TWO DECADES OF QUASI-CONTINUOUS METHANE MEASUREMENTS AT MAUNA LOA OBSERVATORY

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Atmospheric methane has been measured quasi-continuously at Mauna Loa Observatory (MLO) since April, 1987 at a frequency of at least 60 samples per day. Measurements are made by gas chromatography with flame ionization detection; repeatability of the measurements has averaged ~2 ppb. We observe a significant diurnal cycle at MLO that results from local meteorology. At night (downslope conditions), when air from the free troposphere is sampled, CH_4 values are less than during the day (upslope conditions) when boundary layer air is transported to the observatory. Differences in CH_4 of up to 45 ppb between upslope and downslope flow regimes have been observed. To eliminate the impacts of local meteorology and to insure that air masses measured at MLO are representative of large atmospheric volumes, we constrain the data based on local time (0000-0700) to periods of downslope flow.

The average rate of increase in CH_4 at MLO from the start of the measurements through 2006 is 4.7 ppb yr^{-1}, but it has decreased from ~15 ppb yr^{-1} at the start to near zero since 2000. CH_4 at MLO is strongly seasonal, with maximum CH_4 values in winter and spring and minimum values during July and August; the average peak to peak amplitude of the seasonal cycle is 30 ppb. The main cause of seasonal variability is the seasonal dependence of our observations on the CH_4 sink (reaction with hydroxyl radical), but seasonal variations in transport also contribute. When compared with the MLO CH_4 data, CH_4 measurements from samples collected on the Hawaiian coast at Cape Kumukahi are an average of ~20 ppb greater, and the difference varies seasonally. Synoptic variations in CH_4 observed at MLO are strongly related to transport; e.g., CH_4 values observed during trade wind flow are, on average, ~20 ppb less than those observed during westerly flow, when strong Asian emissions contribute to observed signals. Variations in transport between Asian source regions and tropical ocean sink regions result in changes in CH_4 mixing ratio of up to 50 ppb. In addition to these quasi-continuous CH_4 measurements at MLO, we also measure CH_4 in weekly discrete samples. The high-frequency measurements can be used with statistical methods to estimate uncertainties in parameters determined from the discrete samples. As an example, using a Monte Carlo method, we estimate the uncertainty in the trend determined from weekly sample collected at MLO as ±0.5 ppb yr^{-1}.