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Analysis of variability in atmospheric methane in the Arctic

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Methane (CH4) is an important greenhouse gas and contributes 0.5 Wm-2 to radiative forcing. Globally, atmospheric CH4 concentrations have increased since direct measurements began in the early 1980s but then stabilized between 1999 and 2006. However, since 2007, the atmospheric CH4 growth rate has become positive again. This recent change has caused concerns that it may be the response to climate feedbacks in the Arctic, where there is a potential for a large release of CH4 to the atmosphere under warmer conditions. Such feedbacks include high latitude wetlands (and their expansion by melting permafrost) and methane hydrates. Conversely, recent studies, suggest that this change is the result of a rise in wetland emissions of CH4 in the tropics and subtropics, driven by climate variation such as ENSO, combined with a rise in fossil fuel emissions.

We examined the in-situ records of CH4 mole fractions in the Arctic from Zeppelin in Svalbard, Pallas in Finland, and Barrow in Alaska, as well as discrete samples from Alert in Canada and Summit in Greenland. These sites were chosen as they all have measurements at least since the early 2000s. We found marked variability in the atmospheric growth rate of CH4 in the Arctic, in particular, at Zeppelin and Pallas, which was not explained by variability in the global growth rate. Causes of the Arctic variability were investigated using the Lagrangian transport model, FLEXPART, and ECMWF meteorological reanalysis data. We found that the observed variability could also not be explained by changes in atmospheric transport. Measurements of the methane isotope (δ13CH4) at Zeppelin, together with atmospheric transport analyses, point to an important influence of high latitude wetland emissions at this site, especially from Northern Eurasia. Variability in the CH4 growth rate at Zeppelin was found to be correlated with anomalies in soil temperature in Northern Eurasia, suggesting that climate driven changes in high latitude wetland emissions may contribute to atmospheric CH4 variability in the Arctic