THE IMPRINT OF WATER-COLUMN RESONANCE ON SECONDARY MICROSEISMIC SOURCE SPECTRA

M Meschede[1], É Stutzmann[1], V Farra[1], M Schimmel[2], F Ardhuin[3]
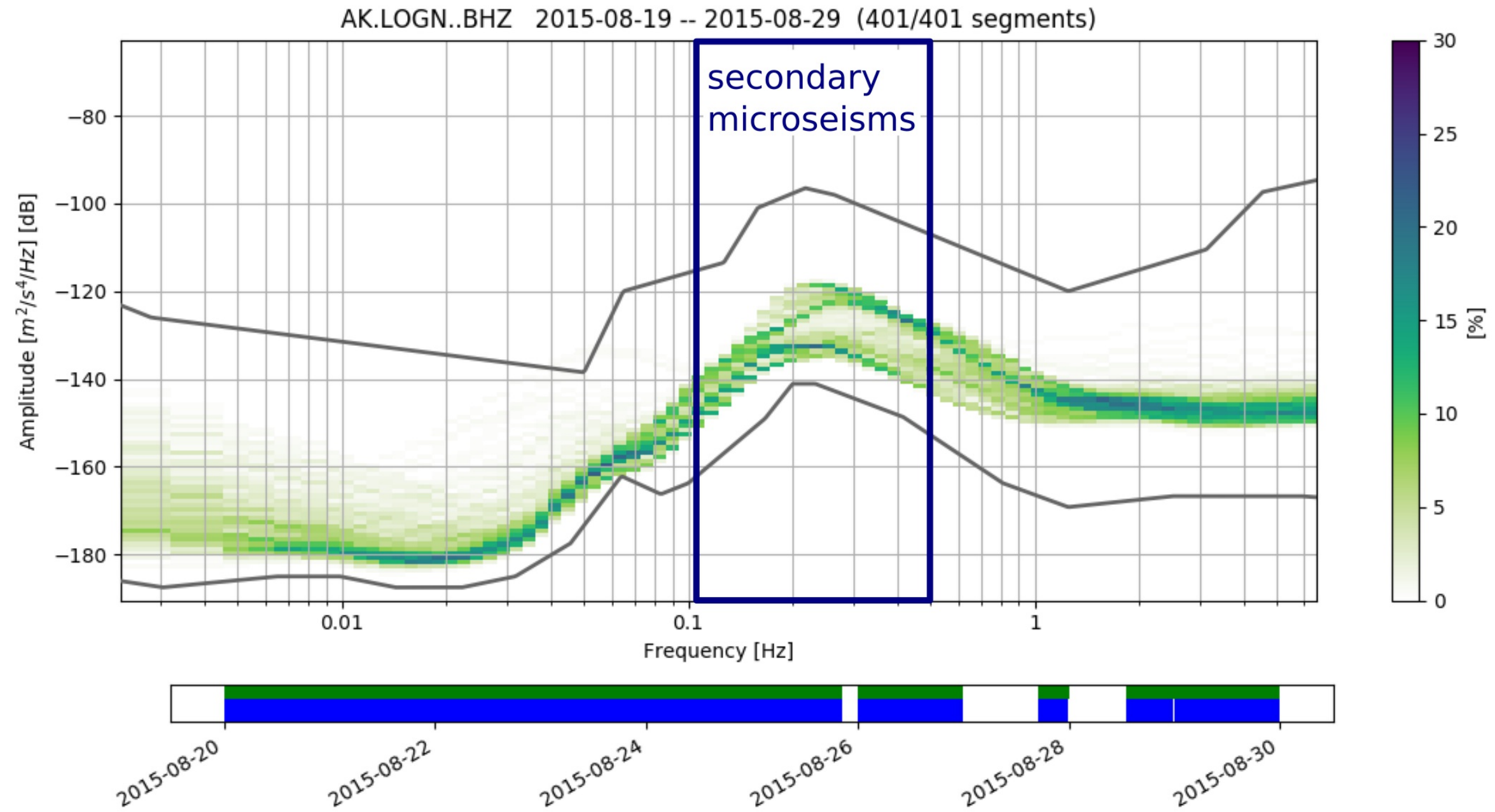
[1] Institut de Physique du Globe de Paris, Paris 75005, France

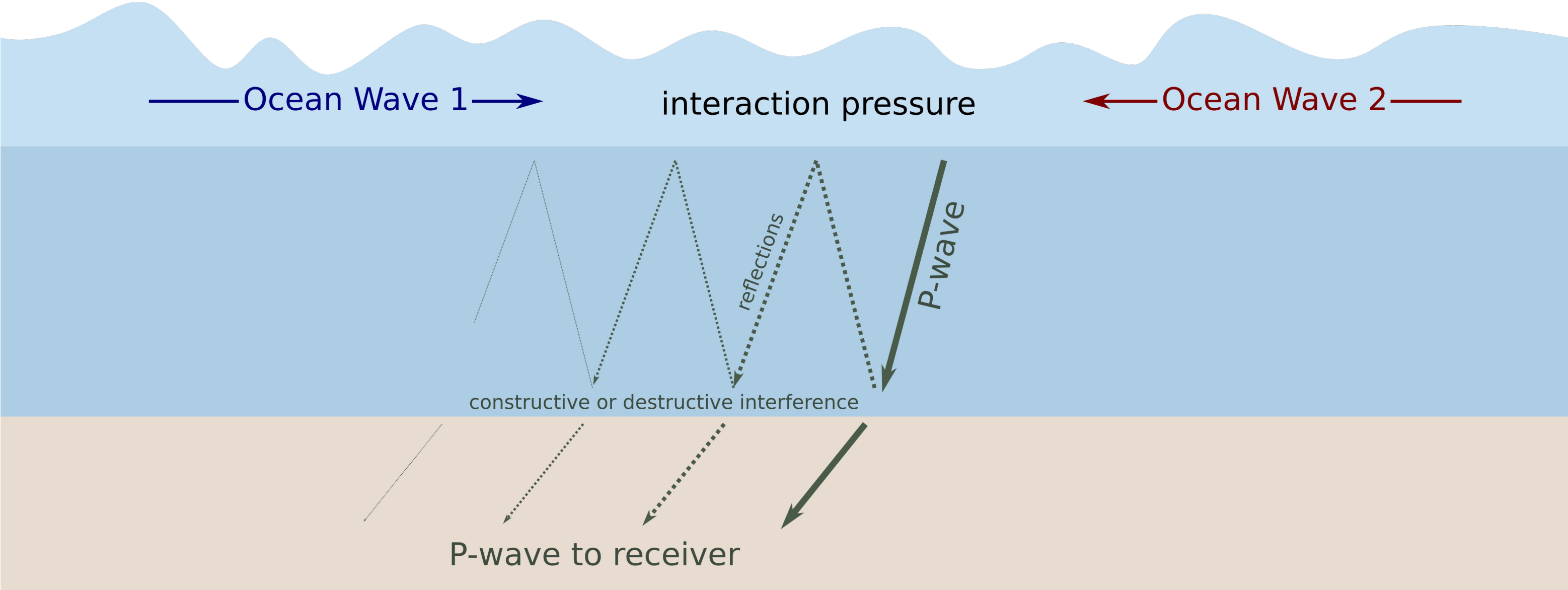[2] Institut of Earth Sciences Jaume Almera - CSIC, 08028 Barcelona, Spain

[3] University of Brest, CNRS, IRD, Ifremer, Laboratoire d'Océanographie Physique et Spatiale, IUEM

The Secondary Microseismic Frequency Band

AK.LOGN..BHZ   2015-08-19 -- 2015-08-29 (401/401 segments)

P-wave Generation from Interacting Ocean Waves

Ocean Wave 1 → interaction pressure ← Ocean Wave 2

reflections

P-wave

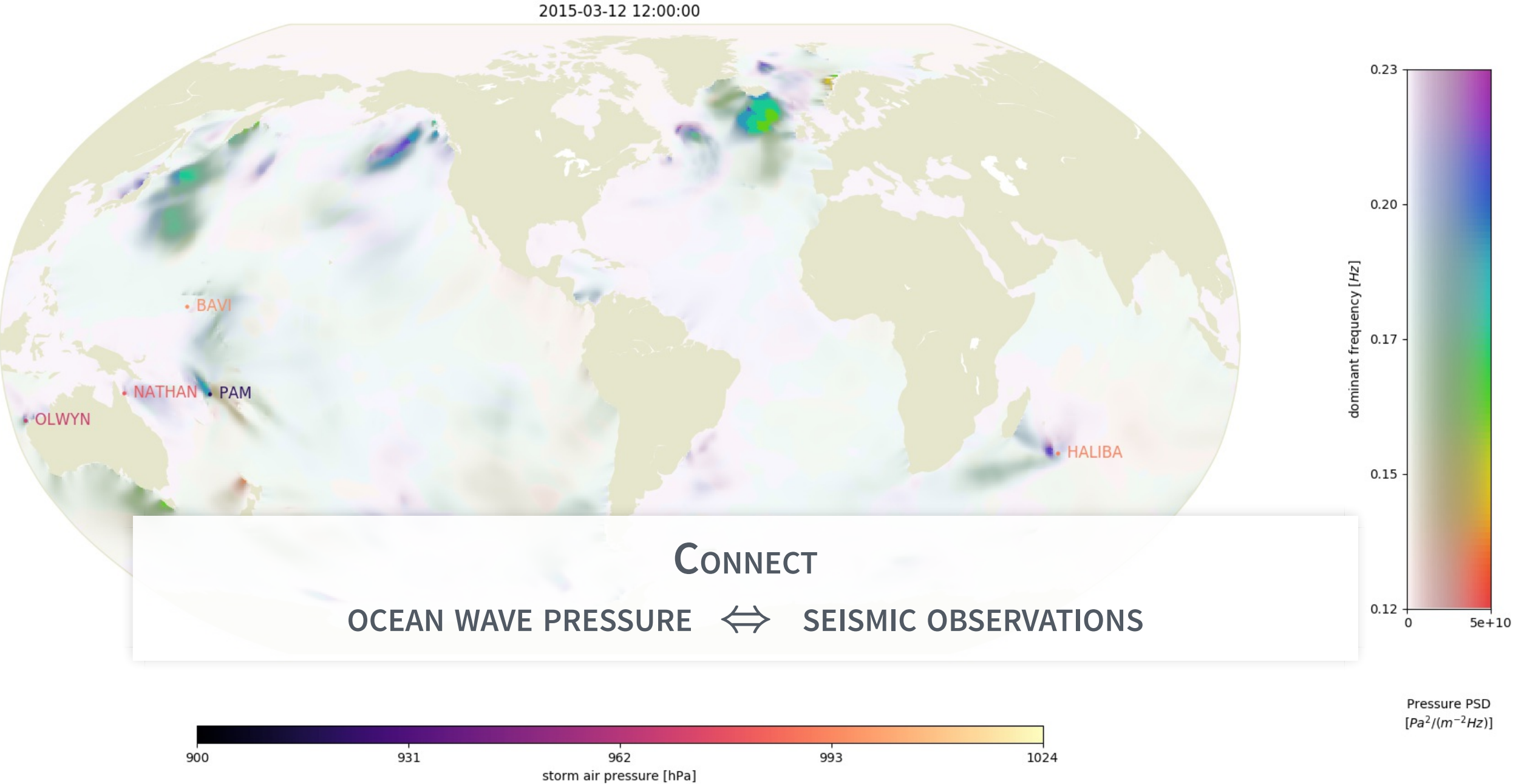constructive or destructive interference

P-wave to receiver

inspired by Gualtieri et al. (2014) and Ardhuin et al. (2013, 2015)

Secondary Microseism Pressure Models
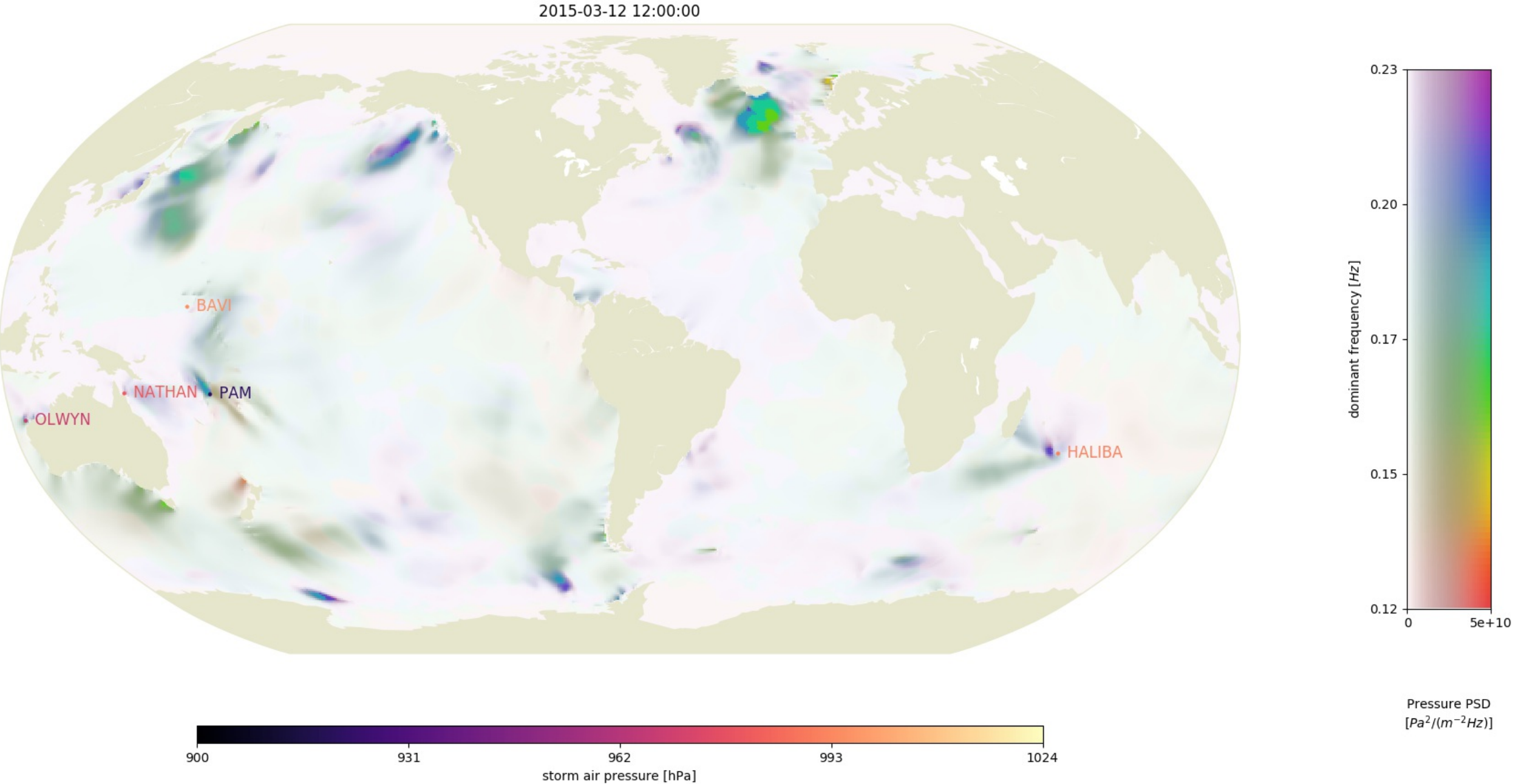
[model by Ardhuin et al. (2011), distributed by IFREMER
for video search "secondary microseism" on youtube]

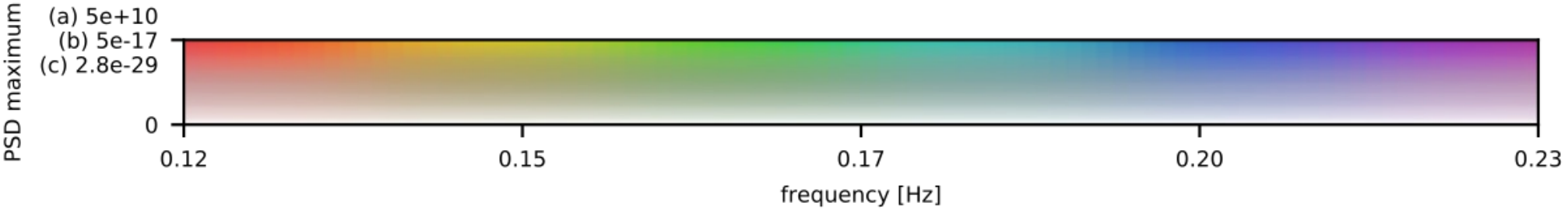# Secondary Microseism Pressure Models

2015-03-12 12:00:00

dominant frequency [Hz]

0.23

0.20

0.17

0.15

0.12

0   5e+10

BAVI

NATHAN PAM

OLWYN

HALIBA

Connect

OCEAN WAVE PRESSURE ⟺ SEISMIC OBSERVATIONS

Pressure PSD
$[Pa^2/(m^{-2}Hz)]$

storm air pressure [hPa]

900   931   962   993   1024

[model by Ardhuin et al. (2011), distributed by IFREMER
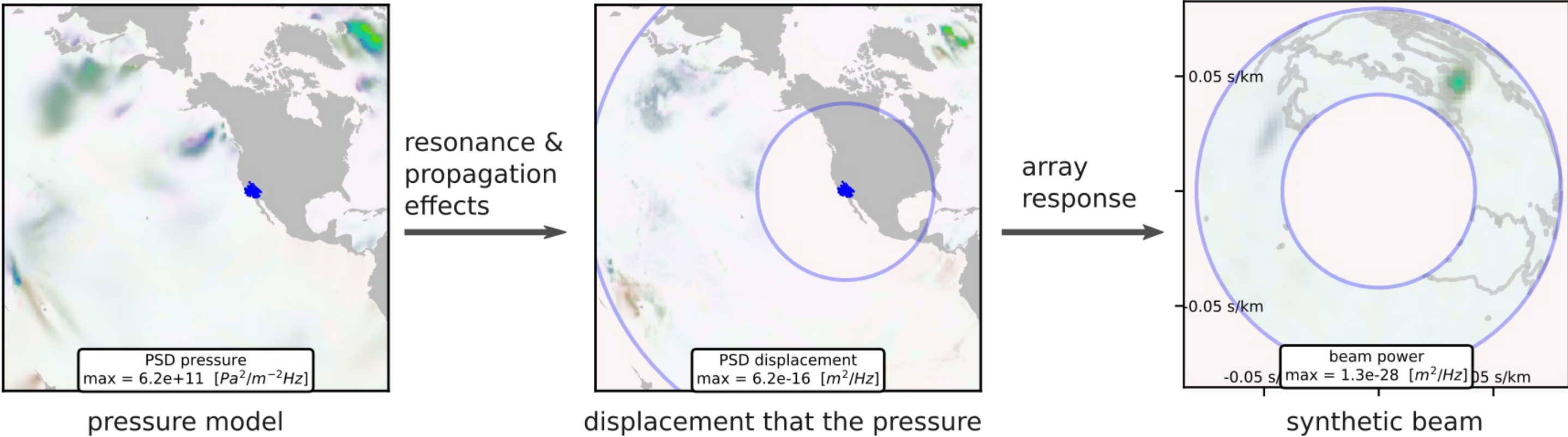for video search "secondary microseism" on youtube]
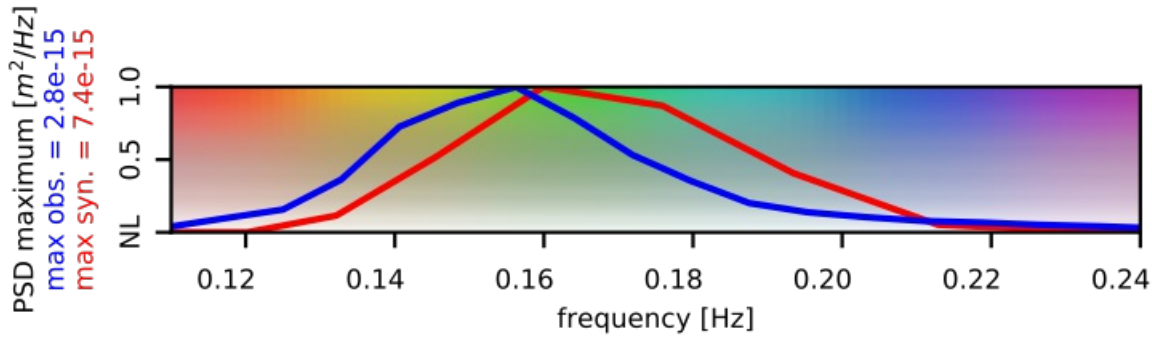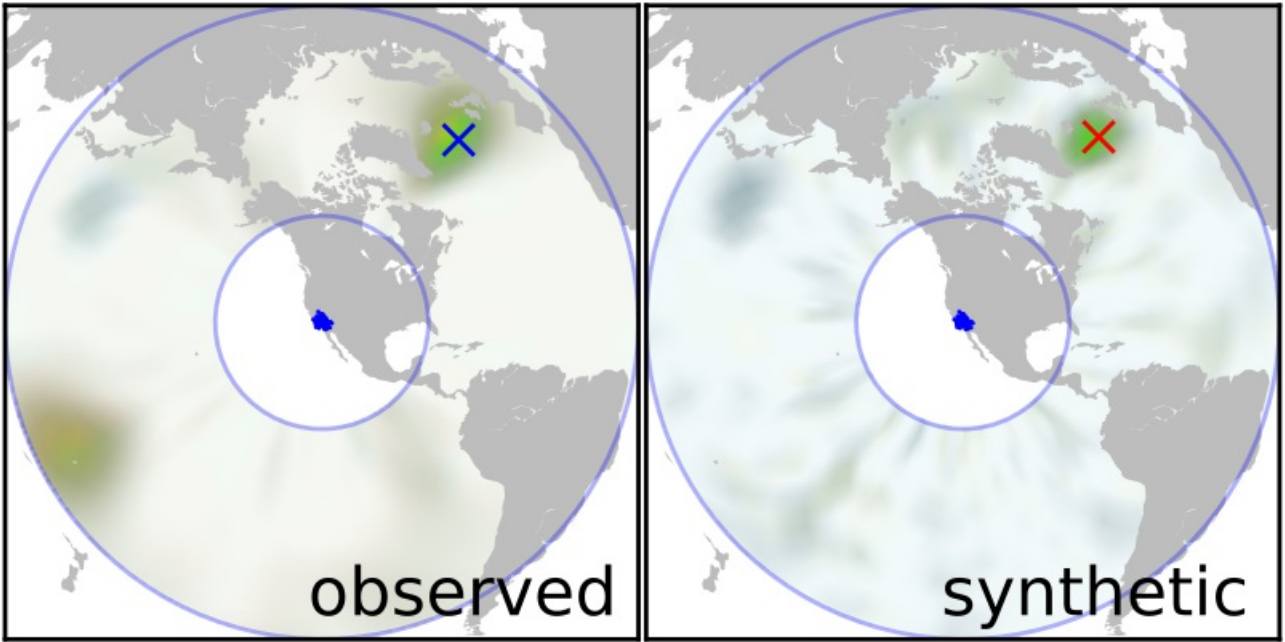
1 year of continuous data per array
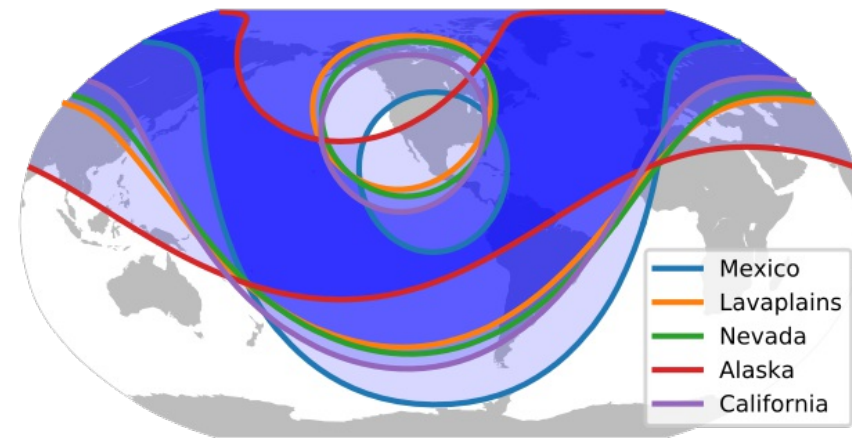
P-wave (30-90 degree) coverage

- five arrays (North-America)

- combined timespan of five years (2006, 2008, 2011, 2015, 2015)

- daily synthetic and observed beams for 3 models
  (1809 beams as a function of slowness and frequency)

- this presentation:
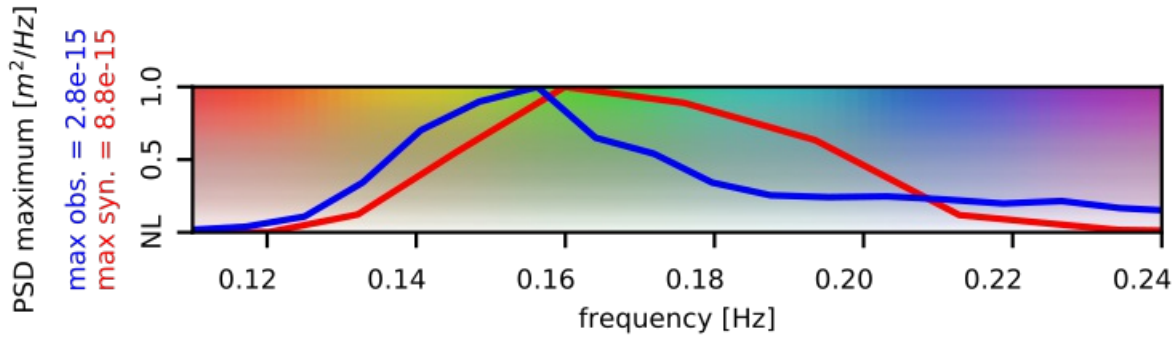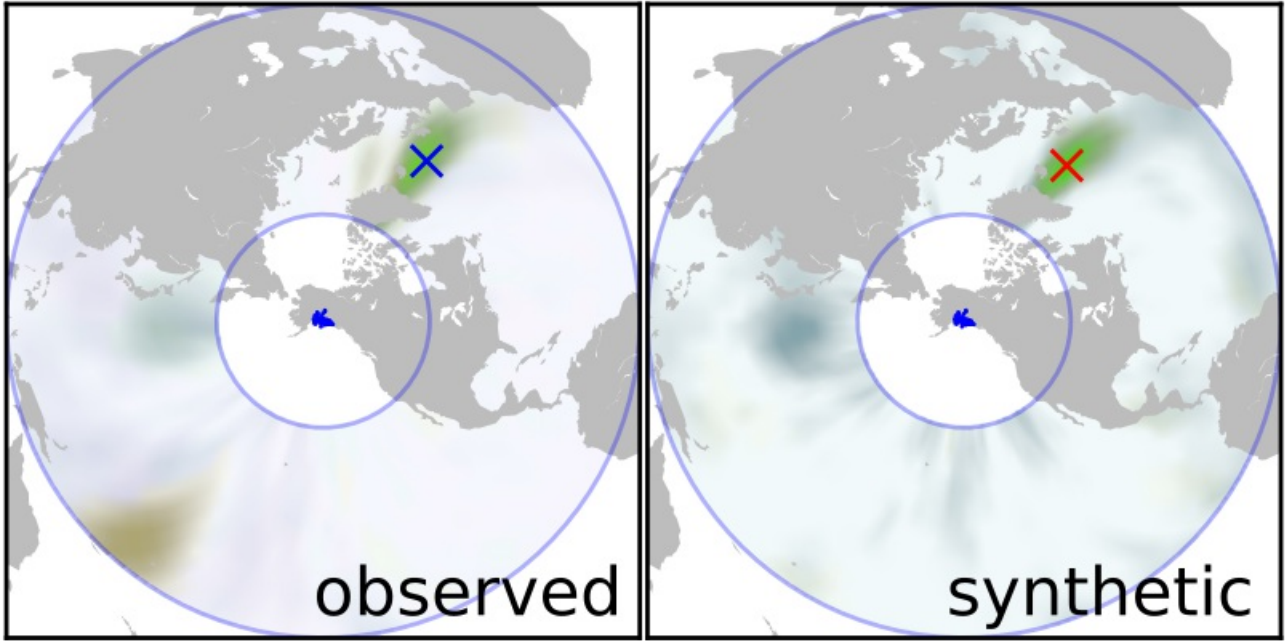 spectral characteristics of the strongest-sources

pressure model

resonance & propagation effects

displacement that the pressure model generates at one station

array response

synthetic beam

California array

Alaska array

The Strongest-Source Distribution

observed

resonance
no coastal reflections

model NR

resonance
coastal reflections

model R

no resonance
coastal reflections

model NA

day count
0 10 20 30 40 50 60 70
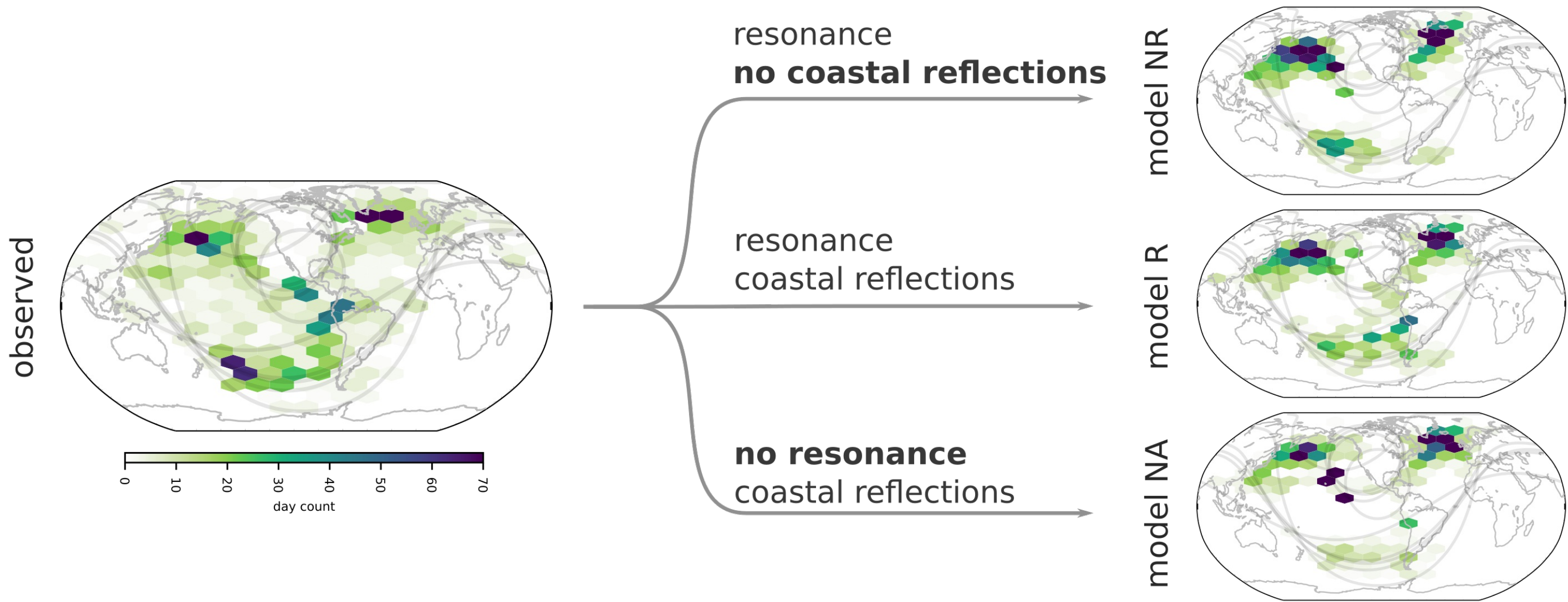
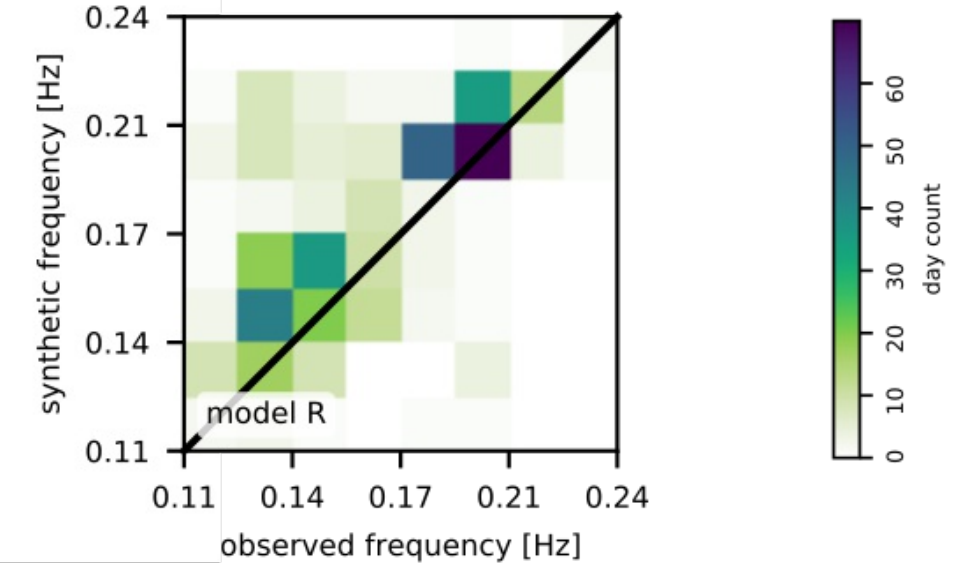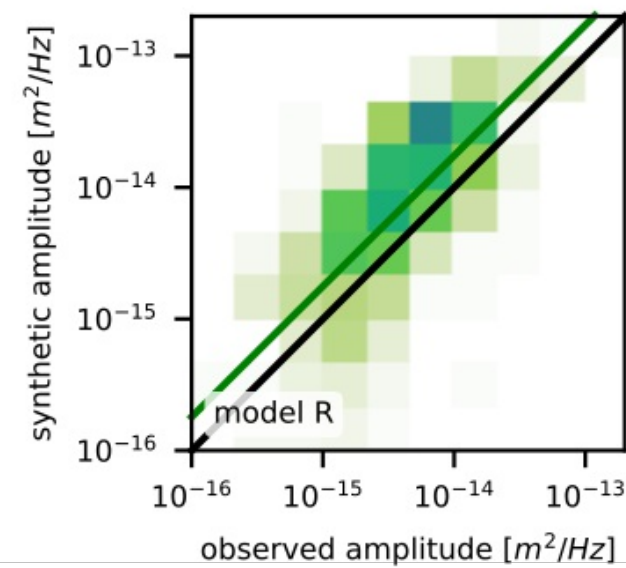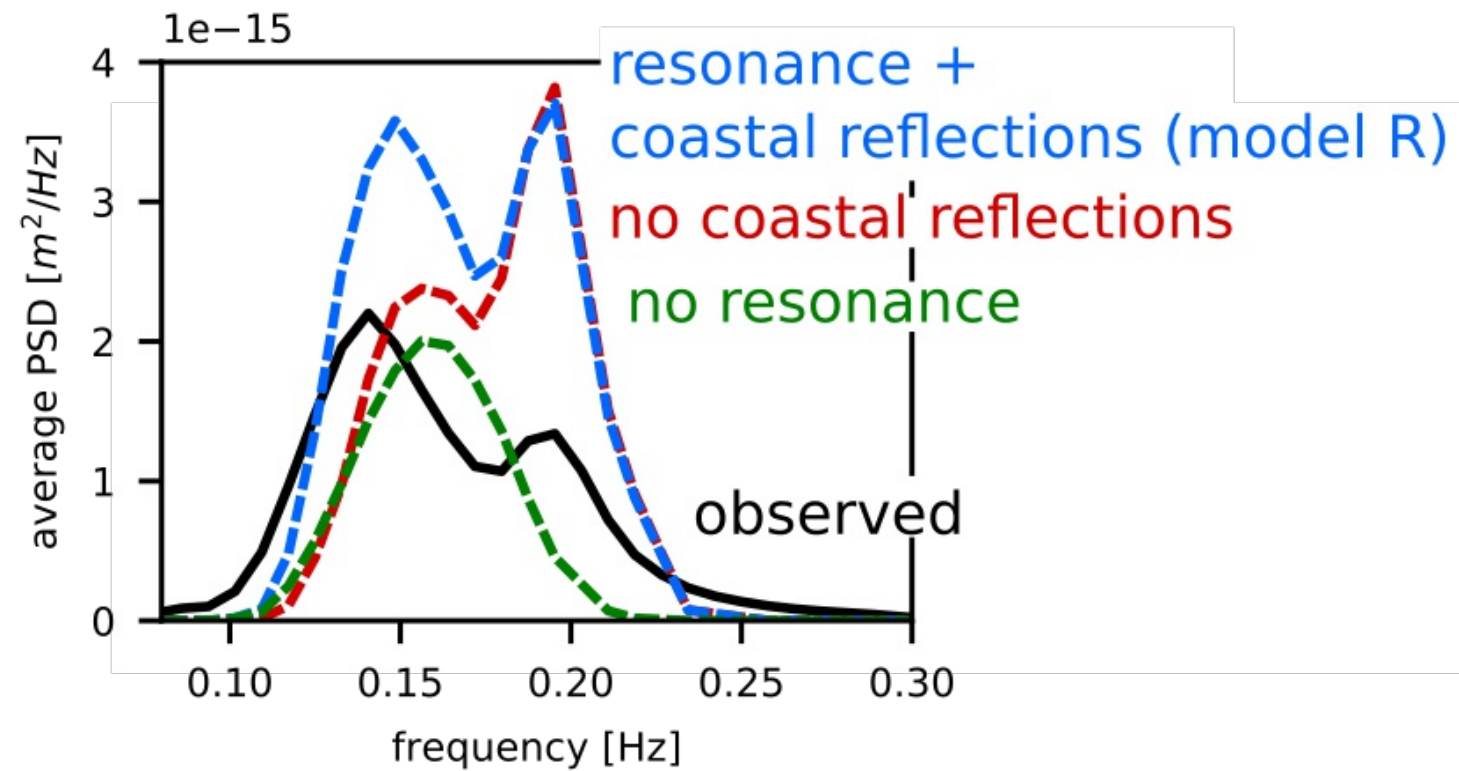observed source time and location ...
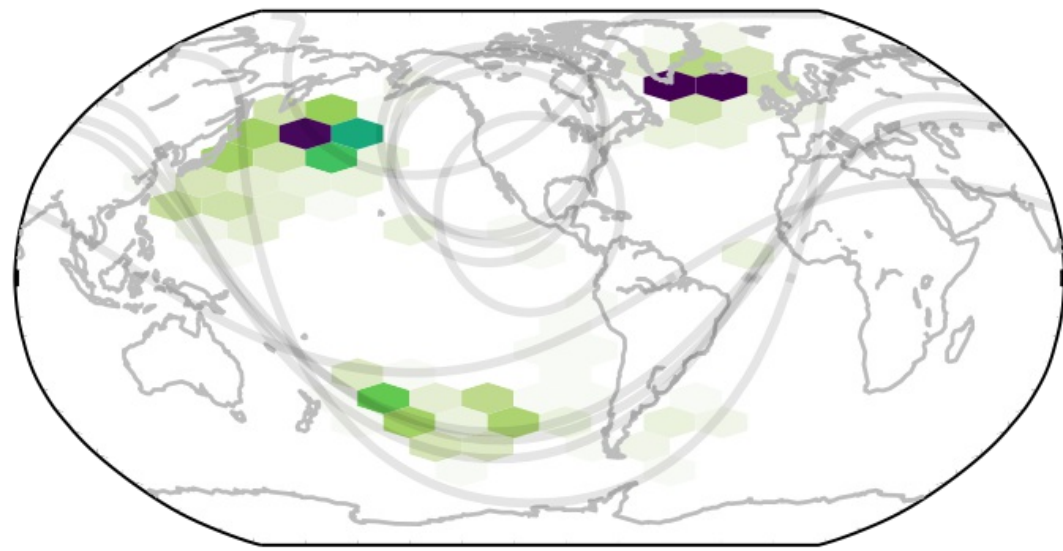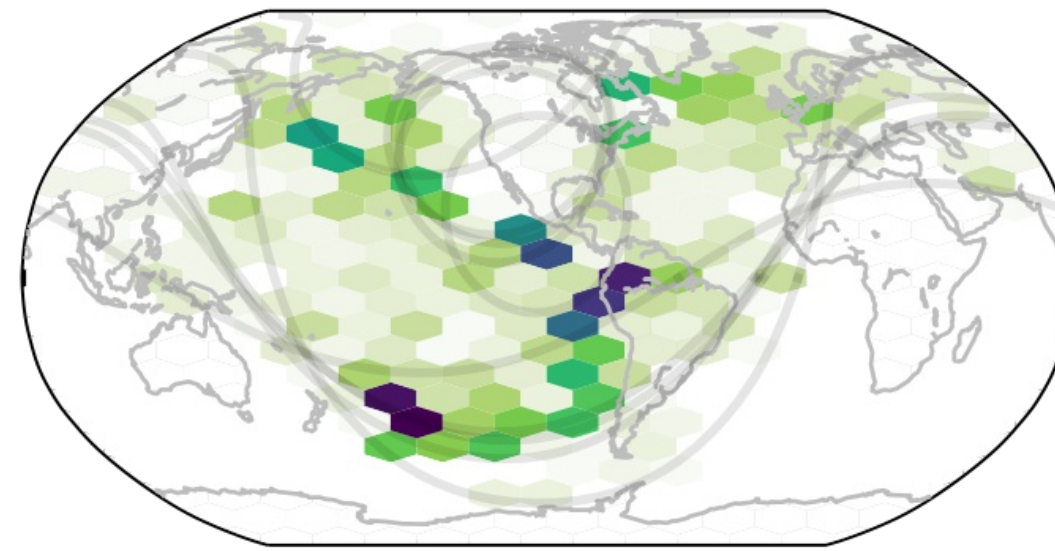
... match with model R   ... don't match with model R

- On 26% (467/1809) days the strongest-sources match
- non-matching sources are mostly microseisms as well

average spectra

amplitude comparison

frequency comparison

- Spectral double peak in observation and models with resonance

- Amplitudes are predicted within factor of 0.5 - 6 (1 std)

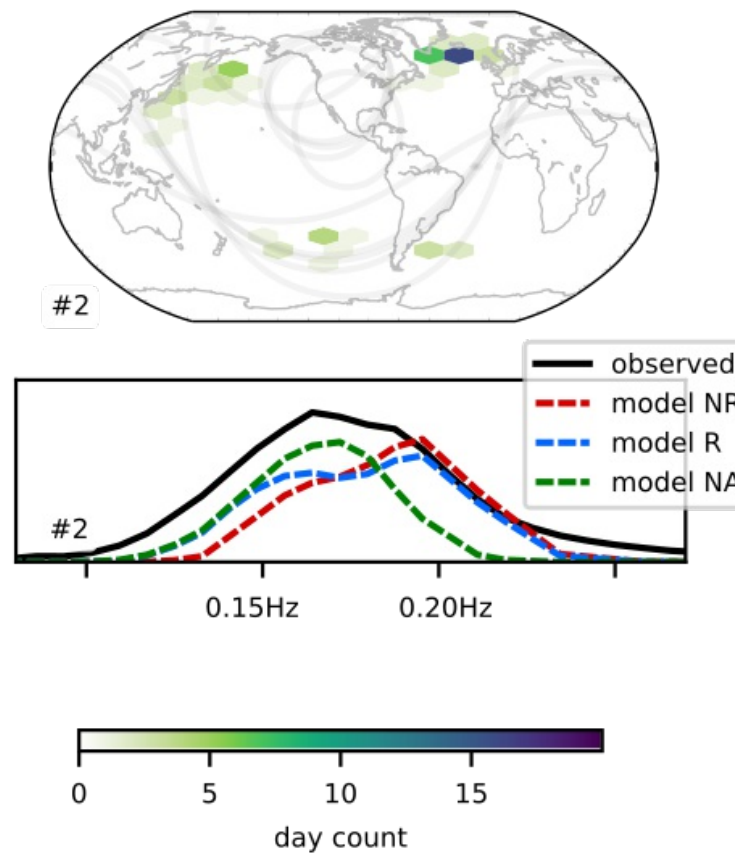- peak frequencies are either low or high

# Associating spectral shapes with geographical regions

low frequency cluster

mid frequency cluster
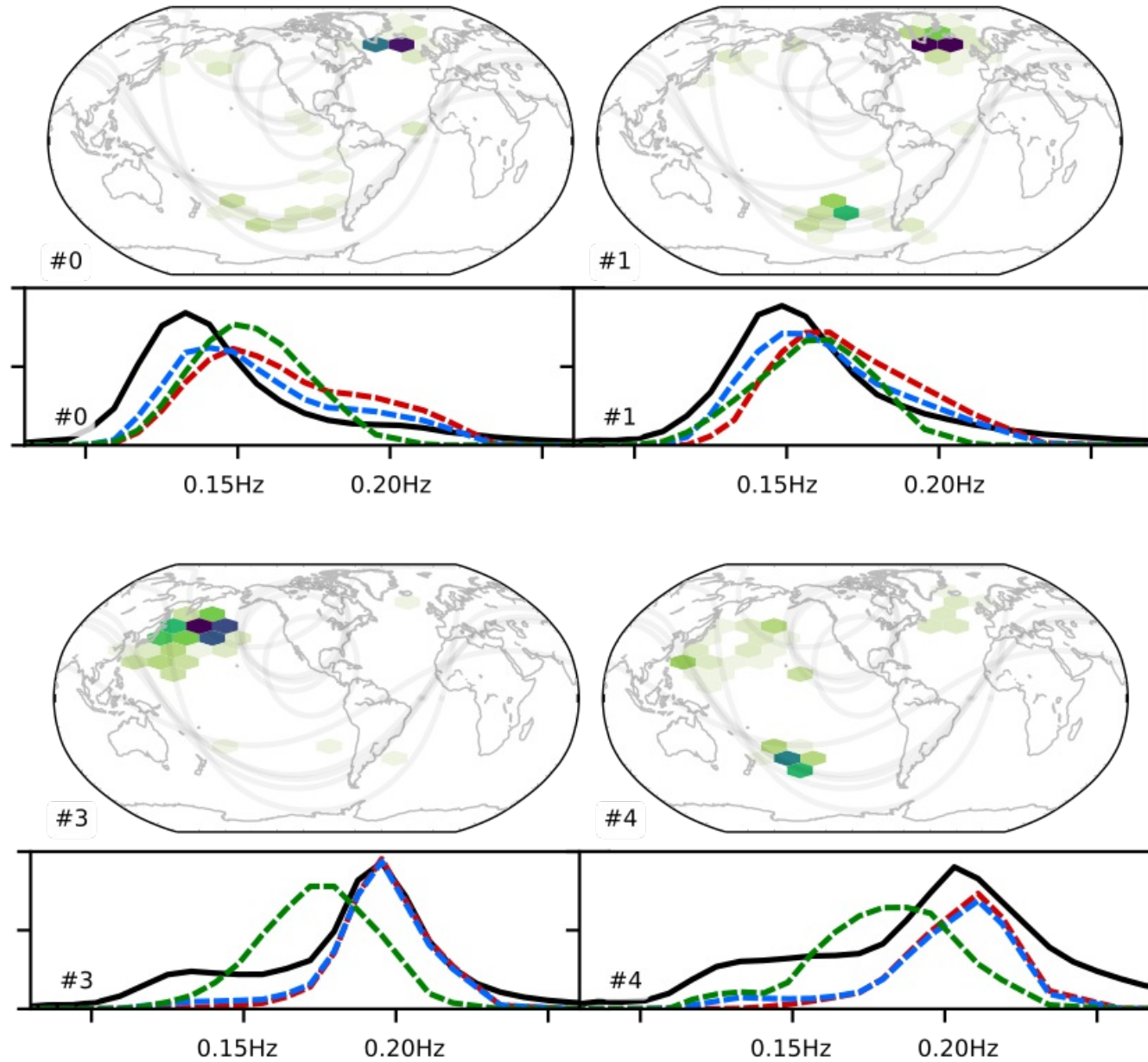
high frequency cluster

- Spectral Shape and Geographical Region are related

- Low frequency peak is broader than the high frequency one

- High frequency spectra are better modeled
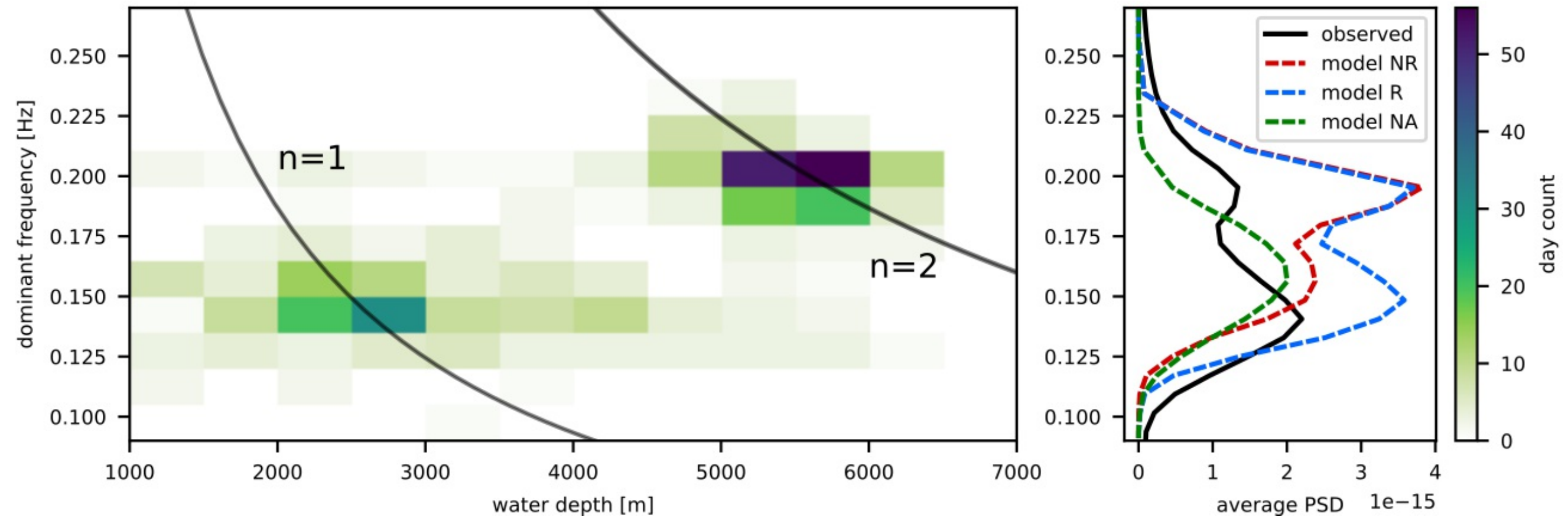
SOURCE SITE RESONANCE

water column amplification factor $|C_p|$

secondary microseisms

histogram of ocean depths
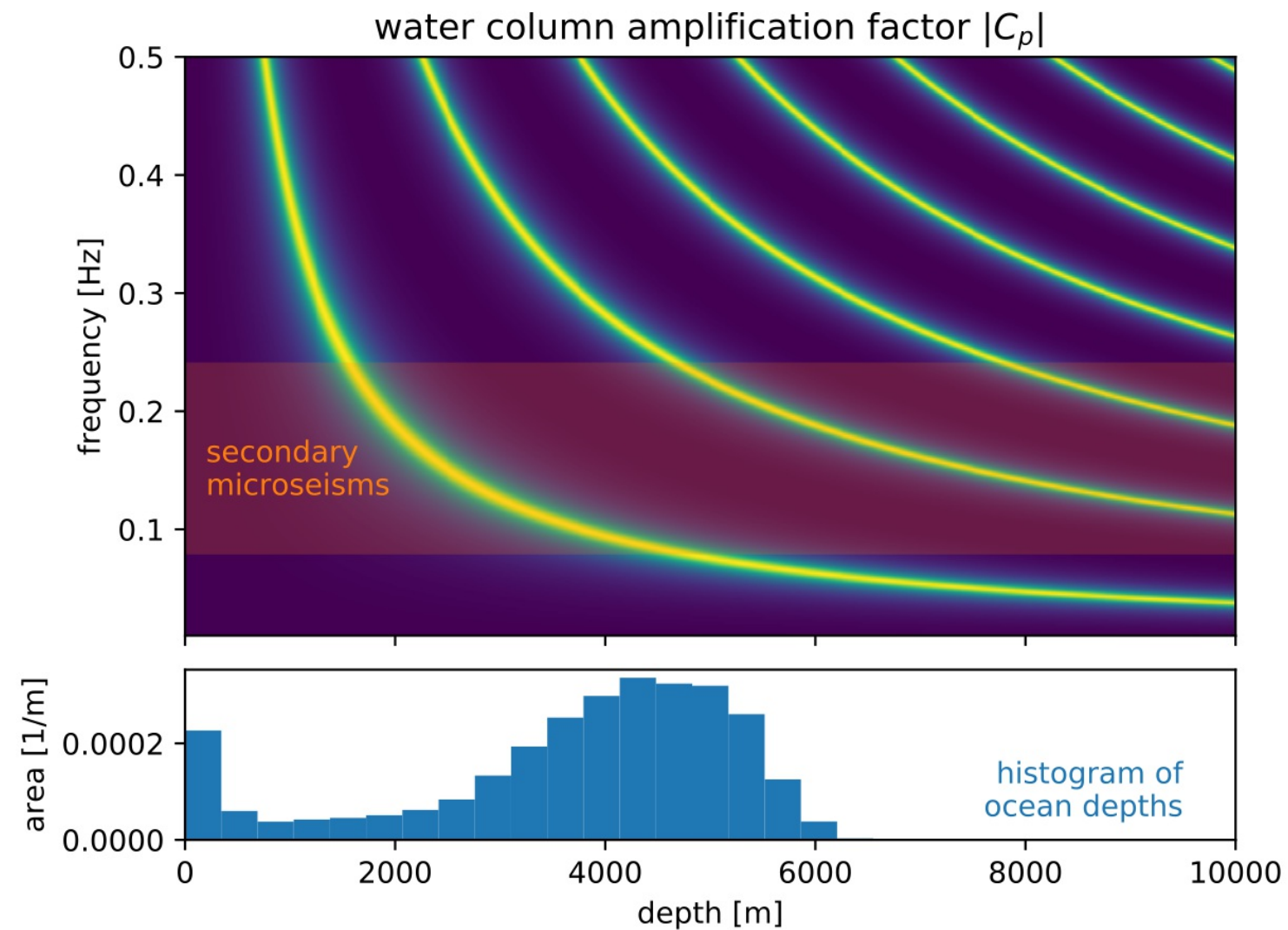
- resonance when $2h/\lambda + 1/2 = n$

- $h = 1/4\lambda,\ 3/4\lambda,\ 5/4\lambda, ...$

- $n = 1$ (shallow ocean) and $n = 2$ (deep ocean) most important for secondary microseisms

SOURCE SITE RESONANCE MAP
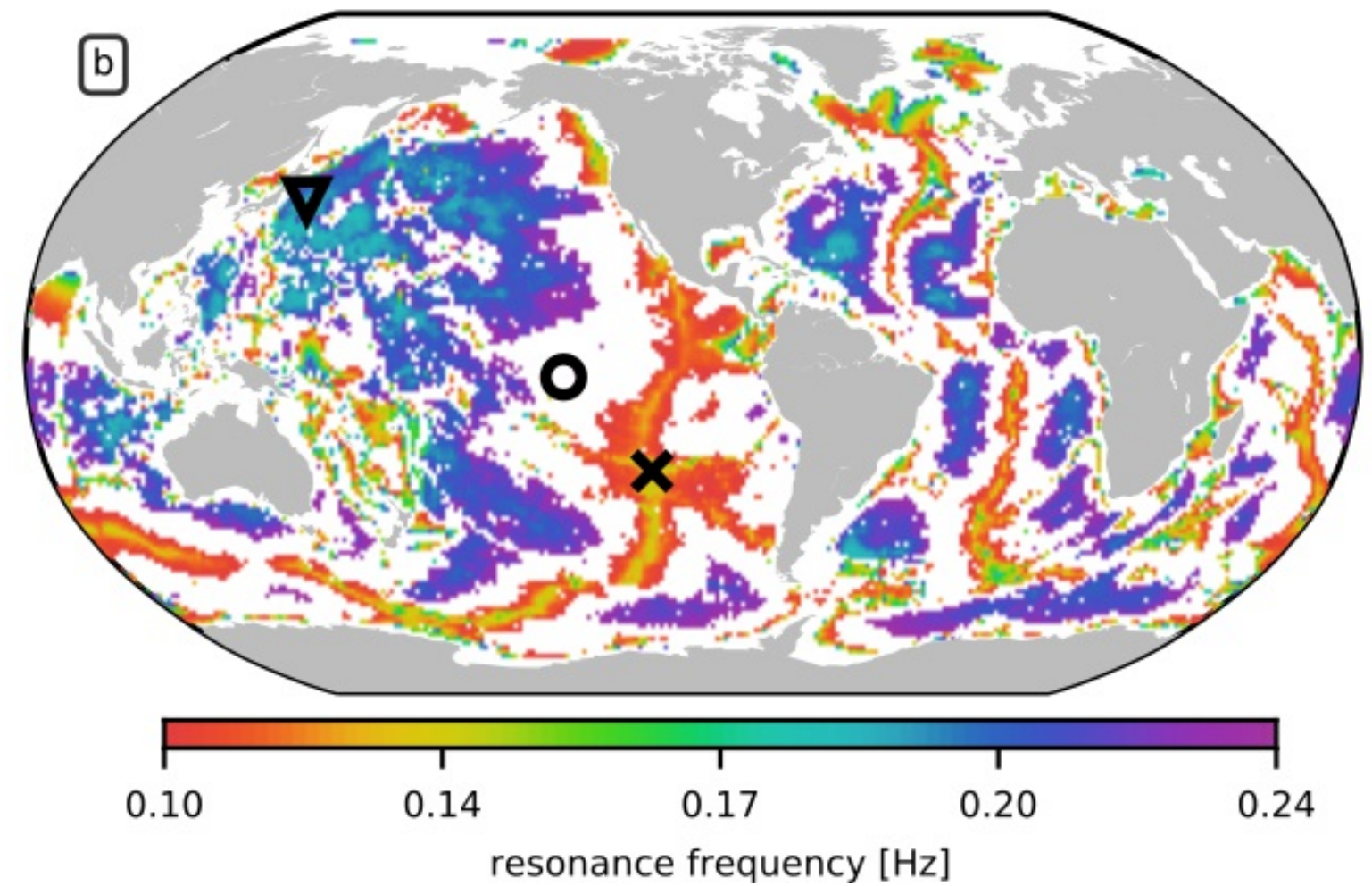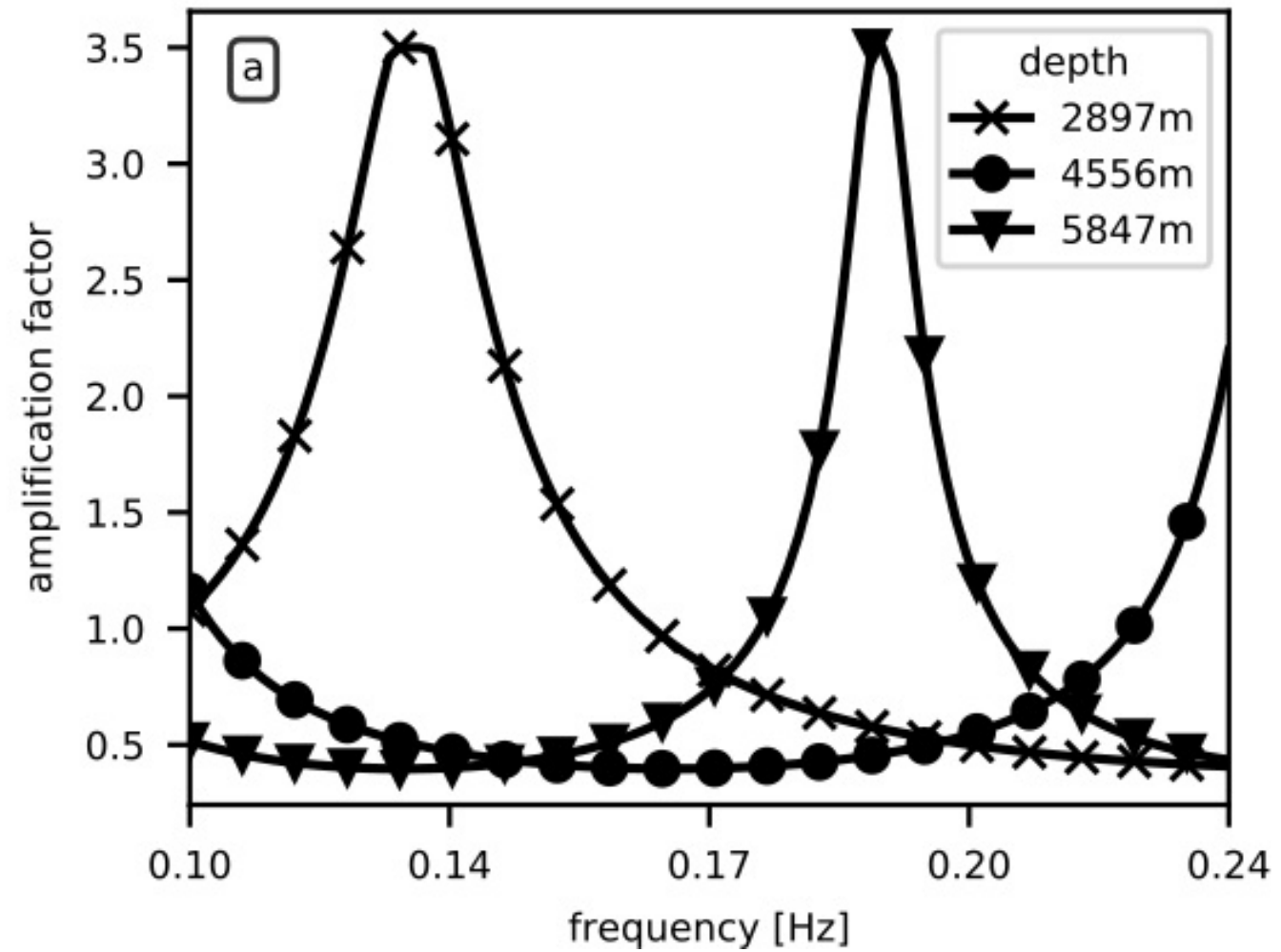
- n=1 in shallow ocean [cross]

- no resonance from 0.10 - 0.24Hz [circle]

- n=2 in deep ocean [triangle]

- secondary microseism P-wave spectra are strongly affected by resonance effects

- bathymetry favours resonance at 0.15 and 0.20Hz (first and second harmonic)

- ocean wave model can reasonably well predict the spectra