Geophysical Research Abstracts
Vol. 13, EGU2011-11582, 2011
EGU General Assembly 2011

Infrasound data inversion for atmospheric remote sensing

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The International Monitoring System (IMS) infrasound network, designed in the framework of the Comprehensive Nuclear-Test-Ban Treaty (CTBT), records various sources of infrasound, such as ocean swell, meteorites, supersonic aircraft and volcanic eruptions at long-range. Several studies have shown that accurate atmospheric specifications are necessary for understanding infrasonic observations. Indeed, current atmospheric models fail to explain a large variety of observed infrasound propagation features. For instance, systematic biases are observed between simulations and observations, especially during seasonal transitions. In addition, the influence of meteorological variability on different timescales (from hours to months), is observed in infrasound records. Observations of ground-truth and natural events point to the limits of current atmospheric models especially in the middle and upper atmosphere where models suffer from lack of available data. In this context, infrasound records provide a unique way to improve atmospheric models above 50 km.
We present a method for inversion of infrasound data from a point source in order to retrieve meteorological parameters of the atmosphere, such as wind velocities and temperature. The forward problem is based on a ray-tracing approach using a Hamiltonian formulation, while sensitivity of ray-path to model parameters is computed using perturbation theory. We then assess the performance of the algorithm as well as the utility of infrasound data for recovering atmospheric profiles using various synthetic data cases in preparation for application to real data.