MLS-Related Scientific Publication

Scientific Themes: Atmospheric Dynamics, Earth Climate

A study of mesoscale gravity waves over the North Atlantic with satellite observations and a mesoscale model. Wu, D. L., and F. Zhang, *J. Geophys. Res. - Atmos.* **109** (D22): Art. No. D22104, 10.1029/2004JD005090, NOV 25 2004.

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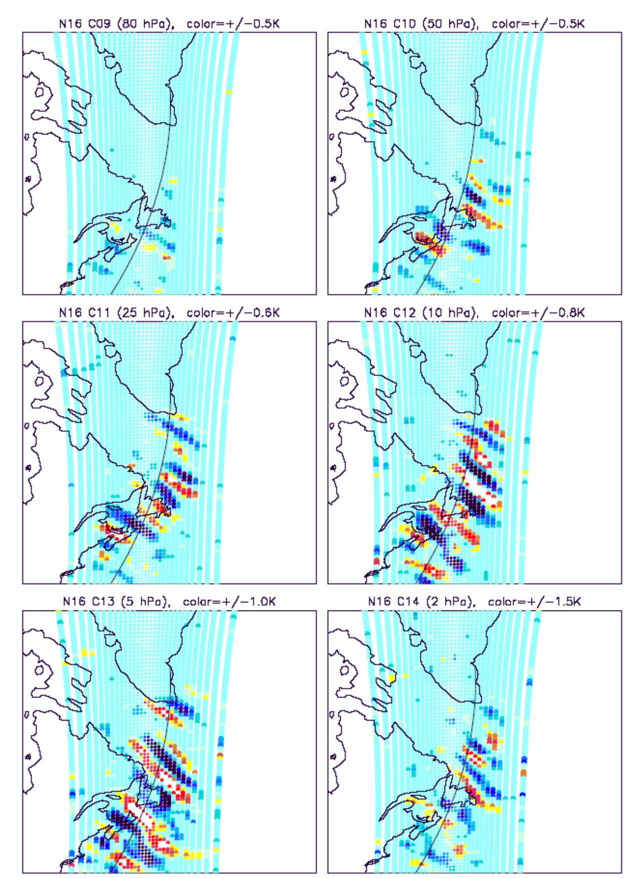
Summary

Satellite microwave data are used to study climatology and variability of gravity waves over North America and the Atlantic Ocean in the December-January period. The mesoscale gravity waves observed are strongly correlated with intensity and location of the tropospheric baroclinic jet-fronts systems. A large-amplitude gravity wave event on 19-21 January 2003 over the North Atlantic and the east coast of the United States is investigated in detail with observations from four AMSU-A instruments in orbit and simulations from a mesoscale model (MM5). The simulated gravity waves compare qualitatively well with the satellite observations in terms of wave structures, timing, and overall morphology. Excitation mechanisms of these large-amplitude waves in the troposphere are complex. The wave genesis and impacts on the dynamics in the stratosphere and mesosphere are subject to further investigations.

Small-scale disturbances at high latitudes play an important role in polar vortex breakdown and induce mixing among chemically-active constituents in the middle atmosphere. This study aims to improve our understanding of excitation and morphology of these waves in the upper troposphere and lower stratosphere.



This figure shows a snapshot of the North Atlantic wave at 6.5Z on 20 January 2003 from 6 pressure levels. The estimated horizontal wavelength ranges between 300 and 600 km. At 5 hPa waves of large amplitudes spread to a wider area than those at 80 hPa but location of the maximum amplitudes at 5 hPa seems to correspond well to the maxima at 80 hPa in general.

A state-of-the-art mesoscale model (MM5) is used to explicitly simulate this episode of enhanced GW activities identified from satellite observations. Excitation of these large-amplitude mesoscale waves is complicated, and multiple mechanisms have been offered to explain their occurrences. Preliminary MM5 results suggest four likely source mechanisms for the 19-21 January 2003 GW event: (1) topographically-forced waves due to jet streaks incepted by large terrains; (2) adjustment-forced waves due to strong flow imbalance associated with the upper-tropospheric jet streaks; (3) diabatically-forced GWs due to moist convection induced by baroclinic waves; and (4) frontally-forced GWs due to frontal collapse near the surface. The last three mechanisms are transient in nature and often inseparable from each other.