Geophysical Research Abstracts,
Vol. 11, EGU2009-13059, 2009
EGU General Assembly 2009

On the Influence of Surface Heterogeneities onto Roll Convection

M. Gryschka (1), C. Drüe (2), S. Raasch (1), and D. Etling (1)

(1) Institut für Meteorologie und Klimatologie, Leibniz Universität Hannover, Hannover, Germany (gryschka@muk.uni-hannover.de), (2) Umweltmeteorologie, Universität Trier, Trier, Germany

Roll convection is a common phenomenon in atmospheric convective boundary layers (CBL) with background wind. Roll convection is observed both over land and over sea for different synoptic situations. There is still some debate about the different types of roll convection and their causes or rather the necessary conditions for their appearance.

The stability parameter $\zeta = -z_i/L$ (z_i: boundary layer height, L: Monin-Obukhov stability length) is widely used as a predictor for roll convection, since numerous studies suggest that convective rolls only appear when $0 < \zeta < 20$. In other words, roll development becomes unlikely for strong surface heating and weak vertical wind shear. In contrast to those studies the presence of roll convection in almost any polar cold air outbreak (as can be seen in numerous satellite images as cloud streets) reveals that even for large ζ roll convection can develop. Some studies report roll convection in cold air outbreaks for $\zeta = 250$.

Our large eddy simulations (LES) on roll convection suggests that the contrasting results concerning the dependency of roll convection on ζ are due to two different types of roll convection: One type which develops purely by self organization if $\zeta < 20$ ("free rolls") and another type which is triggered by heterogeneities in surface temperature and develops also for large ζ ("forced rolls"). We think that most of the cloud streets observed in polar cold air outbreaks over open water are due to rolls of forced type which are tied to upstream located heterogeneities in the sea-ice distribution.

The results of this study suggests that the omission of surface inhomogeneities in previous LES is the reason for the absence of rolls in all LES with strong surface heating and weak vertical wind shear so far. In this contribution we will present a large eddy simulation which successfully represents forced rolls under such conditions.