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Numerical modeling of acoustic and gravity waves propagation in the atmosphere using a spectral element method

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During low-frequency events such as tsunamis, acoustic and gravity waves are generated and quickly propagate in the atmosphere. Due to the exponential decrease of the atmospheric density with the altitude, the conservation of the kinetic energy imposes that the amplitude of those waves increases (to the order of 10^5 at 200km of altitude), which allows their detection in the upper atmosphere.

This propagation bas been modelled for years with different tools, such as normal modes modeling or to a greater extent time-reversal techniques, but a low-frequency multi-dimensional atmospheric wave modelling is still crucially needed.

A modeling tool is worth of interest since there are many different sources, as earthquakes or atmospheric explosions, able to propagate acoustic and gravity waves.

In order to provide a fine modeling of the precise observations of these waves by GOCE satellite data, we developed a new numerical modeling tool. By adding some developments to the SPECFEM package that already models wave propagation in solid, porous or fluid media using a spectral element method, we show here that acoustic and gravity waves propagation can now be modelled in a stratified attenuating atmosphere with a bottom forcing or an atmospheric source. The bottom forcing feature has been implemented to easily model the coupling with the Earth's or ocean's vibrating surfaces but also huge atmospheric events. Atmospheric attenuation is also introduced since it has a crucial impact on acoustic wave propagation. Indeed, it plays the role of a frequency filter that damps high-frequency signals.