(36-240329-A) **NOAA's Global Greenhouse Gas Reference Network (GGGRN): Evolution of the Network and the Foundation for Tracking Global CO_2, CH_4, and N_2O trends and Understanding Emission Changes**

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NOAA Global Monitoring Laboratory began CO_2 measurements in 1967-68 with an initial goal to quantify the role of CO_2 emitted by combustion of fossil fuels on climate. Over the past 5 decades, our network has expanded to a cooperative global measurement network that can accurately and precisely measure spatiotemporal distributions of key greenhouse gases (GHGs). Now our Global Greenhouse Gas Reference Network (GGGRN) is the backbone for tracking atmospheric GHG abundances, and for research to determine budgets and understand carbon cycle feedback.

From GGGRN's global marine boundary layer measurements, we see no sign of key GHG increase slowing in 2023. Globally averaged surface CO_2 reached 419.3 ppm in 2023, 50% greater than pre-industrial level. The CO_2 growth in 2023 was the 3rd highest in the past decade, a result likely from continuous increase in fossil fuel emissions and a small increase in fire emissions in 2023. 2023 marked the 12th consecutive year that CO_2 increased by more than 2 ppm which is unprecedented since the beginning of modern CO_2 monitoring. Atmospheric CH_4 annual increases in 2020-2022 were the largest since NOAA's systematic measurements began in 1983. The 2023 CH_4 growth rate remained high, at 10.5 ppb. Coincident with the accelerated increase in atmospheric CH_4 burden is a shape decrease in $^{13}C/^{12}C$ in atmospheric CH_4 ($\delta^{13}C$-CH_4), which provides insight into the specific sectoral emissions contributing to the recent CH_4 increase. The increases in atmospheric N_2O in 2020-2022 are also the largest in NOAA's record since 2001. In 2023, N_2O increased by 1 ppb. Atmospheric N_2O level now is 25% higher than pre-industrial level, which is mainly driven by the expansion of agriculture activities.

In this presentation, we will show the observed spatial differences in the rate of increase from the CO_2 and CH_4, which can qualitatively indicate where emissions are changing, and results from a few studies using our measurements to make quantitative estimates of recent emission changes.

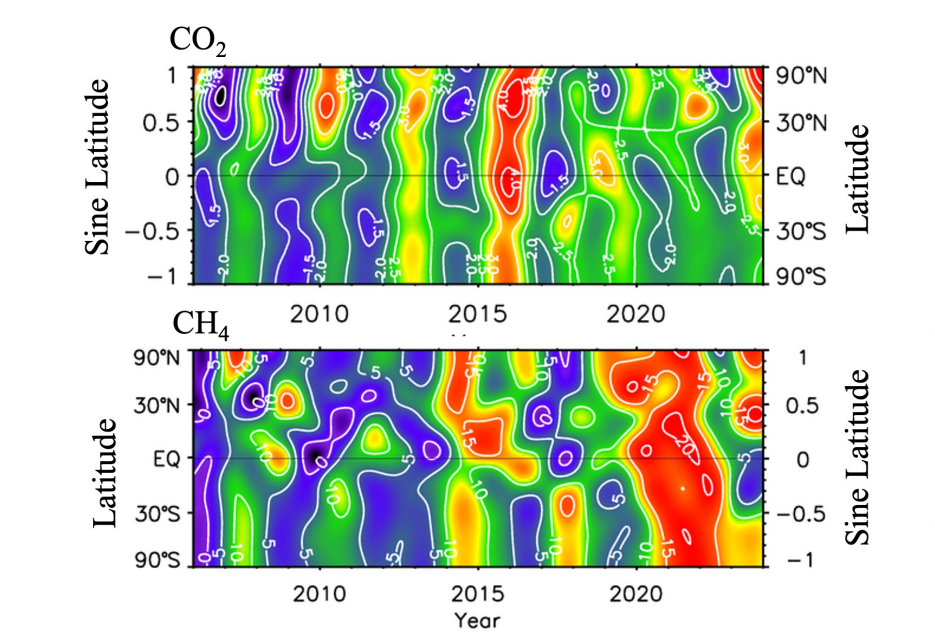

Figure 1. Contours of zonally averaged CO_2 (top panel) and CH_4 (bottom panel) growth rate.