



Supplement of

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

Elham Rouholahnejad Freund et al.

Correspondence to: Elham Rouholahnejad Freund (elham.rouholahnejad@gmail.com)

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Supplement

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20 Table S1. *PREVAH* hydrological and meteorological data. All data are in gridded format and at 500 m spatial

21 resolution and (if relevant) daily temporal resolution

| Data | Source |
|-----------------------------------|---|
| PREVAH soil moisture | Simulations from PREVAH hydrological model, Brunner et al., 2019; |
| (m ³ /m ³) | Speich et al., 2015; Orth et al., 2015; Zappa and Gurtz, 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 |

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26 Figure S1. Land cover map of Switzerland at 500-meter resolution along with the albedo values associated with

- 27 each land cover type (BFS, 1995; Viviroli et al., 2009)
- 28

May 29th, 2004



- 32 Figure S2. a) Spatial distribution of input data at 500 m resolution for a arbitrarily selected day (29.05.2004) to
- 33 calculate ET. Potential evapotranspiration (PET, mmyr⁻¹) is calculated using the Priestley-Taylor equation (Eq.
- 3), and evapotranspiration (ET, mmyr⁻¹) is calculated using the approach used in the GLEAM model (Miralles et
- al., 2011; Martens et al., 2017; Eq. 1). b) Aggregation bias estimated from 500 m temperature (°C), soil
- 36 moisture (w_w), net radiation (R_n), their variances at each grid scale, and the covariances of all the pairs using
- 37 Eq. 7. Even at the finest resolutions (1/32 and 1/16 degrees) the aggregation bias rises to 50-100 %
- 38 overestimation in daily ET estimates in South Switzerland. c) Daily approximated aggregation bias in ET
- 39 estimates versus daily true aggregation bias in ET estimates at several spatial scales for 29.05.2004.
- 40 Approximated aggregation bias is calculated using Eq.7. The true bias is the difference between the finer-
- 41 resolution ET estimates from finer-resolution input data, averaged over several spatial scales (average of
- 42 functions) and average ET estimated from average inputs at each spatial scale (function of averages). The
- 43 coefficient of determination (R²) between the true and approximated aggregation bias confirms the
- 44 appropriateness of the proposed method and Eq. 7 for approximating the aggregation bias.



46 Figure S3. Same as in Fig. S2 but for another arbitrarily selected day (18.07.2004).

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50 Figure S4. Standard deviation of altitude across several grid scales calculated from 500 m resolution

51 topographic data (Bundesamt für Landestopographie, 1991). The spatial patterns of topographic variability at

52 each grid scale are similar to spatial patterns of the median of daily aggregation biases shown in Fig 2 of the

- 53 manuscript.
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57 Figure S5. Soil moisture (m³ m⁻³) averaged over several grid scales calculated from 500 m resolution soil

moisture data (m³ m⁻³) for a arbitrarily selected day (29.05.2004). The 500 m resolution soil moisture data are
simulated by the PREVAH hydrological model (Brunner et al., 2019; Speich et al., 2015; Orth et al., 2015; Zappa

60 and Gurtz, 2003).



64 Figure S6. Same as in Fig. S5 but for another arbitrarily selected day (18.07.2004).

66 Data availability

- 67 Temperature data are an interpolation of MeteoSwiss data after Viviroli et al. (2009) and are originally from
- 68 archive data of MeteoSwiss ground level monitoring networks. However, the acquired data may not be used
- 69 for commercial purposes (e.g., by passing on the data to third parties or by publishing them on the internet).
- As a consequence, we cannot offer direct access to the data used in this study. Daily soil moisture saturation,
- net radiation, and temperature data over Switzerland at a 500m resolution for the year 2004 can be retrieved
- 72 from EnviDat at https://doi.org/10.16904/envidat.176 (Rouholahnejad Freund et al., 2020).
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