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# Carbon Dioxide Circulation

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Carbon cycle models referred to by the IPCC are all-encompassing and they apply several sub-models designed for special tasks like $CO_2$ exchange with plants. The objective of this presentation is to analyze critically the IPCC's carbon cycle model and to compare its key figures to the results of the 1DAOBM-3 model of Ollila.

The $CO_2$ circulation models referred to by the IPCC show that the increase of atmospheric $CO_2$ by 240 GtC from 1750 to 2011 is anthropogenic, which corresponds to the permille value of about -13 ‰, for $^{13}C$ but the observed value is only -8.3 ‰, see Figure 1.

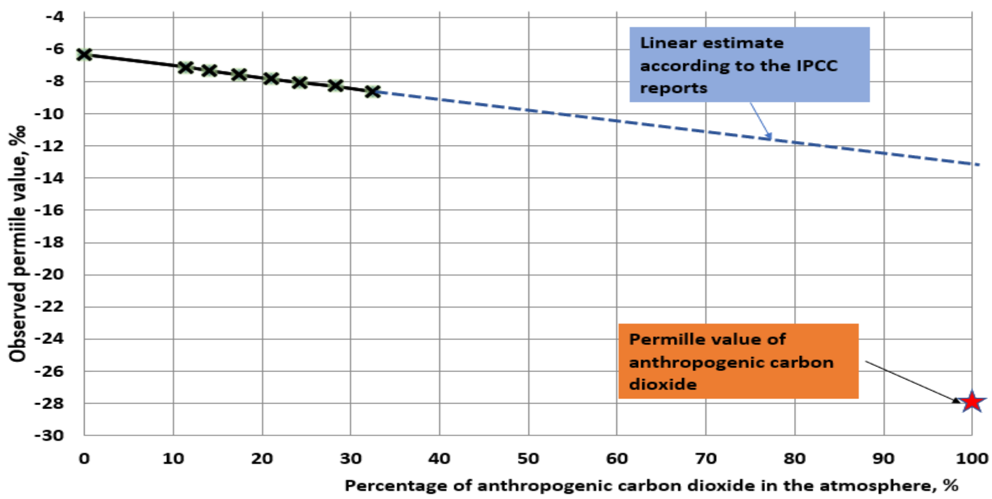


*Figure 1. The permille value of the atmospheric $^{13}CO_2$ would be about 13.0 ‰ if it were totally anthropogenic by origin according to the IPCC calculation method.*

Because most of the $CO_2$ circulation models use the buffer-restricted ocean uptake rate of about 2.3 GtC $yr^{-1}$, they have this same "wrong carbon" problem as in the atmosphere.

This may be the reason why the $\delta^{13}C$ data and analyses are almost nonexistent in Assessment Report 6. The carbon cycle fluxes of the IPCC between the atmosphere, the ocean, and the land show discrepancies. The removal rate of the anthropogenic $CO_2$ conflicts with the observed decay rate of 64 years of $^{14}C$ which is an ideal tracer test of anthropogenic $CO_2$ decaying rate in the atmosphere.

The $CO_2$ circulation model 1DAOBM-3 of the author is based on 26 equations that describe $CO_2$ fluxes between the three reservoirs, namely the atmosphere, the ocean, and the land. The $CO_2$ fluxes and yearly amounts since 1750 have been divided into natural, anthropogenic, and total.

Basic physical processes like mass balances, mixing, and absorption have been utilized. Only one parameter in these equations is based on the observation, namely the permille value of the year 2017. Even though 1DAOBM-3 does not apply the “buffer-factor” approach like in the IPCC models, the maximum net dissolving rate of total $CO_2$ is only 1.9 GtC $yr^{-1}$, which is smaller than the maximum uptake rate of 2.3 GtC $yr^{-1}$ found in the IPCC models. The explanation is that the ocean dissolves anthropogenic $CO_2$ in greater amounts but returns natural $CO_2$ almost in the same amounts back to the atmosphere which keeps the total uptake amount of the ocean very small.

The author’s improved 1DAOBM-3 carbon circulation model shows that the anthropogenic $CO_2$ amount in 2011 was only 72 GtC, satisfying the observed atmospheric permille values from 1750 to 2017. The $CO_2$ circulation between the ocean and the atmosphere has increased the amount of atmospheric $CO_2$ by natural $CO_2$ 198 GtC from the ocean. The fossil fuel $CO_2$ increase by 2017 has been 433 GtC, divided into three reservoirs: 72 GtG in the atmosphere, 127 GtC in the biosphere and 234 GtC in the ocean, Figure 2.

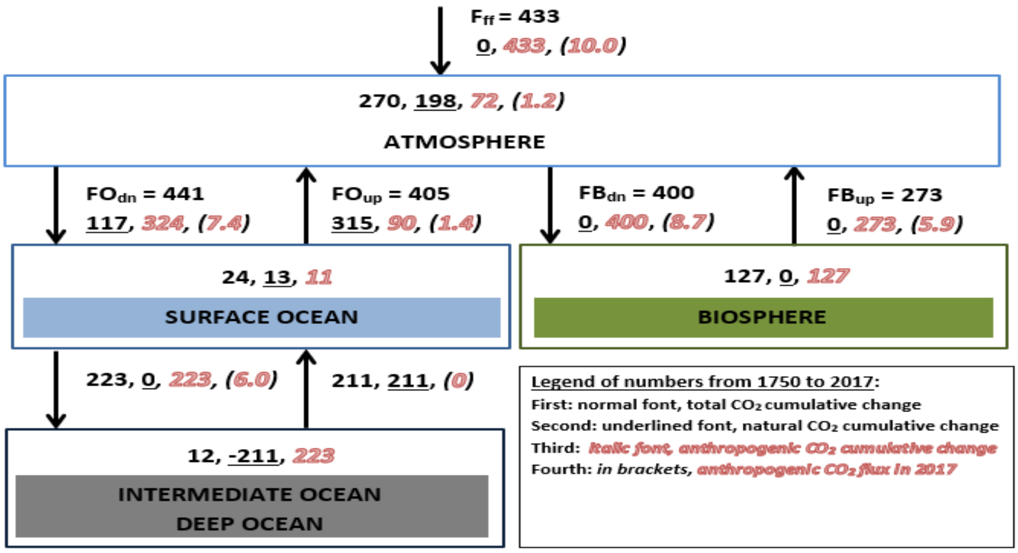


*Figure 2. The carbon budget amounts and fluxes according to 1DAOBM-3 model.*

The simulations for 1000 GtC emissions by 2100 have been carried out by three models, including 1DAOBM-3, Bern2.5CC, and the mean model of 15 circulation models (called Joos2013). The residence time of 1DAOBM-3 is 16 years for anthropogenic $CO_2$ impulse, the same as for the radiocarbon decay time. The residence time of the total atmospheric $CO_2$ approximated with one time constant is about 70 years meaning a relaxation time of 280 years. These values are much shorter than the residence times of two other models, which show that 25±9 % of any anthropogenic $CO_2$ is still found in the atmosphere after 1,000 years. The reasons have been analyzed. The advantage of 1DAOBM-3 over the other models is that its results are in line with the oceanic and atmospheric observations from 1750 to 2017 like the permille value of the atmosphere, the model-calculated $CO_2$ concentration, and the decay rate of the anthropogenic $CO_2$.

## Reference

Ollila, A. (2019*). Analysis of the Simulation Results of Three Carbon Dioxide ($CO_2$ ) Cycle Models.* DOI: 10.9734/psij/2019/v23i430168