Long-term trends and spatial distributions of CO_2, CH_4, N_2O and SF_6 from NOAA's global background measurements

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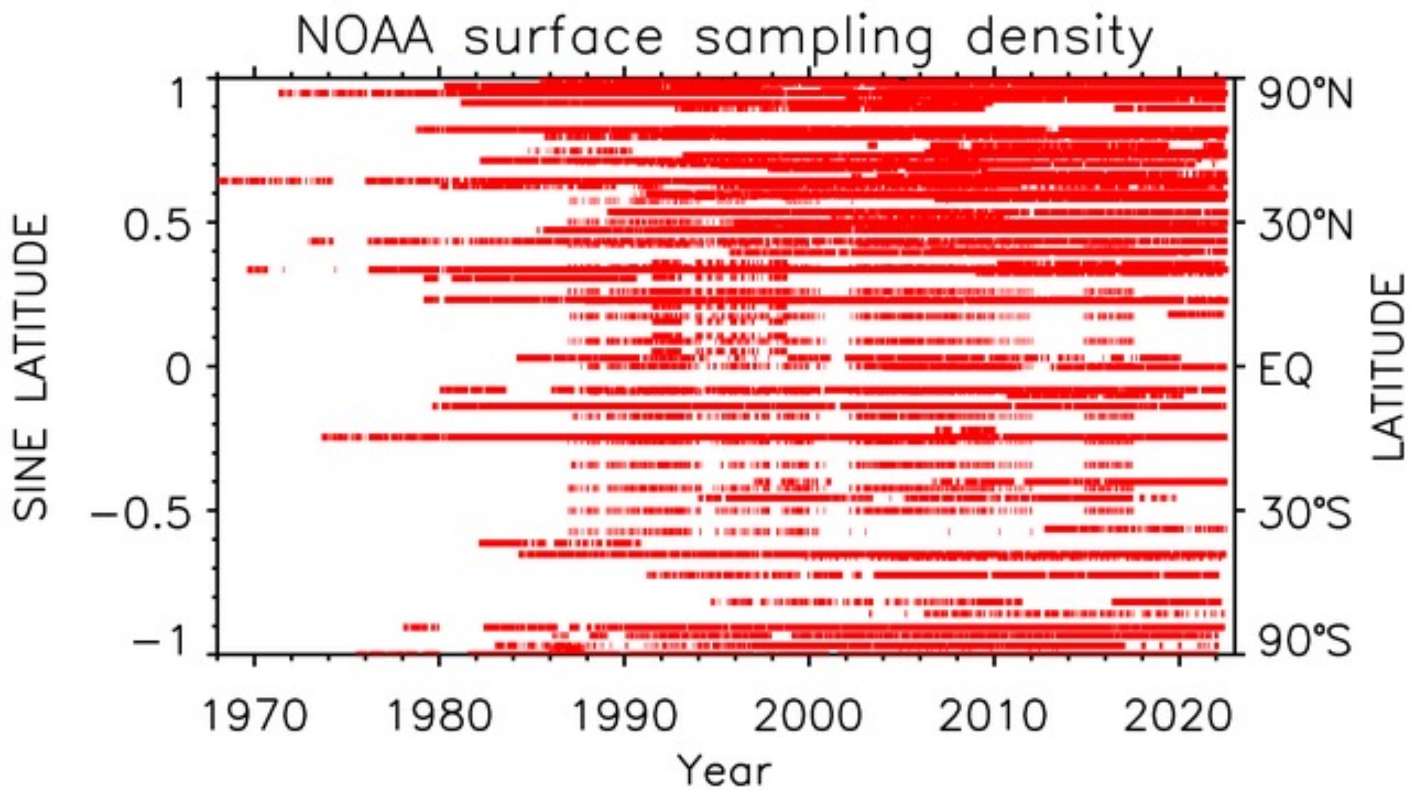
Introduction

NOAA's Global Monitoring Laboratory began monitoring CO_2 from weekly discrete air samples collected at Niwot Ridge, Colorado and Ocean Station M in 1968. Since then, the network of flask-air sampling sites has grown, with more than 50 active sites in early-2022, and we now precisely measure CO_2, CH_4, N_2O, and SF_6. The goal of this network is to track the GHG abundances, determine budgets and understand carbon cycle feedback. Success or failure at meeting this goal depends the long-term continuity of measurements with sufficient network sampling density, but most importantly, it depends on the measurement quality as whether they can provide precisely measure on spatial and temporal distributions.



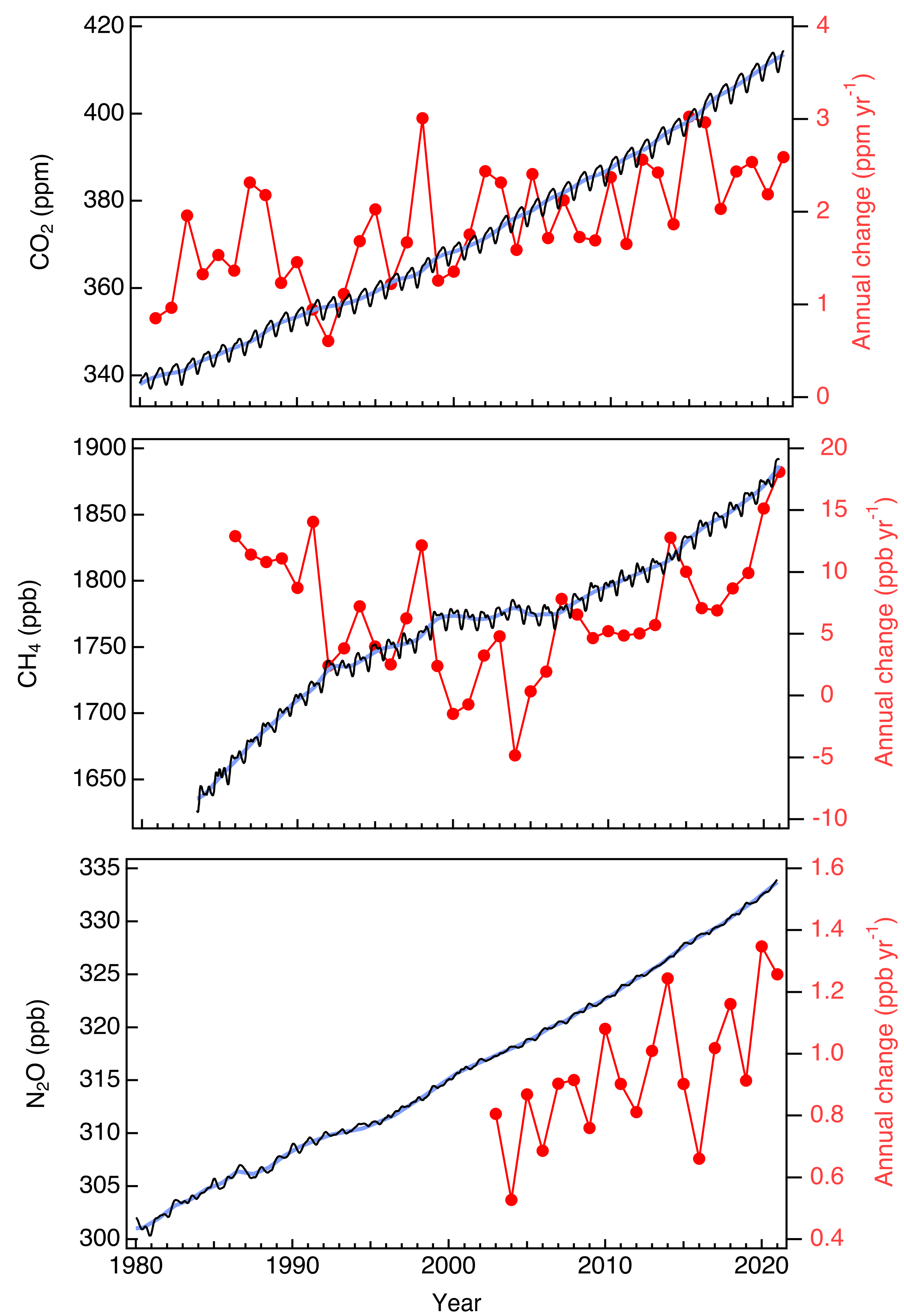
Analytical Capabilities (flask-air)

Our network delivers internally-consistent, calibrated observations over long time scale by enforcing detailed QA/QC procedures

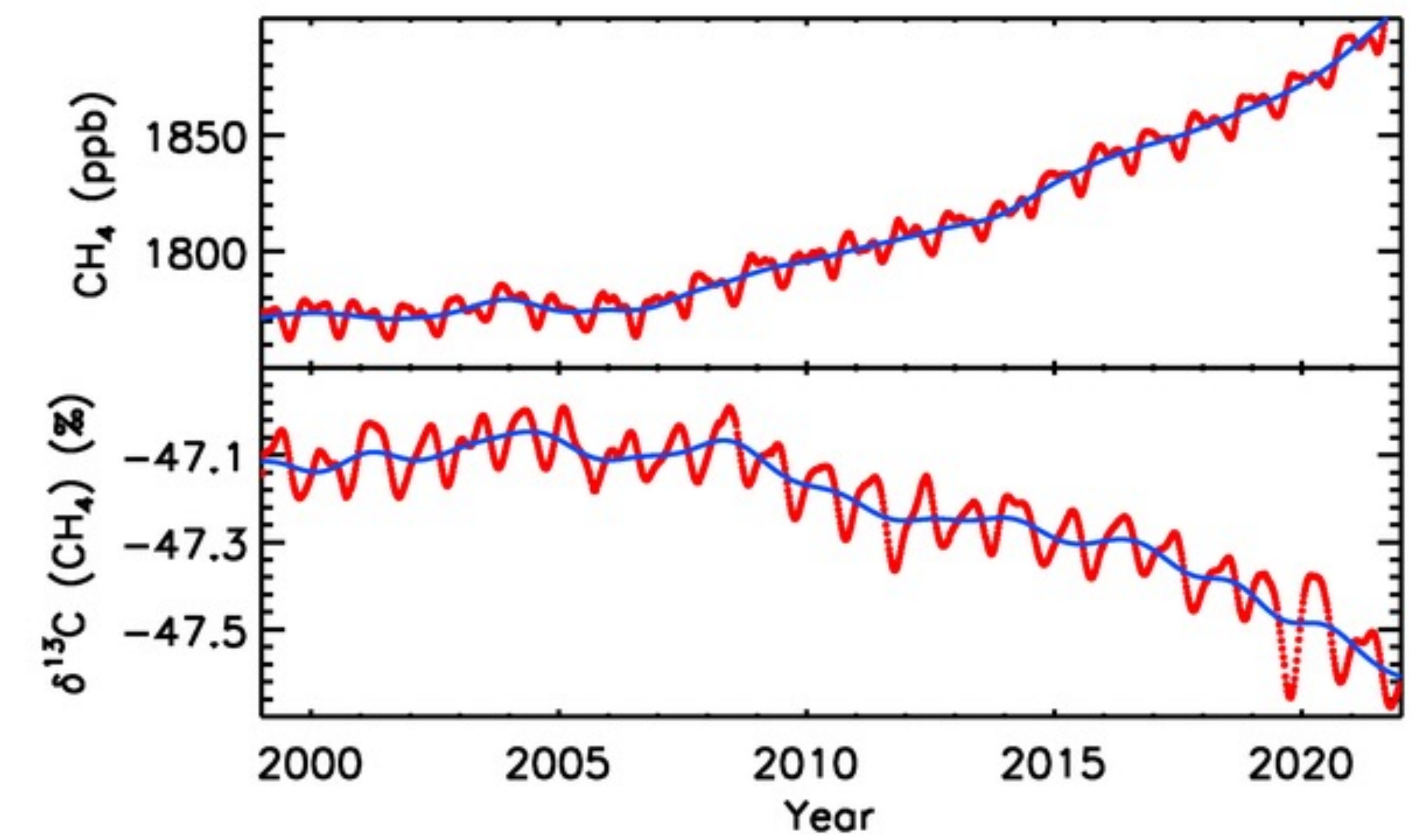
Gas	Uncertainty (68% CI)	Technique
CO_2	0.07 → 0.04 µmol mol^{-1} (ppm)	NDIR → CRDS
CH_4	0.9 → 0.6 nmol mol^{-1} (ppb)	GC/FID → CRDS
N_2O	0.26 → 0.16 nmol mol^{-1} (ppb)	GC/ECD → TILDAS
SF_6	0.04 pmol mol^{-1} (ppt)	GC/ECD
$\delta^{13}CO_2$	*0.01‰	DI-IRMS
$\delta^{13}CH_4$	*0.06‰	GC/CF-IRMS

Uncertainty includes short-term repeatability, long-term reproducibility and scale propagation uncertainty
* Repeatability only

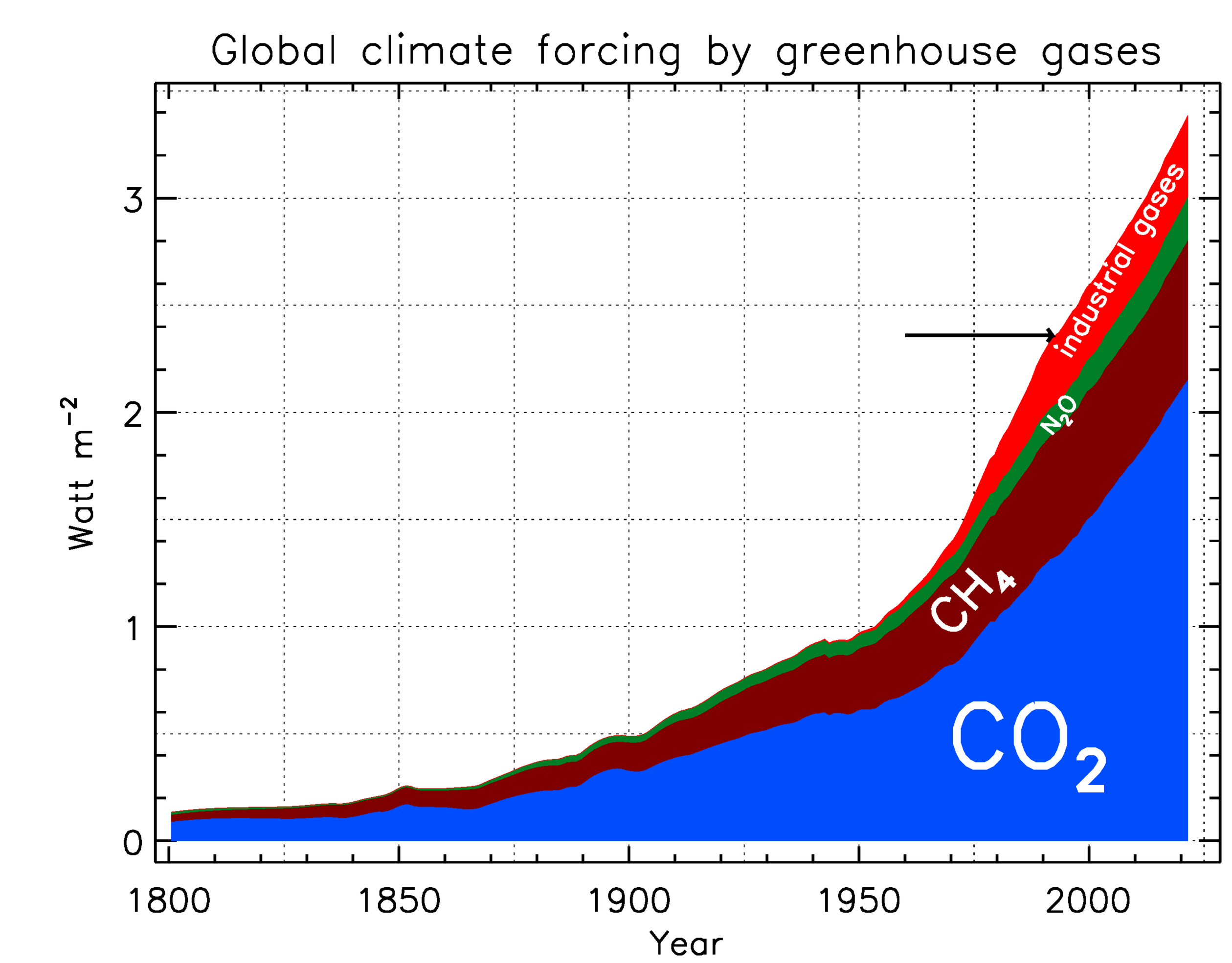
Atmospheric abundance



Global mean dry-air surface mole fractions (approximately weekly data in black, left axis) and annual change (red, right axis) derived from the NOAA Global Greenhouse Gases Reference Network. Deseasonalized trend curves are shown in blue. N_2O data prior to 2001 are too sparse to allow robust estimates of annual growth rates. Atmospheric abundances of these greenhouse gases have been increasing significantly in the past few decades



Measurements of CO_2 and CH_4 isotopes are available from our network to improve our understanding on the underlying emission/sink processes. The increasing trend of CH_4 coincide with the decreasing trend in $\delta^{13}C$-CH_4 indicates a dominant role of increasing microbial emissions after 2006.



Increase in atmospheric CO_2 contributes 66% of the increase in all GHGs radiative forcing since the pre-industrial era while the increase in CH_4 contributes 16%. Over the last five years, the increase of instantaneous climate forcing by CO_2 has accounted for about 80% of the rate of increase of all GHG forcing. The increase of CH_4 has been a quatre as large as the increase caused by CO_2. The increase of forcing by N_2O over has been 70% as large as the increase caused by CH_4. Reduction of CO_2 emissions must remain the focus in mitigating climate change.