

Review of Bing et al., 2022

This study analyzes the global and regional uptake of CO₂ by lime through the different process of lime production from 1963 to 2020. This study is of interest for the global carbon community, as it is important to more accurately account for sources and sinks of CO₂ by lime-containing materials for better estimation of its impact on the carbon cycle. However, the manuscript is not clear for certain aspects of the study, a lot of information is missing, and more analyses should be done. I could not find the supplementary information, and the study mentions a model to conduct this work but no information on this model is provided in the manuscript. Please, find my comments below.

General comments:

Ln. 22. For the period 1963 to 2020, your results show that 38.79% of CO₂ emissions were sequestered by lime production from the total global CO₂ lime emissions. So, your results and this sentence suggest that global CO₂ sink from lime corresponds to ~40% with ~60% of global CO₂ source from lime. How, Ln 22-23, can you justify that lime materials is a global carbon sink that can reduce the carbon footprint of lime production? Need more clarification in the abstract.

Additionally, in the abstract you are only giving numbers of the CO₂ lime uptake at a global scale and for China. What about the CO₂ lime emissions for the 1963-2020 period for China and at global scale?

Ln 65. You mentioned “this study significantly improves the global carbon uptake model” but what was improved and how? No information in the whole manuscript could be found on this improvement. More information should be provided on this improvement.

Ln.80. You assumed for the PCA calculation that you have a linear relationship between variables, but how would you justify that there is a linear relationship for the data over the period 1963-2000? Additionally, is the lime production linear over the period 1963-2020 for all three regions?

Ln. 96. “Considering the availability of lime production data”, what do you specifically mean by availability of the data? Additionally, what are the uncertainties associated with the dataset used in this study? Any uncertainty in the lime production data of China and US?

Ln 96 and Equation 1. Why are you using method 1 and not method 2 (which use a correction factor) or 3 here? Should be mentioned in the text. The indexes “I” and “i” in your equation are not defined.

Ln 101. Is this method for estimating emissions factors based on tier1 method from IPCC 2006? If yes, which tier method for choosing the emissions factor are you using exactly?

Emission factor for combustion have values depending on the category and on the target year. Are the values of emission factor used for lime production and in this line for specific year and specific process type?

Based on the table available from IPCC 2006 (https://www.ipcc-nggip.iges.or.jp/EFDB/find_ef.php?ipcc_code=2.A.2&ipcc_level=2), developing countries emission factor for dolomitic lime production is equal to 0.77 t CO₂/tlime while developed countries value is of 0.86. The emission factors mentioned in your paper do not correspond to those from IPCC database, can you develop why?

What are the uncertainties associated with the emission factor and how did you count of these uncertainties in your study?

Equation 3. According to IPCC 2006, the amount of dust depends on the type of kiln used in lime production. Have you considered the type of kiln in the parameter r_{kld} of your equation?

Section 2.3. In this section, there is no information on where all parameters used for the equation come from. For instance, there is no information on the rate of Cao to CaCO₃ in dust. More information on these parameters should be inserted.

Ln. 193. “[...] were utilized as inputs for the model (see the Supplementary Information).” First, I could not find the Supplementary Information. Second, there was no information of the model used for this study so far. Model name, model goal, model algorithm, ... were not introduced so far. There should be a section to describe the model used for this study.

Ln. 195. This expression is not clear. Why use the year t_i-1 to calculate the uptake of CO₂ in year t_i ? It is not clear also how the contribution of annual uptake of carbon to the total carbonation can be calculated by using this expression. Please, clarify.

Section 2.5. The uncertainty analysis is not enough detailed. The carbon absorption factors, and activity level data are only introduced here. More information on these parameters are needed. More information on the model uncertainty and statistics should be found here and not in supplement information (which cannot be found).

As mentioned in IPCC 2006, complete activity data are needed. Omission of use or lime production as a non-marketed intermediate, not well accounted for in inventories, may lead to an underestimation of lime production by country by a factor of 2 or more. Uncertainties associated with LKF are also non negligible. Have you accounted for these uncertainties by country?

A section should give information on the carbon sequestration analytical model used for this work.

Ln.207-211. You mentioned a decrease in emissions in 2009 due to the financial crisis of 2008. But we can also observe a decrease in 2017, 2018, and some other years before. What are the reasons for all these decreased emissions?

Additionally, what is the reason for the sudden increase in emissions starting 2002? Ln. 213 seems to answer this question, but it is not clear if the increase mentioned Ln. 213 refers to the large increase starting in 2002.

You should give a description of the net emissions here. As we can see, net emissions (process + uptake) show net source of CO₂ emission at global scale.

It is not clear also if these results are based on the inventories or your model results. Please, clarify.

“Subtraction of the amount of CO₂ absorbed from CO₂ emissions”, it is not clear which CO₂ absorbed from CO₂ emissions are you talking about. Please, clarify.

Ln 214. There should be information as well about the period 2002-2020 for comparison with the global annual average.

You considered ROW as regions of developing countries Ln. 101. However, countries considered as developed countries might be included in it, such as Canada. Ln. 225, you mentioned there is “significant

import of lime from Canada” to the US. Is Canada part of ROW region? If yes, can you really consider ROW as developing countries?

If ROW region was grouped into two categories (developed and developing countries), what would be the CO₂ emissions for both categories?

Ln. 231. What is the percentage of uptake of CO₂ compared to the emissions of CO₂ at global and regional scales?

Figure 3.b. Results from this figure have not been used. What is this figure used for and telling us?

Ln. 247. Should be Fig.3b

Ln. 248. This sentence is not clear. Do you mean, the uptake of CO₂ by dust decreases or increases since 1963? Uptake of CO₂ by dust in 2020 is available but value for 1963 should be mentioned here as well.

Ln. 270. According to your results, “the uptake of lime-containing materials rapidly increased from 1963 to 2020”, but you mentioned earlier as well that this increase is proportional to the lime-containing materials uses and production. Does the uptake increase proportional to the emission during the period, or is this uptake increasing at a certain point? Maybe your results should be displayed by removing the trends, or additional detrending results should show the uptake and emissions of CO₂ during all stages of the lime cycle, by region and a global scale. With your current results, it is difficult to say if there is or is not an increase in CO₂ uptake by lime-containing materials.

Ln. 275. You mentioned that if the lime sink would be incorporated in the global carbon budget (GCB), the carbon sinks could be improved, however, let’s not forget that the emissions of CO₂ associated with the calcination of lime and limestone outside of cement production is not considered in the GCB. Knowing that the net emissions from lime production are a source of CO₂, if the lime source and sink were included in the GCB, how much do you think the net emission from the GCB would change? Discussion on this aspect should be included here.

Ln. 285 and Figure 5. Additional results should show the cumulative sources of CO₂ as well as the cumulative net CO₂ emissions. And further discussion should be added about the net emissions.

Ln. 300. How can we consider lime as a carbon sink when the net emissions show a source of CO₂?

Specific Comments:

Ln. 14. Which existing data are you referring to? You are analyzing these data (satellite, in situ?) in your study, so you should mention here the data used (names of data?).

This sentence contains twice materials (“materials associated with the production [...] of lime-containing materials”), could you rephrase?

Ln. 15. The model used should be mentioned here.

Ln 20. Which associated process are you mentioning? Is this process the production of lime materials?

Ln. “Total uptake”, do you mean total global uptake?

Ln 62. The three stages should be mentioned here for clarification:

Limestone calcination (lime production)
Hydration reaction (lime decomposition)
Lime carbonation

Ln. 72. “[...] data on lime production from 1963 to 2000 in China were not available in the existing databases.” What do you mean? Regarding the following sentence, you should mention that there was no data during this period in the China Statistical Yearbook.

Ln. 79. What are xxx and xx? Need more precision. “A linear regression was then built with xx”, what does xx correspond to?

Ln. 94-96. The sentence needs to be rephrased.

Ln.98. “in the present”, what do you mean by it? Today?

Ln. 105. A reference is missing here.

Equation 2. what is “l” referring to?

Ln. 117. Units are missing

Ln. 155. How many years are sufficient consequently?

Equation 11. Indexes “m” and “p” are not defined.

Ln. 182. Only “a” and “b” are in equation 18. Where are “a” and “b”?

Ln. 193. “were utilised” should be “were utilized”

Figure 1 was not used in the manuscript.

Ln. 204. “and at a global scale” should also be mentioned.

Ln. 445. (a) should mention “at a global scale”

Figure 2. Are the global annual CO₂ emissions from IPCC 2006? The dataset used for US, China and ROW emissions were defined in the methodology but not the global annual emissions.

Figure 2.a. What are the shadows representing? Information on this shadow should be included in the caption of the figure.

Ln. 232. “whereas the area represents the cumulative uptake in each region under natural conditions.” it is not clear which area you are talking about. Which natural conditions are you mentioning? For which process?

Ln. 205. The meaning of CI (Confidence Interval) should be mentioned in the text.

Ln. 233. Is this value for global scale or for a specific region?

Ln. 273-275. Specific values in Gt/yr should be mentioned here.

Ln. 288. “inconsistent”, what do you mean by these results are inconsistent with those from cement carbon sink? Maybe inconsistent should be changed with another word: “these results contrast with those obtained for the cement carbon sink [...]”?

Ln. 294. CO2 -> CO₂

Ln. 301-302. Global CO₂ emissions reported here in MtCO₂.yr⁻¹ are smaller than reported for China in section 3.1. Please, revise.