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International Monitoring System infrasound measurements for the study of large-scale atmospheric waves

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The infrasound network of the International Monitoring System (IMS) for the verification of the Comprehensive Nuclear-Test-Ban Treaty has been designed for the detection and the localization of atmospheric nuclear explosions. It is composed of sixty stations, which measure micropressure changes produced in the atmosphere by infrasonic wave propagation. Most IMS infrasound stations use microbarometers MB2000 or MB2005 associated with acquisition units dedicated to geophysics. These absolute infrasound sensors measure ambient atmospheric pressure over a frequency bandwidth from DC to tens of Hz. This bandwidth not only includes the entire infrasound frequency range used for operational monitoring, but also a lower one corresponding to internal gravity waves and meteorological processes. Among gravity waves, atmospheric tides are waves with periods corresponding to integral fractions of a solar day (primarily diurnal and semidiurnal). They are produced by the atmospheric solar heating combined with upward eddy conduction of heat from the ground. Their importance is high as they regularly cause oscillations in atmospheric wind, temperature and pressure fields. However the IMS network has been designed for infrasound detection and its use for the study of such low frequency waves need a careful assessment of its ultimate capabilities.

First, the sensor output dynamic range is reduced by a high-pass filter with a 0.02 Hz cut-off frequency. This reduces the signal-to-noise ratio for waves with frequencies beyond the filter cut-off frequency. The signal-to-noise is thus evaluated for several digitizers used on IMS stations. It remained globally satisfactory down to a period of 24 hours. Secondly, atmospheric temperature changes, which can be neglected for few second pressure measurements, modify the measurement chain electronic and mechanical response. The absolute sensor intrinsic thermal susceptibility is very low compared with differential infrasound sensors such as microphones but can still reaches 10 Pa/K. A spectral analysis as well as a study based on diurnal pressure oscillations show that the influence of temperature on IMS pressure measurement is very low. This is mainly due to the fact that microbarometers are set up underground and not subjected to large temperature variations.

The seasonal variation of atmospheric tides detected by IMS stations is studied in several Earth locations. It is found that the diurnal pressure oscillation (S1) is comparable in magnitude to the semidiurnal pressure oscillation (S2) over much of the globe except for the low-latitude open oceans, where S2 is about twice as strong as S1. These results are in good agreement with previous modelling and observations. However strong S1 variations, not predicted by global modelling, are also observed during short time-period on continental stations. These variations are not only detected by IMS infrasound sensors but also by absolute pressure sensors part of IMS meteorological stations. The study of these phenomena is of high importance as it can modify atmospheric wind profiles and therefore influence infrasonic wave propagation.