Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC1
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Comment on amt-2021-169

Anonymous Referee #1

Referee comment on "Biomass Burning Aerosol Heating Rates from the ORACLES 2016 and 2017 Experiments" by Sabrina P. Cochrane et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-169-RC1, 2021

This is a useful analysis of the heating rates derived for biomass burning aerosols over the south-east Atlantic during the ORACLES campaign. The dependence of the heating rates on various driving factors is isolated by making use of a newly conceived parameter, the "heating rate efficiency" or HRE. This parameter removes the linear dependence on aerosol extinction coefficient and incoming solar flux in each layer (i.e. the main drivers for the heating rates) by dividing the heating due to aerosols by these factors. The remaining dependencies on underlying cloud albedo, aerosol single-scattering albedo, and path length for the direct solar beam are then readily observed.

Whilst HRE provides a useful intermediary in determining the relationship between heating rates and various parameters, I'm not convinced of its utility as a general purpose parameter (for reasons outlined in the comments below). Despite that, this is a well written and useful study that I would recommend for publication subject to fairly minor revision after addressing the following comments.

1) The method used to segregate the contribution to heating rates from different components is only really applicable for small perturbations caused by the removed component. For example, if you remove aerosol from the whole profile and then recalculate the heating rate at layers below the aerosol layer, the heating in those layers is likely to be higher than before because more direct flux would have penetrated to that depth. This would lead you to conclude the aerosol has a negative heating rate at these altitudes. These issues should be explained. A different approach would be to calculate the component's contribution to the heating rate layer-by-layer by only removing the component from a single layer each time, and therefore leaving the flux arriving at the layer principally unaltered. Was this considered?

2) The description of the way heating rates are segregated by absorber is a bit disjointed. The explanation of this in lines 156-166 would be better left to section 3 (along with a discussion of the issues highlighted in comment 1 above).

3) The heating rate efficiency has been defined to make use of the available observations, but these are inconsistent in wavelength: the heating rates are for the total heating over all wavelengths, the extinction is defined at 532nm and the fluxes are for the range 350 - 2100nm. The HRE parameter cannot therefore be ascribed any physical meaning and is

not generally applicable, which I suspect will limit its usefulness in a wider context. You state one future use of the parameter (around line 382) would be to translate extinction profiles into heating rates. To do this you would also need not only cloud albedo, SSA and solar zenith angle but also the downward fluxes at each level between 350 - 2100nm (which is not stated). Is the intention for HRE to be used specifically with the instruments that cover the required wavelengths?

4) The HRE parameter appears to be a fairly arbitrary intermediary parameter. It is useful to remove the linear dependence on extinction to expose the remaining dependencies. The division by downward flux, however, hides the dependence on the state of the atmosphere above as well as the solar illumination at the top of the atmosphere. Why stop there? You could have divided through by (downward + upward) flux which would have removed the dependence on the state of the underlying atmosphere (i.e. the cloud albedo), leaving the dependence on SSA and path length, etc.

5) Paragraph starting at line 79 indicates HSRLs will be able to provide extinction profiles directly. Can you provide a reference / explanation for how this is done? This paragraph goes on to state that HREs could be used to translate these extinction profiles directly in to aerosol heating rates. How can this be done without knowing the downward fluxes at each level?

6) At lines 240, 292 and various other places you have used the terms 'extensive' and 'intensive'. It's not clear to me what these terms mean in this context. Could you please define your usage of these words or perhaps use an alternative description.

Typo's and minor adjustments:

1) Abstract line 27: I think the term "curtains" needs explaining on first use.

2) Tables and figures are not referenced in order.

3) line 224: day^1 -> day^-1

4) line 337 & 338: sentence is repeated

5) line 352: and -> an