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Atmospheric Measurement Techniques Discussions

Interactive comment on "Observations of water vapor within a mid-tropospheric smoke plume using ground-based microwave radiometry" *by* D. R. Clabo

Anonymous Referee #1

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This manuscript presents several case studies of smoke plumes observed by a microwave radiometer, also using visible satellite imagery to identify the plume locations. The study is interesting and potentially useful, but conclusions on the presence of elevated moisture in smoke plumes are not fully convincing and require further analysis.

Major comments

1) The comparison between moisture values inside and outside the plume needs to be done with more statistical and scientific rigour. There are two tests that need to be passed:

(i) Statistical significance. This should be relatively easy to determine using a Student's

t-test on the hypothesis that mean moisture values are higher inside than outside the plume. In general it would be helpful to see some tables giving the exact time periods considered 'inside' and 'outside' the plume as this is not always easy to glean from the text. Also the tables could contain the mean, standard deviation, and number of samples in each period, from which it will be possible to compute the statistical significance of the difference in water vapour between inside and outside the plume.

(ii) Physical significance. As illustrated by the various timeseries of water vapour from the radiometer, there is a lot of background temporal variability in WV as different airmasses are advected over the observation site. The task the authors face (possibly difficult) is to show that the plume moisture values have been elevated above and beyond this natural variability. In the absence of any smoke plumes or cloud, on days with similar weather conditions to those in the case studies, if we were to pick a number of 2-hour periods at random and compute the difference in WV between the first and second hour in that time period, what size WV difference could be expected? The in-plume WV elevation has to fall outside the PDF of this background variability to be significant.

2) In general it would be good to see more information on the quality and characteristics of the radiometer observations. In particular one of the conclusions of the study is that a radiometer is useful for evaluating elevated moisture levels in plumes. To support this conclusion, it would be good to evaluate the error in the water vapour retrieval by comparison to the nearby radiosonde ascents (i.e. to give the mean and standard deviations of typical difference between the radiometer retrieval and the sonde). Since the authors are examining 3-6km average mixing ratio, it would be most useful to know the error characteristics of this average.

Minor commments

1) Section 2, on the radiometer: Although the WV retrievals are performed on a 0.25km grid in the vertical, as the comparisons to radisonde profiles illustrate, the true vertical

resolution is likely to be much lower. It would be useful to give this true resolution (noting that a neural network retrieval cannot supply this information, but there must have been studies using physical inversion techniques applied to similar radiometers that can supply this information).

2) Is anything known about the radiative impact of smoke aerosol at frequencies used by the microwave radiometer? Presumably it is minimal, but it would be good to see some physical confirmation of this.

3) Figure 6: Some explanation of the meaning and units of the colour scale needs to be given here. In particular the significance of the grey areas is not clear.

4) Figure 11: It is impossible to distinguish the aerosol zone from the ambient air, especially in panels b-d. Some adjustments may need to be made (e.g. to the colour scale?) on these figures.

5) Figure 14, caption: Are panels (a) and (b) really both 1345 UTC?

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