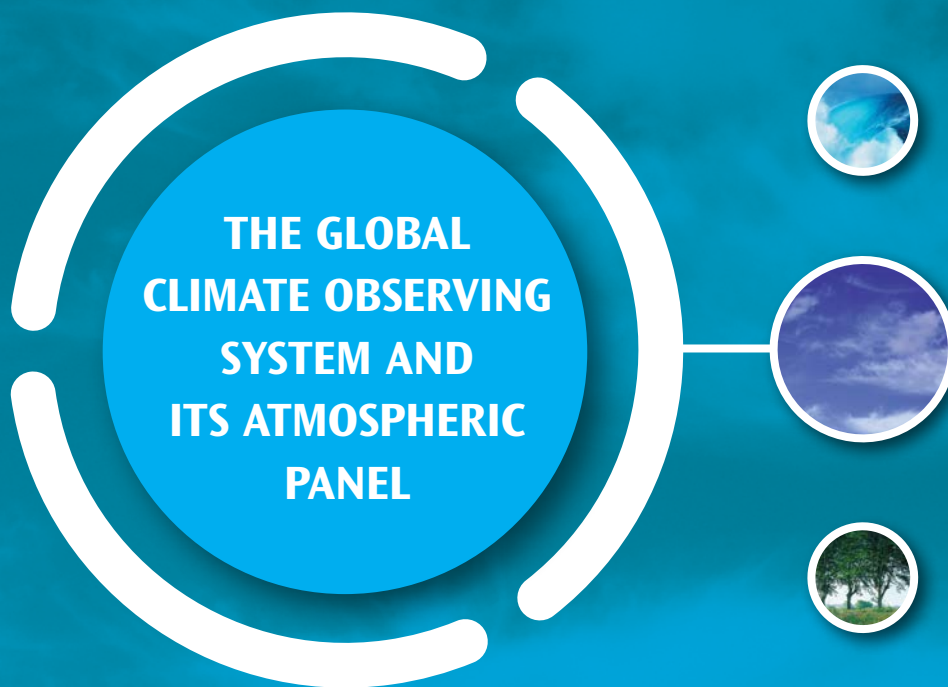




# GCOS

GLOBAL CLIMATE OBSERVING SYSTEM



<http://gcos.wmo.int>



ICSU

International Council for Science



UNEP

**The Global Climate Observing System (GCOS)** is an internationally coordinated network of observing systems and a programme of activities that support and improve the network. It is designed to meet evolving national and international requirements for climate observations. GCOS was an outcome of the Second World Climate Conference and was established in 1992.



GCOS addresses the total climate system, including physical, chemical and biological properties, and atmospheric, oceanic, terrestrial, hydrological and cryospheric components. Climate observations must be sustained and enhanced so that users may:

- Detect further climate change and determine its causes;
- Model and predict the climate system;
- Assess impacts of climate variability and change;
- Monitor the effectiveness of policies for mitigating climate change;
- Support adaptation to climate change;
- Develop climate information services;
- Promote sustainable national economic development; and
- Meet the requirements of the United Nations Framework Convention on Climate Change (UNFCCC) and other international conventions and agreements.

**Many observing systems contribute to the GCOS network of global observing systems for climate.** In many cases they also serve other functions, such as weather forecasting and air-quality



monitoring. The contributing systems include the climate-observing components of the Global Ocean Observation System, led by the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural

Organization (UNESCO), and the Global Observing System and Global Atmosphere Watch of the World Meteorological Organization (WMO). A number of other research and operational systems provide important contributions. The composite observing system designated as GCOS serves as the climate-observation component of the Global Earth Observation System of Systems. The observations themselves may be ground-based or provided by airborne or satellite systems.

GCOS experts introduced the widely accepted concept of Essential Climate Variables (ECVs). ECVs are considered to be the minimum set of variables needed to describe the Earth's climate system and should be observed on a global scale.

**Three science panels** have been established by the GCOS Steering Committee to define the observations needed in each of **the three main global domains – atmosphere, oceans and land** – to prepare specific programme elements and to make recommendations for implementation. The three science panels are:

- The Atmospheric Observation Panel for Climate (AOPC);
- The Ocean Observations Panel for Climate (OOPC); and
- The Terrestrial Observation Panel for Climate (TOPC).



GCOS is both supported by and supports the international scientific community, so the three science panels are therefore co-sponsored by the **World Climate Research Programme (WCRP)**.

WCRP works with the three GCOS panels to achieve, in particular, its objectives of assessing and improving the accuracy of climate predictions.

GCOS addresses the need for global coverage and timeliness of data, for example, through the promotion of **ECVs** and the formulation of the **GCOS Climate Monitoring Principles**. The concept was adopted by the Conference of the Parties to the UNFCCC. The Panels' expertise is essential for assessing the capabilities, gaps and deficiencies of current climate-observing systems. Their work and discussions contribute directly to the regular reports to the UNFCCC about the status of global climate-observing capacities.



**United Nations**  
Framework Convention on  
Climate Change

SEA - SURFACE  
TEMPERATURE,  
TEMPERATURE,  
OCEAN COLOUR



TEMPERATURE,  
WATER VAPOUR,  
TRACE SPECIES



SEA LEVEL, SEA STATE,  
SURFACE CURRENT



TEMPERATURE, WIND,  
WATER VAPOUR, OZONE



CARBON

LAKES



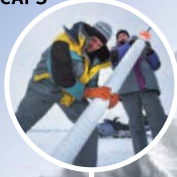
PERMAFROST



SEA-ICE



ICE SHEETS,  
GLACIERS &  
ICE CAPS



SNOW COVER

TEMPERATURE,  
SALINITY



SURFACE

CARBON DIOXIDE PARTIAL  
PRESSURE, OCEAN ACIDITY



SEA - SURFACE SALINITY,  
PHYTOPLANKTON

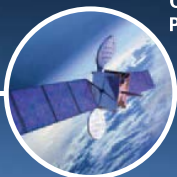
SUB-SURFACE



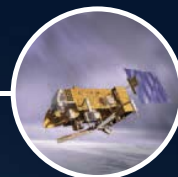
NUTRIENTS, TRACERS,  
OCEAN ACIDITY,  
CARBON DIOXIDE  
PARTIAL PRESSURE

OCEAN CURRENT,  
OXYGEN

**CLOUD PROPERTIES,  
PRECIPITATION**



**EARTH RADIATION  
BUDGET**



**ALBEDO, SURFACE  
RADIATION BUDGET**



**WIND SPEED &  
DIRECTION**



**FIRE DISTURBANCE,  
LAND COVER**



**WATER VAPOUR**



**OZONE & AEROSOL,  
SUPPORTED BY THEIR  
PRECURSORS**



**AIR TEMPERATURE,  
PRESSURE**



**ABOVE-GROUND BIOMASS,  
FAPAR, LEAF AREA INDEX**



**CARBON DIOXIDE,  
METHANE & OTHER  
LONG-LIVED  
GREENHOUSE GASES**



**RIVER DISCHARGE,  
WATER USE**



**SOIL MOISTURE**



**GROUNDWATER**





**The Atmospheric Observation Panel for Climate (TOPC)** was established in recognition of the need for specific scientific and technical input concerning atmospheric climate observations. Its aim is to ensure the required quality, long-term homogeneity and continuity of data.

**Key activities are:**

- Assessing the current state of the atmospheric component of the global observing system for climate and identifying its gaps and inadequacies;
- Securing the implementation of designated GCOS networks and promoting the establishment and enhancement of other systems to provide long-term and consistent data and information for atmospheric ECVs, such as Earth radiation budget, Surface radiation, Greenhouse gases, Water vapour, Clouds, and Aerosols;
- Liaising with relevant research, operational and end-user bodies in order to determine and maintain the requirements for data to monitor, understand and predict the dynamical, physical and chemical state of the atmosphere and its interfaces on seasonal to multi-decadal timescales, on both global and regional levels;
- Promoting the transfer and accessibility of data to the user community, as well as the rehabilitation of historical observational and proxy climate datasets.



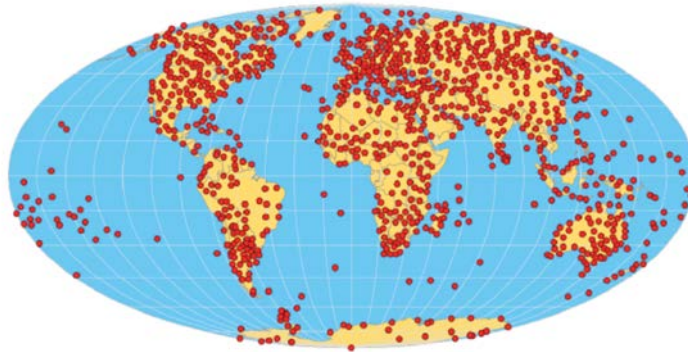
AOPC is supported, amongst others, by the **WMO Integrated Global Observing System (WIGOS)** – an integrated, comprehensive and coordinated system that comprises in situ and space-based observations of the present WMO global observing systems. WIGOS represents an integrated framework of existing WMO observing systems and aims at providing the data required for delivering services in all regions around the globe in an effective and efficient manner.

## Achievements:

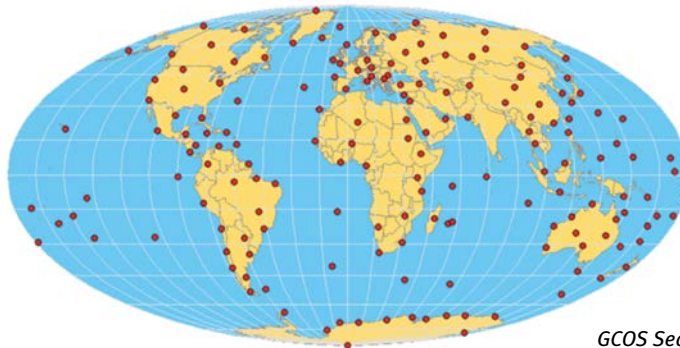
### GCOS Surface Network, GCOS Upper-Air Network and GCOS Reference Upper-air Network

One of the first tasks of GCOS was to define a subset of the World Weather Watch stations appropriate for basic climate monitoring. The subset of some 1 000 baseline surface stations became the GCOS Surface Network (GSN), while a select set of 150 upper-air stations was designated as the GCOS Upper-air Network (GUAN). These were built on existing WMO classifications and became the initial baseline components of the atmospheric networks. Considerations for selection of GSN

**GCOS Surface Network**  
(1 017 stations)

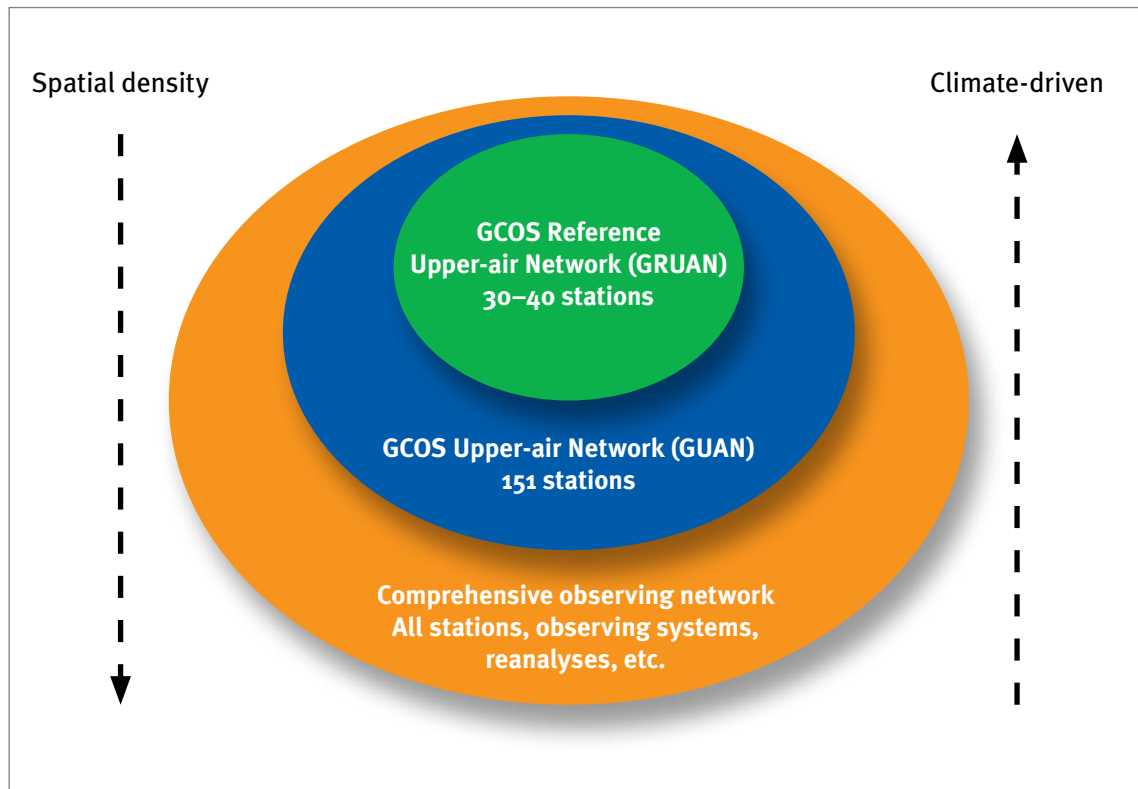


**GCOS Upper-air Network**  
(171 stations)



*GCOS Secretariat, 1 March 2014*

included spatial distribution, length and quality of record, long-term commitment and degree of urbanization. Similar considerations were used for GUAN, except surface environmental factors were not of major importance. Designation of these networks benefited both GCOS and the National Meteorological and Hydrological Services (NMHSs). For GCOS, designation helped incorporate climate requirements into NMHS procedures. For NMHSs, designation of a station as part of the global climate network helped sustain support for these long-running sites. These networks provided the foundation for the Regional Basic Climatological Network, which provides far greater spatial detail about climate variability.



Recognizing that a balance had to be struck between standards and completeness of ground-based measurements, GCOS established a hierarchy of observational networks and systems, comprising comprehensive, baseline and reference networks underpinned by assumptions of spatial sampling needs.





An example of a particularly successful step forward in implementing a global observing system for climate is the initiation of a reference network for upper-air observations – the GCOS Reference Upper-air Network (GRUAN). This network is the prototype of a hybrid observing system, combining operational upper-air measurement sites with research sites and providing high-quality reference data for atmospheric profiles. GRUAN sites are undertaking high-quality atmospheric-profile measurements that will help understand trends in upper-air ECVs, assist in investigating processes in the upper troposphere and lower stratosphere, and provide data for calibrating satellite measurements and validating independent climate analyses and models. At GRUAN sites, the principles of quality, traceability and complete error characterization have been heeded, for at least part of the observing programme. The network is planned to grow from its initial size of 15 stations and to introduce climate-quality standards to a larger number of sites.



**GRUAN**

## Chairs of the AOPC

1994–1996	Lennart BENGTTSSON (Germany)
1997–2006	Michael MANTON (Australia)
2006–2013	Adrian SIMMONS (United Kingdom)
2013–present	Kenneth HOLMLUND (Finland) and Albert KLEIN-TANK (Netherlands) (Vice-Chair)

## Terms of reference (as of October 2014)

The goal of the AOPC is to plan and promote the atmospheric component of GCOS. Its specific terms of reference are as follows:

1. To liaise with relevant research, operational and end-user bodies in order to determine and maintain the requirements for data to monitor, understand and predict the dynamical, physical and chemical state of the atmosphere and its interfaces on seasonal to multi-decadal timescales, on both global and regional levels.
2. To promote the establishment and maintenance of an overall system to provide long-term, high-quality, consistent data and information to meet those requirements.
3. To review the current state of the atmospheric component of the global observing system for climate.
4. To identify gaps and inadequacies in the atmospheric component of the current global observing system for climate.
5. To propose and promote the establishment of new systems, or enhancements to current systems and practices, to eliminate deficiencies.
6. To promote the transfer, as appropriate, of research observing systems to operational networks.



7. To promote the rehabilitation of historical observational and proxy climate datasets.
8. To promote and review institutional arrangements to ensure that:
  - GCOS observations are of the highest quality and are collected in accordance with the highest standards of practice;
  - GCOS data products are relevant and of the highest quality;
  - GCOS data are archived and accessible to the user community.
9. To liaise with the other GCOS panels, WCRP steering groups and other relevant entities, such as the WMO technical commissions and the Committee on Environmental Observing Satellites, on atmospheric climate-observing-system issues.
10. To carry out agreed assignments from the GCOS Steering Committee.
11. To report regularly to the GCOS Steering Committee and the WCRP Joint Scientific Committee on issues related to the atmospheric component of GCOS.



## GLOBAL CLIMATE OBSERVING SYSTEM

GCOS Secretariat | c/o World Meteorological Organization | 7 bis, avenue de la Paix  
P.O. Box 2300 | CH-1211 Geneva 2 | Switzerland  
Tel: +41 (0) 22 730 8275/8067 | Fax: +41 (0) 22 730 8052 | E-mail: [gcos@wmo.int](mailto:gcos@wmo.int)

<http://gcos.wmo.int>

GCOS is a joint undertaking of the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational Scientific and Cultural Organization (UNESCO), the United Nations Environment Programme (UNEP) and the International Council for Science (ICSU).



**ICSU**  
International Council for Science

