Towards a 3-D model for large-scale glacier simulations

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Representation of glacier dynamics in large-scale glacier evolution studies

For an overview, refer to Hock et al. (2019, JGlac) and Marzeion et al. (2020, Earth's Future)

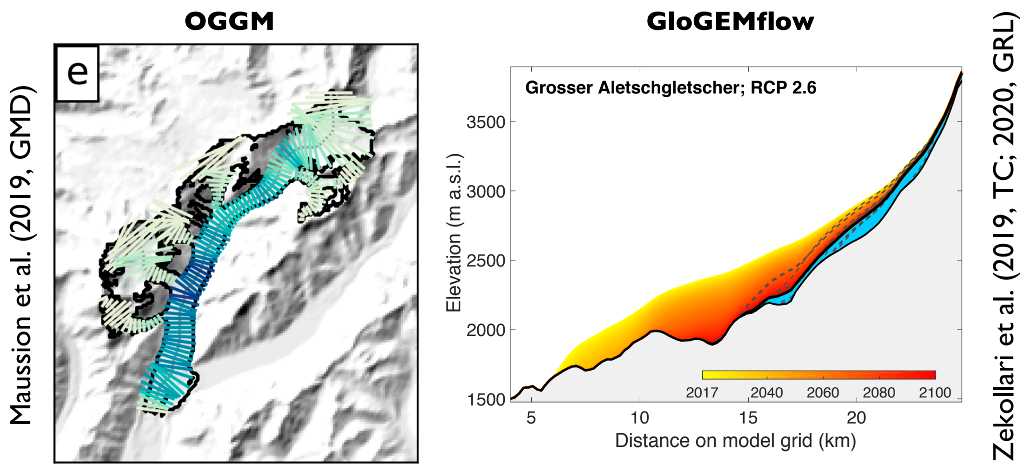
e.g. Radic & Hock (2011, NatGeo); Marzeion et al. (2012, TC)

Volume-area-length scaling methods

Δh-parameterisation

e.g. Huss and Hock (2015; Frontiers); Rounce et al. (2020, JGlac)

Ice flow modelling along flowlines



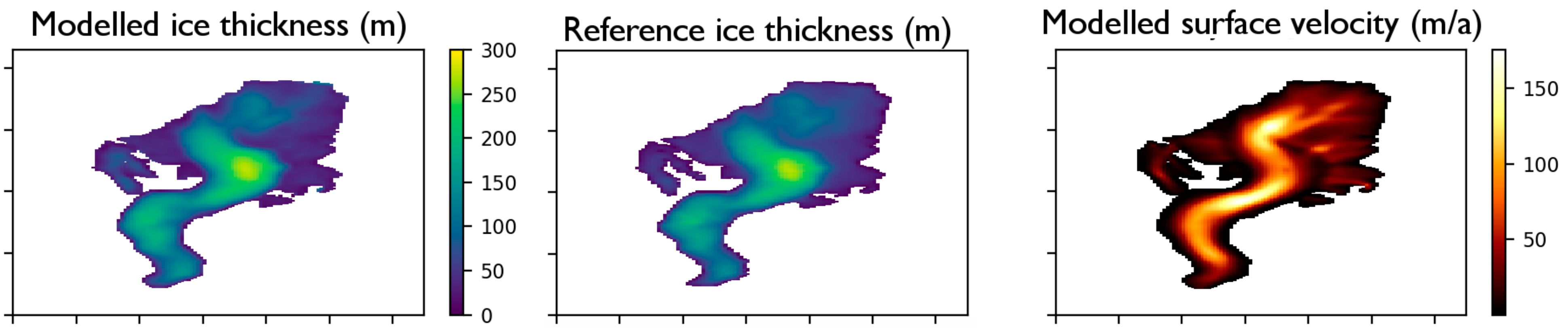
3-D modelling

- ☑ Ideal for ice caps and glaciers with a non-elongated shape
- ☑ Advantage to represent e.g. glacier calving and debris cover evolution

- ☒ Computationally expensive for large-scale applications
- ☒ Not always justified given the lack of detailed glacier information

Towards a 3-D model for large-scale glacier simulations

- First steps to create a 3-D model that can be applied for large set of glaciers
- Needs to be fast (= simple!)
- First tests for glaciers in the European Alps:
  - Considering only internal deformation and relying on Shallow Ice Approximation
  - Surface mass balance parameterized as a function of elevation
  - Try to obtain a **steady state** that is close to observed geometry



Example for Rhone glacier (CH)
50 m resolution
ELA at 2930 m
SMB gradient: 0.008 m i.e. a^{-1}
Max SMB = 3 m i.e. a^{-1}
Flow parameter: 1×10^{-16} Pa^{-3} a^{-1}

- Able to reproduce reference ice thickness distribution (Farinotti et al., 2019, NatGeo) relatively well.
- Realistic velocity pattern, but magnitude not correct (velocities are overestimated in general)

Still in initial test phase. Next steps: transient simulations, basal sliding, more realistic SMB,....etc.

Interested in more details? Or do you want us to model your glacier of interest?

Join the chat (CR5.1., May 7, 4:15-6:00 PM CET) or contact us (h.zekollari@tudelft.nl)!

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