Calibrating a regional glacier model using post-LIA glacier length changes in the Alps

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2 minute pitch
Motivation

- **Dynamic calibration** can be used to match model simulations with observations
Motivation

- **Dynamic calibration** can be used to match model simulations with observations
- But calibration is no validation
- No information for unknown periods
Goal: time invariant calibration with uncertainty assessment

- Open Global Glacier Model
- 3 varying parameters for:
  - input climate
  - model dynamics
  - mass balance
- 1365 unique combinations
- 30 Alpine glaciers
Goal: time invariant calibration with uncertainty assessment

- Open Global Glacier Model
- 3 varying parameters for:
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- 1365 unique combinations
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- Select ensemble of runs
- Cross-validate results

⇒ For details see uploaded display and join the break-out room
additional material
30 selected glaciers -> 25% of today’s glaciated area
Model and data

- Open Global Glacier Model (OGGM) [1]
- Applicable to all glaciers
- Excels at large scales
- HISTALP [2] climate data
- RGI [3] glacier outlines
- GLAMOS [4] length change observations for Swiss glaciers
- WGMS [5] length change observations for the rest
Chosen calibration parameters

- **precipitation scaling factor**
- Glen A - Ice flow creep parameter
- mass balance bias

\[
m = p_{sf}P_{\text{solid}} - \mu^*T_{>\text{melt}} + \epsilon
\]

- $m$ mass balance
- $p_{sf}$ precipitation scaling factor
- $P_{\text{solid}}$ solid precipitation
- $T_{>\text{melt}}$ temperature available for melt
- $\epsilon$ residual
- $\mu^*$ temperature sensitivity

→ calibrated against measurements
Chosen calibration parameters

• precipitation scaling factor
• Glen A - Ice flow creep parameter
• mass balance bias

• Also: Elevation feedback → Volume difference
Chosen calibration parameters

- precipitation scaling factor
- Glen A - Ice flow creep parameter
- mass balance bias

**glacier mass balance \([m \text{ w. e. a}^{-1}]\)**

\[ m_{meas} = m_{model} - \Delta m \]

- **bias** \(\Delta m\) derived from measurements
- subtracted in the model
  \(\rightarrow\) negative values **add mass**
Chosen calibration parameters

- precipitation scaling factor
- Glen A - Ice flow creep parameter
- mass balance bias

- $\in [1.0, 4.0]$, 0.25 steps (OGGM default: 1.75)
- $\in [1.0, 4.0]$, 0.5 steps (OGGM default: 1.0)
- $\in [-1.4, 1.0]$, 0.2 steps (OGGM default: $\pm 0$)

- 1365 individual parameter combinations
Influence of the different parameters

- Fixed:
  Glen A = 1.0
  MB bias = -200

- Variable:
  $p_{sf}$
Influence of the different parameters

- **Fixed:**
  
  MB bias = -200
  
  $p_{sf} = 3.5$

- **Variable:**
  
  Glen A
Influence of the different parameters

- **Fixed:**
  
  Glen A = 1.0
  
  $p_{sf} = 3.5$

- **Variable:**
  
  MB bias
Select run ensemble

• reduce from all runs to 20%
  • 10% smallest mean error > 0
  • 10% smallest mean error < 0

• randomly select (Monte Carlo) 10–20 ensemble members

• choose best ensemble based on:
  • coverage: percentage of observations within ± 1 standard deviation
  • MAE: mean absolute error of the ensemble mean
  • ensemble skill: $\frac{RMSE}{SPREAD}$ ($SPREAD = \sqrt{VAR}$)
Some results

Glacier de Argentiere

10 ensemble members:
coverage = 0.85
ensemble skill = 0.87
MAE ensemble = 162m
(min MAE run = 142m)
Some results

Mer de Glace (with Leschaux)

17 ensemble members:
- coverage = 0.73
- ensemble skill = 0.95
- MAE ensemble = 208m
  (min MAE run = 174m)
12 ensemble members:
coverage = 0.72
ensemble skill = 0.96
MAE ensemble = 292m
(min MAE run = 167m)
Some results

Unterer Grindelwaldgletscher

- Observed length change
- run with min MAE
- ensemble mean +/- 1 std
- ensemble mean

14 ensemble members:
coverage = 0.72
ensemble skill = 0.82
MAE ensemble = 300m
(min MAE run = 207m)
Some results

Glacier du Trient

10 ensemble members:
coverage = 0.72
ensemble skill = 0.91
MAE ensemble = 85m
(min MAE run = 78m)
Thank you for your attention!

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