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**Observations and analysis of UTLS aerosol detected over northern France**

by K. Strawbridge et al.

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The paper describes a very promising lidar trailer featuring autonomous measurements of the three most important species that can be measured with lidar. The capability of the system is well documented and demonstrates the high value of simultaneous and continuous lidar measurements of several species. I recommend publication after modifications based on the following comments:

P. 2, line 4: Add a statement on the level of dryness found in intrusions.

P. 3, line 8: I am not sure if these two references are suitable for documenting ozone production in biomass-burning plumes. This process has been verified at lower latitudes, but there is doubt in ozone formation at high latitudes. See also my remarks below.

P. 3, line 10: The selection of literature in some way seems to reflect a historic sequence. Thus, I suggest to cite Stohl and Trickl, J. Geophys. Res. 104 (1999), 30445-30462, instead of (Trickl et al., 2015). Another nice paper is J. Geophys. Res. 117 (2012), D18305, doi:10.1029/2012JD017695.

P. 3, line 14: Please, add "and water vapor".

P. 3, lines 27-28: "aerosol processes" are (e.g.) particle growth, particle evaporation, chemical transformation, heterogeneous chemistry. I doubt that lidar measurements can yield insight into these processes. Lidar measurements can yield hints on transport or optical properties. Please, rephrase!

P. 4, line 4: Water vapour is the primary greenhouse gas, responsible for 2/3 of the greenhouse effect. Please, change phrase to "Also, as the primary greenhouse gas".

P. 4, line 7: You could add a sentence concerning the extreme spatial and temporal variability of water vapour (Vogelmann et al., Atmos. Chem. Phys. 14 (2015), 3135-3148). This is a great problem for trend studies, but a strong motivation for lidar measurements because of the good spatial and temporal resolution.

P. 4, line 15: "Garmisch-Partenkirchen/Zugspitze"? In principle, "Garmisch-Partenkirchen" would be enough since the Zugspitze mountain belongs to that town.

P. 4, line 17: Replace "However, all of" by "Several of": OHP is not a high-mountain site at all, and in Garmisch-Partenkirchen most lidar systems are not located at high altitude. I think all three species are also measured at Table Mountain.

P. 5, lines 1-4: There are several lidar networks such as the lidar team of NDACC, EARLINET, the East Asian lidar network and others. References: For NDACC: web site; for EARLINET Papayannis et al., J. Geophys. Res. 113 (2008), D10204; doi: 10.1029/2007JD009028, Pappalardo et al., Atmos. Chem. Phys. 13 (2013), 4429-4450.

P. 5, line 10: AB presumably means "Alberta". There may be readers who do not know this.

P. 5, lines 16-17: What does CAMI and the text in brackets mean?

P. 7: In an autonomous system automatic data evaluation is an important issue. I did not find much on this topic, in particular on the quality of automatic aerosol corrections. This is a rather demanding procedure that usually introduces additional uncertainty. Several methods exist and are discussed in (Eisele and Trickl, Appl. Opt. **44** (2005), 2638-2651).

P. 7, line 10: Add reference (e.g., Leblanc et al., Atmos. Meas. Tech. 9 (2016), 4029-4049).

P. 7, line 15: "the addition of just a few optics"; one could mention the small addition space requirement. A DIAL would require much more space and is more complex, but would allow daytime measurements.

P. 7, line 24. "absorption" is perhaps not fully adequate. Raman scattering is a two-photon scattering process. An "intermediate electronic state" may exist or not. In general non-resonant scattering is considered. Please, rephrase!

P. 9, line 12: Unfortunately, somebody in the remote past who obviously had no idea about the benefits of the ideal gas law introduced g/kg for $H_2O$ instead of the volume mixing ratio. Generations of $H_2O$ researchers then followed this example. In atmospheric sciences usually the volume mixing ratio is used and I recommend the authors to join the community in the future.

P. 10, line 19: Please, add statement about the section where the figure is described.

P. 11, line 6: What kind of optic?

P. 22: Computer cards pick up noise from the computer. How clean is the signal?

P. 11, line 29-30: Only one of the two 45º optics is explained!

P. 12, line 31: 45 mJ: 266 nm?

P. 13, line 2: 20 %????

P. 13, line 17: The events are not mixed! Change to "in long term events" ("in long-term events").

P. 13, line 23: The two color-coded plots?

P. 13, line 25;: "mixes down": There is not much mixing in the free troposphere. "descends" is more adequate. See also Fig. 10.

P. 14, line 9: Explain "boxcar smoothing" (at least add a reference)

P. 14, line 24-25: Confusing sentence! If you mean "all corrections but" (comma removed): the cross sections are no correction!

P. 15, line 31: "observing the impact of many atmospheric processes" (see above).

P. 16, lines 5.6: This is a highly remarkable statement and deserved a few more words! At lower latitudes (Granados-Munoz, Leblanc, Atmos. Chem. Phys. 16 (2016), 9299-9319) also high fractions were reported for winter, but not for summer. It seems that STT is more important (at least

in mid-latitudes) that previously thought, as indicated by Trickl et al. (Atmos. Chem. Phys. 10 (2010), 499-524).

P. 16, line 15: How dry? 50-100 ppm would be indicative for UTLS air, 4-5 ppm for free stratospheric air (e.g., Hurst et al., J. Geophys. Res. 116 (2011), D02306, doi: 10.1029/2010JD015065). For consistency you should convert 50-100 ppb and 4-5 ppb to g/kg.

P. 16, line 23: Please specify where 120 ppb is reached (not in the intrusion peaks!).

P. 17, line 19: "well documented": See above (P. 3)! How do you know?

P. 17, line 25: The air seems to be dry: Can you exclude an intrusion? See (Trickl et al., 2015) for examples. Did you calculate trajectories?

P. 17, lines 29-30: On what basis do you hypothesize?

P. 18, line 14: Please, define S!

P. 18, line 30: The determination of lidar ratios is highly uncertain since the calculation of small extinction coefficients is based on derivate formation. A few error bars in the lidar-ratio plots would be helpful.

P. 19, line 1: "in this case"?

P. 19, line 10 ": "is due to the forest fire activity": Please, provide evidence. The air seems to be rather dry which could, again, suggest STT. Did you calculate trajectories?

P. 19, li ne 20.21: levels are, level is?

P. 20, line 11-13: Error bars are missing (see above); add a few.

P. 21, line 32: The "valuable dataset" was already emphasized. Maybe you could write "provide further value".

**Figures:**

The symbols are frequently rather small. The colour coding is no clear. Black looks like absence of data. I suggest to use a brighter grey to achieve more contrast. At least statements about the concentrations in the "black" altitude range would be helpful. Finally: Add numbers to the colour scales!

Figs. 2, 3, others: Add something like "The abbreviations are explained in a separate box in the plot".

Fig. 11, 12, 15, 20: The colours are hard to distinguish in the legend (the text is also small)

Fig. 5: Please, specify the shift of the local time with respect to UTC.

**Style:**

P. 1, line 29: "we added" instead of "we have added"?

P. 3, line 20: "travel over"?

P. 3, line 27: “therefore” / ”,therefore,”: There is an obvious trend in the literature for less punctuation. Within the papers I have reviewed this one is record setting in omitting commas and hyphens.

P. 4, line 24: “to simultaneously measure” (and other examples in the paper, e.g., P. 5 line 6, P. 14, line 3): split infinitive!

P. 12, line 9: Stanford

P. 12, line 13: Add a comma between “week” and “except” for clarity.

P. 13, line 18: signal to noise ratio (signal-to-noise ratio)

P. 21, line 16: “The three-LIDAR system” would be clearer.