SnT 2021
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PREPARATORY COMMISSION

The Coherent Infrasound Wavefield: New IMS Broadband Bulletin Products for Atmospheric Studies and Civilian Applications

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O1.1-389

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ORAL PRESENTATION

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MOTIVATION

Infrasound: passive remote sensing technique for supplementing observational data of the middle atmosphere

- Surplus of IMS infrasound data for atmospheric and natural hazard applications has been demonstrated (e.g., ARISE project; Blanc et al., 2018)
  - probing the winds in the middle atmosphere (Le Pichon et al., 2015), with the potential to be assimilated in weather or climate models (demonstrator by Amezcua et al., 2020)
  - monitoring natural hazards for civil security
    - large bolides entering the Earth's atmosphere (e.g., Arrowsmith et al., 2008; Pilger et al., 2020)
    - volcanic eruptions (e.g., Dabrowa et al., 2011; Matoza et al., 2013, 2019; Marchetti et al., 2019)
- But: limited access to IMS infrasound waveform data
- Idea: tailored open-access data products of the broadband bulletins ("product of a product") – *neither providing raw data nor the comprehensive detection lists, thus not replacing the privileges of a vDEC access or IDC registered users (e.g., Reviewed Event Bulletin)*

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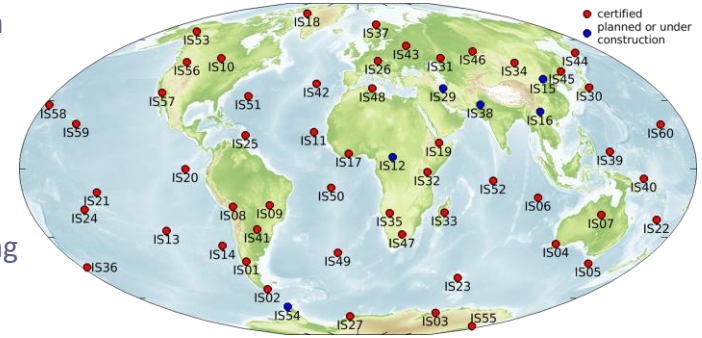
INTRODUCTION

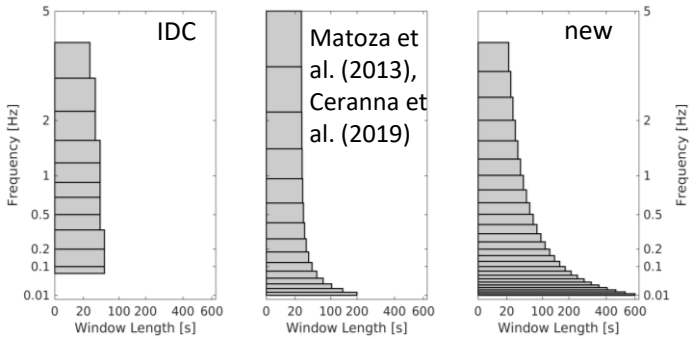
Regularly updated IMS infrasound bulletin lists available for >18 years, updated PMCC configuration

- First systematic broadband (0.01-5 Hz) analysis of IMS infrasound data by Matoza et al. (2013)
- Full (and increasing) IMS infrasound data set is regularly reprocessed by the German NDC (Ceranna et al., 2019)
- Latest reprocessing with PMCC V5.7.4 and one-third octave configuration: **more accurate estimate of signal parameters**, better discrimination between interfering signals
- **Improved quality assessment** of the detections lists

Technical processing details: e-poster **P1.1-399, P. Hupe**

- Recent applications of our detection lists:
  - Reference data set for microbarom model validation (**O1.1-531, M. De Carlo**)
  - Identifying signatures from 1001 rocket launches (**P2.3-232, P. Gaebler**)
  - Volcanic eruptions, lightning activity (work-in-progress)





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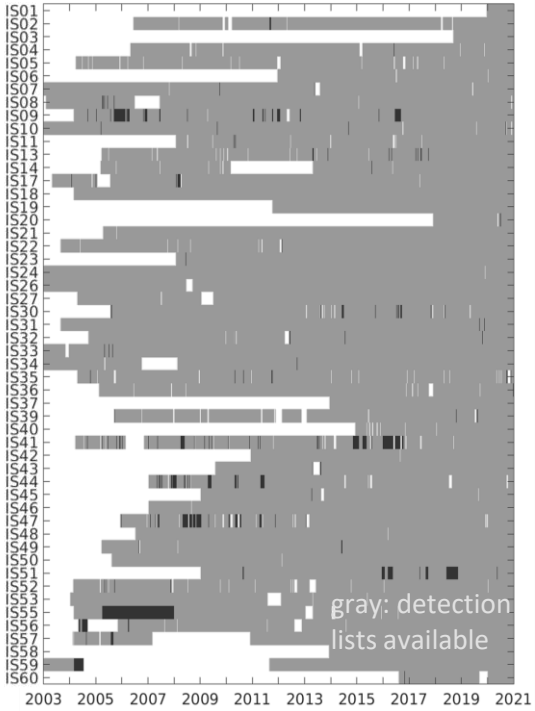
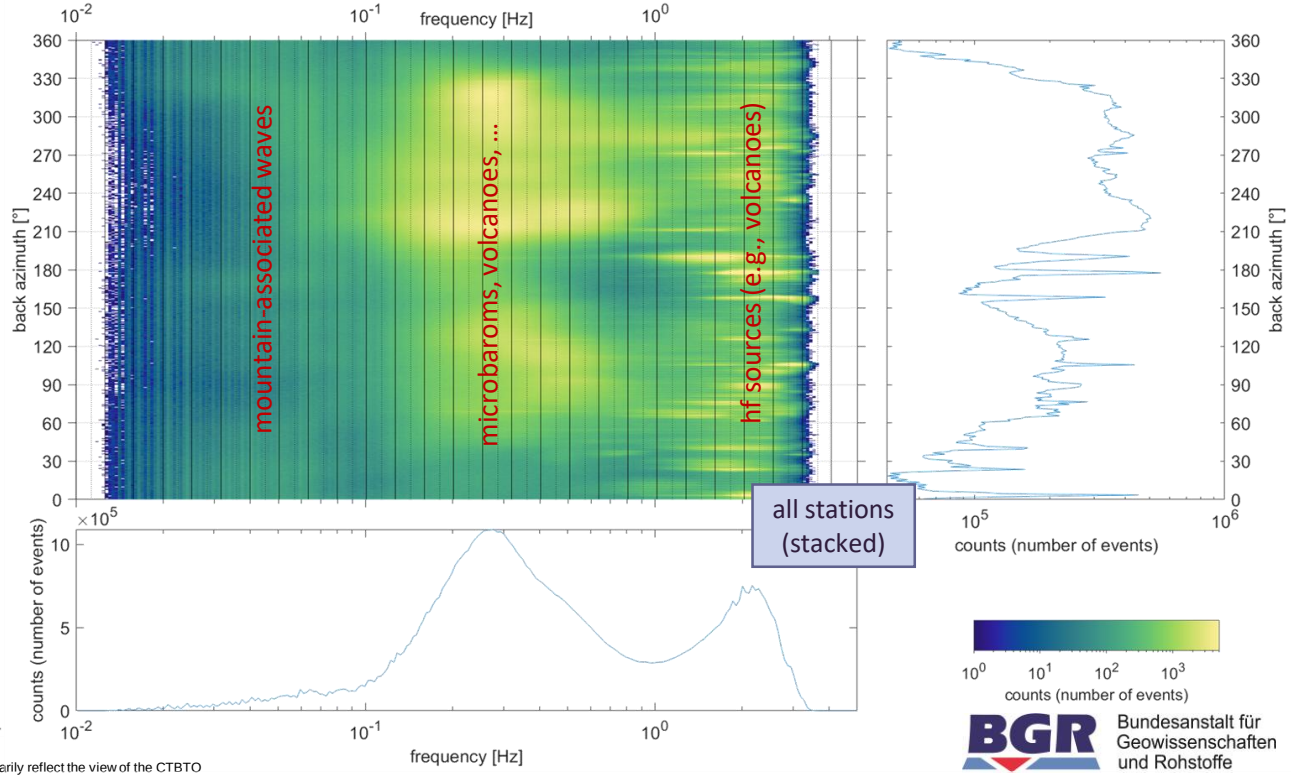
DATABASE

Detection lists: >81 million entries with center frequencies between 0.02 and 3.5 Hz (all stations)





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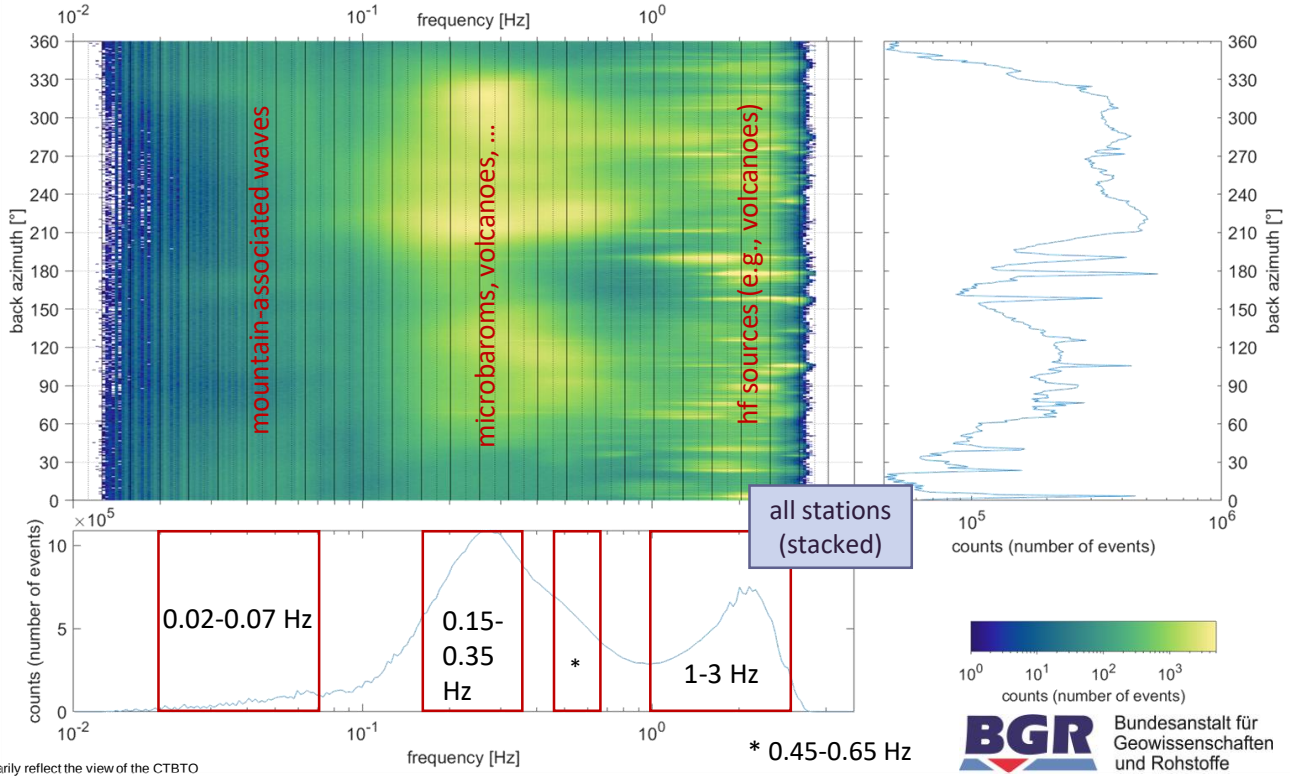
PRODUCTS

Data products covering the spectral peaks

1. Low-frequency product (e.g., mountain-associated waves)
2. "Microbarom" products, both
   a. lower and
   b. higher frequency spectrum
3. High-frequency product (e.g., volcanoes)

- Products available at equally-spaced time steps (30, 15, and 5 min, resp.)
- Provided parameters reflect dominant detections (family size) within time window



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PARAMETERS

Parameters of dominant within a time window, additional quality assessment parameters

1. Low-frequency product (e.g., mountain-associated waves)
2. "Microbarom" products, both
   a. lower and
   b. higher frequency spectrum
3. High-frequency product (e.g., volcanoes)

- Products available at equally-spaced time steps (30, 15, and 5 min, resp.)
- Provided parameters reflect dominant detections (family size) within time window
- Additional quality parameters

Selection of the detection parameters provided at each time step (unless NaN)

- "Dominant" azimuth (largest family size) within time window

Correspondingly, maximum values or weighted mean values (by family sizes):

- Signal duration
- Apparent velocity
- Amplitudes (RMS, P2P)
- Frequency
- Number of detections with the same (dominant) azimuth (**quality parameter**)
- Number of detections within the time window (**quality parameter**)

\+ standard deviations over all events within the time window (**quality parameter**)

- Additionally calculated parameter for **quality assessment**, incorporating correlation coefficient, fisher ratio, number of available sensors, and array size

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EXAMPLES

Recent sources of infrasound covered by the bulletin products

IS26 (Germany) / IS48 (Tunisia)	Stromboli eruption on 3 July 2019 e.g., **P1.1-133, A. Le Pichon**	Beirut explosion on 4 August 2020 e.g., **O2.1-228, C. Pilger**
Detection lists (center frequency)	O / O 0.2-0.9 Hz / 0.8-1.5 Hz	O / O 0.3-0.8 Hz / 0.55-1.55 Hz
MAW product (0.02-0.07 Hz)	X / X	X / X
MB_lf product (0.15-0.35 Hz)	O / X	O / X
MB_hf product (0.45-0.65 Hz)	O / X	O / O
hf product (1-3 Hz)	X / O	X / O

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APPLICATION

PMCC bulletins: microbarom detections (0.1-0.5 Hz) reflect the stratospheric conditions (Ceranna et al., 2019)

Daily effective sound speed ratio per station, for propagation paths from west to east (back azimuth 270°)

Mean back-azimuth within 8 days (window length), time step 4 days; Vertical scale: #detections ($\log_{10}$)

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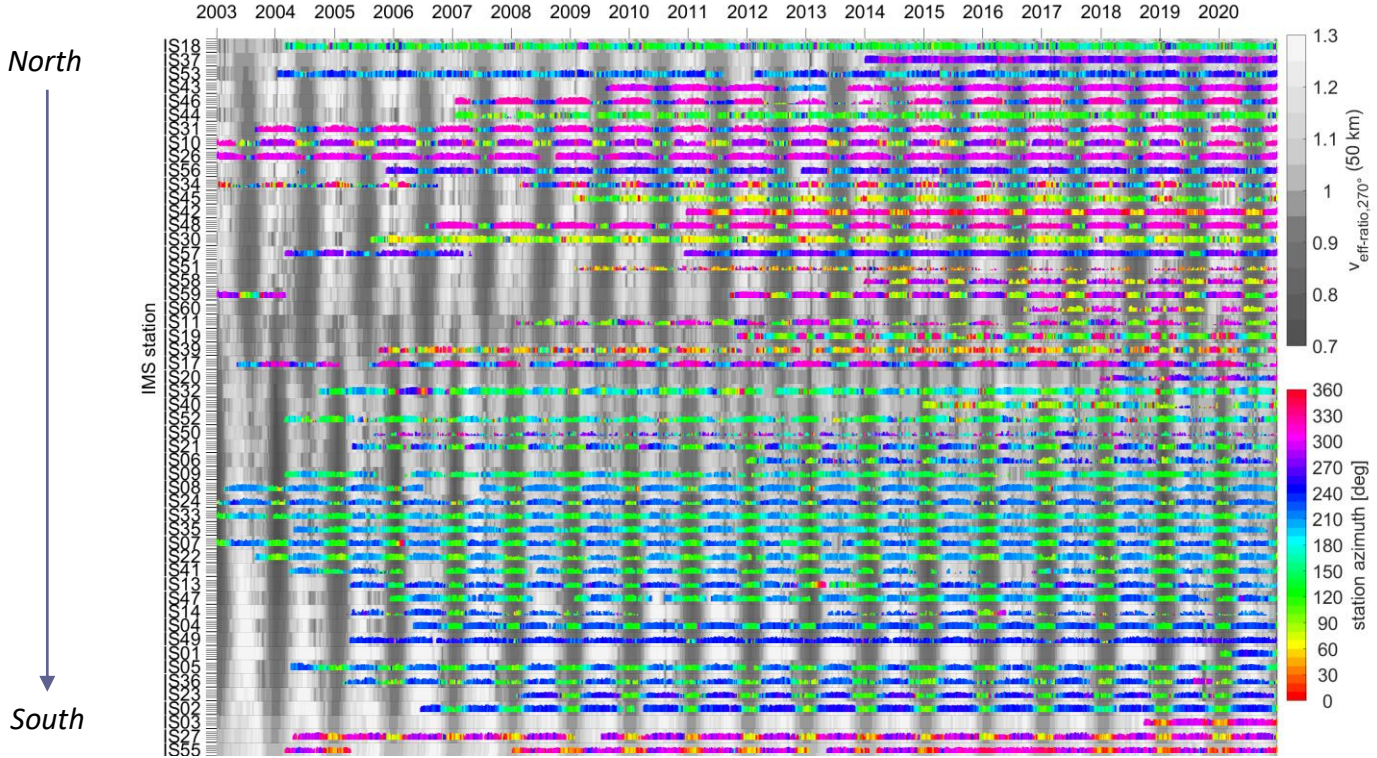
APPLICATION

Bulletin product (mb_lf) provides a very similar picture of the propagation conditions



Daily effective sound speed ratio per station, for propagation paths from west to east (back azimuth 270°)

Mean back-azimuth within 8 days (window length), time step 4 days; Vertical scale: #detections (scaled, $\log_{10}$)

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APPLICATION

Bulletin product (mb_hf) exhibits some differences

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Mean back-azimuth within 8 days (window length), time step 4 days; Vertical scale: #detections (scaled, $\log_{10}$)

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CONCLUSIONS

Soon: publication of tailored data products derived from PMCC broadband bulletins

- *neither providing raw data nor the comprehensive detection lists, thus not replacing the privileges of a vDEC access or IDC registered users (e.g., Reviewed Event Bulletin)*

- Make PMCC bulletin products available as a scientific dataset
- **Specific products** derived from detection lists (no reconstruction of high-resolution bulletins possible), based on a uniform processing scheme
- **DOI-assigned, open-access**
- Accompanying open-access publication
- Reference data base for natural infrasound sources
- Useful for atmospheric studies, microbarom modelling, volcano monitoring, calibration (e.g. ARISE-3, Infra-AUV)
- First step: **full period 2003 to 2020**

- Outlook: regularly updated products (“near-real-time”), in accordance with vDEC transition period (3 months)

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