SIO 217B Atmospheric and Climate Sciences II

Exercise #23

1. a) Download the files containing temperature and geopotential height of the 1000, 925, 850, 775, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, and 30 hPa levels (a total of sixteen levels) for 1993 March 14 00Z. For each longitude point between 260-300°E along the 35°N latitude line, extract temperature and geopotential height from all pressure levels and interpolate temperature to regular vertical intervals between 0 and 24 km (I used an interval of 250 m). Plot contours of temperature in a longitude-height cross-section figure for 260-300°E and 0-24 km elevation along the 35°N latitude line. Use a contour interval of 10 °C.

   b) Calculate the zonal temperature gradient for each height level and longitude point and multiply by 10^6 for more convenient units. Add contours of zonal temperature gradient to the contours of temperature in the longitude-height cross-section figure. Use a contour interval of 10 (actually 10×10^{-6} °C m^{-1}).

   c) Why does temperature in the upper half of the plot not decrease rapidly with height like it does in the lower half of the plot?

   d) Below 12 km elevation, is it warmer in the west or in the east? Above 12 km elevation, is it warmer in the west or in the east?

   e) Note the region of strong zonal temperature gradient that is located between 285°E and 290°E at the surface and slopes back toward the west with height. With what weather map feature in Exercise #7 does this temperature gradient pattern correspond?

2. a) Download the files containing meridional wind component at the 1000, 925, 850, 775, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, and 30 hPa levels (a total of sixteen levels) for 1993 March 14 00Z. For each longitude point between 260-300°E along the 35°N latitude line, interpolate meridional wind to regular vertical intervals between 0 and 24 km. Plot contours of temperature and contours of meridional wind in a longitude-height cross-section figure for 260-300°E and 0-24 km elevation along the 35°N latitude line. Use contour intervals of 10 °C and 10 m s^{-1}.

   b) Note how the contour line of zero meridional wind is near 280°E at the surface and tilts westward with height. With what feature in Exercise #22 does this zero contour correspond?

   c) With what weather map feature in Exercise #20 does the region of maximum meridional wind generally correspond?

   d) Note how northward meridional wind at 285°E increases between the surface and 8 km elevation and then decreases to zero at 24 km elevation. How is this related to the vertical pattern of zonal temperature gradient at 285°E?

   e) Briefly explain how the difference in temperature between the western and eastern sides of the lower half of the plot is physically related to the direction of the meridional wind in the western and eastern sides of the plot.

3. a) Calculate potential temperature at the 1000, 925, 850, 775, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, and 30 hPa levels (a total of sixteen levels) for 1993 March 14 00Z. For each longitude point between 260-300°E along the 35°N latitude line, interpolate potential temperature to regular vertical intervals between 0 and 24 km. Plot contours of potential temperature and contours of meridional wind in a longitude-height cross-section figure for 260-300°E and 0-24 km elevation along the 35°N latitude line. Use contour intervals of 10 K and 10 m s^{-1}.

   b) With what region of the atmosphere do the closely spaced potential temperature contours correspond?

   c) What is the elevation of the tropopause at 260°E? What is the elevation of the tropopause at 300°E?

4. a) **Optional.** Download the files containing zonal wind component and pressure vertical velocity at the 1000, 925, 850, 775, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, and 30 hPa levels (a total of sixteen levels) for 1993 March 14 00Z. Convert vertical velocity in pressure coordinates to vertical velocity in height coordinates as in Exercise #13. For each longitude point between 260-300°E along the 35°N latitude line, interpolate height vertical velocity to regular vertical intervals between 0 and 24 km. Plot contours of potential temperature and contours of meridional wind in a longitude-height cross-section figure for 260-300°E and 0-24 km elevation along the 35°N latitude line. Use contour intervals of 10 K and 10 m s^{-1}. Add vectors that show the combined direction and magnitude of zonal and vertical velocity. Note that you will need to multiply vertical velocity by a large constant in order to make vertical motions discernable on the plot.

   b) **Optional.** What area of the plot has substantial downward motion? How is this spatially related to the region of strong zonal temperature gradient?

   c) **Optional.** What area of the plot has the substantial upward motion? How is this spatially related to the region of strong zonal temperature gradient?