Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 6, 1091-1104, 2006
www.atmos-chem-phys.net/6/1091/2006/

Small-scale gravity waves in ER-2 MMS/MTP wind and temperature measurements during CRYSTAL-FACE

L. Wang[1], M. J. Alexander[1], T. B. Bui[2], and M. J. Mahoney[3]
[1]NorthWest Research Associates, Inc., Colorado Research Associates Div., 3380 Mitchell Lane, Boulder, CO 80301, USA
[2]NASA Ames Research Center, Moffett, CA 94035, USA
[3]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA

Abstract. Lower stratospheric wind and temperature measurements made from NASA's high-altitude ER-2 research aircraft during the CRYSTAL-FACE campaign in July 2002 were analyzed to retrieve information on small scale gravity waves (GWs) at the aircraft's flight level (typically ~20 km altitude). For a given flight segment, the S-transform (a Gaussian wavelet transform) was used to search for and identify small horizontal scale GW events, and to estimate their apparent horizontal wavelengths. The horizontal propagation directions of the events were determined using the Stokes parameter method combined with the cross S-transform analysis. The vertical temperature gradient was used to determine the vertical wavelengths of the events. GW momentum fluxes were calculated from the cross S-transform. Other wave parameters such as intrinsic frequencies $\hat{\omega}$ were calculated using the GW dispersion relation. More than 100GW events were identified. They were generally high frequency waves with vertical wavelength of ~5 km and horizontal wavelength generally shorter than 20 km. Their intrinsic propagation directions were predominantly toward the east, whereas their ground-based propagation directions were primarily toward the west. Among the events, ~20% of them had very short horizontal wavelength, very high intrinsic frequency, and relatively small momentum fluxes, and thus they were likely trapped in the lower stratosphere.
Using the estimated GW parameters and the background winds and stabilities from the NCAR/NCEP reanalysis data, we were able to trace the sources of the events using a simple reverse ray-tracing. More than 70% of the events were traced back to convective sources in the troposphere, and the sources were generally located upstream of the locations of the events observed at the aircraft level. Finally, a probability density function of the reversible cooling rate due to GWs was obtained in this study, which may be useful for cirrus cloud models.

Final Revised Paper (PDF, 1310 KB) Discussion Paper (ACPD)

Citation: Wang, L., Alexander, M. J., Bui, T. B., and Mahoney, M. J.: Small-scale gravity waves in ER-2 MMS/MTP wind and temperature measurements during CRYSTAL-FACE, Atmos. Chem. Phys., 6, 1091-1104, 2006. Bibtex EndNote Reference Manager