Recent Increases in the Burden of Atmospheric CH_4: Implications for the Paris Agreement

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More than three decades of observations of the global distribution of atmospheric CH_4 reveal a dynamic budget of emissions and sinks. From 1983 to 2006, CH_4's global burden approached steady state with near-zero growth from 1999 to 2006, but then abruptly began increasing again in 2007. Annual increases in globally-averaged CH_4 at Earth's surface in 2014 and 2015 exceeded 10 ppb. These recent increases in the burden of atmospheric CH_4 jeopardize the goals of the United Nations Framework Convention on Climate Change's Paris Agreement to limit globally-averaged temperature increase this century to 2° C above pre-industrial temperature, and to pursue policies to limit it to 1.5° C. Observations of $\delta^{13}C(CH_4)$ can be used to constrain changes to atmospheric CH_4 emissions by source-sector and sinks, and they show something remarkable: after increasing for about two centuries (based on measurements from air extracted from ice cores), $\delta^{13}C(CH_4)$ began decreasing nearly simultaneously with the increase in CH_4 burden.

A variety of explanations have been proposed to explain changes in atmospheric CH_4 burden, many of them inconsistent with one another. In Nisbet et al. (2019), an observation-driven analysis of the data with a four-box mass-balance model, the scenario most consistent with the long-and short-term changes in globally-averaged atmospheric CH_4 and $\delta^{13}C(CH_4)$ and changes in their spatial patterns is an increase in emissions from microbial sources in the tropics. The observations further show that recent increases in radiative forcing from CH_4 exceed those in the only IPCC scenario that keeps radiative forcing to ≤2.6 W m^{-2} by 2100 (RCP2.6), which is the only one of four considered in AR5 that could limit global average temperature increase to 1.5° C. Despite the extensive long-term observations presented here, the global CH_4 budget remains poorly constrained by observations, especially in the tropics, and this limits our ability to determine if the recent changes are anthropogenic or driven by climate change. If the former, it creates an opportunity to significantly reduce radiative forcing from CH_4. But if these recent increases in CH_4 burden result from feedbacks from climate change, the potential for reductions become much more uncertain.

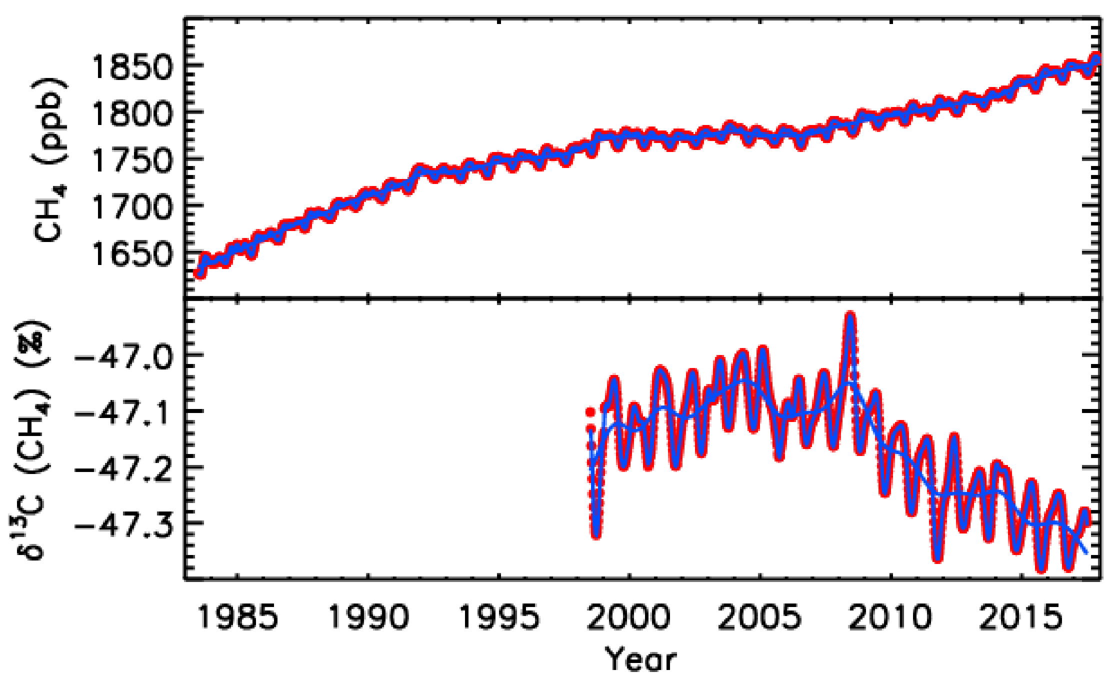

Figure 1. Globally-averaged CH_4 (top) and $\delta^{13}C(CH_4)$ (bottom) from GMD's cooperative global air sampling network (red symbols). The global averages have been fitted with a smooth curve and deseasonalized trend (blue lines).