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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The impact of aerosol hygroscopic growth on the single-scattering albedo and its application on the NO_2 photolysis rate coefficient" *by* J. C. Tao et al.

Anonymous Referee #1

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General comments: This paper focuses on the influence of relative humidity (RH) on single-scattering albedo (SSA) and its implication for atmospheric photolysis. Observational data from the Wuqing and Tieta sites in the North China Plain (NCP) are analyzed in detail. Aerosol optical properties, such as scattering, absorption and single-scattering albedo (SSA), are calculated using a Mie-theory model from number size distribution and hygroscopic growth factor measured at Wuqing during the 2009 HaChi campaign. It is found that the SSA of the NCP aerosol population is highly sensitive to RH, mainly due to the positive dependence of aerosol scattering on RH. UVB irradiance is calculated using the NCAR TUV model for different conditions. Comparison

of the calculated UVB data with those observed at the Tieta site in 2010 reveals the impact of aerosol hygroscopic growth on UVB irradiance. Furthermore, the profiles of the photolysis rate of NO2 are calculated for different optical depth and SSA, showing negative impact of aerosol hygroscopic growth on the photolysis of NO2 at the ground level and positive impact above about 1 km.

The impact of aerosol hygroscopic growth on the optical properties including SAA is not a new topic. So is the impact of aerosol optical properties on the photolysis rate of NO2. This paper presents an in-depth study of the impact of RH on SSA of aerosol over the NCP and shows that such RH impact has an important implication for atmospheric photochemistry. The authors have used sound methods and acceptable assumptions in this paper, and properly cited the related literature. I think the results of this paper are of interest for climate forcing assessment and photochemical studies. In general, the paper is well structured and written. I have a few points and found many technical errors. I recommend publication of this paper in ACP after minor revisions.

Specific comments:

1. Since there have been a number of publications reporting more or less the impact of hygroscopic growth on aerosol optical properties and actinic flux, the authors should state clearer the differences of their study from the previous ones and major foundings of this study.

2. For atmospheric photochemistry, the photolysis rates of O3, HONO, HCHO, etc., are important as well. Using the TUV model and the data they already have, the authors may easily obtain impacts of aerosol hygroscopic growth on these photolysis rates, which are important in photochemical simulations.

3. The simulated UVB values are based on the conditions during the 2009 summer campaign at the Wuqing site, while the observed UVB values are from the 2010 summer campaign at the Tieta site. Is there any problem in direct comparison of both? This should be discussed.

4. JNO2 should be calculated using optical property data in the wavelength between 290 nm and 420 nm, while UVB represents UV radiation in the range of 280-315 nm. Therefore, it is not correct to say “JNO2 is determined by the UVB irradiances. . .” (Page 16368, lines 25-26).

5. Page 16353, line 16: “Aerosol absorption slightly varies with RH, and is often considered to be constant”. Aerosol absorption can be considered to be independent of RH but cannot be considered to be constant.

Technical errors and suggestions:

6. Page 16353, line 10: “varies at different RHs”. Do you mean “varies with RH”?

7. Page 16354, line 5: change “RHs is” to “RH is”.

8. Page 16354, line 9: change “suffers a series of severe aerosol pollutions” to “suffers severe aerosol pollution”.

9. Page 16354, line 22: “is still uncovered”?

10. Page 16356, line 25: dependence of . . . on what?

11. Page 16358, lines 13-14: Do you mean “assumed to be independent of RH”?

12. Page 16359, line 9: what does f stand for?

13. Page 16359, lines 13-15: make sure that “Eq. (7)” and “Eq. (6)” are correct.

14. Page 16359, line 22, change “uptakes water” to “takes up water”.

15. Page 16360, lines 8, 11, and some other places: “solution”? Do you mean “solute”? A water solution includes water and solute.

16. Page 16361, line 5: there is no sigma(ap) in Eq. (11).

17. Page 16361, line 6: “Eq.(13)”?

18. Page 16361, line 8: delete “comes”

19. Page 16361, line 10: cite a reference here.

20. Page 16362, lines 7-19: add a figure to facilitate the explanation or combine this paragraph with paragraph 1 of section 3.2.

21. Page 16363, line 13: change “RHs” to “RH”.

22. Page 16363, line 23: give explanation to AVG-PRM.

23. Page 16363, line 27: delete “can”.

24. Page 16364, line 2: “at ambience”? What do you mean?

25. Page 16367, line 24: “untaken”?

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 16351, 2014.