MLS-Related Scientific Publication

Scientific Themes: Atmospheric Dynamics, Earth System Modeling.

Mesospheric inversions and their relationship to planetary wave structure. Murry Salby, Fabrizio Sassi, Patrick Callaghan, Dong Wu, Philippe Keckhut, and Alain Hauchecorne *J. Geophys. Res.*, **107,** 10.1029/2001JD000756 (2002).

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Summary

Measurements of thermal structure reveal the sporadic occurrence of temperature inversions in the mesosphere, which are characterized by positive lapse rates of temperature. Several explanations have been proposed for this anomalous thermal structure, including gravity waves and thermal tides. This paper investigates the relationship between mesospheric inversions and planetary waves in a two-pronged analysis: observed three-dimensional structures of mesospheric inversions from French lidar and UARS MLS, and model simulations. The study finds that mesospheric inversions may be part of a more extensive pattern related to planetary wave activity.

Thermal structure in the mesosphere is believed to be a sensitive indicator of global climate change. These analyses improve our understanding of the Earth thermal structure in the upper atmosphere, and will benefit society by making scientific progresses in atmospheric physics and dynamics.

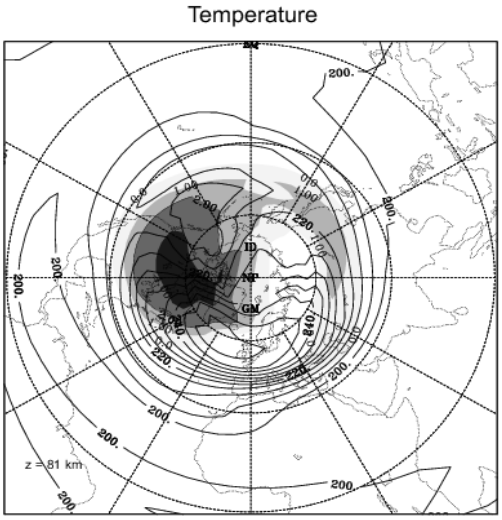

Figure 5 presents the synoptic map of temperature at 81km, a level that slices through the top of the inversion and the steepest negative lapse rate. The warm anomaly is intensified at this altitude, reflecting inverted thermal structure below.

The mesospheric inversions form in association with an abrupt phase shift of planetary wave temperature. It drives wave temperature out of phase with wave geopotential, which in turn alters the vertical structure of planetary waves: from westward tilt and upward amplification below the inversion to nearly barotropic structure and decay above the inversion. Attending the upward decay of planetary waves is a relaxation of flow distortion, as the vortex is gradually restored towards polar symmetry. This behavior is favored during stratospheric warmings. Planetary waves are then amplified in the stratosphere and lower mesosphere, leading to a major displacement and distortion of the vortex.

The synoptic global structure shown here reveals a coherent pattern of inverted thermal structure, one that extends over large horizontal dimensions and is closely related to planetary wave structure. The correspondence between mesospheric inversions and planetary wave structure does not rule out contributions from other mechanisms. However, it makes clear that distortions of the circulation associated with planetary waves can produce inverted thermal structure that is coherent over large space scales and timescles.