(62-220422-C) **Atmospheric CH_4: A Record Annual Increase in 2021**

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High-quality measurements of CH_4 and its stable carbon isotopic composition from weekly air samples collected at a globally-distributed network of air sampling sites provide fundamental constraints on the global CH_4 budget and its impact on climate. For the second year in a row, atmospheric CH_4 increased at a record rate, 17 ppb in 2021. This continues a trend of increasing growth rate that started in 2007, and total global missions are now undoubtedly greater than any time since measurements began in 1983. Spatial differences in the rate of increase (Figure 1) qualitatively indicate where emissions are changing, and this can be made quantitative using an atmospheric transport model. Coincident with the increase in CH_4 burden is a decreased in $^{13}C/^{12}C$ in atmospheric CH_4; measurements of CH_4 alone do not allow us to distinguish among source types causing the increase, but the delta-$^{13}C(CH_4)$ measurements indicate a dominant role for microbial sources in the driving the increase.

Should we be alarmed by record rates of increase over the past two years and their impact on climate? Yes and no. Since current data are insufficient to distinguish between natural (e.g., wetlands) and anthropogenic (e.g., agricultural) microbial emissions, part of the increase may be resulting from climate feedbacks that society has no control over. But, despite microbial emissions driving the increase over the past 15 years, emissions from fossil fuel exploitation are quite large (~30% of total CH_4 emissions) and there are cost-effective options for significant reductions. Given that CH_4 has a relatively short atmospheric lifetime of about 9 years, the climate impacts of today's CH_4 emissions are reversible, unlike CO_2, whose emissions today will impact climate for 1000s of years in the future.

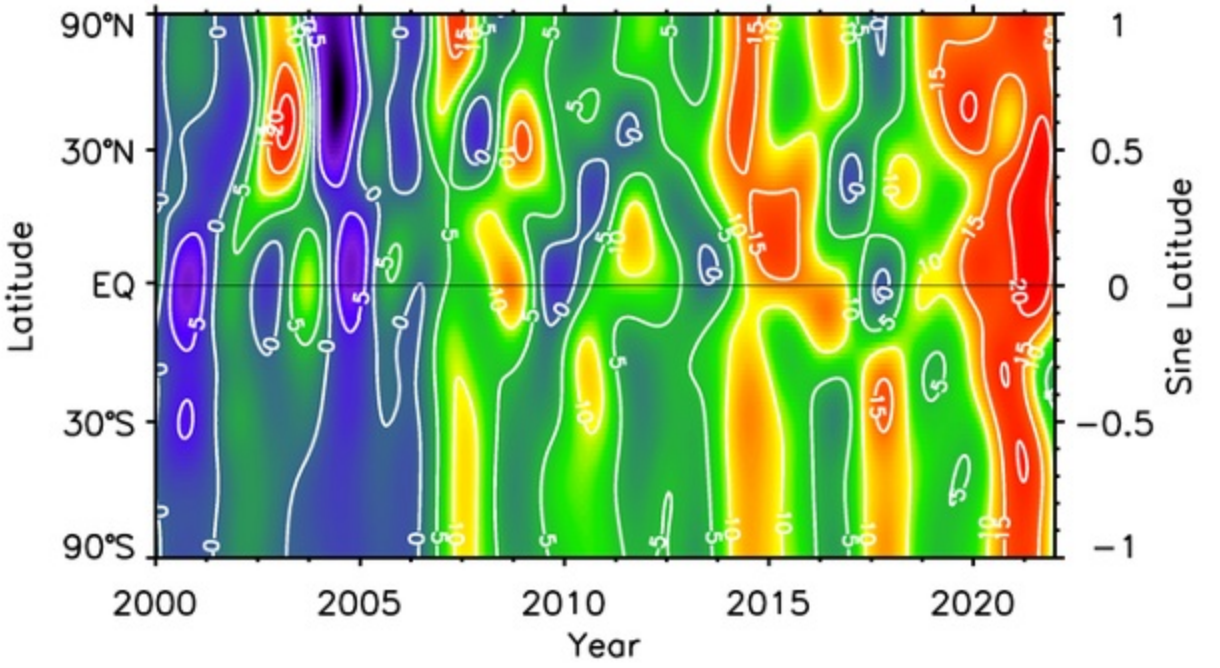

Figure 1. Contours of zonally averaged CH_4 growth rate from 2000 through 2021. Contour spacing is 5 ppb yr^{-1}. Warm colors show where the combined effects of source/sink and transport result in greater than zero growth rate and cool colors where it is less than zero.