Atmos. Chem. Phys. Discuss., 3, S1413–S1416, 2003
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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Volcanic eruptions recorded in the Illimani ice core (Bolivia): 1918-1998 and Tambora periods" *by* M. De Angelis et al.

M. De Angelis et al.

Received and published: 28 August 2003

General comments

We are very grateful to Reviewer 2 for helpful comments. We have carefully revised the manuscript, and we hope that he will be happy with the proposed changes. In particular the section dealing with Andean volcanism (section 3.4). As suggested by the Reviewer, this section has been reorganized and simplified:

- The potential sources of SO_4^{2-} and $SO_4^{2-}{}_{exe}$ are more clearly presented and discussed. First of all, the marine biogenic source is assessed and ruled out. Then, a first estimate of anthropogenic contribution (which was not considered as a last resort in the first version, but it was probably not clearly explicated) is made using the marked tendency of wet season deposits. Of course, sporadic events may occur even during dry season, but, at this time of the year, atmospheric stratification seems to be not very favorable to strong vertical exchange. Mostly plumes injected at rather high altitude (like dust, fire or volcanic plumes) are expected to very high Andean sites. Finally, the regional volcanic source is proposed.

- After that, $SO_4^{2-}{}_{exc}$ profile is described considering other volcanic potential markers like strong acidity (H^+) or halogens. Dating used in this section and corresponding estimated uncertainty are presented with more details in section 3.2.

- A non exhaustive list of volcanoes likely to have contributed to sulfate deposits during the period covered by the upper part of the Illimani core (0-50 m) is presented in Table 3. Choice criteria are more clearly explained. As suggested by the Reviewer and lacking of meteorological information, we don't try to attribute peaks to given eruption. This list is only a prospective tool, showing that, regional volcanism may effectively influence the atmospheric composition over high Andean areas.

Specific comments (see the revised version)

Dating uncertainty: A detailed chemical stratigraphy based on the combination of several strong seasonal patterns allowed to identify annual layers along most of the profiles, and to provide a year by year dating of the core. We used continental dust markers (Ca^{2+}, the total mass of insoluble microparticles and Al, Correia et al, 2003) and nitrogen ionic species assumed to be related to biomass burning during dry season (Legrand and de Angelis, 1995, de Angelis in preparation). According to this dating, the core covers the 1919-1998 time period. Dating uncertainty is estimated to be in the range of $\pm$1 yr from the surface to 41m depth (1947) and $\pm$2 yr at the bottom of the core (1919). This independent year by year dating is in agreement with ^{137}Cs increase (34.7 - 32.7 m) attributed to the tropical record of 1961 and 1962 thermo nuclear test (Knüsel et al., 2003, Simöes et al., in preparation). Text has been changed correspondingly (see page 6, lines 7-17).

Gypsum-like and volcanic sulfate estimates: we agree with Reviewer comment. The

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text dealing with acidity (page 6, line 19 - page 7, line 17) has been slightly reorganized and completed, and a comment on the possible underestimating of volcanic sulfate added (page 7, lines 14-17).

Temperature change linked to Pinatubo eruption: δD profile must be published and discussed elsewhere. This part of the manuscript, which was not essential, has been removed.

Agung section: this Reviewer comment is due to a printing error in manuscript. Indeed HCl and HF masses were given with a wrong unity (kg instead of metric tons). Emission estimates by Devine et al., and Sigurdsson et al. were 1.5×10^6 tons (i.e. 1.5 Tg), 8×10^5 tons (i.e. 0.8 Tg), and 2.8×10^6 tons (i.e. 2.8 Tg) for HCl, HF, and H_2SO_4, respectively. Unities have been corrected (see page 12, lines 6-14).

Anthropogenic cause to recent sulfate increase: the part of the text dealing with potential sulfate sources has been reorganized (page 14, line 30-page 15, line 17). The way of estimating anthropogenic increase is explicited page 14, line 6-13. Once this correction made, one can see in Fig.8 that $SO_4^{2-}{}_{exc}$ average peak height and frequence do not vary so much until mid-1970's. Please note that Cl^-_{exc} is now reported in Fig. 8.

Past volcanism: as explained at the beginning of our answer, section 3.4 (page 13, line 17 - page 15, line 12) has been substantially modified, taking into account Reviewer comments. Text has been reorganized, clarified, and parts have been removed. In particular, we are much more cautious when discussing our profiles. We donŠt try to relate sulfate peaks to given eruptions, but only suggest that, beside other sources, regional volcanism may noticeably influence the atmospheric composition over high altitude Andean sites. The last sentence of the abstract and the end of the conclusion have been modified.

Technical corrections

They have been made according to Reviewer comments. In particular μEq L^{-1} was

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used as in other scientific publications like JGR, depth scales were added in Figures 5 and 6 (top).

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