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A framework to quantify the influence of land-atmosphere feedbacks on surface evaporation

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We present a quantitative framework in which the daily evolution of evaporation over land can be decomposed into contributions by the relevant processes that determine the evaporation, such as the incoming radiation, the atmospheric temperature and humidity, the surface layer characteristics and the land surface properties. Our method allows for a seperation of feedbacks from forcings and for a seperation of the land surface, surface layer and boundary layer feedbacks from each other. The method requires vertical profiles of temperature and moisture and data of surface heat fluxes which can be provided by measurements or by model data. The essence of our framework is that we created a tendency equation for evaporation in which each of the feedbacks and forcings has its own distinct contribution to the time evolution of the surface evaporation.

By applying our method to some real data cases we show that dry air entrainment between the convective boundary layer and the free troposphere has a very significant contribution to the surface evaporation throughout the day. This is especially true in locations where the overlying free troposphere is dry compared to the boundary layer, such as at the Southern Great Plains site or in the Sahel, as has been observed during the AMMA campaign. In addition, we show that in nearly all conditions boundary layer feedbacks are of much larger importance to the daily evolution of the evaporation than surface layer feedbacks. Finally, we show how our method can help in quantifying the degree of coupling between the land surface and the atmosphere.