

Glaciology on the cloud

Research and education in your web browser

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My take home messages for today

- ① Cloud (or HPC) computing **in your web browser** is the future of geoscientific data analysis, possibly of (glaciological) modelling as well
- ② **Emerging technologies make the cloud welcoming to all**, even for us glaciologists who like to play outside more than on computers
- ③ For big data / modelling deployments: don't try this at home! You probably want to **convince your institution** to deploy for you instead
- ④ **Try the tools, learn about them and join us:** <http://edu.oggm.org>

Stories

- **Open Science**
code alongside papers to allow peer-review and collaboration
- **Reproducible Science**
encapsulation of computational environments as safeguard against “chaos”
- **Knowledge Transfer**
web browser and cloud resources for universal access to education
- **Big Data**
bring your analysis workflow *to the data*, not the other way around

Open Science

- **Collaborative platforms:** GitHub, GitLab...
- **Archiving tools:** Zenodo...
- **Attribution:** OS Licenses, DOIs...
- **Enforcement from publishers:**
new GMD editorial (v1.2)



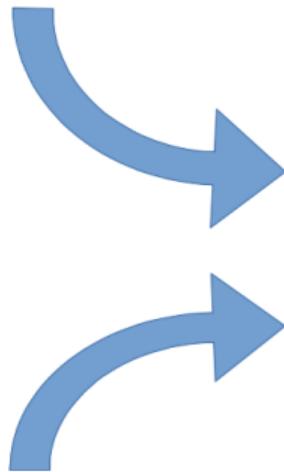
Take home

There is no **practical** obstacle to open-science software any more
→ **Open Science is becoming “the rule”**

Software “capsules”: container technologies

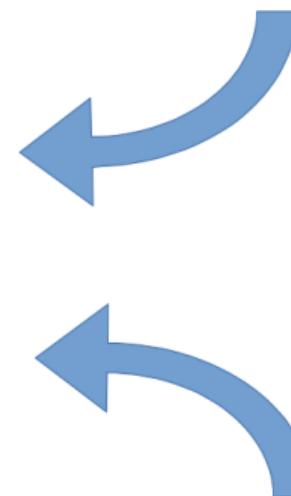
System tools

Python, wget, vim, nco...



Documentation

Scripts, tutorials...



Libraries

Numpy, matplotlib, OGGM...



Data

Or link to DOI

New market: example Code Ocean

CODE OCEAN EXPLORE HELP + New Capsule LOG IN SIGN UP

Search keyword, research field, title, author, DOI, etc.

More Capsules

ENGINEERING Nov 2018

Separated source 1 by unsupervised learning

Separated source 2 by unsupervised learning

Tzu-Hao Lin

Demonstration of soundscape separation by...

A demonstration of using MATLAB-based Soundscape Viewer toolbox to separate a marine soundscape...

Scientific Reports, 2017

BIOINFORMATICS Nov 2018

Organoid cell-types and activities

Identity programs

- Auto-1 ■ ES-1
- Auto-2 ■ Dpp-1
- Auto-3 ■ Dop-1
- Auto-4 ■ NT-1
- Auto-5 ■ NC-2
- Auto-6 ■ Nodal-Hox
- Ret-1 ■ PP
- Ret-2 ■ Muscle-T1
- Ret-3 ■ Muscle-Tm
- Ret-4 ■ Muscle-T2
- Ret-5 ■ Cx-1
- Ret-6 ■ Cx-2
- FB-1 ■ CF
- FB-2 ■ CR

Activity programs

- Cell Cycle
- Hypoxia

Dylan Kotliar, Adrian Veres, M. Aurel Nagy, Shervin T...

This capsule is meant to accompany a manuscript "Identifying Gene Expression Programs of Cell-type..."

bioRxiv, 2018

EARTH SCIENCES Jan 2019

Tamsin Edwards

Revisiting Antarctic ice loss due to marine ice cliff...

This Code Ocean capsule reproduces the main analysis of the below paper, which emulates and...

Nature, 2019

Open source model



<http://edu.oggm.org>

Demo



Starting repository: OGGM/oggm-edu-r2d/master

New to Binder? Check out the [Binder Documentation](#) for more information

Build logs

[show](#)

Here's a non-interactive preview on [nbviewer](#) while we start a server for you. Your binder will open automatically when it is ready.



oggm-edu-r2d

JUPYTER

FAQ



master

Demo

The screenshot shows a Jupyter Notebook interface with two tabs open: "welcome.ipynb" and "flowline_model.ipynb". The left sidebar displays a file tree under "oggm-edu-notebooks > oggm-edu", listing several Jupyter notebooks: "flowline_model.ipynb", "getting_started_with_notebooks.ipynb", "ice_flow_parameters.ipynb", "mass_balance_gradients.ipynb", "surging_experiment.ipynb", "temperature_index_model.ipynb", and "welcome.ipynb". The "welcome.ipynb" tab is currently active, showing the OGGM Edu logo (a sun with a mountain inside) and the text "Open Global Glacier Model". Below the logo, it says "Welcome to the OGGM Edu Notebooks!". It also lists the available notebooks and provides a link to "https://edu.oggm.org".

File Edit View Run Kernel Tabs Settings Help

Name Last Modified

- flowline_model.ipynb seconds ago
- getting_started_with_notebooks.ipynb 6 minutes ago
- ice_flow_parameters.ipynb 6 minutes ago
- mass_balance_gradients.ipynb 6 minutes ago
- surging_experiment.ipynb 6 minutes ago
- temperature_index_model.ipynb 6 minutes ago
- welcome.ipynb 6 minutes ago

Launcher welcome.ipynb flowline_model.ipynb

OGGM
edu

Open Global Glacier Model

Welcome to the OGGM Edu Notebooks!

Here are the notebooks you can play with:

- Getting started with the Jupyter Notebook: an introduction to Jupyter Notebooks
- Getting started with flowline models: idealized experiments
- Influence of ice flow parameters on glacier size
- Glacier surging experiments
- Mass balance gradients
- Temperature index model

For more information, visit <https://edu.oggm.org> !

Demo

Screenshot of a Jupyter Notebook interface showing a file browser and a code editor.

The file browser on the left shows the directory structure:

```
oggm-edu-notebooks > oggm-edu
  +-- flowline_model.ipynb (selected)
  +-- getting_started_with_notebooks.ipynb
  +-- ice_flow_parameters.ipynb
  +-- mass_balance_gradients.ipynb
  +-- surging_experiment.ipynb
  +-- temperature_index_model.ipynb
  +-- welcome.ipynb
```

The code editor on the right displays two code cells:

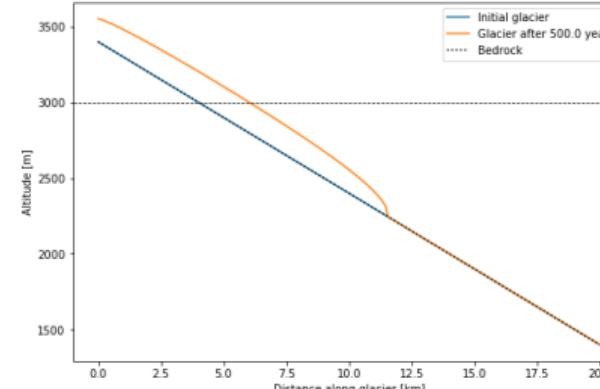
```
[18]: model.run_until(150)
print('Year:', model.yr)
print('Glacier length (m):', model.length_m)

Year: 150.0
Glacier length (m): 4800.0

If we want to compute longer, we have to set the desired date. Hereby, the model computes only the additio
```

```
[19]: runtime = 500
model.run_until(runtime)
edu.glacier_plot(x=distance_along_glacier, bed=bed_h, model=model, mb_model=mb_model,
```

A plot titled "glacier_plot" is shown below the code. The y-axis is "Altitude [m]" ranging from 1500 to 3500. The x-axis is "Distance along glacier [km]" ranging from 0.0 to 20.0. The plot shows three lines: a blue line for the "Initial glacier", an orange line for the "Glacier after 500.0 years", and a grey dotted line for the "Bedrock". The initial glacier starts at approximately 3400m altitude and 0.0 km distance. The glacier after 500 years has retreated significantly, ending at approximately 1400m altitude and 20.0 km distance. The bedrock is a horizontal dashed line at 3000m altitude.



The challenge of big data. Solutions...

- ... from business / closed source: Google Earth Engine, Climate Data Store
(CDS relies heavily on OS tools though)
- ... from the scientific community: Pangeo.io

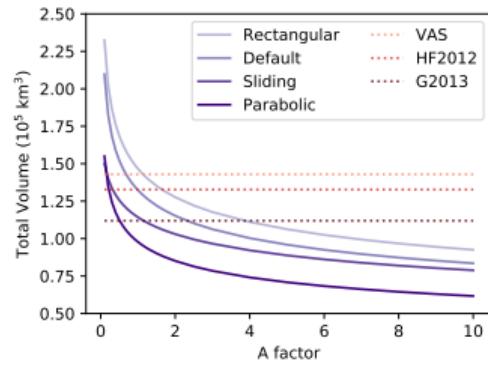
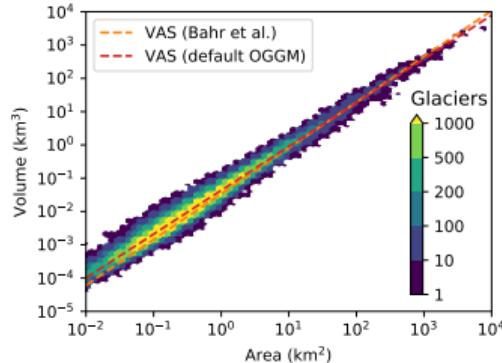


PANGEO

A community platform for Big Data geoscience

And because I feel sorry for this geeky talk

Here is a graph ...

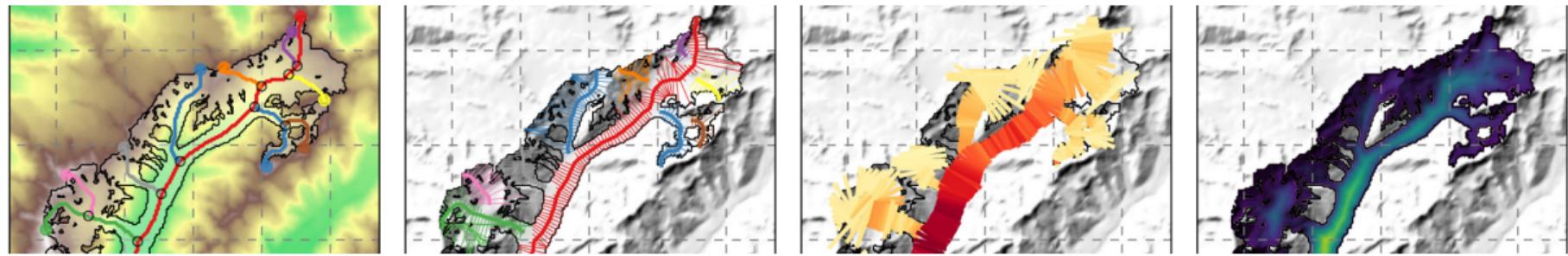


... and a glacier in the cloud:



Advantages / disadvantages of cloud computing

- allows to use familiar tools in a browser and reduces the tech entry level bar
- accessible to all
- facilitates discovery and collaboration
- a great step forward for reproducible science
- the only viable solution to current and future big data problems
- economy of scale (hardware / software / knowledge)
- numerical modelling and I/O remains a challenge (people are working on it)
- requires an internet connection
- requires support from IT to set your own deployment up
- universities and HPCs are behind



Thank you for your attention!

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