Evapotranspiration and cloud variability at regional sub-grid scales

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In regional and global models uncertainties arise due to our incomplete understanding of the coupling between biochemical and physical processes. Representing their impact depends on our ability to calculate these processes using physically sound parameterizations, since they are unresolved at scales smaller than the grid size. More specifically over land, the coupling between evapotranspiration, turbulent transport of heat and moisture, and clouds lacks a combined representation to take these sub-grid scales interactions into account. Our approach is based on understanding how radiation, surface exchange, turbulent transport and moist convection are interacting from the leaf-to the cloud scale. We therefore place special emphasis on plant stomatal aperture as the main regulator of CO2-assimilation and water transpiration, a key source of moisture source to the atmosphere.

Plant functionality is critically modulated by interactions with atmospheric conditions occurring at very short spatiotemporal scales such as cloud radiation perturbations or water vapour turbulent fluctuations. By explicitly resolving these processes, the LES (large-eddy simulation) technique is enabling us to characterize and better understand the interactions between canopies and the local atmosphere. This includes the adaption time of vegetation to rapid changes in atmospheric conditions driven by turbulence or the presence of cumulus clouds. Our LES experiments are based on explicitly coupling the diurnal atmospheric dynamics to a plant physiology model. Our general hypothesis is that different partitioning of direct and diffuse radiation leads to different responses of the vegetation. As a result there are changes in the water use efficiencies and shifts in the partitioning of sensible and latent heat fluxes under the presence of clouds.

Our presentation is as follows. First, we discuss the ability of LES to reproduce the surface energy balance including photosynthesis and CO2 soil respiration coupled to the dynamics of a convective boundary layer. Second, we perform systematic numerical experiments under a wide range of background wind conditions and stomatal aperture response time. Our analysis unravel how thin clouds, characterized by lower values of the cloud optical depth, have a different impact on evapotranspiration compared to thick clouds due to differences in the partitioning between direct and diffuse radiation at canopy level. Related to this detailed simulation, we discuss how new instrumental techniques, e.g. scintillometery, might enable us to obtain new observational insight of the coupling between clouds and vegetation. We will close the presentation with open questions regarding the need to include parameterizations for these interactions at short spatiotemporal scales in regional or climate models.

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Refreshments 3:15 PM
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