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Geoscientific Model Development Discussions

Interactive comment on "Two new submodels for the Modular Earth Submodel System (MESSy): New Aerosol Nucleation (NAN) and small ions (IONS) version 1.0" *by* Sebastian Ehrhart et al.

Anonymous Referee #1

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This paper documents the creation of two modules for use for the MESSy system. It does fine for providing this documentation, and my comments are relatively minor.

P2 L4: Merikanto et al. (2007) was not the first. Napari et al. (2002), An improved model for ternary nucleation of sulfuric acid–ammonia–water, The Journal of Chemical Physics 116, 4221 was earlier (and there may be others earlier than this).

P2 L32: what does EMAC stand for?

P4 L2: Confusing. Does 214Bi go to 214Po first?

R1-R5: Do all of the species here need to be advected in the model? Many of the

species lifetimes are shorter than typical advection timescales.

P4 L17: What is IGRF? Citation for where these "first 3 coefficients" come from?

P4 L31. The discussion around Eq 2 largely discusses radius, and the variable is "r_um", so I was surprised to see that it was defined as "diameter". Is it actually diameter or is it radius? If it is diameter, it would be better to have the variable be "d" and the use "diameter" for the rest of the discussion.

P5 L3-10: So is growth of small charged particles to larger sizes where they are then "large ions" a loss of small ions then?

P6 L12: "oni"

Table 1 and Section 3.2.1: If I'm correct, this evaluation of the placement NAN before, within, or after GMXe has to do with operator splitting and master timesteps vs. internal GMXe timesteps. By taking NAN out of GMXe nucleation is called on the master timestep and then other aerosol microphysical processes are called in GMXe for the master timestep. When NAN is in GMXe, I'm guessing it can be called more frequently in some internal GMXe timestep. The balance between condensation and nucleation are quite sensitive to the timestep and order of operations, especially when the timestep is similar to or longer than the condensation sink timescale (and this could explain why the results in Figures 5 and 6 are sensitive to the placement of NAN for some cases by not for most). Am I correct about this? If yes, it would make sense to frame the motivation and discussion of Table 1 and Section 3.2.1 around errors due to timesteps and order of operations. Right now, the paper is fairly cryptic as to why the differences arise ("linearization to non-linear processes", but if my hypothesis is correct, I think the explanation is straightforward.

P11 L18: "For two of the stations". It's 3 stations, right?

P12 L10: "Large uncertainties remain, mainly due to the incomplete nature of the implemented nucleation rate parameterizations." This sounds like the authors are saying

that if we just fixed our nucleation rate parameterizations, most of the model uncertainties in aerosol predictions would go away. However, simulating nucleation perfectly would only marginally improve simulations (e.g., Lee, L. A., Pringle, K. J., Reddington, C. L., Mann, G. W., Stier, P., Spracklen, D. V., Pierce, J. R., and Carslaw, K. S.: The magnitude and causes of uncertainty in global model simulations of cloud condensation nuclei, Atmos. Chem. Phys., 13, 8879-8914, doi:10.5194/acp-13-8879-2013, 2013.), Or am I misinterpreting what the authors are trying to say here?

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