Sensitivity analysis on Stratocumulus-topped Boundary Layers for wind energy applications

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Stratocumulus Clouds are known to have a significant impact on the entire Earth's boundary layer structural properties. One of the key phenomena that they introduce is the convective instability caused by cloud-top radiative cooling (Mellado, 2017). The convection they introduce can influence the entrainment of warm air from the troposphere as well as the mean wind speed, and even the turbulent stresses at the ground (Koning et al., 2021).

In this work, the main parameters that influence such convective instability are investigated. By leveraging Large Eddy Simulations (LES), we study the effect of many parameters, including the subsidence rate, sea surface semperature, free-tropospheric stability, geostrophic velocity, on the evolution of Stratocumulus Topped Boundary Layers (STBL) and their key statistics, such as the liquid water content, the inversion height and the precipitation generated.

Overall, with this contribution we aim at improving the knowledge of STBLs, necessary for future climate predictions. Furthermore, the findings will be applied to the wind energy field, showing their relevance on the prediction of future wind energy generated as well as demonstrating the ability to make a step further in the simulation and understanding of the so-called *terra incognita* of wind energy (Veers et al., 2019).

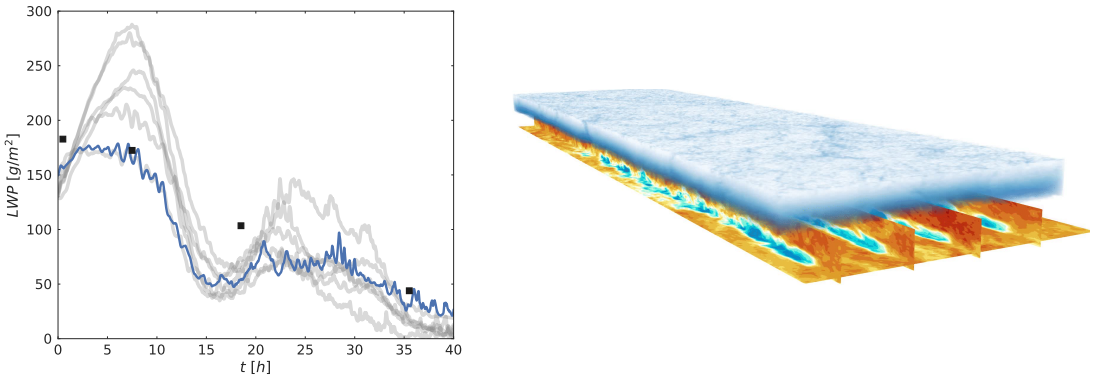

Figure 1: Left: Vertically integrated liquid water content throughout the LES results of the ASTEX campaign; blue line: present work, grey lines: comparison of different codes by v. d. Dussen et al. (2013), black dots: measurements. Right: visualisation of an off-shore wind farm in a Stratocumulus-topped Boundary Layer.

References

Koning A. M., Nuijens L., Bosveld F. C., Siebesma A. P., van Dorp P. A., Jonker H. J. J., 2021, J. Geophys. Res. Atmos., 126

Mellado J. P., 2017, Annu. Rev. Fluid Mech., 49, 145

Veers P., et al., 2019, Science, 366

v. d. Dussen J. J., et al., 2013, J. Adv. Model. Earth Syst., 5, 483

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