

Continuous concentration measurements of gases from ice cores: An idea boosted by advancement of technology

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One of the parameters that are exclusively recorded in ice cores is the composition of the past atmosphere. So far methane concentration measurements were made on individual samples. Such work is laborious; it took two decades to obtain the data for the composite record in Figure 1.

Chemical measurements, initially also made on individual samples, have evolved in a different direction. In the 1990s a system now known of Continuous Flow Analyses (CFA) was invented and perfected since (Bigler et al. 2011; Kaufmann et al. 2008). Here a section of the ice core is continuously melted. The melt water is then split up and diverted into detectors specific to the chemical species that is to be analyzed. In that way a whole range of chemical components can be analyzed already on the drill site. For the chemical analysis the air in the ice (on the order of 10% by volume) is disturbing and therefore removed.

It has been a long time dream to also measure the gas composition in a similar way. The University of Bern developed a system based on a small portable gas chromatograph (GC) for CH₄ concentrations (Schüpbach et al. 2009). However, the resolution achievable is limited by the requirement to 1) preconcentrate the sample and 2) separate the trace gases chromatographically. In addition, the analytical precision proves to be about 3%, i.e. sufficient to reveal the main features of atmospheric CH₄ concentration changes recorded in the ice (Schüpbach et al. 2009).

Using cavity enhanced laser spectrometry for concentration measurements LGGE (Laboratoire de Glaciologie et Géophysique de l'Environnement, Grenoble) and the CIC (Centre for Ice and Climate, Copenhagen) have been working independently on a system making use of the new technology for on line measurements from ice cores.

In 2010 a combined system was used during the NEEM (77.49°N, 51.2°W) field season. Figure 1 shows a compilation of several Greenland ice cores on top and raw data from the respective laser spectrometers. **In just 2 months we matched the number of measurements from 2 decades.** Although the system was regularly calibration with standard gas there are obvious differences and inconsistencies between the records. Those arise from leaks in the setup and from incomplete gas extraction. For the 2010 records the only way to calibrate the data is by measuring at least some individual samples (Chappellaz et al., 2013). Improvements were made on following measurement campaigns in the laboratory. I will talk about the latest developments, improvements and limits of the method.

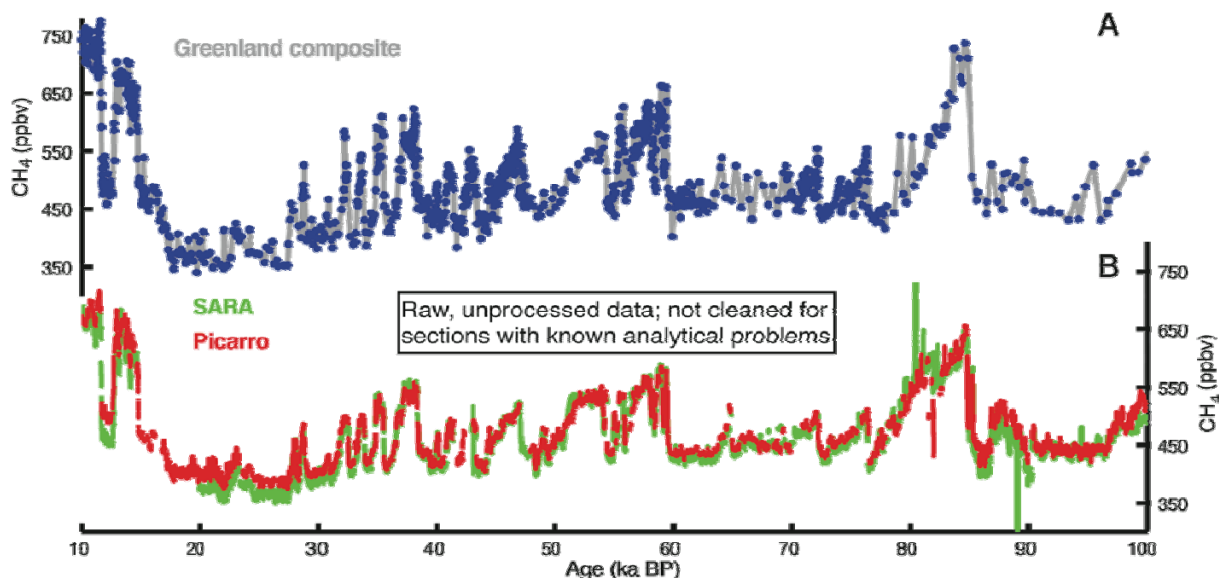


Figure 1: (A) Compilation of several Greenland ice cores (Blunier et al. 2007) and (B) raw data from SARA and Picarro laser spectrometers (Chappellaz et al., 2013). This data should not be taken face value. It is uncelebrated and contains sections with known analytical issues.

References

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