

## SWITZERLAND

Switzerland has a long tradition of ozone study which started in the twenties in Arosa. A practically uninterrupted monitoring of total ozone was initiated at that time. Later on, other monitoring programs were developed in particular the balloon ozone sounding at Payerne (1968), the radiation network CHARM (1995) and the aerosols monitoring at Jungfraujoch (1995). The monitoring activities are under the responsibility of MeteoSwiss, while a large part of the research activities are seeded in the Universities and research laboratories.

The Swiss contribution to the GAW (Global Atmosphere Watch) has conducted to the development of two WMO calibration centres.

In 1995, Switzerland has contributed to the build up of the ozone sounding station of Nairobi, Kenya. There is a continuing support to this station as technical assistance (regular visit) and operators training and schooling. The data quality control and transmission to the SHADOZ project data base are assured in collaboration with MeteoSwiss.

### Monitoring activities

The monitoring activities under the MeteoSwiss responsibility cover three aspects: **ozone**, **radiation** and **aerosols**.

#### *Operational ozone measurements:*

Ozone is a well developed monitoring activity in Switzerland. The Payerne and Arosa stations are well known for their long record of ozone measurements.

- Total Ozone:
  - Total ozone measured at Arosa with two semi-automated Dobson spectrophotometers (D101 & D062) and three automatic Brewer instruments B040 & B072 (Mark II) and B156 (Mark III).
- Ozone profiles:
  - Balloon soundings at the Payerne aerological station using a Brewer-Mast O<sub>3</sub>-sonde,
  - Umkehr profiles from automated Dobson (D051) and Brewer (B040) instruments at Arosa,
  - Micro-wave radiometer at Bern.

#### *Operational aerosols measurements:*

The aerosol part of the monitoring is based on the measurements conducted at the Jungfraujoch station. Several instruments have been operated since 1995 (a 3-wavelength nephelometer (450, 550 and 750 nm), an aethalometer, a condensation particle counter and an epiphaniometer) by the Paul Scherrer Institute (PSI) in collaboration with MeteoSwiss.

#### *Operational radiation measurements:*

The **Swiss Atmospheric Radiation Monitoring** programme (CHARM) is another task of MeteoSwiss. It consists of 4 stations spread over an altitude range of 366 to 3587 m a.s.l which was built up between 1995 and 2001. The monitoring programme is coordinated with the ozone activities and includes:

- The direct, diffuse and global components of the broad-band erythema UV-ERY radiation (Solar Light UV-Biometers),
- Spectral direct irradiance measurements with Precision Filter Radiometers (PFR) at selected wavelengths in the range 305 nm to 1024 nm.

At Arosa, spectral scans of global UVB measurements using the Brewer instruments are regularly measured since 1988. Direct sun UVB scan will be included this year in the data acquisition programme.

### **Research and development activities associated with the monitoring**

Some of such activities linked to the monitoring activities are listed hereafter:

- Development and improvement of the calibration methods for radiation monitoring instruments in collaboration with the World Optical Depth Research and Calibration Centre at Davos.
- Study of the influence of atmospheric (ozone, cloud cover, aerosol optical depth, water vapour) and geographical parameters (altitude, albedo) on the UV-B variability.
- Improvement of the Brewer-Mast ozonesonde operational procedure and tests of the ECC O<sub>3</sub>-sonde. In particular, it is planned to switch to ECC ozonesonde at Payerne in 2002.

### **Academic activities with an ozone component**

The Institute for Atmospheric and Climate of the Swiss Federal Institute of Technology, Zurich, has different projects related to ozone. In particular, the different ozone series from Payerne and Arosa have been extensively studied. Recently, the following projects have been completed:

- Re-evaluation, homogenisation and trend calculations of the ozone time series: total ozone since 1926, Umkehr series since 1957 and balloon soundings since 1968.
- Ozone and Nitrogen Oxides have been measured along Air Routes with measurements on a Jumbo jet.
- An UV-Index forecast has been developed and related research have been performed on the characteristics of the UV-ERY radiation within the COST 713 Action on UVB forecasting. Presently, MeteoSwiss is forecasting the UV-index during summer.

At the University of Berne, the Institute for Applied Physics has a recognised expertise in the development of passive microwave radiometers. In particular, the following instruments have been developed recently:

- A new microwave receiver for ozone profiling has been developed and it is now in a pre-operational phase. It will be installed at MeteoSwiss in Payerne for monitoring purpose later on this year.
- A microwave radiometer for ozone profiling of the former generation is installed at the University of Bern since 1994 and it belongs to the primary NDSC station Jungfrauoch.
- A new radiometer for the detection of ClO has been installed at Jungfrauoch. It has been built within the EC-project EMCOR and is presently operational there.
- Tools have been developed for the study of aerosol, columnar ozone and water vapour based on narrow-band spectral measurements in the UV and visible range from the CHARM measurements

The Swiss Federal Institute of Technology, Lausanne, is running an ozone LIDAR instrument but with a range limited to troposphere profiling. A laboratory for the study of heterogeneous chemistry of ozone related components is also active in this institute.

Besides the operational monitoring activities, the PSI participates to campaign of intensive measurements with additional equipment at Jungfrauoch. In 2000, the CLACE (Clouds and Aerosol Characterisation Experiment) campaign has been successfully conducted in the February-March period to characterise the free troposphere as well as occasionally the convective boundary layer developed by local convection.

## **Calibration centres**

The WMO has attributed the role of calibration centres to two swiss institutes: ground based ozone instruments calibration centre (WCC) at Swiss Federal Laboratories for Materials (EMPA) and the World Optical Depth Research and Calibration Centre (WORCC) at Davos.

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