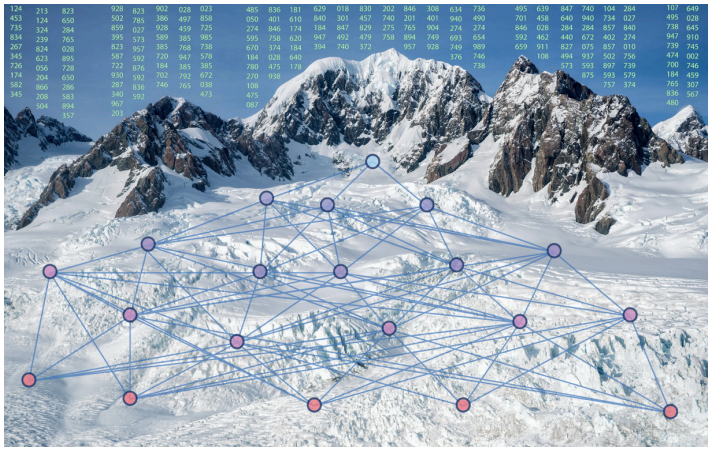
Master of Science Project

Department of Geoscience and Remote Sensing (GRS)

Theme: Climate Change/Cryosphere

Physics-informed machine learning applied to global glacier mass balance modelling



Research context

We are looking for a MSc candidate to work on our new project ODINN, aiming at exploring the use of scientific machine learning in global glacier modelling.

New global remote sensing products, coming from satellite imagery, are revolutionizing the way we can calibrate and build large-scale glacier evolution models (Hugonnet et al., 2021; Millan et al., 2022). Machine learning presents a promising way forward to model glacier evolution while exploiting these datasets (Bolibar et al., 2020, 2022; Jouvet et al., 2022), but its lack of interpretability hinders progress in our understanding of key physical processes.

ODINN is a new research project aiming at utilizing new methods bridging physics and differential equations with machine learning in global glacier modelling. Coded in the Julia programming language, ODINN attempts to exploit the benefits of the Julia Scientific Machine Learning (SciML) ecosystem, in order to improve the representation and our understanding of key physical processes driving climate-glacier interactions at large scales.

Glacier evolution is mainly determined by two large families of processes: (1) ice flow dynamics and (2) mass balance. Most efforts in the project have been so far applied to ice flow dynamics, trying to find ways to learn new parametrizations of ice rheology from new datasets

Purpose of the research

The goal of this MSc thesis will be to take the first steps in (2), the mass balance component of the model. Glacier mass balance is the result of the interactions between a glacier and the climate, via the mass gained through accumulation (e.g. snowfall) and the mass lost via ablation (e.g. melt). The suggested tasks of the thesis will include (but will be open to suggestions from the candidate):

- Code a basic temperature-index model in ODINN as a baseline.
- Augment a mass balance model with machine learning, while respecting physics
- Try to learn new parametrizations to be used in mass balance models from new datasets (e.g. Hugonnet et al. (2021)).

Requirements:

- *Strong coding skills: Julia and/or Python*
- *Motivation to work at the intersection of multiple fields: earth sciences, computer science and machine learning.*
- *Background in glaciology and/or climate science is a plus.*

Further information and project supervisors:

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- Jordi Bolibar (Utrecht University; j.bolibar@uu.nl)

In collaboration with Facundo Sapienza (University of California, Berkeley)