Dear Editor,

We sincerely thank you for the careful re-evaluation of our manuscript. We appreciate the editor's recognition that the manuscript has been substantially improved. We have carefully addressed the remaining concerns and revised the manuscript accordingly. Our point-by-point responses are provided below.

Comment 1:

At Line 30, the statement that the four trapping mechanisms "occur sequentially" is overly restrictive, because these mechanisms may overlap and operate concurrently over different timescales. Please revise this statement accordingly.

Response: Thank you for this valuable comment. We agree with the reviewer that describing the four trapping mechanisms as occurring sequentially is overly restrictive. We have revised the sentence at Lines 30–31 as follows:

"structural, residual, dissolution, and mineral trapping may operate concurrently and evolve over different timescales"

Comment 2:

Please carefully check the consistency between the in-text citations and the reference list. For example, Saaltink et al. are cited as both 2013a and 2013b, although only one corresponding reference is listed. Similarly, Wang et al. (2022b) is cited without a corresponding Wang et al. (2022a). These citations should be corrected and standardized throughout the manuscript.

Response: We thank the reviewer for identifying these inconsistencies. We have carefully cross-checked all in-text citations against the reference list and standardized the citation format throughout the manuscript.

Specifically, the citations to "Saaltink et al. (2013a)" and "Saaltink et al. (2013b)"

have been corrected to “Saaltink et al. (2013)”. Similarly, “Wang et al. (2022b)” has been corrected to “Wang et al. (2022).” Other citations and reference entries were also reviewed to ensure that every in-text citation has a corresponding entry in the reference list and that the year suffixes are used only when multiple publications by the same authors in the same year are cited. We also reformatted the complete reference list according to the HESS reference style and verified that every in-text citation has a corresponding reference-list entry and that every listed reference is cited in the manuscript.

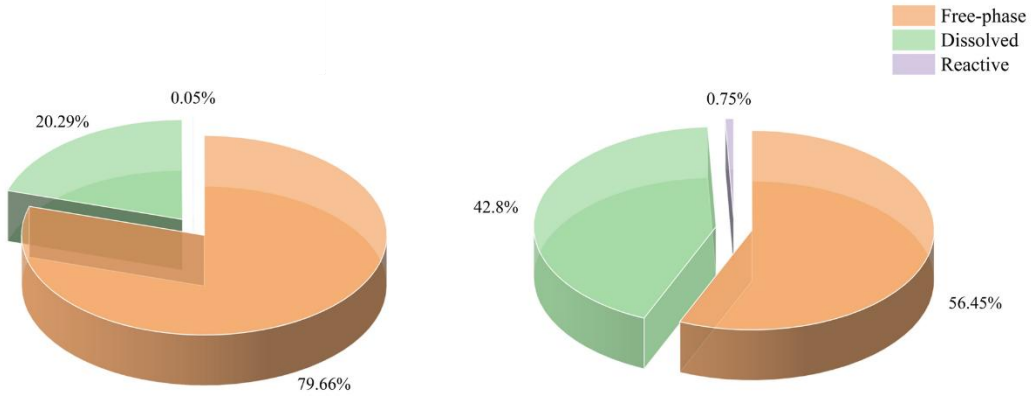
Comment 3:

Figure 7 and the associated interpretation require further revision. The use of a stacked-area plot with a logarithmic y-axis makes it difficult to interpret the stated relative contributions of approximately 60% physical trapping, 40% dissolution trapping, and less than 1% mineral trapping. It is unclear how these percentages can be directly derived from the current figure. Please revise the figure or its presentation so that the relative contributions of the different trapping mechanisms can be clearly and quantitatively identified.

More importantly, the treatment of calcite dissolution as “mineral trapping” requires reconsideration. Mineral trapping conventionally refers to the net incorporation of injected CO_2 into solid carbonate minerals through precipitation. Calcite dissolution may influence aqueous carbon storage and provide cations for subsequent mineral precipitation, but it does not by itself represent mineral trapping. The authors should therefore re-examine the definition and calculation of the mineral-trapping contribution reported in Figure 7.

Response: We sincerely thank you for this important comment. We agree that the original stacked-area plot with a logarithmic y-axis did not allow the relative

contributions of the different CO_2 states to be identified directly and quantitatively. To improve the clarity of Figure 7, we have replaced the original time-dependent stacked-area plot with two pie charts showing the relative proportions of CO_2 in the different modeled states at 1 year and 500 years, respectively. The percentage contribution of each state is now explicitly labeled in the figure. This revised presentation provides a direct comparison between the early and late stages of the simulation and more clearly illustrates the progressive transformation of CO_2 from the free-phase to the dissolved phase over time.



(a) 1year (b)500 years

Figure 7: Relative proportions of CO_2 in the free-phase state, dissolved state, and reactive state at simulation times of 1 and 500 years. The two pie charts illustrate the redistribution of injected CO_2.

We also agree with the reviewer that calcite dissolution should not be referred to as "mineral trapping." The present model considers calcite dissolution and associated geochemical reactions but does not include secondary carbonate precipitation. Therefore, the previously used term "mineral trapping" was inaccurate. Accordingly, we have replaced "mineral trapping" with "reactive CO_2" throughout the revised manuscript and Figure 7. See lines L273-279:

"Figure 7 illustrates the temporal evolution of the contribution of each trapping mechanism in the study case. Given the practical difficulty in distinguishing between

structural and residual trapping, these are collectively categorized as free-phase CO_2. The results indicate that free-phase CO_2 remains the dominant mechanism throughout the simulated period, accounting for 79.66% of total trapped CO_2 during the early injection period (within 1year). As dissolution and geochemical reactions progress, the proportion of free-phase CO_2 gradually decreases to 56.45% (500 years). After 500 years, dissolved CO_2 accounted for 42.80% of the total sequestered fraction. Reactive CO_2 constitutes less than 1% of the total. As dissolved CO_2 concentration declines in later stages, the reactive fraction stabilizes at 0.75%."