

## Global Carbon Budget 2024

### Response to Referee 2

It is an impressive annual update and an increasingly significant body of work. I have some minor comments below to improve readability. On a minor note, the style of the figures is quite different and could be harmonised, but this doesn't detract from the results, discussion and conclusion.

Specific comments:

Line 431 remove “(“ and add comma

**Done, sentence rephrased to: “Four bookkeeping approaches were used to quantify gross emissions and gross removals and the resulting net  $E_{\text{net}}$ , the updated estimates each of BLUE (Hansis et al., 2015), OSCAR (Gasser et al., 2020), and H&C2023 (Houghton and Castanho, 2023), and the new estimates of LUCE (Qin et al. 2024).”**

Line 627 what are hidden neurons - bootstrapping?

**The term “Hidden Neurons” refers to artificial neurons in a neural network layer referred to as “hidden layer” in the literature. Hidden layer simply refers to a network layer that is neither input nor output layer (thus hidden). For more clarity we rephrased the sentence to: “To avoid overfitting, the neural network training was done using a Monte Carlo approach, with a variable number of artificial neurons (varying between 2-5) and 20% of the randomly selected training data were withheld for independent internal testing”**

Line 654 summer is not always boreal, also this sentence has something wrong grammatically

**Corrected and slightly rephrased to: “Like for the ocean forecast, the land CO<sub>2</sub> sink forecast for the year 2024 is based on (a) the historical (Lan et al., 2024) and our 2024 estimate of atmospheric CO<sub>2</sub> concentration, (b) the historical and our 2024 estimate of global fossil fuel emissions, and (c) the boreal summer (June, July, August) Oceanic Niño Index (ONI) (NCEP, 2024).”**

Line 659 - missing neurons?

**Similar to above we rephrased for clarity: “To avoid overfitting, the neural network was trained with a variable number of artificial neurons (varying between 2-15), larger than for  $S_{\text{OCEAN}}$  prediction due to the stronger land carbon interannual variability. As done for  $S_{\text{OCEAN}}$ , a Monte Carlo type pre-training selects the optimal number of artificial neurons based on 20% withheld input data, and in a second step, an ensemble of 10 forecasts is produced to provide the mean forecast plus uncertainty”**

Line 666 and subsequent, shouldn't xCO<sub>2</sub> be written XCO<sub>2</sub>?? not mole fraction of CO<sub>2</sub>

**Done**

Line 1047 this statement seems self-evident something is always greater than nothing

**Sorry, we cannot see which statement in the manuscript this referee comment refers to.**

Line 1100 Orphan “(“

**Done**

Line 1106 “does” should be “do”

**No, the subject of this sentence is singular (the effect of climate change)**

line 1176 strange formatting

**Corrected**

Line 1212 add “may” underestimate

**Done**

Line 1247 This sentence doesn't quite make sense. “As for the ocean...”

**Corrected**

Line 1348 should be “is derived from”

**Done**

Tables: 2 in CO<sub>2</sub> should be a subscript

**Done**