

SIOC 210

Problem Set 4

Dec. 3, 2019, due Dec. 6

(You can hand in at final exam; if you can scan you can submit via Canvas, or bring to class on Dec. 5, or arrange with Ray Shi to hand in on Dec. 6)

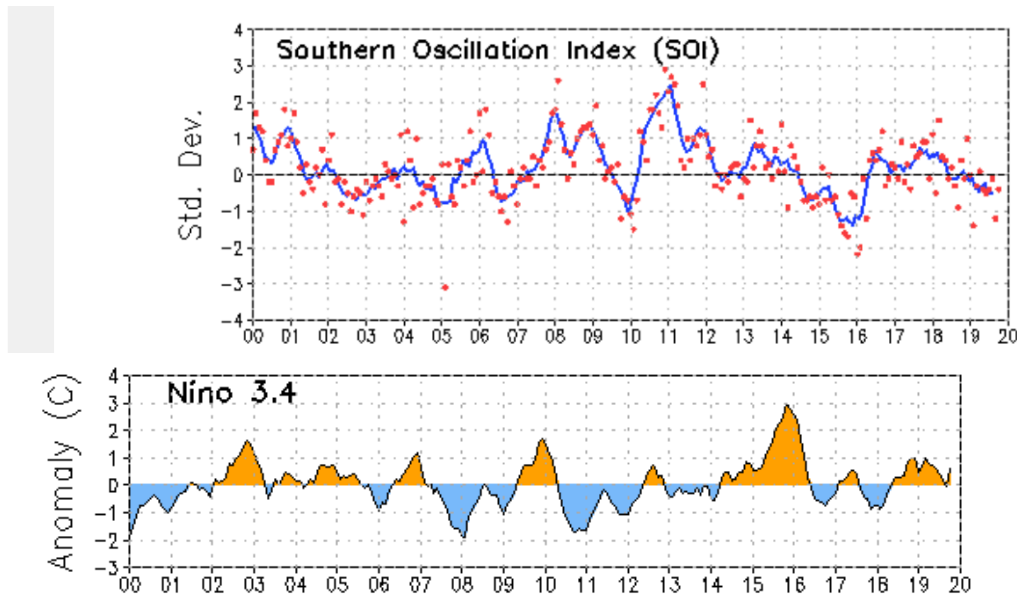
### 1. ENSO

The figures show the Southern Oscillation Index and an SST anomaly time series, from the NOAA Climate Diagnostics Bulletin.

<https://www.cpc.ncep.noaa.gov/products/CDB/>

To speed up your search for answers to (c) and (d), good sources are

- NOAA ocean products
- TAO at NOAA PMEL (use dynamic height instead of sea level height)
- NASA El Nino



- (a) Write down the definition of the Southern Oscillation Index (SOI).
- (b) Based on these figures, what phase of ENSO are we in now? (El Niño, La Niña, or normal?)
- (c) Use the internet to find a figure showing a **map** of the SST anomaly in the Pacific Ocean for some time in the last few months. Insert that map in your homework answers. List your website source.

Describe the SST anomaly map (tropical Pacific portion only), in terms of the current phase of ENSO and in terms of the SOI.

(d) Do the same to find a map of the sea surface height (SSH) anomaly for some time in the last few months. Include in your homework, and list your website source.

Describe the SSH anomaly map as in part (b).

## 2. Dynamics: Abyssal circulation

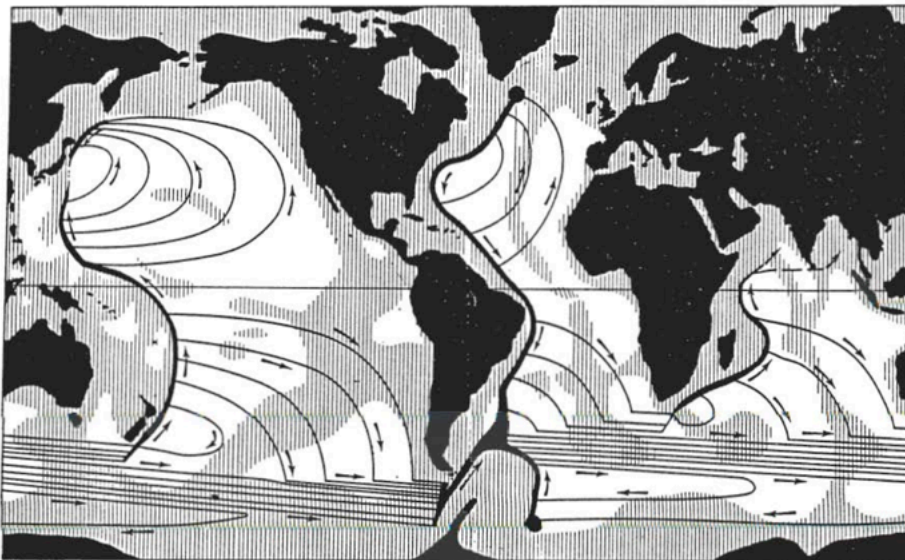
The figure shows an early (Stommel, 1958) idealized theoretical calculation of the ocean's abyssal circulation, ignoring any deep topography, and assuming that all dense water sources feed into the same abyssal layer.

(a) On this map, circle Stommel's simplified version of the two principal sources of deep and bottom water. (They are marked subtly on the map.) What are the water masses associated with these sources?

(b) Look at the circulation in the North Atlantic. Explain in words why the flow in the ocean interior is towards the north.

(c) What is the name of the current in the North Atlantic indicated by the heavy black curve?

(d) If this were the actual deep circulation, then would the velocities depicted here, both in the interior and at the boundaries, be geostrophic? Why or why not?

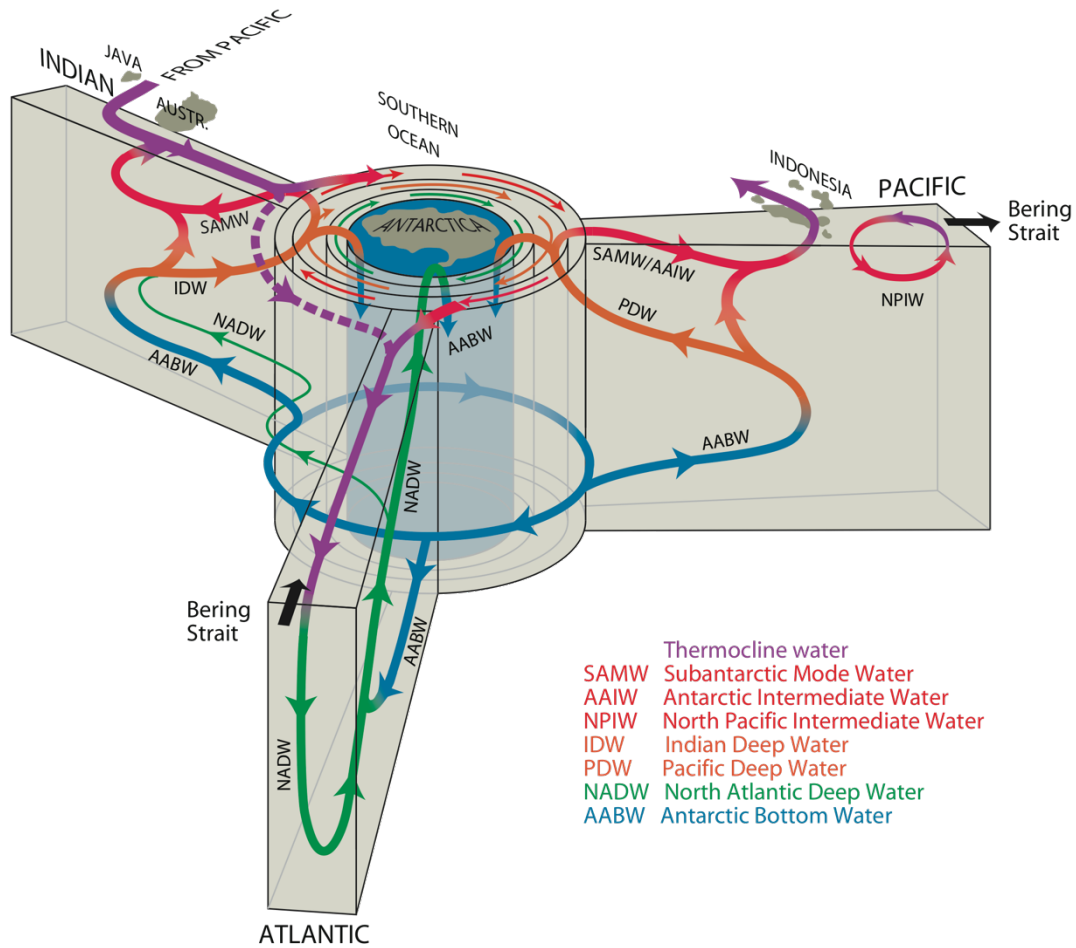


## 3. Global circulation

This is an overturning schematic for the global ocean, modified from DPO Fig 14.11.

(a) There is a purple path at the top. Describe the significance of this pathway in terms of the

global overturning circulation. (Describe what waters are involved and what their role is in the overturn.)



(b) Which pathways/conversions depicted here are dominated by diapycnal diffusion?

c) NADW is the most complicated water mass in the diagram because it is composed of several different source water masses, which are NOT provided in the diagram. They are included in the map of the global overturning circulation.

- (i) In the tropical Atlantic, list two water properties that can we use to identify NADW, and what characterizes NADW in these properties
- (ii) List the 3 new water masses formed in the N. Atlantic that join together to form NADW.
- (iii) List the 2 southern water masses that mix into the NADW.