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Understanding the recent evolution of atmospheric methane

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Methane plays an important role in the chemistry and radiative properties of the atmosphere. With a global warming potential of about 25 over a 100-year horizon, methane is a potent greenhouse gas, and understanding the recent evolution of its atmospheric budget is fundamentally important for understanding the future evolution of methane and potential climate feedbacks. Currently, anthropogenic sources are thought to account for roughly 60% of the global atmospheric methane budget, with natural sources making up about 40%. Emissions from wetlands are the largest contribution from natural sources, while agriculture (rice and ruminants) and waste dominate anthropogenic emissions. Fugitive emissions from fossil fuel extraction are thought to make up about 20% of the global atmospheric methane budget. After declining over the past decades, the global growth rate of methane has started to increase again, and the cause of this trend is not currently understood. Climate-driven increases in wetland emissions likely played a role, especially in the tropics and the Arctic, although atmospheric observations provide no current evidence of a rapid increase in emissions from the Arctic. Anthropogenic emissions as estimated from economic data have also been increasing, especially due to rapidly expanding Asian economies. In this paper we use a state-of-the-art ensemble data assimilation system (CarbonTracker-CH4) to attribute methane variability and trends to anthropogenic and natural source processes. We pay particular attention to the Arctic, where some recent years have been the warmest on record, and to the tropics and the potential role of ENSO in driving variability of wetland emissions. Finally, we explore whether a signal in anthropogenic emissions is present in the atmospheric network observation, and whether it is present in flux estimates from the methane assimilation. We find that high latitude and tropical wetland emission anomalies are readily identified by the assimilation, however, changes in Asian anthropogenic emissions are still difficult to estimate using the assimilation because of the sparseness of the global network. This highlights the importance of increased surface observations as well as the possible use of space-based observations.