

# **Greek report on activities with respect to the GCOS Implementation Plan**



**Submission to the United Nations Framework Convention  
on Climate Change (UNFCCC)**

**Hellenic Ministry for the Environment, Physical Planning  
& Public Works**

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## Contents

<i>Introduction</i>	<i>3</i>
<i>1. Common issues</i>	<i>4</i>
<i>2. Atmospheric essential climate variables</i>	<i>6</i>
<i>3. Oceanic essential climate variables</i>	<i>15</i>
<i>4. Terrestrial Observations</i>	<i>24</i>
<i>ANNEX I</i>	<i>28</i>

## **Introduction**

This report constitutes the submission of Greece on progress with the GCOS implementation plan, as described in decision 11/CP.13. It provides additional information on national GCOS activities using the revised “UNFCCC reporting guidelines on Global Climate Observing Systems” (FCCC/SBSTA/2007/L.14/Add.1).

An updated version will be provided within the 5th National Communication of Greece in January 2010.

The structure of this report and the caption numbering of the tables included follow the structure described in the above mentioned guidelines.

## 1. Common issues

Systematic observations of the Greek environment started immediately after the Revolution of 1821 and the foundation of the modern Greek state in 1829. In 1842, the National Observatory of Athens (NOA) was established, aiming at the promotion of observations of astronomical and other parameters of natural science. The first observations taken in 1842 concerned meteorological rather than astronomical parameters. NOA collects and classifies in a systematic fashion environmental data since 1862. In an attempt to cover all areas of the physical environment, the Meteorological and Seismological Institutes were founded in 1896 and followed much later, in 1954, by the Ionospheric Institute.

The operation of the Hellenic National Meteorological Service (HNMS) comprised part of the Meteorological Institute in NOA until 1934, when it is transferred to the then Ministry of Military Affairs. In 1954, NOA starts the first program to measure solar radiation parameters, and in 1965 establishes an air pollution monitoring network for Athens, which continued operation till 1975 when it was transferred to the newly founded air pollution directorate of the Ministry for the Environment, Physical Planning and Public Works (MEPPPW).

Greece is among the countries with very high earthquake activity because of its location at the confluence of 3 tectonic major plates. Measurements of the seismic activity in the Greek territory began in 1896 by the newly founded Seismological Institute (now the Institute of Geodynamics), which continues to provide the Greek state with advice and official information on all parameters of seismic activity in the land.

To cover the needs of telecommunication, the Ionospheric Institute (now Institute for Space Applications and Remote Sensing) was founded in 1954, aiming primarily at the study and observation of ionosphere. The institute has since expanded to include research in the magnetosphere and remote sensing techniques of the earth's surface..

In view of the geography of Greece (18400 km of coastline, 9835 islands), and the historical preoccupation with the sea (fishing, trading and shipping), a Hydrographic Office is founded in 1905 under the General Navy Staff which begins systematic observations of currents, salinity, sea surface temperature and other sea state marine parameters. In 1920 the Hydrographic Office is upgraded to form the Hellenic Navy Hydrographic Service (HNHS), which is responsible, among others, for the establishment and operation of a network of permanent stations for measuring and collecting hydrographic, oceanographic and marine information.

In 1945, the Hydrobiological Institute is founded in the Academy of Athens, and in 1970, it forms the core of an independent Institute for Oceanography and Fishing, which in 2003 is converted to the today's Hellenic Centre for Marine Research (HCMR).

In 2001, Greece became associated and then, in 2005, full member of the European Space Agency (ESA), participating in all the core activities of the Agency, including those of Global Monitoring of Environment and Security (GMES). The ESA activities are at present coordinated by the General Secretariat for Research and Technology (GSRT) of the Ministry of Development.

The network of systematic observation of climatic parameters in Greece includes the Hellenic National Meteorological Service (HNMS), services of the Greek Armed Forces, the Ministry of Rural Development and Food, the Ministry for the Environment, Physical Planning and Public Works, as well as a number of national research centers. Furthermore, the Public Power Corporation of Greece (PPC) operates a network of meteorological stations in the vicinity of its thermal and hydro power plants and dams for electricity production.

## **2. Atmospheric essential climate variables**

### **Measurements of meteorological parameters**

The Hellenic National Meteorological Service (HNMS) operates a network of 88 surface and 3 upper air measurement stations, along with 22 automated meteorological stations. 69 of them (66 and 3 of surface and upper air, respectively) provide meteorological data on a continuous basis to international networks. In addition, all of them (113) are registered to World Meteorological Organization (WMO). The available data time series cover a period of 35-40 years. The majority of the stations have been in operation since 1955.

The Ministry of Rural Development and Food has been operating a large network of agrometeorological stations, some of which have been operating for more than 50 years. In the last years, after a complete refurbishment, 40 of these stations are operating under the supervision of the Department for Agricultural Research of the Ministry, and provide a full and continuous set of data, which are collected and stored centrally. Another 120 agrometeorological stations are operated by three different Departments of the Ministry (80 of them by the Department of Plant Protection with the rest divided between the Departments of Forests and Land Reclamation). Measurements are taken automatically every minute and averages are recorded every hour (except for precipitation which is recorded every 10 minutes in order to capture intensity).

The Institute of Mediterranean Forestry Ecosystems and Forestry Products Technology, part of the National Agricultural Research Foundation (NAGREF), operates a network of 21 additional agrometeorological stations since 1960, which was refurbished in 1994 so as to become fully automated. The stations cover mostly forest areas, while the data are fed into a database of meteorological information that covers a period of 40 years.

The National Observatory of Athens (NOA) also operates two 1st class meteorological stations in Athens (in Thessio since 1842 and Penteli since 1998). These stations measure, on a continuous basis, air temperature, barometric pressure, rainfall, relative humidity, wind direction and velocity, along with a full set of solar radiation parameters. The availability of data time series varies from 10 to 50 years in relation to the respective station and measured parameter. Since early 2006, NOA has started the installation of automated meteorological stations along the country. Till September 2008, 79 stations have been installed, 65 of which belong to NOA. These stations measure and record every 10 minutes temperature, relative humidity, pressure, rainfall, wind direction and velocity.

A number of national research centers, namely the National Centre for Research in Physical Scientific Research 'Demokritos', the Centre of Renewable Energy Sources (CRES) and universities (National Technical University of Athens, Universities of Athens and Thessaloniki), also operate meteorological stations. The time series of these stations vary in length from a few years to a few decades, and their data are widely available:

- National Centre of Scientific Research "DEMOKRITOS" operates two meteorological stations, one of which measures aerosol parameters.

- In the wider area of Athens (687 km<sup>2</sup>), 10 fully automatic telemetric hydrometeorological stations are installed and already operating in the framework of the METEONET network. This network was developed by members of the Laboratory of Hydrology and Water Resources Management of the National Technical University of Athens (School of Civil Engineering). The measurements performed by the METEONET network concern air temperature and precipitation, wind speed and direction and surface radiation, whereas the Zografou station performs also measurements of air pressure and water vapour. All data measurements are publicly available at the webpage of the METEONET project (<http://meteonet.chi.civil.ntua.gr/en/divs.html>). The data are collected every ten minutes and updated (in the webpage) every 8 hours on a daily basis. Historical data, concerning the period of operation of each station (2005-now) are available on demand. These data are not provided to any international data centre and are used for national purposes only at the moment.

The Ministry of Rural Development and Food and the Ministry for the Environment, Physical Planning and Public Works operate a large network of rain gages and snow gages. The network consists of more than 250 rain gages and 1000 snow tables.

### **Measurements of atmospheric electricity discharges**

The National Observatory of Athens (NOA) has been operating a network of stations aimed at detecting lightning strikes. The network consists of 6 recording stations, located in the UK, Denmark, Romania, Italy, Cyprus, Portugal and Greece. It has been in operation (detection and recording) since 2005, covering a major part of Europe, whole Mediterranean Sea area and part of northern Africa. The lightning-strike data provide real-time information regarding the location of thunder cells and severe rainstorm activity. This is crucial information for predicting floods and providing more accurate local forecasts. This information is provided to the meteorological community via the Internet ([www.noa.gr/forecast/lightning.gif](http://www.noa.gr/forecast/lightning.gif)).

### **Meteorological RADAR**

HNMS has a network of meteorological radars

- 4 C-band Doppler
- 2 C-band Doppler / dual polarization
- 2 S-band Doppler

The above-mentioned network is fully automated, covers the major part of the territory of Greece (limited coverage of south west area), carries out two kinds of scanning (short range: 150km and long range: 300km), with a frequency of 15 min. The network is to operate in full scale as from October 2008.

Moreover, NOA operates a mobile X-band / dual polarization meteorological radar. This radar is used for research purposes.

## Wind Measurements

The Centre of Renewable Energy Sources (CRES) and several companies have established and operate wind measurement masts, usually of 30m height, for the collection of data to estimate wind energy potential and identify possible locations for the establishment of wind parks. The number of masts varies with the needs of possible wind park developers. The number of stations that are in operation are 55. Data collected, apart from the ones collected by CRES, are not available free of charge.

## Ozone and UV-radiation measurements

The Universities of Thessaloniki and Athens have been monitoring the total (column) ozone amount at two locations on a continuous basis for more than 30 years. Since 2005 total ozone is derived also at the 9 stations of UVNET (described in this section) from multifilter radiometer data.

The University of Thessaloniki-Laboratory of Atmospheric Physics hosts the World Ozone Mapping Center, which utilizes measurements from the 90 stations of WMO Global Ozone System (part of GAW) and of TOMS (Total Ozone Mapping Spectrometer) to generate and archive global maps of total ozone column (<http://lap.physics.auth.gr/ozonemaps/>). Furthermore, the Institute of Mediterranean Forestry Ecosystems and Forestry Products Technology of NAGREF, also measures (since April 2000) average monthly ozone concentration in 3 forest areas (in Vatada near the town of Amfilohia at 350 m height, St Nicolas in the Evrytania province at 1120 m height and on Ossa mountain at 740 m height).

At the station of Thessaloniki (AUTH-LAP) solar UV radiation is monitored since the beginning of the 1990s with 2 spectroradiometers providing spectral irradiance measurements several times during the day. The UV-A, erythemal irradiance (UV-B) and total solar radiation are measured continuously since 1981, 1991 and 1993 respectively.

However, since 2004 a team effort coordinated by the Atmospheric Physics Laboratory of the **Aristotle University of Thessaloniki (AUTH)** resulted in the establishment of the **National Network for Monitoring of Solar UV Solar Radiation, UVNET** ([www.uvnet.gr](http://www.uvnet.gr)), that aims at the long-term monitoring of solar ultraviolet radiation over Greece and Cyprus, with the following goals:

- Studying of the effects of UV exposure on human beings and the ecosystem, as well as the short-term forecast of UV radiation levels.
- The awareness of the public concerning their protection from the biological effects from their exposure to ultraviolet radiation.
- Providing of continuous and reliable information to all relevant public organizations, national or international organizations, health services and also to any citizen for the actual level and the possible effects from the exposure to the biologically effective UV rays of the sun.

In the framework of this network, 9 stations have been installed at Thessaloniki, Mytilene, Ioannina, Athens, Patras, Heraklion, Nicosia, Rhodes and Xanthi using state



of the art instrumentation and technology for obtaining the measurements and the dissemination and exploitation of the results.

The instruments that are used are the NILU-UV multi-filter radiometers, which measure solar irradiance at 5 narrow bands in the UVB (280-315 nm) and UVA (315-400 nm), and the Photosynthetically Active Radiation (PAR, 400-700 nm). The instruments are connected on-line with a central data base maintained at AUTH, enabling immediate recording and display of the measurements. Based on appropriate methodologies and software the following products are derived from the network measurements:

- The solar spectral irradiance at specific wavelengths (305, 312, 320, 340 and 380 nm)
- The total column of ozone.
- The transmittance of the atmosphere in the UV and visible part of the spectrum
- The cloud optical depth
- The photolysis rates of ozone, nitrogen dioxide and formaldehyde
- The UV-B and UV-A irradiance and the PAR
- Biologically relevant doses related to the influence of UV radiation to humans and plants.

In collaboration with the Team of Atmospheric Models and Weather Forecast of the **University of Athens** and the National Centre of Protection of the Environment in U.S.A. (NCEP), forecasts of the UV index are provided for Greece and Cyprus.

Since 2006, aerosol optical properties are monitored with a Cimel sunphotometer which is part of the AERONET. Finally, LAP operates broadband radiometers for the measurement of UV-B, UV-A and total solar radiation since the beginning of 1990s.

The National Observatory of Athens' station in Thessio (Athens) measure UV total since 1989, UV-B since 1995 and total solar radiation components since 1989, 1995 and 1953, respectively.

### **Ground level air pollutants**

The Ministry for the Environment, Physical Planning and Public Works operates local networks for monitoring air pollution in the major urban areas of Greece. In the greater Athens area, the network consists of 19 stations that measure air pollutants of which 16 measure ground level ozone and 12 also measure standard meteorological parameters). The greater Thessalonica area network consists of 8 stations, 7 of which measure ozone. Eight additional stations, all of which measure ozone, are located in other cities. The data are available to the public through the National Environmental Data Center of Ministry for the Environment, Physical Planning and Public Works and through the European Environmental Agency.

In addition, the Public Power Corporation of Greece operates 30 air quality stations (+2 which are under construction) near its power plants that monitor air pollutants (SO<sub>2</sub>, NO<sub>x</sub>, PM<sub>10</sub> and O<sub>3</sub>) and meteorological parameters (wind direction and velocity, temperature and relative humidity). All stations are automated, operating continuously. Data are gathered and kept in a centralised database.

Details about on the contribution of Greece in international systems and networks are presented in tables 1a, 1b and 1c. The abbreviations in brackets next to the number of stations correspond to the organization that operates the respective station(s). Thus, HNMS stands for Hellenic National Meteorological Service, NTUA for National Technical University of Athens, NOA for National Observatory of Athens, NCSR for National Centre of Scientific Research "DEMOKRITOS", NAGREF for National Agricultural Research Foundation, HNMS Hellenic National Meteorological Service.

### **Satellite observations**

Greece is a member of the European organization for the exploitation of Meteorological Satellites (EUMETSAT), the consortium that operates the meteorological observation satellite METEOSAT, and is represented in EUMETSAT by HNMS. For more details it is recommended to visit the EUMETSAT home page (<http://www.eumetsat.int>). It should be noted that EUMETSAT has a decentralised network of Satellite Application Facilities (SAFs) for the generation of products from EUMETSAT satellite data.

In addition, Greece is a member of ESA and participates in basic, as well as in optional, research projects. Greece also participates in three actions of the Global Monitoring for Environment and Stability (GMES) program of ESA. The first one concerns the monitoring of the Eastern Mediterranean Sea through satellites ERS-2, ENVISAT and RADARSAT-2, for the timely tracking of oil spills from ships, the second one, ICAROS-NET, the measurement and monitoring of air pollution and mostly of particulate matters and the third one the estimation of forest land change and of forest carbon reserves (GMS-Forest Monitoring).

**Table 1a. National contribution to the surface-based atmospheric essential climate variables**

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	4 (HNMS)	4 (HNMS)	4 (HNMS)	4 (HNMS)	4 (HNMS)
	Precipitation	4 (HNMS)	4 (HNMS)	4 (HNMS)	4 (HNMS)	4 (HNMS)
<b>Full World Weather Watch/Global Observing System (WWW/GCOS) surface network</b>	Air temperature, air pressure, wind speed and direction, water vapour	66 (HNMS) 10 (NTUA), 2 (NCSR) 6 (NAGREF) 1 (NOA)	66 (HNMS) 10 (NTUA)	66 (HNMS) 10 (NTUA) 2(NCSR) 1 (NOA)	49 (HNMS)	49 (HNMS) 1 (NOA)
	Precipitation	66 (HNMS) 10 (NTUA) 5 (NAGREF) 1 (NOA)	66 (HNMS) 10 (NTUA)	66 (HNMS) 10 (NTUA) 1 (NOA)	49 (HNMS)	49 (HNMS) 1 (NOA)
<b>Baseline Surface Radiation Network (BSRN)</b>	Surface radiation					
<b>Solar radiation and radiation balance data</b>	Surface radiation	10 (NTUA) 1 (AUTH) 1 (NOA) 5 (NAGREF)	10 (NTUA) 1 (AUTH)	10 (NTUA) 1 (AUTH) 1 (NOA)	1 (AUTH)	1 (AUTH) 1 (NOA)
<b>Ocean drifting buoys</b>	Air temperature, air pressure					
<b>Moored buoys</b>	Air temperature, air pressure	10 (HCMR)	10 (HCMR)	11 (HCMR)	10 (HCMR)	10 (HCMR)
<b>Voluntary observing ship climate project</b>	Air temperature, air pressure,					

<b>Contributing networks specified in the GCOS implementation plan</b>	<b>ECVs</b>	<b>Number of stations or platforms currently operating</b>	<b>Number of stations or platforms operating in accordance with the GCMPs</b>	<b>Number of stations or platforms expected to be operating in 2010</b>	<b>Number of stations or platforms providing data to the international data centres</b>	<b>Number of stations or platforms with complete historical record available in international data centres</b>
<b>(VOSclim)</b>	wind speed and direction, water vapour					
<b>Ocean Reference Mooring Network and sites on small isolated islands</b>	Air temperature, wind speed and direction, air pressure					
	Precipitation					

**Table 1b. National contribution to the upper-air atmospheric essential climate variables**

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 Upper Air Network (GUAN)	Upper-air-temperature, upper-air wind speed and direction, upper-air water vapour					
Full WWW/GOS Upper Air Network	Upper-air-temperature, upper-air wind speed and direction, upper-air water vapour	3 (HNMS)	3 (HNMS)	3 (HNMS)	3 (HNMS)	3 (HNMS)

**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 organization/Global Atmosphere Watch (WMO/GAW) Global Atmospheric CO <sub>2</sub> and CH <sub>4</sub> Monitoring Network	Carbon dioxide					
	Methane	1 (NOA)		1 (NOA)		
	Other greenhouse gases	1 (NOA)		1 (NOA)		
WMO/GAW ozone sonde network	Ozone					
WMO/GAW column ozone network	Ozone	1 (AUTH) 1 (NTUA)	1 (AUTH) 1 (NTUA)	1 (AUTH) 1 (NTUA)	1 (AUTH) 1 (NTUA)	1 (AUTH) 1 (NTUA)
WMO/GAW Aerosol Network	Aerosol optical depth	1 (AUTH)	1 (AUTH)	1 (AUTH)	1 (AUTH)	
	Other aerosol properties	1(NCSR) 1 (AUTH)	1 (AUTH)	1(NCSR) 1 (AUTH)	1(NCSR) 1 (AUTH)	
EARLINET-ASOS Aerosol Network	Aerosol optical depth	2 (NTUA)		3 (NTUA)	2 (NTUA)	
	Other aerosol properties	2 (NTUA)		3 (NTUA)	2 (NTUA)	

### 3. Oceanic essential climate variables

#### Overview

The main institutions that contribute to the national oceanic observations are the **Hellenic Centre for Marine Research (HCMR, <http://www.hcmr.gr/>)** and the **Hellenic Navy Hydrographic Service (HNHS, <http://www.hnhs.gr/en/enindex.htm>)**.

#### Hellenic Centre for Marine Research (HCMR)

The Hellenic Centre for Marine Research (HCMR) was set up as a single institution in order to integrate government-funded marine science research in Greece. Formally established by government decree on June 3 2003, it combines the former research institutes NCMR and IMBC, together with their respective field stations.

Its present structure consists of five institutes, which carry out research into specific thematic areas.

- Institute of Oceanography
- Institute of Aquaculture
- Institute of Marine Biological Resources
- Institute of Inland Waters
- Institute of Marine Biology and Genetics

It enjoys top-level scientific support from its two research vessels, the RV AEGAEON and RV PHILIA, its state-of-the-art 2-man submersible THETIS as well as two deepwater ROVs, named the MAX ROVER and the SUPER ACHILLES.

The global scientific community can also access the HCMR Journal of Mediterranean Marine Science, HCMR publications, Collected Reprints abstracts, and data-rich projects such as HNODC, IASON and ELNAIS.

The HCMR is a member of the European Global Ocean Observing System (EuroGOOS). In the previous years the HCMR has participated in the following operational oceanography R&D projects:

- **MFSPP** (1998-2001): Development of multiparametric M3A station, VOS Measurements, High resolution regional and coastal models
- **MFSTEP** (2002-2004): Consolidation of MFS observing system
- **MARSAIS** (2001-2003): Synergy between SAR and buoy data, Validation of Algorithms, Detection and forecasting of oil-spills
- **FerryBox** (2002-2005): Implementation of a European network for FerryBox measurements, Operational phase: 2002-2003
- **MAMA** (2002-2004): Coordination on Mediterranean Scale, Capacity building
- **MERSEA\_S1** (2003-2004): GMES Initial phase
- **ROSES** (2003-2004): ESA GSE

- **EPAN/ESPEN** (2003-2005): Improved wave monitoring and forecasting products – oil spill risk assessment
- **MERSEA-IP** (2004-2008): Global monitoring and forecasting. HCMR: Coordination of Mediterranean Observations, M3A system
- **MARCOAST** (2005-2008): ESA GMES service network

The following paragraphs include some information over the projects currently run by the HCMR, concerning the observation of ECVs.

### **The TELEFOS project**

**TELEFOS** (Telephonic monitored drifters for ecological studies) is a state of the art system for measuring currents and calculating dispersion (e.g. pollutants) in the near surface waters. Its concept is based on a new design on an old idea, i.e. of using drifters to monitor the circulation in aquatic bodies.

The system consists of a monitoring station (which may be placed either on land or aboard the deployment/retrieval vessel), and the drifter fleet. The drifters' positioning exploits the highly accurate GPS system.

By 2010 five drifting buoy arrays are going to be used for the observation of position-change-based currents, under the context of the above described project (TELEFOS). These arrays have already finished their pilot implementation, and will be used for the observation of waste dispersion (0-50m).

### **The POSEIDON System**

The main monitoring, forecasting and information system is the **POSEIDON System**, developed by HCMR. By establishing a network of observation buoys and the creation of a specialized operational centre for the processing of the data collected and the production of forecasts, POSEIDON system is an infrastructure at the leading edge of modern oceanography in Europe.

The network of observation buoys records continuously the physical, biological and chemical parameters of the Greek seas. These data are then transmitted to the operational center where they are sorted and fed into forecasting models. The ten stations providing atmospheric and sea data are presented in table 3.1. The observation buoys are equipped with sensors that monitor:

- Air-pressure
- Air-temperature
- Wind speed and direction
- Wave height, period and direction
- Sea surface salinity and temperature
- Surface current speed and direction
- Sea surface dissolved oxygen
- Light attenuation with fluorescence





- Salinity and temperature in depths 0-50 m
- Chlorophyll-A
- Nutrients
- Radioactivity

All the stations report data on air temperature and pressure, wind speed (mean and gust) and direction, as well as sea surface temperature, waves (significant and maximum height, direction) and current (speed and direction) data. These data are online available in the POSEIDON webpage (<http://www.poseidon.hcmr.gr/>) either as time series graphs or as text based format for the latest transmission.

Currently, there are five buoys (located in Athos, Lesvos, Mykonos, Santorini and Kalamata) capable to measure standard atmospheric and marine parameters up to 50 meters depth and two buoys equipped with extra sensors for recording a number of parameters up to 1000 meters depth. These multi-sensor buoys are located in Cretan Sea (E1M3A) and in Ionian Sea (close to Strofades island).

Concerning the future of the Poseidon system, among the main goals of POSEIDON-II project (2005-2008), which is funded by EFTA (75%) and Hellenic Ministry of National Economy (25%), are the following:

- The complete upgrade of the existing buoys with next generation atmospheric and oceanographic sensors and state of the art communication devices
- The extension of the network coverage to the Ionian Sea.

#### Location of the buoys network of the POSEIDON System

Name/Location
SE of mount Athos
Lesvos
Skyros
Saronikos
Mykonos
Santorini
Kalamata
Cretan sea (E1M3A)
Pylos
Zakynthos

## **Participation in the Euro-Argo Network**

The HCMR has already submitted to the Ministry of Development the proposal and detailed implementation plan for the participation of Greece in the European component of the global ARGO network.

The EURO-ARGO network will constitute an important asset of the ARGO network. The ARGO network is a global network of autonomous instruments-drifting buoys-which can continuously measure, throughout their lifetime, important variables that characterize the ocean (column distribution of temperature, salinity, oxygen etc.) and report it, using satellite connections, to data gathering and processing centres.

The expected benefits in scientific and socioeconomic level include:

- Use of measurements for scientific purposes (climate research)
- Data use for the operational oceanography in Greece (POSEIDON system), taking into consideration that these data also concern the Ionian sea. In any case, ARGO data will be systematically used (via the system for the assimilation of observation data) by the forecasting model for the Mediterranean Sea (which is part of the POSEIDON system).
- Participation in the global/European programme concerning continuous observation of the ocean.
- Participation in the decision making processes regarding the identification of the European strategy for measurements (esp. the locations covered).

The Greek team has not participated yet in the Argo network, in opposition to other countries that have an active role in the global buoy network. Greece, Bulgaria, Portugal and Poland are the newly-entered Parties in the measuring network and will focus on examining the possibility of continuous financing for their participation in the EURO-ARGO. More specifically the Greek team will:

- examine the structural and legal structure of the EURO-ARGO (in cooperation with the other teams)
- investigate the possibility of long-term national financing for the Greek participation
- co-operate with the other teams for the configuration of the final implementation plan for the EURO-ARGO network.

## **Voluntary Observation Ships**

As regards to voluntary observing ships, in general there are 18 ships cooperating with the HCMR, although their use is not organized on a regular basis. These ships cooperate with HCMR under the context of various programs. However, in the present there is no such program running.

### **The Hellenic Navy Hydrographic Service**

The mission of the Hydrography and Operations Division of the Hellenic Navy Hydrographic Service is to implement measurements in the field, bottom research and data processing, in order to impress the seabed and all its natural or artificial objects. More specifically the Division:

- Plans and executes hydrographic surveys, geodetic and topographic projects that are required for the compilation and updating of nautical charts, special nautical charts, sailing instructions for the hellenic waters, list of lighthouses and other publications.
- Executes hydrographic surveys, geodetic and topographic campaigns that are necessary to meet the demands of the Hellenic Navy, as well as of public and private companies for the compilation of bathymetric sheets and studies.
- Installs, controls and maintains the network of tide gauge stations measuring the sea level changes.
- Executes special measurements for the control of arming systems in the Hellenic Navy vessels.
- Elaborates technical specifications and watches the developments in the areas of Hydrography /Topology.
- Materialises the operational requirements of various Administrations within the Hellenic Navy.
- Participates in different national and international programs in order to support the growth of geosciences (Geodesy, Hydrography, Topography), such as:
  - 2nd and 4th Seapower Symposium
  - GAVDOS Pilot Program
  - ESEAS Pilot Program

The Hellenic Navy Hydrographic Service maintains a quite dense network of permanent tide gauge stations equipped with instruments for measuring sea surface temperature. In some locations tide data are observed for more than 20 years. Seven out of 22 stations of sea level measurements are equipped with a sensor for measure sea temperature, which permits the possibility of direct and wireless transmission of the measurements.

All the tide gauges have been connected by levelling with tide poles which located close to them and frequently supervised by the Service's personnel, cooperating with coast guard or port authorities.

Three stations provide data in the European Sea Level Service, whereas all 22 stations report completed historical data in the Permanent Service of Mean Sea Level.

### National Contribution

In tables 3.1 to 3.3 the total national contribution to oceanic essential climate variables are reported. The climate of Greece does not justify the participation in some networks (ie global tropical moored buoy network). In this case the relevant cells are shaded grey.

**Table 3a. National Contributions to oceanic essential climate variables - 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
Global surface drifting buoy array on 5x5 degree resolution	Sea surface temperature, sea level pressure, position-change-based current	0	N.A.	5	0	0
GLOSS Core sea-level framework	Sea level	22	N.A.	22	3	22
Voluntary observing ships (VOS)	All feasible surface ECVs	25	N.A.	25	0	0
Ship of opportunity programme	All feasible surface ECVs	0	N.A.	1	0	0

N.A. not available.

**Table 3b. National contributions to the oceanic essential climate variables – 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
Global reference mooring network	All feasible surface and subsurface ECVs	10	10	11	10	10
Global tropical moored buoy network	All feasible surface and subsurface ECVs					
Argo network	Temperature, salinity, current					
Carbon inventory survey lines	Temperature, salinity, ocean tracers, biochemistry variables					

### Satellite observations

Using information gathered by the HCMR, and the Hellenic National Meteorological Service, the global products that require satellite observations and are being currently developed are presented in Table 3.4.

Moreover, the launching of a satellite by 2010 is expected to improve data collection.

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

ECVs/ Global products requiring satellite observations	Fundamental climate data records required for Product generation (from pas, current and future missions)
<b>Sea Level</b> Sea level and variability of its global mean	Altimetry
<b>Sea Surface Temperature</b> Sea surface temperature: assessment of spatial and temporal variability. Use of SST products (Sea Surface Temperature) in the EUMETCAST context of the EUMETSAT organization. For wave height and other sea level measurements, products of satellites JASON 1 & 2 are being used in the context EUMETCAST context of the EUMETSAT organization.	Single and multi-view IR and microwave imagery
<b>Ocean color</b> Examination of the patterns of ocean color (i.e. light intensity) and oceanic chlorophyll-a concentration derived from several sensors (Sea WiFS, MODIS)	Multi-spectral VIS imagery
<b>Ocean salinity</b> Research towards the measurement of changes in sea surface salinity	Microwave radiance

### Actions taken in response of the recommended actions in the GCOS implementation plan

1. Including sea level objectives in the capacity-building programmes of GOOS, JCOMM, WMO, other related bodies and the system-improvement programme of GCOS: The possibility of including sea level objectives on the gathering of satellite data is under consideration by the HCMR.
2. Implementing a wave measurement component as part of the Surface Reference Mooring Network: The observation buoys of the POSEIDON System are equipped with sensors that monitor wave height period and direction. The offshore wave forecasting model of POSEIDON system uses the outputs of the weather and circulation models to produce 72 hours prediction of wave conditions in the

Aegean Sea. The wave forecast consist from the following parameters:

- Significant wave height
- Mean wave direction
- Mean wave period

3. Developing capability for systematic measurement of biochemical and ecological ECVs
4. Supporting data rescue projects and implementing regional, specialized and global data and analysis centres: The Hellenic National Oceanographic Data Centre (HNODC) was established in 1986, as part of the Hellenic Centre for Marine Research (HCMR). It operates as a National Agency and is responsible for processing, archiving and distributing marine data. HNODC is also developing techniques for oceanographic data processing and data base maintenance. Furthermore it promotes the International Exchange of Data in the frame of its cooperation with the "Intergovernmental Oceanographic Commission (IOC) of UNESCO as it is responsible for the coordination of International Data Exchange (IODE) in Greece. HNODC runs many projects and European activities. Further information on these projects can be found in the webpage <http://hnodc.hcmr.gr/projects.html>.

## **4. Terrestrial Observations**

### **Overview**

The main institutions that contribute to the national terrestrial observations are the Ministry of Environment, Planning & Public Works, the National Technical University of Athens, the Public Power Corporation, the Institute of Geology and Mineral Exploration and the National Agricultural Research Foundation.

### **Observation System on quantity/quality of surface water**

An effort for gathering all available meteorological and hydrological data in one database is the project of the National Data Bank of Hydrological & Meteorological which was assigned to the National Technical University of Athens by the Ministry of Environment, Planning & Public Works. This project provides the required infrastructure for the implementation of the E.U. Water Framework Directive for the protection, rational management and exploitation of the water resources in the national level.

The core of the project is the development of a Data Bank which will contain the total amount of hydrometeorological and hydrogeological data covering the whole country. The data are acquired from 2500 stations which are distributed in Greece and are placed by the participating organisations:

- The Ministry of Environment, Planning and Public Works
- The National Meteorological Service
- The Public Power Corporation
- The Ministry of Rural Development and Food
- The Ministry of Development
- The National Observatory of Athens

Various software applications are linked to the central Database of the project supporting the analysis and synthesis of the data and the elaboration of secondary information. The distributed form of the database allows a continuous online operation and exchange of data between the participating organisations.

Furthermore, the Ministry of Rural Development and Food and the Ministry for the Environment, Physical Planning and Public Works, PPC and NAGREF operate an extended network of rainfall and snowfall gages. The network consists of more than 250 rain gages and more than 1000 tables to measure the height of snow. Furthermore, the Institute of Geology and Mineral Exploration (IGME) operates a large network of surface and ground water measurements.



Among these stations, only 47 hydrometric stations, supervised by PPC, meet international specifications so as to be able to contribute quality controlled data to the corresponding databases. The Ministry of Rural Development and Food also operates 220 stations for the measurement of surface water quantities. Of those, 120 (90 of which for river-stream flows and 30 for river water quality) operate during the whole year producing monthly measurements, and the rest operate only during the irrigation period. IGME has established a network of 27 stations (monitoring frequency one time per ten years as geological services of Greece proposed) for the observation of the quality of surface water as far as its chemical composition.

Finally, groundwater quality and quantity measurements are carried out by the Ministry of Rural Development and Food (250 stations mostly in rural areas, such as Thessalia, and by IGME (approximately 505 stations, which are placed in wells, springs and bores in 14 different areas with frequency monitoring 4 times per year). Several stations among them measure parameters related to water pollution such as ammonia, nitric and pH, mostly caused by agricultural activities.

### **Observation System on quantity/quality of ground**

IGME in corporation with the other Geological Institutes of Europe ([www.eurogeosurveys.org](http://www.eurogeosurveys.org)) have prepared the «Geochemical Atlas of Europe» using the Global Geochemical Baselines (a program of International Union of Geological Sciences, IUGS, and International Association of GeoChemistry, IAGC). In the framework of this program, the following stations operate in Greece:

- 41 stations for the observation of residual soil
- 41 stations for the observation of floodplain sediments or alluvial soil of large catchment areas.
- 41 stations for the observation of overbank sediments or alluvial soil of small catchment areas.

Moreover, NAGREF operates three stations for the observation of ground temperature in two depths and another one is going to be established. The data from these stations are provided to the respective European Union services.

### **Forest ecosystem health observation**

In the scope of the country's participation in the International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests, (ICP Forests) and the European Union Scheme for the Protection of Forests against Atmospheric Pollution, the Institute of Mediterranean Forestry Ecosystems and Forestry Products Technology of NAGREF has established in 1988 and operates since 91 observation stations of Level I and 7 of Level II. Of the 91 Level I stations, 75 have been placed in high canopy forests and in 16 in maquis areas to provide information on tree conditions. The Level II stations have been placed (4 in 1994 and 3 in 2004) in forest ecosystems of typical terrestrial and geological types aiming at the study of the relations between the ecological and physical parameters (meteorological characteristics, vegetation, soil, plant nutrition and air pollution) as they affect forest development.

### **CO2 flux measurements**

A station for CO2 vertical flux measurements has been established and operated for a number of years in Kalamata by NAGREF, in the frame of the research project MEDFLUX of the European Commission.

### **National Contribution**

In Table 5 the national contribution to the terrestrial domain essential climate variables is reported.

### **Satellite observations**

Greece is a member of ESA and participates in basic, as well as in optional, research projects. Greece also participates in three actions of the Global Monitoring for Environment and Stability (GMES) program of ESA. In the framework of this program estimation of forest land change and of forest carbon reserves (GMS-Forest Monitoring) is performed.

**Table 5. National contributions to the terrestrial domain essential climate variables**

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					
GCOS Baseline Lake Level/Area/Temperature Network (GTN-L)	Lake level/area/temperature					
WWW/GOS synoptic network	Snow cover					
GCOS glacier monitoring network (GTN-G)	Glaciers mass balance and length, also ice sheet mass					
GCOS permafrost monitoring network (GTN-P)	Permafrost borehole temperatures and active layer thickness					
Global Terrestrial Network – Hydrology (GTN-H)	Available data from existing global hydrological observation networks	3	3	3	3	3

## **ANNEX I**

### **Acronyms**

**ASAP** Automated Shipboard Aerological Programme  
**CLIPS** Climate Information and Prediction Services  
**CRES** Center of Renewable Energy Sources  
**EDMEP** European Directory of Marine Environmental Data  
**ECMWF** European Centre for Medium-range Weather Forecast  
**EUMETSAT** EUropean Organization for the exploitation of METeorological SATellites  
**ESA** European Space Agency  
**FLUXNET** Global Terrestrial Network – Carbon  
**FRST** Foundation for Research, Science and Technology  
**GAW** Global Atmosphere Watch of WMO  
**GCOS** Global Climate Observing System  
**GMES** Global Monitoring of Environment and Security  
**GMS** Geostationary Meteorological Satellite  
**GOOS** Global Ocean Observing System  
**GSN** GCOS Surface Network  
**GSRT** General Secretariat for Research and Technology  
**GTN-G** Global Terrestrial Network – Glaciers  
**GTN-L** Global Terrestrial Network – Lakes  
**GTN-P** Global Terrestrial Network – Permafrost  
**GTN-R** Global Terrestrial Network – Rivers  
**GTOS** Global Terrestrial Observation System  
**GUAN** GCOS Upper Air Network  
**HCMR** Hellenic Centre for Marine Research  
**HNHS** Hellenic Navy Hydrographic Service  
**HNMS** Hellenic National Meteorological Service  
**HNODC** Hellenic National Oceanographic Data Center  
**IGME** Institute of Geology and Mineral Exploration  
**IOC** Intergovernmental Oceanographic Commission of UNESCO  
**LCDB** Land Cover Data Base  
**LTER** Long Term Ecological Research  
**MAMA** Mediterranean network to Assess and upgrade Monitoring and forecasting Activity  
**MEDATLAS** Mediterranean Hydrographic Atlas  
**MedGOOS** Ocean Observing System for the Mediterranean  
**MEPPPW** Ministry for the Environment, Physical Planning and Public Works  
**MFSPP** Mediterranean Forecasting System Pilot Project  
**MFSTEP** Mediterranean Forecasting Systems Towards Environmental Predictions  
**NAGREF** National Agricultural Research Foundation  
**NOA** National Observatory of Athens  
**NOAA** National Oceanographic and Atmospheric Agency (USA)  
**NSA** NIWA SST Archive  
**NCSR** National Centre of Scientific Research "DEMOKRITOS"  
**NTUA** National Technical University of Athens  
**NVS** National Vegetation System

**PPC** Public Power Corporation

**SFC** Surface

**SOOP** Ship of Opportunity Programme

**SST** Sea Surface Temperature

**Sub-SFC** Sub-surface

**TIROS** Television Infrared Observation Satellite

**TOMS** Total Ozone Mapping Spectrometer

**UNEP** United Nations Environment Programme

**UNESCO** United Nations Educational, Scientific and Cultural Organization

**VOS** Volunteer Observing Ship

**WCRP** World Climate Research Programme

**WHYCOS** World Hydrological Cycle Observing System

**WMO** World Meteorological Organization

**WWW** World Weather Watch of WMO