Mission concept and implementation status for the detection of gravity waves in the upper atmosphere

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Abstract:

Gravity waves have a vital role in the mesosphere and beyond, significantly influencing a variety of atmospheric processes. These waves are essential for the transfer of energy and momentum from the lower atmosphere to the upper layers and can be generated by various sources, including weather systems, mountains, and thunderstorms. As gravity waves propagate, they have a profound impact on temperature, wind patterns, and atmospheric composition. Furthermore, gravity waves can disturb the ionosphere by inducing vertical motion among charged particles. This leads to fluctuations in electron density, altering the ionosphere's refractive index and interfering with radio communication signals used in aviation, maritime, and other operations. Additionally, gravity wave-induced variations in the ionosphere can affect the accuracy of global navigation satellite systems impacting navigation and timing.

Observing gravity waves from space poses a unique challenge due to their small-scale atmospheric fluctuations, particularly in the vertical dimension. Limb sounding emerges as the most feasible method for passive detection. In this presentation, we introduce an innovative concept for capturing gravity waves in the mesosphere and lower thermosphere using a CubeSat constellation consisting of two satellites with precisely aligned viewing angles.

This mission concept relies on an advanced spatial heterodyne spectrometer, resembling a Michelson interferometer, to detect gravity waves. To achieve the necessary resolution with just two such instruments, we present a study aimed at extracting two spatially independent data sets from a single interferogram.

Additionally, we provide an update on the status of a prototype instrument set to be deployed in space within the next 2-3 years. This prototype will serve as a demonstration of the observation concept, highlighting its significant potential.