

Interactive comment on “Impact of geomagnetic events on atmospheric chemistry and dynamics” by I. Suter et al.

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We thank Referee 2 for the detailed comments and hope that the revised manuscript is now publishable.

Comment 1: Even though it is a nice sensitivity study, the paper is setting itself a task for which the model used is not suitable, namely to discuss regional precipitation changes in the past. Given the poor horizontal resolution of the model system, it is obvious that this task must fail. I am not saying the authors should not mention this motivation, but it should be much clearer from the beginning that they cannot expect an answer, and that they are focusing on the question "Is the global climate sensitive to a reduction in dipole moment?"

C3640

Authors reply: We agree with the Referee and delete the discussion about the possible impacts of an excursion on the glaciation in the Central Andes from the abstract. In the introduction, we add "The *initial* motivation for this study..."

Comment 2: Another major comment is that the authors treat some aspects of the coupled circulation-chemistry system as very deterministic: Quite often they describe consistent changes as causality (examples below).

Authors reply: To better address this issue we will introduce a few sentences at the beginning of "results and discussion". Some of the causalities are well established while others are inferred from the evolution of the atmospheric properties with time.

Comment 3: Finally, it would be nice to close with a nice conclusion regarding the sensitivity of the climate system to changes in dipole moment and not with a non-conclusion about regional climate change that cannot be resolved at T32.

Authors reply: We modified the conclusion, which now reads: "Regional models might provide more insights into possible precipitation changes in the Andes. High-resolution and well-dated polar ice core and subtropical speleothem records at least are in good agreement with our model showing that geomagnetic excursions very likely do not have direct and significant impacts on the global climate"

Comment 4: 6606, L16-18: This is one example of overstated causality. Yes, the ozone change is certainly a driver of circulation change, but the circulation change itself will change the ozone. A slightly stronger focus on the seasonal development would help.

Authors reply: The referee is right. The feedback processes are described in the ozone section.

Comment 5: 6606, L21-25: This is not a challenge. It cannot be done with the model used.

Authors reply: : We have removed this aspect from the abstract

C3641

Comment 6: 6607, L19: word order: last global

Authors reply: "global last" -> "last global"

Comment 7: 6607, L23: Why is this odd acronym introduced (SWW)? You discuss the NH as well (without acronym).

Authors reply: "SWW" replaced by "SH westerlies" at various locations.

Comment 8: 6608, L04: Odd reference for long-standing text-book knowledge.

Authors reply: Reference removed

Comment 9: 6608, L15: Just say that you test one of the mechanisms.

Authors reply: Sentence removed since we explain it in the next paragraph anyway.

Comment 10: 6609: Please make sure you explain the quantities (e.g. phi) before you use them.

Authors reply: The physical meaning of phi is explained directly after the use in this section and the name and symbol were introduced at the end of the introduction part.

Comment 11: 6609, L25: You use a constant NO_x conversion factor of 1.25, which is an approximation.

Authors reply: "The conversion factor for NO_x is 1.25 ..." -> "We use a constant conversion factor for NO_x of 1.25 ..."

Comment 12: 6610, L27: insert "magnetic" before pole

Authors reply: "magnetic" added

Comment 13: 6611, L4: What is a normal magnetic field?

Authors reply: The values can be found in table 1. Here "normal" refers to equal conditions as the reference.

C3642

Comment 14: 6613, L20-23: I don't follow the implied causality here, please see main comment above.

Authors reply: A stronger vortex "traps" the airmass inside it, exchange of polar and subtropical air is reduced. The polar air receives little solar radiation during winter but continues to emit IR following the Stefan-Boltzmann law, cooling down in the process.

Comment 15: 6614, L4-13: Not sure I can follow the lightning argument: Lightning NO_x sources are below the tropopause, your change seems higher (obviously the model diagnoses the lightning NO_x sources and you could check). What are augmented ozone concentrations? Are you talking about an increase?

Authors reply: The source for lightning NO_x is indeed the troposphere. Yet, the lower NO_x concentrations in the southern hemispheric troposphere lead to a smaller transport to the stratosphere. Hence also stratospheric NO_x concentrations are lower compared to the northern hemisphere. Added "leading to a smaller influx from the troposphere" "Augmented" replaced by "higher"

Comment 16: 6614, E1: Why do you need the equation? It is never used.

Authors reply: The reviewer is right that the equation is never explicitly used. Yet the authors believe that the formula provides concise insight into the behaviour of geostrophic wind in presence of a temperature gradient. It is clear that the wind change is in a right angle to the temperature gradient, increases with height and changes sign between the hemispheres without lengthy explanation.

Comment 17: 6615, L3: Give this a positive twist: Seasonal development of change is important!

Authors reply: Text modified to: "However, stratospheric zonal winds reverse semiannually and analysing wind anomalies in particular seasons might provide more detailed insights"

Comment 18: 6615, L11: colder should be lower, another case of overstated causality,

C3643

see above

Authors reply: "colder" -> "lower"

Comment 19: 6616, L11: I have no idea what this statement means! Taking differences of two geostrophic wind fields, there is no reason for not having a vertical anomaly. Delete!

Authors reply: We state that the way how a stratospheric wind anomaly can continue into the troposphere is not very well understood. I.e. the mechanisms responsible for downward transport of momentum are not well known.

Interactive comment on Clim. Past Discuss., 9, 6605, 2013.