ATSC 5160 HW 1 due Mon 9 Feb (6% of the course grade)

Please answer at least the figures in an electronic doc (eg doc, ppt), so you can insert color figures, and email me this assignment. Please keep your answers short & focused. For the first 4 questions, half of the credit goes to the figures, the other half to your written answer.

(1) (10%) Use the NOAA ESRL 32 km NARR plotting tool
http://www.esrl.noaa.gov/psd/cgi-bin/data/narr/plotmonth.pl

Plot the January-mean sea level pressure and 1000 mb geopotential height on a polar stereographic map (10-90°N; 200-300°E) (2 maps – show them side by side, with labels): you should find that the patterns look very similar.
question: explain why they should. Draw a schematic and use equations in your explanation. Think in 3D. For some people this similarity is counterintuitive, because pressure decreases with height, yet GP height increases. Try to convince those people in your answer.

(2) (40%) Use the NOAA ESRL NCEP global reanalysis plotting tool
http://www.esrl.noaa.gov/psd/cgi-bin/data/composites/printpage.pl
for all plots, use both colors and contours. Please organize them nicely, e.g. a 4 or 6 panel figure

- Plot the January-mean 1000-500 mb thickness and 500 mb height on a northern hemisphere (NH) polar stereographic map.
- Plot the July-mean 1000-500 mb thickness on a NH polar stereographic map
- Plot the July-mean 500 mb height on a SH polar stereographic map.
- Plot a meridional transect of zonal wind speed for the NH, for January and July. (6 maps in total)

questions:

a) Estimate the lower-tropospheric (1000-500 mb) temperature difference between 30-60°N. Do this for January and July.
b) Using your estimate in (a) and thermal wind balance, estimate the average strength of the 500-1000 mb zonal wind shear in the 30-60°N belt. Again do this for January and July. Compare your estimate with the mean 1000-500 mb westerly shear in January and July in the same latitude belt.
c) Explain the mid-latitude troughs and ridges at 500 mb in the NH, compared to the remarkable azimuthal (zonal) symmetry in the SH.
d) Estimate the wavelength of these waves (easiest method: determine the wavenumber & compute the Earth circumference at a representative latitude). Compute the Rossby wave phase-speed. Are these waves, embedded in the westerly flow, eastbound or westbound? If this phase speed is NOT close to zero, explain why such waves are still apparent on a monthly-mean map?

(3) (30%) Use the same global reanalysis plotting tool to examine the average sea level pressure (color) on a both a NH and a SH polar stereographic map for January and for July. (4 maps in total)
questions:

a) Explain why, in the SH, a subtropical (about 30°S) high and a polar (60°S) low prevail in both seasons
b) Do you see any shift in the average latitude of the subtropical high from July to January? This may be hard to see, but it is evident over Australia for instance. Explain such shift.
c) Explain why highs dominate over the NH continents in winter & over the NH oceans in summer, and why the opposite applies to lows.

(4) (10%) Generate your own Hövmoller diagram, exactly as in Fig. 1.20b in the textbook, except for the last 30 days (go to the site http://www.esrl.noaa.gov/psd/map/time_plot/) .

a) Estimate the speed of a few (say 3 different) persistent troughs or ridges. Do the more narrow features (shorter wavelength) propagate faster to the east than the wider features (this is the phase velocity)?
b) Do you see any packets of Rossby wave energy (high-amplitude waves) propagating rapidly towards the east (i.e. at the group velocity, as suggested in Fig. 1.20a in the textbook)

(5) (10%) Show equation 2.18 in the textbook, specifically, show that $\frac{\partial T}{\partial p} - \frac{\alpha}{c_p} = T\frac{d\ln\theta}{dp} = -\frac{\sigma p}{R}$