



How to derive global weathering rates from ice core measurements of atmospheric tetrafluoromethane?

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The net balance of CO₂ emitted from the Earth interior and the global silicate weathering rate is one component regulating the atmospheric CO₂ concentration on glacial/interglacial timescales. Deriving robust estimates on global weathering rates is a difficult multidisciplinary field. Here we present a new approach using reconstructions of atmospheric tetrafluoromethane concentrations from deep ice cores and discuss its limitations. Fluorite, which is an accessory mineral found in rocks like granite and gneiss, contains trace amounts of tetrafluoromethane, CF₄, (Harnisch et al., 1996). Recent sources are dominated by anthropogenic emissions from aluminum smelters and the semiconductor industry, whereas weathering of fluorite bearing rocks is the only natural source of this atmospheric trace gas.

As tetrafluoromethane is inert to destruction processes in the troposphere and stratosphere, the only sink lies in the high mesosphere due to destruction by short wave UV radiation. As a consequence, CF₄ has a very long life time in the order of 100 ka or even longer.

As CF₄ is mainly released from weathering of granitic rocks we assume that its atmospheric concentration might show fluctuations on longer time scales as weathering intensity should change on glacial-interglacial timescales or longer. Also glacial erosion of the large continental ice sheets in Canada and Scandinavia could be important as these areas have widespread granitic or gneiss basement rocks and glacial erosion is more intense than ordinary fluvial erosion.

From firn air measurements we know that its preindustrial concentration was about 35 pptv (Worton et al., 2007). The only information from older times comes from a few measurements around the LGM and the last deglaciation on outcropping ice from Greenland, with almost constant values around 35 pptv (Muhle et al., 2010). So, there exists no indication of variations on time scales of 10000 years.

Our first low resolution measurements covering the last 750 ka show remarkably constant CF₄ concentrations, ranging between 31 and 37 pptv. Additionally, we do not see pronounced concentration changes during glacial-interglacial transitions. If these atmospheric CF₄ reconstructions were taken at face values for global erosion rates, then erosion was relatively uniform during this time interval. However, open questions have to be answered before past atmospheric CF₄ concentrations can be used to estimate weathering rates, e.g. the current data base on the CF₄ content of rocks is limited given the widespread distribution (Harnisch et al., 1998, Harnisch et al., 2000). As the CF₄ concentration of these granite samples showed a large variability (one order of magnitude), it is clear that weathering in one region emits more CF₄ than other regions thus biasing any global estimate. With a better data basis on CF₄ rock concentration one could possibly identify key regions, which dominate the global CF₄ budget.

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