The authors greatly appreciate the constructive comments from Prof. Yves Balkanski. The reviewer pointed out that this paper could have come to even more robust conclusions with some more works. The reviewer maintains that this paper is interesting and deserve after a few improvements and corrections.

We carefully revised our manuscript in a number of locations in response to the reviewer's comments. The specifics are listed below.

This manuscript presents the importance that iron-oxides have to determine optical properties of dust. It shows how small variations of these oxides translate into large variations of the absorbing properties of dust. The authors provide a good review of the refractive indices of hematite and goethite, they then try to infer from measurements of total iron and or free-iron the range of hematite and possibly of goethite. From a proposed size distribution of dust, they study different mixing rules to document how optical parameters vary as a function of wavelength. Interestingly they show how these mixtures compare with the optical properties of pure illite as a proxy of dust without any iron-oxide. In itself, the paper is interesting and deserve after a few improvements that I propose below before being published.

1) **The authors claim that goethite has not been quantified in dust. They oversaw a reference that they cite that just did that, the mineralogical database of Journet et al. (2014) provide a quantification of hematite and goethite in soils and also as these minerals are transported in the atmosphere. The authors could have more relied on that work to narrow down the range of iron-oxides that they study (they use 0%, 2.5%, 5.0% and 7.5% by mass as study cases).**

Hematite and goethite is the major iron-minerals in airborne dust. By the regular filter sampling method, dust aerosol with the microgram mass on the filter is obtained. However, till now, the abundance of goethite in dust on filters is hard to be quantified by the laboratory analysis, such as PIXE, ICP, SEM-EDX. With the analysis of DRS, the ratio of goethite/hematite could be detected. More recently, XANES and extended X-ray absorption fine structure (EXAFS) were also used to study the specific mineral phases of iron oxides in dust, but these technologies could also not fix the abundance of goethite. Fortunately, Journet et al. (2014) provide a quantification of hematite and goethite in soils, this database could be used in dust models. The content variations during the dust emission and transport progresses are still unknown, but the study of Journet et al. (2014) could be cited as the upper limit for hematite and goethite in our study.

Journet et al. (2014) reported that the total elemental iron content of the clay fraction ranges between 0 and 15 % (in their Figure 7a), which is consistent with our summary for total iron. Thus, we cited this study in paragraph 1 line 13 of Page 5632.

In paragraph 1 line 8-10 of page 5623, we revised "hematite" as "hematite and goethite".

As Journet et al. (2014) reported that the hematite content in the clay fraction is usually < 1.5 % but reaches 5% in some regions, and even more than 5% in southern Brazil/northern Argentina. Goethite occurs in both the clay- and silt-sized fractions and the content ranges from 0 to 15%. Actually, this modeling has underestimated the optical effects of goethite. However, the limited and discontinuous refractive indices of goethite have constrained the evaluation of the effects of specific compositions of goethite and hematite to dust optical properties and solar balance. Thus, we only set different abundance (0%, 2.5%, 5.0% and 7.5%) for hematite in the sensitive modeling. In order to further illustrate this question, we add “Due to the limited and discontinuous refractive indices of goethite, this setting may underestimate the actual optical effects of goethite in dust aerosol.” to the end of line 16 in page 5635.

2) **A thorough review of the single scattering albedo (SSA) measured for dust during campaigns or inferred from AERONET measurements would have helped the authors show that having more that 5% of iron-oxides by mass could hardly be reconciled with the SSA measured for dust in the absence of black carbon (BC).**

We agree to the reviewer. A very good advice for this paper, we carefully reviewed on the reported SSAs during campaigns or inferred from AERONET measurements and satellite retrieves, and list them on Figure 4b. The measured results for dust mixed with BC were excluded during our review progress, such as the results from the campaign of AMMA. More detailed data were listed in Table 4 of our revised manuscript.

3) **The choice of the size distribution for dust particle size with an r0 of 0.5 and 0.7 μm and a σ of 2.0 is not well justified. Observations of dust size distribution can only be represented by at least 3 modes or more (see Osborne et al., 2008) and the authors would be better off considering several modes to infer dust properties.**

We thank the reviewer for pointing out that the need for further considering several modes to infer dust optical properties. We are agreeing to the presence of 3 modes or more modes for dust size distribution. In this study, we just want to fix the optical effects of iron oxides in dust aerosol, and thus we want to weaken the effects of size distribution. With reference to the OPAC, We simply choose one mode of dust to calculate the optical properties. Although this choose may be ideal with compare to the field observations and recent knowledge on size distribution of dust (Osborne et al., 2008; Mahowald et al., 2014). More recently, a modified size distribution with only one mode following brittle fragmentation theory had been published by Kok et al. (2011), but we are not agree to this theory and we are agree to the old multi-modes for dust size distribution. More detailed formula proving, please see http://editor.copernicus.org/index.php?_mdl=msover_md&_jrl=10&_lcm=oc108lcm109w&_acm=get_comm_sup_file&_ms=28358&c=85559&salt=1619220327230502394. Although previous studies on mineral dust size distributions have often attributed three to five lognormal modes, the median radii, magnitudes and standard deviations of the modes vary from study to study owing to the time-varying nature of dust particles and the source regions. In a word, one mode size distribution was chosen to simplified calculation, to compare with Sokolik et al (1999) and to help better understanding for different readers.

With considering the advices of (2) and (3), we reviewed the reported values by several dust campaigns and AERONET observations, and then compared them with the calculated SSA curve in Figure 4b. It is shown that the SSAs were mostly ranged in 0.95-0.99 from the observation during different campaigns, but much lower (0.944-0.95) for the AERONET which cannot exclude the presence of black carbon with higher absorbing. Our calculated result could consistent with the higher part (0.97-0.99) of measured SSAs, but higher than the lower part (0.95-0.97) due to the effect of coarse particles during different dust campaigns. It is hard to compare the calculated the SSAs with measured values by considering the varied median radii, magnitudes and standard deviations of the modes, and even illustrated them in the same figure.

Mahowald N, Albani S, Kok J F, et al. The size distribution of desert dust aerosols and its impact on the Earth system[J]. Aeolian Research, 2014, 15: 53-71.

Kok J F. A scaling theory for the size distribution of emitted dust aerosols suggests climate models underestimate the size of the global dust cycle[J]. Proceedings of the National Academy of Sciences, 2011, 108(3): 1016-1021.

Minor Points:

In the abstract you mention the 'climate forcing' of dust, strictly speaking it is better to refer to it as a climate perturbation as the majority of the dust in the column is from natural sources.

We have corrected the 'climate forcing' as 'climate perturbation' in the abstract.

Page 3, lines 18 to 20: you could explain better that the radiative perturbation of dust has a positive of negative sign depending mostly on: underlying surface albedo, particle size distribution and mineralogy (see Liao and Seinfeld, 1999 and Claquin et al., 1998).

We have revised as ' However, these effects can lead to either positive or negative net radiative perturbation depending mostly on the underlying surface albedo, vertical profile (optical depth and height of dust layer), particle size distribution and mineralogy (Liao and Seinfeld, 1998; Calquin et al., 1999).'

Claquin T, Schulz M, Balkanski Y J. Modeling the mineralogy of atmospheric dust sources[J]. Journal of Geophysical Research: Atmospheres (1984–2012), 1999, 104(D18): 22243-22256.

Liao H, Seinfeld J H. Radiative forcing by mineral dust aerosols: sensitivity to key variables[J]. Journal of Geophysical Research: Atmospheres (1984–2012), 1998, 103(D24): 31637-31645.

Page 5, line 10: contrary to what is stated, Journet et al. (2014) provide the goethite fraction (in mass) globally and by regions for both the clay and silt fraction of dust.

We have corrected as 'More recently hematite and goethite has been taken into account interactively in global climate simulations due to the availability of global mineralogical distribution maps (Nickovic et al., 2012; Journet et al., 2014).’.

Page 9, line 4: The reference LG1985 is not defined in the text and I could not find it in the reference list.

We are sorry for error writing the “QE1985” as “LG1985”, and have corrected it as “QE1985”in the manuscript.

Page 16 lines 20-24 state: ‘’ Based on the above reported results, we conclude that the iron-oxides account for approximately half of the mass of elemental Fe and for between 2 and 5% of the dust mass. Most of them are composed of goethite, representing between 50 and 75% of the iron oxide mass.” How do you then justify the choice of your 4 cases : 0, 2.5, 5.0 and 7.5% hematite lines 14-17 page 17. Please indicate very clearly whether these fracions refer to mass fractions or volume fractions (since when you work with optical parameters you consider volume).

The abundance of hematite was used to calculate the effective complex refractive indices for dust by the volume mixing method, the Bruggeman approximation and the Maxwell–Garnett approximation. For the volume mixing method, the simplest way to sum up the refractive indices of its individual constituents weighted by their volume (or mass). The volume fractions of hematite that converted from mass fractions with using the density of hematite (5.3 g/cm3) and illite (2.75 g/cm3) (Moosmüller et al., 2012). Then the volume fractions of hematite were used in above three methods.

In order to very clearly indicate this question, we have added “Using the density of hematite (5.3 g/cm3) and illite (2.75 g/cm3), volumetric hematite fraction was converted from the mass hematite fraction to calculated the effective complex refractive indices for dust.” to the end of line 17 of page 5635. The 4 cases were also further explained as 0, 2.5, 5.0 and 7.5% hematite in mass in lines 14-17 of page 5635.

Page 19 lines 14 to 17. ‘’ This is explained by Fig. 4b where the two datasets have the same optical scattering and absorbing properties for λ < 0.55 μm but the dataset of QE1985 leads to higher optical absorption for λ > 0.55 μm.”. Check the Figure you refer to, I could not reach your conclusion by looking at Figure 4b.

We have rechecked the figure and make sure that we refer to Figure 4b. In order to check the spectral difference of SSA between QE1985 and LG1988 and simple to read figure 4b, we only drawn the dashed purple line for LG1988_7.5% with compare the solid pink line for QE1985_7.5%. Similar spectral features of other abundances for hematite and were omitted in Figure 4b. With the comparison between the dashed purple line and the solid pink line, we got that “the two datasets have the same optical scattering and absorbing properties for λ < 0.55 μm but the dataset of QE1985 leads to higher optical absorption for λ > 0.55 μm”.

Page 21 line 27. The sentence that starts with ‘Therefore, the employment of

refractive indices. . .' is akward, replace it with 'Therefore, the use of refractive indices. . .'
We have revised it.

Pages 21 and 22 have been hastily written, try to improve the text for these 2 pages.
We have extensively improved the text from 5639-5640.

The conclusions might need some work to extract better your main findings.
We have reorganized the conclusions in the revised manuscript.