The case for dual radiosonde launches

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1 Introduction

ALMA needs accurate estimates of the temperature profile with height for refraction pointing corrections, amplitude calibration and determination of path from WVR brightness temperature measurements. The case for a temperature profiler at the site is outlined in the Ancillary Devices document, however an unresolved issue is whether there is a need for some simple temperature and water vapour monitors at each antenna – in particular where there is a significant altitude difference between the antennas.

2 The problem

Above 1 km in the tropical troposphere the temperature at a given pressure level in the atmosphere tends to be constant to within a few tenths of a degree, and waves propagate to balance out any temperature anomalies that arise. Measurements of the temperature profile at a single location are therefore likely to provide a good estimate for the rest of the Chajnantor site.

Closer to the ground, however, the temperature is strongly affected by heat transfer to and from the surface. If the timescale for dissipation of horizontal temperature differences is greater than the timescale for heating or cooling from the surface, significant temperature differences could arise above antennas of differing altitudes. (In the extended array configuration the antennas are expected to vary in altitude by up to 500 m.)

At present, because we don't know the timescales for the surface heating rate compared with the dissipation of heat via atmospheric waves, it is hard to estimate how the difference in altitude will affect the shape of the temperature profile. It could be that this follows quite a simple law – for example, the profiles might show the same variation with height above the ground up to a certain height, and then follow the variation with pressure above this height, with some smoothed transition. It may be that the temperature is equalised at every point with the same pressure, irrespective of height above the ground. It is also likely that the behaviour varies with time of day.

3 Dual radiosonde launches

A few radiosonde launches may provide significant insight into how the temperature profile is affected above antennas located at different altitudes. An ideal experiment would be to perform simultaneous radiosonde launches from locations on the plateau that vary significantly in altitude. In practice, however, if there is only one tracker, the sondes could be launched one after the other. Since the main issue is to determine what happens close to the ground, the sonde would only need to sample the lowest 1-2 km of the atmosphere, and so one could stop tracking the first sonde after only 15-20 minutes, before releasing and tracking the second one. This time difference would not be expected to affect the results significantly. Since the behaviour of the temperature profile is highly likely to be a function of time of day, ideally we would want to sample four different times of day – say 9am, 3pm, 9pm, 3am local time. These would not necessarily have to be carried out in the same 24 hour period.

4 Logistics

Logistically, there would clearly be a number of issues to sort out – for example identifying suitable locations for the radiosonde releases, and managing to time two releases within a short time span, possibly at several km separation. It may also be worth considering increasing the ascent rate to obtain a steeper angle of ascent, even if this is at the expense of some of the resolution in the vertical.

If these issues can be resolved, this data could provide valuable information about how to extrapolate the temperature profile from the oxygen sounder above different antennas, and to what extent additional temperature monitors on the antennas could assist with this extrapolation.

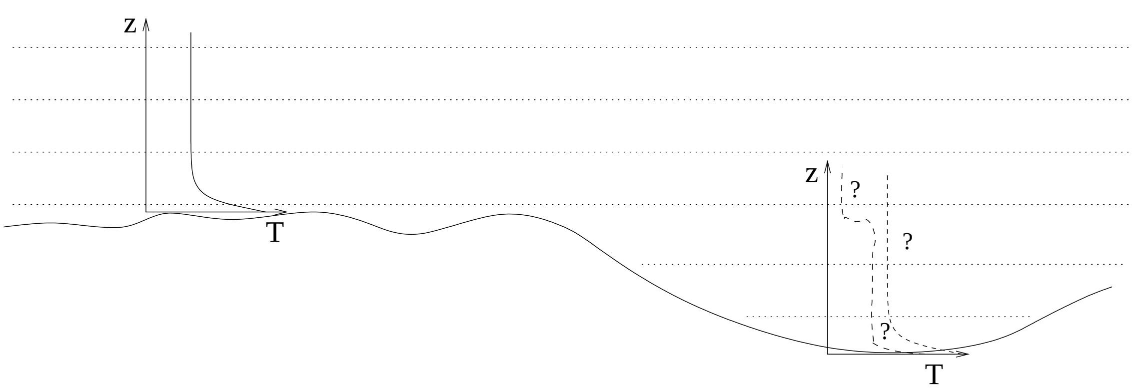

Figure 1: Figure illustrating the problem of how the temperature profi le behaves above ground at different altitudes. Dotted lines show lines of constant pressure – the temperature is expected to be near-constant for a given pressure level a few hundred meters above the ground, but near the surface, the temperature is strongly controlled by the surface temperature.