

ITALY

INTRODUCTION

Italy is active in many areas of stratospheric research, including atmospheric processes, monitoring of Ozone and UV levels, modeling of Ozone and related species. Research is performed by university departments and Italian Research Council's (CNR) groups. Research activities are supported principally by the Italian government, Italian Space Agency (ASI), European Space Agency (ESA) and European Union.

Following the **Decision V/3** (recommendations of the fourth meeting of the Ozone Research Managers taken by the Fifth Meeting of the Conference Parties to the Vienna Convention for the Protection of the Ozone Layer), Italian research groups are particularly active in:

- monitoring and archiving of measurements of tropospheric and stratospheric ozone and other trace species and aerosols;
- developing and implementing new observational capabilities such as aircraft-based measurements;
- investigating and quantifying stratospheric and tropospheric processes through routine monitoring and experimental campaigns;
- studying the interaction between ozone and climate and the impact of aircraft emission on ozone.

RESEARCH ACTIVITIES

The main directions of ozone research in Italy can be summarized as follows:

- **Ozone monitoring.** A series of stations is taking routine measurements on ozone, UV radiation and chemical compounds.
- **Ozone related studies (observations and process study).** This is being carried out mainly through coordinated activity in the fields (campaign) in different part of the world. Italy has been an active part in developing and operating a new airborne platform for stratospheric measurements.
- **Modeling activity** in connection to the development of the algorithms for the use of satellite data. This activity also include Chemical and Transport Modeling of the stratosphere and trajectory modeling to interpret the field data and assessment studies carried out with a class of models.

1. Ozone monitoring

Routine daily measurements of column ozone are carried out at the stations of Vigna di Valle (42.1 N, 12.2 E), Sestola (44.2 N, 10.8 E), Brindisi (40.6 N, 17.9 E) and Messina (38.2 N, 15.5 E) by Servizio Meteorologico of Aeronautica Militare, by means of three Dobson and four Brewer spectrophotometers. Data from these stations are regularly sent to the WMO3UDC in Toronto.

Routine measurements are also carried out at Ispra (45.8 N, 8.6 E) and Rome (41.9 N, 12.5 E) using a Brewer spectrometers managed by University of Rome "La Sapienza".

Ozone sounding and Dobson readings at S. Pietro Capofiume station (44.6 N, 11.6 E -WODC station 297) were performed on a weekly base from 1991 to 1997, and after that during short time campaigns in the frame of EU project (such as Match or Votalp) and for key studies. Also, in conjunction with campaigns, ozone soundings are taken at university of L'Aquila (12E, 43N).

ENEA (National Agency for the Environment and the Energy) operates a station for climate observation on the Lampedusa Island (35.5 N, 12.5 E), where it performs routine observations of ozone and UV using a Brewer spectrometer. Stratospheric aerosols are being monitored from the lidar site of Brasimone in central Italy

Regular measurements of column and tropospheric ozone as well as of selected greenhouse gases are performed at the GAW observatory of Mt. Cimone (northern Apennines, 2150 m) maintained by the Aeronautica Militare.

ISAC/CNR coordinates daily measurements of total ozone and nitrogen dioxide, performed by means of a Differential Optical Absorption Spectrometer (DOAS), at the following stations: M.te Cimone (since 1994), Terra Nova Bay-Antarctica (since 1995) and Stara Zagora-Bulgaria (since 1999).

Other monitoring activities are carried out by ISAC/CNR using brewer instruments installed seasonally in Ushuaia (Argentina, 54°S) and steadily in Antarctica at Scott and Belgrano stations.

A daily bulletin on the UV-B radiation exposure times is disseminated to the public since the summer 1995 by ENEA, in a collaboration with Ministero per l'Ambiente, following methods used by the Atmospheric Environment Service of Canada, and University of Thessaloniki (Greece).

2. Ozone observations and process studies

Many research groups are involved in programs addressed to the study of stratospheric ozone and related problems.

- Observations

At present lidar instruments from Italian institutions or within international collaborations are operational at some stations which participate in the Network for Detection of Stratospheric Changes, NDSC, i.e. at Thule (76.5 N, 68.8W, Greenland, University of Rome "La Sapienza"), Lauder (New Zealand, IFAC/CNR), Dumont d'Urville and McMurdo (Antarctica, IFAC/CNR and ISAC/CNR). From these stations lidar observations of stratospheric aerosol, temperature and ozone are carried out. In particular, the formation, evolution and climatology of Polar Stratospheric Clouds, and their influence on the ozone depletion process, are studied in the high latitude regions during the winter and spring seasons.

Aerosol depolarization, multi-wavelength backscattering and, occasionally, ozone profiles are measured at Rome and Florence. Measurements of aerosol and temperature profiles are carried out from Frascati: the long term behavior of the thermal structure of stratosphere and mesosphere and the propagation of gravity waves are among the main arguments of study. The evolution of the temperature profile and of the gravity waves is studied at Brasimone with a Rayleigh and Na resonance scattering lidar.

An high resolution Fourier transform spectrometers for atmospheric emission measurements in the far-infrared spectral range has been developed by ISAC/CNR and deployed on board of stratospheric aircraft and balloons to perform limb sounding observations of minor atmospheric constituents involved in the ozone chemistry. The IBEX instrument (Infrared Balloon Experiment) was flown from the NSBF (National Scientific Balloon Facilities) bases in Texas and New Mexico and from the Italian base of Milo, Sicily.

- APE project

Since 1996 the Airborne Platform for Earth observation (APE) project is being carried out. APE is an international scientific project, which involves also CNR, ENEA, the Italian Antarctic Program and the Universities of L'Aquila and Rome, in a cooperation with Russian institutes (Central Aerological Observatory, CAO).

This project is addressed to the study of the chemistry-physics of the stratosphere by means of instruments installed on a high-altitude aircraft, the M-55 Geophysika (Fig. 1). This aircraft is able to reach 21 km of altitude with a 1500 kg payload. Many of the instruments onboard the M-55 are developed in Italy. The payload includes: (1) a pressurized elastic backscatter Lidar (Air-Borne Lidar Experiment, ABLE) operated by the University of Rome; (2) a Fourier Transform spectrometer (Spectroscopy of the Atmosphere with Far-IR Emission-Airborne, SAFIRE-A) operated by IFAC/CNR (Fig. 2); (3) a DOAS spectrometer (GASCOD) operated by ISAC/CNR; (4) a multi-wavelength backscatter instrument (air-borne MAS) operated also by ISAC/CNR; (5) a chemiluminescent ozone sensor (FOZAN) operated by ISAC/CNR in collaboration with CAO. Various APE field campaigns have been performed in the past: in the Arctic (APE-POLECAT campaign, Rovaniemi, Finland, winter 1996/97), in the tropics (APE-THESEO, campaign, Seichelles, spring 1999) and in the Antarctic region (APE-GAIA campaign, Ushuaia, Argentina, autumn 1999). The M-55 will operate during the 2002-2004 period in the following projects: EUPLEX (European Polar Stratospheric Cloud and Lee Wave Experiment), TROCCINOX (Tropical Convection, Cirrus, and Nitrogen Oxides Experiment) and for the ENVISAT Satellite Validation Mid-lat. and Arctic Campaign. Responsibility for data interpretation and modeling support to all past APE missions has been mostly of the University of L'Aquila.

- ENVISAT validation

Various Italian scientist groups from CNR and University departments will participate to the geophysical validation of the data from the ENVISAT Earth observing satellite. Validation activities are devoted principally to the MIPAS, GOMOS and SCIAMACHY instruments on board the ENVISAT, and will be performed by means of instrumental measurements, theoretical modeling and data assimilation.



FIG. 1: The M55-Geophysika stratospheric aircraft Spectrometer



FIG. 2: The SAFIRE Fourier Transform

3. Modeling

In the IFAC/CNR Institute in Florence observational techniques, instruments and methods of analysis are developed for studying the Earth atmosphere. Since 1995, in the frame of an ESA study involving a large international consortium of scientists, IFAC has developed the algorithm for the near real time Level 2 analysis of MIPAS measurements performed on board the ENVISAT platform. In parallel, IFAC is participating in the AMILD2DA CEE project, involving many international groups working on MIPAS data analysis, and devoted to MIPAS data analysis itself and comparison of the obtained profiles with the products of the other atmospheric instruments on ENVISAT.

University of L'Aquila has contributed to the ozone assessment of WMO/UNEP, by using photochemical modeling based on IPCC scenarios, with the main purposes of studying aviation and stratospheric aerosol effects on ozone. University of L'Aquila participates, in the framework of

the TOPOZ-II projects, to an extensive validation of 3D Chemical and Transport Models (CTM) which uses data from the MOZAIC campaign and ozonesondes. A General Circulation Model (GCM) coupled with a chemical code, is also used to study the upper troposphere and lower stratosphere (UTLS) region, with particular regard to climatic feedback due to aerosol and ozone distribution changing (Fig. 4).

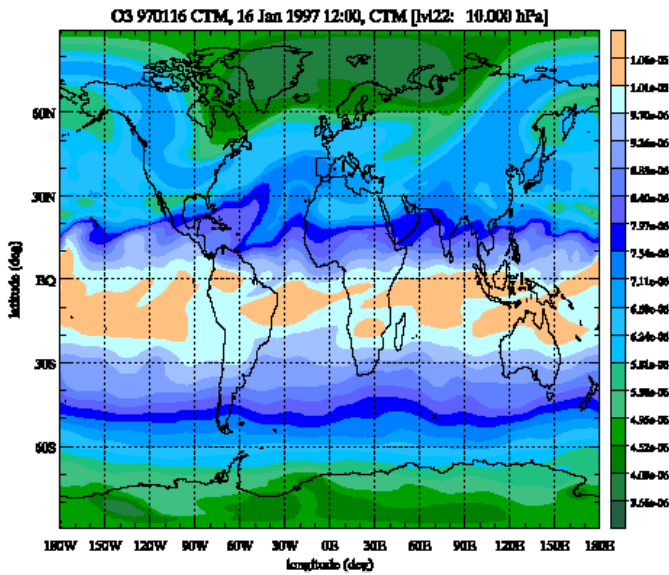


FIG. 3: Example of stratospheric O₃ field assimilated in a 3D Chemical Transport Model from satellite (MLS/UARS) data, for winter 1997.

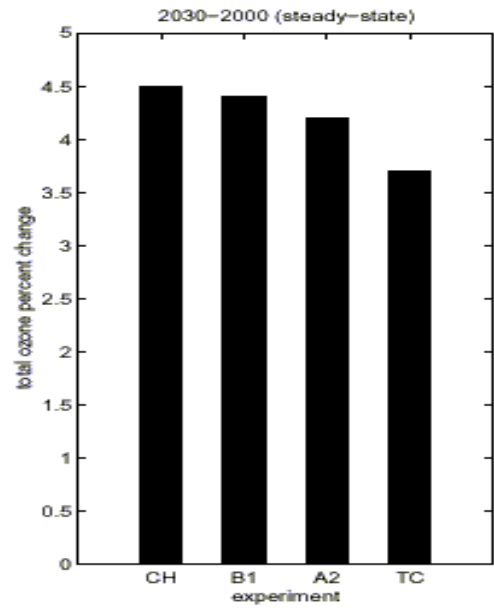


FIG. 4: Example of calculated O₃ % changes under different WMO / IPCC scenarios.
