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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Implementing Gas-to-Particle Partitioning of Semi-Volatile Inorganic Compounds in UCLALES-SALSA" *by* Innocent Kudzotsa et al.

Anonymous Referee #1

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General Comments

This paper presents an implementation of the process of dissolution of semi-volatile inorganic gases (HNO3 and NH3) into aerosol/cloud/precipitation within their sectional microphysics model coupled with a large-eddy simulator. Subsequently, investigated are the impacts on aerosol size distribution, cloud droplet numbers and size, and rain rate.

The context of this paper is topical, especially due to anticipated increase in ammonia and nitric acid, especially over polluted regions, and furthermore, the consequent impacts on new particle formation. However in its present form it fails to contribute

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Discussion paper

substantially to our scientific knowledge (Kulmala et al., 1993; Laaksonen et al., 1998, Kokkola et al., 2003, Romakkaniemi et al., 2005 – are important examples in literature by some of the present co-authors themselves, among various other papers), by being simply an implementation of Jacobson, 1997 into Tonttila et al., 2017. Another issue with this paper, as the title itself portends, is that it reads more like a technical report than a scientific paper. It may be that it was initially drafted towards publication in GMD and thus model (incremental) development and validation are provided more focus than unraveling substantial scientific points. The authors themselves note this in P14L12: "However, a more comprehensive analysis of the effects of these gases on the different microphysical processes and the effectiveness and pathways with which these gases are removed from the atmosphere in different meteorological and aerosol conditions shall be explored separately." Furthermore, the draft appears rushed, lacking goal-oriented structuring, with incomplete sentences and errors (detailed in following sections). In addition to the above, the consideration of co-condensation of semi-volatile inorganic gases and associated water uptake is not even a novel proposition. While the authors purport in P03L05 that they "assess for the first time, the efficiency with which these semi-volatile gases are sequestered from the atmosphere", the bulk of this paper is focused elsewhere, and it is not the "first time" (a recent example is Luo et al., 2019 & 2020). For these weaknesses and considering the scope of ACP, which carries high-quality studies that further our understanding of atmospheric chemical and physical processes, my recommendation is to reject the present paper for publication.

Specific Comments

Section 2.3.1 and 2.3.2 can go into an appendix as they are not original developments (Jacobson, 1997, 2002, 2005).

Section 3.1: Kokkola et al., 2018 have already developed confidence in the SALSA condensation routine. What is new here?

P11L33: "we configured SALSA to nucleate cloud droplets"; isn't this the parameterizations of Abdul-Razzak and Ghan in SALSA?

Definition of CEF: What are the assumptions and resultant errors associated with using a simple ratio of CDNsvc:CDN0 as a quantitative estimator of the effect on cloud formation? Or in other words, in Fig. 3(a), CEF = 1 falls within $\mu \pm \sigma$ of CEF w.r.t. [SVC]; is there then a (demonstrated) dependence?

Section 3.3: The discussion here is merely descriptive and does not provide insight.

Section 4.2: Why, if these (P16L06: "1 ppb of HNO3 and 1 ppb of NH3") values of SVCs were relevant, were they not in the range of evaluation of SALSA-standalone?

P16L12: "There is a notable increase in CDNC, which happens because the dissolved gases increase the sizes especially those of interstitial aerosols, which then reduces their corresponding critical saturation ratios (Kokkola et al., 2003b), and hence increasing the number of aerosols that can be activated into cloud droplets." What and how notable is the increase in CDNC? Where and by how much is the increase in aerosol sizes? Kokkola et al., 2003b is not needed here. What is the ostensible increase in CCN? What the reader would be interested in is a discussion supported by quantitative/statistical values.

P16L19: "Of course, other conditions upon which the experiments were conducted are different but the results compare reasonably well." Yet again is a statement that appears ambiguous due to the absence of details/numbers.

A general issue throughout the paper is that the write-up associated with the figures are descriptive in nature. While this is alright to guide the reader through the figures, the absence of a quantitative discussion (things that answer questions such as "How much more/less?", "How significant?", "Why/How much contribution of purported cause-effect?") makes the discussion appear speculative. Furthermore, a detailed discussion supported by statistics may uncover insights/interesting scientific points that are not currently demonstrated.

Technical Corrections

Table 1: Please recheck the values of the mean and standard deviation of particle diameters. There seems to be a copy-paste error. Additionally, standard deviation has the same units of measurement as the variable.

Figure 1: (a) x-axis: Confirm if radius or diameter. Also, the units reported seem wrong.

Figure 4: There is a panel label for the figure which is unnecessary and presently mislabeled.

Figure 5: It is unclear how the ratios (right panels) can go below 0. Also, the units reported for precipitation rate is W/m2; is this the cooling due to precipitation or change in clear-sky radiative cooling or just an error and should be kg/s/mˆ2?

Figure 7: Please recheck the legend of panel (b).

P01L15-24: References can be cleaned up: either they may be omitted if the above is cited, since all the information has moved from literature to textbooks, or the more pertinent and initial studies should be cited.

P01L17: IPCC AR5, 2013 would be a better "scientific" reference than Pörtner et al., 2019, which, although more recent, is a summary for policymakers.

P02L21: Please add a line about changing atmospheric ammonia for completeness.

P03L13: Period after "Section" to be removed. Also "the last section of the paper" to be replaced with "Section 5".

P14L09: Please remove the comma.

P17L01-02: "Fig. 6 shows the domain averaged" is out of place.

P17L03: "depended" -> "dependent"

P17L03: "It is obvious that..." It may not be obvious to the reader. Please remove these words and then discuss why is it so.

P17L05: “It is apparent that…” It may not be apparent to the reader. Please remove these words and then discuss why is this so.

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