

## 2.11 Other Greenhouse Gases

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A number of other gases have been identified as contributing significantly to the enhanced greenhouse effect. The most important is nitrous oxide ( $\text{N}_2\text{O}$ ), which is emitted from natural decay processes in the oceans and soils. It is also the result of human activities; in Ireland one of the main sources is the agricultural sector. Synthetic gases which are exclusively produced by human activity and which are very potent greenhouse gases include hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), chlorofluorocarbons (CFCs), perfluorocarbons (PFCs) and sulphur hexafluoride ( $\text{SF}_6$ ). These synthetic gases are controlled under the Montreal Protocol, due to their role in ozone depletion. However, their replacements are known to be also potent greenhouse gases.

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**Map 2.11.** Location of other greenhouse gas observation stations.

'Gases which replaced those which deplete ozone are increasing steadily and are contributing significantly to the enhanced greenhouse effect.'

### Measurements

Many of these greenhouse gases are measured routinely at the Mace Head Atmospheric Research Station, Carna, Co. Galway, which is one of the five global stations forming the AGAGE network. Monitoring of a number of HFC and HCFC compounds started in 1994, and PFCs and  $\text{SF}_6$  in 2004.  $\text{N}_2\text{O}$  and CFCs were measured at Adrigole, Co. Cork (blue) from 1978 to 1984.

$\text{N}_2\text{O}$  in the stratosphere is inferred from measurements by sensors on board the US *AURA* and European *MetOp* satellite series. Sensors on the European *ENVISAT* satellite were used to measure the stratospheric distribution of some HCFCs.

## Time-series and Trends

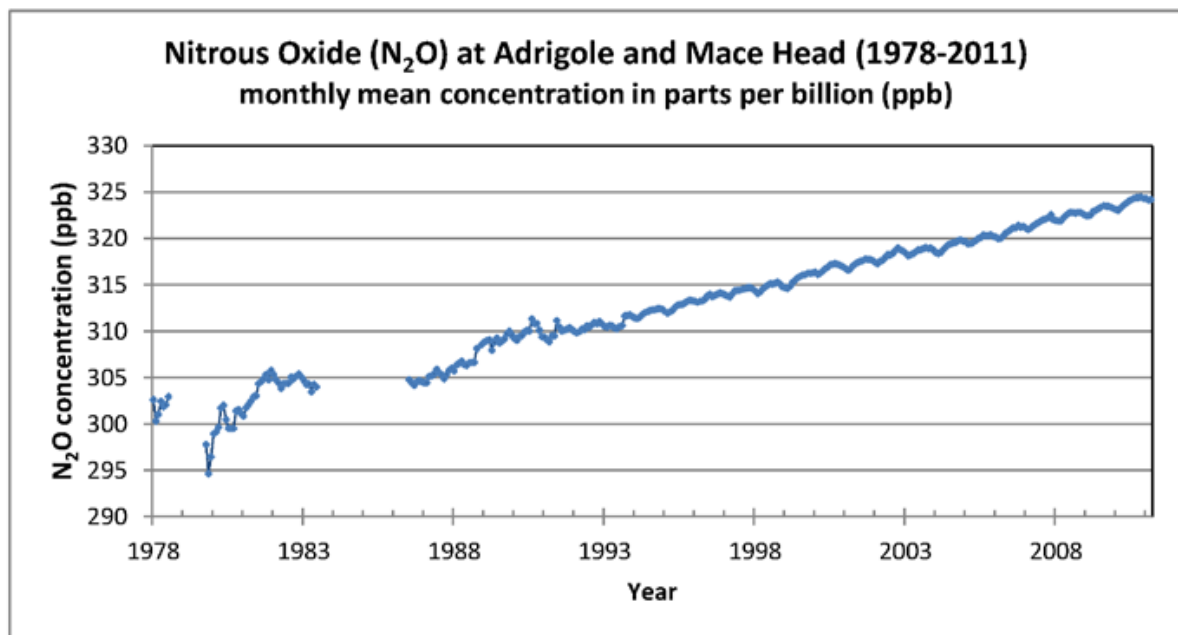
Before the industrial era atmospheric  $\text{N}_2\text{O}$  concentrations were approximately 270 ppb. Measurements at Adrigole and subsequently at Mace Head (Fig. 2.19) have shown a steady increase, with concentrations now above 320 ppb.

CFC-12 concentrations (Fig. 2.20) increased rapidly through the 1980s but after implementation of the

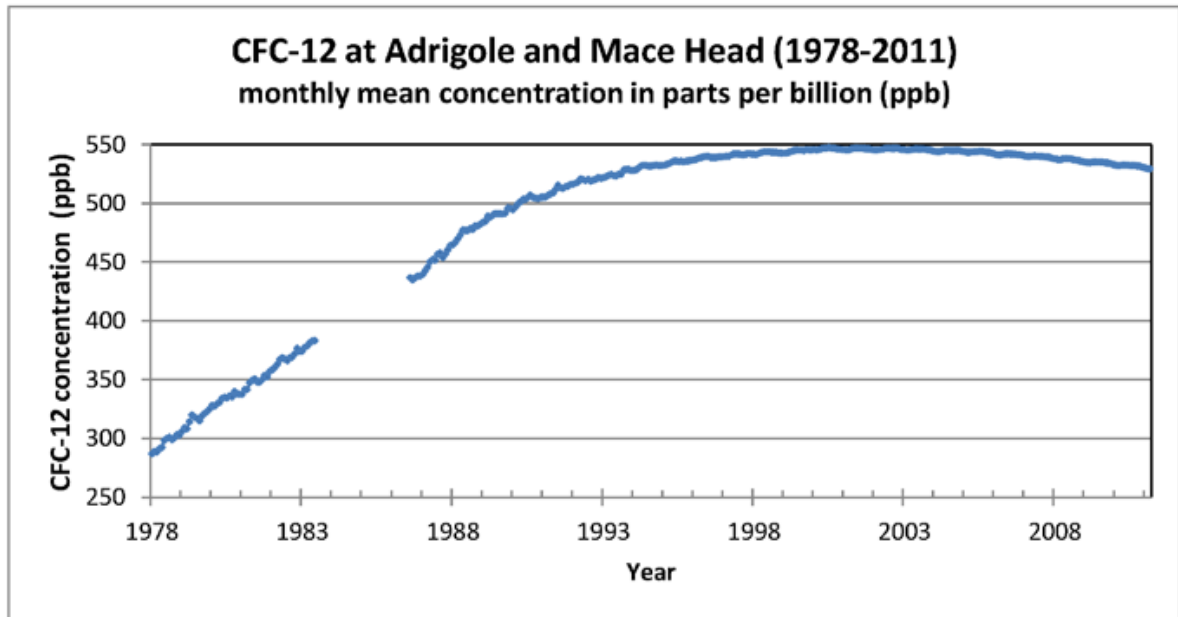
Montreal Protocol in 2000 there was no further increase and levels have begun to drop since 2004. This is confirmation that the international agreement is working.

HFC-134a is an example of one of the refrigerant products that replaced ozone-depleting CFCs. It is also used in mobile air-conditioning and in foam-blowing applications. Its concentration, as well as a number of other synthetic gases, in the atmosphere is increasing steadily as shown in Fig. 2.21.

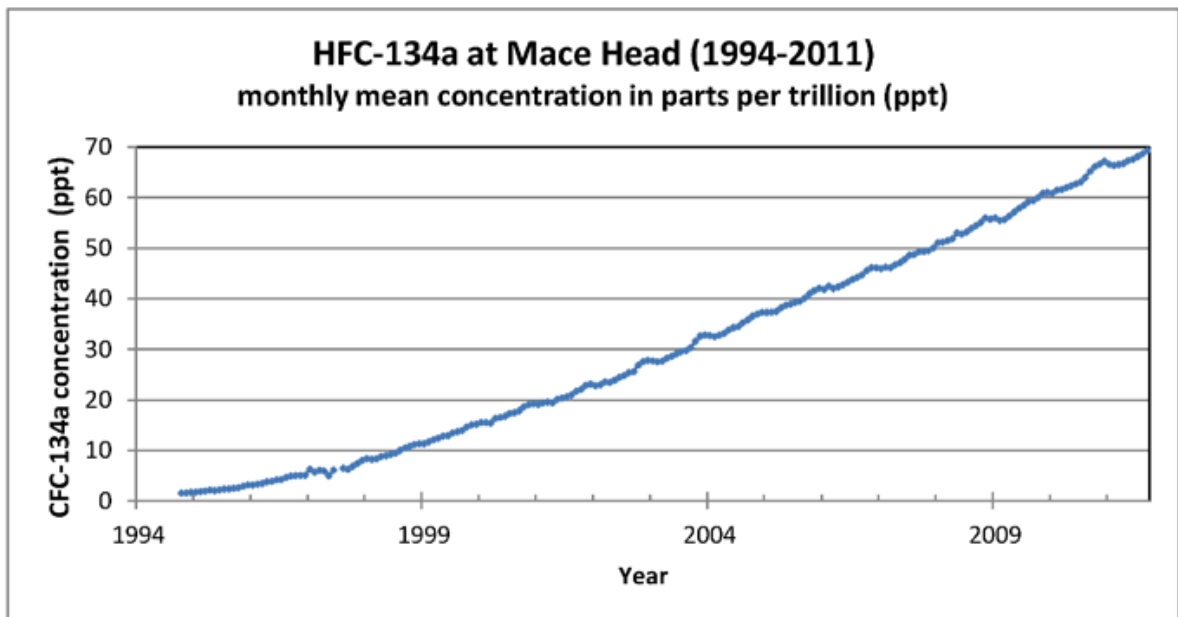
‘The Mace Head research station is a key part of the global greenhouse gas observation network.’



**Figure 2.19.** Monthly mean nitrous oxide concentration observed at Adrigole and Mace Head Research Station (1978–2011). There are some gaps in the data record.



**Figure 2.20.** Monthly mean CFC-12 concentration observed at Adrigole and Mace Head Research Station (1978–2011). There are some gaps in the data record.



**Figure 2.21.** Monthly mean HFC-134a concentration observed at Mace Head Research Station (1994–2011).

## Maintaining the Observations

Funding for greenhouse gas observations at Mace Head was originally from the UK's DEFRA and since 2007 the DECC, as part of its contribution to AGAGE. There is also funding from the US NASA. AGAGE equipment is maintained by staff from the National University of Ireland Galway.

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## Further Information and Data Sources

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O'Doherty, S., Cunbold, D.M., Manning, A., Miller, B.R., Wang, R.H.J., Krummel, P.B., Fraser, P.J., Simmonds, P.G., McCulloch, A., Weiss, R.F., Salameh, P., Porter, L.W., Prinn, R.G., Huang, J., Sturrock, G., Ryal, D., Derwent, R.G. and Montzka, S.A. (2004) Rapid growth of hydrofluorocarbon 134a and hydrochlorofluorocarbons 141b, 142b, and 22 from Advanced Global Atmospheric Gases Experiment (AGAGE) observations at Cape Grim, Tasmania, and Mace Head, Ireland, *Journal of Geophysical Research*, Vol. 109, D06310.

Information on the Montreal Protocol: [http://ozone.unep.org/new\\_site/en/montreal\\_protocol.php](http://ozone.unep.org/new_site/en/montreal_protocol.php)

GHG observations from Mace Head and other AGAGE observatories: <http://cdiac.esd.ornl.gov/ndps/alegagage.html>

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

Greenhouse Gas Online provides information and links to peer reviewed materials on the main greenhouse gases: <http://www.ghgonline.org/index.htm>

Information and data from the European *Infrared Atmospheric Sounding Interferometer* (IASI) instrument: <http://smc.cnes.fr/IASI/>

Information and data from NASA's Microwave Limb Sounder (MLS) instrument: <http://mls.jpl.nasa.gov/>