**Atmospheric
Chemistry
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Discussions**

Interactive comment on "On the efficiency of rocket-borne particle detection in the mesosphere" *by* J. Hedin et al.

Anonymous Referee #3

Received and published: 25 February 2007

General Comments

Faraday-cups and other types of instruments have been used on sounding rockets to study the mesosphere for about a decade. These instruments can detect smoke particles of cosmic origin or icy aerosol particles in the summertime. These particles are generally too small to be visible and thus observable by optical methods. It has been realized that the shock wave developing in front of the instrument has a strong influence on the collection efficiency of the nm sized particles. Hedin and his coauthors point out in their work that the continuous air drag model, often used to simulate the effect of the shock wave, is inadequate for particles smaller than about 10 nm. The manuscript is well-written and organized, however I have reservations about some of their results, and would like to ask for further clarifications before recommending the

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publication of this manuscript.

Specific comments

The authors apply the Monte Carlo method for tracing nanometer sized particles toward the detector through the shock wave that develops due to the supersonic motion of the sounding rocket. This method is the right choice to solve the problem. However, several of the presented results seem to go against common sense. The conclusion of this referee is that most likely there is a bug in the simulation code. These indications are summarized below. 1) In Fig. 4 the probability of detection decreases close to R = 0 for all particle sizes. Is there a reason why smoke particles entering the detector at R = 0 would have a smaller probability being detected than those entering for example at R = 20 mm?

2) Figure 4 shows the probability of detection of particles with 20 nm radius being approx 70 % at its maximum. This is about the same as for particles with 5 nm radius. One would expect that in the large particle limit the continuous and Brownian models would give the same answer. The authors put this threshold around 10 nm. Clearly the continuous model would give close to 100% detection (compare to Fig. 2).

3) Figure 3 shows the Brownian motion of smoke particles with 5 nm radii. There are very abrupt changes in the particles trajectory. Often the deflection is 90 degrees or more and these occur even outside the shock region. How do these collisions happen? The 5 nm radius corresponds to about 1.5×10^{-21} kg in mass, that is over 33,000 times heavier than the N2 molecule. It is very hard to imagine a series of collisional events that would change the trajectory by as much as shown in the picture. Rather, one would expect very smooth trajectories for these smoke particles.

These discrepancies in the presented results suggest the need for checking the numerical procedures and, most likely, to re-run the calculations. The same error might have affected other results presented in the work.

The effect of dust charge has been omitted from the model description (section 2).

Figure 7: It is hard to judge from this figure if venting the detectors helps or not to enhance performance. In the figure the 50 % transmissive detector has maximum detection efficiency only 50% and cannot be directly compared to the detector without a vent. Perhaps would be better to normalize to the actual area of the collector surface. This also applies to the conclusions presented on p. 1196, lines 9-24.

Technical corrections

1) The method the authors apply in tracing the motion of the smoke particles is widely known as Monte Carlo. This should be noted.

2) Page 1186 reviews the instrument used for the in-situ detection of mesospheric aerosols. The referee is aware of three flights using magnetically shielded detectors. These should also be mentioned as they work on a similar principle. See for example Smiley et al, J. Atmos. Solar-Terr. Phys. 68, 114, 2006 or Robertson et al. IEEE Trans. Plasma Sci. 32, 716, 2004.

3) P. 1191, line 12. Change to: "Second, the..."

4) P. 1193, line 1. It is stated that the time step is dt. What is the relation of this to the mean collision time?

5) P. 1193, lines 15 - 17. A table should be presented listing the number densities and temperatures for the given altitudes in case one would like to reproduce the DSMC calculations.

6) P. 1194, line 1. Change "...should be..." to "is".

7) P. 1194, line 20. The "...certain distance..." is not informative enough. Better to use something like: in the undisturbed region in front of the detector.

8) P. 1195, line 11. It is stated that "Essentially all modeled particle sizes will be detected at and above 95 km." Without looking at the figure this sounds like everything

is detected. Are the authors trying to say that all particles sizes are sampled, although with a different probability?

9) P. 1203, eq. A15. Isn't Vg supposed to be Vg0?

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