SIOC 220 Course Syllabus

Objectives:

The aim of this class is to:

1. To provide a broad overview of global ocean circulation and the role of ocean circulation in climate. This will include the strength, spatial structure and temporal variability of the oceans' boundary currents and interior flows, and the circulation of water masses around the globe.
2. To enable students to interpret the literature of observational oceanography:
- through familiarization with controversial issues in modern oceanography,
- by understanding the implications of oceanographic data sets,
- by distinguishing between conjectural and well-supported conclusions.
3. To familiarize students with the global observing system. Provide access to modern global datasets and become accustomed to instrumentation and methods used for observing the large-scale circulation.

In general, the course should provide sufficient background for students to be able to search, review, and assess the state of knowledge on any given topic in large-scale ocean circulation, for example as part of an NSF proposal or the introductory section of a paper.

Format:

- Everyone will take turns acting as discussion leader for individual topics.
- A preliminary list of references is provided by the instructor, including some ideas on an appropriate focus for discussion.
- The discussion leader will designate the main paper for discussion.
- The instructors’ function is to act as a resource and to offer additional perspective or recent information (e.g. what does Argo add to our knowledge of this topic?).
- The objective of each class discussion should be to reach a consensus on:

- Background and significance of the topic

- Observational basis of the paper – Adequacy?

- Analysis methods and results

- Conclusions – What is robust; what is conjectural?

- Follow-up using modern datasets (Argo, altimetry… What would you do next?)

The format is designed to meet the objective of the course to advance your ability to synthesize background material and recognize the issues arising from a specific data set or experiment. This is a skill you must develop in order to be able to plan and propose your own experiments and evaluate others. The topics are chosen to constitute a broad survey, though not a complete one, of the global large-scale circulation and can be somewhat tailored to the class's interests.

Grade

Grade will be based on class participation only. There are no exams or finals. You are expected to read all papers, participate in class discussions, and lead class discussions.

SIOC 220 SCHEDULE
Observations of Large Scale Ocean Circulation
Spring 2021: T 1:30-3:20; Th 1:30-2:20/3:30

T: March 30: Introduction, class objectives, and decide on class topics and presenters, Introduction to the global observing system, and Example: Bryden Nature 2005

8 students
Each has 4 presentations
32 slots
Topics list has 45 entries, each with a reading list

Student order:
1. Jack
2. Andrea
3. Ben
4. Helen
5. Taylor
6. Sophie
7. Kerstin
8. Aurora

Subtropics

Th: April 1:

a) Leeuwin Current (Lynne)

Ridgway, K. R., and J. S. Godfrey (2015), The source of the Leeuwin Current seasonality, J. Geophys. Res. Oceans, 120, 6843–6864, doi:10.1002/2015JC011049

T: April 6:

a) California Current (Student 1 Jack)

Auad, Guillermo, Dean Roemmich, and John Gilson. "The California Current System in relation to the Northeast Pacific Ocean circulation." *Progress in Oceanography* 91.4 (2011): 576-592

b) DYNAMICS: Ekman spiral and transport (Student 2 Andrea)

Chereskin, T.K., 1995. Direct evidence for an Ekman balance in the California Current. J. Geophys. Res. 100, 18261-18269

Th: April 7

a) The East Australian Current (Student 3 Ben)

Oke, P. R., M. Roughan, P. Cetina-Heredia, G.S. Pilo, K.R. Ridgway, T. Rykova, M.R. Archer, R.C. Coleman, C.G. Kerry, C. Rocha, A. Schaeffer, E. Viarelli, 2019. Revisiting the circulation of the East Australian Current: Its path, separation, and eddy field. Progr. in Oceangr., 176, 102139, https://doi.org/10.1016/j.pocean.2019.102139

T: April 13:

a) The Agulhas Current (Student 4 Helen)

Beal, Lisa M., and Shane Elipot. "Broadening not strengthening of the Agulhas Current since the early 1990s." *Nature* 540.7634 (2016): 570-573

b) The Southern Hemisphere Super-Gyre (Student 5 Taylor)

Ridgway, K. R., and J. R. Dunn (2007), Observational evidence for a Southern Hemisphere oceanic supergyre, Geophys. Res. Lett., 34, L13612, doi:10.1029/2007GL030392

Tropics

Th: April 15:

a) The Indonesian Throughflow (Student 6 Sophie)

Sprintall, J., S. E. Wijffels, R. Molcard, and I. Jaya (2009), Direct estimates of the Indonesian Throughflow entering the Indian Ocean: 2004–2006, J. Geophys. Res., 114, C07001, doi:10.1029/2008JC005257

T: April 20

a) The South Equatorial Current Bifurcation (Student 7 Kerstin)

Gourdeau, L., W.S. Kessler, R.E. Davis, J. Sherman, C., Maes, E., Kestenare (2008). Zonal Jets entering the Coral Sea. Journal of Physical Oceanography, March 2008. DOI: 10.1175/2007JPO3780.1

b) DYNAMICS: Sverdrup balance (Student 8 Aurora)
Gray, A., and S. Riser, 2014: A Global Analysis of Sverdrup Balance using Absolute Geostrophic Velocities from Argo. J. Phys. Oceanogr., 44, 1213-1229 doi:10.1175/JPOD-12-0206.1

Th: April 22

a) Ocean circulation and El Niño (Student 1 Jack).
McPhaden, M., 1999. Genesis and evolution of the 1997-98 El Nino. Science, 283, 950- 954.

b) Geostrophy near the Equator (Student 2 Andrea)
Lukas, R. and E. Firing, 1984. The geostrophic balance of the Equatorial Undercurrent. Deep-Sea Research, 31, 61-66.

T: April 27

a) Interior sources of the equatorial Pacific thermocline (Student 3 Ben):
The Mean and the Time Variability of the Shallow Meridional Overturning Circulation in the Tropical South Pacific Ocean - N. V. Zilberman, D. H. Roemmich-, and S. T. Gille , 2013 [Zilberman, N.V., D.H. Roemmich, and S.T. Gille, 2013 The mean and the time-variability of the shallow meridional overturning circulation in the tropical South Pacific Ocean. Journal of Climate, 26, 4069-4087. doi: 10.1175/JCLI-D-12-00120.1]

b) Dynamic height and steric height (Lynne): DPO chapter S7.6 (use the supplemental version 'S' rather than the textbook version; see DPO folder in Papers)

High latitudes

Th: April 29

a) AABW formation (Student 4 Helen).
Johnson, G. C. (2008), Quantifying Antarctic Bottom Water and North Atlantic Deep Water volumes, J. Geophys. Res., 113(C5), C05027–13, doi:10.1029/2007JC004477.

b) Antarctic Circumpolar Current (Student 5 Taylor)
Donohue, K. A., K. L. Tracey, D. R. Watts, M. P. Chidichimo, and T. K. Chereskin (2016), Mean Antarctic Circumpolar Current transport measured in Drake Passage, Geophys. Res. Lett., 43, 11,760–11,767, doi:10.1002/2016GL070319.

T: May 4

a) DYNAMICS: Southern Ocean dynamical balance (Student 6 Sophie). Warren, B.A. 1990: Suppression of deep oxygen concentrations by Drake Passage. Deep-Sea Res., 37, 1899–1907. https://doi.org/10.1016/0198-0149(90)90085-A

b) Labrador Sea Water formation (Student 7 Kerstin) Yashayaev, I., and J. W. Loder (2017), Further intensification of deep convection in the Labrador Sea in 2016, Geophys. Res. Lett., 44, 1429–1438, doi:10.1002/2016GL071668

Th: May 6

a) Ocean forced glacial melting (Student 8 Aurora)

Straneo, F., Curry, R., Sutherland, D. *et al.* Impact of fjord dynamics and glacial runoff on the circulation near Helheim Glacier. *Nature Geosci* **4,** 322–327 (2011). https://doi.org/10.1038/ngeo1109

b) Arctic circulation (Student 1 Jack)

T: May 11

a) Southern Ocean surface layer under seasonal ice (Student 2 Andrea)
b) Antarctic Intermediate Water (Student 3 Ben)

Overturning circulation and abyssal circulation

Th: May 13

a) Pacific Deep Water and the global overturning circulation (Student 4 Helen)

T: May 18

a) Deep transport from S. Pacific via Samoan Passage (Student 5 Taylor)
b) Heat transport (Student 6 Sophie)

Th: May 20

a) Ocean Mixing (Student 7 Kerstin)
b) TBD-freshwater or E-P (Student 8 Aurora)

T: May 25:

a) Internal waves (Student 2 Andrea)

Global change

b) Global Ocean Warming (Student 1 Jack)

Th: May 27:

a) Sea level rise (Student 3 Ben)
b) Glacial-interglacial variations of the MOC (Student 4 Helen)

T: Jun 1

a) Salinity anomaly in the North Atlantic (Student 5 Taylor)
b) Deep ocean warming (Student 6 Sophie)

Th: Jun 3

a) Time variability of the Atlantic MOC (Student 7 Kerstin)
b) Sea ice changes (Student 8 Aurora)