Séminaire

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Unlocking the potential of carbon-14 in ice cores: methane time bombs, cosmic rays and atmospheric chemistry

Measurements of 14C in carbon dioxide (CO2), methane (CH4) and carbon monoxide (CO) from glacial ice are potentially useful for absolute dating of ice cores, studies of the past atmospheric CH4 budget and for reconstructing the past cosmic ray flux and solar activity. Interpretation of 14C signals in ice is complicated by the fact that there is a poorly-understood in situ cosmogenic component in addition to the trapped atmospheric component.
We have developed new methods for high-precision analyses of 14C from large-volume samples of ancient air extracted from glacial ice. These measurements have allowed for the first time to use 14C to test the hypothesis that massive natural reservoirs of "old" carbon, such as marine methane clathrates and permafrost destabilize and release large amounts of methane into the atmosphere at times of global warming, providing a positive feedback to the warming. Our results from Greenland and Antarctica suggest that old carbon sources do not play a significant role in the largest abrupt atmospheric methane increase event during the last deglaciation.
Our results have also allowed for an improved understanding of the cosmic-ray produced component of 14C in glacial ice. We have demonstrated for the first time that 14C-methane is produced directly in ice as a result of neutron and muon interactions with O-16. Our measurements have also showed conclusively that 14C that is produced in the firn (compacted snow layer near the top of an ice sheet) is lost very rapidly to the atmosphere. This rapid loss of in situ cosmogenic 14C opens the door to using 14C of trapped atmospheric carbon monoxide in ice cores as a tracer of past variations of the overall oxidative capacity of the atmosphere.