

**UK Report on national activities  
with respect to the GCOS  
Implementation Plan**

**Prepared for submission to the United Nations  
Framework Convention on Climate Change  
(UNFCCC)**

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# 1. Introduction

This report provides an assessment of UK contributions towards the realisation of the GCOS Implementation Plan. It represents the UK's response to the invitation made by the Subsidiary Body for Scientific and Technological Advice (SBSTA) of the Conference of Parties to the UNFCCC for Parties to submit information on their national activities with respect to the GCOS Implementation Plan to the GCOS secretariat<sup>1</sup>. It is understood that the report will be used by the GCOS secretariat to provide a comprehensive report on progress towards the realisation of the GCOS Implementation Plan for consideration by the SBSTA at its thirtieth session in June 2009.

The report uses the new reporting structure set out by the UNFCCC Secretariat in its Draft decision - /CP.13 'Reporting on global observing systems for climate'<sup>2</sup>.

The process for compiling the report has been to reformat two earlier reports to fit the new guidelines and then to seek updates from those involved directly with the programmes. The section on common issues (Chapter 2) reuses text from websites and other documents to summarise UK inputs, as well as inputs from those involved directly with the programmes.

The report includes systematic observing systems operated by or on behalf of UK public sector organisations that are relevant to the GCOS Implementation Plan. Observations made by international organisations to which the UK contributes, such as the European Space Agency (ESA) and Eumetsat, are presented under the auspices of the host countries — in these two particular examples, France and Germany respectively. Similarly, the reanalysis work of the European Centre for Medium-Range Weather Forecasts (ECMWF) is included in this report because the ECMWF is based in the UK.

The structure of the report follows that requested by the UNFCCC Secretariat. In outline, this is as follows:

- Common issues
- Atmospheric ECVs
- Oceanic ECVs
- Terrestrial ECVs
- Additional information

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<sup>1</sup> Subsidiary Body for Scientific and Technological Advice, Twenty-third session, Montreal, 28 November–6 December 2005, FCCC/SBSTA/2005/10, paragraph 95.

<sup>2</sup> Subsidiary Body for Scientific and Technological Advice, Twenty-seventh session, Bali, 3–11 December 2007, FCCC/SBSTA/2007/L.14/Add.1

## **2. Common issues**

### **2.1 Planning**

#### **2.1.1 Overview**

Climate research and procurement of climate-related observations are highly devolved activities in the UK. They are sponsored by various government departments to support a range of responsibilities and policy requirements. In addition, some research is increasingly being funded from a wider stakeholder base in both public and private sectors, particularly in the area of climate impacts and adaptation. Although the UK does not therefore have set national plans for climate research and observations, and at present there are no plans to produce such plans, it regularly reviews such activities through the Global Environmental Change Committee (GECC). The preparation of this and the previous report have assisted the task of forming a national overview of activities.

#### **2.1.2 Responsible departments**

The Department of Energy and Climate Change (DECC) was formed on the 3<sup>rd</sup> of October 2008, absorbing elements of the Department for Environment, Food and Rural Affairs (Defra) and the Department for Business, Enterprise and Regulatory Reform (BERR). DECC has the lead on climate change policy and provides funds for climate research and observations to advise the UK's policy and its impacts and response strategies. Defra will remain responsible for domestic adaptation to climate change and provides funds for environmental observations, including some climate observations. The Department for Innovation, Universities and Skills (DIUS) funds work on new technologies and provides funding for the Research Councils. These Councils are responsible for maintaining the science base and operate at a distance from Government, though they participate in the GECC and ERFF coordination processes described below. The Research Council with the greatest direct interest in climate observations is the Natural Environment Research Council (NERC). NERC is responsible for basic research on climate prediction and processes and for some monitoring activities. The Met Office, as the national meteorological agency, also has a strong involvement in climate research (undertaken at its Hadley Centre) and observation.

Systematic observations in the UK and its overseas territories are made by a number of national agencies and organisations. The Met Office is the lead agency for making and collecting meteorological and atmospheric observations. Observations are also made by others, including the NERC Centres and Surveys. These include the following:

##### Research Centres:

- British Antarctic Survey
- British Geological Survey
- Centre for Ecology and Hydrology
- Proudman Oceanographic Lab.

##### Established collaborative centres:

- National Centre for Atmospheric Science
- National Centre for Earth Observation
- National Oceanography Centre, Southampton
- Plymouth Marine Laboratory
- Scottish Association for Marine Science
- Sea Mammal Research Unit

Collection of oceanographic (and marine) observations is widely distributed throughout the UK, with many government departments and laboratories, universities and commercial companies involved. Terrestrial observations are made or coordinated by NERC, the Environment Agency (EA), the

Scottish Environment Protection Agency (SEPA), the Northern Ireland Environment Agency (NIEA), the Forestry Commission and others. The UK also contributes to space-based observations through the European agencies; the European Space Agency and the European Organisation for the Exploitation of Meteorological Satellites.

### 2.1.3 Coordination processes

UK activities in the science and technology of climate change are co-ordinated through the Global Environmental Change Committee (GECC), an inter-agency Committee chaired by the Chief Scientist of DECC. The UK's Environment Research Funders' Forum (ERFF) brings together the UK's major public sector sponsors of environmental science, aiming to make best possible use of funding. The ERFF provides broader co-ordination for funding of climate change related research activities that clearly add value, could not be done by a single member acting alone, and have the potential to advance environmental research in the UK and internationally.

Over the last year, the ERFF has developed the UK Environmental Observation Framework (UK-EOF)<sup>3</sup>, which was launched formally in July 2008. This initiative stemmed from work to catalogue the full range of UK environmental monitoring activities carried out in 2006. It was clear from this work that a more strategic approach to observation activities would be valuable both for UK needs and to enhance UK participation in international activities; the UK-EOF seeks to provide this. Many of the observation activities are of value for climate change assessments and for this reason, the UK-EOF has established close links to the Observation Subgroup of the GECC.

In the marine sector, the newly established Marine Science Coordination Committee (MSCC) has taken over the role of the former Inter Agency Committee on Marine Science and Technology (IACMST). The MSCC is expected to work closely with bodies involved in the implementation of the UK Marine Monitoring and Assessment Strategy (UKMMAS). Within UKMMAS, climate-related observations are currently the responsibility of the Healthy and Biologically Diverse Seas Evidence Group (HBDSEG) but are expected to transition to a new Ocean Processes Evidence Group (OPEG).

### 2.1.4 International involvement

The UK participates in a number of international programmes, and in particular with activities at European level. Such activities include the following:

- **ESA:** The UK contributes to a number of ESA programmes. In the past these have included the ERS and Envisat satellite programmes, and continuity from these will be provided by the GMES Sentinel Missions. The UK is also involved in the ongoing ESA Earth Explorer programme, which is developing new forms of observation of value to climate studies such as Cryosat, EarthCare and ADM Aeolus. GMES is now referred to as Kopernikus<sup>4</sup>.
- **Eumetsat:** The UK contributes to the Eumetsat Geo (Meteosat) and Polar (Metop) satellite programmes, as well as to the Jason-2 satellite altimeter mission.
- **EUMETNET Composite Observing System (EUCOS):** The Met Office contributes to the EUCOS network, which aims to establish and operate a European observing network under the auspices of the European Meteorological Network (EUMETNET) to deliver increased efficiency, leading to better-quality numerical and general forecasts, initially on a European scale. EUCOS includes a terrestrial segment (surface and upper-air observing) and a surface marine programme, both of which contribute to GCOS.

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<sup>3</sup> <http://www.erff.org.uk/publications/reports/2008-05-uk-eof.aspx>

<sup>4</sup> <http://ec.europa.eu/kopernikus/overview.htm>

- **ECMWF:** The UK is a partner in the European Centre for Medium Range Weather Forecasts (see section 2.5). The principal objectives of the Centre are:
  - development of numerical methods for medium-range weather forecasting;
  - regular preparation of medium-range weather forecasts for distribution to the meteorological services of the Member States;
  - scientific and technical research directed at the improvement of these forecasts;
  - collection and storage of appropriate meteorological data.
 In addition, the ECMWF undertakes important reanalysis work, which is highly relevant to the GCOS Implementation Plan.
- **GMES:** GMES (now known as Kopernikus) is a joint initiative of the European Commission (EC) and the ESA, to which the UK contributes. In addition to the Sentinel satellite activity referred to under ESA above, GMES also involves in-situ measurements and the provision of services. GMES makes a number of measurements of value to climate research and modelling, and a related activity on data processing specifically for climate applications is currently under consideration.
- **GEO:** The UK is a member of the international GEO programme as a national delegation and also through participation in a number of the GEO committees.
- **CEOP:** The Coordinated Energy and Water Cycle Observations Project (CEOP), an element of the World Climate Research Programme (WCRP) initiated by the Global Energy and Water Cycle Experiment (GEWEX), has invited the Chilbolton Facility for Atmospheric and Radio Research (CFARR) to become one of its reference sites in Europe.
- **AGAGE:** The UK is involved in the international AGAGE programme through its activities at Mace Head. The Advanced Global Atmospheric Gases Experiment (AGAGE), and its predecessors (the Atmospheric Life Experiment, ALE, and the Global Atmospheric Gases Experiment, GAGE) have been measuring the composition of the global atmosphere continuously since 1978. AGAGE is distinguished by its capability to measure over the globe at high frequency almost all of the important species in the Montreal Protocol (e.g. CFCs and HCFCs) to protect the ozone layer and almost all of the significant non-CO<sub>2</sub> gases in the Kyoto Protocol (e.g. CF<sub>4</sub>, SF<sub>6</sub>, HFCs, methane, and nitrous oxide) to mitigate climate change.

## 2.2 Implementation

The Met Office operates surface, upper air and marine observing networks that contribute to GCOS. These are mostly funded through the Public Weather Service (PWS), whose remit is to provide a coherent range of weather information and weather-related warnings to the UK public, on the basis that the GCOS commitments align well with PWS objectives. (Should PWS and GCOS requirements diverge in the future, new funding arrangements would be needed.) The PWS also provides UK climate and weather statistics.

A significant portion of the UK's open-ocean observations capability lies within the NERC marine centres and are funded through research budgets. The NERC marine centres, together with the Marine Biological Association (MBA) and Sir Alistair Hardy Foundation for Ocean Science (SAHFOS) have jointly established a strategic research programme 'Oceans 2025', which includes support for various long-term monitoring activities, a number of which are relevant to GCOS.



## **2.3 Quality control**

### **2.3.1 Efforts to ensure ECV-observing activities adhere to the GCOS climate monitoring principles**

The National Centre for Atmospheric Science (NCAS) has established interactions with the National Physical Laboratory for the development and harmonisation of international reactive gas standards and is a regular participant in blind inter-comparison activities with EU and US partner organisations.

The Met Office has carried out a comparative analysis of data from wooden and plastic thermometer shelters, before adopting the latter. A similar comparison of sunshine recorders (the old Campbell-Stokes glass balls and a modern Kipp and Zönnen instrument) is being undertaken at a few sites. Sunshine is a useful proxy providing spatial detail for surface radiation measurements.

As part of the Meteorological Monitoring System (MMS) project to replace existing Met Office automatic weather stations, parallel trials are planned for 2 stations to ensure we understand any differences in data that might be introduced by the MMS. Also, the Met Office are introducing sonic anemometers onto its offshore moored buoys. These are initially being deployed alongside the regular cup and vane anemometer system to provide a period of overlap for inter-comparison.

### **2.3.2 Difficulties encountered in protecting the integrity of long-term climate data records and steps being taken or required to address those difficulties**

The Met Office has earmarked a small set of observing stations to ensure the consistent maintenance of the 350-year Central England Temperature record (see section 2.5).

The Met Office Hadley Centre continues to develop corrections to the global record of sea surface temperature (SST) since 1850 to account for biases resulting from historical and ongoing changes in the composition of the data base, particularly relating to measurement platforms, methods and country of origin. Uncertainties in these corrections are also quantified and made available together with uncertainties relating to under-sampling. The dataset will be considerably enhanced when much of the undigitized ship logbook data held in the UK are digitized. DECC is funding scanning of the documents, with digitization taking place in the USA. Work has nearly finished with the 1940s and 1910s, and will progress to earlier logbooks from the 19th century, funding permitting.

The Met Office has occasional contacts with National Meteorological Services (NMSs) supplying CLIMAT observations with a view to improving data exchange. They also liaise regularly with the GCOS Monitoring Centres at the Deutscher Wetterdienst (DWD) and the Japan Meteorological Agency (JMA).

## **2.4 International data exchange and data analysis**

### **2.4.1 National policy or guidance that has been promulgated relevant to the international exchange of ECV data**

No national policy or guidance has been promulgated on this issue.

## 2.4.2 Policy-level barriers to international exchange of climate data and their provision to international data centres (IDCs)

The UK has a policy of seeking some cost recovery from public investments, and some detailed observational data concerning the UK are only freely available under conditions that restrict use to supporting openly-published research.

## 2.5 Data centres

### The Met Office Hadley Centre (MOHC)

**Datasets:** The Met Office Hadley Centre receives, quality controls, and archives large amounts of observed climate data. These are used for monitoring the climate, in studies of the causes of climate change, and in climate modelling.

On the national scale, indicators of historical and present changes in climate include Central England Temperature (CET) and England and Wales (total) Precipitation (EWP). CET is representative of a roughly triangular area of the UK enclosed by Bristol, Lancashire and London. The monthly series begins in 1659, and to date is the longest available instrumental record of temperature in the world. The monthly time series of EWP begins in 1766 and the series is currently based on weighted averages of daily observations from a network of stations in five regions. It is the longest instrumental series of this kind in the world. Additional resources for monitoring the UK climate include monthly series of 5km gridded data and associated areal series, the longest of which are temperature (1914), precipitation (1914) and sunshine duration (1929).

On the global scale, the Met Office Hadley Centre monitors the global average temperature on land and over the sea, and the sea surface temperature in the tropical Pacific, which is an indicator of variations associated with El Niño. Key global gridded datasets include monthly blended land surface air temperature and sea surface temperature (HadCRUT prepared in collaboration with the Climatic Research Unit (CRU) of the University of East Anglia); sea surface temperature with sea ice (HadISST); stand-alone sea surface temperature (HadSST); night marine air temperature (HadMAT1 and MOHMAT) and sea level pressure (HadSLP). Under development is a global subsurface ocean analysis of temperature (HadGOA), and, with NOAA (USA), worldwide gridded land daily temperatures (HadGHCND). Many of these data sets and analyses are provided with quantified uncertainties. These data holdings are fully described on: <http://hadobs.metoffice.com/>. The following list summarises the contents of the web site:

#### MARINE DATASETS

- HadISST - Globally complete sea-ice and sea-surface temperature
- HadSST2 - Uninterpolated sea-surface temperature
- MOHMAT - Uninterpolated night marine air temperature
- EN3 - ENSEMBLES: quality controlled in situ ocean temperature and salinity profiles
- HadGOA - Global subsurface ocean analysis of temperature
- HadDTR - A climatology of the diurnal temperature range of the sea surface

#### PRESSURE DATA

- HadSLP2 - Monthly gridded sea-level pressures
- EMSLP - Daily gridded sea-level pressures

#### UPPER AIR DATA

- HadAT - Gridded free-atmosphere temperatures from radiosondes
- QUARC - Quantifying Uncertainty in Adjusted Radiosonde Climate records

#### DAILY DATA/EXTREME INDICES

- HadGHCND - Gridded land daily temperatures
- HadEX - Indices of climate extremes

#### LAND SURFACE DATA

- HadCET - Central England temperatures
- HadUKP - England & Wales Precipitation
- UK monthly gridded data and areal series
- CRUTEM3 - Gridded land monthly temperatures
- Urban - data used in study on urban temperature effects

#### COMBINED LAND/MARINE

- HadCRUT3 - Gridded monthly temperatures
- HadCRUH - Gridded monthly specific and relative humidities

#### OLDER DATASETS

- GISST, MOHSST, HadSLP1, and HadRT are now obsolete and have been moved to a deprecated datasets page. They are retained solely for the purpose of comparison to the current datasets.

#### OTHER RESOURCES

- Reports related to the datasets
- MarineClimatology.net (forum) (wiki)

The data sets are available in NetCDF, ASCII and Met Office pp format. Access to these datasets is freely available, but registration enables the Met Office to inform users of changes and/or new dataset versions. The website is not an operational service. It is run by research staff with the primary aim of improving collaboration with fellow researchers, so there is little support to enable users to extract subsets of sometimes large global datasets. Everyone is welcome to use the site, and the Centre's staff aim to make it reliable, but it does not have the same level of support as the official Met Office web site.

Met Office Hadley Centre model data are distributed through the Climate Impacts LINK Project hosted by the British Atmospheric Data Centre (see below). Some runs are also available on the WCRP CMIP3 Multi-model data archive, and through the PCMDI archive related to the Intergovernmental Panel on Climate Change (IPCC).

**Reanalysis work:** The Met Office Hadley Centre has a representative on the GCOS/WCRP Working Group on Observational Data Sets for Reanalysis and chairs or co-chairs three GCOS Working Groups on SST and Sea Ice, Surface Pressure and Atmospheric Reference Observations. There are also 3 UK representatives on the Atmospheric Observations Panel for Climate (AOPC) including the Chairman (Adrian Simmons of ECMWF).

The Met Office Hadley Centre maintains a capability to perform reanalyses of many of its data sets and analyses.

It also hosts the international Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative, which is an end-to-end project that facilitates both the historical global weather observational data needs of surface-observations-only climate quality reanalyses, and the seamless feeding of 3D weather products produced by these reanalyses into climate applications and impacts models. This activity is funded primarily by the Queensland Climate Change Centre of Excellence, but the project is run at the Met Office Hadley Centre. ACRE achieves this outcome by:

- linking international meteorological organisations and data rescue infrastructure to facilitate the recovery, extension, quality control and consolidation of global historical terrestrial and marine instrumental surface data covering the last 250 years;

- making these observations available to new pioneering surface-observations-only reanalyses;
- ensuring that reanalysis products can be tailored/downscaled to seamlessly flow into various climate applications and production models.

**LINK:** The Climate Impacts LINK Project (known as LINK) provides climate simulations from the Met Office Hadley Centre to the UK and international academic communities. The data include climate runs from a range of Met Office Hadley Centre models including HadCM2, HadCM3, HadRM2, HadRM3 and HadGEM1.

The current generation of Met Office Hadley Centre models is the HadGEM suite. Previously the HadCMX suite produced both global datasets (CMx) and regional model data (RMx). HadCM2, HadCM3 and HadGEM1 are global coupled atmosphere-ocean models. HadCM2 was used in the IPCC Second Assessment Report, and was followed by HadCM3, the model used in the Third Assessment Report. HadCM3 included an improved representation of the atmosphere and ocean physics compared to HadCM2. In particular, the improvement in physics means that HadCM3 has a reasonable, stable climate without the use of a flux correction. HadGEM1 is yet higher in spatial resolution and contributed most recently, along with HadCM3, to the Fourth Assessment Report.

HadRM2 and HadRM3 are high resolution atmospheric models run over the European domain. HadRM3 simulations were used to develop the scenarios underpinning the UKCIP02 Scientific Report on Climate Change Scenarios for the United Kingdom. Additional HadRM3 ensemble simulations are being used to generate probabilistic projections of climate change for the UK 21st Century Climate Scenarios (UKCIP08).

LINK was established by Defra in 1991. In 2006, the British Atmospheric Data Centre (BADC) took over the delivery of this service, and now sub-contract to the Met Office Hadley Centre to provide the substantial quantity of data and additional ancillary information describing the simulations.

LINK was initially focussed on the climate impacts community only and datasets were selected with that specific community in mind. The incorporation of the LINK datasets into the BADC infrastructure has allowed exploitation of synergies with other projects to expand both the size of the user community and the volume and number of datasets that can be delivered. With Met Office Hadley Centre support the efficiencies of data extractions and services that can be provided to users has been greatly enhanced.

The LINK project acts as an umbrella activity under which the various Met Office Hadley Centre datasets are now held. These are being archived as individual BADC datasets even though applications for LINK data will allow users to access multiple model datasets where the conditions of use allow it. Users can also browse the BADC catalogue under the LINK directory to find symbolic links to these other datasets from a single location.

The data are all stored in Met Office pp-format. Users wishing to access the data directly in pp-format can download the files via FTP or the data browser. Users wishing to access the data in NetCDF format, to access subsets of the data and/or to generate plots from the data can visit the BADC Data Extractor<sup>5</sup> once registered.

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<sup>5</sup> <http://badc.nerc.ac.uk/data/link/>

## **Global Collecting Centre for Marine Climatological Data (GCC)**

The UK (Met Office), together with Germany (DWD), operates one of two Global Collecting Centres for Marine Climatological Data (GCC). The aim of the GCC is to ensure that marine data are received from contributing members around the world and processed to an agreed standard. The data are then distributed on a quarterly basis to eight responsible members, each with their own geographic area of responsibility<sup>6</sup>.

## **Permanent Service for Mean Sea Level (PSMSL)**

The Permanent Service for Mean Sea Level (PSMSL) has been responsible for the collection, publication, analysis and interpretation of sea level data from the global network of tide gauges since 1933. It is based in Liverpool at the Proudman Oceanographic Laboratory (POL), which is a component of the UK Natural Environment Research Council (NERC). The PSMSL is a member of the Federation of Astronomical and Geophysical Data Analysis Services (FAGS) established by the International Council for Science (ICSU). It is supported by NERC.

**Data sets:** As of September 2008, the database of the PSMSL contained 56,800 station-years of monthly and annual mean values of sea level from tide gauge stations around the world. On average, approximately 2,000 station-years of data are entered into the database each year. Data for all stations are included in the PSMSL METRIC (or total) data set. The METRIC monthly and annual means for any one station-year are necessarily required to be measured to a common datum, although, at this stage, datum continuity between years is not essential. The year-to-year datum checks become essential, however, if the data are subsequently to be included in the PSMSL 'Revised Local Reference (RLR)' component of the data set, which contains records for which time series analysis of sea level changes can be performed. The geographical distribution of longer RLR records contains significant geographical bias towards the northern hemisphere, a situation which is being rectified by the establishment of the Global Sea Level Observing System (GLOSS) global sea level network. The PSMSL Data Set (monthly and annual means, global distribution) is freely available from the web site ([www.pol.ac.uk/psmsl](http://www.pol.ac.uk/psmsl)), together with accompanying metadata.

PSMSL, together with the British Oceanographic Data Centre (BODC), are also responsible for the delayed-mode high frequency GLOSS data bank. (High frequency means hourly rather than monthly/annual values). These data are available on-line through the GLOSS ([www.gloss-sealevel.org](http://www.gloss-sealevel.org)) or BODC ([www.bodc.ac.uk](http://www.bodc.ac.uk)) web-sites. This includes historical data and metadata for approximately 150 stations.

**Other Activities:** The PSMSL attempts to stimulate the development of tide gauge networks with other countries at national, regional and global level. The most important component of this work is its planning, and part-management of, the GLOSS programme. It provides, through GLOSS and via other routes, advice and training to national sea level authorities and individual sea level scientists and technologists. It organises major international meetings on the themes of sea level changes and tides. It also supplies software packages for tidal data analysis and quality control and helps with the provision of training information and manuals. It maintains full participation with altimeter and space gravity working groups in view of the importance of those techniques to sea level research. The PSMSL Director is a Principal Investigator for the T/P, Jason, ERS and Envisat missions. Indeed, the future development of the global tide gauge network is closely linked to the symbiosis with precise altimetry and also with space gravity (GRACE and GOCE missions).

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<sup>6</sup> <http://www.metoffice.gov.uk/research/interproj/gcc/index.html>

### **British Oceanographic Data Centre (BODC)**

The British Oceanographic Data Centre (BODC) is one of seven Designated Data Centres (DDCs) operated by the Natural Environment Research Council (NERC). It is a national facility for storing and distributing data concerning the marine environment, based at the Proudman Oceanographic Laboratory in Liverpool. Data holdings include biological, chemical, physical and geophysical oceanographic data, including measurements of nearly 10,000 different variables.

The BODC's international roles include:

- IOC/IHO Digital Atlas Centre for the General Bathymetric Chart of the Oceans (GEBCO);
- CLIVAR Data Assembly Centre for delayed-mode sea level data;
- CLIVAR Data Assembly Centre for moored instrument data;
- Coordinating centre for IOC's GLOSS Station Handbook;
- Coordinating centre for IOC's international current meter inventory;
- Operating the UK Argo data centre (for processing UK Argo data) and leading on the Argo Regional Centre for the Southern Ocean.

### **British Atmospheric Data Centre (BADC)**

The NCAS British Atmospheric Data Centre (BADC) is also a NERC Designated Data Centre. Its role is to assist UK researchers to locate, access and interpret atmospheric data and to ensure the long-term integrity of atmospheric data produced by NERC projects.

The data held at the BADC are of two types:

- Datasets produced by NERC-funded projects; these datasets are of high priority since the BADC may be the only long-term archive of the data.
- Third party datasets that are required by a large section of the UK atmospheric research community and are most efficiently made available through one location (e.g. Met Office and ECMWF datasets).

There is also considerable interest from the international research community in BADC data holdings, in particular the Met Office data. The BADC makes available the Met Office Hadley Centre data as described in the previous section on LINK.

### **Antarctic Environmental Data Centre (AEDC)**

The British Antarctic Survey-operated Antarctic Environmental Data Centre (AEDC) coordinates the management of data collected by UK-funded scientists in Antarctica and the Southern Ocean. It was established by the Natural Environment Research Council (NERC) as the Designated Data Centre for Polar Science, and is the UK's National Antarctic Data Centre in the SCAR/COMNAP Joint Committee on Antarctic Data Management<sup>7</sup>. The British Antarctic Survey (BAS) based in Cambridge maintain a database of all Antarctic surface climate and radiosonde ascents through its support of the READER (Reference Antarctic Data for Environmental Research) project, which has been approved through SPARC (Stratospheric Processes And their Role in Climate).

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<sup>7</sup> <http://www.jcadm.scar.org/>

## **National Water Archive (NWA)**

The National Water Archive (NWA) is also a NERC Designated Data Centre. Its two core components are the National River Flow Archive (NRFA) and the National Groundwater Level Archive (NGLA).

The NRFA is the UK's focal point for hydrometric data, providing stewardship of, and access to, over 50,000 years' daily and monthly flow data for approximately 1300 gauging stations nationally. Maintenance of the NRFA involves routine collation, quality control, and archiving of river flow data from UK measuring authorities (MAs), namely, the Environment Agency (EA), in England and Wales, the Scottish Environment Protection Agency (SEPA), and, in Northern Ireland, the Rivers Agency. As well as river flow data, the NRFA includes data for 4000 UK rain gauges (supplied under licence by the Met Office), evaporation and soil moisture model estimates, and it also has access to a variety of spatial data sets derived by the Centre for Ecology and Hydrology (CEH) and the British Geological Survey (BGS) (e.g. rivers, landform, land cover, geology and hydrogeology). NRFA data are freely available for educational and research purposes, but there is a charge for data retrievals for commercial use to cover the staff time involved in retrieving data and handling requests.

Efforts are made to improve data quality through a rigorous quality assurance/quality control programme. This involves a regular programme of quality control, to validate the data provided by the Measuring Authorities on an annual basis. Data are validated through a range of techniques, including plausibility checks and expert judgment. Data provision from the Measuring Authorities is covered by a service level agreement (SLA) which sets standards for timeliness of provision, completeness and data quality. The aim of the SLA is to monitor and drive improvements in data quality. In addition, efforts are made to improve long-term data quality through a programme of liaison between the NRFA and data providers. Hydrometric Audits are carried out to examine the quality of data capture (in particular, examining the credibility of hydrological extremes), the homogeneity of long-term records, and to ensure user-guidance metadata is provided with time series. The NRFA also liaises with the measuring authorities to evaluate and optimise the hydrometric monitoring network.

The NRFA services many of the UK's international commitments and obligations on hydrometric data by submitting river flow data and summary information to organisations such as:

- the WMO Global Runoff Data Centre (GRDC);
- the FRIEND (Flow Regimes from International Experimental and Network Data) European Water Archive (FRIEND is a component of the International Hydrological Programme (IHP) of UNESCO);
- the European Environment Agency;
- Eurostat (the Statistical Office of the European Communities);
- OECD (Organisation for Economic Cooperation and Development); and
- the OSPAR and PARCOM conventions.

The NRFA presently supply the GRDC with data for the 200 gauging stations whose daily flow records have been reconciled with UK measuring authorities. Data are normally supplied in the late summer/autumn, after an annual validation round, and contains flows for the previous calendar year. The NRFA are in the process of reconciling a further 200 stations' data, and will supply these data to GRDC upon completion of the process in March 2009. The 400 gauging stations will include the entire UK "benchmark" network - 120 gauging stations of good hydrometric data quality having minimal artificial influences.

The National Groundwater Level Archive (NGLA) brings together water level data from the monitoring agencies for a set of boreholes chosen to provide a representative national network, with boreholes in



all major aquifers, that can be used to assess seasonal resource variations and long term trends. Particular attention is paid to long term data, with a number of records from the 1800s; the longest time series held dates from 1838.

### **European Centre for Medium-Range Weather Forecasts (ECMWF)**

The ECMWF is a European Centre that is supported by 31 states. It is based in Reading in the UK, which is why it is reported here.

ECMWF's core mission is to develop its global weather forecasting system, run it operationally and distribute the results to its Member States. It is not to carry out climate simulations. However, through its core activity, ECMWF is contributing significantly to climate change studies.

The first major contribution is with reanalyses. Initially a by-product of the assimilation system developed for global weather forecasting, it was aimed at:

- Studying the evolution of the observing system and evaluating the impact on the quality of the forecast.
- Testing forecasting techniques over a long period and developing calibrations.

However the quality and ease of use of recent reanalyses has attracted a growing interest from the climate community: the IPCC Fourth Assessment Report published in 2007 contains many references to the ECMWF reanalysis, ERA-40. Recent work on homogenization of the observations and detailed comparisons between satellite instruments is still increasing the credibility of climate trends deduced from reanalyses (although without much more effort in the sonde homogeneity area, reanalyses will only be of climate quality for trend analysis from 1979). Such work will be further developed in the coming years, thanks to the continuous improvement of the assimilation techniques, in particular those associated with atmospheric chemistry, oceans and continental surfaces.

Over the past decade, reanalyses of multi-decadal series of past observations have become an important and widely utilized resource for the study of atmospheric and oceanic processes and predictability. The first reanalysis at ECMWF was carried out in early 1980s for the First GARP Global Experiment (FGGE) year 1979, when ECMWF operations began. Two major ECMWF reanalyses have exploited the substantial advances made since then in the forecasting system and technical infrastructure. The first project, ERA-15 (1979-1993), was completed in 1995 and the second extended reanalysis project, ERA-40 (1957-2002), in 2002. Products of ERA-15 and ERA-40 have been used extensively by the Member States and the wider user community. They are also increasingly important to many core activities at ECMWF, particularly for validating long-term model simulations, for helping develop a seasonal forecasting capability and for establishing the climate of EPS (Ensemble Prediction System) forecasts needed for construction of forecaster-aids such as the Extreme Forecast Index.

ECMWF is currently producing ERA-Interim, a new global reanalysis of the data-rich period since 1989. The ERA-Interim system is based on a recent release of the Integrated Forecasting System (IFS Cy31r2) containing many improvements both in the forecasting model and analysis methodology. ERA-Interim reanalysis is expected to catch up with operations in late 2008. The reanalysis will then be continued in near-real time with the same system in order to support climate monitoring<sup>8</sup>.

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<sup>8</sup> [http://www.ecmwf.int/research/era/do/get/Reanalysis\\_ECMWF](http://www.ecmwf.int/research/era/do/get/Reanalysis_ECMWF)



A second important contribution is emerging with the concept of seamless systems unifying weather and climate predictions. There are important synergies between numerical weather prediction (NWP) and climate prediction. The first synergy is that many of the key feedbacks that lead to uncertainty in climate predictions are associated with processes such as clouds, convection or boundary-layer turbulence, whose intrinsic timescales lie within the domain of NWP. Another one is that, due to obvious time constraints (the need to deliver a forecast before the event), NWP has developed code optimisation and supercomputing tools that can also benefit climate prediction: this, in particular, is key to increasing the resolution of climate predictions. This contribution is fully recognised and ECMWF was requested by the World Climate Research Programme (WCRP) and the World Weather Research Programme (WWRP) to host their “World Modelling Summit for Climate Prediction” which aims at identifying and developing such synergies. This is not a one-way road and NWP is also benefiting from developments in climate prediction, in particular in addressing model errors. From this point of view, the EC-EARTH initiative by several Member States, which aims at developing a climate version of the Integrated Forecasting System (IFS), is most welcome and will be of benefit to the ECMWF forecasting system.

Thirdly, ECMWF’s core activities will contribute to the adaptation of our societies to climate change. The ECMWF strategy puts the early warning of severe weather at the heart of its principal goals. As severe weather events are likely to increase in frequency or magnitude with climate change, early warnings will become even more crucial for mitigating the consequences of these events. Recent examples when such warnings were available 3 to 5 days in advance (e.g. storm Kyrill in January 2007 and the storm surge in the North Sea in November 2007) have shown that early warnings are crucial for enabling civil protection authorities to make appropriate and timely decisions<sup>9</sup>.

ECMWF also has responsibility of routine monitoring of daily TEMP and CLIMAT TEMP reports for the GCOS Upper Air Network (GUAN) as part of the GUAN Analysis Centre after the Met Office Hadley Centre ceased monitoring of CLIMAT TEMP messages in May 2007 (the Met Office Hadley Centre still provides data to users and creates global and regional statistics for the Centre).

## **2.6 Capacity building**

### **2.6.1 GUAN activities**

A number of projects aimed at improving the operation of the GCOS Upper Air Network (GUAN) have been initiated using funds provided through the US Climate Change Research Initiative and in-kind contributions from the Australian Bureau of Meteorology, New Zealand Met Service and the UK Met Office. Using priorities set by the GCOS/WCRP Atmospheric Observation Panel for Climate, the GCOS secretariat, working with the WWW and RCD Departments, has designed and is implementing projects to benefit 13 GUAN stations, primarily in equatorial areas of Africa, South America and on oceanic islands. Specific improvements included two new upper-air stations to bridge gaps in network coverage, replacement of hydrogen generators when old units had become inoperable, and radiosondes for stations whose operation had ceased because they could no longer afford them<sup>10</sup>. Apart from these activities involving the GCOS’s donor initiatives, the UK supports some overseas GCOS and GSN sites directly (e.g. Pitcairn Island for the GSN and the GUAN sites at Seychelles, Penrhyn, Tarawa and Funafuti) (see sections 3.1 and 3.2).

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<sup>9</sup> Dominique Marbouty; ‘Contributing to climate change studies’, ECMWF Newsletter No. 115 – Spring 2008

<sup>10</sup> [www.wmo.ch/pages/prog/gcos/scXV/11\\_GCM.pdf](http://www.wmo.ch/pages/prog/gcos/scXV/11_GCM.pdf)

Another activity that the Met Office has performed for GCOS in the last year is a training workshop for radiosonde operations in Africa. This workshop was held in Namibia, with the lecturers provided from the Met Office's Upper Air Team, Observations Research and Development. Support has been requested for a similar activity planned for 2009 in India for GCOS in Region II.

### **2.6.2 ClimDev Africa**

The ClimDev Africa (Climate for Development in Africa) initiative received UK support (as cited in the report<sup>11</sup> on the "Status of ClimDev Africa and GCOS Development Activities" for the GCOS Steering Committee, Fifteenth Session, Paris, France, 16-19 October 2007). The ClimDev Africa Programme is one of the first major follow-up initiatives to the GCOS Regional Workshop Programme and, in particular, to the GCOS Regional Action Plans for Eastern and Southern Africa and for Western and Central Africa. In seeking funding support for implementation of these Action Plans, the GCOS secretariat pursued the opportunity provided by the 2005 G8 Gleneagles Plan of Action, in which G8 members noted the importance of climate monitoring and declared their intention to support efforts to help developing countries, especially in Africa, "obtain full benefit from GEOSS and GCOS." Subsequent to this announcement, and with UK support and co-sponsorship by the UN Economic Commission for Africa (UNECA), the GCOS Secretariat organized a meeting in Addis Ababa, Ethiopia in April 2006. The meeting brought together providers and users of climate information to discuss needs and a strategy for the way forward. The UK Department for International Development (DFID) and other development partners made clear that their fundamental interest was in supporting activities leading to achievement of the Millennium Development Goals. Thus, climate risk management in agriculture, health, water resources planning, disaster risk reduction, and other sectors comprises a major part of the Programme. It was fully recognized, however, that improved climate risk management fundamentally depends on the availability of adequate and appropriate climate observations and the provision of user-focused climate services. These two ClimDev Africa "result areas" that are especially relevant to the mandates of WMO and the African National Meteorological and Hydrological Services (NMHSs) are thus embedded in the larger ClimDev Africa Programme.

### **2.6.3 Cape Verde Atmospheric Observatory**

The National Centre for Atmospheric Science, in conjunction with the Max-Planck-Institut für Biogeochemie, Jena, Germany (MPIB Jena), and the Leibniz-Institut für Troposphärenforschung, Leipzig, Germany (IFT), opened a major new WMO GAW station on Sao Vicente, Cape Verde in 2006. The observatory is currently supported financially by the UK and Germany and operated by the local National Meteorological and Hydrological Service, the Instituto Nacional de Meteorologia e Geofisica (INMG). The observatory contributes to a number of GAW networks and has been a key means to build people capacity associated with the atmospheric composition research in the West African region. Supported by the EU project TENATSO (Tropical Eastern North Atlantic Time-Series Observatory), a number of regional awareness raising workshops have been held in Cape Verde and, through support from the Royal Society, a continuing education programme for graduate-level staff from INMG has been established, supporting exchange visits to the UK and other EU states

## **2.7 Acquisition and synthesis of palaeoclimate data**

Palaeoclimate data relating to a range of climate variables are being acquired and synthesised by a number of groups in the UK, including those listed below. This list is very general, and it is likely that

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<sup>11</sup> [www.wmo.ch/pages/prog/gcos/scXV/10\\_Development\\_Activities.pdf](http://www.wmo.ch/pages/prog/gcos/scXV/10_Development_Activities.pdf)

many of the studies are of little relevance to GCOS. Some will be, but it would take more co-ordination to determine the exact relevance to the ECVs designated within GCOS.

- The Palaeoceanography and Palaeoclimate Research Group at the National Oceanography Centre in Southampton. Current research topics include:
  - Quaternary sea-level changes
  - Interannual to decadal ocean/climate variability
  - Extreme Climates
  - Changes in the East Greenland Current and Deep Western Boundary Current
  - Cenozoic "Pacific Equatorial Age Transect"
  - Palaeogene climate change in high northern latitudes
- University of Aberdeen:
  - Research into climatic variability during the last Ice Age, including global synchronicity of late-glacial climatic shifts.
- British Antarctic Survey, Cambridge:
  - Research to understand the behaviour of the ice-atmosphere-ocean system in Antarctica in the past, and to use this knowledge to predict future behaviour. Work is also carried out in Greenland and Svalbard.
- University of Cambridge:
  - Cambridge Arctic Shelf Programme (CASP): Research into the Quaternary geology of the pan-Arctic and sub-Arctic areas, East Greenland, the North Atlantic margins, Svalbard, Russia and other areas of the former Soviet Union. Relevant research has included reconstructions of the Arctic Ocean and ice conditions in the Barents Sea area.
  - 'Cambridge Quaternary': High-resolution isotope records of the history of ice sheet fluctuations during the Quaternary; proxy climatic indicators to investigate the relationship between orbital forcing and climatic change; palaeoceanographic processes; ice-rafting events and salinity changes.
- Cardiff University:
  - Research into late-glacial and postglacial evolution in Ireland, Wales and England, and into permafrost and climate change in Europe.
- Climatic Research Unit at the University of East Anglia, Norwich, Norfolk:
  - quantitative climate reconstructions, climate change detection and historical documentary climatology.
- University of Edinburgh:
  - Quaternary palaeoenvironments; modelling of ancient ice sheets.
- University of Glasgow:
  - Quaternary science and polar environments.
- Liverpool John Moores University:
  - Quaternary palaeoenvironments.
- University of London, Royal Holloway and Bedford New College:
  - Quaternary research, palaeohydrology.
- Environmental Change Research Centre at University College London:
  - Reconstruction of climate and nutrient histories for lakes in a number of areas, including the Arctic (Svalbard, Kola Peninsula), the Antarctic (South Orkney Islands, Vestfold Hills) and Southern Africa.
- Met Office Hadley Centre:
  - ACRE initiative (see section 2.5)
- University of Southampton:
  - Palaeohydrological and permafrost data studies, palaeoecology/palaeoclimate, numerical modelling of Quaternary ocean/ice sheet dynamics.

## **2.8 Guideline issues**

Further clarification of the information that GCOS requires, particularly with regard to satellite observations and palaeoclimate data, would be useful.

## **3. Atmospheric ECVs**

### **3.1 Contributions to the GCOS Surface Network (GSN)**

The UK's contribution to the GSN comes from the national network (for the UK itself) of 20 stations within the UK's Regional Basic Climate Network (RBCN) and the 34 stations within the UK's Reference Climate Network. The 6 UK GSN stations run by the Met Office are Lerwick (3005), Stornoway (3026), Eskdalemuir (3167), Valley (3302), Waddington (3377), Camborne (3808) and additionally 2 overseas stations: St Helena (61901) and Ascension Island (61902). All 8 are expected to be operating in 2010. Lerwick, Stornoway, Eskdalemuir, Camborne and St Helena are funded via the National Meteorological Programme (NMP) and are considered secure. Stations at Valley, Waddington and Ascension Island are at Royal Air Force (RAF) airfields and could be at risk were these airfields to be closed. All 8 of these UK Met Office run GSN stations operate to the specific GCOS standards and therefore supply their data to the IDCs – but only back as far as they have been digitized.

The British Antarctic Survey (BAS) runs 3 Overseas GCOS Surface Network stations: Halley (89022), Rothera (89062) and Fossil Bluff (89065). All 3 are expected to be operating in 2010. BAS has upgraded the station at Grytviken, South Georgia and will investigate whether this could be designated as a GSN station. This site has a record back to 1903. All 3 of the UK BAS GSN stations operate to GCOS standards and historic data have been supplied to the IDCs, for their operational periods where the data have been digitized. BAS also operates Larsen, Uranus Glacier, Butler Island and Ski Blu Automatic Weather Stations in the Antarctic.

There are additional stations for which the UK is not directly responsible, though the UK Public Weather Service does fund the Pitcairn station. These 3 overseas GCOS Surface Network stations (UK Overseas Territories) are Gough Island (68906), Bermuda (78016) and Pitcairn (91964). All three are expected to be operating in 2010: Gough Island is run by the South African Weather Service (SAWS); Bermuda is run by Serco for the Bermudan Government; and Pitcairn is funded by the NMP and serviced by NZWS.

The UK land surface observing network currently comprises 282 climate stations (Form 3208), 157 synoptic stations and 44 climate data loggers. There are an additional 2824 rainfall-only stations. These stations are partially compliant with GCOS standards, but are much more subject to site changes or closures than those in the GSN, Regional Basic Climate Network and the UK's Reference Climate Network. Historic time series from a small number of the UK surface climate and rainfall stations are available in IDCs, but there has been no comprehensive activity to add all that are digitally available.

The UK contributes to the Baseline Surface Radiation Network (BSRN) with two stations, at Lerwick and Camborne. Both are expected to be operating in 2010. These stations are supported by the NMP and both stations provide data to the IDC. There are 86 UK stations measuring downwelling global radiation, in addition to the 2 BSRN stations. The 86 stations are partly compliant with the GCMPs and no changes are planned before 2010.

The Met Office contributes to the EUCOS (European Composite Observing System) Surface Marine (E-Surfmar) programme (managed by Meteo-France), which aims to deploy up to 175 drifters per year

in the North Atlantic, Nordic Seas and Mediterranean. 102 E-Surfmar funded buoys (including 2 ice-buoys and 28 upgraded NOAA drifters) should have been operating at the end of July 2008. 95 of these are currently operating, and the others are expected to be operational soon. In addition to deploying drifting buoys for E-Surfmar, the Met Office also procures and deploys drifters in the South Atlantic/Southern Ocean in support of the global drifter array. Two drifting buoys are also deployed by the Scottish Association for Marine Science (SAMS), primarily in the Arctic, and 8 others are planned for deployment by 2010. No moored buoys are operated in support of the GCOS tropical moored buoy network, although the Met Office operates 9 moored buoys around the UK and in Biscay, which contribute to the full WWW/GOS surface network. All 9 report their data to the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). BAS, POL and the National Oceanography Centre, Southampton (NOCS) also operate some moored buoys in the Southern Ocean from which air pressure can be derived.

The Met Office currently has 60 ships contributing to VOSclim and also operates the real time monitoring centre for VOSclim data. In addition, the Met Office also manages around 300 manually observing ships (of which 265 reported in 2007) and 12 ships with automatic weather stations (AWSs) that contribute to the overall VOS programme. The Met Office plan to deploy a surface moored buoy in 2009 to complement the deep ocean mooring at the Porcupine Abyssal Plain (PAP) (see section 4.2). There are about 250 active manual observing ships and approximately an additional 20 with AWS, but not all are fully compliant with GCMP standards. All data are exchanged on the Global Telecommunication System (GTS) and available to ICOADS.

**Table 1a: National contributions to the surface-based atmospheric ECVs**

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
<b>GCOS Surface Network (GSN)</b>	Air temperature	6 + 2 (Met Office) 3 (BAS) 3 (non UK, supported by Met Office, but will be reported by other countries)	11	11	11	11
	Precipitation	11	11	11	11	11
<b>Full World Weather Watch/Global Observing System (WWW / GOS) surface network</b>	Air temperature, air pressure, wind speed and direction, water vapour	483	All have fair compliance	No specific planned changes	Some	Some
	Precipitation	2,824	Not fully compliant	No specific planned changes	Some	Some
<b>Baseline Surface Radiation Network (BSRN)</b>	Surface radiation	2	2	2	2	2
<b>Solar radiation and radiation balance data</b>	Surface radiation	86	partly	No specific planned changes	Some	Some
<b>Ocean drifting buoys</b>	Sea surface temperature, air pressure (and position-derived surface current)	95	95 5 Met Office drifting buoys operating at Aug 2008	102	All	All
<b>Moored buoys</b>	Air temperature, air pressure	None for GCOS	11	19	11	11
<b>Voluntary Observing Ship Climate Project (VOSCLim)</b>	Air temperature, air pressure, wind speed and direction, water vapour	60 + 300	60 VOSCLim ships do not all operate to GCOS standards The 300 are likely not fully compliant	~60	All	All
<b>Ocean Reference Mooring Network and sites on small isolated islands</b>	Air temperature, wind speed and direction, air pressure	0	0	1	0	0
	Precipitation	0	0	0	0	0

## 3.2 Contributions to the GCOS Upper Air Network (GUAN)

The UK contribution to the GUAN network is 2 stations, plus 6 overseas stations. The 2 in the UK are Lerwick (3005) and Camborne (3808). There are 3 GUAN stations overseas: Gibraltar (8495), St Helena (61901) and Mt. Pleasant (88889), and 3 GUAN stations in UK overseas territories: Ascension (61902), Gough Island (run by SAWS) (68906) and Bermuda (78016). There is one BAS GUAN station at Halley (89022). All are expected to be operating in 2010. Lerwick, Camborne and St Helena are NMP funded so secure. Gibraltar and Mt. Pleasant are on RAF airfields, so cannot be guaranteed against closure. The 6 UK-run stations provide data to the IDCs. These are the 2 in the UK, the 3 UK-run stations overseas and the BAS station at Halley. The 3 run by others on UK overseas territories are also presumed to provide their data to the IDCs.

In addition to GUAN stations, the Met Office also operates 4 autosonde stations in the UK making routine ascents and 2 range stations that make ascents during range hours. The Met Office also operates 6 wind profilers as part of the EUCOS wind profiler network. The 4 autosonde sites are at Ablemarle, Castor Bay, Herstmonceaux and Watnall. These stations meet the minimum requirement for profiles to 100 hPa but not the target of 5hPa, although AOPC has reduced this target to 30hPa. Additionally, the BAS station at Rothera has commenced a regular upper air monitoring with a commitment to continue in the long term. In addition to the above, the Met Office also provides support (mainly consumables, i.e. radiosondes) to GUAN stations at Seychelles, Penrhyn, Tarawa and Funafuti.

**Table 1b: National contributions to the upper-air atmospheric ECVs**

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
<b>GCOS Upper Air Network (GUAN)</b>	Upper air temperature, upper air wind speed and direction, upper air water vapour.	2 + 3 (Met Office) + 1 (NERC BAS) +3 (on UK overseas territory, but run by other organizations)	6	6	6	6
<b>Full WWW / GOS Upper Air Network</b>	Upper air temperature, upper air wind speed and direction, upper air water vapour.	6 (radiosonde and wind profilers)	6	6	6	6



### **3.3 Contributions to the Global Atmospheric Watch (GAW)**

The UK contributes to the Cape Verde Atmospheric Observatory<sup>12</sup>, which is a bilateral undertaking between the UK and Germany. Cape Verde Atmospheric Observatory is expected to continue operating in 2010. Measurements at Cape Verde Observatory include all greenhouse gases, surface ozone, reactive halocarbons, CO, DMS, NO, NO<sub>2</sub>, NO<sub>y</sub> and VOC. The Cape Verde site has been accepted by GAW for gas phase species<sup>13</sup>. Hourly data for CO<sub>2</sub> and O<sub>3</sub> are submitted to the World Data Centre for Greenhouse Gases (WDCGG)<sup>14</sup>. Submission of these data on other timescales and measurements of other gas phase species (e.g. NO<sub>x</sub>, VOCs and greenhouse gases) will follow. In addition, the site is one of only a few existing stations that make long-term VOC measurements, and as a result is integral in the set-up of the newly established GAW VOC network<sup>15</sup>. Further details can be found at: [www.york.ac.uk/capeverde](http://www.york.ac.uk/capeverde). The UK supports these measurements (through NERC, University of York and others) in partnership with Germany and the Cape Verde government. The observatory reports all its measurements to GAW and provides data to WMO WDCGG.

DECC supports the Irish Mace Head GAW station, which measures greenhouse gases and ozone. Measurements began in 1994 and 1987, respectively. Mace Head provides data to WMO WDCGG and the Carbon Dioxide Information Analysis Center (CDIAC) and the station is expected to continue operating in 2010. Met Office involvement in sampling of carbon dioxide at Lerwick (which has a record to 1957) ceased in 1996, although sampling continued until 2004.

Total column ozone is measured at Lerwick (record to 1957) and the University of Reading and there are BAS stations at Halley (long term record to 1956) and Rothera. BAS also support the Ukraine station at Vernadsky. Stations are expected to continue operating in 2010.

Two GAW stations that measure aerosols are supported through the National Centre for Atmospheric Science (NCAS): Cape Verde Atmospheric Observatory (see above) and Weybourne Atmospheric Observatory<sup>16</sup> (see section 6). Aerosols are also monitored at Chilbolton and Plymouth (see next section for additional information).

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<sup>12</sup> <http://www.york.ac.uk/capeverde/>

<sup>13</sup> [www.empa.ch/gaw/gawsis/reports.asp?StationID=-739518679](http://www.empa.ch/gaw/gawsis/reports.asp?StationID=-739518679)

<sup>14</sup> <http://gaw.kishou.go.jp/cgi-bin/wdcgg/accessdata.cgi?index=GVA116N00-UYRK&select=inventory>

<sup>15</sup> [www.wmo.int/pages/prog/arep/gaw/documents/gaw171final.pdf](http://www.wmo.int/pages/prog/arep/gaw/documents/gaw171final.pdf)

<sup>16</sup> <http://weybourne.webapp1.uea.ac.uk/>

**Table 1c: National contributions to the atmospheric composition**

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
World Meteorological Organisation / Global Atmosphere Watch (WMO / GAW) Global Atmospheric CO <sub>2</sub> & CH <sub>4</sub> Monitoring Network	Carbon Dioxide	1	1	1	1	1
	Methane	1 + 1	2	2	2	2
	Other greenhouse gases	1 + 1	2	2	2	2
WMO / GAW ozone sonde network	Ozone	1 + 1	2	2	2	2
WMO / GAW column ozone network	Ozone	4	4	4	4	4
WMO / GAW aerosol network	Aerosol Optical Depth	2	2	2	2	2
	Other Aerosol Properties	2	2	2	2	2

### Atmospheric reanalyses

See section 2.5.

### Sustained measurements of the atmospheric composition ECVs, supplementary to those activities implicit in table 1c:

#### A. Carbon dioxide, methane, ozone and other long-lived greenhouse gases

- Measurements of surface ozone are taken at Weybourne Atmospheric Observatory. The measurements are funded by Defra and NERC and have been taken for nearly fifteen years. The data are stored in a national network data archive sponsored by Defra.
- Measurements of surface carbon dioxide are also taken at Weybourne Atmospheric Observatory. These measurements are funded by the EU CarboOcean project and have been taken since 2007.

#### B. Aerosol Optical Depth

- Chilbolton — A CIMEL sunphotometer owned by the NERC Field Spectroscopy Facility (FSF) operates at the NERC/STFC Chilbolton Facility for Atmospheric and Radio Research (CFARR) in Hampshire. The instrument has been running for nearly 3 years, providing daily data of aerosol optical depths and water vapour to NASA AERONET. AERONET derive aerosol size distributions from these data and make them available globally via the internet. This instrument is expected to

be operating in 2010. CFARR also measure aerosol optical depth using a 355 nm polarisation lidar.

- Wytham Wood — A CIMEL sunphotometer owned by the NERC Centre for Ecology and Hydrology (CEH) is about to be permanently deployed at the Environmental Change Network (ECN) site in Wytham Wood, Oxfordshire as part of the NASA global AERONET network. The instrument will make daily measurements of aerosol optical depth and column water vapour measurements. AERONET will derive aerosol size distributions from these data and make them available globally via the internet. The instrument will be a permanently-supported system, run by staff from CEH Wallingford. This instrument is expected to be operating in 2010.
- Plymouth Marine Laboratory — A PREDE POM01-L sky radiometer was installed on the roof of the Plymouth Marine Laboratory (PML) (50°21'57.12"N 4°8'51.66"W) in May 2001 to replace the CIMEL sunphotometer at Rame Head (50°21'57.6"N 4°8'56.4"W), which was decommissioned in 1999. The main purpose of the radiometer is to support the atmospheric correction research of the PML Remote Sensing Group. The instrument is an automatic sun-tracking photometer system that operates at 7 wavelengths (315, 400, 500, 670, 870, 940 and 1020nm) and scans at pre-set angles away from the solar disk to determine various properties of aerosols within the atmospheric column, including aerosol optical depth.

## **4. Oceanic ECVs**

### **4.1 Measurements of oceanic ECVs**

The Met Office routinely produce (and periodically enhance) many global ocean products (including SST, see section 2.5).

POL operates 11 GLOSS stations: Lerwick, Stornoway, Newlyn, Gibraltar, Rothera (with BAS), Signy, St Helena (currently not operational whilst the harbour is being reconstructed), Port Stanley, Ascension, Tristan da Cunha (not currently operational because the gauge was washed away in a storm, but a new gauge has been purchased and will be installed in the future) and South Georgia (King Edwards Point).

POL contributes to measurements at Vernadsky/Faraday (joint with Ukraine), Bermuda (joint with NOAA) and Diego Garcia (joint with UHSLC). POL also support Pemba (Mozambique), Inhambane (Mozambique), Aden (Yemen), Karachi (Pakistan), Djibouti (Djibouti) and Cananeia (Brazil) for GLOSS. Chabahar (Iran), Nouakchott (Mauritania) and Takoradi (Ghana) are also in the process of being adopted by GLOSS and supported by POL.

It is expected that the 11 stations run by POL will be operational in 2010. The most likely exception is Signy – this equipment is difficult to maintain and unlikely to be replaced if it ceases to function. It is also anticipated that Vernadsky, Bermuda and Diego Garcia will still be operational. It is also anticipated that the 9 stations for which POL provides support will be fully operational in 2010. All 11 tide gauge stations currently producing data, or which have produced data in the past, provide these to PSMSL (based at POL) and to the two GLOSS data centres (BODC and UHSLC). Vernadsky, Bermuda and Diego Garcia provide data to international data centres. All 11 stations have complete historical records in international data centres (PSMSL, BODC, UHSLC). The first 3 stations (Lerwick, Stornoway, Newlyn) are part of the UK Tide Gauge Network which is illustrated below (for UK locations only). Historical data from Vernadsky, Bermuda and Diego Garcia are also in international data centres.

The UK National Tidal and Sea Level Facility (NTSLF) established in 2002 includes the UK National Tide Gauge Network (44 gauges around UK), geodetic nets for land movement and gauges in South Atlantic and Gibraltar.



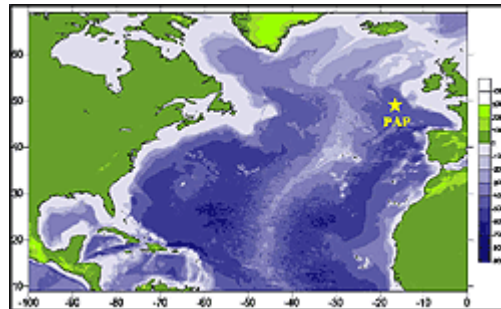
**Table 3a: National contributions to the oceanic ECVs - surface**

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
<b>Global surface drifting buoy array on 5x5 degree resolution</b>	Sea surface temperature, sea level pressure, position-change based current	95	95	102	All	All
<b>GLOSS Core Sea-level Network</b>	Sea level	3 UK + 1 (Gibraltar) + 7 South Atlantic (NERC POL)	11	11	11	11
<b>Voluntary observing ships (VOS)</b>	All feasible surface ECVs	60	60	60	60	60
<b>Ship of Opportunity Programme</b>	All feasible surface ECVs	Up to 300	250 of the 300, 20 with AWS	250 of the 300, 20 with AWS	250 of the 300, 20 with AWS	250 of the 300, 20 with AWS

## 4.2 Water Column

The UK operates the Porcupine Abyssal Plain (PAP) mooring site at 4800m depth in the temperate North Atlantic, which is maintained by NERC/NOCS (Richard Lampitt). The PAP mooring is recognised as an international site by GCOS, GECC, the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) and OceanSITES. Funding is secure to 2012 (via

NERC/Oceans 2025). PAP data are managed at NOCS and also forwarded to BODC and international data portals (Coriolos and OceanSITES). PAP's location is shown in the following figure. The PAP measurements continue work by the Joint Global Ocean Flux Study (JGOFS) North Atlantic Bloom Experiment (1989) and the EU BENGAL programme (1998-2001) and links with the ongoing French POMME programme.



The UK presently operates about 100 Argo floats. The UK Argo programme is managed by the Met Office and operated in partnership with NOCS, BODC and the United Kingdom Hydrographic Office (UKHO). The programme expects to be operating in 2010. All UK Argo float data, irrespective of location, are processed by BODC and the data are submitted in real-time to the WMO GTS and to the Argo Global Data Assembly Centres (GDACs). All UK Argo float data are subjected to delayed-mode quality control by BODC and submitted to the GDACs. At present about 40% of eligible data (for floats that have expired or been operating for longer than 18 months) have been submitted.

For carbon inventory surveys, there are 5 current survey-based programmes:

1. UK involvement in EU CarboOcean project — VOS-based upper ocean CO<sub>2</sub> parameters ([www.carboocean.org](http://www.carboocean.org)), University of East Anglia (UEA), Andrew Watson
2. Swire-NOCS Ocean Monitoring System (SNOMS) — VOS-based upper ocean CO<sub>2</sub> parameters, funded by the Swire Group Trust ([www.noc.ac.uk/snoms](http://www.noc.ac.uk/snoms)), NOCS, David Hydes
3. Carbon-Ops project — underway for CO<sub>2</sub> parameters from UK research ships ([www.bodc.ac.uk/carbon-ops](http://www.bodc.ac.uk/carbon-ops)), PML, Nick Hardman-Mountford
4. Atlantic Meridional Transect (AMT) — biogeochemical surveys of North and South Atlantic, PML lead, Andy Rees
5. Deep ocean hydrographic transect lines with biogeochemical measurements, NOCS and UEA, Brian King and Andrew Watson.

Funding for these various projects generally has a limited life span. CarboOcean ends in 2009 and national renewal bids are in preparation. At present, SNOMS has funding to continue until FY 2009/10. A Carbon-Ops renewal bid is in preparation. AMT funding is secure until 2012. Funding for deep ocean transect lines is secure until 2012. All these activities provide data to international data centres (CDIAC for CO<sub>2</sub> data, also SOCAT); CLIVAR for hydrographic data.

**Table 3b: National contributions to the oceanic ECVs – water column**

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
<b>Global reference mooring network</b>	All feasible surface and subsurface ECVs	1	1	1	1	1
<b>Global tropical moored buoy network</b>	All feasible surface and subsurface ECVs	0	0	0	0	0
<b>Argo network</b>	Temperature, salinity, current	~100	~100	~100	~100	~40
<b>Carbon inventory survey lines</b>	Temperature, salinity, ocean tracers, biogeochemistry variables	5	5	5	5	5

### 4.3 Satellite-based products over the ocean

**Table 4. Global products requiring satellite observations – oceans**

ECVs/ Global products requiring satellite observations	UK comments
<b>Sea Surface Temperature</b>	<p>In most cases, UK space based observation is presented under submissions from ESA and Eumetsat. The Advanced Along-Track Scanning Radiometer (AATSR), however, is a UK-funded instrument flown on ESA platforms as an announcement of opportunity mission and is therefore included as a specific item for reference.</p> <p>The AATSR instrument, procured by DECC in conjunction with NERC and the Australian Government, was successfully launched on the satellite ENVISAT in 2002. Validation of the data has demonstrated the accuracy of the satellite instrument, and its ability to detect climatic trends in the ocean. Preliminary analyses of the data indicate an observed warming trend between 0.1–0.2 °C per decade. The AATSR data will be added to measurements from previous satellite instruments, ATSR-1 and ATSR-2, to provide a sea surface temperature record covering approximately 15 years. This data series will be continued after the ESA Envisat mission by the ESA Sentinel 3 Mission, which is part of the GMES programme. There is also a specific programme proposal under consideration to ensure the long-term climate standard processing of the data from Sentinel 3 and other ESA missions.</p>

## Additional information

### Observations:

- Repeat hydrographic surveys are carried out under the Rapid Climate Change (RAPID) and RAPID-Watch programmes (East-West transect of the North Atlantic)<sup>17</sup>.
- The Continuous Plankton Recorder (CPR) Survey, which is operated by SAHFOS, currently collects *in situ* data from about 10,000 nautical miles (nm) towed per month. The survey currently uses 20 SOOPs operating in the North Atlantic, North Pacific and Southern Ocean. The survey will be expanded to Arctic waters in 2009. All CPRs in the survey measure phytoplankton and ocean colour. As of early 2008, 50% of CPRs were also collecting sea surface temperature and sea surface salinity. The data collected are used by the Met Office, the International Council for the Exploration of the Sea (ICES) and the Ocean Biogeographic Information System (OBIS).
- BAS is beginning to use instrumented seals to collect oceanographic data, which is especially important for making oceanographic measurements in remote and inaccessible regions.
- The Environment Agency will be taking on responsibility for telemetered-data gathering from the 44 UK Class A Tide Gauges that comprise the Storm Tide Forecasting Service Network (from Lerwick to the Channel Islands). It is also possible that from 2010/11 a further 300 or so existing tidal level gauges will be upgraded to a consistent standard to supplement the information from the Class A gauges.

### Analyses:

- Sea surface temperature: Since April 2006, the Met Office has produced an Operational Sea Surface Temperature and Sea Ice Analysis (OSTIA). OSTIA uses satellite data provided by the GHRSSST project<sup>18</sup>, together with in-situ observations, to determine the sea surface temperature. The analysis is performed using a multi-scale optimal interpolation (OI) technique. The analysis is produced daily at a resolution of 1/20° (approx. 5km). OSTIA data is provided in GHRSSST-PP netCDF format every day and is freely available (under license) for academic and non-commercial applications.
- Deep ocean: The Met Office runs the Forecasting Ocean Assimilation Model (FOAM) in a variety of model configurations. Real-time and archived data from 1° global FOAM, 1/9° North Atlantic FOAM and 1/8° Mediterranean FOAM are available (without charge) for research and education use via the NERC Environmental Systems Science Centre (ESSC) GODIVA server<sup>19</sup>.

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<sup>17</sup> [www.noc.soton.ac.uk/rapid/rw](http://www.noc.soton.ac.uk/rapid/rw)

<sup>18</sup> <http://www.ghrsst-pp.org/>

<sup>19</sup> <http://www.nerc-essc.ac.uk/godiva/>



## **5. Terrestrial ECVs**

The UK reports 6 river discharge measurements to GTN-R. These sites are at: Ballathie on the River Tay, Blairstone on the River Clyde, Colwick on the River Trent, Kingston on the River Thames, Norham on the River Tweed and at Redbrook on the River Wye. All 6 sites operate in accordance with the GCMPs, though they should be reviewed and potentially replaced with other sites from the Global Runoff Data Centre that are less impacted by abstractions, discharges and impoundments. All 6 will continue to 2010. In addition, the National River Flow Archive currently supplies the Global Runoff Data Centre with data for the 200 gauging stations whose daily records have been reconciled with UK measuring authorities. The majority of sites discussed have a complete historical record with GRDC.

For snow cover, of the 167 stations in the UK that are part of the WWW/GOS network, 54 have automatic snow depth sensors (at 3 of those sites there is also a manual observer who may choose to override the automatic observation) and there are another 22 sites making manual observations of snow depth. Of the 22 sites making manual observations, 3 will close this year, 1 may close by 2010 and 1 will probably be converted to an automatic site. The other 17 are projected to remain open past 2010. All 54 automatic sites are projected to remain open past 2010. Currently no data are sent to the National Snow and Ice Data Center (NSIDC) or the National Climatic Data Center (NCDC). In the UK there are an additional 78 climate stations that are not part of the WWW/GOS network that report snow depth. 54 automatic snow depth sensors have been deployed since 2004 to improve observations of snow cover and snow fall.

The UK does not have any glaciers, nor any locations with year-round permafrost. BAS does have networks of GPS stations measuring the movement of key icestreams, and one station that contributes to the determination of isostatic recovery of Antarctica.

The UK does not have a lake within the GTN-L network. Lake Windermere could be considered for inclusion, as measurements of surface water temperature (10-15 cm depth), water level (using a depth gauge) and rainfall have been made at the site on most days since 1933. These measurements are expected to continue in 2010. The data are not currently available to the international community (although they are available on request from the Freshwater Biological Association).

**Table 5: National contributions to the terrestrial domain ECVs**

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms expected to be operating in 2010	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS baseline river discharge network (GTN-R)	River discharge	6 (GCOS) 200 (UK)	6 200	6 200	6 200	6 200
GCOS Baseline Lake Level/ Area/Temperature Network (GTN-L)	Lake level/area/temperature	0	0	0	0	0
WWW / GOS synoptic network	Snow cover	76	76	72	0	0
GCOS glacier monitoring network (GTN-G)	Glaciers mass balance and length, also ice sheet mass balance	0	0	0	0	0
GCOS permafrost monitoring network (GTN-P)	Permafrost Borehole temperatures and active layer thickness	0	0	0	0	0

### Additional Information

Groundwater monitoring in the UK is mostly carried out by the regulatory agencies, EA, SEPA and NIEA. Groundwater levels are monitored at around 4000 sites, at measurement intervals ranging from 15 minutes to 6 months. Increasingly, key monitoring sites will be equipped with digital recorders or telemetry.

Following the National Audit Office review of Water Resources in 2005, the Environment Agency (which covers England and Wales) developed a risk-based approach to hydrometric monitoring and recently completed a review of their national hydrometric surface water level, flow and groundwater level networks. In the future, there will be greater focus on the quality of the hydrometric data. Over 280 flow gauging stations (about 20% of the Environment Agency network) have been identified as candidates for improvement. In some cases performance needs to improve at both high and low flows. The groundwater network review also identified deficiencies in the collection and archiving of groundwater level data that are precluding the use of data from 30% of the network. These changes will be co-ordinated via new National and Regional Hydrometry and Telemetry Monitoring panels. To support these and other changes, new tools and data acquisition, quality review and management processes have been developed and rolled out to operational staff.

In Scotland, the groundwater monitoring network currently comprises 278 groundwater quality monitoring sites, 25 groundwater level monitoring sites and 24 dual purpose sites for both groundwater quality and levels. Over the next two years it is anticipated that these numbers will

increase to 340 groundwater quality monitoring sites, 30 groundwater level monitoring sites and 32 dual purpose sites. SEPA currently operate 398 river gauging stations across Scotland. Of these, 262 are full flow range stage/discharge stations, of which 283 report to the NRFA. This river gauging station network is being expanded somewhat over the next few years to meet Water Framework Directive needs. 17 new stations are planned. SEPA also currently operates 7 loch level measurement stations. A further 4 new stations are planned over the coming years. SEPA has recently formed a national Hydrometric unit within its Hydrology function. This will bring consistency of approach to practices and methods used. SEPA's hydrology function has also recently introduced a new national HIMS (Hydrology Information Management System) to improve data checking, processing, and data access.

## 6. Additional information

### Met Research Unit, Cardington

The Met Office has a Research Unit at Cardington in Bedfordshire (52° 06' N, 00° 25'W, 29m amsl). This unit maintains a suite of surface-based and mast-mounted instrumentation. Its main aim is to provide data for atmospheric processes research, and for the testing and validation of numerical model output and performance. The site measures (amongst other variables):

- Wind and turbulence (at heights of 10m, 25m and 50m)
- Temperature (at heights of 1.2m, 10m, 25m and 50m)
- Humidity and relative humidity
- Surface radiation (the site has a full suite of radiometers, measuring all the main components of the radiation budget)
- Visibility and aerosol measurements (an MRI integrating nephelometer measures the atmospheric scattering coefficient of dry aerosols).
- Precipitation
- Barometric pressure

### Weybourne Atmospheric Observatory (WAO)

The WAO is an established research site positioned on the North Norfolk coast, at Weybourne. The site operates continuously, monitoring trace gases in the atmosphere. It houses instruments that are part of the UK Ozone network, the European Hydrogen network and the CarboOcean project. The ECVs measured at the site are: surface carbon dioxide and ozone (see section 3), surface air temperature, air pressure, wind speed and direction, irradiance, net irradiance (via AWS, SONIC), and upper air temperature, wind speed and direction (via SODAR). Many of the instruments at the site are supported by NERC NCAS as part of a long term measurement initiative and feed data to the BADC national facility.

### Chilbolton Facility for Atmospheric and Radio Research

The NERC-Chilbolton Facility for Atmospheric and Radio Research (CFARR) at the STFC-Chilbolton Observatory operates twenty major instruments, including a fully-steerable meteorological radar. Continuous observations of cloud and aerosol profiles are made with multiple Doppler radars, lidars and radiometers.

The twenty major instruments operated at the Observatory are: 3 GHz Doppler-polarisation radar; 1275 MHz clear air radar; 94 GHz cloud radar; 35 GHz Doppler cloud radar; 10 GHz insect radar; 905 nm ceilometer; 355 nm Raman lidar; 1.5  $\mu\text{m}$  Doppler lidar; 355 nm polarisation lidar; microwave profiling radiometer; broadband radiometers; sun photometer; sonic anemometer and CO<sub>2</sub> /H<sub>2</sub>O probe; dual frequency scintillometers; IR whole-sky camera; lightning sensor; precipitation sensors; meteorological sensors; GPS receiver; GRIMM aerosol spectrometer (on a one-year deployment by the University of Manchester during the NERC-APPRAISE project)<sup>20</sup>.

Measurements relevant to the ECVs are: surface air temperature; surface air pressure; dew point; wind speed and direction; precipitation; net, and down-welling, solar and infra-red radiation; water vapour profiles, integrated water vapour and total liquid water; integrated water vapour path; humidity

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<sup>20</sup> <http://www.chilbolton.rl.ac.uk/facilities.htm>

profiles; cloud properties; aerosol optical depth and particle size; aerosol particle count and size distribution.

The data from CFARR is archived at the British Atmospheric Data Centre (BADC). In addition, the atmospheric aerosol measurements made with the sun photometer are fed directly to the NASA-AERONET project.

CFARR is the centre of operations for a number of major international measurement campaigns:

- CSIP – the Convective Storms Initiation Project studying the onset of storms
- Cloudnet – a European Commission Framework 5 project in which continuous observations of cloud profile properties made at CFARR were used to evaluate European operational weather
- CLARE'98 – a campaign funded by ESA as part of its Earth Observation Preparatory Programme to collect and analyse radar and lidar as well as in-situ data to support the development of EarthCARE, a joint European-Japanese satellite mission.

CFARR has been invited to become a European reference site for the Coordinated Energy and Water Cycle Observations Project, CEOP phase II. It is anticipated that (1) surface meteorological and radiation data, (2) flux data, and (3) a comprehensive set of radar, lidar and radiometer data could be made available to the project.

#### **Rothera Oceanographic and Biological Time Series (RaTS) project**

This project has operated since 1997, collecting physical oceanographic data (Seabird CTD casts to 500m taken every 5 days in summer (November to April) and weekly in winter; precision salinity measures to monitor CTD calibration; observations of type and coverage of ice in Ryder Bay, South Cove and Hangar Cove) and biological oceanography data (sensor attached to Seabird CTD provides depth profile of total chlorophyll and light climate; water bottle samples taken from 15m depth immediately after the CTD cast provide data on the size distribution of chlorophyll and total chlorophyll and *in situ* monitor at 20m depth on Cheshire Island provides high-resolution data; dissolved organic carbon (DOC) samples are taken from all water bottle casts; samples are taken from all water bottle casts to determine seasonal and interannual variability in NO<sub>3</sub>, NO<sub>2</sub>, PO<sub>4</sub> and SiO<sub>2</sub>).

#### **Other observations of ECVs**

The British Antarctic Survey routinely measures mesospheric temperatures at Rothera and Halley stations.

## 7. Definitions of acronyms

AATSR	Advanced Along-Track Scanning Radiometer
ACRE	Atmospheric Circulation Reconstructions over the Earth
AEDC	Antarctic Environmental Data Centre
AGAGE	Advanced Global Atmospheric Gases Experiment
ALE	Atmospheric Life Experiment
AMT	Atlantic Meridional Transect
AOPC	Atmospheric Observations Panel for Climate
AWS	Automatic Weather Station
BADC	British Atmospheric Data Centre
BAS	British Antarctic Survey
BGS	British Geological Survey
BODC	British Oceanographic Data Centre
BSRN	Baseline Surface Radiation Network
CASP	Cambridge Arctic Shelf Programme
CDIAC	Carbon Dioxide Information Analysis Center
CEH	Centre for Ecology and Hydrology
CEOP	The Coordinated Energy and Water Cycle Observations Project
CET	Central England Temperature
CFARR	Chilbolton Facility for Atmospheric and Radio Research
COMNAP	Council of Managers of National Antarctic Programs
CPR	Continuous Plankton Recorder
CRU	Climatic Research Unit
CSIP	Convective Storms Initiation Project
CTD	Conductivity Temperature Depth
DDC	Designated Data Centre
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DFID	Department for International Development
DIUS	Department for Innovation, Universities and Skills
DOC	Dissolved organic carbon
DWD	Deutscher Wetterdienst
EA	Environment Agency
EC	European Commission
ECMWF	European Centre for Medium-Range Weather Forecasts
ECN	Environmental Change Network
ECV	Essential Climate Variable
EPS	Ensemble Prediction System
ERFF	Environment Research Funders' Forum
ESA	European Space Agency
ESSC	Environmental Systems Science Centre
EUCOS	EUMETNET Composite Observing System
EUMETNET	European Meteorological Network
EWP	England and Wales total Precipitation
FAGS	Federation of Astronomical and Geophysical Data Analysis Services
FGGE	First GARP Global Experiment
FOAM	Forecasting Ocean Assimilation Model
FRIEND	Flow Regimes from International Experimental and Network Data
FSF	Field Spectroscopy Facility
GAGE	Global Atmospheric Gases Experiment
GAW	Global Atmospheric Watch
GCC	Global Collecting Centre
GCOS	Global Climate Observing System
GDAC	Global Data Assembly Centre
GEBCO	General Bathymetric Chart of the Oceans
GECC	Global Environmental Change Committee
GEWEX	Global Energy and Water Cycle Experiment

GLOSS	Global Sea Level Observing System
GMES	Global Monitoring for Environment and Security
GOCE	Gravity field and steady-state Ocean Circulation Explorer
GPS	Global Positioning System
GRACE	Gravity Recovery and Climate Experiment
GRDC	Global Runoff Data Centre
GSN	GCOS Surface Network
GTS	Global Telecommunication System
GUAN	GCOS Upper Air Network
HBDSEG	Healthy and Biologically Diverse Seas Evidence Group
HIMS	Hydrology Information Management System
IACMST	Inter Agency Committee on Marine Science and Technology
ICES	International Council for the Exploration of the Sea
ICOADS	International Comprehensive Ocean-Atmosphere Data Set
ICSU	International Council for Science
IDC	International data centre
IFS	Integrated Forecasting System
IfT	Leibniz-Institut für Troposphärenforschung
IHP	International Hydrological Programme
INMG	Instituto Nacional de Meteorología e Geofísica
IOC	International Oceanographic Commission
IHO	International Hydrographic Office
IPCC	Intergovernmental Panel on Climate Change
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
JGOFS	Joint Global Ocean Flux Study
JMA	Japan Meteorological Agency
MA	Measuring authority
MBA	Marine Biological Association
MMS	Meteorological Monitoring System
MOHC	Met Office Hadley Centre
MPIB	Max-Planck-Institut für Biogeochemie,
MSCC	Marine Science Coordination Committee
NCAS	National Centre for Atmospheric Science
NCDC	National Climatic Data Center
NERC	Natural Environment Research Council
NGLA	National Groundwater Level Archive
NIEA	Northern Ireland Environment Agency
NMHS	National Meteorological and Hydrological Service
NMP	National Meteorological Programme
NMS	National Meteorological Service
NOAA	National Oceanic and Atmospheric Administration
NOCS	National Oceanography Centre, Southampton
NRFA	National River Flow Archive
NSIDC	National Snow and Ice Data Center
NTSLF	National Tidal and Sea Level Facility
NWA	National Water Archive
NWP	Numerical weather prediction
OBIS	Ocean Biogeographic Information System
OECD	Organisation for Economic Cooperation and Development
OPEG	Ocean Processes Evidence Group
OSTIA	Operational Sea Surface Temperature and Sea Ice Analysis
PAP	Porcupine Abyssal Plain
POL	Proudman Oceanographic Laboratory
POMME	Programme Océan Multidisciplinaire Méso Echelle
PSMSL	Permanent Service for Mean Sea Level
PWS	Public Weather Service
RAF	Royal Air Force
RAPID	Rapid Climate Change Programme
RaTS	Rothera Oceanographic and Biological Time Series
RBCN	Regional Basic Climate Network
READER	Reference Antarctic Data for Environmental Research

RLR	Revised Local Reference
SAHFOS	Sir Alistair Hardy Foundation for Ocean Science
SAMS	Scottish Association for Marine Science
SAWS	South African Weather Service
SBSTA	Subsidiary Body for Scientific and Technological Advice
SCAR	Scientific Committee on Antarctic Research
SEPA	Scottish Environment Protection Agency
SLA	Service Level Agreement
SNOMS	Swire-NOCS Ocean Monitoring System
SOCAT	Surface Ocean CO <sub>2</sub> Atlas
SODAR	Sonic detection and ranging
SPARC	Stratospheric Processes And their Role in Climate
SST	Sea surface temperature
STFC	Science and Technology Facilities Council
TENATSO	Tropical Eastern North Atlantic Time-Series Observatory
UEA	University of East Anglia
UHSLC	University of Hawaii Sea Level Center
UK-EOF	UK Environmental Observation Framework
UKHO	United Kingdom Hydrographic Office
UKMMAS	UK Marine Monitoring and Assessment Strategy
UNECA	UN Economic Commission for Africa
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
VOSclim	Voluntary Observing Ship Climate Project
WAO	Weybourne Atmospheric Observatory
WCRP	World Climate Research Programme
WDCGG	World Data Centre for Greenhouse Gases
WMO	World Meteorological Organisation
WWRP	World Weather Research Programme