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Interactive comment on "Aerosol-climate interactions in the Norwegian Earth System Model – NorESM" *by* A. Kirkevåg et al.

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Thank you very much for your comments and questions concerning the water uptake scheme in the model. I hope you will find the following replies to your questions (repeated below) satisfactory. The full references of the publications referred to but not given below are found in the manuscript.

1. Do you use a similar method as in Liu et al. (2012, link below)?

The method is similar, since it is also based on equilibrium Köhler theory, but the hygroscopic growth factor is allowed to vary with particle radius within each mode to take into account that volume fractions of each of the internally mixed aerosol constituents may vary with size. As explained on Page 2608 of the manuscript, this is not calculated

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online in the model, but is taken into account in the pre-calculated look-up tables for aerosol optical properties as function of relative humidity (and other process specific parameters). The exact form of the Köhler equation that is used, as well as the principle of the method for growth by hygroscopic swelling and how this is used in making the look-up tables are described in Sects. 3.2 – 3.4 of Kirkevåg and Iversen (2002) and Sect. 2.8 of Seland et al. (2008). As also mentioned in Seland et al. (2008), an update concerning OM from an intermediate model version is described in Sect. 2 of Kirkevåg et al. (2005), see http://folk.uio.no/kirkevag/instrep128_Kirkevag-etal.pdf. In the final revised paper we will state this more explicitly in Sect. 2.1 by adding the main references to the sentence in lines 11 to 12, Page 2608: "Hygroscopic swelling is treated as described by Seland et al. (2008), i.e. by use of the Köhler equation on the form of Eq. 13 in Kirkevåg and Iversen (2002)."

2. If so, what are the hygroscopicity values (kappa) you assumed for various species?

As described by Kirkevåg and Iversen (2002), we do not use one hygroscopicity value for each of the species, which otherwise could be listed in the paper, but rather fitted functions of the hygroscopicity, which reproduce the size dependent growth factor values (r/r0) of (mainly) d'Almeida et al. (1991) for each of the species when not internally mixed. (d'Almeida, G. A., Koepke, P., and Shettle, E. P., 1991. Atmospheric aerosols: Global Climatology and Radiative Characteristics. Deepak Publishing, Hampton, Virginia, USA.)

3. What's the maximum RH value (RH ceiling) assumed in the aerosol water uptake calculation?

The RH ceiling in the look-up tables (see point 4 below) for aerosol optical parameters is 99.5%.

4. When calculating the aerosol water uptake, do you use the grid-box mean RH or the clear-sky portion RH value?

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The grid-box mean RH is used. Calculation of clear-sky values of aerosol optics are also based on grid-box mean RH, but weighted with respect to clear-sky conditions, see Sect. 4.2.3. As a follow-up on points 3 and 4, we can include this information in and following the sentence in lines 17-19 on Page 2608: "The process-tagged aerosol mass concentrations and relative humidity (RH) (grid-box mean values) are given as input to the tables. The maximum RH value in the look-up tables for aerosol optical parameters is 99.5%."

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