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.

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<td>1. Increase computational and numerical literacy among EOAS graduates.</td>
<td><strong>Python</strong> <em>(standard for data science)</em>, to be taught across EOAS curriculum*. GitHub as a standard for sustainability &amp; learning benefits. Engaging data science content and activities for all levels (Jupyter Notebooks and Dashboard Apps).</td>
<td>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 &amp; UBC.</td>
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<td>2. Engage students in current Earth Science challenges through applied quantitative &amp; computational assignments.</td>
<td>Interactive dashboards: 4 done; 2 courses; 3 demos; more coming. Fig 1 ➔ Jupyter notebooks for eosc211, 354, 372, 410, atsc301, others coming. OCESE &amp; 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 &amp; procedures (Fig 5).</td>
<td>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. * Instructor feedback about dashboards: “new in-class group work is more effective than old approaches”.*</td>
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<td>3. Contribute to development of a minor in Data Science.</td>
<td>DSCI-100: adapt for a Python-based, EOAS-oriented section. Upgrade EOSC 410 as a rigorous “capstone” data science course. Employ MDS graduate students.</td>
<td>Cost to convert R to Python: in progress. Goal: inspire students by using climate, ocean, &amp; Earth science data at 1xx level.</td>
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<td>4. Engage new and existing faculty in development and dissemination of cutting-edge opensource quantitative Earth science curricula.</td>
<td>9 courses to be “transformed” to use python &amp; opensource methods. Atsc301, envr 420, eosc 211, 410, 354, 442, 471, 429, dsci100 9 courses to get dashboards for lessons, assignments &amp; assessments. envr300, eosc112, 340, 325, 372, 329, 373, 350, vant110 Currently. 9 courses participating in years 1 &amp; 2. Faculty ProD: Training, doc’nts, &amp; engagement activities being developed.</td>
<td>Some delays: COVID reduced the capacity of some faculty to participate. STLFL support is beneficial (eg eosc325 &amp; 354) Docs &amp; training are being based on challenges identified by student (and other) contributors.</td>
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<td>5. Serve as a test bed for deploying affordable, scalable cloud computing facilities for undergraduate teaching and learning.</td>
<td>Jupyter hubs for small classes (&lt;~30). Jupyter hubs scalable for 150+ students. Fig 3 ➔ Enhance nbgrader (quiz management and autograding). Refine code &amp; methods for interfacing to Canvas. Clarify how Dep’t, F.o.S. &amp; UBC support teach/learn computing needs. Directed studies projects used OCESE infrastructure &amp; procedures Fig. 4 ➔.</td>
<td>Hubs for small classes can be local Hubs for large classes need cloud computing support ‘Containers’ for dashboards &amp; Jupyter hubs: Workflows are being developed. Still seeking clarity on who will support necessary infrastructure.</td>
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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*. Jupyter hubs scalable for large classes (>~30). Jupyter hubs for small classes (<~30). Documentation & training available.
- Fig 4. Undergrad research project titles; made feasible with OCESE J-hubs, J-notebooks, GitHub & faculty support.
- Fig 5. Student feedback from piloting 2 dashboards in ENVR 300.