G331 2018 Paleoceanography

The course utilizes primary literature—journal articles—made available during the course.

The course will investigate past ocean circulation changes and their connection to climate. In the process, the participants will become familiar with ocean circulation and the strengths and weaknesses of different paleoceanographic tools (proxies, dating, mediums, models etc.) that are employed to investigate the past ocean. In addition, participants should gain proficiency reading scientific literature and in identifying the scientific value/contribution and weaknesses of each study—developing assessment and evaluation skills are crucial to the scientific method and to doing well at the master level and beyond.

By the end of the course students should:

Specific learning outcomes

- Have knowledge of the modern and past ocean circulation states and applied knowledge of paleoceanographic proxies including their utility and limitations.
- Have a state-of-the-art understanding of the chosen scientific theme (e.g. instability of thermohaline circulation (THC) during past warm climate states).

General learning outcomes

- Be able to formulate and coherently present scientific arguments and concepts.
- Have the ability to work and discuss in groups to collectively interpret scientific data.
- Have developed analytical skills and a demonstrable ability to critically assess scientific studies for robustness, logical and empirical consistency, clarity, and reflect on the significance of a result.
- Be able to provide a peer review for a scientific article.
- Be able to formulate a hypothesis and create/design an experiment/study to test the hypothesis.

<u>Work and Grading (expectations):</u> This course will be based on scientific literature focused around a common theme of interest. The theme will be chosen during the first class meeting. Past examples include last glacial maximum ocean circulation, ocean circulation under warmer than present conditions, and the role of ocean circulation in millennial scale climate change. Articles will be handed out and/or provided on "mitt uib" on a weekly basis. You will be expected to critically read scientific articles and contribute to the in class discussion of those articles. <u>Attendance</u> and <u>involvement</u> in the discussion are <u>required</u> for passing.

In addition to discussion, each week you will have to hand in a single paragraph summary of what you thought the main contribution of the paper was and what its shortcomings/weaknesses were. It does not have to be more than 4-8 sentences. When writing consider the following:

-why did they write the paper, what was the problem/hypothesis?
-what was the test/experiment, how did they address the problem?
-was the test/work successful (how)?
-how does the original hypothesis change or what new hypotheses are generate, ie. what did we learn?

The final task will be for the students to propose a research project (1-2 page proposal) that will significantly advance our understanding beyond the state-of-the-art. Given the Students will evaluate each other's proposals and act as referees; selecting the best proposal(s) for funding.

Tentative theme: Ocean circulation and (in)stability during past warm periods

Outline: (input for theme suggestions or additions will be discussed at first meeting)

Wk3 (NO CLASS: READ papers for week 4 meeting)

Wk4 Basic Introduction (oceanography background; THC and AMOC)

1) Rahmstorf'06-THC http://www.pik-potsdam.de/~stefan/Publications/Book_chapters/rahmstorf_eqs_2006.pdf
2) Read also (at minimum) highlighted portions of Delworth et al., (mitt.uib "files").

This is a bit of reading but you have the rest of this week and next week to get through it.

Not required but potentially of interest as background:

- *Kuhlbrot et al, 2007 paper on driving processes for AMOC (more quantitative version of the Rahmstorf paper; http://onlinelibrary.wiley.com/doi/10.1029/2004RG000166/epdf*
- *Broecker's 1991 paper on the conveyor. http://tos.org/oceanography/assets/docs/4-2_broecker.pdf*

The rest of the course is tentative based on the theme chosen (outline suggested)

Wk5 Holocene changes—Oppo et al. 2003 (and Olsen and Ninnemann, 2010?)

Wk6 Abrupt event—Ellison et al., 2006

Wk7 Abrupt event—Kleiven et al., 2008

Wk8 Holocene Trends/transitions (Hoogakker et al., 2011 or Mjell et al, 2015/2016, or Thornalley et al, 2013)

Wk9 LIG circulation--stable (Adkins et al., 1997)

Wk10 LIG circulation stable after deglacial suppression (Govin et al 2012)

Wk11 LIG hints for variability (e.g. McManus et al., 1999)

Wk12 LIG evidence for variability (e.g. Hodell et al., 2009)

Wk13 LIG circulation—highly variable! (Galaasen et al., 2014)

Wk14 *TBD*

Wk15 EASTER

Wk16 Pliocene case study—NADW stronger? (Raymo et al., 1996)

Wk16 also Pliocene models—NADW not stronger? (Haywood or Valdez papers)

Wk18 Students proposals

Wk19 proposal evaluation