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CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

NORSAR

Estimating tropospheric and stratospheric large-scale wind components using infrasound from explosions

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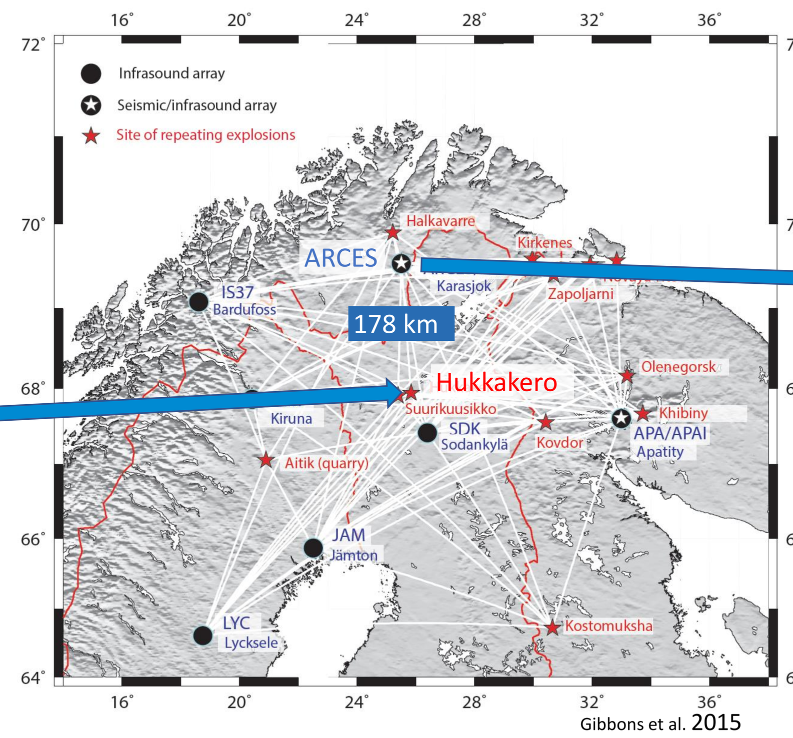
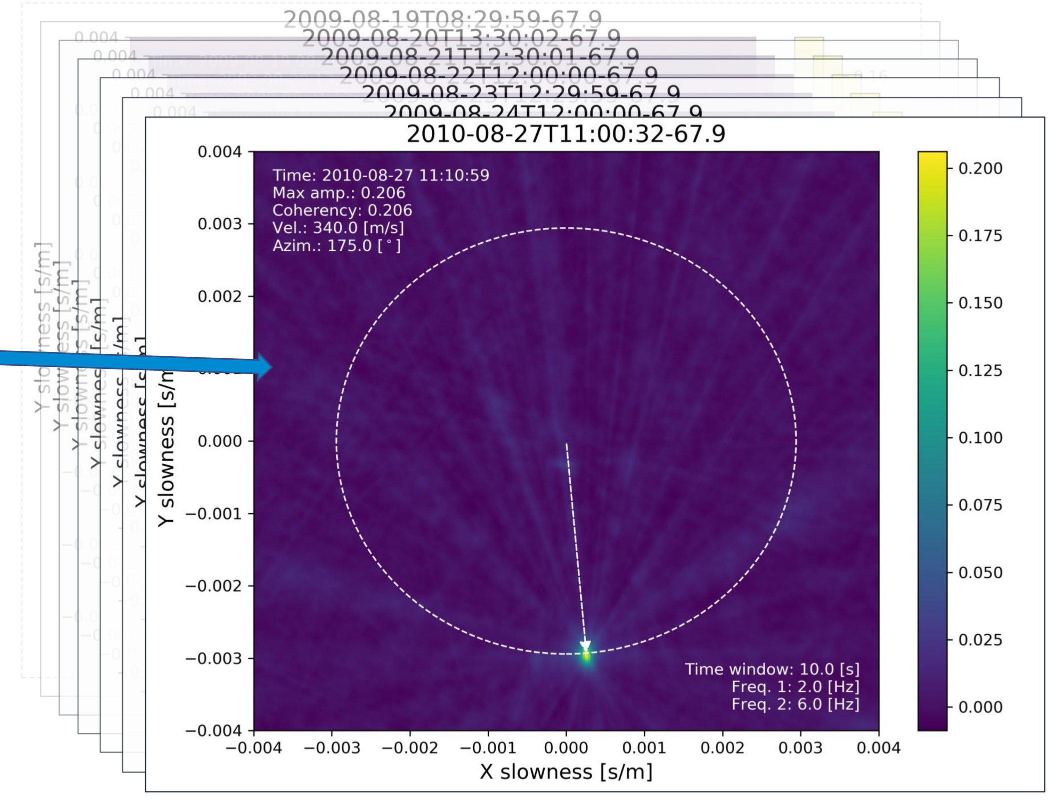
Data

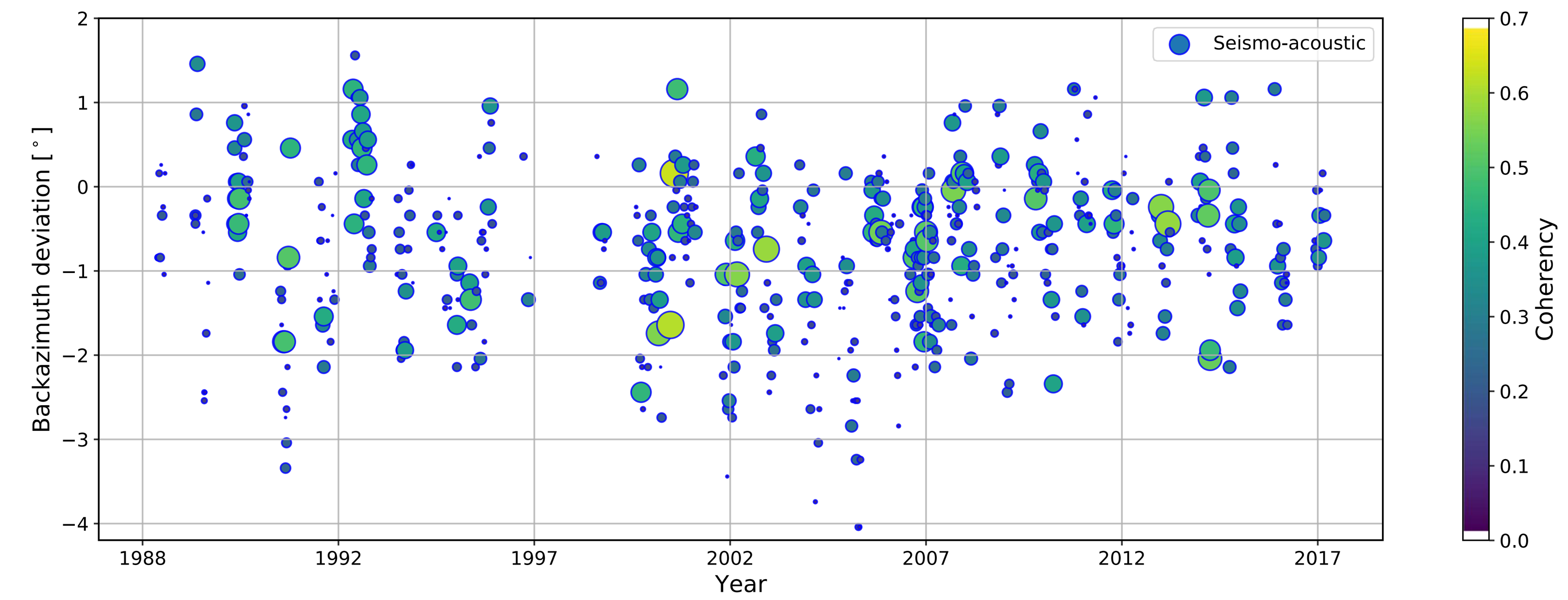
~600 explosions in Finland over 30 years





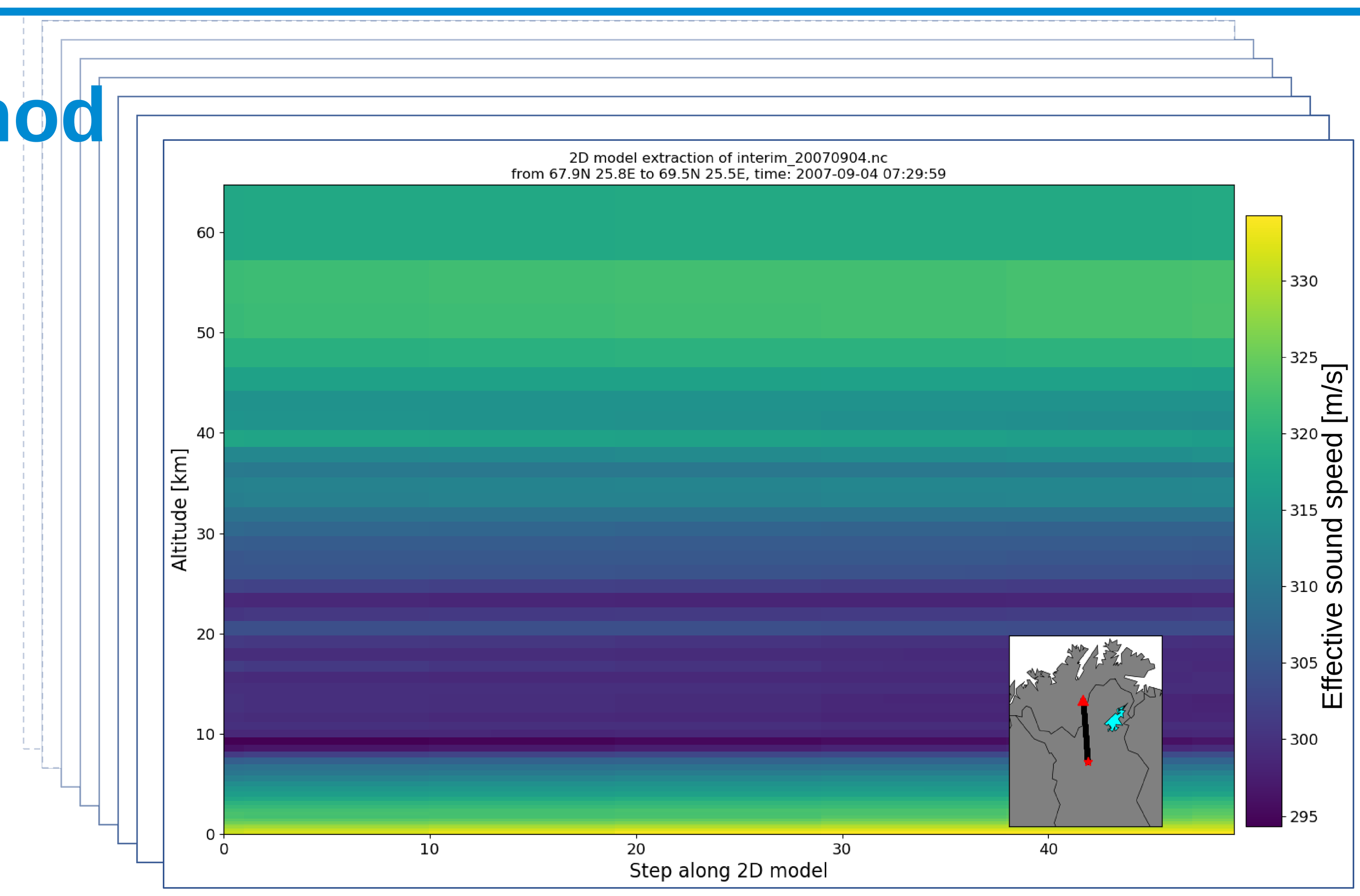
All explosions recorded as seismo-acoustic events at the ARCES seismic array

Backazimuth and traveltime of the most coherent arrival for each event is analyzed



Backazimuth deviation as a function of time for the 30-year long timeseries of explosions

Method

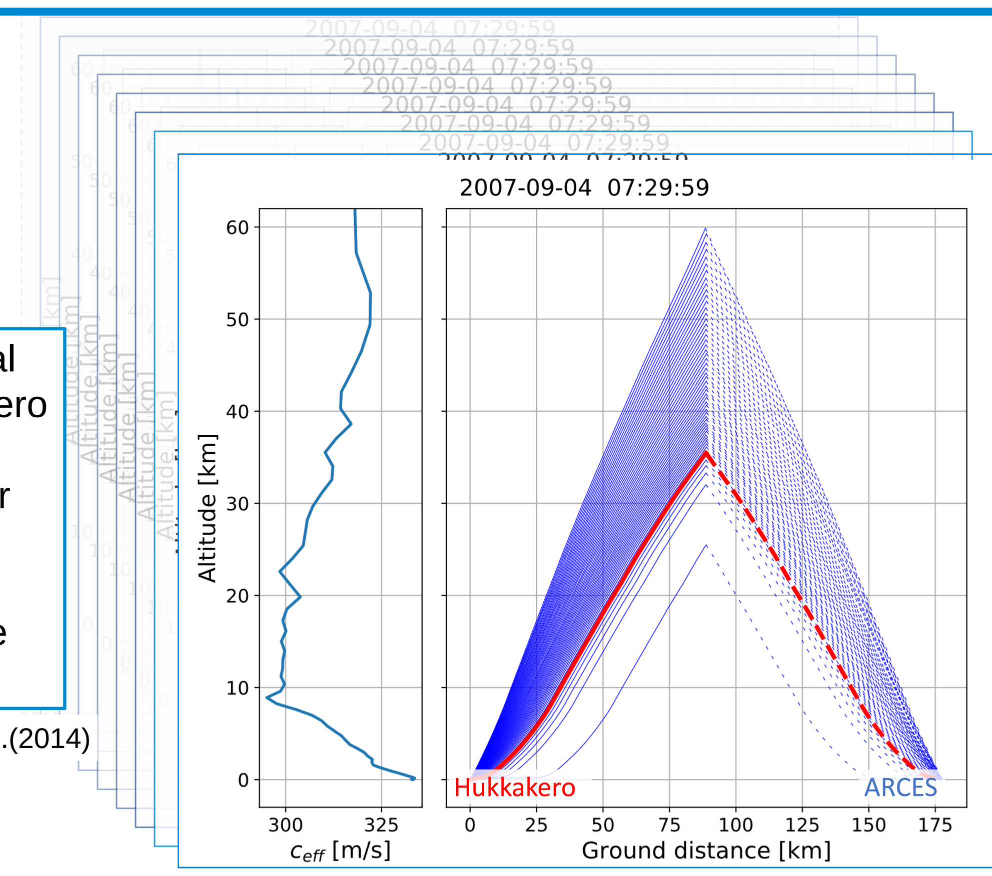


Extract ERA-Interim 2D atmospheric profiles for all events

ARCES is in the classical shadow zone of Hukkakero

Trace infrasound rays for each event, assuming partial reflection off stratospheric small-scale features

Kulichov (2010) & Chunchuzov et al.(2014)

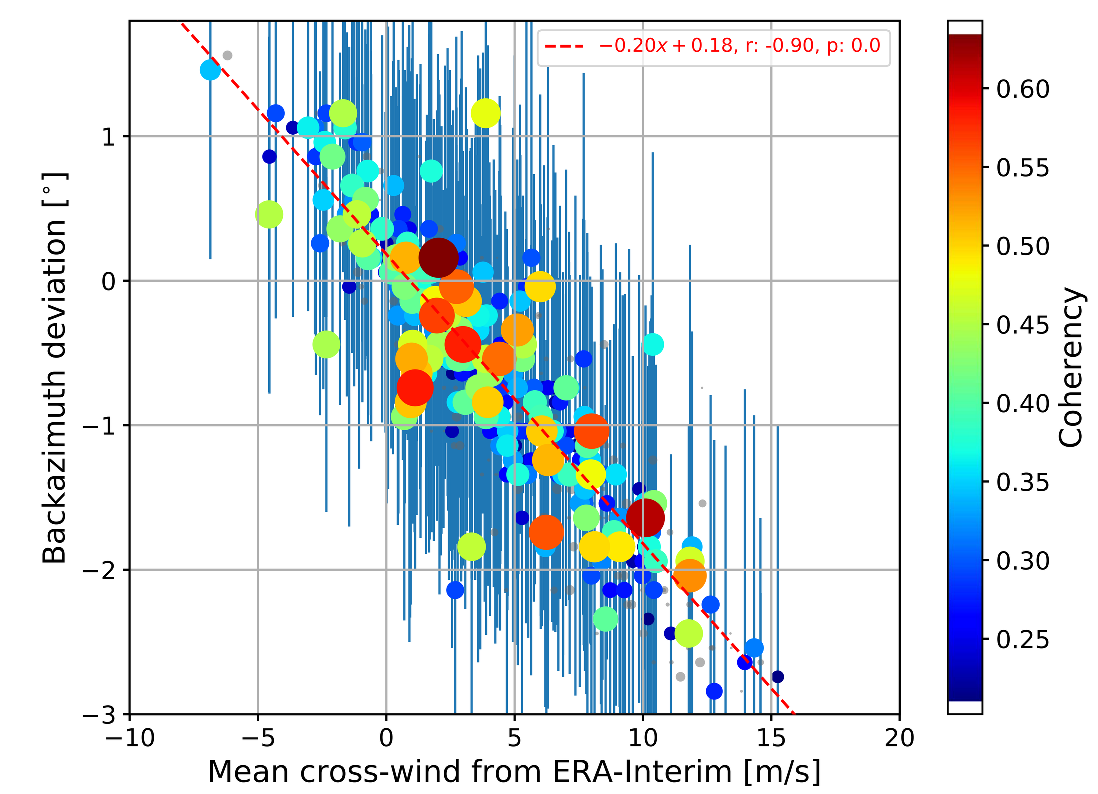


Ray tracing through all events. Eigen-ray (red dashed line) defined by matching travel time

Define mean cross wind along eigen-ray as

$$\widehat{W}_{c,T} \equiv \frac{1}{T}\int_0^T W_c \, dt$$

Where T is the travel time and W_c is the cross wind



High correlation between reanalysis cross wind, and observed infrasound backazimuth deviation

Discussion

During time T, infrasound propagates

$$X = v\,T$$

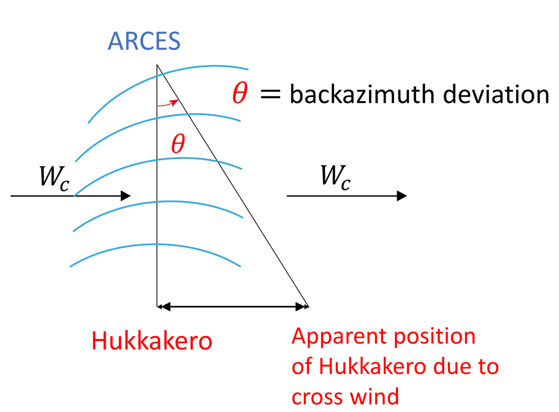
It also drifts sideways a distance

$$Y = \int_0^T W_c \, dt$$

so that the backazimuth deviation becomes

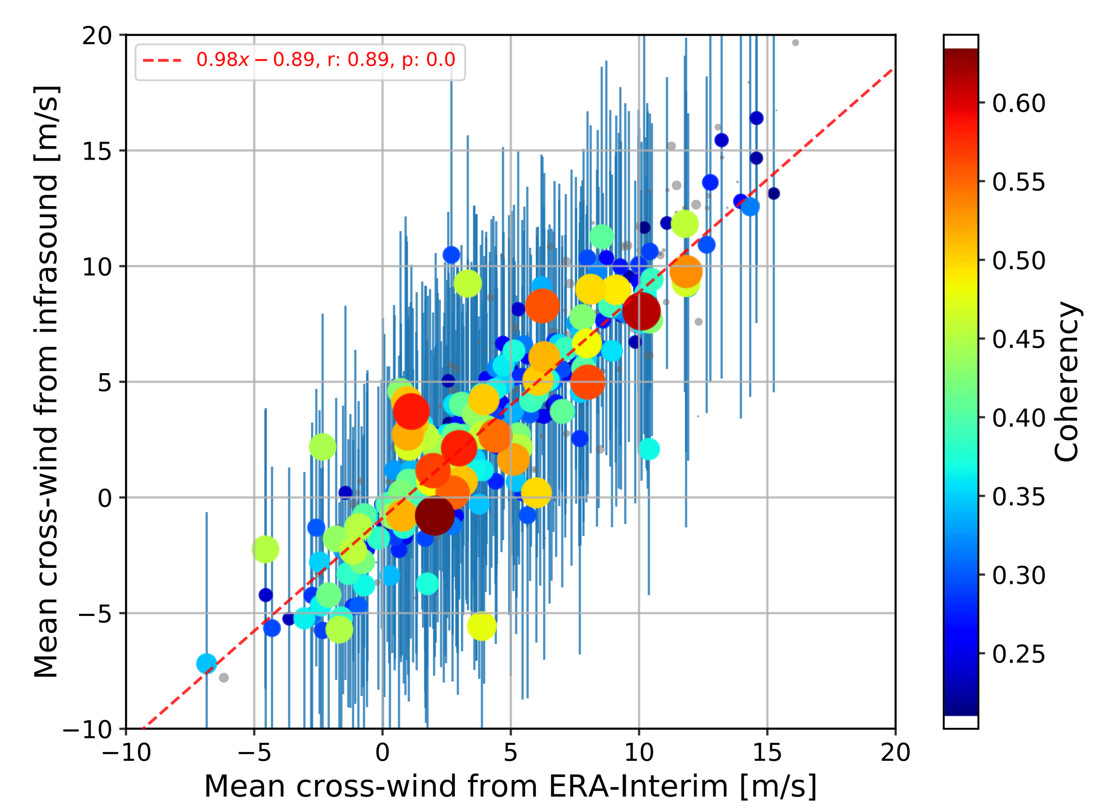
$$\tan\theta = -\frac{1}{vT}\int_0^T W_c \, dt = -\frac{\widehat{W}_{c,T}}{v}$$

Diamond (1964)



Because both the celerity and backazimuth deviation are known from infrasound observations, the mean cross wind can be estimated directly from infrasound

$$\widehat{W}_{c,T} = -v\tan\theta$$



Summary & outlook

- Infrasound data from ~600 ground truth explosions, covering 30 years, has been analyzed
- The observed backazimuth deviation is highly correlated to the mean cross wind along the propagation, evaluated using ERA-Interim reanalysis
  - Confirms that atmospheric reanalysis products can be used to improve localization of infrasound events via a simple method
- The atmospheric mean cross wind, as estimated from infrasound observations directly, correlates well with the ERA-Interim reanalysis product
  - Demonstrates the potential for utilizing infrasound observations as an independent technique to constrain atmospheric model products