Review of HESS Manuscript #2019-153

Title: Impacts of non-ideality and the thermodynamic pressure work term pΔv on the Surface Energy Balance

Author: Massman

Review

This paper describes how latent heat of vaporisation and a missing pdV terms might contribute to energy imbalance in global flux databases. It is an old fashioned approach in that the conclusion is that neither of the considered corrections can make any major difference. This is a return to the days when negative results were routinely published. It is very useful!

I had some technical comments on the manuscript but nothing major and all should be easily fixed by the author.

Other Comments

1. Formatting of references. On the first few pages, every time the U. Paw or Kowalski studies were cited, there were a number of extra symbols that clearly did not belong. Some sort of font conversion problem I assume. For example, p. 2, line 2 was the first but there are many instances after that. I leave it to you to sort out.

2. p. 2, lines 15-20. The mechanism/s discussed here are almost identical to those discussed by Makarieva et al (2013). Even more interesting was the controversy generated by the Makarieva et al (2013) paper. See for example: https://judithcurry.com/2013/01/31/condensation-driven-winds-an-update-new-version/ written from the point of view of the authors. More generally, it might be useful to frame the mechanism in terms of Makarieva et al (2013).

3. p. 3, lines 9-10. "……. specific enthalpy of pure water". In this context by water you mean liquid water. Given the overall context and the precision of this work, it might be better to call this …. pure **liquid** water ……. Perhaps adopt that convention throughout.

4. p. 3, line 17 & Figure 1. In the text it states, ….. overlays the blue line ….". But in Figure 1, the red line overlays a dashed black line so this needs to be fixed. More generally, I found Fig. 1 very hard to understand. Instead why not have a secondary axis on the right hand side, or another panel.

5. p. 3, lines 15-20 & Figure 1. I did not see the advantage of including the change in internal energy du since it is not explained ? The origin of the $p^*\Delta v^*$ (or RT_k/M_w) term is also not explained in sufficient detail. Here I suggest expanding this section to include equations for internal energy (and enthalpy) and to show the origin of the $p^*\Delta v^*$ term (and the RT_k/M_w term as well). Without this explanation this is very hard to follow for a reader not experienced with classical thermodynamics.

6. P. 3, line 21. Range should be from the triple point, i.e., 273.16 K (not 273.15 K).

7. P. 3, line 20- p. 4, line 4. Why start with a liquid-dry air system and then add vapour? This is hard to understand and is non-physical sdince it is hard to imagine starting with liquid in contact with dry air but the liquid is not evaporating. Instead you could start with a liquid-vapor equilibrium and then add dry air which is easy to do experimentally and MUCH easier for a reader to visualise. For example, in your terminology, the initial state is $N_v h_v^* + N_l h_l^*$ and you add dry air to increase the gas pressure from the initial vapour pressure to the standard pressure (1 bar, or I note you use 1 atm). The final state then has an additional term for the dry air and depending on how the change has been carried out (e.g., constant T, P, V, etc..) you will not have to worry about the evaporative cooling. Have I missed something here?

8. Eqn 2. I can see you have used a different symbol, curly H, for the change. But why not Δh instead? That would be MUCH easier for a reader to understand.

9. P. 5, line 4. I did not understand the statement about ……. enthalpic change at constant pressure or constant volume? Have I missed something here? The change in enthalpy is TdS + VdP. At constant pressure, the enthalpic change is just the heat flux (= TdS) and enthalpy is often called the heat function for constant pressure. By similar logic, the internal energy is the heat function for constant volume? I think what is meant here is whether the process is carried out at constant pressure or constant volume. Correct?

I hope these suggestions prove useful.

References

Makarieva A.M., Gorshkov V.G., Sheil D., Nobre A.D., Li B.-L. (2013) Where do winds come from? A new theory on how water vapor condensation influences atmospheric pressure and dynamics. Atmospheric Chemistry and Physics, 13, 1039-1056.