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The effects of sub-grid heterogeneity on evapotranspiration estimates in the data-driven global evaporation model, GLEAM

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Land surface heterogeneity and the processes involved in terrestrial evapotranspiration operate at spatial scales that cannot be typically represented by large-scale land surface models and hence are often averaged over large grid cells. The Global Land Evaporation Amsterdam Model (GLEAM) is one such model that uses remotely sensed data and a simple conceptual modelling framework to estimate terrestrial evaporation at the global scale. It operates at a relatively coarse resolution of 0.25° grid cells to balance computational costs while accommodating existing global observations. Evapotranspiration (ET) estimates in GLEAM are expressed as a function of potential evaporation and a stress factor that accounts for water limitations. Using the Priestley-Taylor formula for calculation of potential evaporation, ET estimates in GLEAM are nonlinearly related to temperature, net radiation, and soil moisture (available water). At large scales, only coarse grid-cell-averaged values of these variables are available. In this study we show how averaging over sub-grid heterogeneity of temperature, net radiation, and soil moisture (drivers of ET) leads to biases in grid-cell-averaged evapotranspiration rates as estimated by GLEAM across Switzerland. We use 500-meter resolution data across Switzerland to quantify the heterogeneity effect at several spatial scales and show that averaging over land surface heterogeneity leads to over-estimation of ET in steep mountainous areas and underestimation of ET in lowland areas and valleys.