Mid-term Exam

Climate V2100
Spring 2001
March 7, 2001

1) Put your name at the top of each page
2) When asked to sketch something, make it big and clear, label the axes and include units
3) Explain your reasoning
4) If you need more space to answer the question, you can continue your answer on the back of the page
5) Note that different questions are worth different amounts of points
Name ______________________________

1) 15 points. Consider the following scenario: We are following an air parcel from Seattle eastward over the Cascade Mountains into Washington State.

a) Sketch a section with distance on the x axis and height on the y axis. The height of the mountain chain in the middle of the graph is 2000 m. Indicate on the graph at various points the air temperature and dew point temperature of the air parcel. The conditions a ground level in Seattle are 15 C with a dew point of 5 C.

b) At which height will clouds form (use round number lapse rates)?

c) What are the conditions (including temperature and dew point) at the peak of the mountain?

d) What is the temperature and dew point temperature at sea level downwind of the mountain. Is the relative humidity higher or lower compared to Seattle?
2) 15 points. Plot the two components of the top-of-the-atmosphere energy (heat) flux as a function of latitude on the same graph. Label each curve with numbers and units.

a) Do the two curves have identical values at each latitude?

b) If not, what are the implications of the differences for the Earth’s climate?

c) What atmospheric phenomena exist as a result?
3) 20 points. Sketch the mean winter surface pressure distribution of the North Atlantic Sector. Make sure that you locate a High and a Low pressure system over the islands that they were named after.

a) Add a few pressure contours and give their rough magnitude (units?).

b) Sketch the balance of forces that result in surface winds (neglect friction) for the High and the Low pressure system.

c) If we now consider friction at the surface where do we expect rainfall to occur and why?

d) The High on your graph is part of a well-known large-scale circulation cell. What is its name? Give a brief description and sketch of its circulation in the height latitude plane.
4) 15 points.
a) Make a sketch of global surface ocean circulation on this map.
b) Explain in detail the circulation pattern in the North Atlantic.
c) Include in your answer an explanation of which currents in the North Atlantic are warm and which ones are cold.
Name ______________________________

5) 15 points. Consider the following plot of average surface ocean conditions.

   a) Which curve is salinity? Explain your reasoning and the causes of the salinity variations along this north-south section. Label approximate salinity values on the left, include units.

   b) Which curve is temperature? Explain your reasoning and the causes of the temperature variations along this north-south section. Label approximate temperature units on the right, include units.

   c) Which curve is density? Explain your reasoning and the causes of the density variations along this north-south section.
6) 20 points.
   a) Consider an aquarium tank filled with water. If you provided heat and cold to the water surface as shown in the first figure, what would be the resulting circulation? Sketch it, and provide an explanation.
   b) The next figure is a section running from North to South through the center of the Atlantic Ocean. Sketch the water circulation pattern, and explain the similarities and differences to the first figure.

   Cold Source       Heat Source       Cold Source

   North             Equator             South