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Atmospheric Measurement Techniques Discussions

Interactive comment on "Ground-based water vapor Raman lidar measurements up to the upper troposphere and lower stratosphere – Part 1: Instrument development, optimization, and validation" *by* I. S. McDermid et al.

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There are no significant differences from the original version, therefore the comments to the initial version are still valid as follows:

Review of: Ground-Based Water Vapor Raman Lidar Measurements up to the Upper Troposphere and Lower Stratosphere. Part 1: Instrument Development, Optimization, and Validation Paper content The paper presents the results of an upgrade of a HSLS

Raman lidar for water vapor observations.The main goal of the upgrade is the elimination of systematic errors, caused by the auto-fluorescence of the receiver optics. The optics auto-fluorescence, together with the insufficient rejection of the excitation radiation are the main sources of systematic errors in Raman and fluorescent spectroscopy and as such are widely discussed in the respective spectroscopic literature. It is known that any optical or, other element of the receiver can be a source of fluorescent light when illuminated by excitation radiation, especially if containing or contaminated with organic matter. Optical fibers, usually, are most prone to fluorescence because of the higher energy density of the excitation radiation and the long interaction length of the media. The fiber auto-fluorescence in water vapor Raman lidars has been discussed in details in Scherlock 1999 and reported in other publications e.g. Serikov ILRC 23 p.171, Dinoev ILRC 24 p.1045 . Having in mind the above, the work does not present a new contribution. The authors present different stages of the upgrade starting with blocking of the elastic light with a filter and eventually working without optical fiber. The use of an optical fiber, however, in addition to reducing the telescope obscuration (as discussed in the paper), has the following advantages: 1 scrambles the incident light and thus reduces the risk of having systematic errors due to photomultiplier surface inhomogeneity (other important source of systematic errors) , and 2 improves the overall alignment stability of the lidar. The reasons for the two times signal loss when a filter and a fiber are used remain unclear since they are not discussed and no technical details about the filters or the design are presented. Long pass filters with transmission higher than 98% at the Raman wavelengths and rejection 10ˆ6 for the laser wavelength are available e.g. the Semrock Razor edge filter and their use will lead to significantly smaller signal loss. There are no details either concerning the reasons for the receiver efficiency increase (10X !!!) while working without a fiber. It is not clear if the signal increase is for the whole profile or just for its upper part. The improved filter transmission and PMT quantum efficiency could contribute only partially to this increase. Details on the overlap before and after modification could probably give some ideas. The authors control the effect of the anti fluorescence improvements by comparing the lidar against reference radiosonding and other Raman lidars (apparently suffering from the same problem). More straightforward and cost efficient method would be laboratory measurements of the receiver auto-fluorescence (without atmosphere returns). Performing such tests before the first atmospheric operation would save time and efforts. Paper organization The paper presents the lidar development chronologically and in my opinion with some unnecessary and irrelevant to the paper goals details (e.g. only on p 4-5: “Data were acquired . . ...with the two other operating lidars on site(tropospheric ozone lidar, and stratospheric ozone/aerosols/temperature lidar)”. At the same time, as already mentioned above, essential information that would allow estimation of the work is missing. The paper is, in my opinion, overloaded with graphical material. For example the original optical design of the lidar was presented in several publications, the results of the intercomparison campaigns like those shown in Fig.3 have the goal to illustrate the problem and maybe one or maximum two plots instead of four would be sufficient, etc. Some of the plots like those in Fig 12 present too many overlapping curves, which in combination with the color coding make the plots difficult to follow. It is difficult to find the calibration lamp on Fig 11.

Conclusion

The paper does not present new contribution to Raman spectroscopy and Raman lidar technique since the problem of optics auto-fluorescence is already known and solutions have been proposed. Still the described upgrade eliminates the auto-fluorescence of the lidar and allows to perform accurate water vapor observations in the UTLS region. The paper in my opinion will benefit if some unnecessary details and excessive graphical material are reduced and other essential information concerning the technical details (as discussed above and in the notes to the paper) are discussed. Therefore I suggest a major paper revision.

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