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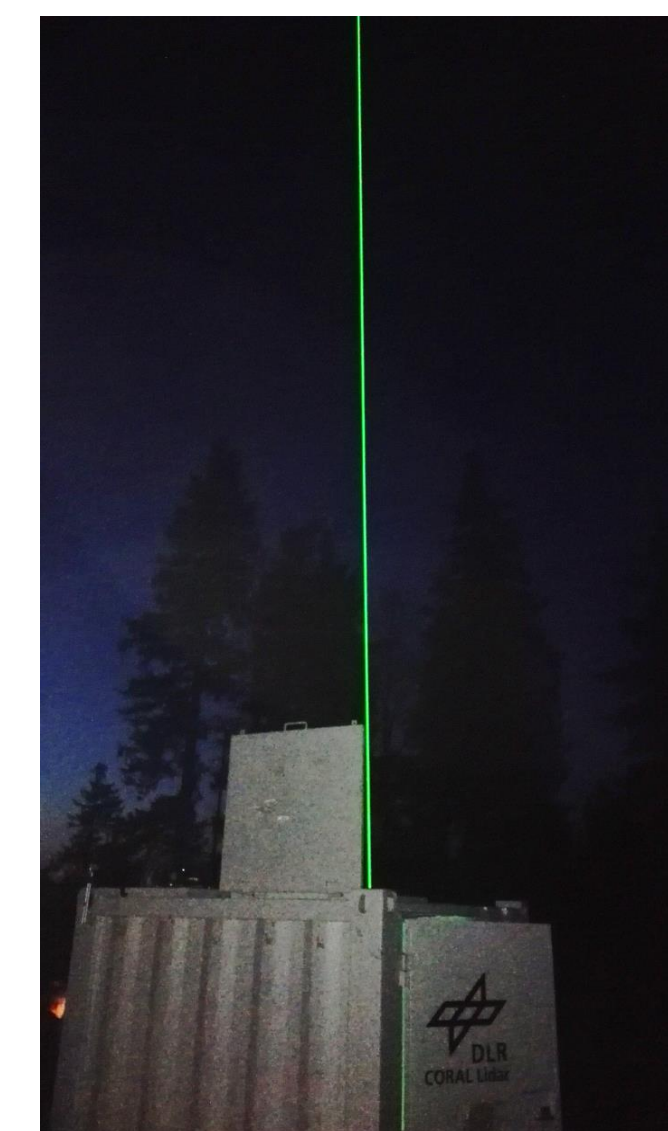
abstract & background

In the routine processing of IMS infrasound data, microbaroms (0.1–0.5 Hz) appear in overlapping frequency bands. This ambient noise signal is almost continuously detected at IMS stations worldwide and can therefore interfere with signals from explosive events. It has been shown that the seasonal variation of the middle atmosphere dynamics well explains the majority of microbarom detections (T1.1-P27; see also Landès et al., 2012; Ceranna et al., 2019). This variation refers to the predominant propagation duct between the surface and the stratospheric jet, the latter of which reverses twice the year. However, short-time fluctuations in temperature and winds lead to outlier detections.

In order to enhance the understanding of such detections, a microbarom model (T1.1-P8; De Carlo et al. 2019) has been developed which incorporates temperature and wind data of the high-resolution (HRES) operational analysis model of the European Centre for Medium-Range Weather Forecasts (ECMWF). In a study at the German infrasound station IS26, it was shown that incorporating temperature and wind measurements, obtained by light detection and ranging (lidar), will improve the prediction skill for microbarom amplitudes (Hupe et al., 2019).

This poster provides first results of modelling microbarom detections at IS02 (Argentina) using temperature observations of the autonomous lidar CORAL (Fig. 1) in 2018. The advance of the lidar campaign at IS02, compared to the one at IS26 in 2016 (seven months), is that almost daily comparisons with ECMWF's operational analysis have been incorporated in the microbarom model for a whole year.

Fig. 1: The Compact Rayleigh Autonomous Lidar (CORAL) during a measurement at night. For more information on the measurement principle and the observation campaign near IS02, please attend the poster T1.1-P10.



microbarom detections at IS02

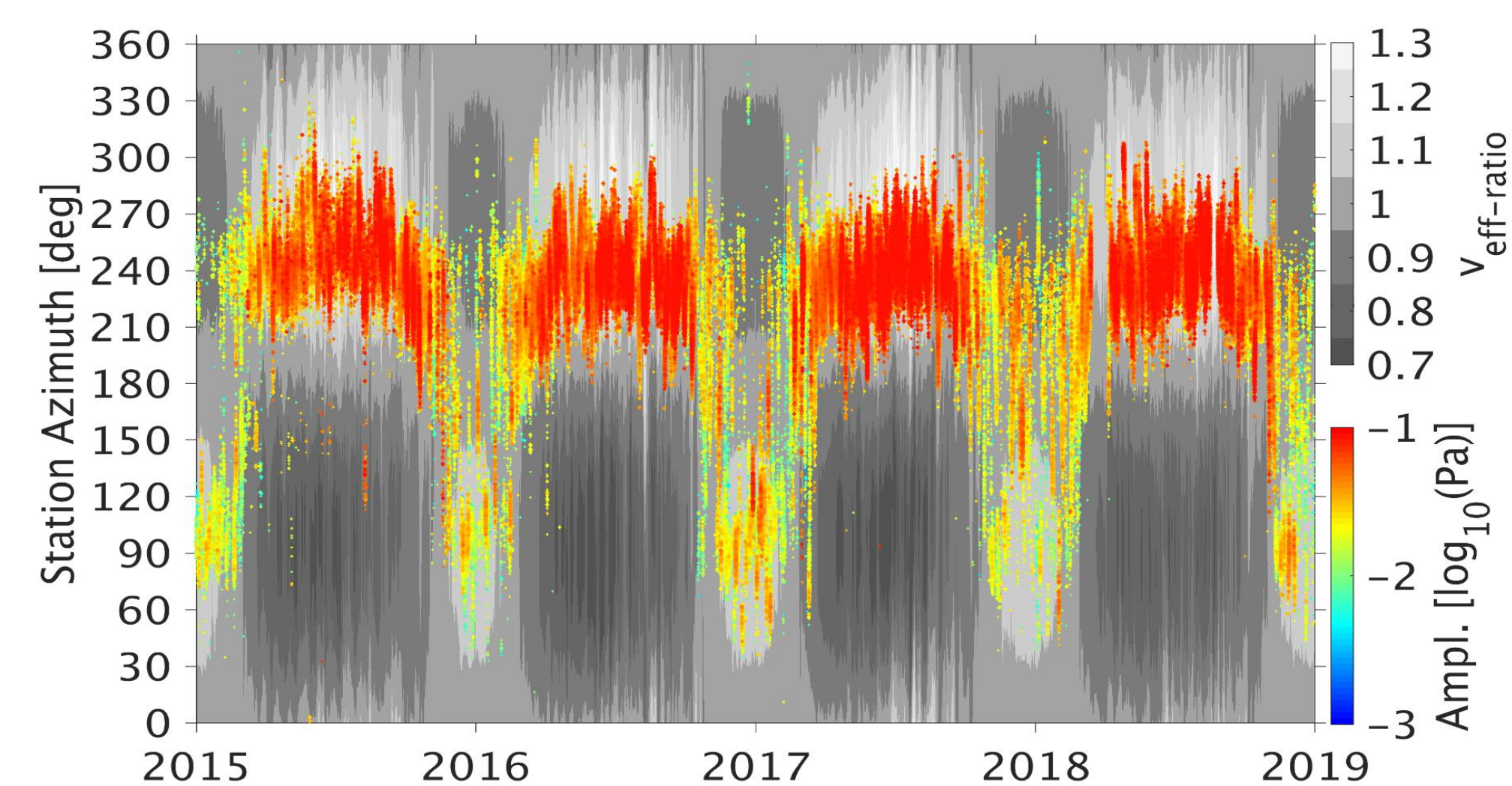


Fig. 2: The majority of PMCC (Cansi, 1995; here: Version 5.7.4) detections in the microbarom frequency range (0.1–0.5 Hz) follow the seasonal cycle of the propagation conditions. These are represented by the effective sound speed ratio (the maximum sound speed between 40 and 60 km relative to the sound speed at the ground). In the summer, some outliers and lower amplitudes can be found.

microbarom sources

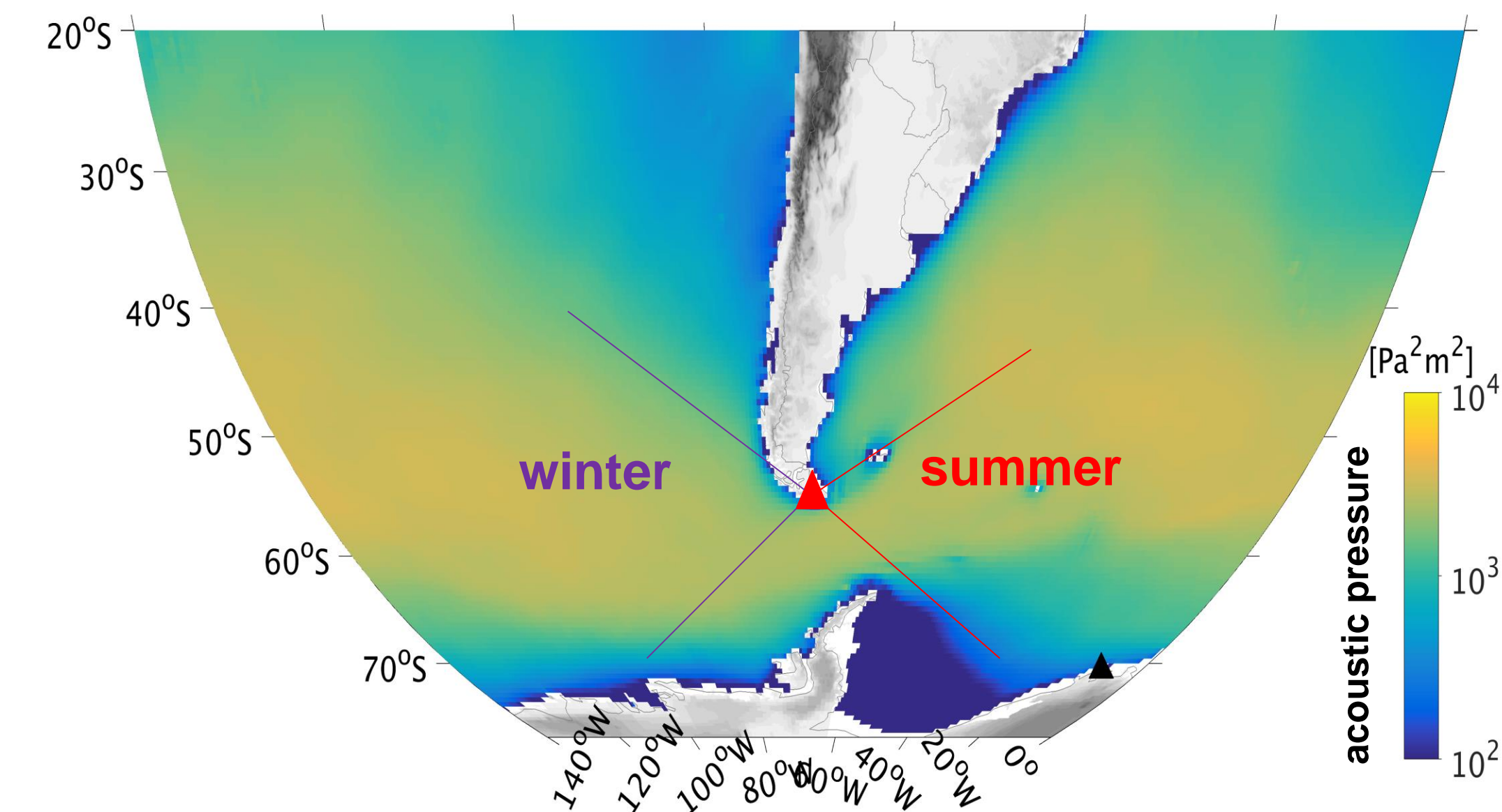


Fig. 3: IS02 (red triangle) is located at the southern tip of Argentina. The mean ocean swell activity in 2018 (based on data of Arduin & Herbers, 2013) highlights the Antarctic Circumpolar Current as the dominant source. The maxima in the west and the east of the station generally agree with the preferred back-azimuths of the detections.

modelling set-up

The microbarom model was run for modelling signals at IS02 in 2018. A detailed description of the model and the incorporated data is given on poster T1.1-P8. For this study, six simulations were run. These differ in the effective sound speed representing the propagation conditions in the middle atmosphere. The effective sound speed ratio was calculated as stated in Fig. 3.

- 1) Standard model run:** ECMWF's HRES operational analysis of wind and temperature.
- 2) Temperature-corrected runs: (2a)** On a daily basis, the ECMWF temperature profiles were corrected by the mean bias as observed with the lidar each night (Fig. 4). When the lidar did not operate during a night, the data bias was interpolated using the nearest observation (in time). Temperature uncertainty – the daily 2σ deviation was (2b) added to, and (2c) subtracted from 2a.
- 3) Wind-corrected runs:** The ECMWF effective sound speed ratio was corrected by the factors of (3a) 1.1 and (3b) 0.9, indicating strong wind perturbations that increase and decrease the effective sound speed, respectively.

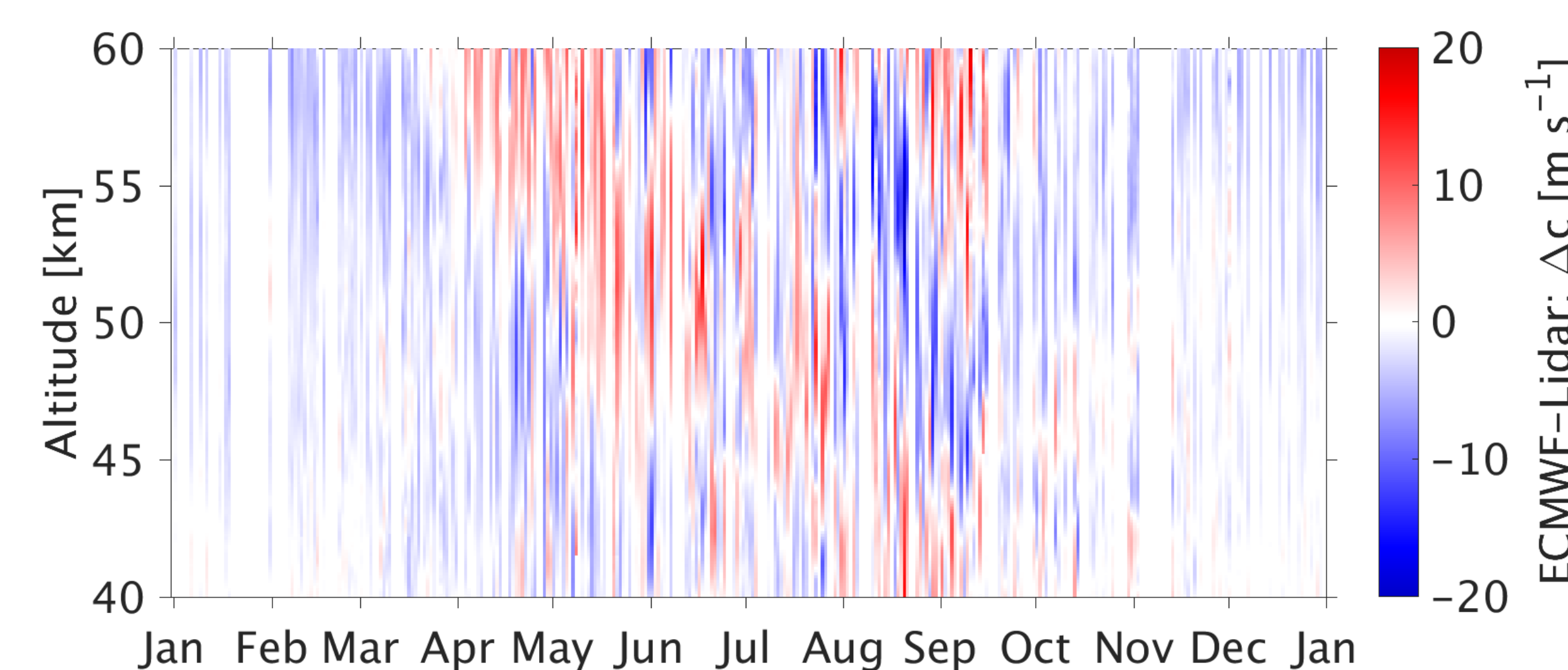


Fig. 4: The southern Andes are a gravity wave hotspot. In the austral winter (here: 2018), these waves heavily perturb the middle atmosphere temperature and wind profiles. These perturbations are not fully represented in the ECMWF model, as shown by the difference in the adiabatic sound speed ($c \sim \sqrt{T}$) between the ECMWF analysis and the Lidar. In the austral summer, the differences are relatively small ($< 5 \text{ m s}^{-1}$).

first results

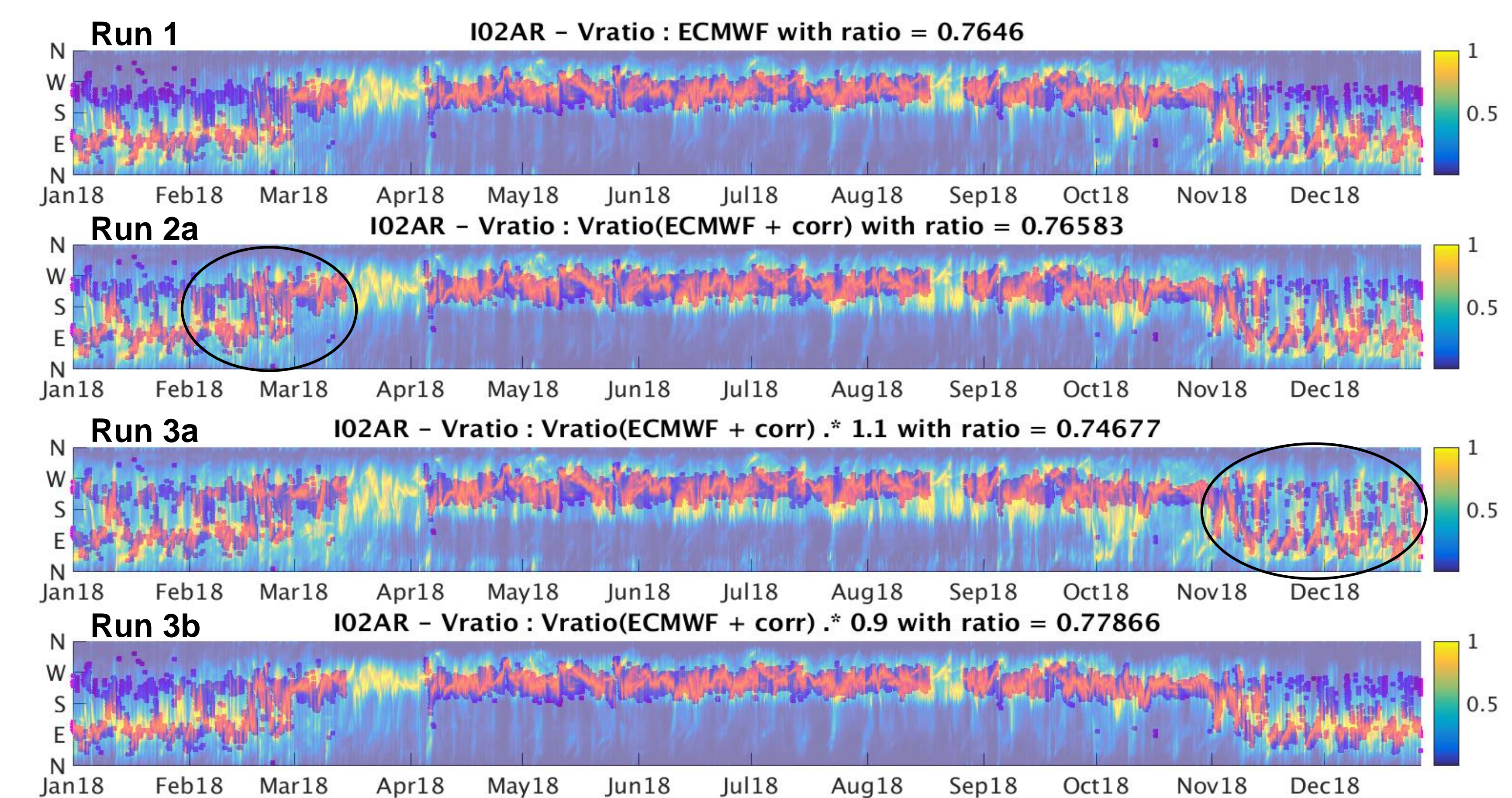


Fig. 5: Results of the modelling runs as defined above – color bars: detection probability of a microbarom signal at each time step of the model (3 h); blue squares: the dominant PMCC detection per time step. If a detection coincides with a detection probability of at least 0.8, it is colored in red. Main findings:

- The prediction skill of the model is very high during the winter. This is the result of strong sources in the west and an effective sound speed ratio $\gg 1$. In turn, the microbarom detections at IS02 are well explained due to the strong stratospheric duct in the winter.
- In the summer, the peculiarity is that two directions of detections dominate. This is not reflected by the ECMWF HRES analysis (Run 1).
- Adding the daily temperature bias as observed with the lidar (Run 2a) results in an increased detection probability for westerly directions in the summer; in late February and early November, detections are better explained.
- The daily 2σ uncertainties (Runs 2b & 2c) do not result in significant changes (not shown), compared to Run 2a.
- Fictive wind perturbations (Runs 3a and 3b) enable a better explanation of detections from both the southeast and southwest during the austral summer (Run 3a), which calls for the need of a wind lidar prototype.

conclusions & outlook

The microbarom model enables the prediction of the dominant back-azimuths being detected at the infrasound station IS02 in Argentina. Incorporating daily temperature uncertainties in the ECMWF model, as observed with a mobile temperature lidar prototype, better explains the back-azimuth of microbarom detections during the seasons when the stratospheric jet reverses. The analysis of the effects on amplitudes is ongoing. Nevertheless, the fictive perturbation of the effective sound speed ratio shows that wind observations are required for better explaining detections during the summer. Therefore we suggest to develop a mobile wind lidar prototype, similar to CORAL, for a campaign at an infrasound station. In addition, the IS02 detections show the need for improving the detection algorithms for multiple source separation. This could be incorporated in the microbarom model accordingly.

References:

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