What have we learned from three decades of atmospheric CH_4 measurements?

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Methane is arguably the most interesting of the long-lived greenhouse gases. It is emitted by a diverse set of processes and sources. Emission rates are often small and variable, both temporally and spatially, making quantification of emissions difficult, except at global scales. NOAA observations of globally averaged atmospheric CH_4 began in 1983. The data are rich in signals, capturing small changes in its budget of emissions and sinks. From the start of measurements through 1999, the rate of increase of atmospheric CH_4 was decreasing. This was followed by a period through 2006 when its atmospheric burden remained nearly constant. Assuming a constant lifetime from 1983-2006, this implies that total global CH_4 emissions were constant and atmospheric CH_4 achieved steady state. Superimposed on top of the long-term pattern are significant interannual variations in growth rate. The latest and largest variation began in 2007, when CH_4 began increasing again. Still assuming constant lifetime, this latest variation corresponds to an imbalance between emissions and losses of ~16 Tg CH_4 yr^{-1}. Many possible explanations exist for this increase, but the one most consistent with observations (e.g., CH_4 abundance, $\delta^{13}C(CH_4)$, and precipitation anomalies) involves increased emissions from tropical wetlands and anthropogenic sources like fossil fuel exploitation. One thing is clear: the increase that started in 2007 can no longer be considered a short-term anomaly in growth rate. It has persisted for more than 8 years, and analysis of preliminary data suggests the growth rate increased further in 2014.