Response to Referee #1 (acpd-14-C4784-2014):

General comment:

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 singlescattering 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.*

Response: Thanks for the suggestion. We have revised it accordingly in the abstract and the summary.

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.*

Response: We agree with the referee that there are many important photolysis reactions in troposphere, such as NO_2, ozone, HONO, etc. Among these reactions, the photolysis of NO_2 accounts for most of the ozone, and is the most important and representative (Dickerson et al., 1997;Seinfeld and Pandis, 2006;Palancar et al., 2013). This is why we use J_{NO2} to evaluate the influence of aerosol radiative effect on ozone photochemistry.

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.*

Response: Thanks for the comment. Previous studies reveal that the aerosol measurement in Wuqing site is found to be representative in the NCP (Ma et al., 2011;Liu et al., 2011;Xu et al., 2011;Ran et al., 2011). It's proper for the intercomparison between the two sites. More description on this issue has been added in the introduction.

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).*

Response: Thanks for the suggestion. We have revised it as "J_{NO2} *depends on the UV irradiances and thus affected by aerosol optical properties.*"

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.*

Response: Thanks for the suggestion. We have changed it to "*Aerosol absorption slightly varies with RH*".

Technical errors and suggestions:

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

Response: Thanks for the suggestion. Yes, we have revised it.

7. *Page 16354, line 5: change "RHs is" to "RH is".*

Response: Thanks for the suggestion. We have revised it.

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

Response: Thanks for the suggestion. We have revised it accordingly.

9. *Page 16354, line 22: "is still uncovered"?*

Response: Thanks for the suggestion. We changed *"uncovered"* to *"unresolved"*.

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

Response: Thanks for the suggestion. We have revised as *"The RH dependence …"*

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

Response: Thanks for the suggestion. We have revised it accordingly.

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

Response: Thanks for the suggestion. It should be *"g"* and we have revised it.

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

Response: Thanks for the suggestion. We have checked it.

14. *Page 16359, line 22, change "uptakes water" to "takes up water".*

Response: Thanks for the suggestion. We have revised it.

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

Response: Thanks for the suggestion. Yes, it should be *"solute"*. We have revised it.

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

Response: Thanks for the suggestion. We have added the equation of σ_{ap}.

17. *Page 16361, line 6: "Eq.(13)"?*

Response: Thanks for the suggestion. It should be *"Eq.11 and Eq.12"*. We have revised it.

18. *Page 16361, line 8: delete "comes".*

Response: Thanks for the suggestion. We have revised it.

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

Response: Thanks for the suggestion. We have added the reference.

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

Response: Thanks for the suggestion. We have combined and adjusted these two parts.

21. *Page 16363, line 13: change "RHs" to "RH".*

Response: Thanks for the suggestion. We have revised it.

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

Response: Thanks for the suggestion. We have added the explanation.

23. *Page 16363, line 27: delete "can".*

Response: Thanks for the suggestion. We have revised it.

24. *Page 16364, line 2: "at ambience"? What do you mean?*

Response: Thanks for the suggestion. We have changed "ω at ambience" to "ambient ω".

25. *Page 16367, line 24: "untaken"?*

Response: Thanks for the suggestion. It should be *"taken up"* and we have revised it.

Reference:

Dickerson, R. R., Kondragunta, S., Stenchikov, G., Civerolo, K. L., Doddridge, B. G., and Holben, B. N.: The impact of aerosols on solar ultraviolet radiation and photochemical smog, Science, 278, 827-830, 10.1126/science.278.5339.827, 1997.

Liu, P., Zhao, C., Göbel, T., Hallbauer, E., Nowak, A., Ran, L., Xu, W., Deng, Z., Ma, N., and Mildenberger, K.: Hygroscopic properties of aerosol particles at high relative humidity and their diurnal variations in the North China Plain, Atmos. Chem. Phys, 11, 3479-3494, 2011.

Ma, N., Zhao, C., Nowak, A., Müller, T., Pfeifer, S., Cheng, Y., Deng, Z., Liu, P., Xu, W., and Ran, L.: Aerosol optical properties in the North China Plain during HaChi campaign: an in-situ optical closure study, Atmos. Chem. Phys, 11, 5959-5973, 2011.

Palancar, G. G., Lefer, B. L., Hall, S. R., Shaw, W. J., Corr, C. A., Herndon, S. C., Slusser, J. R., and Madronich, S.: Effect of aerosols and NO2 concentration on ultraviolet actinic flux near Mexico City during MILAGRO: measurements and model calculations, Atmospheric Chemistry and Physics, 13, 1011-1022, 10.5194/acp-13-1011-2013, 2013.

Ran, L., Zhao, C., Xu, W., Lu, X., Han, M., Lin, W., Yan, P., Xu, X., Deng, Z., and Ma, N.: VOC reactivity and its effect on ozone production during the HaChi summer campaign, Atmospheric Chemistry and Physics, 11, 4657-4667, 2011.

Seinfeld, J. H., and Pandis, S. N.: Atmospheric chemistry and physics: from air pollution to climate change, John Wiley & Sons, 2006.

Xu, W. Y., Zhao, C. S., Ran, L., Deng, Z. Z., Liu, P. F., Ma, N., Lin, W. L., Xu, X. B., Yan, P., He, X., Yu, J., Liang, W. D., and Chen, L. L.: Characteristics of pollutants and their correlation to meteorological conditions at a suburban site in the North China Plain, Atmospheric Chemistry and Physics, 11, 4353-4369, 10.5194/acp-11-4353-2011, 2011.