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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol Properties and Their Influences on Low Warm Clouds during the Two-Column Aerosol Project" *by* Jianjun Liu and Zhanqing Li

Anonymous Referee #2

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Liu and Li "Aerosol Properties and Their Influences on Low Warm Clouds during the Two-Column Aerosol Project"

Based on field experiement observations from Two-Column Aerosol Project field campaign over Cape Cod, Massachusetts, this study investigates the aerosol properties and their impacts on the cloud development. Aerosol first indirect effect (FIE) is quantified and its sensitivities to aerosol compositions are examined. While there are a lot of FIE quantification studies, the uncertainties related to aerosol first indirect effect are still large and theoretical understandings are still needed. The findings of this study could help advance our knowledge in the field of aerosol-cloud interaction. Thus, I

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Discussion paper

would recommend its acceptance for publication after a minor revision.

Page 1. Line 26-29, please modify the sentence to correct the grammar. Page 1, Line 30, either “a stable condition” or “stable conditions” Page 2. line 2, you may remove “with increasing LWP” Page 2, Line 3-5, grammar error for “can significantly made”, also “narrowed” Page 2, Line 15-28, many references should be cited here. For example, the aerosol direct effect (Yang et al. 2016, 2018; doi:10.1002/2016JD024938, doi: 10.1016/j.atmosres.2018.04.029), the aerosol indirect effect (Feingold et al., 2003; Garrett et al., 2004; Zhao et al., 2018, 2019), lifetime effect (Albrecht 1989), thermal emissivity effect (Zhao and Garrett, 2006; Garrett and Zhao, 2015); semi-direct effect (Koren et al.). Feingold, et al., First measurements of the Twomey indirect effect using ground-based remote sensors, Geophys. Res. Lett., 30(6), 1287, doi:10.1029/2002GL016633, 2003. Garrett, et al., 2004: Effects of varying aerosol regimes on low-level Arctic stratus. Geophys. Res. Lett., 31, L17105. Zhao, et al. (2018). Negative Aerosol-Cloud re Relationship from Aircraft Observations over Hebei, China. Earth and Space Science, 5, 19-29. Zhao, et al. (2019), A case study of stratus cloud properties using in situ aircraft observations over Huanghua, China, Atmosphere, 10, 19. Albrecht, B.A., 1989: Aerosols, cloud microphysics, and fractional cloudiness, Science, 245(4923), 1227-1230. Garrett, T. J. and C. Zhao, 2006: Increased Arctic cloud longwave emissivity associated with pollution from mid-latitudes. Nature, 440, nature04636, 787-789. Zhao, C., and T. Garrett, 2015:ÂăEffects of Arctic haze on surface cloud radiative forcing,ÂăGeophys. Res. Lett.,Âă42, 557-564, doi:10.1002/2014GL062015. Page 2, Line 32, for surface remote sensing, Garrett et al. (2004) and Qiu et al. (2017, 8-Year ground-based observational analysis about the seasonal variation of the aerosol-cloud droplet effective radius relationship at SGP site) should be cited. Page 3, Line 2, for aircraft measurement-based studies, Yang et al. (2019, Toward understanding the process-level impacts of aerosols on microphysical properties of shallow cumulus cloud using aircraft observations) and Zhao et al. (2018, 2019) should be cited, which are for North China region. Page 3. Line 17-20, The effect is also dependent on the availability of water vapor, or the amount of water vapor,

and meteorology (such as vertical velocity), as indicated by Qiu et al. (2017) and Yang et al. (2019). Page 3, Line 22-23, Garrett et al. (2004) also examined the sensitivity of FIE to aerosol size and number, which shows weak sensitivity of FIE to aerosol number concentration for those small sizes, but good sensitivity for aerosols with relatively large size (such as CCN or accumulation mode aerosol). Page 4. Line 13-14, What is the maximum size for Na? You might also give this information. Page 5 Line 10-21, The uncertainty information for cloud boundaries should be provided. As indicated by Zhao et al. (2012, Toward Understanding of Differences in Current Cloud Retrievals of ARM Ground-based Measurements) and Zhao et al. (2013, Ground-based remote sensing of thin clouds in the Arctic), the uncertainties in cloud bases and tops measured by ARM are generally 7.5 m and 45 m, respectively. Page 5. Line 28, "density of liquid water", and COD is cloud optical depth at visible wavelength. Page 8, Line 12-15, please check and correct the grammar here. Page 10, Line 1-5, Other studies as mentioned earlier have also indicated this likely evaporation and entrainment effect near cloud tops, which could be cited. Page 10, Line 7, "can possible" -> "can be possible" Page 10, Line 10-14, Yang et al. (2019), Zhao et al. (2018, 2019) have also made similar descriptions. Page 12, Line 20-21, Zhao et al. (2012) have indicated that using different aerosol variables to represent the aerosol loading amount, the quantified FIE values could vary, which is worthy to be mentioned here. Page 13, Line 11, also Zhao et al. (2012); Lin 12-13, Yang et al. (2019) too. Page 13, Line 24, I would suggest "the question how sensitive the cloud properties are sensitive to ..." Page 13, Line 26, what is the size range for the aerosol concentration? Page 14, Line 13, "larger"?

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