

Review on the “What controls the vertical distribution of aerosol? Relationships between process sensitivity in HadGEM3–UKCA and inter-model variation from AeroCom Phase II” by Kipling et al.

This paper examines the relative contribution of aerosol processes to the vertical distribution of aerosols using HadGEM3-UKCA model and AeroCom Phase II results. They have conducted more than twenty sensitivity runs to show that the vertical aerosol distributions are most sensitive to a few number of processes including in-cloud scavenging, growth by condensation, vertical extent of emission, and dry- and below cloud removal. The method is reasonable and the paper is well written. As its findings are beneficial to the readers, I recommend publication with minor revision.

1. The vertical position metric of the mean-mass-weighted mean pressure level (or vertical center of mass in pressure coordinates), $p(c)$ is defined in Eq (1) of section 4.3. $m(k)*M(k)$ [which is the product of aerosol mixing ratio and air mass] can be combined into aerosol mass. Then $p(c)$ term is quite similar with Koffi's (2012) “extinction mean height diagnostic”. Following Koffi et al, The current $p(c)$ can also be called as the “mass mean pressure height diagnostic”.
2. The current paper only relies on model simulations without any observational constrain. I would think that constraining aerosol vertical distribution with observation is highly difficult task. Vertical distribution of number concentration would be even more difficult. However some satellite data such as CALIOP (Koffi et al., 2012) provides global view of vertical distribution of aerosol extinction. Please discuss how your results are compared with observations.
3. In section 5 and 6, it is stated that HadGEM3-UKCA does not reproduce “inverted S” and “U” shapes that are common to other models. I wonder what is physical implication of the unique patterns in HadGEM3-UKCA. Please discuss what are the controlling mechanisms that determine those shapes in other models. Are these shapes are just model-simulation feature or are they constrained by observations? Also please specify that the “inverted S” shape is inferred from the log scale in Figure 1.
4. Page 25941 L6-11: It needs references. Or please specify if they are assumed.
5. Please provide mean height in numbers in Table 3. Also please add a sentence why DU is zero in NO-BLMIX.