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The rise in methane – causes, consequences and possible mitigation

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Methane, which has been rising since 2007, is arguably the greenhouse gas most divergent from compliance with the UN Paris Agreement. Methane in remote background air rose from about 1775 ppb in 2006 to 1860 ppb now. Current growth began in 2007. Growth was especially rapid in 2014 ($\sim$13 ppb/yr) and 2015 (10 ppb/yr), and has continued at >7ppb/yr in 2016 and 2017 (NOAA data). In contrast to past centuries of positive shift, methane's δ13C has concurrently shifted negative, a clear trend in all RHUL and NOAA/INSTAAR time series. Methane is now over 100ppb above an expected "Paris pathway". This growth in methane is already significantly counterbalancing expected progress in controlling CO_2 emissions.

One explanation of the growth and isotopic shift is that emissions from biogenic sources are increasing, especially in the tropics and sub-tropics (mainly tropical wetlands and cattle) and that the biogenic proportion of the emissions is rising compared to methane from fossil fuel and biomass burning emissions. An alternative explanation of growth is that the oxidative power of the atmosphere is changing, with a decline in methane's total sinks. These include OH, Cl and soil methanotrophy. The hypotheses are non-exclusive, and both may be climate change feedbacks. All explanations of the growth have isotopic impact; they also have seasonality and geographic foci: by assessing the regional and latitudinal distribution of growth and the seasonality, it may be possible to determine which processes are acting to drive growth. But at present there is no consensus. It is hoped that in future the measurement of D/H time series in methane in remote stations, coupled with better knowledge of isotopic signatures of sources, may help improve our understanding.

Although the causes of methane's rise are controversial, the remedy is obvious – reduce anthropogenic emissions. This is increasingly possible and cost-effective with real advances being made in locating, characterising and quantifying leaks. In particular, it is becoming inexpensive and easy to detect and monitor leaks in production gasfields and urban reticulation systems by routine vehicle drive-by. Light aircraft or UAV surveys can be used to quantify fluxes, while sensors can be deployed in remote sites to detect intermitted leaks. Isotopes are powerful discriminators between juxtaposed sources (e.g. landfills next to gas plants). Catalytic destruction of fugitive emissions from industrial processes, and perhaps methanotrophic removal of methane from ambient air around intractable agricultural sources may become feasible. Cutting the methane burden will require implementation of a wide array of approaches – there is no magic bullet – but the cost may be relatively low compared to the parallel and very necessary measures to reduce CO_2.