Interactive comment on "Continental anthropogenic primary particle number emissions" *by* P. Paasonen et al.

Anonymous Referee #1

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The authors present an implementation of global particle number emission factors to the GAINS model. Such work is very important for atmospheric aerosol studies, to move more towards a complete description of the aerosol also from the emission side. The manuscript gives an overview of the applied methodology, and also gives a general description of the results of the application. The main sources of uncertainty are also discussed in some detail. The manuscript is an valuable addition especially for modellers in the atmospheric community, and it should be published. There are some comments that should be answered before publication, though.

Generally, the manuscript (according to the title) discusses primary particles. As also discussed in parts in the text, some sources emit vapours that in some conditions quickly form particles. For some sources, this is not captured by the emission factors, because such particles are purposefully removed e.g. by heating, while for some

sources these particles will be present. This is an issue for example for the sulphur-related emissions. Is there a distinction between the "actual-primary" and "quickly-formed secondary" particles done in the current work? Are there possible errors in the emission estimates due to this?

Point-by point comments:

p4, line 3: the authors refer a couple of times to coagulation as the main sink of particle number. The study that they are referring to (Kerminen et al., 2001) refers to recently-born particles, and should not be generalized to all sub-100 nm particles. For example, particles with a diameter of 50 nm have ca. 50-fold lifetime due to coagulation when compared to 5-nm particles, and other loss mechanisms will become important as particles grow. Please change the text to reflect this. Coagulation will of course be important immediately after emission and at high concentrations, and the effect of increasing number with decreasing mass emission is thus possible.

p 7 line 1: it would be nice to know the number and spacing of the size sections, especially also the lower limit of the size sections.

P7 l8: uncertain language: this statement seems to me a bit vague. Measurement methods are generally less uncertain in these size ranges. As explained later, authors mean that even a small error in the number of near- 1um particles causes a large error in the number of smaller particles when converting mass concentrations. This is a valid and good point, but the wording here should be fixed.

P7 l18 Which TNO study is meant? Two references were originally given.

p12 l9-13: What is meant here? Surely the emissions are dependent on the sulphur removal techniques as well as the fuel content, but this has not been accounted for in the modelling? Or is something else meant here? These sentences should be clarified, as well as the the reasoning for this factor only causing an underestimation.

p13 l4: please also give a pointer to the specific reason for the inconsistency discussed

in Sect 4.

p14 line 31: neglected is probably not the right word here?

page 15, section 3.3. and Fig 5: I think using the measure of particles/grid cell is not the right choice, especially if this is then used for comparisons between different geographical areas. This because the grid area is different near the equator than near the poles (the gridding is based on latitudes and longitudes), and for comparison purposes the emissions should be normalized by the grid cell area.

p18, l23: "In Europe and Northern America, the overall uncertainties can be estimated to be relatively small, both in terms of current and future emissions." This is a quite optimistic sentence. The word 'relatively' makes it probably correct in terms of comparisons with other estimates, but there remain several factors in measurement technologies, changes in abatement technologies, ultrafine particle concentration variability etc. that I think that a statement that uncertainties are small is yet preliminary.

p19 l10 -> "This may result ..." this is an interesting point. How does the GAINS model see particles that are formed due to a decrease CS from the original source? Such particles could also be considered secondary particles, should such particles be covered by emission inventories? See also general comments.

p20 line 6, "Effects of ambient conditions on emissions": This is an important point. Here, the authors consider only a very limited temperature effect on the emissions; actually, also many other factors, such as the existing aerosol concentration, might affect the emission, especially if some secondary particles are also considered in the emission factors. This could be elaborated on in this section.

p22 l32: remove "the transport emissions". Also, remove hyphen from "Southern America"

Table 1, l4 (page 33) : This sentence is very complex: what is decreasing or increasing, and what causes what? How can high FSC cause effects when it is assumed to be

replaced by low FSC? This is explained better in the text, but understanding the table is hard with this caption.