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Atmospheric Chemistry and Physics Discussions

Interactive comment on "CARIBIC aircraft measurements of Eyjafjallajökull volcanic plumes in April/May 2010" *by* A. Rauthe-Schöch et al.

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Reply to anonymous Reviewer 2

General comments

We would like to thank the anonymous Reviewer #1 for his review of our manuscript and his helpful suggestions for improving the manuscript. In the following, we will answer his specific comments. The reviewer's comments are written in italic and our answers are given below each comment. The references can be found in the revised manuscript.

I believe the basic reason for the CARIBIC activity was not just a scientific one, but

public-relation driven. The opportunity was taken to show up with some observations to demonstrate that Lufthansa is active.
While this may have been one of the motives of Lufthansa which led them to offer us these targeted volcano flights, the focus of the CARIBIC team members was the interesting science of dedicated and targeted volcanic measurement flights and the possibility to operate the upgraded container in flight conditions to make sure all instruments are working properly before resuming the regular monthly CARIBIC measurement flights.

Specific comments

Page 16702: The basic method (how to get the number concentrations at diameters from 1 to 10 microns and thus a realistic estimate of the mass concentration) should be illustrated in a figure.
We have added a figure as suggested (see Figure 1 below and Figure 3 in revised manuscript) and extended the description of this procedure in the text in sections 2.1 & 4.3.

Page 16709: 240 μg m^{-3} over northeastern Germany on 20 April 2010 seems to be much too high (about a factor of 5–10). Is that observation supported by model results (FLEXPART) ? How do you know that this was ash and not just sulphate accumulation particles or other particles ?
As we have stated in the discussion in section 6.1, the ash was encountered close to the top of the boundary layer and from the aerosol information alone it would not have been possible to tell that it was really volcanic ash. However, the back-trajectories pointed to a volcanic origin and the FLEXPART dispersion simulation for that day show values of up to 173 μg m^{-3} for all size bins (see plot below) or 111 μg m^{-3} (not shown) when restricted to particles smaller than 5 μm which the CARIBIC OPC would have counted. Albeit this value was shown in the FLEXPART simulations over the Baltic Sea and not over northeastern Germany.

Following the suggestions of Reviewer #2, we have performed a sensitivity study using different volcanic ash refractive indices of n = 1.50−0.01i, n = 1.55−0.001i and n = 1.60−0.0001i. We now find a maximum 277 μg m^{-3} for n = 1.50−0.01i or 163 μg m^{-3} for n = 1.60−0.0001i. These values are not so much larger than results from the FLEXPART model for 20 April 2010, although they were found at a different position than simulated by FLEXPART.

Page 16718: CARIBIC data significantly add to the modest amount of Eyja measurements. ... is stated. Hm!? ... So please provide a more realistic statement.
We have changed this sentence to:
"Nevertheless, the CARIBIC aircraft conducted a comprehensive suite of measurements in volcanic ash clouds of variable age during the three flights which add some unique in situ observations to the multitude of measurements collected during the Eyjafjallajökull eruption in 2010."

Page 16719: Non volcanic air ? Please specify more clearly what you mean! How is non volcanic air defined ?
Non-volcanic air is air which does not contain ash or volcanic gases and which did not have contact with the volcanic cloud. We have changed the sentence to read:
"Moreover the OPC observations (not shown) indicated enhanced particle concentrations only during the first part of the particle sampler integration time for that sample. Hence, the particle sample was collected only partly in air loaded with volcanic ash but partly also in ash-free background air which did not have contact with the volcanic cloud."

Page 16719: Who knows the exact injection height? Therefore, there is always a large uncertainty in all the particle size estimates for given flight levels.
We have changed the last sentence on page 16719 to mention this uncertainty: "Hence even though there are considerable uncertainties and a large variability of the injection height of the ash, probably most of the particles $>$20 μm were removed from the ash cloud before the CARIBIC aircraft measurements"

Figure 4: The CARIBIC potential to detect and document new particle formation is a unique point. That should be emphasized.
For the flight on 16 May, no OPC mass concentrations are available. From the CPC number concentrations alone it is difficult to say how new particle formation is influenced by the (volcanic) precursor gases and the available particle surface area.

For the flight on 19 May (Fig. 7 in revised manuscript) CPC and OPC data is available. Here it is clear that some particle formation happened in the volcanic cloud even though the particle mass and hence the available particle surface area was quite high. But at the highest observed particle mass, no new particle formation was found. The last paragraph in Section 6.1 discussing the CPC results has been expanded. We have also added a sentence to the conclusions in Section 7:
"The three size channels of the CPC provided signs of new particle formation in the volcanic clouds and suppression of new particle formation at the largest particle mass and hence particle surface concentrations."

Technical corrections

Page 16696, line 1: More lidar papers are available.
As requested, we have added more references: Ansmann et al., JGR, 2011; Mona et al., ACPD, 2011 & Wiegner et al., Phys. Chem. Earth, 2011 in press.

We have also added a reference to Bukowiecki et al., ACPD, 2011, for measurements at the Jungfraujoch station in Switzerland and to Marzano et al., ACP, 2011 for microwave weather radar studies of the eruption.

Figure 7: The dotted bars are hard to detect.
The dotted bars in the upper panel of Figure 7 (now Figure 8) have been replaced with solid long bars in matching colours.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 16693, 2011.

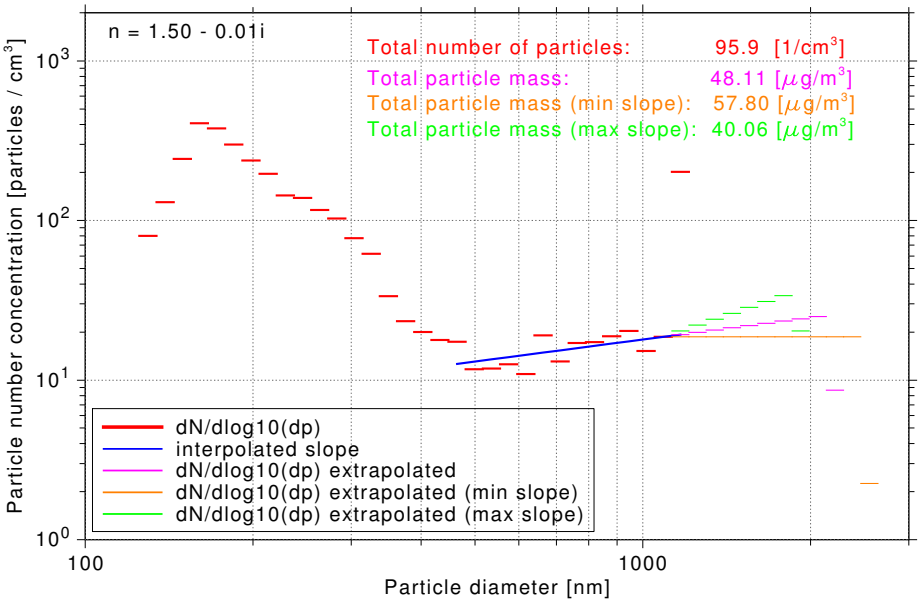

Fig. 1. Example for extrapolation of size distribution on 19 May 11:14 UTC

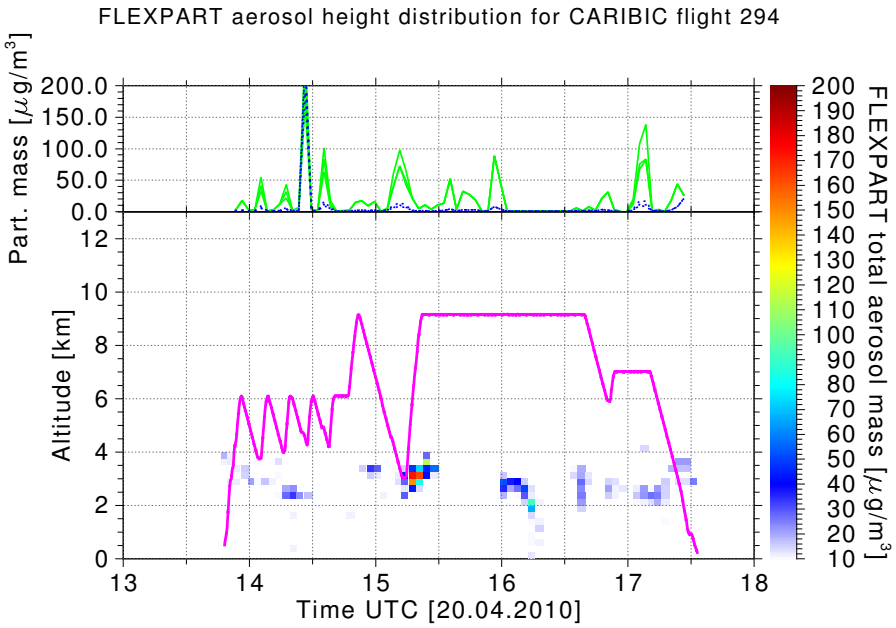

Fig. 2. FLEXPART simulated ash mass concentration on 20 April 2010