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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Probabilistic model of shattering effect on in-cloud measurements" *by* V. Shcherbakov et al.

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The paper discusses an important aspect: the impact of ice particle shattering on in-cloud measurements. It discusses the knowledge on this and describes a model to estimate the impact of shattering on measurements of the extinction coefficient, and particle number concentration.

The model considers the size distribution of the particles in the ice cloud and the number distribution of the ice particles not affected by shattering. But the model has no information about the number of ice particles produced from shattering. Also it has no information on the size distribution of the fragments. However, it seems that this information may not be needed if instead the effective diameters of these size distributions would be known.

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In fact, although this is not clearly stated, the paper claims that the relative errors in terms of differences between measured extinction and actual extinction and measured number of particles and actual number of particles depends on the given size distribution of the particles as measured and on the effective radius of the actual size distribution and the effective radius of the size distribution of the fragmented particles. The word “actual” here refers to the particles in the atmosphere that should be measured.

I must say, I was unable to understand this from the paper. The language is hard to digest. It is often unclear what is meant.

In order to understand the claim, I considered a very simple case, as plotted in Fig. 1. The figure shows a simple model of particles. The left part shows the “actual” particles to be measured. The right part shows the measured particles. The set 2 contains the particles which undergo shattering and result in a set F of fragments. The subset 1 of the actual set of particles is measured without shattering.

Let us assume that the “actual” particles include one large and one small particle. Further let us assume that the one large particle gets shattered at the instrument inlet into a number z of fragments of various sizes, conserving the ice water content, and that all these particles get measured as such. The smaller particle is assumed to remain free of shattering and gets measured as such. For example, let us assume that the larger particle is of 30.E-6 m diameter, and the smaller of 10.E-6 m diameter.

The corresponding Fortran code is given in Fig. 2. The number of fragments z is computed using a standard function providing random numbers RAND.

The subroutine SDEFF computes the effective diameter deff, the total number of particles ENTOT, the extinction EXT and the total volume VTOT.

Finally from output file 7, we plot the values of the errors in extinction (dEXT) and numbers of particles (dENTOT) versus the effective diameter of the fragments (deffF), see Fig. 3.

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For this case, with fixed effective diameter deff0 of the actual size distribution, the figure shows that the errors follow a simple curve. Therefore, the errors are pure functions of the effective diameter deffF of the fragments.

Hence, at least in this simple example, the major claim of this paper is correct.

I still do not quite understand how the errors estimates depend on the shape of the size distribution in addition to its effective diameter. From Eq. (10) of the ACPD paper it seems that the results also depend on deff2/deffF, i.e. on the effective diameter of the actual size distribution of the set of particles that gets shattered relative to the effective diameter of the size distribution of the fragments. I suggest investigating this with more numerical experiments in the sense of the example given above.

The summary and the abstract so far miss to mention, that the paper assumes that the extinction efficiency is constant (about 2) both for the particles to be measured and for all the fragments. Hence,this study excludes very small fragments. In addition the analysis assumes spherical particles both for the actual particles and for the fragments. This is of course not very realistic for ice particles. There is no discussion on what the consequence could be for other fragment habits.

The text needs many minor corrections. However, I do not list all these minor points because I suggest that the paper undergoes major revision with the aim to make it better understandable. I am convinced that the basic message can be described with far less text.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 11009, 2010.

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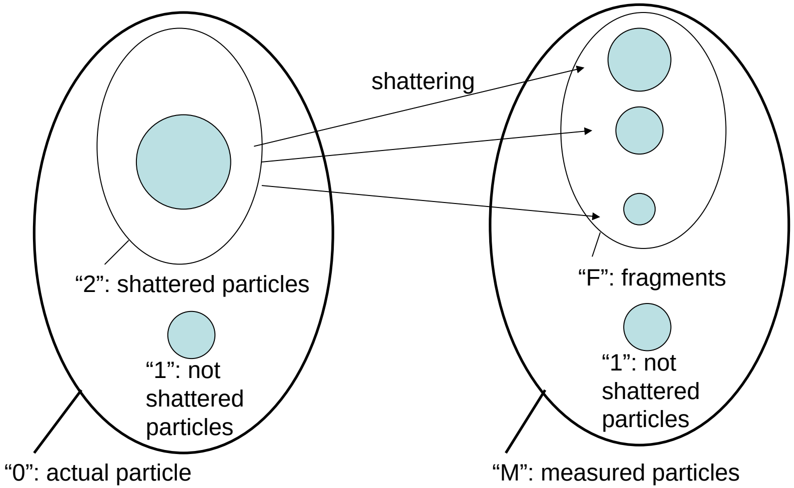

Fig. 1.

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```
      PROGRAM MAIN
      PARAMETER(M=2)
      REAL EN0(M),D0(M)
      REAL ENF(M),DF(M)
      REAL ENM(M),DM(M)
c
      open(7,file='erg.txt',form='formatted')
      DO ICASE=1,100
      EN0(1)=1.
      EN0(2)=1.
      D0(1)=30.
      D0(2)=10.
      ENF(1)=3.+8.*RAND()
      ENF(2)=0.
      DF(1)= D0(1)*(EN0(1)/ENF(1))**(1./3.)
      DF(2)=D0(2)
c
      ENM(1)=ENF(1)
      ENM(2)=EN0(2)
      DM(1)=DF(1)
      DM(2)=D0(2)
c
      call Sdeff(M,EN0,D0,deff0,ENTOT0,EXT0,VTOT0)
      call Sdeff(M,ENF,DF,defff,ENTOTF,EXTF,VTOTF)
      call Sdeff(M,ENM,DM,deffM,ENTOTM,EXTM,VTOTM)
c
      WRITE(6,100) deff0,ENTOT0,EXT0,VTOT0
      WRITE(6,100) defff,ENTOTF,EXTF,VTOTF
      WRITE(6,100) deffM,ENTOTM,EXTM,VTOTM
  100 Format(' defff,ENTOTF,EXTF,VTOTF',4F15.5)
      dEXT=(EXTM-EXT0)/EXT0
      dENTOT=(ENTOTM-ENTOT0)/ENTOT0
      WRITE(7,101) deff0,defff,dEXT,dENTOT
  101 FORMAT(1X,4f14.5)
      END DO
      STOP
      END
      SUBROUTINE Sdeff(M,EN,D,deff,ENTOT,EXT,VTOT)
      REAL EN(M),D(M)
      PI=0.
      PI=2.*ACOS(PI)
      A=0.
      V=0.
      ENTOT=0.
      DO I=1,M
      A=A+(PI/4.)*EN(I)*D(I)**2
      V=V+(PI/6.)*EN(I)*D(I)**3
      ENTOT=ENTOT+EN(I)
      END DO
      VTOT=V
      if(A.le.0.) THEN
      PRINT*,' A',A
      deff=0.
      ELSE
      deff=3.*V/(2.*A)
      END IF
      QEFF=2.
      EXT=QEFF*A
      RETURN
      END
```

Fig. 2.

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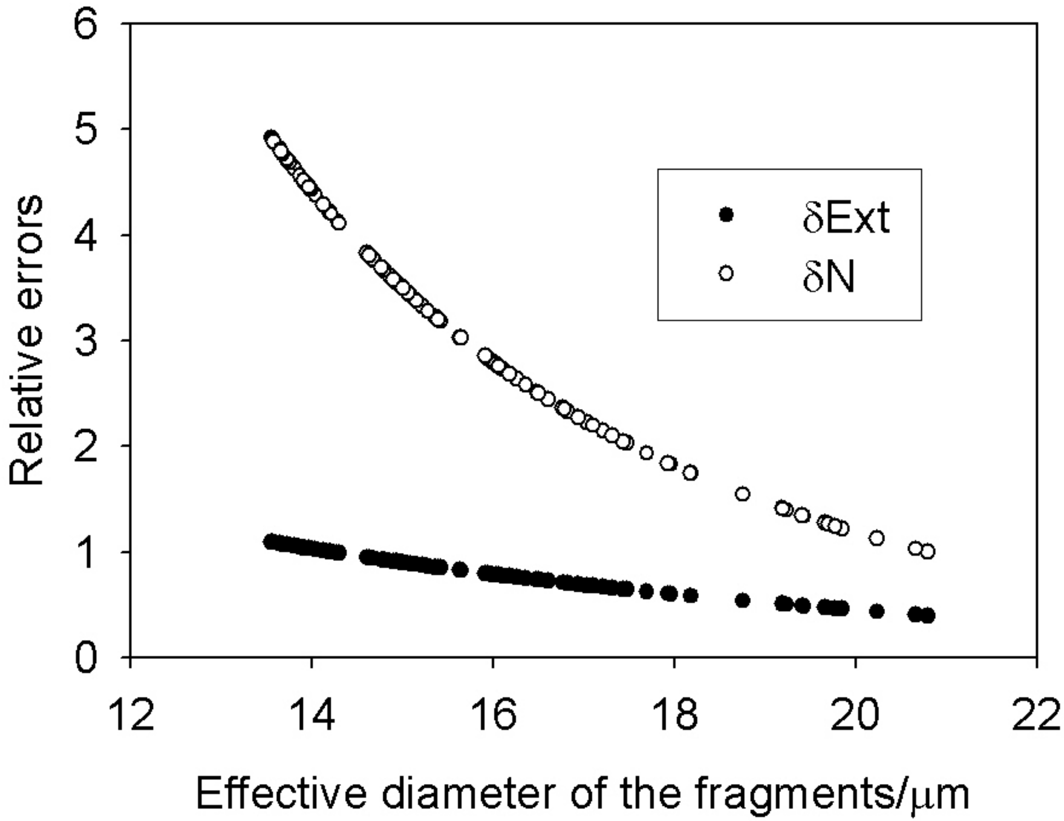

Fig. 3.

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