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Insights into the atmospheric state through observations of infrasound from a ground-truth source at regional distance

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From the more than 160 tests of the ARIANE-5 main engine carried out by the German Aerospace Center (DLR) facility near Heilbronn, Germany, a large overall portion was detected at IMS infrasound station IS26 in the Bavarian forest. Located at a distance of about 320 km in an easterly direction (99° east-southeast from North) these observations were mostly made in the winter season between October and April with a detection rate of more than 70% , as stratospheric winds favor infrasound propagating through the atmosphere within the stratospheric duct. Only two exceptions were found for the summer season when stratospheric ducting is not predicted neither by climatologies nor the applied weather prediction models, due to a reversal of the middle atmosphere wind pattern.

Numerical weather prediction models for summer and winter seasons, or times with detections or non-detections were compared. It is then found that these models differ significantly in the sound speed profiles producing either a strong stratospheric duct for altitudes between 30 and 60 km in the case of detection, i.e. in winter months – or a lack thereof inhibiting regional sound propagation in summer months. It is of course reflected by the effective sound speed ratio, mostly exceeding a value of 1 for detections and less than 1 for non-detections. A significant portion of profiles representing non-detections, however, exhibit a sound speed profile that should enable infrasound signal observations. These cases are analyzed in detail to identify which fine structures within the sound speed profiles could explain the lack of observations.