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Atmospheric Measurement Techniques Discussions

Interactive comment on "Contrail study with ground-based cameras" *by* U. Schumann et al.

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We thank the reviewers for their helpful comments.

We prepared a minor revision of our paper accordingly: We take all suggestions of the two reviewers into account. As a result, the text will be changed at a few places, as explained below.

In addition, we made a correction, as we found that the geometric altitude is lower, and not higher than the pressure altitude, in this case.

Detailed responses:

Reviewer 1:

We thank the reviewer for the general comments. The main point of the paper is the

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camera model. The set of four contrails is used to test the camera model. But the analysis should also provide some insight into contrail dynamics and contrail modeling.

Range for 100 m resolution: The plots are correct, but the table entries had to be corrected. The correct ranges are 116, 52, 315, 38.5 km for the cameras 1, 2, 3, 4, respectively.

Angle range: The ranges Delta A are now stated explicitly in the paper.

Why did the analysis of the contrails end at 09:09?: Answer: As the reviewer assumes, the contrails drift from the camera field of view at that time. To avoid misunderstanding, we now replace the sentence including “traced forward in time” by “The contrails were visible in the MIM images until about 09:09”.

Page 7743, line 25 through Page 7444, line 2: The reviewer asks about the intent of this paragraph. Answer: The purpose of this paragraph it now clarified by starting with: “Errors of the order of 200 m my be acceptable when considering other sources of uncertainty: ....”

Assumption of zero sedimentation rate. Answer: As we explained in the text one sentence before, “The NWP underestimates the real humidity at some flight levels.” We add: We assume zero sedimentation because sedimentation depends on the particle sizes and these are strong functions of ambient supersaturation. Sedimentation has small effect for the young contrails.

Page 7448, lines 11 through 13: The reviewer asks whether there were any flights within those intermediate altitudes during the time of the contrail observations that could have produced contrails: Answer: Yes; as was stated in the text on page 7445, line 18, the aircraft causing C4 was climbing, but no contrail was visible at those intermediate levels. To make this clearer, we now add “The shortness of C4, formed by a climbing aircraft,...”.

Page 7449, lines 1 through 3: The atmospheric conditions for contrail C4 must be

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questioned. Response: We agree, and that is what is mentioned: “Only with such high humidity...”

The reviewer asks whether the good agreement for contrail C4 is the result of low horizontal wind shear? Response: We agree, the minimum shear might contribute to an explanation of this behavior. This is now mentioned: “Contrail C4 experiences the weakest shear and may stay more narrow, therefore.”

Typographical errors and minor objections: Thank you; now corrected.

Reviewer 2:

We thank for the general comments.

p7441, l9, p7441, l10: The reviewer asks that we state more clearly that a height/speed determination is only possible due to the use of at least two cameras in the determination. Answer: This limitation was stated explicitly in the Introduction, page 7427, line 26. However, as a reminder, we now add “is observed by the two cameras”.

p7445, l1: The reviewer cites Wikipedia, suggesting that only small aircraft flying at lower levels are not equipped with ADS-B. Answer: This is an interesting remark. Unfortunately, we cannot be sure that this is true in general. For example, the DLR research aircraft Falcon is not equipped with ADSB but is operating at altitudes up to 13 km forming contrails. Therefore, we changed the text to: “Presently, most aircraft in operation are equipped with ADSB transponders. Exceptions may occur in particular for small jets.”

p7447, l24: "motions“ => "motions“ - replaced by “motion”

p7448,l6-7: "likely because of“ - we changed the text as suggested.

Conclusions: The reviewer asks whether the observations could be extended to single camera observations. Answer: This may be possible and may be a subject of future studies. We added a corresponding sentence to the last paragraph of the conclusions:

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“Even single camera observations may be useful in this respect when combined with altitude information from other sources (e.g. ADSB data or ground based lidar)”

Fig.13: The reviewer suggests expressing RH in percent. Answer: As the referee indicates, this is a matter of taste.

Correction:

During further work with the camera model and with the ECMWF data, we found that we had to correct the statement on page 7443, line 21: The geometric altitude is lower, and not higher than the ICAO pressure altitude. This triggered a reanalysis of the data. In the course of this reanalysis, we changed page 7443, line 1-3: Instead of following the cross point between the contrail lines and the east-west axis, we now follow the cross point between the contrail lines and the line connecting the two camera positions. This is a less arbitrary choice and turned out to be the more accurate approach (smaller fit rms errors). This change caused some changes in the numerical values in Table 1, but the figures and conclusions remain unchanged, except that the error limit has been increased from 200 to 230 m

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Interactive comment on Atmos. Meas. Tech. Discuss., 6, 7425, 2013.