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Understanding the rapid growth of background concentrations of methane in 2007

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The growth of background levels of atmospheric methane showed a marked increase in both hemispheres in 2007. This paper looks at the data from a range of observation stations that monitor methane at high frequency, including Barrow (Alaska), Ragged Point (Barbados), Trinidad Head (California), Cape Grim (Australia), Cape Matatula (Samoa), Gosan (South Korea) and Mace Head (Ireland), to try to understand the likely causes for this sudden rise. At each station the recent history of the air arriving at each station is considered using the NAME model. NAME (Numerical Atmospheric-dispersion Modelling Environment) is a Lagrangian atmospheric dispersion model that uses 3D meteorology from the UK Met Office numerical weather prediction model.

High temporal resolution and high precision measurements of a wide range of trace gases in ambient air are available from the instrumentation at the AGAGE (Advanced Global Atmospheric Gases Experiment), NOAA and Korean measurement stations. The locations of these stations span both hemispheres and therefore allow global changes to be monitored. In this work, we are primarily interested in the measurements of methane and carbon monoxide.

Baseline concentrations of methane and carbon monoxide have been determined for both the Northern and Southern Hemispheres using NAME and statistical post-processing of the observations at each measurement station. For this application, NAME is run backwards in time for ten days for each 3-hour interval for the years of specific interest 2006-2008 inclusive, releasing thousands of model particles at each observing site. A map is then produced estimating all of the surface (0-100m) contributions within ten days of travel arriving at each site during each interval. The resulting matrix describes the dilution in concentration that occurs from a unit release from each grid as it travels to the measurement site. By identifying regions where air is expected to be unpolluted, baseline periods can be determined. Statistical filtering of the remaining data allows a daily baseline concentration to be estimated for each station. These baselines are used to generate a time series of "polluted" (above baseline) observations at each station. Analysis of these baseline and polluted levels over time allows identification of changes in growth rates and seasonal cycles for each species, site and hemisphere.

In 2007, the growth rate of background levels of methane was significantly elevated at all AGAGE stations (Rigby et al., 2008). The increase in growth rate appears to have occurred nearly simultaneously in both hemispheres. This raises the possibility of a common global cause for the change and a previously postulated explanation is that it could be due to a change in the global OH sink. However, OH is the main atmospheric sink for carbon monoxide and we see no coincident change in the growth rate of this species. In fact, there has been negligible growth in carbon monoxide at Mace Head since the end of 2005. The magnitude of the observed change also varied with location and was highest in the high Arctic. Another postulated theory was enhanced emissions in the high Arctic, but in isolation this would fail to explain a change that was seen so rapidly across the globe, particularly in the Southern Hemisphere.

We present detailed analyses of the origin of the air reaching each site during the start of the period of growth. For each point identified as baseline, we consider the recent history of the air to determine whether there was a significant change in the source area of measured methane during this period and discern the geographical area responsible for the rise in background levels. The results provide useful insight to the key questions as to

whether all sites were affected simultaneously (or whether there was a gradual change between different sites over a few months) and why the magnitude of the change may have been different at different latitudes.

Reference:

Rigby, M., et al. (2008), Renewed growth of atmospheric methane, Geophys. Res. Lett., 35, L22805, doi:10.1029/2008GL036037.