

***Interactive comment on* “Estimates of aerosol radiative forcing from the MACC re-analysis” by N. Bellouin et al.**

Anonymous Referee #1

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This study estimates the direct radiative effect by total aerosol and individual components, and the cloud albedo effect by anthropogenic aerosols based on an aerosol re-analysis (i.e., ECMWF aerosol model constrained by MODIS total AOD). The total AOD from the re-analysis was separated into dust, sea-salt, anthropogenic, and fine-mode natural (originating from land) aerosols in an empirical way. The direct radiative effects were then calculated with AERONET observed aerosol optical properties. The cloud albedo effect by anthropogenic aerosols was estimated using satellite-based cloud susceptibility function (the method itself is debatable). The study represents an effort of acquiring observation-based aerosol radiative forcing, although a number of assumptions have been made. It addresses an important topic of climate change science. I recommend the paper be published after issues listed in the following are adequately addressed.

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Major concerns:

1. Section 3 describes how the total AOD is separated into individual components. I would suggest that they do readers' favor by including a flow chart to streamline the procedure, similar to that in Bellouin et al. (2005).
2. The dust AOD was simply taken from the reanalysis. This represents a large uncertainty. As stated (line 5-26, p20080), "a large fraction" of mineral dust is fine-mode due to assumptions made on the size of emitted dust particles. How large is the fraction? If dust particles have been assumed to be too small in size, they may have been transported too far and global dust AOD may bias high. In the uncertainty assessment (line 18-29, p. 20082), uncertainties associated with dust AOD were not accounted for. I would like to suggest that they evaluate their dust AOD with some observations, such as AERONET observations in desert regions, dust AOD over ocean from Bellouin et al. (2005, 2008), MISR non-spherical AOD, and AIRS/IASI (Peyridieu et al., ACP, 10, 1953-1967, 2010; ACPD, 12, 23093-23133, 2012).
3. Figure 6: a trend based on 8 years data is not very useful. How did you fit the trend? What is confidence level of the trend? I would suggest the confidence level is marked in the figure.

Other comments:

1. throughout the paper: "sea-salt aerosol" should be changed to "marine aerosol", including sea-salt, sulfate transformed from DMS, and maybe organics.
2. p.20075, line 11: what do you mean "correct"?
3. p.20075, line 27-28: the statement is not correct because satellite observations of above-cloud AOD are emerging.
4. p.20077, line 14-15: "Simulations by numerical aerosol models are not affected by the limited sampling of satellite retrievals". What does this sentence really mean?

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Please clarify.

5. p.20078, line 18-20: This SO₂ to sulfate transformation scheme appears too simple to me. Is it justified?
6. p.20078, line 27: please clarify how the model trajectory is updated during the assimilation process.
7. p.20079, line 20-23: “interestingly”. Why is this comparison interesting?
8. p.20081: how does the model define FMF? Is the definition consistent with MODIS or some in-situ observations?
9. p.20081, line 24: “using emissions of natural aerosols only”. Please specify what kinds of natural sources are considered here. Do you consider biomass burning aerosol to be completely natural?
10. p.20082, line 1: please specify if you considered the seasonal and spatial (on a scale of model horizontal resolution) variations of anthropogenic fraction?
11. p.20082, line 14-15: “Sea-salt AOD is maximum over mid-latitude oceans where near-surface wind speeds are large” It is interesting that maximum sea-salt AOD is not in the “roaring forties”.
12. p.20082, line 24-29: please give some details about the Monte-Carlo estimate of uncertainty. Also the uncertainty associated with dust AOD should be included.
13. p.200823, line 5-6: Why is the impact of the FMF uncertainty reduced when the method only compares the FMF to a threshold?
14. p.20084, line 15-16: “Anthropogenic aerosols contribute most to the absorption” Can you give a percentage?
15. p.20090, line 12: “Given the available data”, what data?
16. p.20094: what are optimal finger printing techniques?
17. p.20094, line 25-27: need a reference here to back up the statement that calibration issues result in spurious trends of AOD.

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