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Interactive comment on “Importance of aerosols for annual lightning production at global scale” by S. Venevsky

Anonymous Referee #1

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The maritime-continental contrast in lightning has been a source of discussion for many years. Two main factors are usually applied: lapse rates and aerosols, both of which tend to be higher over sufficiently large land masses. A critical flaw in the paper is that although aerosols have effects on cloud microphysics (and on radiative forcing) and therefore on electrification, aerosols by themselves do not produce deep convection. Thermodynamic instability is a necessary condition for deep storms and lightning. The correlation between aerosols and lightning comes through the correlation of aerosols to large land masses and thus to instability. Aerosols only have a modulation effect, and if that could be captured in a simple model it would be much more interesting. As it is, the paper develops a correlation between aerosol optical depth and lightning, which happens to capture the thermodynamic contrast between continental and mar-

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itime conditions, but no new real physical insight is presented.

I don't think there is much question now that aerosols can play a role in affecting thunderstorm electrification via the effects on the cloud microphysics. Those effects are likely to vary substantially from case to case, however, so the extrapolation of simulations using a single environment (Mansell and Ziegler, 2013) to the whole globe is difficult to justify. The effects are subject to factors such as wind shear, so invigoration may or may not happen. So aerosols can modulate convection, but the modulation is not necessarily monotonic. You can have whatever aerosols you want, but without the thermodynamic instability there will be no convection and no lightning. Figure 1 of Alaratz et al. (2010) shows a rather selective analysis area that excludes many higher flash densities at low AOD.

One effect of aerosols at high concentration is ignored, and that is the cooling (and stabilization) of the boundary layer by the backscattering of radiation. This weakens convection by reducing instability, and would be difficult to separate from reduced precipitation from the microphysical effect of smaller droplets.

Figure 4 suggests a substantial high bias in the AH model for low flash rates over oceans. Although the African continent looks better by eye than the thermodynamic model, it seems to do less well in South America (too low) and has a poor pattern in North America, basically missing the high flash rates in central and southeastern United States. Central Europe and Asia also show high bias. (The Thermo model has a high bias in Asia, as well.) Just looking at the figure, the Thermo model has a much better map of overall coverage of lightning.

Table 3 is not explained at all. The p values in the tables are mostly ridiculously small, so why bother?

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 4303, 2014.

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