The Mysterious Global Methane Budget

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Atmospheric methane (CH_4) contributes 0.5 W m^{-2} to global radiative forcing, making it the second most important anthropogenic greenhouse gas after carbon dioxide. Over half of global CH_4 emissions are related to human activities that range from food and energy production to waste disposal. The largest natural source of atmospheric methane is microbial production in wetlands, and this source is difficult to quantify and potentially sensitive to changing climate. Understanding the global CH_4 budget is essential due to the large human influence on the global CH_4 budget and the potential for climate feedbacks, especially for formulation of climate mitigation policy. ESRL/GMD's global observations of CH_4 and related species are fundamental to understanding the CH_4 budget, and globally-distributed observations are essential for estimating regional emissions, such as for the U.S. and the Arctic where ESRL/GMD observations currently suggest no significant increase in emissions despite rapid Arctic warming.

CH_4 has an atmospheric chemical sink that approximately balances emissions globally, although the size and variability of the sink is uncertain. Until 2006 it seemed that atmospheric CH_4 had reached steady-state after a precipitous rise over the industrial period from pre-industrial levels of ~800 ppb to ~1770 ppb. Since 2006 the atmospheric growth of global CH_4 has increased, even accelerating to over 10 ppb/yr in recent years. Currently, global average CH_4 is about 1850 ppb. The reason for the recent increase is not currently well understood, although global measurements of CH_4 isotopes strongly suggest that the recent atmospheric growth is due mainly to microbial sources. Despite this, there remains considerable controversy about the causes of the period of stability in the late 1990s and early 2000s, and the recent growth. Various studies implicate wetlands, fossil fuels, biomass burning, and changes in the chemical sink. Why is it so difficult for scientific consensus on what drives variability in global atmospheric CH_4, and what do we need to do to make progress?

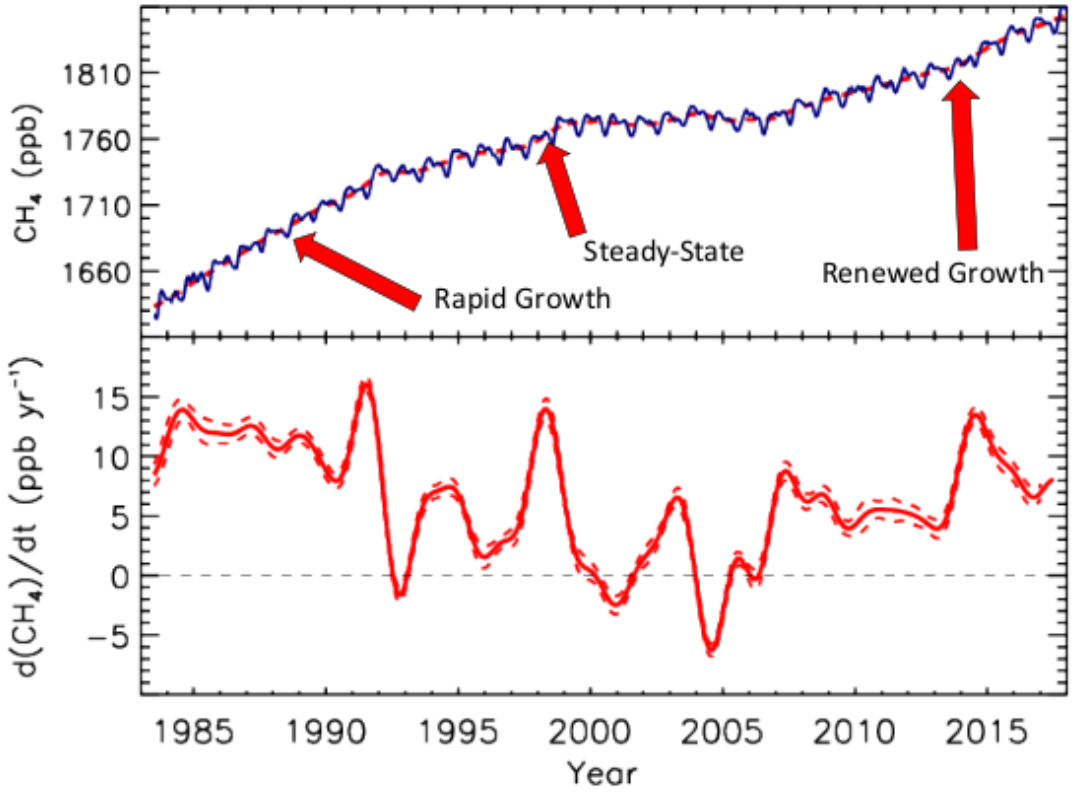

Figure 1. Global average CH_4 and its growth rate based on ESRL/GMD measurements.