CA4

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1. Given the sounding, please plot the vertical profiles of dry static energy, discuss the vertical structure, and compare it to the potential temperature.

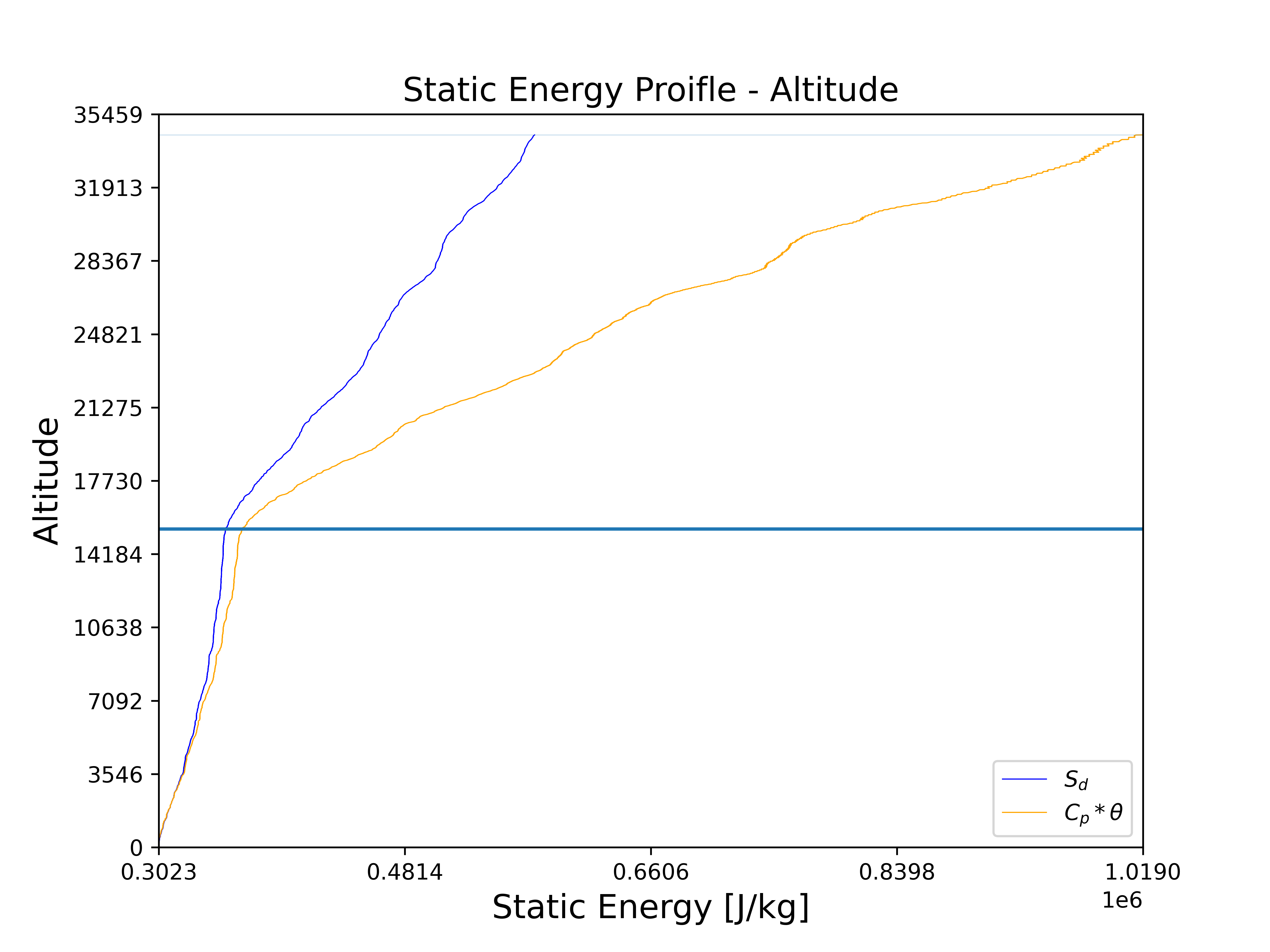


Figure Plotting:

The graph is composed of static energy and potential temperature. The blue line represents the static energy, the orange line represents potential temperature times heat capacity in isobaric process. The thick blue line represents the tropopause. The thin blue line represents the upper limit of the data.

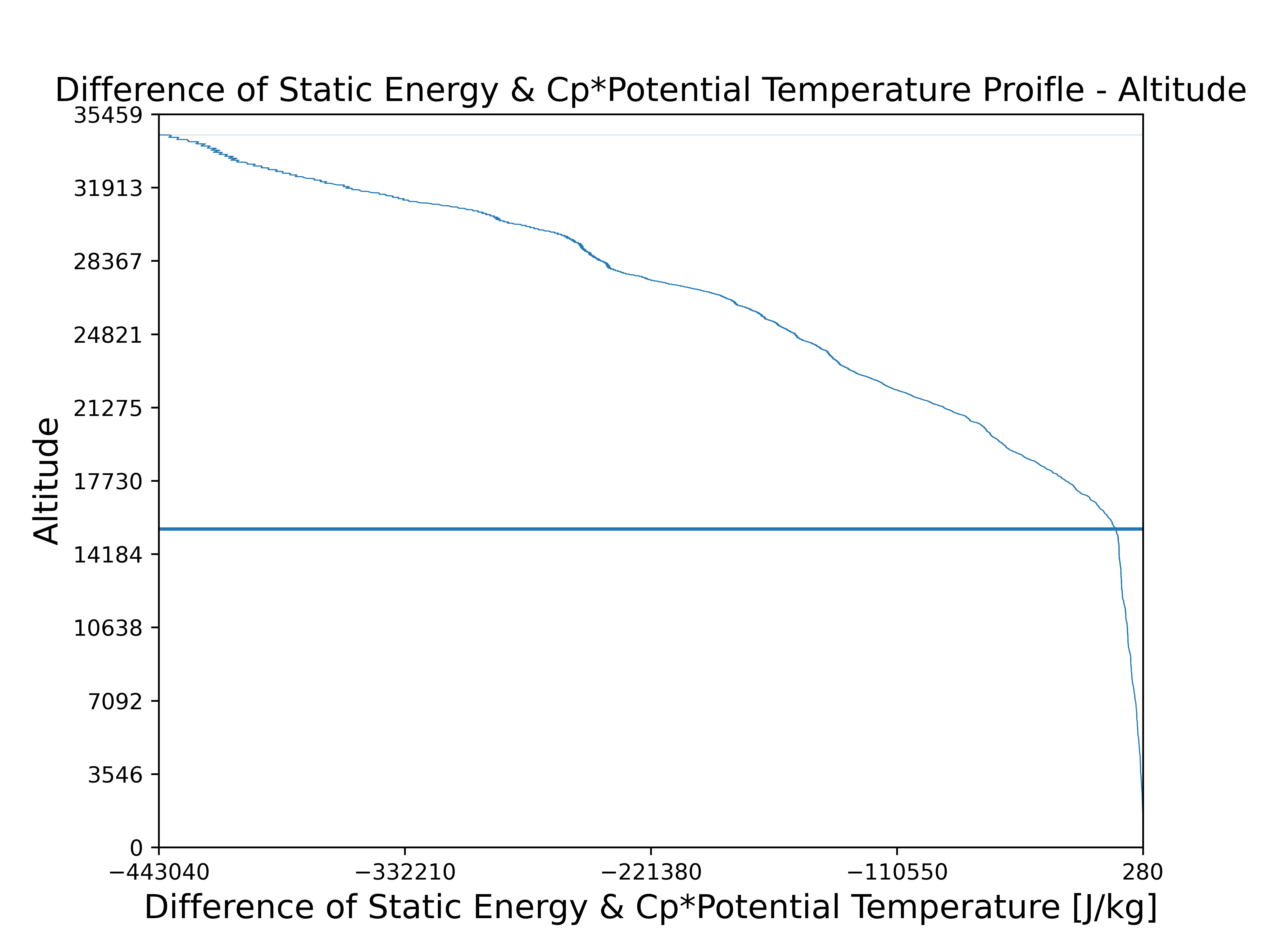
Discussion:

To derive the relationship between potential temperature and static energy, we need to use the definition of potential temperature and calculus to conduct:

By the relationship of and , we can observe that if , then:

By the definition of , the temperature is decreasing, however, the geopotential energy is constantly greater than . In the other cases, the stratospheric temperature is constantly increasing, the sum becomes greater. Therefore, both of lapse rate of the features are greater than troposphere.

In the plot, in lower atmosphere, the two factors are almost the same, however, when the altitude is higher than tropopause, the difference like below:



The difference between two features, static energy minus \*potential temperature, become greater as the altitude increasing.

Because air parcel lifting process in atmosphere can somehow be approximated as adiabatic process. Thus, static energy can be regard as a constant. By the difference be written in:

In the discussion above, static energy can be regarded as constant. However, the pressure is decreasing as the altitude increasing.

In the discussion above, static energy can be regarded as constant. However, the pressure is decreasing as the altitude increasing. Thus, is constantly increasing and positive, transfer from positive to negative. The difference is constantly decreasing in the profile.

1. Consider an infinitesimally small dry surface parcel which has same temperature as the environment, what is the temperature, potential temperature, and dry static temperature difference between this parcel and the environment if it is moved adiabatically to the tropopause?

For temperature, the profile likes below:

一張含有 圖表 的圖片

自動產生的描述

The profile above is the comparison of temperature between the two different conditions.

The reason why the plot only draws the altitude of 16000 m because the temperature of dry are parcel will be no sense in too high altitude.

the blue line represents the sounding profile, the green one represents the condition of dry air parcel. The pink area represents the section of altitude that the temperature of real sound lower than the dry air parcel. Which means that the dry air parcel is easy to lift into upper atmosphere. In another words, the atmosphere below 636 m is unstable, any parcel is likely to lift into higher altitude.

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自動產生的描述

The profile represents the potential temperature of sounding and the dry air parcel. The green line is potential temperature of dry air parcel, and the blue one represents the sounding potential temperature.

The green line seems to be a smooth curve, there are the derivatives of its equation:

Using the hypsometric equation:

Using ideal gas law:

By the definition of :

Using hypsometric equation:

Substitute :

By doing calculus:

If we simplify the equation:

Because the equation is a hyperbola equation.

The reason why can derive this equation in this simple form is that many value that regard as variable can be seem as constant.

By observation, there is a little section that potential temperature of dry air is greater than real sounding. The graph likes below:

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自動產生的描述

There is a intersection a 636 m, this altitude is the same as the temperature of dry air and sounding intersections.

By definition of potential temperature, t

1. Following (2), a line-shaped dry parcel with 1 km thickness is hydrostatic balanced near surface, what is the temperature, potential temperature, and dry static temperature difference between this parcel and the environment if it is moved adiabatically and hit to the tropopause. (Assume that the parcel is still 1 km thick)