

Volume/area scaling model vs. OGGM flowline model

A Master's Thesis SITREP

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Introduction



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Testing the importance of explicit glacier dynamics for future
glacier evolution in the Alps

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- ▶ Future ice volume projection

Volume/area scaling model

Hintereisferner - Blick Richtung Weißkugel und Langtaufererspitze
21.10.20 14:00 3.4°C



foto-webcam.eu

Volume/area scaling model

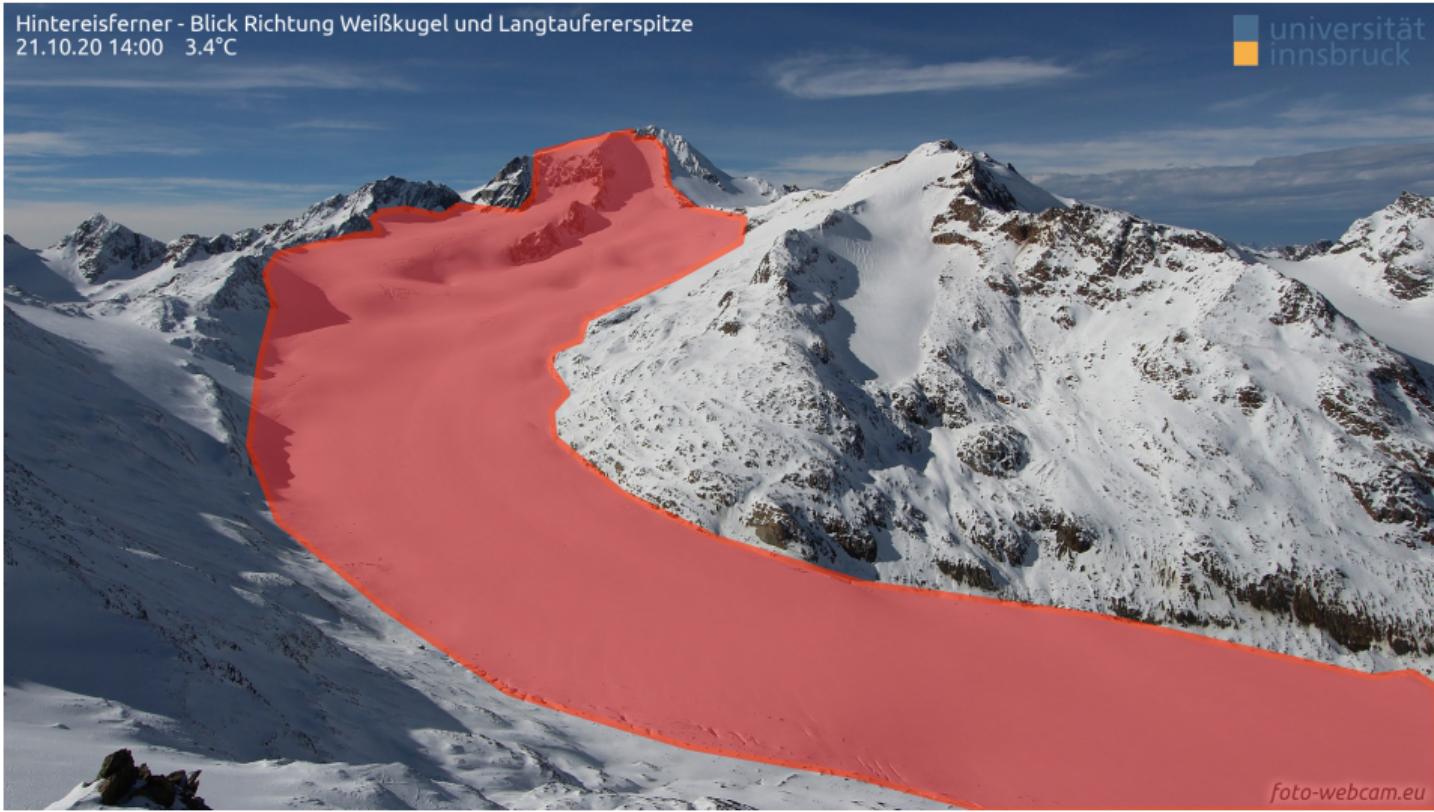
Hintereisferner - Blick Richtung Weißkugel und Langtaufererspitze
21.10.20 14:00 3.4°C

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Volume/area scaling model

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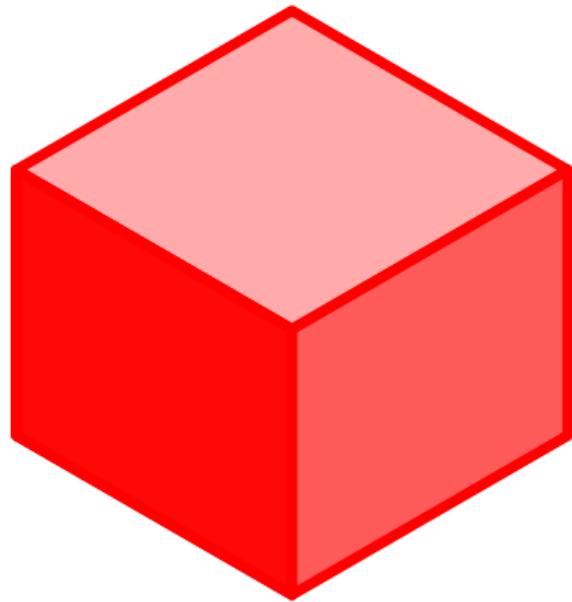


Volume/area scaling model

Volume/area scaling relation:

$$V_0 = c_A \cdot A_0^\gamma$$

Volume/area scaling model



Volume/area scaling model

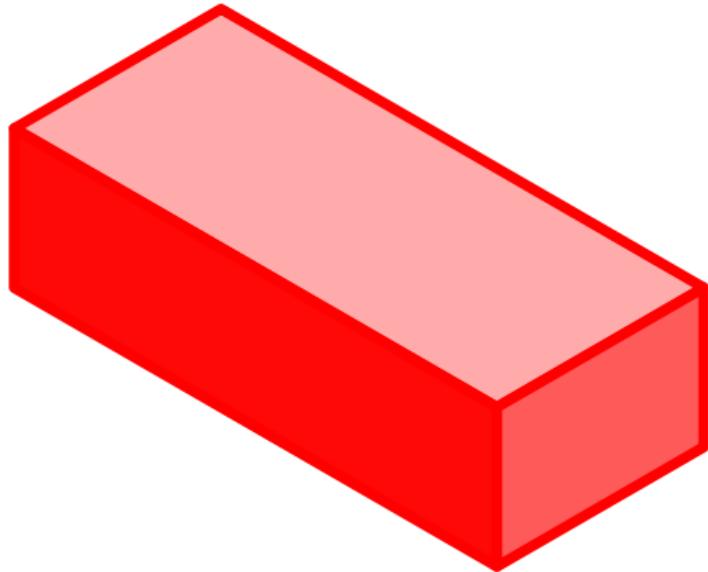
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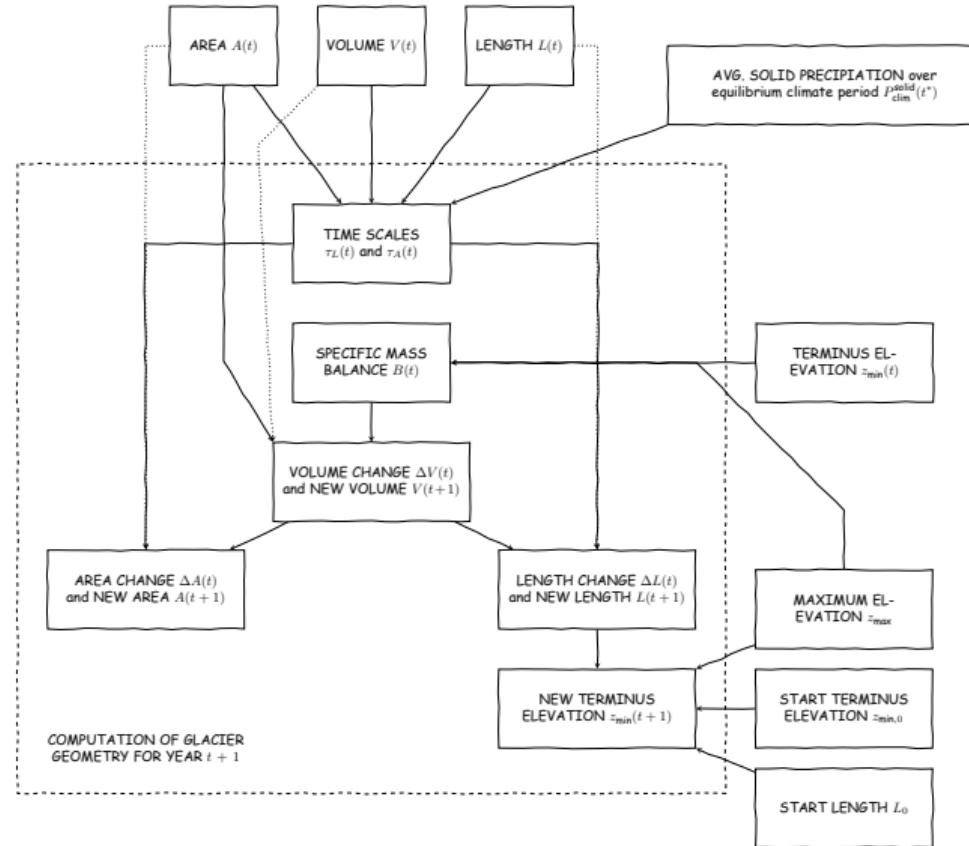
Inverted volume/length scaling relation:

$$L_0 = \frac{V_0^{1/q}}{c_L}$$

Volume/area scaling model



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Volume changes instantaneously:

$$\Delta V(t) = \frac{1}{\rho_{\text{ice}}} A(t) \cdot B(t)$$

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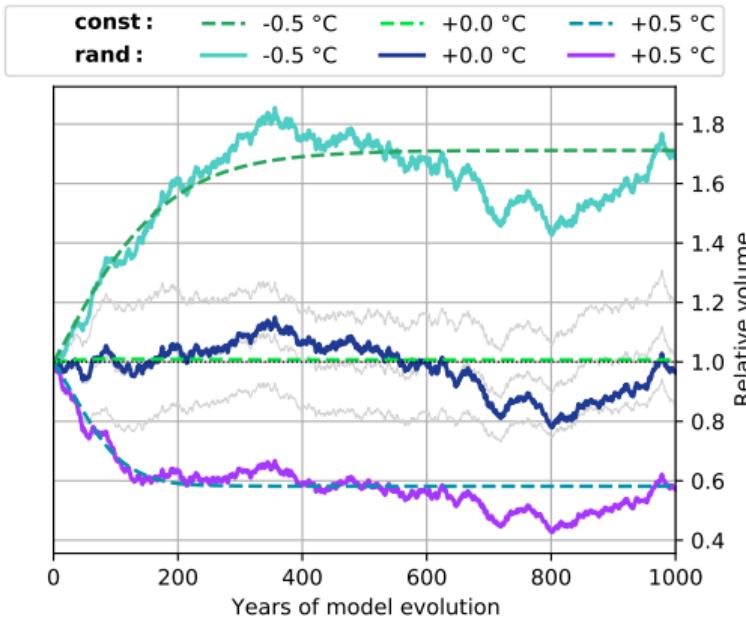
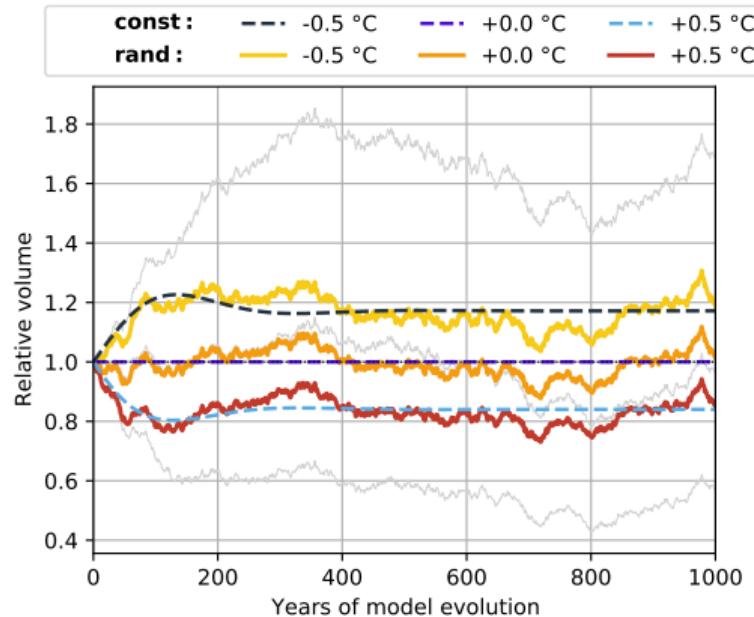
Area and length follow **response time scaling**:

$$\Delta L(t) = \frac{1}{\tau_L} \left(\left(\frac{V(t)}{c_L} \right)^{1/q} - L(t) \right)$$

$$\Delta A(t) = \frac{1}{\tau_A} \left(\left(\frac{V(t)}{c_A} \right)^{1/\gamma} - A(t) \right)$$

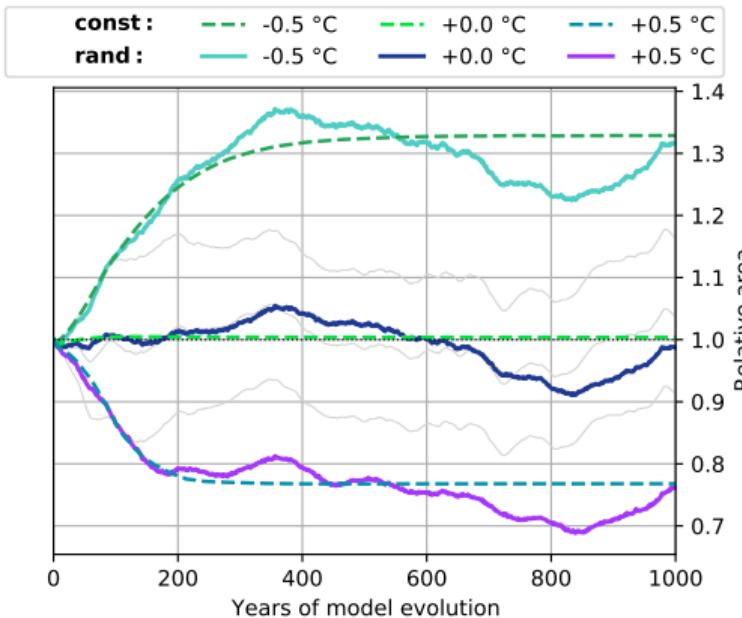
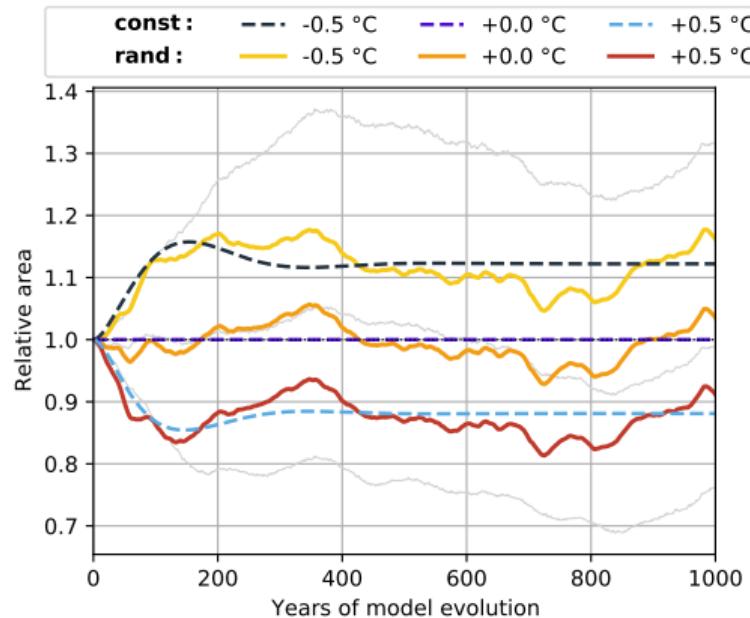
Hintereisferner test case

Relative ice volume:



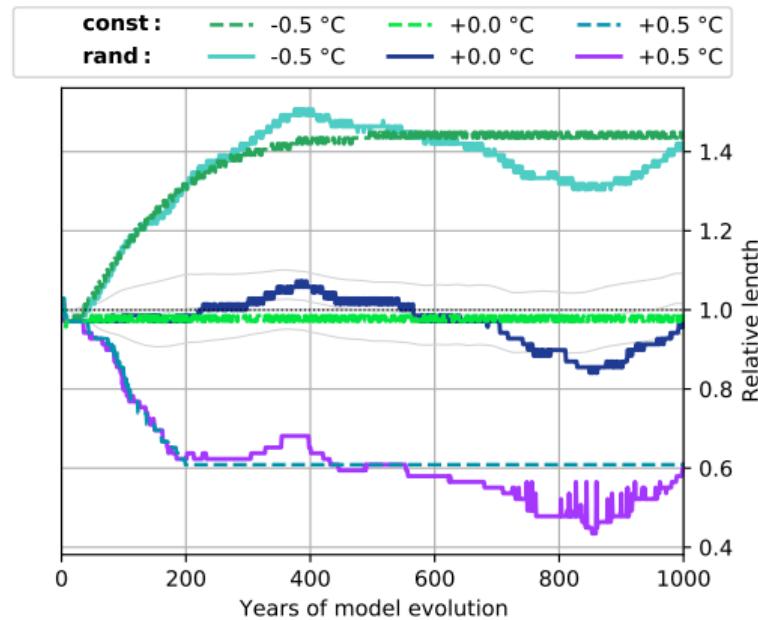
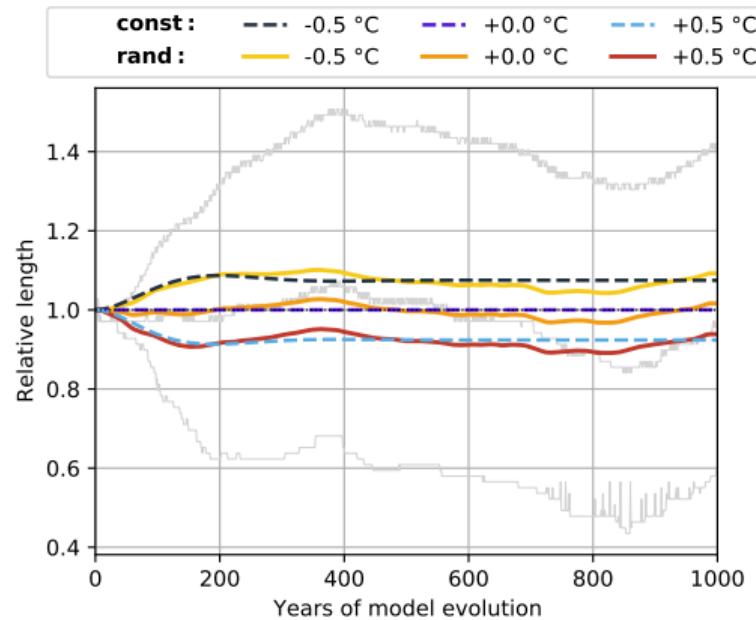
Hintereisferner test case

Relative surface area:



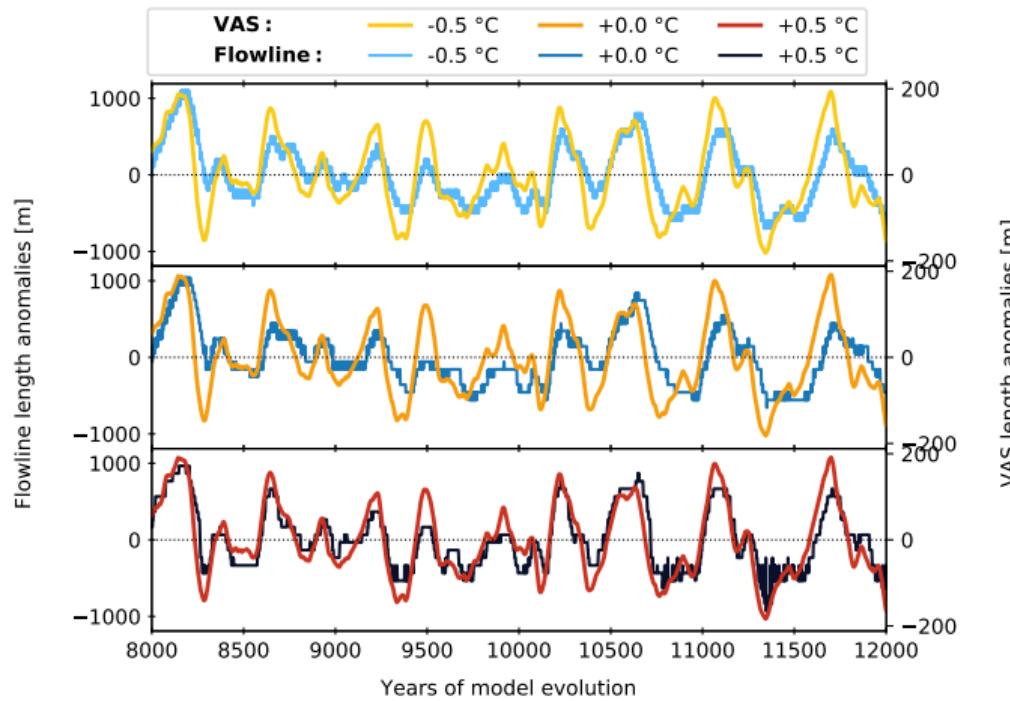
Hintereisferner test case

Relative glacier length:



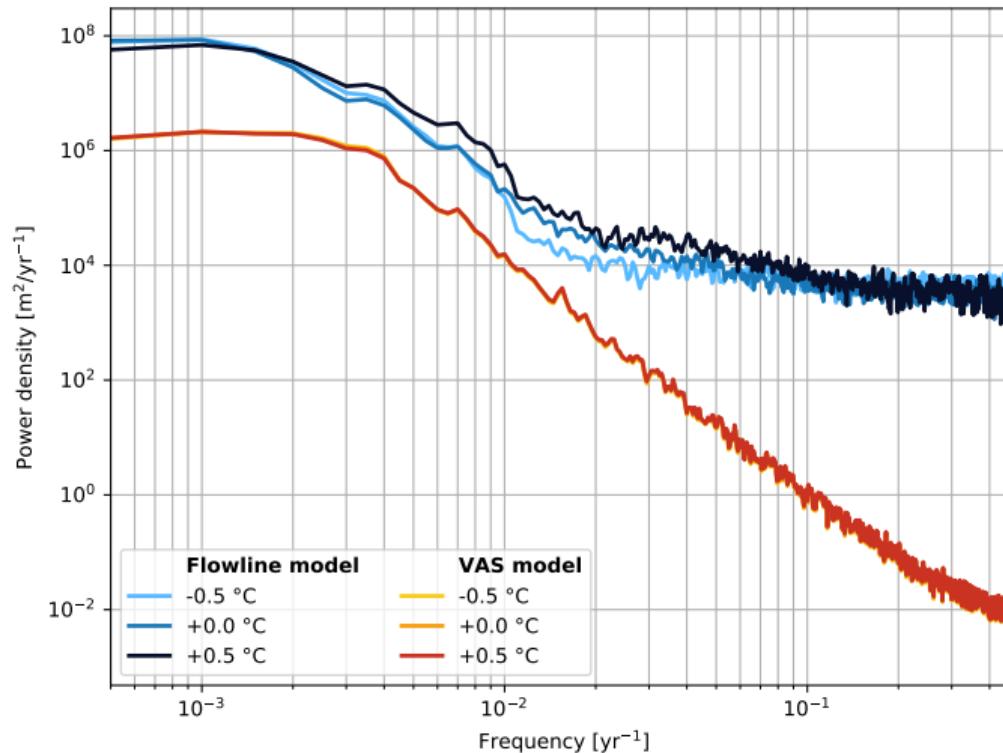
Power spectral density

HEF - Length under random climate:



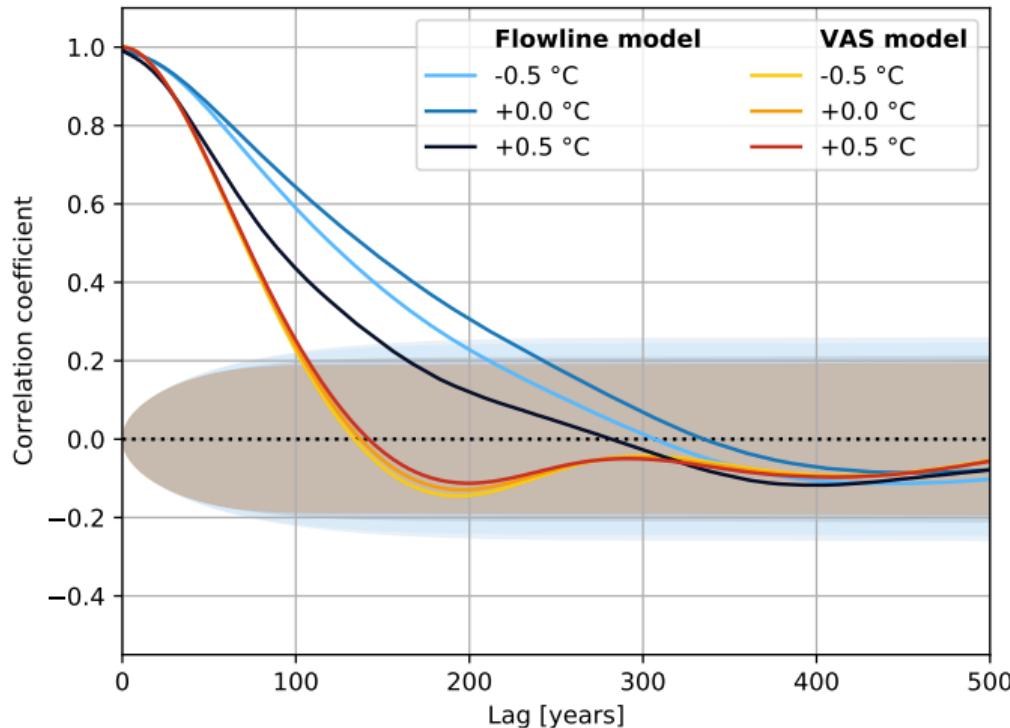
Power spectral density

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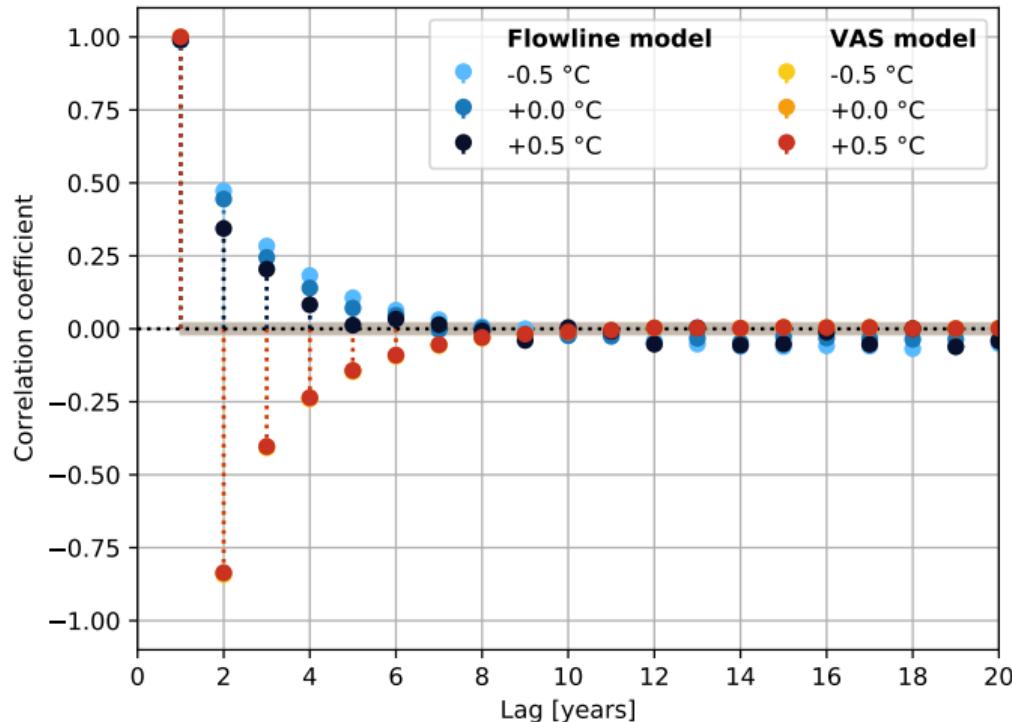
Autocorrelation function

HEF - Autocorrelation function:



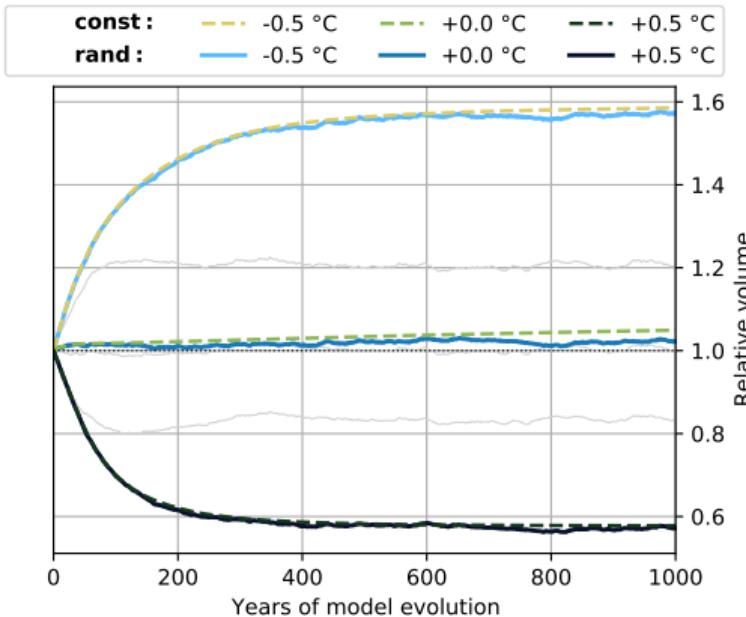
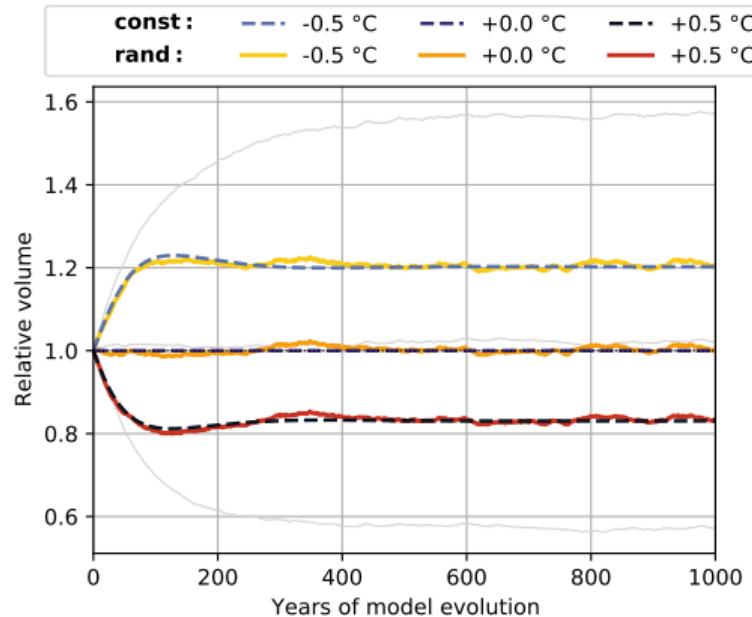
Autocorrelation function

HEF - Partial autocorrelation function:



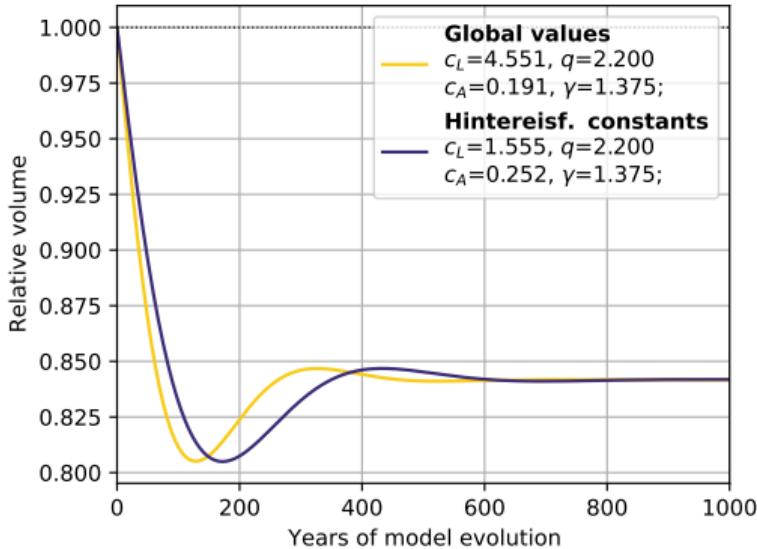
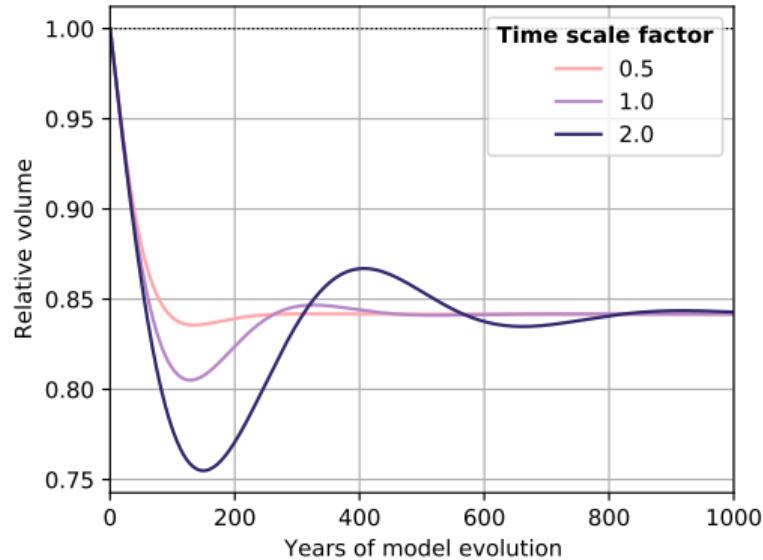
HISTALP domain

Relative ice volume:



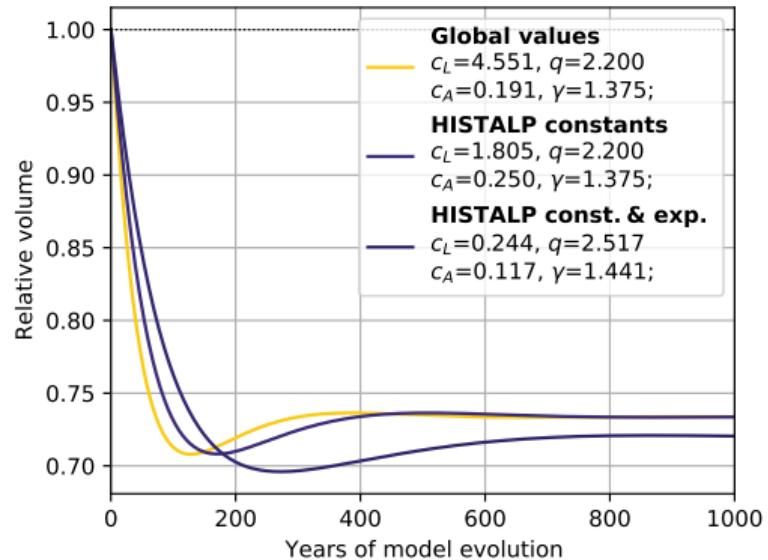
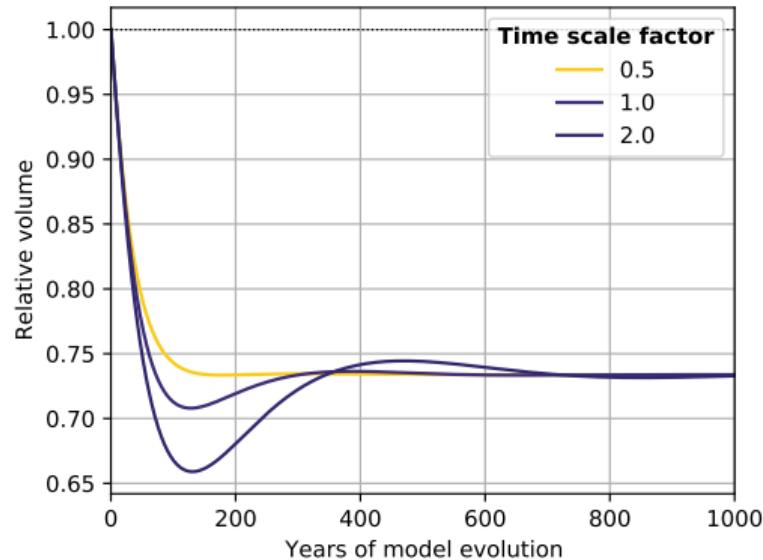
Sensitivity experiments

Hintereisferner:



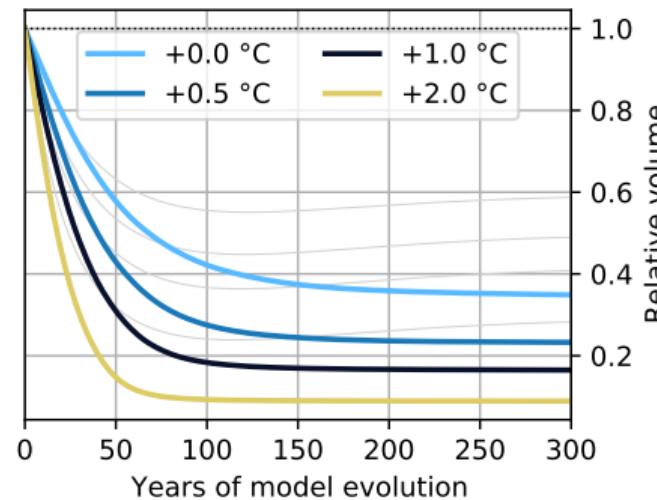
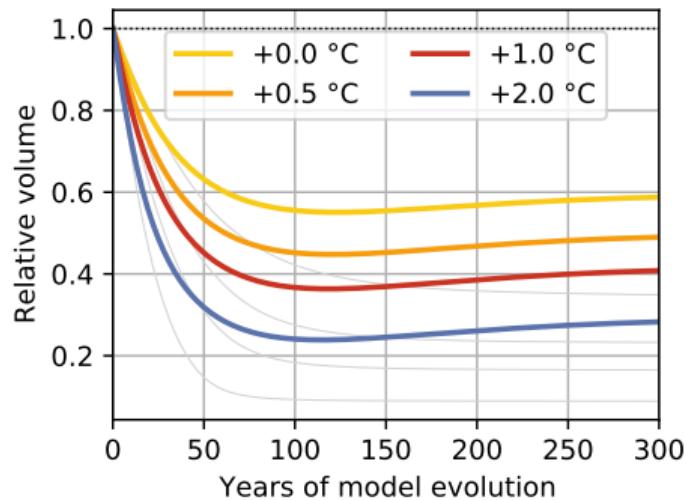
Sensitivity experiments

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Future projection

Relative ice volume:



Take Home Message

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- ▶ Weak sensitivity to scaling parameters

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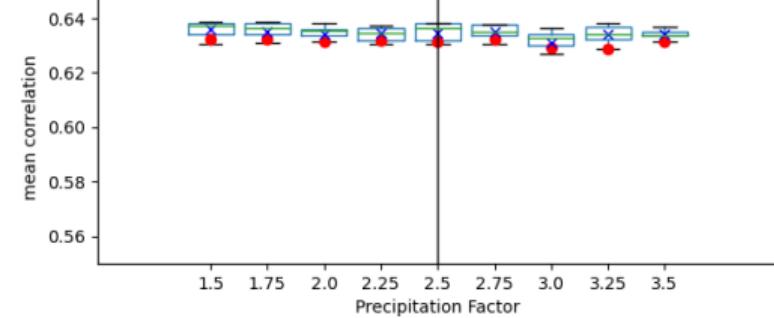
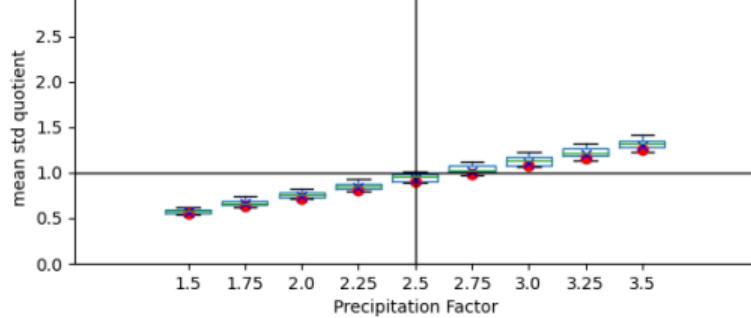
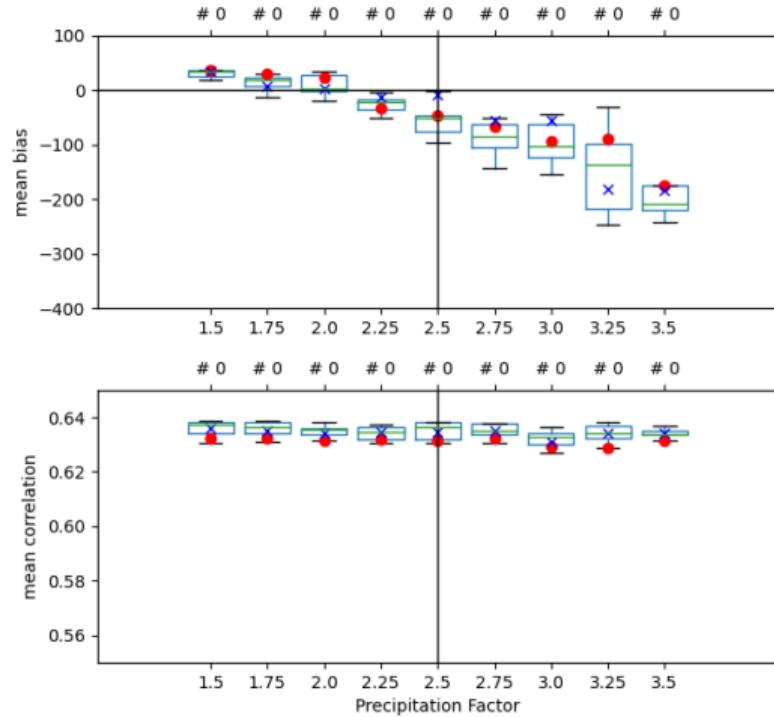
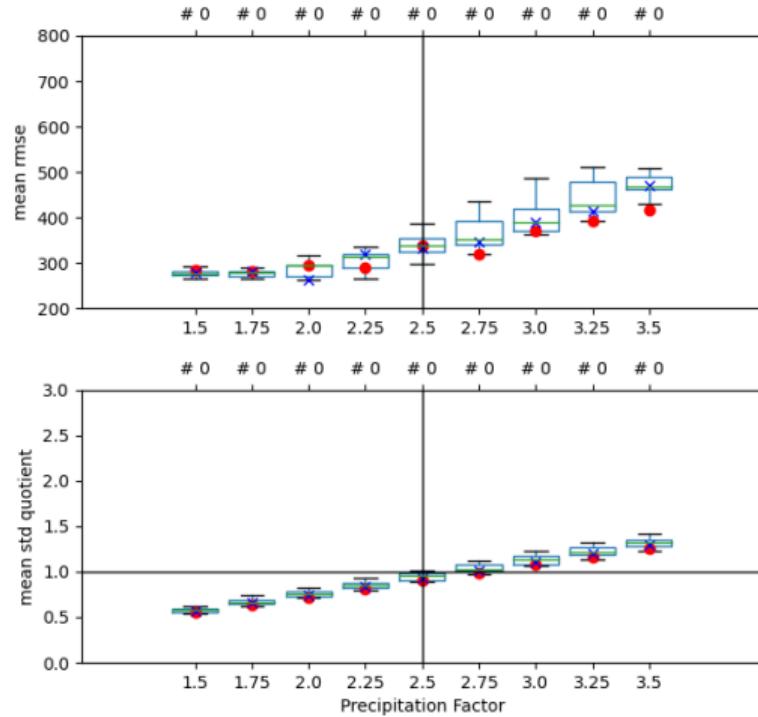
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(Maybe) not up to date, anymore.

Crossvalidation

Crossvalidation results with respect to Precipitation Factor (48 reference glaciers)

'# x': number of removed data points (from a total of 2160 data points per Precipitation Factor value)



References

Marzeion, B., A. H. Jarosch, and M. Hofer, 2012: Past and future sea-level change from the surface mass balance of glaciers. *The Cryosphere*, **6** (6), 1295–1322, doi:10.5194/tc-6-1295-2012.