

SIO 210 Final Exam
Dec 8 2006

Name: _____

Turn off all phones, pagers, etc.... You may use a calculator.

This exam is 9 pages with 19 questions. Please mark initials or name on each page.

Check which you prefer regarding the return of this exam

_____ I will pick up the exam in Nierenberg Hall 310 (after Dec 12)

_____ Return the exam to me via campus mail

Mailing Address _____

[1-10] Multiple Choice 3 points each _____ / 30

[11-13] Short Answer 5 points each _____ / 15

[14-15] Triplets 9 points each _____ / 18

[16] Current map 10 points _____ / 10

[17] ENSO diagrams 12 points _____ / 12

[18] Long Answer 12 points _____ / 12

[19] Calculation 12 points _____ / 12

Total _____ / 109

Final Course Grade _____

Multiple Choice (circle the single best answer for each)

- 1) Intermediate water can reliably be identified in a vertical profile by...
 - A) extremum in salinity
 - B) oxygen minimum
 - C) extremum in temperature
 - D) potential density “jump”

- 2) The change in sea surface elevation across a strong current (e.g. the Gulf Stream) is
 - A) not measurable
 - B) ~ 1 cm
 - C) ~ 1 m
 - D) ~ 10 m

- 3) Sverdrup circulation is
 - A) not in geostrophic balance
 - B) always equatorward
 - C) driven by divergence/convergence in the Ekman layer
 - D) the dominant mechanism for deep water formation

- 4) The dominant process of heat input to the ocean is...
 - A) evaporation
 - B) stagnation
 - C) short wave radiation
 - D) wind-driven sensible heat exchange

- 5) Suppose you want to estimate the volume transport (mean and variability) of the equatorial undercurrent. Which of the following would be most useful?
 - A) satellite altimetry
 - B) moorings outfitted with an array of Acoustic Doppler Current Profilers
 - C) the geostrophic method applied to hydrographic (CTD) observations.
 - D) sea surface temperature

- 6) Which is NOT true of North Atlantic Deep Water?
- A) it is the dominant deep water formed in the northern hemisphere
 - C) characteristic water properties include high salinity and oxygen
 - D) formation rates are estimated to be about 50 Sv.
 - E) the signature of NADW can be seen in both the Pacific and Indian oceans.
- 7) Which is NOT true of surface Ekman layer of the ocean?
- A) typical depth of 50-100 m
 - B) Ekman transport tends to be largest in the subpolar regions
 - C) the primary momentum balance is between wind stress and the Coriolis effect
 - D) the net transport is to left of the wind in southern hemisphere
- 8) A parcel of water at the surface of the ocean is adiabatically relocated to a depth of 4000 m. Which of the following properties would NOT change?
- A) temperature
 - B) potential temperature
 - C) pressure
 - D) density
- 9) Which is NOT true of the North Atlantic Ocean?
- A) Deep western boundary current flows opposite to direction of the Gulf Stream
 - B) Deep water formation occurs in the Labrador Sea, Mediterranean Sea and Greenland/Norwegian Seas
 - C) The large-scale Ekman currents in the subtropical gyre are divergent.
 - D) Volume transport of the Florida current is about 30 Sv.
- 10) Which is NOT true of the North Pacific Ocean?
- A) The magnitude of the Kuroshio Current is determined by the wind stress pattern across the subtropical gyre
 - B) Indian Ocean water flows into the Pacific Ocean via gaps in the Indonesian archipelago
 - C) The sub-polar Alaska gyre circulates counter-clockwise
 - D) The Kuroshio Current and Kuroshio Extension are regions of significant heat loss by the ocean.

Short-Answers. (Answer in space provided, THREE Sentences Max)

11) Why is no deep water formed in the North Pacific?

12) Why is the Mediterranean Sea important for formation of NADW even though the net volume exchange of water with the N. Atlantic is quite small?

13) In the Indian Ocean, why is the summer (e.g. Southwest) monsoon associated with strong upwelling in the Arabian Sea?

14) State three characteristics which distinguish eastern boundary currents from western boundary currents. (Note: stating that they are on opposite sides of the basin does not count as one of the three characteristics)

#1:

#2:

#3

15) You are presented with two bottles of sea water and told that each was collected one year ago, one from the surface subtropical North Atlantic and the other from 3000m in the North Pacific. State three properties which could be used to determine which bottle is the surface water. For each property indicate how the bottles would differ. [Assume the bottles were properly sealed at time of collection]

Property #1 _____

Property #2 _____

Property #3 _____

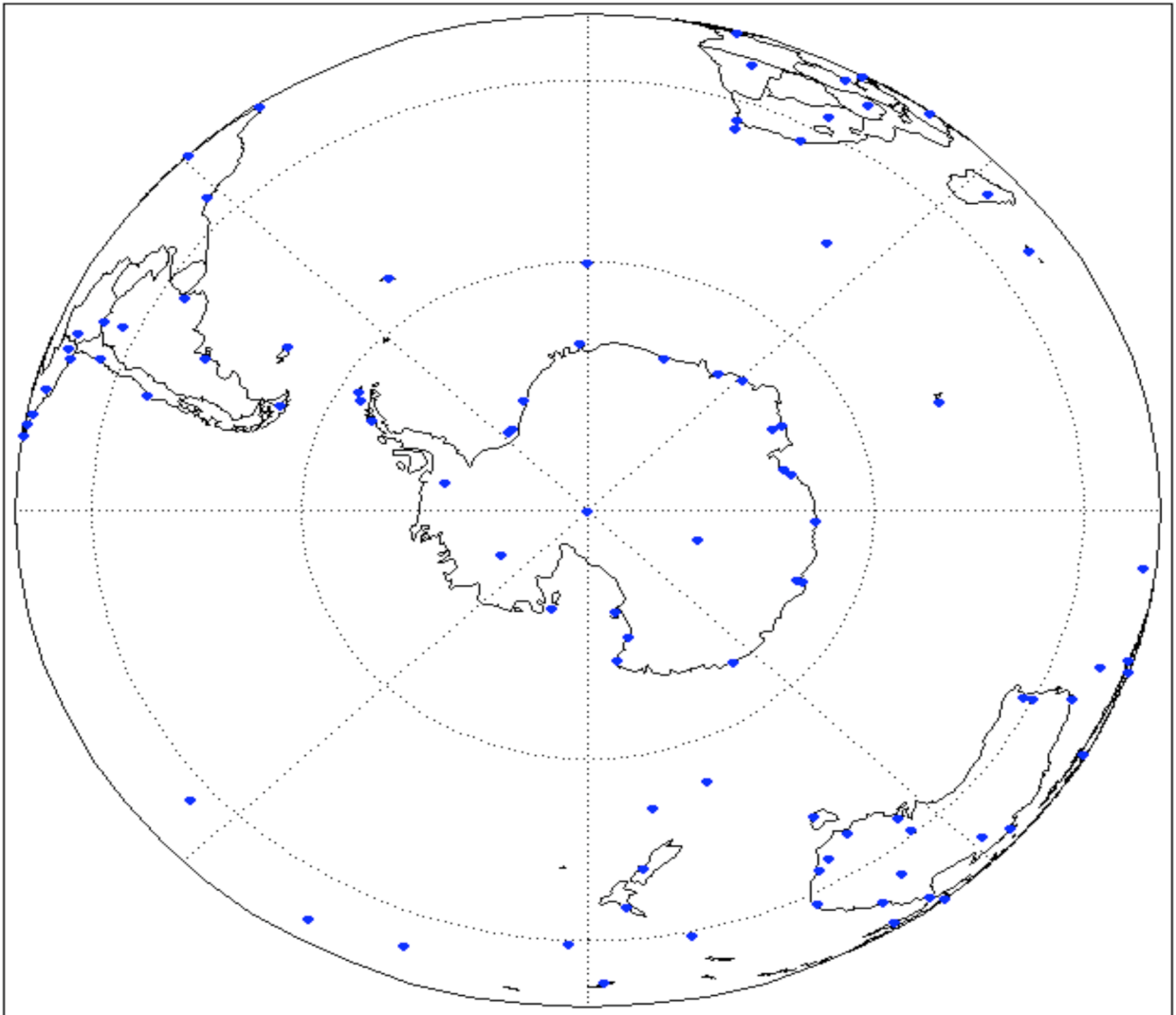
16) On the following map mark the location of the following ...

- A) Ross Sea
- B) Weddell Sea
- C) Mozambique Channel

Mark and label the following currents (use arrowheads to indicate current direction)

- D) Agulhas Current
- E) Agulhas Current Retroflexion
- F) Antarctic Circumpolar Current
- G) Boundary current of subtropical South Atlantic
- H) Weddell Gyre

Of the currents (D-H) which is characterized by three distinct fronts? _____

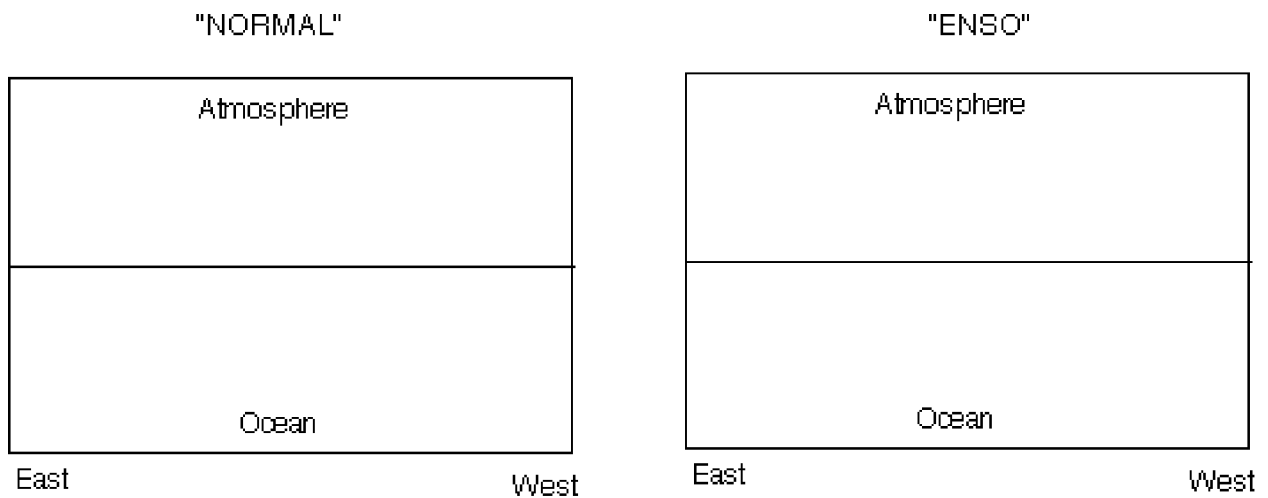


17) On the zonal sections of the Equatorial Pacific, mark the following features for both 'normal' conditions and 'ENSO' conditions. Label the Z-coordinate of each plot to denote the characteristic scale of each ocean and atmosphere feature.

A) Walker Circulation

B) Thermocline Depth (e.g. 20-degree isotherm)

C) Equatorial Undercurrent



Identify how a strong El Nino changes the following properties:

i) Magnitude of Net Biological Productivity in the Eastern Tropical Pacific

increases decreases

ii) Rainfall in northern Australia

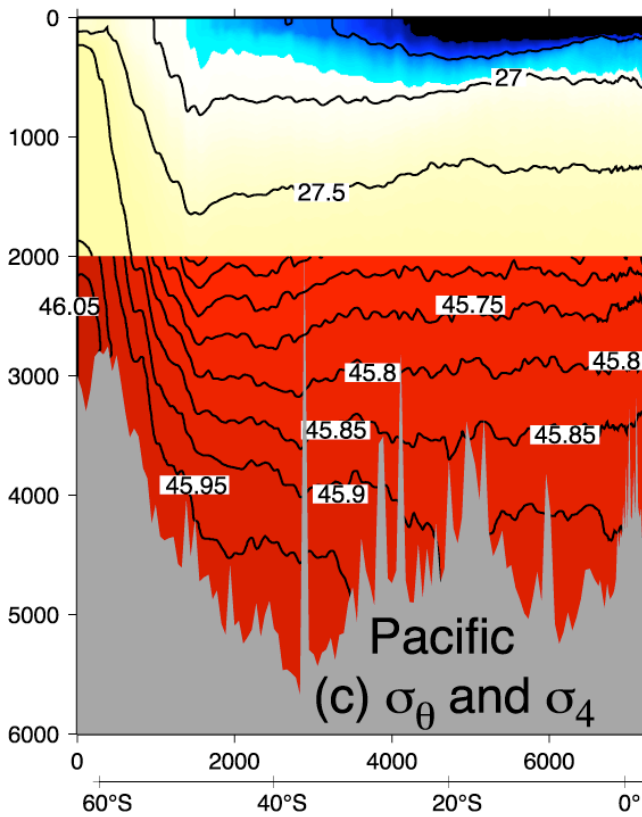
increases decreases

iii) Strength of the Pacific trade winds

increases decreases

Not-so-short question

19) The figure shows potential density (using two reference pressures) along a meridional section in the South Pacific Ocean.



(a) Label the Antarctic Circumpolar Current. Mark its northern edge.

(b) Assume that the Antarctic Circumpolar Current is geostrophic. On the diagram, indicate which way it is flowing.

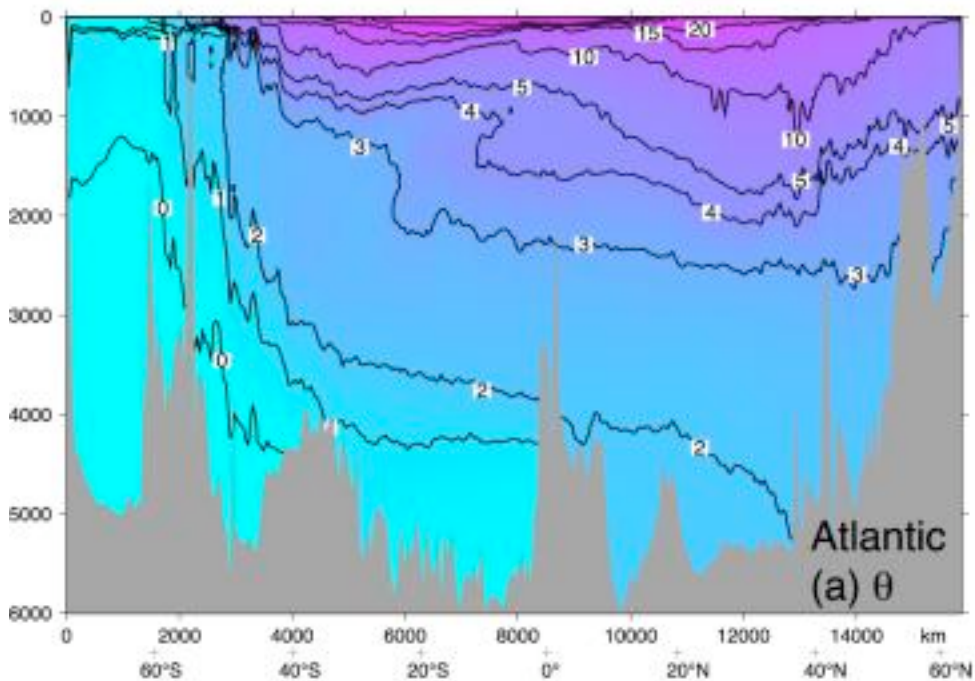
(c) On the diagram, indicate where the sea surface is **low**, and where the sea surface is **high**.

Long answer question

20) Suppose there is a planet "Nohaline" that is exactly like Earth except that there is **no salt** in its ocean water. Everything else is the same: continents, ocean basins, winds, moon, distance from the Sun.

(a) Would you expect the subtropical gyres to look about the same on Nohaline as on Earth? (consider location, shape, depth dependence) Explain your answer briefly.

The following figure is the potential temperature on a meridional section in the Atlantic Ocean, which will be used in several of the parts below.



(b) As an oceanographer on Nohaline you wish to trace water from the surface down into the ocean. Would you use temperature or potential temperature? Explain your answer.

(c) What would a typical temperature/potential temperature profile look like in the top of the subtropical gyre on Nohaline, from the surface to about 1500m? Do you expect any major differences from such a profile on Earth? (Draw and describe very briefly.)

(d) Suppose that ice forms on Nohaline in the same places as on Earth. At what temperature does ice form on Nohaline? Does this differ from Earth?

(e) As the ocean water on Nohaline cools down towards freezing, there is a density maximum at about 4°C. What would you expect the **deep ocean** temperature/potential temperature to look like on Nohaline? (at depths > 1500 m or so). Compare with the potential temperatures on the section above.

(g) What might a vertical temperature profile look like at the far southern end of this Atlantic section on Nohaline? (south of 60°S)? Draw and describe.

(h) In the absence of salt in sea water, one of the major mechanisms for forming deep and bottom waters would be absent. What is this process?

(i) Where might deep and bottom water to form on Nohaline? Compare this with where deep and bottom water form on Earth.

(j) On the section above, at about 20°S, there is major inversion in potential temperature. What allows this inversion (on Earth)?

(k) For Nohaline to have no salt in its sea water, what would have to differ from Earth? (That is, what is the source of salt in the ocean?)