



## **Project of Strategic Interest NEXTDATA**

Scientific report for the reference period 01/01/2013 - 31/12/2013

### **WP 1.2 - GAW-WMO climate observatories**

**WP Coordinator: Angela Marinoni**  
CNR-ISAC

**Partners:**  
CNR-ISAC, URT Ev-K2-CNR

## **1. Planned activities and expected results**

Italian Institutions are managing two Global Stations belonging to the GAW-WMO programme: the Italian Climate Observatory “O. Vittori” at Monte Cimone (2165 m asl, northern Apennines) and the Nepal Climate Observatory – Pyramid (5079 m a.s.l., Nepal). Thanks to their location at high altitudes, the measurements performed at these Global Stations are considered well representative of wide geographical areas, which allow an effective characterization of atmospheric variability over large regions and long time frames for two regions (the Mediterranean basin and the Himalayas) particularly affected by anthropogenic pressures and climate change.

During the second year, NextData supported the measurement programmes already in place at these GAW stations. Moreover, several upgrades have been performed at GAW-WMO stations. The measurement upgrade strategies have been defined according to national and international strategies (GAW-WMO, GMES, UE Projects).

## **2. Deliverables expected for the reference period**

D.1.2.4 (PM24): Report on the activities and on the data transmission to the General Portal

D1.2.5 (PM24): Report on the upgrade of GAW-WMO stations with Italian management and related to SHARE Project.

## **3. Activities actually carried out during the reference period**

The observations and study activities have been continued at the GAW-WMO global station Monte Cimone (GAW ID: CMN) and Nepal Climate Observatory – Pyramid (GAW ID: PYR), as already started within the SHARE Project. Within this framework, activities were carried out concerning instrument calibrations and data validations for trace gases (greenhouse and reactive), atmospheric aerosol (chemistry and physics), meteorological parameters and solar radiation fluxes (short-wave and long-wave) observations, according to the guidelines of the GAW-WMO Programme.

During the reference period, data of atmospheric composition were submitted to the GAW-WMO reference data-base (<http://ds.data.jma.go.jp/gmd/wdcgg/>, <http://ebas.nilu.no/Default.aspx>).

Data have been shared with the NextData General Portal..

In the framework of the activities relating WP1.2, ISAC-BO personnel, performed regular visits to Global Station “O. Vittori” (Monte Cimone, Italy) and one annual calibration campaign at Global Station NCO-P (Himalayas - Nepal), the latter with personnel from URT EV-K2-CNR. During 2013, a research contract was signed between CNR-ISAC Bologna and RSE SpA (Ricerca sul Sistema Elettrico SpA), the Institution managing the Plateu Rosa GAW/WMO Regional Station..

Several upgrades at GAW-WMO stations with Italian management were carried out during the second year of NextData, based on feasibility studies performed during first year of project and concerning aerosol, gases and radiation measurements at Monte Cimone, Nepal Climate Observatory-Pyramid, and Plateau Rosa (upgrade activities carried out for the Mt. Portella SHARE station are reported by WP1.1) . The following upgrades are reported in Deliverable D1.2.5.

In particular at **Monte Cimone** the following measurement programs have been upgraded:

*THE DMPS SYSTEM FOR THE MEASUREMENTS OF AEROSOL SIZE DISTRIBUTION FROM 10 nm TO 800 nm HAS BEEN COMPLETELY RENEWED ACCORDING TO GAW/ACTRIS RECOMMENDATIONS.*

*THE SYSTEM FOR THE AEROSOL SCATTERING COEFFICIENT DETERMINATION (MEASURED SINCE 2007 AT 525 nm) HAS BEEN UPGRADED WITH MEASUREMENT IN TWO ADDITIONAL WAVE LENGTH: 450 AND 700 nm.*

*A SYSTEM FOR THE AEROSOL SIZE DISTRIBUTION DETERMINATION FROM 500 nm TO 20 µm BASED ON THE ANALYSIS OF THE TIME OF FLIGHT OF AEROSOL PARTICLES WAS SET UP IN JULY 2013.*

*A FEASIBILITY STUDY FOR THE EXECUTION OF AOD MEASUREMENTS HAS BEEN CARRIED OUT.*

*A SYSTEM FOR THE CONTINUOUS MEASUREMENTS OF NITROGEN OXIDES (NO<sub>x</sub>), NITRIC OXIDE (NO) AND NITROGEN DIOXIDE (NO<sub>2</sub>) WAS TESTED AT THE ISAC LABORATORIES IN BOLOGNA.*

*A SYSTEM FOR THE CONTINUOUS MEASUREMENTS OF (SO<sub>2</sub>) SULFUR DIOXIDE MEASUREMENTS WAS TESTED AT THE ISAC LABORATORIES IN BOLOGNA*

*THE MT. CIMONE INFRASTRUCTURE HAS BEEN UPGRADED TO HOST A LIDAR SYSTEM (TESTED DURING 2012) FOR CONTINUOUS DETERMINATION OF AEROSOL PROFILES.*

At **Nepal Climate Observatory-Pyramid** the following improvements concerning aerosol and gases measurements have been carried out:

*THE SYSTEM FOR AEROSOL SIZE DISTRIBUTION MEASUREMENTS FROM 10 nm TO 800 nm HAS BEEN COMPLETELY RENEWED AT LGGE LABORATORIES (FRANCE) ACCORDING TO GAW/ACTRIS RECOMMENDATIONS.*

*A FEASIBILITY STUDY FOR THE EXECUTION OF CONTINUOUS (SO<sub>2</sub>) SULFUR DIOXIDE MEASUREMENTS HAS BEEN CARRIED OUT.*

*A NEW SAMPLING PROGRAMME FOR CARBON ISOTOPES STARTED IN SPRING 2013.*

At **Plateau Rosa** GAW/WMO Regional Station

*A NEAR-REAL-TIME DATA DELIVERY SYSTEM HAS BEEN ACTIVATED. THIS WILL ALLOW THE PROVISION OF NEAR-REAL TIME DATA OF GREENHOUSE GASES (CO<sub>2</sub>, CH<sub>4</sub>, O<sub>3</sub>) TO THE NEXTDATA ARCHIVES AS WELL AS TO INTERNATIONAL INITIATIVES, E.G. THE EU MACC-2 PROJECT.*

*THE ACQUISITION OF A SECONDARY O<sub>3</sub> CALIBRATOR BY THE ISAC-BO LABORATORIES AND THE LINK WITH THE WORLD CALIBRATION CENTER AT EMPA, CAN HELP IN CREATING A DIRECT LINK BETWEEN O<sub>3</sub> MEASUREMENTS AT PLATEAU ROSA WITH THE GAW-WMO REFERENCE SCALE.*

### *3.1 Research Activities*

At the **Nepal Climate Observatory – Pyramid (NCO-P)**, a feasibility study for the realization of a field campaign (in collaboration with Helsinki University and Paul Sherrer Institute) for

studying processes involved in the new particle formation phenomenon has been performed. As a first step the need of sulfuric acid measurements was highlighted. Due to the high power consumption and effort for maintain a CI-APiTOF, the choice was diverted to a SO<sub>2</sub> UV-fluorescence analyser, that is a more robust instrument. A "state of the art" SO<sub>2</sub> instrument similar to that "already identified for ICO-OV is planned to be installed in Spring 2014 at Nepal Climate Observatory –Pyramid.

During May 2013, a maintenance campaign was undertaken at NCO-P to check and calibrate the experimental set-up. Technicians and researchers from URT Ev-K2-CNR, ISAC BO and the Nepali Pyramid personnel, participated in this campaign. ISAC-BO personnel also assessed the results of the major technical interventions carried out at NCO-P. The Scanning Mobility Particle Sizer has been removed for upgrades (actually ongoing at Laboratoire de Glaciologie et Géophysique de l'Environnement in Grenoble) and replaced by a Condensation Particle Counter, which allows to detect the total aerosol particles number concentration. Currently, this system is under a complete revision in order to completely fulfil the recommendations described in Wiedensohler et al (2011), and suggested both by the ACTRIS Project and the GAW programme.

On 2013 a new collaboration between ISAC-BO and Stockholm University was established with the goal of measuring the ratio of Carbon isotopes in the aerosol particles at NCOP, useful for evaluate the fractionation of BC from different sources (e.g. fossil fuels vs biomass). A new special protocol for the aerosol sampling, based on the use of a high volume PM<sub>10</sub> sampler, has been developed together with Stockholm University: the Nepalese staff has been trained for this new activity during the calibration campaign in Spring 2013. The sampling program foresees one long duration sample for each season: the correct time of sampling has been evaluated on the basis of the analysis of black carbon climatological concentrations observed at NCOP in the previous years. The sampling activity started on 18 May 2013. Once available, the results will contribute in better defining the contribution of combustion processes related to biomass burning against those related to fossil fuels on the atmospheric composition properties in the Himalayas. This represents one of the major "scientific questions" in the Himalayan region, as also defined in the framework of the ABC-UNEP Project.

At the GAW-WMO Global Station **Monte Cimone**, the DMPS system has been completely re-designed, according to the ACTRIS/GAW recommendation. The new revisited instrument participated to the Intercomparison workshop (organized in the framework of ACTRIS at World Calibration Center for Aerosol Physics, hosted at Leibniz Institute for Tropospheric Research), where new modifications were suggested in order to improve the instrument functionalities. The DMPS will be tested again in May 2014 at WMO World Calibration Center for Aerosol Physics.

The observation program for the aerosol scattering coefficient has been upgraded with a new integrating nephelometer (TSI 3563), which is able to measure both scattering and backscatter coefficient at three different wavelengths (scattering coefficient has been measured at Monte Cimone since 2007, only at 525 nm wavelength). The main goal of this measurement program is to determine the variability of aerosol scattering coefficient at Monte Cimone as a function of air mass origins and to well characterize the aerosol scattering variability in the Mediterranean basin. Together with data of absorbing coefficient (measured at Monte Cimone by MAAP and Aethalometer), these data can be used to estimate the direct aerosol radiative forcing for the region.

An Aerodynamic Particle Sizer (TSI model 3321) has been added to the instrumental equipment of the Monte Cimone Station: it will be used as reference instrument to investigate how different air masses affect the size distribution of aerosol particles. In particular, the new instrument allows to improve the detection and the characterization of Saharan dust transport and anthropogenic pollution. It has been installed in July 2013, continuously providing aerosol size distribution from 500 nm to 20  $\mu\text{m}$ .

A further (major) upgrade foreseen for Monte Cimone is the implementation of a system able to provide continuous AOD measurements. A PFR (Precision-Filter-Radiometer) sun photometer system has been identified as the best solution, as recommended by WMO/GAW. In collaboration with the EU Project ACTRIS, two systems for the measurements and the investigation of  $\text{NO}_x$  and  $\text{SO}_2$  variability at the GAW/WMO Global Station Monte Cimone were implemented at the ISAC-BO laboratories in Bologna and will be installed in Monte Cimone in February 2014. In particular, an enhanced system for  $\text{NO}_x$  measurements based on the Chemiluminescence detection was equipped with a photolytic converter. This system was coupled with a calibration device for gas phase titration and dilution. The system is based on a commercial instrument which has been modified with the purpose of reaching the Data Quality Objective indicated by ACTRIS/GAW/WMO for "enhanced" measurement sites.

During the first reference period, a LiDAR system was installed at the Mt. Cimone Station on October 2012, on the equipped terrace. The instrument was equipped with a special system for snow and ice removing which, however, appeared to be ineffective due to the harsh weather conditions affecting the measurement site. With the aim of starting a continuous LIDAR monitoring programme and to allow the installation of the system inside the building, the Station has been equipped with a specific heated quartz window. .

### *3.2 Applicative, technological and information developments*

- The upgrade of Differential Mobility Particle Sizer for aerosol size distribution measurement was carried out at Monte Cimone. Both software and hardware has been modified.
- Labview© and Python software have been created to manage the analysers which will be devoted to the measurements of the nitrogen oxides ( $\text{NO}_x$ ), nitric oxide (NO) and nitrogen dioxide ( $\text{NO}_2$ ) and sulfur dioxide ( $\text{SO}_2$ ). Moreover, specific software have been created to manage the calibration and the data acquisition.
- At the GAW/WMO Plateau Rosa Station a service for the NRT data delivery ( $\text{O}_3$ ,  $\text{CH}_4$ ,  $\text{CO}_2$ ) has been implemented.
- At the Mt. Cimone Station, services for the NRT data delivery of CO and aerosol particle number has been implemented.
- New sampling for carbon isotopes started at NCOP in Spring 2013, a special sampling protocol has been established.

### *3.3 Training activities*

During the calibration campaign at NCO-P (Nepal), activities devoted to the training of local staff were continued with the aim of increasing their ability to manage and maintain the experimental instrumentation. A special attention was dedicated to the aerosol sampling with different protocols.

A PhD programme has been activated: “ Investigation of ozone and black carbon variability in Himalayas” .

### 3.4 Dissemination

None in the reference period.

### 3.5 Participation in conferences

BONASONI P., A. MARINONI, P. CRISTOFANELLI, B. ADHIKARY, D. PUTERO, R. DUCHI, F. CALZOLARI, S. DECESARI, T. LANDI, P. LAJ, M. MAIONE, J. ARDUINI, E. VUILLERMOZ, G. VERZA, M. ALBORGHETTI, M. SPRENGER, and S. FUZZI: Aerosol and trace gas observations from the NCO-P station: a multi-year analysis. *Workshop on atmospheric composition and the Asian summer monsoon*, Kathmandu, Nepal, 9-12 June 2013.

CRISTOFANELLI P.: Atmospheric Brown Cloud studies in the high Himalayas at the GAW/WMO global station Nepal Climate Observatory - Pyramid (5079 m a.s.l.). *GAW 2013 Symposium*, WMO Secretariat, Geneva, Suisse, 18-20 March 2013.

PUTERO, D., VUILLERMOZ, E., ADHIKARY, B., MARINONI, A., CRISTOFANELLI, P., DUCHI, R., CALZOLARI, F., FUZZI, S., LANDI, T. C., VERZA, G. P., ALBORGHETTI, M., and BONASONI, P.: Aerosol and ozone observations at Pakanajol, Kathmandu, and NCO-P, Himalaya, during the SusKAT-ABC field campaign. *SusKat-ABC Data Workshop*, Kathmandu, Nepal, 27-29 August, 2013.

BOURCIER L, G. ZACCARIA, A. MARINONI, P. CRISTOFANELLI, R. DUCHI, and P. BONASONI: Climatology of dust events at Mt Cimone (2165 m a.s.l.), Italy. *The 2013 European Aerosol Conference (EAC 2013)*, Prague 1-6 September, 2013.

## 4. Results obtained during the reference period

### 4.1 Specific results (databases, measurements results, model outputs, etc).

Activities at the GAW-WMO global station Monte Cimone and Nepal Climate Observatory – Pyramid, resulted in a data-base concerning meteorological parameters, trace gases mixing ratios and atmospheric aerosol. Observations have been submitted to GAW WDCGG, EBAS and ABC DISC databases.

### 4.2 Publications

MARINONI, A., CRISTOFANELLI, P., LAJ, P., DUCHI, R., PUTERO, D., CALZOLARI, F., LANDI, T.C., VUILLERMOZ, E., MAIONE, M., BONASONI, P., 2013: High ozone and black carbon concentrations during pollution transport in the Himalayas: five years of continuous observations at NCO-P global GAW station. *J. Environ. Sci.* 25 (8)1618-1625.

CRISTOFANELLI, P., DI CARLO, P., ALTORIO, A.D, DARI SALISBURGO, C., TUCELLA, P. BIANCOFIORE, F., STOCCHI, P., VERZA, G.P.,LANDI, T.C., MARINONI, A. CALZOLARI, F., DUCHI, R. AND BONASONI, PAOLO. 2013: Analysis of Summer Ozone Observations at a High Mountain Site in Central Italy (Campo Imperatore, 2388 m a.s.l.). *Pure and Applied Geophysics*, pp. 1-15.

PUTERO, D., LANDI, T.C., CRISTOFANELLI, P., MARINONI, A., LAJ, P., DUCHI, R., CALZOLARI, F., VERZA, G. P., AND BONASONI, P., 2014: Influence of open vegetation fires on black carbon and ozone variability in the Southern Himalayas (NCO-P, 5079 m a.s.l.). *Environmental Pollution*, 184, 597-604.

#### *4.3 Availability of data and modeling output (format, support, etc.)*

Please, see Deliverable D1.2.4

#### *4.4 Completed Deliverables*

D1.2.4: Report describing the activities, data transfer to archives and to the General Portal

D1.2.5: Report on the upgrade of GAW-WMO stations with Italian management and related to SHARE Project.

#### **5. Comment on differences between expected activities/results/Deliverables and those which have been actually performed.**

No difference between expected activities and those which have been performed.

#### **6. Expected activities for the following reference periods**

- Continuation of observation and investigation activities at the GAW-WMO Global Station led by Italian Institutions (implementation of measurement programmes and technological facilities).
- Prosecution of the upgrade activities at remote GAW-WMO stations in Italy and at other SHARE stations.
- The scientific community will be informed about the upgrade/implementation activities at the stations. The obtained data will be shared.