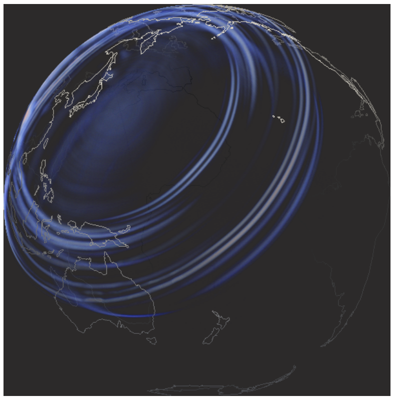
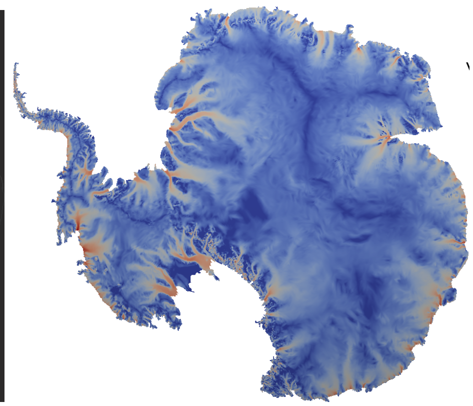
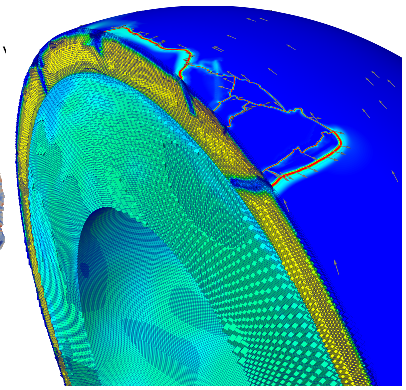
GEO 384F: Finite Element Method in Geophysics
Fall 2020
Hybrid: #26795   Online: #26799

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Lectures: Monday/Wednesday 5-7pm, GDC 1.406 (but see note below about our changing our online meetings to a more convenient time of day). Office hours will be held immediately after class. In addition, feel free to contact me to set up meetings at other times.

Covid-19: In light of the high number of daily Covid-19 infections in Travis County (relative to April and May), this course is now offered in "hybrid" mode (#26795), with a purely-online option (#26799). We'll start off with online lectures, and switch to in-class lectures only if we see a substantial decrease in the rate of new infections. Since we'll be meeting online for at least the first part of the course, we don't have to stick with the assigned meeting time. Instead we'll try to find a more convenient time to meet. The first lecture will be held over Zoom on Wednesday August 26 at 5pm (CDT) at the following address: `https://utexas.zoom.us/j/93039006156`. At this first meeting, we'll figure out a better time to meet that doesn't conflict with other commitments. So please come ready to discuss scheduling.

Canvas: We'll be using Canvas for all messaging, discussion, handouts, assignments, etc. (we were going to use Slack but it doesn't have the integration with Zoom that Canvas has). Within Canvas, I've combined both versions of the course—the hybrid one and the internet one—into a single course. This is just in Canvas, to avoid redundancy. You will still officially be in the version of the course you registered for.

Description: This course covers numerical methods for the solution of partial differential equations (PDEs) arising in continuum geophysics. Our focus is on the finite element method (FEM), for its generality, adaptivity, and accuracy. The FEM is applicable to a broad spectrum of geophysical and environmental models including those arising in seismology, geodynamics, subsurface flow and transport, geomechanics, ocean dynamics, atmospheric sciences, and glaciology. We will begin by developing the core ingredients of the FEM—weak formulation, Galerkin approximation, piecewise polynomial basis functions, numerical quadrature, isoparametric elements, assembly—with reference to 1D and 2D heat conduction problems. We will then study finite element approximations of fundamental continuum mechanics and continuum physics PDEs that underlie a spectrum of geophysical problems, including elasticity, wave propagation, viscous flow (Stokes and Navier Stokes), and porous media flow and transport. To implement the FEM, we will employ the powerful finite element toolkit `FEniCS`, which abstracts away low level implementation details, allowing students to focus on high level issues that are critical for finite element solution.

Prerequisites: Graduate standing or consent of instructor. The background required is just the vector calculus, linear algebra, and differential equations included in the curriculum of a standard undergraduate science or engineering degree. The required mathematical and computational background will be covered as needed, albeit quickly. Ask me if you're unsure! Auditors are more than welcome.

Required work: Course grades will be based solely on 5 or 6 equally weighted assignments. These will involve a mix of paper-and-pencil solutions, and computer work. The lowest grade will be dropped. We won't have a final exam.

Optional Text: E.B. Becker, G.F. Carey, and J.T. Oden, *Finite Elements: An Introduction* (Volume 1 of Texas Finite Element Series), Prentice Hall, 1981. (Out of print, but copies will be made available to students for purchase.)