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Interactive comment on "Tracing devastating fires in Portugal to a snow archive in the Swiss Alps: a case study" *by* Dimitri Osmont et al.

Anonymous Referee #2

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This manuscript attempts to link emissions from a known fire event and their deposition on snow close to JFJ in the Swiss Alps through extensively investigating a severe fire event occurred on 17-24 June 2017 in Portugal. This study is attempting to provide an interesting approach, connecting a set of valuable record of charcoal, black carbon, and ions in the snow pit and a combination of atmospheric in-situ measurement, remote sensing, air mass trajectory calculation, and transport simulation, to better understand the information of particle deposition in snow in European high-altitude sites. This approach is very useful to understand atmospheric processes of aerosol particles how to transport over long distances, be scavenged by snow fall, and be deposited to snow by providing clues. However, there is an issue that should be considered seriously to publish the results. Authors measured charcoal, refractory black carbon (rBC), and ions

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in snow collected near JFJ and compared their profiles with equivalent black carbon (eBC) measured in the atmosphere at JFJ. The elevations of charcoal in the upper layer of C in snow (sample "2" in figure 2e) and eBC in atmosphere on 22 June (figure 2a) were obvious with an increase relative to background level by ~6 times and ~10 times, respectively, indicating that the fire plume reached JFJ. In contrast to them, rBC in sample "4-6" (figure 2d) increased a little and changes in ion concentrations are even indiscernible. Readers reasonably expect that potassium, ammonium, and nitrate can be elevated in their concentrations if the big fire plume indeed reached and is detectable by charcoal and eBC. In the same snow layer, the rBC concentration was elevated just 1.5 times relative to the second peak with rBC concentration of ~5 ng/g, that is probably from local fires as suggested by authors. Discuss this issue in depth and provide more evidences and/or assumption to support your argument.

L135: Since the fire event studied in this work was a well-documented recent extreme event, authors need to calculate forward air mass trajectories to see if the plume departing from the exact fire spot reach the JFJ site. Consider that a starting height of air mass trajectories is not necessarily just above ground because fire-emitted particles can be directly injected into the free troposphere up to > 3 km. Also, it would be great to see if the area-averaged time series of AOD match with forward air mass trajectories. For AOD, just simply check GIOVANNI platform (https://giovanni.sci.gsfc.nasa.gov/giovanni/#service=DiArAvTs&starttime=&endtime=&bbox=-180,-90,180,90). Intense fire plumes are often easily captured by AOD, and thus AOD near JFJ should be elevated day-by day.

L206: The upper size limit of BBHG is generally <300 nm, although which depends on the instrumental setting. Please check if authors mentioned "BBLG" instead of "BBHG".

L205-214: In figure 2d, the diameter of rBC particles in sample "4-6" (figure 2d) seem similar to that of other layers except for sample "13". The size of atmospheric rBC particles generated from biomass combustion is generally larger than that from urban fossil emissions. If the rBC size is not obviously large in sample "4-6", the possible

reason should be suggested, regarding for example, cloud or wet-scavenging during transport and/or scavenging by snowfall, etc.

L224: Authors mentioned that smoke particles can be lifted up to free troposphere and travel over long distance. It can be true not only for charcoal but also for rBC particles. As noted above, it should be seriously considered why rBC and ionic particles did not elevated unlike charcoal. rBC particles are small with diameters < 1 micrometer, which thus can travel longer distances, as found in previous studies so far. Also, authors may need to check if the number of particles in SP2 scattering channel ("SCLG" or "SCHG") is elevated in the snow layers. The profile of scattering particles, i.e., number concentration, might correspond to that of charcoal.

L230: Both ammonia (NH3) and NOx can be emitted from fires, and during the transport time in the atmosphere, ammonium nitrate (NH4NO3) and other forms of nitrate and ammonium can be formed particularly under high relative humidity via aqueous reaction. Authors should seriously consider why such inorganic ions are not sufficiently detected in the snow layer corresponding to smoke plume. Meteorological conditions, for example too dry condition in FT and/or too warm in PBL, were not favorable for the aerosol formation? Moreover, potassium has been broadly used as an indicator of biomass combustion so far. Did authors observe a peak of potassium in the snow layer?

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