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# CO-OPERATION WITH RELEVANT INTERNATIONAL ORGANIZATIONS

## Monitoring of greenhouse gases in the atmosphere

## Note by the secretariat

CONTENTS



GE.97-

# I. INTRODUCTION

## A. <u>Mandate and scope of the note</u>

1. At its fourth session, the Subsidiary Body for Scientific and Technological Advice (SBSTA) welcomed the efforts of the secretariat to encourage co-ordination of relevant methodological activities among international organizations, bodies of the United Nations and related conventions and requested the secretariat to further explore ways to enhance this co-ordination, for example, on the monitoring of greenhouse gases (GHGs) in the atmosphere with the World Meteorological Organization (WMO) and to advise the SBSTA on these activities (FCCC/SBSTA/1996/20, para. 42).

2. Further to this request, and in co-operation with the secretariat, WMO has prepared a progress report on the monitoring of GHGs in the atmosphere which is presented in the attached annex.

# II. POSSIBLE ACTION BY THE SBSTA

3. The SBSTA may wish to:

(a) Take note of the information provided by WMO on the world-wide systematic observation of GHGs in the atmosphere within the Global Atmosphere Watch (GAW), which provides the basic information for scientific studies on the impacts of changes in atmospheric composition on the climate system, and, as such, for the assessments by the Intergovernmental Panel on Climate Change (IPCC);

(b) Express its appreciation to those Parties already operating stations within the existing network, as well as to the Global Environment Facility (GEF) for its support in the establishment and operation of several stations;

(c) Invite Parties and relevant funding organizations and programmes to provide financial and other support to strengthen and maintain the GAW; and

(d) Invite WMO to continue its efforts to implement the GAW and to report on progress to future sessions of the SBSTA.

Annex

# THE GLOBAL ATMOSPHERE WATCH[1, 2]

## A system for environmental monitoring and research

Introduction

The major responsibility for monitoring global changes in the atmospheric environment belongs to the World Meteorological Organization (WMO). The Organization coordinates the environmental monitoring activities and scientific assessments of its 178 Member states and 5 territories through its Global Atmosphere Watch (GAW), a system of networks of observing stations, related facilities, and infrastructure encompassing the measurement and related scientific assessment activities devoted to the investigation of the changing chemical composition and related physical characteristics of the global atmosphere. GAW serves as an early warning system to detect further changes in atmospheric concentrations of greenhouse gases, changes in the ozone layer and in the long-range transport of pollutants, including acidity and toxicity of precipitation as well as of atmospheric burden of aerosols (dirt and dust particles).

Background

GAW was established by the WMO Executive Council in June 1989 to strengthen and better co-ordinate WMO environmental data-gathering activities that began in the 1950s. It provides framework design, standards, intercalibrations and data collection systems for global monitoring and data evaluation. Through GAW, state-of-the-science measurements of a number of mostly low-concentration chemical and physical constituents of the atmosphere at levels extending from the surface to the stratosphere and at some of the most difficult locations on Earth are being made. Some three hundred stations now comprise the WMO GAW network (Figure 1). GAW has become broadly recognized, both by governments and within the scientific community at large, as an essential tool for monitoring the state and the evolution of the composition of the atmosphere and for improving the understanding of its interactions with all aspects of the environment.

Bearing in mind heightened public awareness and concerns for climate and environmental issues in general, activities associated with the further development and implementation of GAW continue to be prominent. In recent years, new stations have been added to the network and existing ones upgraded. Complementing this overall extension of the observing network are important supporting activities in areas such as education and training, and quality assurance and assessment procedures. In particular, the establishment of Quality Assurance/Science Activity Centres (QA/SACs), a number of World Calibration Centres (WCCs) and the increased number of WMO World Data Centres such as the WMO World Data

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[1] This document has been produced as received and is without formal editing
[2] For figures: see at the back of this document

Centre for Greenhouse Gases in Japan are seen as major steps forward for maintaining consistent and known data quality in the GAW Programme.

The Measurement of Greenhouse Gases

In 1956, long-term carbon dioxide measurements were begun at Mauna Loa Observatory in Hawaii, USA. Since that time three other gases were recognized as important greenhouse gases: nitrous oxide ($N_2O$), methane ($CH_4$), halocarbons (CFCs) and tropospheric ozone.

**Carbon Dioxide** Carbon dioxide data have been included in the WMO atmospheric monitoring programme in the 1960s and as early as 1975 WMO issued an authoritative assessment of the potential role of the $CO_2$ increase for climate. In the mid 1970s, the WMO Research and Monitoring Project on Atmospheric Carbon Dioxide was initiated whose objectives were to strengthen long-term monitoring for better trend determination, to predict its concentration through the next century, and to assess its possible effects on the climate. The monitoring aspects of $CO_2$ remain within WMO GAW whereas the other objectives have been further developed within the WMO World Climate Programme activities. In Figure 2, the long term record from four diverse locations show the global $CO_2$ increase.

To measure $CO_2$ an instrument called a non-dispersive infra-red analyser (NDIR) is more or less universally used. Numerous manufacturers make this instrument. It compares the absorption of infra-red radiation from a source in the instrument (sample) with the absorption of a known concentration of $CO_2$ (reference) in a specially prepared mixture of standard gases. The $CO_2$ concentration is determined from the relative analyser output between the sample gas and the reference gas. $CO_2$ concentration is also determined by collecting air in flasks and returning the flasks to a central laboratory where NDIR measurements are made. The network coordinated by the US National Oceanic and Atmospheric Administration is shown in Figure 3.

**Methane** $CH_4$ is emitted into the atmosphere from a variety of natural and anthropogenic sources such as natural wetlands, rice patties, fermentation processes in animals, biomass burning, natural gas production and landfills. While the major sources of atmospheric methane have been identified, the relative strength of each source is not yet clearly known. It can be seen in Figure 3 that methane is also measured at the locations along with $CO_2$. The most common method of measurement is by gas chromatography which can only be done at locations with high technical skills. The global distribution of methane is shown in Figure 4.

**Nitrous Oxide** $N_2O$ is also an important greenhouse gas which has both natural and man-made sources. However these are poorly quantified. Determination of global concentrations is difficult since nitrous oxide, which is released mainly from soils, is very heterogeneous. It is estimated to contribute about 6% to the overall greenhouse effect. Trends in $N_2O$ are shown in Figure 5.

**Halocarbons** The main concern with the family of man-made halocarbons has been their impact on the destruction of the stratospheric ozone layer. However they also act as greenhouse gases. The restriction imposed by the Montreal Protocol show that for selected halocarbons there has been a decrease in their growth in the atmosphere (Figure 6).

**Tropospheric Ozone** Tropospheric ozone has just been recognized as a potentially important greenhouse gas. Because it varies both regionally and vertically, it is hard to assess its long-term global trend. Under the GAW programme, there is a great need to expand the measurement of this gas on a world-wide basis. A number of ozone vertical measurements have been proposed.

Use of the network

Recently a major effort has been to expand the GAW greenhouse gas network through the support of the Global Environment Facility (GEF). As project manager WMO, working closely with UNDP, has established six new GAW stations of global importance in Algeria, Argentina, Brazil, China, Kenya and Indonesia. These stations are already producing data or will shortly. Furthermore, a regional GEF project in South America which is managed by the WMO has been established to increase the measurement of ozone (Argentina, Brazil, Chile, Paraguay and Uruguay). These two projects have successfully demonstrated that some of the gaps in greenhouse gas measurements can be filled. However, similar projects are needed in other parts of the world, in particular in Africa and Asia.

Without WMO's coordinated greenhouse gas measurement programme, the potential problem of climate change due to the changing atmospheric composition would not have been recognized. With this recognition, climate modellers have used these data to predict climate change scenarios. This has been the key to the analysis under the activities of IPCC. Particularly, the WMO's GAW programme is considered the atmospheric chemistry contribution to the Global Climate Observation System (GCOS). Figure 7 shows a conceptional design of an operational framework of observations, analysis prediction and research underpinning climate services to society.

Global warming of the Earth-atmosphere system is being brought about by the greenhouse effect. The uncertainties in the predictions relating to the timing, magnitude and regional patterns of climate change are being addressed and here the WMO GAW greenhouse gas network is essential in providing the basic data used to resolve these uncertainties. These critical data are obtained from monitoring sites located in pristine regions of the world. Siting criteria is very specific from the standpoint of evaluating global trends. Only accurate monitoring over long periods of time can provide the data necessary to document trends and project potential of future pollution loads. Relating changes in climate, or other factors of the global environment, to concurrent trends in the background levels of greenhouse gases may permit forecasting of future changes. The low levels found in background conditions and the accuracy required to document small changes require continued scientific studies.

Infrastructure

WMO, through its earlier monitoring programmes and now GAW, has promulgated standardization of measurements by bringing interested scientists together at regular intervals. For example, to date five specialized conferences discussing methods of $CO_2$ observations and analysis have been sponsored by WMO (Bern 1981, Interlaken 1985, Hinterzarten 1989, Carqueiranne 1993 and Cairns 1997).

As an important function of GAW, the data obtained are archived at the WMO World Data Centre for Greenhouse Gases (WDCGG) established in Tokyo, Japan in 1990. There, systematic collection and distribution of data on the concentrations of greenhouse gases ($CO_2$, $CH_4$, CFCs, $N_2O$ etc.) and the related gases (e.g. CO, $NO_x$ , $SO_2$) are made. Further, the WMO has established three Quality Assurance Science Activity Centres in Germany, Japan and the United States where the quality of the GAW measurements are overseen on an international basis. For example, under this system the World Calibration Centre for Carbon Dioxide Measurements is at the NOAA laboratory in Boulder, USA.

Summary and future needs

To better predict climate change due to the greenhouse effect, there is a need to sample the atmosphere much more comprehensively, but still at reasonable cost. From the GAW monitoring perspective, the following needs can be outlined:

- The GAW system has been successful in establishing a world-wide network to measure greenhouse gases. However there are still many areas where there is an urgent need to expand these measurements if we are to understand the full implementations of climate change. GEF should consider this as a number one priority.

- The technical aspects of maintaining a sophisticated measurement programme require a strong infrastructure to ensure the consistent global quality. For example, though international calibration standards for carbon dioxide are in place, no such standards are available for the other greenhouse gases. This is one of the flaws in the GAW in ensuring a harmonized data set.

- A framework for the measurement of greenhouse gas concentrations is in place but to understand their sources and sinks requires measuring transport and flux in both the horizontal and vertical. Aircraft measurements play an important part in this where new automated techniques are now just being developed.

- Stronger ties between the modelling and measurement communities must be fostered. The upcoming meeting in Cairns, Australia (8-12 September 1997) will be the forum for such discussions.

There is no question that the accurate measurement of the concentrations and fluxes of greenhouse gases under the WMO's GAW programme is a basic activity in understanding and forecasting climate change.

*Figure 1. The Global Atmosphere Watch Network*

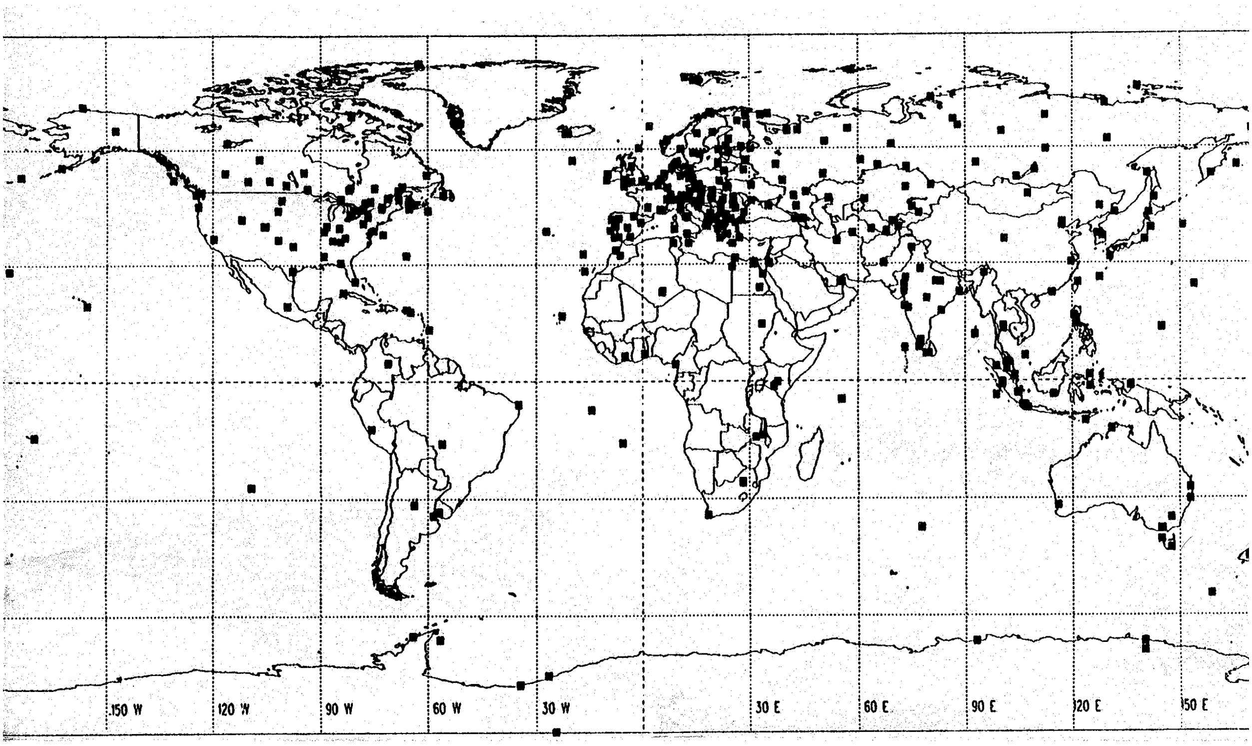


*Figure 2. The long-term measurement of $CO_2$ concentration in Alaska, Hawaii, Samoa, and the South Pole*

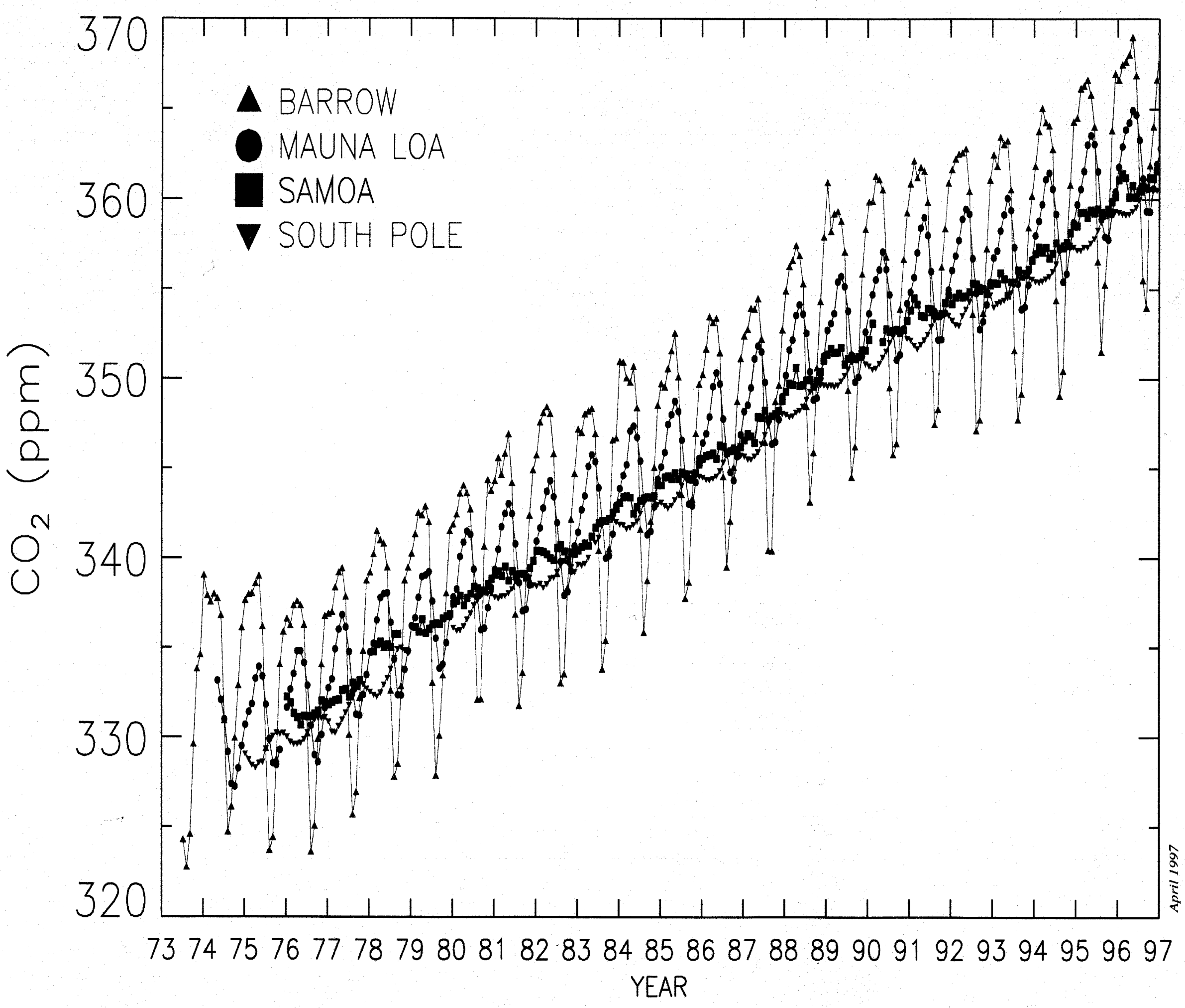
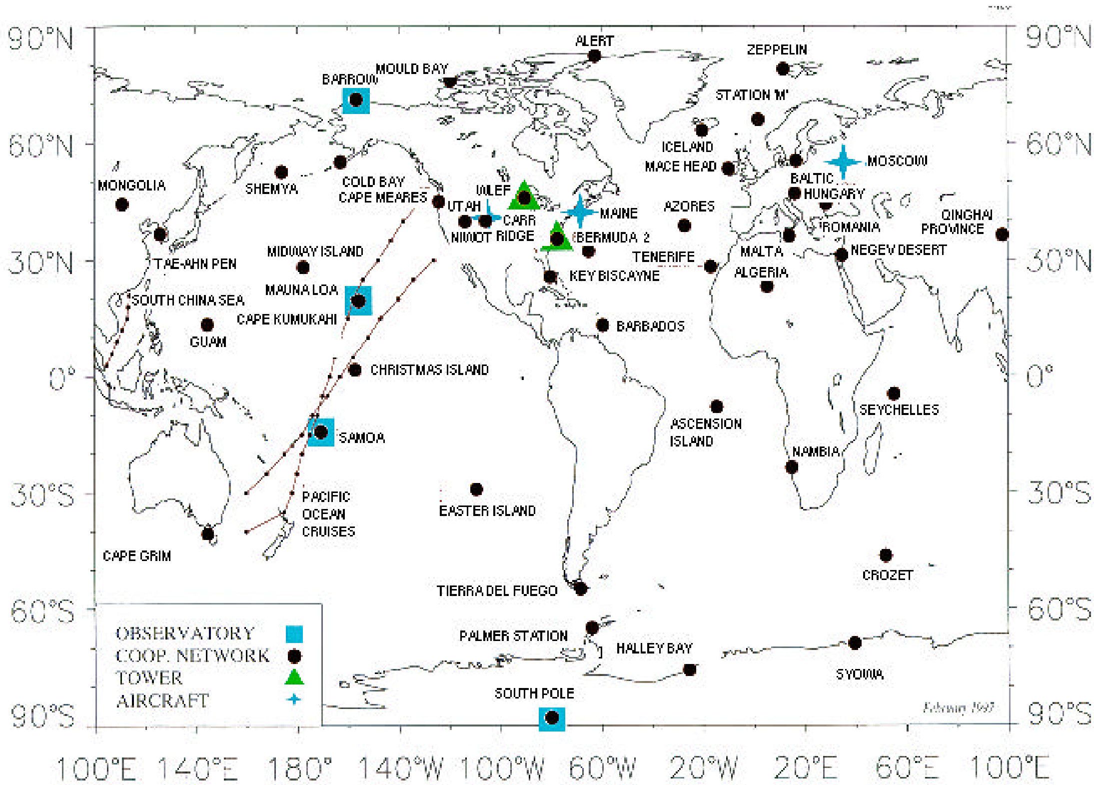


*Figure 3. The GAW network of $CO_2$ and other greenhouse gases around the world. Countries actively involved include: Australia, Canada, China, France, Germany, Hungary, Italy, Japan, Korea, New Zealand, Sweden and USA*



*Figures 4. Global distribution of methane*

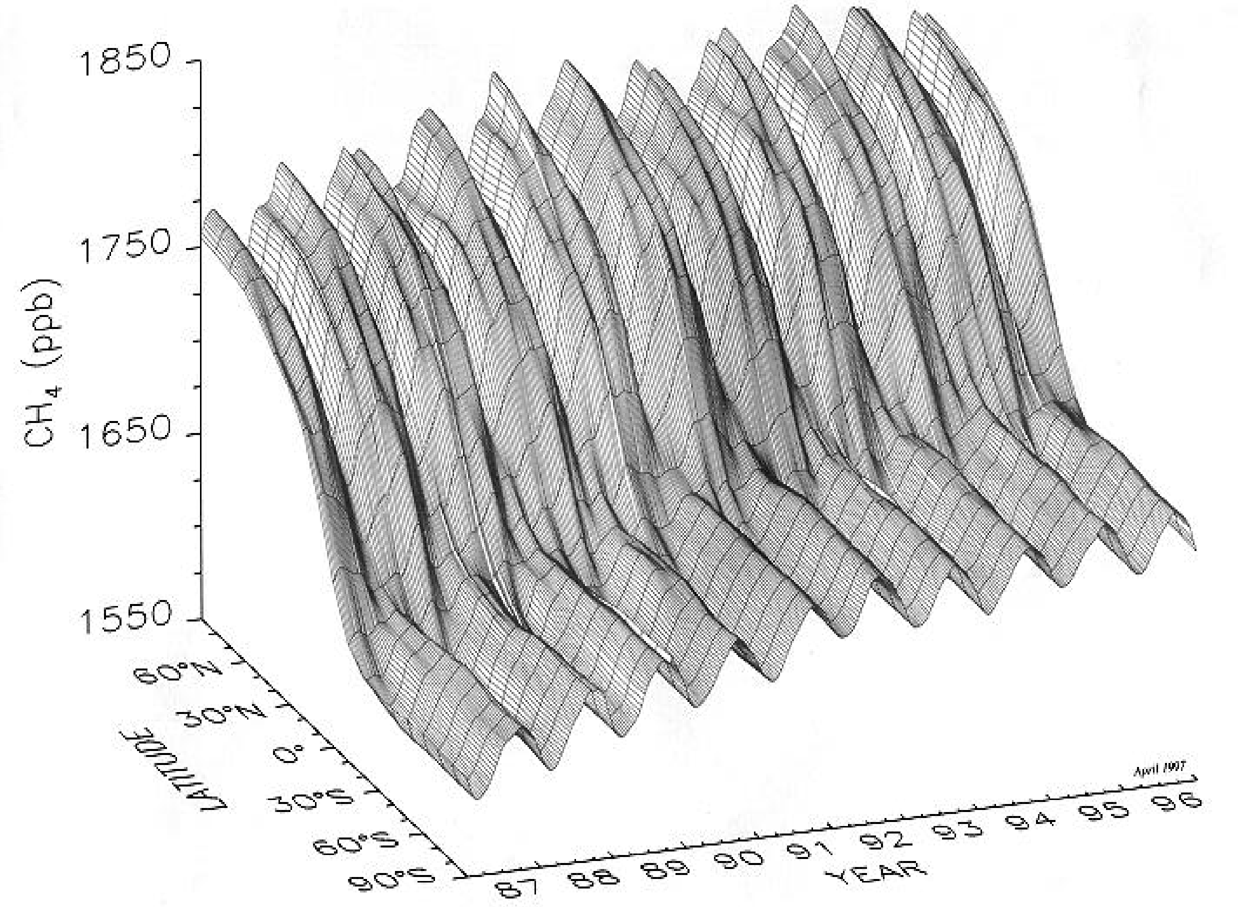


*Figure 5. Monthly average $N_2O$ concentrations at GAW global sites*

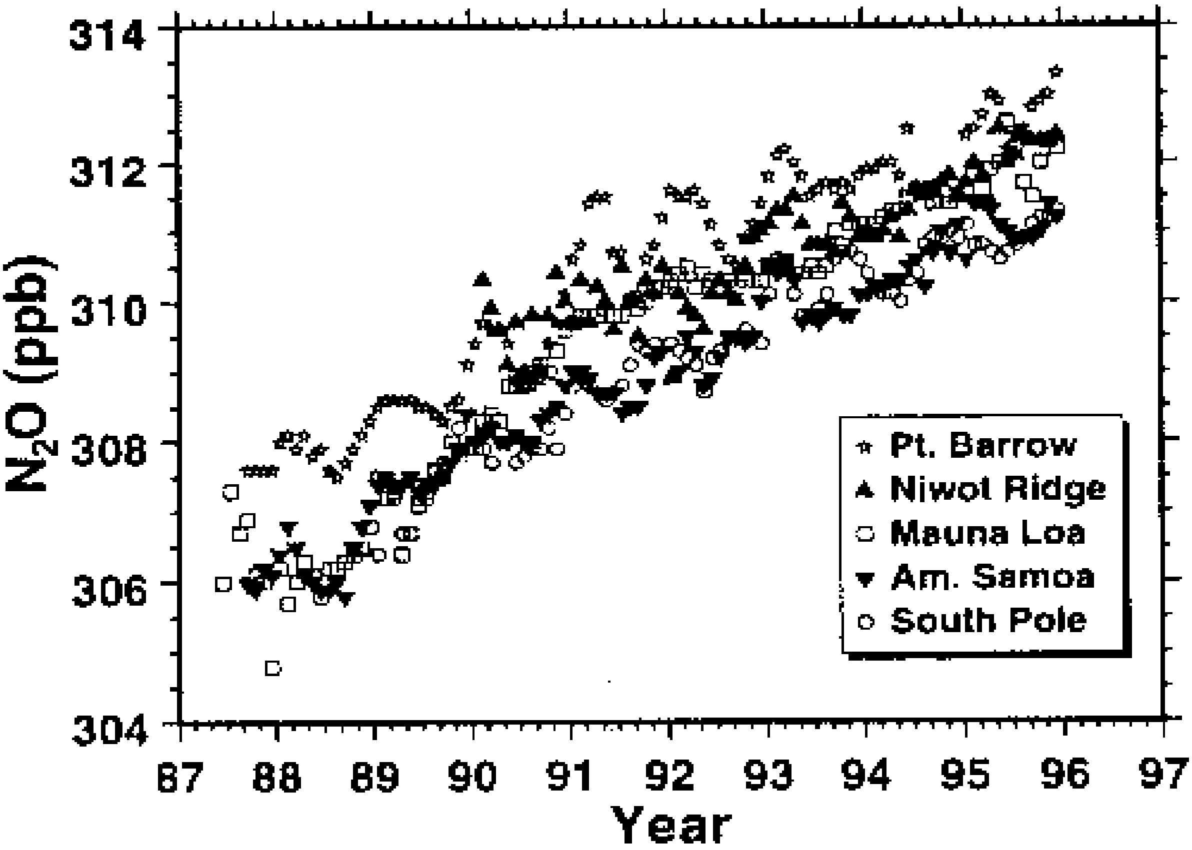


*Figure 6. Concentrations of selected halocarbons at GAW global sites*

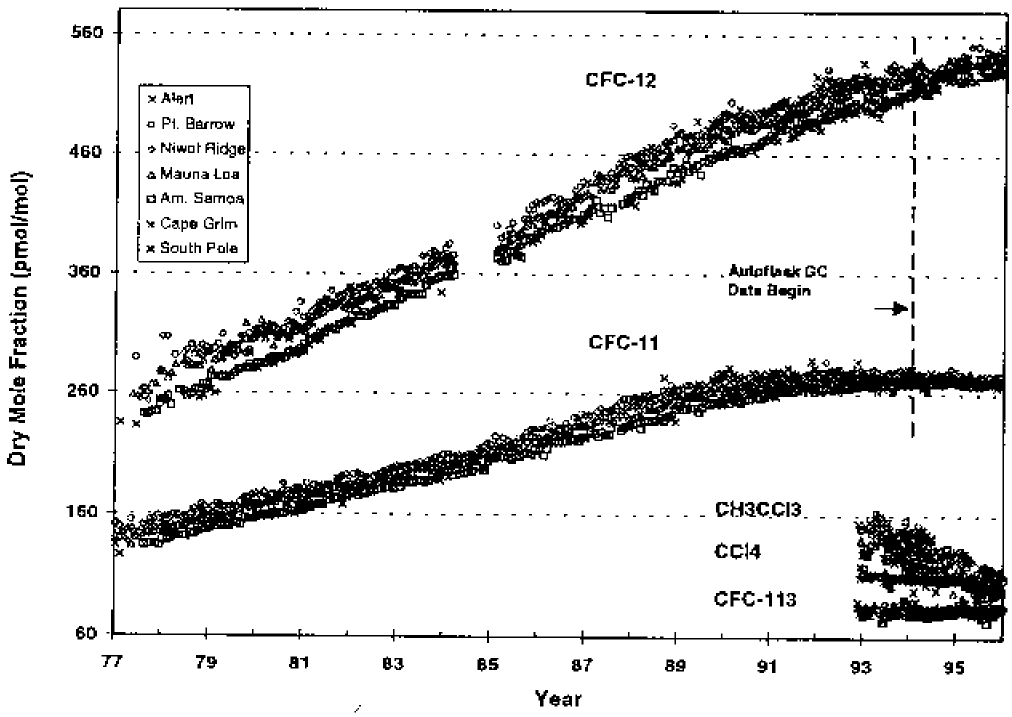
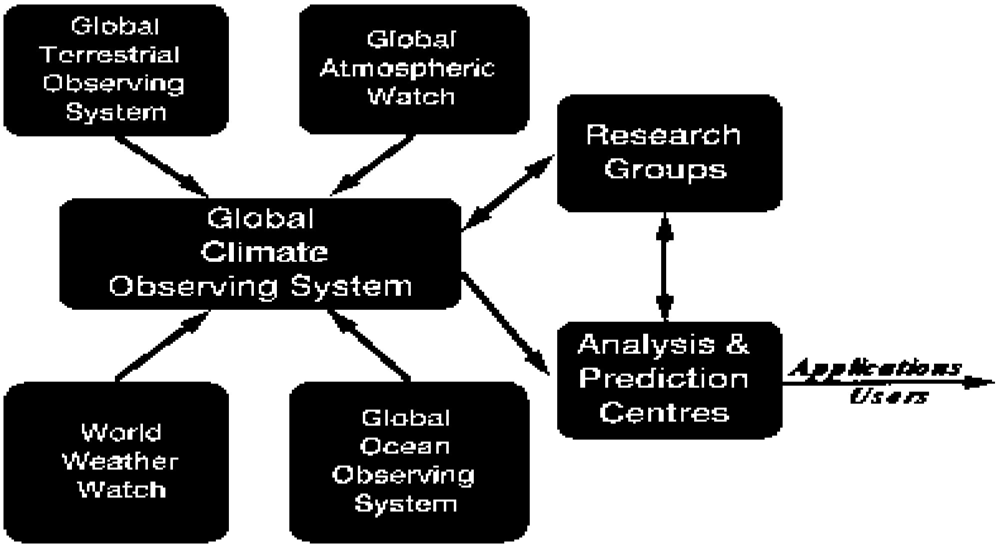


*Figure 7. Operational framework of observations, analysis and research*

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