T1.1-P26

The Global and Coherent Infrasound Field: Revisiting the Reprocessing of the full International Monitoring System Infrasound Data, Part 1: Processing

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abstract

In this study we are going to present results of global coherent infrasound measured at IMS infrasound stations and its correlation with atmospheric dynamics. A new implementation of the Progressive Multi-Channel Correlation (PMCC) algorithm enables characterization, with a single processing run, of coherent noise in log-spaced frequency with one-third octave bands from 0.01 to 5 Hz. Such a new array processing algorithm enables a better characterization of all received signals in their wave parameter space (e.g. frequency-azimuth space, frequency trace-velocity space). This, in turn, enables more accurate signal discrimination, and source and propagation studies. We are currently performing re-processing of the entire previous IMS infrasound database covering the time period from January 2003 to November 2018; whereas the number of stations has increased from 8 to 51. The obtained results clearly indicate a continuous spectrum of coherent signals at IMS stations within the 0.01 to 5.0 Hz frequency range; especially when comparing the recent results with those of previous re-processing approaches as well as the standard IDC products.

re-processing of IMS infrasound data

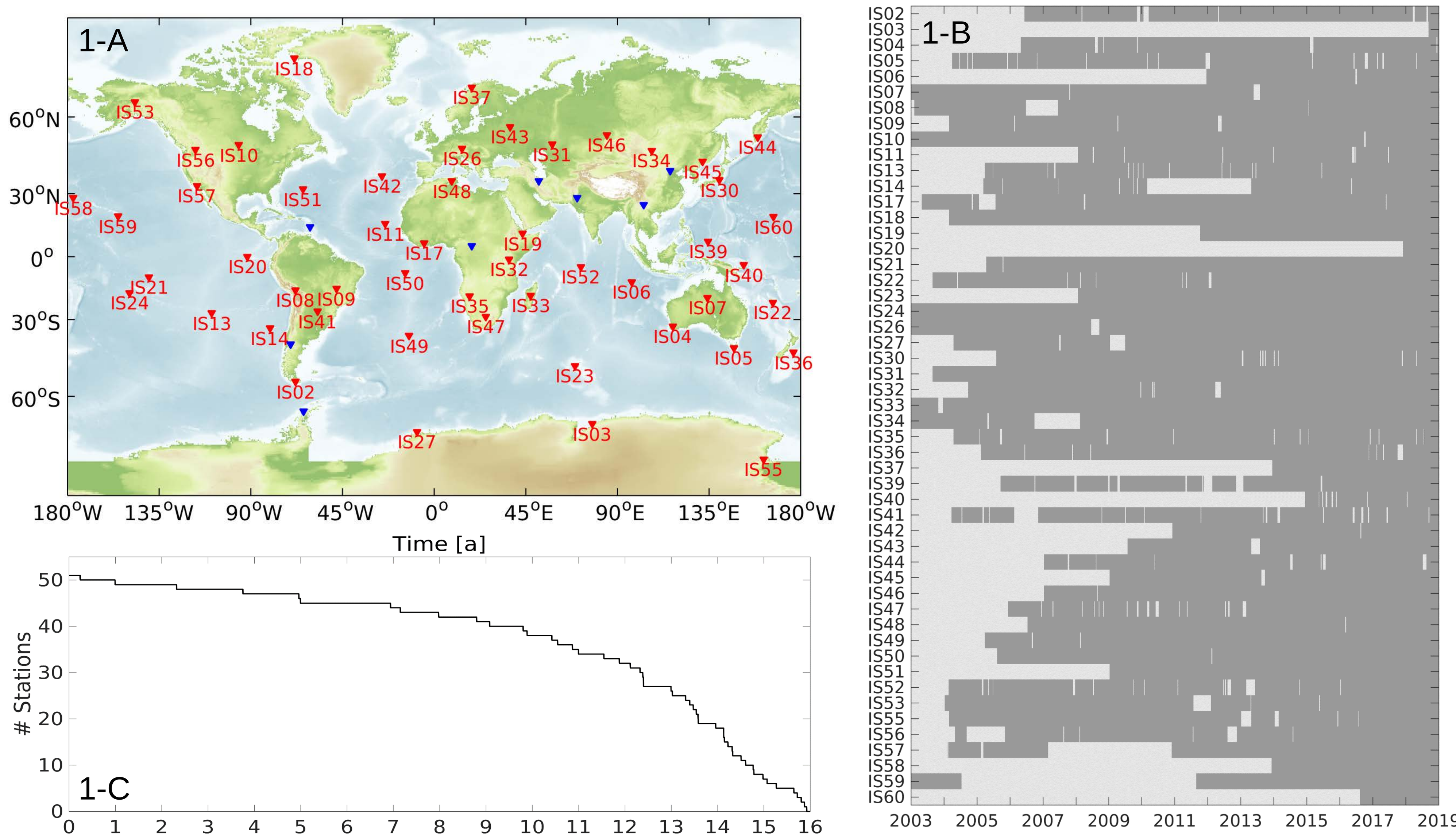


*Fig. 1: In **1-A** the current status of the IMS's infrasound network is shown, ▼ denote certified arrays providing data and ▼ planned stations, respectively. On a daily basis the data availability of all 51 certified stations is displayed (dark gray in **1-B**). In average ~50 % of the current network provides data for more than 10 a, and at least ~90 % of the network has been in operation for 3 a, enabling global studies (**1-C**).*

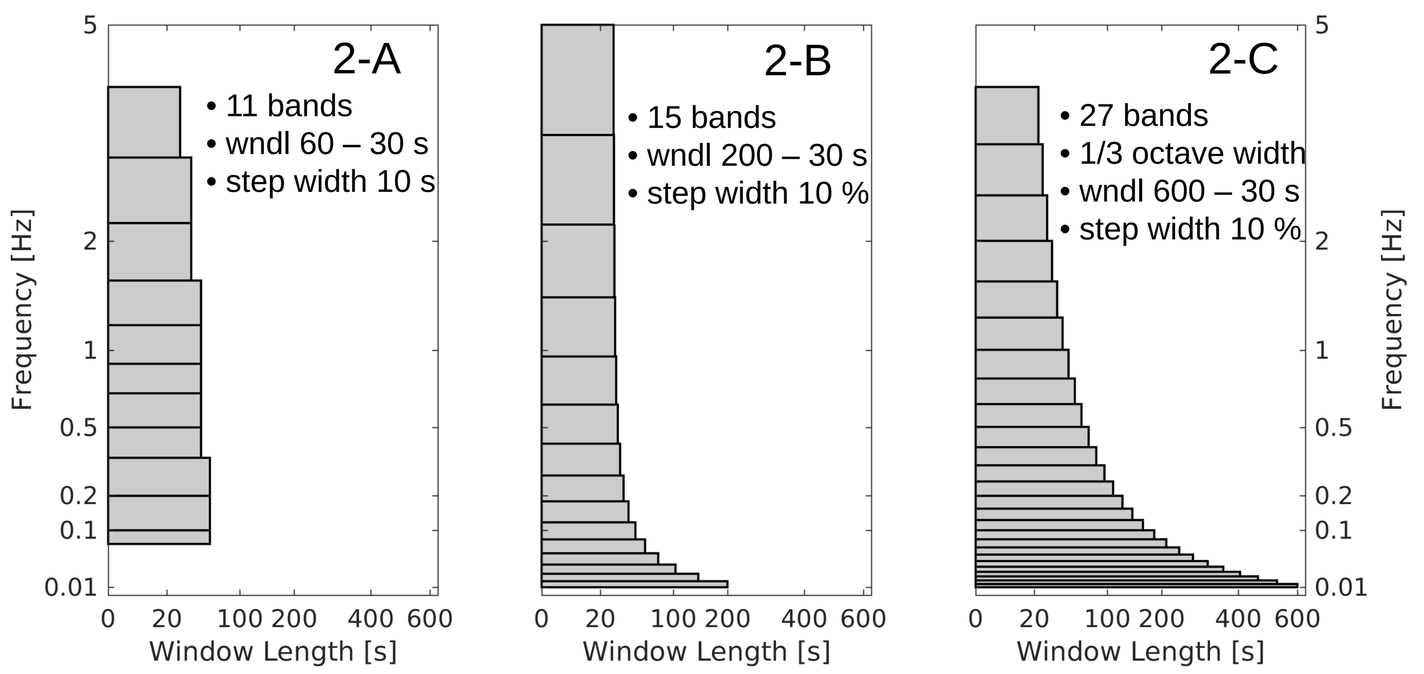


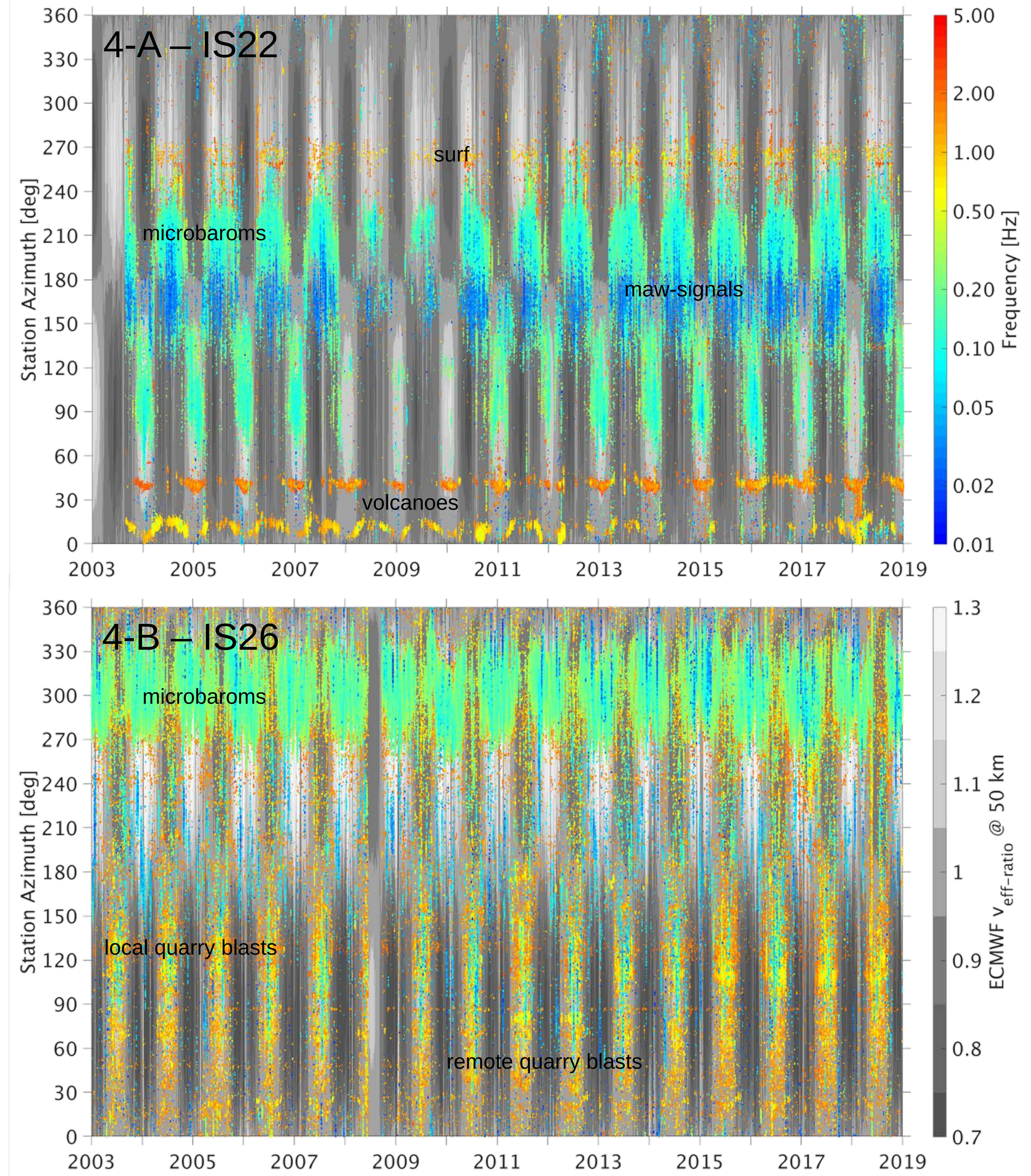
*Fig. 2: Comparison of standard PMCC processing parameters (especially number of bands, window length , and frequency width) used at CTBTO's International Data Centre with our two new set of parameters (**2-A**, **2-B**, and **2-C**, respectively); whereas the our proposed settings allow broad-band analysis down to 0.01 Hz in a single run.*

comparing IDC, our OLD, and our NEW PMCC processing

*Fig. 4: For 16 a the detections are shown as function of time and station azimuth, the centre frequency is colour coded; whereas each detection is equally treated as a single dot. Here infrasound arrays **IS22** (**4-A**) and **IS26** (**4-B**) are considered. At both sides mb-signals are the dominating features. These signals are following a seasonal variation, which is clearly underlined by under-laying effective sound speed ratios (ratio of phase velocity plus wind speed between its maximum in the stratosphere and the surface) of the prevailing directions as grey shades. These ratios are obtained from ECMWF profiles at the station sites and they provide a 1st order estimate of the detection capability of remote infrasonic sources, where the light grey colours indicate ratios above 1 indicating a stable stratospheric duct.*

While in New Caledonia IS22 is mostly characterised by natural phenomena (surf noise, volcanoes, mb- and maw-signals), in Central Europe at IS26 anthropogenic sources also play an important role (quarry blasts, dams, and super-sonic aircrafts). Therefore the distribution in station azimuth at IS26 looks more randomly distributed compared to an remote island station like IS22. Noteworthy, no clear dominant directions for maw signals can be identified at IS26.

In addition to that, such a processing allows to monitor the station's state-of-health status. For approximately 2 a (2008 – 2010) one element of the four-element IS22-array was not in operation, yielding in a clear reduction in the number of detections during that time. Moreover, wave-front parameter are indicators for an appropriate station design and correct co-ordinates



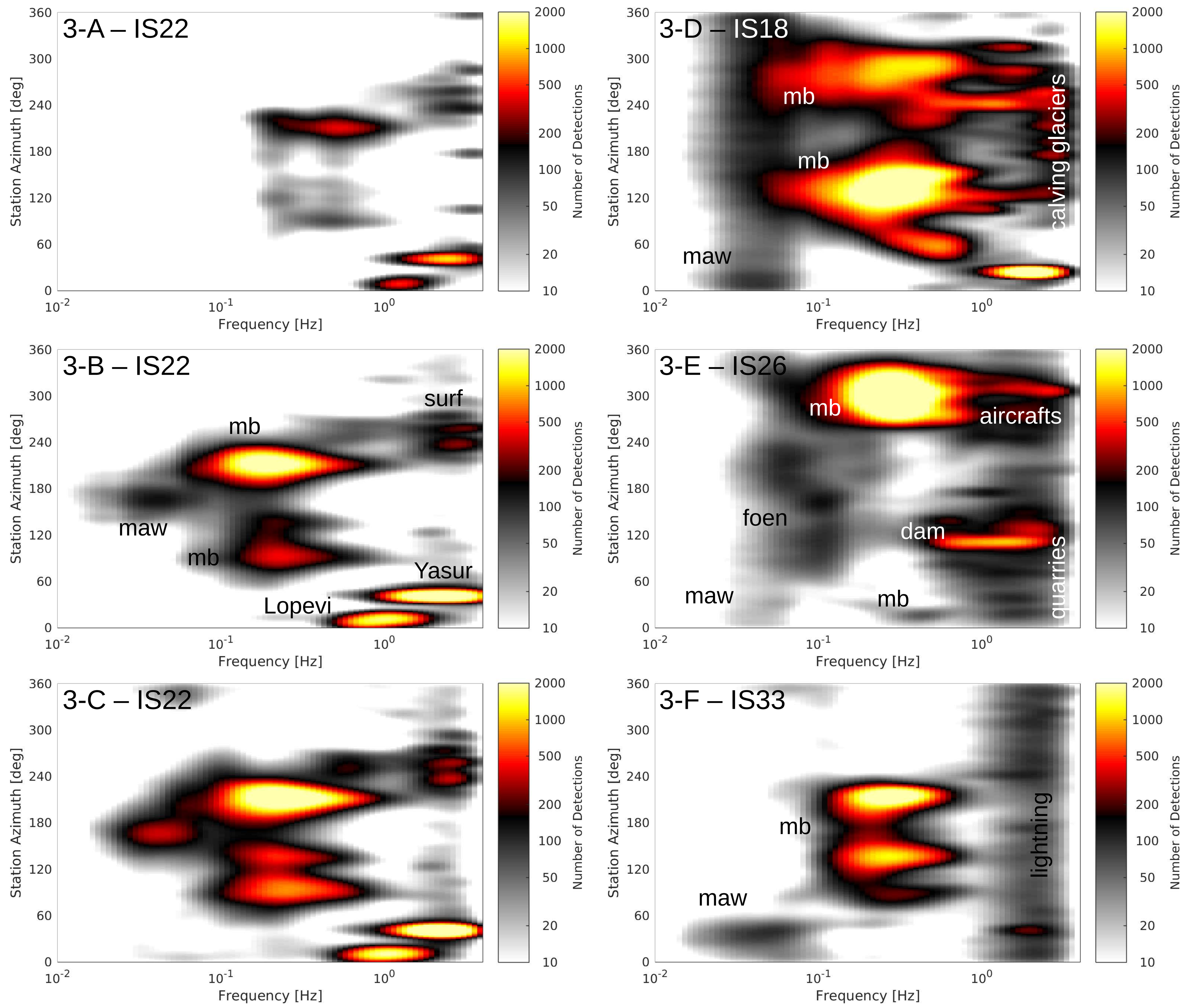


*Fig. 3: Considering the frequency distribution of detections made at stations **IS22** (**3-A** to **3-C**, config. **2-A** to **2C, respectively**) as well as **IS18, IS26, IS33** (**3-D** to **3-F**, config. **2C**) as a function of centre frequency and station azimuth provides a good overview for comparing the standard IDC results with our new ones. The annual number of detections is up to 5 times increased (257T@IS18; 136T@IS22; 207T@IS26; 69T@IS33), the estimate of signal frequency is more accurate (most obvious for mb-signals), high-frequency artefacts are reduced, and new long period signals like maw signals are resolved.*

conclusions & findings

For characterizing the coherent infrasound noise field the re-processing of the IMS infrasound data provides an ideal basis. Since the new bulletins permits a more accurate estimate of signal parameters (e.g., frequency, azimuth, trace velocity) the identification of new sources, especially at longer periods like maw-signals, and, generally, a better discrimination of between interfering signals are enabled. Also the quality assessment of stations is improved. Overall, it has been found that:

1. signal detections exhibit systematic variations correlated with global atmospheric dynamics;
2. some source processes (e.g., mb and maw) also show seasonal variations;
3. at all stations a continuous detection of coherent noise signals in the frequency range from 0.01 to 5 Hz is observed (0.5 – 5 Hz, persistent volcanic activity, surf, etc; 0.1 – 0.5 Hz, mb-signals; 0.01 – 0.1 Hz maw-signals);
4. processing with 27 f-bands might lead to artifacts at longer periods, therefore at the 2 lowest bands need to be treated separately, otherwise the maw pictures are blurred;
5. a 1/3-octave processing algorithms outperforms the other approaches by providing a precise picture of infrasonic activity (natural and anthropogenic) at infrasound arrays.

References:

- Le Pichon et al., 2010, Inframatics, 26, 5-8.
- Ceranna et al., 2019, Chapter 13, 471-482, in Infrasound Monitoring for Atmoshpheric Studies, 2nd Edition, Springer.

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