Abstract ID : **110**

Improving the interpretation of isotopic composition of oxygen in the atmospheric dioxygen trapped in ice core from biological experiments in closed controlled chambers

Content

The isotopic composition of dioxygen trapped in air bubbles in ice core can be used to reconstruct global gross biosphere productivity in the past as well as document the evolution of low latitude water cycle. Still, the isotopic composition of dioxygen is influenced by many physical, chemical and biological processes during consumption and production of dioxygen by the oceanic and terrestrial biosphere. For an accurate quantification of the past biosphere productivity, it is thus important to determine the different fractionation processes occurring in the biosphere during respiration and photosynthesis processes.

We present here quantification of fractionation coefficients associated with δ18O and the Δ17O of O2 during respiration and photosynthesis within the terrestrial biosphere. The experimental set-up relies on closed biological chambers in which all the environmental parameters are controlled and measured.

For a first experiment, the triple isotopic composition of oxygen is regularly measured in a single closed chamber (with soil and Festuca arundinacea) through sampling of flasks at a low frequency (4 h to 4 days). The isotopic composition of the dioxygen was measured an IRMS equipped with dual inlet (Thermo Scientific MAT253 mass spectrometer). Seven 2-month long experiments were performed in order to check the reproducibility of our set-up and quantify uncertainty on the determination of the fractionation coefficients. For the first time, with this closed chamber, a terrestrial photosynthetic fractionation has been discovered.

For a second experiment currently underway, the isotopic and elemental composition of dioxygen is regularly measured in 3 chambers in parallel using regular sampling for IRMS analyses and continuous measurements with a new optical spectroscopy instrument based on the Optical Feedback Cavity Enhanced Absorption Spectroscopy (OF-CEAS) technique. The aim of this second experiment is to compare the different respiration and photosynthesis fractionation factors for different plant functional types. For example, a good application is to study the difference between C3 and C4 plants because C4 plants do not photorespire.

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Track Classification: Biogeochemical Cycles in the Earth system – data and models