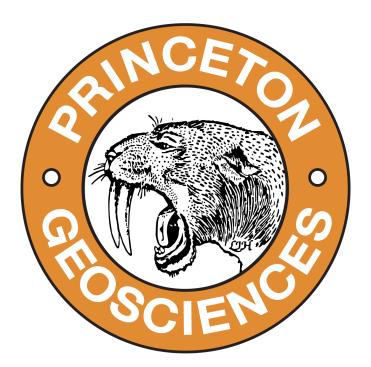
Joel D. Simon¹ (jdsimon@princeton.edu), Yong Yu², Masayuki Obayashi³, Hiroko Sugioka⁴, Frederik J. Simons¹, Jessica C. E. Irving⁵, and The EarthScope-Oceans Consortium





¹Princeton University, United States; ²Southern University of Science and Technology, China ³Japan Agency for Marine-Earth Science and Technology, Japan; ⁴Kobe University, Japan; ⁵University of Bristol, United Kingdom

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









15 January 2022 Hunga Tonga-Hunga Ha'apai Eruption

Largest volcanic eruption on Earth since Krakatoa in 1883

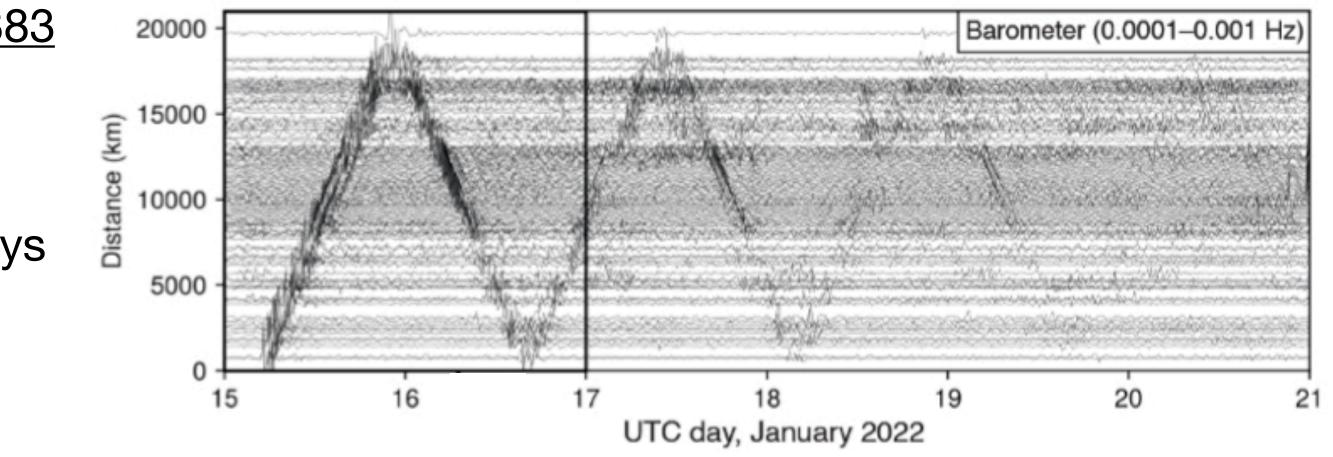
- Generated surface-wave magnitudes of M 5.8
- Produced atmospheric waves that circled Earth for days
- Excited solid-earth normal modes
- Spawned megatsunami



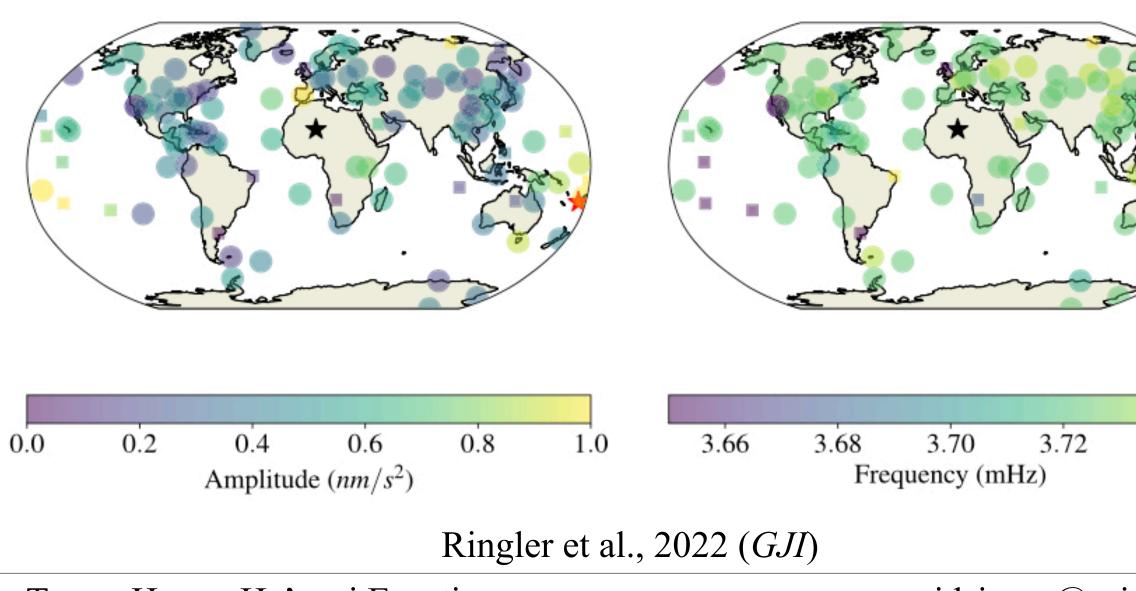
Tonga Geological Services / EOS.org

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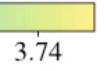
MERMAIDs Record the Hunga Tonga-Hunga Ha'apai Eruption



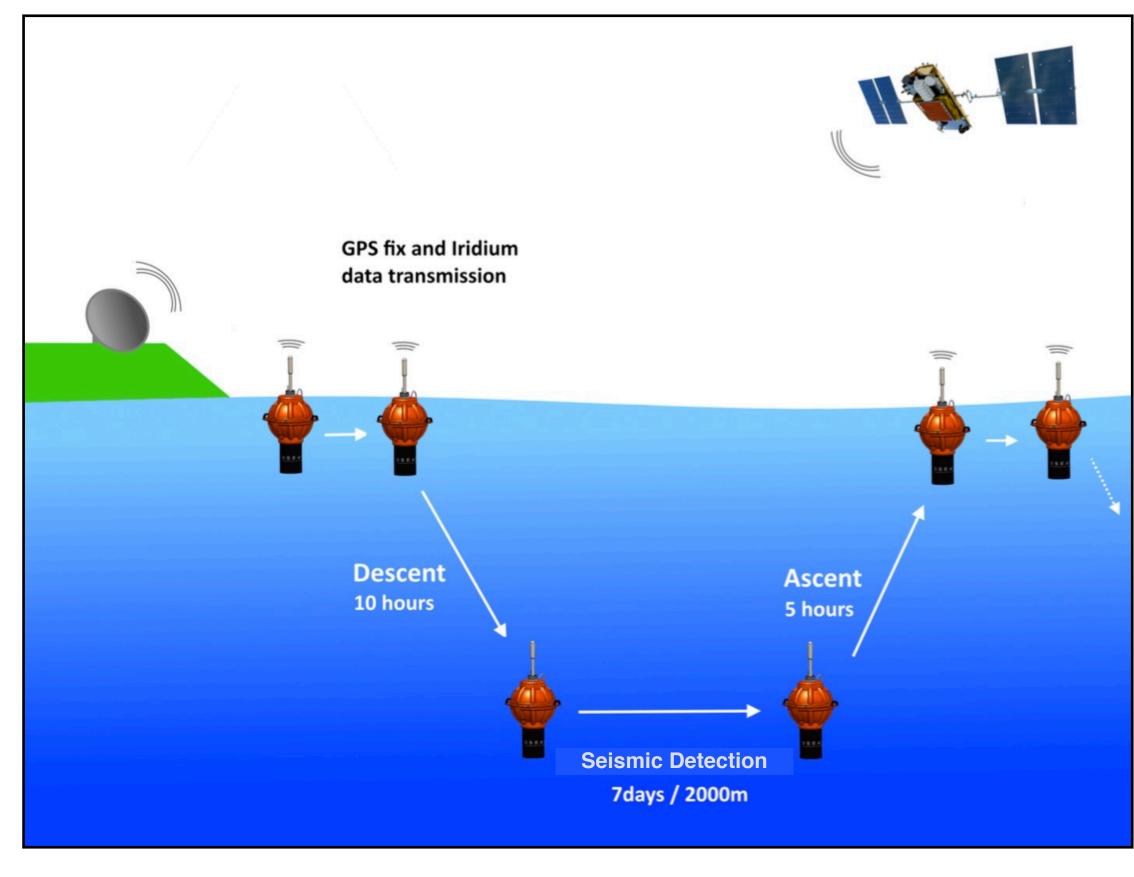
Matoza et al., 2022 (Science)





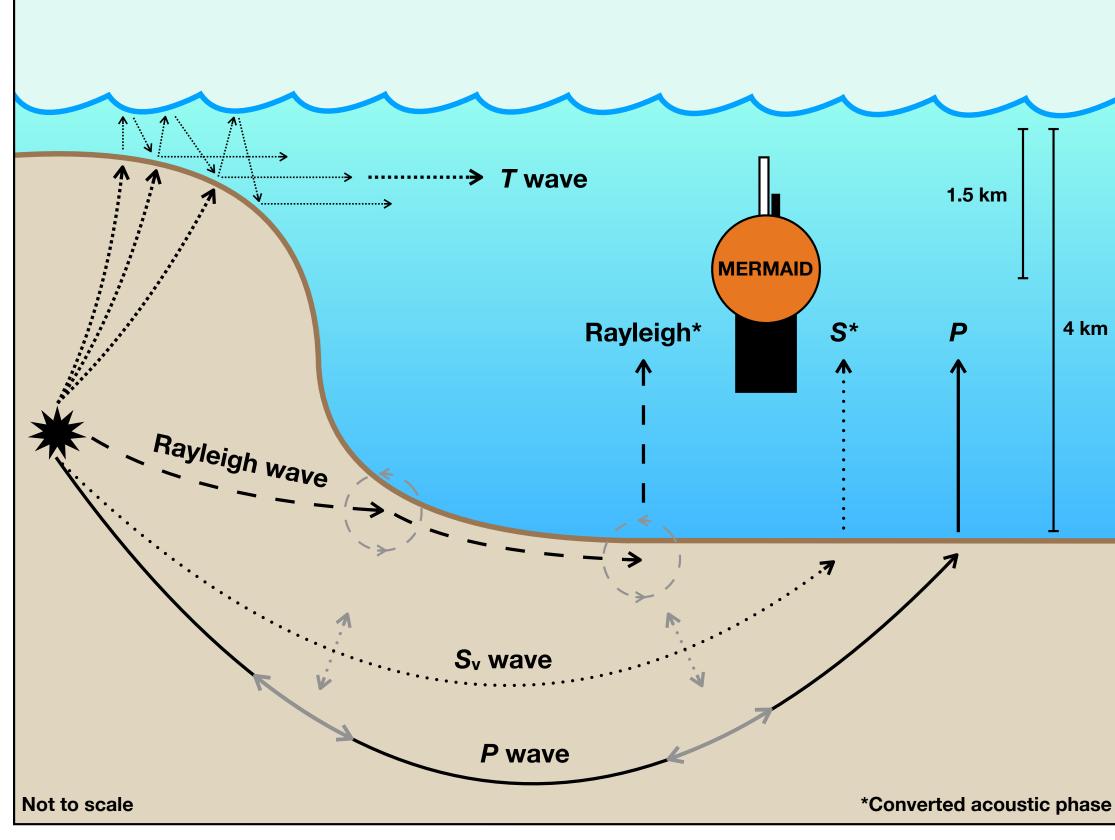


Mobile Earthquake Recording in Marine Areas by Independent Divers



OSEAN.fr

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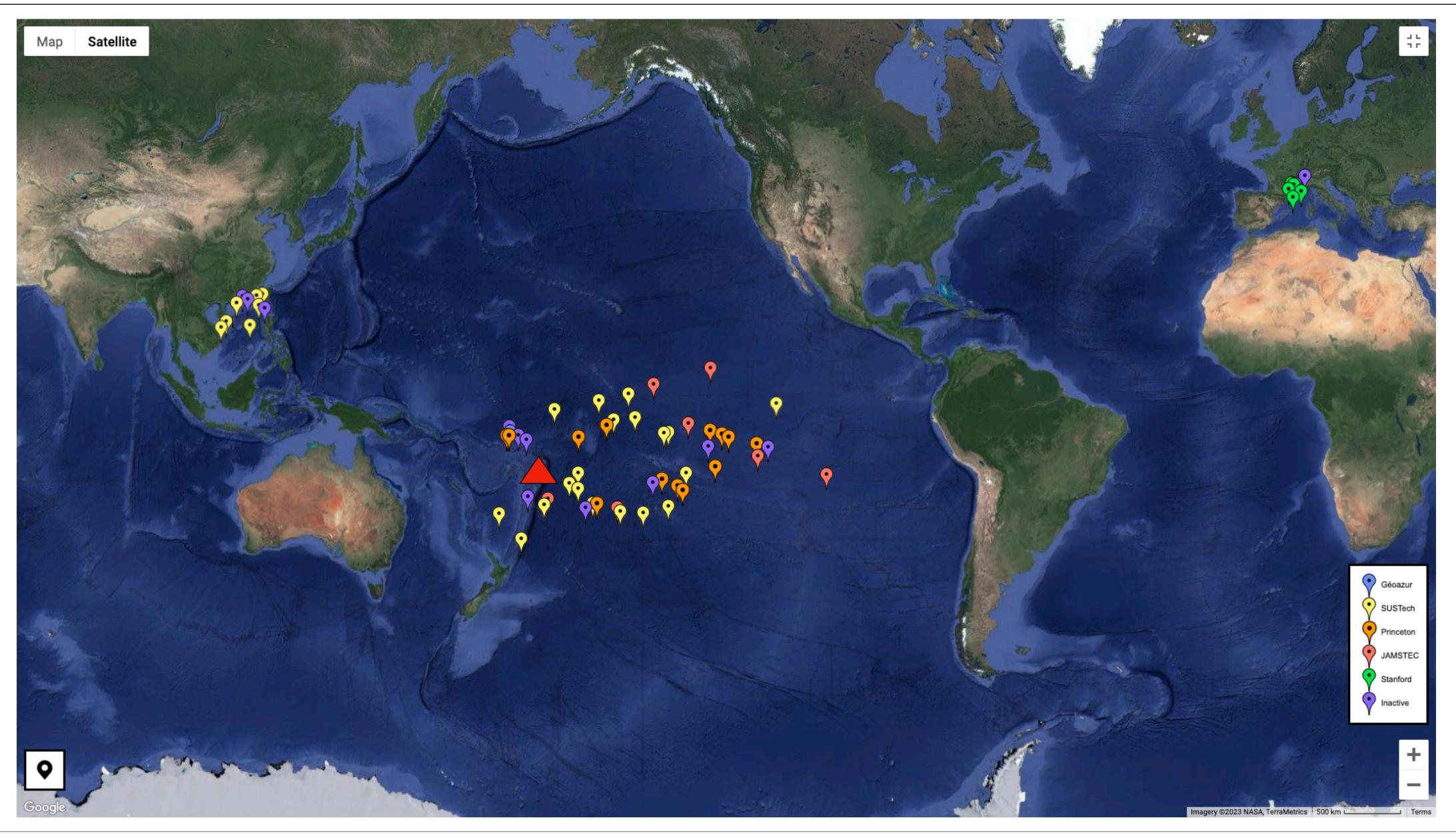


Simon et al., 2021 (SRL)





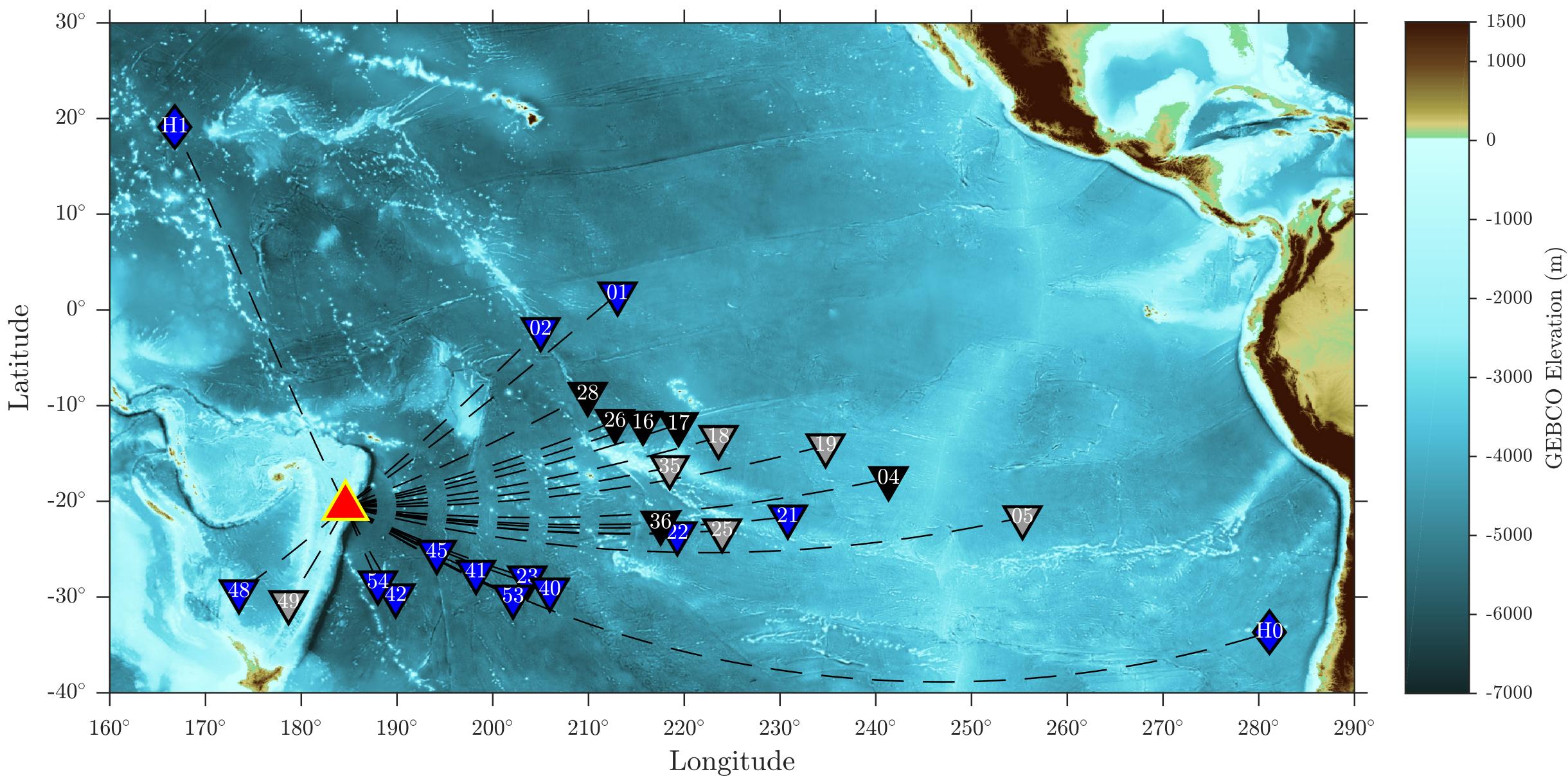
EarthScopeOceans.org



MERMAIDs Record the Hunga Tonga-Hunga Ha'apai Eruption



MERMAID Locations on 15 January 2022



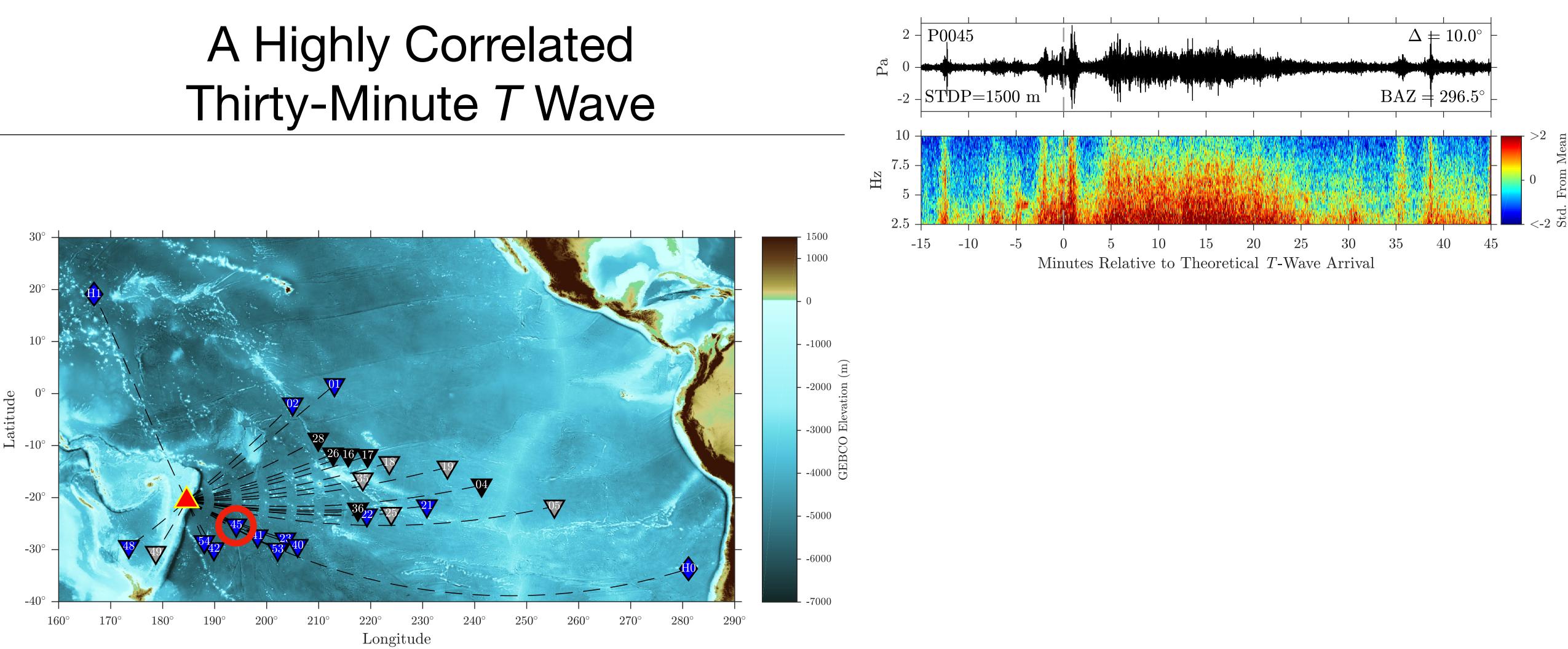
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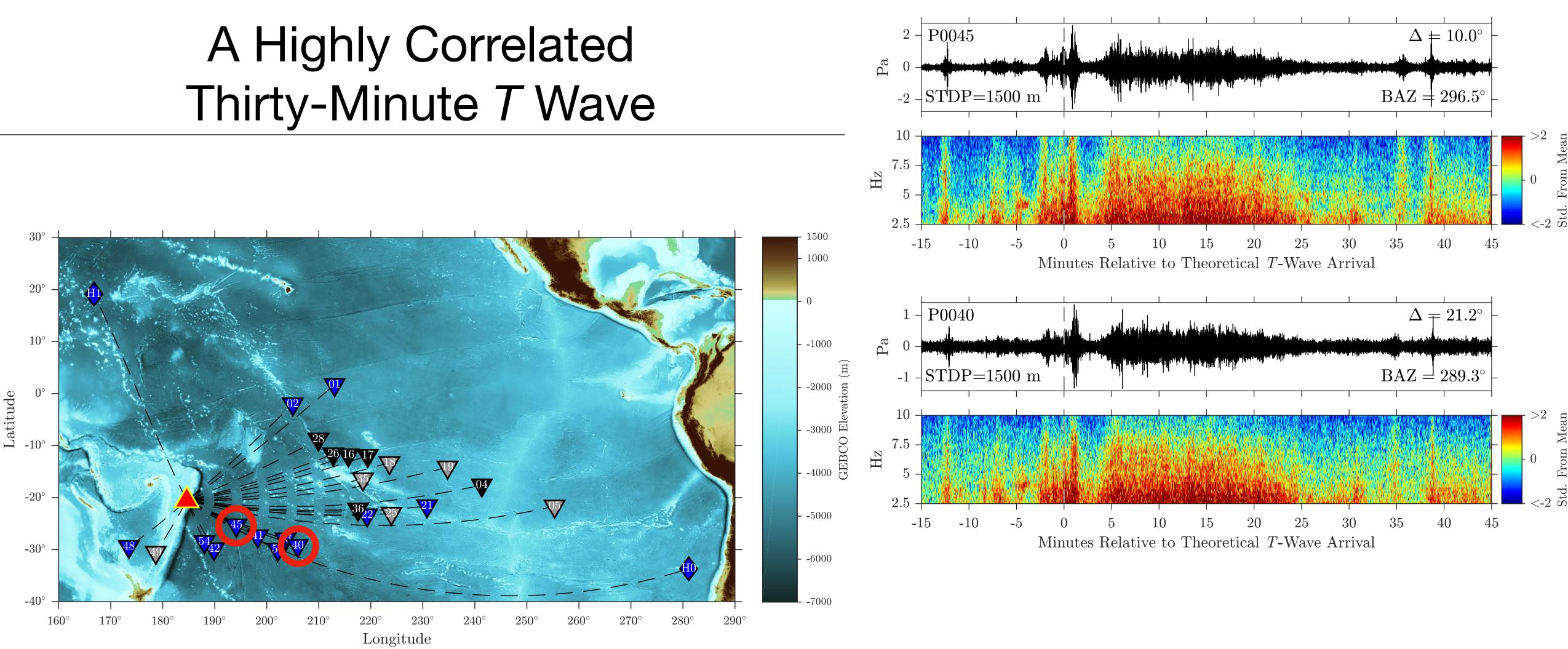
MERMAIDs Record the Hunga Tonga-Hunga Ha'apai Eruption

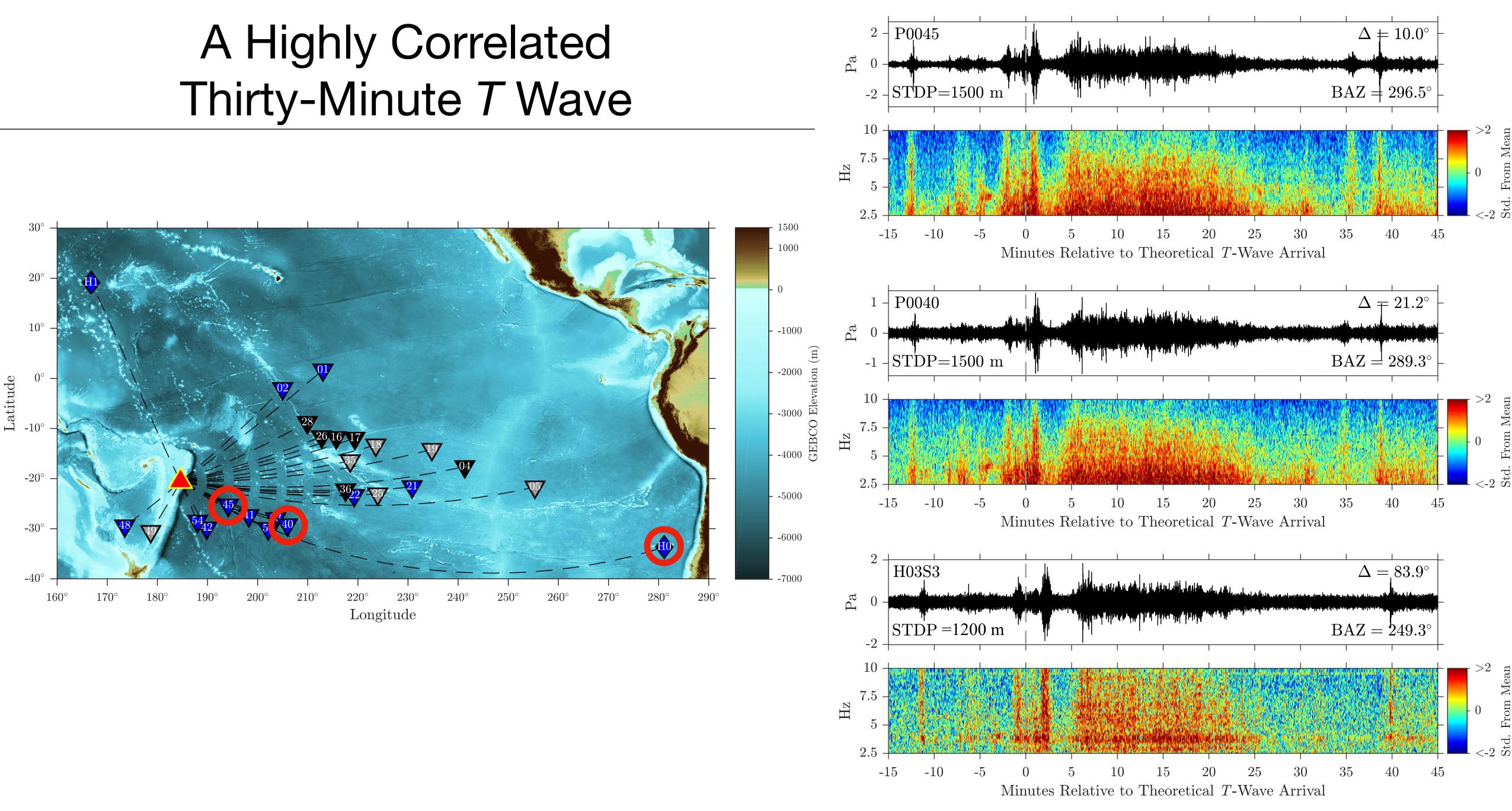
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5—10 Hz

15 Minutes Relative to Theoretical T-Wave Arrival

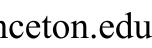


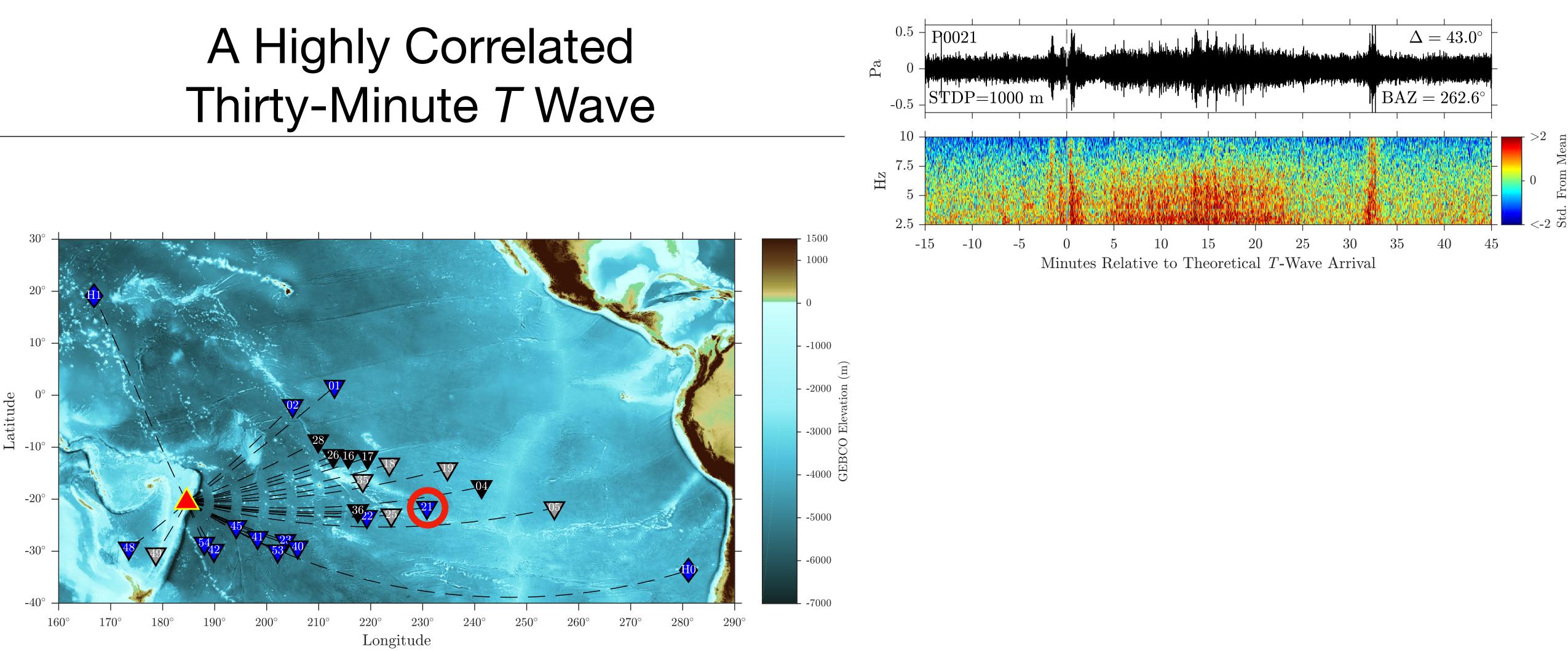


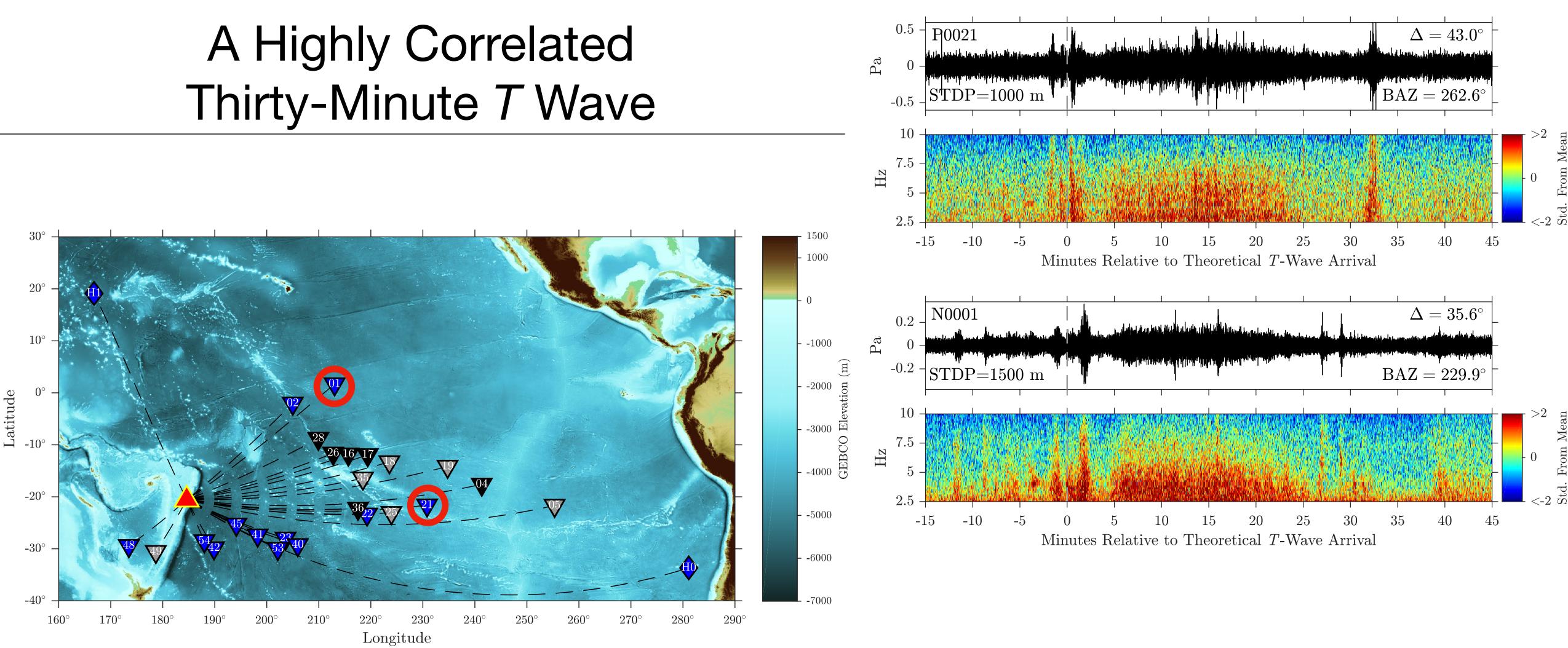


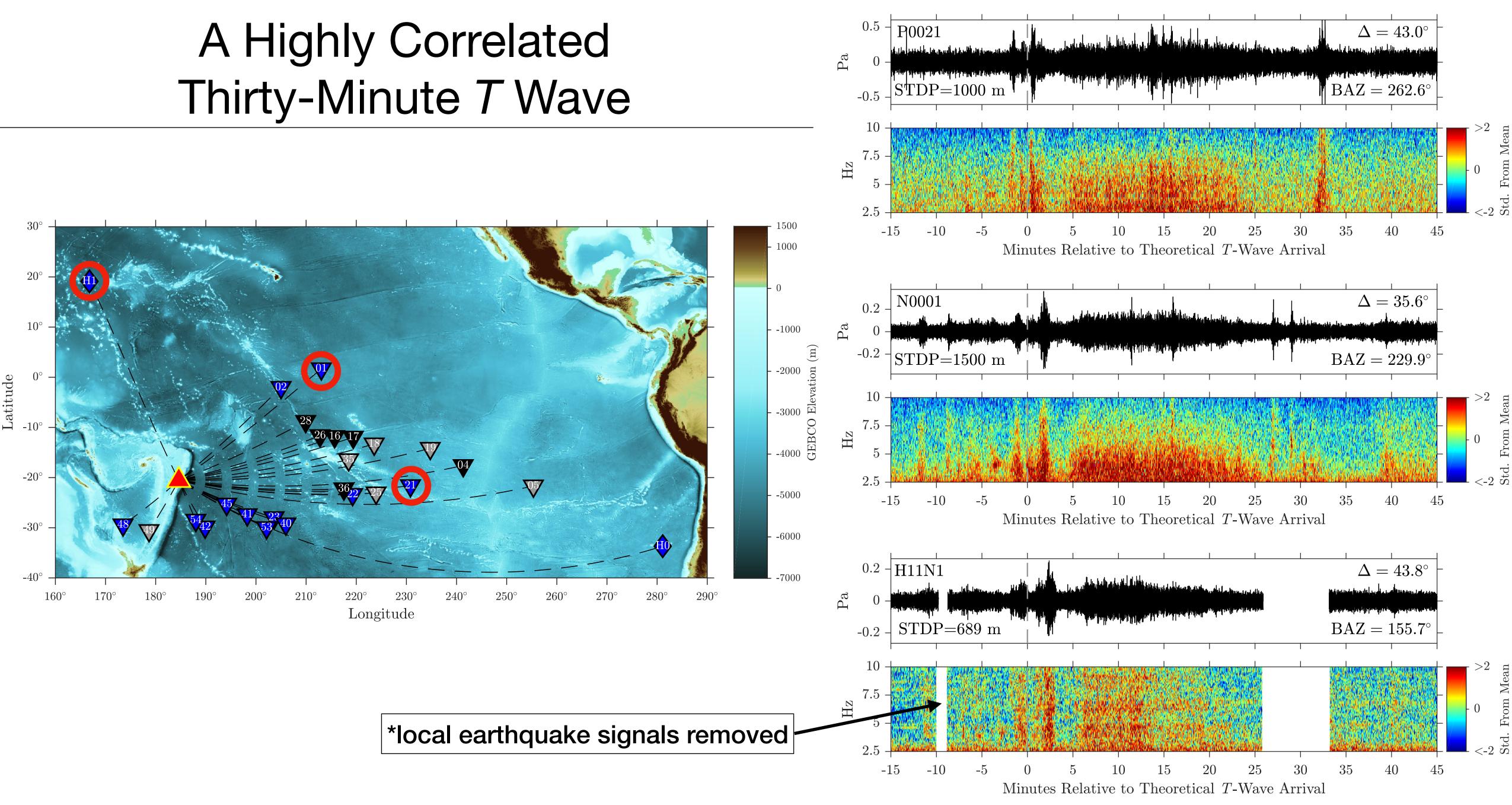
MERMAIDs Record the Hunga Tonga-Hunga Ha'apai Eruption

jdsimon@princeton.edu



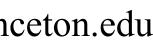






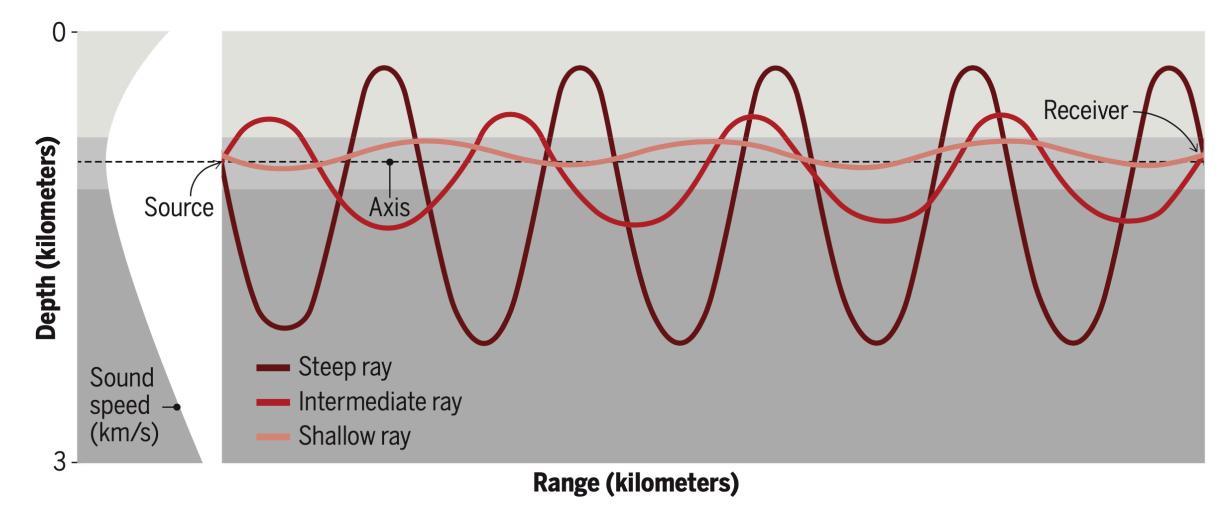
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jdsimon@princeton.edu



SOFAR is *Depth* and Fresnel Zone is *Breadth* of Influence

SOFAR: Sound Fixing and Ranging Channel

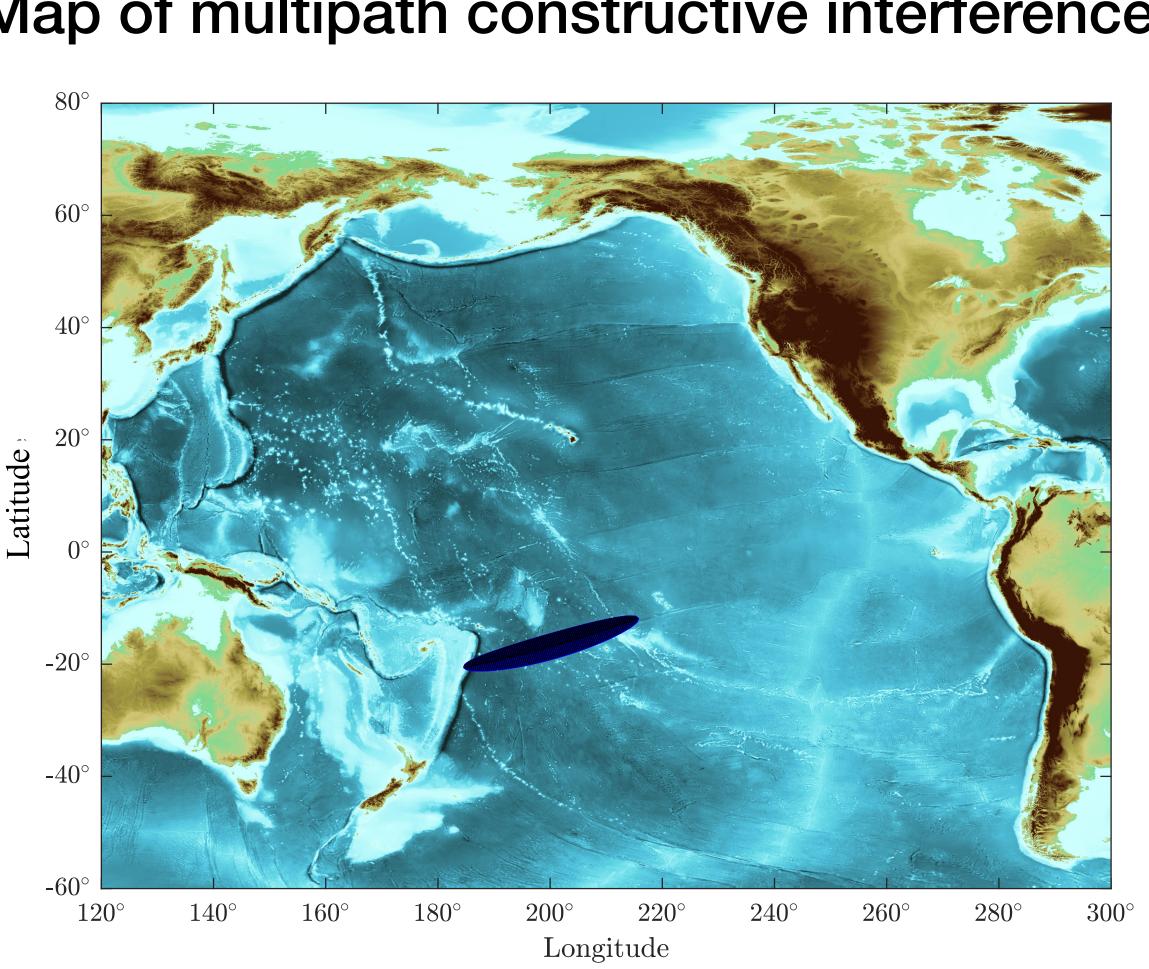


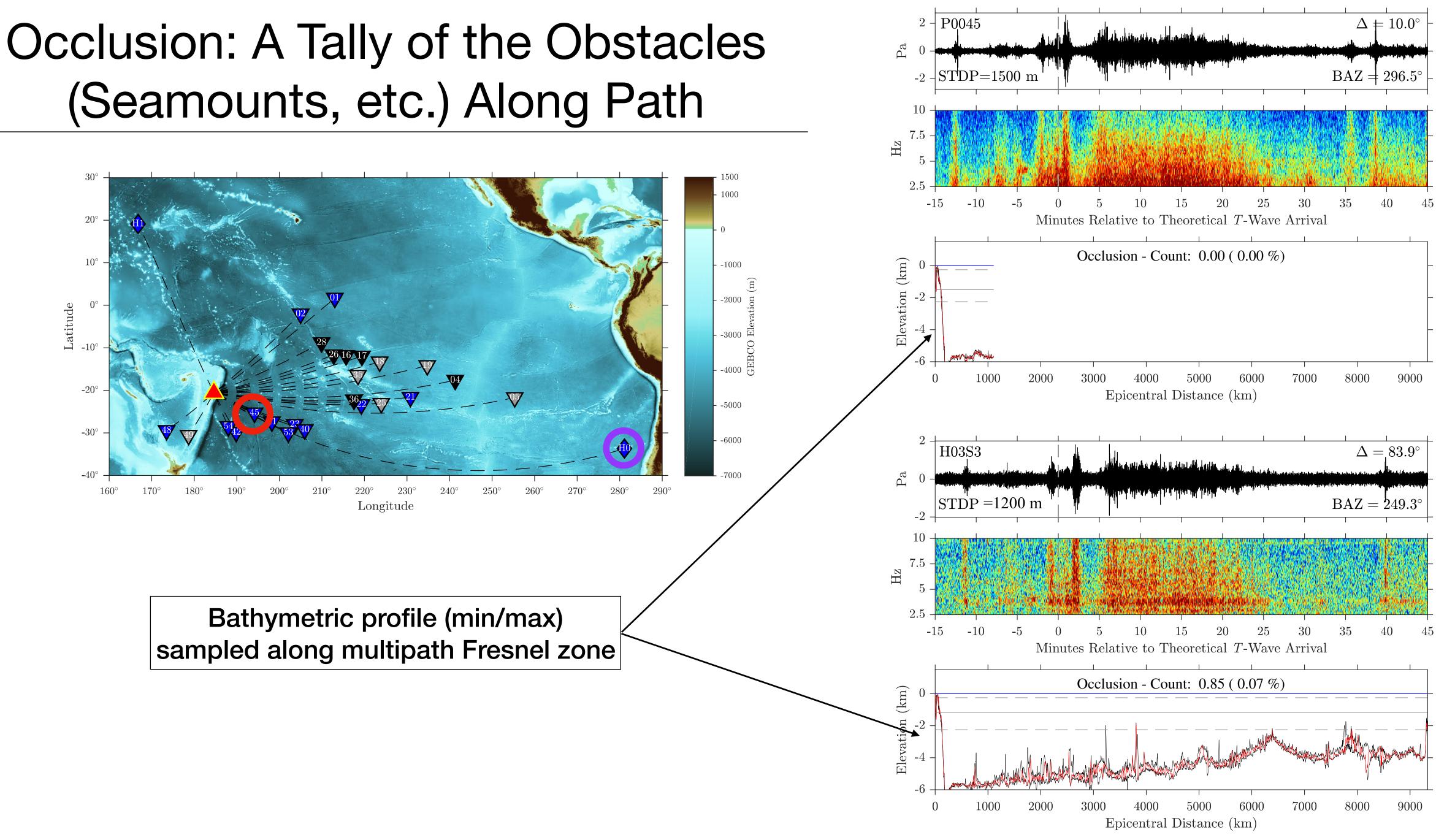
Wunsch, 2020 (Science)

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Fresnel zone: Map of multipath constructive interference

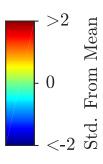


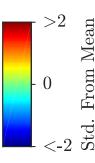


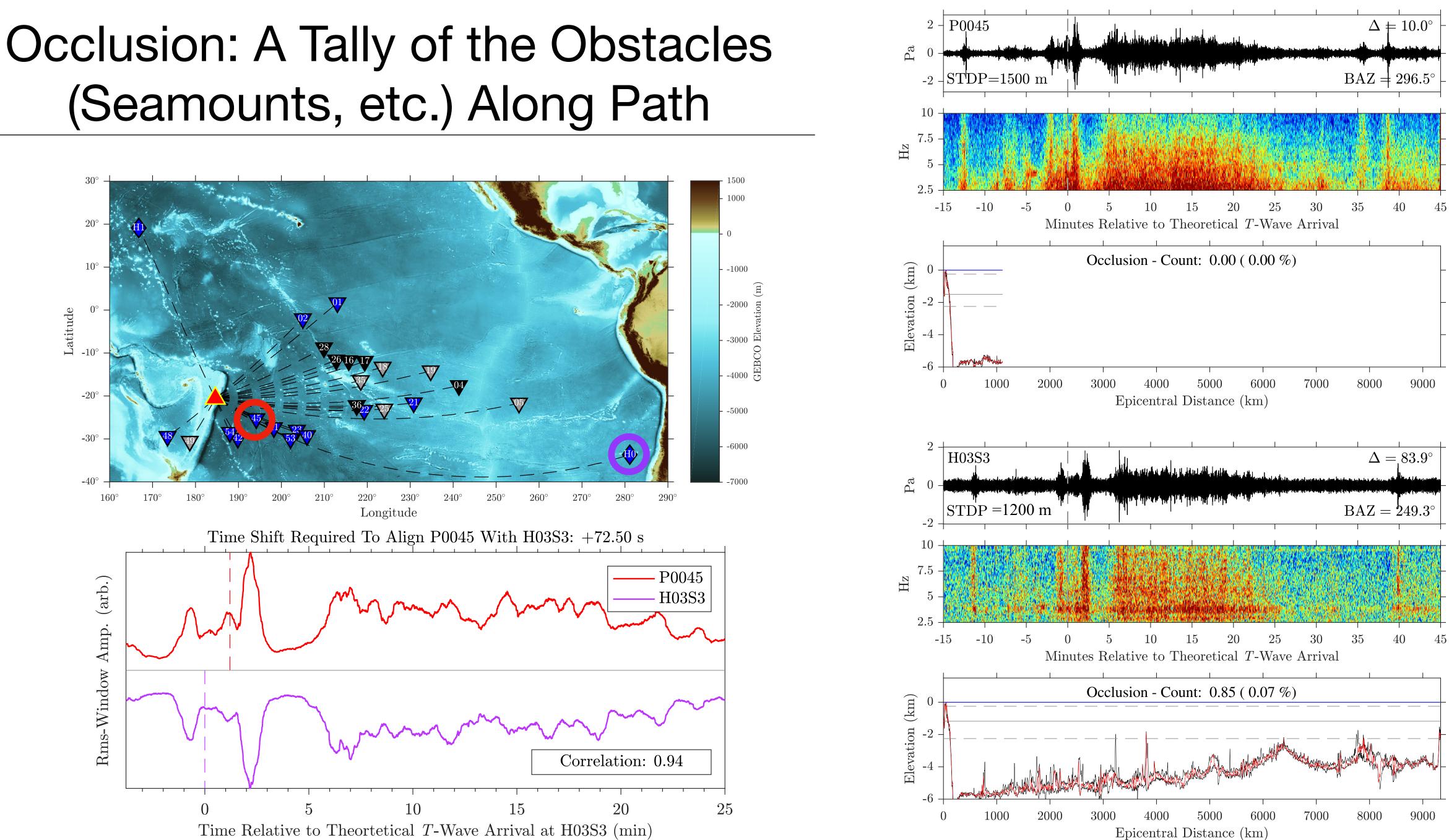
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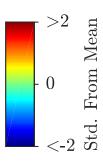


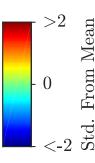


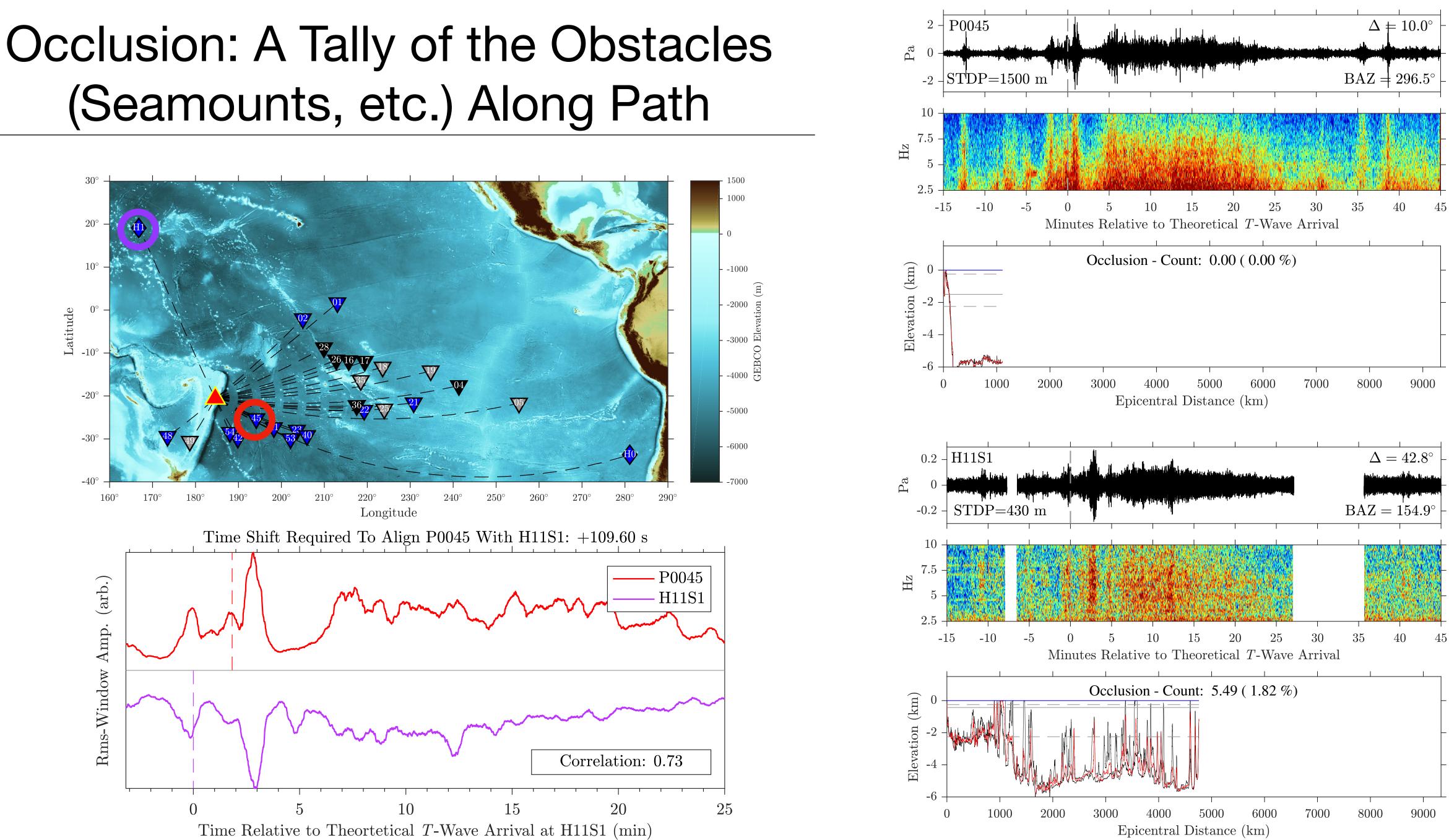
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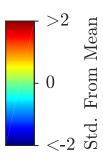


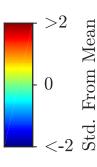




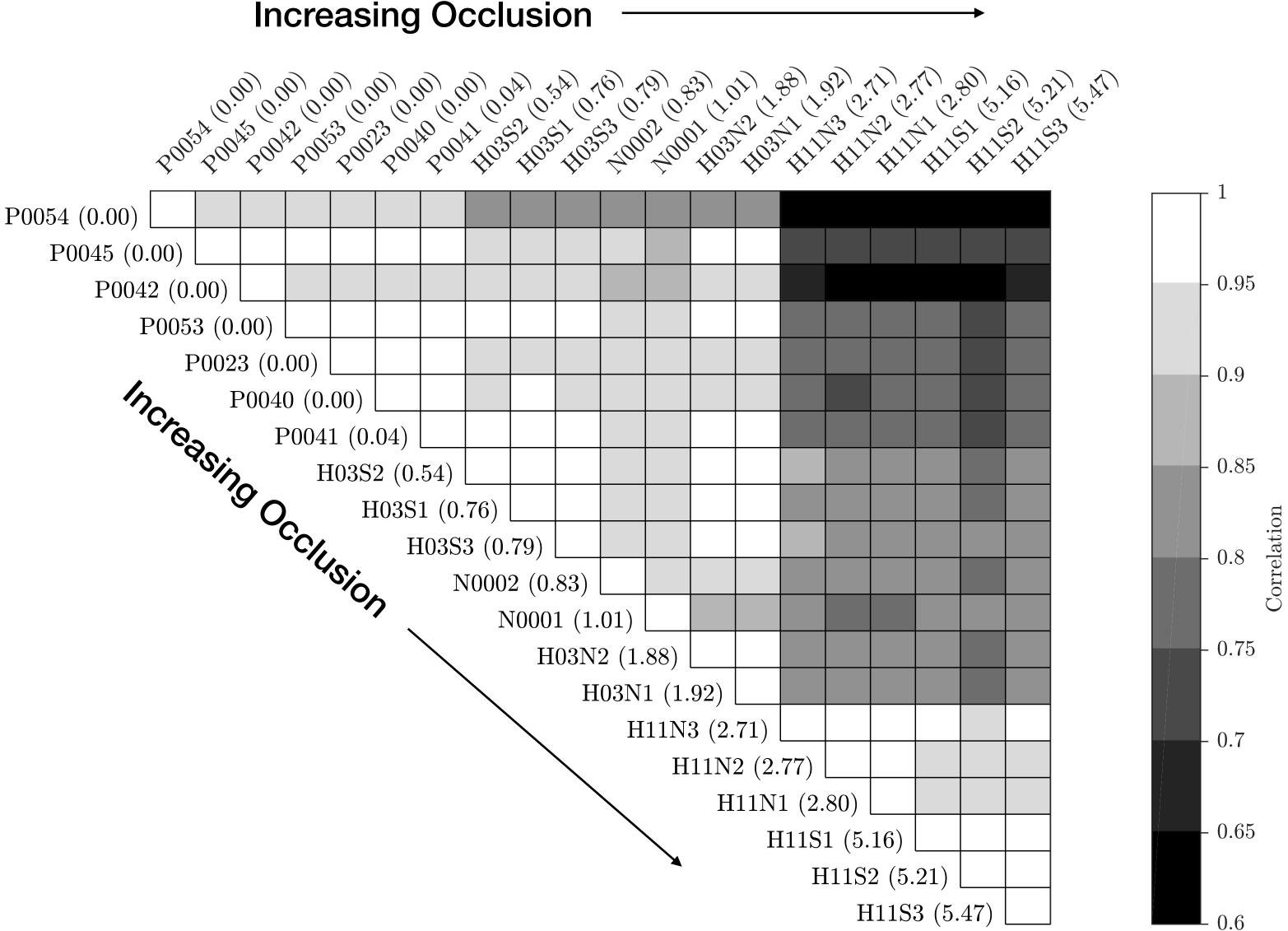
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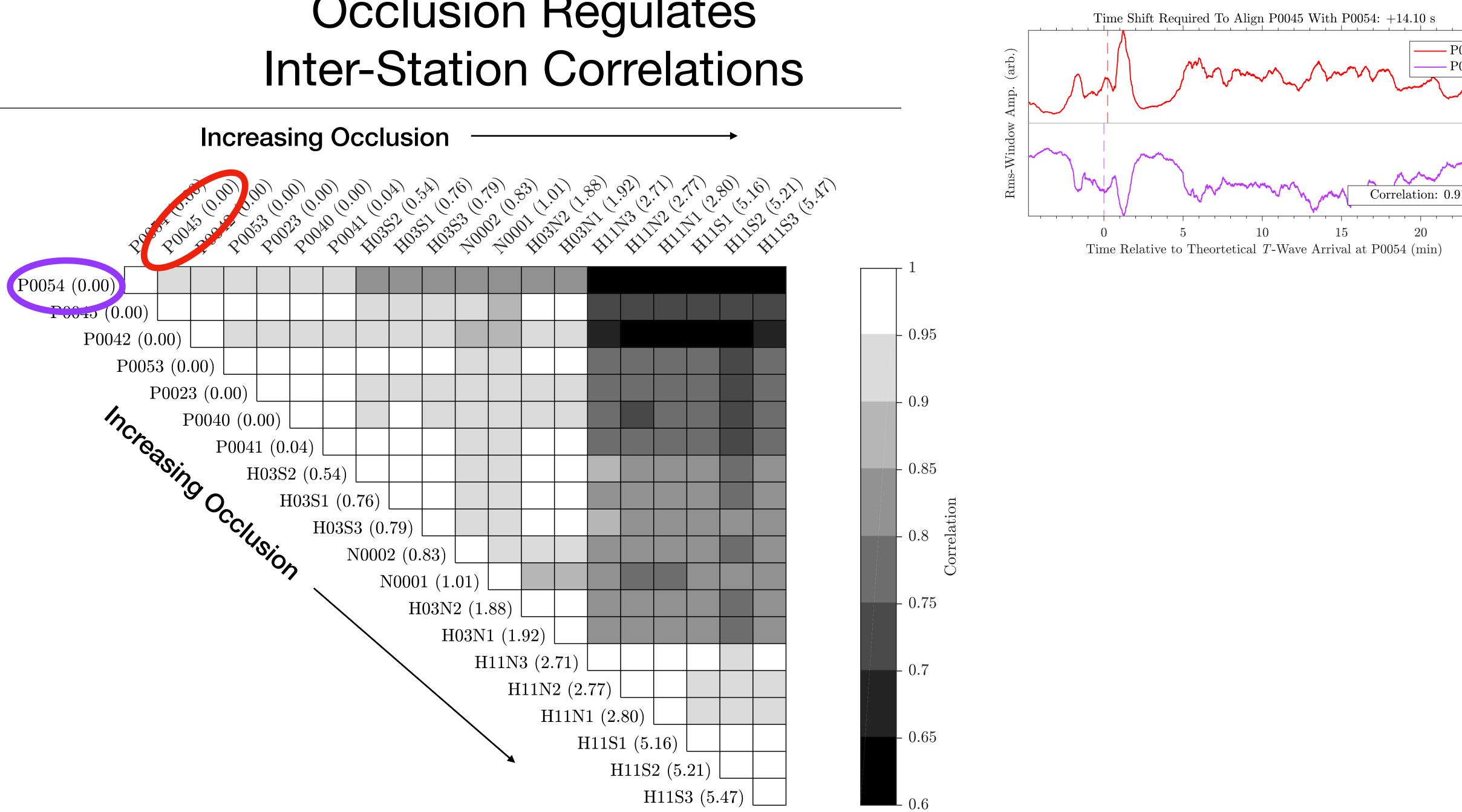
Occlusion Regulates Inter-Station Correlations



MERMAIDs Record the Hunga Tonga-Hunga Ha'apai Eruption



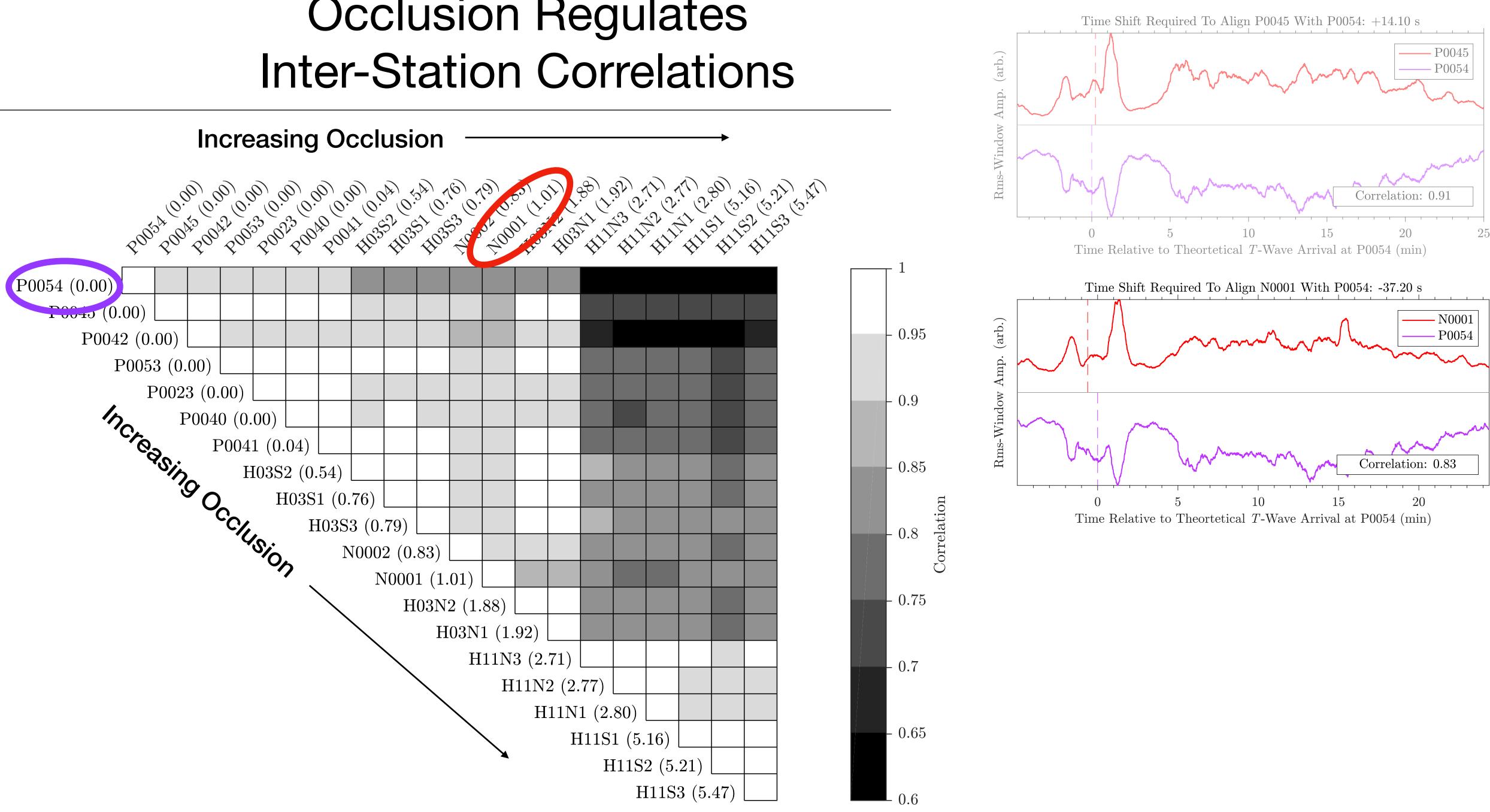
Occlusion Regulates



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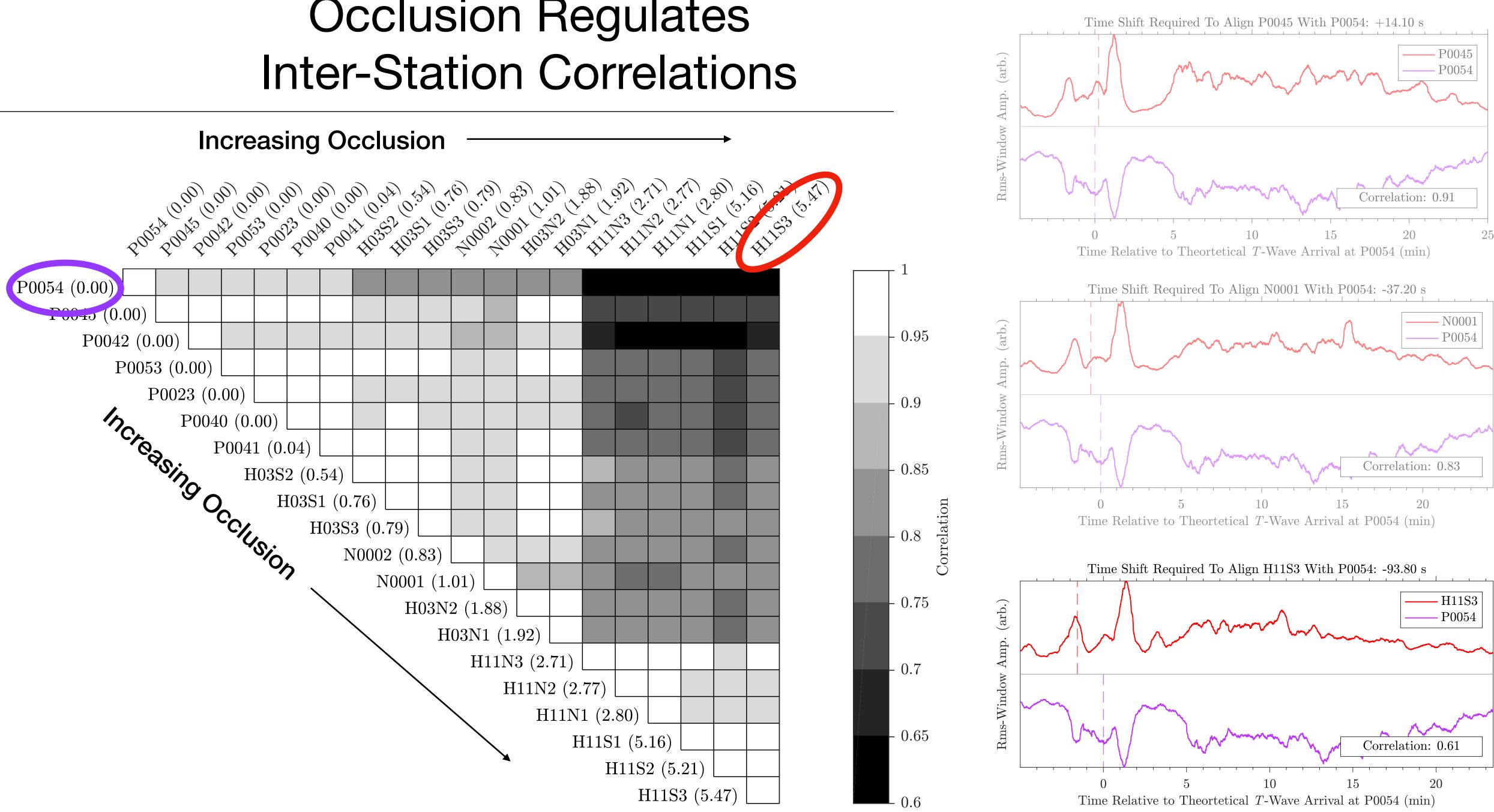


Occlusion Regulates



MERMAIDs Record the Hunga Tonga-Hunga Ha'apai Eruption

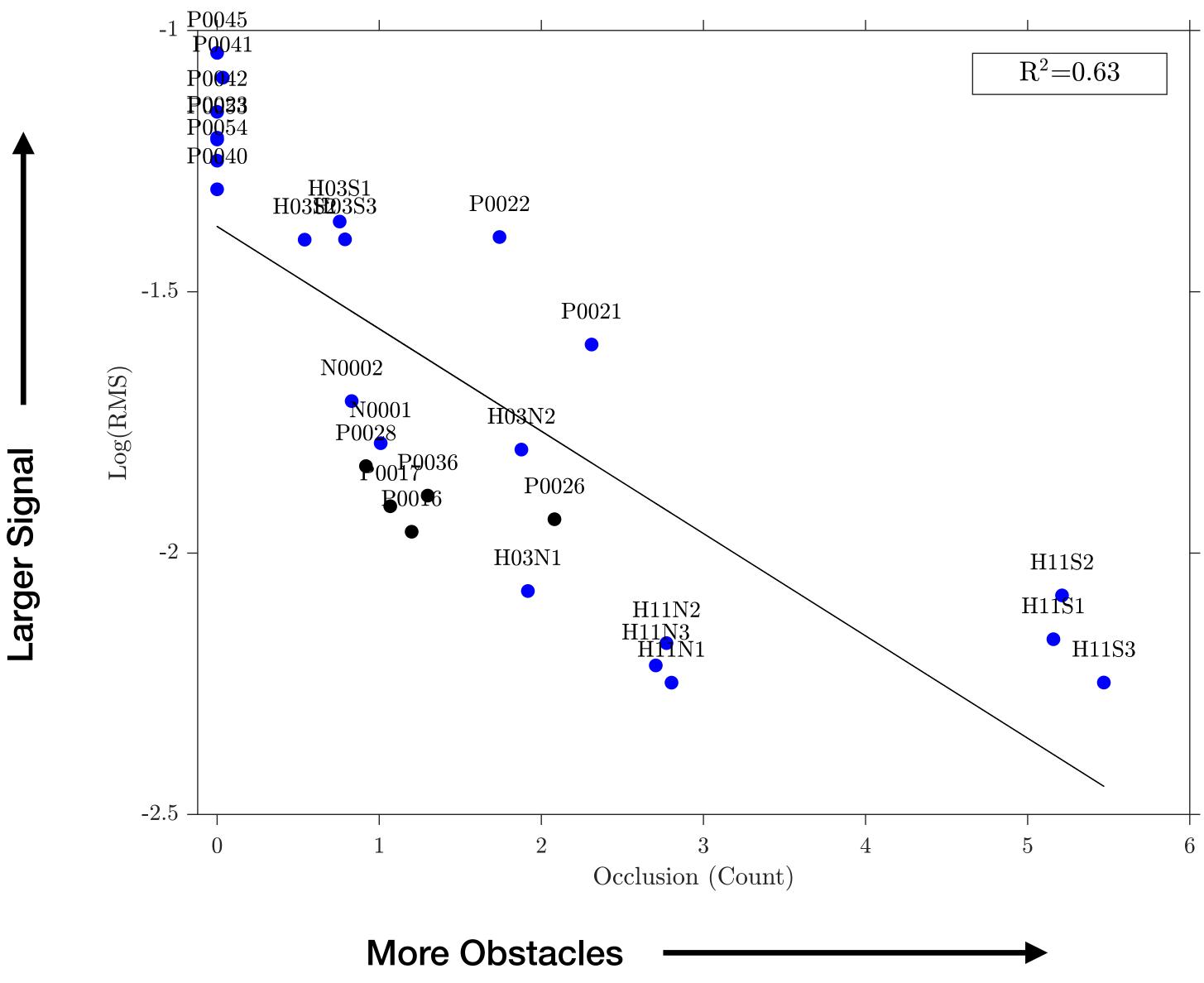
Occlusion Regulates



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Occlusion Regulates Signal Strength

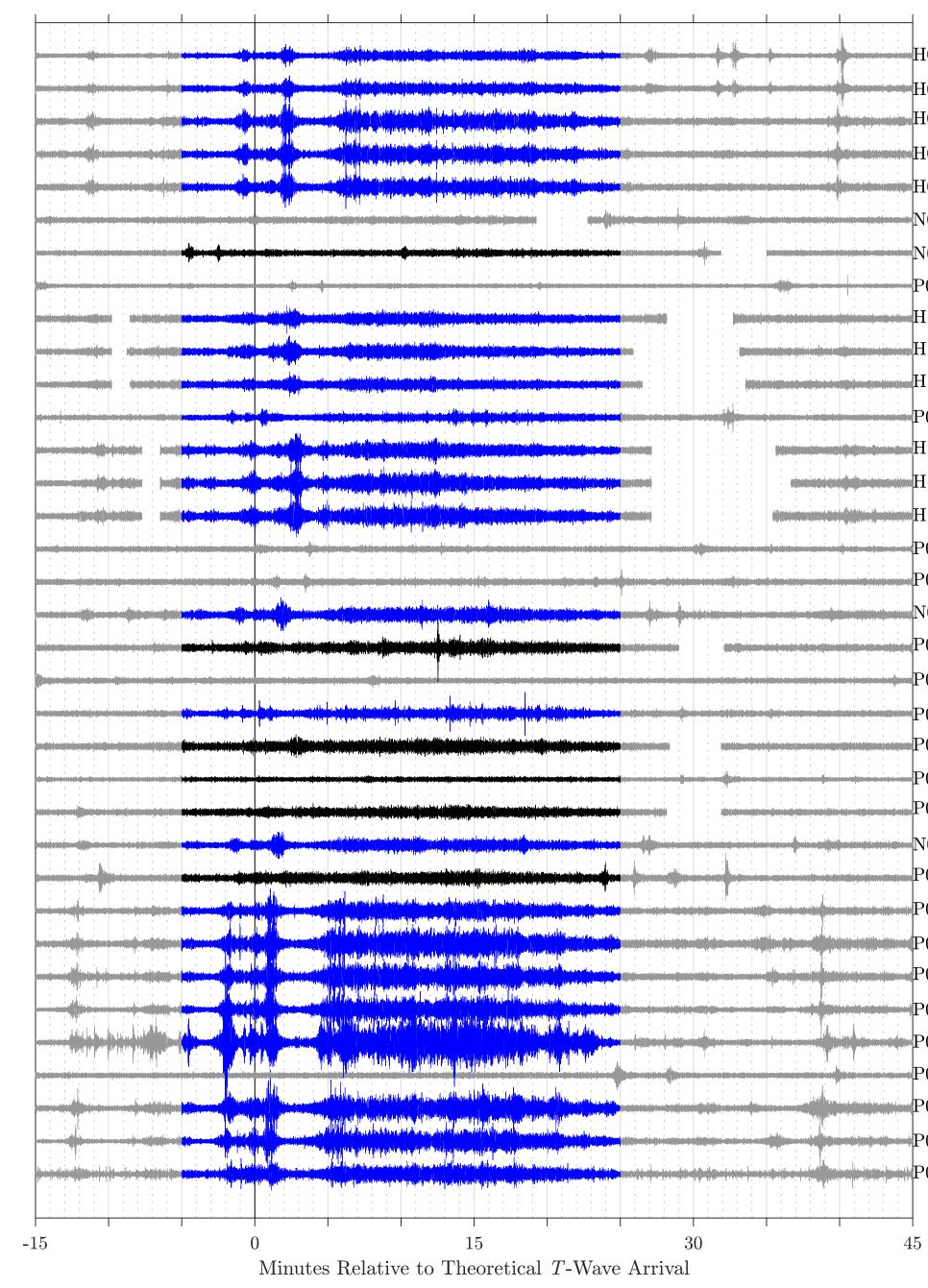


MERMAIDs Record the Hunga Tonga-Hunga Ha'apai Eruption



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





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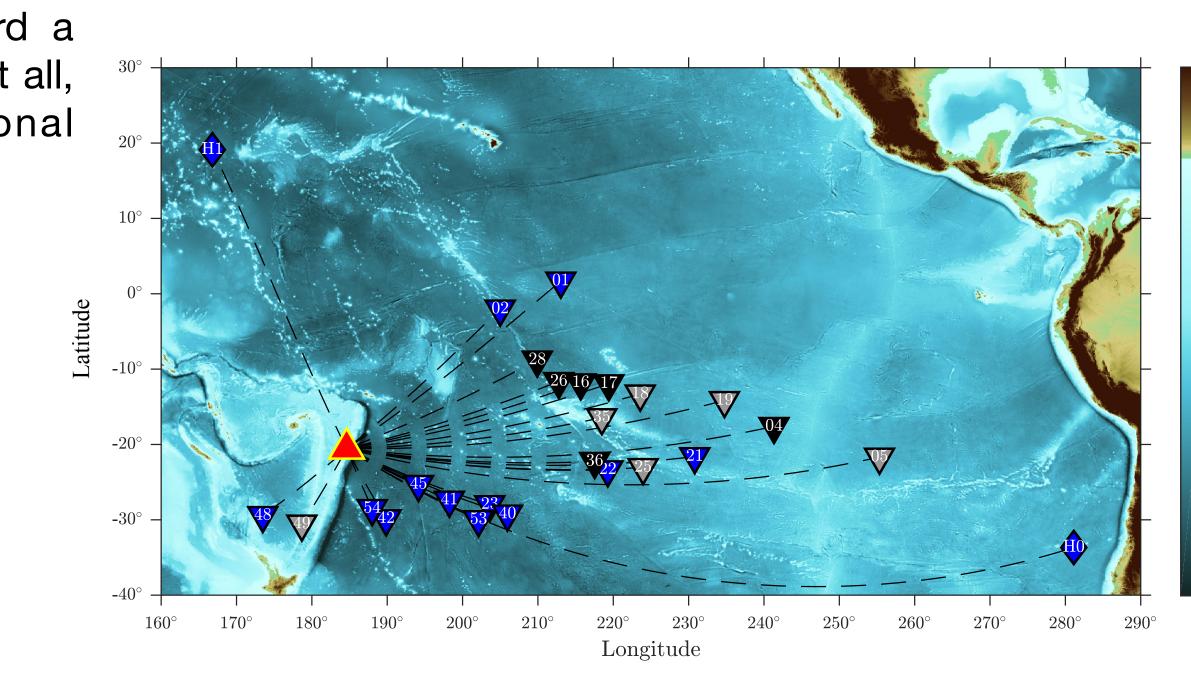
jdsimon@princeton.edu

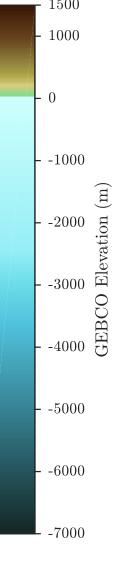
H03N1H03N2 H03S1H03S2H03S3 N0005 N0004P0019 H11N2 H11N1 H11N3P0021H11S1H11S3 H11S2P0018 P0025 N0001P0017P0035P0022 P0016 P0036 P0026 N0002 P0028 P0040 P0023 P0053 P0041 P0048 P0049 P0042 P0045 P0054

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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



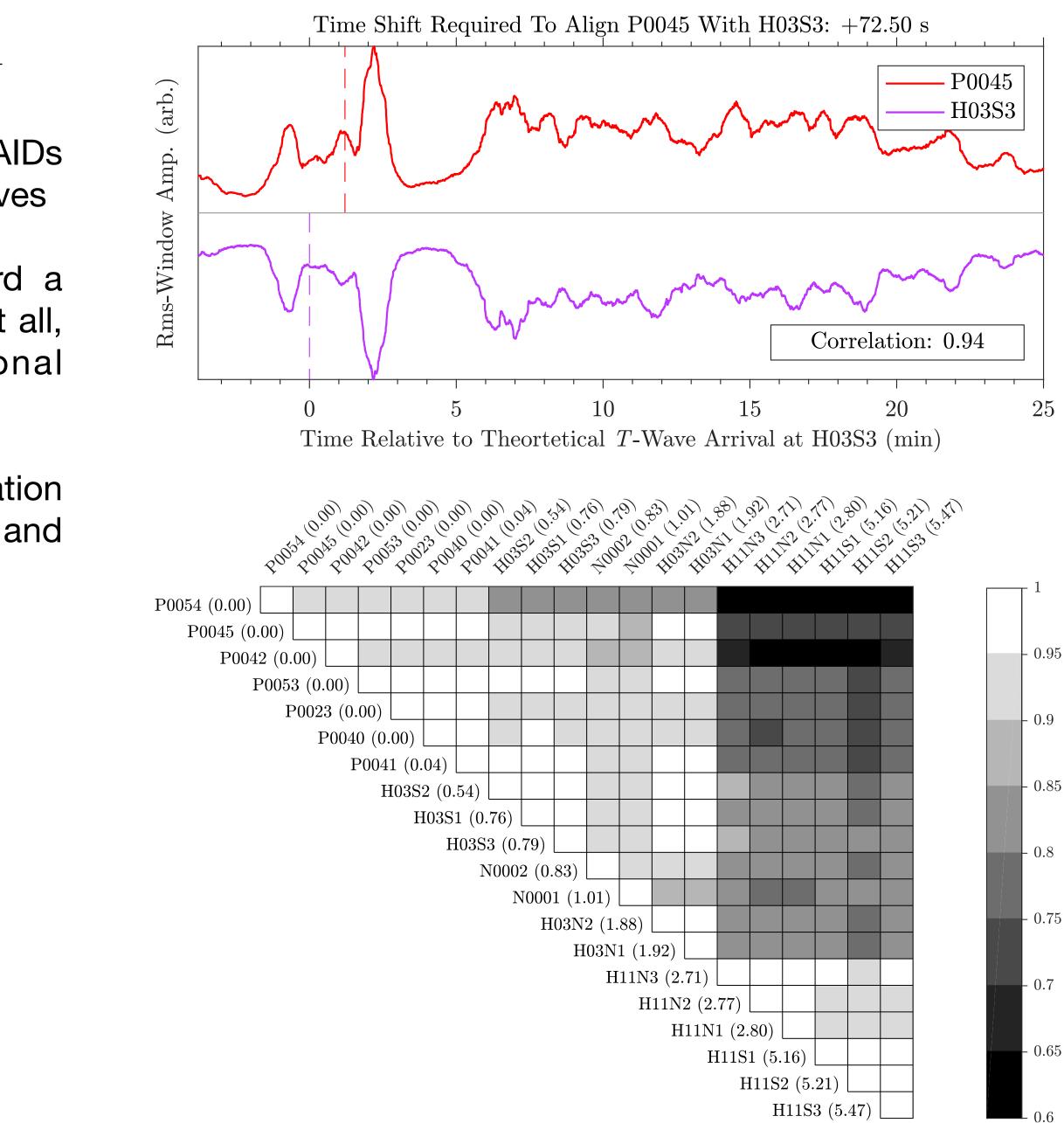




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[] For the strongest signals, occlusion neatly organizes inter-station correlations ("obstacles reshape signals in a consistent and explainable manner")



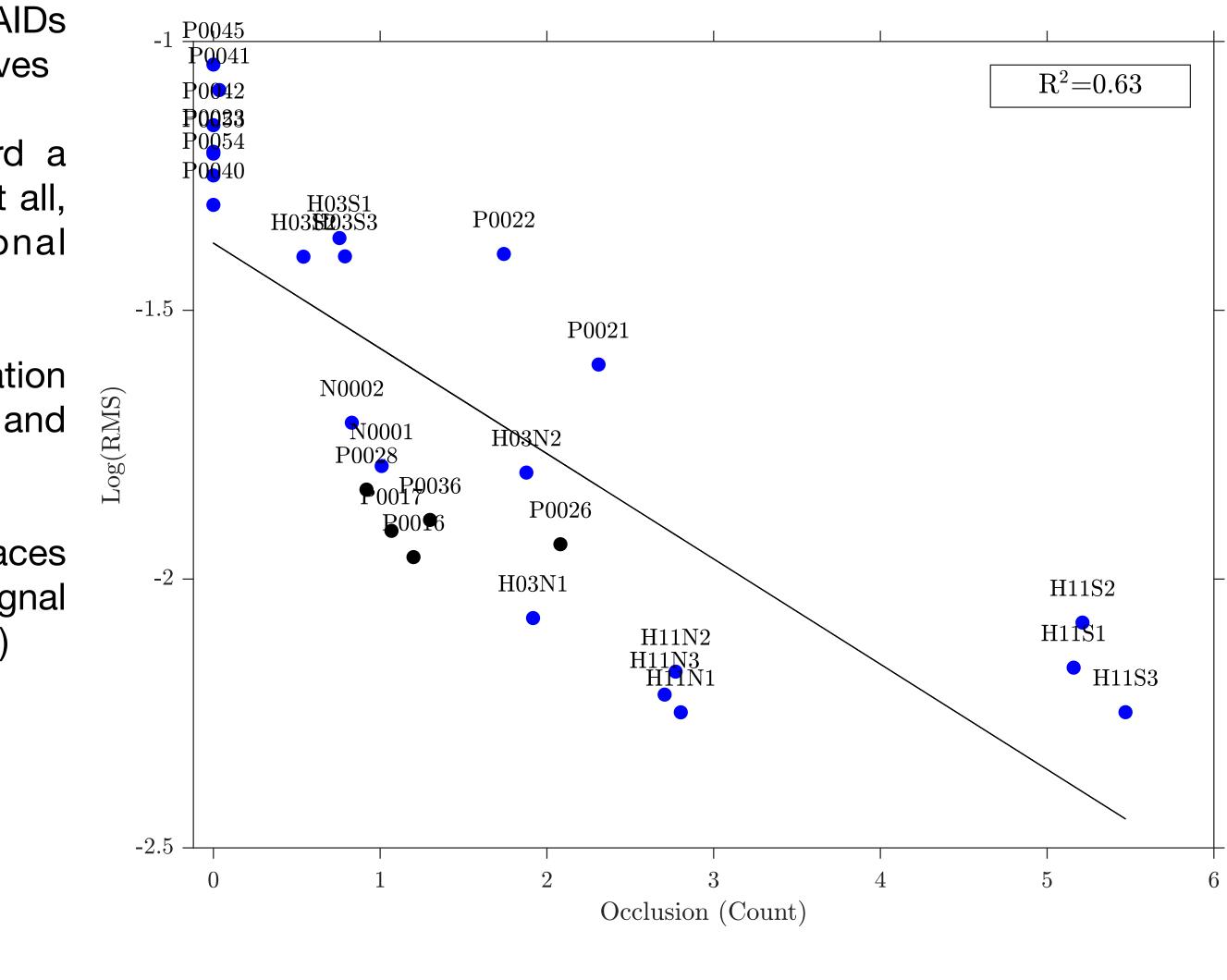
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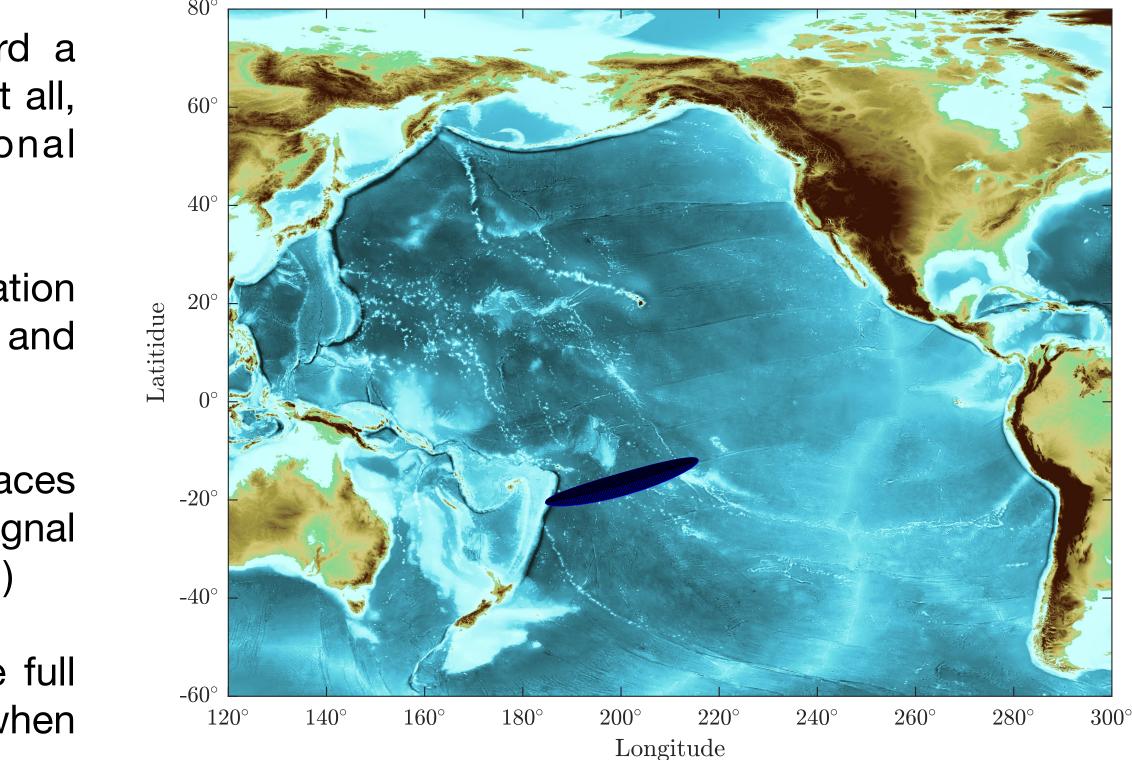
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[] Neither of these findings hold if one does not consider the full *depth* of the SOFAR channel and *breadth* of the Fresnel zone when quantifying path occlusion





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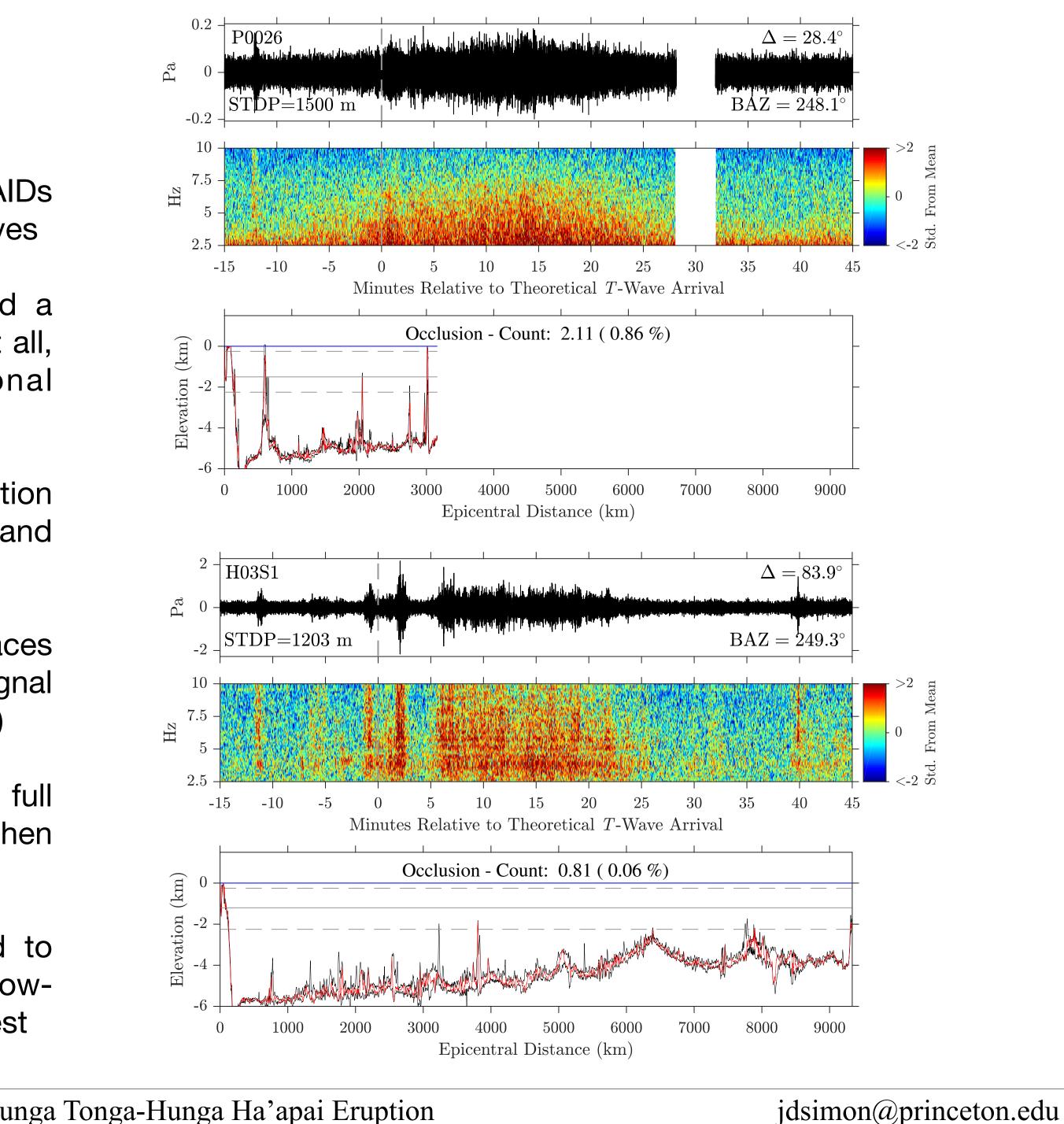
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Recommendation: hydro(seismo)acoustic stations designed to monitor various sounds are best located at the intersection of lowocclusion paths ("clean SOFAR") radiating from regions of interest



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