The unprecedented 2017-18 stratospheric smoke event: Decay phase and aerosol properties observed with EARLINET

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This paper summarises measurements from the European lidar network of the notable event in 2017 when pyrocumulus convection over British Columbia lifted a thick smoke layer into the stratosphere. The paper concentrates on the decay phase of the evant and is mainly concerned with lidar measurements from the Polly network, which measured backscatter and depolarisation at 532 nm. Despite the fact that the Polly lidar is not optimised for stratospheric measurements, the smoke distribution in the period covered by the paper was sufficiently uniform that long exposure times could be used, and the paper provides a valuable summary of the distribution and some of the microphysical properties of the smoke as measured over Europe. The team is very experienced and for the most part I have only minor comments.

However, I have one major comment. The final two paragraphs of section 3.2, and all of section 3.3, are based on a particular interpretation of fig 4a – i.e. that the observed smoke layer consisted of a 'background' distribution of constant altitude, and a much thinner ascending layer, going from ~16 km in early September to 22 km in November. The paper claims that the depolarisation ratio is slightly higher for this layer, but fig. 6 does not really support this interpretation, especially when likely errors in depolarisation measurement above 20 km are considered. Otherwise there is little to distinguish the layers, apart from the eye of faith applied to Fig 4a. One could as easily say that a higher layer of particles appeared in November, or indeed that on occasion the particles were found above 20 km (mid-Sept, mid-Nov, early and late Dec). In summary, I find the evidence for a **coherent** ascending layer measured throughout this period to be very weak.

It might be appropriate to say that one interpretation of fig 4a is that there is an ascending layer, but to devote an entire section to the possible causes of the ascent is pushing the data far too much. A section on underlying transport processes is appropriate, but should give an overall discussion of the spread of the layer and its link to the dynamics, rather than the material on p.11. For example, why did the smoke layer linger a lot longer over the Eastern Mediterranean than over the Western Mediterranean? The authors should also be careful of terminology. The classical Brewer-Dobson circulation consists of ascent in the tropics to the mid-stratosphere, followed by poleward transport by the planetary-wave-driven meridional circulation, and descent at high latitudes. The transport being discussed here is in the lower stratosphere, mostly accomplished by synoptic-scale waves. The process described on p.12 is correct but it isn't the B-D circulation. Section 3.3 therefore requires a rewrite.

Minor comments

p.3. l.3 'then led to'

p.3. l.25 homogeneous nucleation is the process whereby droplets freeze without an external nucleus (i.e. a random nucleation process). Anything involving an external nucleus is heterogeneous

p.4 l.16 'effort was played by'

p.4 l.28 'stratospheric'

p.5 l.28 Lidar retrievals are generally sensitive to the assumed molecular density profile so the phrase 'significant differences' needs more quantitative elaboration p.7 l.21 Why does the height of the tropopause affect the maximum height of the smoke layer? To first order, transport in the lower stratosphere is isentropic, so it is the tilt of isentropic surfaces that must be considered, not the tropopause (which crosses the isentropes).

p.7 l.22 ‘smoke reached 22 km’

p.7 l.25-28 What is the point of the Sicard reference? It adds nothing to the argument

p.7 l.30 ‘from’ not ‘since’

p.9 l.22 ‘introduction’

p.22 l.1 omit ‘shown

p.22 l.6 ‘vertically average’