Atmospheric gravity waves produced by auroral sources: A link between the upper and lower atmosphere

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Abstract

Atmospheric gravity waves (AGWs) [1] play an important role in transporting momentum and energy through the atmosphere. Solar wind coupling to the magnetosphere-ionosphere-atmosphere (MIA) system has been recognized as an important source of AGWs that are manifested in the ionosphere as traveling ionospheric disturbances (TIDs) and observed by HF radars [2] and ionosondes. Solar wind Alfvén waves modulating Joule heating and/or Lorentz forcing of the high-latitude lower thermosphere have been shown to generate medium-scale AGWs [3]. Using the dispersion relation between the gravity wave frequency and the wave vector [1,3], ray tracing in a model atmosphere shows three distinct group paths (wave propagation modes) that reach the F region of the ionosphere: waves that travel directly upward, waves that are reflected in the mesosphere, and waves that are reflected in the troposphere or from the Earth's surface. Another approach is the Transfer Function Model (TFM) [4] that describes gravity wave response in the atmosphere and shows that propagating waves originating in the thermosphere can excite a spectrum of AGWs in the lower atmosphere, albeit with much smaller amplitudes. These include "lower modes" that are of particular interest in the present paper: the wave reflected from the Earth's surface and the ducted wave that propagates in the lower atmosphere to large distances away from the source and leaks up into the thermosphere. We will present observations of TIDs and consider possible impacts of these gravity waves in the troposphere. The observations are supported by ray tracing and TFM results.

References

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