Investigation of the Global Methane Budget Based on Improved Measurement Datasets and Prior Emission Information

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The global atmospheric CH_4 abundance was stable during 1999 to 2007, but has significantly increased ever since. The reasons behind the post-2007 increase in global CH_4 remain uncertain. Current debates include changes in major sources and sinks. Another uncertainty in the CH_4 budget concerns the quantification of emission magnitudes from individual CH_4 source categories. The emission magnitudes are not well understood considering that bottom-up estimates of all CH_4 sources surpass top-down estimates by more than 30%. These uncertainties are partially caused by the sparsity of global atmospheric measurements and the difficulty in accurately quantifying CH_4 sources at policy-relevant spatial scales. Analyses using spatially representative isotopic ($\delta^{13}CH_4$) source signatures to partition source contributions are still limited.

Understanding emission magnitudes from individual sources and their contributions to temporal changes in CH_4 abundance is important to predict the response of CH_4 sources to future climate and design mitigation policies. This study attempts to improve our understanding of the CH_4 budget by using forward and inverse modeling with the following features: (a) an extensive atmospheric CH_4 and $\delta^{13}C\text{-}CH_4$ measurement dataset with contributions from 32 laboratories worldwide complemented by remote sensing products, (b) newly developed gridded CH_4 and $\delta^{13}C\text{-}CH_4$ maps of geologic seeps and (c) improved spatially resolved $\delta^{13}CH_4$ signatures from wetland emissions. In addition to illustrating these features, this presentation will highlight our new model results to evaluate different source and sink scenarios by comparing observed and simulated long-term trends and spatial gradients of CH_4 and $\delta^{13}CH_4$.
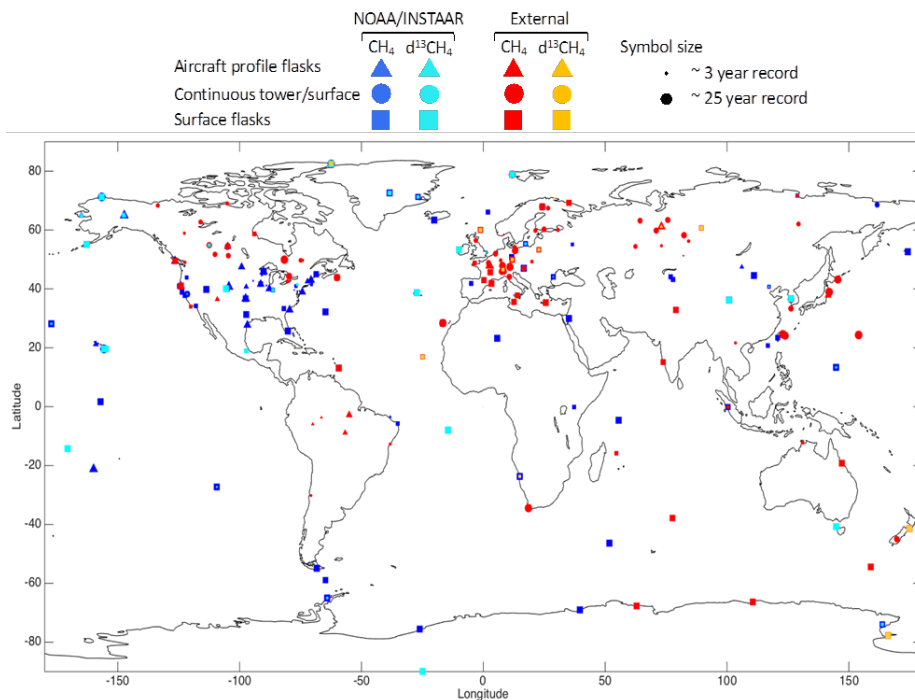

Figure 1. Overview of combined NOAA/INSTAAR (blue/cyan) and external (red/yellow) atmospheric CH_4 and $\delta^{13}C\text{-}CH_4$ dataset compiled for this study. Only "fixed" sites are shown, and additional data include measurements from container ships and aircraft routes.