

## ***Interactive comment on* “Subgrid-scale variability of clear-sky relative humidity and forcing by aerosol-radiation interactions in an atmosphere model” by Paul Petersik et al.**

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Received and published: 20 November 2017

This study introduces stochastic sampling of the PDF of humidity to examine subgrid humidification effects on aerosol radiative forcing. Although this represents an advance over previous estimates of aerosol radiative forcing, important details that could substantially influence the results are missing in the description of the treatment. I cannot recommend publication until these details are provided, and only then if the clarified treatment does not substantially bias the results.

1. Page 3, lines 23-28. How is the hygroscopicity of each mode determined from the hygroscopicity of each component in the modes?

2. Section 2.3 a. How is humidification effect on extinction treated? Extinction is not a simple function of particle radius. See, for example, the method of Ghan and Zaveri (2007). The treatment must be described and justified. b. Does the model treat absorption enhancement by humidification? Some people (Jacobson) think this is quite important. c. Why use the clear-sky value? This biases the estimate of ERF<sub>air</sub>. Why not include a diagnostic no-aerosol radiation calculation and diagnose ERF<sub>air</sub> following Ghan (2013)?

3. Page 7, last paragraph. Your argument about scattering vs absorption would be stronger if you compare the impact on AOD with the impact on AAOD. It is likely that the sensitivity of ERF<sub>air</sub> is biased by your treatment of humidification effects on absorption and by neglecting contributions from cloudy sky.

#### References

Ghan, S. J., and R. A. Zaveri, 2007: Parameterization of optical properties for hydrated internally-mixed aerosol. *J. Geophys. Res.*, 112, D10201, doi:10.1029/2006JD007927.

Ghan, S. J., 2013: Technical note: Estimating aerosol effects on cloud radiative forcing. *Atmos. Chem Phys.*, 13, 9971–9974, doi:10.5194/acp-13-9971-2013.

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Interactive comment on *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2017-839>, 2017.

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