Project of Strategic Interest NEXTDATA

WP 1.2 - GAW-WMO climate observatories

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

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Report on upgrade carried out at GAW Global Stations "O. Vittori" at Monte Cimone and Nepal Climate Observatory Pyramid in the Himalayas

1. "O. Vittori" at Monte Cimone (2165 m, Northern Appenines)

The upgrades carried out at Monte Cimone station concern aerosol, gases and radiation measurements. In particular the following measurement programs have been upgraded:

- Aerosol size distribution from 10 nm to 800 nm has been completely renewed according to GAW/ACTRIS recommendations.
- Aerosol scattering coefficient measured since 2007 at 525 nm has been upgraded with measurement in two additional wave lengths: 450 and 700 nm.

Moreover, the following measurement programs have been newly started:

- The aerosol size distribution from 500 nm to 20 μm based on time of flight was set up in July 2013.
- Radiation measurement program (feasibility study).
- Continuous nitrogen oxides (NOx), nitric oxide (NO) and nitrogen dioxide (NO2) measurements suitable for remote high-mountain stations (on test at Bologna laboratories).
- Continuous of (SO_2) sulfur dioxide measurements is on test in Bologna laboratories, ready for installation at CMN station.
- Observations of aerosol vertical profiles have been carried out at Mt. Cimone. After a test installation in October 2012, several improvements were carried out in order to guarantee continuous observations also during winter season.

I. Aerosol size distribution from 10 nm to 800 nm

The number size distribution of atmospheric aerosol particles is a basic, but essential parameter required in calculations of the effects of aerosols on climate, human health, and eco-systems. It is also an important parameter with regard to the description of aerosol dynamical processes as well as heterogeneous chemical reactions in the atmosphere.

In particular particle size distribution constrains:

i. aerosol radiative forcing, as they directly relate to the optical properties of an aerosol population,

ii. cloud forming capacity of an aerosol population, as they directly relate to the number of available cloud condensation nuclei (CCN),

iii. the health impact of aerosols, as they provide useful information on the lung-penetrating fraction of the aerosol population.

An accurate knowledge of long-term particle number and size variability is therefore clearly relevant to aerosol and climate sciences. In particular very little information exists to date from high altitude remote sites. An important phenomenon associated with the atmospheric aerosol system is the formation of new atmospheric aerosol particles. Once formed, aerosol particles need to grow further to sizes >50-100 nm in diameter until they are able to influence climate, even though smaller particles may have influences on human health and atmospheric chemistry.

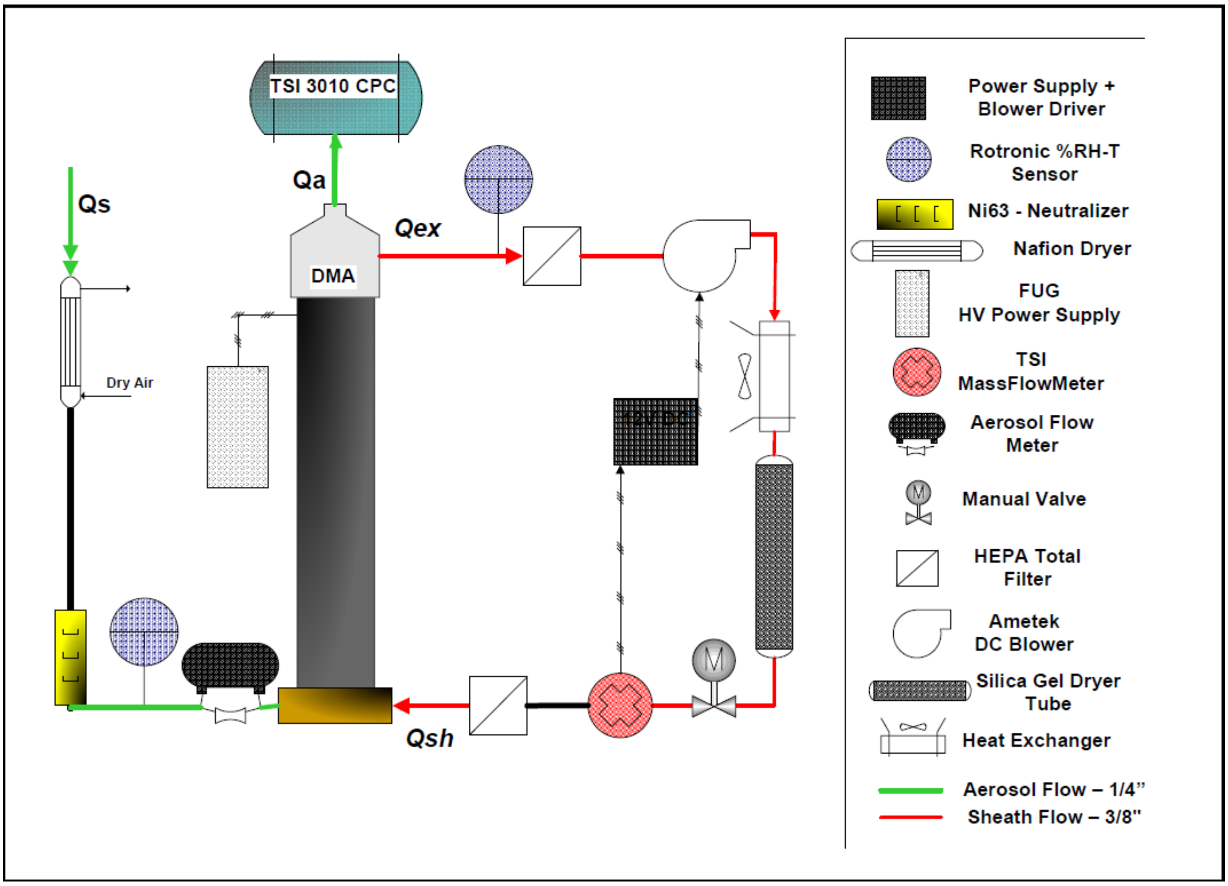

Fig. 1. Layout of the new DMPS system with DC blower arrangement.

In order to study these different processes, a Differential Mobility Particle Sizer (DMPS) was installed at ICO-OV in November 2005, in collaboration with Kuopio University (Finland) and it was upgraded in 2008, partially following the mandatory recommendations of EUSAAR EU-project, in particular sensor for monitoring physical parameters in the two main flow of the instrument were added (T/RH measurements in sheath and aerosol flow). The DMPS has been re-built in summer 2013, organized in a new small rack and a new hardware and software set up is ongoing. Layout and characteristics of the new system are summarized in Figure 1. The main improvement was the replacement of a vacuum pump with an adjustable blower and the modification of the sheath flow from 10 to 5 Lpm.

The technical characteristics of the part used in the new system are:

1. **Aerosol Nafion Dryer**: L =12”, Diam.Int =0.11”, fittings 1/4”. Aerosol Sample Flow = 1 l/min. Purge Flow(Dry Air) = Max 3 x (Aerosol Sample Flow).
2. **Neutralizer Ni63**: fittings 1/4”.
3. **Aerosol Flow Rotronic SC04 RH-T Sensor**: Diam.Probe =4 mm inserted in aT-fitting stainless steel 1/4”.
4. **Aerosol Flow Meter** (PFM): flow meter built with a pressure transducer (Druk, 0-20 mbar, 0-10V, Vcc=10-30V) and a calibrated critical orifice (made in an Anticorodal support and orifice with Di=1.1mm). The calibration curve (Fig 2) was obtained by comparing Volt signal of differential pressure sensor and flow value measured by TSI Mass flowmeter, varying the flow using a needle valve in the range 0.8 - 2 l/min. The equation shown in Figure 2 was used in the LabView acquisition program for conversion of differential pressure (mbar) into flow measurement (L/min).

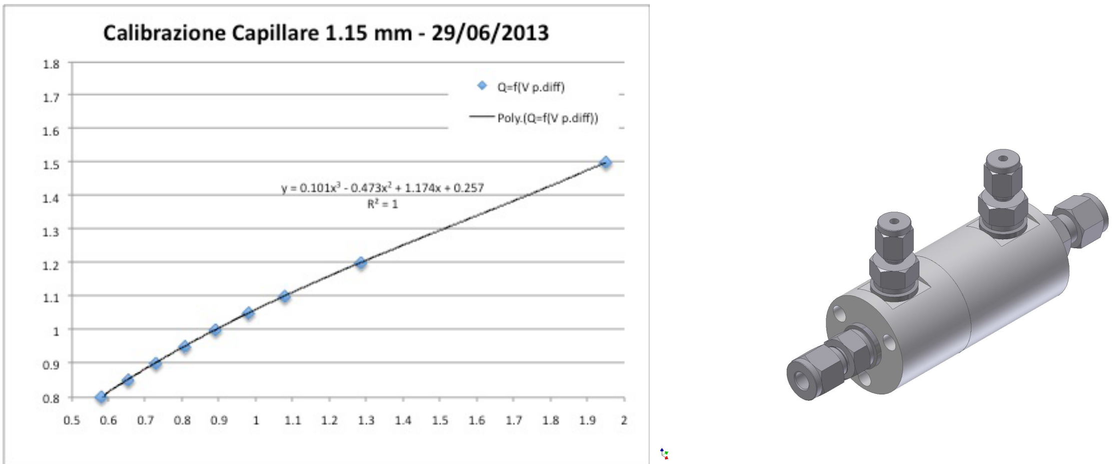

Fig. 2. Calibration curve for ΔP, pressure transducer used in the aerosol flow line.

5. **DMA Vienna Type**: L= 28 cm, Di= 25 mm, De= 33 mm.
- Qs (aerosol sample flow) = 1.00 lpm
- Qa (mono-d. aerosol sample flow) = 1.00 lpm
- Qsh (DMA sheath flow) = 5.00 lpm (regulated by Blower Driver)
- Qex (DMA excess flow) = 5.00 lpm (come Qsh essendo in “closed loop”)

6. **SheathFlow Rotronic SC04 RH-T Sensor**
7. **Two Hepa Total Filter**
8. **DC Blower Ametek**: 12V DC Brushless Motor (1A max). Set up for regulating a sheath flow of 5 l/min in a closed loop with DMA, circuit realized with silicon tubes. The flow regulation is managed by a microprocessor (ATMEL, Arduino Mini Pro, 5V) and electronic Driver for brushless motor, through a MassFlowMeter TSI.
9**. Heat Exchanger**: exchanger air/air, with blower supplied at 220 Vac.

In Figure 3, the DMPS in the previous and current configuration is shown: the new system is much more compact, portable and completely fulfills the recommendations described in

Wiedensohler et al (2011), suggested both by the ACTRIS and GAW programs. Moreover, thanks to the improvements applied, the system (different flow ratio between aerosol and sheath) that measured the size distribution from 10 to 500 nm, is now able to work in a larger range: from 10 to 850 nm.
The system in the new version participated in an intercomparison workshop, organized in the framework of the ACTRIS Project by World Calibration Center for Aerosol Physics, hosted at Leibniz Institute for Tropospheric Research (*TROPOS*), Leipzig, Germany. The results of the intercomparison suggested further improvements both on the hardware and on the software of DMPS System. The upgrade is actually ongoing in ISAC Laboratories at Bologna and DMPS is actually not measuring at Monte Cimone.

Fig. 3. DMPS as installed in November 2005 at Monte Cimone (left) and the new system re-built in July-August 2013 (right).

II. Aerosol scattering coefficient observation at three wave lenghts

Ambient aerosol particles play an important role in the overall energy balance of the atmosphere by scattering and absorbing incoming and outgoing solar and terrestrial radiation (the "direct effect") and by modifying microphysical properties of clouds (the "indirect effects") through their role as cloud condensation nuclei. The determination of the direct effects of aerosols on the earth radiation balance requires quantitative information on the optical properties of atmospheric aerosols.

Through scattering and absorption of solar radiation, aerosols can cool or warm the Earth's atmosphere and alter the climate. Measuring the scattering variability is an attempt to understand how the aerosol optical properties vary with time, season and long range transport of pollutants.

Fig. 4. The new instrument, ready for installation at Monte CImone.

The main goal of this measurement program is to determine the variability of aerosol scattering coefficients at Monte Cimone in relation to air mass origins, and to derive information to describe the most common conditions observed at this location. In addition, observed values of the scattering coefficient, combined with absorption, can be used to estimate the direct aerosol radiative forcing for the region.

Aerosol scattering coefficient is continuously observed at Monte Cimone since April 2007, through an Ecothech M9003 instrument, working at one wavelength (525 nm).

In the framework of the NextData Project, the observation program has been upgraded with a new integrating nephelometer (TSI 3563) that is able to measure both scattering coefficient and backscatter at three different wavelengths. This instrument detects scattering properties by measuring light scattered by the aerosol and subtracting light scattered by the gas; the three-wavelength model splits the scattered light into red (700 nm), green (550 nm) and blue (450 nm) wavelengths, and measures back-scattered light at these wavelengths as well. It offers sensitivity to light scattering coefficients lower than 10^7 $meter^{-1}$ (blue and green wavelengths), much lower better than the previous instrument. Moreover, this has the advantage of selectable averaging time, allowing data to be tailored to different test requirements. It includes temperature and humidity sensors.

This three-color nephelometer allows to measure both total and backscatter signals at different wavelengths, allowing to derive the wavelength dependency of aerosol scattering coefficient and many other parameters, useful for characterizing optically, physically and even chemically the aerosol type. As an example, the calculated Ångström exponent is often used for aerosol characterization: changes of Ångström exponents indicate changes of the volume median diameter of the particle population, where it is inversely related to the average size of the particles in the aerosol: the smaller the particles, the larger the exponent. Thus, the Ångström exponent is a useful quantity to assess the particle size of atmospheric aerosols and the wavelength dependence of the aerosol/cloud optical properties.

The multi-wavelength measurements also allow a more precise calculation of single scattering albedo (SSA), representing the fraction of extinction that is absorbed by the aerosol particles. Moreover, the integrating nephelometer gives back the backscatter coefficient, an important parameter useful, for example, to calculate the asymmetry parameter: the radiative transfer calculations of the Earth's atmosphere require the scattering phase function or at least the asymmetry parameter of airbone particles. One method of estimating the asymmetry parameter is to convert the measured back scatter fraction, the ratio of hemispheric backscattering to total scattering, into their corresponding asymmetry parameters.

The TSI 3563 Integrating multiwave lenght nephelometer has been recently acquired by ISAC Bologna and a new software is being tested with a different setting of the instrument. Once installed at Monte Cimone, new nephelometer observations will be also part of the ACTRIS

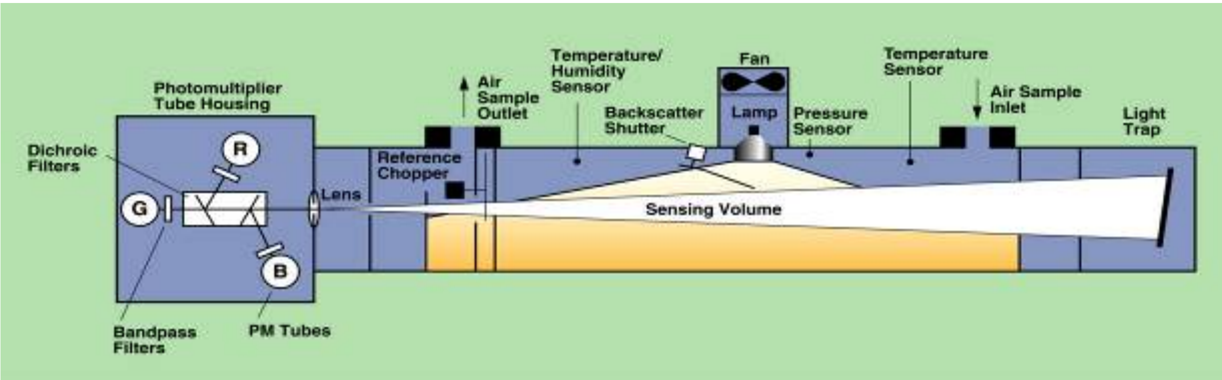

Fig. 5. TSI 3563 Nephelometer schematic courtesy of TSI Incorporated.

task concerning Near-Real-Time data provision to ensure fast and reliable data transfer from sensors to the user. Data formatted in Level0 NASA-AMES, will be sent to NILU server and updated every hour.

III. Aerosol size distribution from 500 nm to 20 μm based on time of flight was set up in July 2013

Aerosol concentration and size distribution of particles with optical diameter between 0.30 and 20 μm have been continuously recorded in 15-size channels by using an Optical Particle Counter (Mod. GRIMM 1.108). These measurements permit the determination of a fraction of fine mode (0.3 μm ≤ Dp ≤ 1 μm) and coarse mode (1 μm ≤ Dp≤ 20 μm) particles with a 1-minute time resolution. The instrument is based on the quantification of the 90° scattering of light by aerosol particles; each particle is sized by the amount of incident light scattered. Proper sizing may be ensured by the use of monodisperse polystyrene latex (PSL) and proper mass correlation may be established by the use of polydisperse dust. The density correlation may be established by mass correlation found in the environment. The fact that the aerosol refractive index can have a very large variation, according to the air mass type, infers a relatively high uncertainty in the size distribution measurement. Thus, especially in the case of aerosol with very high refractive index (real part), such as during Saharan dust transport from North Africa, that is a not negligible phenomenon at Monte Cimone (more than 10% of the time during the last decade), allows to significantly affect the measurement of size distribution. In fact optical particle counters are suggested and recommended for study of particle number variation, while the study of size distribution is affected by a large uncertainty.

Alternatively, time-of-flight instruments may be used to obtain particle number concentration by aerodynamic size over a size range similar to that of optical particle counters. In a time-of-flight instrument, an aerosol is accelerated through a nozzle, and particles lag behind the carrier gas because of their inertia. Particles are sized according to the time that they take to traverse two laser beams (i.e. the time-of-flight) near the nozzle outlet, with larger particles having longer time-of-flights. In contrast to the optical particle counters (only a single study was found in peer-reviewed literature to document their performance), the performance of

Fig. 6. The Aerodynamic Particle Sizer(TSI 3321) installed at Monte Cimone in July 2013.

the time-of-flight instruments, such as the Aerodynamic Particle Sizer (APS) model 3321 (TSI, Inc., St Paul, MN, USA), has been documented in more than 25 peer-reviewed journal articles (Baron *et al*., 2001). Volckens and Peters (2005) showed that the APS 3321 is capable of accurate sizing and has 85–100% counting efficiency for solid particles between 0.8 and 10 µm. Consequently, the APS may be used as a reference instrument for measuring the aerosol size distribution in the accumulation and coarse mode and thus also to evaluate the performance of other real-time instruments, such as the optical particle counters for the measurement of dry aerosols.

The TSI aerodynamic particle sizer (APS) model 3321 has been added to the instrumental equipment at Monte Cimone and it will be used as reference standard in order to identify how the different air masses affect the size distribution measurement by scattering at 90°. It has been installed in July 2013 and continuously provided aerosol size distribution from 500 nm to 20 µm. Data are also available in Near real Time on the webpage of the ICO-OV Global Station (http://www.isac.cnr.it/cimone/realtime).

IV. Feasibility study for the radiation measurement program

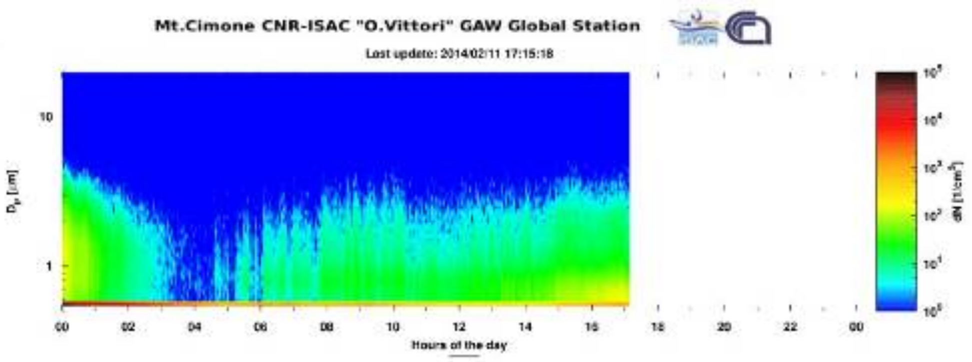

Fig. 7. An example of data observed by the APS at Monte Cimone, available in NRT at the webpage http://www.isac.cnr.it/cimone/realtime

As reported in the fourth IPCC record (IPCC, 2011), the indirect and direct effects of aerosols largely contribute to the total uncertainty of radiative forcing. Ground-based monitoring of atmospheric columnar aerosol properties are usually performed using sun-photometers. A sun-photometer is oriented towards the Sun to detect the attenuation of solar radiation along the slant path from the top-of-atmosphere to the ground. Aerosol load leads to a decrease of the solar radiation transmitted through the atmosphere, which depends on the aerosol optical depth (AOD). Therefore, spectral measurements of the transmitted solar radiation at several wavelengths are used to determine the spectral values of aerosol optical depth AOD (λ). The value of AOD (λ) is related with the total vertical content of aerosol, while the spectral feature of AOD at different wavelengths is related with the microphysical aerosol properties.

One of the major upgrade foreseen in the framework of NextData Project was to implement a system providing continuous measurements of AOD at the GAW-WMO Global Station at Mt. Cimone.

Various GAW reports focused on guidelines about global aerosol optical depth network (GAW 2004; GAW 2005) and a global network of aerosol optical depth (AOD) observations was started in 1999 by PMOD/WRC in collaboration with GAW Global Observatories as proposed by SAG/Aerosols and funded by MeteoSwiss, utilizing the PFR (Precision-Filter-Radiometer) sunphotometers. The optical depth of the particulate is one of the five basic variables characterizing aerosols, recommended for long-term measures according to the program GAW Programme (e.g. GAW Report No. 162). The GAW-PFR network was launched in 1999 as a pilot project starting in twelve pre-existing GAW stations by installing 12 Precision Filter radiometers (PFR). This network is based on a mutual collaboration between the various GAW stations, and now the AOD observation program includes 24 additional sites in Europe, Japan and the polar regions (Arctic, Antarctic), as shown in (http ://www.wmo.int/pages/prog/arep/gaw/aerosol.html). The GAW Report # 143 confirms that the sun photometer GAW-PFR (section 3.5, page 35) ensures the determination of the aerosol optical depth with an accuracy adequate to meet the objectives of GAW. The sun photometers GAW-PFR are currently developed and produced by the PMOD/WRC, which is based in Davos, Switzerland.

In particular, the aerosol properties to be observed include:

Fig. 8. The PFR installed at the Zugspitze station.

1) aerosol columnar content (AOD at selected wavelengths, Ångström exponent),
2) aerosol type (e.g. dust, maritime, fire smoke, urban haze) and microphysical properties (e.g., volume and surface concentrations, size distribution parameters).

Thus, the implementation of continuous AOD measurements with a high frequency at the GAW-WMO Global Station at Mt. Cimone is a key activity, also for constraining the uncertainties of observed LiDAR backscatter ratios and extinction coefficient (e.g. Raout and Chauzette, 2007, ACP), in order to retrieve without assumptions the aerosol microphysical properties, and considering the difficulties arising in using sky radiometers (e.g. Cimel and Prede) in this station (considering the environmental/meteorological conditions and the limits of aerosol algorithms retrieval due the averages low values of AOD).

Moreover, the implementation of such an instrument at this GAW-WMO Global Station will provide information about the columnar aerosol content and aerosol typology, taking advantage of the synergy between the passive remote sensing technique of sunphotometers, and the active remote technique of LiDARs .

The instrument was already ordered and the installation of PFR at Monte Cimone ICO-OV is planned for April 2014.

The next paragraph is devoted to the instrumental description

Instrument description

The PFR system consists of a weather-proof instrument tube and a control box containing the data acquisition system and power supply. The airtight tube with a diameter of 86mm, a length of 90mm and a mass of 3kg has an entrance window of synthetic quartz.

The instrument has 4 independent channels with nominal center wavelengths at 862, 500, 412 and 368nm and 5nm FWHM bandwidth. Dielectric interference filters manufactured by ion-assisted-deposition technique are used to assure a significant improvement of stability versus classic soft-coatings. The silicon photo detectors are tilted by an angle of 3° from the optical axis to avoid inter reflections between filter and diode. The view geometry is determined by two apertures of 3.0 and 7.0mm diameter, separated by 160mm, for a full field of view angle of 2.5o and a slope angle of 0.7o.

A built-in electronic pointing sensor monitors the proper alignment of the instrument towards the Sun.

The PFR was designed for instrumental stability by keeping the delicate optical filters in a dry and dark environment at constant temperature.

An active, Peltier type, thermostatic system maintains the temperature of the detector head at 20°C±0.5°C over an ambient temperature range from -20°C to +35°C. This system eliminates the need for temperature corrections of the sensitivity and prevents accelerated ageing of filters that were stabilized at elevated temperatures.

An automated shutter opens only briefly during actual measurements so that exposure related degradation of the detectors is minimized.

The instrument tube is permanently purged with dry nitrogen. O-ring seals maintain the internal atmosphere over typically several years. Purging is achieved by repeated evacuation with a vacuum pump and subsequent flushing with dry and oil-free nitrogen gas to a slight overpressure of ca. 1500hPa. Thus the instrument tube should never be opened before pressure is released through the valve at its back end.

The control box contains the power supply and a commercial data logger representing an integral part of the PFR system that controls the internal operation of the PFR instrument by its data acquisition program. The data logger takes quasi-simultaneous measurements of all four radiometric channels plus a complementary set of housekeeping data and stores the results in internal memory. It may communicate with a personal computer over an opto-isolated RS-232 or optional TCP/IP interface for program uploading, data downloading or real time monitoring. Once configured and operating, it will recover from a power failure with no loss of data and continue to measure automatically.

In control boxes manufactured after July 2008, a Campbell Scientific CR1000 data logger is used instead of the CR10X which is no longer available. The CR1000 achieves or exceeds the specifications of the former CR10X. A solid-state pressure transducer mounted in the control box reads barometric pressure simultaneously with PFR measurements for instrument deployed to initial GAW stations.

Commercial instruments are offered with an optional meteorological grade sensor.

V. Continuous nitrogen oxides (NOx), nitric oxide (NO), nitrogen dioxide (NO2) and sulfur dioxide (SO2) measurements suitable for remote high-mountain stations

As stated in the framework of GAW-WMO (2011), "measurement of NOx in the global atmosphere is important since it has a large influence on both tropospheric ozone (O3) and on the hydroxyl radical (OH)", thus affecting oxidation properties of the troposphere. NOx has an indirect influence on the radiative forcing by influencing CH4 and tropospheric ozone (O3) mixing ratios. This is particularly important considering that tropospheric O3 is also a powerful pollutant which is harmful to human health and ecosystems. For these reasons, GAW-WMO (2011) recognised the necessity of establishing a global network for the measurement of oxidized nitrogen compound mixing ratios. In particular, in the first phase of implementation, it is recommended that "the nitrogen programme should focus on high quality measurements of NO and NO2 in as many locations as possible".

The implementation of such measurement programmes is planned for next spring and would significantly upgrade the observing capacity of Monte Cimone station, as well as the GAW-WMO observational capability in the Mediterranean sea hot-spot, directly influenced by Po Valley pollution in summertime. Being located at high altitude or in remote locations, NOx

Fig. 9. The rack with NOx, NO, SO2 and O3 measurements on test in ISAC Bologna Laboratories, the installation is foreseen for 2014, March.

measurements at these stations can provide a reasonable indication of free tropospheric air composition and the possible impact of long-range transport.

The feasibility of installing a chemiluminescence detector (CLD) at remote high altitude stations was specifically evaluated in the D.122 report. As here stated and according to the "scientific questions" (Deliverable D1.1.1), also thanks to the interaction with the EU Project ACTRIS, two systems for the measurements and the investigation of NO_x and SO_2 variability at the GAW/WMO Global Station Monte Cimone were implemented at the ISAC-BO laboratories in Bologna. In particular, an enhanced NOx measurement system was based on the

Chemioluminescence detection and was equipped with a photolytic converter. This system was coupled with a calibration device with gas phase tritation and dilution. The systems are in test in Bologna Laboratories and the installation to the GAW/WMO Global Station at Monte Cimone is foreseen for 2014, March. The system is based on a commercial instrument which has been modified in agreement with the feasibility study presented in D1.2.2 with the purpose of reaching the Data Quality Objective indicated by ACTRIS/GAW/WMO for “enhanced” measurement sites.

VI. Observations of aerosol vertical profiles have been carried out at Mt. Cimone. After a test installation in October 2012, several improvement were carried out in order to guarantee continuous observations also during winter season.

As indicated by the GAW (2008), observations of vertical aerosol field are mandatory to improve the understating of aerosol processes and their implications on the aforementioned issues. In particular, information relating to vertical aerosol distribution is extremely important for a better assessment of aerosol-climate interaction, because most effects of aerosols on climate occur at elevated layers. At the same time, the implementation of aerosol vertical distribution measurements is important also for air-quality issues focusing especially on investigating the role of transport and transformation processes occurring at different spatial scales.

Until now, no continuous observations of aerosol vertical profiles have been carried out at the GAW-WMO Global Station at Mt. Cimone, part of the NextData Project. As reported in the GAW-WMO Strategic Plan 2008 – 2015 (GAW, 2007), "to determine the spatio-temporal distribution of aerosol properties related to climate forcing and air quality up to multidecadal time scales" is a primary goal. To this end, the GAW Atmospheric Lidar Observation Network (GALION) was lunched with the objective of “providing the vertical component of this (aerosol) distribution through advanced laser remote sensing in a network of ground-based stations” (Task. 7.84 of the GAW-WMO Strategic Plan 2008 - 2015). As planned in D.122 (§5), the backscatter (BL) depolarization lidar (DL) with night-time Raman capabilities (RL) system was installed in the year 2012; as the system was tested for the first time in a such extreme climate condition, several aspect were improved along the year

The aerosol parameters retrievable from the system are:

- Range corrected signal (colour plots of aerosol and cloud distributions)
- Attenuated backscatter coefficient (calibrated range-corrected signal)
- PBL depth
- Aerosol backscatter coefficient
- Aerosol type discrimination (dust, anthropogenic)
- Aerosol extinction coefficient (estimate), optical depth, column lidar ratio

Fig. 10. External view of the LIDAR system on 5 December, 2012, as encountered during the technical survey.

.The LIDAR system was installed at the “O. Vittori” Station on 23 October, 2012. It was located on the equipped terrace of the laboratory. The system was connected to the power and data lines of the station. This allows for the remote control of the system and near-real time data download. Even if the system was already operative just after the installation, the beginning of experimental activity had to be postponed until 16 November, 2012 due to the delay in obtaining the permit to operate (NOTAM) from the National Aviation Authorities. The snow removing system was a critical point at Monte Cimone, because of frequent icing and riming conditions, also in proximity of 0°C (see Figure 11). Because of this data covering in the winter period has been very limited.

The LiDAR is actually under maintenance and upgrading in ISAC Laboratories in Rome, and it will be installed in spring 2014 at Monte Cimone, inside the Ottavio Vittori Observatory.

2. GAW Global Stations Nepal Climate Observatory - Pyramid (5079 m, Southern Himalayas)

The improvements carried out at NCOP station concern aerosol and gases measurements. In particular the following measurement programs have been upgraded:

- Aerosol size distribution from 10 nm to 800 nm complete renewal is ongoing at LGGE Laboratories according to GAW/ACTRIS recommendations

Moreover, the following measurement programs have been newly started:

- Continuous (SO2) sulfur dioxide measurements are planned for installation at NCOP station during a spring calibration campaign.
- New sampling for carbon isotopes started in spring 2013.

I. Aerosol size distribution from 10 nm to 800 nm

In order to provide a complete maintenance and rebuild the parts completely fulfilling the recommendation described in Wiedensohler et al (2011), and suggested both by ACTRIS and GAW programs, the Differential/Scanning Mobility Particle Sizer (D/SMPS) installed at NCOP in March 2006 was disassembled and sent to Laboratoire de Glaciologie et Geophysique de l'Envirionnenment in Grenoble, France. The measurement of size distribution was replaced by the total number of particles.

II. A continuous (SO2) sulfur dioxide measurement instrument is planned for installation at NCOP station during the spring calibration campaign

In the framework of the 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, the need of sulfuric acid measurements was highlighted. The CI-APiTOF for measuring sulfuric acid concentration was considered too heavy in term of power consumption and effort for maintain the instrument at the NCOP conditions. We decided to switch the choice on a SO2 monitor, that is more plug and play instrument, and already considered for installation in Monte Cimone. The buying procedure to acquire the state-of-the-art instrument already identified for ICO-OV is underway and we plan to install it in spring 2014 at Nepal Climate Observatory –Pyramid.

III. New sampling for carbon isotopes started in spring 2013.

In 2013 a new collaboration between ISAC-BO and Stockholm University was established with the aim- of measuring the ratio of Carbon isotopes in the aerosol particles at NCOP, useful for evaluating the fractionation of BC from different sources (e.g. fossil vs biomass) during long-range transport to NCO-P. The technique that will be used, THEODORE protocol, is based on a thermal-oxidation approach (CTO-375) that was developed for soot-BC in sediments back in

1997 (Gustaffson) and now adapted to modify a standard Sunset OCEC analyzer to allow for cryotrapping of the specific CO2 released from the EC peak as defined by standard protocols on this workhorse method for the aerosol community. The same procedure is already used for 14C-EC at locations in the Indo-Gangetic Plain, at MCOH (Maldives), KCO-G (Jeju Island, Korea) at sites in China, and very recently for the Kathmandu Valley campaign.

A special protocol for aerosol sampling, using high volume PM10 sampler, has been developed together with Stockholm University and Nepalese staff has been trained for this new activity during calibration campaign in spring 2013. The sampling program foresees one long duration sample for each season; time of sampling has been calculated on the basis of climatological concentrations observed at NCOP in the previous years. Three seasons were already sampled and part of the samples already analyzed.

3. Upgrade of Italian GAW-WMO regional stations related to the SHARE project
Mt. Portella high mountain observatory

The Monte Portella station (42°26'52.96" N, 13°33'02.41", elevation 2401 m. a.g.l.) on the Gran Sasso chain (Central Italy), was installed at the beginning of July 2012 (Fig. 12): continuous measurements of meteorological parameters and atmospheric composition started on July 19th, 2012. As reported in the WP1.1 activity report, the observed parameters are: temperature, relative humidity, pressure, velocity and wind direction, rain precipitation, O_3, NO and particle size distribution (0.28 mm ≤ Dp ≤ 10 mm).

Fig. 11. External view of the Portella station in the Gran Sasso Park at 2401 m. a.s.l..
In the background, Corno Grande (2912 m. a.s.l.), the highest peak of the Gran Sasso chain.

As reported by the Deliverable D1.2.3, a series of criticalities, deserving upgrade activities, characterized the station. Among these:

1) provision of adequate systems of power continuity, conditioning of laboratories and technological facilities capable of supporting long-term data coverage equal to 90% (< 10% missing data).

2) Measurement tracking to primary GAW standards, with regard to surface ozone measurements.

With the purpose of increasing the effectiveness of the air-sampling as well as the quality of the recorded data, basing on the technical details provided by ISAC-BO, in June 2013 a common inlet for O_3, NO and future gas measurements was installed at the Mt. Portella Station (see also WP1.1). In particular, the system was designed to meet the GAW directives. An air intake with internal diameter equal to 120 mm, and length 2000 mm was implemented. The air intake was composed by Pyrex, in order to prevent any interaction with gases during the sampling. The main flow is guaranteed by a turbo blower, which is able to minimize the residence time of the air sampling (less than 5 s) within the air intake, preventing any significant interaction between ozone and NO as well as ineffective sampling during high wind speed conditions.

With the purpose of improving the data coverage as well as the data quality of the O_3 measurements, ISAC-BO begun the procedure for the acquisition of a state-of-art UV-absorption O_3 analyser. According with NIST concept for ozone determination, a system based on a dual cells photometer will be implemented in Spring-Summer 2014.

Moreover, during the reference period, an O_3 photometer calibrator was also purchased by ISAC-BO to be installed at the ISAC laboratories in Bologna. This calibration system will be traced back to the SRP#15 GAW/WMO reference scale hosted at the GAW/WMO World Calibration Center for surface O_3 hosted by EMPA (Switzerland). The availability of this system will allow to track O_3 measurements carried out within NextData at WMO/GAW and SHARE stations (e.g. Mt. Portella) to the GAW/WMO reference scale.

Plateau Rosa GAW/WMO Regional Station

Located at 3480 m altitude in western Italian Alps, the Plateau Rosa station (Fig. 13) is representative of the background conditions of southern Europe and is in a strategic position for studying the contribution of long-range western transport to variability in atmospheric composition. In particular, the Station of Plateau Rosa is employed for studies and measurements relating to the analysis of long term atmospheric variability of greenhouse gases.

During 2013, a research contract was signed between ISAC-BO and RSE SpA (*Ricerca sul Sistema Elettrico SpA*), the Institution managing the Plateu Rosa GAW/WMO regional Station. The research contract allowed RSE SpA to afford the technical upgrades for activating a near-real-time delivery system for transmitting every hour gas data (CO_2, CH_4, O_3). This will allow the provision of near-real time data to the NextData Archives as well as to international initiatives, e.g. the EU MACC-2 Project (see Deliverable D1.1.1).

As reported by deliverable D1.2.1, one criticality affecting the Plateau Rosa activity is related to the availability of the funding for monitoring activities which are subject to approval, i.e. it can be reduced or withdrawn on an annual basis, and this leads to a "stop and go" situation in measurement continuity that is far from ideal in terms of producing quality data. The signing of a research contract could thus help the station manager in demonstrating the interest of the scientific community for Plateau Rosa data and providing a certain amount of funding useful for sustaining the monitoring activity.

Fig. 12**.** External view of the "Testa Grigia" Research Station, which hosts the GAW-WMO station of Plateau Rosa.

Finally, the acquisition of the O_3 calibrator at the ISAC-BO laboratories and the link with the World Calibration Center at EMPA can help in creating a direct link between O_3 measurements at Plateu Rosa and the GAW-WMO reference scale.