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Towards constraining the stratosphere-troposphere exchange of radiocarbon: strategies of stratospheric $14CO_2$ measurements using AirCore

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Radiocarbon (14C) plays an important role in the carbon cycle studies to understand both natural and anthropogenic carbon fluxes, but also in atmospheric chemistry to constrain hydroxyl radical (OH) concentrations in the atmosphere. Apart from the enormous 14C emissions from nuclear bomb testing in the 1950s and 1960s, radiocarbon is primarily produced in the stratosphere due to the cosmogenic production. To this end, better understanding the stratospheric radiocarbon source is very useful to advance the use of radiocarbon for these applications. However, stratospheric 14C observations have been very limited so that there are large uncertainties on the magnitude and the location of the 14C production as well as the transport of radiocarbon from the stratosphere to the troposphere.

Recently we have successfully made stratospheric 14C measurements using AirCore samples from Sodankylä, Northern Finland. AirCore is an innovative atmospheric sampling system, which passively collects atmospheric air samples into a long piece of coiled stainless steel tubing during the descent of a balloon flight. Due to the relatively low cost of the consumables, there is a potential to make such AirCore profiling in other parts of the world on a regular basis. In this study, we simulate the 14C in the atmosphere and assess the stratosphere-troposphere exchange of radiocarbon using the TM5 model. The Sodankylä radiocarbon measurements will be used to verify the performance of the model at high latitude. Besides this, we will also evaluate the influence of different cosmogenic 14C production scenarios and the uncertainties in the OH field on the seasonal cycles of radiocarbon and on the stratosphere-troposphere exchange, and based on the results design a strategy to set up a 14C measurement program using AirCore.