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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Reappraising the appropriate calculation of a common meteorological quantity: Potential Temperature" *by* Manuel Baumgartner et al.

Anonymous Referee #2

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This manuscript constitutes a thorough and very well-presented revisit of a classical variable widely used in astmospheric science: potential temperature. The presentation is very pedagogical, with a brief and welcome account of the history of this quantity. The examination of the different effects and approximations are remarkably well exposed and discussed. The resulting text is perhaps a bit long and sometimes technical, but this is likely to become an important reference, at least for applications (such as middle atmospheric circulation) where a more exact defintion of potential temperature introduces significant differences. The study is very complete, with each approximation well explained, and with solutions for an approximate caluclation of the 'reference' potential temperature described for practical implementation. The conclusion include

the (expected) judgement that the conventional definition is quite acceptable for most uses, especially in the troposphere, but the possible cases where this reappraisal is relevant and useful are well and convincingly exposed. Overall, this is a well-written, rigorous investigation of a central quantity in dynamic meteorology. Publication after very minor revisions is advised.

- Abstract, line 1: 'changes of state' → should this be changed to or complemented by 'motions'; changes of state in my understanding mostly refers to thermodynamic changes of state, e.g. for a mixture of air and water. Potential temperature is already extremely useful for dry air undergoing displacements in the atmosphere, or even simply experiencing pressure changes.
- l42-44: meaning not clear, although I believe I know what is meant; the formulation is somewhat confusing
- l59: "Occasionally" means "on occasion, now and then", according to the Merriam-Webster dictionnary; it does not seem appropriate for this sentence. Suggestion: "Examples of definitions based on the potential vorticity include..."
- l185: has ξ been introduced before, or does it make sense only upon reding Weigel et al 2016? If that is the case, perhaps it is sufficient to mention 'a coefficient factor, cf Weigel et al 2016'?
- l192 and 194: it seems odd that the same reference (WMO, 1966) both suggests the value of 1005 and 1011 J/(kg K)
- l224: the range of uncertainty displayed in figure 2 is an upper bound, obtained using the extreme values one may find in textbooks for c_p. A more plausible interval is probably 1004 - 1006, with key references like Holton (2004) and Emmanuel (1994) serving as classical references for one and the other extreme. Perhaps

the authors could indicate how this more limited range modifies the $\Delta\, c_p$ at 50 km (from 75 K down to ..?)

- l347: seductive → appealing? attractive? tempting?
- l495: should the authors recall what effects are dominant in the difference between ideal and real gas, or would this be too redundant with the first sections?
- l618: '. . . depending on the textbook consulted.' Perhaps recall the range of values, or at least refer to the table so the reader can quickly find the range of values (this table is useful and thought-provoking).

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