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Automated large-eddy simulations of realistic atmospheric boundary layers

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Large-eddy simulations (LES) are the most realistic numerical model available for studies of flow in the Atmospheric Boundary Layer (ABL). However, since large scale processes cannot be solved within the LES domain of typically 10x10x5km, LES is nearly always limited to idealized circumstances. In this study, we use the mean state of a regional model to drive and relaxing LES with the analysis of a regional model, in analogy to the way single column models (SCMs) are driven. That way, many different days can be studied, each with their own meteorological characterization. Specifically, diurnal cycles of clear and cloud-topped boundary layers are investigated, including effects of precipitation and soil feed backs.

The focus of this study lies on the meteorology around the Cabauw tower in the Netherlands during May 2008. During this month, Cabauw was the focus of the Intensive Observation Period of the EUCAARI-IMPACT campaign, which gives a very rich set of observations to compare with. Given a sufficiently large relaxation time, boundary layer processes are given the room in LES to fully develop, and characteristics such as cloud height and boundary layer thermodynamics compare well with the environment. In order to robustly run LES for the various days without strong assumptions, it turns out to be important to have a reliable radiation and surface model.

The LES results are embedded in an intercomparison test bed, where LES, several SCMs, and observations can be compared with each other on a daily basis. In this way, a wide range of studies can be done. For instance, the role of individual processes, like radiation, cloud microphysics, or soil and vegetation, can be directly assessed in the controlled environment of LES. Furthermore, the availability in LES of all relevant variables in three dimensions and with a high time resolution in LES allows us to diagnose relations that form the basic assumptions of large-scale model parametrizations.