Hydrology and Earth System Sciences

Supporting Information for

Averaging over spatiotemporal heterogeneity substantially biases evapotranspiration rates in a mechanistic large-scale land evaporation model

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Content of this file

- Table S1, PREVAH hydrological and meteorological data
- Figure S1, Land cover map of Switzerland with corresponding albedo values
- Figures S2-S4
- Data availability

Table S1. *PREVAH* hydrological and meteorological data. All data are in gridded format and at 500 m spatial resolution and (if relevant) daily temporal resolution

Data	**Source**
PREVAH soil moisture (m^3/m^3)	Simulations from *PREVAH* hydrological model, Brunner et al., 2019 ; Speich et al., 2015; Orth et al., 2015; Zappa et al., 2003
precipitation (mm d-1)	Interpolation of MeteoSwiss data after Viviroli et al., 2009
radiation (W m-2)	Interpolation of MeteoSwiss data after Viviroli et al., 2009
relative humidity (-)	Interpolation of MeteoSwiss data after Viviroli et al., 2009
sun duration (hr)	Interpolation of MeteoSwiss data after Viviroli et al., 2009
temperature (°C)	Interpolation of MeteoSwiss data after Viviroli et al., 2009
vapor pressure (Pa)	Interpolation of MeteoSwiss data after Viviroli et al., 2009
CH land use	BFS, Swiss Federal Statistical Office, 1995

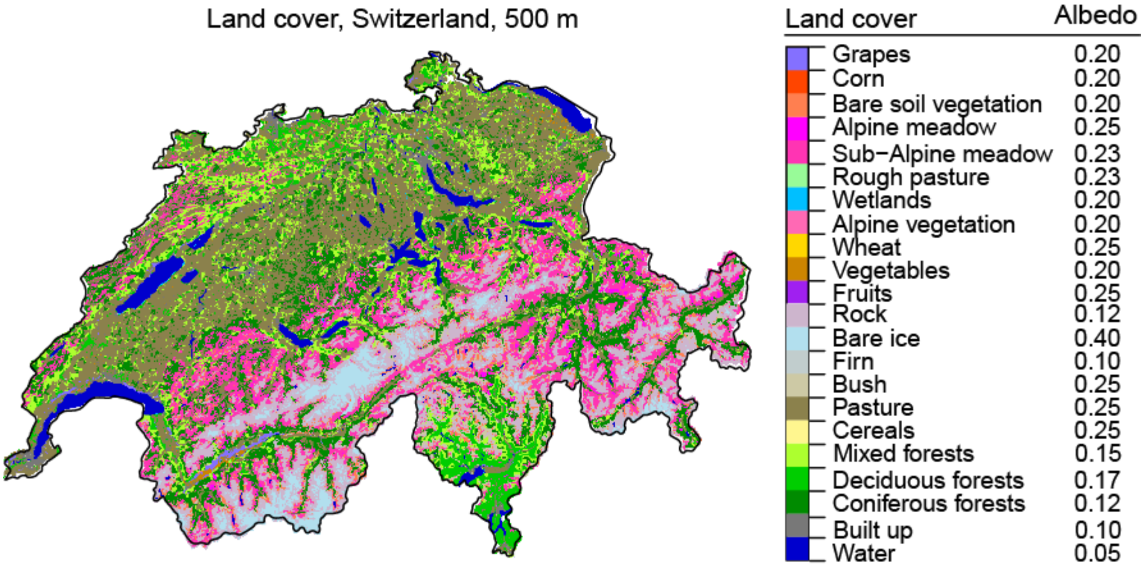

Figure S1. Land cover map of Switzerland at 500-meter resolution along with the albedo values associated with each land cover type (BFS, 1995; Viviroli et al., 2009)

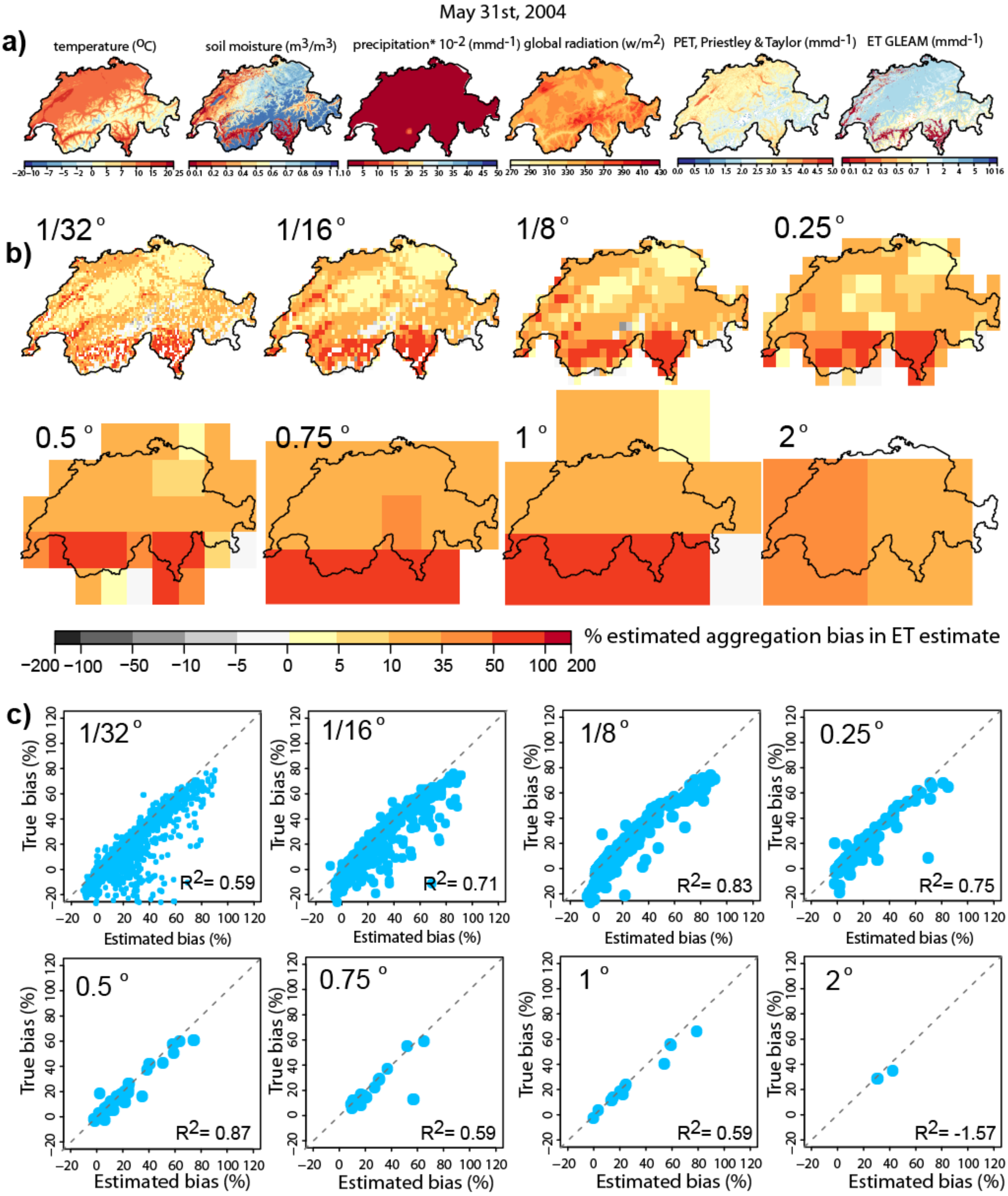

Figure S2. a) Spatial distribution of input data at 500 m resolution for a randomly selected day (31.05.2004) to calculate ET. Potential evapotranspiration (PET, mmyr^{-1}) is calculated using Priestley-Taylor equation (Eq. 3), and evapotranspiration (ET, mmyr^{-1}) is calculated using the approach used in GLEAM model (Miralles et al., 2011; Martens et al., 2017; Eq. 1). b) Aggregation bias estimated from 500 m temperature (°C), soil moisture (w_w), net radiation (R_n), their variances at each grid scale, and the covariances of all the pairs using Eq. 7. Even at the finest resolutions (1/32 and 1/16 degrees) the aggregation bias rises to 50-100 % overestimation in daily ET estimates in South Switzerland. c) Daily approximated aggregation bias in ET estimates versus daily true aggregation bias in ET estimates at several spatial scales for 31.05.2004. Approximated aggregation bias is calculated using Eq.7. The true bias is the difference between the finer-resolution ET estimates from finer-resolution input data, averaged over several spatial scales (average of functions) and average ET estimated from average inputs at each spatial scale (function of averages). The coefficient of determination (R^2) between the true and approximated aggregation bias confirms the appropriateness of the proposed method and Eq. 7 for approximating the aggregation bias.

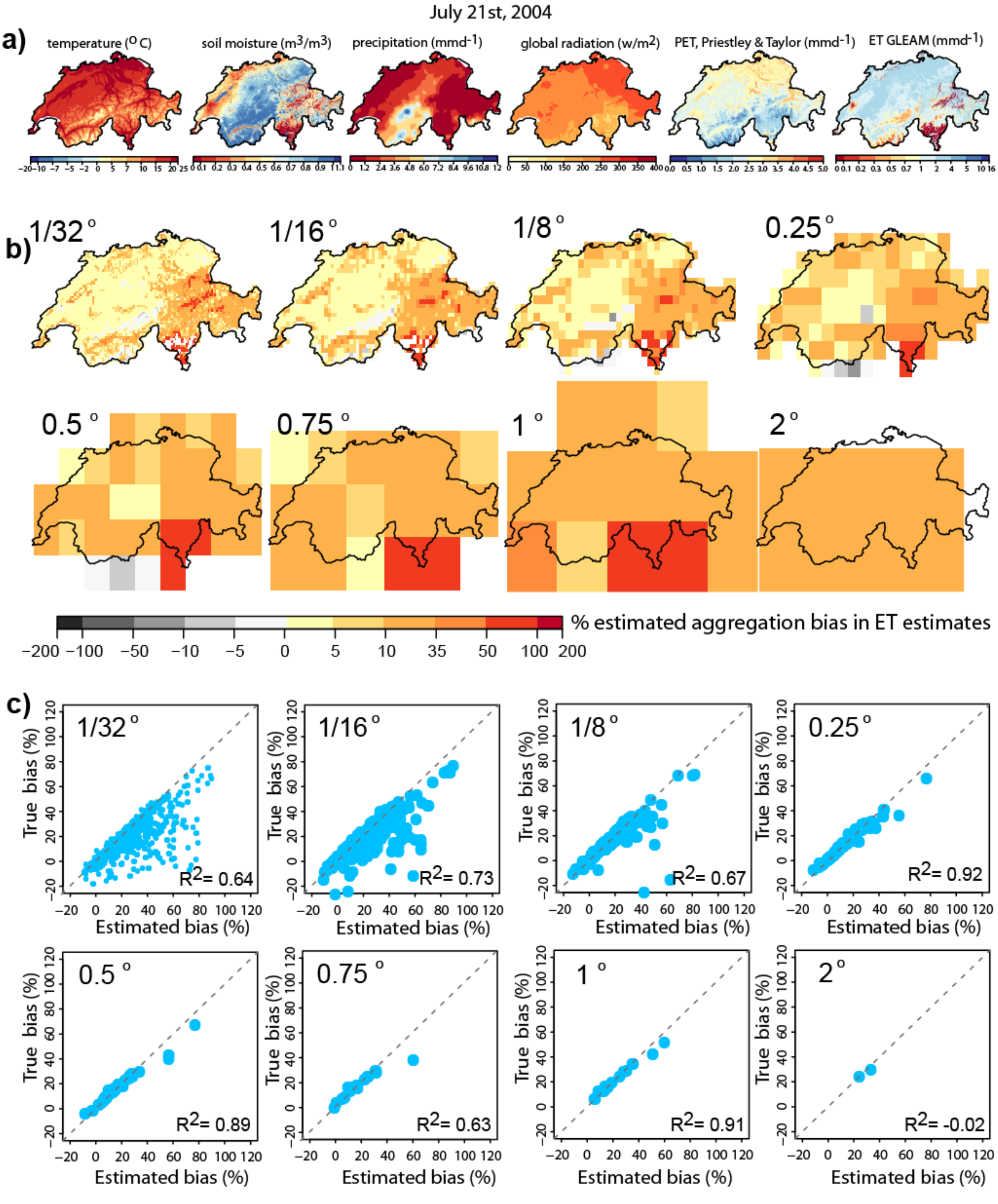

Figure S3. Same as in Fig. S2 but for another randomly selected day (21.07.2004).

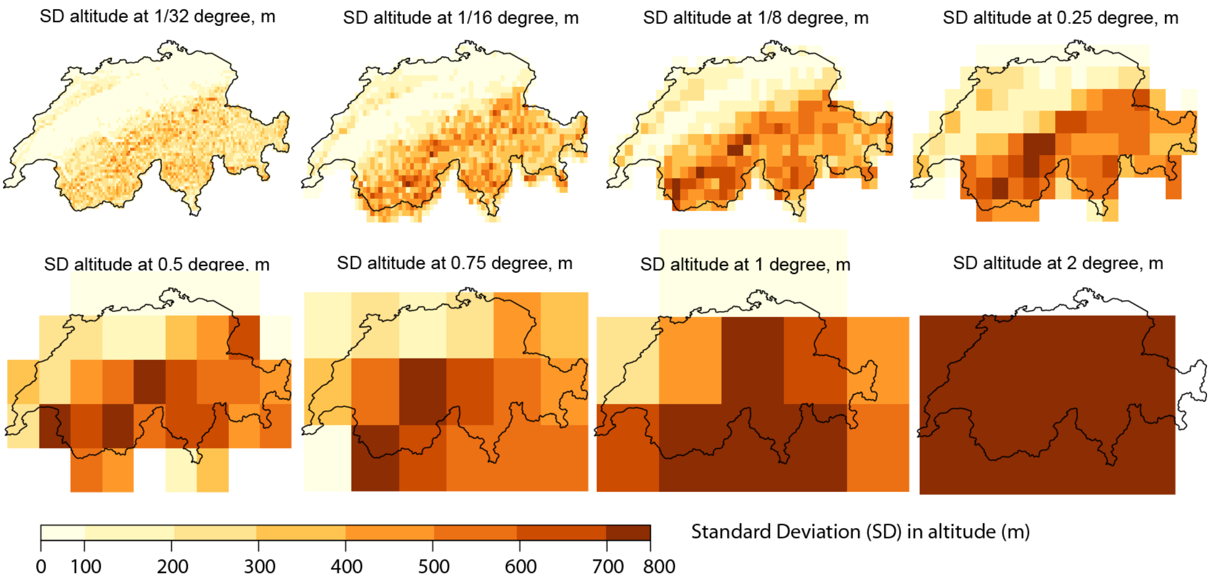

Figure S4. Standard deviation of altitude across several grid scales calculated from 500 m resolution topographic data (Bundesamt für Landestopographie, 1991). The spatial patterns of topographic variability at each grid scale are similar to spatial patterns of the median of daily aggregation biases shown in Fig 2 of the manuscript.

Data availability

We will upload the source data for this study to a FAIR repository and provide the URL with the final version of the paper.