UNITED KINGDOM

In accordance with decision VCV/3 part (a) of the Fifth Meeting of the Conference of the Parties to the Vienna Convention, the UK has continued to maintain instruments and develop monitoring, calibration and archiving of stratospheric and tropospheric ozone, and other associated trace species and aerosols. Part (c) of VCV/3 states that investigation and quantification of stratospheric and tropospheric processes through routine monitoring and experimental campaigns should be increased in order to understand current changes and to further develop and implement predictions of stratospheric change both for the short term and long term. The UK has also supported a number of projects that fulfil this objective. Details of current monitoring and investigation of stratospheric and tropospheric processes follow.

1. Monitoring stratospheric ozone

1.1 DEFRA funds an on-going monitoring programme that records total ozone values at two UK locations: Lerwick in the Shetlands, and Camborne in Cornwall. 3 UK Dobson spectrophometers are used to record daily values, although weather conditions sometimes prevent values from being recorded and Lerwick shuts down for a short period each winter when the sun is too low. Daily values are sent to WOUDC (World Ozone and UV Data Centre) at the end of each month, and to the WMO GAW ozone-mapping centre at Thessaloniki.

1.2 One of the spectrophotometers was re-calibrated in 1999 (at Camborne), and the other two were re-calibrated in 2000 (against a world-class instrument at Hohenpeissenberg, Germany). All three are carefully maintained and checked monthly. A number of checks are performed in order to ensure the integrity of the data, including comparison of daily results with satellite measurements, and the nearest ground-based measurements. The values are compared to those obtained at European stations at similar latitudes, and there is good agreement between Camborne and the Belgian station at Uccle, and between Lerwick and Oslo.

1.3 The Natural Environment Research Council (NERC) also supports column ozone monitoring at Aberystwyth. This has been performed for the last nine years. Further details on this can be obtained from: http://users.aber.ac.uk/ozone/ .

2. Stratospheric ozone research

2.1 DEFRA funds a research project that analyses the ozone data collected at Camborne and Lerwick. This research concentrates on identifying low ozone events, and predicting how the frequency of low ozone events could alter as stratospheric levels change.

2.2 In accordance with decision VCV/3 part (d), which states that a high priority should be given to research into interactions between ozone and climate, DEFRA has also supported research at the University of Cambridge and the Met Office into current and future stratospheric ozone depletion and the implications of climate change. This research has used 20-year simulations with a coupled stratospheric chemistry-climate model to compare modelled and observed trends and to predict ozone trends for the period 2000-2019. This project is part of the wider research carried out by the Met Office stratospheric processes group, which aims to assess the impact of changes in greenhouse gases and halogen loadings on stratospheric ozone and temperature, and to provide future predictions of these quantities. Funding for this group is also provided by NERC and CEC.

2.3 The Met Office is one of the partners in the EuroSPICE project (Stratospheric Processes and their impacts on Climate and the Environment). (Other partners are: CNRS-SA, France, CNRS_LMD, France, Finnish Met. Inst., Finland, Free University of Berlin, Germany, University of Reading, UK, University of Buenos Aires, Argentina.) The specific aim of the EuroSPICE project is to update the observed stratospheric trends in ozone, surface UV and temperature and simulate those trends using climate models with/without coupled chemistry. The simulations will then be used to predict the behaviour of these quantities over the period 2000-2019, determine the likely cause of past stratospheric trends and develop understanding of the impact of stratospheric change.

2.4 The European Ozone Research Co-ordinating Unit (EORCU), which is based at the University of Cambridge, co-ordinated the extension of the Third European Stratospheric Experiment on Ozone (THESEO) into the winter of 1999/2000 in conjunction with the Sage III Ozone Loss and Validation Experiment (SOLVE) led by NASA. This was the largest ever field experiment into polar ozone loss.

2.5 The Natural Environment Research Council (NERC) has funded the Upper Troposphere/ Lower Stratosphere OZONE Programme which commenced in 1999 and will continue for 7 years to 2006. The main aim is to improve understanding of the causes of ozone change in the upper troposphere and lower stratosphere in the past, present and future. This is a region where ozone has been changing but the causes still remain uncertain. To date, 40 scientific research projects have been funded which cover a wide variety of research topics. These range from transport of trace gases on annual and seasonal timescales, dynamical processes occurring on short-timescales, studies of chemical processes in the atmosphere and the laboratory and modelling studies of chemistry-climate interactions. Results from the Programme have shown, in particular, that interactions between dynamics (meteorology) and chemistry in the atmosphere play an important role in governing the distribution of ozone and other trace gases in the upper troposphere and lower stratosphere.

3. Tropospheric ozone monitoring and research

3.1 Ground-level ozone is recorded hourly at 73 automatic recording stations (52 urban and 19 rural) across the UK. Data collection is managed by DEFRA, and the department has also commissioned research to model the formation of ozone and provide forecast tools. Research into the impacts of changing tropospheric ozone levels on vegetation has also been funded by DEFRA.

3.2 Tropospheric ozone modelling is carried out at the Met Office as part of the Climate Prediction Programme funded by DEFRA. Prediction of future climate requires predictions of radiatively-active trace gases such as ozone, and a coupled climate-chemistry model has been developed to fulfill these requirements. Recent research with this model uses multi-decadal simulations to investigate the role of climate change as a feedback process for tropospheric chemistry. This feedback has been found to be extremely important and results in lower predictions of ozone and methane concentrations. The simulations do not yet include the indirect effects of climate change on tropospheric chemistry through changes to the biospheric emissions, and work has started with coupled ecosystem models in order to investigate this process.

4. Monitoring ozone-depleting substances

4.1 DEFRA has provided support for projects that monitor ozone-depleting substances by analysing ground-based measurements at Mace Head (Ireland) and Weybourne. Aircraft data obtained with the support of the EU funded CARIBIC programme has also been analysed. The measurements have shown that UK emissions of CFCs are declining steadily and emissions of bromine-containing species are stable.

4.2 The aircraft data has enabled identification of two new ozone-depleting substances present in the atmosphere, n-propyl bromide (NPB) and hexachlorobutadiene (HCBD). Samples of European plumes have been monitored to ascertain the level of success achieved by the Montreal Protocol in reducing emissions of ozone depleting substances. The data has also shown that there may be issues with non-compliance as there is a positive correlation between some controlled and replacement species.

4.3 DEFRA has funded a new project that will build on this work by continuing to measure emissions of halocarbons and identify new ozone-depleting substances. Part of this project will also involve identification of additional data sources for comparison purposes. The bulk of the monitoring for this project will take place at Mace Head on the coast of Ireland. The location of this station is advantageous; the instruments are able to monitor background levels of trace gases when winds are westerly and have travelled over the Atlantic, and can monitor levels in polluted European air when winds are easterly.

5. Monitoring and research into effects of increased UV-B radiation

Decision VCV/3 part (f) stated that research into the effects of UV-B radiation and efforts to monitor such effects should be increased. DEFRA and the Department of Health (DoH) have funded monitoring contracts and research into the effects of UV-B.

5.1 A DEFRA funded contract makes spectral measurements of solar shortwave UN radiation at the surface to produce a UV climatology which allows detection of long-term trends that may arise as a result of stratospheric ozone depletion.

5.2 Two UV monitoring sites are in operation – there is a green-field site at Reading, and a city site in Manchester. The Reading site spectroradiometer is calibrated on site and has been providing regular measurements since 1992. It provides hourly spectrums between sunrise and sunset in the 280-500nm range. Periodic international comparisons with other UV spectroradiometers have provided consistently good results. The Manchester instrument provides five minute averages in each of five narrow wavebands (305, 313, 320, 340, 380nm). It is calibrated annually on site and in 2000 it was calibrated to the Norwegian standard instrument. Apart from calibration periods, the instrument has been in continuous operation since 1997, and provides a southern site in the Nordic network of GUV radiometers.

5.3 DEFRA also funded an assessment of the impacts of ozone depletion on aquatic ecosystems. The project concentrated on three aquatic life forms: marine animals, plant life and fish. Increased UVB was shown to have a detrimental effect on all three groups.

5.4 The Department of Health provides support for UV monitoring performed by the National Radiological Protection Board (NRPB). The NRPB Solar Radiation Monitoring Project at NRPB provides information for the Global Solar UV Index in association with WHO, WMO, UNEP and the International Commission on Non-Ionizing Radiation Protection.

6. Key results and future directions

6.1 Significant UK contributions to research have been made in a number of areas:

- Interaction of chemistry, dynamics and radiation in the upper troposphere and lower stratosphere
- Role of dynamical and chemical influences on past ozone trends

- Modelling future changes in stratospheric ozone in response to the anticipated reduction in halogen loading and the effects of climate change
- Estimating the importance of climate feedback on future tropospheric ozone predictions.
- Understanding the microphysics and photochemistry of ozone loss in polar regions
- Understanding the impact of aviation on the atmosphere
- Use of satellite data with models and data assimilation to understand stratospheric ozone

6.2 The main thrust of future work is toward understanding the interaction between the stratosphere and climate change, and to work out what the effects will be on stratospheric ozone and UV radiation. Issues include the impact of CH4 and N2O emissions on ozone recovery (thought to offset halocarbon reductions quite significantly); the effect of changing dynamics on polar ozone depletion particularly in the Arctic (through lower temperatures and changed vortex stability); the impact of changing dynamics on mid-latitude ozone; understanding the causes and implications of currently unexplained long-tern increase in stratospheric water vapour; and, given their importance in climate change, investigating what the future tropical influence on the stratosphere (where there is currently no significant ozone trend) might be.

7. Commitment to future monitoring and research

7.1 At this stage DEFRA has not specified the areas that will receive direct government funding in the future. However, given the high priority of VCV/3 part (d), some research into stratospheric interactions and climate will be included in the contract funded by DEFRA at the Met Office. Monitoring of a comprehensive range of ODSs will be funded, for at least the next three years, in line with VCV/3 part (a). The current basic level of ozone monitoring will be maintained but any expansion of the monitoring activities will depend on budgetary constraints.

7.2 NERC are planning to support future ozone research and monitoring through their UTLS (Upper Troposphere Lower Stratosphere) and COSMAS (Core Strategic Measurements for Atmospheric Science) programmes, which run until 2003 and 2005 respectively. The focus of COSMAS will be determined by the infrastructure and knowledge base requirements by upcoming NERC, UK, EU and international programmes (such as UTLS and EU ozone experiments). A joint UTLS-COSMAS meeting will be held in July to identify the priorities for the two programmes. More information on these programmes can be found on the following web-sites:

www.utls.nerc.ac.uk and www.nerc.ac.uk/funding/thematics/cosmas/ .

8. Further information

8.1 Details of DEFRA funded research, including the full reports for scientific contracts, can be accessed from the DEFRA website at www.defra.gov.uk. by following the llinks to the environment pages.

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