Department of Earth, Ocean and Atmospheric Sciences

Opensource Computing for Earth Sciences Education: *Lessons learned in year 1 of 3*

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Project Overview

We aim to make the learning of opensource computational and quantitative skills more comprehensive and consistent across our Department's curriculum. Jupyter notebook-based modules and interactive dashboard activities will be incorporated into 17 core & elective courses. We are working with others at UBC and beyond to develop computing infrastructure that will provide sustainable cloud computing infrastructure and corresponding teaching practices.

More details:

- GitHub: https://github.com/eoas-ubc/eoas_tlef
- Website: https://eoas-ubc.github.io/
- Summary: https://www.eoas.ubc.ca/education/current-major-initiatives/ocese

Contributors so far:

Faculty: T. Ivanochko (P.I.), P. Austin (Lead), F. Jones (STLF), C. Johnson, V. Radic, A. Ameli, M. Bostock, S. Waterhouse.
Students: A. Loeppky, M. Solen, D. Platonov, B. Chang, H. Umashankar, J. Byer, C. Zhang, C. Ridell, Y. Su, Z. Wang, J. McFarlane.

Project Objectives	Activities	Lessons being learned in year 1
1. Increase computational and numerical literacy among EOAS graduates.	• **Python** (standard for data science), to be taught across EOAS curriculum*. • **GitHub** as a standard for sustainability & learning benefits. • **Engaging data science content and activities** for all levels (Jupyter Notebooks and Dashboard Apps). * Consistent with STATs and CPSC, & UBC's new **Minor in data science**	• **Phasing in:** 2-3 years to phase MatLab out and Python in. **TA support** has been key! • **Scaling up for large courses** requires coordination between Department, Faculty & UBC.
2. Engage students in current Earth Science challenges through applied quantitative & computational assignments.	• **Interactive dashboards**: 4 done; 2 courses; 3 demos; more coming. Fig 1 ➔ • **Jupyter notebooks** for eosc211, 354, 372, 410, atsc301, others coming. • **OCESE & Climate Science**: partnerships with climate-science ed'n projects **i)** Climate science in EOSC 1xx courses; **ii)** climate modelling dashboards • **Student team-members:** 10, listed above. • **Ugrad research projects:** 5 used OCESE resources & procedures (**Fig 5**).	• **Ambitious apps** are feasible: e.g. Fig 2 ➔ • **Sophisticated undergrad research** is made feasible with J-hubs, J-notebooks and GitHub. See Fig. 4 below 🡻 • **Student feedback** about dashboards: Fig 5. below 🡻 • **Instructor feedback** about dashboards eg. *"new in-class group work is more effective than old approaches".*
3. Contribute to development of a minor in Data Science.	• DSCI-100: adapt for a Python-based, EOAS-oriented section. • Upgrade EOSC 410 as a rigorous "capstone" data science course. • Employ MDS graduate students.	• **Cost** to convert R to Python: in progress. • **Goal: inspire** students by using climate, ocean, & Earth science data at 1xx level.
4. Engage new and existing faculty in development and dissemination of cutting-edge opensource quantitative Earth science curricula.	• **9 courses to be "transformed"** to use python & opensource methods. Atsc301, envr 420, eosc 211, 410, 354, 442, 471, 429, dsci100 • **9 courses to get dashboards** for lessons, assignments & assessments. envr300, eosc112, 340, 325, 372, 329, 373, 350, vant110 • **Currently**, 9 courses participating in years 1 & 2. • **Faculty ProD:** Training, doc'nts, & engagement activities being developed.	• **Some delays**: COVID reduced the capacity of some faculty to participate. • **STLF support** is beneficial (eg eosc325 & 354) • **Docs & training** are being based on challenges identified by student (and other) contributors.
5. Serve as a test bed for deploying affordable, sustainable cloud computing facilities for undergraduate teaching and learning.	• Jupyter hubs for small classes (< ~30). • Jupyter hubs scalable for 150+ students. Fig 3 ➔ • Enhance nbgrader (quiz management and autograding). • Refine code & methods for interfacing to Canvas. • Clarify how Dep't, F.o.S. & UBC support teach/learn computing needs. • Directed studies projects used OCESE infrastructure & procedures Fig. 4 🡻.	• Hubs for small classes can be local • Hubs for large classes need cloud computing support • 'Containers' for dashboards & Jupyter hubs: Workflows are being developed. • Still seeking clarity on who will support necessary infrastructure.

Fig 4. ***Undergrad research project titles;*** *made feasible with OCESE J-hubs, J-notebooks, GitHub & faculty support.*

- *Mapping clear-cuts in the Amazon rainforest using multi-temporal Landsat TM images.*
- *Exploring sea-ice thickness using the CCCma CanESM5 climate model.*
- *CMIP6 intercomparison of Beijing precipitation and air pressure under future climate change for two climate change scenarios (edited).*
- *Evaluation of two WRF PBL parameterization in the NWP grey zone.*
- *Examination of the high-resolution rapid refresh model precipitation-type forecast.*

Figures – etc.

Fig 1. Simple dashboard: Ocean depth profiles.

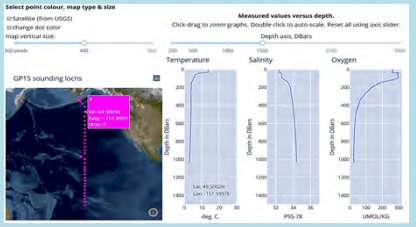


Fig 2. CMIP-6 climate model dashboard. Uses online data to explore 9 global / regional climate parameters from 4 climate models.

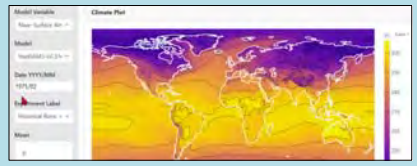
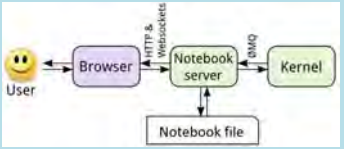


Fig 3. Serving notebooks via cloud servers.*



* From https://datacadamia.com/ide/jupyter/start

Fig 5. Student feedback from piloting 2 dashboards in ENVR 300.