Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2016-314-AC1, 2016

Atmospheric Measurement Techniques Discussions

Interactive comment on "Forest Fire Finder – DOAS application to long range forest fire detection" *by* Rui Valente de Almeida and Pedro Vieira

Rui Valente de Almeida and Pedro Vieira

rf.almeida@campus.fct.unl.pt

Received and published: 20 December 2016

We begin by saying that we have great pleasure in reading and discussing comments to our work and by thanking the referee for the comments.

We will divide this document in order to address the points raised by the referee individually and in order, as they were presented to us.

Major Comments

Comment:
'Figure 1 and Figure 3 are not very relevant for the study since they describe set-up

which are not used (wireless sensor network, active doas). However, we miss a figure with a map of the 13 FFF system in the forest. We also miss typical DOAS fits corresponding to a fire detection, and a picture of the instrument on site. As described, the detection is a black box to the reader. We read that the system is trained to recognize smoke scenes, but what are the main criterion for the presence of smoke in the algo in the end?'

Reply:
Indeed, Figures 1 and 3 are not *directly* relevant to the study at hand, but we do feel they add a measure of depth to the subject by illustrating alternatives to the proposed methods. However, we acknowledge that they are not crucial for the study and will be happy to remove them if the referee maintains the stated opinion.

The 13 systems that were deployed in the Peneda Gerês National Park are property of the Portuguese National Authority of Civil Protection. The systems' locations are not publicly known and we are not authorised to disclose them. We can, nevertheless, include a picture of one of our systems.

Regarding the issue of detection, we acknowledge the referee's comment that it may seem to be a black box for the reader. However, we are not confident that we can make it transparent, starting with the DOAS typical fits for a fire detection. The device's operating mode means it compare spectra in order to find *relative* column densities. This in turn has two consequences:

- The device never knows absolute column densities or tries to calculate them;
- Human eyes are not able to differentiate between a fire and a non fire spectrum by looking at a fit.

As stated in the first paragraph of Section 5.2.2 of our article, we calculate column density ratio values for five chemical compounds in the atmosphere and then feed

these ratios into our Support Vector Machine (SVM). These algorithmic tools are used to find patterns that might indicate the presence of a smoke column. In this case, a five dimension problem, it would be very hard for a human to detect and identify these recurring patterns.

Now, SVMs, as all supervised learning techniques, demand that a training operation is performed prior to use. It is possible that this is the part that the referee felt lacking. We agree that the training process might be better explained. Nevertheless, after the training procedure and during the SVM operation, we do not possess information on how the separation takes place. We rely on the algorithm's proven classification validity.

Comment:
The authors mention twice that other papers are in preparation: P7 l 21 'These devices are out of scope for this paper ... will be revisited for another article...'. and P7 L30: 'During the night, this camera is also used... shall also be approached in another publication'. As the paper is rather short, I believe this additional material could be added to the paper instead of adding publication.

Reply:
Although we understand the referee's concerns over the article's conciseness, the topics which are said to be out of scope are really out of scope. On the one hand, they range from instrument and software design; from technical drawings to PCB design, through to the software architecture and implementation. On the other hand, they include a series of image processing routines, with no spectroscopic measurement of any kind, developed solely for night fire detection for this particular device.

Minor Comments

Comment - Introduction 1:

The authors should mention the species emitted by fire (NOX, CO ...) and include in the reference list some DOAS studies on forest fire, eg from space
...
I also suggest to mention other routine monitoring applications using DOAS such as volcanic monitoring from space

Reply:
We appreciate these suggestions and will take them into account.

Comment - Introduction 2:
On the other hand, the prediction of 11.53% increase of the market between 2014 and 202O (p2 l.11) does not seem serious.

Reply:
We have based this section of the text on a market research report by Research and Markets (www.researchandmarkets.com). Although a prediction is by definition not certain, we have no reason to doubt this company's methods nor to say that their presented numbers are in any way dishonest.

Comment - State of The Art:
References are needed for the satellite instruments
Reply:
We will complete our references for this section.

Comment - Technique:
If the authors choose to be pedagogical with DOAS, they need to explain the symbol used in the equations, this is done after eq 3 but not eq 1 and 2 so the explanation of I Io, sigma, c and L should be at the beginning for the sake of clarity. Equation 4

should be modified, the integral is on the optical path for the slant column, the authors wrote that the integral is on the atmosphere which can be confusing with the vertical column. P 6 L 22 We miss a reference for the Ring effect. P 7 L 3 Overdetermined does not imply that there are many possible solutions, on the contrary, but it does imply a criterion to select a state close to the solution.

Reply:
These are very valid points and we will address them accordingly.

Comment - Technique 2:
The authors seem to have used the QDOAS software but it s not explicit. Can they be more explicit on that?

Reply:
The QDOAS software was not used for the development of this article or this device. As we state in the last paragraph of Section 4, the system uses MATLAB and C# custom made routines. We have, however, used the software's manual as reference in Section 3.

Comment - Technique 3:
Figure 7: The y axis for Optical thickness is labeled 'AU' but the optical thickness is a dimension less quantity

Reply:
We appreciate the comment and will address the issue.

Comment - Section 6 1:
It's not clear to me how we can say that true detection and false positive vary in similar way. I understand the authors' explaination of why it could be the case but how can we see it from the table 2? It seems that we would need time series to see such a link.

Reply:
This is a valid comment. Table 2 does not show that information in any way and the reference should not be there. We will change this paragraph accordingly.

Comment - Section 6 2:
About the false detection on cloudy days: with more details on the different columns for the 'detected' case, the authors could discuss more accurately their assumption. These false alarm could be linked with variation in the O4 column due to clouds, which may also occur in fire smoke.

Reply:
As mentioned above, a detection does not present itself by a clear column pattern that can be identified by a human. Thus the need for artificial intelligence algorithms like the SVM.

As to the clouds and the O4 column variation, we are inclined to believe that while this can definitely be a contributing factor for a false detection (this is actually one of our current lines of research, though still in the early stages), but it certainly is not the only one. If that were the case, we would expect a much higher number of false alarms, given the discrepancy between the number of clouds and the number of fire events.

We hope we have given satisfactory answers to every point raised and remain ready to provide further information, should the need for it arise.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2016-314, 2016.