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

Atmos. Chem. Phys., 6, 4577-4589, 2006
www.atmos-chem-phys.net/6/4577/2006/

Mesoscale temperature fluctuations in the stratosphere

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Abstract. An airborne instrument that measures altitude temperature profiles is ideally suited for the task of characterizing statistical properties of the vertical displacement of isentrope surfaces. Prior measurements of temperature fluctuations during level flight could not be used to infer isentrope altitude variations because lapse rate information was missing. The Microwave Temperature Profiler instrument, which includes lapse rate measurements at flight level as a part of temperature profiles, has been used on hundreds of flights to produce altitude versus ground track cross-sections of potential temperature. These cross-sections show isentrope altitude variations with a horizontal resolution of ~3 km for a >6 km altitude region. An airborne isentrope-altitude cross-section (IAC) can be compared with a counterpart IAC generated from synoptic scale data, based on radiosondes and satellite instruments, in order to assess differences between the altitudes of isentrope surfaces sampled at mesoscale versus synoptic scale. It has been found that the synoptic scale isentropes fail to capture a significant component of vertical displacement of isentrope surfaces, especially in the vicinity of jet streams. Under the assumptions that air parcels flow along isentrope surfaces, and change temperature adiabatically while undergoing altitude displacements, it is possible to compute mesoscale temperature fluctuations that are not present in synoptic scale back trajectory parcel temperature histories. It has been found that the magnitude of the mesoscale component of temperature fluctuations varies with altitude, season, latitude and underlying topography. A model for these dependences is presented, which shows, for example, that mesoscale temperature fluctuations increase with altitude in a systematic way, are greatest over mountainous terrain, and are greater at polar latitudes during winter.

Final Revised Paper (PDF, 1239 KB) Discussion Paper (ACPD)

Citation: Gary, B. L.: Mesoscale temperature fluctuations in the stratosphere, Atmos. Chem. Phys., 6, 4577-4589, 2006. Bibtex EndNote Reference Manager