T1.1-P22

On the use of infrasound observations from volcanoes for improving weather forecasts

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A

Did you know?

- **Infrasound propagation**: low frequency acoustic waves (infrasound) are emitted by various sources and can propagate in atmospheric ducts/waveguides, especially in the stratosphere;
- **Weather forecast**: there is a lack of dynamical measurement in the stratosphere to bound the initial conditions of Numerical Weather Prediction (NWP) models.

Our goal:

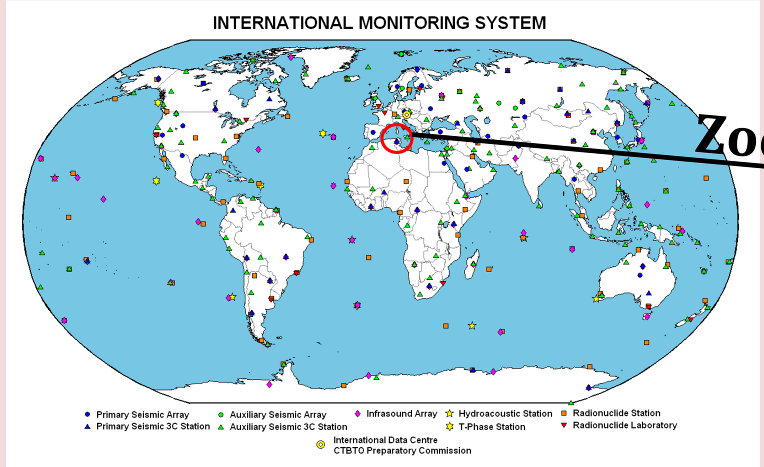
Use the sensitivity of **infrasound** detections to stratospheric structures for constraining the French **NWP** model ARPEGE[1].

B

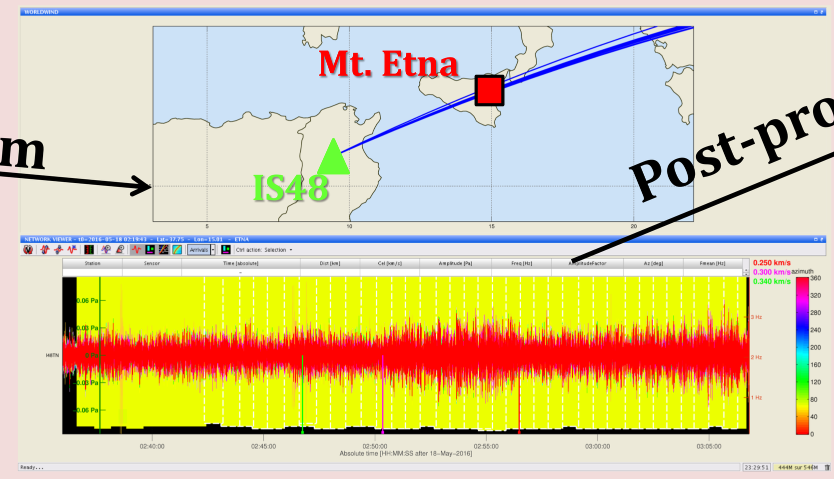
Specifying Y

Infrasound data available:

Infrasound detections gathered by the International Monitoring System network (51 infrasound stations IS).



Zoom

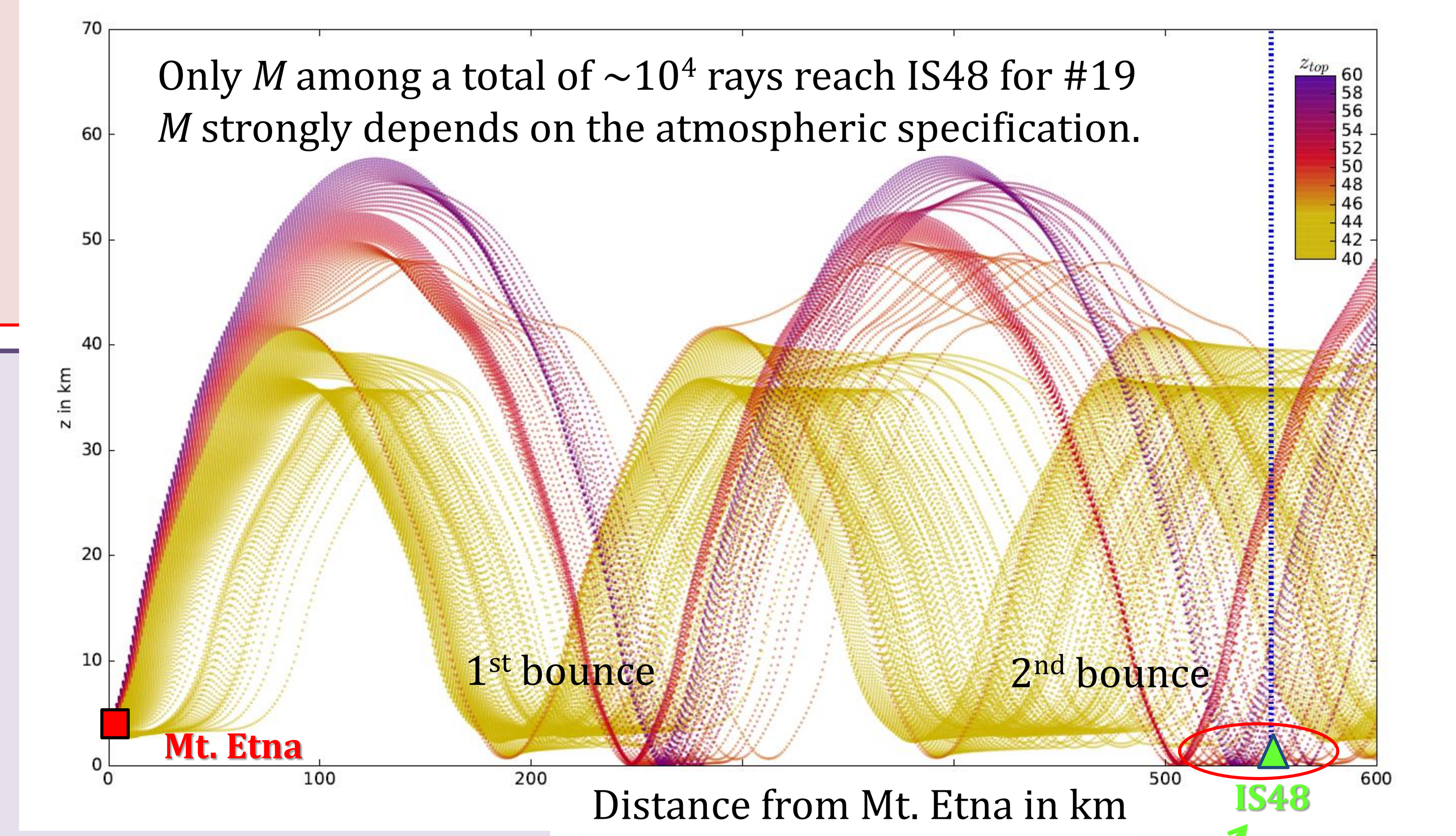


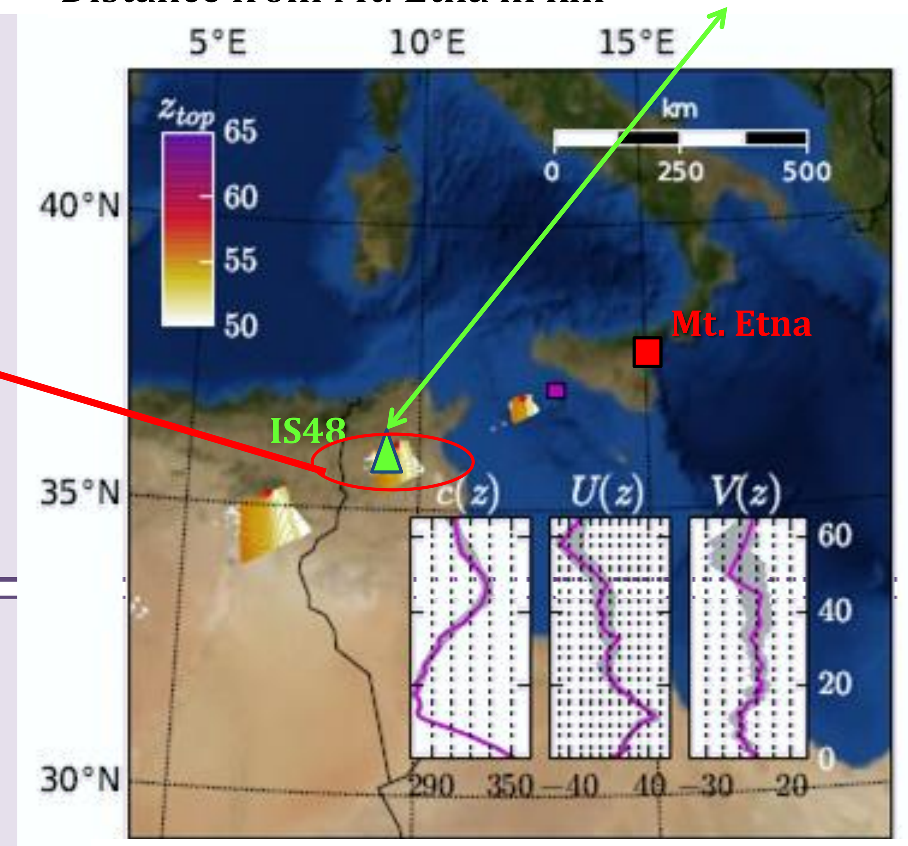
Post-processing

Key components of a detection:

$\hat{Y}$: i=1. travel time, i=2. back-azimuth angle, i= 3. trace velocity, …

Can a given detection be related to a source?





The source ? Mt. Etna volcano!

C

Specifying X

From ARPEGE ensemble analysis (AEARP)

x25 for AEARP

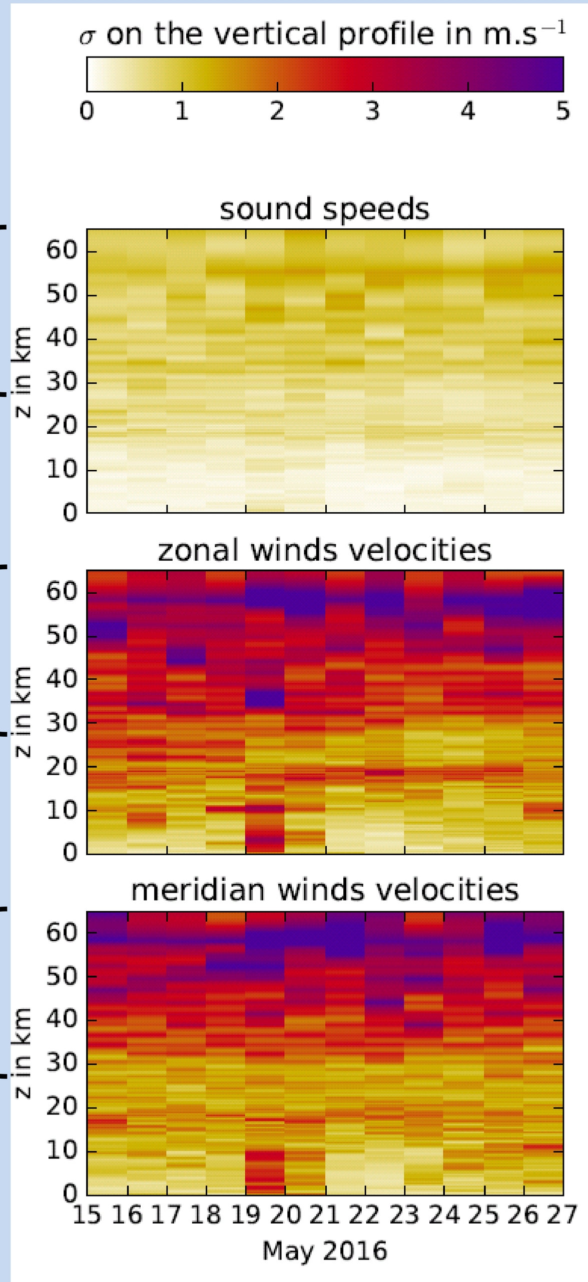
to atmospheric specifications (X)

- Extraction of atmospheric quantities: wind components, temperature, pressure and specific humidity from the AEARP grid (reduced Gaussian grid - 42km and 105 hybrid-pressure vertical levels).
- Conversion of these quantities into 3D atmospheric specifications (X) and interpolation onto regularly distributed vertical levels.

Variability in the stratosphere:

- 2-3 m.s^{-1} for c(z)
- 10-15 m.s^{-1} for U(z)
- 10-15 m.s^{-1} for V(z)

The ensemble carries out different scenarii in the stratosphere.
Then this variability should be seen on the propagation, especially on the back-azimuth deviations $\delta\Phi$.



D

Selection of 'best' X|Y

$\hat{Y}$ are independent and identically distributed

$$P(\mathbf{X}|\hat{\mathrm{Y}}) \propto P\big(Y(\mathbf{X}) = \hat{\mathrm{Y}}|\mathbf{X}\big)P(\mathbf{X})$$

Those X^k!

Uniform

$$\exp\left(-\min_{j\in[\![1;M]\!]}\sum_i \frac{(\hat{y}_i - y_{i,j,k})}{2r_i}\right)$$

No error on Y(X)

$Y(X^k)$: which X^k?

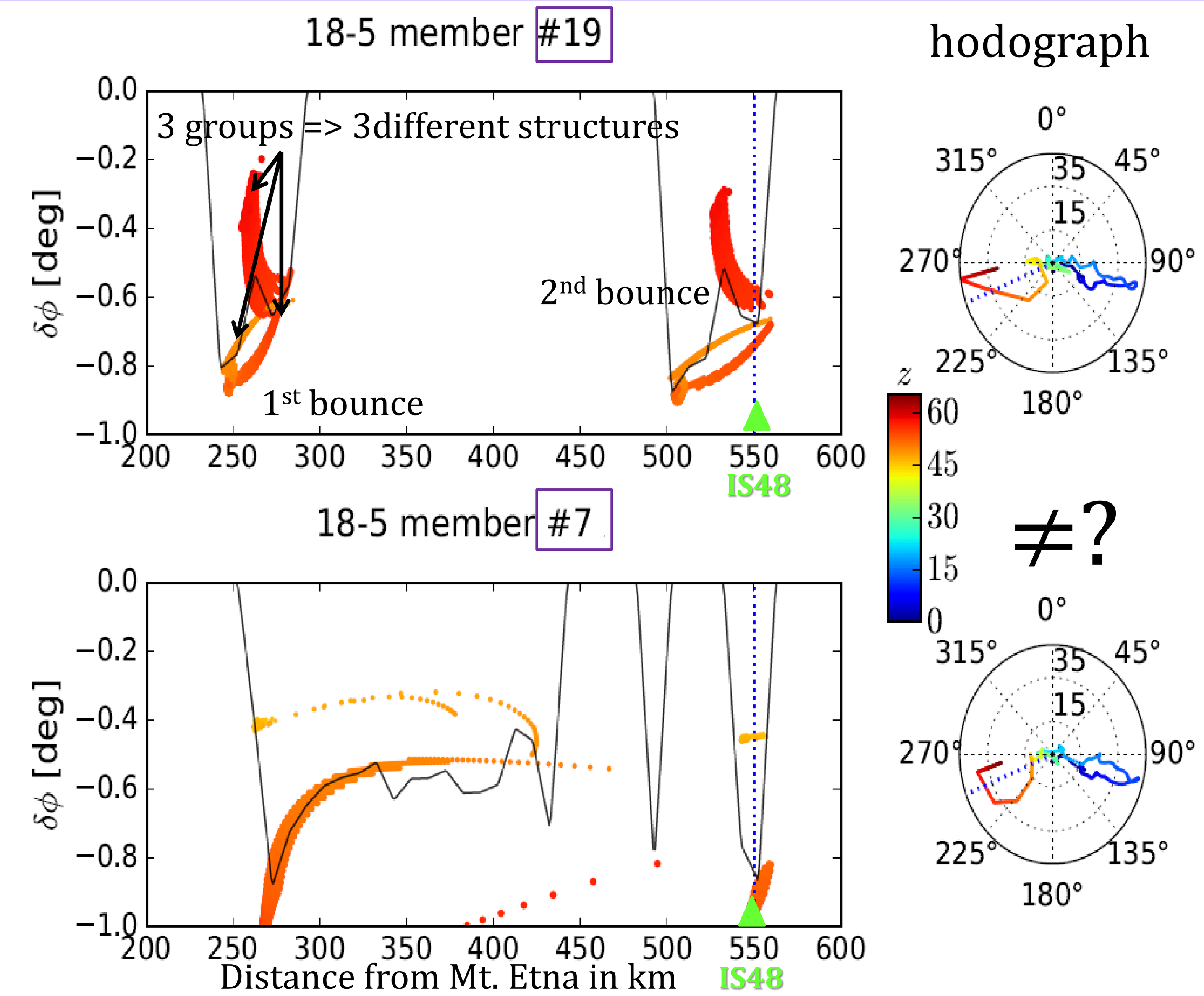
Covariance matrix
Same for all the members and observations.
10 s (i=1), 0.5° (i=2) and 5 m.s^{-1} (i=3) for IS48.

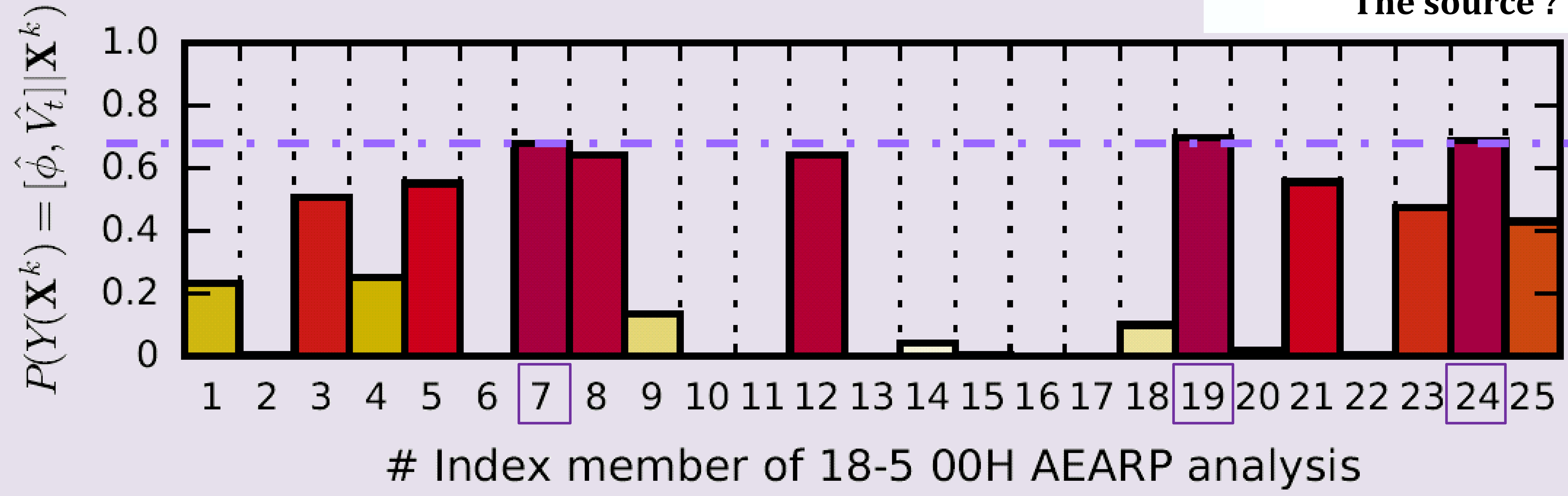
where i, j, k denote the components of the observation vector Y, the ray index and the member.

E

Mt. Etna activity on 18th May 2016 [02h00 ; 03h00 UTC]

The averaged probability distribution is computed through considering only the backazimuth Φ and the trace velocity V_t.





Members #7, #19, #24 lead to quite close effective sound speed profiles but rather different T,U,V, profiles.

F

Conclusions:

- While the Bayesian approach provides a ranking X^{19}>X^4>… of the ensemble members according to some infrasound measurements, there is no physically meaningful methods for decoupling the role of U, V and T in the inversion process;
- However, the most likely members are associated with similar effective sound speed profiles, thereby leading to a possibility of designing an observation operator using the infrasound detections;
- Need to pursue this approach for measuring the impact in assimilation processes.

[1] ARPEGE is the operational global NWP model of French meteorological office.

Acknowledgments: to E. Marchetti for the near-field detections and to the European Commission's project ARISE2 (Grant Agreement No. 653980)