

# Glaciology and Machine Learning Summer School - Intro Slides

GlaMacLeS

June 15, 2025



## Introductions

- Name
- Research focus
- What you like to do when you're not working!
- (and whatever else you think is pertinent)

## Why are we here?

- To gain knowledge needed to *understand* applied ML literature.
- To gain knowledge needed to *apply* ML to novel cryosphere research.
- To build a *community* of practitioners.

## A little history



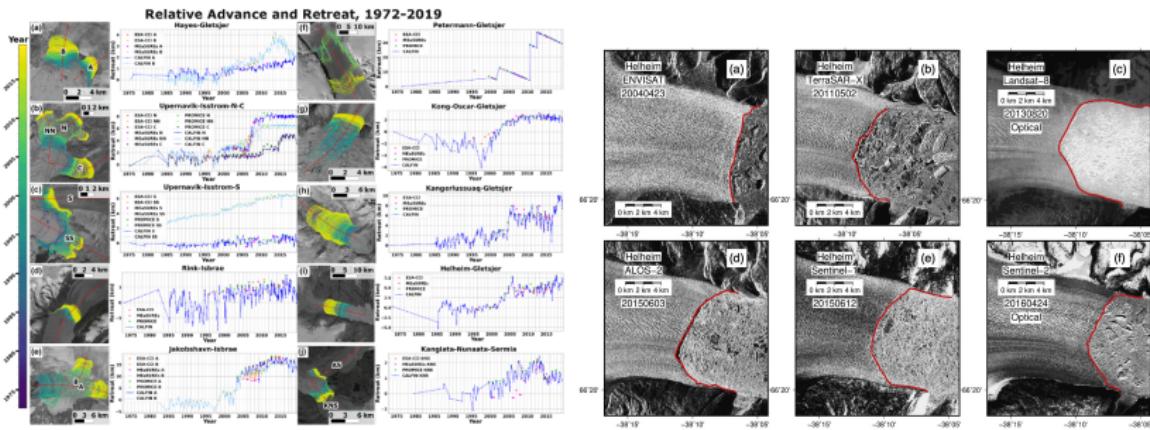
## An operational definition of Machine Learning

**Wikipedia:** ‘Machine learning (ML) is a field of study in artificial intelligence concerned with the development and study of statistical algorithms that can learn from data and generalize to unseen data, and thus perform tasks without explicit instructions.’

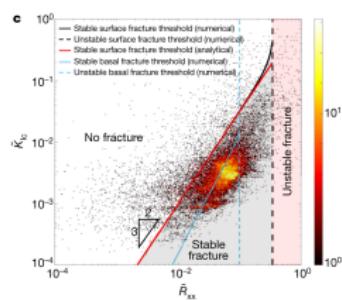
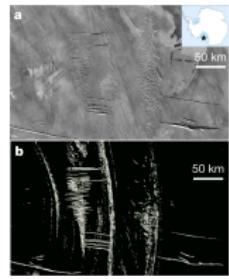
**Goodfellow et al.:** ‘The difficulties faced by systems relying on hard-coded knowledge suggest that AI systems need the ability to acquire their own knowledge, by extracting patterns from raw data. This capability is known as machine learning.’

**Yan Lecun:** ‘Deep learning is constructing networks of parameterized functional modules and training them from examples using gradient-based optimization. That's it.’

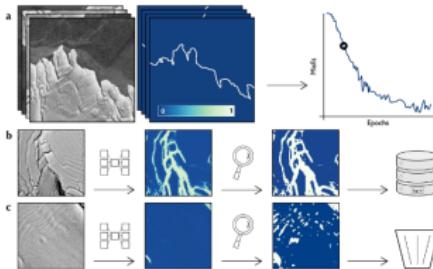
## Uses in glaciology - Calving fronts



# Uses in glaciology - Crevasse detection

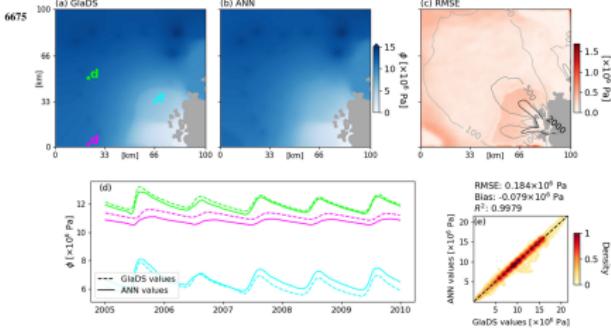
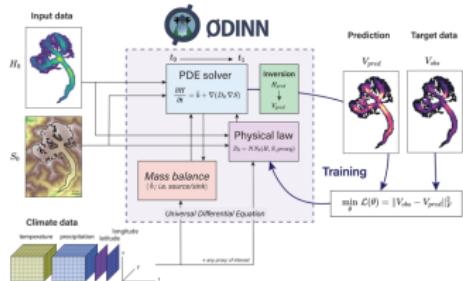


T. Surawy-Stepney et al.: Mapping Antarctic crevasses at high resolution

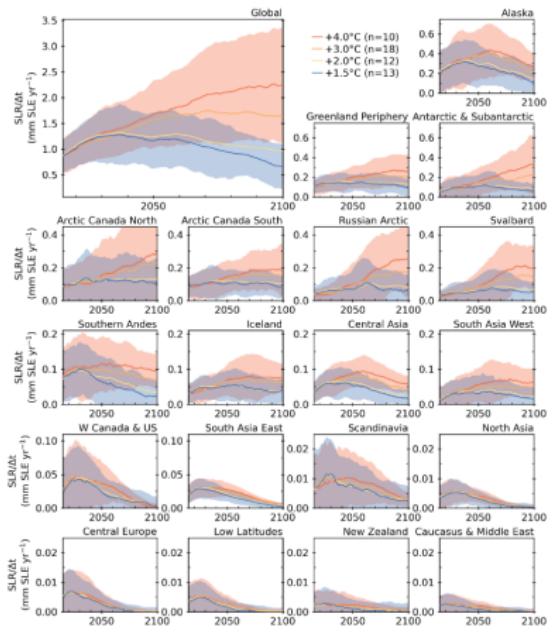
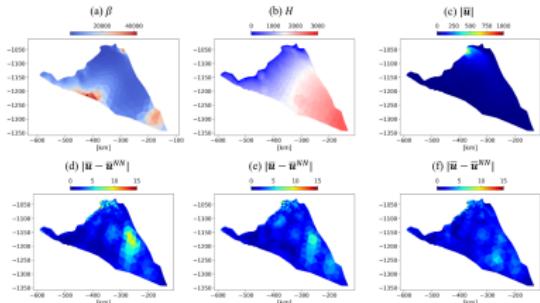


# Uses in glaciology - Replacement of processes

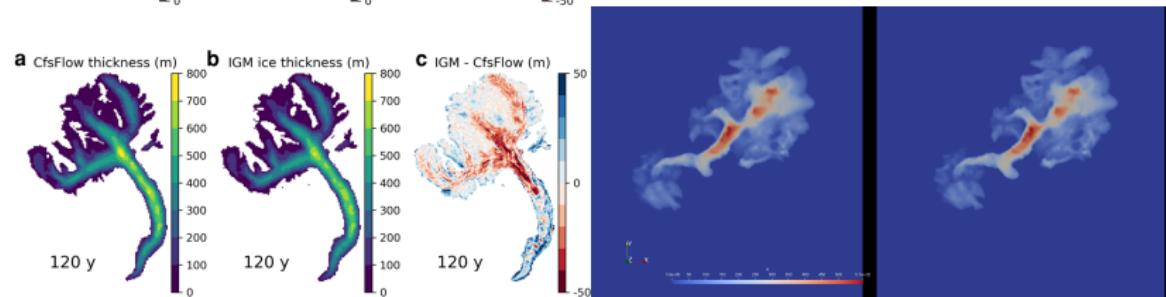
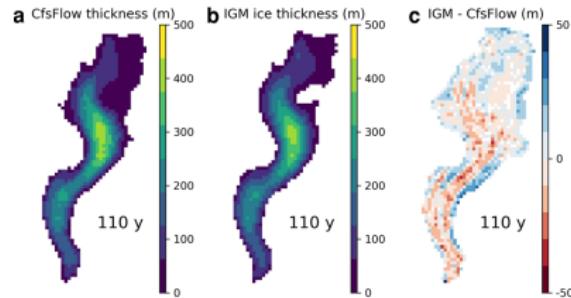
J. Bolíbar, F. Sapienza, et al.: UDEs for glacier ice flow modelling



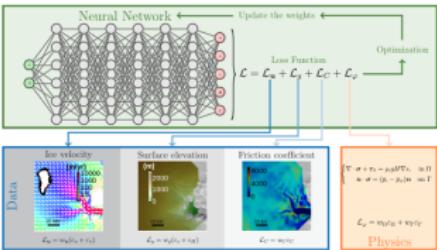
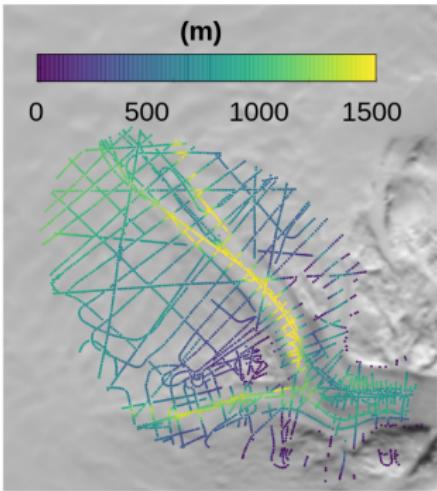
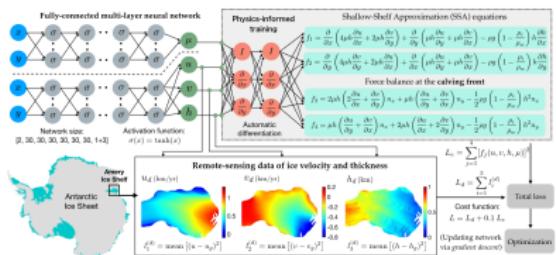
# Uses in glaciology - Parameter to observable map



# Uses in glaciology - Solution operator



# Uses in glaciology - PDE solving



# Curriculum (broadly)

## Topics

- Glaciers
- Neural nets
- Optimization
- Bayesian inference
- Architectures
- Pytorch
- Emulation
- Etc.

## Projects

- Generative modelling
- PINNs
- CNNs - remote sensing
- CNNs - SMB modelling
- Emulators and Bayesian inference

Friday



Paul Reiffer

## Other considerations

- Be awesome to and learn from one another.
- Don't hesitate to talk to me, any instructor, or TNC staff if you're not feeling good about something.
- Enjoy the location!