

# Introduction to Oceanography

## EAS 4300

### Homework # 3

*Homework on Chapter 7 on Air-Sea Interaction and part of Chapter 8 Ocean Circulation*

Figure 1 show to map of mean sea level pressure.

- a) Draw the direction of the winds in the North Pacific, label the low and high pressure systems.
- b) In agreement with the low and high pressure system label the location of a cold front and a location of a warm front. Where do you expect more intense precipitation and why?
- c) According to the maps where do you expect the winds to be the stronger and how can you tell?
- d) If I told you that the upwelling winds are stronger in summer along the California coast, can you tell me which map represents the summer mean and which one the winter mean? Can you think of another way to determine which map is summer and which is winter?

Figure 2 shows two maps of mean precipitation.

- a) Label which map is the January mean and which one is the August mean. Explain how you determined your answer. Label the location of the ITCZ.
- b) Panel B shows two region of high precipitation in the North Pacific and North Atlantic. Which current systems are responsible for these features and how?
- c) Why is precipitation on average more abundant over the oceans?
- d) In panel B, if you were to guess the values for the Sea Surface Temperature (SST) would they be higher at p1 or p2? Explain why?
- e) Evaporation cools the ocean by fluxing heat into the above atmosphere. Precipitation in turn cools the ocean. However the net exchange of heat during evaporation minus precipitation is usually positive toward the atmosphere, indicating that on average the atmospheric air gets warmer. With this in mind what is the impact of stronger westerlies in the north Atlantic on the weather over Northern Europe? Would you expect a dry/cold, wet/cold, dry/warm or wet/warm weather? Explain.

Figure 3 shows a map of the surface wind stress.

- a) What is wind stress and how is it different from wind speed?
- b) Indicate upwelling or downwelling conditions at location A, B,C and D.
- c) Draw the approximate location of the ITCZ according to the surface wind stress.
- d) Label with letter T the trade winds and letter W the westerlies in the North Pacific.
- e) What is the role of friction in the exchange of mechanical and thermal energy between the surface of the planet and the atmosphere?
- f) If you had no friction between the surface of the planet and the overlying atmosphere, would you still have winds? Would they be stronger or weaker? Explain the changes for both the equatorial regions and higher latitudes.

Figure 4 shows 2 maps of the SENSIBLE Heat Flux. Negative sensible heat flux indicates that the surface is cooling and the atmosphere is warming.

- a) In a region of negative flux is the surface of the planet warmer or colder than the overlying atmosphere?
- b) Which panel (A or B) represent the northern hemisphere summer? Explain how you determine that.
- c) In panel A, the Gulf Stream and Kuroshio Current are regions of very negative flux when compared to panel B. Explain why.

HINT: remember that to leading order the continental surface temperature is controlled by the sun. On the other hand air masses are heated mostly through evaporation and precipitation.

Figure 5 shows a map of ocean temperatures at 150m.

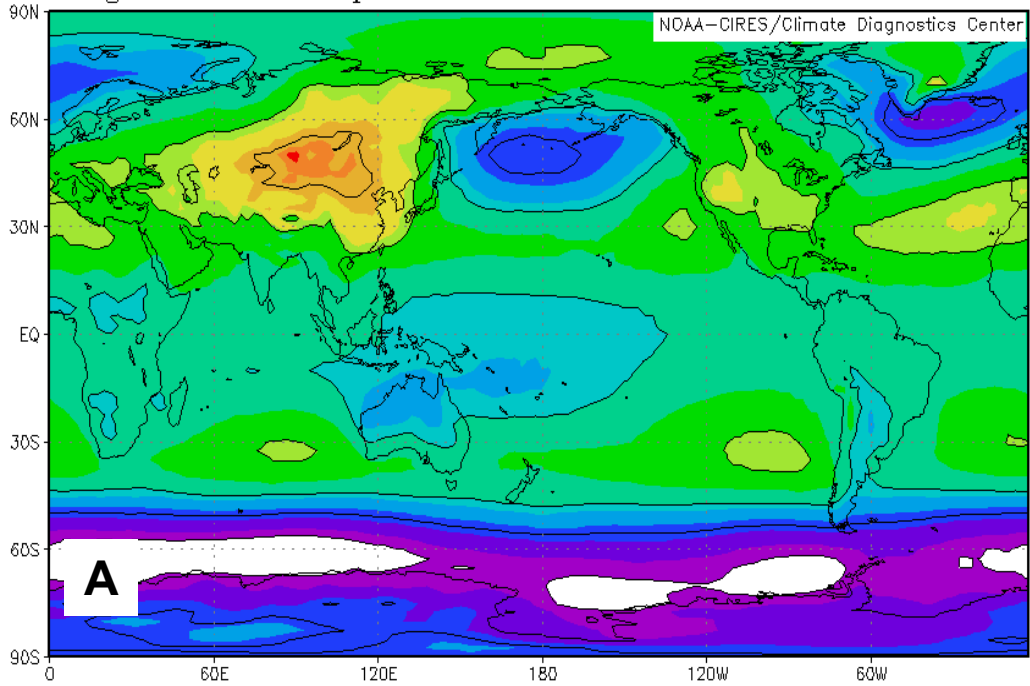
- a) Label the location of high pressure, do they correspond at 150 m to regions of warmer or colder temperature? Explain why.

b) You have learned that ocean mixing induced by the wind extends deep up to 100-150 m (associated with the Ekman Layer). In this mix layer region surface and subsurface properties are well mixed.

Given what you see in the map of ocean temperature at 150 m (figure 5), can you say what processes controls the structure of the temperature field? In particular would you say that it is mostly controlled by the ocean currents or by the surface exchanges of heat with the above atmosphere?

- c) What is the difference between geostrophic currents and Ekman currents? (HINT: the difference can be understood based on the driving force of these currents).

Long Term Mean slp millibars



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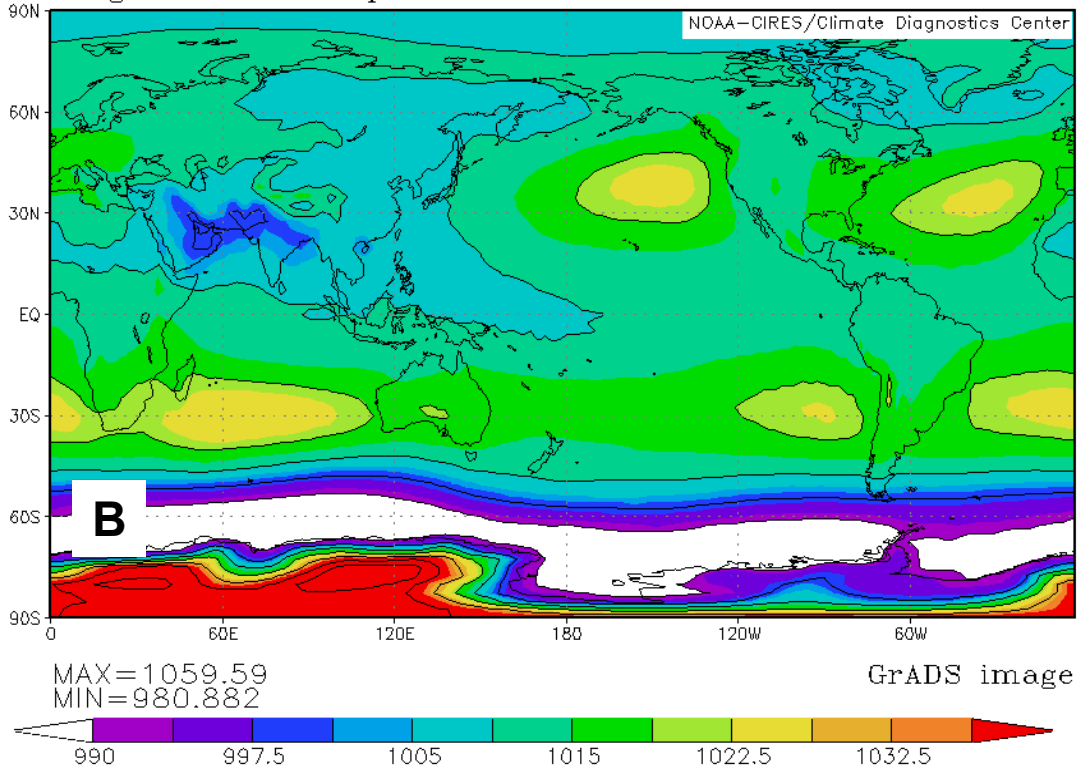
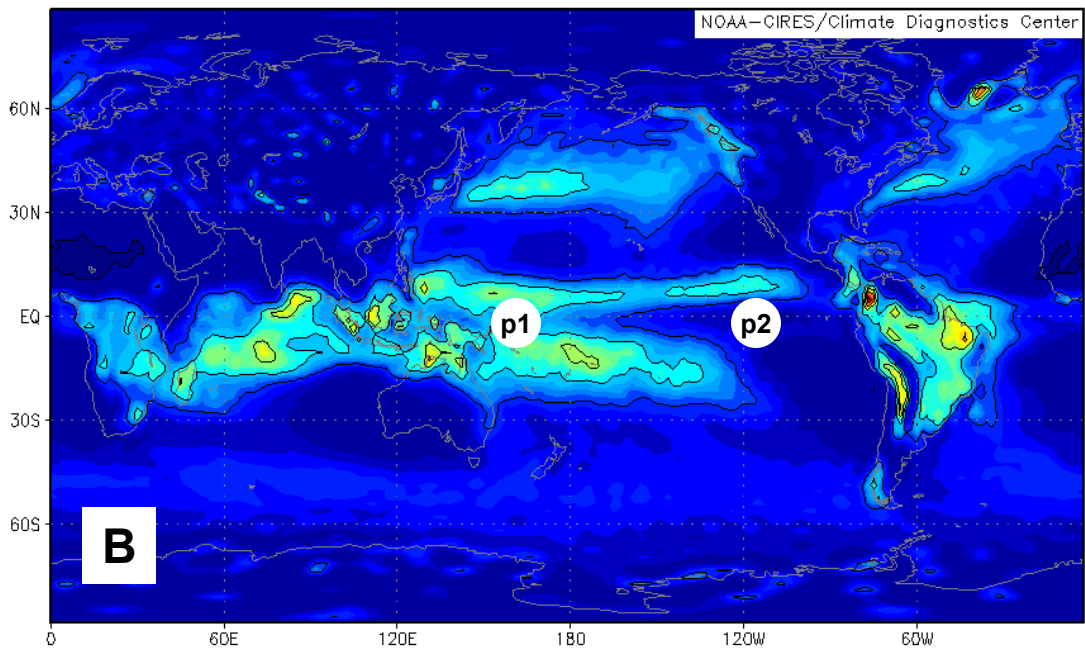
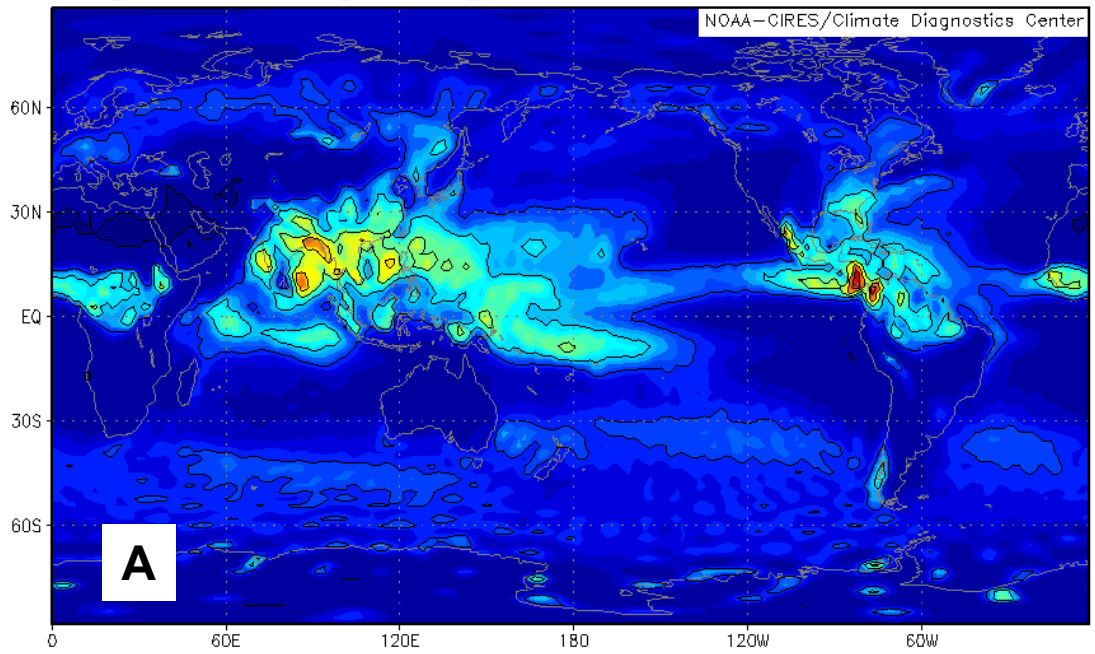


Figure 1

Long Term Mean prate Kg/m<sup>2</sup>/s



MAX=0.000223832  
MIN=-2.32831e-10

GrADS image

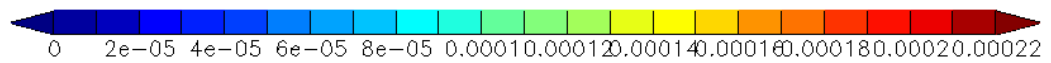


Figure 2

# Mean Surface winds over the ocean

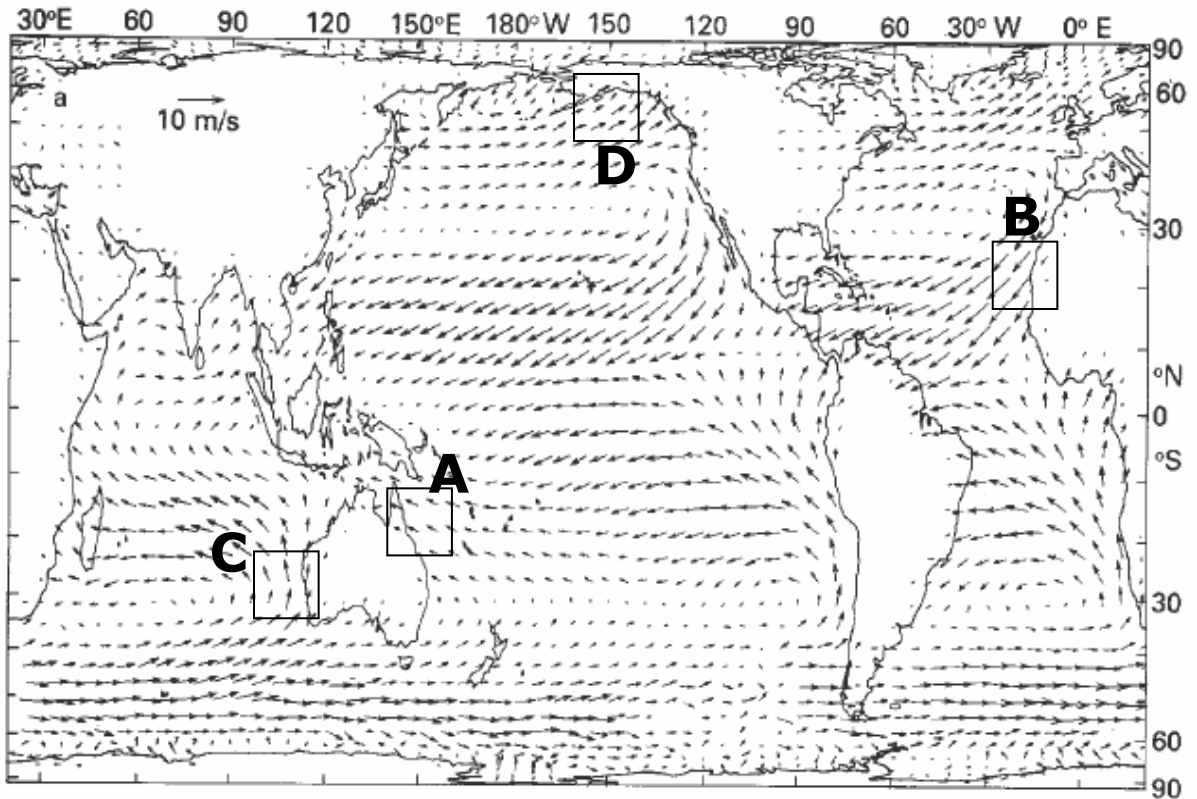
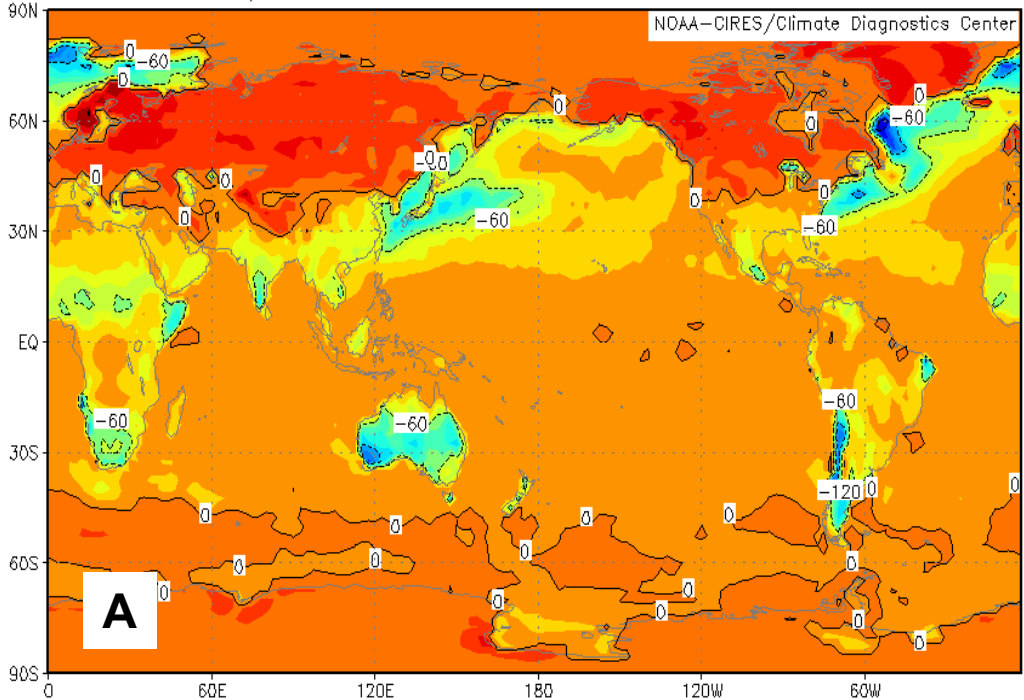


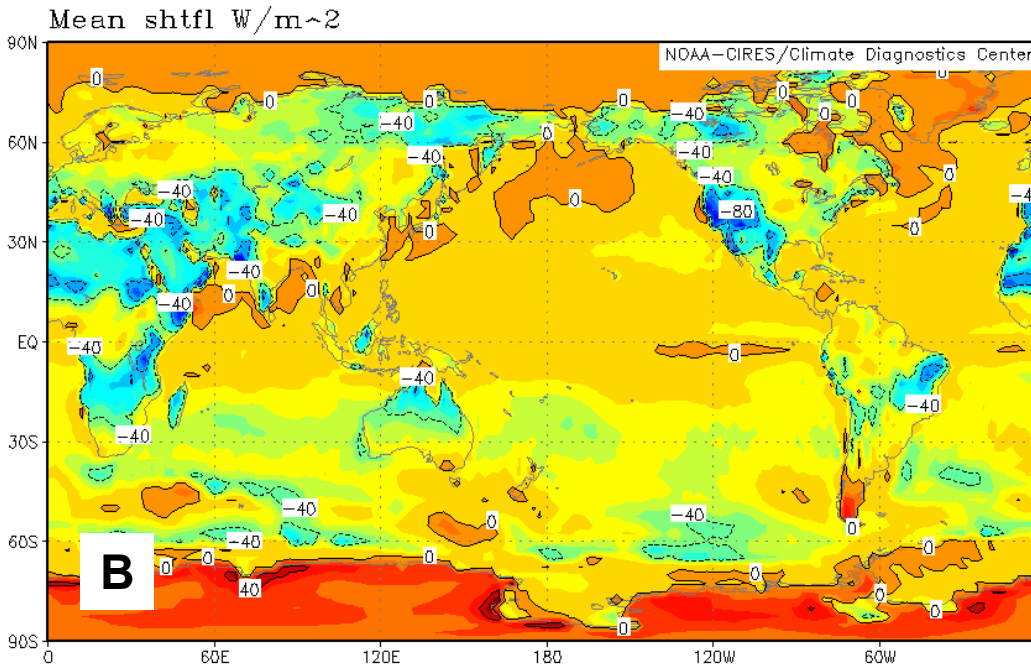
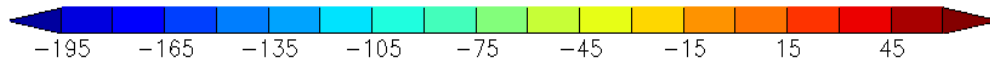
Figure 3

# Surface SENSIBLE Heat Flux



MAX=62.55  
MIN=-208.2

GRADS image



MAX=56.3499  
MIN=-137.55

GRADS image



Negative indicates that the surface is cooling  
**Figure 4**

# Ocean Temperature at 150m

Longitude

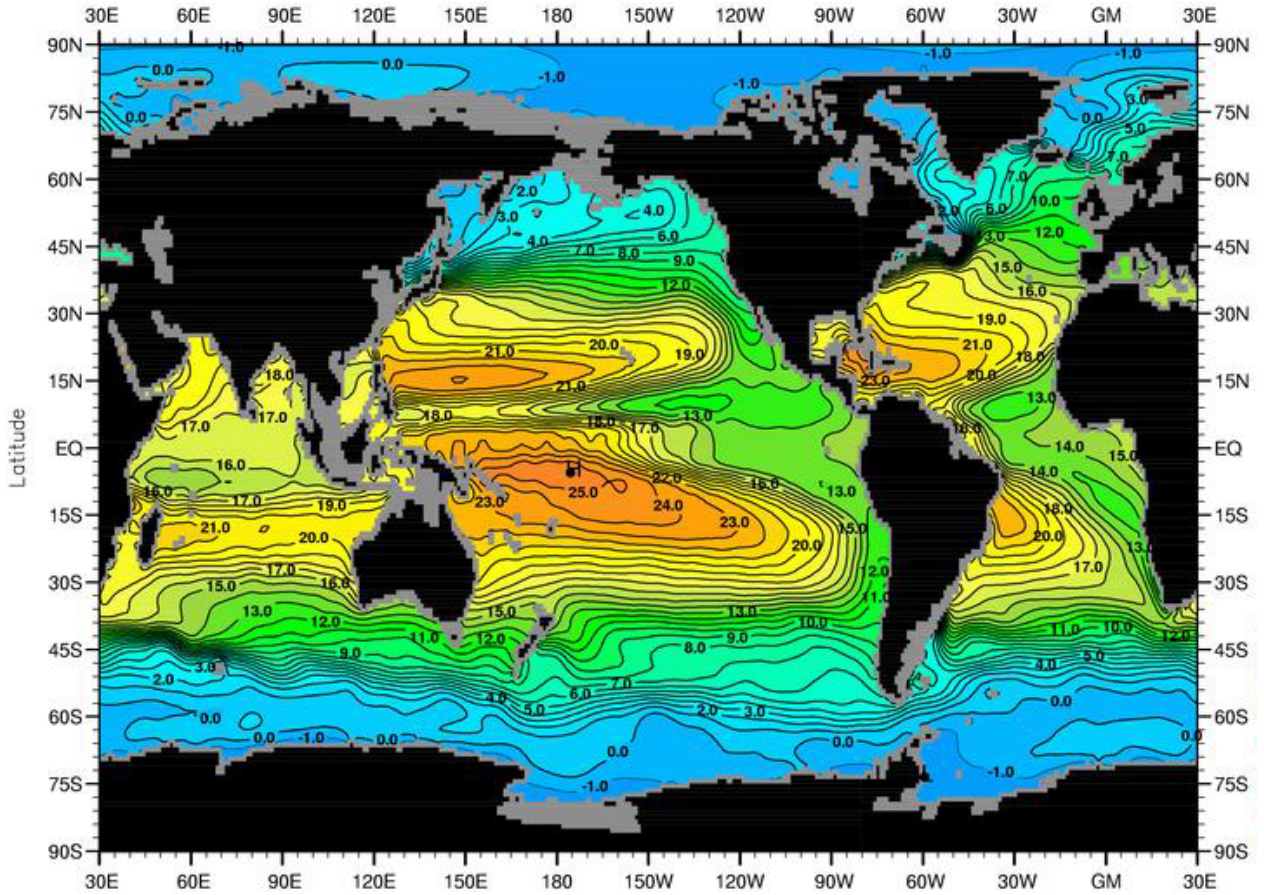


Figure 5