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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Analysis of elevated spring-time levels of Peroxy Acetyl Nitrate (PAN) at the High Alpine research sites Jungfraujoch and Zugspitze" *by* S. Pandey Deolal et al.

Anonymous Referee #2

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This paper reports on a Flexpart cluster analyses applied to two sets of PAN, and associated species measurements at European mountain sites, Jungfraujoch and Zugspitze. While there are multiple years of data for both sites, some after 2008, the period of analysis is limited to May 2008. It is difficult to see how this paper really advances our knowledge relative to the previous paper by this group, Pandey Deolal et al. [2013], that interpreted data from Jungfraujoch. The case for the value of this paper needs to be made before it is acceptable for publication. In addition, there are a number of general and specific comments that need to be dealt with.

General Comments

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Contrary to what is stated in the introduction there is a significant PAN background in the northern hemisphere, see for example Roberts [1990] for older data and Fischer et al., [2014] for recent data. The results of the flexpart model need to be assessed in relation to that background. Why is only May 2008 being analyzed? There are several other months in that year, and apparently data from 2009 and 2010. Why aren't those time periods being analyzed? Aren't there a lot of other marker species measured at these sites? Why not use some of those other measurements to track some of the airmass origins? There are several PAN data sets from Mountain side/top sites that show a common meteorological phenomenon, daytime warming of the ground causes upslope flow and nighttime cooling of the ground causes subsidence, pulling air from aloft down to the site. If the PBL height is above the altitude of the site, this usually results in higher PAN at night. Examples of this effect can be found in Roberts et al., [1995].

Specific Comments

Pg. 12730, Lines 2-3: The statement is made that background concentrations of PAN are "close to negligible" This is simply not true. Depending on latitude, altitude and season, background concentrations of PAN can be several hundred pptv, not negligible relative to the values reported here.

Pg. 12730, Lines 10-11: Strange that the authors chose to use a relatively crude model study to make the point about PAN distributions when there are so many actual measurements that can be referenced. The authors could start with the references in Fischer et al., 2014, and if they really want to be thorough there are several review articles and book chapters that could be consulted.

Pg. 12730, Lines 20-23: There are several more key studies of Springtime continental/hemisphere scale transport that describe specific conditions under which PAN and NOy get transported over long distances. These instances involve warm conveyer belt transport associated with frontal passage. See for example Cooper et al., [2001; 2004],

ACPD
14, C4042–C4045, 2014

and Nowak et al., [2004].

Pg. 12739 line 15: There is no solid black line in the left panel of Figure 2.

Pg. 12741 discussion of thermal decomposition: The net rate of thermal decomposition depends not just on temperature, but also on NO and NO2. The PA radical will reform PAN through reaction with NO2 unless removed by reaction with NO (or another radical if NO concentrations are low). This can be a substantial correction to the simple thermal decomposition rate.

Pg. 12742 lines 15-18. There are a lot of examples of PAN-O3 correlations in a whole range on environments, but perhaps most importantly at mountain top sites as noted above.

Pg. 12745 line 12. This statement is wrong, there is an obvious noon maximum in PAN for Cluster 1. It is obvious in the mean but the extent of it is obscured because the standard deviation bars overlap. Ground sites that are in urban areas or otherwise influenced by local emissions have a noontime maximum in PAN.

Pg. 12746 lines 20-21: The period of high O3 and low water vapor is an obvious stratospheric intrusion, why doesn't the cluster model pick that out? Shouldn't it be left out of the remaining analysis?

Pg 12747. Line 22. This statement is wrong. The Cluster 3 diurnal profile at JFJ does not show simple daytime injection of PAN into the PBL, rather it shows the classic mountain-top nighttime maxima due to subsidence of PAN-rich PBL air due to nighttime cooling of the surface, hence higher PAN at night.

Pg. 12748, Lines 8-9. I assume the authors are referring to the washout of the soluble NOy species HNO3 and particle nitrate?

Pg. 12750, Line 2: The PAN/CO for Cluster 4 was not the highest, Cluster 3 was higher.

Figure 2. The colored lines are hard to see. The designation of the black triangles

ACPD
14, C4042–C4045, 2014

doesn't make any sense, aren't those data already shown by the red line and triangles?

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