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Observations and parameterization of longwave radiative flux divergence in the stable boundary layer over land

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Longwave radiation divergence plays an important role in governing the temperature structure of the stable boundary layer over land during calm conditions. Unfortunately, longwave radiation divergence in the stable boundary layer is poorly represented in large-scale weather forecast and climate models. Radiative transfer models are usually calibrated on the mean cooling in the full atmospheric column. However, the stable boundary layer (SBL) is only a shallow layer close to the ground where the cooling rate can significantly differ from the tropospheric cooling rate. In addition, the dynamics of the SBL over land is relatively fast and radiation impacts strongly on the vertical structure. As such, radiation divergence needs to be represented properly and calculations are needed with high temporal resolution, which is often circumvented in operational models because of computational demand.

Direct observations of radiation divergence close to the surface are scarce. Here we present a half-year dataset of observed radiation divergence on a 20 m tower over grassland in The Netherlands. We examine the relative contribution of radiation divergence to the total cooling rate. We will also present a robust and simple model for parameterizing long wave radiation divergence in large-scale models. It appears that longwave radiative cooling in the stable boundary layer can be reasonably estimated from the curvature of the temperature profile, the gradient of the humidity and the temperature difference between the surface and screen level. In addition, we show the impact of the parameterization in a column model, and we compare the results with

results obtained with a grey-body emissivity scheme.