Review on "Modeling dust as component minerals in the Community Atmosphere Model: development of framework and impact on radiative forcing" by R. A. Scanza et al. S. Nickovic (Referee)

This study for the first time explores, using two versions of a global atmospheric-dust model how multiple mineral fractions in dust affect the atmospheric radiation. This work is also a basis for authors to build a modelling framework to be used in the future to study the influence of different minerals to processes other than radiation (e.g. ocean productivity due to deposited dust carrying soluble iron; role of minerals in cloud formation).

The manuscript is well organized and clearly written. The importance of the study objective and the obtained results qualify the article to be published. Before publishing I would ask the authors to consider the following comments and suggestions:

We thank the reviewer for the very helpful comments, and revise the text to clarify the points addressed by the reviewer.

Pg 3. Lines 12-18. Long sentence and difficult to follow. It would be re-written. (Based on these simulations, we estimate the all-sky direct radiative forcing at the top of the atmosphere as +0.05Wm-2 for both CAM4 and CAM5 simulations with mineralogy and compare this both with simulations of dust in release versions of CAM4 and CAM5 (+0.08 and +0.17Wm-2) and of dust with optimized optical properties, wet scavenging and particle size distribution in CAM4 and CAM5, -0.05 and -0.17Wm-2, respectively)
We modified the text to make this sentence easier to follow on p.17751, lines 12-17 (online) or line 32:
"Based on these simulations, we estimate the all-sky direct radiative forcing at the top of the atmosphere as +0.05 Wm^{-2} for both CAM4 and CAM5 simulations with mineralogy. We compare this to the radiative forcing from simulations of dust in release version of CAM4 and CAM5 (+0.08 and +0.17 Wm^{-2}) and of dust with optimized optical properties, wet scavenging and particle size distribution in CAM4 and CAM5, -0.05 and -0.17 Wm^{-2}, respectively. "

Pg 4. Lines 14-15.Goethite is mentioned, although not later explicitly considered; please clarify (Efforts to separate the components of absorbing dust single out the iron oxides, e.g., hematite and goethite.)
We modified the text to clarify this on p.17752, lines 14-15 (online) or line 58: "Efforts to separate the components of absorbing dust single out the iron oxides, e.g., hematite and goethite, **although in this study, we simulate the iron oxides collectively as hematite."**

Pg 4. Line 18 Add Journet et al, 2014 reference

The text has been modified to include Journet et al., 2014 on p.17752 line 18 (online) or line 62:
"Recent modeling studies that consider the speciation of dust into its mineral components include work by Balkanski et al., 2007; Sokolik and Toon, 1999, Nickovic et al., 2012 **and Journet et al., 2014."**

Additional text has been added to compare with the Journet study on p.17753, line 1 (online) or line 72:
"Journet et al., 2014 expands on the soil mineralogies from Claquin et al., 1998 by including many additional soil mineralogy measurements and increasing the number of minerals; however, these maps were not available at the time the simulations in this study were performed."

Liu et al., 2013 not in the reference list
We remove the reference to Liu et al., 2013.

Pg 13. Lines 1-4 Why the given fractions in Mahowald are used instead of the fractions from the mineralogy database? (CAM3 optics were used (Mahowald et al., 2006), which were computed assuming Maxwell-Garnett mixing of 47.6% quartz, 25% illite, 25% montmorillonite, 2% calcite and 0.4% hematite by volume, with density = 2500 kgm-3 and hygroscopicity prescribed at 0.14)
Because of the construction of the LW code in the CAM3/CAM4 model, including LW aerosol interactions is very difficult. Because the future of the model will be the CAM5 code, for which LW aerosol interactions are easy to include, we did not include these effects in the CAM4 model.
We modify the text to clarify this on p.17760, line 27:
"In CAM4, the LW aerosol effects are ignored in the release version, and are generally very difficult to calculate accurately, which is one of the many advantages of the new radiation scheme inside CAM5. We do not have a method to calculate the LW optics in CAM4 so we have to use the LW optics from CAM3 (Mahowald et al., 2006). In place of LW optical properties for the minerals, CAM3 optics were derived from refractive indices of a dust blend provided by Zender, C. S, assuming Maxwell-Garnett mixing of 47.6% quartz, 25% illite, 25% montmorillonite, 2% calcite and 0.4% hematite by volume with density = 2500 kgm^{-3} and hygroscopicity prescribed at 0.14."

Comment please the effects of using of different radiation schemes in CAM4 and CAM5 on comparability between two groups of simulations. Was this not possible to use a unique radiation model?
Unfortunately, it is not possible to run the CAM4 aerosol code with the CAM5 radiation code or vice versa. Therefore we do not include this in the paper. We think that including mineralogy in two different versions of the model, and getting similar results suggests our results are quite robust.

Pg 13. Lines 25-27. The argument of not using the same number of minerals in both model due to computational requirements does not sounds convincing. Remove it or

offer different justification. Personally, I think it limits the comparability of results from two models and generality of the study. (The fewer tracers in CAM5 were simply for computational efficiency; the capability to add the additional minerals included in CAM4 is feasible and future simulations may involve including these.)
Effectively we have additional diagnostic tracers in the CAM4 simulations (added mineralogical resolution), which we don't use in calculating their radiative effect from their optical properties; rather we use them just to see the distribution of minerals. Therefore, the do not impact the simulations nor the comparability of the runs. We add text to clarify this point of p.17761, line 23:
"CAM5 was modified to include five mineral tracers for each of the two modes, four minerals and an additional tracer to carry the rest of dust. As previously mentioned, neglecting the radiative properties of the additional minerals in CAM4 facilitated a comparison between CAM4 and CAM5. In effect, we have a few extra diagnostic tracers in our CAM4 simulations with mineralogy, which do not impact the simulation, and can use these in the mineralogical comparisons. However, their optical properties are identical to the "rest of dust" tracer in CAM5 and do not impact the radiative forcing differently. "

Define the term dynamic variability
We replace this term with "range of variability." The text has been modified to define this term on p. 17766 line 24:
"There is one instance of the range of variability of mass with size where the CAM4 simulation did not predict this variability for gypsum (Fig. 4g)."

It would be useful if the authors in Discussion and conclusion compare their results on radiation forcing with other similar studies (e.g. Balkanski et al, 2007, etc.) and discuss reasons for substantial differences (if any)
Balkanski et al., 2007 considers radiative forcing with different mixtures of minerals but does not include spatially explicit minerals as we do in this study. We include a reference to this and other recent papers in the conclusions to put our paper in the context of recent work, p.17780, line 7:
"A recent study of the radiative forcing of dust as a function of mineralogical composition that does not include the spatially explicit variability of minerals estimated a TOA forcing between -0.03 and -0.25 Wm^{-2} from mineral dust with an internal mixture of 1.5% hematite by volume (Balkanski et al., 2007). Both CAM4 and CAM5 cases with tuned dust (0.4% inclusion of hematite by volume) fall within the reported range."