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Climate of the Past Discussions

Interactive comment on "How to treat climate evolution in the assessment of the long-term safety of disposal facilities for radioactive waste: examples from Belgium" *by* M. Van Geet et al.

M. Van Geet et al.

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Reply to the interactive comment of J. Naslund

We received comments from 3 referees (e.g., M. Thorne, J. Naslund and D. Paillard) on the paper "How to treat climate evolution in the assessment of the long-term safety disposal facilities for radioactive waste: examples from Belgium" submitted for publication in "Climate of the Past".

Each of the referees stress that Climate of the Past could be a good place to publish this paper as it exposes a problem of interest for its readers. However, two reviewers (e.g., J. Naslund and D. Paillard) propose to modify the content of the paper: to decrease largely the part on the general context of radioactive waste disposal and to expand the

part on the climate; on the contrary, M. Thorne would like to expand the overall context by describing the main issues in more details. We decided to follow the proposal of D. Paillard and J. Naslund and to focus the paper on the climatic issue and its impact on the radioactive waste disposal instead of presenting the overall methodology followed to assess long-term safety. Moreover, the comments of M. Thorne will be treated in the SFC1 that ONDRAF/NIRAS is currently preparing.

The paper has been revised in accordance with the three referee's comments: the climate part has been amplified and is presented before the general context of radioactive waste which has been largely shortened.

The answers to your specific comments are given hereafter:

1. *"... It is therefore nice to see that the authors recognise the need for describing and analyzing the possible range of climate developments that may occur under the time spans of interest, instead of a heavy focus on a most likely climate development. This is the same approach taken by e.g. Swedish Nuclear Fuel and Waste Management Company (SKB), both in the previous safety assessment (SKB 2006) and the ongoing safety assessment which will be used as part of a license application for building a geological repository for spent nuclear fuel..."*

We refered to SKB (2006) in the revised version of the document.

2. *"reducing the text considerably in Section 2 and 3..."*

There is indeed a rather large introduction on the concept of radioactive waste disposal and the repository design. The aim was to picture the general idea of radioactive waste disposal and to inform climate experts about our specific problem and needs. The reviewer suggests to refer to proper reports, so that the sections 2 and 3 can be reduced, and more focus can be put on the subsequent climatologically aspects. The same comment was made by another reviewer. We therefore reduced Section 2 and 3. Nevertheless, we tried not to lose the main message of these sections, and referred

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to relevant ONDRAF/NIRAS reports. Note also that the order of the chapters has been changed (as recommended by another reviewer), starting with climate change, and then discussing how climate change is treated in the safety assessment of radioactive waste disposal.

3. *"The description of how scenarios are used in the safety assessment is important for the understanding of how various climate evolutions are to be analysed in the safety assessment. ... too lengthy, and should be shortened, with the inclusion of references to proper ONDRAF/NIRAS reports."*

The section on the safety assessment strategy is significantly shortened. Reference is made to relevant ONDRAF/NIRAS reports.

4. *"In the section 6 'How to treat climate changes in the safety assessment of radioactive waste disposal facilities?' it is described that the reference climate case will be a Global warming case, with additional cases describing glacial scenarios. This is fine, and in line with the general approach discussed above. The possibility of regional cooling in Belgium, due to reduced AMOC should be mentioned, even if the cooling would be manifested only as a reduced warming trend. ... If sites are located at low elevations, the possible problems associated with sea-level rise should be mentioned, especially since it is part of the reference case."*

As we cannot exclude such an event (we are even expecting it), we added some sentences on how will sea water flooding be treated in SFC1. We are going to assess the impact of sea water flooding on the different safety statements (e.g., equilibration time, effects on Rn speciation, ...).

5. *"In cases of colder climates, regardless if it occurs within the coming 150 ka or after that, it is likely that permafrost and associated freezing processes will play an important role given the geographical setting of Belgium. This is an issue that probably should be addressed thoroughly in the climate/safety assessment work. This is briefly mentioned in the manuscript, but it would be good to extend this further, including possible effects*

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of possible freezing of various parts of the repositories. Permafrost also may have a profound effect on ground water flow and chemistry. Possible effects that this may have on the specific repositories should also be elaborated more upon."

The authors are aware that the permafrost issue is essential for the long-term safety of a radioactive waste disposal. The impact of such a permafrost will imply changes in, the groundwater flows and the chemistry of the water. However, it seems that the Boom Clay intrinsic properties will remain unchanged. To describe this in details is far beyond the scope of the present paper but will be discussed in the fore coming SFC1 (2013).

6. *"In the conclusions it is said: What are we expecting from the phenomenological community: confirmation of no glaciation within the coming 100 000 years. I am not sure what this is saying. If I interpret the rest of the text correct, this is not to say that colder climate cases will not be treated for the coming 100 ka."*

We agree with the comment of J. Naslund. On the basis of the BIOCLIM hypothesis (CO2 cycle and the related residence time of CO2 in the atmosphere of 200 ka), these calculations point to an absence of new glaciations before c.a. 180 ka. This stringent hypothesis seems, according to more recent publications (e.g., 400 ka in Archer, JGR 2005), to be an underestimation. In conclusion, this timing isn't quantified and only display the current knowledge entailing the CO2 cycle (which seems to be quite slower than 200 ka). It seems thus that we are conservative.

Interactive comment on Clim. Past Discuss., 5, 463, 2009.