What is the correct way to think and teach aerology? Some, even professionals, meteorologists remain committed to the 30 years old concept and tools of forecasting. These meteorologists are quick to point out the limitations and shortcomings of numerical models to try to overcome their own limitations of knowledge. While models are far from perfect, mainly because of the limited number of basic weather data which may lack precision as well, keep in mind that there is currently no better !

Here are 7 points that can be outdated or wrong in some meteorology documents for glider pilots:

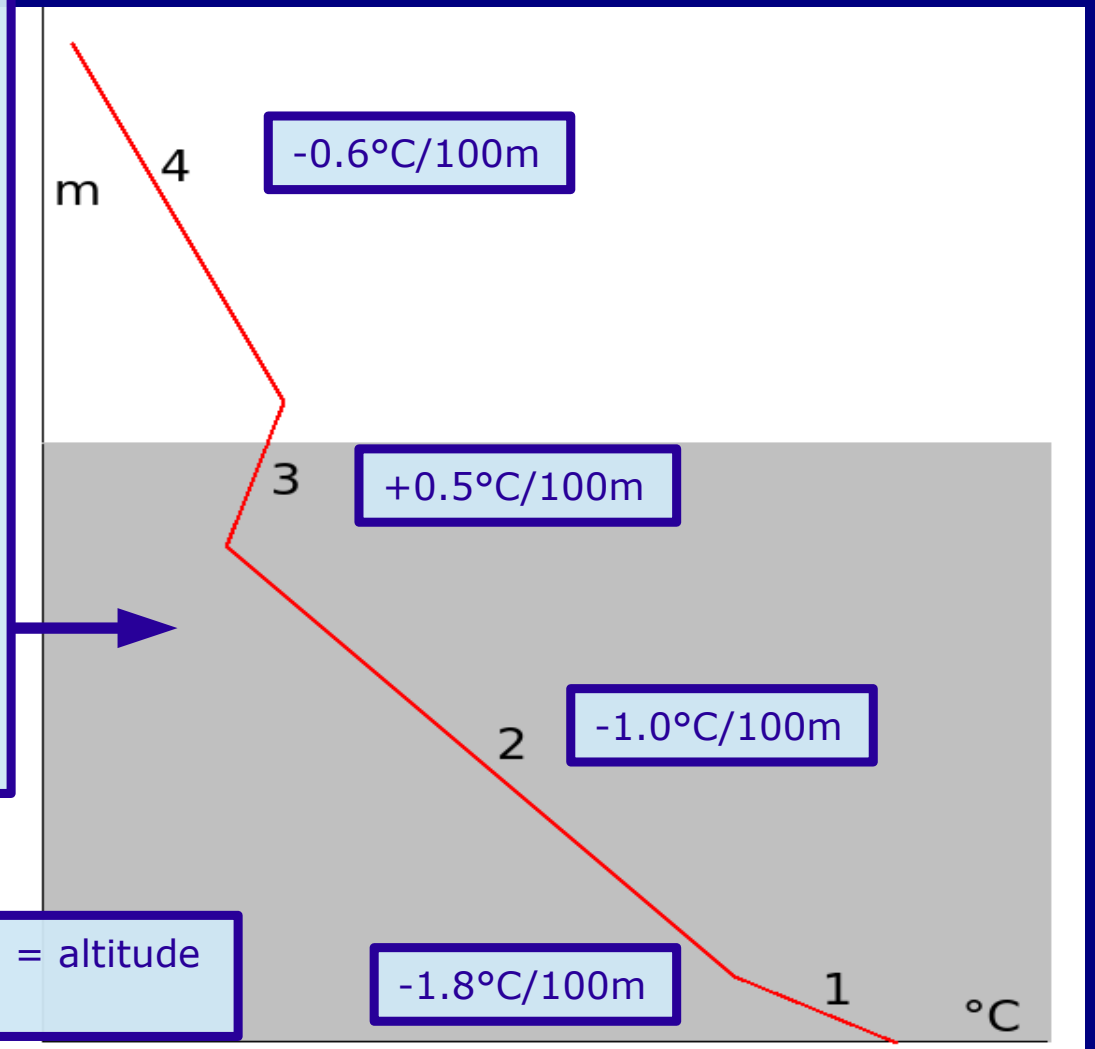
The seven capital sins of conservative conception of aerology

Jean Oberson – soaringmeteo.ch - Version 1

1. To not take into account the concept of convective boundary layer :

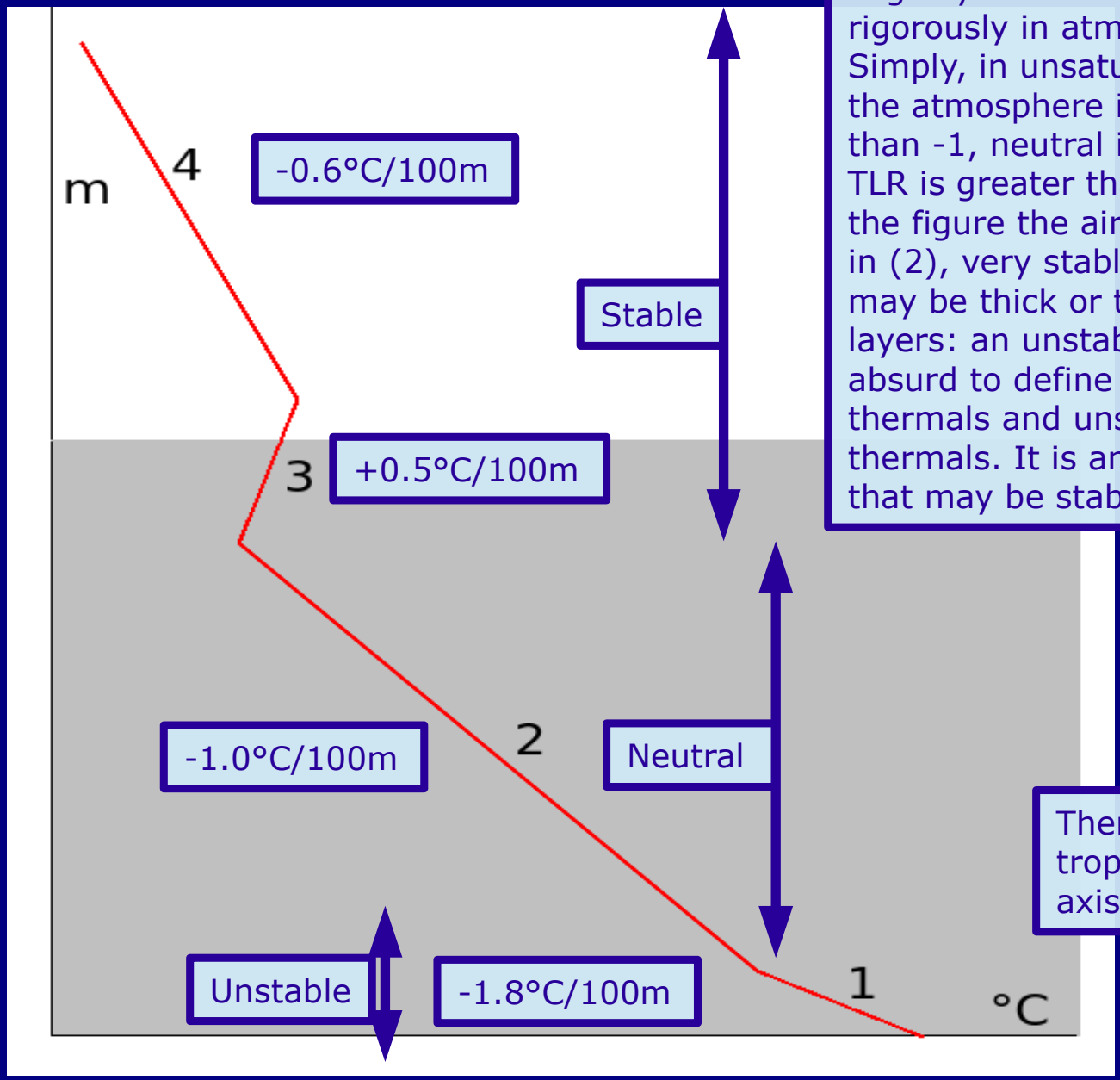
Many recent and serious studies prove the existence and importance of the boundary layer at the bottom of the troposphere. During the day, especially sunny, this convective boundary layer (= BL) will produce the un-stormy convections (= thermals). Do not consider this layer will distort the mental representation of aerology closer to reality. Let us recall as simply as possible the aspect of the temperature curve in the lower troposphere to define the BL.

Close to the ground, there is a thin layer (1) where the temperature lapse rate (TLR) is much lower than -1°C/100m. Just above (2) the TLR is approximately -1°C/100m. Then there is a layer (3) where the TLR is larger than -1 or positive (temperature inversion). The two first layers represent the BL (gray rectangle) capped above by the third layer. Above the BL (4) the TLR varies between -0.8 and -0.4 up to the tropopause . This sunny day configuration is almost immutable. Only the height of the BL varies from hours, days, places and seasons to others. Two other features of the BL are firstly its high concentration of aerosols (dust) hence its misty aspect then secondly the presence of many air turbulences due to incessant vertical atmospheric mixture motions.



Thermal structure of the lower troposphere. M = altitude axis and axis C = temperature.

2. To use the notion of stability / instability inappropriately:



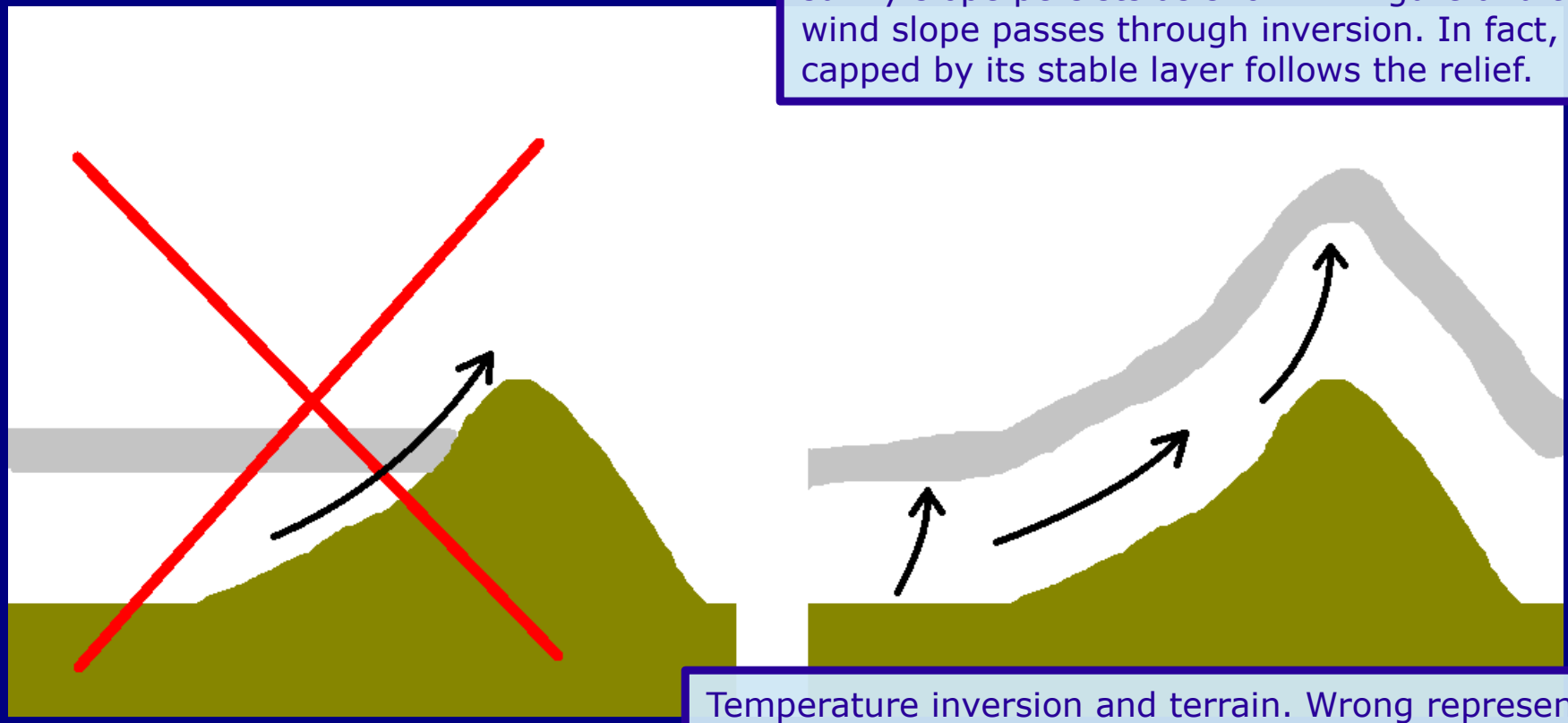
Pilots often use the terms stable and unstable so vaguely and inaccurately. Stability is defined very rigorously in atmospheric thermodynamics. Simply, in unsaturated air of humidity, a layer of the atmosphere is unstable when its TLR is less than -1, neutral if its TLR = -1 and stable, if the TLR is greater than -1 °C/100m. For example on the figure the air layer is unstable in (1), neutral in (2), very stable in (3) and stable in (4). The BL may be thick or thin, we always have these four layers: an unstable, neutral and two stable. It is absurd to define a day as stable if it has small thermals and unstable if it has strong and high thermals. It is an atmospheric layer and not a day that may be stable or unstable.

Thermal structure of the lower troposphere. M = altitude axis and axis C = temperature.

3. To imagine eruditely inversion:

Pilots are often quite proud to announce that they have understood and found an inversion in the sky. Although the BL is capped by a very stable layer, it is not always an inversion. It is impossible to pretend the existence or not of a true inversion only by observation.

But what is particularly absurd to thermodynamic point of view is to believe that the inversion on a sunny slope persists as shown in figure and that the wind slope passes through inversion. In fact, the BL capped by its stable layer follows the relief.

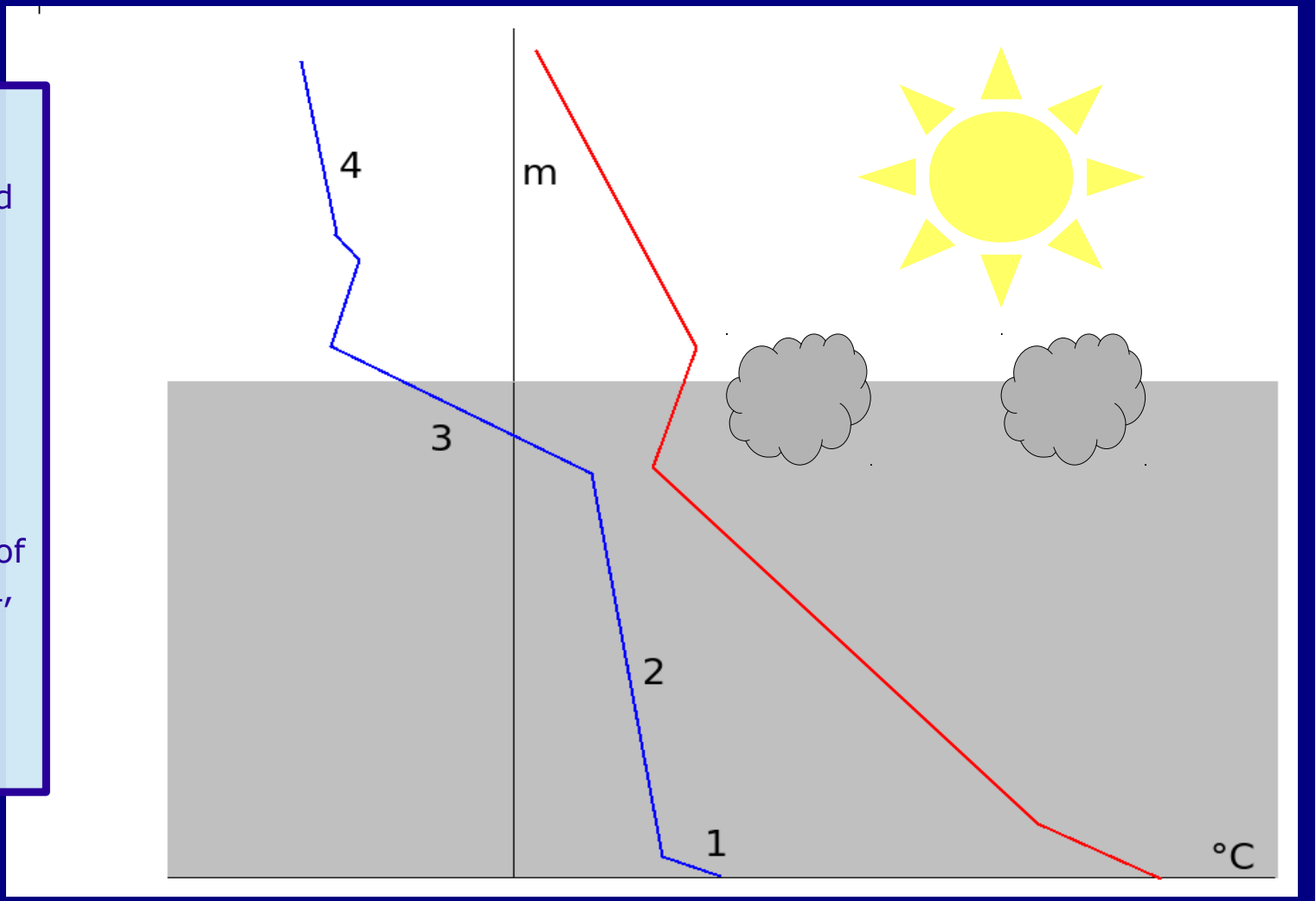


Temperature inversion and terrain. Wrong representation on the left. Realistic representation on the right.

4. To not take into account the moisture curve:

Some authors refer to the temperature curve without saying a word about the moisture curve of the atmosphere from which one can nevertheless infer cloudiness.

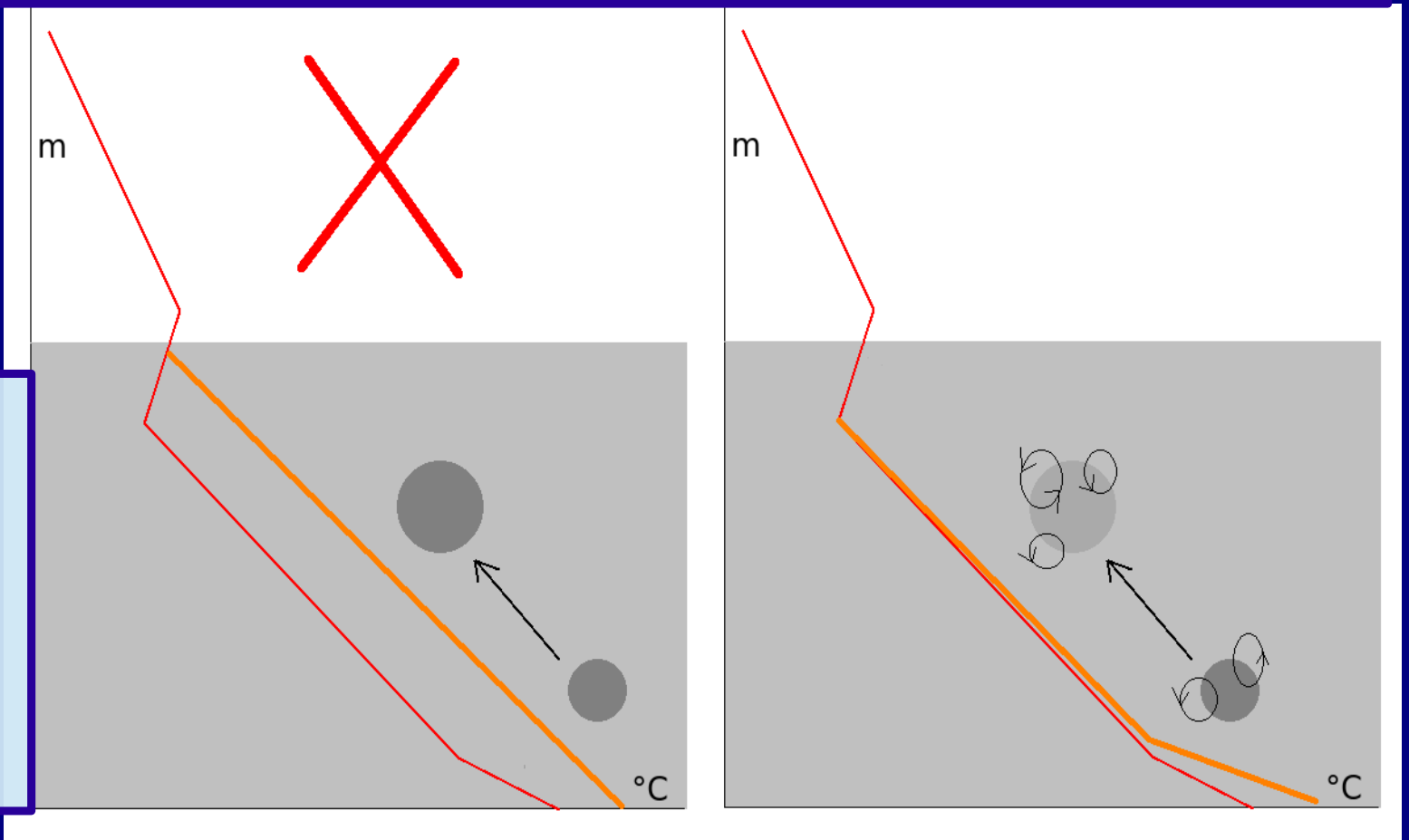
Here are typical beautiful temperature and humidity (dew point) curves of a good flight day. Near the ground, there is a thin layer where moisture drops (1). Then there is a low and regular decline of -0.3 to -0.2° C/100m in almost all of the BL (2). At the top of the BL, capped by the very stable layer, there is a sharp drop of dew point (3). Above the BL, the moisture curve is variable and chaotic (4), depending on the synoptic air mass.



Typical appearance of atmospheric temperature and humidity curves during a sunny day.

5. To believe that the thermal is like a balloon and there is no air mixture between thermal and surrounding air:

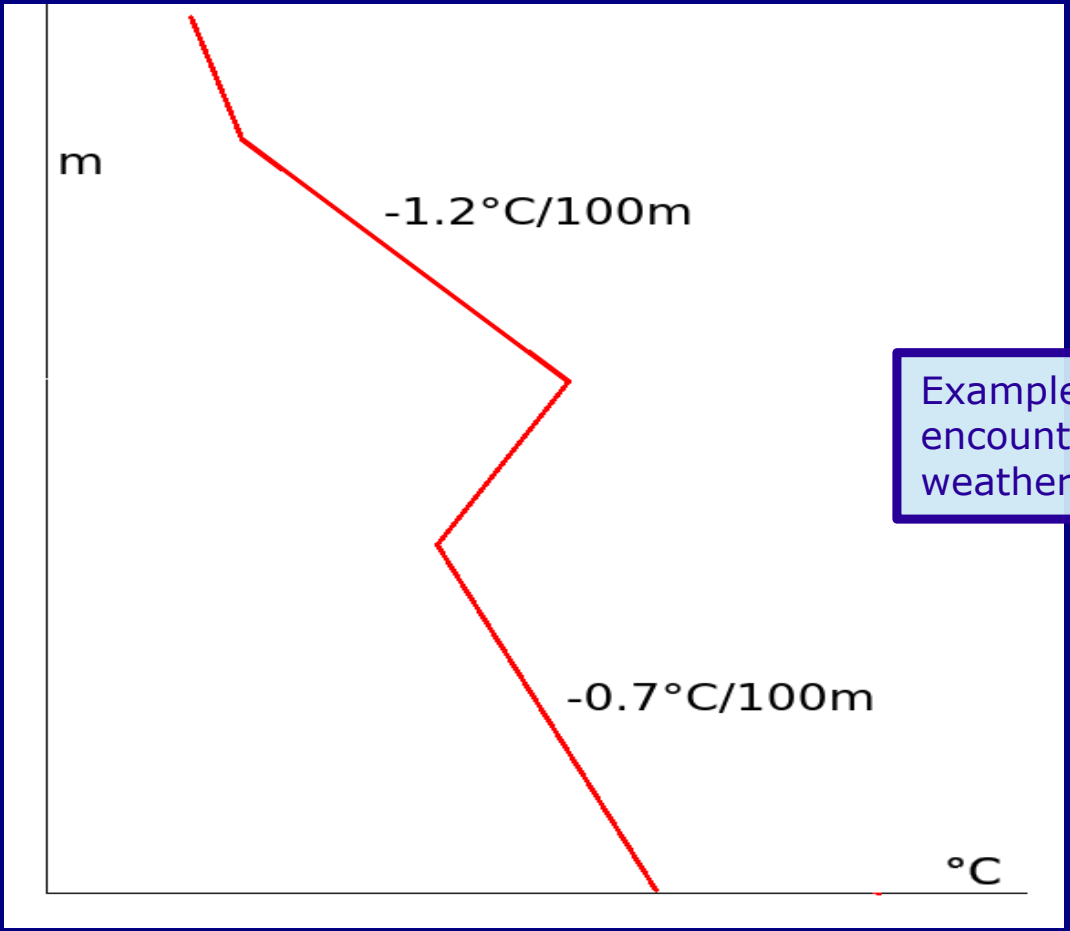
Traditionally, many writers imagine the thermal like a balloon which undergoes an adiabatic process (without heat exchange with the environment) during its ascent. They imagine a temperature difference between the thermal and the surrounding air of 1-3 ° C which persists over the full height of the lift. This is false. In reality, the turbulence around the thermal is such that the air in and out of the thermal mixes quickly. Some serious authors, as the german sailplane pilot and physicist Lindemann, by accurate measurements, have shown that if just above the soil temperature differences in the air can be 1-2 degrees, those can be reduced to less than a few tenths of a degree, above, in the convective layer.



Classical and false representation of the thermals, on the left. Realistic representation, on the right. Red curve: temperature curve outside the thermal. Orange curve: temperature inside the thermal.

6. To imagine fanciful and unreal temperature curves:

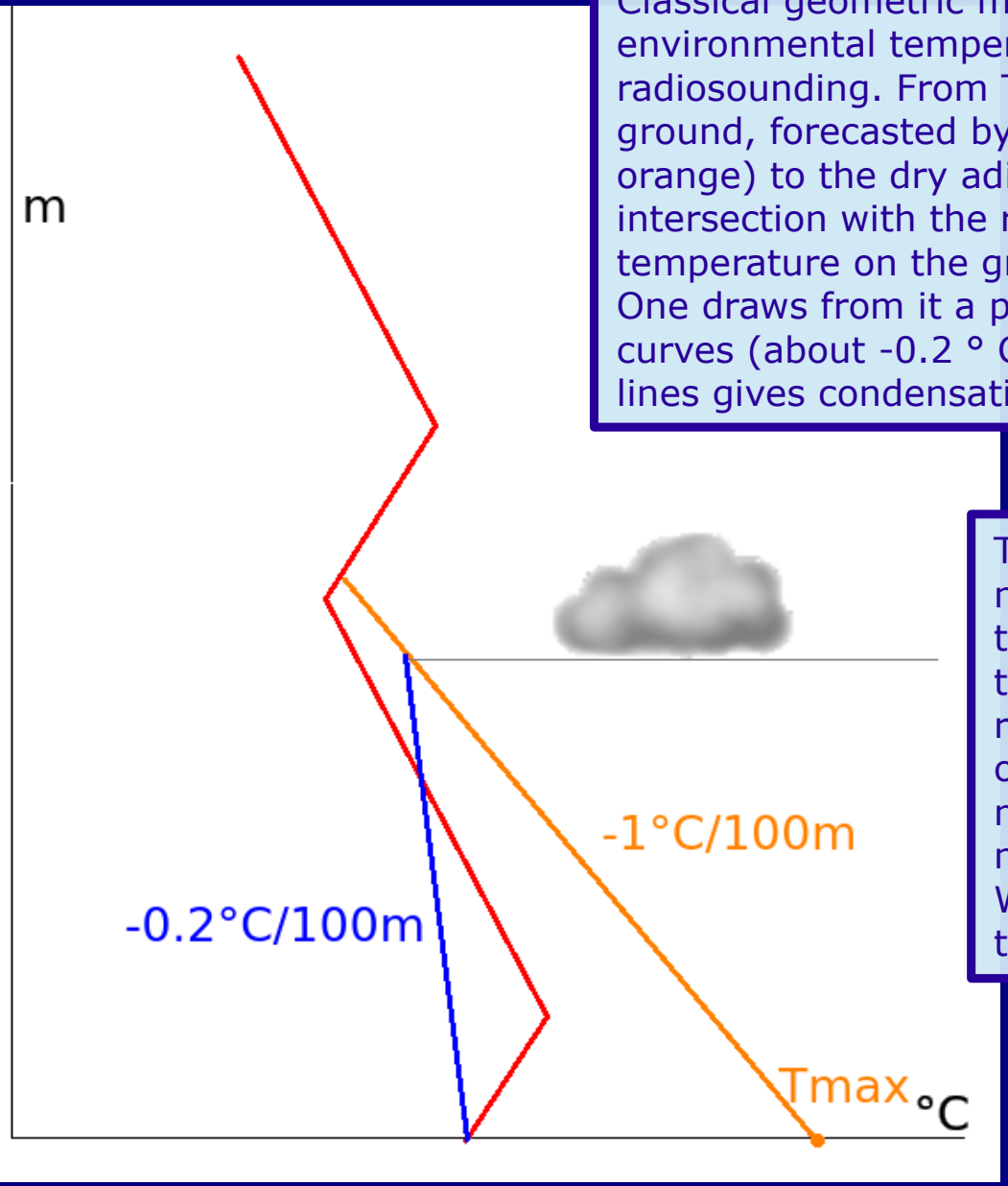
To explain the emagram, other authors invent a fanciful and unreal temperature curve like on below graph. I defy anyone to show me an example of such a curve from a radiosounding during a sunny day. In this graph, the first aberration is a TLR= -0.7°C/100m in the lower atmosphere (BL), while in reality there is the typical BL TLR = -1°C/100m. As against this never observed a TLR as -1.2 °C/100m in the upper troposphere, above the BL, but a TLR between -0.9 and -0.4. There are also other absurdities as a curve starting from sea level on a mountainous region with an average altitude of the ground for example greater than 1000 m.



Example of fantasy curve encountered in some weather books.

7. To naively base its forecasts on the night radiosounding:

Here is the classical and simple geometric method for predicting the BL top and base of cumulus from a radiosounding.



Classical geometric manipulation of an emagram. The red curve is the environmental temperature curve, generally that of a midnight radiosounding. From Tmax (the maximum air temperature near the ground, forecasted by the weather service) we draw a parallel (shown in orange) to the dry adiabatic curves (about -1 ° C/100m) up to the intersection with the red curve. It is considered that the night air temperature on the ground = dew point temperature during the day. One draws from it a parallel line (here in blue) to the mixing ratio curves (about -0.2 ° C/100m). The intersection of the blue and orange lines gives condensation level (the base of cumulus).

The problem is that the method is based on curves measured several hours before the flight and often tens of kilometers away from the flying site whose topography is very different from the place of radiosounding. It takes a heavy dose of bad faith or foolishness to claim the superiority of this trivial method compared to the billions of complex mathematical operations from Eulerian models like WRF, GFS, COSMO that take into account the topography and the time evolution of the weather.

The end