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## **Comment on essd-2021-412**

John King (Referee)

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Referee comment on "Water vapor in cold and clean atmosphere: a 3-year data set in the boundary layer of Dome C, East Antarctic Plateau" by Christophe Genthon et al., Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2021-412-RC1>, 2022

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### **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 (ESSD-2021-414)**

#### **General**

This paper documents an important new dataset of near-surface humidity profiles from Dome C on the East Antarctic Plateau, obtained using a novel hygrometer previously described by Genthon et al, 2017. Unlike many conventional hygrometers, the new instrument is capable of accurately measuring humidities which are supersaturated with respect to ice. Since ice supersaturation occurs frequently at Dome C this dataset provides for the first time an accurate climatological description of near-surface humidity profiles and their variability on daily to annual time scales at this station.

The paper provides a clear description of the measurements and the means by which they were obtained. Some basic climatological analysis is presented, which gives useful insight into the processes that control humidity at Dome C. I have a few comments on the paper (set out below) that require attention but these are all relatively minor and should all be easily addressed by the authors before final publication.

#### **Specific comments**

- Throughout the paper, the term “supersaturation” is used without qualification, and is generally used to imply supersaturation with respect to ice. There is thus some ambiguity in the use of this term and I would recommend that it should always be qualified by “wrt ice” or “wrt liquid water” as appropriate unless it is absolutely clear from the context which of these is being meant. Examples of places where clarification is definitely needed include the caption to fig.3, line 167 and line 473.
- Lines 23-24: Make it clear that these temperatures are for Dome C, not averages for the whole plateau.
- Lines 78-79: Strictly speaking, the humidity gradient isn't the origin of the turbulence (which is generated by wind shear or convection). Maybe say "...because it enables the calculation of vertical moisture transport and exchange with the surface."?
- Line 163: I'm not sure that this is the "traditional" view. Cloud physicists have known for a long time that ice supersaturation occurs in mixed-phase clouds - it is the basis of the Bergeron-Findeisen process, formulated in the 1930s. However, the occurrence of near-surface supersaturation wrt ice seems to have been largely overlooked until appropriate measurements (King and Anderson, 1999; Genthon et al, 2017) became available).
- Figure 8: Is “Hour” local time? Give the difference to UTC.
- Figure 9: There is very little information on this figure. You could make it more informative. Maybe show seasonal mean profiles?
- Lines 326-327: King et al (2001, DOI: <https://doi.org/10.3189/172756501781832548>) present estimates of water vapour fluxes for Halley from humidity profiles.
- Lines 373-374: Not sure what you mean here - that water vapour profiles cannot be used to diagnose convection?
- Lines 475-476: “Thus, it is no wonder...” Do you have a reference that shows that models with appropriate microphysical parametrisations do produce ice supersaturation near the surface at Dome C?
- Section 4: Also using a heated hygrometer, King and Anderson (1999) observed frequent ice supersaturation at Halley but no saturation wrt liquid water. They suggested that this indicated that, even in the clean polar air, cloud condensation nuclei, which will initiate droplet formation at very low supersaturations wrt liquid, are relatively abundant, while ice nucleating particles are rare.

### **Minor points and typographical corrections**

- Line 76: “operational”
- Line 115: Capital “D” for Dome C
- Line 144: Delete space in “humidity”
- Line 183: “divergence” (not convergence)
- Lines 308-310: I don't understand this, please clarify.
- Line 335: “upward” (not downward)
- Lines 467-470: Insert “increasing” before “upward” and “downward”

