Modelling of Alpine Glaciers in the Earth System with ISSM

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(and more)

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Research @BAdW

- ISSM @AWI
  polar ice sheets

- ISSM @BAdW
  - „GIC“
  - focus on the Alps

- Development of a so-called ha-ESM
High-alpine ESM (ha-ESM)

- Concept of an ESM
- Designed for small scale alpine regions
- preCICE coupler
- “negotiated“

(not all for ha-ESM)

Climate dynamics (RCM) -> Ice

Geo
GIA
Permafrost
Ice loading

Hydrology

Larour et al. 2012
Scales

- Different spatial scales
- Grid resolution
  \(\text{\sim} \text{meters vs \sim kilometers}\)
- Commonly full-Stokes
  (flexibility of ISSM to test Approximations)

Aletsch Glacier

Rignot & Mouginot 2012
Clean-ice versus Debris-covered glacier

Clean-ice

Hintereisferner, Ötztal
(www.foto-webcam.eu)

Debris-covered

Urdok, Karakorum
Debris-covered glacier

Relevant processes to explain the turning point (Evatt et al., 2017):
- ↑ different albedo
- ↑ decay of wind speed at ice/debris interface
  - reduction of evaporation
  - increase of melt
- ↓ insulating effect
Interface between atmosphere and ice

The ice flow model needs a surface mass balance ...

PDD (Reeh 1991)
2m temperature
precipitation

SEMIC-EBM
(Krapp et al 2017)
shortwave radiation ↓
longwave radiation ↓
2m wind speed
2m temperature
2m specific humidity
surface pressure
precipitation

Evatt-EBM
(Evatt et al 2017)
shortwave radiation ↓
longwave radiation ↓
2m wind speed
2m temperature
2m specific humidity
surface pressure
precipitation

Clean-ice
Debris-covered

Complexity
Accuracy (?)
Forcing with climate data

- ERA5 (0.25°x0.25°)
- EURO-CORDEX (0.1°x0.1°)

HEF

12km
Thank you!
Debris-covered glacier

Dynamic evolution of debris cover by (i) melt-out of englacial debris and (ii) redistribution by ice flow

Subaerial debris supply
Englacial debris transport
Basal debris supply

Atmospheric forcing
Ablation modification

Graphic: Anne Maussion, Atelier les Gros yeux