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Plain Language Summary: Methane (CH_4) is an important greenhouse gas and plays a significant role in tropospheric and stratospheric chemistry. CH_4 growth rate (i.e., year to year change) in atmosphere varied in three distinct phases in the past three decades (1988-2016); namely, the periods of slowed (1988-1998), quasi-stationary (1999-2006) and renewed (2007-2016) growth phases. These distinct growth rate phases are explained by the anomalies in global and regional emissions that are estimated with an atmospheric chemistry-transport model (ACTM) based inverse modelling framework and observations from 19 sites worldwide. The anomalies in global and regional emissions are further attributed into different sectorial categories with the help of emission inventory.

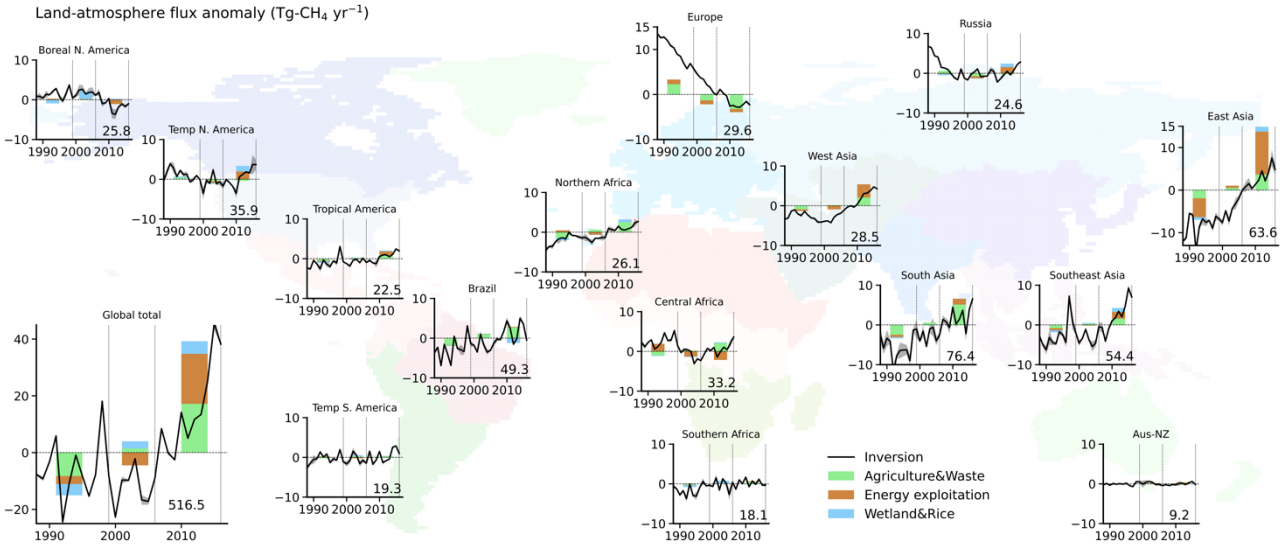

Figure 1. Timeseries (1988-2016) of global and regional CH_4 emission anomalies for 2 inversion ensembles, and the emission changes from 3 aggregated sectors during the three growth rate phases (bar plots). A long-term (2000-2016) mean for each region, given at the bottom-right of each panel (in Tg yr^{-1}), is subtracted to calculate the emission anomalies. The average emissions and range (shaded) for the two inversion cases are shown.

- We proposed that CH_4 growth anomalies can be explained mainly by the changes in anthropogenic emissions, from the oil and gas exploitation, coal mining and livestock farming.
- The natural phenomena, such as the Mt. Pinatubo eruption and more frequent El Niño in the 1990s, have also helped to slow down the growth and achieve the quasi-stationary growth rate.
- Estimated CH_4 emission anomalies are evaluated against independent aircraft observations,

^{13}C-CH_4 isotopic signature, and other inventory/inverse modelling results.