Response to reviewer#1

Thanks for the reviewer's helpful suggestions! The comments are addressed point-by-point and responses are listed below.

Comment: General comments: Uncertainty of aerosol optical properties causes further uncertainties in climate prediction in model simulations, in which the real part of the refractive index is important. Thus, determining the aerosol real part of refractive index (RRI) is an important issue.

Reply: We thank the anonymous reviewer's comments.

Comment: The manuscript entitled "A new parameterization scheme of the real part of the ambient aerosols refractive index" studied the RRI by field measurement in East China. The title is "A new parameterization scheme of the real part of : : :.", however, as I understood, the parameter scheme is just established by the measurements of the system reported by Zhao et al., (2018b). Moreover, the universality of this parameterization scheme at other location is unknown.

Reply: Thanks for the comment. The objective of this article is to bring up a novel idea of parameterization scheme of real part of the refractive index (RRI) for ambient aerosol. Traditionally, RRI is parameterized by the measurement of ambient aerosol main inorganic components (Han et al., 2009). The influence of organic compositions is ignored. In this work, we found that the ambient aerosol RRI was highly related with the aerosol effective density (ρ_{eff}) rather than the chemical components. Thus, a new parameterization scheme of the RRI using the effective density was proposed.

To validate the universality of this parameterization scheme, we conducted another measurement in the campus of Peking University (PKU) (N39°59′, E116°18′), in China, where the aerosol effective density and real part of the refractive index are measured concurrently at 16th, December in 2018. The RRI were also calculated using the parameterization scheme, $\frac{\mathrm{RRI}^2-1}{\mathrm{RRI}^2+2} = 0.18\rho_{eff}$. Comparison of the measured and calculated RRI is shown in fig. R1. Results show that the calculated and measured RRI agree well.

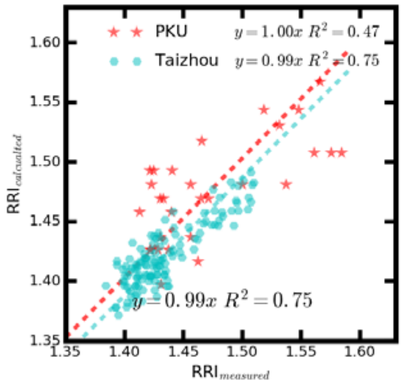

Fig. R1. Comparison between the measured and calculated RRI at PKU and Taizhou.

Comment: Also, the figures and descriptions need be reorganized carefully. Therefore, although this paper focused on the interesting question, it needs further analysis, reorganization, discussion and clarification to improve the confidence of the results.

Reply: We thank the anonymous reviewer's comments and suggestions. We have replotted some figures (1, 2, 5 and 6). We also made some revisions at the introduction and discussion sections in the text.

Comment: Specific comments: 1. Line 26, "reginal" should be "regional".

Reply: Thanks for the comment and we revised it.

Comment: 2. The logics and description of Section "Introduction" are insufficient.

Reply: Thanks for the comment. We have rewritten the introduction and added some descriptions about our work.

Comment: 3. I suggest the authors combine some figures, for example, Figure 1, of the supplement into the main of manuscript.

Reply: Thanks for the comment. Fig. 1 is replotted.

Comment: 4. Line 153-155, the description of variables in equation (5) is confused.

Reply: Thanks for the comment. We added some descriptions in the text. DARF at the TOA is defined as the difference between radiative flux under aerosol-free conditions and aerosol present conditions:

$$\mathrm{DARF} = (\mathrm{f_a} \downarrow - \mathrm{f_a} \uparrow) - (\mathrm{f_n} \downarrow - \mathrm{f_n} \uparrow) \quad (5),$$

where $\mathrm{f_a} \downarrow$ and $\mathrm{f_a} \uparrow$ are the downward and upward radiative irradiance with aerosol present conditions respectively; the difference between $\mathrm{f_a} \downarrow$ and $\mathrm{f_a} \uparrow$

$(f_a\downarrow - f_a\uparrow)$ is the downward radiative irradiance flux with aerosol present conditions; $f_n\downarrow$ and $f_n\uparrow$ correspond to the downward and upward radiative irradiance values under aerosol free conditions respectively; the difference between $f_n\downarrow$ and $f_n\uparrow$ $(f_n\downarrow - f_n\uparrow)$ is the downward radiative irradiance flux for aerosol-free conditions (Kuang et al., 2016).

Comment: 5. Line 152 and Line 234, all of two equations are denoted as (5).
Reply: Thanks for the comment. We have changed the labels for equations.

Comment: 6. Why not use the vertical profiles of temperature, pressure and water vapor at the times corresponding to the aerosol measurements?
Reply: Thanks for the comment. When estimating the aerosol DARF using the SBDART model, the profiles of temperature, pressure, water vapor and the aerosol vertical profiles are necessary. DARF would be different for different vertical profiles of temperature, pressure and water vapor. In this study, we focus on the influence of aerosol RRI variation on the variations in DARF. The profiles of aerosol temperature, pressure, water vapor should be hold constant. Therefore, we use the mean result of the measured radiosonde profile during the field.

Comment: 7. Line 234, what is the meaning of in Equation (5)?
Reply: Thanks for the comment. We have changed the equation into $\mathrm{RRI} = \sqrt{\frac{1+0.36\rho_{eff}}{1-0.18\rho_{eff}}}$, which means that the specific refractive index Re is directly related to aerosol density.

Comment: 8. Can this method be used at other location and other time?
Reply: Thanks for the comment. We have conducted another measurement in Beijing (N39°59′, E116°18′), China, where the aerosol effective density and real part of the refractive index are measured concurrently at 16th, December in 2018. The relationships of the effective density and real part of refractive index are shown in fig. R1. From fig. R1, the results in Beijing agree well with that of Taizhou.

Comment: 9. Why do the authors compare a result with other at different time series and measurement site? So, a reliable result should be induced here to evaluate this study.
Reply: Thanks for the comment. We compare the result with that of Liu and Daum (2008) to demonstrate that their parameterization scheme proposed is not applicable in China. The study of Liu and Daum (2008) is currently the only work that have tried to bridge the effective density and real part of refractive index. The effective density and RRI in their work were estimated using the aerosol chemical components but not the in-situ measurements of effective density and RRI. At the same time, the influence of organic aerosols components on aerosol RRI is not considered in their work.

Comment: 10. In Section 3.1, what's the relation among the wind speed, T and RH with the scattering coefficient and mBC? Which should be reflected in descriptions. Otherwise, the results of meteorology measurements are meaningless.

Reply: Thanks for the comment. The corresponding contents were removed from the text.

Han, Y., Lü, D., Rao, R., Wang, Y. (2009) Determination of the complex refractive indices of aerosol from aerodynamic particle size spectrometer and integrating nephelometer measurements. Applied Optics 48, 4108-4117.

Kuang, Y., Zhao, C.S., Tao, J.C., Bian, Y.X., Ma, N. (2016) Impact of aerosol hygroscopic growth on the direct aerosol radiative effect in summer on North China Plain. Atmospheric Environment 147, 224-233.

Liu, Y., Daum, P.H. (2008) Relationship of refractive index to mass density and self-consistency of mixing rules for multicomponent mixtures like ambient aerosols. Journal of Aerosol Science 39, 974-986.