Review “Inclusion of MyAMI-derived Mg/Ca corrections to the marine carbonate system in the cGENIE.cookie Earth system model (v.0.9.90)” by Adloff et al. for Geoscientific Model Development

General comments

Dear Editor, dear Adloff et al.,

This paper presents a detailed methodological description in how to combine the “MyAMI” model with “cGENIE” Earth system model, to evaluate the seawater ratio of Mg and Ca to marine carbonate systems. First, the lookup-table approach is carefully tested to ensure no substantial errors. Second, it designs reasonable comparable experiments to discuss the mechanisms. Third, it improves the “cGENIE” model application and prediction considering ocean major ion changes, which might be very useful for research ocean carbonate chemistry changes in aragonite sea and calcite sea transition.

I found no major issues in this paper. There are some typos and expressions that need to be corrected. In sum, I am very positive about it and support publication after further improvement.

Suggestions on methodology and evaluation of results

This paper is a further development of the cGENIE model. It has a detailed description of its extension configuration. However, I have some suggestions for the methodology and results:

(1) From the perspective of judging the result, I suggest adding the observed modern states, for example, the marine carbonate contents, and comparing the observed data with the absolute predicted data the model predicted. This steady state comparison would provide more convincing results for the improvement of the model. Could the observed data figures be added to Figure 4 and Fig. SI.6? Please consider.

(2) Another suggestion is that it might be useful to add one or two depth-resolved profiles of other variables like Figure 8, to illustrate how the revised chemistry affects the deep ocean.

Main text

Line 54: Suggest the electric charge should be marked on the top right as line 56 does.

Line 193: Typo, two "K_1", the second one should be "K_2".

Line 232: Suggest writing clearly the abbreviation of what "fCO2" is. It is not mentioned in the preceding text.

Line 240: Typo, missing the right bracket.

Line 246: E25 is wrong. It should be around "0.028", not "0.000416" (this is boron value).

Line 264, 269: Typo, should be "Ω", not "W".

Line 275-278: Suggest rechecking about the unit. If "T" multiply "R", they should both in "K".

Line 277-279: Typo, should be "ΔV", not "DV".

Line 299, 342: Suggest writing clearly the abbreviation of what "F77, f90" is.

Line 360: Typo, it should be "ppm" not "pm".

Line 503-505: Suggest reorganizing the sentences. "Ω increase is largely due to the [CO_3^{2-}] and, to a lesser extent, the increased $K_{sp,cal}$", is opposite to the E28 and basic understanding.

Line 693: Typo, "experiment".

Line 758-759: The reference format is different from others.

Figures in main text

Figure 2: Suggest the name of the explanation of the figure should be changed. Not “in situ K_1”, but “K_s” because “K_1”, “K_2”, and “$K_{sp,cal}$” are all compared.

Figure 3, 6: Suggest making clear the depth ranges of ocean “surface” and “benthic”. This might be already defined in the cGENIE model. A brief explanation for this could help the readers understand the difference of “surface” and “benthic” more clearly.

Figures in supplementary information

Fig. SI.2,3: Typo, missing “K” in each plot title.