NEW CONSTRAINT ON ESTIMATION OF THE ANTHROPOGENIC CO$_2$ BUDGET: RELATIONSHIP BETWEEN CONCENTRATION AND δ^{13}C OF ATMOSPHERIC CO$_2$ DETERMINED FROM ICE CORE ANALYSIS (ABSTRACT)

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Studies on ice cores from Antarctica and Greenland revealed variations in the concentration and δ^{13}C of ancient atmospheric CO$_2$. Since the Industrial Revolution, addition of anthropogenic CO$_2$ to the atmosphere has caused a significant increase in atmospheric CO$_2$, accompanied by a decrease in δ^{13}C of atmospheric CO$_2$. The relationship between them shows that the δ^{13}C value of CO$_2$ which remained in the atmosphere is significantly larger than -25 ‰ of that originated from coal burning and deforestation at mid-latitudes. So, we consider that the δ^{13}C value of CO$_2$ uptaken from the atmosphere should be small. Then we calculated the δ^{13}C value of CO$_2$ which remained in the atmosphere, obtaining a result of about -13‰. We considered that this fact would be useful as a new constraint on the anthropogenic CO$_2$ budget.

On the other hand, IPCC 1994 reported the revised budget of anthropogenic CO$_2$ and emphasized that the problem of the missing sink of CO$_2$ was solved. So, as this budget is determined for carbon as an element (that is, ^{12}C), we examined the budget reported by IPCC for ^{13}C.

In the anthropogenic CO$_2$ budget in IPCC 1994, for the sources the δ^{13}C values of 5.5 Gt/yr of carbon which originates from emissions from fossil fuel burning, and 1.6 Gt/yr from emission from deforestation in the tropical region may be given as -27‰ and -30‰, respectively. For the sinks, the δ^{13}C values of 3.2 Gt/yr of carbon which remains in the atmosphere, 0.5 Gt/yr in northern hemisphere forest regrowth and 1.4 Gt/yr in additional terrestrial sinks may be given as -13‰, -25‰ and $-30\sim-25$‰, respectively. Therefore, as the result of calculation, δ^{13}C of 2.0 Gt/yr of carbon which is uptaken in the ocean became very small, $-54\sim-46$‰. This result cannot be explained by the observed fractionations for CO$_2$ exchange between the atmosphere and the ocean, photosynthesis and formation of carbonate.

This indicates that the anthropogenic CO$_2$ budget reported by IPCC 1994 still has some problem.