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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.

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This manuscript exposes the aims and the methodology of radioactive waste agencies like ONDRAF/NIRAS in Belgium in order to provide an assessment of the long-term safety of nuclear waste disposal facilities, in particular when accounting for future climatic changes. Since it presents no new scientific results and does not deal with past climatic changes, I was first wondering if "Climate of the Past" would be the right place for this manuscript. But its aim is more to raise questions that are indeed very relevant to the paleoclimatic community, since these questions are about the long term evolution of the Earth climate, on thousands to several hundreds of thousands of years. So

I believe it could still be published in "Climate of the Past" since it exposes a problem of interest for its readership. But, in its present form, I have several major comments listed below. In particular, there are some major misunderstandings on long term climatic scenarios that need to be corrected before considering publication in Climate of the Past.

1 - A large part of the manuscript (paragraphs 1 to 4) describes the general context of radioactive waste disposal, in terms of strategy, overall design and safety assessment. A significantly smaller part (paragraphs 5 to 6) discusses the climatic aspects of this problem. These proportions (2/3 versus 1/3) should be reversed. Of course it is necessary to present the overall context, but I believe that the geo-prospective part is the one relevant for publication in Climate of the Past, and the one that will be of interest to readers. As it stands, I am not sure that readers of "Climate of the Past" will read much further than paragraph 2. Another suggestion would be to start first with geo-prospective scenarios, then to discuss how and why they will be used by radioactive waste agencies.

2 - Future climatic scenarios are computed from CO2 scenarios. They are extremely dependent on them and thus there is a strong need to discuss first of all the processes involved. I am not speaking about the anthropogenic emissions, for which we can build several hypothesis based on the IPCC or on ultimate fossil fuel ressources. I am speaking about the natural carbon cycle processes that are not so well understood on such time scales. For instance, Figure 8 assumes that CO2 remains constant (at 700 ppm) over the next millenium. This is of course completely unrealistic since a large part of CO2 will be taken up by the ocean on such time scales. It is a modeling exercise, it is not a future scenario (in contrast to line 6 page 475). The anthropogenic BIOCLIM scenarios have been built on a simple removal function (from Archer et al., 1997) where different processes are accounted for through simple exponential decays. The longest time constant, representing silicate weathering, is CHOSEN at 200 000 years. The fact that no glaciation arises before about 200 000 year is of course directly linked to

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this HYPOTHESIS. It is not a strong result of the climate model but much more simply a bold a priori assumption. Interestingly, in Archer (JGR 2005), this time constant is chosen at 400 000 years. If we had taken this different hypothesis in BIOCLIM, then the next glaciation would have been postponed accordingly. This illustrates the status of knowledge on the long term carbon cycle and, according to the current litterature, this time constant could probably be taken anywhere between 100 000 and 500 000 years. It is not a problem of "climate models" stricto sensu, but much more a question of better understanding the climate - érosion - alteration - carbon cycle feedbacks, something that has never been considered yet for future climates. The authors are apparently not aware of these critical assumptions, which are determining most of the long term future evolution of the Earth.

3 - page 479 line 4: Concerning category A (1000-year time scale): "the present-day climatic conditions can most likely be maintained as representative". I simply don' t understand this statement since the next millenia is precisely the time period which will witness the largest climatic perturbation. In particular, it should be emphasized that BIOCLIM used the traditionnal modeling framework for glaciations of the Quaternary time period. The models used (LLN 2D, or conceptual models) have therefore been built to represent colder time periods (typical glacial-integlacial cycles) but not warmer ones. In particular Greenland is poorly represented and Antarctica is simply absent. According to current projections, a complete melting of Greenland and West Antarctica is a likely scenario on the millenial time scale, which could raise sea levels by 10 to 20 meters. Such a sea level rise is likely to change considerably the environnement - in particular in Northern Belgium. A clear conclusion of BIOCLIM is that we are getting obviously out of the range of Quaternary climates. A recent paper on Antarctica (Naish et al., 2009) clearly highlights the fact that other kinds of "glacial cycles" are likely to appear in a warmer world. If it is true that we are probably not entering a Northern hemisphere glaciation anytime soon (see eg. Paillard, 2006, 2009), it is also quite likely that we are heading towards a "super-deglaciation".

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4 - In the conclusions: "scenarios are ... conservative". Yes indeed, they should be. It is then very dangerous to extract conclusions from a small subset of possibilities. For instance, the authors state: "Based on the BIOCLIM project, it seems acceptable to assume a low probability of high ice volume culmination in the next 180 000 years". This entirely depends on assumptions on the carbon cycle, which have never been properly assessed as explained in point 2. Besides, in order to be conservative, the "natural scenarios A3, A4a,b" have to be considered also, since other planned or unplanned changes in the Earth carbon cycle or other major greenhouse gases cannot be completely rejected. "Models on climate evolution helps in narrowing the amount of scenarios to be considered". This is not necessarily the case, as exemplified in BIOCLIM which has broadened the range of possibilities. Models on climate evolution should on the contrary help to better define this range, and help to link hypotheses made on external or unknown parameters (society, economic choices, AND here carbon cycle...) to possible consequences. Still, the hypothesis should not be forgotten in the process.

Minor details: Fig.1 please specify "A" after "category" Why is Fig.3 labelled in terms of RTI and Fig.1 in terms of NRTI ? A common scale would be desirable for the non-specialists.

References:

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