

## SIO 217B Atmospheric and Climate Sciences II

### Exercise #21

1. Download the files containing geopotential height, temperature, pressure vertical velocity, zonal wind, and meridional wind at the 1000, 850, 700, 500, 250, and 100 hPa levels for 1993 March 14 00Z. For each pressure level, plot geopotential height contours, temperature contours, pressure vertical velocity contours, and wind vectors in the domain 20-50°N, 270-310°E. Use intervals of 6 dkm for height, intervals of 4°C for temperature, and intervals of 20 hPa hr<sup>-1</sup> for vertical velocity. Use uniform scaling across pressure levels for wind vectors.
  
2.
  - a) In round numbers, what is the typical elevation of each pressure level?
  - b) Note how the horizontal temperature gradients are slightly weaker at 1000 hPa than at 850 hPa. This would not be the case over land. Briefly explain why the temperature gradient at the surface is weaker than the gradient at 1 km elevation for ocean regions.
  - c) Broadly describe how the location of the cold front (strong horizontal temperature gradient off the U.S. East Coast) varies going up from the 850 hPa level to the 500 hPa level.
  - d) Broadly describe how the location of the warm front (strong horizontal temperature gradient off the coast of New England and Maritime Canada) varies going up from the 850 hPa level to the 500 hPa level.
  - e) Broadly describe how wind direction at a particular location in the coastal region of the southeastern U.S. changes going up from the 850 hPa level to the 500 hPa level. What kind of horizontal temperature advection occurs at this location in the lower troposphere?
  - f) Broadly describe how wind direction at a particular location in the coastal region of New England changes going up from the 850 hPa level to the 500 hPa level. What kind of horizontal temperature advection occurs at this location in the lower troposphere?
  - g) Broadly describe how the zonal location of the low center or trough axis varies going up from the 1000 hPa level to the 250 hPa level.
  - h) What is different about the spatial distribution of warm and cold temperature at the 100 hPa pressure level compared to the 1000, 850, 700, and 500 hPa pressure levels? Explain this in terms of the gross vertical temperature structure of the troposphere and stratosphere.
  - i) Which pressure level has the strongest winds (e.g., the jet stream)? How is this related to the spatial distributions of temperature above and below this pressure level?
  - j) Which pressure level has the strongest pressure vertical velocity? Which pressure levels have very weak pressure vertical velocity?
  - k) Broadly describe how upward motion in the lower troposphere ( $p > 600$  hPa) is spatially related to locations of surface fronts.
  - l) Broadly describe how upward motion in the middle and upper troposphere ( $p < 600$  hPa) is spatially related to the locations of surface fronts.
  - m) Broadly describe how the region of strongest downward motion is spatially related to the locations of surface fronts.