Can We Explain Recent Increases in Atmospheric CH_4?

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Methane (CH_4) is the most important greenhouse gas influenced by human activities after CO_2. Its chemistry results in additional indirect climate effects from production of tropospheric O_3, which also affects air quality, and stratospheric H_2O. Natural emissions of CH_4, from Arctic wetlands and hydrates, are susceptible to changing climate, and they have the potential to cause strong positive climate feedbacks.

NOAA measurements of atmospheric CH_4 from the carbon cycle group's Global Cooperative Air Sampling Network began in 1983. From the beginning of the measurements through 2006, the rate of increase was decreasing from ~14 ppb yr^{-1} in 1984 to near zero from 1999 to 2006. Superimposed on this decreasing growth rate are significant anomalies in global growth rate. These anomalies result from variations in natural wetland and biomass burning emissions and from changes in [OH]. During 2007, atmospheric CH_4 began increasing again (see Figure). Dlugokencky et al. [Geophys. Res. Lett., 36, L18803, doi:10.1029/2009GL039780, 2009] attributed the increases in 2007 and 2008 to anomalously high temperatures in the Arctic (2007) and greater than average precipitation in the tropics (2007 and 2008). Near-zero CH_4 growth in the Arctic during 2008 suggests we have not yet activated strong climate feedbacks from permafrost and CH_4 hydrates. These inferences, directly from the data, are qualitatively consistent with recent model studies. Continuing increases in 2009 and 2010, each ~5 ppb yr^{-1}, have not yet been analyzed. In 2010, we returned to a very strong La Niña, the same climate pattern responsible for large positive precipitation patterns in tropical wetland regions in 2007 and 2008. Indeed, strong precipitation patterns were observed in SE Asia in 2010. This is a likely cause of continued CH_4 increase, and is consistent with the observation that the largest growth rates in 2010 were in the southern tropics. For 2009, when we were in a weak El Niño, no clear cause has emerged. The observations indicate the largest growth rates were observed in mid-latitudes of the northern hemisphere, a departure from 2007, 2008, and 2010 when signals were clearly dominated by the tropics.

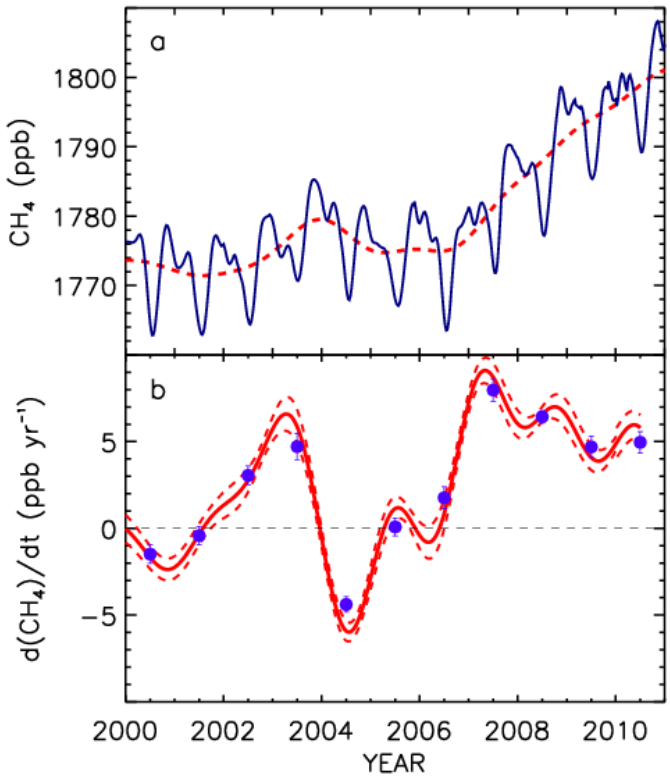

Figure 1. a) Globally averaged CH_4 dry air mole fractions (blue). Red line shows the deseasonalized trend. b) Rate of increase in atmospheric CH_4 (red) and annual increases from Jan1 in year one to Jan 1 in the next year (blue symbols). Uncertainties are 68% confidence limits. 2010 increase is preliminary.