Meto611
Problem Set 8 tropical air/sea interaction

1. (Borrowed from D. Battisti) The state of tropical Pacific oscillates between *El Nino* conditions, in which the eastern tropical Pacific ocean is warmer than usual, with weaker than average Easterly winds, and a *La Nina* state, in which the opposite is true. The reversal in winds is associated with a change in the atmospheric surface pressure gradient across the tropical Pacific Basin known as the *Southern Oscillation*. We will investigate a simple mathematical model for this combined El Nino/Southern Oscillation or "*ENSO*" phenomenon, in terms of coupled ocean-atmosphere processes.

a. Let the *anomaly* (that is, the value relative to the "normal" state) in the strength of the *easterlies* be $U$, and the *anomaly* in eastern tropical Pacific temperatures be $T$. We will assume that

$$\frac{dU}{dt} = \alpha T$$  \hspace{1cm} (1)

where $\alpha$ is a positive constant, and $t$ is time. What are the units of $\alpha$? Physically, what type of ocean-atmosphere feedback process does this describe?

b. We will now also assume that

$$\frac{dT}{dt} = k U$$  \hspace{1cm} (2)

where $k$ is also a positive constant. What are the units of $k$? Does this expression describe a *negative* or *positive* feedback? Physically, what process could this represent?

c. Combine (1) and (2) to get a single differential equation for temperature $T$. What is the solution to this equation? What fundamental feature of ENSO does this solution describe? What significance does the square root of the product of the constants $\alpha$ and $k$ have (hint: what are its units?)