Are Emissions Inventories Consistent with Recent Observations of Atmospheric CH_4?

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Direct and indirect components to anthropogenic radiative forcing by atmospheric methane (CH_4) are estimated to be 0.7 W m^{-2}, or about half the contribution of CO_2. Through its chemistry, methane also affects the abundance of tropospheric ozone, a strong oxidant and greenhouse gas. It is estimated that the increase in atmospheric methane abundance over the past 200 years is responsible for half the increase in background tropospheric ozone levels; moderate ozone levels affect human respiratory function, while higher levels lower agricultural crop yields and damage natural ecosystems. Policies aimed at mitigating the potential environmental effects of atmospheric CH_4 require a detailed understanding of the global CH_4 budget by emission sector and how emission rates are changing with time.

During the past two decades, the globally averaged CH_4 growth rate decreased from ~14 ppb yr^{-1} in 1984 to near zero recently. Through the early-1990s, the decrease in growth rate looked like an approach to steady state, with CH_4 emissions and lifetime both constant. This trend was disrupted during 1992 when the CH_4 growth rate decreased dramatically, particularly at high northern latitudes. Since then, with the exception of 1998, the global growth rate has remained relatively low, and CH_4 annual means were nearly constant at 1750 ± 1 ppb during 1999-2002. The low growth rate during 1992 was accompanied by a significant change in CH_4 latitude distribution that has not recovered. Figure 1 (filled circles) shows how observed average differences in annual mean CH_4 mole fraction between each site and south pole changed from the late-1980s to the late-1990s. The change in distribution is largest at high northern latitude sites such as Barrow, Alert, Cold Bay, and Shemya, and it decreases toward the tropics. Such changes imply a permanent decrease in CH_4 emissions from high northern latitudes. A reasonable test for emission inventories is whether they can capture observed changes in surface CH_4 spatial gradients. We compared observed changes in the difference between annual means of each CMDL sampling site and south pole from the late-1980s to the late-1990s with those calculated from a 3-D model using Emission Database for Global Atmospheric Research (EDGAR, version 3) anthropogenic CH_4 emissions. Model results are plotted as open triangles in Figure 1; agreement is quite good, especially at high northern latitudes. The driving force in EDGAR for the modeled change in CH_4 latitude gradient is a decrease in emissions of 8 Tg of CH_4 from the fossil fuel sector in the former Soviet Union from 1990 to 1995. At 2002 well-head prices, 1 Tg CH_4 fugitive emissions was worth ~$200M in lost revenue; this gives hope that economic incentives alone may be sufficient to stabilize or reduce the global atmospheric CH_4 burden.

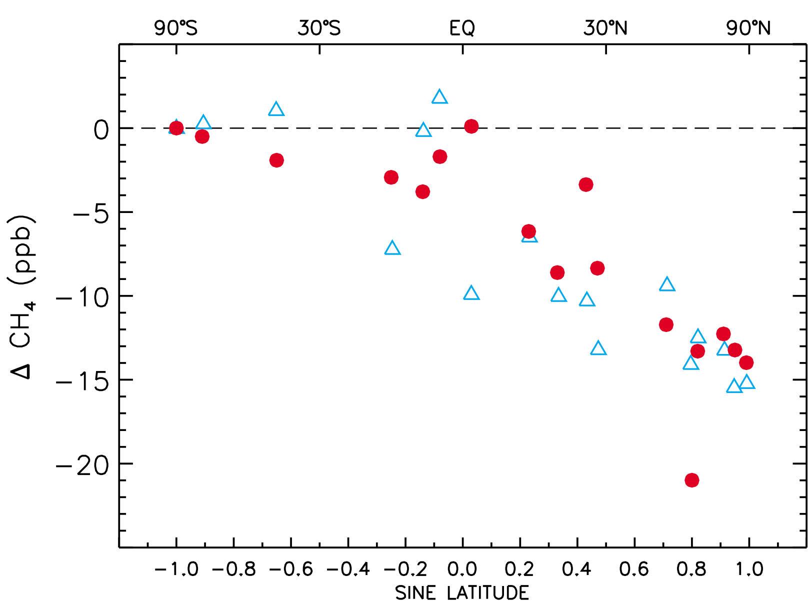

Figure 1. Change in CH_4 latitude distribution from the late-1980s to the late-1990s.