SnT 2025 8 SEPTEMBER ONLINE DAY 9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

P3.5-855

High-resolution analysis of spatio-temporal ambient noise variations across the IMS infrasound network

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INTRODUCTION AND MAIN RESULTS

For a realistic estimate of the station noise statistics, we computed the power spectral density (PSD) at all elements of the operational IMS stations on an hourly basis over a six-year period (2019-2024), resulting in more than 15 million computed PSDs.

This systematic processing of the background noise allows an assessment of the sensitivity of each measurement system to geographic and environmental parameters that include both wind-generated noise and coherent signals from geophysical and anthropogenic events.

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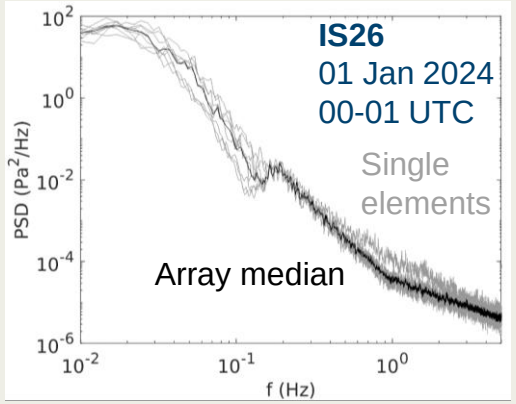
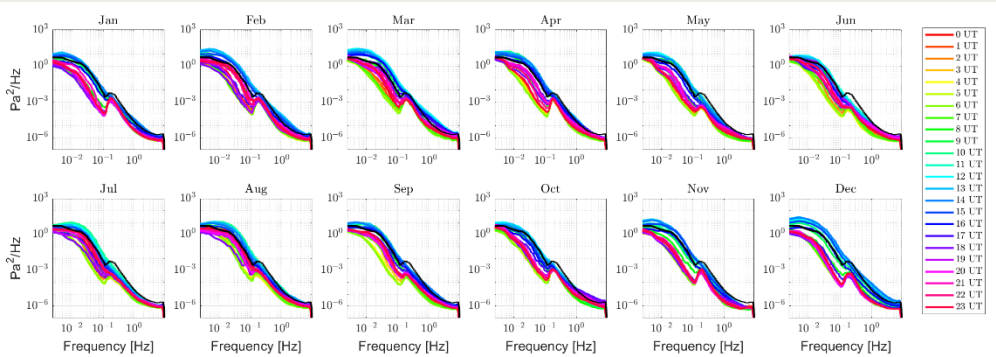
Data and methods

As of July 2025, 53 globally distributed infrasound arrays as part of the IMS are certified for monitoring the atmosphere for compliance with the CTBT.
We applied the Welch (1967) method to hourly waveform data of all array elements with 400 s window length using a Hann function with 75% overlap. For 2019 to 2024, we computed more than 15 million PSDs.

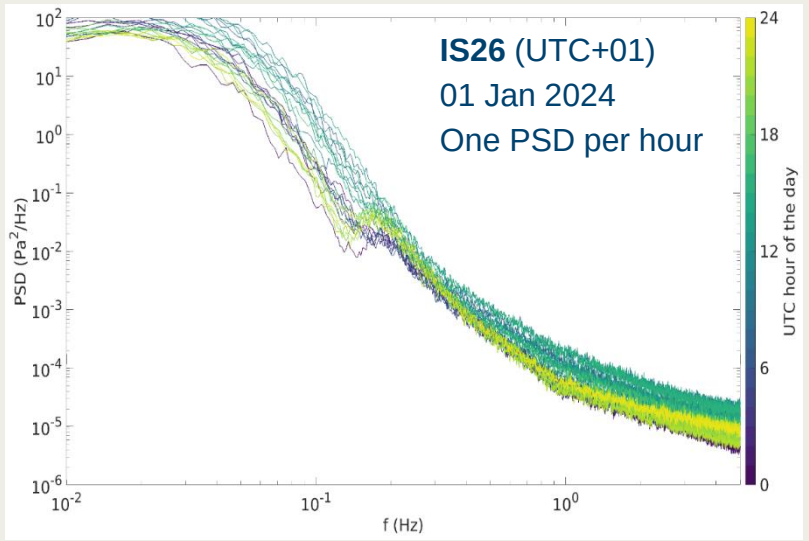


The median hourly PSD over all elements eventually forms the hourly PSD of the array, and likewise for the standard deviation (inter-array element PSD variability).



Hourly variation of the noise

Hourly PSDs show the expected day time variation, with lower PSD values at night (e.g. at IS26). Low night-time PSD levels also exhibit the characteristic peak within the microbarom frequency band (around 0.2 Hz).

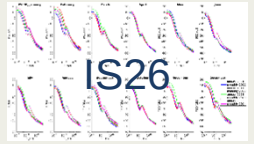


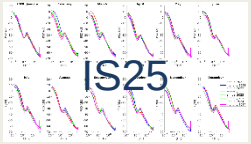
At **IS17** (left), Ivory Coast (UTC+00), the PSD exhibits a significant diurnal variation. The microbarom peak is most prominent at night time and from October to April **2024**.

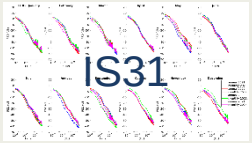
<< *Tap the figure to zoom in!*

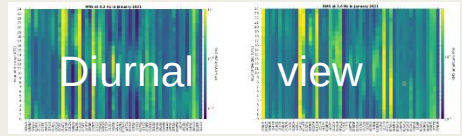
Monthly to inter-annual variation

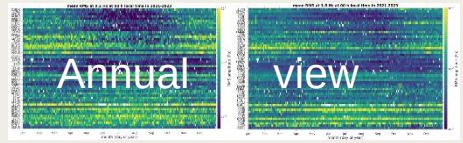
For the years 2021-2024, we compare the respective annual mean and the monthly mean of selected stations. *Tap a station panel to zoom in for details!*











The high-resolution PSD computations enable a spatio-temporal characterization of the ambient noise.
Tap a figure to zoom in for details!

Conclusions

The results are useful for detection threshold monitoring of a station and the assessment of the detection capability of the IMS network at high temporal resolution (see **O4.1-407**). PSDs of IMS stations can be calculated and provided in near-real time in the future by the German NDC.

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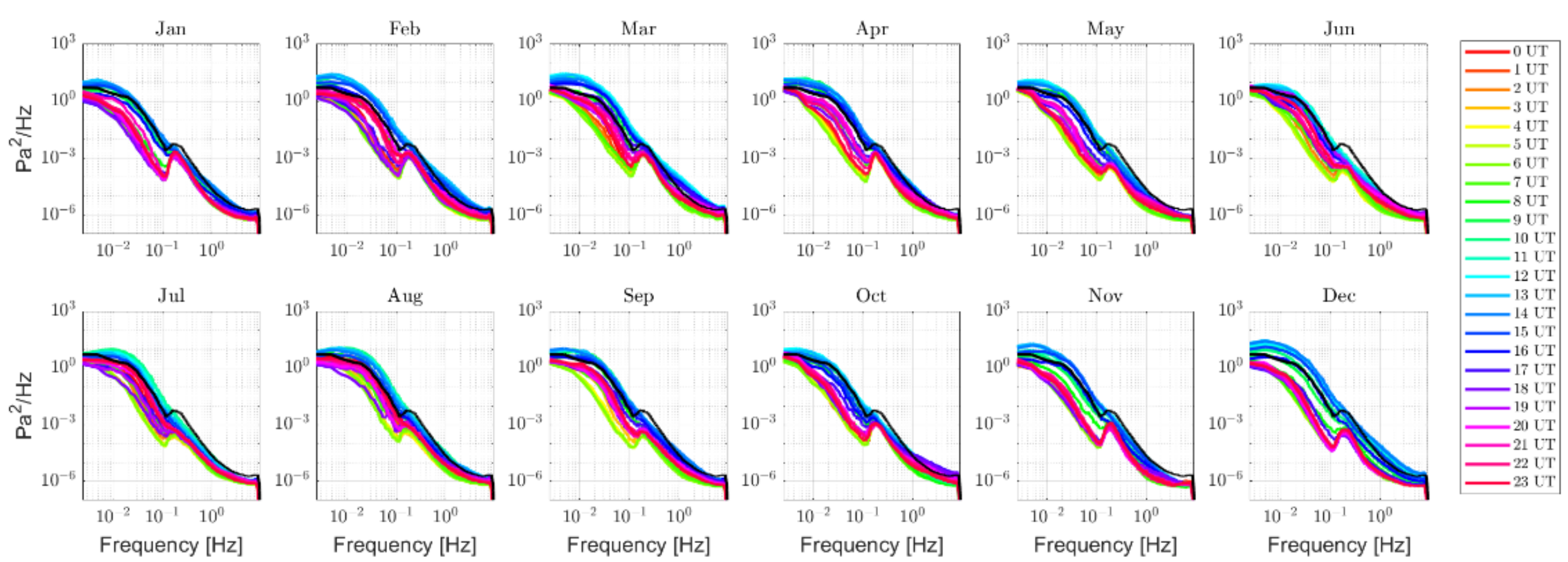
Hourly variation of the noise: IS17, Cote d'Ivore



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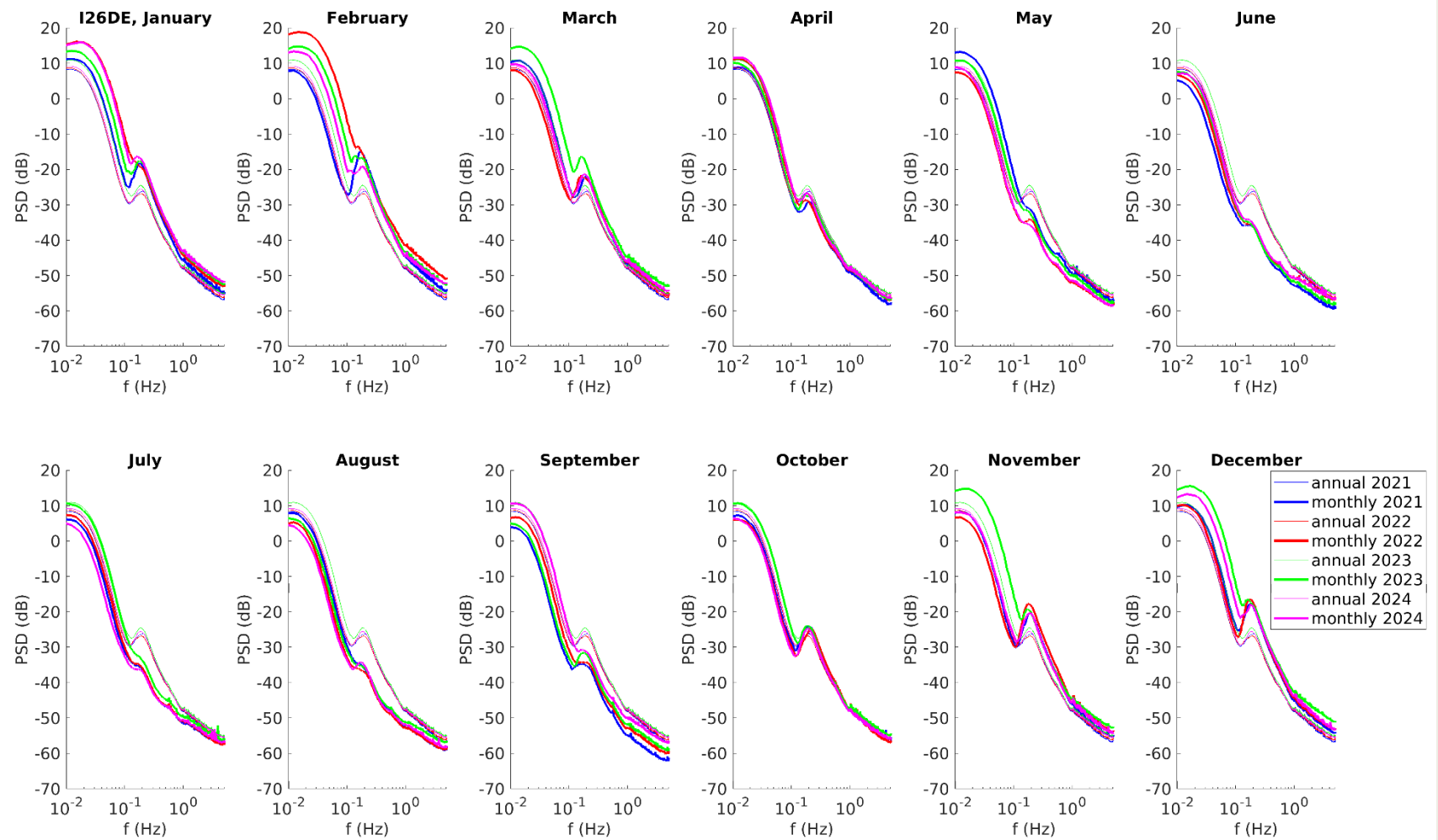
Monthly to inter-annual variation: IS26, Germany

At **IS26** in Germany, the microbarom peak is especially prominent from October to April (dominant source of detections from the North Atlantic Ocean). Inter-annual variations in the microbarom peak are due to source and propagation conditions.



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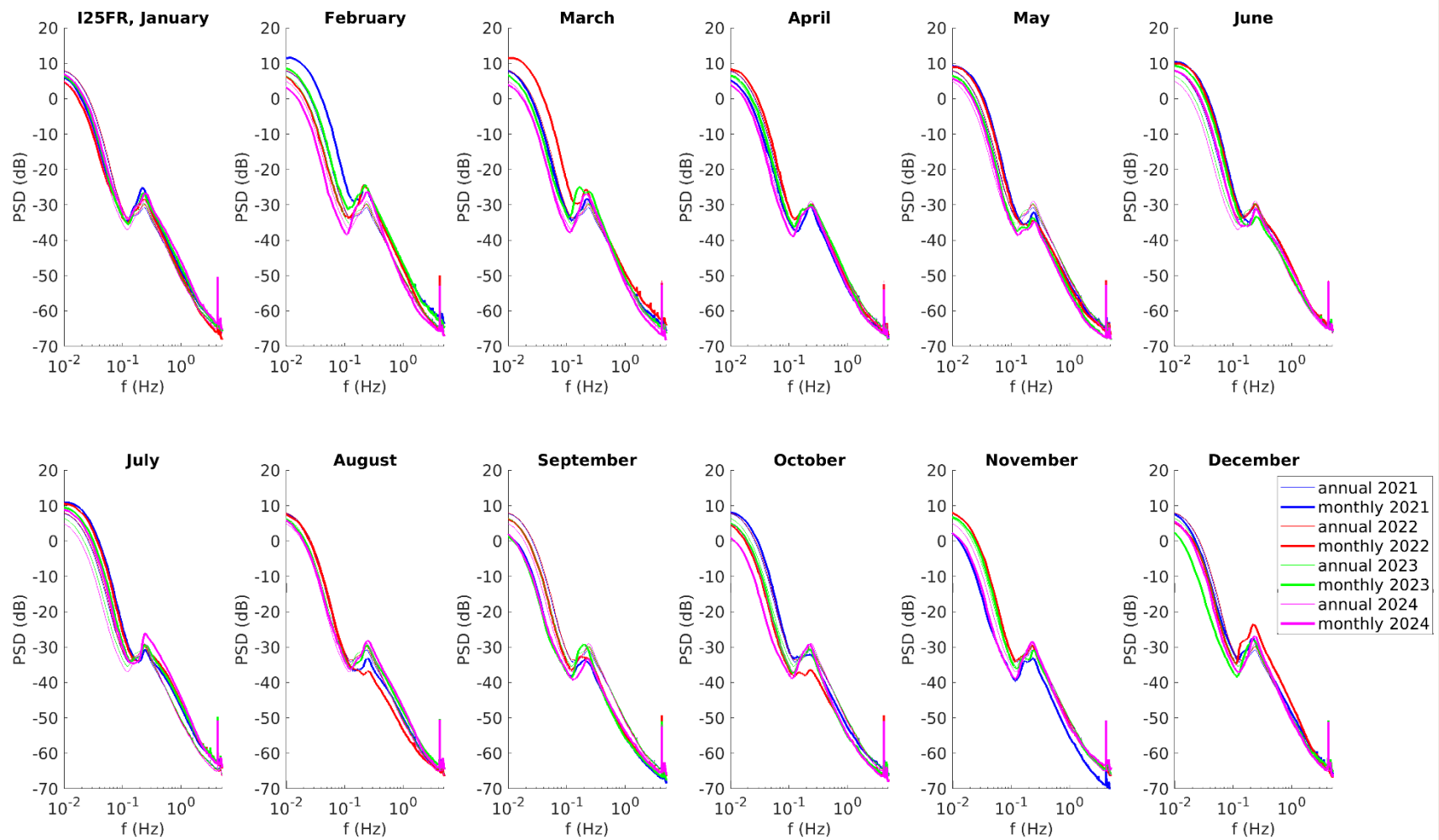
Monthly to inter-annual variation: IS25, Guadeloupe

At low latitude station **IS25**, Guadeloupe, the incoherent wind noise is reduced compared to IS26, where westerlies dominate the mid-latitude region. The microbarom peak is prominent at IS25 all year with present source regions in both zonal directions, i.e. the Pacific and the Atlantic Oceans.



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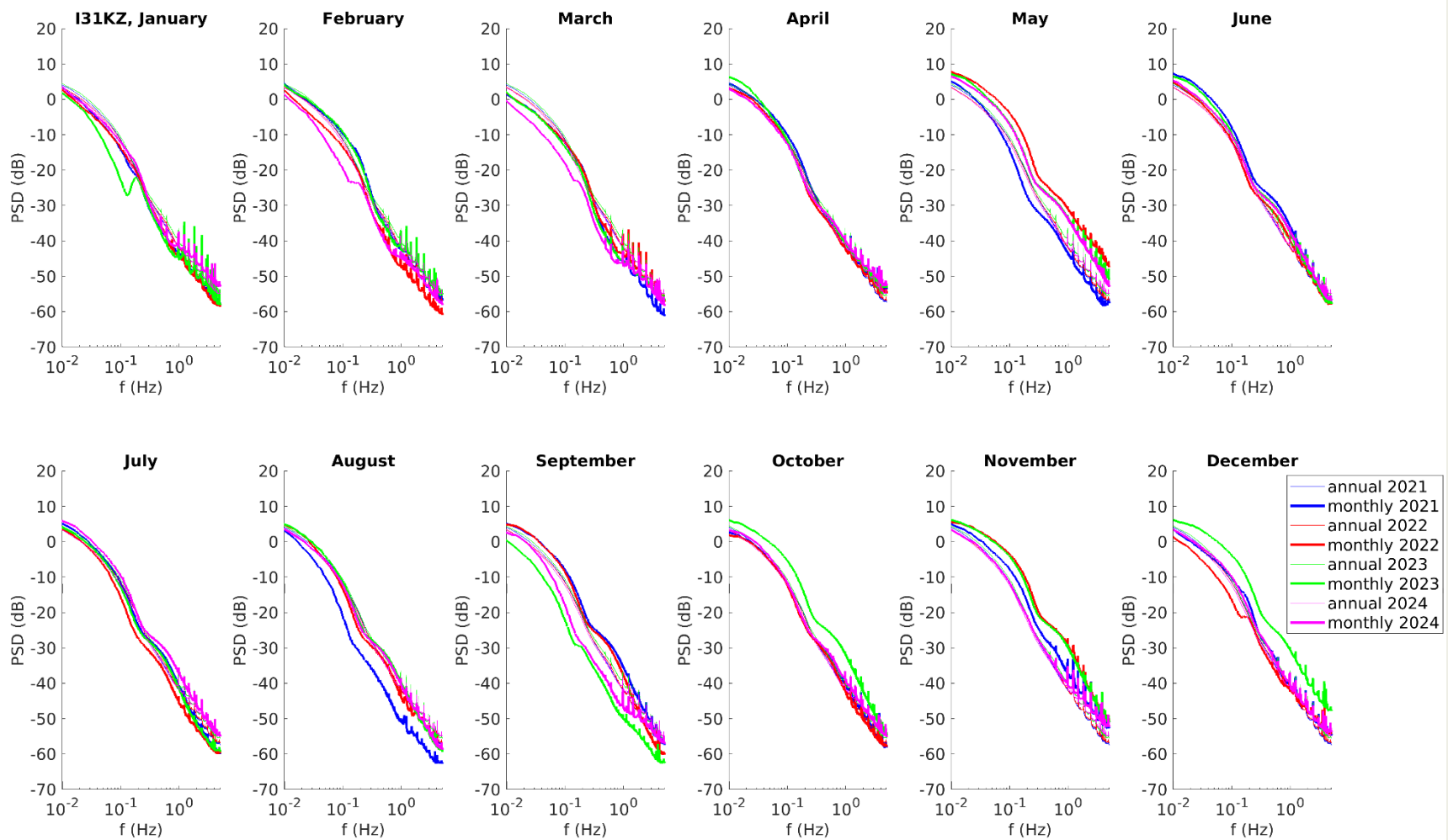
Monthly to inter-annual variation: IS31, Kazakhstan

At a continental mid-latitude station such as **IS31** (Kazakhstan), ambient ocean noise is only occasionally dominant in the background noise. At higher frequencies (~1 Hz and beyond), spectral peaks are related to nearby wind farms.



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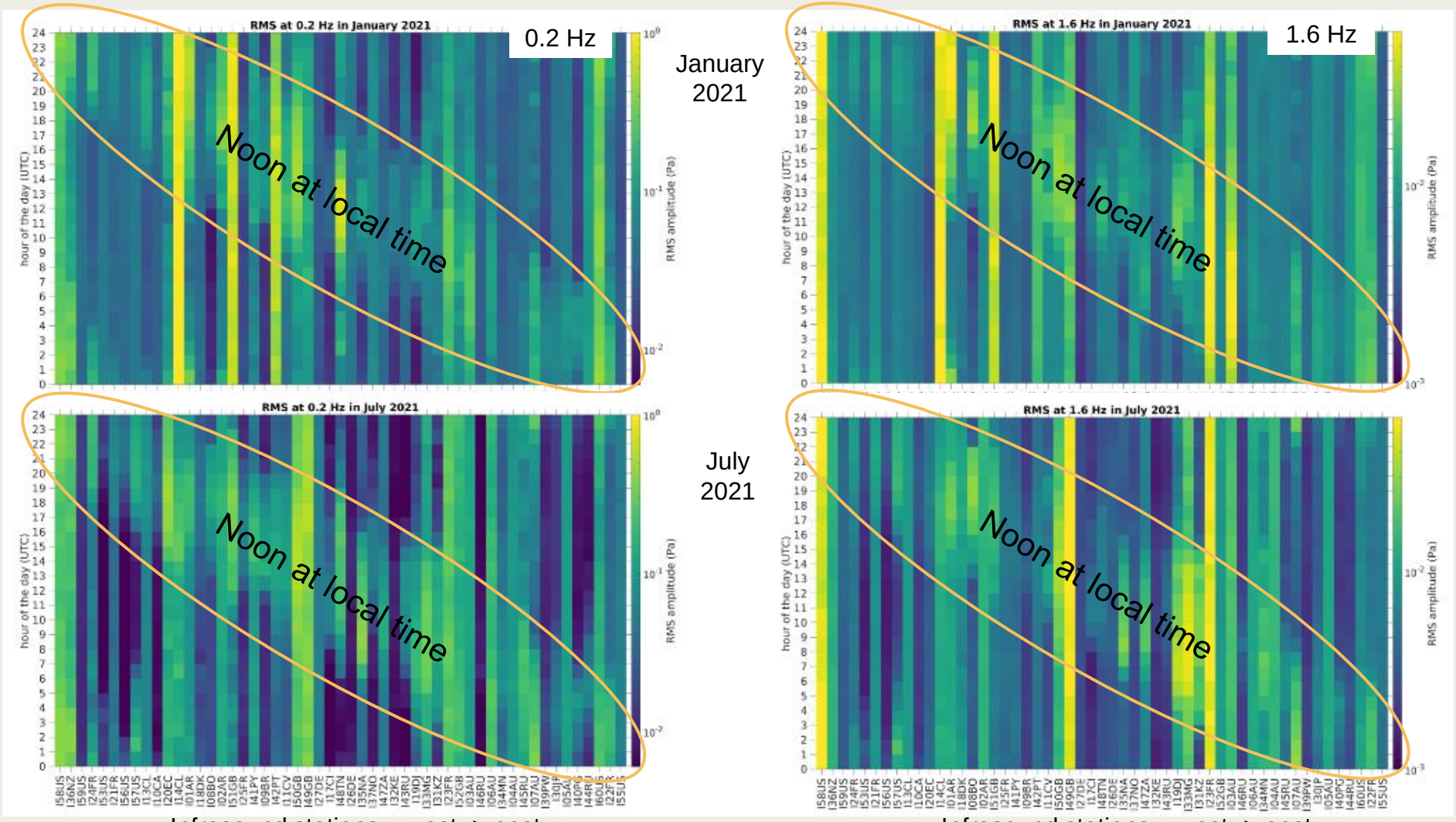
Comparison of PSD-based RMS amplitudes at IMS infrasound arrays: diurnal view



Variation by day time (UTC hours) and geographical location (IMS stations are sorted by longitude from west to east) for different frequency bands: at 0.2 Hz (0.08-0.32 Hz) and at 1.6 Hz (0.64-2.56 Hz).

At noon local time, turbulence in general and cultural/industrial noise at particular sites increase the noise level at the majority of the stations. Stations with a small amplitude variation throughout the day are often located in remote areas and specific environments (e.g. oceanic islands with high wind speeds or Antarctica with a low turbulence impact).

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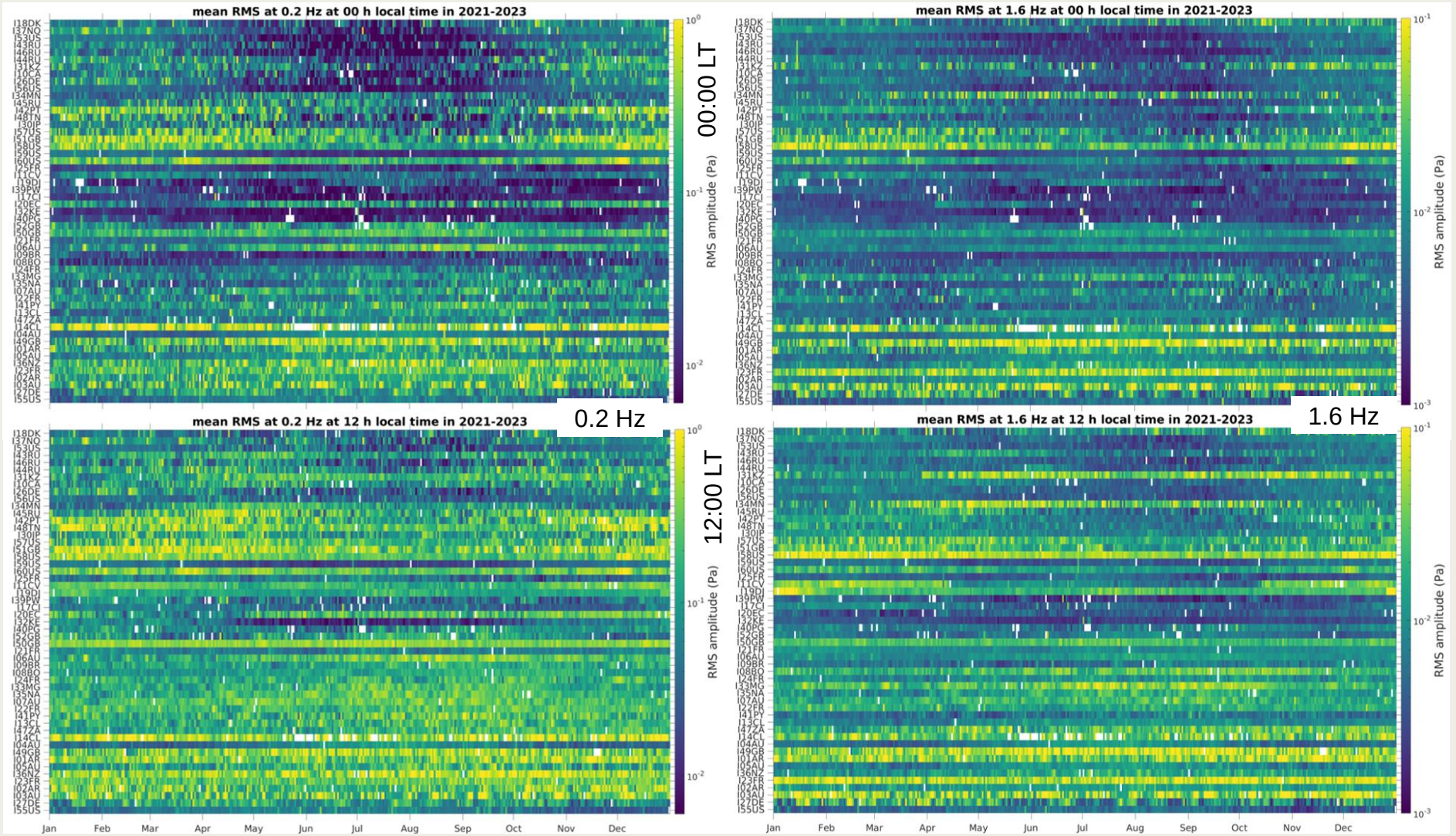
Comparison of PSD-based RMS amplitudes at IMS infrasound arrays: annual view



Mean hourly RMS amplitudes 2021-2023 by day of year at midnight and noon local time (1 pixel = 1 day); IMS stations are sorted by latitude from north to south; frequency bands are centered at 0.2 Hz (0.08-0.32 Hz) and 1.6 Hz (0.64-2.56 Hz).

Besides the diurnal variation (higher noise levels at noon local time than at night), the seasonal impact – in particular in the northern hemisphere – is highlighted in this global view.

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