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Gravity waves produced by the total solar eclipse of 1 August 2008

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Gravity waves are a major component of atmospheric small scale dynamics because of their ability to transport energy and momentum over considerable distances and of their interactions with the mean circulation or other waves. They produce pressure variations which can be detected at the ground by microbarographs. The solar intensity reduction which occurs in the atmosphere during solar eclipses is known to act as a temporary source of large scale gravity waves. Despite decades of research, observational evidence for a characteristic bow-wave response of the atmosphere to eclipse passages remains elusive. A new versatile numerical model (Marty, J. and Dalaudier, F.: Linear spectral numerical model for internal gravity wave propagation. *J. Atmos. Sci.* (in press)) is presented and applied to the cooling of the atmosphere during a solar eclipse. Calculated solutions appear to be in good agreement with ground pressure fluctuations recorded during the total solar eclipse of 1 August 2008. To the knowledge of the authors, this is the first time that such a result is presented.

A three-dimensional linear spectral numerical model is used to propagate internal gravity wave fluctuations in a stably stratified atmosphere. The model is developed to get first-order estimations of gravity wave fluctuations produced by identified sources. It is based on the solutions of the linearized fundamental fluid equations and uses the fully-compressible dispersion relation for inertia-gravity waves. The spectral implementation excludes situations involving spatial variations of buoyancy frequency or background wind. However density stratification variations are taken into account in the calculation of fluctuation amplitudes. In addition to gravity wave packet free propagation, the model handles both impulsive and continuous sources. It can account for spatial and temporal variations of the sources allowing to cover a broad range of physical situations.

It is applied to the case of solar eclipses, which are known to produce large-scale bow waves on the Earth's surface. The asymptotic response to a Gaussian thermal forcing travelling at constant velocity as well as the transient response to the 4 December 2002 eclipse are presented. They show good agreement with previous numerical simulations. The model is then applied to the case of the 1 August 2008 solar eclipse. Ground pressure variations produced by the response to the solar intensity reduction in both stratosphere and troposphere are calculated.

These synthetic signals are then compared to pressure variations recorded by IMS (International Monitoring System) infrasound stations and a temporary network specifically set up in Western Mongolia for this occasion. The pressure fluctuations produced by the 1 August 2008 solar eclipse are in a frequency band highly disturbed by atmospheric tides. Pressure variations produced by atmospheric tides and synoptic disturbances are thus characterized and removed from the signal. A low frequency wave starting just after the passage of the eclipse is finally brought to light on all stations. Its frequency and amplitude are close to the one calculated with our model, which strongly suggest that this signal was produced by the total solar eclipse.