Geophysical Research Abstracts
Vol. 14, EGU2012-3035-1, 2012
EGU General Assembly 2012

Dynamics of orographic banner clouds

M. Voigt and V. Wirth
Universität Mainz, Institut für Physik der Atmosphäre, Mainz, Germany (vwirth@uni-mainz.de, +49 (0)6131 392-3532)

Banner clouds occur downwind of steep mountains or sharp ridges, even on otherwise cloudfree days. Systematic observations at Mount Zugspitze have shown that they can be a rather frequent phenomenon and occasionally persist for several hours. Key scientific questions are the origin of the windward-leeward asymmetry, the underlying basic mechanism, the role of diabatic processes, the role of stratification, and the impact of the mountain shape. Despite many decades of active research in mountain meteorology, the processes and spatial scales relevant for banner cloud dynamics have not recieved particular attention in the past.

This contribution adresses some of the fundamental issues based on numerical simulations. These were carried through with a Large Eddy Simulation model using idealized orography. Key diagnostic is the Lagrangian vertical displacement both on the windward and the leeward side of the mountain. Large upward displacement increases the likelihood for cloud formation.

For a steep, isolated (pyramid-shaped) mountain one obtains a pronounced windward-leeward asymmetry with larger upward displacement on the leeward side. The large leeward upward displacement is associated with boundary layer separation and a rather complex lee-vortex geometry. It follows that banner clouds can be entirely due to orographic dynamics and that moisture asymmetries are not essential. The asymmetry in vertical displacement is lost and even reversed when the mountain becomes more ridge-shaped with the flow becoming increasingly two-dimensional. In that case "flow around the mountain" is replaced by "flow over the mountain" and gravity waves start to play a more dominant role. The latter may give rise to so-called cap clouds, which are conceptually different from banner clouds. Nevertheless, with the help of trajectories it can be shown that there is a quasi-continuous transition between a banner cloud and a cap cloud.