Synoptic Meteorology II: IPV Non-Conservation Exercise

Due: 28 April 2015, in class

The figure below represents a vertical profile of divergence (grey line) from within a mesoscale convective system. You may also recall that it was the first of three such profiles given as question #2 of the Synoptic I final last semester. Superimposed is the corresponding profile of vertical motion (red line), as can be inferred utilizing Dines' compensation. There is weak descent in the lower troposphere with strong ascent in the middle to upper troposphere.

For this profile of vertical motion, one can infer the presence of condensation and freezing in clouds found within the region of ascent. We know that condensation and freezing cause the water molecule to lose heat to its environment; thus, both are associated with diabatic warming. **Such diabatic warming is maximized where ascent is maximized**.

One can infer the absence of clouds in the region of descent. As precipitation falls out of the cloud deck above, presumably some of it evaporates or sublimates within the sub-saturated layer near the surface. We know that evaporation and sublimation cause the water molecule to take in heat from its environment; thus, both are associated with diabatic cooling. **Such diabatic cooling is maximized where descent is maximized**. With all of the above in mind…

1) How will the below-depicted patterns of divergence and vertical motion – and thus diabatic heating, per the discussion above – modify the vertical structure of isentropic potential vorticity? Note that you should use the equation describing the non-conservation of isentropic potential vorticity to answer this equation.

2) How will the below-depicted patterns of divergence and vertical motion – and thus diabatic heating – modify the vertical structure of (a) static stability and (b) absolute vorticity? Note that you will need to use the quasi-geostrophic omega and vorticity equations to answer this question.

convergence ($\delta < 0$)   divergence ($\delta > 0$)
ascent ($\omega < 0$)   descent ($\omega > 0$)