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# What flow conditions are conducive to banner cloud formation?

Volkmar Wirth and Isabelle Prestel
Universität Mainz, Institut für Physik der Atmosphäre, Mainz, Germany (vwirth@uni-mainz.de)

Banner clouds are clouds that are attached to the leeward slope of a steep mountain. Their formation is essentially due to strong Lagrangian uplift of air in the lee of the mountain. However, little is known about the flow regime in which banner clouds can be expected to occur. The present study addresses this question through numerical simulations of flow past an idealized mountain. Systematic sets of simulations are carried out exploring the parameter space spanned by two dimensionless numbers, which represent the aspect ratio of the mountain and the stratification of the flow. The simulations include both two-dimensional flow past a two-dimensional mountain and three-dimensional flow past a three-dimensional mountain.

Regarding boundary layer separation, both the two- and the three-dimensional simulations show the characteristic regime behavior which has previously been found in laboratory experiments for two-dimensional flow. Boundary layer separation is observed in two of the three regimes, namely in the "leeside separation regime", which occurs preferably for steep mountains in weakly stratified flow, and in the "post-wave separation regime", which requires increased stratification. The physical mechanism for the former is boundary layer friction, while the latter may also occur for inviscid flow. However, boundary layer separation is only a necessary, not sufficient condition for banner cloud formation. Diagnosing the vertical uplift and its leeward-windward asymmetry it turns out that banner clouds cannot form in the two-dimensional simulations. In addition, even in the three-dimensional simulations they can only be expected in a small part of the parameter space corresponding to steep mountains in weakly stratified flow.