Ryan Abernathey: Teaching Statement

My teaching has two main goals:

1. Provide students with a solid foundation in the fundamental physics of the ocean
2. Empower students to analyze data and perform simulations using modern computational tools

Achieving these goals results in students who are ready to make serious contributions to research.

Fundamental Physics

Since starting at Columbia, I have taught *Introduction to Physical Oceanography (EESC 4295)* (jointly with Arnold Gordon). This class educates DEES graduate students (as well as plenty of undergraduate majors) on the thermodynamics, water masses, circulation pathways, and basic physical theories governing large scale ocean circulation. Students going on to do research in physical oceanography are the minority; most of the students need this course to inform their studies in climate, geochemistry, or biological oceanography. Consequently, a broad, accessible approach is crucial. Since joining the course, I have contributed significant new elements on ocean mixing, equations of motion, and Southern Ocean circulation. I have also incorporated data analysis into the curriculum.

Another foundational course I teach is *Geophyiscal Fluid Dynamics (EESC/APPH 4210)* (Spring 2015, Spring 2016). This mathematically oriented courses teaches graduate students and advanced undergrads fundamental concepts in the dynamics of rotating stratified flows. We derive the basic equations of motion and examine the approximations relevant to the ocean and atmosphere. Shallow water dynamics, potential vorticity dynamics, and linear wave theory are used to interpret and explain observed phenomena. Quasigeostrophic theory and barotropic / baroclinic instability are the final topics.

I have also recently begun to teach *Ocean Dynamics (EESC G6930)* (spring 2017). This advanced course serves graduate students in physical oceanography and related fields. Topics are chosen based on student research interests. Last year, we studied large-scale ocean circulation theory, boundary layers, ocean turbulence, and mixing.

Research Computing

I believe that computing is a cornerstone of success in research. Consequently, I have strived to make computing a first-class part of of our Earth Science curriculum. These efforts have evolved considerably over the past years.

Shortly after arriving, I began to offer an informal "bootcamp" entitled *Scientific Computing with Python*. I experimented with different formats from 2013-2015, each year attracting have had approx. 80 attendees. This speaks to the deep demand for education in computing within DEES and Lamont. In 2015, the workshop blossomed into a weekly study group exploring different aspects of scientific computing and visualization, with about 15 regular attendees. (In retrospect, I should have turned this into an official seminar, allowing the students to receive credit for their participation.)

In Fall 2016, we organized a much larger workshop, open to graduate students from seven participating departments, in conjunction with the Software Carpentry organization. Over 120 participants spent two days learning the basics of MATLAB, R, or Python, plus other fundamentals of research computing. The broad interest from across the university showed that the need to education in this area exists in most science and education fields.

The culmination of these efforts is a new, full credit DEES graduate course entitlted *Research Computing in Earth Science*. The first iteration in 2017 was taught jointly with Kerry Key and incorporated MATLAB, Fortran, and Python. In 2018, I am the sole instructor, and the focus is exclusively on Python. The course takes a systematic tour through all of the skills students need to become functional researchers, including

UNIX command line, version control, fundamentals of programming , ingestion and cleaning of data in various formats, basic analysis methods, visualization, mapping, and big-data concepts like parallel programming. All examples and assignments are drawn from real Earth Science datasets. The course enrollment is capped at 30; it has been full both semesters, a testament to the strong demand from students. We are conducting ongoing formative and summative assessment of the curriculum and teaching approach in conjunction with an independent consultant. This assessment work, part of the educational component of my NSF CAREER award, should provide us a clear picture of the effectiveness and impact of this new approach to computing. It is noteworthy that this year's class is over 2/3 female, suggesting that education in computation is particularly valuable for underrepresented groups.