

## ***Interactive comment on “Reducing cloud contamination in AOD measurements” by Verena Schenzinger and Axel Kreuter***

**Anonymous Referee #2**

Received and published: 17 November 2020

The manuscript describes a cloud flagging algorithm for a PFR radiometer deployed in Innsbruck. It compares a traditional filtering based on temporal AOD variations with the proposed method based on clustering. The approach is interesting and fits the scope of the journal. However the methods are insufficiently described, and the applicability is questionable or at least not supported by the information provided in the paper. I recommend a major revision is made before it can be published.

### General comments

1. The introduction needs to be improved, with more detailed description of the GAW-PFR network and related references. Other cloud flagging algorithms could be mentioned, as well as the main principles of them (temporal AOD variations, spectral changes/Angstrom exponent, etc.). The AOD spectral derivatives and curvature used

C1

later, suggest including reference to O'Neill papers on this matter. Overall, references are missing to support certain statements throughout the text (see specific comments).

2. The “multiplet” method is not at all described (lines 60-65). First, the authors should provide how many measurements in what time interval are analyzed. And they should also provide the threshold value for cloud flagging. Second, the Smirnov (2000) algorithm is much more complex than the “triplet” criterion. Several other steps are given (on the second temporal AOD derivative, on the AOD standard deviation for the entire day, etc.). The description provided by the authors is too simplified. You need to be much more specific and detailed.

3. The applicability of the method is highly questionable, for two reasons. First, the threshold value used to flag the data (0.012 for d20) seems to be based on the analysis of few days only. This is not acceptable in my view. Many circumstances, simply other AOD level or other aerosol type, can change the variability of the AOD or the Angstrom exponent. This is not considered at all in the discussion. I would recommend analyzing the four variables and the d20 distance in different situations (high and low AOD, different aerosol types, season, etc.) to derive a more robust criterion. Second, this method is restricted to one site. It performs apparently well in Innsbruck, but the authors should not pretend that it can be expanded as is to other sites (or instruments). We have no idea how it would perform in an Amazonian site with highly variable biomass burning aerosol, for instance. Claiming that the method can improve the Smirnov (2000) algorithm (line 145) in cloud flagging is too much to say. Suggesting that it can work as good as Giles (2018) with less input information (line 146), is also too much to say. Those algorithms have been tested over a huge database and thoroughly describe the difficulties and the compromise that needs to be taken in an operational algorithm.

4. The validation of the method needs independent data, such as all-sky camera, lidar, ceilometer, solar radiation or even a human observer. The all-sky camera is mentioned in the paper but nothing is shown and no systematic analysis seems to be used for

C2

analyzing the performance of the clustering routine. The fact that more data points are removed is not sufficient. This can be easily achieved by any algorithm by using stricter thresholds.

#### Specific comments

Line 22: good place to add more information and references about GAW network (Wehrli, Kazadzis), and maybe Skynet cloud-screening (Takamura).

Line 23: do you think your algorithm could be used for lunar measurements too? This is emerging technique and worth mentioning, since your algorithm does not require any additional measurement, only AOD.

Line 25: what happens if there are cirrus or contrails during most of the day? What happens if there is a change of aerosol type during the day?

Line 51: I guess you use all 4 wavelengths, but please specify.

Line 52: this a good place to cite O'Neill papers on AOD spectral derivatives.

Line 61: as mentioned in the general comments, Smirnov's paper includes a long list of criteria. Please be more specific.

Line 63: please provide the time interval for the multiplet and total number of measurements. The PFR raw acquisition time is 2 seconds if I remember correctly. Do you use 1 minute averages, standard deviations, how do you look at fluctuations over de 5 minutes period? Please provide details, including the threshold used for cloud flagging.

Line 74: the division by 10 to make the parameters comparable in magnitude is somewhat arbitrary. This is fine if it works, but couldn't you try some kind of mathematical normalization?

Line 74-75: the sentence about the finite difference units is hard to understand. Please rewrite.

#### C3

Line 80: do you mean high AOD ó high number of data?

Lines 81-84: the procedure to derive the d20 threshold seems arbitrary ("... is further fine tuned using days on which the Multiplet routine fails...") and is not explained at all. The paper must describe this method in detail so that others can reproduce it. Moreover, as explained in the general comment 3, few clear days are in my view not sufficient to derive the threshold. A robust statistics over a large sample of data would be desirable. The description should also reveal the difficulties (too strict threshold removes too many good data, too loose threshold allows too many cloud-contaminated data... and so on). And such analysis requires ancillary information to assess what data points are clear and which are cloud contaminated.

Line 94: the airmass limitation was not mentioned until this point. It is one of the criteria used in Smirnov's algorithm. As explained above, you need to be more specific and detailed in describing the algorithms.

Figures 2 and 3: please enlarge fonts in the axe's labels.

Figure 3 caption: better say "solid line" than "black line" (the lines are actually in white color)

Line 110: maybe add reference about Saharan dust over Austria

Line 114: add reference about Eija volcanic eruption over Austria.

Line 118: what criteria or ancillary data are used for a manual screening? Note that readers need to know how to reproduce your results.

Line 121: maybe add reference about sunshine hours

Line 127: wrong subscript, the longest wavelength is 870nm, I guess.

Line 137: 0.001 is the uncertainty is for the reference instruments if Langleys are made at Mauna Loa (Toledano 2018; Kazadzis 2018). For a field instrument (side-to-side calibration), the uncertainty is rather 0.5-1% in calibration constant or 0.005-0.01 in

#### C4

AOD.

Line 145: the data shown in the paper do not support this strong assessment in the conclusions.

Line 162: the sentence about the results in high latitude sites is speculative and not supported by any data in the manuscript.

Line 165: please rewrite the sentence, it's hard to understand.

Line 170: "association": do you mean correlation, covariance, ...?

---

Interactive comment on *Atmos. Meas. Tech. Discuss.*, doi:10.5194/amt-2020-368, 2020.