

Review of "Water vapor in cold and clean atmosphere: a 3-year data set in the boundary layer of Dome C, East Antarctic Plateau" by Genthon et al. submitted to ESSD

Our answers in red

The paper describes a 3 year timeseries of data from an Antarctic station tower with improved instrumentation to observe supersaturation with respect to ice. The discussion of the observations highlights the frequent occurrence of supersaturation with respect to ice at this location, occasionally up to water saturation. It is suggested this is a useful dataset for atmospheric model validation, with similar conditions to the upper troposphere.

This is an important and useful dataset for helping to quantify and understand supersaturated conditions and for evaluating models. The data is well described and the paper includes an informative analysis of the data.

Thank you

I have a number of comments where further clarity is required, particularly relating to gradients and turbulent fluxes, some of the Figures and use of supersaturation with respect to (wrt) ice or water.

Comments

In the "Short summary" for the paper, the last sentence is

"While supersaturation with respect to ice is frequent throughout the column, relative humidity with respect to (supercooled) liquid water reaches close to saturation."

As a one sentence summary of the results, I think this sentence, as it is, could be confusing.

Suggest something like:

"Supersaturation with respect to ice is frequently observed throughout the column, with relative humidities occasionally reaching water saturation."

Suppose this should be : "Supersaturation with respect to ice is frequently observed throughout the column, with relative humidities occasionally reaching water saturation."

OK taken, the short summary changed accordingly

Line 34

"and even more as freezing nuclei", but you mean even less? Suggest reword to make clearer.

OK, rewritten as: "...and even fewer as freezing nuclei"

Line 41, Tomkins -> Tompkins

OK changed

Line 78

"the vertical humidity gradient ... is the origin of turbulence". It's not the origin, do you mean that it is a result of the turbulence. Please reword this sentence to make it clearer.

OK, changed to "...is the origin of the fact that turbulence can transport..."

Line 93

Only use of "MO" is here and it is not defined. Suggest just state explicitly "Monin-Obukov"

Right, MO should have been mentioned line 82 as short for Monin Obukov. Now done.

Line 96-97

"the vertical moisture gradients used to represent the vertical distribution and mixing of moisture in the boundary layer". Again, a confusing statement. Please simplify/reword, e.g. "the vertical moisture gradient as a result of the mixing of moisture in the boundary layer".

This is not quite what we wish to express. This part is now rewritten as "the vertical moisture gradients which enter the parametrization of mixing of moisture in the boundary layer"

Line 115, dome C -> Dome C

Done

Line 117, according to Goff and Gratch

OK done

Lines 124-131.

There is a bit of duplication in this paragraph and it could be made simpler/shorter to improve clarity.

OK this is transitional text which is now shortened and wrapped up in just one sentence.

Line 129 -> saturation vapor pressure.

OK done

I don't think Figure 2 is necessary and would suggest removing it. The same curve (although on a linear scale) is in Figure 3.

We agree that the same the information on figure 2 shows also on figure 3 but not the same way and this is on purpose. We feel that the fact that expected values range over 3 orders of magnitude is best conveyed by figure 2 while figure 3 is best to show the actual data - the use of a modified y scale being explicitly mentioned in the legend of figure 3. We leave it to the editor to decide whether both figures are indeed useful or to remove figure 2, noting that none of the 2 other reviewers complain having the 2 figures.

Figure 3. For context for later discussions, you could also consider putting svp wrt water on the Figure, highlighting the upper bound of Rhi?

Thank you for this great suggestion. Taken, the new figure shows RH wrt liquid vapor which indeed nicely caps the data cloud.

Line 164, "by the CC curve"

Done

Line 160-180

Because of the previous discussion that the instrument reports vapor pressure with respect water, for clarity it is really important you are clear that Figure 3 and this paragraph discusses vapor pressure with respect to ice, e.g. on line 167, and "ice saturation" on line 178. Also mention this in the caption for Fig 3.

OK. Corrected for line 167, line 178 already explicitly mention "wri". Concerning fig 3, now explicited "Clausius – Calpeyron relations for relative humidity *wri*

Line 167, "frequently largely" -> "frequently"

We really mean that is is frequently **largely** above, not just frequently above.

Line 186, "adiabatic and radiative cooling combine"

Radiative cooling is more obvious, but could you say more about the conditions in this mid-temperature range that are leading to the adiabatic cooling (i.e. ascent) as this is perhaps less obvious over this region.

This is line 187. The observation site is at the summit of a dome which is locally very flat,. However, while the steepest surface elevation change (slope) and associated adiabatic cooling occurs within the 1st couple of hundreds of kms from the coast, the surface elevation still slowly rises further on the way to Dome C.

Line 197, the 18m level also does not show in the 105%-115% range. For improved clarity and simpler explanation I suggest showing the bars in a different way in Figure 5 so all can be seen - either offset or a set of three bars for each bin.

This is no longer an issue with the new figure of the results. However, to make it fully clear, different line types are now used in addition to different colors for the different levels.

Figure 7 - this is exactly the same data as used for the temperature data in Fig 6. Is it needed? Could the information be put on Fig 6 or just described in the text?

The same data are used for the average but more data 10 years are used to calculate the standard deviation. The standard deviation curves could have been implement on figure 6 but the results was somewhat messy and we elected rather to show std on a separate figure. It is expected that figure 7 will be reduced in size when a final version of the paper occurs.

Line 268, "mid" summer/winter rather than "full" summer/winter?

Yes, taken

Line 269, refers -> refer

Right

Line 270 , remove "at"

Right

Line 312, "vertical profile of moisture content determines the turbulent fluxes"

Again, surely the other way round, the vertical profile is determined by the turbulent fluxes. Or you mean it determines the sign of the transport due to the turbulent fluxes?

This is a chicken and egg issue. The gradient determines the flux, to the extent that whatever the quantity of turbulence if the gradient is zero the flux is zero, and with given turbulence the flux is proportional to the gradient. But then the flux in turn affects (reduce) the gradient so in some way the turbulence affects the gradient. We now write: with a given level of turbulence, the vertical profile of moisture determines the turbulent flux.

Does Figure 10 add much? You could just say you looked at individual times to confirm it is not a result of the averaging?

Following rev 2 and 3 comments, figure 10 is removed. We know simply mention that that we looked at individual times to confirm that this is not a result of averaging.

Lines 330, 332. Which gradient? Be clear you are talking about the PPW gradient in this case.

OK gradient "of PPW" added

Line 335, "water vapor flux is downward, exporting surface sublimated moisture"

Did you mean upward?

Yes, corrected

Line 372, for dry convection, surely potential temperature is the key quantity for instability, not temperature?

Yes but over such a shallow depth (~40 m) there is hardly a difference between gradients of temperature and of potential temperature. It is simpler to just mention temperature here.

Line 468, "diurnal cycle in the summer, upward.."

OK

Diurnal cycle of the moisture gradient...

Done

Figure 13, same comment as for Fig 5 for improved clarity.

Yes, again, different line types are now used in addition to different colors for the different levels