Atmos. Chem. Phys. Discuss., 10, C8205–C8211, 2010
www.atmos-chem-phys-discuss.net/10/C8205/2010/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Cosmic rays linked to rapid mid-latitude cloud changes" *by* B. A. Laken et al.

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Final author comments

General author response We kindly thank the anonymous referees for their insightful and helpful comments, and we are pleased at the positive and encouraging nature of their responses towards the science we have presented. The referee comments appear to be in consensus regarding their requests for removal of the speculative aspects of this work, wherein we attempt to outline the possible impacts of GCR on climate over decadal timescales. We agree that this element of the manuscript detracts from the overall findings and the scientific merit of the work, and have edited the paper accordingly. Specifically, we have removed the last line of the abstract, the final paragraph of the discussion, and figure 8. In addition, we have improved the discussion on P. 18241

relating to the weakness of the HadAm3 model cloud simulations, by the insertion of an additional figure (Mollweide projections of vertically averaged cloud amount, from the GCM and ISCCP) (shown in Fig1). We believe that this additional figure will better contextualise the limitations of the GCM experiment performed in this work.

Specific replies to referee comments Anonymous referee #1

1.Regarding the suggestion that the speculative analysis of section 2 (p.18238 line 25 to p.18239 line 14 and Fig 8) should be removed from the manuscript: agreed.

2.The referee has commented that the use of the 10.7cm radio flux is not suitable in this context. We agree that this comment is correct, and have therefore removed the F10.7 dataset and all references pertaining to it. Instead, we have substituted it for direct measurements of the Total Solar Irradiance (TSI) from the Active Cavity Radiometer Irradiance Monitor (ACRIM) reconstructions (an updated figure 4 is shown in Fig2).

3.The referee has commented that the terminology used regarding rates of change is not suitable, and instead suggests that we substitute for the nomenclature “short term change” to reduce confusion. We agree with this comment and have made the necessary alterations. In addition we have amended the accompanying units to “NU” (Normalised Units) defined in the text as a normalised unit representing a change of 1% of the solar cycle amplitude in four days (for GCR variations).

Anonymous referee #2 Reply to Specific Comments 1. This comment refers to the following studies (listed below), these references have been added to the text. Duplissy, J., Enghoff, M., Aplin, L., et al. Results from the CERN pilot CLOUD experiment. Atmospheric Chemistry and Physics. 10, 1635–1647, 2010. Tinsley, B.A. & Yu, F. Atmospheric ionization and clouds as links between solar activity. Geophysical Monograph. 141, 321–339, 2004. Tinsley, B.A., Zhou, L.M. & Plemmons, A. Changes in scavenging of particles by droplets due to weak electrification in clouds. Atmospheric Research. 79, 266–295, 2006. Yu, F., Wang, Z. & Turco, R. Ion-mediated nucleation as an important global source of tropospheric aerosols’. Atmospheric Chemistry and

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Physics. 8, 2537–2554, 2008.

2.The top 5% dates of cloud change are selected by firstly calculating the differential cloud change over area-averaged mid-latitude (30° – 60° N/S) regions, (where the differential cloud change [dcc] of each day is equal to daily average cloud change (x), minus an averaging period of three days (which begins five days prior to each date), as illustrated in the equation shown in the supplement file. Each dcc value is then ranked, and the dates of the top 0.95 percentile negative changes are then compiled. This composite is then filtered to remove dates which were coincident within a -10 to +3 day period of preceding dates to remove consecutive dates from the composite.

3.The referee requested more information on the ISCCP D1 dataset and its limitations: this has been added.

4.The referee requested a comment about the difference between IR/VIS-detected cloud magnitudes. The manuscript has been amended accordingly.

5.'Cloud anomalies' has been altered to 'anomalous changes' as requested.

6.P. 18240, line 22: further clarification of the GCM configuration has been added.

7.The figure captions have been revised, specifically with regard to the misleading comment of 'mid-latitude' regions in figure 1. The typo in figure 5, related to the dashed line has been corrected. However, we have resisted the request to move some of the detail contained in the figure captions into the body of the manuscript, since these captions contain additional information relevant to each figure that may not easily be integrated into the text without detracting from its overall readability.

8.The referee has suggested that we include the Hadley cell sub-tropical high pressure zones in Fig. 3; however we feel that the addition of such information to the figures may unnecessarily obscure the data content. As they are an elementary component of global circulation we are comfortable that their spatial position is suitably well-known to be excluded from the figure here.

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9.A reference to HadAm3 has been added to P 18240, line 22.

10.P. 18240, lines 25 – 27; sentence has been deleted from the manuscript.

Technical corrections:

1.P. 18237, line 1. High magnitude, low frequency GCR variations specifically refers to phenomena such as Forbush Decrease (FD)/Ground Level Enhancements (GLE). Such events are high magnitude variations in the GCR flux, however they occur infrequently. These are distinct from the GCR variations detailed in this work: although they do occur over daily timescales (high frequency), they are not high magnitude variations (with respect to the aforementioned FDs/GLEs). FDs, for example, are a roughly 3% daily timescale reduction in total GCR flux, while the magnitude of the GCR variations detailed here are around 3% of the GCR variations experienced over the 11-year solar cycle (peak-to-peak).

2.P. 18236, line 20. The term “numerous studies” has been substituted with “e.g.,”.

3.P.29238, line 26. SLAT has been defined within the manuscript in addition to the abstract.

4.P.18242, line 9. Bernard cell, has been changed to Bénard cell (and also at all other occurrences within the manuscript).

5.P.18237, line 4. Referee suggests using an alternate (i.e. more current) reference than Marsh and Svensmark, 2000. We feel that the use of this reference is appropriate for several reasons, but primarily because this is a heavily discussed and critiqued paper in the field of cosmic ray – cloud studies. Any reader not versed in the literature, seeking a broader appreciation of this topic, will be able to find a wealth of appropriate literature based on cross-referencing papers. Secondly, it is appropriate to reference work from this research group, as they are primarily responsible for publishing in the area of long-term correlation studies (the context within which this reference is given).

6.P. 18237, line 7. Substitution of “atmospheric” for “environmental”: agreed.

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7.P. 1823, line 7–12, this point has been removed from the text.

8.P. 18240, line 19. “cloud anomalies” has been altered to “anomalies”, which will encompass both cloud/SLAT, as suggested by the referee.

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/10/C8205/2010/acpd-10-C8205-2010-supplement.pdf

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Interactive comment on Atmos. Chem. Phys. Discuss., 10, 18235, 2010.

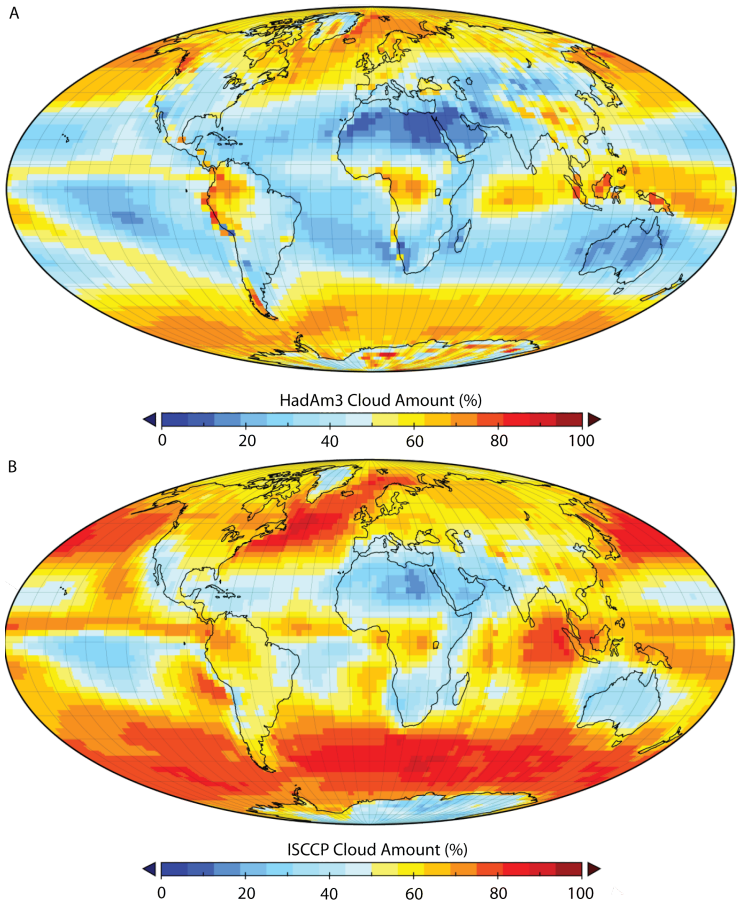

Fig. 1.

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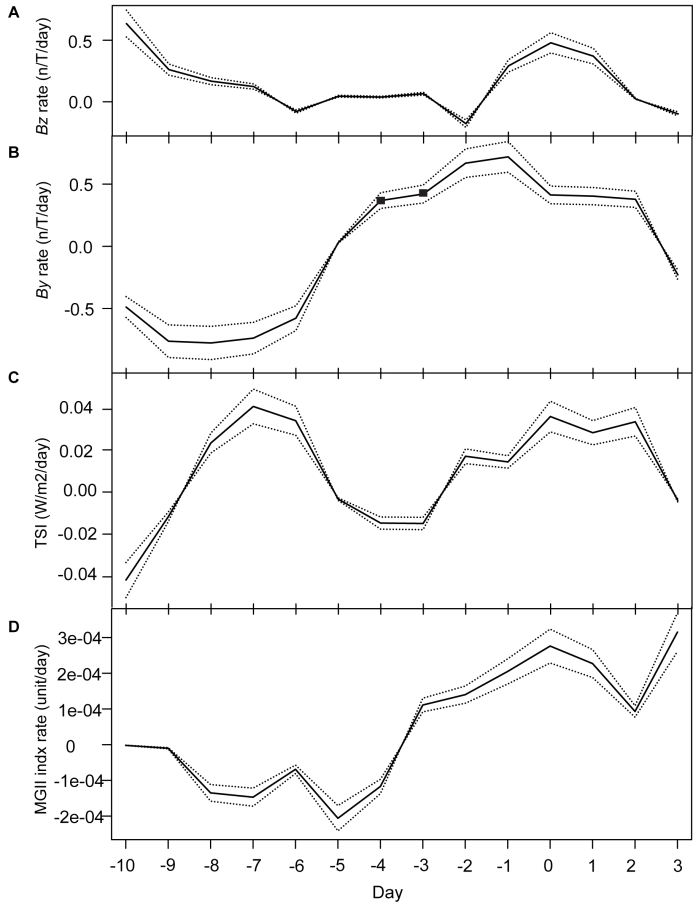

Fig. 2.

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