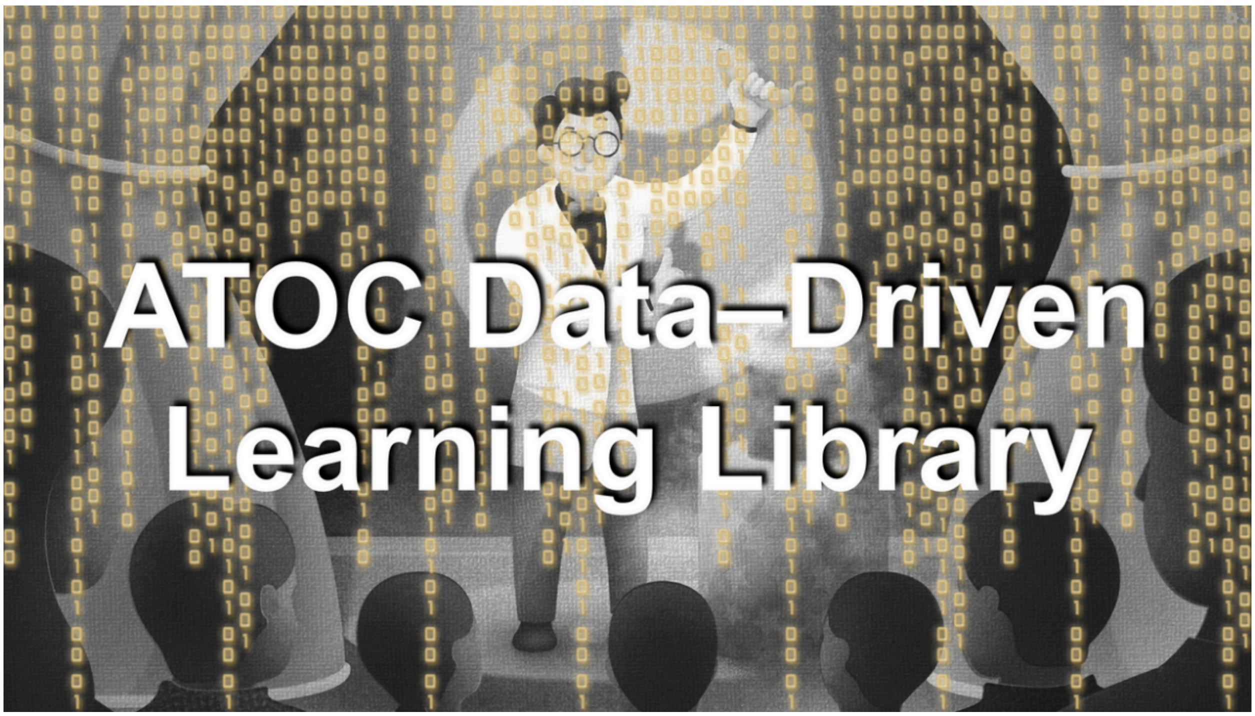
Faculty Fellows Project Report (Karnauskas)

Title and brief description of your project

Title: ATOC Data-Driven Learning Library (https://www.colorado.edu/atoc/ddll)

Brief description: The ATOC Data-Driven Learning Library (DDLL) is a virtual library of discipline-specific modules, ready for integration into the classroom. "Like a closet full of physics apparatus, but for data and models."



Describe the challenge you addressed in your department with this project.

Many ATOC faculty members have specific expertise and familiarity with research-quality observational data sets and Earth system models that have successfully translated into teaching tools or materials for their classrooms.

Technology plays a major role in the field of atmospheric and oceanic science. This is especially true in our research. The breadth of climate research conducted by ATOC faculty and students involves space-based satellite measurements, remote in situ observing technologies such as AUVs (autonomous underwater vehicles) in the ocean and UAVs (unmanned aerial vehicles) in the atmosphere, comprehensive global data sets, one-of-a-kind instruments, and state-of-the-art numerical models of the weather, marine ecosystems, climate change, and ocean currents.

There are ~15 T/TT faculty members in the ATOC department, yet the number of courses we offer is considerably more than 15. Therefore, while each of us certainly have “favorite” courses that perhaps grew out of our own research expertise and competencies, and individual faculty members may teach them regularly, we do rotate classes around quite broadly among faculty members. Most of us already leverage cutting edge research and bring the associated technology into the classroom. Since most of us are also world class researchers and leaders in our particular discipline, this is an enormous intangible benefit to the students.

However, the data sets, models, and technology that each individual faculty member decides to bring into their classroom is driven by what they are already familiar and comfortable with themselves. Whether high or low tech, our research technologies are highly discipline-specific and there are usually only one or two faculty members who know what they’re doing with any one of them. Given how busy faculty members are, it is a daunting prospect to take up the task of learning enough about other tools and technologies used by our departmental colleagues to feel comfortable actually using them in practice and integrating them into our own classrooms.

Describe (desired) result.

The modules served on the DDLL, contributed by faculty and curated by the Technology Committee, are designed to be readily accessible to any faculty member teaching the same or similar courses so that all students may benefit from the full breadth of expertise on the ATOC faculty, independent of who is the instructor at the time.

The modules are *not* complete lesson plans, which would be more prescriptive than the intent of the DDLL. The modules are meant to be a kernel, upon which an instructor can overlay a lesson plan, homework assignment, in-class activity, lab/recitation exercise or even semester project.

Describe the project. What did you do?

I worked with multiple colleagues in my department to generalize one of their favorite exercises into an online module that should be accessible by any other faculty member. After a brief consultation with the faculty members, during which we determined what data sets and what types of ways the students can interact with them, I worked to ensure that the online modules are entirely self-contained, providing all of the necessary data, code and pedagogical suggestions. I also populated a set of metadata to facilitate their selection and appropriate application.

Describe the outcome. What worked, what didn’t work, lessons learned.

Whether or not this outcome will be successful will be determined over the next several years. I will make sure the faculty are aware of this resource; I will periodically and informally ask whether it is being used, and try to add a couple of modules per semester. The more people contribute, the more useful it will be to all.

Reflect on your experience in the Faculty Fellows program and working on your project.

My experience in the FFP was well worth the time investment. My cohort of Faculty Fellows and the FFP leaders assisted in proposing an achievable and useful project that addressed my overall goal of increasing the use of research-quality data and technology in the undergraduate classrooms, in particular those relevant to our newly launched major.

If appropriate, please include other artifacts and visuals (data, weblinks, pictures, write-ups)

https://www.colorado.edu/atoc/ddll

Example module appropriate for all undergraduates:

Investigate changes in the mass of ice sheets using gravity measurements from space

Module ID: 001

Synopsis: By measuring variations in the gravitational pull of Earth's surface from a twin pair of satellites in orbit, the GRACE satellite mission has provided monthly, global gravity maps since 2002. These measurements allow us to observe changes in the mass balance of the Greenland and Antarctic ice sheets. With this module, students can estimate and compare trends and variability in the mass of ice on Greeland and Antarctica. Students can also quickly diagnose the changes in Greenland ice sheet mass based on the individual mass balance components (discharge and the difference between precipitation and evaporation). Possible implementations of this module include in-class activity, lab/recitation exercise or homework assignment.

Curricular tie-ins: Ice sheets; sea level; climate change; uncertainty

Appropriate for: Undergraduate students.

Plausible courses: ATOC 1060; ATOC 3070; ATOC 3300; ATOC 3600; ATOC 4215; ATOC 4500; ATOC 4720; ATOC 4730

Software and skills required: Excel or similar.

Pedagogical suggestion: module_001_ped.docx

Data set: module_001_data.xlsx

Source: Gravity Recovery and Climate Experiment (GRACE) monthly mascon time series for Greenland and Antarctica (JPL | NASA PO.DAAC)

Code: N/A

Representative journal article: Recent contributions of glaciers and ice caps to sea level rise (Jacob et al. 2012, *Nature)*

Faculty contributor: Prof. Jan Lennartz

Example module appropriate for advanced undergraduates and graduate students:

Analyze predictions of future changes in rainfall using global climate models

Module ID: 004

Synopsis: The Intergovernmental Panel on Climate Change (IPCC) relies on the international climate modeling community to provide insight into the range of possible future changes in climate, with shifts in the global distribution of rainfall being of particular concern for society. With this module, students can quantitatively analyze the output of 30 state-of-the-art, global climate model simulations to quantify predictions of future changes in precipitation. Students can assess the significance of predicted trends relative to natural climate variability, determine the extent to which the predictions are model-dependent, and explore the overall sensitivity of the predictions to global CO2 emissions scenario. Possible implementations of this module include lab/recitation exercise, homework assignment or semester project.

Curricular tie-ins: hydroclimate; IPCC; climate change; numerical models; uncertainty

Appropriate for: Advanced undergraduates (4000-level course) and graduate students. *

Plausible courses: ATOC 4500; ATOC 4730; ATOC 5730; ATOC 6100 *

Software and skills required: MATLAB software required. A minimum of prior experience is necessary, as code is provided that can be executed and slightly modified. *

Pedagogical suggestion: module_004_ped.docx

Data set: module_004_data.mat **

Source: Coupled Model Intercomparison Project phase 5 (Earth System Grid Federation | LLNL.gov)

Code: module_004_code.m ***

Representative journal article: Projected changes in mean rainfall and temperature over East Africa based on CMIP5 models (Ongoma *et al.* 2017, *International Journal of Climatology)*

Faculty contributor: Prof. Kris Karnauskas

* This module can be adapted to lower-division undergraduate courses (e.g., ATOC 1060 recitation activity or ATOC 3600) if the instructor simply computes area-averaged time series from the full gridded data file provided, and provides those columnar data in Excel format to the students.

** For security reasons, this .mat file will save to your computer as a .pdf file. After downloading, simply change the extension from .pdf to .mat and it will be readable by MATLAB.

*** For security reasons, this .m file will save to your computer as a .pdf file. After downloading, simply change the extension from .pdf to .m and it will be readable by MATLAB.