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SEMINAIRE CNRM

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THE SPATIOTEMPORAL EVOLUTION OF ATMOSPHERIC BOUNDARY LAYERS OVER A THERMALLY HETEROGENEOUS LAND SURFACE

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Abstract :

The Land surface Interactions with the Atmosphere over the Iberian Semi-arid environment (LIAISE) field experiment took place in July 2021 in the Ebro River Valley in the northeast of Spain. In the domain of the LIAISE field campaign, thermal surface heterogeneity is induced by irrigation which was applied to agricultural fields that cover ~65% of the LIAISE region contrasting with the remaining 35% of the region covered by non-irrigated agricultural fields. Observed Bowen ratios reach approximately 20 in non-irrigated fields, while observed Bowen ratios are approximately 0.1 in the irrigated fields. This contrast could lead to an interaction of scales that range from the a regional scale that encompasses both the irrigated and non-irrigated areas (~10 km) down to a scale of an individual field (~100 m). In addition to surface fluxes, profiles of both the mean state of the atmospheric boundary layer (ABL) and turbulent transport in the ABL were measured over both the irrigated and non-irrigated landscapes. Observations confirm that the surface heterogeneity is felt most strongly near the surface; however, approximately 1000 m above ground level, there appears to be a blending height in which heterogeneity mixes so that the observed ABL potential temperature and specific humidity profiles are similar over both landscapes. Conversely, profiles of turbulent transport shows notable differences between the irrigated and non-irrigated boundary layers. Buoyancy flux over the irrigated area is driven by moisture fluxes, and above an internal boundary layer (approximately 25% of the non-irrigated ABL height), turbulent fluxes of scalers reach their maximum. Turbulence kinetic energy is higher over the non-irrigated landscape because of the increased buoyancy from the surface sensible heat flux, and the

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observed ABL heights are 100-500 m higher in the non-irrigated landscape than the irrigated landscape.

In this study, we discuss novel experiments that combine the synoptic- and meso-scale forcing (ERA5) with the explicit simulation of secondary circulations driven by surface heterogeneity using large-eddy simulation (LES). The surface of the LES is defined with prescribed sensible and latent heat fluxes from observations. With the LES, we aim to better understand the development of the ABL over the LIAISE domain and how the ABL differs in space between the irrigated and the non-irrigated areas. Furthermore, we focus on the turbulent transport – both vertically and horizontally in space – to illustrate the most important processes which contribute to the locally observed ABL.

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