Department of Earth & Climate Sciences Name _____
ERTH 465

Homework 2 Key: Deterministic Temperature Forecasting
using the Simplified Temperature Tendency Equation

A. A Simple Forecast Equation for Temperature

The local tendency of temperature can be used to calculate the rate of change of temperature at a fixed location. This, in turn, can be used to determine the change in temperature over a fixed time interval if that rate is multiplied by the total time period over which the changes will occur.

$$\frac{\partial T}{\partial t}dt = \left(\frac{DT}{Dt} - \vec{V} \bullet \nabla T \right) dt \qquad (1)$$

This, then, can be algebraically added to the initial temperature at the location to obtain a forecast temperature. In this homework, you are only calculating the forecast change.

B. Exercise: Answer on Separate Sheet

Say that the temperature at San Francisco International Airport (SFO) is changing at a constant rate of -0.5 ^{o}C /hr.

1. What is the net LOCAL temperature change at SFO at the end of a 6 hour increment?

   The net temperature change over that six hours is (-0.5 ^{o}C /hr) X 6 hr = --3.0 ^{o}C

2. What are the symbolic forms of the LOCAL CHANGE of -0.5 ^{o}C /hr and the 6 hour increment (in algebraic notation)?

$(\Delta T/\Delta t)_{fixed}$ is the rate at which the temperature changes at San Francisco Airport, as observed by a thermometer there and is the local change. The total time period, in this case, 6 hours, is Δt.

3. What is the symbolic form of the expression you used to answer question (1) in differential calculus notation?

   $\frac{\partial T}{\partial t}$ ***dt* = (-0.5 ^{o}C /hr) X 6 hr**

4. Now, suppose that you know that radiative cooling is responsible for about 1^oC cooling in all the air parcels that moved across the station during that six hour period. In other words, $DT/Dt = -1^oC/6h$

   What was total contribution of three dimensional temperature advection to the temperature change that occurred over the 6 hour time increment?

$$\frac{\partial T}{\partial t}dt = \left(\frac{DT}{Dt} - \vec{V} \bullet \nabla T\right)dt$$

or

$$\frac{\partial T}{\partial t}dt = \left(\frac{DT}{Dt}\right)dt + \left(-\vec{V} \bullet \nabla T\right)dt$$

Local Change Observed By Thermo-Meter	Temperature Change Experienced By Air Parcels	Advective Change

Local Change = -3C
Total change = -1C

Local Change = Total Change + Advective Change
Advective Change = Local Change – Total Change
Advective change = -3 C – (-1 C) = -2 C