Ocean Layering: Density, Salinity, Temperature, and Circulation

Sylvia Cole, Scripps Institution of Oceanography, San Diego CA
Maureen Quessenberry, University City High School, San Diego CA

Quiz – Sample Answers

1. As the temperature of ocean water changes from 10 to 30 degrees C, how does the density change?
A) The water becomes more dense
B) The water becomes less dense
C) The density does not change
D) It is impossible to predict

2. The density of ocean water is influenced by what two factors?
A) Salinity and temperature
B) Water color and chlorophyll
C) Dissolved gases and dissolved solids
D) Dissolved carbon and trace elements

3. DEEP ocean currents are the result of
A) Winds
B) Tides
C) Changes in the density of ocean water
D) The Coriolis effect

4. Which of the following statements describes the formation of DEEP ocean currents?
A) They are driven by the wind.
B) They form as warm water moves along the east coast of North America.
C) They occur when cold, dense water sinks and flows beneath warmer water.
D) They form around Hawaii, isolating the area.

5. Where does DEEP ocean water come from?
A) All over the ocean
B) Near the coasts
C) In a few small places near the equator
D) In a few small places near the poles

6. About how long does it take a blob of water to rise from the bottom of the ocean to the surface?
A) 1 day
B) 10 years
C) 1000 years
D) 1 million years

7. The temperature and salinity of the ocean change the most:
A) Near the surface
B) Near the bottom
C) Near Antarctica
D) Near the equator

8. What is true about the water on the bottom of the ocean?
A) It is the saltiest water found in the ocean
B) It is the densest water found in the ocean
C) It is not frozen because sunlight warms it up
D) It does not move

2) The density of ocean water can be indirectly influence by water color and chlorophyll because sunlight travels further down into the ocean in clear water that has no chlorophyll and is very blue. However, choice "A" is the best answer.
3) Tides do cause tidal currents in the deep ocean. This question is referring to the larger currents than transport heat around the globe.
6) This is the timescale of the global conveyor-belt circulation. See '02t.slides.globallayers' (http://earthref.org/cgi-bin/erda.cgi?n=1014) for comments on this.

Name:

Short Answer:

1) Why are the largest changes in salinity values near the surface?

Good answers:

- Salt changes more at the surface because of evaporation and precipitation.
- Because that is where it rains and where rivers are.
- Because the surface is more affected by winds and weather unlike the deeper parts of the ocean.

Acceptable answers:

- Because of the atmosphere / because that is where the air is.
- Because of the atmosphere and the winds.

Not Acceptable answers:

- Because the sun heats the surface / because it is warmer at the surface. This is true, but does not explain anything about salinity.
- Because salty water is warm and warm water is at the surface. Salty water is not always a certain temperature or a certain density. There is thought involved in this answer, but the answer is not correct.

2) Where on earth does water sink? Why does it sink there?

Good answers:

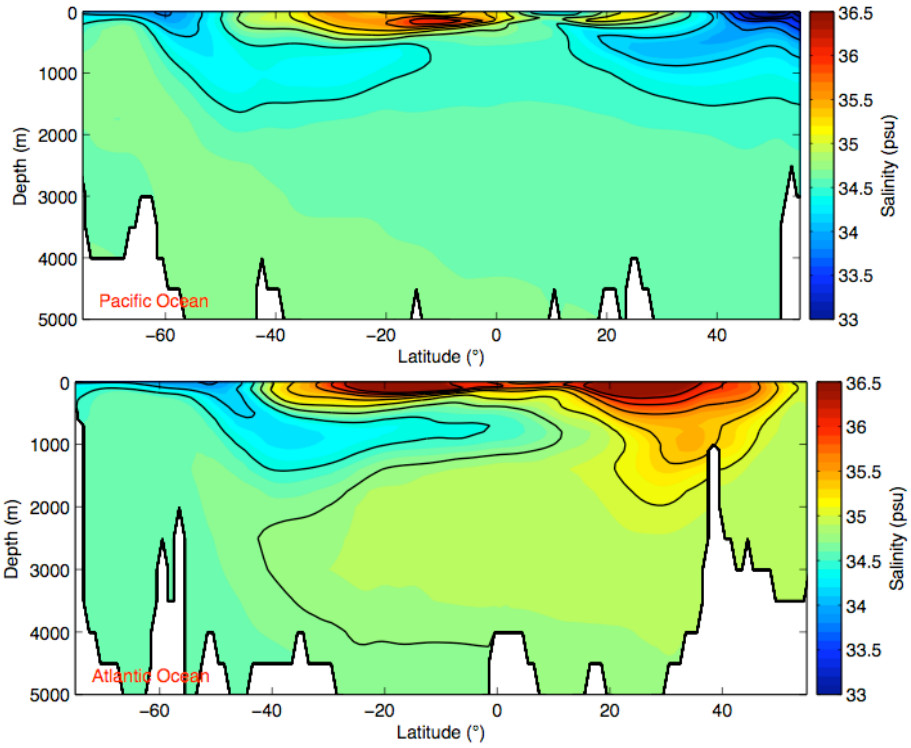
- Water that sinks is found near the poles where it is cold and dense. It sinks because it is cold and cold water is heavier.
- It sinks near the poles because it is near freezing there because there is a decreased amount of sunlight.
- Water sinks near the poles because water there is colder than anywhere else.

Acceptable answers:

- Water sinks where it is cold because that is where the more dense water is.

Not acceptable answers:

- Near the coasts
- In all areas.
- In the Atlantic.



These are sections based on the World Ocean Atlas 2005. They are average salinity along a slice through each ocean from observations taken in the last several decades. See http://www.nodc.noaa.gov/OC5/WOA05/pr_woa05.html for more information. The sections are smoother than the WOCE sections the students looked at previously because they are averages of many observations. The white spaces represent where there is bottom topography. The sections are along 170°W in the Pacific and 27°W in the Atlantic.

Use the pictures of salinity in the Pacific and Atlantic to help answer the following questions.

3) List two things in the pictures that are the same in the Atlantic and the Pacific. Be specific.

Good answers: Both oceans have …

- a layer of freshwater in the south near 1000 m depth.
- the saltiest water at the surface.
- the freshest water at the surface.
- salty pools of water near the surface just south of the equator.
- Salinity that changes the most near the surface.
- Salinity that changes the least near the bottom.
- Salinity between 34.5 and 35.0 psu below 3000 m depth.

Acceptable answers:

- Salinity at -65, 2000 m is green / the pictures are green at -65, 2000 m.
- Both have a medium amount of salt near the bottom.
- The blue in both pictures is near the surface.
- They both have mountains (referring to the white portions where there is no data).
- They both have areas where there is no data.

Not acceptable answers:

- If they are not referring to salinity: both have the same temperature, both have currents, both are about 4,000-5,000 m deep, etc. Inferring current direction from salinity is acceptable.

4) List two things in the pictures that are different in the Atlantic and the Pacific. Be Specific.

Good answers:

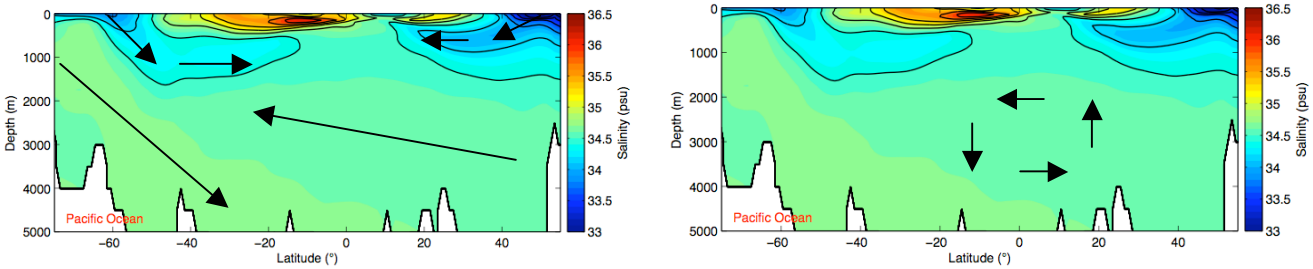
- The Atlantic has more overall salt than the Pacific (trying to get at some concept of the average value).
- The Atlantic has more salt at ___ (45N and 2000m, near the surface at the equator, from -20 to 20, north of the equator, etc.).
- The Pacific has a bigger portion of 34.5-35 psu salinity.

Acceptable answers:

- There is more yellow in the Atlantic / there is more blue in the Pacific.
- They have a different amount of layers.
- Salinity at the surface.

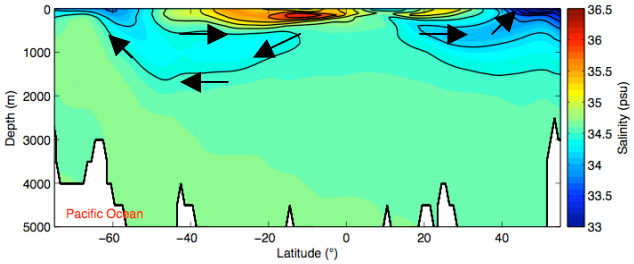
5) Draw arrows on the top picture (Pacific Ocean) to show where you think water is moving based on salinity.

Acceptable:



The left picture is what we're looking for. The lower arrows can be reversed, but the upper arrows in the low salinity tongues should point from the freshest water to the not so fresh water. The right picture is not incorrect, but is not what we're looking for.

Not acceptable:



Arrows following the contours are not correct. Arrows from the region of low salinity to lower salinity are not correct.