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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modelled and observed changes in aerosols and surface solar radiation over Europe between 1960 and 2009" *by* S. T. Turnock et al.

Anonymous Referee #2

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Turnock et al. present an assessment of surface solar radiation (SSR) trends in Europe through combined analysis of observations of aerosol concentrations, SSR, aerosol optical depth (AOD), and chemistry-climate model simulations. The model is found to be in poor agreement with absolute aerosol concentrations, but well reproduces observed trends. Similar to previous studies, the authors find good agreement with "brightening" trends, but cannot match the magnitude of the "dimming" trend. The authors do a good job tying their results into policy relevance. The manuscript is well-written and I recommend it for publication upon review of the following general and specific comments.

General Comments

- Discussion of the model evaluation is good, but could be presented more clearly. Comparison of modeled and observed 1978-2009 averages is a challenging task. Potentially significant details are lost in such a long-term average contains significant emission decreases. For example, according Figure 5, summer sulfate is underestimated early in the record is overestimated (quite significantly) before coming into closer agreement near the end of the record. Such details are likely lost in Figure 6, which very clearly depicts spatial biases, but how have those biases changed throughout the time period? This is important when assessing trends and impacts on SSR.

- The importance of seasonality needs to be further discussed, including in SSR. Differing errors in the sulfate simulation exist summer and winter. This is important when considering differing insolation and hygroscopic growth that impact AOD and forcing.

- The potential role of nitrate needs to be further highlighted. Nitrate likely plays an important role, particularly in winter, and might be able to resolve some of the issues mentioned in the manuscript, but also may exacerbate other problems in simulating AOD/SSR.

- In general, the figures in this manuscript are well done. However, many are tightly cramped into the ACPD structure. Please ensure that the figures are of adequate size to best display their fine detail.

Specific Comments

Page 13464, Lines 12-13 – The meteorology is as close as the model can simulate, but not necessarily a match. This should be clarified.

Page 13456, Lines 6-7 – This is potentially an important omission, particularly in northwestern continental Europe. Later in the manuscript the implications of this omission should be detailed.

Page 13466, Lines 1-10 – This is the standard procedure, but in this application it does

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not allow for segregation of the direct and first indirect effect.

Page 13466, Line 14 – "Time-averaged sporadic" is an oxymoron. Can this be rephrased? Shouldn't sporadic eruptions be allowed to occur at the appropriate place/time in the model to best reconstruct their impact?

Page 13466, Lines 20-21 – Are the biogenic emissions not dependent on local meteorological conditions? Is this an acceptable approximation when looking at monthly mean values?

Page 13467, Lines 13-15 – It is unclear what is meant here. Are ammonia emissions entirely omitted or just fixed to a constant value? This is an important detail.

Page 13469, Line 19 – How was the model data interpolated to each measurement site? A description of the method, even if just by name, or a reference is necessary since many model-observation studies simply compare the box average to measurements.

Page 13471, Line 15 – Are the values plotted in Figure 5 5-year averages or a single year?

Page 13471, Line 24 – "slightly" should be omitted.

Page 13472, Line 13-16 – Is wet deposition data available? Can it be added to the suite of observations used to validate the model?

Page 13476 – Is the discussion SSR clear-sky or all-sky? Is data available to evaluate COD?

Page 134678, Lines 3-12 – Can this be used as a critique of the emission inventory?

Page 13481, Line 1-2 – The percentage change is not what matters, but the absolute magnitude.

Page 13501, Figure 3 caption – It is unclear what is meant by "within each particular

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network." I think that phrase can be removed.

Page 13503, Figure 5 – The legend is not clear, particularly the observation (solid) and model (dotted) lines beneath the annual, DJF, and JJA lines. The S.D. estimates could be shown as colored rectangles rather than lines.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 13457, 2015.