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New insights on the phasing of atmospheric methane and temperature change during the Last Glacial Termination from the North Greenland Eemian (NEEM) Ice Core

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The phasing of changes in temperature, precipitation, and other environmental variables between different regions of the globe during the abrupt climate transitions of the last glacial termination provides a valuable constraint on the possible mechanisms that drive such changes. However, determining precise temporal relationships between records remains a challenge in paleoclimate research. In some cases, this difficulty can be overcome when multiple variables recorded in the same paleoclimate record reflect geographically distinct processes. We apply such an approach to new, very high-resolution measurements of gases from the North Greenland Eemian (NEEM) ice core across the deglacial transition, from the onset of the Bølling-Allerød to the earliest Holocene ($\sim$15 to 11 ka). We capitalize on the fact that changes in atmospheric methane, a gas with widely distributed sources, can be compared with the isotopic composition of atmospheric nitrogen, a proxy for local temperature change and climate-dependent firn properties, with essentially no relative age uncertainty (Severinghaus et al., 1998; Severinghaus and Brook, 1999). Our data include 419 methane and total air content measurements made at Oregon State University and 177 measurements of δ^{15}N made at the Scripps Institution of Oceanography, University of California, San Diego. Both records are sampled at less than 15 cm ($<$10 year) resolution across the abrupt transitions, and at 55 to 220 cm ($\sim$30 to 150 year) resolution during stable climate periods. By comparing the onset of δ^{15}N enrichment with atmospheric CH_4 concentrations, we find that the increase in methane at the Bølling onset is synchronous with warming at the NEEM site. During the Younger Dryas inception, methane decreases concurrently with cooling, also without a time lag. Interpretation of the record is complicated by short-term reversals in the isotopic trends that may be due to firn processes, for example fluctuations in the depth at which the atmospheric signal is trapped. Modeling to investigate such effects is underway.