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Coherent structures in stratocumulus topped boundary layer: sensitivity to surface fluxes, radiative cooling and vertical stability

Paolo Davini (1), Fabio D'Andrea (1), Seung-bu Park (2), and Pierre Gentine (2)

(1) Ecole Normale Superieure, Laboratoire de Meteorologie Dynamique, Paris, France (pdavini@lmd.ens.fr), (2) Department of Earth and Environmental Engineering, Earth Institute, Columbia University, New York, USA

The representation of stratocumulus clouds in global climate models is still a concern for the climate modelling community. This is due to the low efficacy of current parametrization to simulate the full set of phenomena that governs the stratocumulus topped boundary layer (STBL), but also by the inaccurate knowledge of the sensitivities of the STBL dynamics to external large scale forcing.
Here we show that making of a series of high-resolution LES simulations, we are able to detect and track coherent structures such as updrafts, downdrafts and their returning shells (i.e. both ascending and subsiding), together with the entraining air from the inversion layer or the free troposphere in a non-precipitating marine nighttime STBL.
This is done with a new classification method based on octant analysis - using vertical velocity and two passive scalars – which defines the structures also in cloud-free regions. We are thus able to quantify the geometrical and thermodynamic characteristics (e.g. areal fraction, temperature, liquid and total water mixing ratio, buoyancy, etc.) of those structures, highlighting the single contributions to the turbulent transport of mass, heat and moisture.
It is thus possible to estimate the sensitivity of the turbulent fluxes to the intensity of the cloud-top radiative cooling, to the surface latent and sensible fluxes and to the strength of the vertical stability is explored. Indeed, this analysis lays the foundation for a new parametrization of stratocumulus-topped boundary layer for global climate models.