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200 years of NH_3 inventory in Europe inferred from ^{15}N of NH_4^+ in Mont-Blanc ice core with unexpected recent combustion-related emissions

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Today, anthropogenic emissions of ammonia (NH_3) exceed natural emissions causing substantial impacts on radiative forcing, ecosystems, and biodiversity (Sutton et al., 2011). To mitigate these consequences and their associated costs, NH_3 abatement is becoming a priority (Gu et al., 2021). Existing European NH_3 inventories suggest emissions from fertilizers and animal manure to be the main NH_3 source through the last decades (European Environment Agency, 2021). However, a growing body of evidence argues against presumed proportions of sources in NH_3 inventories (Chen et al., 2022).

Ice cores are well-suited archives of past atmospheric composition. We developed a method for extracting NH_4^+, the deposited form of NH_3, and analysing its ^{15}N isotopic composition in ice cores. Applying it to an ice core from the Col Du Dôme glacier (CDD, 4250 m asl, Mt-Blanc), we can reconstruct NH_3 changes regarding its atmospheric reactivity and its emission sources since the preindustrial era in Europe.

Here we present the history of $\delta^{15}N(NH_4^+)$ in the CDD ice core the offering first inventory NH_3 sources in Western Europe for 200 years. During the 19th century, NH_3 emissions decreased from an agricultural share of 60% to 35% by 1900. From 1900 onwards, the evolution of agricultural techniques certainly explains the measured increase in agriculture-induced emissions until the 1950s.

After 1950s, a large increase of NH_4^+ concentration in the ice is accompanied with higher combustion-related NH_3 contribution. For 2010-2016, only 38% of total emissions is explained by agriculture, in strong disagreement with the EMEP inventory (95%).

Our findings demonstrate that the agriculture emission abatement policies have had substantial results in diminishing its contribution to NH_3 emissions while, the Euro5 and Euro6 policies unintendedly conducted to NH_3 production to such extent that it can become the main source of NH_3 in city centres (Elser et al., 2018).

In a desire to control air quality, our measurements show that public policies must now support a reduction in NH_3 emissions from vehicular, industrial and biomass combustion.