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Interactive comment on "The transport history of two Saharan dust events archived in an Alpine ice core" *by* H. Sodemann et al.

H. Sodemann et al.

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We are grateful to Referee 1 for pointing out to us sections in the paper requiring clarification, and for valuable additional comments. Our reply to the raised points is detailed below.

Major comments:

1. The purpose of our study is focused on two core questions:

1) What are the influences of the dust origin, transport pathway and deposition on

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the chemical signal recorded in the ice core? In other words, are differences in the chemical signal for different events due to a differing dust origin, transport or deposition process - or a combination thereof?

2) Is there an archetypal meteorological flow evolution that leads to Sahara dust transport into the Alps, or can different types of meteorological events in principle lead to similar dust signals in Alpine ice cores?

The new trajectory method is a necessary tool that was developed to address these research questions, rather than the ice core data being used to validate the new methodology. We will change the Introduction to state the twofold approach of this study more clearly. Furthermore, we will interchange Sections 3 and 4 to emphasise how the two aims synthesise. (see also Technical comment 1.)

2. Although the ice core was recovered from a glacier saddle, the mean annual accumulation rate is high $(2.6 \pm 0.8$ m water equivalent for the time period 1992-2001). This calculation is based on the yearly intervals identified in the records of δ^{18}O and NH_4^+ concentration (Palmer et al., (2005), manuscript in preparation, will be attached to the letter to the editor). Mean annual precipitation from nearby, low-elevation meteorological stations is much lower (0.93-1.20 m) for the same time period. Nevertheless, the year-to-year variations agree well. This fact together with the high accumulation rate at the ice core site indicates that wind erosion is not significant.

The dating by annual layer counting was started at the surface which corresponds to the date of drilling (March 2002). The attribution of the year 2000 is therefore relatively straightforward. In addition, the Sahara dust event assigned to October 2000 was the only one in the entire core visible by its yellow colour. This event was already detected in a shallow core drilled at the same site in May 2001. In that core the yellow layer was observed at a depth of 2.7 m w.eq., resulting in an accumulation of 1.9 m w.eq. during the 9-month period between the two drilling campaigns (May 2001-March 2002). This value is in very good agreement with the annual accumulation rate deduced from the

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entire core and thus strongly supports the dating. These details on the exposure of the drilling location and the dating accuracy will be added to Section 2.1 and 4.

3. The threshold of wet deposition (rh>80%) is adapted from the parameterisations of the ECMWF NWP model. The section will be edited to clarify this, and a reference to ECMWF (2004), Section IV.6, will be added. Following the suggestion of the Referee, we will give time series of dust and precipitation estimates from the trajectories at the arrival location. This will be included as additional figures, and can then directly be compared with the precipitation record from weather stations around Piz Zupo (see also 5. and Technical comment 5).

ECMWF, 2004: IFS Documentation Cycle CY28r1, http://www.ecmwf.int/research/ifsdocs/CY28r1/index.html,

4. As mentioned in 1., the aim of this study comprises both the understanding of the chemical signature of two dust events in an ice core, and the specific meteorological situation that lead to these dust events. Hence an appropriate discussion of the meteorology is fundamental to the identification of the underlying meteorological processes, and to estimate their impact on the chemical signal. In light of the changes to the Introduction outlined in 1., the discussion in Section 5 holds valuable results concerning (i) the validity of the detailed back-trajectory analysis, and (ii) characteristics of the meteorological situation associated with dust transport to the Alpine area (Conclusion 2). However, in the revised version of Section 5, the implications of the meteorological discussion for the chemical signal will be discussed in more detail, and link between chemistry and meteorology will be strengthened (see also Reply to Referee 2).

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Technical comments:

1. The reviewer's suggestion to add the TSP data from Jungfraujoch to Fig. 6 and to provide dust and precipitation estimates is acknowledged. We will investigate if these data are available for publication, and in that case include them in the revised manuscript. This could allow for a better comparison between the dust and precipitation timing from observations and from the trajectory method.

Our approach to identify the dust events was (i) to determine the approximate month of deposition from the ice core chronology, and (ii) to calculate backward trajectories for that whole respective month (March and October 2000). Periods of possible dust deposition were (iii) confirmed with TSP and other data, if available. We will clarify our approach by interchanging Sections 3 and 4, and revising Sections 3.1 and 4.

2.The location name will be added in Fig. 4.

3.Fig.11 contains only dust mobilisation locations for the dust events recorded in the ice core. We will reformulate the first two paragraphs of Section 6.1 to describe this more clearly.

4.Where appropriate, a star will be added to Figs. 5, 7, 8 and 9 to indicate the location of Piz Zupo.

5.The heavy precipitation around the ice core site in Fig. 6 actually preceded the arrival of dust-laden air masses (11-12 October). During the dust event, precipitation was still heavy, but rather intermittent (13-16 October). From the ice core data (Fig. 3), it appears that the dust shows very high concentrations of Ca^{2+} and other tracers from the beginning of the dust event in the ice core, a "dilution effect" as suggested by the Referee is hence not supported by the ice core data.

On behalf of all authors

Harald Sodemann

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Interactive comment on Atmos. Chem. Phys. Discuss., 5, 7497, 2005.