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Atmospheric Measurement Techniques Discussions

Interactive comment on "Ground-based remote sensing scheme for monitoring aerosol–cloud interactions" *by* K. Sarna and H. W. J. Russchenberg

K. Sarna and H. W. J. Russchenberg

k.sarna@tudelft.nl

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We thank the reviewer for his thorough review. Our specific responses are detailed below.

Response to main review points

- My main comment on the paper is that the authors write at several instances that in their opinion the aerosol-cloud interaction (ACI) metric (Eq. 5) is not ideal, but rather use the correlation coefficient. In my opinion, the paper does not jus-

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tify this statement. No argument is explicitly given why the ACI metric should be inferior to the correlation coefficient. I believe, on the contrary, that the ACI metric yields relevant information that the correlation coefficient does not contain, namely the parameter γ in Eq. 1 that is highly relevant to determine the strength of the aerosol-cloud interaction and thus ultimately the forcing. Compared to the ACI metric, or the regression slope of the droplet concentration vs. ATB, the correlation coefficient is thus of lesser usefulness.

  - In the paper we wanted to underline the assumptions that were made by Twomey and others when deriving the aerosol-cloud interaction (ACI) metric. It is often forgotten in the studies concerned with ACI that Twomey assumed the cloud to be homogeneous, which allowed him to observe the interaction between aerosol and cloud native to the cloud base (nucleation of the cloud droplets on the cloud condensation nuclei) at the cloud top. Te translation of that process to the cloud top in real conditions is not so straightforward. For that reason we proposed a method that allows monitoring ACI at the cloud base. If such method is implemented over multiple locations to long term data and divided into different meteorological regimes, it will provide a valuable information about the process.
    However, after consideration we agree with the referee that the ACI metric brings important information about the factor γ. For that reason we decided to include the ACI metric, which in mathematical terms is the slope of the linear regression line between aerosol and cloud properties. The revised version of the manuscript includes the calculation of ACI together with the correlation coefficient and the coefficient of determination.

- The authors also do not explain why both the correlation coefficient and the coefficient of determination are useful.

  - The coefficient of determination is in fact a square of the correlation coef-

AMTD
8, C5292–C5295, 2016

ficient. It provides the information about what percentage of the change in cloud properties can be explained by the changes in aerosol properties. We think it gives an additional insight about the strength of the ACI.

- I thus request that either the point why ACI is not good be clearly explained, or that the authors move to determine the ACI metric.
  - As we mentioned in the comment above, we the ACI metric was included in the revised version of the manuscript. Further, the revised version was rewritten to explain the connection between ACI and original assumptions made by Twomey.

Response to detailed review points

- p11954 l10 Correlation coefficient for which quantities? l14 The abstract should explain what else is the best way
  - The suggestion was adopted in the revised version of the manuscript. Correlation coefficient is calculated for the ln(r_e) - log normal of effective radius and ln(ATB) - log normal of the Attenuated Backscatter Coefficient.
- p11955 l19 This is true for convective clouds
  - The sentence was rephrased in the revised version of the manuscript.
- p11956 l19 This is for the two studies cited, but – as e.g. discussed in the study by McComiskey and Feingold, a very large range of parameters is inferred from different methods. The theoretical bounds are 0 and 1.
  - This suggestion was included in the revised version of the manuscript.

AMTD
8, C5292–C5295, 2016

- p11957 l17/Eq. 5: The sign of the metric is different when considering r_e or τ_d
  - This was split into two separate ones in the revised version of the manuscript.
- p11958 l5 Twomey did not use aerosol optical depth, this came later with the arrival of satellite retrievals.
  - That is true. Twomey used the absorption optical thickness where he contributed the absorption to the pollution. The sentence was rephrased in the revised version of the manuscript.
- p11958 l25 This statement is unclear. Eq. 1 and Eq. 5 are the same if r_e âĹij $N - 1/3$ which is highly plausible, and it N_a âĹij α, which is more debatable if a vertical integral metric as aerosol optical depth is used.
  - We adopted the suggestion of the referee in regard of the ACI metric. This paragraph was rewritten in the revised version of the manuscript.
- P11963 l16: This is of course only true at constant or decreasing LWP.
  - The specification of constant LWP was added in the revised version of the manuscript.
- P11983 Why not a linear scale for the effective radius?
  - The scale was changed in the revised version of the manuscript.
- P11970 l9 Although I believe I diligently read the paper, I missed the argument why the ACI metric is not the best way to analyse the data
  - This issue was addressed in the response to the main comments.

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8, C5292–C5295, 2016