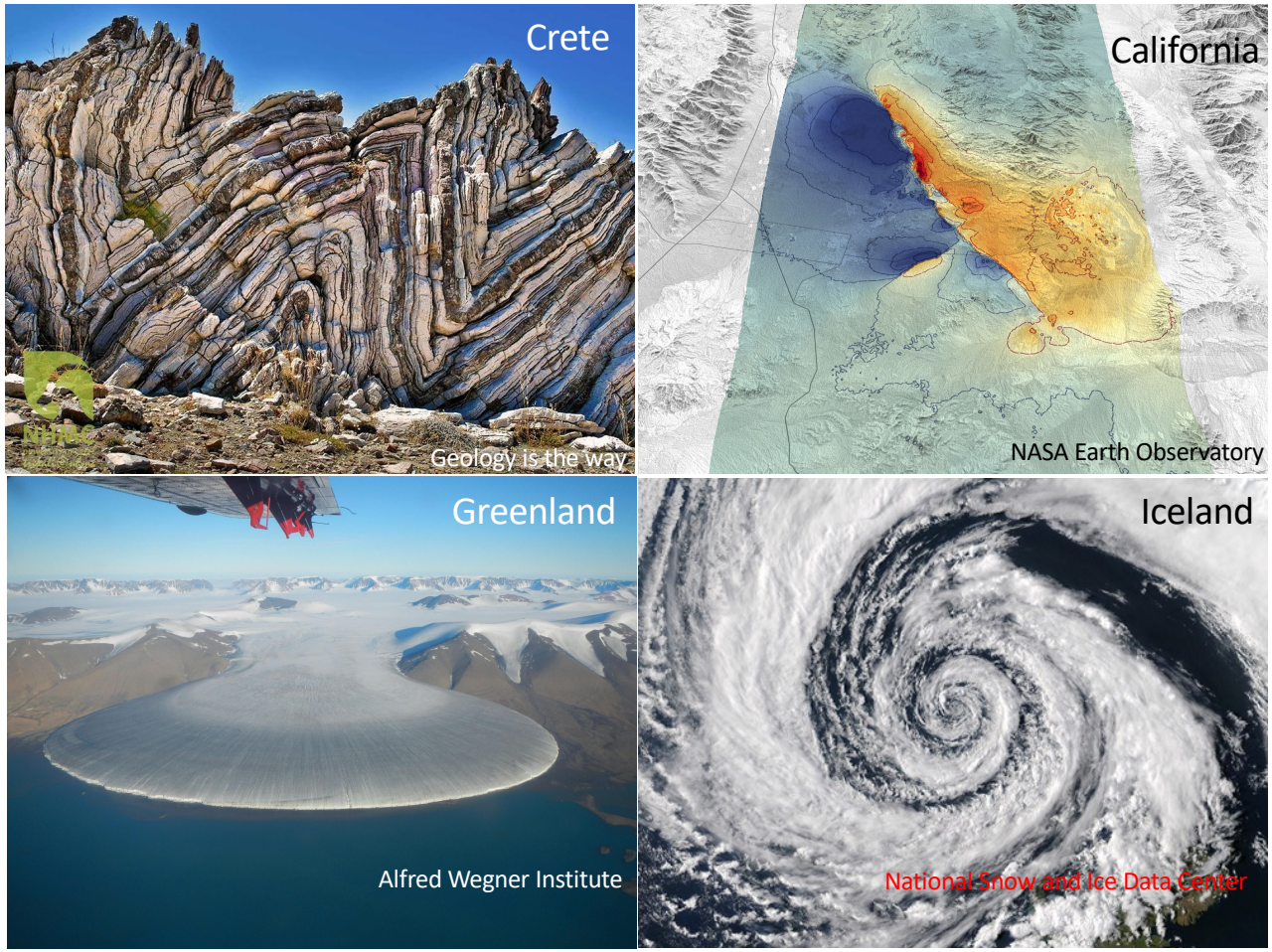
GEO 325C/398C Continuum Mechanics

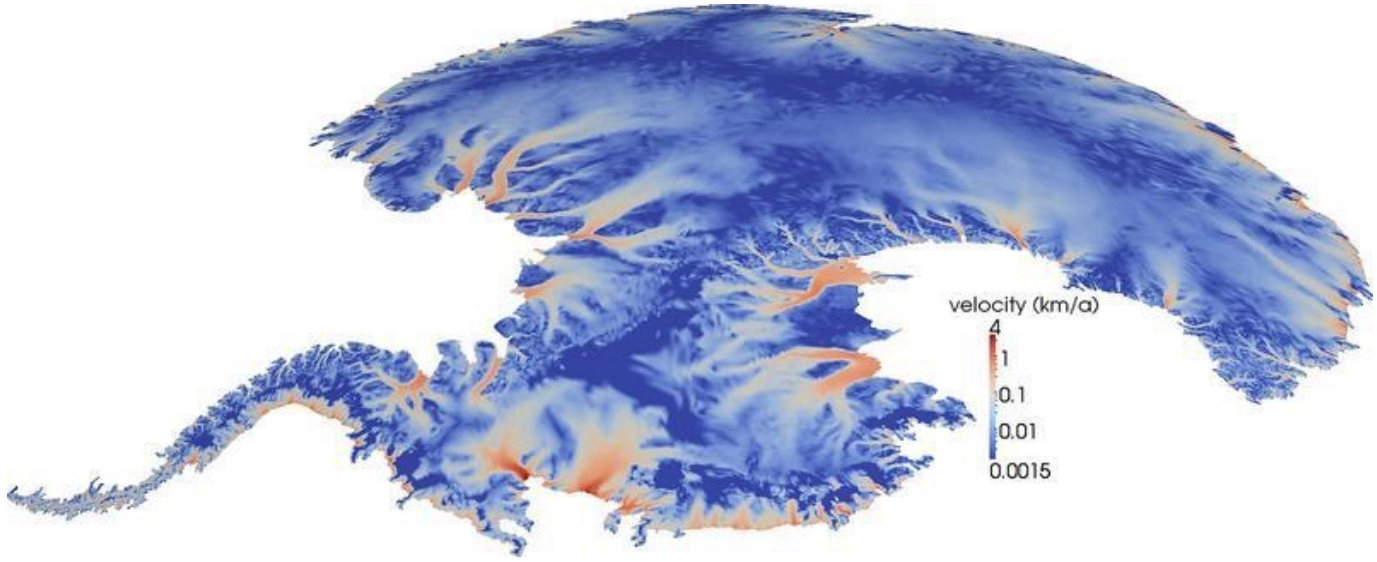


Why take this class?

This class provides the foundation for the modeling of all* **dynamical processes** in the Earth Sciences. It is excellent preparation for higher division classes in geodynamics, seismology, geomechanics, glaciology, atmospheric and ocean modeling.

Numerical model of the Antarctic ice sheet by former UT graduate student Tobin Isaac, taken from the website of the ODEN Institute.

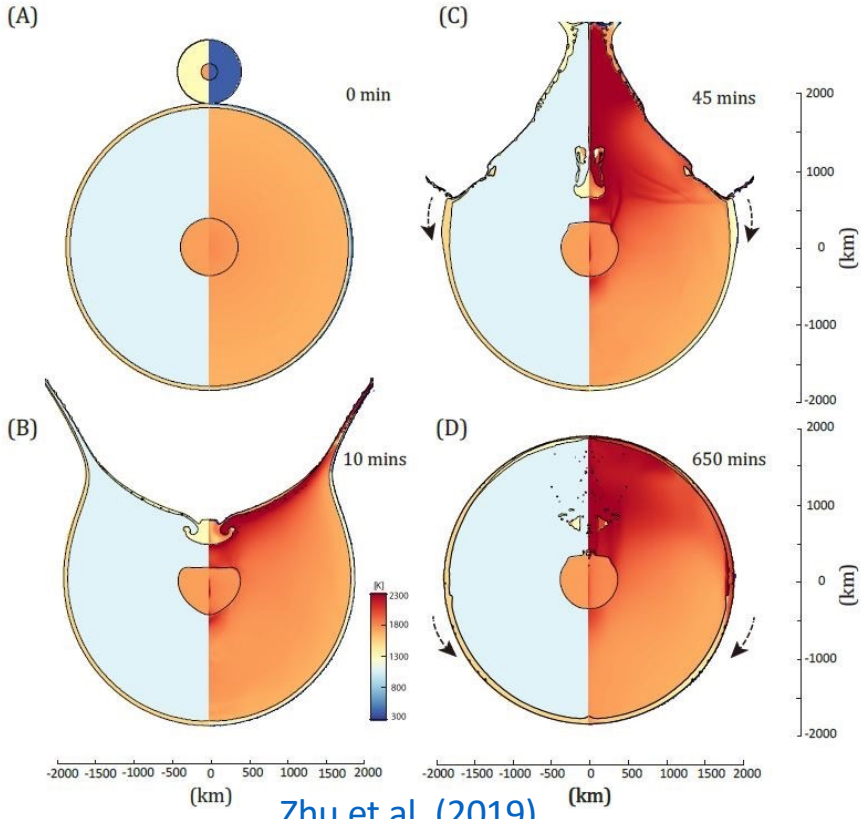
*almost all



What we will be doing:

Topics:

- **I: Force and torque (3 lec)**
- **II: Tensor algebra and stress (6 lec)**
- **III: Tensor calculus (3 lec)**
- **IV: Kinematics and strain (6 lec)**
- **V: Conservation laws (4 lec)**
- **VI: Applications (4 lec)**



Zhu et al. (2019)

Course website(s)

- Class website: https://mhesse.github.io/continuum_mechanics/
  Post all notes, lecture, and recordings (main resource)

- Canvas: https://utexas.instructure.com/courses/1457108
  (Post and submit homeworks, post grades)

- Ed Discussion: TBD (UT changed software on us)
  (class discussion, has latex editing!)

Office hours

Office hours are integral part of the class!

- Conceptual questions answered
- Help with manipulations
- Discuss broader context

$\Longrightarrow$ Students that come to office hours do better!

We need to find time for office hours:

Complete poll: https://www.when2meet.com/?38100457-QIQY8

Assessment

Undergraduates (GEO 325C)

20% Problem sets
15% Midterm 1 (Topic I+II)
15% Midterm 2 (Topic III+IV)
30% Final (comprehensive)
20% Attendance

Graduate students (GEO 398C)

20% Problem sets
15% Midterm 1 (Topic I+II)
15% Midterm 2 (Topic III+IV)
30% Final (comprehensive)
20% Graduate Project

(More on graduate project later.)

Homeworks

- Homework is paper and pencil work.
- Homework needs to be submitted electronically as **PDF files**.
  (please don't submit photos of paper sheets)
- If your PDF is very large (MB's), please compress it before submitting
  (https://www.ilovepdf.com/compress_pdf)

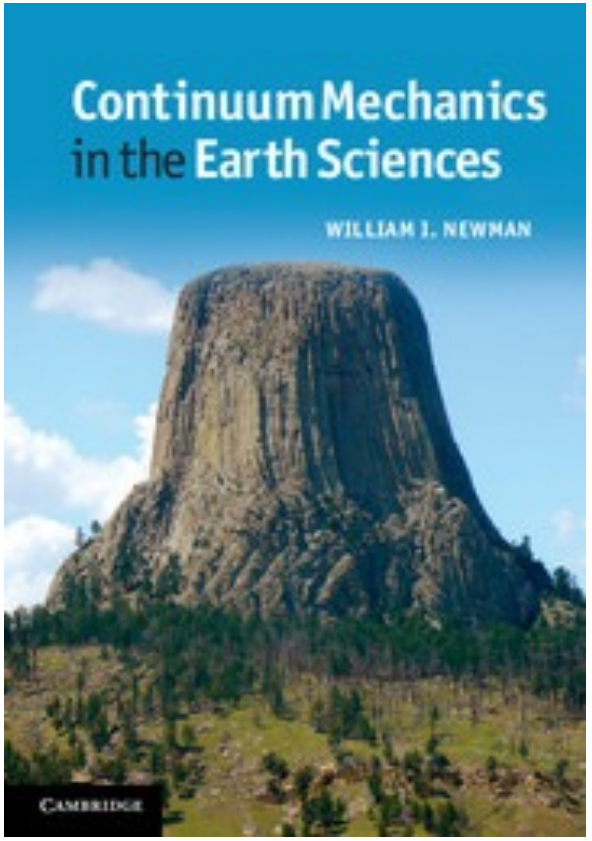
- You need to **start early** to be successful.
- Late penalty is -10% per day late
- Resubmit **up to 3 PS's** for better grade,
  if you have attended **all** relevant classes!

Attendance

- Class attendance is **mandatory** for undergraduates.
- Attending class leads to better results!
- For undergraduates I will take attendance => part of your grade.

- Students that don’t attend class are lost on Problem Sets/Exams
- If you missed class you **cannot** resubmit PS (also grad students)

Books for class



Read lecture notes not the internet

$$\rho \dot{\underline{v}} = \rho \frac{\partial \underline{v}}{\partial t} + \rho(\nabla_x \underline{v})\underline{v} = \frac{\partial}{\partial t}(\rho \underline{v}) - \frac{\partial \rho}{\partial t}\underline{v} + (\nabla_x \underline{v})(\rho \underline{v})$$

using mass balance $\frac{\partial \rho}{\partial t} = -\nabla \cdot (\rho \underline{v})$

$$\rho \dot{\underline{v}} = \frac{\partial}{\partial t}(\rho \underline{v}) + \nabla_x \cdot (\rho \underline{v})\underline{v} + (\nabla_x \underline{v})(\rho \underline{v})$$

using $\nabla \cdot (\underline{a} \otimes \underline{b}) = (\nabla \underline{a})\underline{b} + \underline{a}\,\nabla \cdot \underline{b}$ (see HW5 Q4)

$$\rho \dot{\underline{v}} = \frac{\partial}{\partial t}(\rho \underline{v}) + \nabla_x \cdot (\rho \underline{v} \otimes \underline{v})$$

Hence we have conservative local Eulerian form

$$\boxed{\frac{\partial}{\partial t}(\rho \underline{v}) + \nabla_x \cdot (\rho \underline{v} \otimes \underline{v} - \underline{\underline{s}}) = \rho \underline{b}}$$

conserved quantity: $\rho \underline{v}$ = linear momentum

advective mom. flux: $\rho \underline{v} \otimes \underline{v}$

diffusive mom. flux: $-\underline{\underline{s}}$

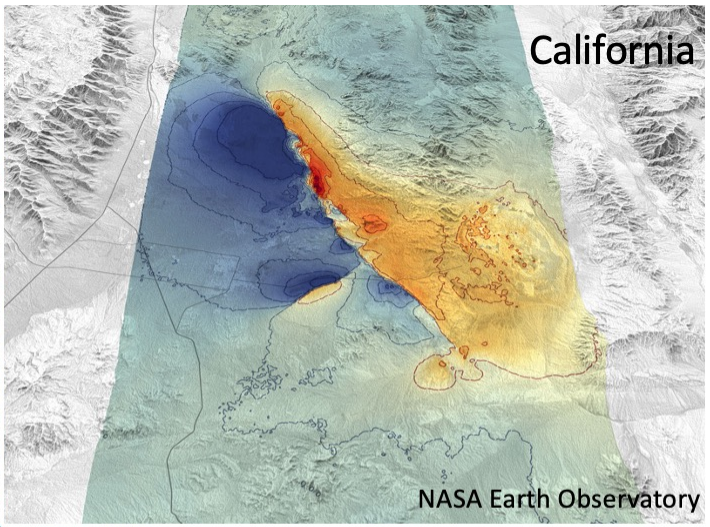
Lecture notes are main reference.

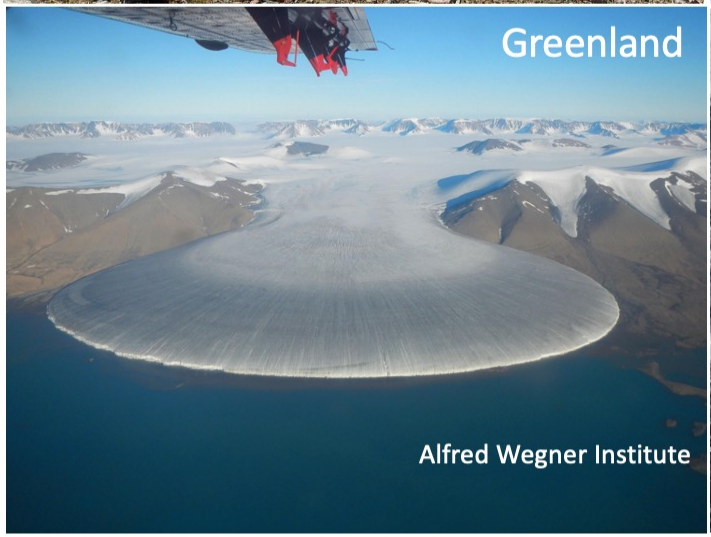
(G&S is second reference)

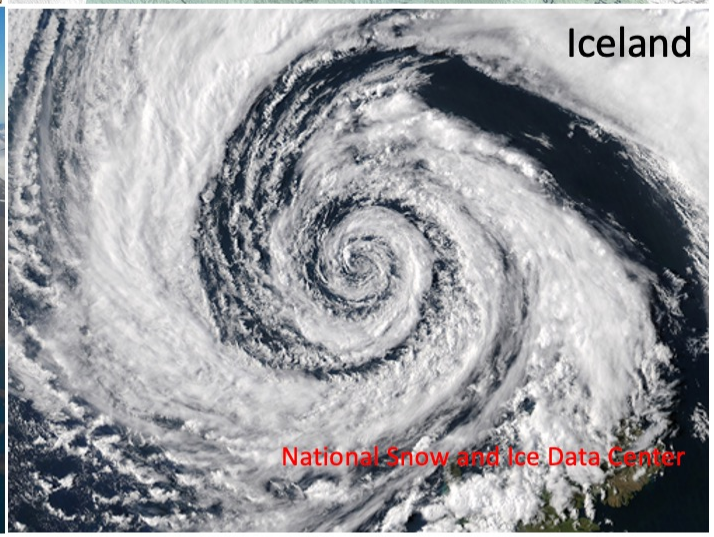
Notes often directly help with HW!

You need to use class notation.


Crete
Geology is the way


California
NASA Earth Observatory


Greenland
Alfred Wegner Institute


Iceland
National Snow and Ice Data Center