Supplementary Figures for: Optimising global landscape evolution models with 10Be

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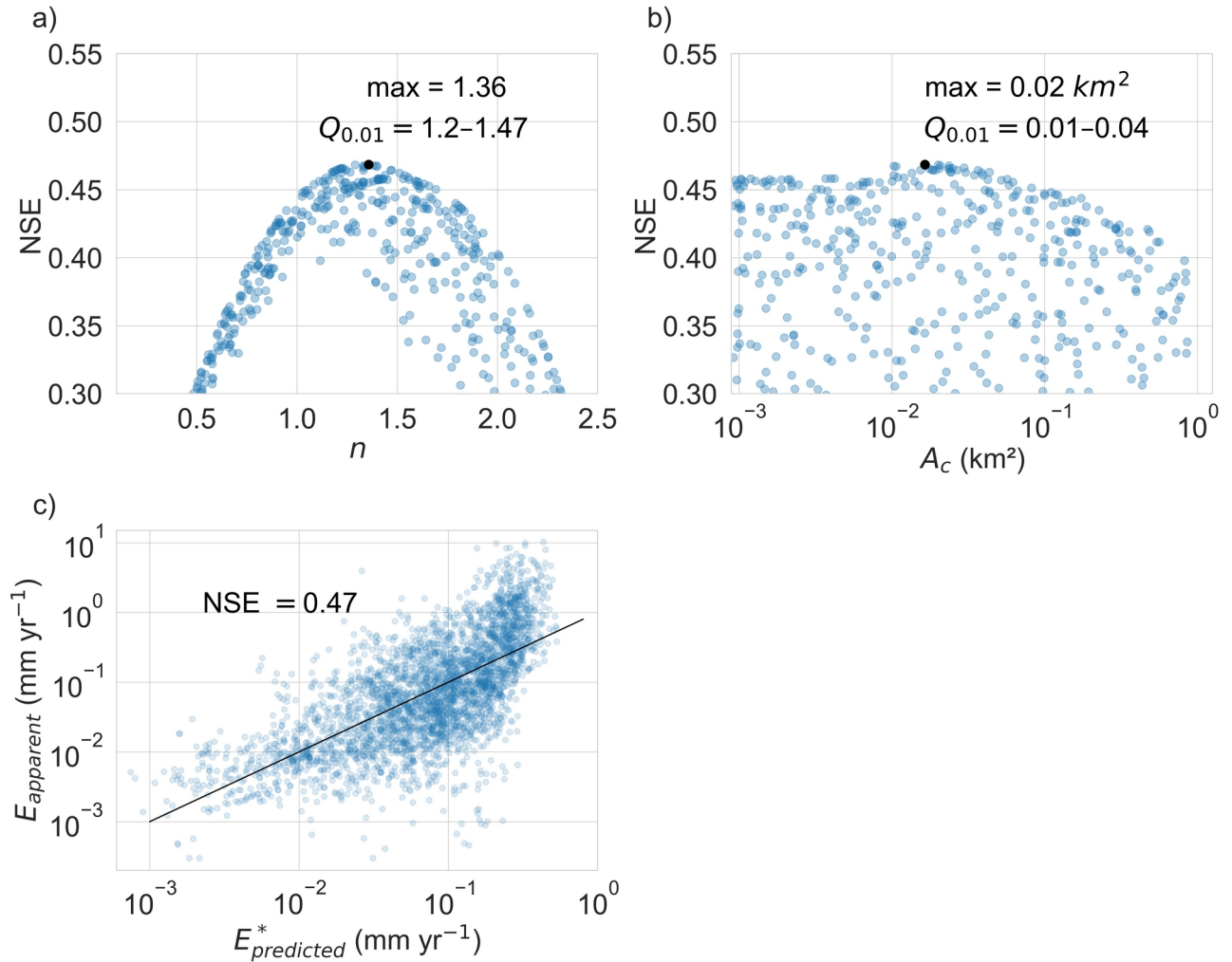3 Department of Physical Geography and Geoecology, Charles University, Prague, Czech Republic

Figure S1: The optimal advection model n value in the 30m resolution models based on the Copernicus 1-arc second DEM (a) is shifted slightly higher compared with the lower resolution model, (optimal value n=1.36 compared with n=1.28 in the optimal 90m resolution model). Meanwhile, the optimal A_c (b) is lower (A_c=0.02 km^2 here vs 0.05 km^2 in the low resolution model). The different resolution models are still largely consistent in spite of these differences, and give a similar maximum NSE of 0.47 (c) compared with 0.48 for the 90m model.
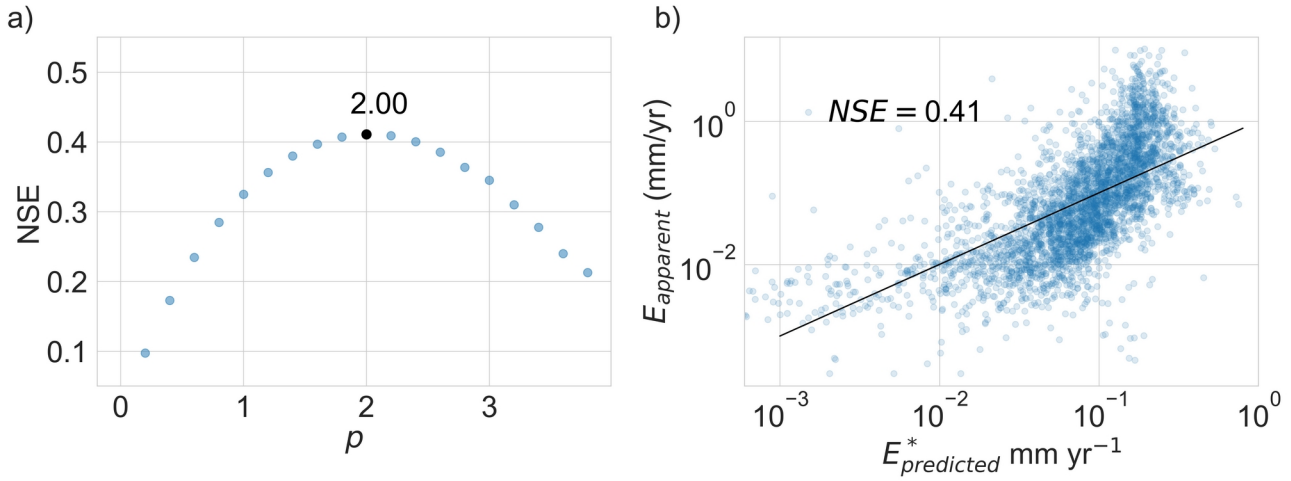
a)

b)

Figure S2: The optimised diffusion exponent in the 30m models of $p=2.0$ is consistent with that of the lower resolution model of $p=2.0$. However, the optimal fit is worse at NSE = 0.41 (compared with NSE=0.51 for SRTM 90). This difference may arise in part because the model based on the SRTM data appears better able to capture the variability of erosion rates (compare panel b to Figure 3b of the main text). This may suggest that the higher scatter of the SRTM surface elevation data, (whether real or due to noise) serves as somewhat of a proxy for surface roughness in steeper / rapidly eroding terranes.

a)

max = 1.28
$Q_{0.01}$ = 1.15–1.43

b)

max = 0.05 km^2
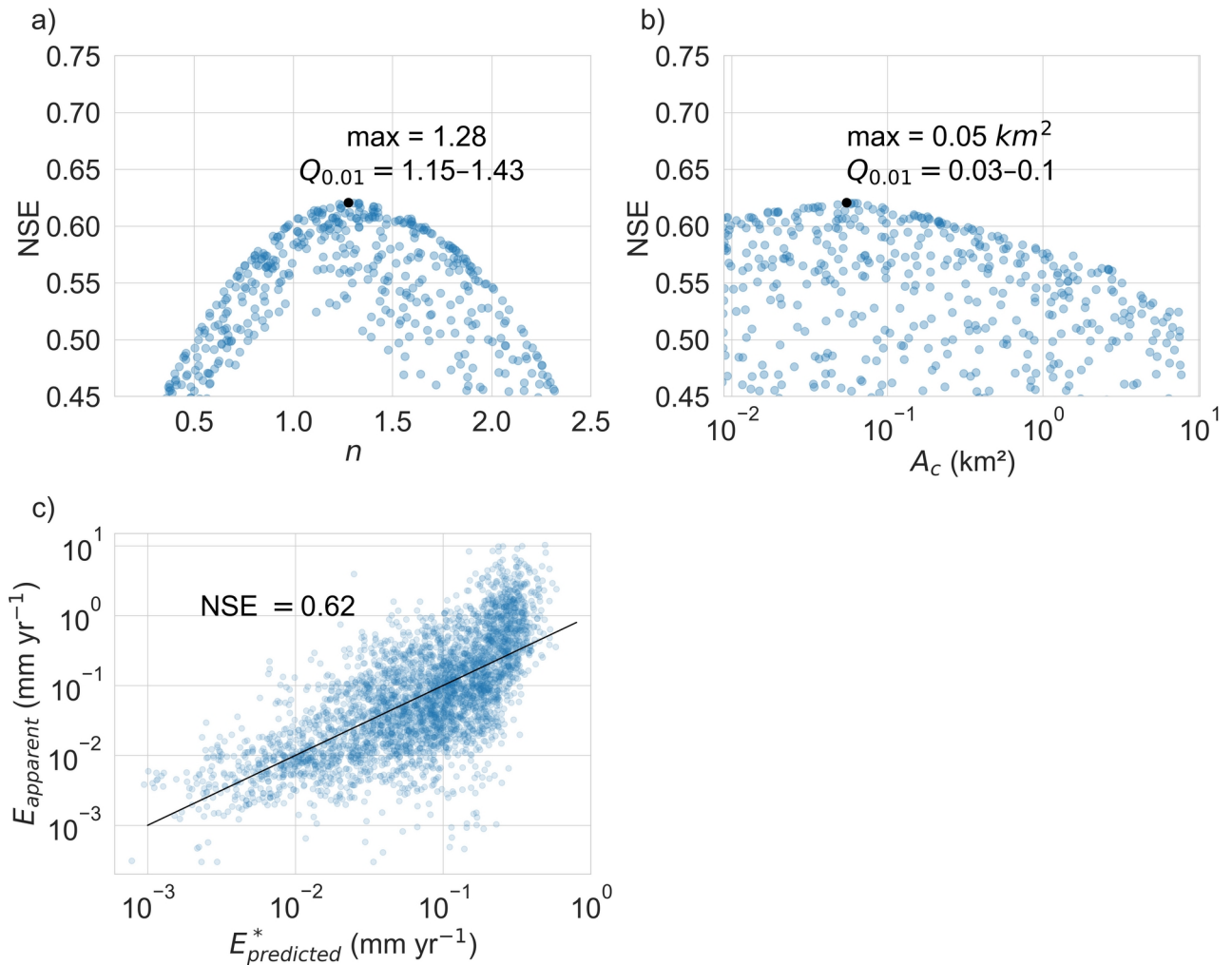$Q_{0.01}$ = 0.03–0.1

c)

NSE = 0.62

Figure S3: Example of the advection-only model run using a form of NSE that accounts for measurement error after Harmel and Smith (2007). The Model yields nearly the same optimized n (1.28) and A_c value (0.05 km^2) as the model run using NSE on the means from the main text (n=1.28, A_c = 0.05). The main difference is that the NSE metric is skewed upwards (c; NSE=0.62) because many $E^*_{predicted}$ estimates lie within the range of measurement error of $E_{apparent.}$
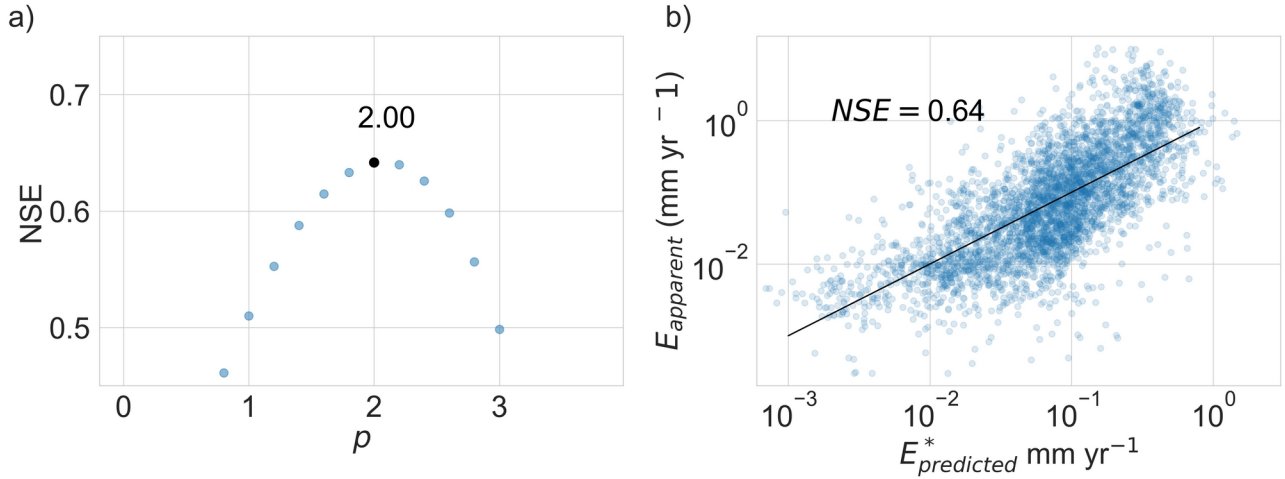

Figure S4: Example of the diffusion-only model run using a form of NSE that accounts for measurement error after Harmel and Smith (2007). The Model yields the same optimized p (2.0) as the model run using NSE on the means from the main text. The main difference is that the NSE metric is skewed upwards (b; NSE=0.64) because many $E^{*p}_{redicted}$ estimates lie within the range of measurement error of $E_{apparent.}$
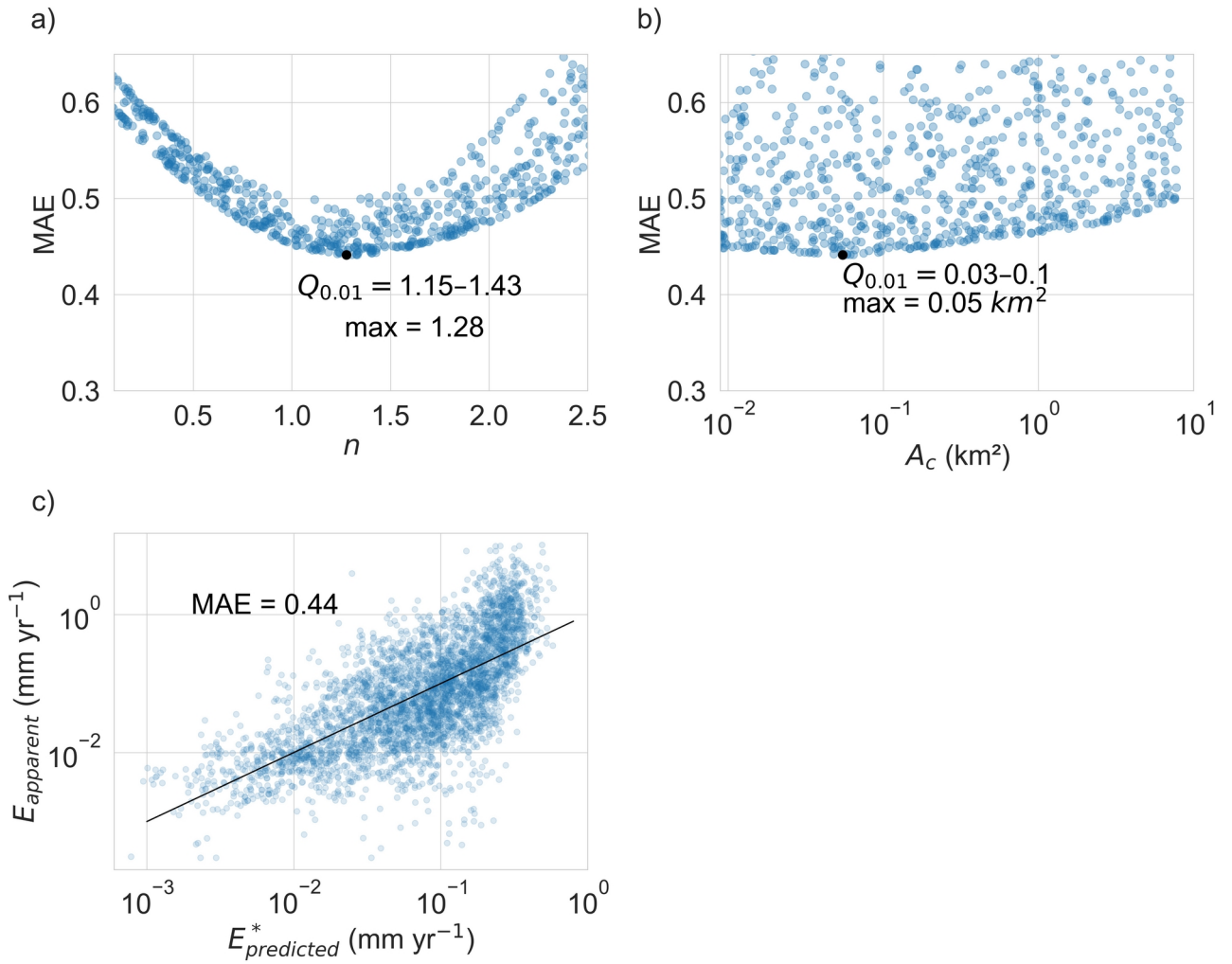
Figure S5: The optimal advection-only values, using MAE as a likelihood function a) n=1.28 and b) A_c = 0.05 km^2 are identical to the results from models optimised using NSE of n=1.28 and A_c=0.05, respectively. The optimal model (c) has an average absolute error of 0.44 (log(mm yr^{-1})).
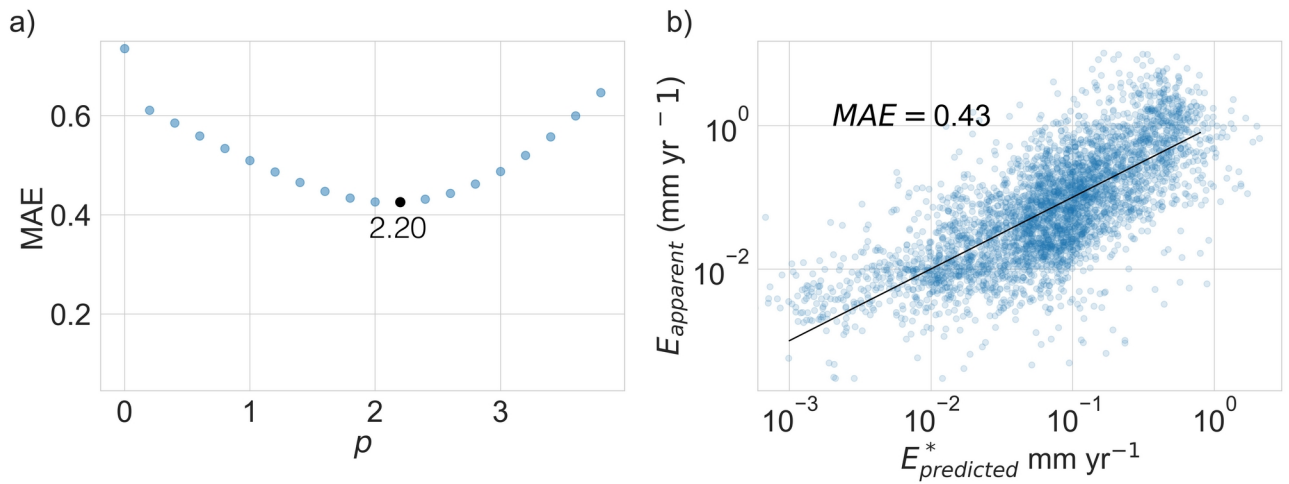

Figure S6: The optimal advection-only values, using MAE as a likelihood function a) p=2.2 is similar to the results from models optimised with NSE, p=2.0. The optimal model (c) has an average absolute error of 0.43 (log(mm yr^{-1})).
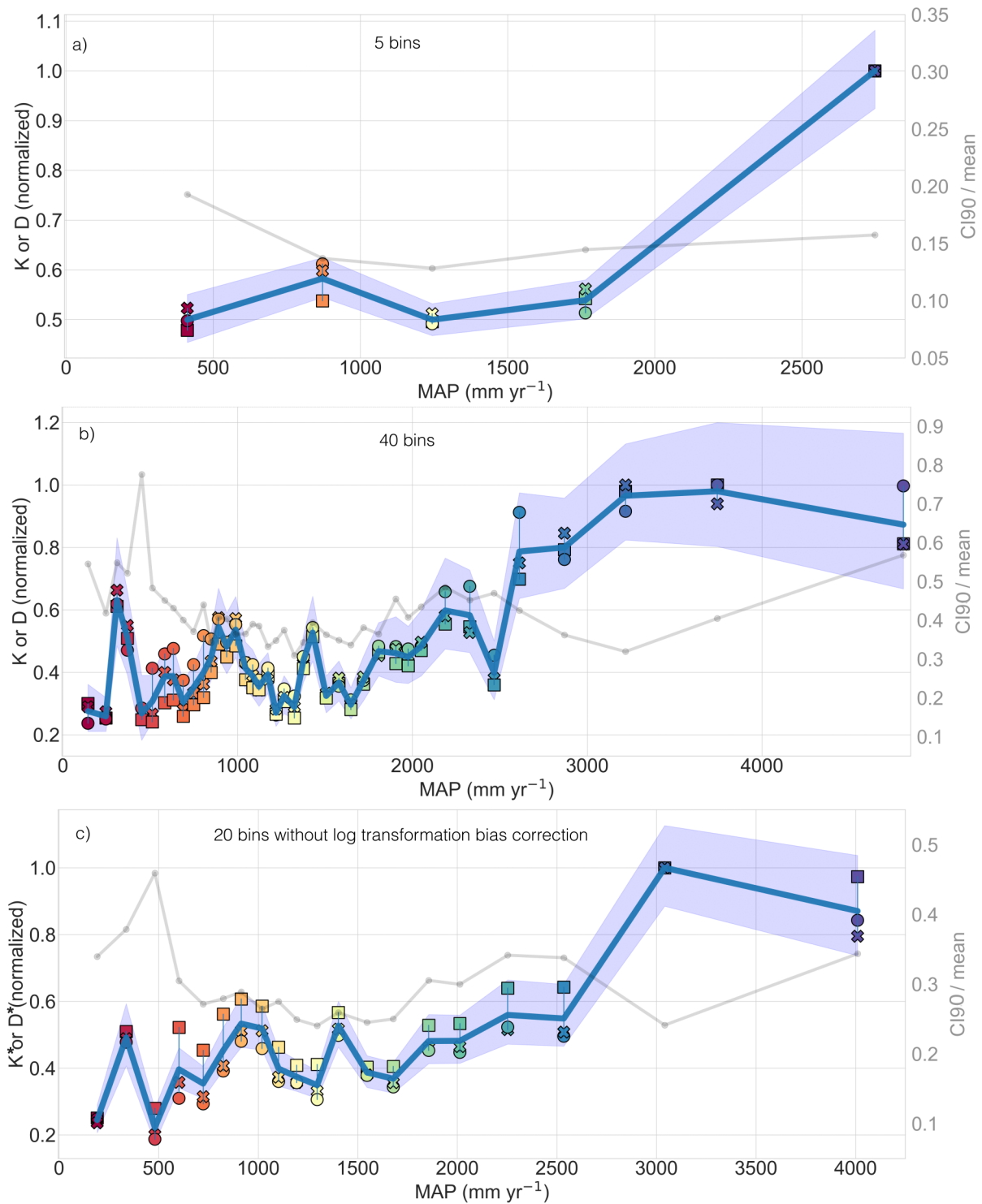
Figure S7: Exploration of binning on the relationships between (*K* or *D*) or (*K** or *D**) and MAP. a) *K* determined using only 5 MAP bins. b) *K* determined using 40 MAP bins, and c) non-log transformed *K* (*K**) determined using 20 MAP bins. Refer to Figure 5 of the main text for a full description of figure elements.
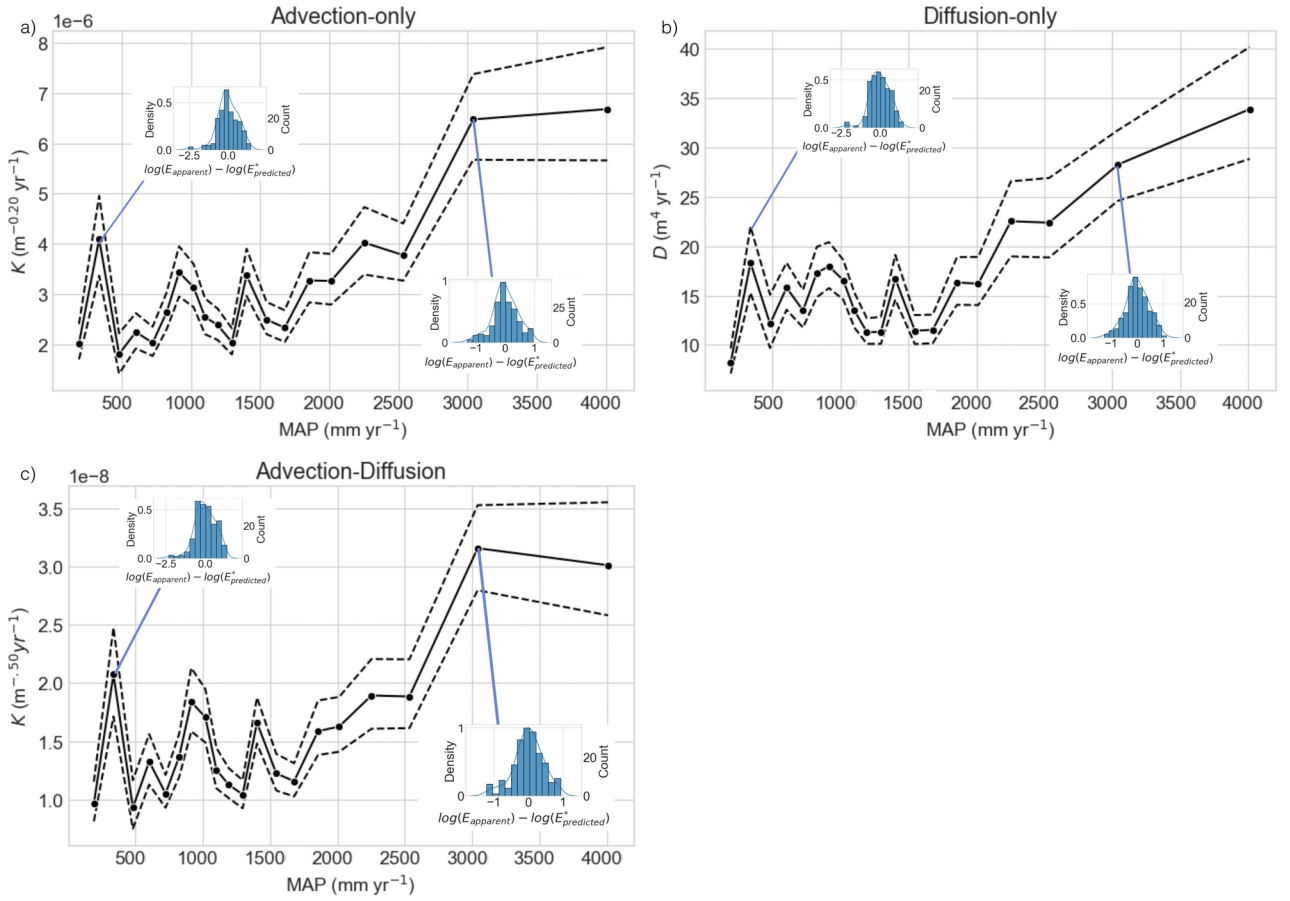
Figure S8: Corresponding Figure for Figure 5 of the main text, showing the 90% confidence intervals surrounding optimized K values within different climate bins and residuals for each bin. CI was determined by calculating K within each bin using (nonparametric) bootstrapped values of $E_{apparent}$ for 1000 iterations. We also show residuals and corresponding high scatter for select bins, but with a generally log-normal appearance for most bins. a): Advection only with $n = 1.28$, $A_c =$ 0.05; b: Diffusion-only with $p = 2.0$; c: Advection-Diffusion with $n=2.26$, $A_c=0.03$, $D/K = 1.79 \ 10^6$.
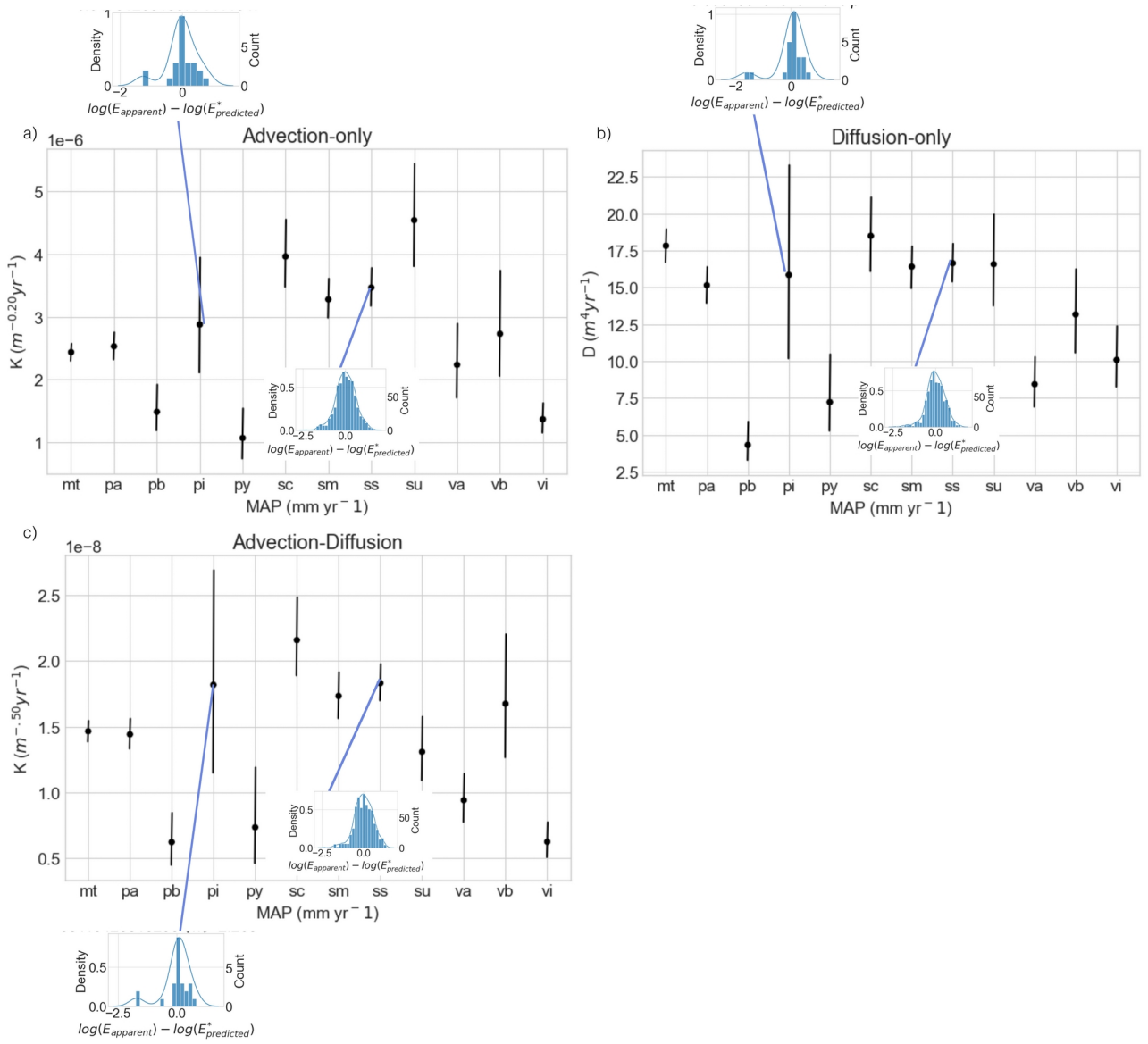
Figure S9: Corresponding Figure for Figure 6 of the main text, showing the 90% confidence intervals surrounding optimized *K* values within different climate bins and (inset) residuals select bins. CI was determined by calculating *K* within each using bootstrapped values of $E_{apparent}$ for 1000 iterations. We also show residuals and corresponding high scatter for select bins, but with a generally log-normal appearance for most bins. The exception to this may be bins with lower numbers of samples (e.g., Plutonic Intrusive), which also have high uncertainty. a: Advection only with $n = 1.28$, $A_c = 0.05$; b: Diffusion-only with $p = 2.0$; c: Advection-Diffusion with $n=2.26$, $Ac=0.03$, $D/K = 1.79 \cdot 10^6$.
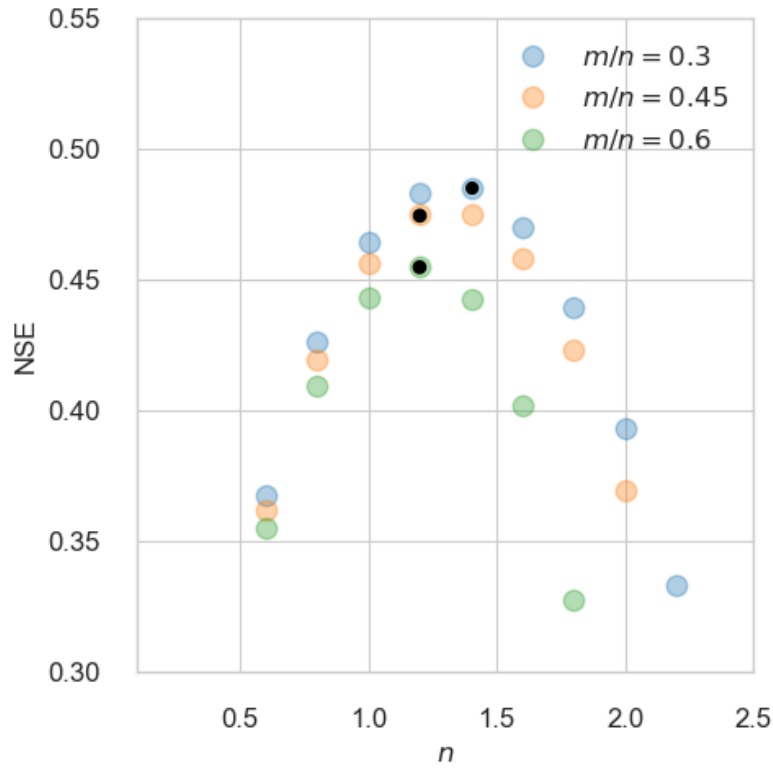
Figure S10: Model results for the advection-only model with free variable *n* using different *m/n* ratios. The best performance is the model run with *m/n* = 0.3 (*n=1.4*, NSE=0.48), slightly higher than the model run with *m/n=0.45* (*n=1.2*, NSE=0.47) and higher than the model run with *m/n=0.6* (n=1.2, NSE=0.45). However, our inability to optimise the global average of *m/n~0.45* suggests that perhaps our method cannot constrain this parameter while simultaneously solving for *n*, and instead it must be inferred directly from topographic morphometry (e.g. Gailleton et al., 2021).