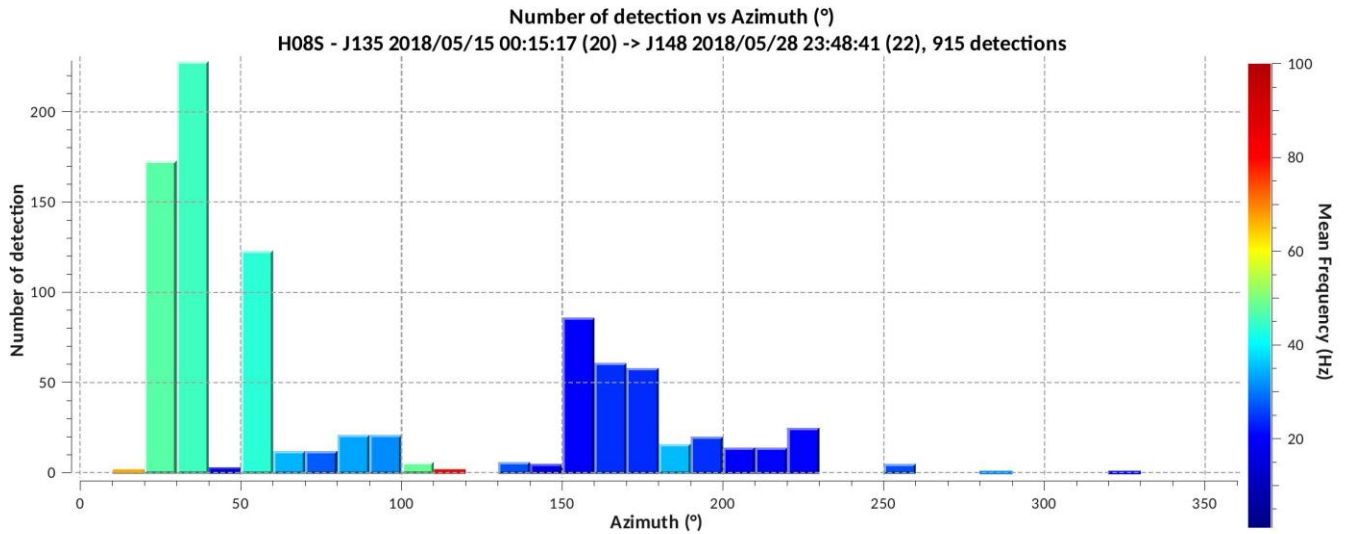
25 – 50
&
250 - 300

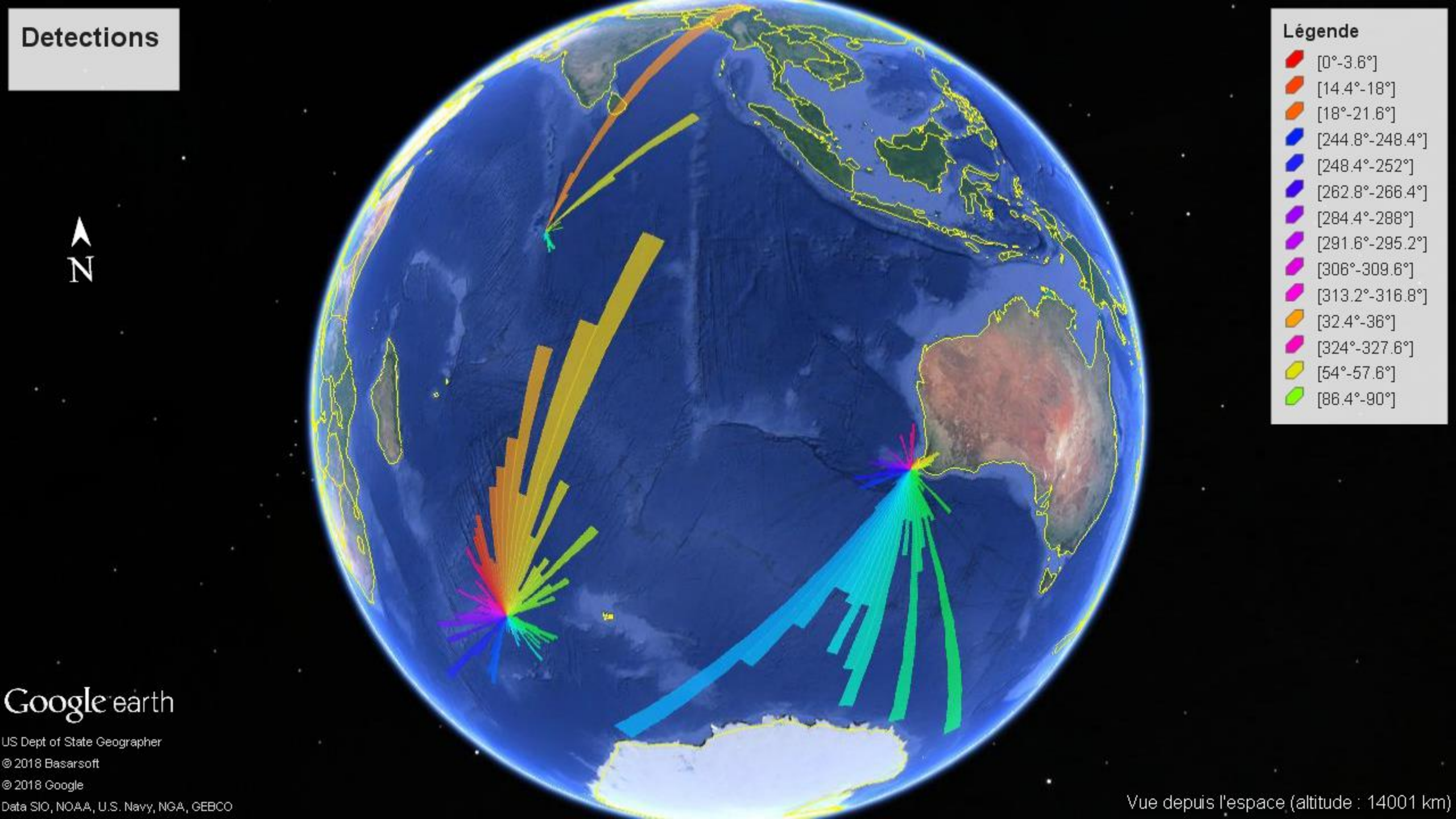




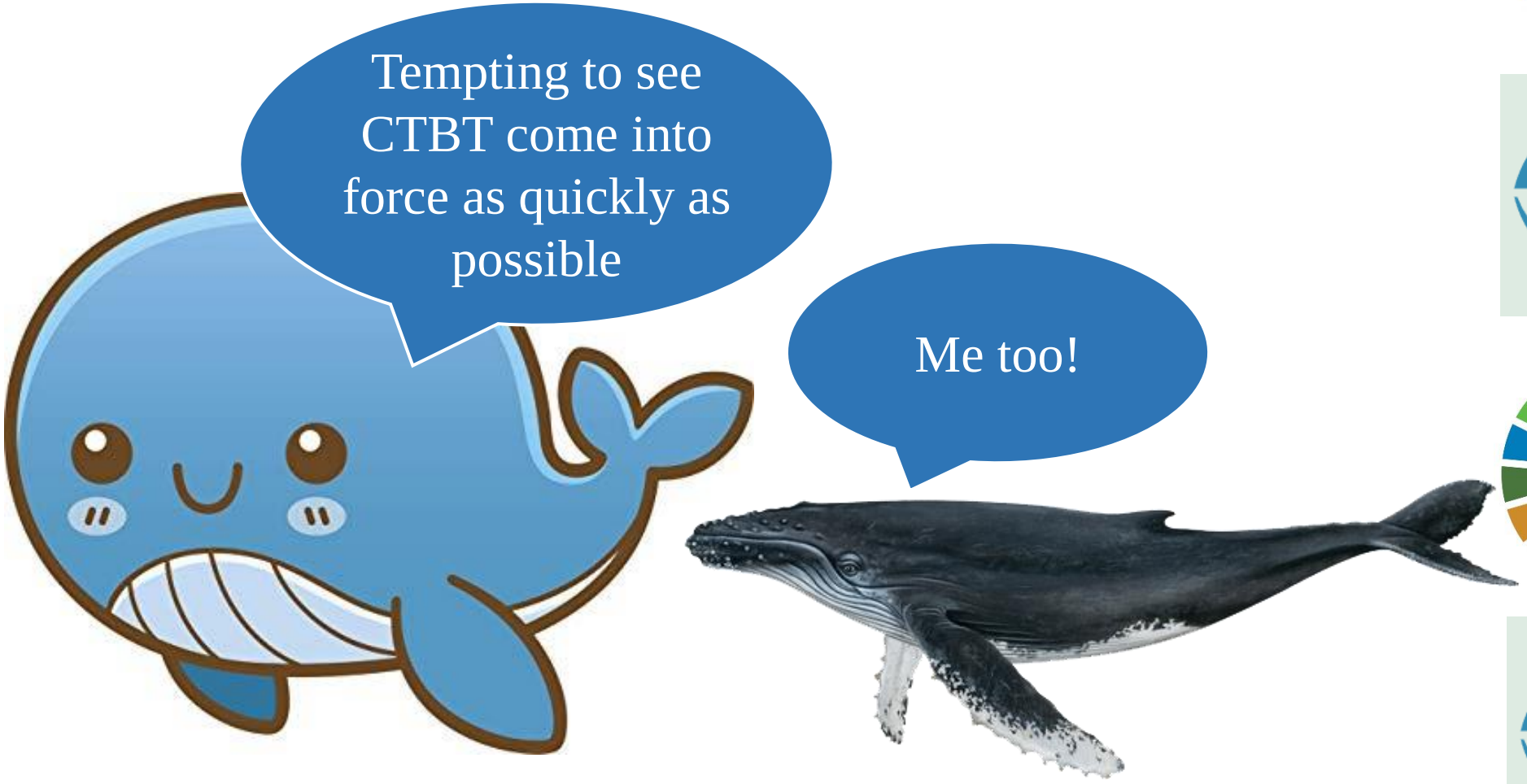
H08S detect events from Azimuth

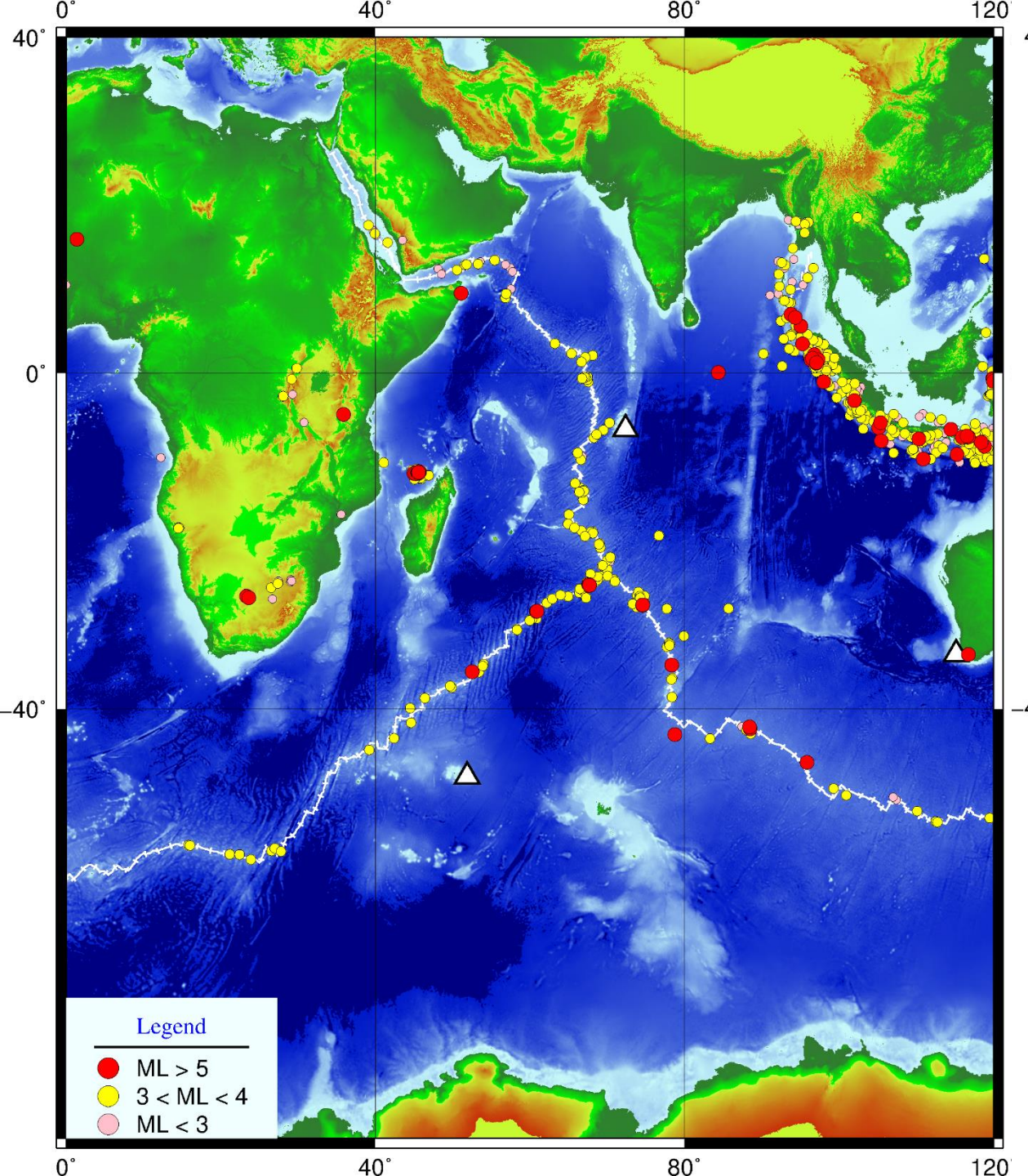
150 – 200
&
Constantly on 25°

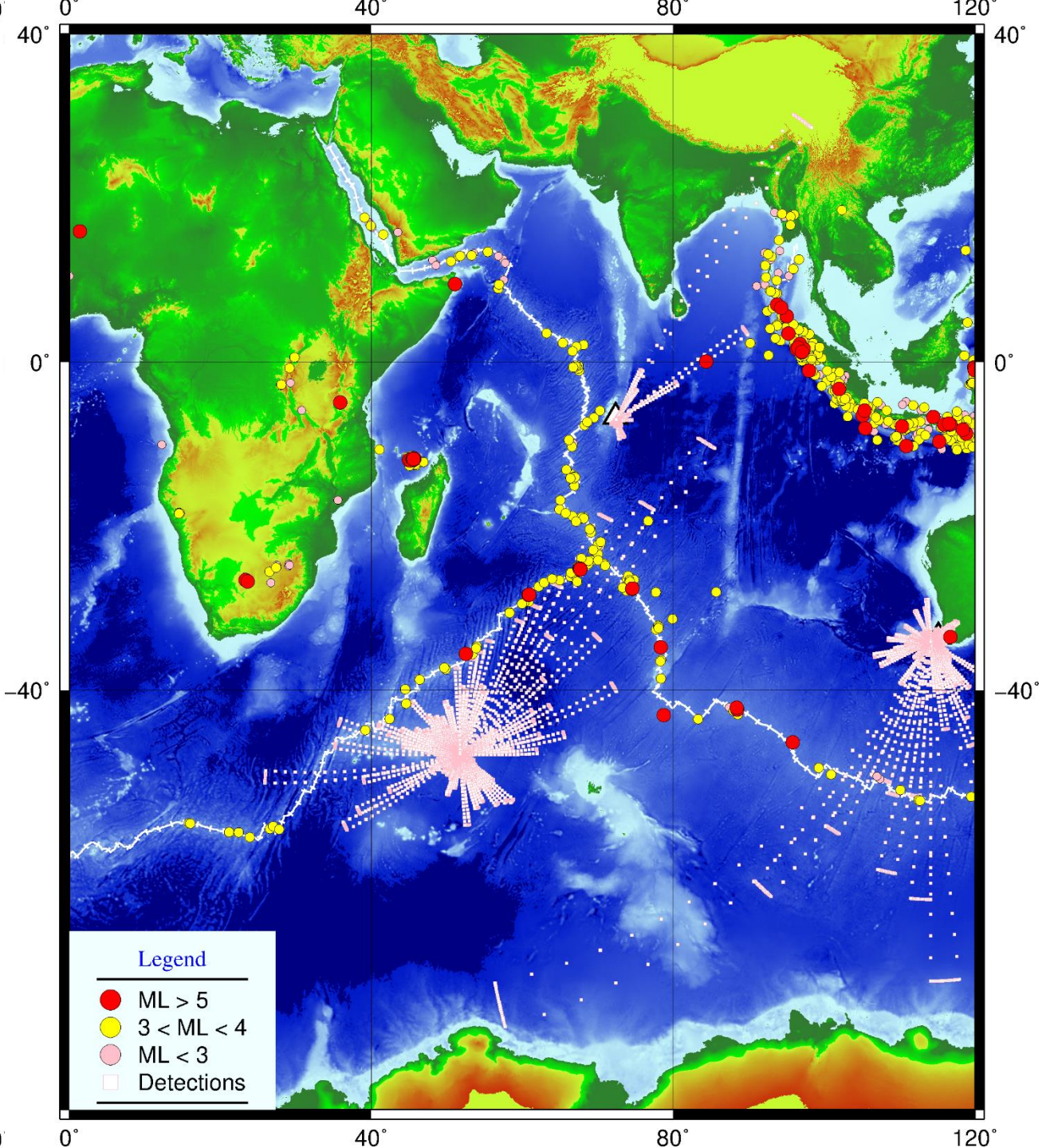



Detections
N
Légende
[0°-3.6°]
[14.4°-18°]
[18°-21.6°]
[244.8°-248.4°]
[248.4°-252°]
[262.8°-266.4°]
[284.4°-288°]
[291.6°-295.2°]
[306°-309.6°]
[313.2°-316.8°]
[32.4°-36°]
[324°-327.6°]
[54°-57.6°]
[86.4°-90°]
Google earth
US Dept of State Geographer
© 2018 Basarsoft
© 2018 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Vue depuis l'espace (altitude : 14001 km)

RESULTS
(LOCATIONS)

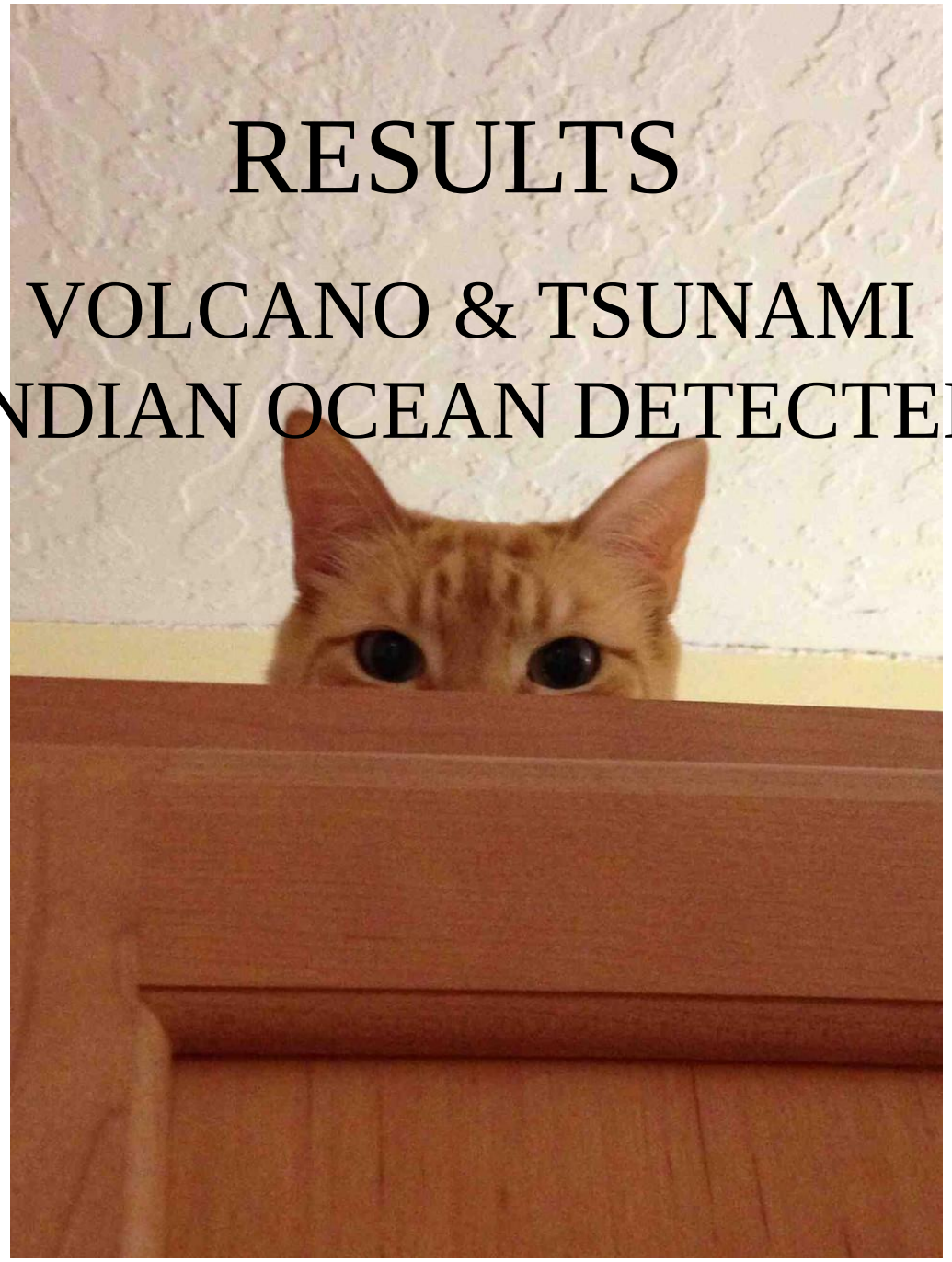



0°
40°
80°
120°
40°
0°
−40°
Legend
ML > 5
3 < ML < 4
ML < 3

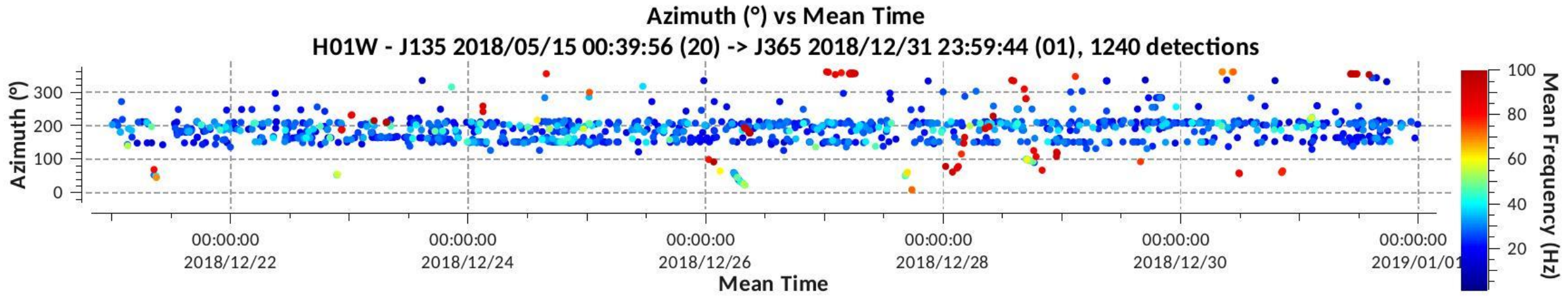

0°
40°
80°
120°
40°
0°
−40°
Legend
ML > 5
3 < ML < 4
ML < 3
Detections

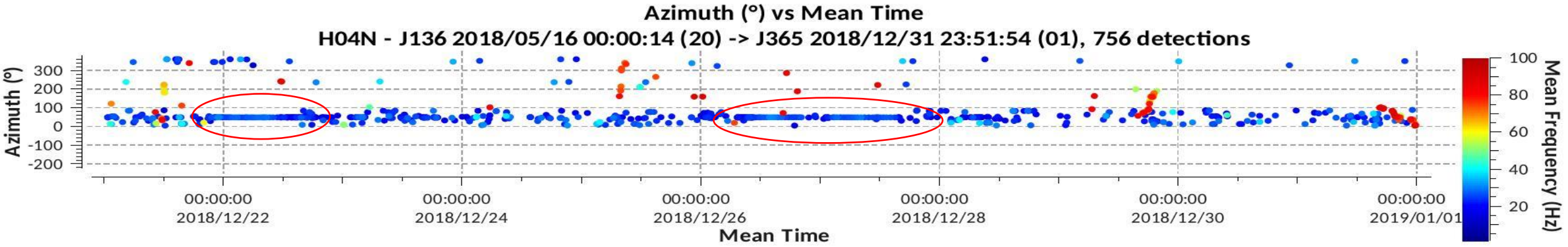
RESULTS

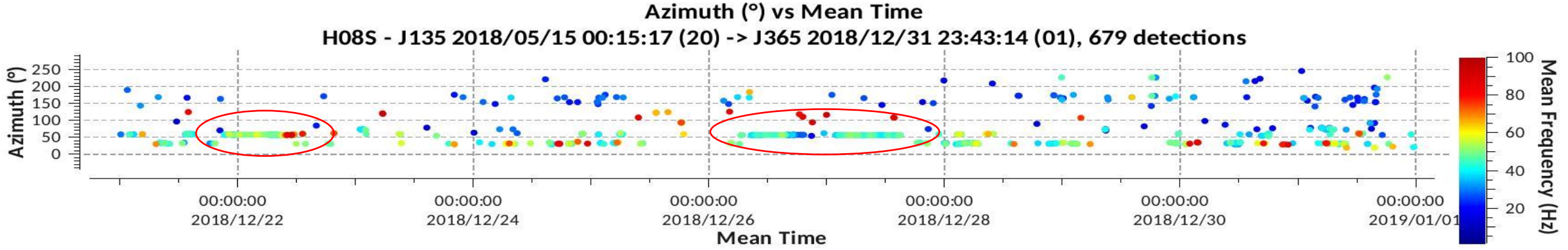
VOLCANO & TSUNAMI IN THE INDIAN OCEAN DETECTED BY IMS

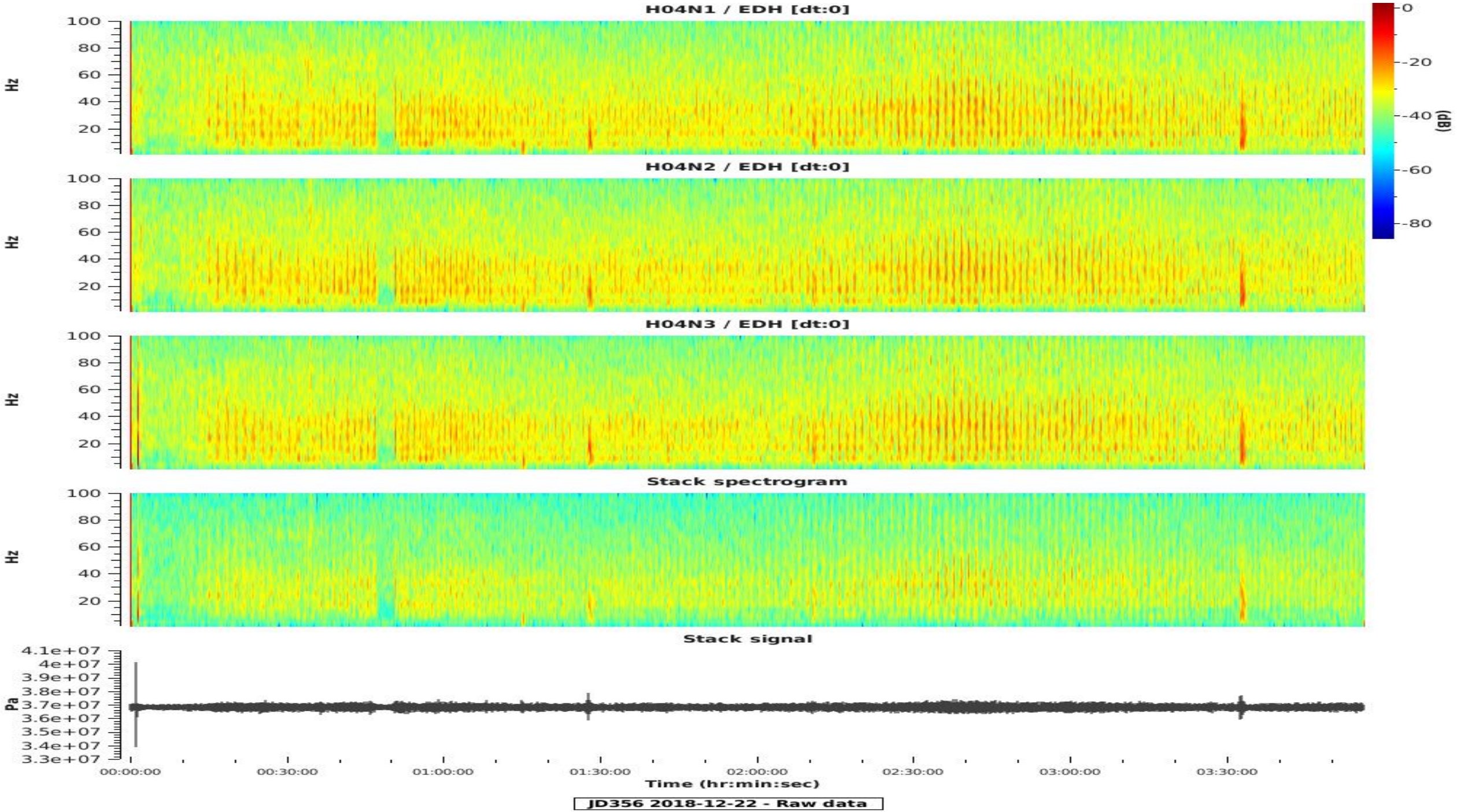


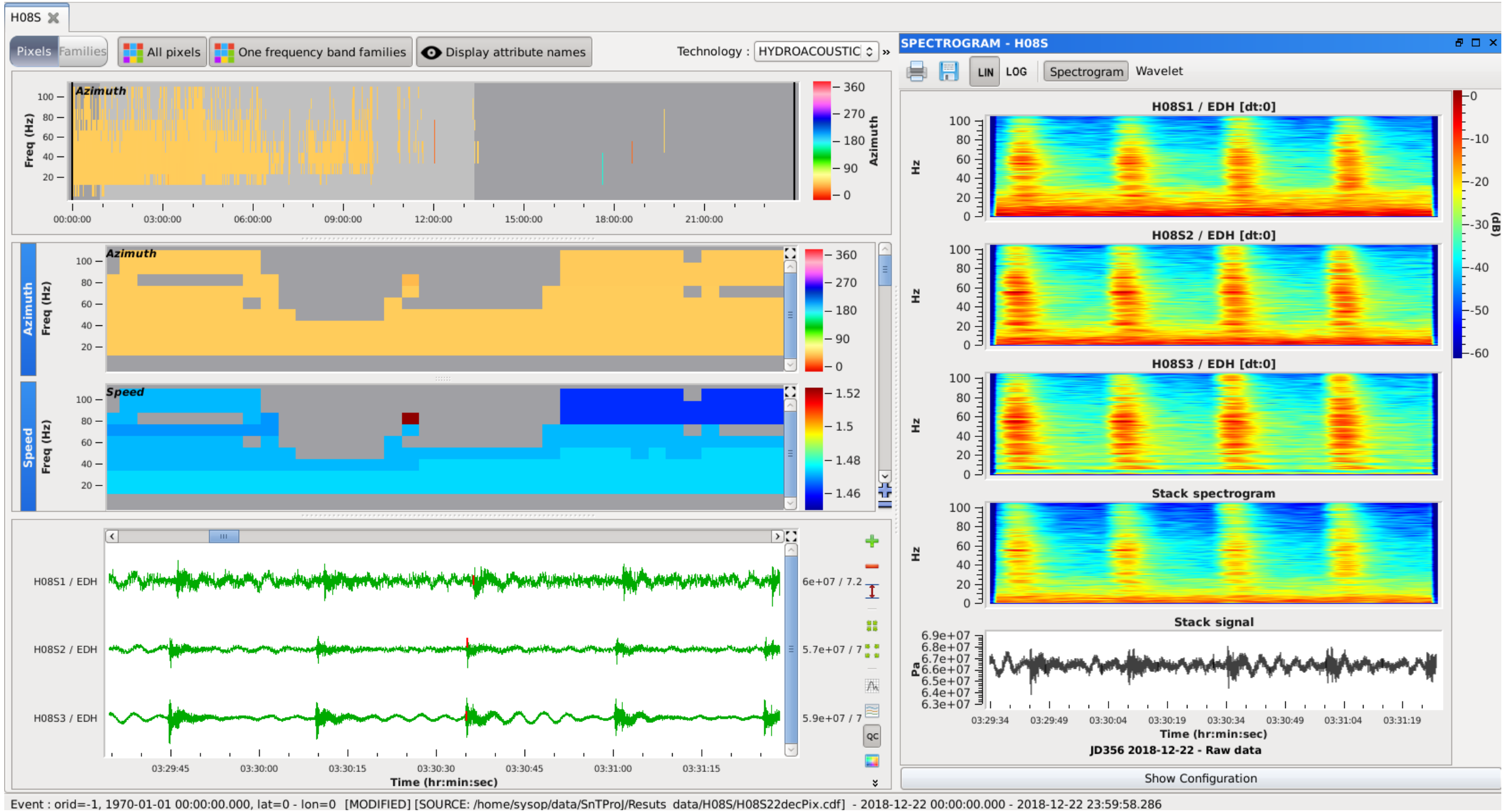
IMS is watching!! No undetected signal shall pass!


Azimuth (°) vs Mean Time
H01W - J135 2018/05/15 00:39:56 (20) -> J365 2018/12/31 23:59:44 (01), 1240 detections
Azimuth (°)
300
200
100
0
00:00:00
2018/12/22
00:00:00
2018/12/24
00:00:00
2018/12/26
00:00:00
2018/12/28
00:00:00
2018/12/30
00:00:00
2019/01/01
Mean Time
Mean Frequency (Hz)
100
80
60
40
20

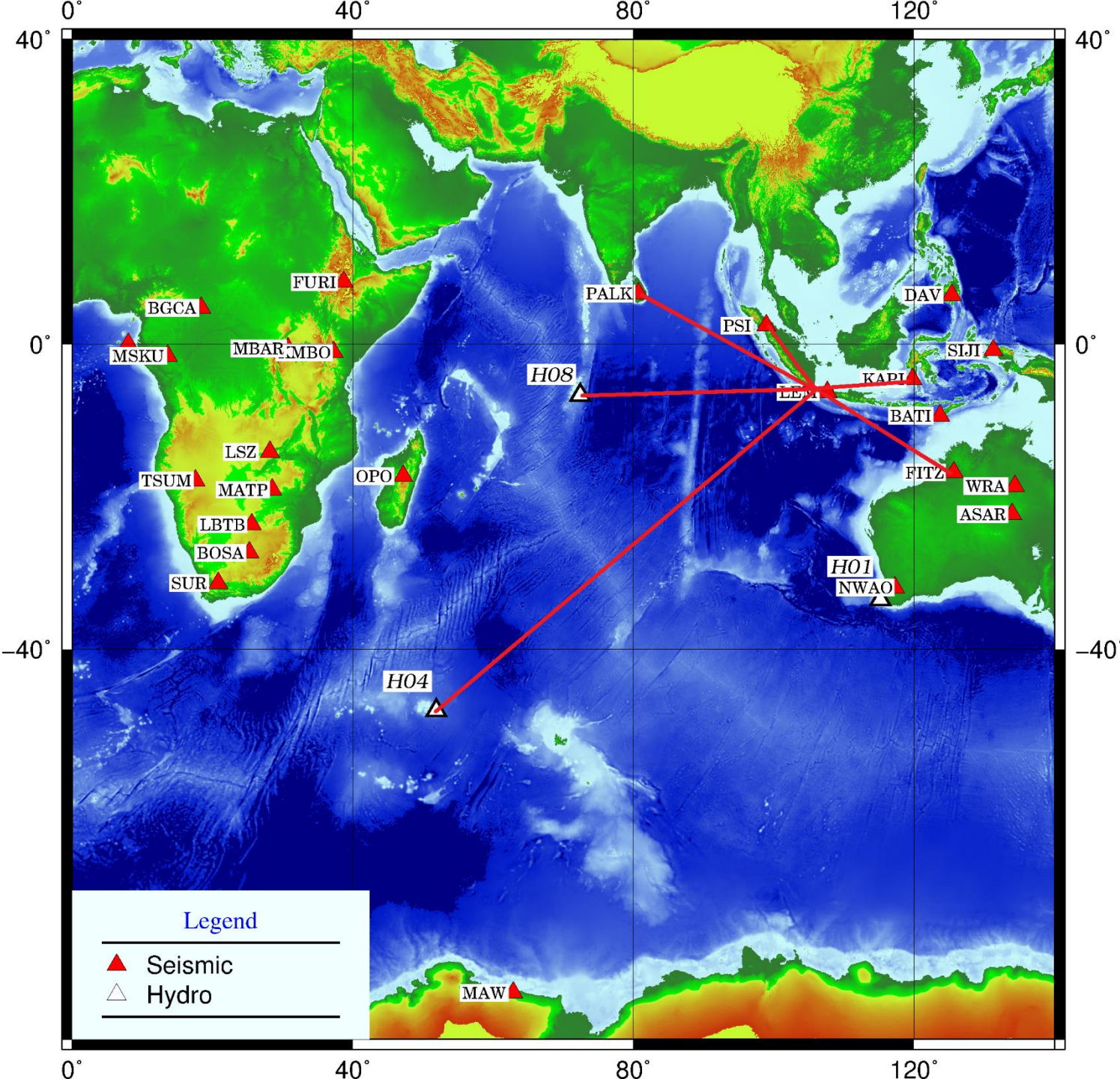

Azimuth (°) vs Mean Time
H04N - J136 2018/05/16 00:00:14 (20) -> J365 2018/12/31 23:51:54 (01), 756 detections
Azimuth (°)
300
200
100
0
-100
-200
00:00:00
2018/12/22
00:00:00
2018/12/24
00:00:00
2018/12/26
00:00:00
2018/12/28
00:00:00
2018/12/30
00:00:00
2019/01/01
Mean Time
Mean Frequency (Hz)
100
80
60
40
20

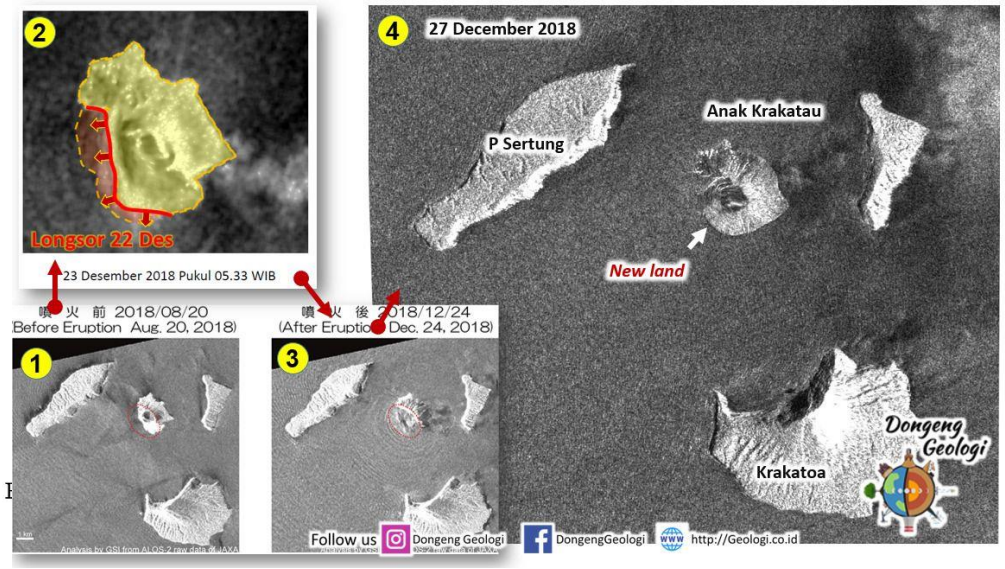

Azimuth (°) vs Mean Time
H08S - J135 2018/05/15 00:15:17 (20) -> J365 2018/12/31 23:43:14 (01), 679 detections
Azimuth (°)
250
200
150
100
50
0
00:00:00
2018/12/22
00:00:00
2018/12/24
00:00:00
2018/12/26
00:00:00
2018/12/28
00:00:00
2018/12/30
00:00:00
2019/01/01
Mean Time
Mean Frequency (Hz)
100
80
60
40
20


H04N1 / EDH [dt:0]
H04N2 / EDH [dt:0]
H04N3 / EDH [dt:0]
Stack spectrogram
Hz
100
80
60
40
20
0
-20
-40
-60
-80
(dB)
Stack signal
Pa
4.1e+07
4e+07
3.9e+07
3.8e+07
3.7e+07
3.6e+07
3.5e+07
3.4e+07
3.3e+07
00:00:00
00:30:00
01:00:00
01:30:00
02:00:00
02:30:00
03:00:00
03:30:00
Time (hr:min:sec)
JD356 2018-12-22 - Raw data



Signals from the krakatoa errutpion





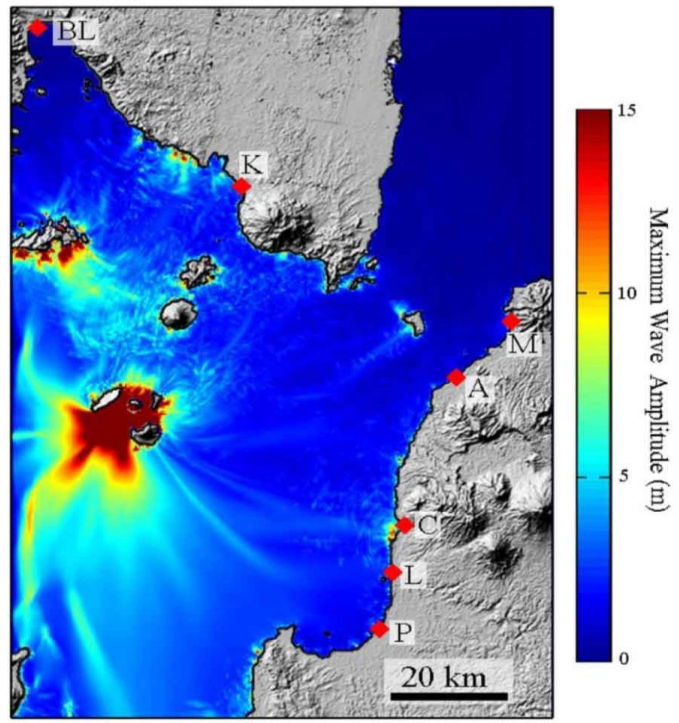
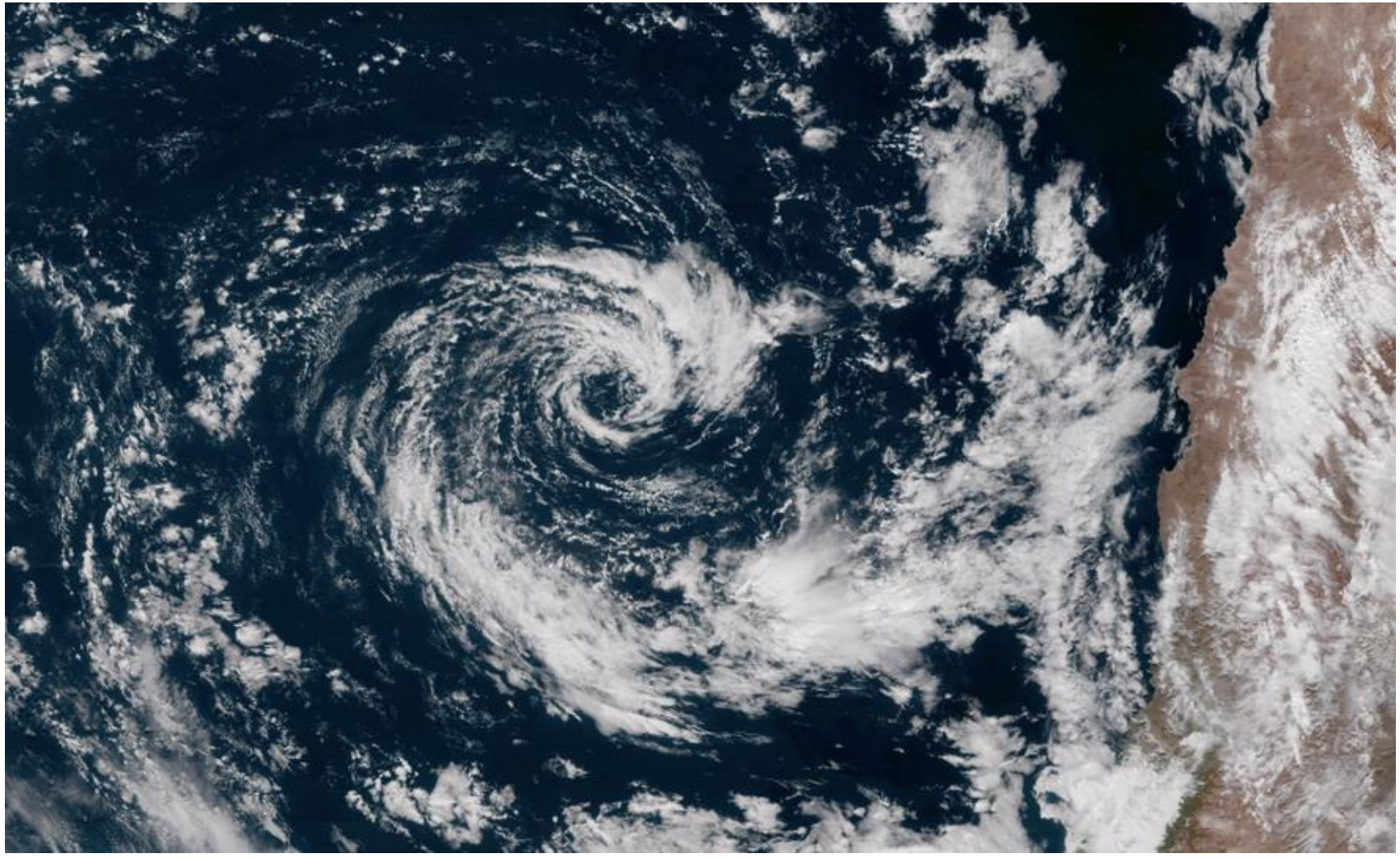


Fig. 5. Maximum wave amplitude (m) recorded over 6000 s of simulation, using a constant retarding stress of 10 kPa to simulate the landslide propagation.

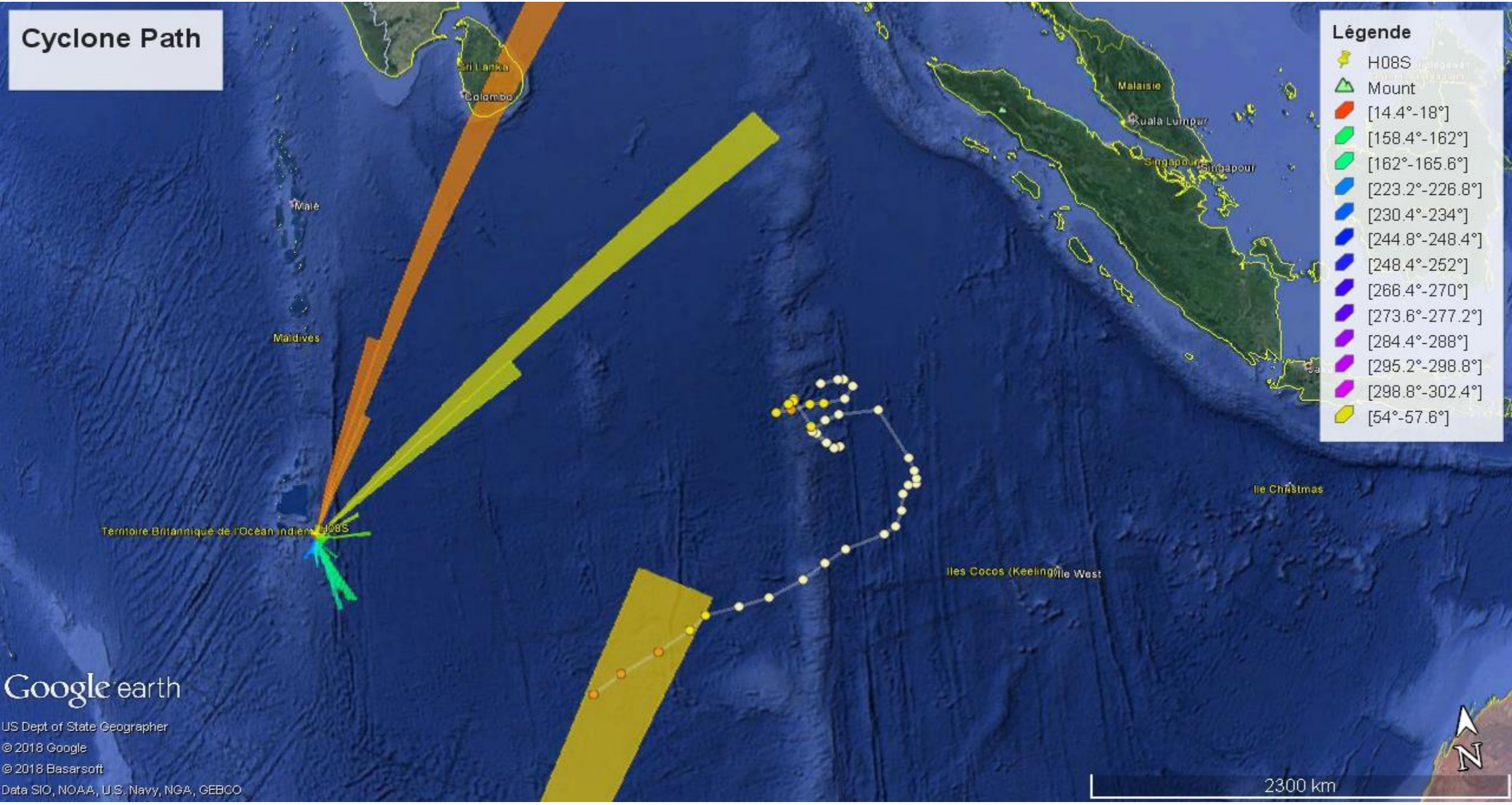
22-23 Dec 2018 eruption & tsunami of Krakatoa


H04N
Pixels
Families
All pixels
One frequency band families
Display attribute names
Technology :
HYDROACOUSTIC
Reload Data
Save image
Print
Azimuth
Freq (Hz)
100
80
60
40
20
360
270
180
90
0
00:00:00
03:00:00
06:00:00
09:00:00
12:00:00
15:00:00
18:00:00
21:00:00
Speed
1.52
1.5
1.48
1.46
H04N1 / EDH
H04N2 / EDH
H04N3 / EDH
3.5e+07 / 3
3.4e+07 / 3
2.7e+07 / 4
Time (hr:min:sec)
Event : orid=-1, 1970-01-01 00:00:00.000, lat=0 - lon=0 [MODIFIED] [SOURCE: /home/sysop/data/SnTProJ/Resuts_data/H04N/H04N22decPix.cdf] - 2018-12-22 00:00:00.002 - 2018-12-22 23:...

RESULTS
(CYCLONES)



Cyclone Bouchra 9 to 22 November 2018



RESULTS
(WHALE SIGNAL NOT FOUND YET)

CONCLUSION

- CTBTO hydroacoustic and seismic data used during this research;
- Volcano, Tsunami, Earhquakes and explosion signals identified and differentiated in the Indian Ocean;
- The next step is to find signals from whales and other species under water;
- Once the whale signals are found the detailed CTBTO IMS SDG:14 «Life below water» contribution strategy can be delivered.

THANK YOU FOR YOUR ATTENTION

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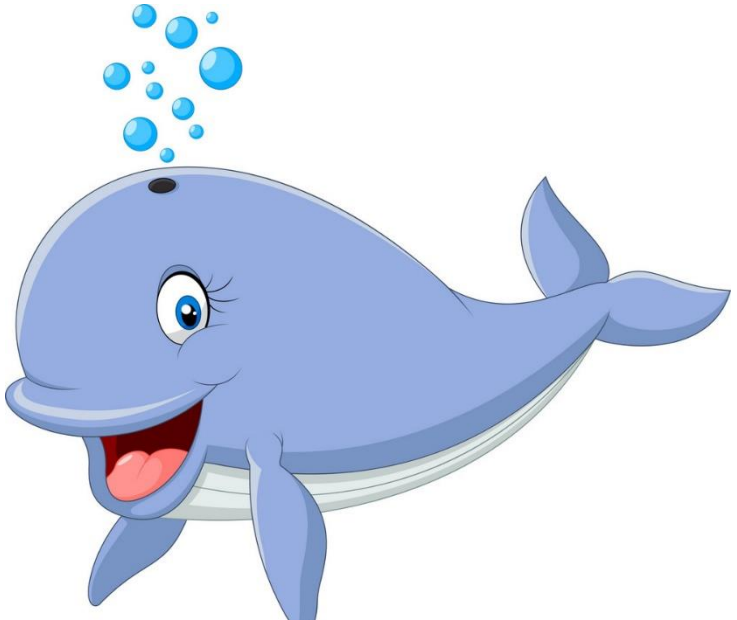

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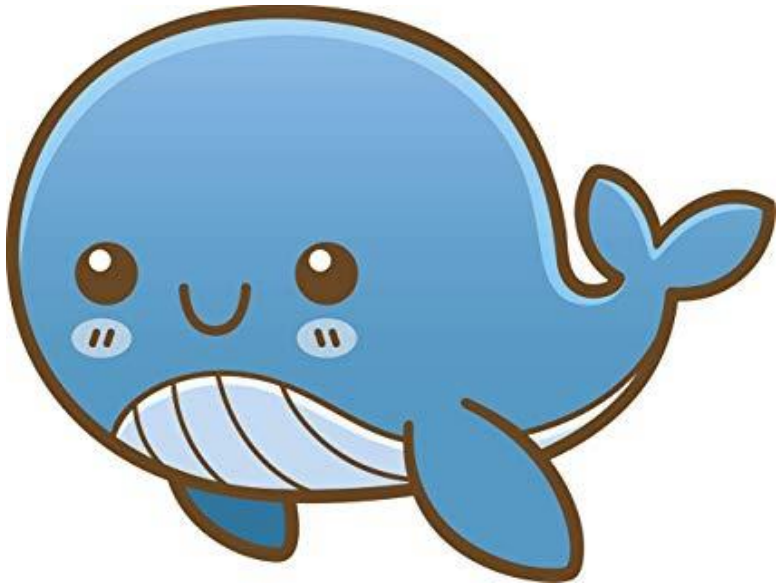

IMS POP UP QUIZ