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Stochastic repercussion of land-surface energy budget noise onto a coupled land-atmosphere model

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The present study is based on the work first introduced by Lettau (1951): in this paper Lettau analytically studied the response of a linearized land-atmosphere model to a sinusoidal forcing of net radiation at the land-surface. The model has been first improved to obtain the analytical solution of the temperature and heat flux profiles in the soil and in the Atmospheric Boundary Layer (ABL) in response to any daily forcing of incoming radiation at the land-surface. With this model, the profiles of temperature and heat are expressed in terms of temporal Fourier series. Moreover the surface variables (temperature, specific humidity, surface fluxes) are also derived analytically and their diurnal course is expressed as a function of both surface parameters (friction velocity, vegetation height, aerodynamic resistance, stomatal conductance).

In this presentation, we further extend the application of this theoretical model to the study of the error in the land-surface energy budget closure. This closure error could result form either modeling or experimental inaccuracies, leading to incorrect energy partitioning at the land-surface. In particular, the response of the coupled land-atmosphere model to the land-surface energy error is investigated. This noise in the energy budget is introduced in the form of a stochastic Brownian Bridge, which is a Brownian Motion conditioned to vanish at 0h and 24h.

First the impact of land-surface noise on the partitioning of land-surface energy partitioning is examined. Moreover the influence of the land-surface noise on Land Surface Temperature and air temperature is carefully analyzed, as it is fundamental for the use of data assimilation in conjunction with land-surface models.

Finally, the repercussion of the surface noise in the ABL and the soil is analytically found and its temporal and spatial dependency is studied. In particular, the correlation between the land-surface state and the ABL state is further investigated. These results emphasize the impact of accurate land-surface modeling on both the atmosphere and the soil representation, leading to strong impact on meteorological and hydrological predictions as well as for data assimilation of land-surface temperature.