

**Contribution to the National Report  
(ITALY)  
for the 9<sup>th</sup> WMO/UNEP Ozone Research Managers Meeting of the Parties to the  
Vienna Convention, 14-16 May 2014, Geneva, Switzerland  
PERIOD 2008-2013**

The contributing institutions are:

INSTITUTION	Short name
<i>CETEMPS/Dipartimento di Scienze Fisiche e Chimiche, Universita' degli Studi dell'Aquila, L'Aquila</i>	CETEMPS/UNIAQ
<i>Università degli Studi di Urbino "Carlo Bo", Urbino.</i>	UNIURB
<i>Dipartimento di Fisica, Università di Roma "La Sapienza", Roma.</i>	UNIRM
<i>ARPA Valle d'Aosta (Regional Environmental Protection Agency).</i>	ARPAVDA
<i>CMCC, INGV, Roma.</i>	CMCC/INGV

#### 1. OBSERVATIONAL ACTIVITIES

##### Column measurements of ozone and other gases/variables relevant to ozone loss.

**CETEMPS/UNIAQ:** The ozone total columns observed on routine basis at L'Aquila (683 m asl, 43.38°N, 13.31°E) are derived from the balloon ozone-sonde profiles

**UNIURB:** In situ continuous measurements of Ozone Depleting Substances by Gas Chromatography-Mass Spectrometry at the CNR Atmospheric Research Station "O. Vittori" at Monte Cimone (Northern Apennines, Italy (2165 m asl, 44°11' N, 10°42' E) and weekly measurements of the same gases at the ABC-Pyramid Atmospheric Research Observatory (Nepal, 27.95 N, 86.82 E) located in the Himalayas, Khumbu valley, at 5079 m a.s.l.

**UNIRM:** Total ozone and total nitrogen dioxide observations have been collected since 1992 at Rome (Lat. 41.9°N, Long. 12.5°E, 75m a.s.l) and at Ispra (Lat. 45.8°N, Long. 8.63°E, 240m a.sl) by using two Brewer MKIV spectrophotometers. Brewer MKIV 067 is located at the Physics Dept. of Sapienza University of Rome. Brewer MMIV 066, located at the Environment Institute of the Joint Research Centre, Ispra (Va) until January 2007, was moved to the alpine station of ARPA (Aosta Valley Regional Environmental Protection Agency) at Saint-Christophe, Aosta (Italy), at approximately 100 km east from Ispra. Aerosol optical depth (AOD) retrievals in the UV and visible regions are now available.

**ARPAVDA:** Total ozone and total nitrogen dioxide measurements have been collected sine 2007 in Saint-Christophe (45.74°N, 7.36°E, 570 m a.s.l.), Aosta, using the Brewer MKIV spectrophotometer #66. This instrument, owned by Sapienza – University of Rome, was moved from the Joint Research Center, Ispra (VA), where it has been measuring since 1992. The spectrophotometer is now being operated by ARPA Valle d'Aosta. Estimates of the total ozone content every 30 minutes are available since 2006, retrieved from the Bentham spectroradiometer. The results have been successfully compared with those obtained by the Brewer #66 and OMI satellite data.

### **Profile measurements of ozone and other gases/variables relevant to ozone loss**

**CETEMPS/UNIAQ:** The ozone profiles (balloon-sonde) have been collected since 1994. From 2004 this activity has achieved a routine pace: about 1.5/2 ozone profiles (from ground up to 10hPa altitude) per month (This activity is also part of the commitments included in a Convention between University of L'Aquila/CETEMPS - *Centre of Excellence for the integration of remote sensing techniques and modelling for the forecast of severe weather-* and Italian Government/Ministry of Environment. The Italian Ministry of Environment (*Ministero dell'Ambiente e della tutela del Territorio*) provides the needed resources for the acquisition of the ozone-sondes, the maintenance of the radio-sonde system.). The ozone profiles database has been available for several calibration/validation campaigns.

### **UV measurements**

**CETEMPS/UNIAQ:** *Broadband measurements*

UV-A and UV-B (Yankee Environmental Systems) instruments have been operating since 2004.

**UNIRM:** Spectral UV irradiance (from 290 to 325nm at 0.5 nm stepwidth) have been measured by Brewer spectrophotometer #067 operational since 1992.

**ARPAVDA:** Three UV broadband radiometers (2 KIPP&ZONEN UV-S-AE-T, double band A/E, and 1 Yankee YES UVB-1) have been operating since 2004 at three different sites (Saint-Christophe, 570 m asl, La Thuile, 1640 m asl, and Plateau Rosa, 3500 m asl) to account for the altitude and snow effect.

### **Calibration activities**

**UNIRM:** The absolute calibration of Brewer 067 is made by the IOS inc. (International Ozone Service) almost every year. Furthermore, UV measurements are intercompared with the travelling standard spectroradiometer B5503 from PMOD/WRC (Physikalisch- 10 Meteorologisches Observatorium Davos, World Radiation Center) every two years. The YES radiometer participated into the broadband radiometer inter-comparison at PMOD/WRC at Davos (Switzerland) in August 2006.

**ARPAVDA:** The ozone calibration of Brewer #66 is performed by the IOS inc. (International Ozone Service) almost every two years. UV measurements of the Brewer spectrophotometer and Bentham spectroradiometer are intercompared with the travelling standard QASUME from the PMOD/WRC (Physikalisch-Meteorologisches Observatorium Davos, World Radiation Center) every two year.

The Bentham spectroradiometer is calibrated every month by a local operator by means of 2/3 calibration lamps (portable field calibrators, 200W, from Schreder CMS). The lamps are calibrated by the PMOD/WRC and represent a calibration triad. Cross-calibration between the spectroradiometer and the spectrophotometer are regularly performed. The broadband radiometers spectral response function and cosine response are measured every year in a specialized laboratory (Scheder CMS, Austria).

## **2. RESULTS FROM OBSERVATIONS AND ANALYSIS**

**CETEMPS/UNIVAQ:** Ozone trend analyses: The extended ozone profile database (2004-20013) has got the quality-standards for being used in a preliminary analysis concerning the possible trends of the ozone content in the different atmospheric region. In summary, such studies show that: there is not any significant trend in the lower troposphere; the same in the higher troposphere and in the lower stratosphere (these data have a larger standard deviation). In the middle stratosphere [20-25 km], it is evident a small decreasing in the ozone content (about  $7 \pm 5$  DU/decade) which is consistent with other kind of observations (i.e., IPCC's Special Report on Safeguarding the Ozone Layer and the Global Climate System, 2005)

**UNIRM:** Surface UV radiation: A climatological characterization based on the time series of UV index was carried out. The mean of maximum UV index is ( $7.2 \pm 0.2$ ) at Ispra and ( $8.9 \pm 0.4$ ) at Rome under clear sky conditions. High exposure category ( $6 < \text{UV index} < 7$ ) is more frequent at Rome (32%) than at Ispra (26%). Very high UV indexes ( $\geq 8$ ) occur only at Rome.

**ARPAVDA:** Surface UV radiation: The UV indexes are measured in the three stations. Extreme UV indexes occur in the Alps of Valle d'Aosta: close by 9 at Aosta and La Thuile, during summer, and higher than 12 at Plateau

Rosa, because of the coupled effect of altitude (3500 m asl) and snow cover (perennial snow is always present on the glacier).

### 3. THEORY, MODELLING, AND OTHER RESEARCH

**CETEMPS/UNIVAQ:** Stratospheric and tropospheric Ozone: Research and assessment studies on stratospheric ozone have been made using a global chemistry-transport model (ULAQ-CTM) and a chemistry-climate coupled model (ULAQ-CCM), both including an interactive module for calculation of aerosol formation and growth. Both models have been validated with satellite and aircraft data and then used for future projections of the ozone layer and changes of the ozone radiative forcing on climate. The above models have also been adapted and used for studies of tropospheric ozone and its precursors, as well as for future trends of tropospheric O<sub>3</sub>. CETEMPS/UNIVAQ modelling activities have also contributed to the UNEP/WMO/IPCC: Scientific Assessment of Ozone Depletion: 2006; Chapter 5: Climate-Ozone Connections, *Review Ed. D. Albritton*, 49 pp., Geneva, Switzerland, 2007; and to UNEP/WMO/IPCC: Scientific Assessment of Ozone Depletion: 2006; Chapter 6: The Ozone Layer in the 21<sup>st</sup> Century.

**UNIRM:** Comparison with Ozone and UV satellite data: The daily mean ozone values from Brewer spectrophotometer #067 showed a good agreement with OMI ozone data retrieved by means of both OMI-TOMS 5 (bias=-1.8%) and OMI-DOAS (bias=-0.7%) algorithms. The comparisons between satellite-based and ground-based UV data showed that, on average, OMI UV products exceed ground-based UV measurements by more than 20%. This may be attributed to the fact that the satellite instrument does not effectively probe the boundary layer, where the extinction by the aerosols can be important, mainly in an urban site as Rome.

**ARPAVDA:** Radiative transfer models (e.g. LibRadtran) are routinely used for the forecasts of the UV index in cloudless conditions and for quality control.

**CMCC/INGV:** Global Modeling of Stratospheric Ozone: MAECHAM general circulation models of the troposphere, stratosphere and mesosphere, as well as with one of its version coupled to a stratospheric ozone chemistry model [the MAECHAM4CHEM chemistry climate model (CCM), and its further evolution, the ECHAM5/MESSy1]. CCMs include the full representations of dynamical, radiative, and chemical processes in the atmosphere and their interactions. We have been part of the MAECHAM4CHEM model team that has contributed to the coordinated simulations of past ozone evolution and scenarios of future ozone projection of the last ozone assessment. Analysis of various aspects of the modelling of stratospheric ozone with comprehensive global numerical models

Modelling of shortwave radiative transfer in Atmospheric Global Models. The spectral resolution of the shortwave radiation parameterization used in the Middle Atmosphere (MA) ECHAM5 model has been improved.

### 4. DISSEMINATION OF RESULTS

#### Data reporting

**CETEMPS/UNIVAQ:** The multi-annual UV and ozone profile data can be freely used on request at CETEMPS. Model data for international data centers. Contributions to the forthcoming 2014 WMO/UNEP scientific assessment of the understanding of the depletion of the stratospheric ozone layer.

**UNIRM:** Daily total ozone are submitted to international datacenters at the end of every year.

**ARPAVDA:** Every measurement is published in real time on the website of ARPA. Daily total ozone and B-files are submitted daily to the WOUDC.

**CMCC/INGV:** Preparation of numerical data from the MAECHAM4CHEM model for submission to the British Atmosphere Data Centre (BADC) data center, within the procedures for the last ozone assessment (WMO, 2007).

#### Information to the public

**CETEMPS/UNIVAQ:** An annual report concerning the stratospheric ozone and surface UV levels is yearly compiled within the existing Convention between CETEMPS/UNIVAQ and Italian Government/Ministry of

Environment. The observational procedures and their scientific content are widely exploited along continuous on-site visiting activities (secondary schools, university students, foreign scientists) and press releases.

#### **5. PROJECTS AND COLLABORATION**

**CETEMPS/UNIVAQ, UNIURB, UNIRM, ARPAVDA** and **CMCC/INGV** are involved in several National and International projects.

**This report has been compiled in April 2014.**

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