Geophysical Research Abstracts, Vol. 8, 06170, 2006
SRef-ID: 1607-7962/gra/EGU06-A-06170

Infrasound monitoring of volcanoes: a remote sensing method of the upper atmosphere

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Known and quasi-permanent infrasonic sources are needed to evaluate and improve upper-wind models. Infrasounds generated by continuous volcanic activity offer a unique opportunity for atmospheric studies. The I22FR station installed in New-Caledonia is part of the global infrasonic network of the International Monitoring System (IMS). This station continuously detects coherent infrasonic waves originating from several active volcanoes in Vanuatu (New-Hebrides Islands). Most of the volcanic eruptions in Vanuatu are Strombolian or mild-Vulcanian, sometimes resulting in huge expanses of thick ash. Even at several hundreds of kilometers from the volcanoes, differences in the waveforms and frequency contents of the detected signals are observed and related to different kind of volcanic activities. In order to get the acoustic source function, microbarometers have recently been installed near the crater of some volcanoes. Correlation between acoustic measurements near and at large distances from the source makes easier the evaluation of the atmospheric transfer function. Preliminary results dealing with signal attenuation with distance will be presented. A continuous infrasound monitoring over three years shows clear seasonal trends in the detected direction of infrasound arrivals at I22FR. We relate the cyclical azimuthal variations to the seasonal zonal stratospheric wind reversals which strongly affects the deflection of the ray direction. From austral summer to austral winter, the largest azimuth variation approaches 15°. A 3D ray-tracing modeling associated with the NRL-G2S climatological database are used to simulate the propagation and explain seasonal trends in the observations. Simulation results show that propagation modeling roughly explains seasonal changes in infrasonic observables but underestimates their fluctuations. An inversion procedure has been developed for adjusting the vertical structure of

high-altitude winds. The main results show that the speed of the mesospheric wind jet in the original wind model is significantly underestimated, and the strong wind region in the stratosphere should be extended to the lower-thermosphere. This favorable setting in Vanuatu provides new insights on quantitative relationships between infrasonic observables and atmospheric specifications. In this regard, a continuous infrasound monitoring of volcanoes would greatly enhances our understanding of the dynamics of the upper atmosphere in a region where routine measurements still remain illusive. More studies like the one presented here could estimate more precisely how large are the errors in the upper wind models and will better determine the role of different factors that influence propagation predictions.