2.10 Methane

Ned Dwyer and Simon O'Doherty

Methane (CH_4) is the second most important greenhouse gas. It also influences concentrations of ozone and water vapour in the upper atmosphere. Approximately 40% of all CH_4 emitted globally is due to natural processes (e.g. wetlands, termites) while the remaining 60% is due to various human activities such as rice-growing, ruminant-raising, vegetation fires and fossil-fuel burning. In Ireland over 80% of reported CH_4 emissions are due to agricultural activities, with the remainder caused by waste disposal (e.g. landfill) and the energy sectors.

Photo: © Ned Dwyer

Map 2.10. Location of methane-observation stations.

'Current average global CH_4 concentrations of more than 1800 ppb are 140% higher than pre-industrial concentrations.'

Measurements

Atmospheric CH_4 concentrations have been measured at the Mace Head Atmospheric Research Station, Carna, Co. Galway (red) since 1987. High-precision measurements are made at 40-minute intervals. Given its location at the extreme west of Europe and because of prevailing westerly winds, the measurements are representative of the underlying concentrations of

atmospheric methane in the northeast Atlantic area. CH_4 concentrations have also been measured at Carnsore Point, Co. Wexford and Malin Head, Co. Donegal (blue) since 2009.

The amount of CH_4 in the atmosphere can be inferred from satellite observations, such as those which were made by the European *ENVISAT*. These can help fill in gaps in the global coverage of CH_4 observations. Ground-based measurements are vital for the validation of these satellite observations.

Time-series and Trends

Average global CH_4 concentrations in the atmosphere are now approximately 1800 ppb (parts per billion): this is a 140% increase on pre-industrial concentrations of approximately 750 ppb. Concentrations at Mace Head (Fig. 2.17) are higher because most sources of CH_4 are located in the northern hemisphere. Methane does not persist for more than a decade in the atmosphere, so these high concentrations are maintained due to human activities. Appropriate mitigation actions could reduce these concentrations quite quickly.

At Mace Head, increases in CH_4 have been observed from 1987 to 1998 (after which emissions level off). A further increase since 2007 can be observed. It is not clear what the source of this increase may be, although one hypothesis suggests that warmer than average summers in Siberia and increased precipitation in the tropics lead to more emissions from the vast wetlands in these regions.

A global map of atmospheric CH_4 concentrations for 2005[10] determined from the SCIAMACHY sensor on *ENVISAT* (Fig. 2.18) shows that the highest methane concentrations are in the northern hemisphere. Some of the major methane sources include wetlands in Siberia and tropical areas and rice fields in China and India.

'The Mace Head research station is of global importance as the CH_4 observations are representative of the underlying concentration in the northeast Atlantic region.'

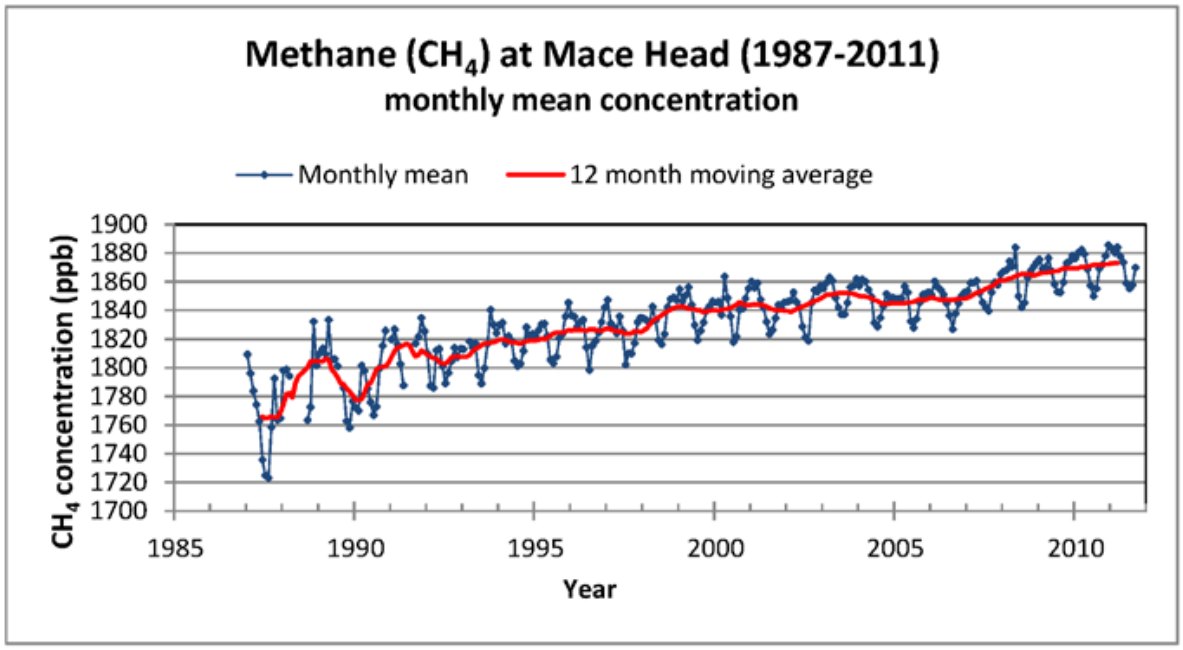

Figure 2.17. Monthly mean methane concentration observed at Mace Head Research Station (1987–2011).

10 from: http://www.iup.uni-bremen.de/sciamachy/NIR_NADIR_WFM_DOAS/index.html

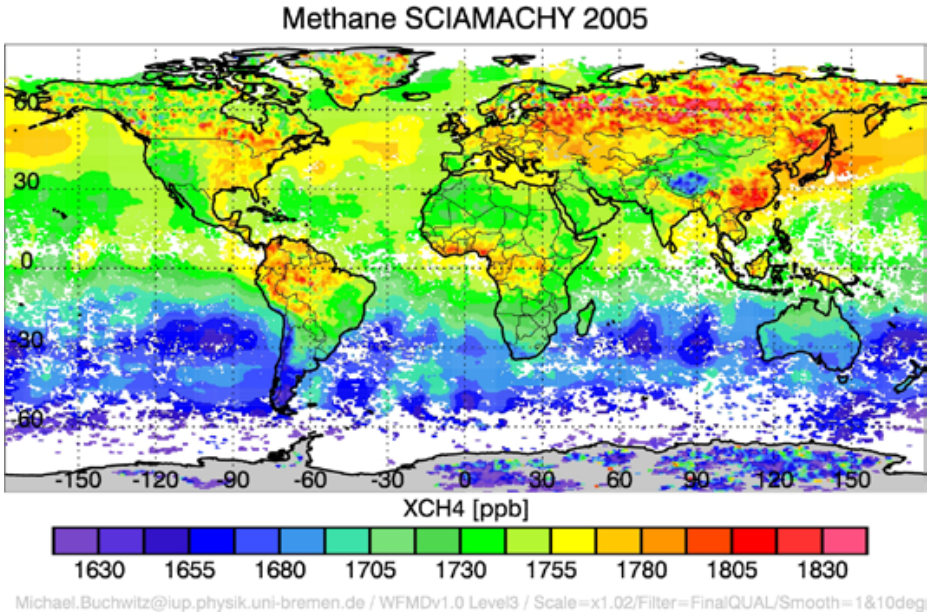

Figure 2.18. Example of annual global mean methane concentration for 2005 as derived from satellite observations.

Maintaining the Observations

Funding for CH_4 observations at Mace Head was originally from the UK's Department of Environment, Food and Rural Affairs (DEFRA) and since 2007 has been funded by the Department of Energy and Climate Change (DECC), as part of its contribution to the Advanced Global Atmospheric Gases Experiment (AGAGE). There is also funding from the US National Aeronautics and Space Administration (NASA). AGAGE equipment is maintained by staff from the National University of Ireland Galway. CH_4 observations at Carnsore Point and Malin Head are funded under an EPA research programme as part of the European Integrated Carbon Observation System (ICOS).

Further Information and Data Sources

Dlugokencky, E.J., Bruhwiler L., White, J.W.C., Emmons, L.K., Novelli, P.C., Montzka, S.A., Masarie, K.A., Lang, P.M., Crotwell, A.M., Miller, J.B. and Gatti, L.V. (2009) Observational constraints on recent increases in the atmospheric CH_4 burden, *Geophysical Research Letters*, Vol. 36, L18803.

Rigby, M., Prinn, R.G., Fraser, P.J., Simmonds, P.G., Langenfelds, R.L., Huang, J., Cunnold, D.M., Steele, L.P., Krummel, P.B., Weiss, R.F., O'Doherty, S., Salameh, P.K., Wang, H.J., Harth, C.M., Mühle, J. and Porter, L.W. (2008) Renewed growth of atmospheric methane, *Geophysical Research Letters,* Vol. 35, L22805.

Methane observations from Mace Head and other AGAGE observatories: http://cdiac.esd.ornl.gov/ndps/alegage.html

Information about the AGAGE network: http://agage.eas.gatech.edu/

Information on the Integrated Carbon Observation System (ICOS): http://www.icos-infrastructure.eu/

Information and data from ESA's Climate Change Initiative greenhouse gas project: http://www.esa-ghg-cci.org/

Data products from SCIAMACHY at the University of Bremen: http://www.iup.uni-bremen.de/sciamachy/NIR_NADIR_WFM_DOAS/