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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Tropospheric ozone variations at the Nepal climate observatory – pyramid (Himalayas, 5079 m a.s.l.) and influence of stratospheric intrusion events" *by* P. Cristofanelli et al.

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General Remarks The paper describes interesting results for a very special station in a region where presumably not much atmospheric sounding had been done before. The analysis is very carefully done. The paper should be published after the following comments are considered by the authors.

We thank the referee for the very useful comments. All points were accurately evaluated and point-to-point discussed in the following. In italic characters are

reported modifications now introduced along the paper.

Specific Comments The page and line number refer to the "printer friendly version". (1) Abstract: The abstract is rather long. Although this is frequently found in this field shortening might be considered. For instance, the climate issue is stressed twice.

The abstract was shortened by omitting the final sentence about climate influence.

(2) P. 1485, line 25: "Wild, 2007": You should also consider earlier work such as Roelofs and Lelieveld (Tellus B 49 (1997), 38-55) who estimated that as much as 40 % of the tropospheric ozone originates in the stratosphere. From the observational side a hint confirming this may be found in Trickl et al., Atmos. Chem. Phys. 10 (2010), 499-524.

OK, these references have been inserted.

(3) P. 1488, line 9: "Trickl et al., 2009" should be replaced throughout the paper by the citation already given above.

OK

(4) P. 1490, line 25: Fig. 2 must be printed in a full-page layout!

OK, we will ask to the editorial office to take care of this suggestion.

(5) P. 1492, line 16: "titration": is there evidence of sufficient NO? If not, rephrase more cautiously.

OK, the sentence has been rephrased

(6) P. 1493: The findings for the diurnal cycle are very interesting indeed.

OK

(7) P. 1494, line 10: "....often leading to strong mixing between stratospheric and tropospheric air": I doubt that this is explixitly concluded in the publications cited in this context (they show complex cases nevertheless). In particular, Trickl et al. (2010) re-

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port on indications that intrusions could by substantially dryer than found in the in-situ RH measurements. I suggest to replace “often leading to strong” by “also including”, and cite some of the relevant literature, such as Shapiro, J. Atmos. Sci 37 (1980), 994-1004, Parrish et al., J. Geophys. Res. 105 (2000), 24363-24374.

OK, we rephrased this sentence

(8) P. 1495, lines 7-8: The justification of a 60% threshold looks strange. 60 % is by no means a stand-alone criterium for stratospheric air. It could represent the width (“full width at half maximum”) of an intrusion, which cannot be determined by, e.g., RH = 10 %.

Yes, we totally agree with referee. In fact, this threshold was applied in synergy with two further thresholds. The 60% threshold value has been inserted to take into account possible mixing of stratospheric air-masses along the troposphere. This value represents the average upper threshold for the RH values observed during SI events at the NCO-P (as also deduce by case study analyses). Moreover, also at other high mountain stations, several events were characterised by RH not lower than 60%. These points were better clarified in the text (Section 4.1) as following: *“For these reasons and with the purpose of selecting the SI related to downward transport not associated with coherent airstreams, we also considered those days characterised by the co-presence of dry air-masses and elevated O3 concentrations at the measurement site. To this aim we adopted an RH threshold of 60% to detect SI. Besides as being applied at other mountain stations to identify stratospheric air (e.g. Trickl et al., 2010), this value represents the typical “upper boundary” of RH at NCO-P able to contribute to the identification of SI events”*

(9) P. 1499, lines 9-10: Is there observational evidence for the influence of the orographic circulation, is there any publication on this? How far away is the next area with enhanced air pollution? Can the air pollution move along the entire valley within a

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single day, or does this require a series of diurnal cycles? Is there similarity to related studies elsewhere (e.g., Vergeiner and Dreiseitl, Meteorol. Atmos. Phys. 36 (1987), 264-86; VOTALP special issue, Atmos Environ. 34, around p. 1400)?

The issue of the thermal circulation influence on atmospheric composition was accurately investigated in many papers now published in this ACPD special issue. In particular, please refer to the papers by Bonasoni et al. and Marinoni et al., now referenced also in the paper. As reported by Bonasoni et al. (2010) "NCO-P is located away from important anthropogenic sources of pollutants, and only small villages are present along the valley: Lobuche, Pheriche, Tyangboche, Namche Bazar (the biggest village with about 800 inhabitants), Phakding and Lukla (Fig. 1). The closest major urban area is Kathmandu (1 081 845 inhabitants; 2001 census), situated in the valley of the same name (estimated population of the valley in 2009 was about 3 million). The city, located about 200 km South-West of the measurement site and more than 3.5km lower . . .". As reported by Bonasoni et al. (2010) and Marinoni et al., (2010) the typical diurnal variations of anthropic aerosol (with well-defined diurnal cycles characterised by maxima during day-time) would imply that the valley represents an efficient "channel" for pollution in the ABL to be transported to the high Himalayas. Experimental evidences collected during events of extended biomass burning in the Himalayas foothills, suggest that pollution from these regions can be transported to the measurement site also in 1 single day.

Language: Title: "Pyramid" instead of "pyramid"? **YES**

Line 1 of Abstract: Replace "2-years" by "2 years" or "two years". **OK**

P. 1487, line 1: Change to "Signals". **OK**

P. 1493, line: 22: Change to "air masses". **OK**

P. 1495, lines 17-18: Change complicated final sentence to "This demonstrates that the

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measurement site was influenced by stratospheric air masses during a non-negligible fraction of time"; however, it would be even better to extend the previous sentence like this: "...investigated period, a non-negligible fraction of time." since the rest in the final sentence is already mentioned. **OK**

P. 1496, line 25: Change to "...transported to NCO-P by up-valley flows..." **OK**

P. 1498, line 15: Change to "... the first 2 years..." or "....the first two years...". **OK**

P. 1499, line 11: I would write either "transport" or "transport processes". **OK**

P. 1499, line 17: Change to "to identifying **OK**

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 1483, 2010.