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Atmospheric turbulence studies using radar and balloon observations during the MUTSI campaign

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Shear instabilities are believed to be the main source of turbulence within a non-convective atmosphere. Doppler pulsed radars are useful tools for the study of this turbulence since they can give access to both the intensity of turbulence and wind shears. In combination with High-Resolution balloon measurements of temperature, these observations can improve our knowledge on the small-scale morphology of the turbulent structures, on their generation mechanisms and on their evolution with time.
The MUTSI (MU radar, Temperature Sheets and Interferometry) campaign near the Middle and Upper atmosphere (MU) radar (8-26 May 2000) was devoted to such investigations. The radar was operated in different observational modes (e.g. Multi-Beam Scanning and Frequency and Spatial Domain Interferometry modes) in order to obtain thorough information on the radar echo characteristics. Simultaneously to these radar observations, high-resolution temperature measurements by balloon have been performed owing to a specific equipment developed by Service d'Aeronomie (CNRS, France). With a frequency sampling of 64 Hz and a time response of the sensors less than 3 ms, a vertical resolution of about 10 cm could be obtained. Ten balloon borne gondolas have been launched during night periods.

In the present work, a complete overview of these observations will be given. In particular, radar observations using the dual Frequency Domain Interferometry mode (devoted to improve the range resolution of the radar) will be described. The FDI technique is able to reveal echoing layers thinner than the range resolution used
(e.g. Kilburn et al., 1995) but the underlying atmospheric structures responsible for these echoing layers are not well-known. The FDI layers will then be interpreted in light of the structures observed in the temperature field. The temperature profiles exhibit thin stable layers of several meters in thickness (temperature sheets) as already described by Dalaudier et al. (1994) and turbulent layers in which temperature fluctuations are strongly inhomogeneous. Analyses of the wind and wind shear profiles seem to indicate that the characteristics of the turbulent mixing depend on the nature of the shear, i.e. if it results from variations of wind speed or wind direction.
The profiles also indicate the presence of nearly neutralized layers resulting from turbulent mixing generated by dynamic shear instabilities, and possibly by Kelvin-Helmholtz instabilities (Luce et al., 2002). Such observations may have important consequences on the mechanisms of transport of minor components within the stratified atmosphere. The neutralization process by turbulent mixing can also be one of the generation mechanisms of the temperature sheets mainly observed within the lower stratosphere. Consequently, the characteristics and occurrence of the mixing processes and their conditions of generation must be clarified.
Some preliminary results will be presented.

References

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