EAS372 Assignment 1 Due: Tues. 7 Feb., 2017

Format: Please submit a tidy, organized report covering the exercise below. Format: PDF file, single-sided, double spaced, font size 12 pt. The page limit is **two**, not counting figures and tables. (Please consult the file of suggestions regarding assignment writing).

Task: Record a two week time series (two points per day) of (a) the 1000-500 hPa thickness (b) temperatures (T_{850}, T_{700}, T_{500}) at a Canadian radiosonde station[1]. Thickness can be obtained from the soundings (see course URLs) or (less accurately and more laboriously) by interpolating between contours on CMC analyses at 00Z and 12Z. Likewise, temperatures could be taken off the analyses, but it is simpler to grab all needed data off the sounding text data.

Let any given point in the thickness time series be labelled ΔZ_i ($i = 1...28$), where i indexes time ("t_i"). Compute the mean value $\overline{\Delta Z}$ of your thickness time series, and calculate the time series

$$\Delta Z_i' = \left(\Delta Z_i - \overline{\Delta Z}\right) \quad [\text{dam}] \tag{1}$$

of the *deviation* of each thickness value from its two-week average. Then define

$$q_i' = \frac{1}{2}\,\Delta Z_i' \quad [\text{dam}] \tag{2}$$

where the factor of 1/2 is suggested by the hypsometric equation (for the relationship between changes in thickness and changes in mean layer temperature). Verbally, we can define q_i' to be the "anomaly in the *half*-thickness of the layer".

We are interested in the relationship of this time series q_i' with temperature, and we know that the hypsometric equation hints it is a *height-averaged* temperature that is relevant. Thus, for each time t_i define the following (approximation to the) layer mean temperature

$$\langle T_i \rangle = \frac{1}{9}\left[2\,T_i^{(850)} + 3\,T_i^{(700)} + 4\,T_i^{(500)}\right], \tag{3}$$

and compute the mean value $\overline{\langle T \rangle}$ of this series. Finally, compute the time series of the *anomaly* in your layer mean temperature,

$$T_i'' = \langle T_i \rangle - \overline{\langle T \rangle}\,. \tag{4}$$

[1]Each student to use a different station.

Product: Tabulate your calculations. Graph your two time series q'_i and T''_i versus time (t_i) on the same graph using the same "y-axis" for both quantities. Explain the relationship you find between q'_i and T''_i, and compare it against the relationship given by the hypsometric equation[2].

Comment: Note that we are using two different types of average in this exercise. The time average is denoted by the overbar, and the height average by the angle-brackets.

Organization of the data

The index i orders your data in time. Presumably it is easiest to perform the needed calculations in a spreadsheet, which might resemble Figure (1); MATLAB would be equally suitable for this task.

Table 1: Stony Plain sounding data organized for calculation. (Incomplete.)

i	Day	Time	Z_{500}	Z_{1000}	ΔZ	$q'_i \equiv \frac{\Delta Z - \overline{\Delta Z}}{2}$	T_{850}	T_{700}	T_{500}	$\langle T_i \rangle$	T''_i
1	10Jan/11	12Z	5420	321	5099		-19.5	-19.1	-32.3	-25.1	
2	11Jan/11	00Z	5420	317	5103		-17.1	-19.3	-32.1	-24.5	
3	11Jan/11	12Z	5400	300	5100		-16.5	-19.3	-32.5	-24.5	
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.											
28	23Jan/11	...									
Avg.					5100.7						

[2] Lackmann's Eq. (1.37). You may ignore the difference between virtual and actual temperature in the cold, dry winter atmosphere; the gas constant for dry air $R_d = 287\,\mathrm{J\,kg^{-1}\,K^{-1}}$ and with sufficient accuracy $g_0 = 9.81\,\mathrm{m\,s^{-2}}$; $p_{\mathrm{low}}/p_{\mathrm{up}} = 1000/500$.