Atm 409–509 **Problem Set #1** **Fall 2016**

The focus of problem set #1 is on atmospheric stability. The first two problems are taken from Bluestein Volume I (p. 398). The third problem **(optional for Atm 409 students)** requires you to play with gridded datasets to get a solution.

1. Calculate the static stability parameter, σ, at 700 hPa. Let T = 11.0 °C at 850 hPa, and T = -18.0 °C at 500 hPa. Assume that $\partial\theta/\partial p$ is constant below 500 hPa. What is the “effective” static stability parameter, σ_e, in this case?

2. Use the temperature profile given in the first problem and assume that at the level of nondivergence, taken to be 600 hPa, the vertical motion $\omega = -10.0 \times 10^{-3}$ hPa s^{-1}. Assume further that $\omega = 0$ at 1000 hPa and that the magnitude of $|\omega|$ increases parabolically up to the level of nondivergence. Neglect differential temperature advection, vertical advection of stability, and differential diabatic heating. How long will it take the static stability ($-\partial\theta/\partial p$) at 800 hPa to decrease to 0.1 °C (1000 hPa)$^{-1}$?

3. A crude, but effective, way to approximate the static stability of the lower half of the troposphere is to calculate the 850–500 hPa temperature difference. This temperature difference will be a crude measure of the environmental lapse rate (note that the dry adiabatic lapse rate between 850 hPa and 500 hPa yields a temperature difference of ~40 °C).

Use the script provided on the ATM 409–509 website to calculate monthly mean 850–500-hPa temperature differences at 0000 and 1200 UTC over the Northern Hemisphere (NH) for January, April, July, and October. The 850-hPa and 500-hPa temperatures to be used are from the NCEP CFSR gridded datasets. Plot your results on maps of the NH.

Discuss your results synoptically and answer the following questions:

a.) What similarities and differences are evident when you compare 850–500 hPa temperature differences over continents versus oceans?
b.) Why do these lapse rate differences exist and what do they mean physically?
c.) What diurnal lapse rate signals are evident from a comparison of the NH maps for 0000 and 1200 UTC?