

PORTUGAL

**SECÇÃO PORTUGUESA DAS UNIÕES INTERNACIONAIS
ASTRONÓMICA E GEODÉSICA E GEOFÍSICA
(SPUIAGG)**

**INTERNATIONAL ASSOCIATION OF
METEOROLOGICAL AND ATMOSPHERIC SCIENCES
IAMAS**

NATIONAL REPORT

1999 – 2002

**PRESENTED TO THE XXIII GENERAL ASSEMBLY
OF THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS**

HOLD AT SAPPORO, 30 JUNE – 11 JULY 2003

Coordinated by

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1 - INTRODUCTION

The Portuguese report to IAMAS concerning 1999-2002, to be submitted during the XXIII General Assembly of IGGU (Sapporo, 30 June-11 July 2003) is composed of the contributions from the national institutions that have developed most activity in the different areas of meteorology and its applications.

The oldest weather observations in Portugal, carried out with continuity for a reasonable period, the results of which have been published, are those carried out in Lisbon by Jacob Crisóstomo Pretorius, also known as Jacques Pretorius, from 1777 to 1785. They were published in 4 volumes of «Almanach de Lisboa» (1782 to 1786), Man No. 352/17, Mem. Mat. Biblioteca de Ciências de Lisboa. They were followed by those carried out by Marino Franzini in the periods 1816-1825 and 1835-1855.

D. Joaquim de Assunção Velho, professor of Physics and Mathematics at «Real Colégio dos Nobres», carried out meteorological observations at Mafra from 1783 to 1786 and the results were published in «Memórias de Matemática e Física da Academia das Ciências de Lisboa», Tome I (from 1780 to 1788; 1st Series) and Tome II (from 1789 to 1790; 1st Series).

In Oporto, José Bento Lopes, medicine doctor and correspondent of «Real Academia das Ciências de Lisboa», carried out medical and weather observations in 1792, their results having been published in «Anno Medico».

On 21 July 1853 «Escola Politécnica» decided to have a meteorological observatory built near the fence of the school. It was then named the decree nominating Dr. Guilherme Pegado, professor of Physics, stated: «to direct the marine meteorological observations which the government had decided that should be carried out on board of Portuguese war vessels and commercial ships, in accordance with the universal system proposed by Maury».

On becoming central institute of the Portuguese meteorological network in the mainland territory and in the colonies, «Observatório do Infante D. Luis» placed Portugal among the first countries in the world having one State meteorological service superintending as sole entity in the whole national territory and the sea. «Observatório do Infante D. Luis» began to collaborate in the service of international meteorology in 1857, as soon as Lisbon was linked to Paris by electric telegraph and the received warnings were published by the press daily. In 1864, «Boletim Internacional» listed over 50 observatories and rainfall stations, among which those in Lisbon, Oporto, Moncorvo, Guarda and Campo Maior.

In April 1864, the director of «Observatório do Infante D. Luis» insisted with the local authorities that meteorological stations should be installed in the Azores and Madeira, « this being very necessary for the service of international meteorology».

This was done by end 1864 and beginning 1865 with the operation of stations at Funchal, Angra and Ponta Delgada. In order that the observations carried out might be used in works of weather forecasting, it was necessary to have a telegraph cable to send them to Lisbon, which only happened in 1874 for Madeira and 1893 for the Azores. At São Vicente (Cape Verde) the observations began to be sent to Lisbon in 1884.

On 1 December 1865 began in Lisbon the «daily service of weather forecast» with the elaboration of a bulletin distributed to the daily newspapers. Corresponding to severe weather warnings, the respective signals were hoisted at the signal-stations of Arsenal da Marinha, Viana do Castelo, Porto/N^a S^a da Luz, Cabo Carvoeiro, Oitavos, Cascais, São Julião, Cabo Espichel and Sagres.

From 1882 onwards, the bulletin became a regular publication of the Observatory, which in 1911 kept meteorological stations at Oporto, Moncorvo, Guarda, Évora, Beja, Lagos, Montalegre, Campo Maior, Serra da Estrela and Funchal.

The Institute for Meteorology is now the national authority responsible for the activities of the Portuguese State in the areas of meteorology, climatology and composition of the atmosphere.

At the Universities of Aveiro, Évora (Geophysical Centre of Évora) the activities are essentially teaching and research. However, some research and services to the community were supplied by these Universities on the period 1999-2002.

2 - INSTITUTE FOR METEOROLOGY

In accordance with the structure of the Institute for Meteorology, the report for the period 1999-2002 will follow the previous report (1995-98) structure, developed in 3 chapters regarding the main areas and activities of meteorology:

- Meteorological Observation and Networks
- Weather Watch
- Climate and Atmospheric Environment.

2.1 - Meteorological Observation and Networks

2.1.1 - Generalities

The actions generally required for the operation of the various networks for surface (meteorological, solar radiation) and upper-air observation have proceeded since 1999 in continuity of the activities in the domain of meteorological watch already in development in IM (Institute for Meteorology) and in the precedent institutions, such as National Meteorological Service (SMN,1946-1977) and National Institute of Meteorology and Geophysics (INMG,1977-1993), in order to ensure an efficient implementation of the observation programmes, as well as the subsequent procedures aiming at the processing, validation and archive of the results of observations.

The programmes of observation and measurement in progress meet the requirements for the IM to fulfill its duties as national and international responsible entity and other commitments freely accepted.

Most of these programmes are included in different national programmes of meteorological watch (information available in real time, useful for weather analysis and forecasting, as well as for meteorological watch and in particular to storm warnings and evolution in space and time of bad weather conditions). These programmes provides a meteorological support to various public, economic and safety activities and climatological aspects and to the study and research with others meteorological watch systems (radar, satellites) or with other kinds of available information.

In order to respond to the present and near future requirements, since 1999 the IM keep developing a considerable effort to increase both the quantity and the quality of the available meteorological information. For these purpose we have to develop and to renovate the actual resources of equipment, to implement new software an finally to automate the flux of meteorological data in accordance with last technologies in these areas.

2.1.2 - Surface Networks

Classical meteorological/climatological network



Classical meteorological/climatological station

The classical surface meteorological/climatological network is composed by the main network with 31 principal climatological stations (25 mainland, including 6 stations of the Portuguese Air Force (FAP); Açores: 9; Madeira: 3); 21 of them are national synoptic stations, 13 are part of the RBSN (Regional Baseline Synoptic Network) of WMO. The ordinary network includes, 80 ordinary climatological stations (Mainland: 67; Açores: 8; Madeira: 5), and a few udometric stations operated by the IM, as wells some 250 udometric stations operated by the 5 Regional Environment Directorates. The main meteorological stations issue Synop reports (meteorological data codified) in real time with national, regional or world wide dissemination, and 12 of them issue and transmit CLIMAT reports (month climatic data) monthly. The operation and maintenance of the meteorological stations is supported the sector which ensures the technical assistance and the repairing and provision of services in calibration of the meteorological instruments.

Surface Automatic Meteorological Network

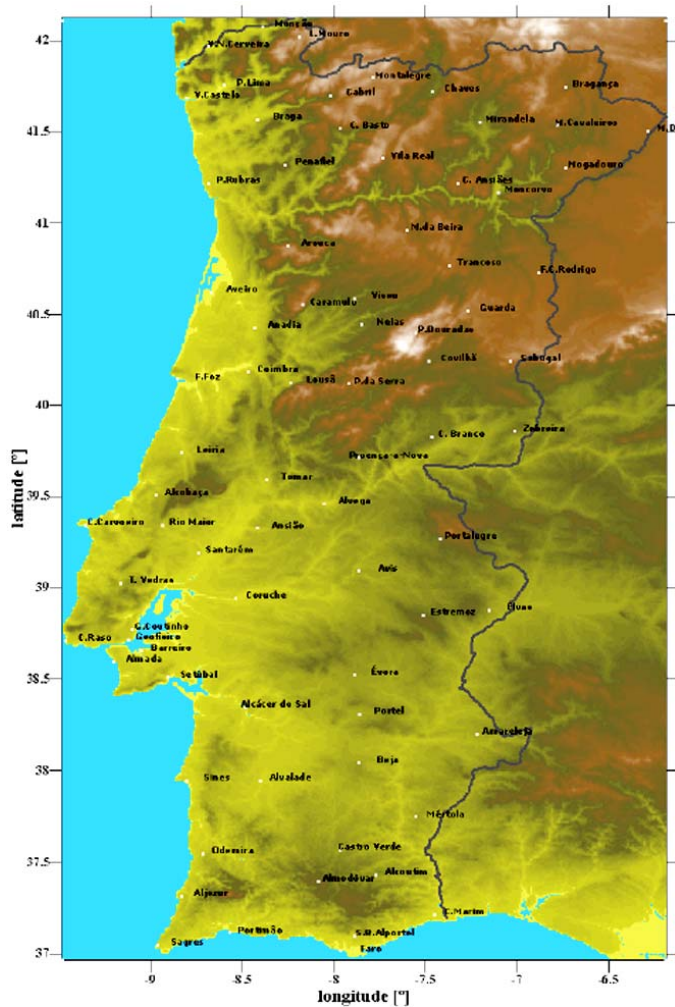
IM concluded the development of a multi-phase project for the installation of a network-system of automatic meteorological stations “EMAs” (Estações Meteorológicas Automáticas) in Portugal Mainland, Açores and Madeira Islands, allowing the modernization of the surface observation network in the Portuguese territory. This system has been in operation and expanding since 1996, allowing for an increasing amount of meteorological/climatologic information to be automatically centralized at IM headquarters.



Automatic station site

With this network-system, the availability of WMO coded SYNOP messages, some of them including the results of visual observations made by professional observers, increased from the traditional three-hour to the hourly reports. Attached to each SYNOP message there are 10 minutes data records also transmitted on an hourly basis by the EMAs stations. The alarms procedures, which allows the EMAs stations to automatically send alarm messages to the national concentrator, every time a defined threshold is exceeded (for wind, precipitation and temperature), has been improved in order to overcome some technical difficulties. This alarms are very important tools for weather watch purposes, in order to help the edition and broadcast of warnings to the authorities and the public.

The installation of the 3rd phase of EMAs stations started in 1999 (10 sites in Mainland), and finished in 2002 with the installation of 9 EMAs on the Islands (5 in Açores and 4 in Madeira). Nowadays, the IM's surface automatic network consists in 93 EMAs stations, 27 of them are type I stations (with pressure sensor and local PC for interaction) and 66 are type II stations. In Portugal Mainland there are 78 EMAs stations (17 type I), in Açores Islands there are 9 EMAs (8 type I) and in Madeira Islands there are 6 EMAs (2 type I). A set of central computers (concentrators) is also part of the network-system, composed by 5 regional centers in Mainland, 1 regional center in Açores and 1 in Madeira, plus 1 national center installed at IM/Lisboa.



Distribution of EMAs on Mainland

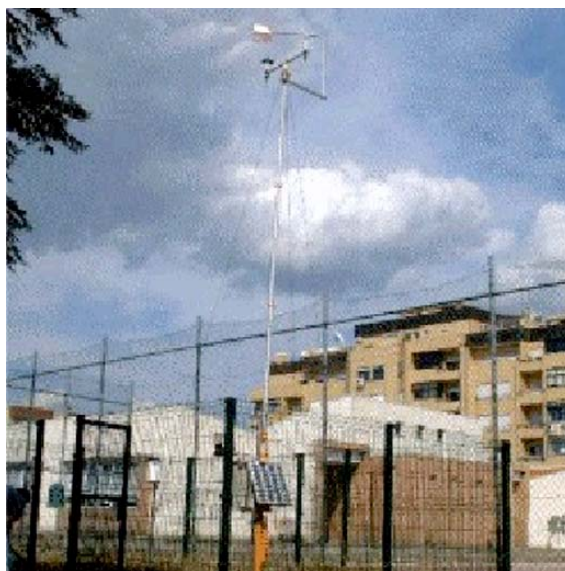
Since 1999 until now, the development of procedures for quality control of data from the EMAs stations continued. The automation of some of those procedures took place in 1999, and in the following years data series analysis have been made in order to develop more detailed data validation algorithms to be implemented in the near future. Since then all data records retrieved from the EMAs is being archived in a new relational database prepared for the 10 minutes records.

Urban Meteorological Stations Network

Over the last decades there has been an increasing growth in urban areas, associated with the growth and development of surrounding industrial plants. This urban growth has a direct impact on local and regional climate conditions, causing them to become substantially different from those in suburban and rural areas. Climate research and investigation in urban areas, as well as validation of climate models, will only be possible with resort to the results of local meteorological observation, and it is essential to have records/meteorological stations available in the major urban centers for that purpose.

Within the scope of PIDDAC project A7, the Institute for Meteorology started the implementation of an Urban Automatic Meteorological Stations Network (UAMSN) in year 2000 which is operational since January 2002. It is composed by 18 Automatic Meteorological Stations (AMS), 5 Regional Concentrators (RC) and 1 National Concentrator (NC). The criterion for the installation of the stations took particularly into account the number of inhabitants of the major urban centers in the country. Therefore, 1 AMS was allotted for each 100,000 in the case of the urban centers of Lisbon and Oporto (more than 100 thousand inhabitants) and 1 AMS in the remaining urban centers in the country more than 50,000 inhabitants).

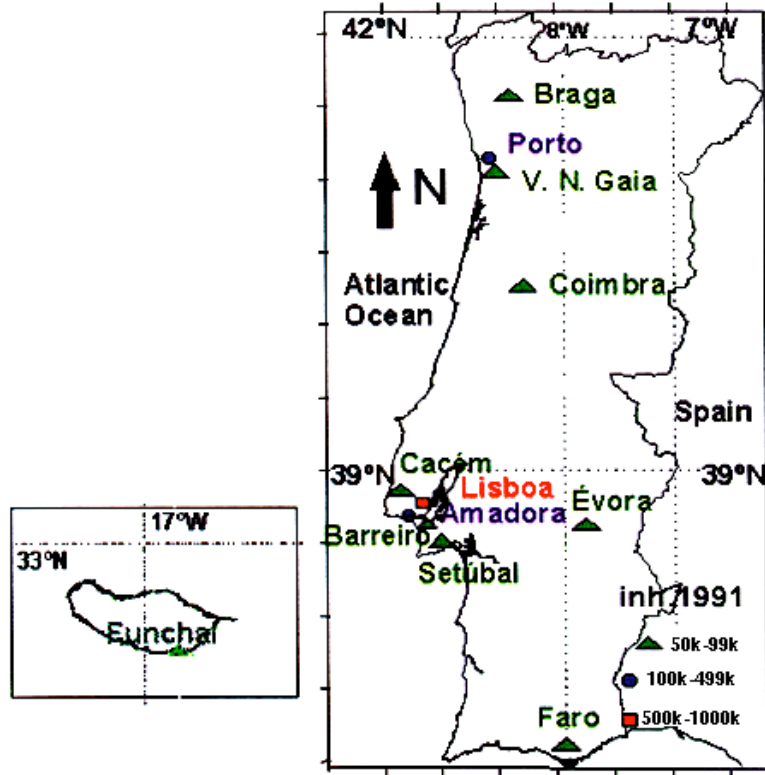
The geographic distribution of the AMSs, the RCs and the NC, as well as the quantification of the criterion used for the installation of the AMSs, [legend annexed to the map in thousands of inhabitants].



Urban automatic station

The AMSs, the RCs and the NC are installed at:

- 1 AMS in Braga
- 3 AMSs in Porto + RC
- 1 AMS in V. N. de Gaia
- 1 AMS in Coimbra + RC
- 1 AMSs in Cacém
- 5 AMS in Lisboa + RC + NC
- 1 AMS in Amadora
- 1 AMS in Setúbal
- 1 AMS in Barreiro
- 1 AMS in Évora + RC
- 1 AMS in Faro + RC
- 1 AMS in Funchal + RC



Schematic distribution of the UAMSN network.

All AMSs are equipped with sensors for air temperature and relative humidity, precipitation (amount, duration and intensity) and global solar radiation; 50% of the AMSs are equipped with instruments for the observation of wind speed and direction.

The meteorological information is initially organized in local archives, i.e., at each AMS, and usually relayed to the RCs and the NC every hour, using the GSM data transmission networks. It should be mentioned that the stations are programmed to issue alarms whenever values corresponding to eventual severe weather conditions are recorded.

Therefore, alarms are prepared and sent to the NC whenever one of the following conditions occurs:

- Mean wind speed in 10 min > 15 m/s*
- Instantaneous wind speed > 23 m/s*
- Precipitation amount in 10 min > 5 mm*
- Air temperature < 1°C or > 40°C*

At the RCs and NC it is possible to display all meteorological information from the UAMSN stations in alphanumeric and/or graphic format. However, when necessary and/or convenient, access to all meteorological data recorded at one or more AMSs is possible at any moment (except for cases of damage).

The UAMSN enables to make meteorological information available, namely to:

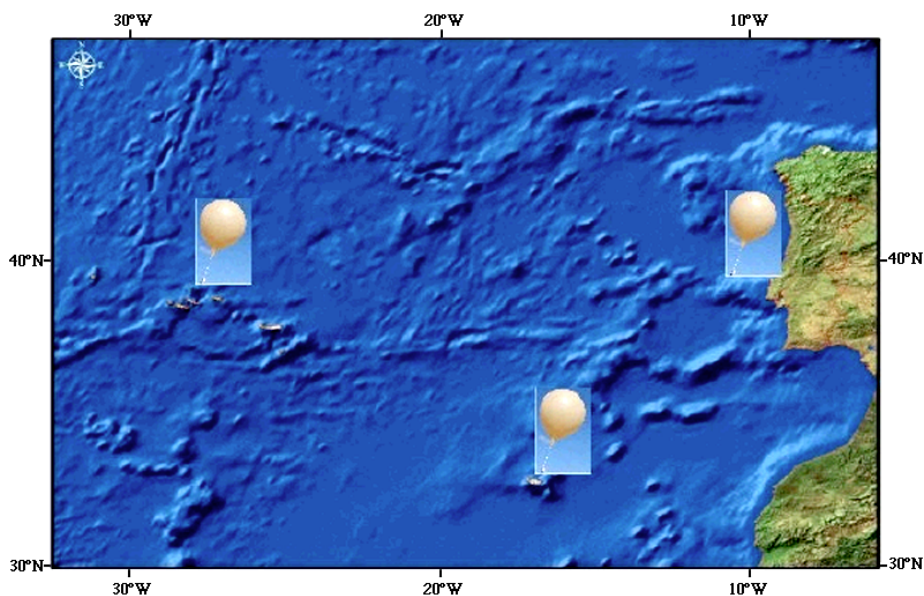
- Improve weather watch in urban areas;*
- Describe the local weather conditions and support weather forecasting;*
- Issue warnings from the IM to the civil protection;*
- Investigation of pollution and urban planning;*
- Research and studies on climate in urban areas.*

2.1.3 - Upper-air Stations



Upper-air Station-Funchal

The Portuguese upper-air network composed by 3 radiosounding stations (Lisboa and Funchal/Madeira operated by IM and Lajes/Açores operated by the Portuguese Air Force) continued operating between 1999-2002, following the normal program of 2 soundings per day, at 00 and 12 UTC. These stations are equipped with semi-automated radiosounding systems to perform upper-air observations of pressure, temperature, humidity and wind (direction and intensity), with radiosondes and balloons, which allow ascents up to more than 30 km. The ground systems for radiowind at Lisboa and Funchal stations have been upgraded in 1999 for using the GPS technique and new radiosondes (the Lajes station was earlier upgraded for GPS wind finding system in 1997). Also the two mobile sounding systems owned by IM have been upgraded for GPS wind-finding method, in 1999. The results of these upper-air observations are transmitted in real time through the WMO/GTS network in coded reports using TEMP format and also CLIMAT TEMP reports format, for transmission of monthly climatic data. All data gathered from those stations are subject to processing, validation and archiving in a central database.



Location of Upper-air Stations

2.1.4 - Lightning Network

The electric atmospheric discharges, in their extreme form, are the origin of lightning, and without a doubt, the most devastator atmospheric phenomena, which can cause the loss of human life and property and affect the operation of numerous socio-economic activities.

The forecast of this kind of phenomena, in a short period of time, is based on traditional meteorological observations, on results obtained by numeric forecast models and most of all on satellite images, on data from meteorological radars, in data from lightning detection and location system. These last ones are extremely important to determine the location of the electric discharge and to predict the path of the nebulous system that generates it, working as a complementary information to the meteorological radar, in places less covered.

With the purpose of improving the meteorological surveillance and supporting the weather forecast, specially of the lightning and intensive rain usually associated, the Meteorological Institute is operating, after June 2002 a lightning network, which is composed by four IMPACT 141T-ESP detectors, LP2000 and by CATS software.

The detectors installed in Braga / Aerodrome, Castelo Branco / Coordinator Center of the MI, Alverca / Airport and Olhão / Quinta de Marim, allow the measuring of the variations of the atmospheric electromagnetic field and the transmission of this variation to a concentrator/processor located in Lisbon, at the Meteorological Institute. Remote terminals are connected to the concentrator in the MI installations, where it is possible to visualize the information available by the system network.



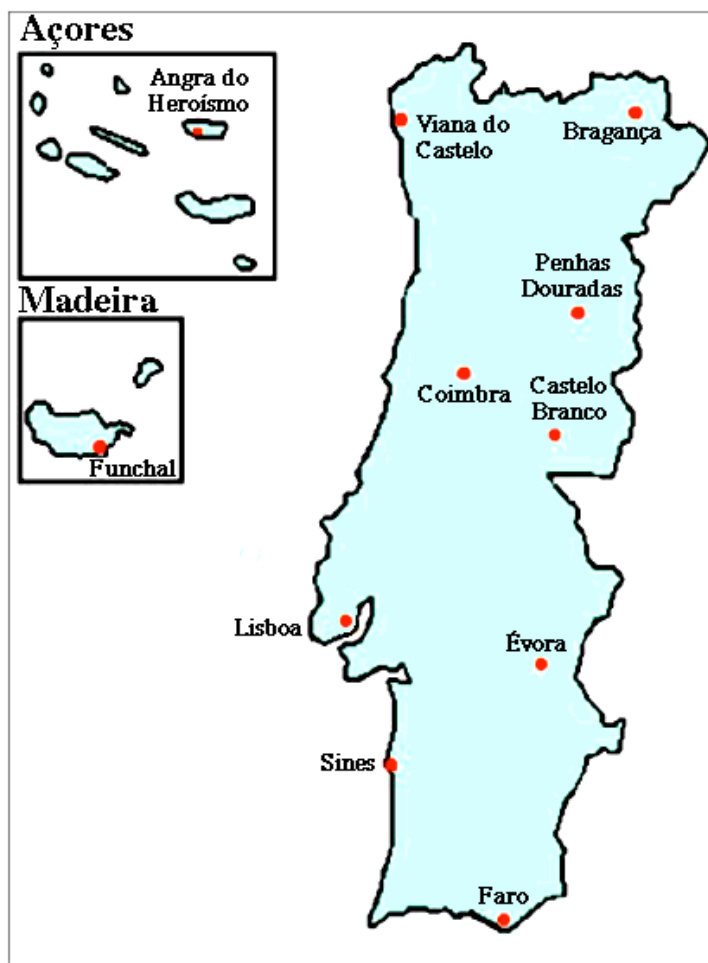
Lightning network

An interchange of real time data with the Spanish National Meteorological Institute is also operational, regarding four detectors (Santiago de Compostela, Salamanca, Córdoba e Jerez de la Frontera), which allow an improvement in the efficiency of the system network and in the accuracy of detection and location of the electric discharges in both countries.

2.1.5 - Atmospheric Composition Network

The Global Atmosphere Watch (GAW) is one of the most important force lines of the WMO. It recommends the implementation and intensification of observational programmes and the monitoring of relevant parameters in order to characterise the natural composition of the atmosphere and the availability of atmospheric pollutants concentrations. The atmospheric watch programmes in progress since 70's are included in national and international programmes like WMO/GAW and EMEP.

Within the scope of the global atmosphere watch, various programmes are in development to determine the concentrations of trace components of the atmosphere and to characterise the physical and chemical properties of precipitation. Almost all of these programmes are included in international programmes aiming at the assessment and better understanding of the effects of the pollution of the atmosphere as a result of human activities and its impact on climate, biosphere and ecosystems in general.



IM atmospheric composition network

	OBSERVATIONAL PROGRAMMES						
	Total Ozone	Surface ozone	UV	SPM	Deposition Chemistry	SO ₂ and SO ₄	Greenhouse gases
Bragança		T.B.I.		X	X	X	
Viana do Castelo		T.B.I.	X	X	X	X	
Penhas Douradas		X					
Cernache (Coimbra)			X				
Castelo Branco		T.B.I.		X	X	T.B.I.	
Lisboa/Gago Coutinho	X	X	X				
Angra do Heroísmo		X		X	X		X*
Évora		T.B.I.		T.B.I.	T.B.I.	T.B.I.	
Monte Chão (Sines)			X				
Faro/C.C.			X				
Funchal (Madeira)	X	X	X	X	X		

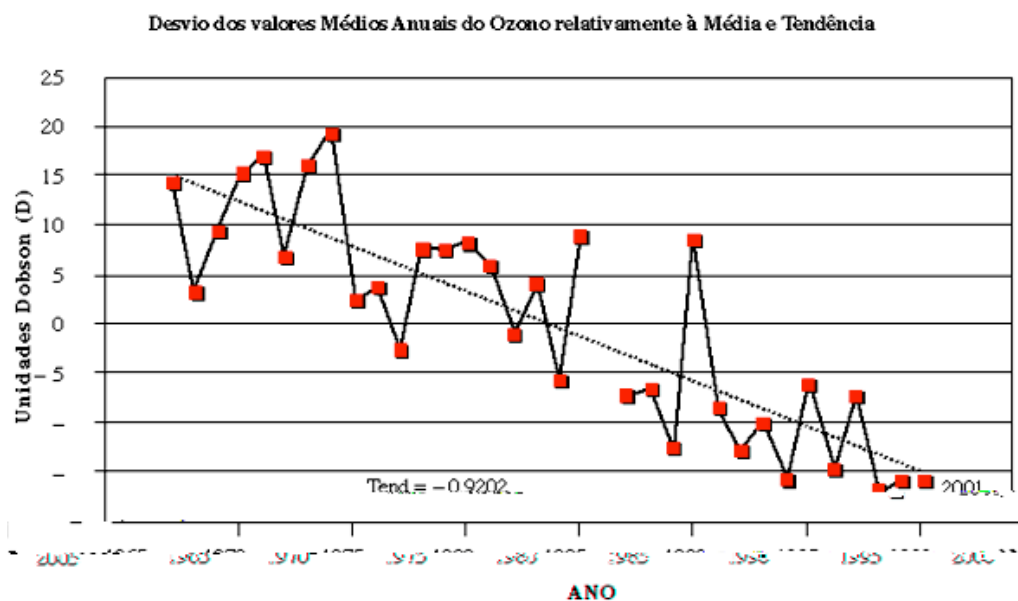
T.B.I.: To Be Installed

* On Serreta Site

Observational programmes carried out at IM satations

The IM network included in the regional GAW network is composed by 11 stations (Mainland: 9; Azores Is: 1; Madeira Is: 1), which carry out several programmes according to available local conditions. The purpose of these programmes (see the following table) is to assess the long-term variations of the composition of the atmosphere related with regional variations resulting from human activities.

As a member of the WMO, IM has continued the activities performed in the past on observation of stratospheric ozone and monitoring UV-B radiation. The first total ozone measurements were performed in 1951 at Sta Maria Island/Azores with a Dobson ozone spectrophotometer, borrowed from the International Ozone Commission since 1951. The instrument was moved to Lisboa in 1960 where, since 1967, regular measurements of total ozone and Umkehr effect are carried out.

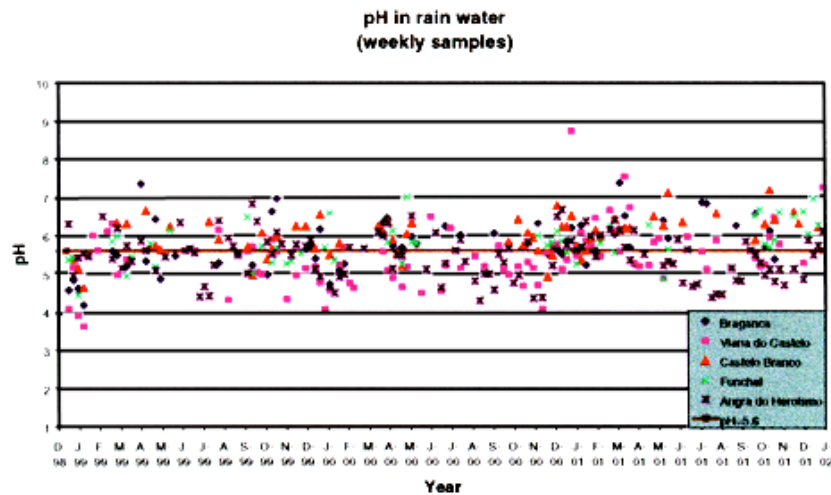


Annual average deviations (Dobson units) of total ozone observed at Lisboa (1967-2001)

This activity was accomplished later with ozone soundings campaigns, surface ozone and UVB monitoring. To assure a good calibration level for the Dobson spectrophotometer network, IM has participated in regular international inter-comparison sessions under the technical support of WMO and other services. IM has also participated in the COST Action 713 “UV-B Forecasting” and has an operational programme of UV Index forecasting that is disseminated for the public. Spectral measurements collected are submitted to the EDUCE (European Database for UV Climatology and Evaluation) database, an EU funded project.

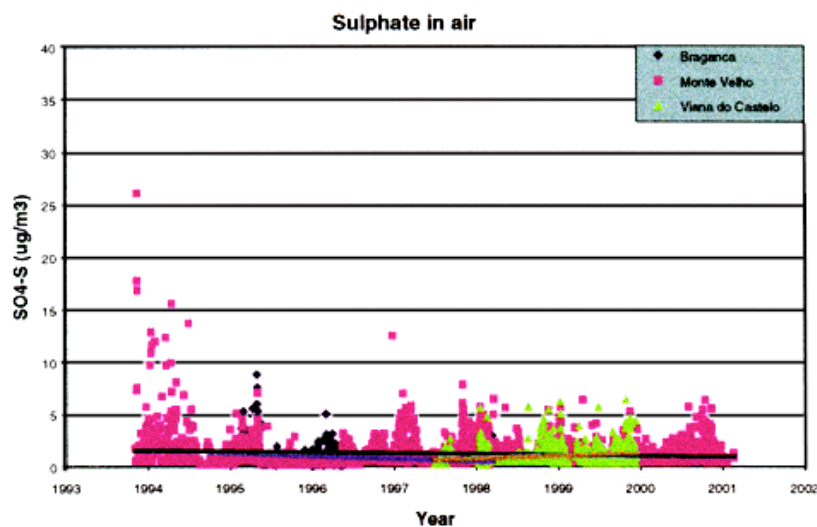
Weekly air sampling for greenhouse gases analysis (NOAA/CMDL) in flask samples are currently carried out by IM personnel at Terceira Is. (Azores).

Weekly samples of wet deposition and monthly samples of dry deposition are regularly collected since 1979 in several meteorological stations (Bragança, Viana do Castelo, Castelo Branco, Funchal and Angra do Heroísmo) using automatic wet/dry samplers. Samples are sent to a certified laboratory (St. Andrew - DRAOT/Alentejo) for chemical analysis of pH, electrical conductivity, ion concentration (Cl^- , NO_3^- - N, SO_4^{2-} - S, NH_4^+ - N, K^+ , Na^+ , Mg^{++} and Ca^{++}) and metals (Ni, Mn, Cu, Zn, Cd and Pb). Braganca and V. Castelo stations are also EMEP stations where daily precipitation samples are also collected and analysed.



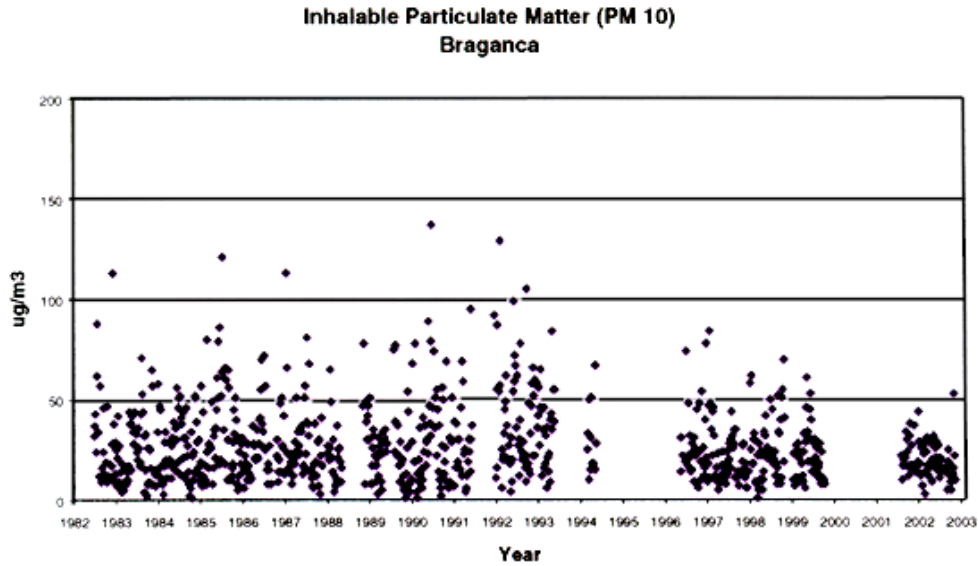
pH in rain water weekly samples collected at IM stations in 1999-2001

Sulphur dioxide and sulphate in air and aerosol measurements started in 1979 in the scope of EMEP programme. Daily samplings are collected in Bragança, V.Castelo and Monte Velho/Sines using sequential air samplers developed by NILU. New samplers based on impregnated filters should replace the old ones and should be also installed in Castelo Branco, Evora and Ria Formosa/Algarve.



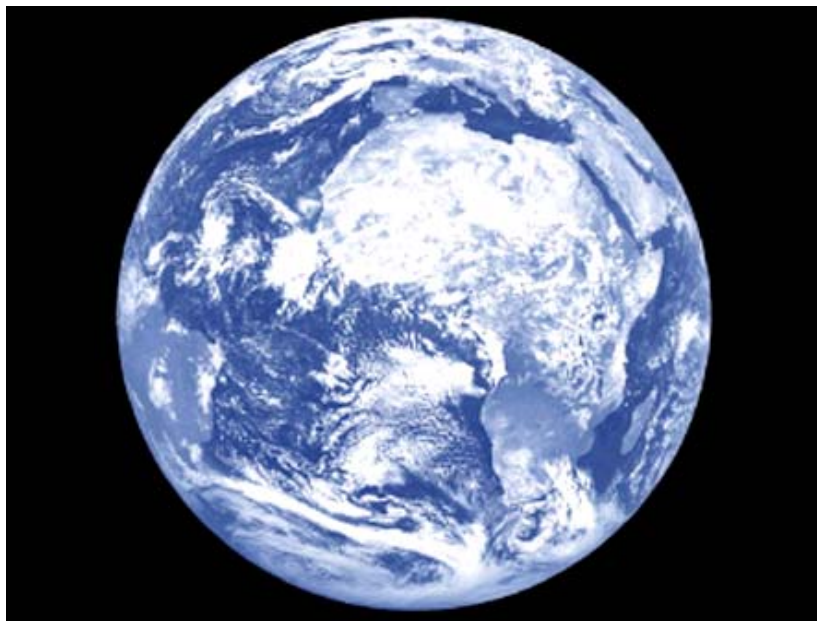
Concentration of sulphate aerosols in daily air samples collected at IM stations in 1999-2001

In 1982, sampling of SPM started in Braganca and Faro in the scope of BAPMoN programme. 24-hour samples are collected with an interval of 6 days using fiber glass filters and High Volume samplers with impactors. SPM concentration is determined by gravimetric method. The monitoring programme was extended to Viana do Castelo and Castelo Branco (1987), Angra do Heroismo (1992) and Funchal (1993).



**Concentration of Suspended Particulate Matter (PM10) in air samples collected
at Braganca station since 1982**

2.1.6 - Weather Radar, Satellites and Radiometers



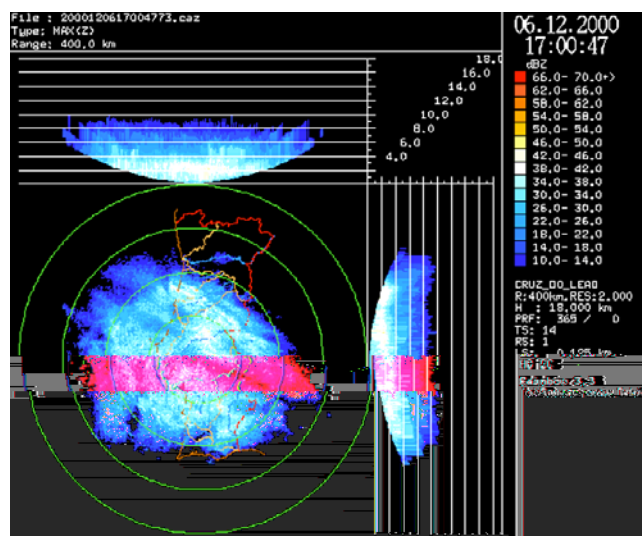
Full METEOSAT image - received and processed at IM

The data from satellites and weather radar are a very important aid in the support to operational meteorology and related activities, such as Hydrology and Climatology, for the benefit of a number of socio-economic activities, such as aerial, terrestrial and maritime transports, agriculture, fishery, construction industries and other outdoor industrial activities, water resources management, urban hydrology and sanitation, production and distribution of hydro-electric energy and water supply, telecommunications and tourism. These means of observation are also a very important source of data for research in atmospheric sciences, in the control and monitoring of the urban and rural development and for many other applications. The data obtained, or the derived meteorological parameters, processed and distributed in near real time, are essential in weather watch and very short-range forecast and can also be used as input for numerical prediction models.

The main project being carried out in the field of radar meteorology is aimed at the design, installation, operational exploitation and development of the national weather radar network covering the whole country in the mainland, Azores and Madeira. When complete, this network will include seven radar stations.

The core of the telecommunications sub-system is an IP WAN (based on VPN technology) serving the IM headquarters in Lisbon, together with the meteorological centres in Faro, Oporto, Ponta Delgada (Azores) and Funchal (Madeira) airports. The WAN is based on a 1 Mbit collector installed at IM headquarters and 128 Kbps frame-relay links (upgradeable to 512 Kbps). The Lisbon node enables the connection to the WMO GTS.

The radar stations are connected to the nearest meteorological centre, where a WAN node is installed, via a 2 Mbps radio link.



Weather radar maximum reflectivity image showing a stratiform rainfall event with a bright band signature in both vertical side projections

A distributed command, monitoring and processing sub-system is resident in a number of computer platforms installed in the radar stations, in the meteorological centres across the Country and in IM headquarters, enabling the real-time operational exploitation of the radar data. An important component is the national compositing centre, where data from multiple radars, some national and some from neighbouring countries, are merged to create mosaics covering the Country and adjacent areas of interest.

The integration in the IM headquarters LAN allows the data assimilation by weather prediction numerical models and other models developed by IM, the integration with other kinds of data in meteorological information systems, the transmission to the WMO GTS, the archive in IM data base, the web-publishing and real-time dissemination of products to external users through the Internet and the FTP servers, in numerical or standard graphical formats, etc.

The first radar station, located 70 Km Northeast from Lisbon, has been under operational exploitation by IM for weather watch and severe weather warning, nowcasting and very short-range forecasting, Aeronautical Meteorology, Hydrology and Climatology. Data have also been disseminated to the external users for defence, civil protection, research and other purposes of public interest (e.g., flood forecasting, urban hydrology and urban drainage systems control, traffic and road maintenance, etc).



Cavalos do Caldeirão weather radar station (Faro), showing both the radar and radiolink radomes

The second radar station, located near Faro, is being commissioned.

Work is in progress to install a real-time processing system directly connected to the RPG of a WSR-88D NEXRAD system not owned by IM and installed in Terceira Island (Azores). This system will enable the radar operational exploitation at Ponta Delgada Meteorological Centre and its data integration in the national network through the Azores node of the national WAN.

There has been scientific and technical co-operation with the Community of Portuguese-speaking Countries and the Special Administrative Region of Macao of the People's Republic of China, work being in progress in joint projects with Macao Meteorological Bureau, *Universidade Estadual Paulista*, Brazil, and *Instituto Nacional de Meteorologia* of Mozambique.

Various R&TD actions have been carried out by IM in the areas of radar meteorology and radar systems development in co-operation with both the classical and technical Universities of Lisbon and integrated in the European R&TD effort in that sector, there having also been co-operation with Universities and State Laboratories of Brazil and China.

There has been participation in various European projects, namely in the Action COST 717 "Use of Radar Observations in Hydrological and NWP Models" as well as in the project "Operational Programme for the Exchange of Weather Radar Information" (OPERA) of EUMETNET.

An effort has been exerted towards the development of techniques of measurement of precipitation by radar and of very short-term precipitation forecasting, aiming at improving the quality and availability of precipitation data in order to meet the operational and R&TD requirements in the areas of Hydrometeorology and hydrological forecasting, including flood forecasting.

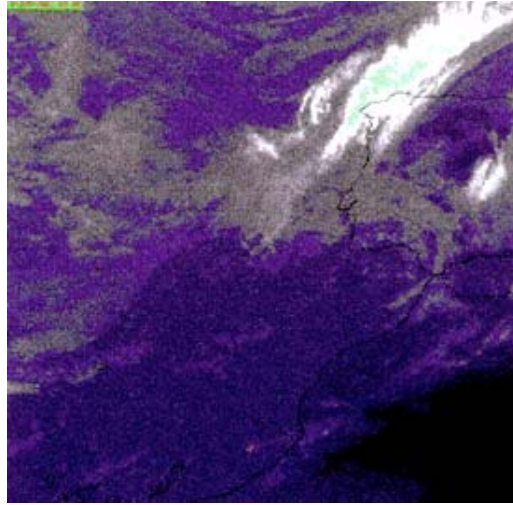
Work has also been performed on the identification of physical quantities and evaluation of their potentiality as short-term weather predictors and on the assessment of existing conceptual models suitable for use in the algorithms on which objective or semi-objective techniques can be based.

Bearing in mind the future assimilation of radar derived wind products in NWP models, work has also been done in the assessment of the performance of the Weather Radar Wind Profile product.

Research is also being performed on statistical signal processing with applications to weather radar.

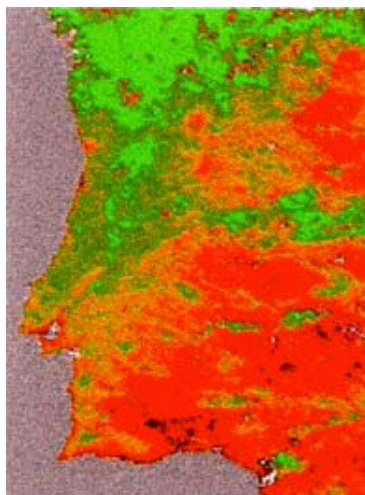
In the scope of satellite exploration, studies have been carried out on synoptic conditions responsible for severe storms over the Portuguese mainland. In the fields

of Climatology, works have been carried out on applications of remote sensing, using data from NOAA-AVHRR sensors and METEOSAT.



IR METEOSAT image showing a cold frontal system

Some applications have been developed and some research has been carried out in the fields of Meteorology and Climatology on the use of water vapour data from METEOSAT. Methods and algorithms were developed for monitoring and analysing cloud systems, aiming at obtaining precipitation from convective systems. Algorithms have been developed to obtain operationally forest fire risk indexes and to estimate the dryness conditions of the vegetation. Studies have been carried out on the applications of remote sensing to large-scale utilisation of the soil, to crop yield prediction and to obtain seawater temperature. The alternative system for the chain of acquisition of METEOSAT data was received in 1995, within the framework of project “Remodelling of the satellite imagery monitoring and processing system”.



Forest fire risk index processed at IM using NOAA imagery

The MSG launch and the expected start of operations in the middle 2003 impose the procurement of a new satellite receiving station to be installed at IM headquarters.

The exploration of an existing airborne multispectral radiometer system (Daedalus ATM-X) and of two sets of surface digital spectral radiometers ASD – FeildSpec Fr and D&P-Model 101 (IR), together with respective processing system, is a priority. Important flights will be done over selected areas, obtaining information to be used within several projects as EUMETSAT LSA SAF and DEMETER.

Operations of testing/calibration of the sensors of the airborne digital radiometer Daedalus ATM-X were carried out in laboratory, as well as collection of typical spectral signatures of soil and vegetation.

During 2002, some data were obtained from surface reflectances over ocean, near the northern Portuguese coast and using ASD – FieldSpec FR. The goals of these studies, conducted in collaboration with the Oporto University (Mathematics Faculty), were:

- Calibration of ASTER satellite
- Sea pollution monitoring along the coast.

2.1.7 - Co-operation with National Entities and International Organisations

Cooperation in the framework of EUMETNET (The Network of European Meteorological Services)

IM participated in the following programmes and projects in the domain of Observations:

- EUCOS, Eumetnet Composite Observing System
- E-AMDAR, Eumetnet-Aircraft Meteorological Data Relay
- AWS, Automatic Weather Stations
- PWS, Present Weather Systems
- OBS-INFO, Exchange of Information on the Observing Systems
- OPERA, Operational Programme for the Exchange of weather RADAR information
- WINPROF, Wind Profilers.

Various R&TD actions have been carried out by IM in the areas of radar meteorology and radar systems development, in co-operation with both the classical and technical Universities of Lisbon, namely:

- **On-going research on statistical signal processing** with applications to weather radar including: “Spectral moments estimation”; “pulse compression” and “pulse deconvolution”.

- **Correction for the attenuation due to precipitation using non-linear filtering**, specifically the development of a non-linear filtering technique aiming at the correction of the attenuation.
- **Studies on meteorological and hydrological applications of weather radar.**
- **Studies on radar measurement of precipitation**; the work in progress in this area has been focused in the development of a radar rainfall data adjustment model based in the Kalman filter concept, including (in the state-space model) both the raingauge data traditionally used and a second predictor, characterising the synoptic-scale circulation, namely the relative vorticity at 500 hPa level obtained from the ECMWF analysis.
- **Studies on the use of weather radar for nowcasting and very-short term forecasting**; work is in progress in the scope of the identification of physical quantities and evaluation of their potential as short term weather predictors.

Within the scope of these activities, the “VIL” quantity has been evaluated as a predictor of high rainfall intensities at low levels and conceptual models of multicell systems and other related mesoscale phenomena have been assessed.

A study based on radar and lightning data merging as been performed, the results seeming promising regarding the issue of severe weather short term forecasting.

National R&D projects

ROCA “Rede de Observação da Composição da Atmosfera” (Atmospheric Composition Observing Network), headed by IM in cooperation with University of Lisbon (Physics Department and “Fundação da Faculdade de Ciências de Lisboa”) and University of Azores; Funded by the national Science and Technology Foundation, in the framework of “PRAXIS XXI” programme.

CLIMLIS “Prescription on Climatic Principles in Settlement Planning – Application to Lisbon”, in co-operation with Lisbon University, namely in observational meteorological field campaigns to investigate the thermo-mechanical structure of the lower troposphere in Lisbon area.

CICLUS “Climate Impact of Changes in Land Use”, conclusion of the project together with the Lisboa and Évora Universities, through surface and upper-air observational programmes in the Alentejo region.

STRATOZON, participation in this project coordinated by University of Aveiro and Nuclear and Technological Institute (BIOCAL).

International R&D projects

MEDEX “*MEDiterranean EXperiment* on Cyclones that produce high impact weather in the Mediterran”, headed by INM (Spanish Meteorological Service); Approved in 2000 by WMO in the framework of WWRP (World Weather Research Programme).

EDUCE “UV spectral Database”, a European funded project coordinated by Hanover University, with the participation of more than 20 scientific European institutions; IM data are regularly submitted to this database.

In the scope of satellite exploration, several international contacts are maintained in particular with:

- EUMETSAT – European Organization for the Exploitation of Meteorological Satellites;
- Satellite Applications Facility for Land Surface Analysis - Project Team and Steering Group;
- COST 719 - “The Use of GIS Systems in Support of Climate Monitoring, Climate Data Quality Control and Climate Information”;
- COST 720 – “Integrated Ground-based Remote-Sensing Station for Atmospheric Profiling”.

In the field of radar meteorology, the main co-operation projects are:

“Operational Programme for the Exchange of Weather Radar Information” (OPERA) of EUMETNET:

The general objectives of the programme are to harmonise and improve the operational exchange of weather radar information between National Meteorological Services. The technical objectives of the Programme are to agree on a common specification for the radar sensor hardware and software and to establish common standards for data acquisition methods.

Participation in the activities (campaigns, data exchange, etc) of the following COST Actions:

C-WINDE 99 Project (1999) of COST Action76 “Development of VHF/UHF Wind profilers and Vertical Sounders for Use in European Observing Systems”.

COST 713 "UV-B Forecasting".

COST 715 "Meteorology Applied to Urban Air Pollution Problems".

COST Action 717 "Use of Radar Observations in Hydrological and NWP Models".

COST 720 "Integrated Ground-Base Remote Sensing Atmospheric Profiling".

Other cooperation forms

The Observations and Networks Department (DOR) of IM participated in some cooperation activities with Portuguese Speaking Countries, in the framework of CRIA agency (Clima e Respectivas Implicações Ambientais – Climate and its Respective Environmental Implications), namely in Brasil in April 2001 (II Journeys on Climate and Applications, in the framework of CPLP (Portuguese Speaking Countries Community), and in Cape Verde in July 2002 (Consultancy mission for Automatic Stations Network).

The IM/DOR have been cooperating every year with several Secondary Schools and also with some private companies that operate meteorological stations, providing technical support and consultation regarding the acquisition and installation of meteorological equipments and sensors.

The IM/DOR have been cooperating with the Portuguese Air Force Academy providing training for Meteorology Officials, on the subjects relating to meteorological instruments and methods of observation.

IM provides infrastructure and personnel support to air radioactivity network operated by IA (Environment Institute), installed in mainland and island territories.

Daily total ozone data is submitted to World Ozone Data Center (CMC-Canada) and to the WMO North Hemisphere Ozone Mapping Center (LAP-Greece) were daily total ozone maps are available on the web.

Precipitation water sampling for chemical and physical analysis, SO₂ measurements in air and SO₄ in aerosol samples, atmospheric, air sampling for suspended particulate matter concentration, are also made within the scope of WMO/GAW (5 stations) and EMEP (2 stations) programs. Data collected are sent on a regular basis to the respective WMO World Data Centers.

Participation on the flasks sampling programme for greenhouse gases analysis coordinated by Climate Monitoring and Diagnostic Laboratory (CMDL/NOAA-USA) at Terceira Is.(Azores).

Co-operation with Michigan Technological University and University of Azores for the installation and exploitation of a free troposphere monitoring station at Pico mountain (Azores), in the scope of the IGAC (International Global Atmospheric Chemistry) program. Efforts are currently done for the installation of a baseline station in Azores for monitoring of background pollution.

Within WMO groups, particular contacts are maintained with:

- International TOVS Working Group;
- Space Frequency Coordination Group.

Co-operation with the Community of Portuguese-speaking Countries is progress in projects of scientific and technical co-operation with “Universidade Estadual Paulista”, Brazil, and “Instituto Nacional de Meteorologia” of Mozambique.

Co-operation with People’s Republic of China and the Special Administrative Region of Macao, Both technical and scientific activities have been developed in this scope.

There has been co-operation regarding the evaluation of the performance of two different radars in the Hong-Kong / Macao / Guangzhou area and also regarding specific problems involved in Macao & Guangzhou radar data merging.

There were also developed activities related with rainfall measurements using radar together with rain-gauges and other available meteorological information, as appropriate.

2.2 – Weather Watch

2.2.1 – Weather Analysis and Forecast Centre

The weather watch is the main operational activity in this Centre along with general and regional weather forecast for Portugal and for maritime areas, high seas and near the coast of Portugal, including Azores and Madeira.

The activity is based mainly on:

- a) surface observations every hour in the AWS Portuguese network (93 stations, 78 in mainland, 9 in Azores islands and 6 in Madeira islands)
- b) surface observations at the network of 18 urban AWS installed on urban areas with more than 50 000 inhabitants
- c) upper air observations
- d) radar observations

- e) Meteosat and NOAA satellite images (VIS, IR and WV)
- f) observations of lightning network operated by IM since June 2002
- g) surface and upper air analysis and forecasts (ECMWF)
- h) surface and upper air mesoscale analysis and forecasts based on ALADIN model
- i) post-processing products based on the ECMWF and ALADIN models

«Severe weather warnings» are prepared for the National Civil Protection Service as far as certain limits are reached for specified meteorological parameters (wind, rainfall, hail and fog). Similarly, «severe weather warnings» are issue when strong winds and /or high waves are forecasted in the sea. «Heat waves warnings» are also issue by this Centre.

Daily, a «post mortem» analysis and evaluation of the forecast is made. Specific weather forecasts and products are prepared for different users, namely for the Army, Navy, Air Force, for their military and naval exercises, and since March 2000 for other users, to assure our commercial agreements.

Daily, during the forest fires season (June to September) the meteorological forest fire index is calculated as well as the evolution of this index for the next day in order to support the forest fire prevention. Specific forecasts and products are issue for the fire brigades.

There is a daily cross-border exchange of warnings and of weather forecast bulletins between the portuguese Weather Forecast Centre and the spanish Regional Weather Forecast Centers near the border.

2.2.2 - Meteorological Data Processing including Numerical Weather Prediction

Since 1998, no major actions have taken place on the Portuguese Meteorological Data Processing unit. Special effort has been put on the maintenance of our processing system year 2000 compliant. However, this system initially built under ECMWF (European Centre for Medium-range Weather Forecasts) software, is still based on the OpenVMS (VAX) operating system. Typical values for data from GTS in use are (daily received number of reports):

SYNOP (including automatic).....	32 539
SHIP.....	5290
TMEP and TEMPSHIP.....	1067
PILOT.....	511
DRIBU.....	10563
METAR.....	6371

Besides this data, several products are daily received in GRIB format from the following centres: ECMWF, EGRR (UK); LFPW (France) and LPMG (Portugal).

The METVIEW/MAGICS graphical software (ECMWF) is used to display meteorological and related information.

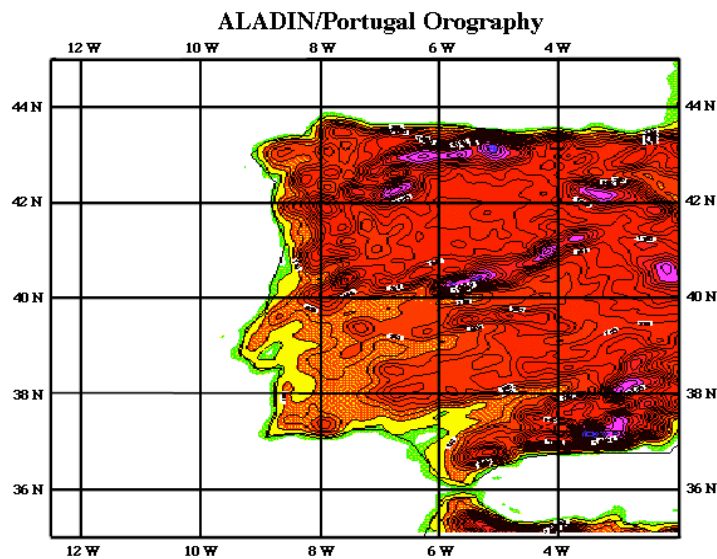
On the other hand, Numerical Weather Prediction activities suffered an important change in April 2000 with the introduction in operational mode of the Portuguese version of the ALADIN model ⁽¹⁾. The operational environment and main characteristics of ALADIN/Portugal are:

Computer characteristics

DEC Alpha XP1000 (Compaq), 500MHz, 1 Gb memory
DIGITAL UNIX V4,0
DIGITAL F90 and 77 Compiler V5.1, native C Compiler

Model characteristics

Spectral hydrostatic model
Hybrid vertical co-ordinates
DF initialisation
Semi-Implicit Semi-Lagrangian two-time-level advection scheme
ISBA surface parametrisation scheme
Initial and lateral boundary conditions from the latest ARPEGE forecast
6 hour coupling frequency from ARPEGE



⁽¹⁾ Horanyi, A. I. Ihasz and G. Radnoti, 1996: ARPEGE/ALADIN: A numerical weather prediction model for central-Europe with the participation of the Hungarian Meteorological Service. *Időjaras* 100, 277-301.

Integration domain:

Size: 100x90 points
Number of vertical levels: 31
Horizontal resolution: 12,7 km
Time step: 600 s
Integration frequency: twice a day (00 and 12 UTC)
Forecast range: 48 hours
Output frequency: 1 hour.

Since 1999, ALADIN/Portugal forecasts are objectively verified on a regular basis. An annual report is published in English.

2.2.3 - Aeronautical Applications

The Meteorological Centre for Aeronautics in Lisbon carries out continuous watch of the FIRs of Lisbon and Sta. Maria (Azores), issuing reports on adverse weather conditions for evaluation (SIGMETs).

Forecasts for eight national airports (Lisboa, Porto, Faro, Funchal, Porto Santo, Sta. Maria, Pont Delgada and Horta), issued every three hours (TAFs with 9 hours validity) and every 6 hours (TAFs with 18 and 24 hours validity), amendments being made when significant deviations from the observed conditions occur; these products are disseminated by the AFTN network.

Route forecasts for the Mainland area are also elaborated, twice a day, to support VFR flights, between surface and FL 180, through an automated fax service.

This Centre, as well as the Meteorological Centres for Aeronautics located at the national airports, carry out routine coded observations (METAR) and observations whenever significant changes in weather conditions occur (SPECI), which are disseminated by the AFTN network.

All provide folders with materials for flight support (significant weather charts, surface analysis, charts of wind/temperature aloft, TAFs and METARs for departure, destiny and alternate airports), as well as customised support to crews and companies.

The Meteorological Centre for Aeronautics in Lisbon was linked to the IM computer network in November 1997, thus being possible to accede to a set of products made available by VPN and INT. A working station of the new weather radar was established in November 1998. By the same time, produces alot of products based on the SADIS system, which enabled a significant improvement in the quality of the services provided to the different users.

Simultaneously, technical meetings and training actions in these areas were held with the participation of the majority of the specialists aeronautical staff. Works were carried out in the area of weather events hazardous for aviation, particularly conditions of fog formation/duration/dissipation.

2.2.4 – Maritime Applications

Technical support was provided to the officers who carry out weather observation at the coastal meteorological stations (sea surface temperature measurement stations 7 in Mainland Portugal, 8 in the Azores and 2 in Madeira, corresponding to more than 6000 observations per year) and on board national ships.

The MAR3G model of wind generated waves, developed in this sector, since installed 1996 was exploited operationally, and training was provided to the officers for an adequate operation; an upgraded version of this model is being developed.

2.3 – Climate and Atmospheric Observation

2.3.1 – Introduction

The Climate and Environment Department of IM intends to respond, both at national and international level, to the challenges of climate change, taking into account the new pattern for climate services, based on the opinion that the economic decisions may take benefit from a better understanding of climate conditions.

The strategy adopted, within the framework of the overall objectives of IM, is based on:

- The challenges and opportunities to come, which are related with the economic, social and technological development, both at national and international level;
- The increasing awareness that historical climate information, as well as monitoring and prediction of climate conditions in a near future, are pieces of information that will be essential, not only to the various sectors of activity, but also to the development of social policies;
- To reduce the vulnerability to environment hazards, which in modern societies and competitive markets especially affect water resources, power supply and agricultural productivity, understanding present and future climate conditions is the key to a successful development of suitable management strategies;

- The increasing recognition that international co-operation is vital for developing and sharing the benefits of understanding the climate system.

The activities and actions thus carried out aim at:

- Promoting and reinforcing climatological, agrometeorological and hydrometeorological surveillance;
- Providing scientifically and technically reliable information in these areas;
- Supporting climatology, hydrometeorology and agricultural meteorology in the areas of protection, prevention and minimisation of natural hazards of meteorological and climatic kind;
- Providing data, products and services of climatological, hydrometeorological and agrometeorological kind, in order to support the various social and economic activities and afford the maximum potential benefits;
- Using Geographical Information Systems in the area of climate and its applications;
- Reinforcing scientific and technical co-operation, both at national and international level.

2.3.2 – Climate data and monitoring

The foundation for essentially all climate-related research and services is the systematic long-term acquisition, collection, management and analysis of climate data. Accessible and reliable climate records are essential to achieving progress in climate applications, monitoring and research, the assessment of climate impacts, the detection of climate variation and the development of strategies to mitigate potentially adverse effects of climate variability and change.

Climate monitoring and analysis

Climate monitoring concerns the monitoring of the atmosphere and of other components of the earth system as well as the monitoring of climate indicators (e.g. mean surface temperature and precipitation) to obtain well-founded statements on regional/local climate development (trends and fluctuations) and on concomitant effects, including extreme weather events (short-term).

The following activities have been developed:

- Implementation of programmes of analysis and monitoring of climate, its spatial and temporal variations;
- Studies of climate variability and statistical properties of the observed time series;
- Development and use of indices and indicators of climate variability;
- Identification of the NAO and oceanic variability modes by diagnostic analysis of observations and models;
- Preparation of climatological standard normals, weather records, and other analyses of climatic conditions;
- Regular elaboration (e.g. monthly) of climate monitoring products, annual statements of the status of the climate, periodical climate reviews, and reviews of major climatic events.

Climate Applications

Development of other sectorially related climate services, including those for water resources management, health, food production, energy conservation and renewable energy sources, land use planning, tourism and recreation, and combating drought and desertification.

2.3.3 – International agreements and other climate-related cooperation

Within the scope of international activities stress should be laid upon those actions aiming at the fulfilment of legal provisions and/or commitments taken by Portugal in International agreements and Conventions, namely, Framework Convention on Climate Change and Convention to Combat Desertification, and in WMO Programmes, Commissions and Working Groups and in other international climate-related Programmes.

As well as specific cooperative projects, a number of bilateral or multilateral agreements at government or institutional level have been established which either focus on cooperation on climate issues or include climate as a key area of interest.

2.3.4 – Projects

Most of the activities of climate studies are based on observational research. A wide variety of development and research is performed in the framework of national and international Projects.

National Projects

- **Evaluation of extreme precipitation events using multifractals.** This project will focus on the multifractal analysis of precipitation time series from Mainland Portugal, concentrating on the statistics of extreme events. The data are from a large number of locations distributed over the territory, differing with respect to climatic origin. The time span of the records is up to more than 50 years. The highest resolution of some data is in the order of minutes. Analyses of such data set will contribute to the subject especially because of the long time-span of the records, and because of the data resolutions that will be studied. Moreover, the multifractal models that will be used are expected to offer a more correct description of the extreme precipitation events and to lead to a better characterisation of precipitation variability in Mainland Portugal. This could benefit many hydrological studies and applications involving precipitation-induced non-linear processes.
- **CLIVAR** (Climate VARIability and Change: Patterns and Impacts at the regional Scale). This Project proposes to clarify some aspects of the Iberian regional climate, which are important, both for downscaling of long-term and seasonal weather predictions and for climate change assessments. CLIVAR will study relationships between the large-scale circulation and its variability, and the regional features, which are due to the Iberian geometry, topography, soils and land use. The aim is not only to explore the regional aspects of climate variability and change, but also to assess the interactions between expected climate change, coming from increased greenhouse gases concentrations at the world level, and other climate change forcing associated with changes in land use at the regional and local levels.
- **SIAM** (Scenarios, Impacts and Adaptation Measures). This project focuses on the impacts and adaptation measures in Mainland Portugal. It is the first integrated and comprehensive assessment of climate change impacts using GCM – derived climate scenarios in a southern European country.
- **The Influence of Storm movement on overland flow.** The main objective of this proposed research project is to study the effect of storm movement on the hydraulic characteristics of the underlying overland flow. This proposal is based on laboratory and field experiments, with a movable sprinkling-type rainfall simulator, simulating a moving storm. Results should indicate and quantify considerable differences in runoff volumes and peaks, times to peak

and hydrograph shapes, for storms moving in different directions across a drainage area.

- **Multifractal Study of Precipitation in Mainland Portugal.** In this Project one proposes to investigate the temporal structure of rainfall by means of multifractal analysis of high-resolution, daily and monthly rainfall, measured with recording and non-recording rain gauges, over periods up to more than 90 years.

International Projects

- **DIS/MED Desertification Information System for the Mediterranean.** The goal of the DIS/MED project is to establish an operational information system for planning needs in the Mediterranean region. The overall objective of the DIS/MED project is to improve the capacity of national administrations in the Mediterranean countries to effectively program measures and policies to combat desertification and the effects of drought by reinforcing communication, facilitating the exchange of information and establishing a common information system to monitor the physical and socio-economic conditions in areas threatened or affected by desertification and drought and to assess the extent, severity and trends of land degradation in those areas.
- **COST 719 – The use of Geographical information Systems in Meteorology and Climatology** The main objective of this Action is to broaden and enhance the potential of GIS in the fields of climatologic and meteorology by developing applications in those fields, with emphasis on the procedures and capabilities for integrating and adding value to data from various sources and on quality control and presentation of climate and other related data.

In the framework of EUMETNET/ECSN:

- **Climate Generate Monitoring Products** aiming at developing, generating and distributing standardized climate monitoring products for the European region, on a monthly as well as on an annual basis, involving ECSN- and non-ECSN-countries and thereby strengthening the cooperation of the European National Meteorological and Hydrological Services.
- **Climate Atlas of Europe.** The atlas will contain monthly normals of temperature, precipitation, wind and sunshine duration and additional statistical information for these parameters and for the occurrence of

phenomena such as fog, thunderstorm, hail and snow. The computation period will be 1971-2000.

- **European Climate Assessment (ECA).** The objective is to analyse the temperature and precipitation climate Region VI (Europe and Middle East) of WMO, focussing especially on trends in twentieth century observational series of extremes at meteorological stations.
- **Drought Investigations.** The objectives are the following ones: evaluation and use of different drought indices; analysis of long drought index series; study of thresholds of drought indices; calculate the spatial distribution of drought indices on different time scales; recommendation of drought indices.

ANNEX

LIST OF PUBLICATIONS ISSUED IN THIS PERIOD

PAPERS AND PRESENTATIONS

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3. AVEIRO UNIVERSITY

The University of Aveiro, at the moment graduates students in Meteorology and Oceanography. This degree is the only one in Portugal and is directed to future professionals in the areas of Meteorology and Oceanography. Since its beginning, in 1981, it has formed several students in Meteorology, that, at the moment, are working as professionals, in the National Institute for Meteorology (IM).

With this purpose since its beginning, the UA has hired professionals of the IM to form our students namely in the Climatology and Oceanography areas; the IM receives students in the final year of the Licentiate to acquire some professional practice inside IM.

Moreover, classical meteorological station, was installed in the UA, that is part of the National net of Climatology and it is in operation since October 1980 - its observers are part of technical staff of the Physics Department; the maintenance of this station is made by the IM.

In the last five years:

- a) the professors do IM continue teaching classes in the UA.
- b) in the meteorological university park of the classic station, the IM installed an automatic station that belongs to the national net of automatic stations EMA, sending the later to the UA. In this same park the UA installed, with the support of the program Ciência, another automatic station of 30 meters, which completes the previous one – its results are introduced in the Internet.
- c) there's been an increase of the collaboration especially in the post-graduation training (Phd).
- d) there are some scientific projects, like AMAZOC, CROP, CRIA that both entities participate.
 - *Ambiente Atmosférico em Zonas Costeiras e consequências para o escoamento ao nível da qualidade do ar, do solo e do lençol.* n.º 3/3.2AMB/38/94. AMAZOC.
 - Processos Transversais em Ambientes Contrastantes (CROP).

The reseach areas of the teaching staff in this area centres mainly in the following aspects:

- 1) Climate variability in different Spatial and Temporal scales.
- 2) Climate applications to the health and agricultural areas.

Overview

The automatic station of University of Aveiro is located in the campus, on the Meteorological Observations site, and has been working since 1997 – a Web page was created at the time, which indicated data on temperature, relative humidity, and wind speed, among those that a WindSonic Ultrasonic Anemometer, installed in the month of Julio the 2002. The station has 30 m of height and the sensors are distributed in different levels. This database has been improved every year.

In this same site a 702 station, which belongs to the National Meteorological Institute, has been installed.

Recently an adaptation of the MM5V3 & WRF models has been developed for different areas (3 areas for the MM5 and one for the WRF) using as a centre Portugal.

The activities of this group are essentially teaching and research.

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4. ÉVORA UNIVERSITY

Évora Geophysics Centre

Web page: <http://www.cge.uevora.pt>

1. INTRODUCTION

The Geophysics Centre of Évora, with almost 10 years of existence, has methodically and persistently acquired increasing expertise in the fields of Seismology, Applied Geophysics, Geology, Atmospheric Physics and Satellite Remote Sensing, Climate Dynamics, Scenarios and Impacts of Climate Change through a firm strategy of capacity building in highly qualified scientific human resources. The research team of the Centre currently has 48 members, of which 40 are based at the University of Évora where half of these have a PhD.

1.1. Overview

The Centre for Geophysics of Évora was created in 1991 under the Science Programme (Programa Ciência) and research activities began in 1993, developing its scientific research in the areas of Sciences of the Earth, climate, environment and space and covered the following activities:

- R&D projects;
- Advanced training;
- Organization of Conferences/Workshops and Advanced Courses;
- Cooperation with other institutions, promotion of scientific awareness and providing technical advice.

In the following areas:

- Atmospheric Physics /Climate / Meteorology;
- Internal Geophysics / Seismology;
- Tectonics / Geodynamics;
- Systems Dynamics.

The aim of the research is to contribute to a better understanding of:

- Physical properties of the terrestrial crust and the main geotectonic units;
- Seismic source and earthquake focal mechanism;
- Geologic and seismic risks;
- The optical, chemical and electrical properties of the constituent atmospheric gases, aerosols and clouds;
- Remote sensing of the atmosphere and of the physical and chemical properties of the terrestrial and atmospheric constituents;
- Climate variability, climate forcing, regional scenarios and impacts of climate change;
- Mesoscale meteorological phenomena;
- Transfer processes and transport in cavities and porous media;
- Dynamical phenomena: studies of turbulence, climate behaviour and biological phenomena;
- and spans theoretical, experimental, observational and modelling activities.

Advanced training activities include academic training of researchers, collaboration with researchers with post-doctoral grants and with invited scientists and the participation in Master's degrees in "**Climate and the Atmospheric Environment**" and Structural Geology.

The co-operation with other institutes includes:

- Collaborative protocols with SNPC, EDP, IM, IGM;
- Dissemination of scientific knowledge in Secondary Schools: educational seismic network, geology in the summer.
- Development of prototypes: earthquake machine, vertical seismometer and UV-Vis spectrometers.

- Participation in national and international campaigns (ACE-2, INDOEX, SAFARI 2000, VELETA 2002) and in remote sensing networks of aerosol (AERONET).
- Participation in organisations and international networks: ESA, EUMETSAT.
- Participation in several bilateral programmes: CRUP/DAAD, CRUP/CNIG, ICCTI/CNR, ICCTI/CNRST, etc.

1.2. Scientific Team

- Prof. Rui Namorado Rosa – Director of the Unit
- Prof. Ana Maria Silva
- Prof. António Heitor
- Prof. António Miguel
- Prof. João Corte-Real
- Prof^a Solange Mendonça Leite
- Prof. Paulo Sérgio Lucio
- Doutor Quian Budong
- Doutor Xu Hong
- Doutor Thierry Elias
- Doutora Paola Formenti
- Dr. João Carlos Santos
- Dr Daniele Bortoli
- Dr. Rui Salgado
- Dr. Maria da Graça Carraça
- Dr. Maria João Costa

- Dr. Orlando Cruz e Silva
- Dr^a Lourdes Bugalho
- Eng. Francisco Neves
- Dr. Claudia Serrano
- Eng. David Zuber
- Andrea Ramos (Ph.D)
- Fábio Conde (Ph.D)
- Ana Isabel Serrano (Ph.D)
- Nuno Belo (Bc.S)
- Susana Mendes (Bc.S)

1.3. Technical team

- Eng. Mouhaydine Tlemçani (Ph.D)
- Eng. José Pombinho
- Eng. Paulo Canhoto
- Samuel Bárias
- Sérgio Aranha

2. MAIN ACTIVITIES OF THE ATMOSPHERIC PHYSICS, CLIMATE AND METEOROLOGY GROUP

2.1. Principal Fields of Research in the period 1999-2002

- Atmospheric Physics - Aerosols, Clouds, Remote Sensing, Electric Processes, Nucleation and Fog Formation
- Climate, Climate Change and Impacts

- Mesoscale Meteorology
- Energy and Mass Transfer Processes – Enclosures and Porous Media Indoor Aerosol Transport and Deposition

2.2. Principal Results

Installation of the Atmospheric Observatory in Évora for:

- **Aerosol Characterization and Identification** of Major Sources of Aerosols over Portugal : Columnar (ground-based and satellite) and in situ aerosol optical properties, modelling aerosol optical properties, aerosol dynamics and aerosol radiative forcing.
- **Characterization of the Atmospheric Radiative Field:** Spectral radiances and fluxes, broadband fluxes.
- **Meteorological Network**

Due the main synoptic/pollution conditions find in **Évora**, the site has been **elected** for permanent inclusion in the world-wide **network of sun/sky radiometers** managed by NASA (**AERONET**, **AErosol RObotic NETwork**). **Cabo da Roca** site has also been elected for permanent inclusion in the **AERONET**, under the **DAEDALUS/CREATE** project

- *Development of an Operational Aerosol Prototype for correction of MSG Satellite images- EUMETSAT SAF Land.*
- *Installation of an experimental set up for:*
 - Indoor Aerosol Transport and Deposition.
- *Development of a Uv-Vis Spectrometer Prototype for:*
 - Trace Gases Detection;
 - Satellite Retrieval of Gases.
- *Development of a mesoscale meteorological model.*
- *Development of Regional Scenarios of Climate Change for Continental Portugal.*
- *Participation in Intensive Field Campaigns*

2.3. Organization of Scientific Conferences

- International Meeting “**Climate Change and the Kyoto Protocol**”, Évora, 15-16 November 2001, 300 participants, 11 invited speakers, 6 invited experts from Portuguese Organizations various fields of activities.
- School “**Porous Media in Modern Technologies**” which will be organized in Évora, 17-21 June 2002, with 60 participants.

2.4 Advanced Training

- **Master Course on *Climate and Atmospheric Environment*** since 2001/2002. (UE+IM)
- **Post Graduate Positions:**
 - 6 Pos-Doc
 - 6 Ph.D. Students
 - 10 Master Students
- **Graduate Positions:**
 - 4 Students

2.5. Projects R&D

ACE-2 Clear Sky Column Closure Experiment

State: Concluded (1999)

Coordination: IFT (Leipzig-Germany)

ROCA- Rede de Observação da Composição da Atmosfera

State: Concluded (2002)

Coordination: IM

EUMETSAT Satellite Application Facility on Land Surface Analysis- SAF- Land

State: Current (1999-2004)

Coordination: IM (EUMETSAT)

Dynamics of aerosol particles in buildings

State: Current (2001-2003)

Coordination: CGE (Sapiens)

Long Term and Spatial Remote Sensing of Aerosol Optical Properties and Dynamics

State: Current (2002-2005)

Coordination: CGE (Sapiens)

Development of an Aerosol Database for Assimilation and other environmental Use- DAEDALUS-CREATE

State: Current (2003-2006)

Coordination: LOA (EU)

Observatory and Laboratory in Earth Sciences, Atmospheric Sciences and Climate

State: Pending

Coordination: CGE

Water Resources : The Influence of Climate Change in Europe (WRINCLE)

State: Concluded (2002)

Coordination: EC

Modelling Impacts of Climate Extremes (MICE)

State: Current (2002-2005)

Coordination: EC

Sustainable Water Uncertainty, Risk and Vulnerability in Europe (SWURVE)

State: Current (2002-2005)

Coordination: EC

Clouds, Aerosols, Portugal Experiment (CAPEX): AERosols Over PORTugal: Optical and Radiation Measurements (AEROPORT), Clouds, Aerosols and Microstructure (CLAMI) and Vertical Profiles of Radioactive Aerosol Constituents Over Portugal (VPRACOP), that was submitted to the CAATER (Co-ordinated Access to Aircraft for Transnational Environmental Research)-

State: Current (2004)

Coordination: CGE/ICAT, ITN Funding Entity: EU.

2.6. Publications

Ph.D Thesis:

QIAN, Budong, Prof. João Corte Real, 2000: “Precipitation over Europe and Large-Scale Climatic Variability”.

XU, Hong, Prof. João Corte Real, 2000: “Downscaling Local Precipitation from Large-Scale Atmospheric Circulation”.

Elias, Thierry, Prof. C.Devaux, 2000, “ Restitution des proprietes optiques et Microphysiques des aerosols a partir d’observations sol des luminances totale et polarise dans le visible et le proche infrarouge”, LOA, Université de Lille, France.

Books (author)

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Proceedings (Editor)

2002

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2001

Climate Change and the Kyoto Protocol, Eds:**Rui Namorado Rosa, João Corte Real, Ana Maria Silva**, University of Évora, 2001- 172430/01

Books (chapters)

2002

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P.G.Lind, J.Corte-Real and J.A.C.Gallas (2002): “Using advection to control the velocity of patterns in rings maps”, *Physica D*, 168-169, 93-105.

P.G.Lind, J.Corte-Real and J.A.C.Gallas (2002): “Modeling velocity in gradient flows with coupled-map lattices with advection”, *Physical Review E*, 66, 016219.

Antonio Endler and **Jason A.C.Gallas** (2002), “Arithmetical signatures of the dynamics of the Hénon map”, *Physical Review E*, 65, 036231.

A. F. Miguel, A. H. Reis :“Transient forced convection in an isothermal fluidsaturated porous-medium layer: effective permeability and boundary layer thickness”, *Journal of Porous Media* (2002) [submitted for publication]

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M. J. Costa, Marco Cervino, Elsa Cattani, Francesca Torricella,Vincenzo Levizzani, **Ana Maria Silva**.”Aerosol characterization and optical thickness retrievals using GOME and METEOSAT satellite data”. *Meteorology and Atmospheric Physics*, 81, 289-298, 2002.

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Reis M.J., Rosa R., Bettencourt A.O., Brogueira A.L., “Size Distributions of Short-Lived Radon and Thoron Daughters and Cosmogenic ⁷Be Associated with Aerosols in the Surface Air at Sacavém (Lisbon)”, submitted to *Applied Radiation and Isotopes*(2001).

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