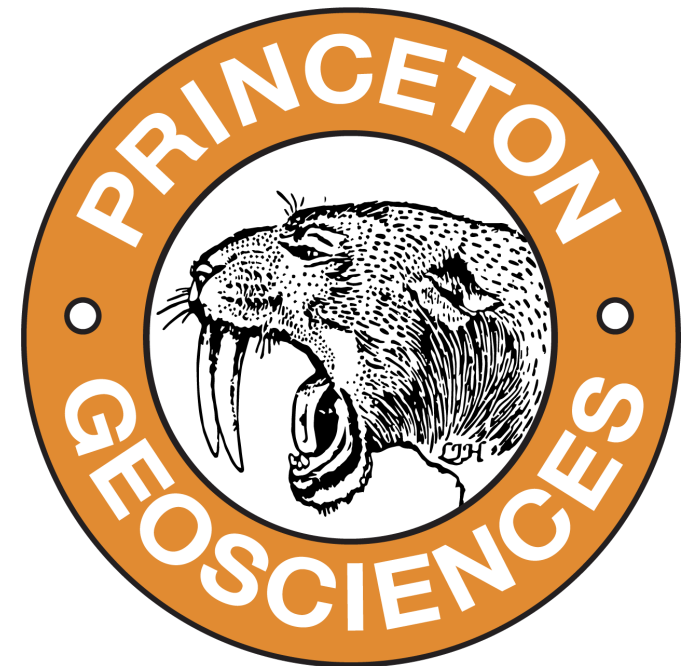


# The 15 January 2022 Hunga Tonga-Hunga Ha'apai Eruption as Recorded by **MERMAID**s Adrift in the Pacific: Investigating the Effects of **Bathymetric Occlusion** on Hydroacoustic Signature



**Joel D. Simon**<sup>1</sup> (jdsimon@princeton.edu),  
Yong Yu<sup>2</sup>, Masayuki Obayashi<sup>3</sup>, Hiroko Sugioka<sup>4</sup>, Frederik J. Simons<sup>1</sup>,  
Jessica C. E. Irving<sup>5</sup>, and The EarthScope-Oceans Consortium

earth  
scope  
oceans



University of  
**BRISTOL**



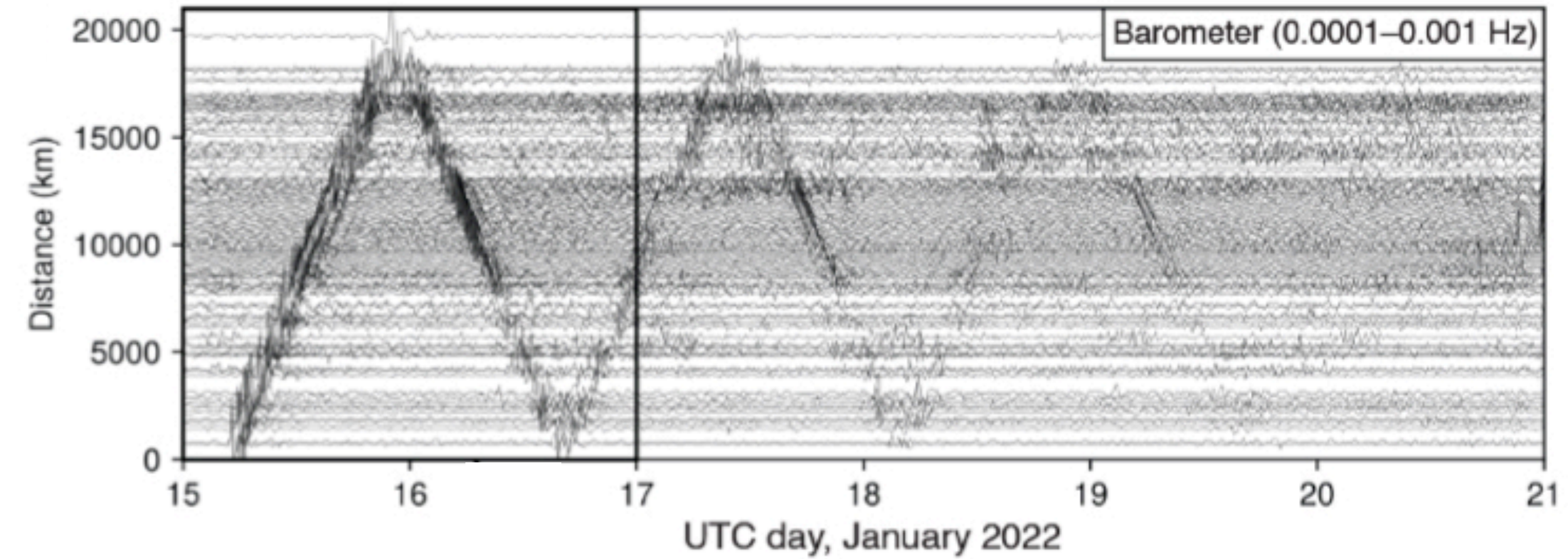
<sup>1</sup>Princeton University, United States; <sup>2</sup>Southern University of Science and Technology, China

<sup>3</sup>Japan Agency for Marine-Earth Science and Technology, Japan; <sup>4</sup>Kobe University, Japan; <sup>5</sup>University of Bristol, United Kingdom

# 15 January 2022 Hunga Tonga-Hunga Ha'apai Eruption

Largest volcanic eruption on Earth since Krakatoa in 1883

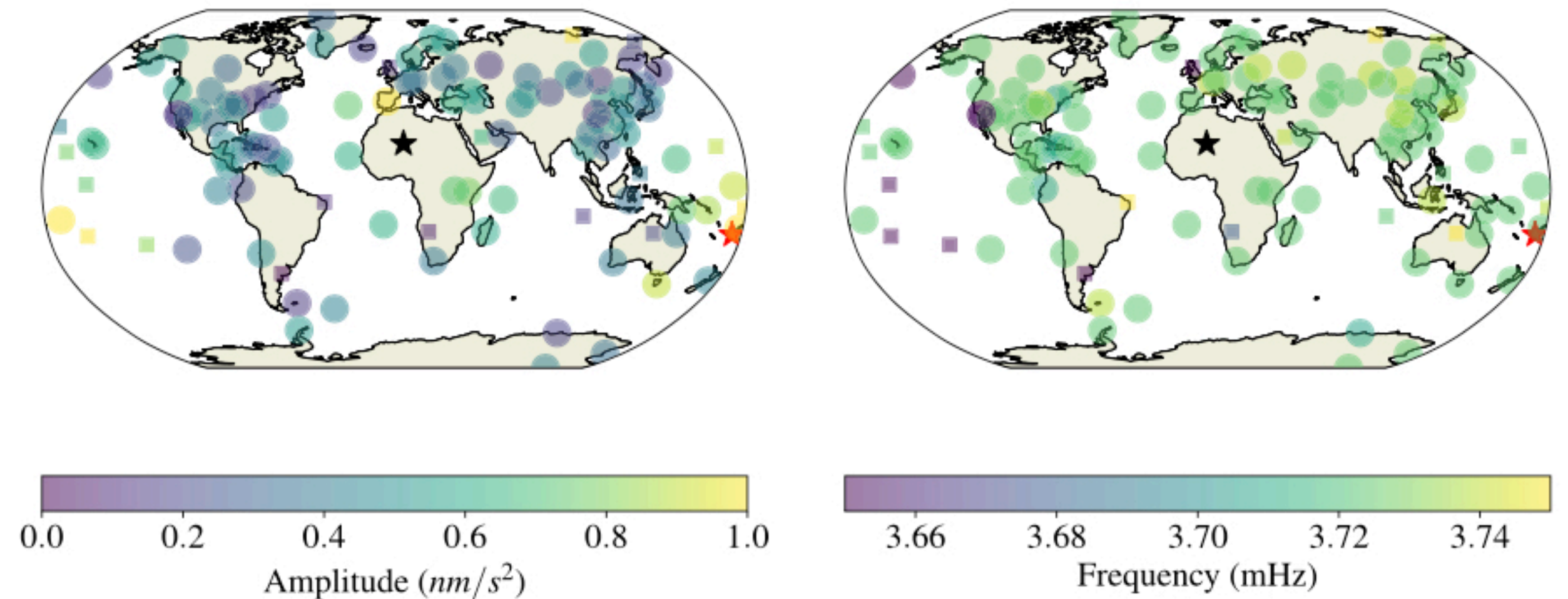
- Generated surface-wave magnitudes of M 5.8
- Produced atmospheric waves that circled Earth for days
- Excited solid-earth normal modes
- Spawned megatsunami



Matoza et al., 2022 (*Science*)

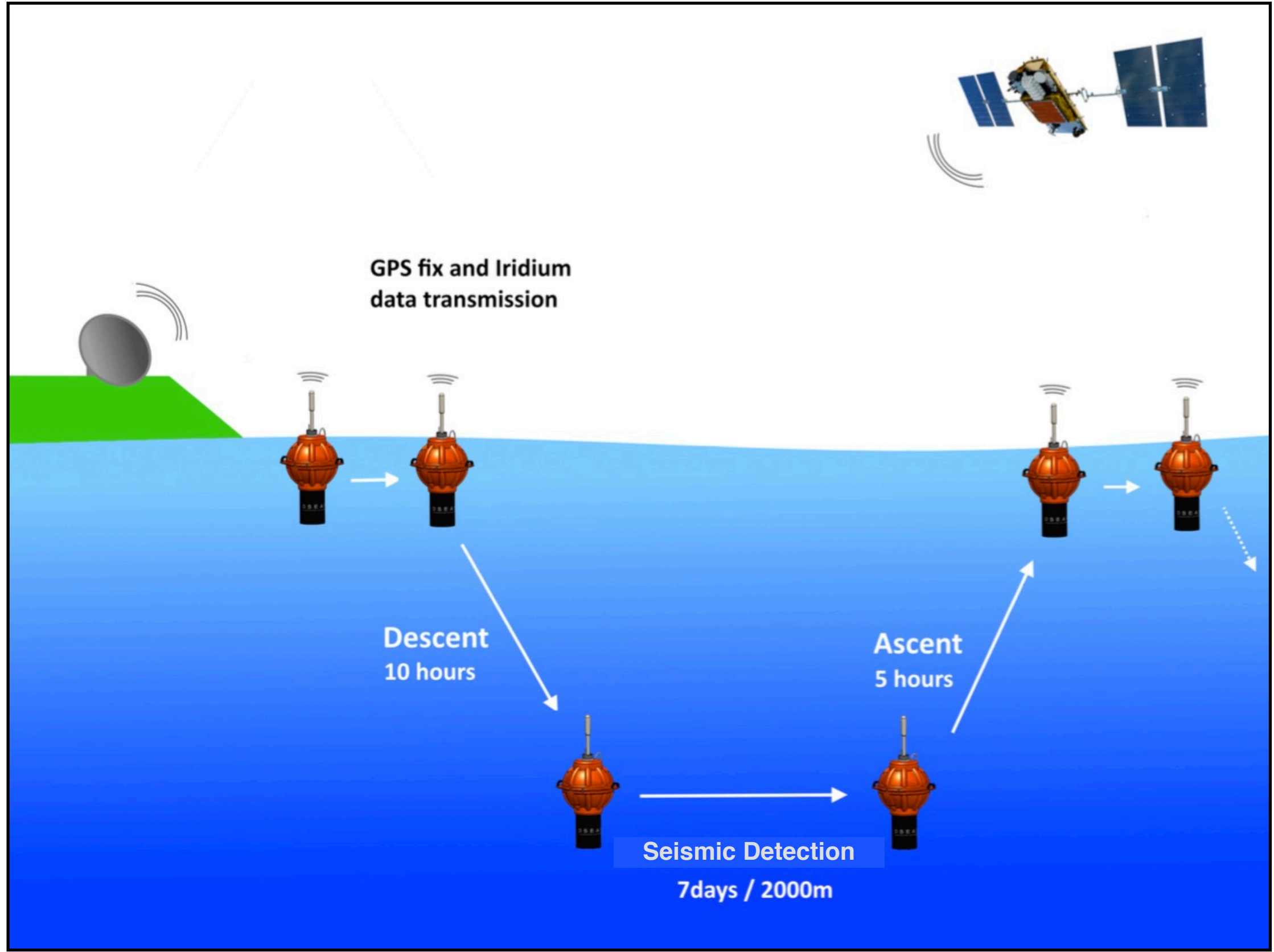


Tonga Geological Services / EOS.org

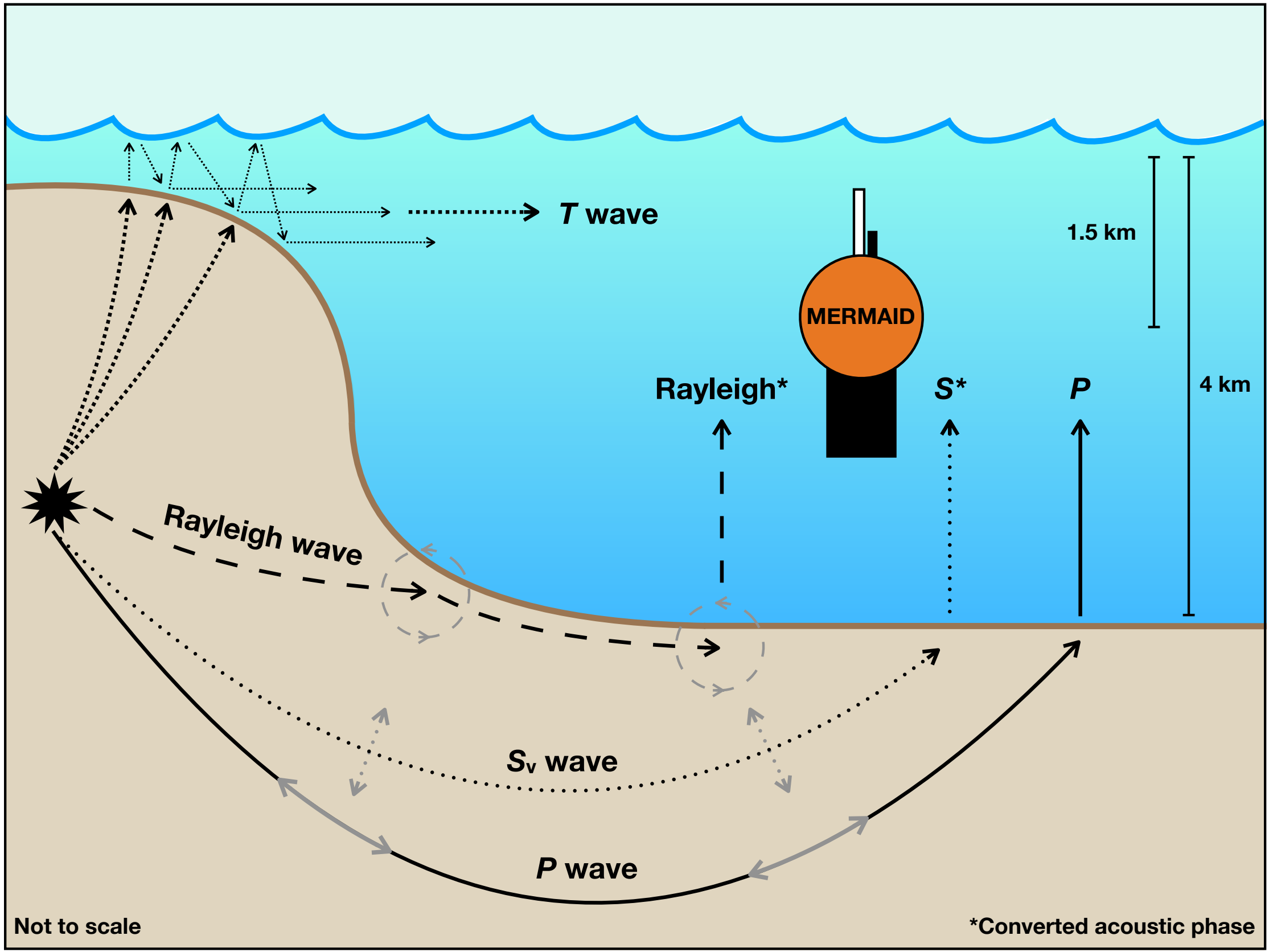


Ringler et al., 2022 (*GJI*)

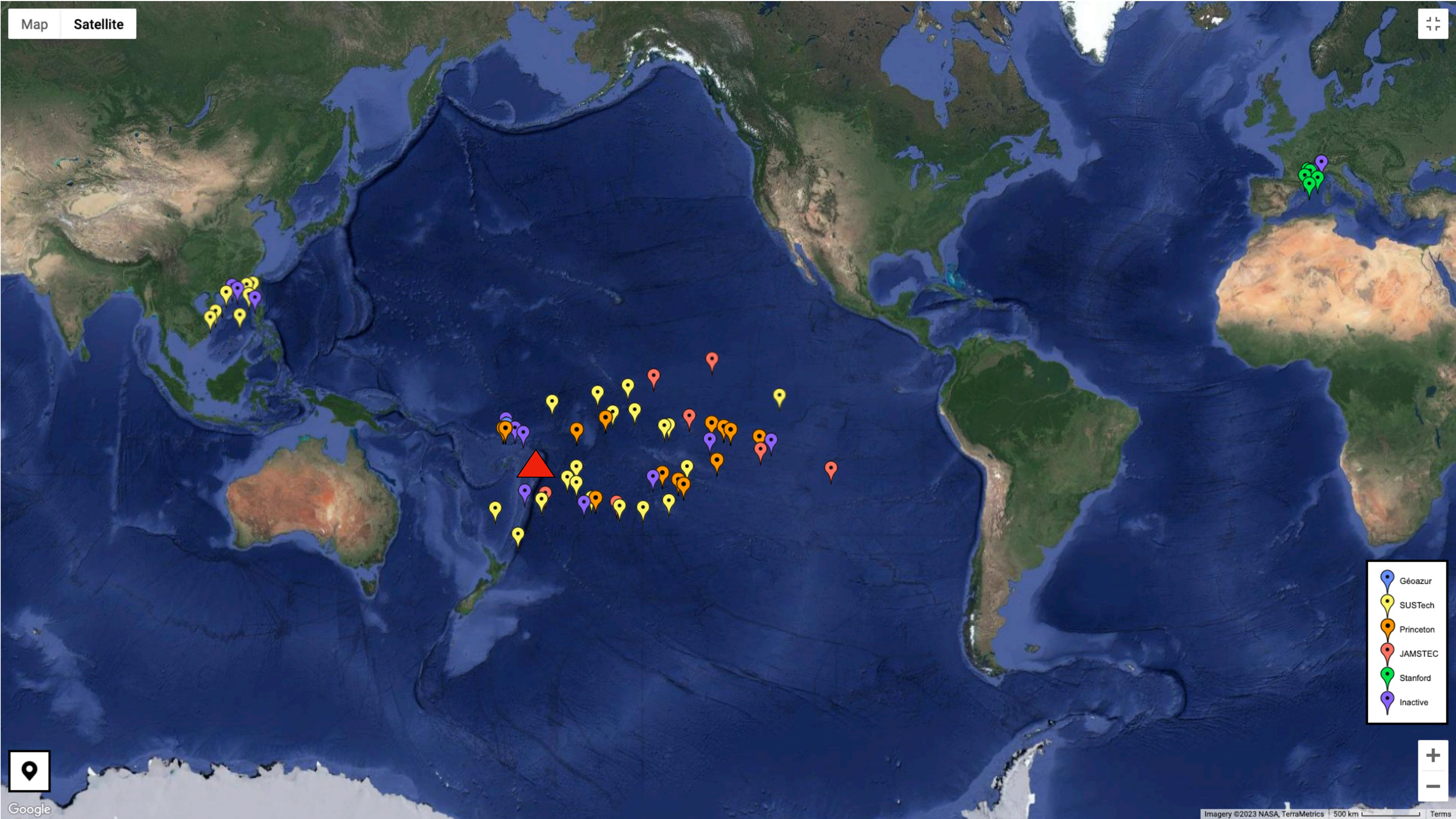
# Mobile Earthquake Recording in Marine Areas by Independent Divers



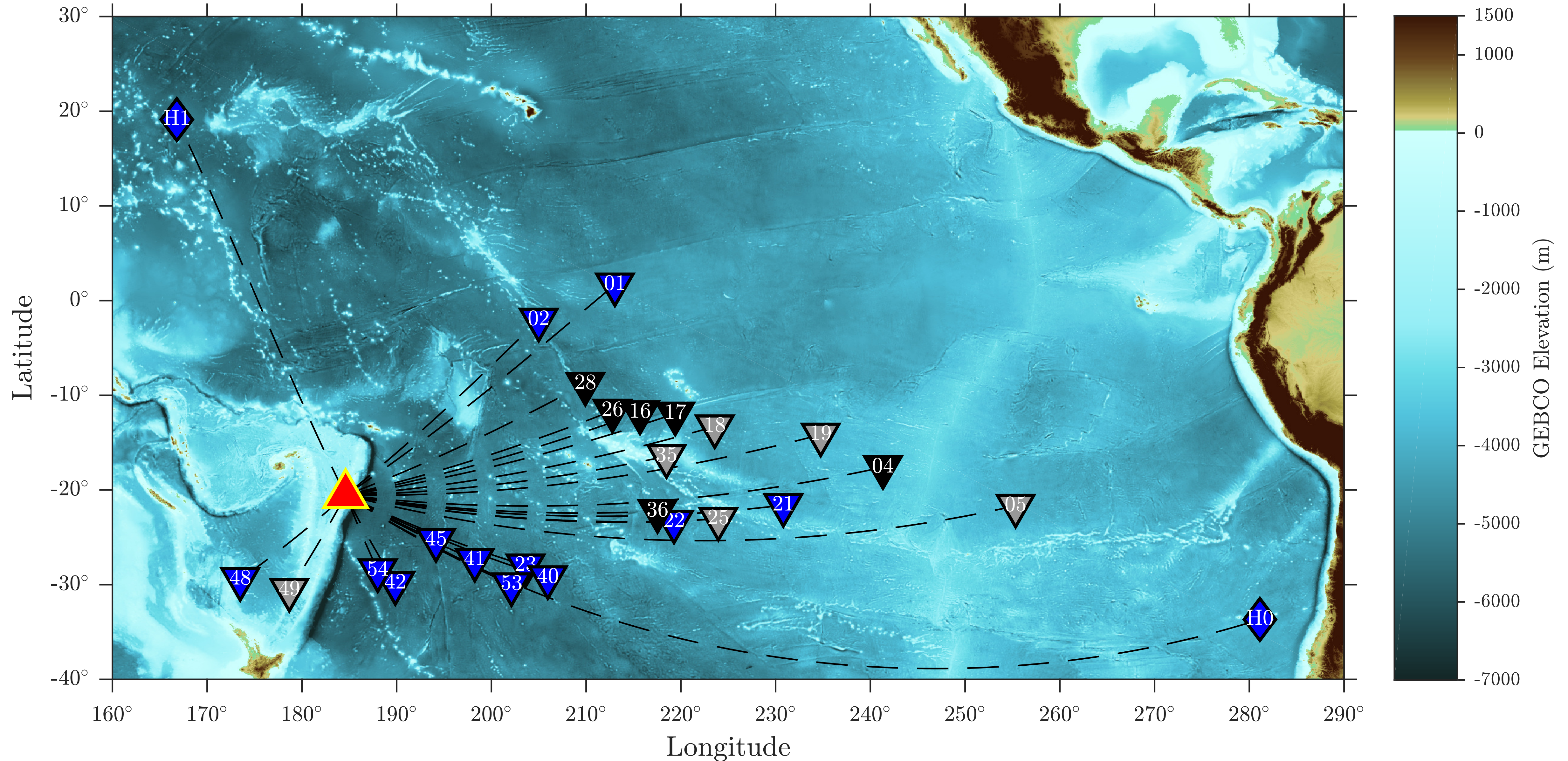
OSEAN.fr

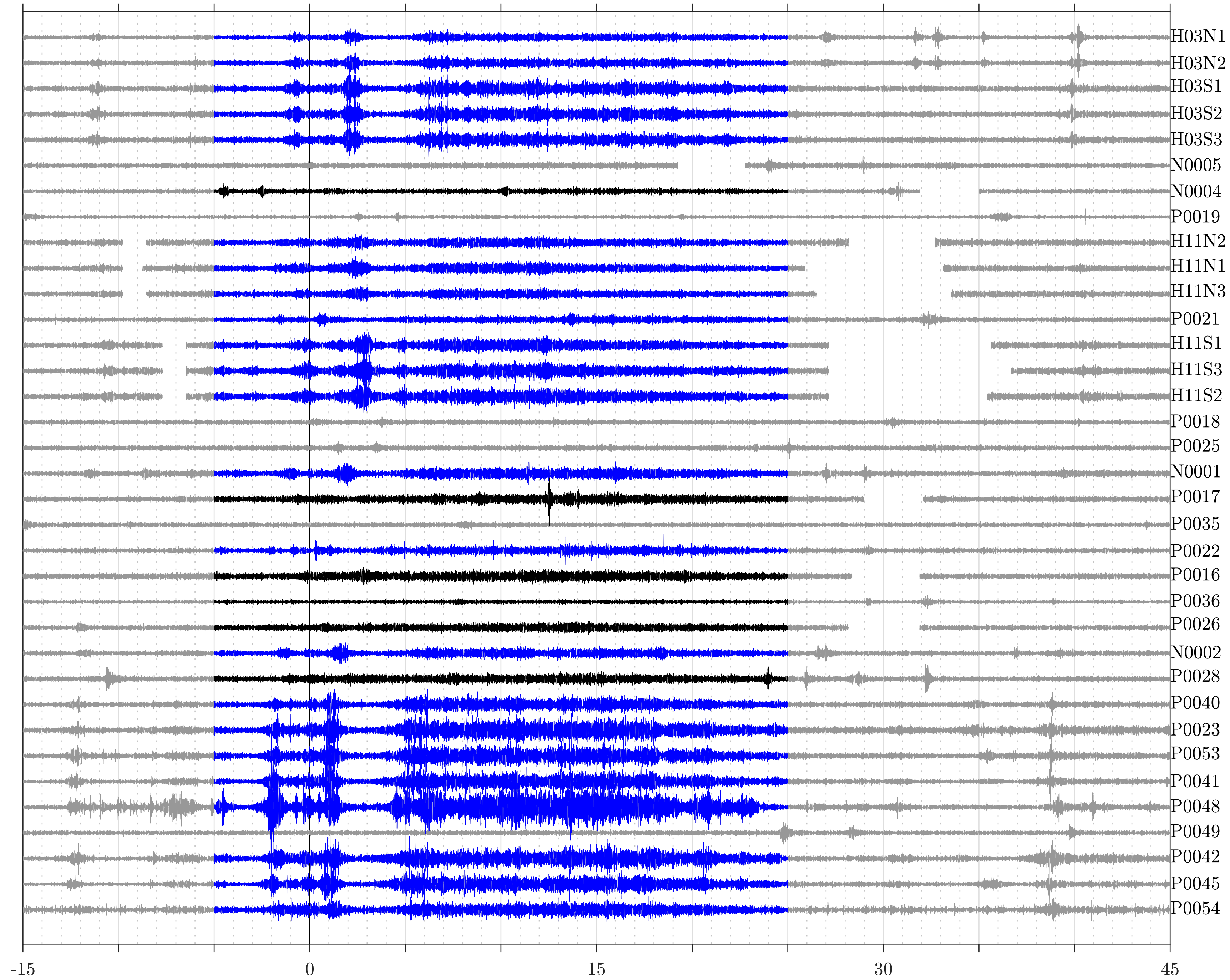


Simon et al., 2021 (SRL)

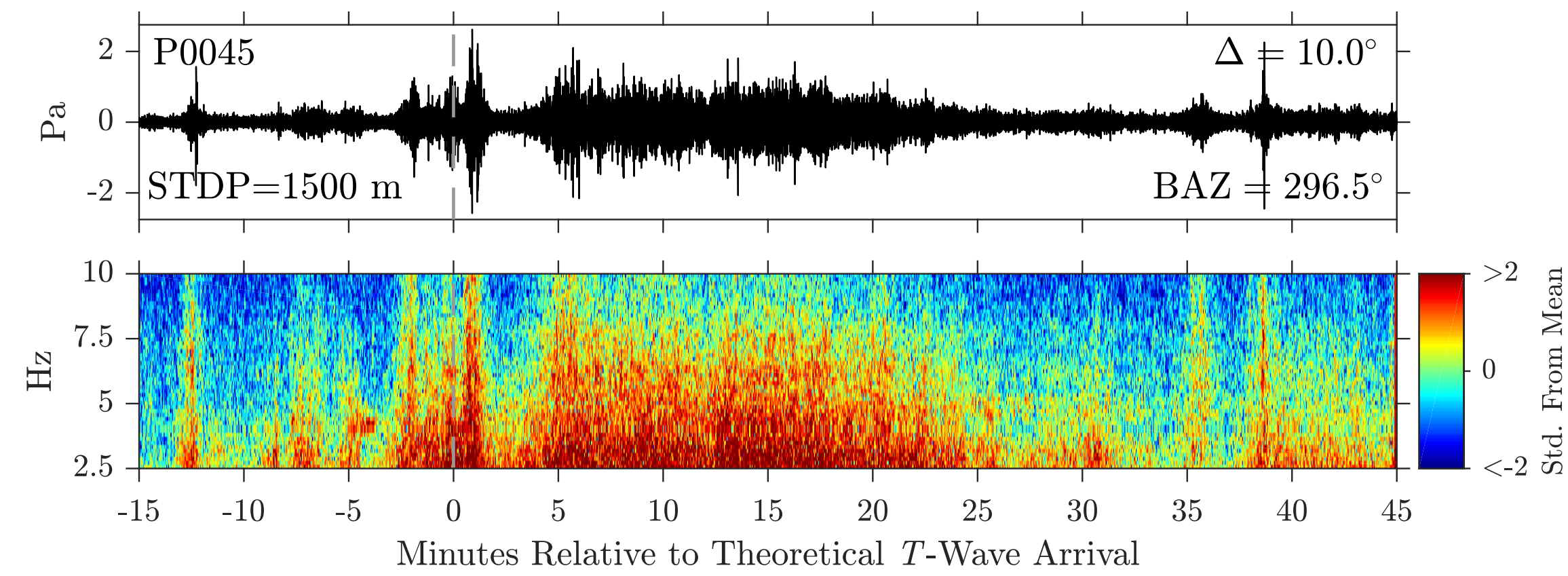
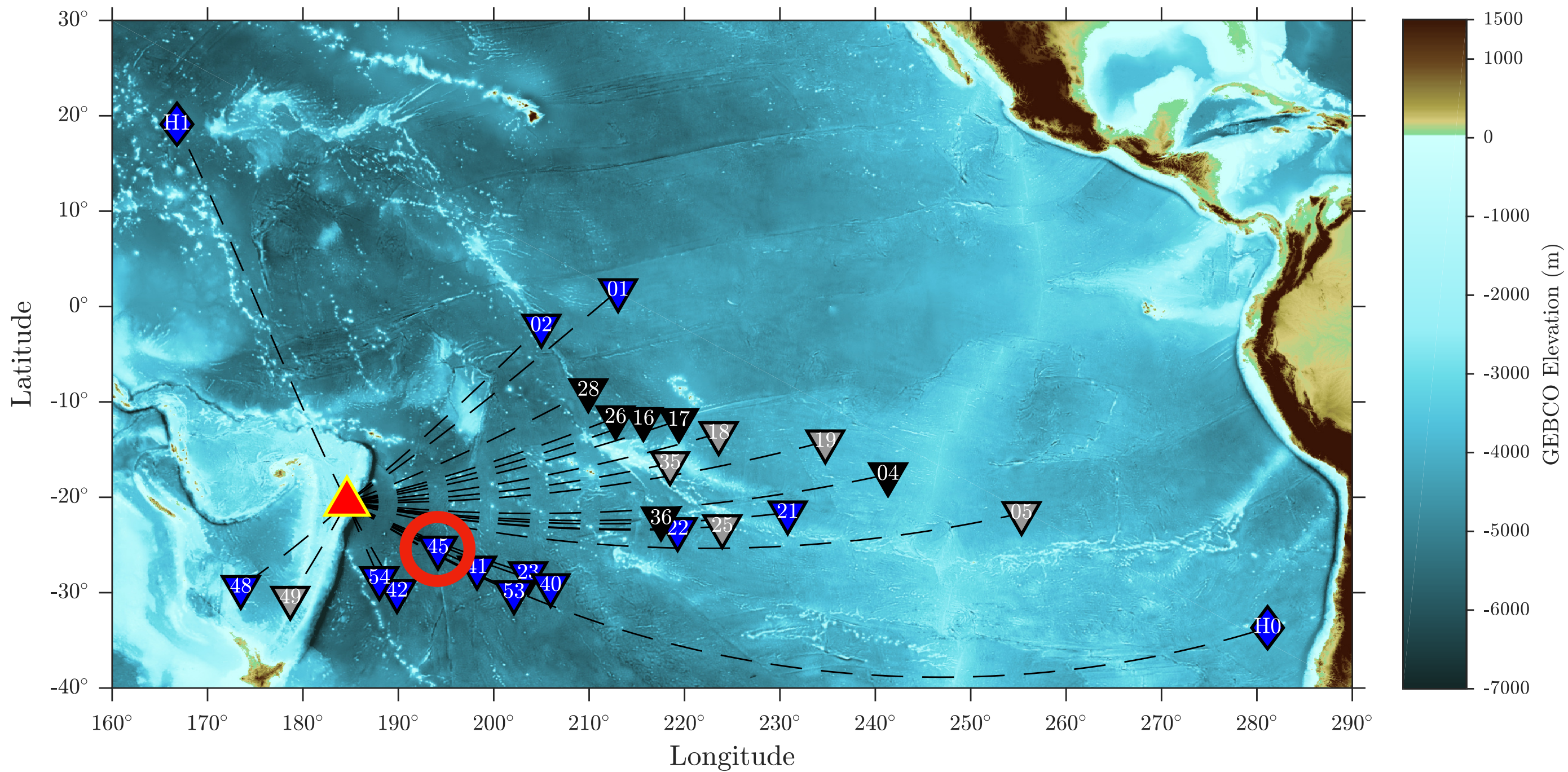


# MERMAID Locations on 15 January 2022

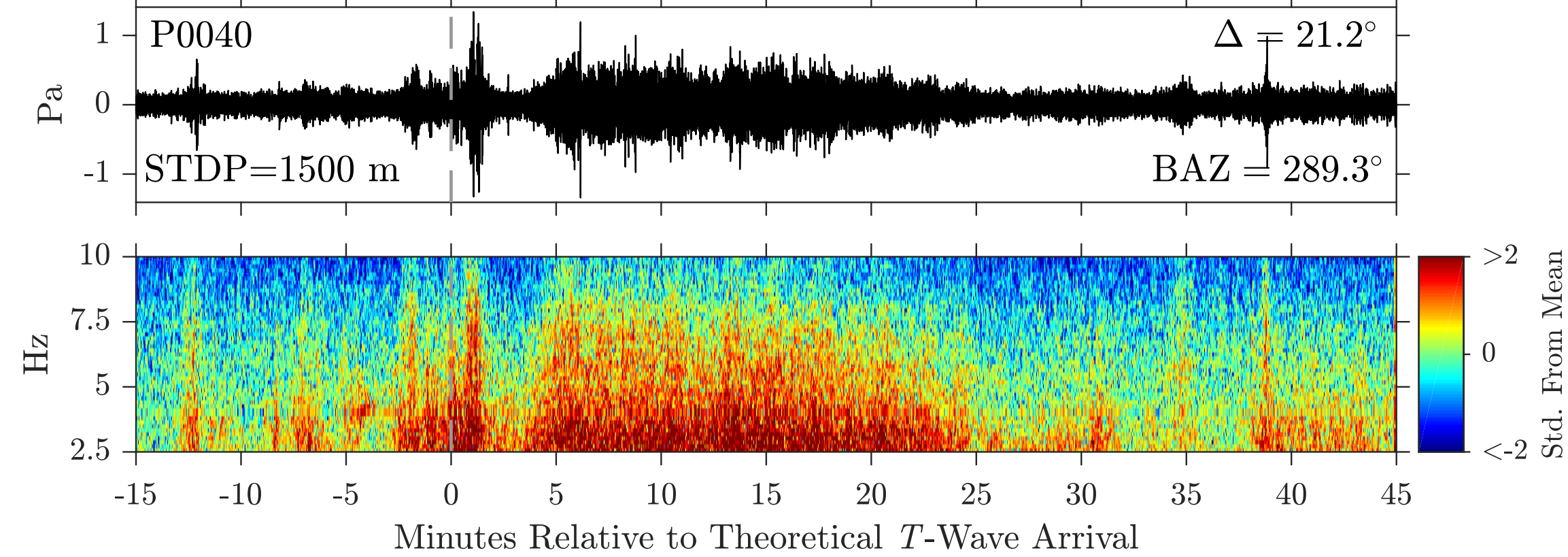
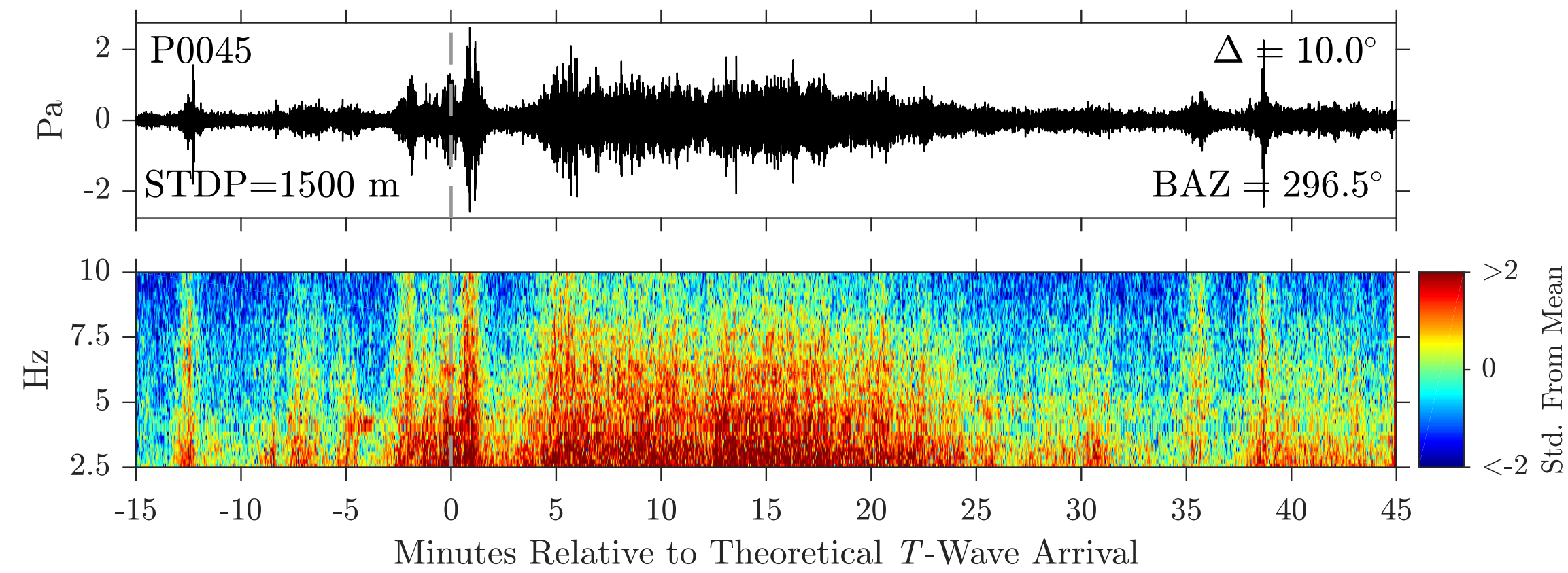
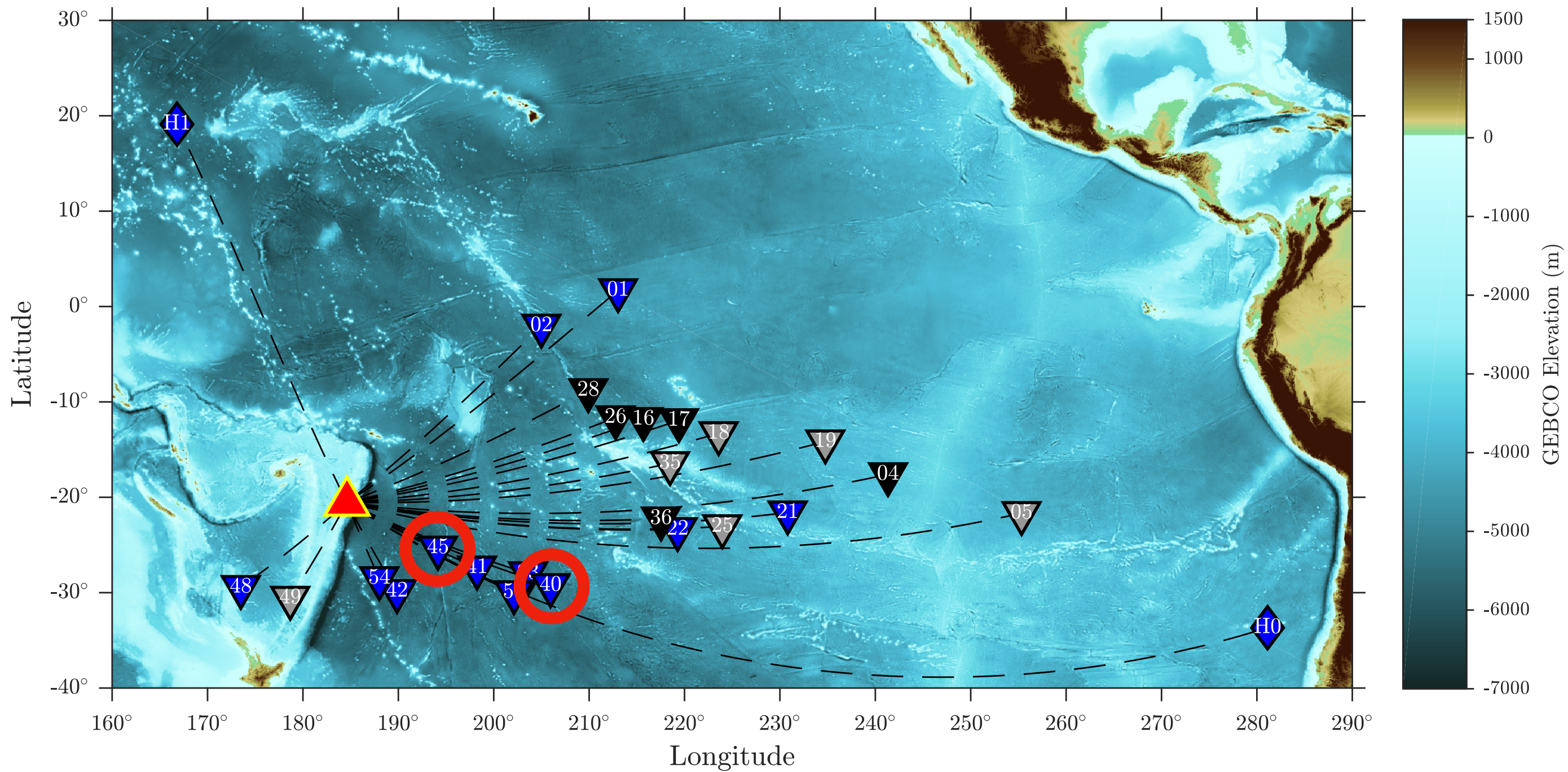




# A Highly Correlated Thirty-Minute *T* Wave

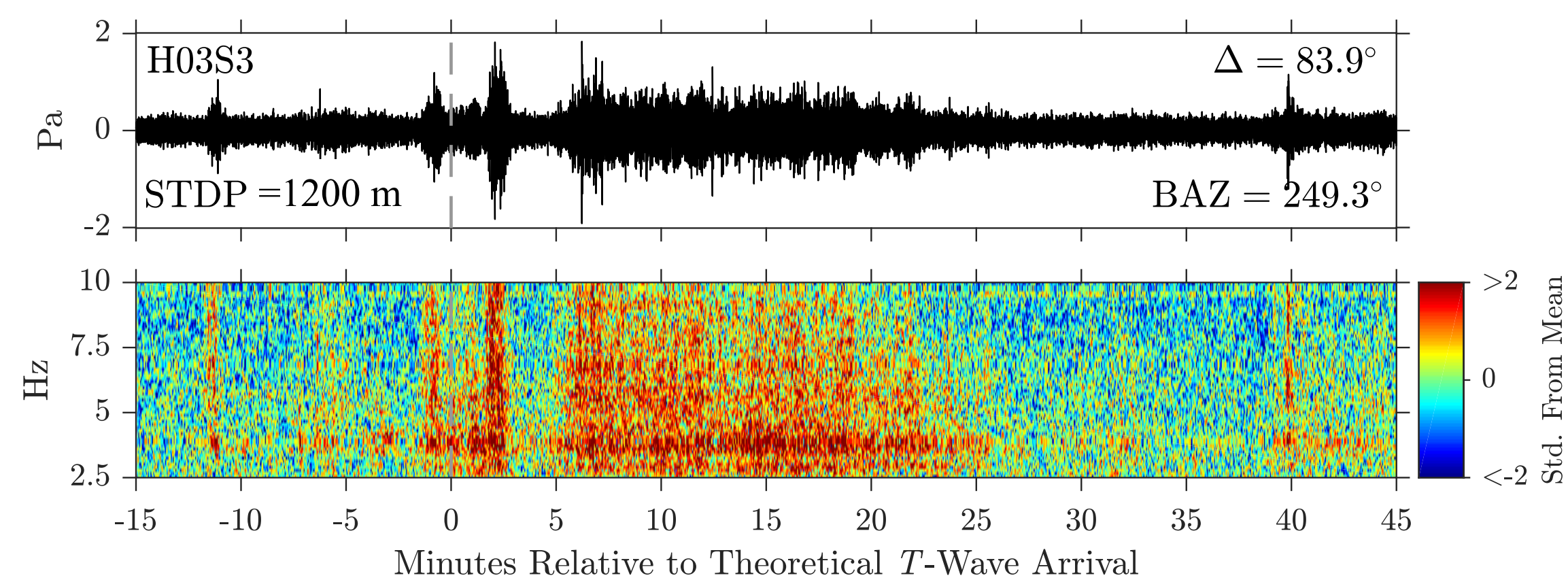
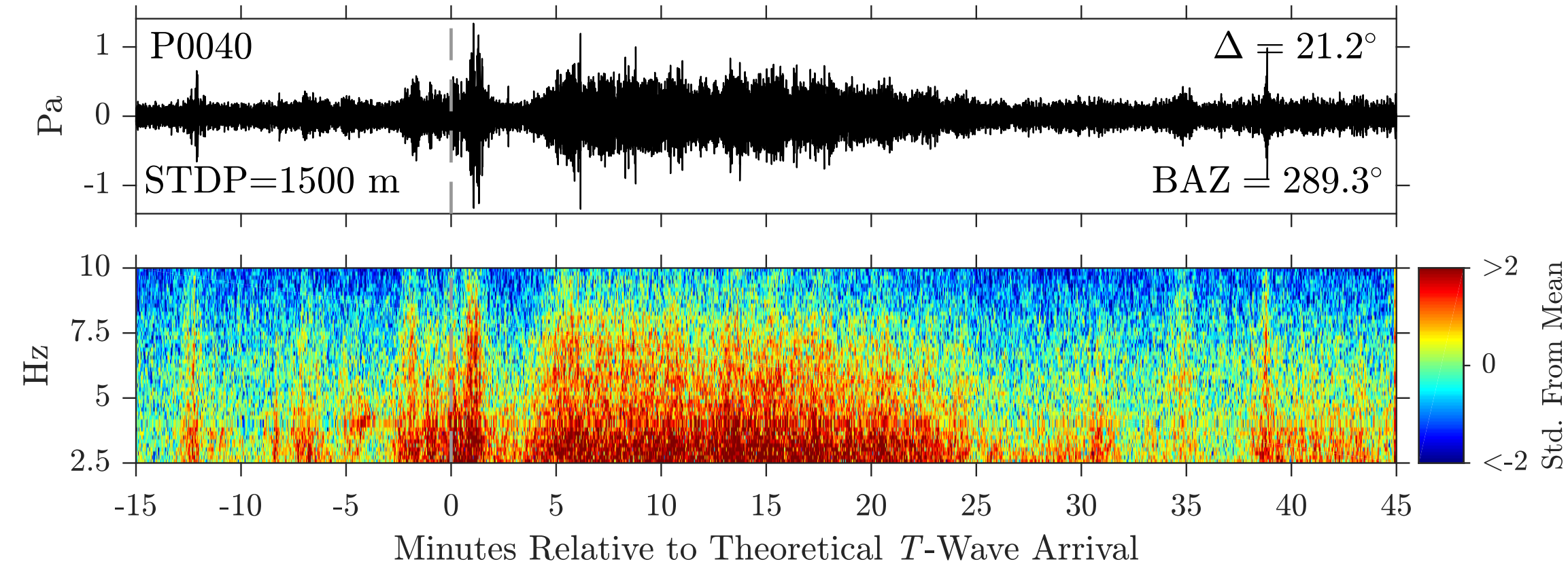
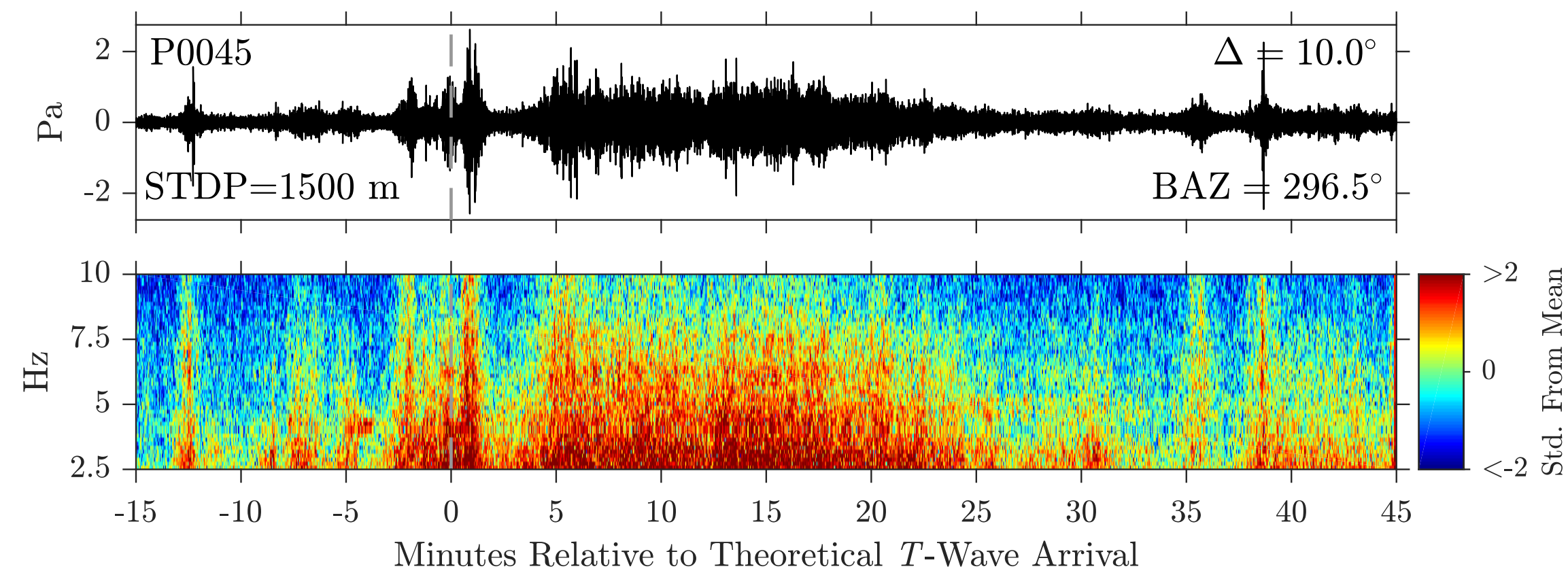
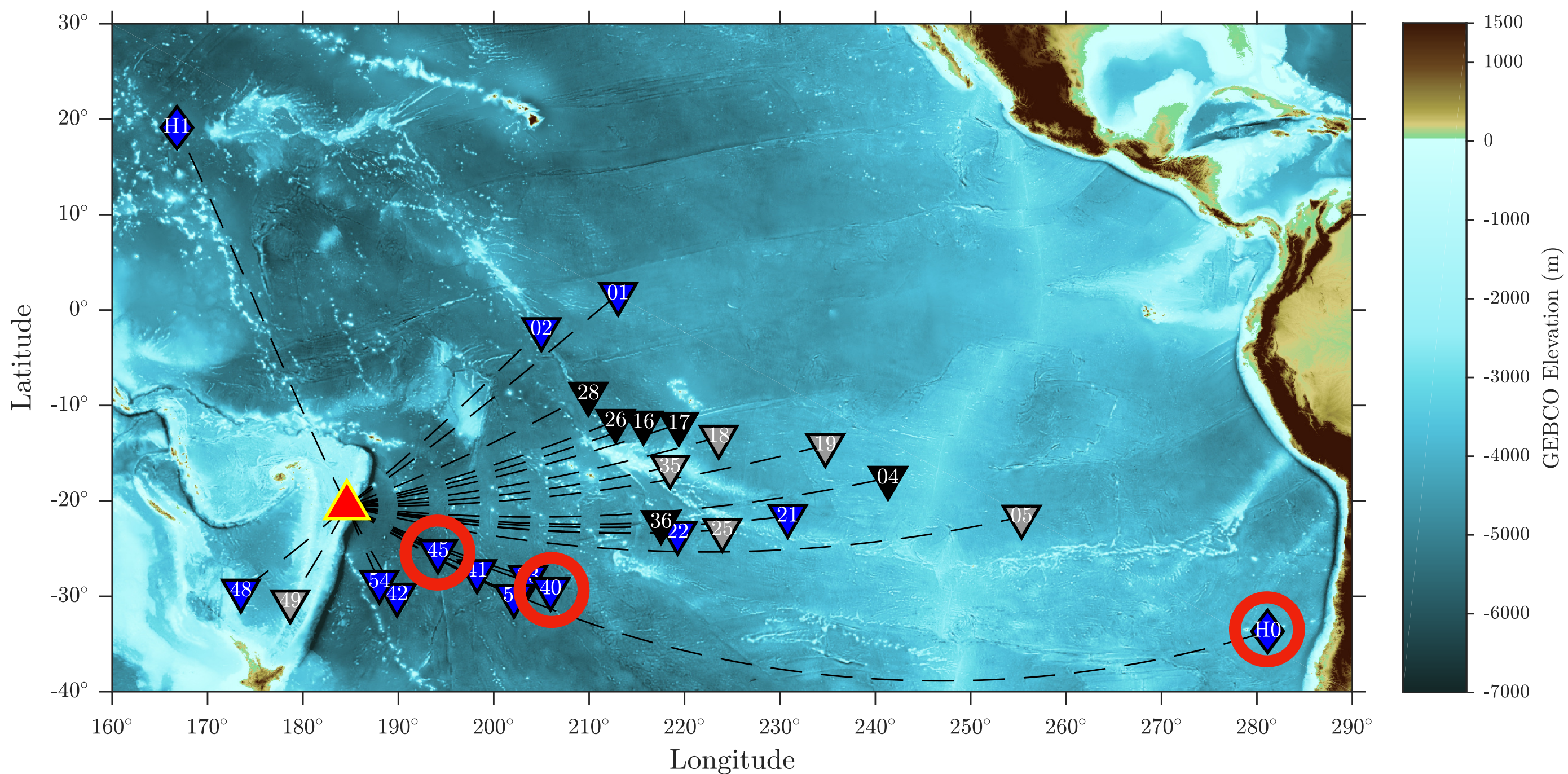


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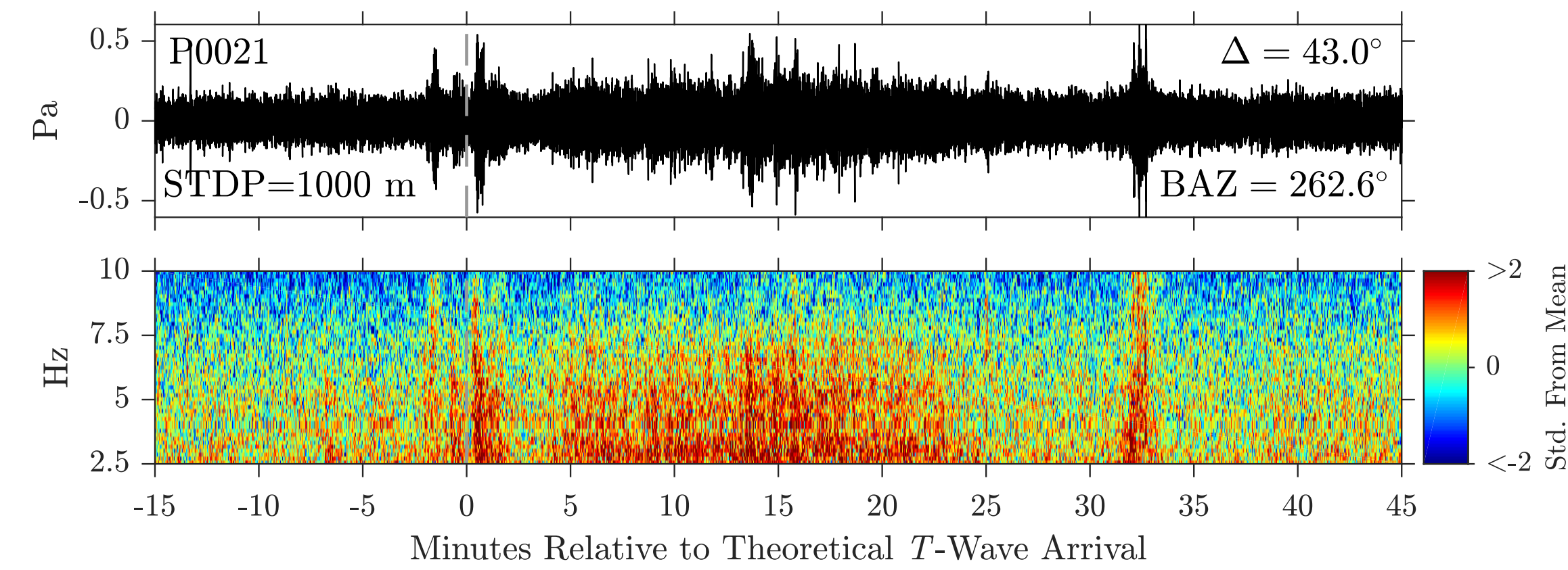
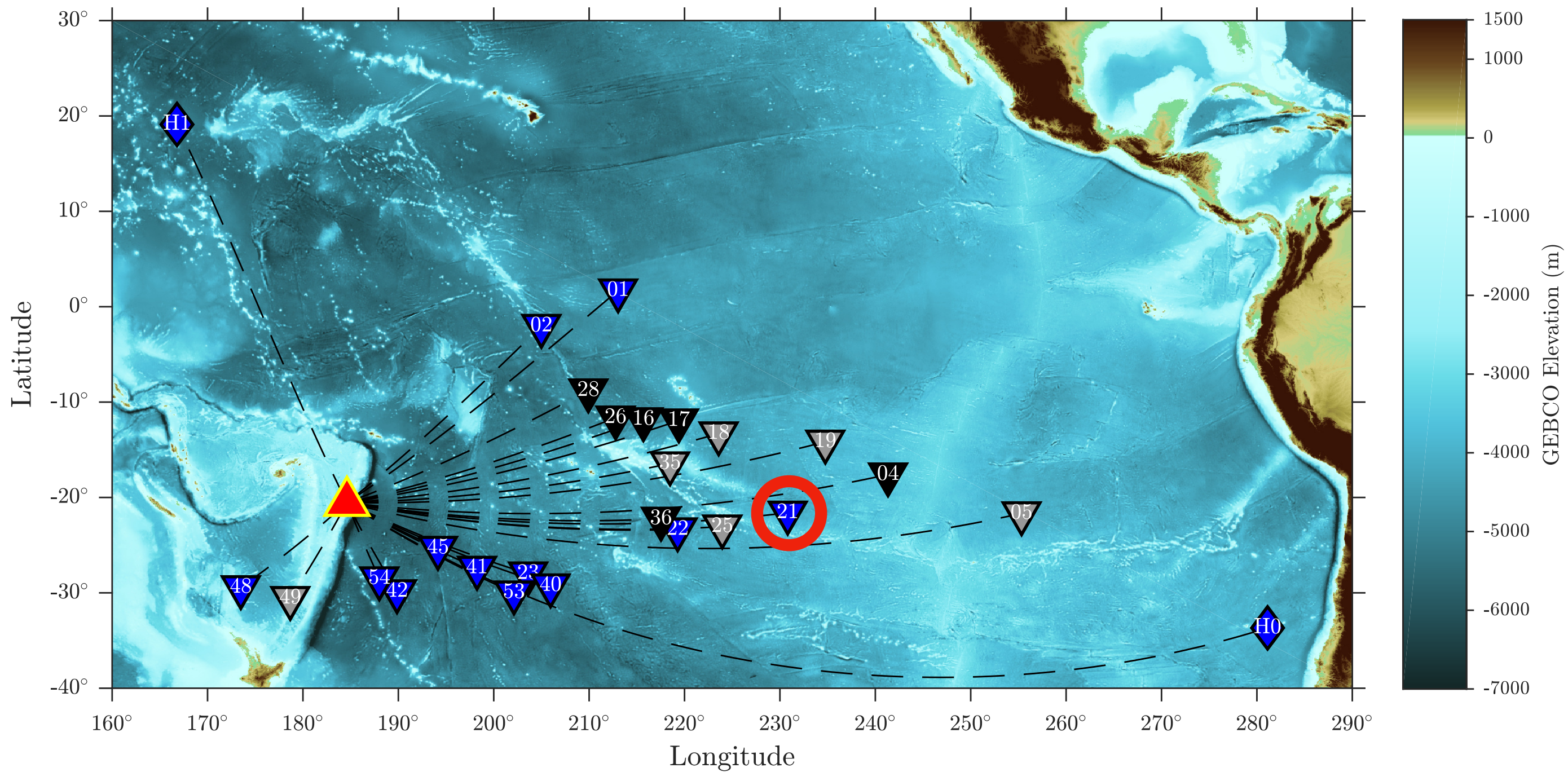




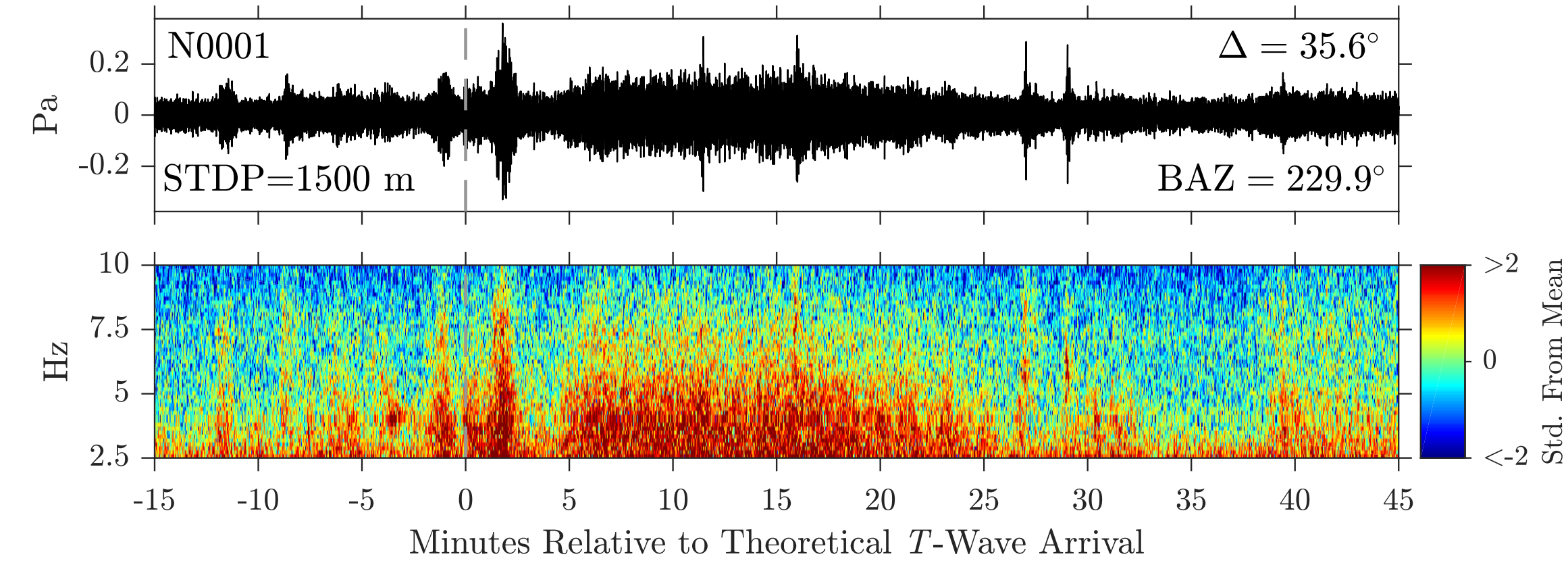
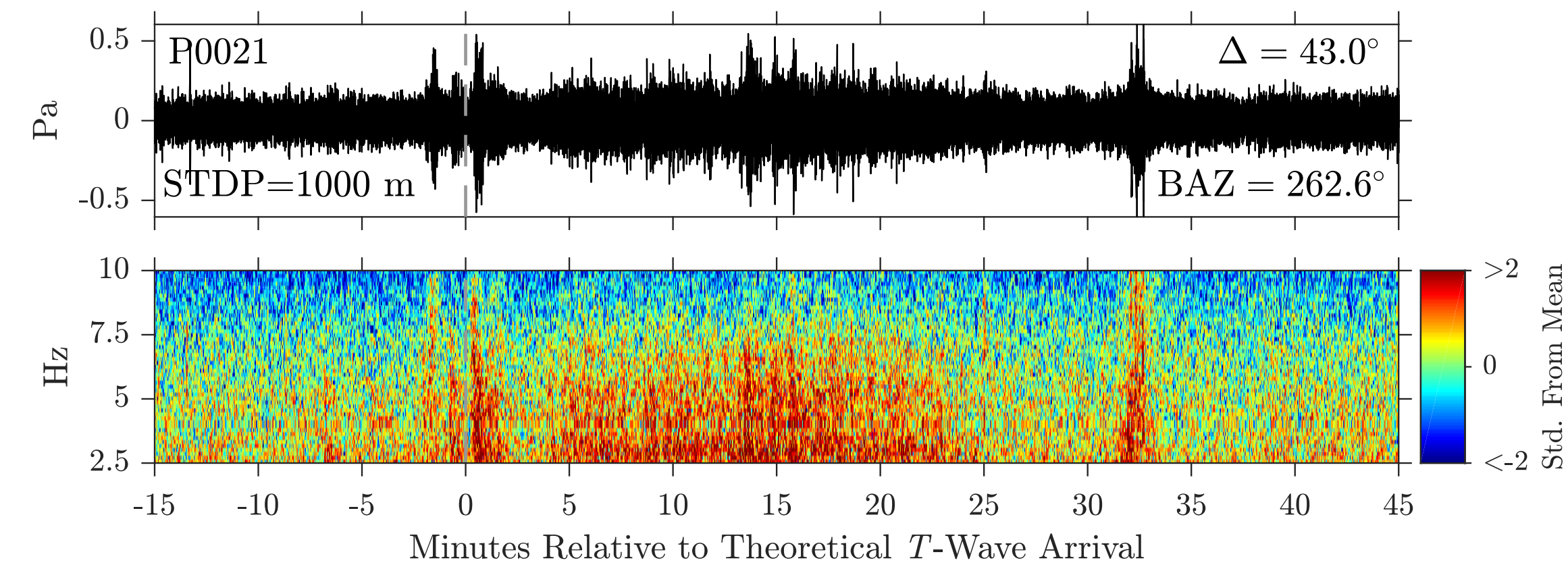
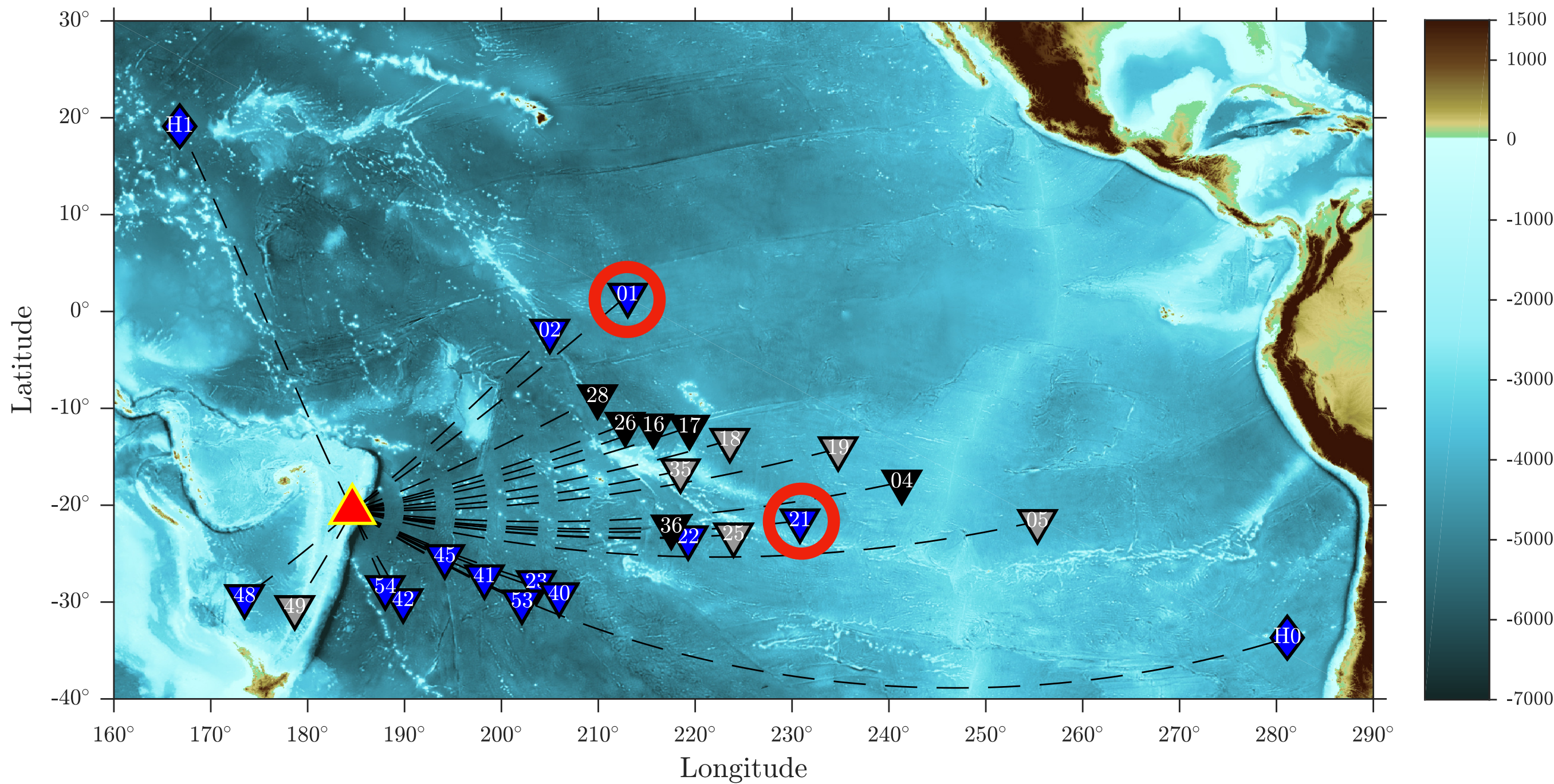
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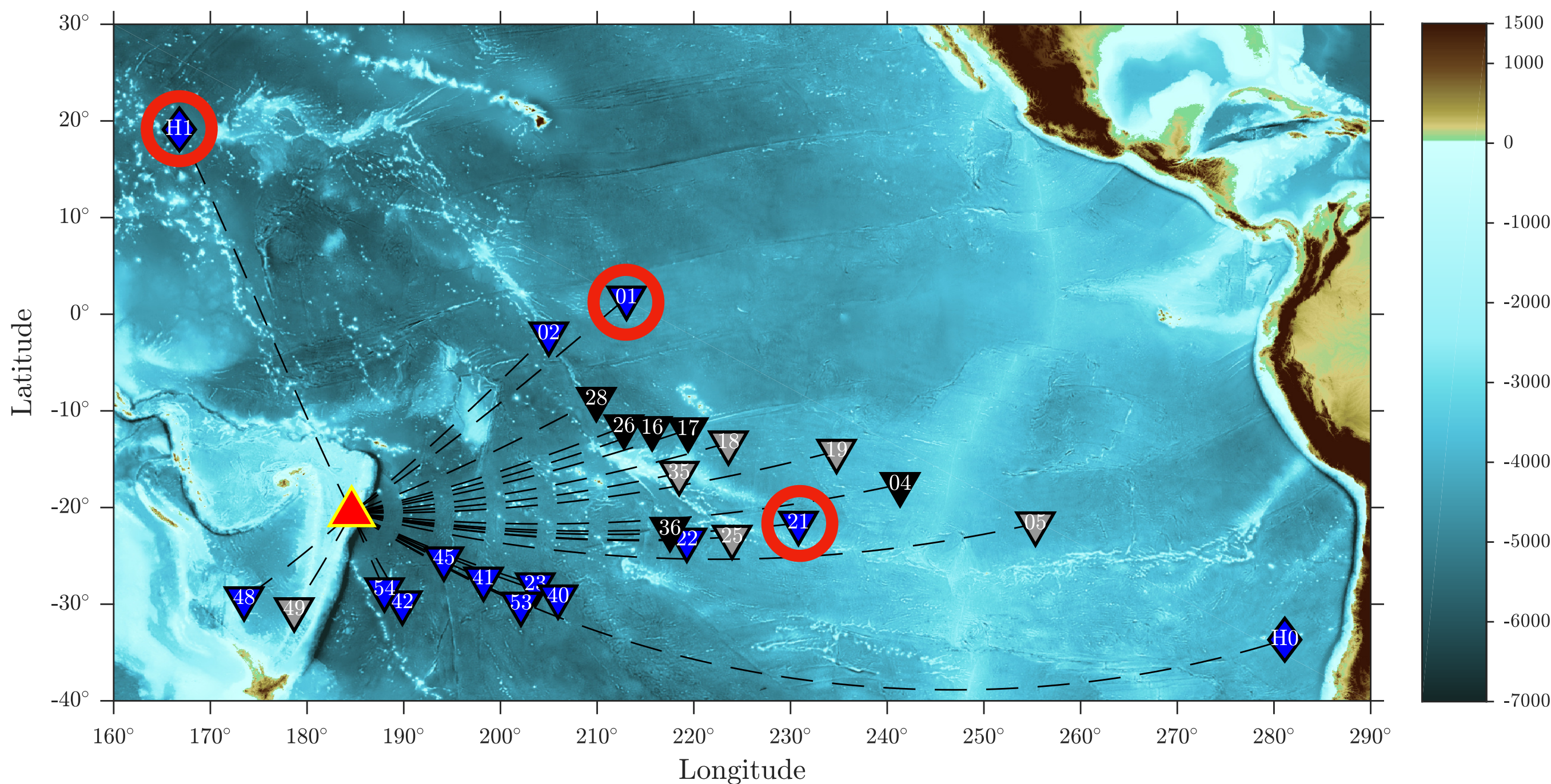
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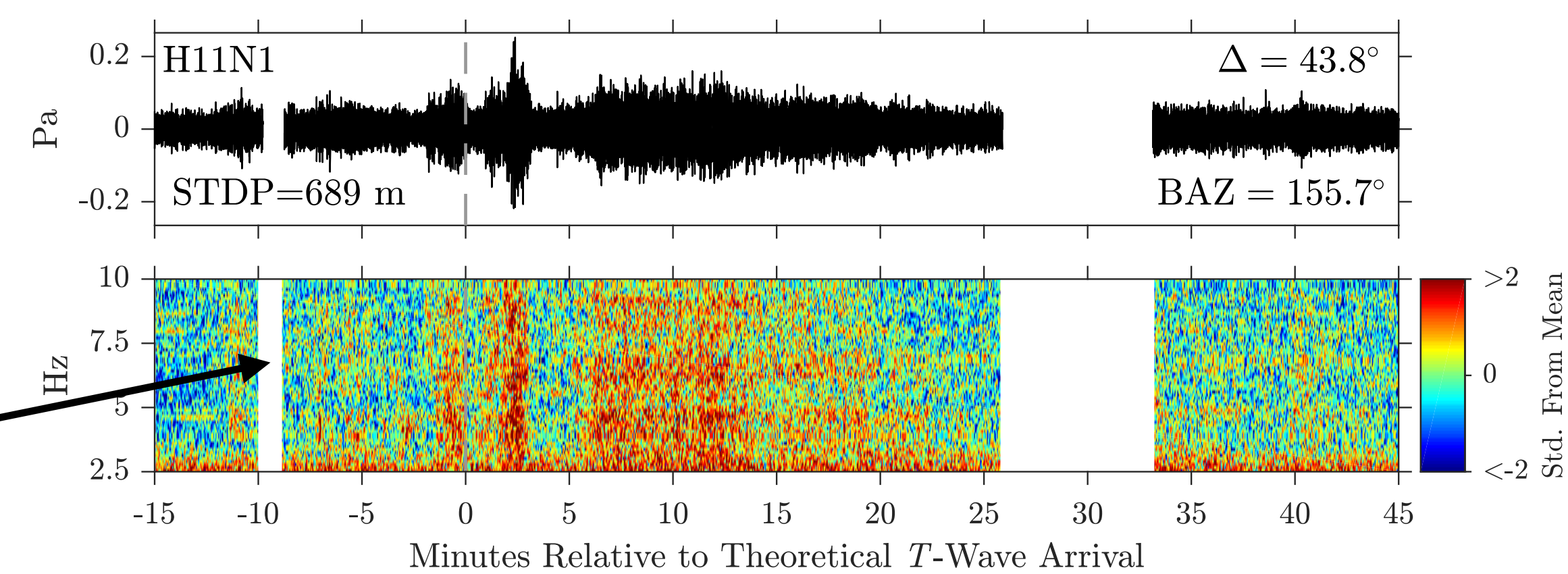
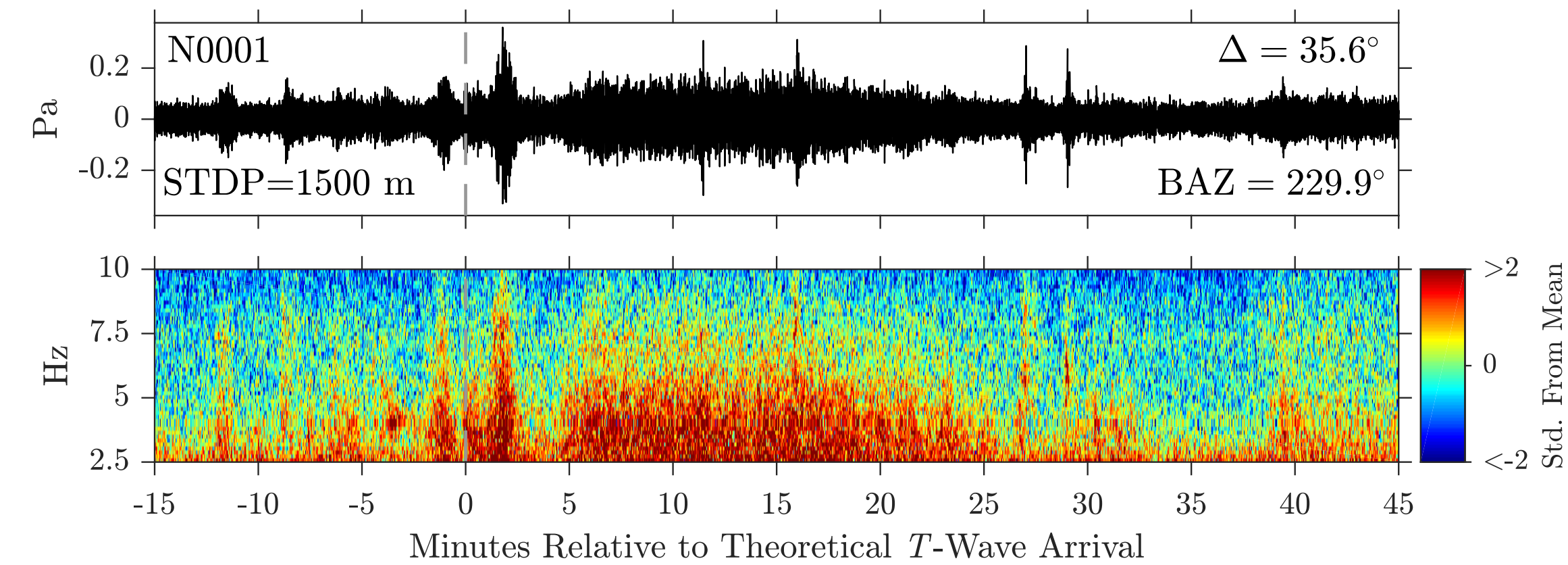
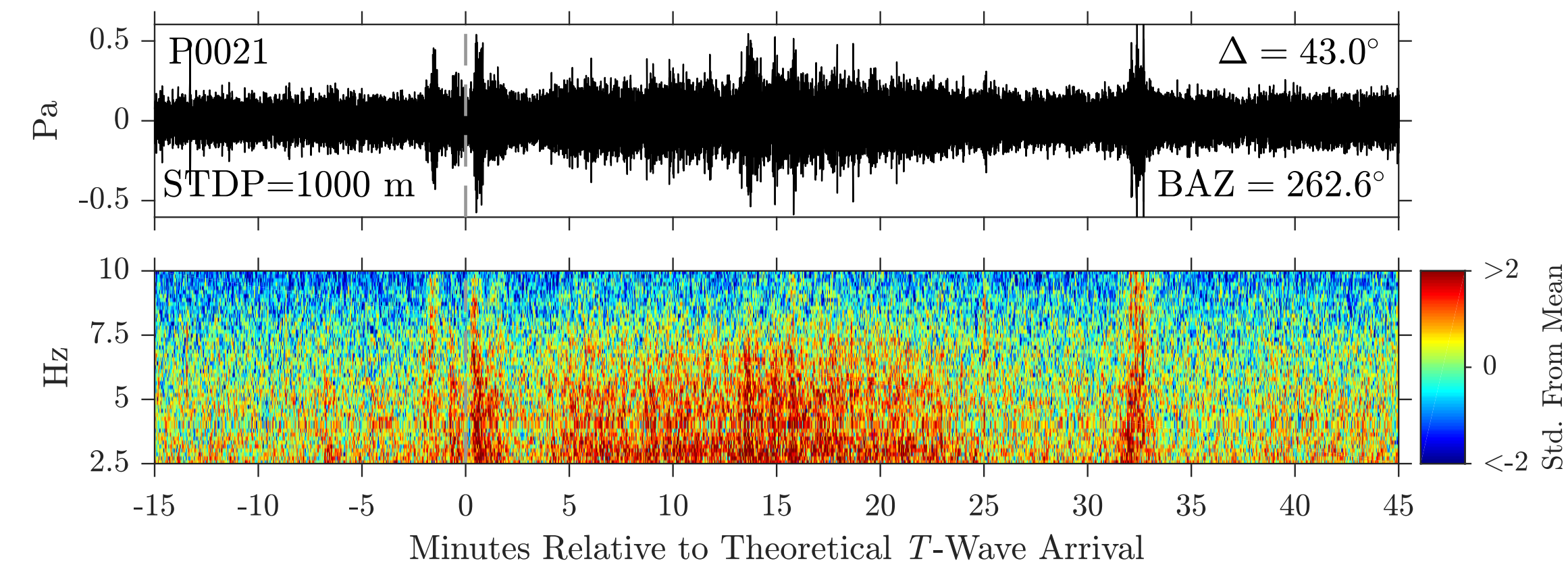
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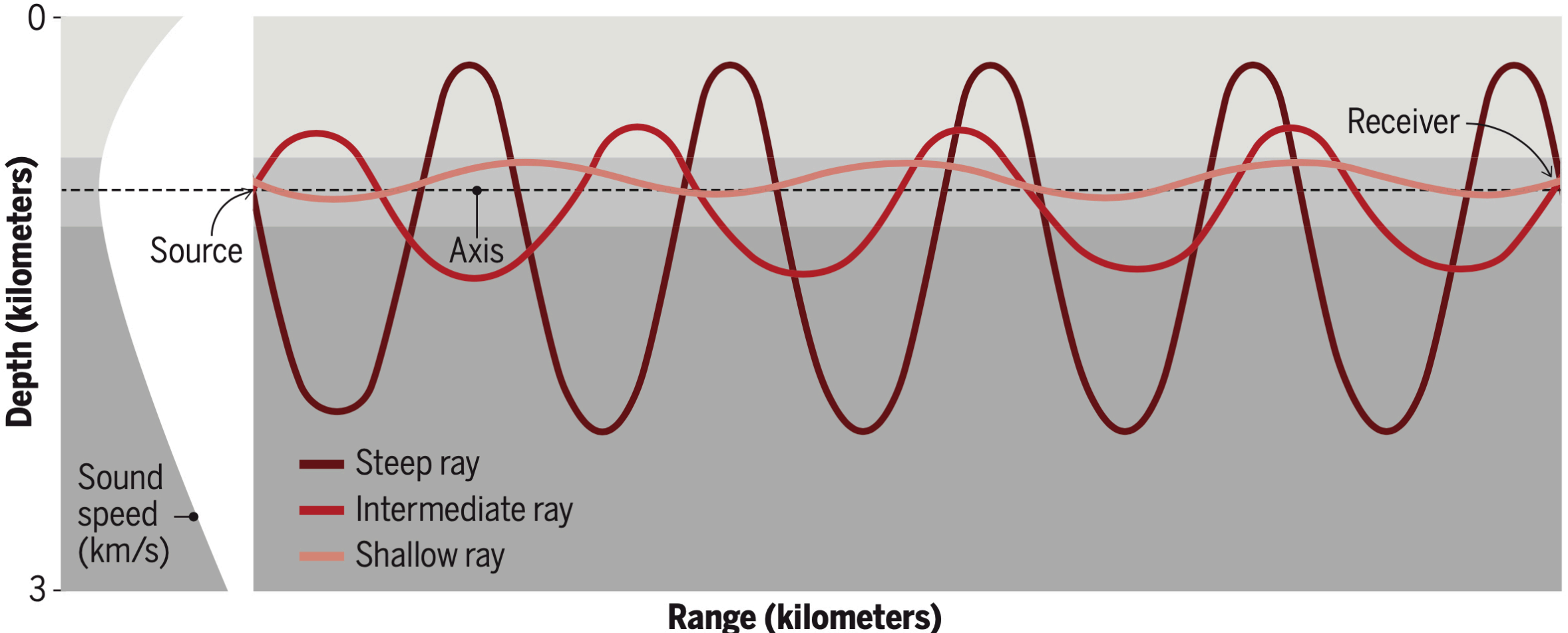


\*local earthquake signals removed



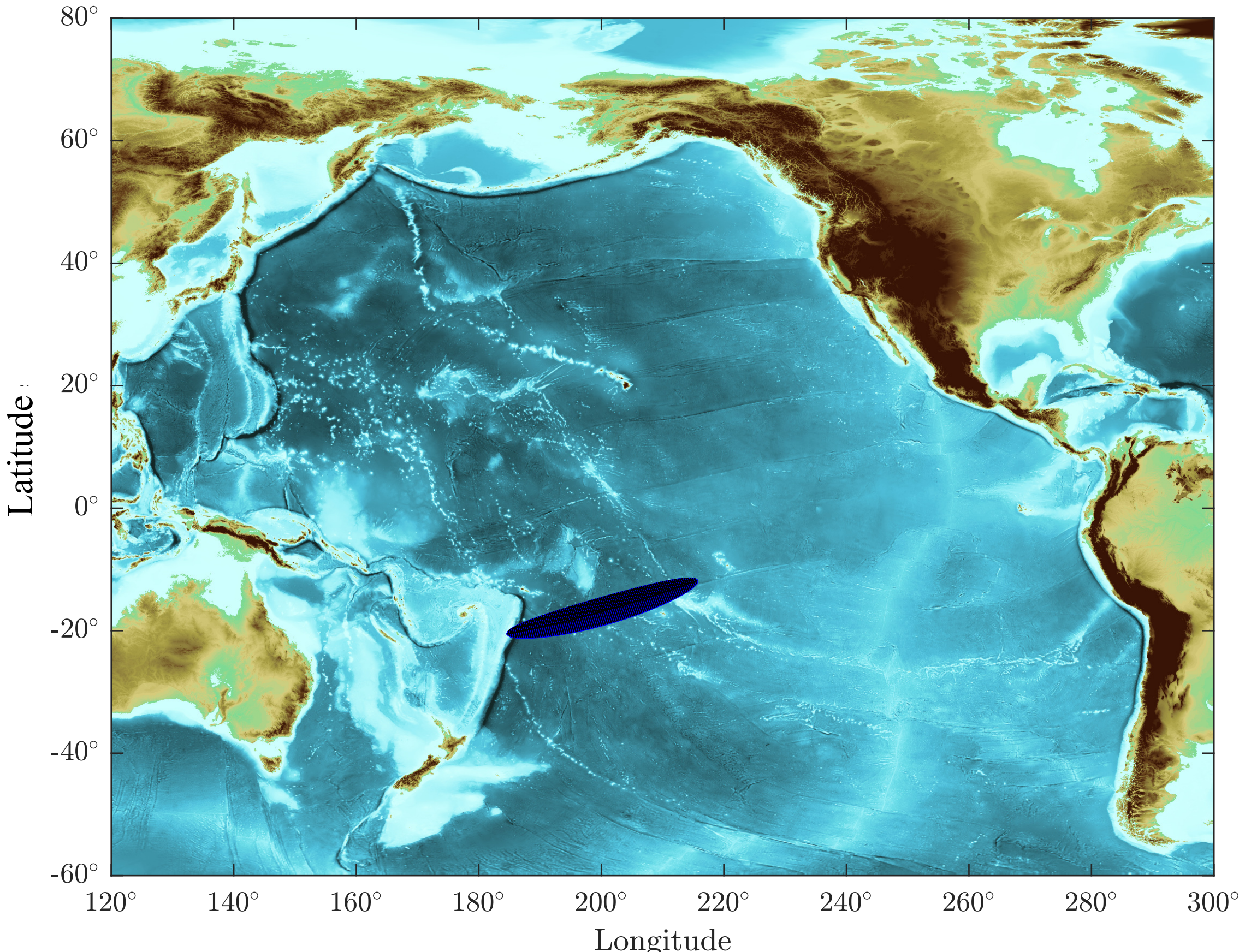
# SOFAR is Depth and Fresnel Zone is Breadth of Influence

## SOFAR: Sound Fixing and Ranging Channel

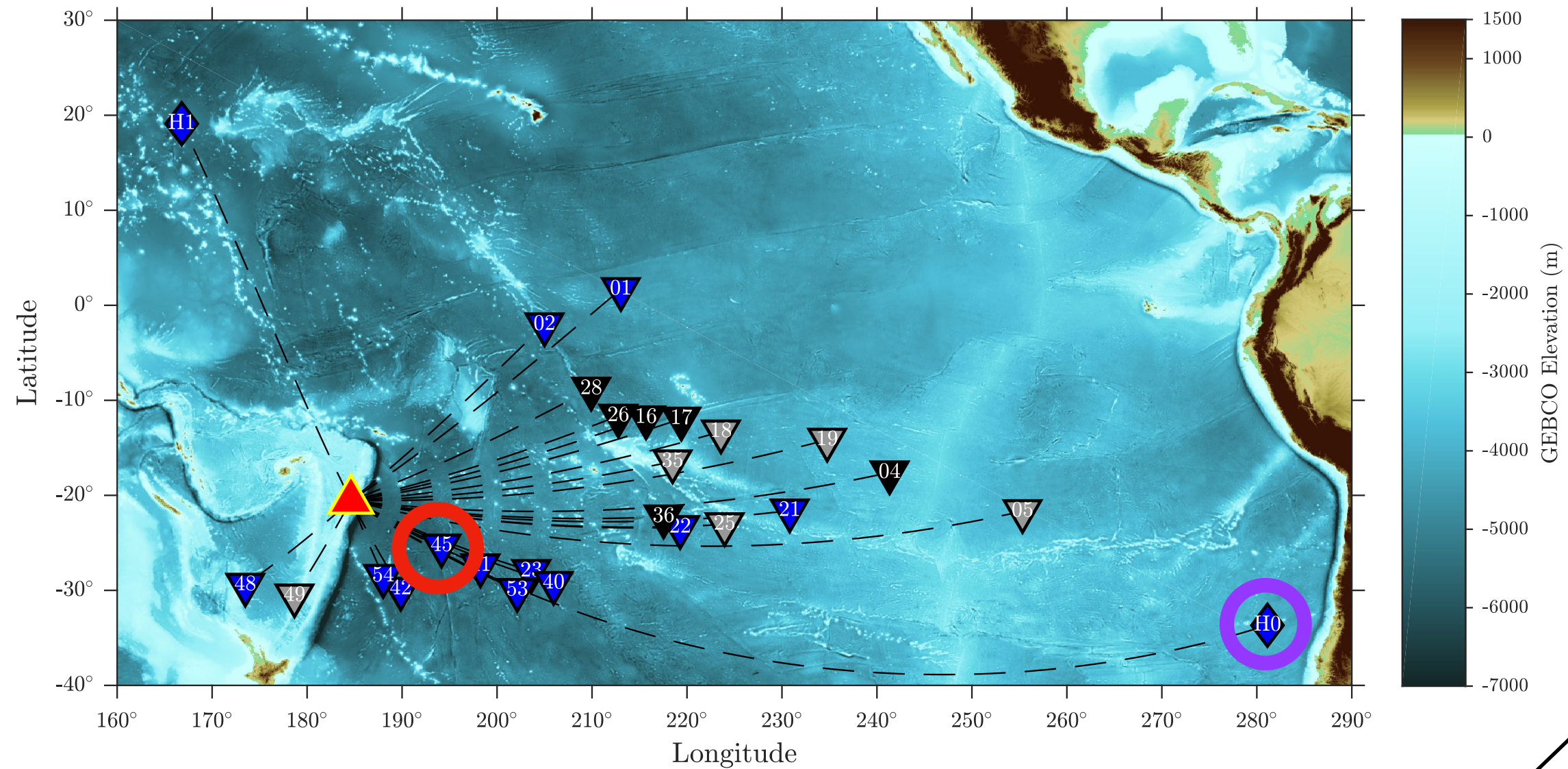


Wunsch, 2020 (*Science*)

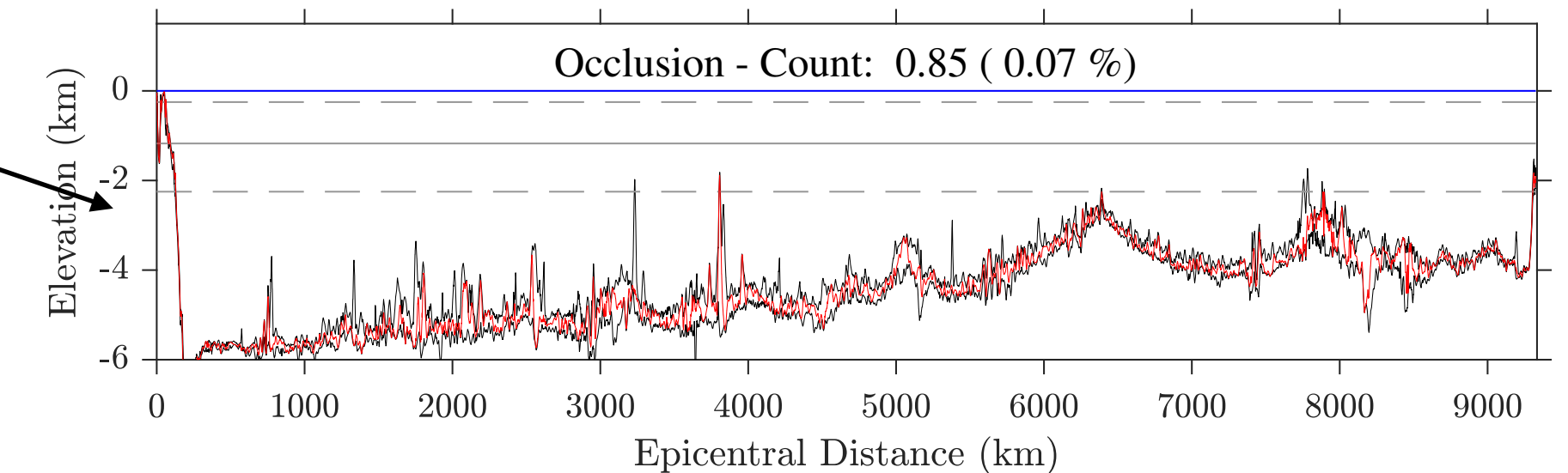
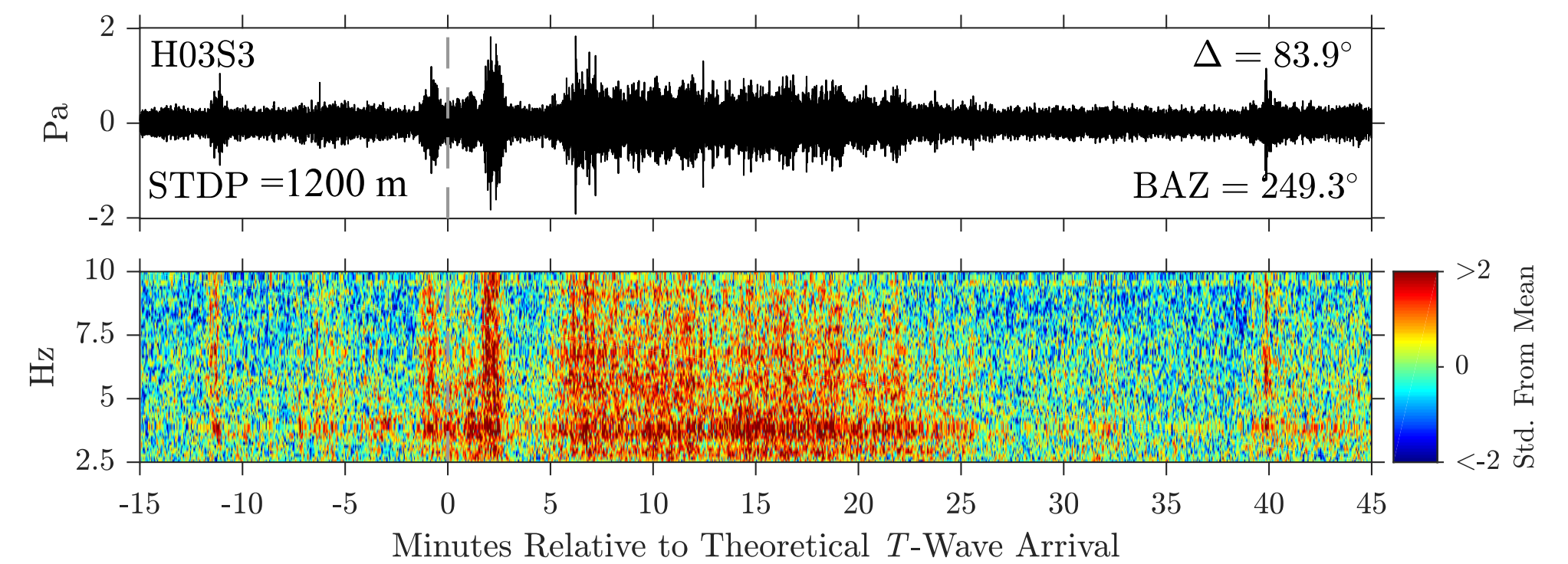
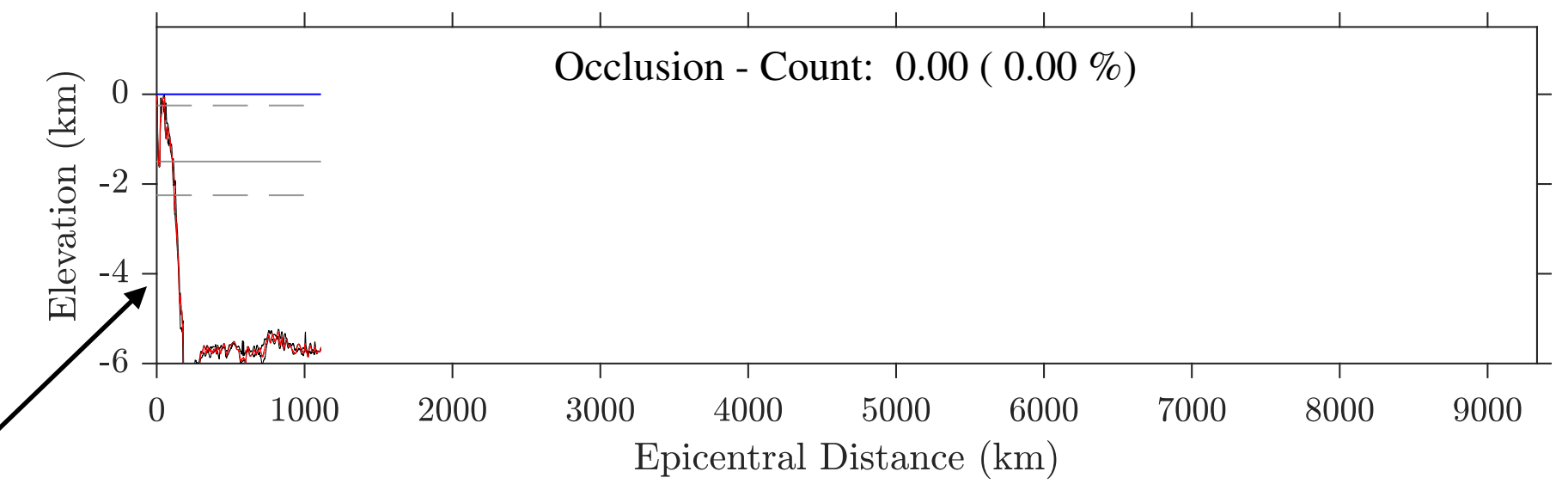
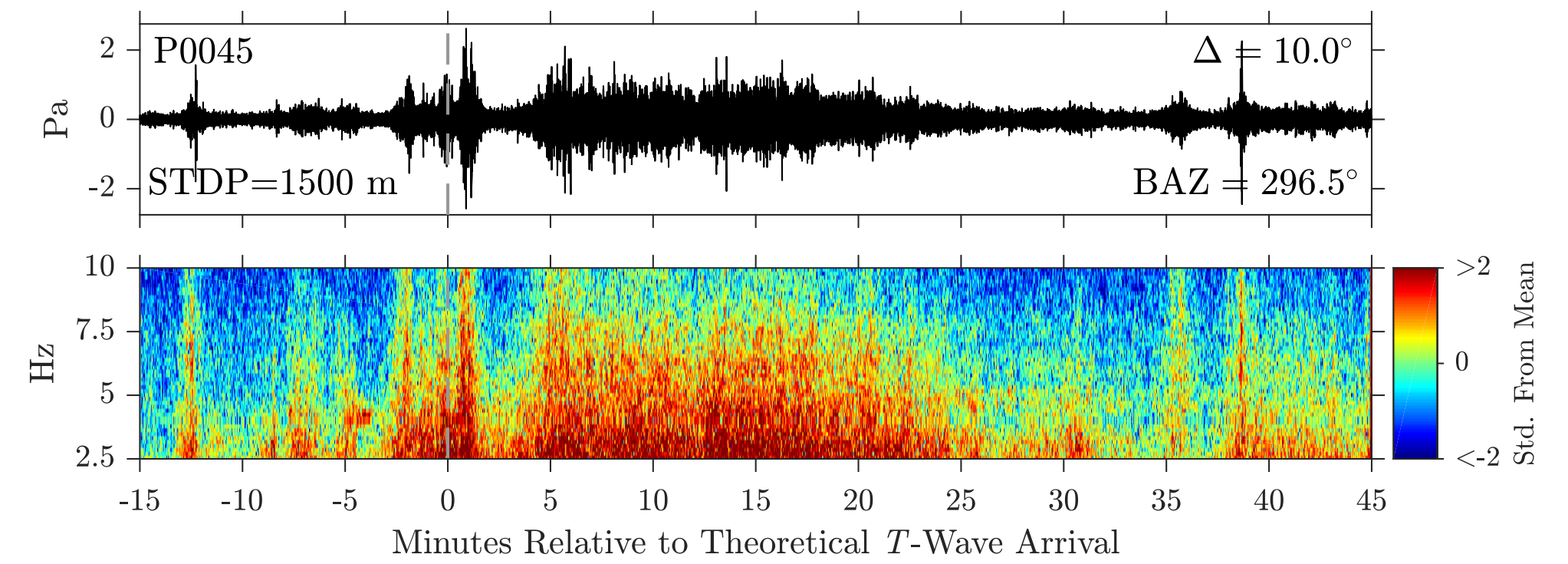
## Fresnel zone: Map of multipath constructive interference



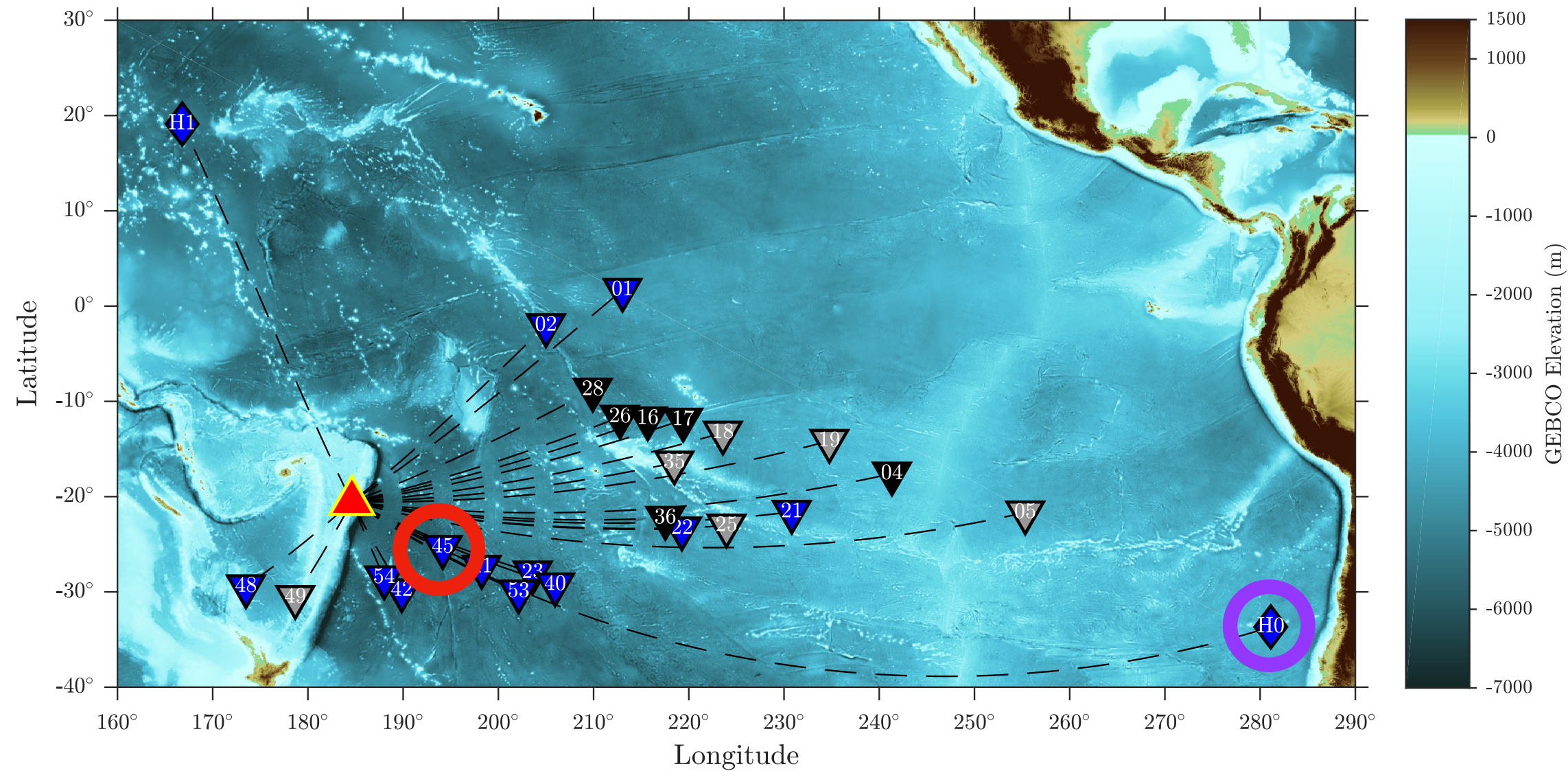
# Occlusion: A Tally of the Obstacles (Seamounts, etc.) Along Path



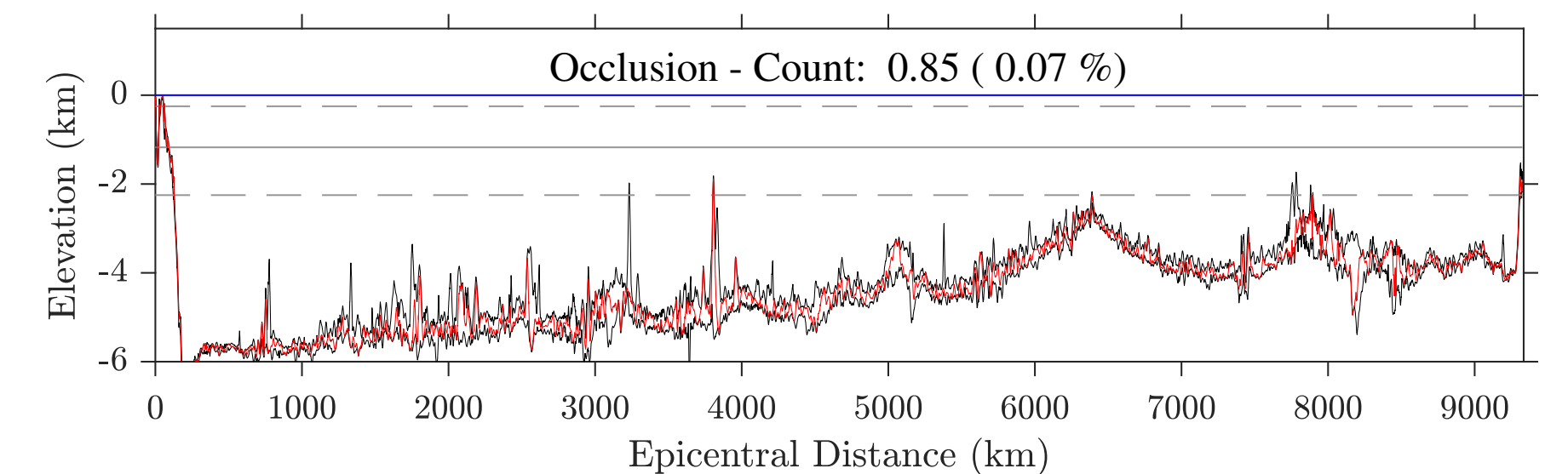
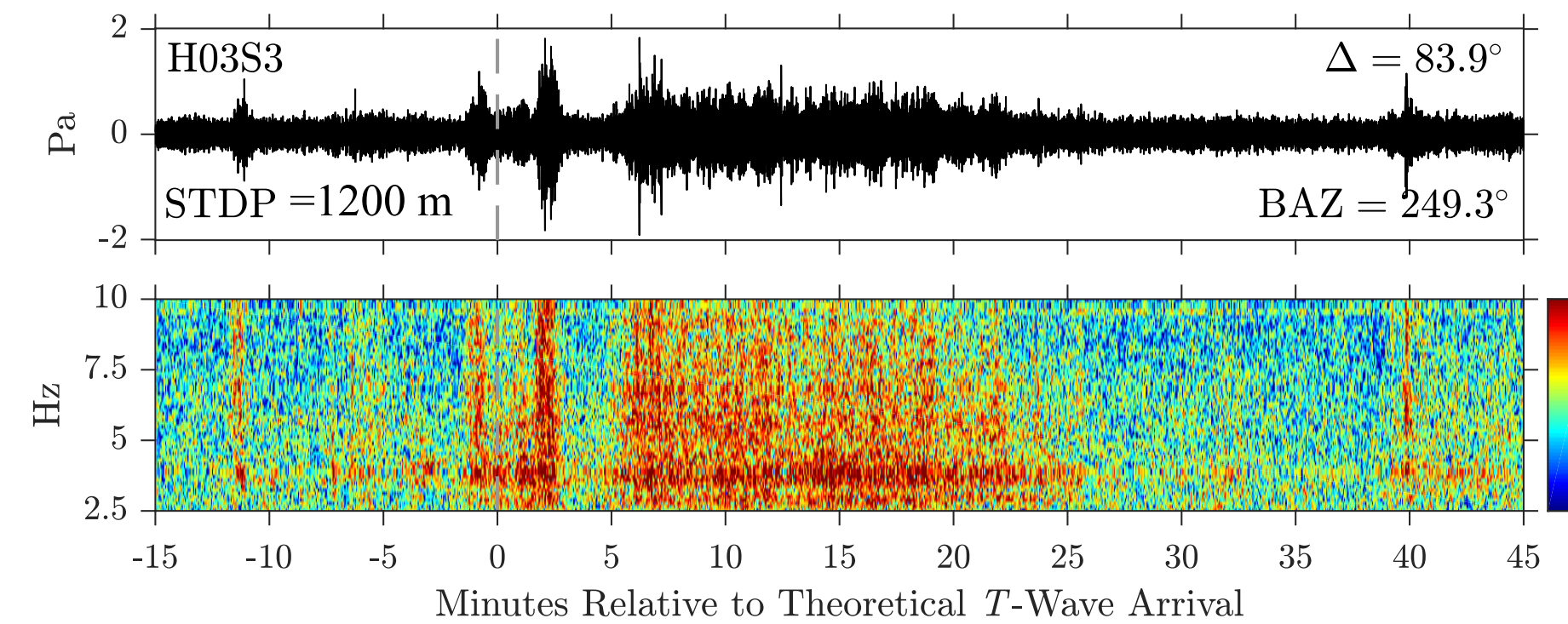
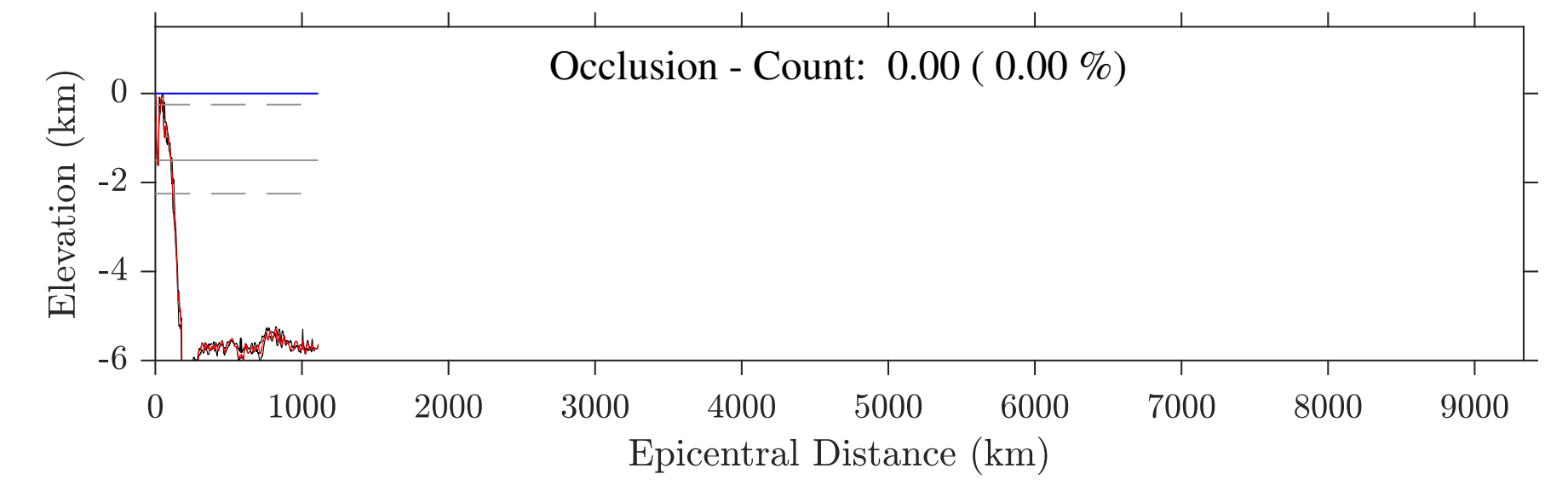
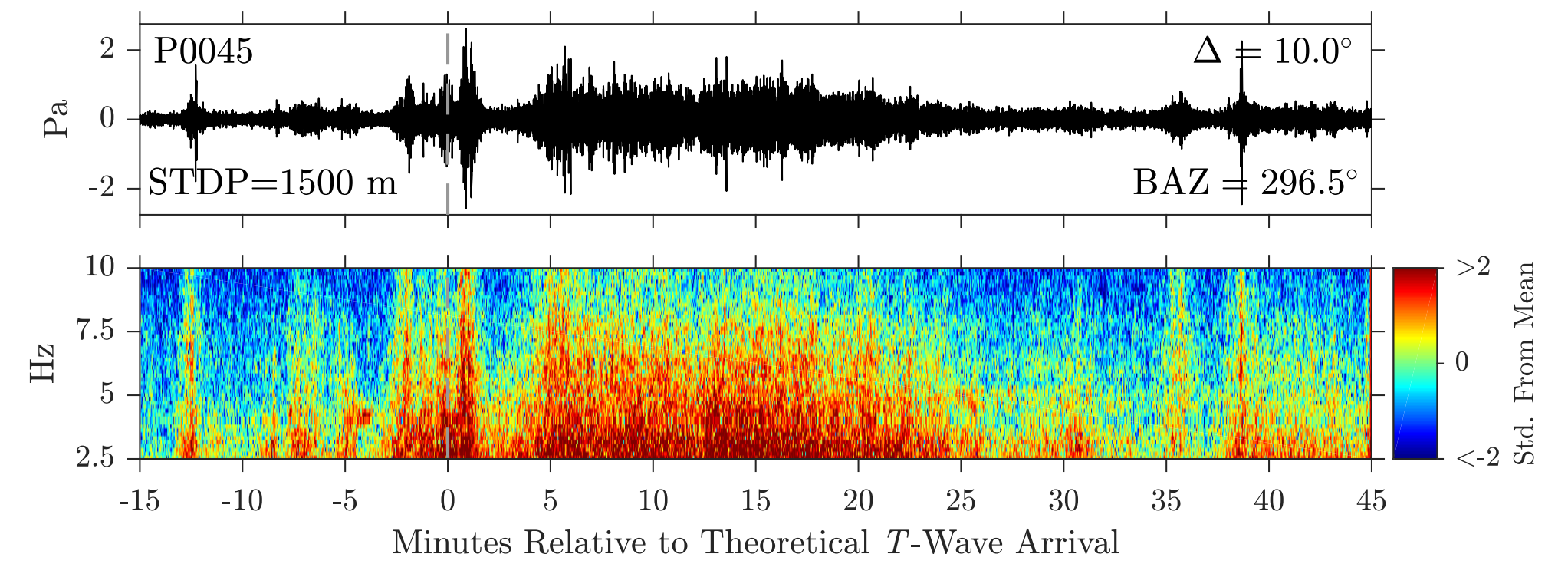
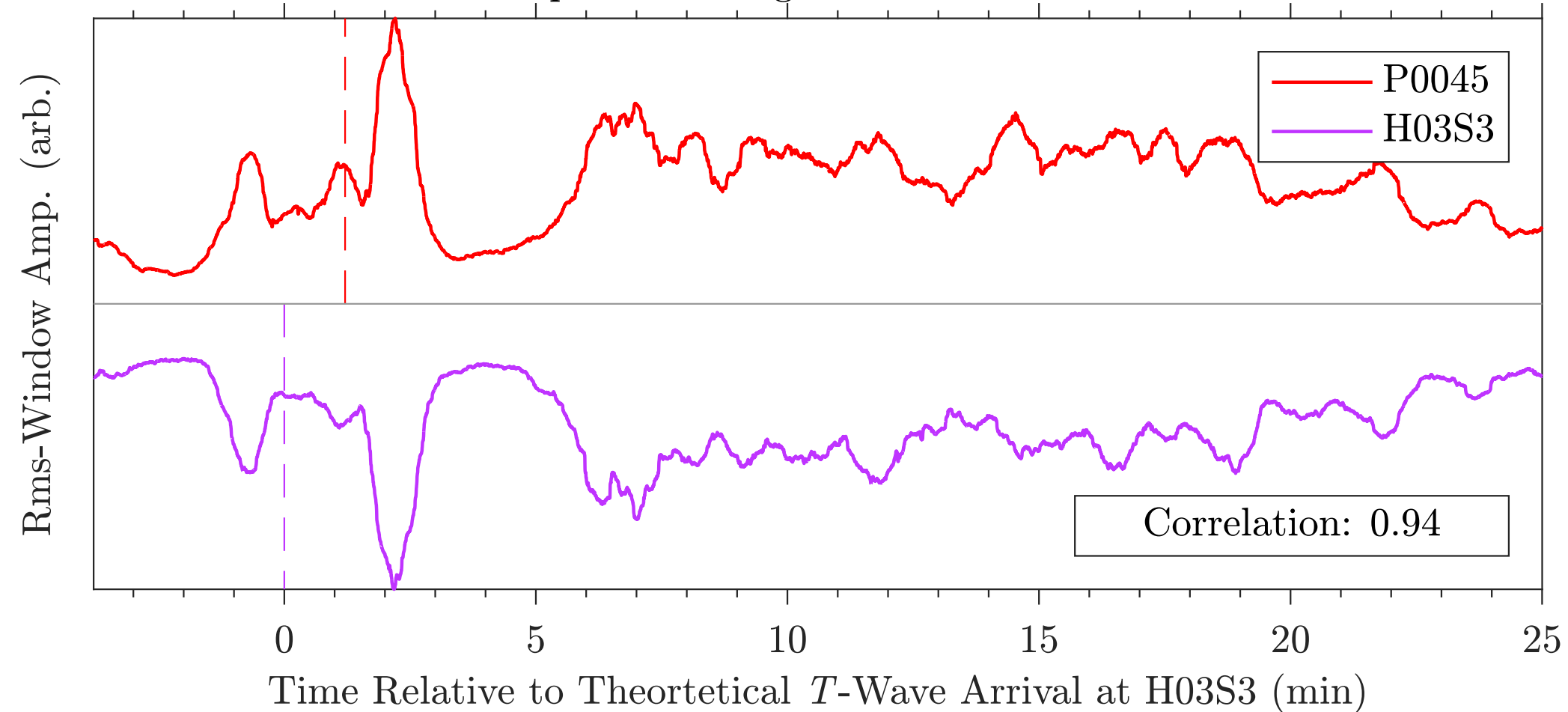
Bathymetric profile (min/max)  
sampled along multipath Fresnel zone



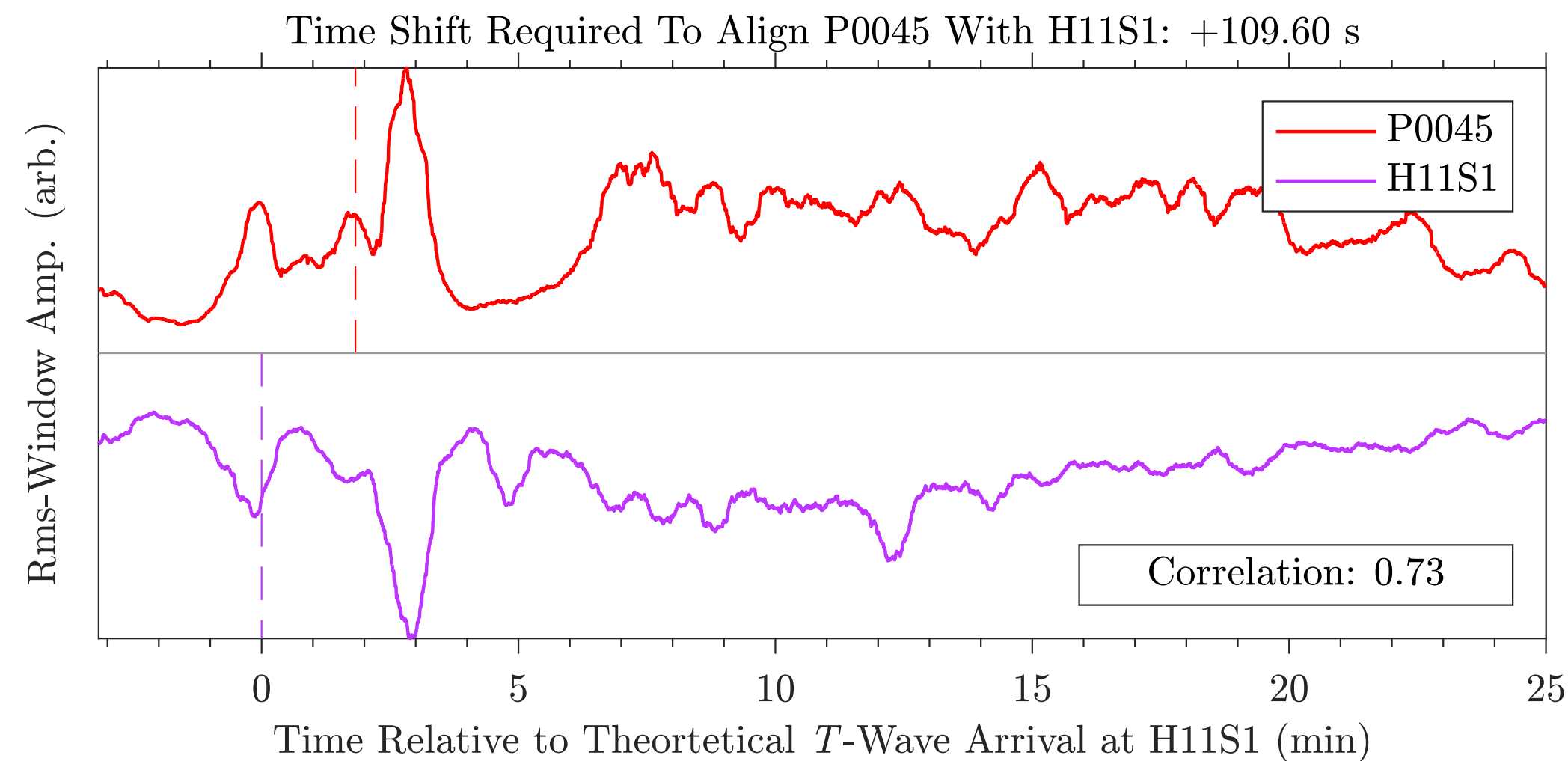
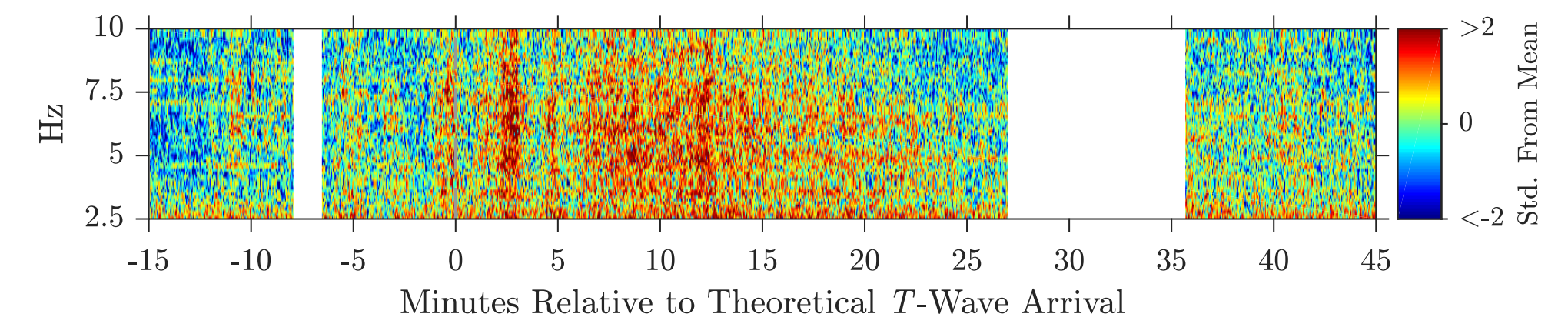
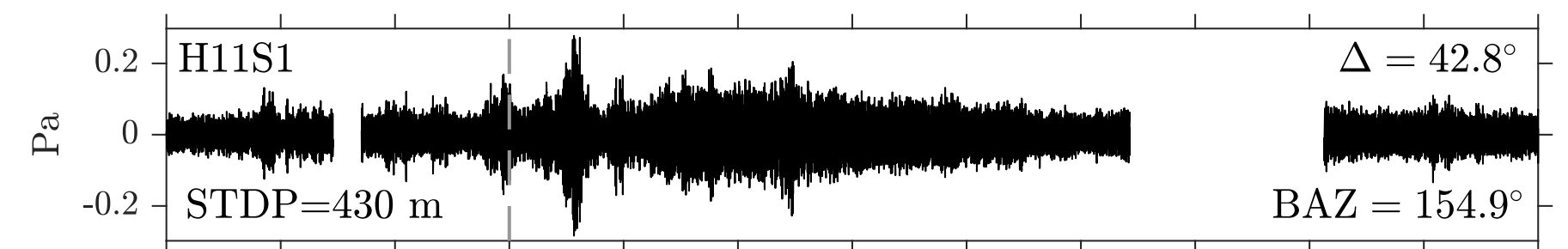
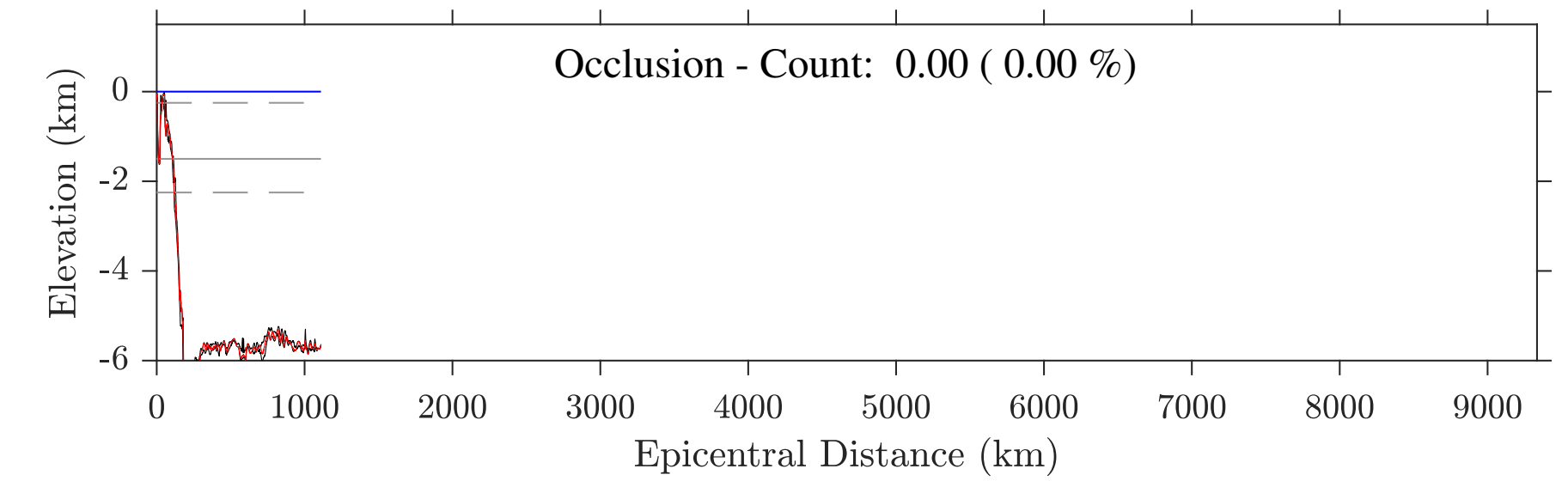
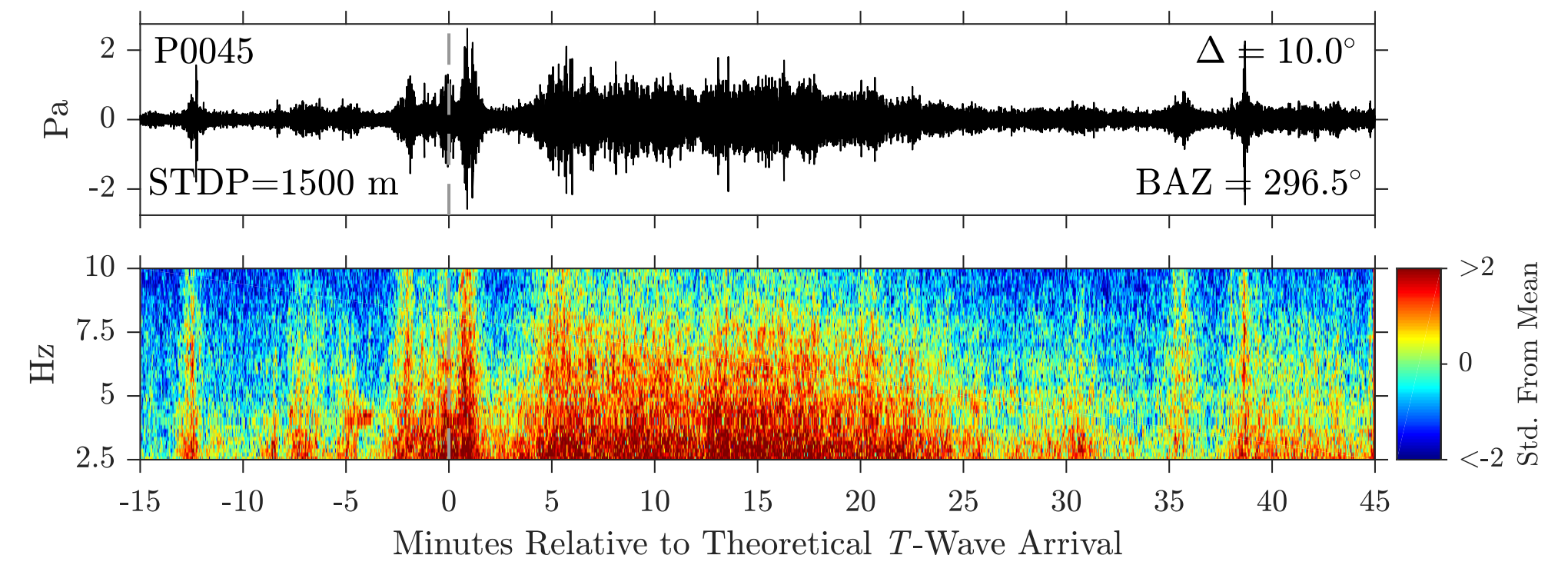
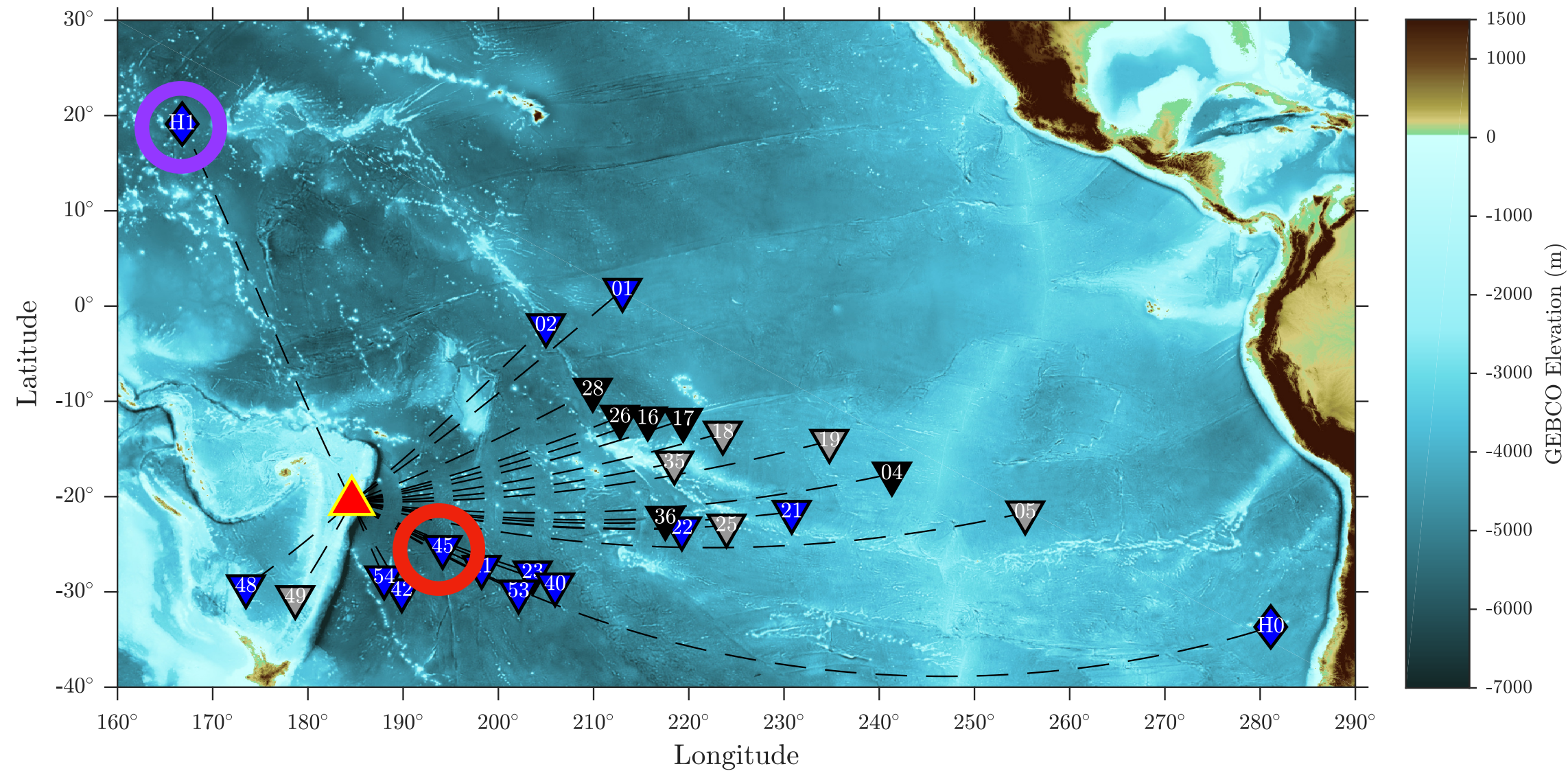
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Time Shift Required To Align P0045 With H03S3: +72.50 s

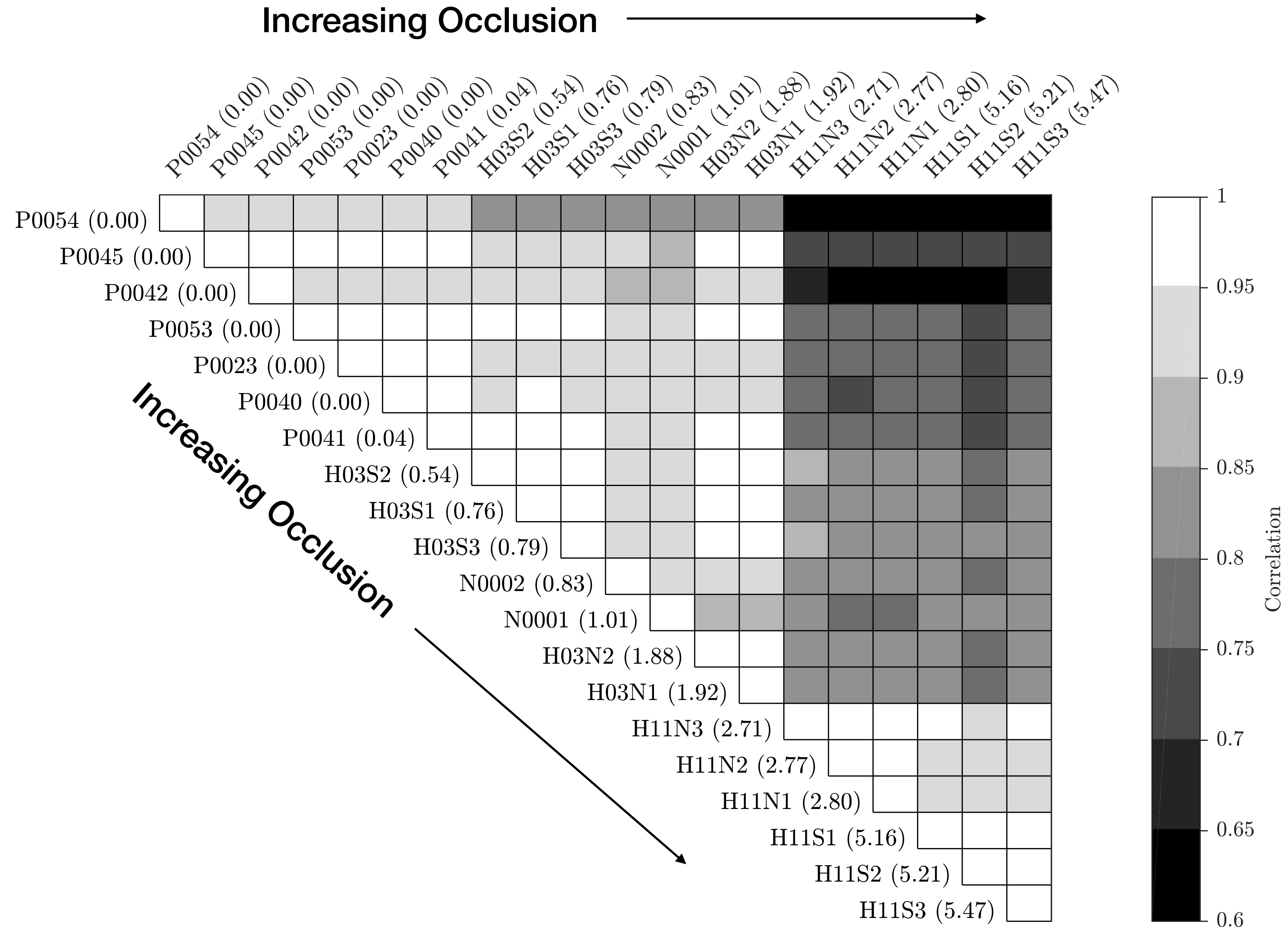


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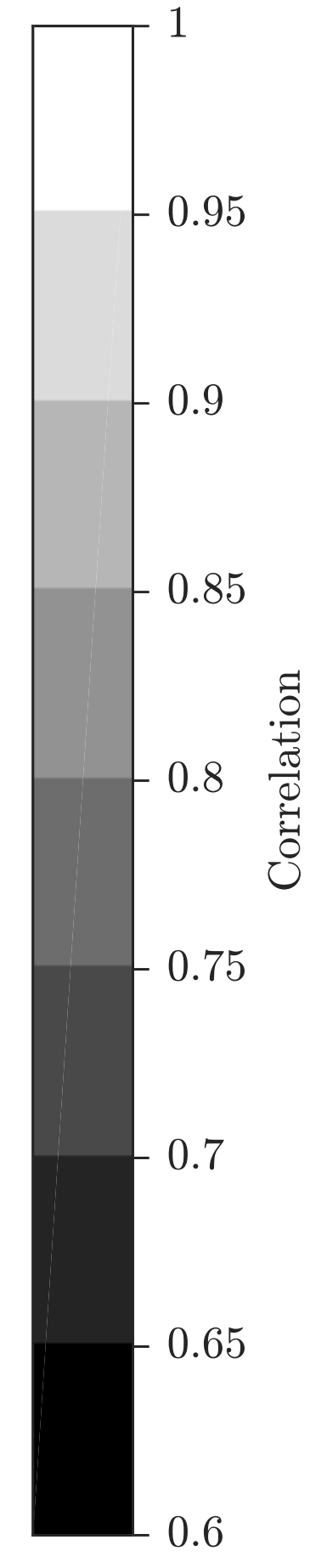
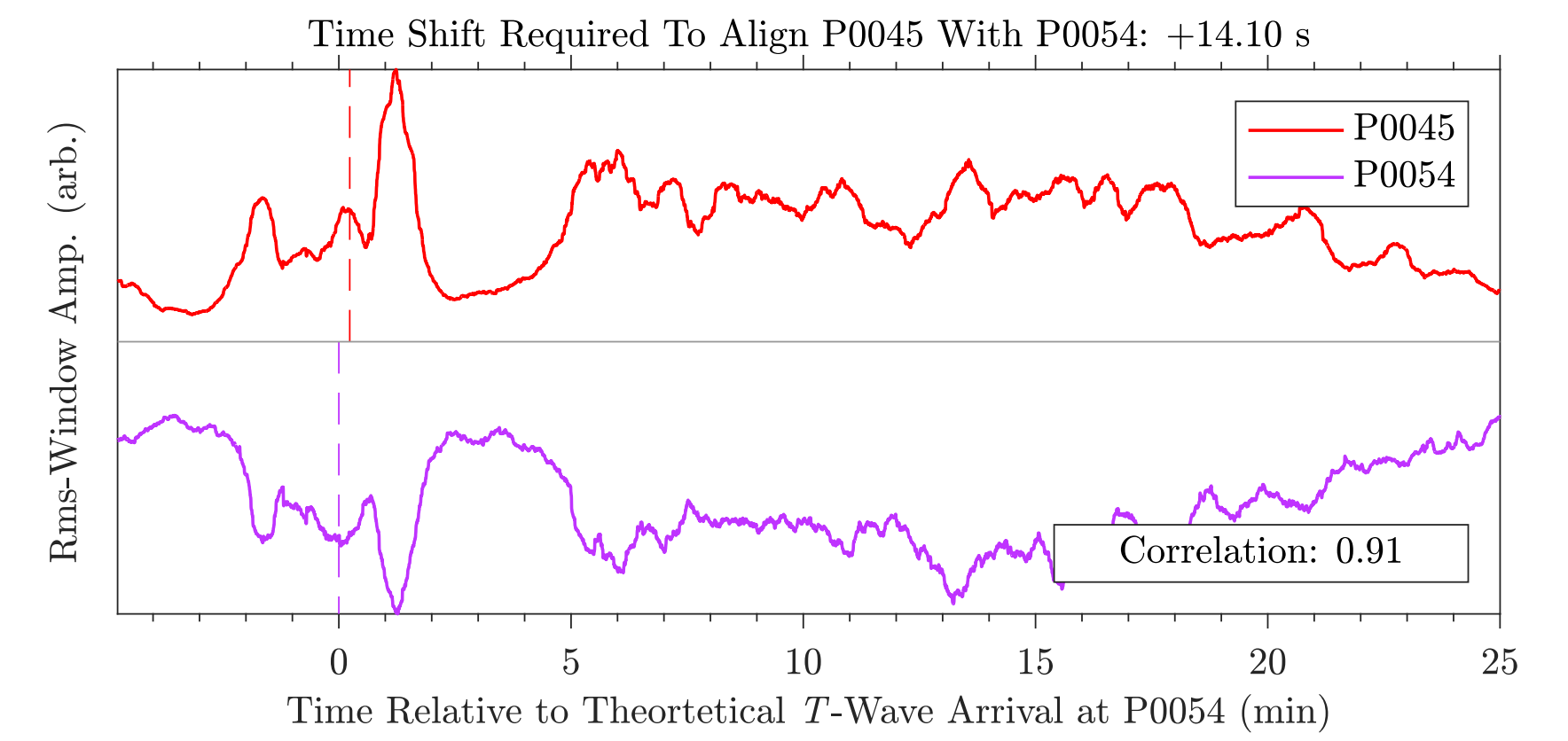
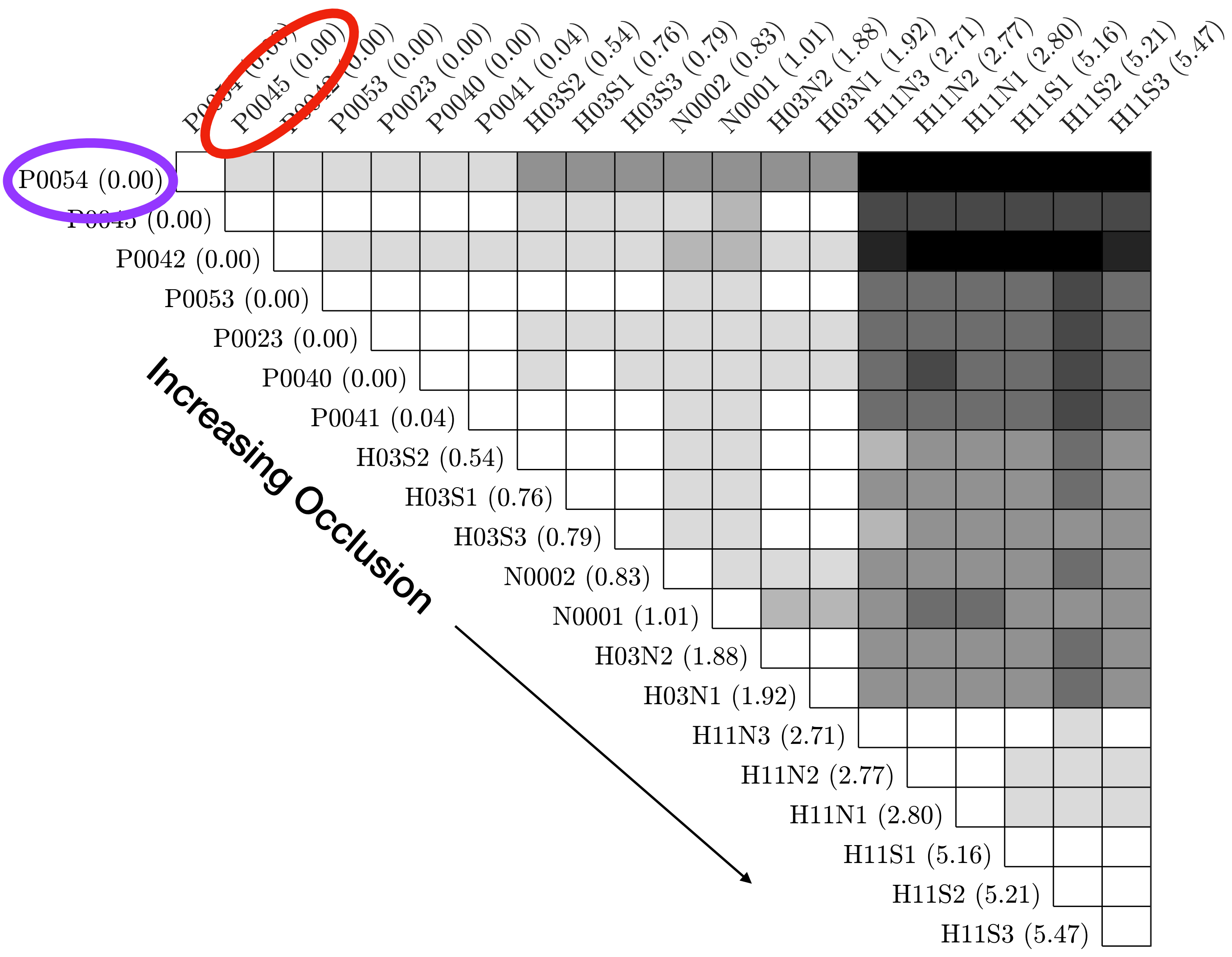


# Occlusion Regulates Inter-Station Correlations



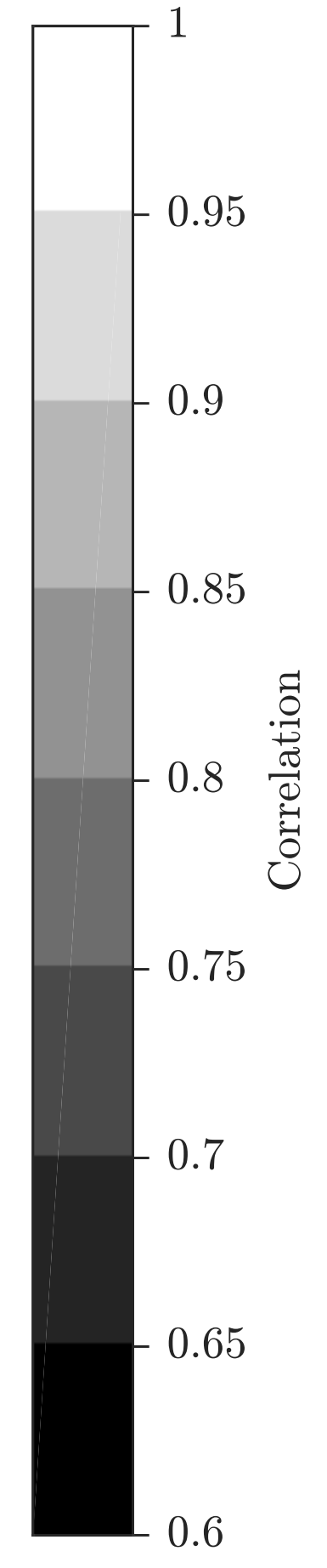
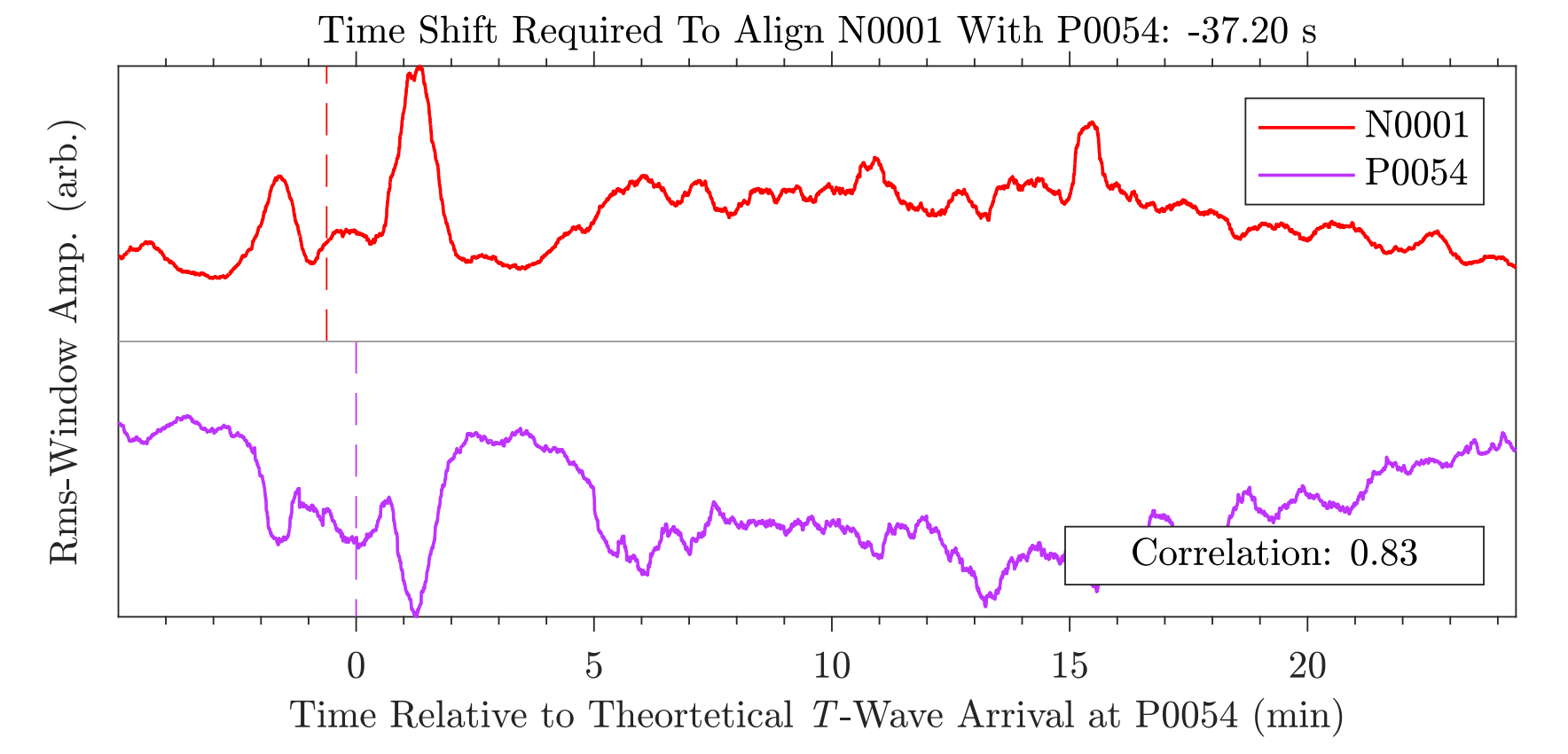
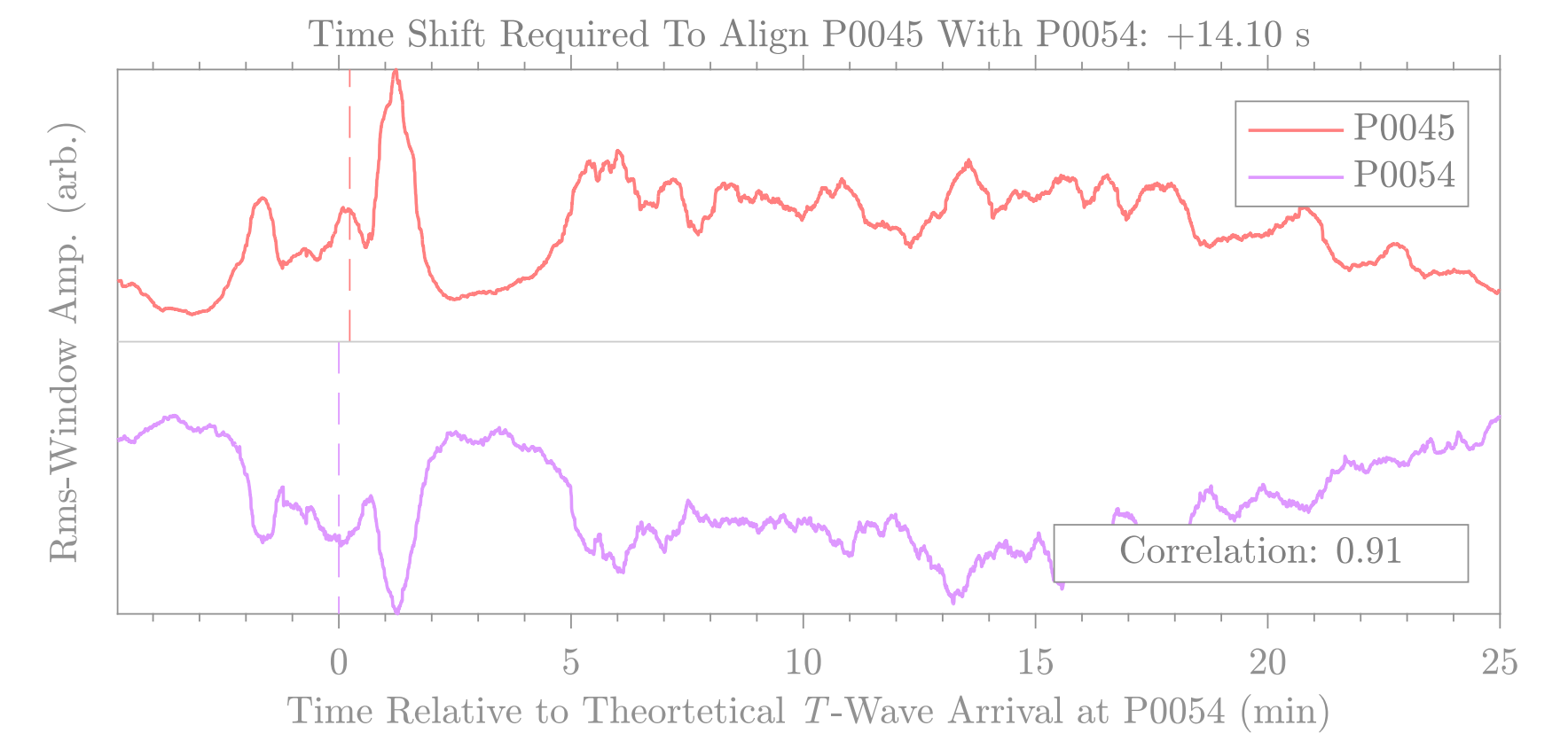
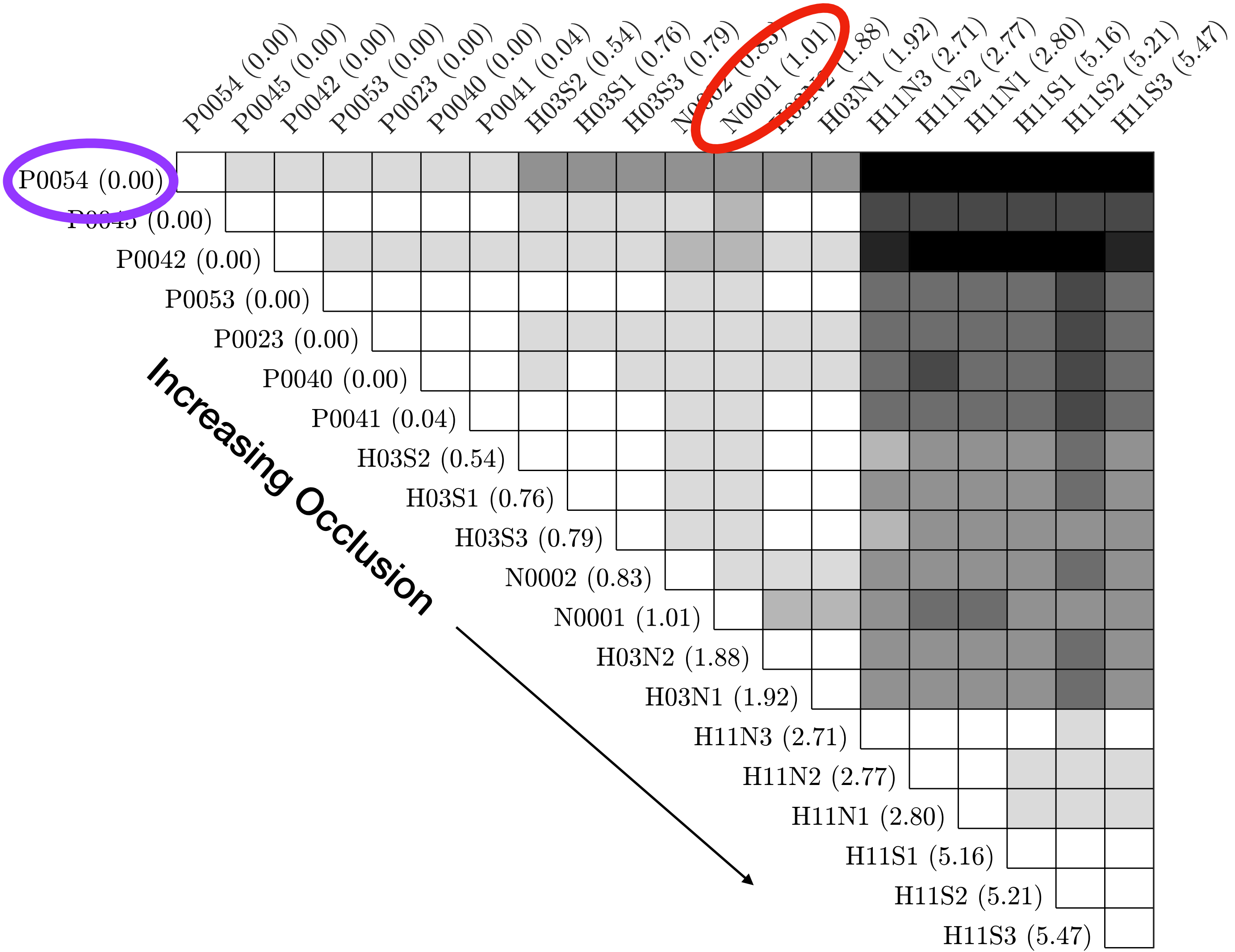
# Occlusion Regulates Inter-Station Correlations

Increasing Occlusion  $\longrightarrow$



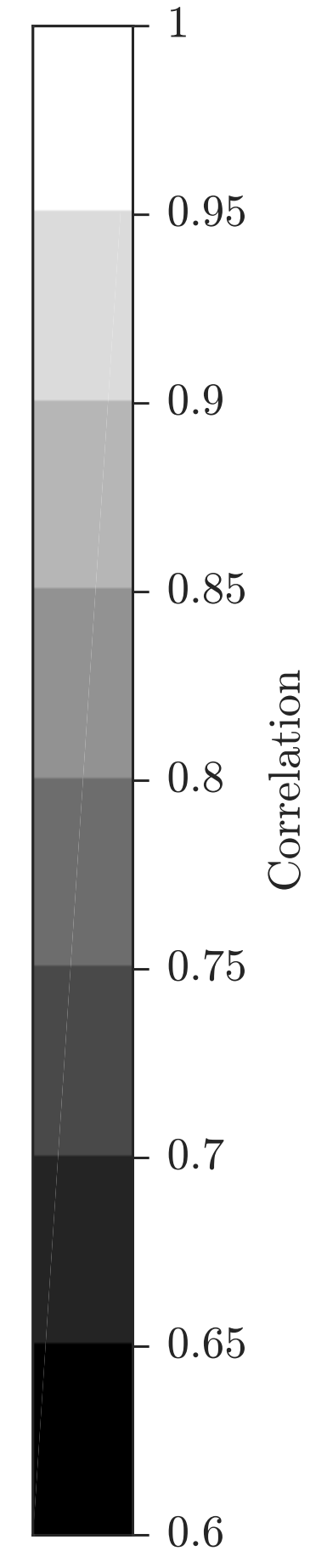
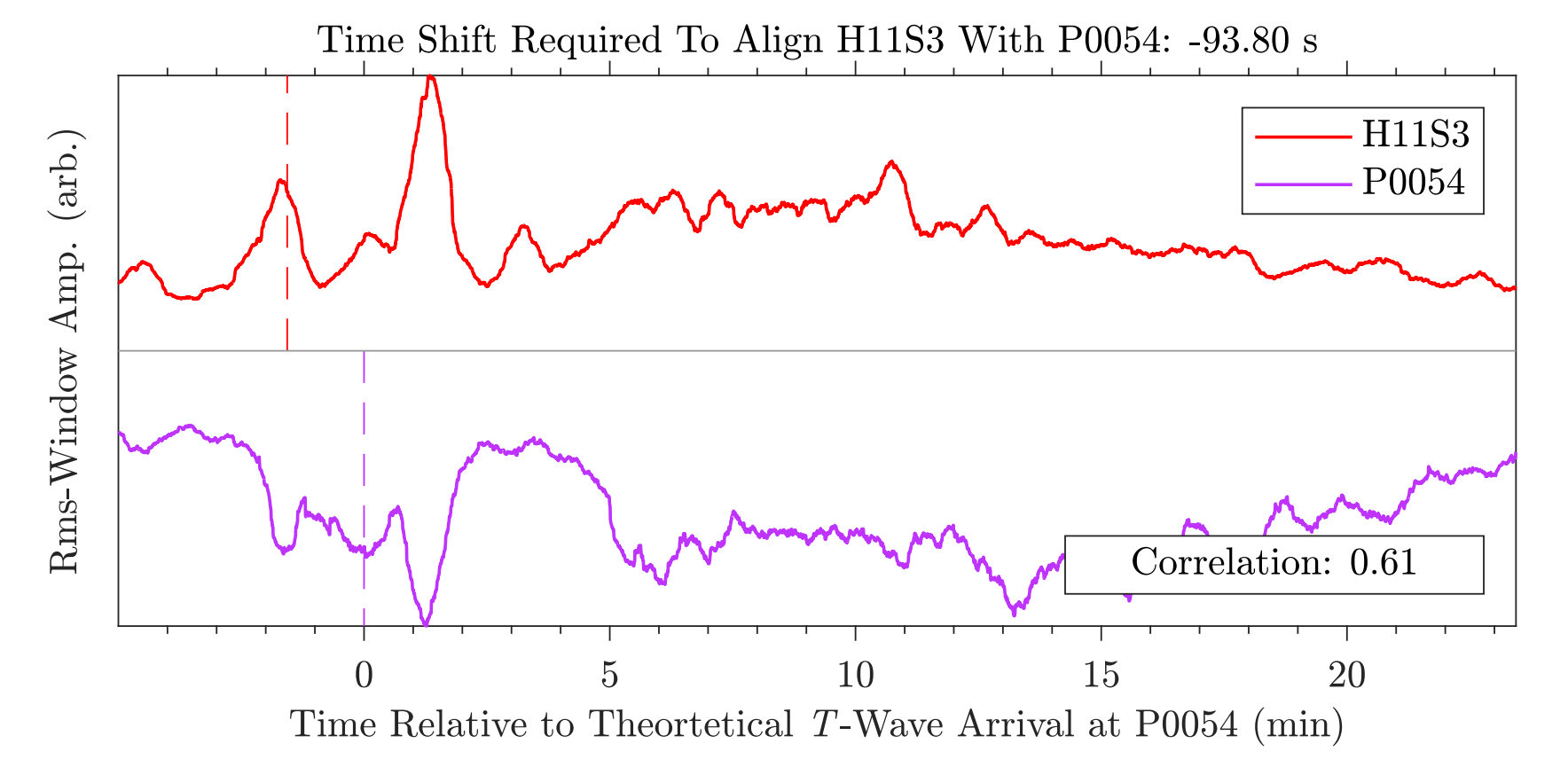
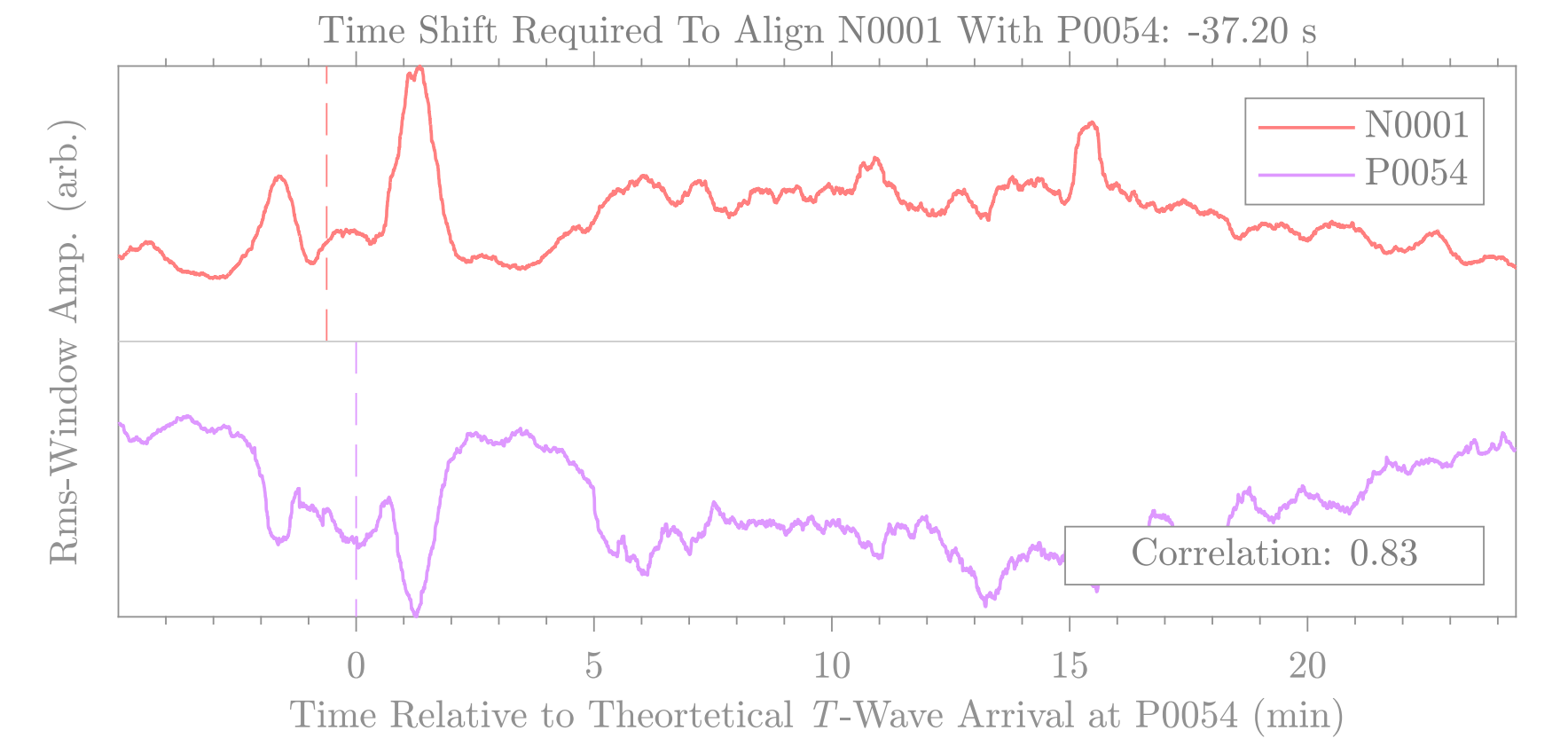
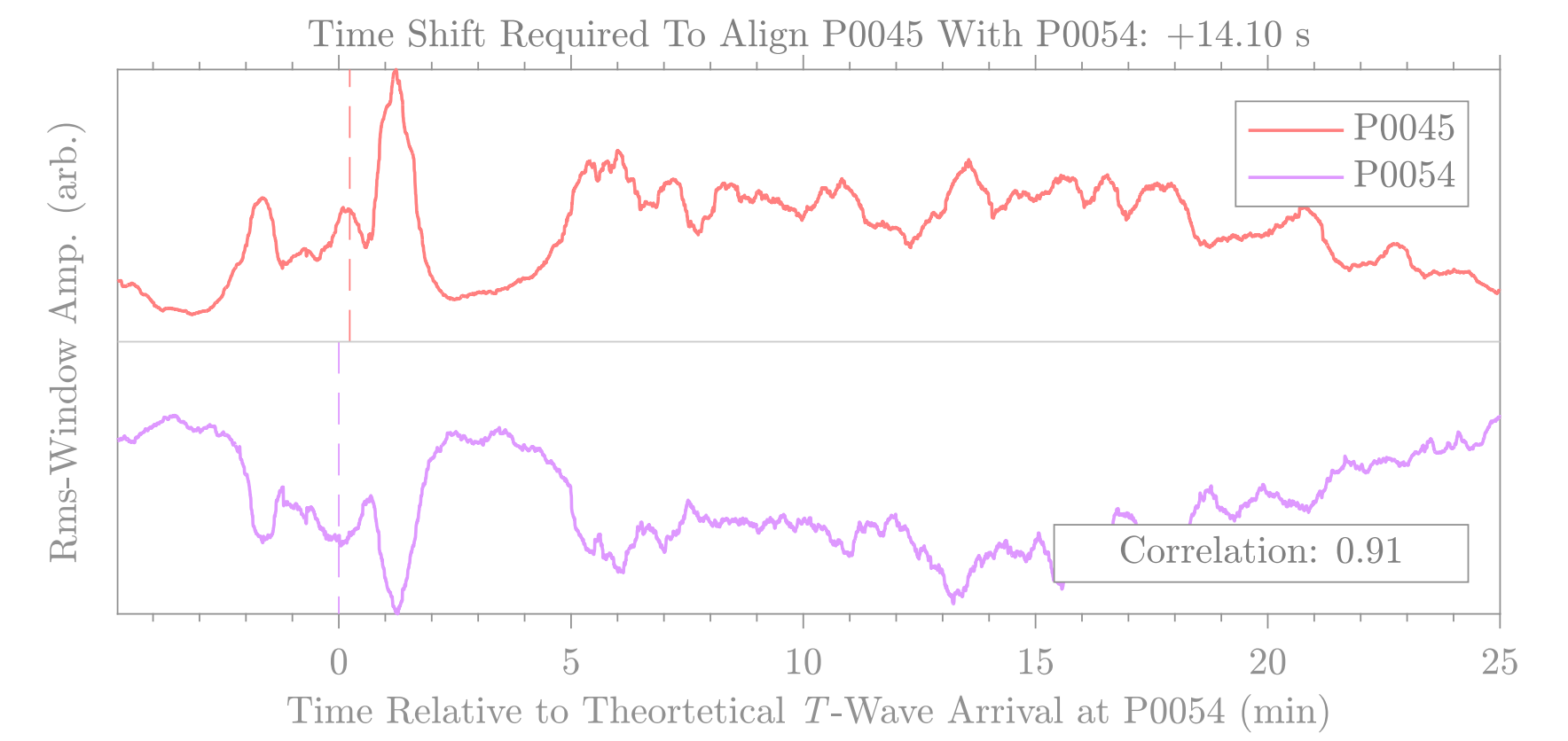
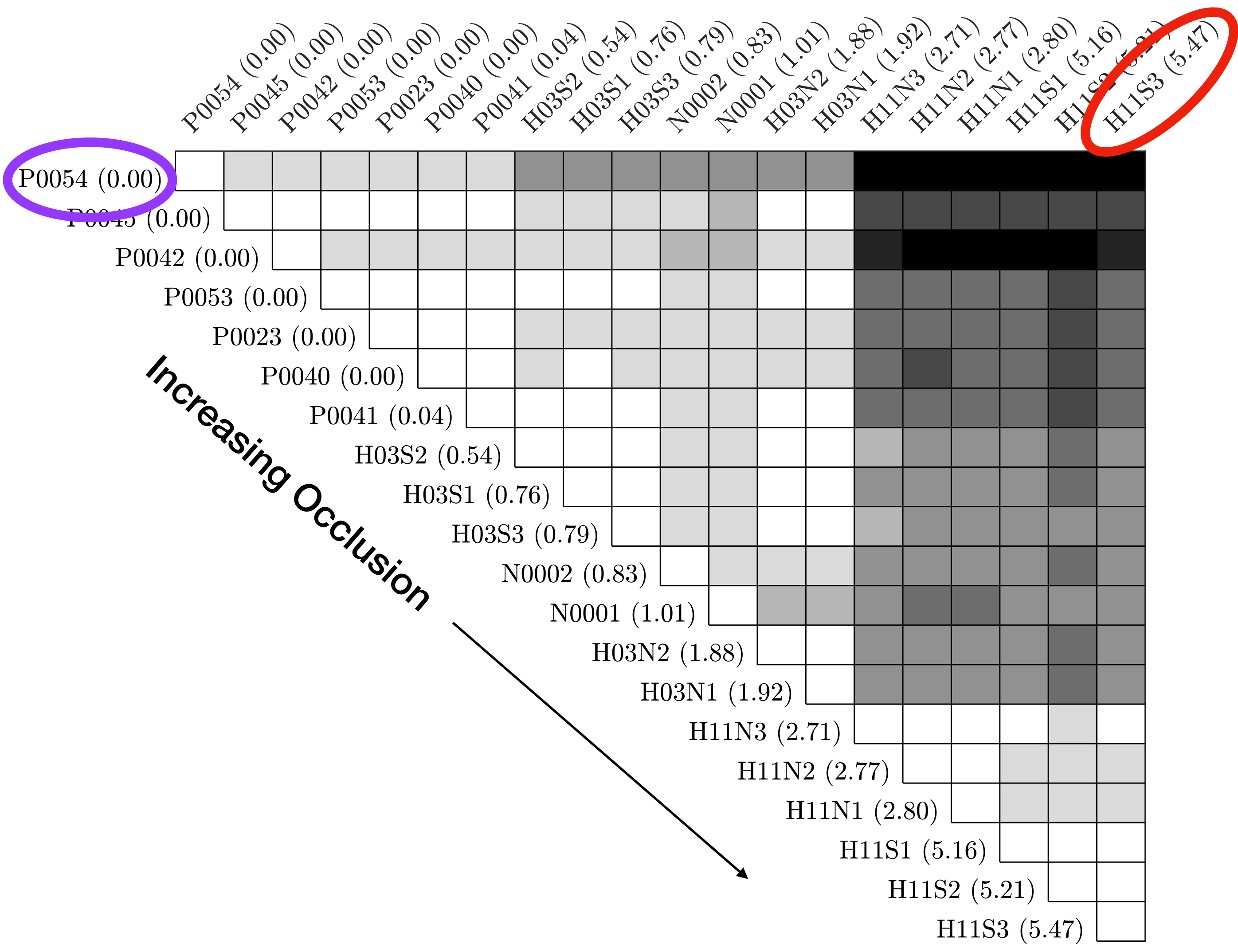
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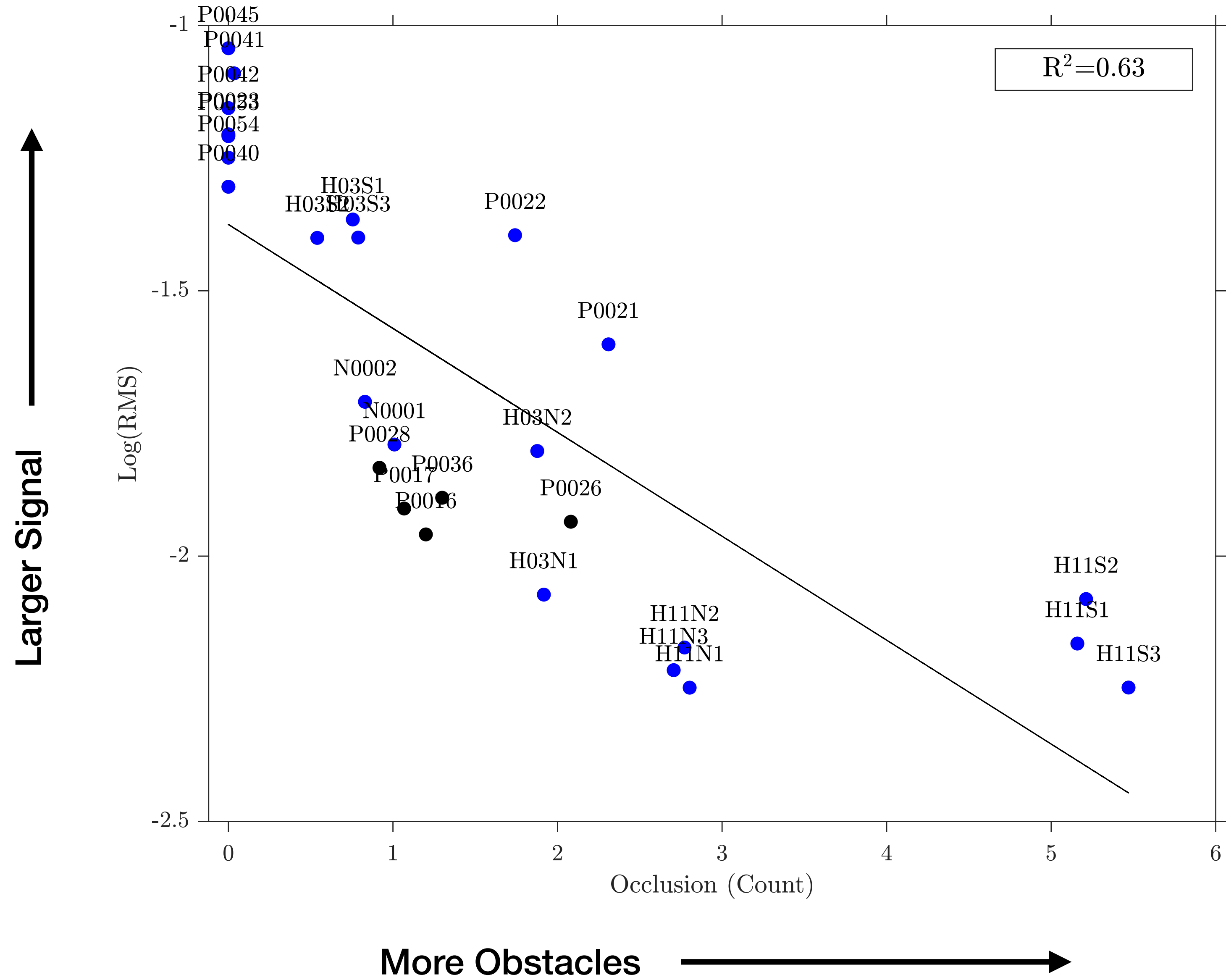


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Increasing Occlusion  $\longrightarrow$

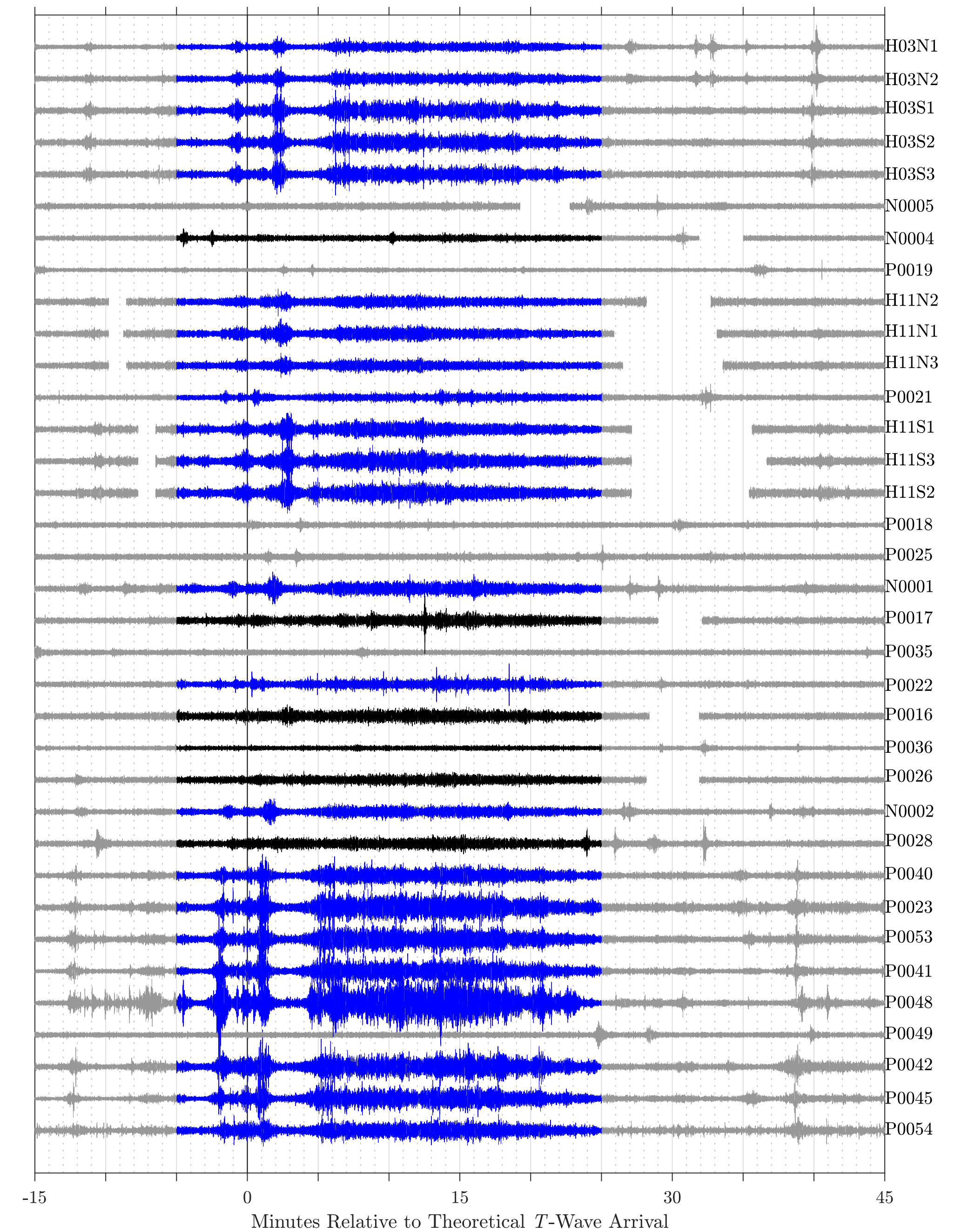


# Occlusion Regulates Signal Strength



# Summary

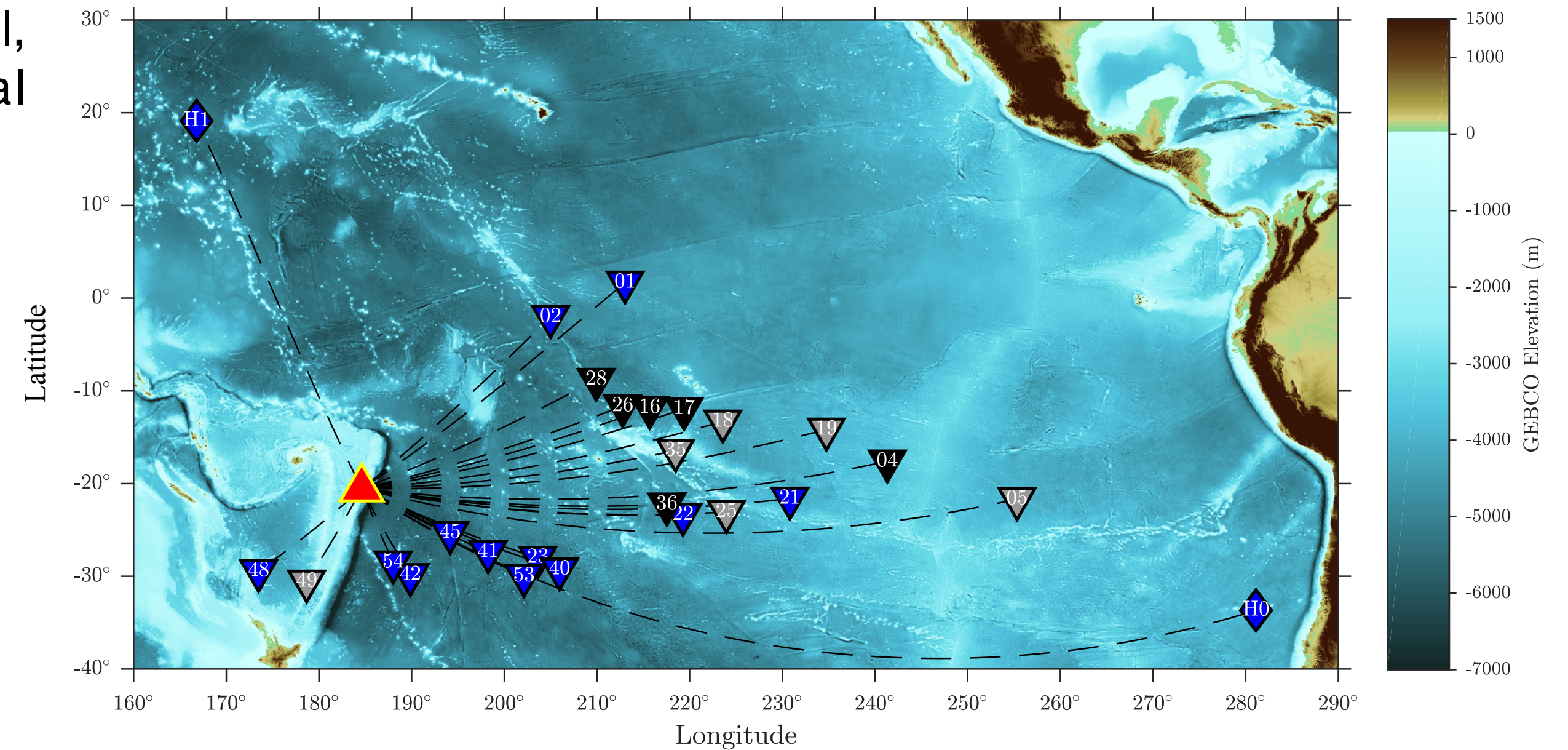
□ We recovered data from the HTHH eruption from 24 MERMAIDs and 11 IMS stations, with many showing highly correlated  $T$  waves



# Summary

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□ Occlusion alone cannot explain why some stations record a strong signal, and others record a diffuse signal or no signal at all, which leads us to conclude there must be additional uncharacterized near-source effects

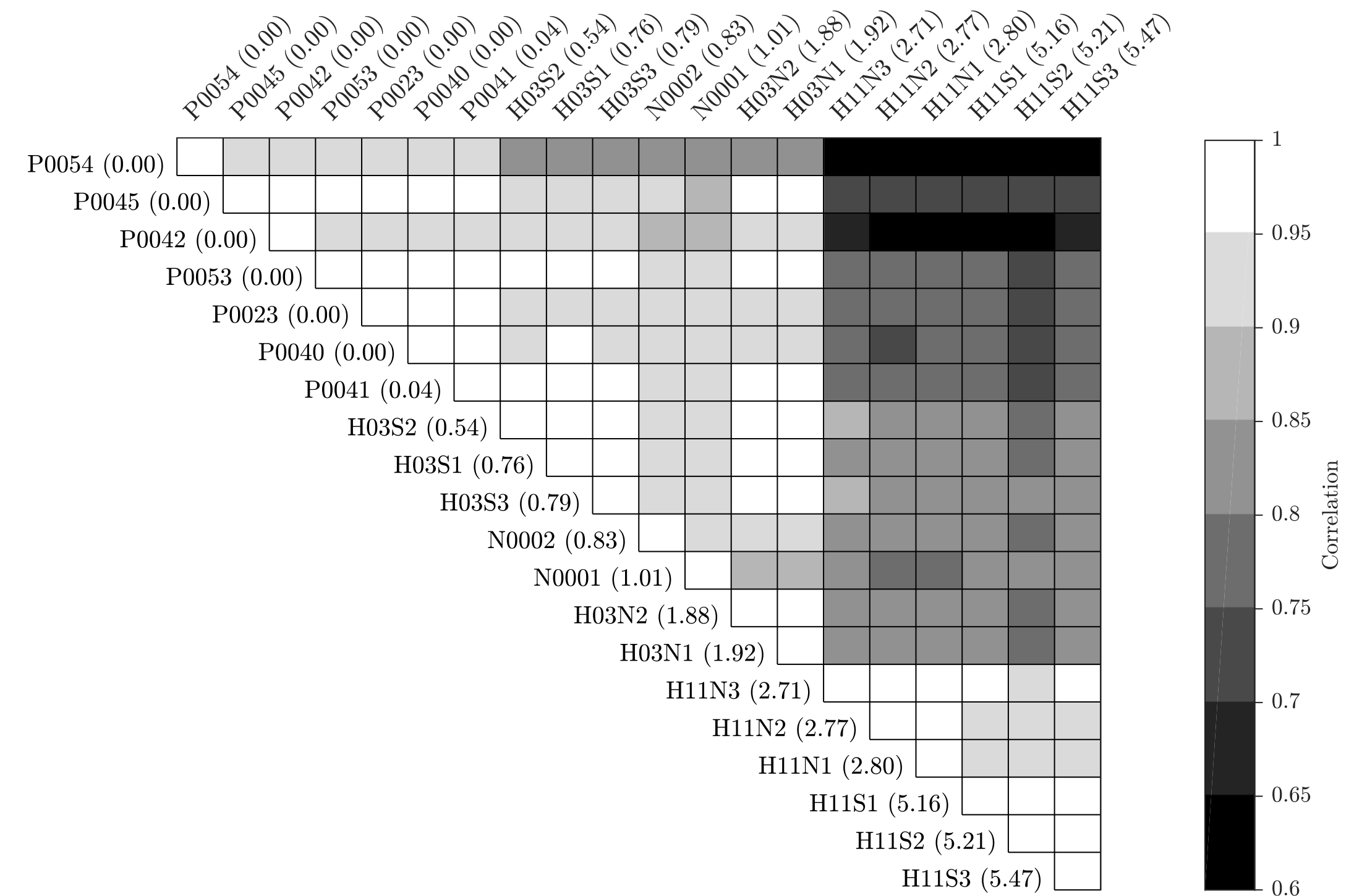
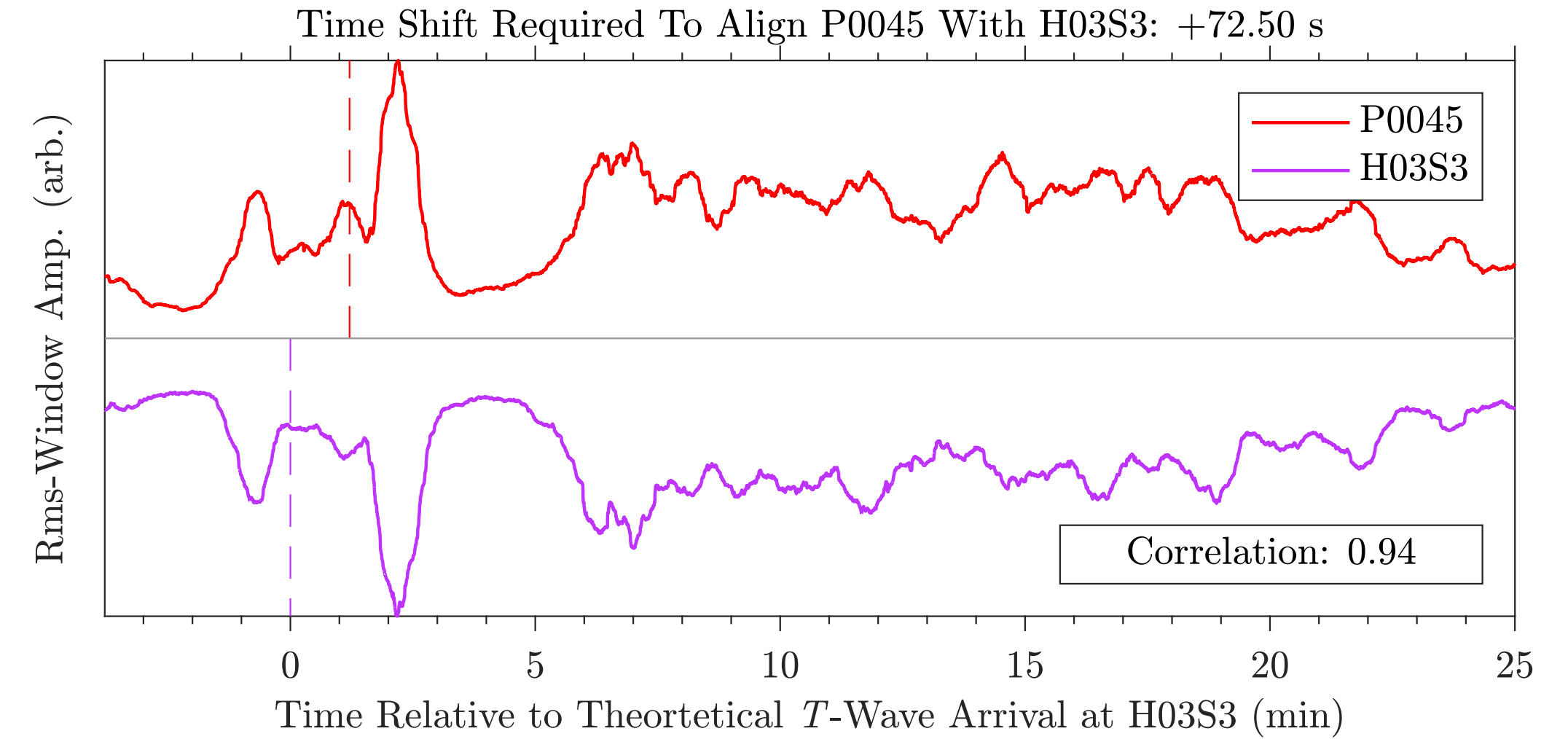


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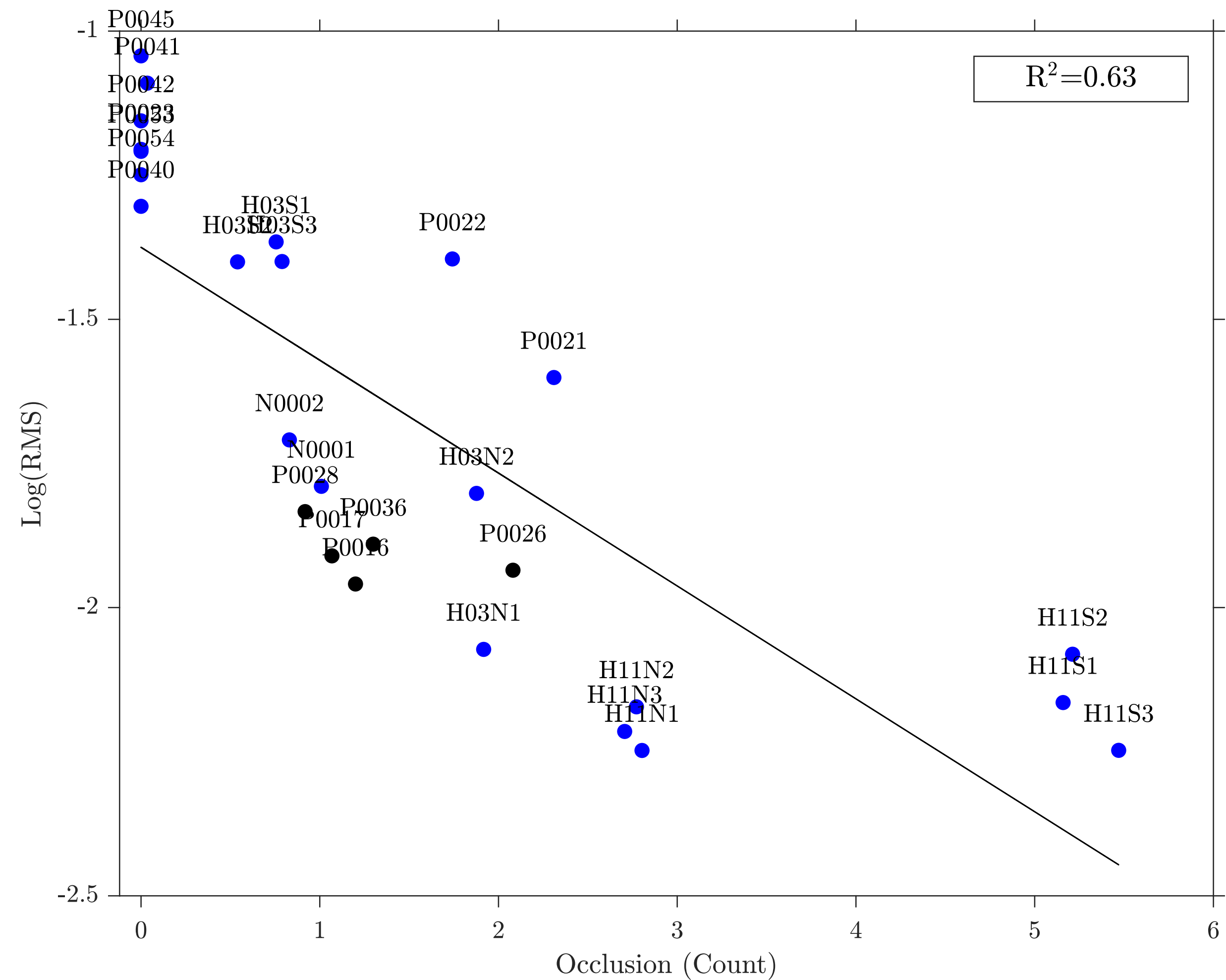
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# Summary

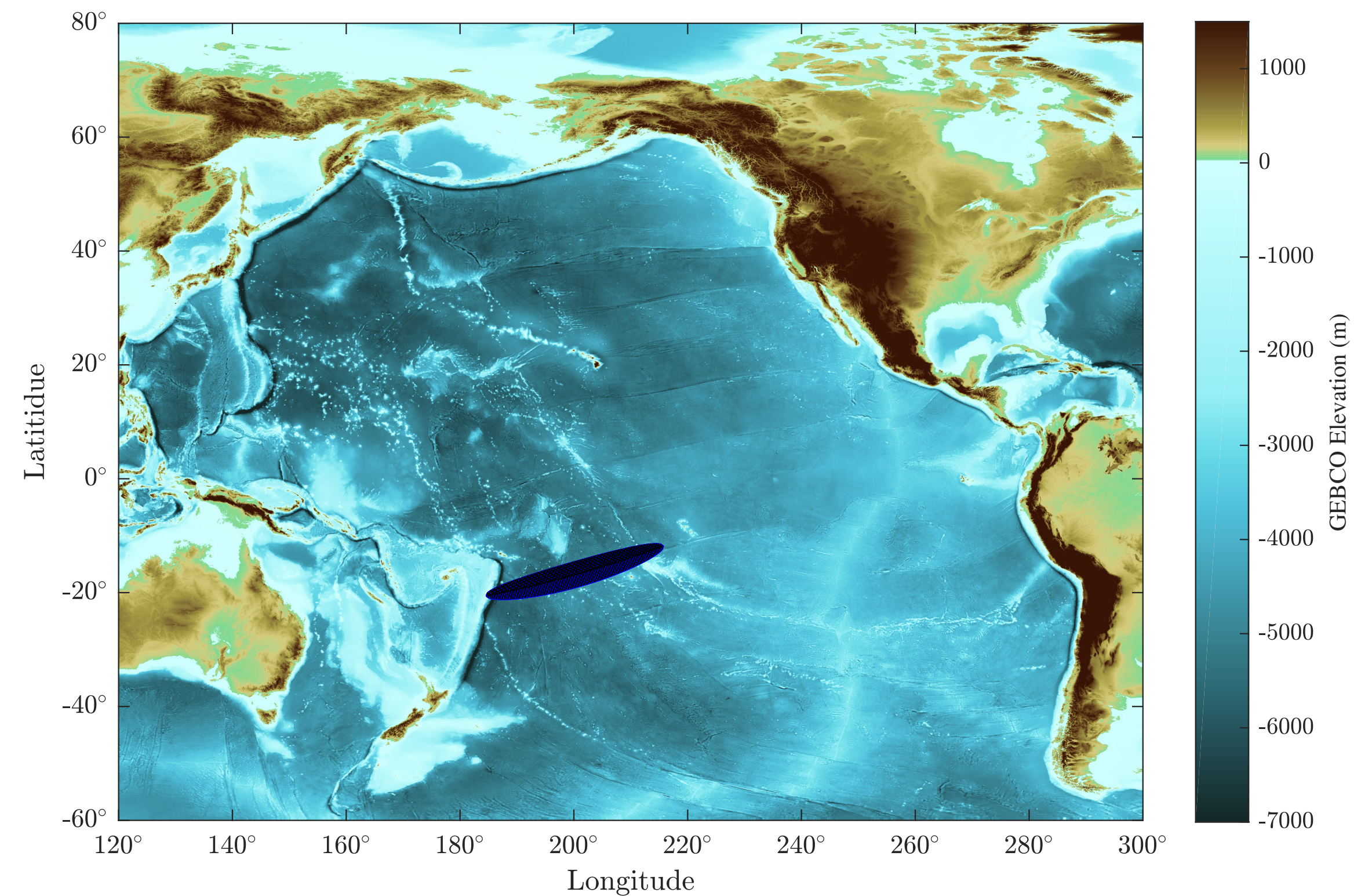
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□ Recommendation: hydro(seismo)acoustic stations designed to monitor various sounds are best located at the intersection of low-occlusion paths ("clean SOFAR") radiating from regions of interest

