

Interactive comment on “Modeling of stability of gas hydrates under permafrost in an environment of surface climatic change – terrestrial case, Beaufort-Mackenzie basin, Canada” by J. Majorowicz et al.

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This is a good paper describing the development of methane hydrate and permafrost bodies during the Quaternary. The author's discuss the issues of casting this history in a finite difference numerical model adequately, and in particular argue convincingly the issues that arise when modelling the simultaneous growth of permafrost and hydrate within the same pore space, and the manner by which the authors addressed it. The figures are well done. Some attention needs to be given to the text that needs some editing. I have made some suggestions. I recommend publication after considering the

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following suggestions.

Particular points on the manuscript: Page 2864: Abstract: GST should be written out in full for its first occurrence (e.g., see BMB, above it). Page 2865 line 3: insert “the overlying IBP” in place of “IBP” Page 2865 line 20-21: “and the overlying permafrost impede its migration. . .” Page 2866 line 10: This is a huge report. . .should include the citation to the authors of the actual chapter in the IPCC volume rather than just “IPCC”. Page 2866 line 15 and 19 and elsewhere: Wikipedia is not an acceptable authority for a paper.. Page 2867 section 3: good discussion of arguments re timing of IBP and GH formation and consequences. Page 2871 line 8: as also was done by Taylor (1999; 2005). Line 27-28 et seq. “as also shown by Taylor (2005: abstract and text and Fig. 3)”. Page 2871 line 17: “. . .below 250 m the GH forms first.” Not clear why this should be so. From line 10-11: “. . .it is prescribed at each depth point, which fraction. . .water/ice and which GH.” Is this “prescription” a legitimate tact to make the model work (which is OK, just say so), or is the prescription based on the thermal kinetics of permafrost and hydrate growth? More discussion needed as this enters the discussion of your Case 1 and Case 2. Page 2872 line 4: “constrained by present temperature observations and current IBP and GH layer thicknesses (needs citation to source of temperatures and thicknesses)”. Line 19: Majorowicz 2008 is not a good reference here; suggest refer to a particular paper in the original literature on Mallik, i.e. a paper in Dallimore and Collett 2005 volume. Your 3rd author should be useful here. Page 2873 lines 12-17: Since you ran the transient model, why refer here to results from the steady state profiles? Or dfid you start your transient model at 14 Ma? What does your transient results show? The “mean temperature of the cycle” is meaningless if your model considered the transient variation in surface temperatures “from -11.5 to -7.5oC”. What you mean here has to be stated better, perhaps by noting your time steps presented earlier. Line 21: reference needed to the observed hydrate at Mallik. Page 2875 lines 1-2: these incremental times in years are confusion with the equivalent times indicated on Figure 6. A simplification might be “. . .42 500 a after 6 Ma when the GST cooled from -4.5 to -5.5oC. Also, might be better to start

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the paragraph with how the model accommodates the period 14 Ma to 6 Ma. . .do you model the transient temperatures through this period? Otherwise, this paragraph is a good explanation of the assignment of available pore space and the time sequence of filling it. Page 2876 line 2: suggest “. . .shortly after the subsequent increase in GST from -5.5 to -4.5oC.Note that the GH continued downward briefly despite the increase in surface temperatures because of the time lag in the surface change reaching at depth. Line 18: “. . .IBP and GH bases. . .”. Page 2877 lines 24-25: Intra-permafrost gas hydrate was inferred at Mackenzie Delta corehole (Dallimore and Collett, 1995). Line 27: “. . .IBP and GH bases. . .”. Page 2878 13: delete comma (“;”) afyer IBP at end of line. Page 880 line 20: correct spelling is “Henninges”.

Figures: Figure 1: indicate and label the location of the Mallik well, as text references to it. Then also include reference to Mallik in the caption (Dallimore and Collett, 2005). Figure 2: which scale does the blue curve relate to? The Vostok delta T or the Benthic Carbonate? “mln” is an incorrect abbreviation for “million” in SI. Change both labels from “cycle” to “cycles” Figure 3: conductivity “3.4 x 2.1” is confusing. I know what you mean, but clarify it. It is always helpful to paraphrase the text and indicate in the figure caption what it shows: i.e., “The figure shows that gas hydrate is not stable under steady state surface temperatures higher than -5oC” or “. . .gas hydrate is stable only for steady state surface temperatures lower than about -5oC for the terrestrial heat flow and thermal properties of the Mackenzie-Beaufort region.” Figure 4: Figure 5: Figure 6: indicate “Case 2” in the caption. The green line (labelled 5.49998 Myr”) should be rounded to “4.5 Myr”, i.e., the profile just after the rise in GST. Suggest add additional text as in Figure 7. Figure 7: indicate “Case 2” in the caption. Same comment about rounding off as Figure 6. Figure 8: indicate “Case 2” in the caption. Replace (“the real one”) by something like “upper boundary of theoretical hydrate according to. . .” Figure 9: indicate “Case 2” in the caption. Same comment as in Figure 8.

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