Project of Strategic Interest NEXTDATA

Deliverable D1.2.6
Report describing the activities, data transfer to archives and to the General Portal

WP Coordinator: Angela Marinoni
ISAC-CNR, Bologna

Authors

P. Cristofanelli, A. Marinoni, R. Duchi, D, Putero, T. Landi, F. Calzolari and P. Bonasoni
ISAC-CNR, Bologna

E. Vuillermoz, R. Toffolon, M. Alborghetti, G. Verza
EV-K2-CNR, Bergamo

J. Arduini, M. Maione
Urbino University, Urbino

R. Balestrini
IRSA-CNR, Brugherio

Italian Institutions are managing two Global Stations belonging to the GAW/WMO programme: the Italian Climate Observatory "O. Vittori" at Monte Cimone (2165 m a.s.l., 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 allows an effective characterization of atmospheric variability over large regions and long time frames for two hot-spot regions (the Mediterranean basin and the Himalayas) particularly affected by anthropogenic pressures and climate change. Here we provide information about the activities, data transfer to archives and to the General Portal during the third year of the NextData Project. The results of these activities were possible thanks to the collaboration of different Institutions: ISAC-BO, Ev-K2-CNR, University of Urbino, ENEA-UTMEA, IRSA-CNR.
The observations and the study activities have been continued at the GAW/WMO Global Station Monte Cimone (GAW ID: CMN) and at Nepal Climate Observatory – Pyramid (GAW ID: PYR). Within this framework, the activities were carried out concerning instrument calibrations and data validations for trace gases (greenhouse and reactive), atmospheric aerosol (chemistry and physics), precipitation (rain and snow chemistry), meteorological parameters and solar radiation fluxes (short-wave and long-wave) observations, according to the guidelines of the GAW/WMO and BSRN (Baseline Surface Radiation Network) programme. Thanks to the collaboration with the Urbino University, the data concerning 23 different halogenated greenhouse gases were submitted to the GAW-WMO database (WDCGG).
The temporal availability, for the year 2014, of the measurements in the framework of GAW/WMO, is reported in the Annex 1, for the two Global Stations "O. Vittori" – Monte Cimone and Nepal Climate Observatory – Pyramid.
During the reference period, data of atmospheric composition, meteorology and precipitation chemistry were submitted to the GAW/WMO databases (http://ds.data.jma.go.jp/gmd/wdcgg/, http://ebas.nilu.no/Default.aspx, http://wdpc.org).
Data were also shared with the NextData General Portal by submission to the Geonetwork system (WP2.1). Mt. Cimone data of surface ozone and carbon monoxide were delivered in NRT to MACC-2 Project (http://gmes-atmosphere.eu/d/services/gac/verif/grg/gaw/gaw_station_ts!All!Mt.%20Cimone!Carbon%20monoxide!macc!od!enfo!gaw_station_ts!201306!/).

A new NRT data provision service was activated on January 2014 for providing number particle concentration data to the WMO programme WAS-SDS, to support the identification of dust outbreaks over Europe (see D1.2.4). Moreover, an experimental "dust alert" service was activated at Mt. Cimone. This system is based on the NRT analysis of coarse particle number concentration and air-mass back-trajectory forecast.
Thanks to an agreement with the RSE SpA (Ricerca sul Sistema Elettrico SpA) and ISAC-BO (signed on December 2013), the greenhouse gas data (CO_2, CH_4, O_3) were shared with NextData. A system for delivery of data in near-real-time (NRT) was implemented by RSE SpA to provide every hour greenhouse gas mixing ratios. ISAC-BO is in charge for the data formatting and delivery to ECMWF (European Center for Medium range Weather Forecast): these NRT data have been made available to the MACC-2 Project (see Deliverable D1.1.1). Here we present, for the year 2014, the comparison between the hourly values of O_3, CO_2 and CH_4 delivered by NRT mode (blue dots) and that retained after validation processes (red dots) from Plateau Rosa (Figure 1). It is noteworthy that most part of the data delivered in NRT mode was flagged as good after extended QA/QC.

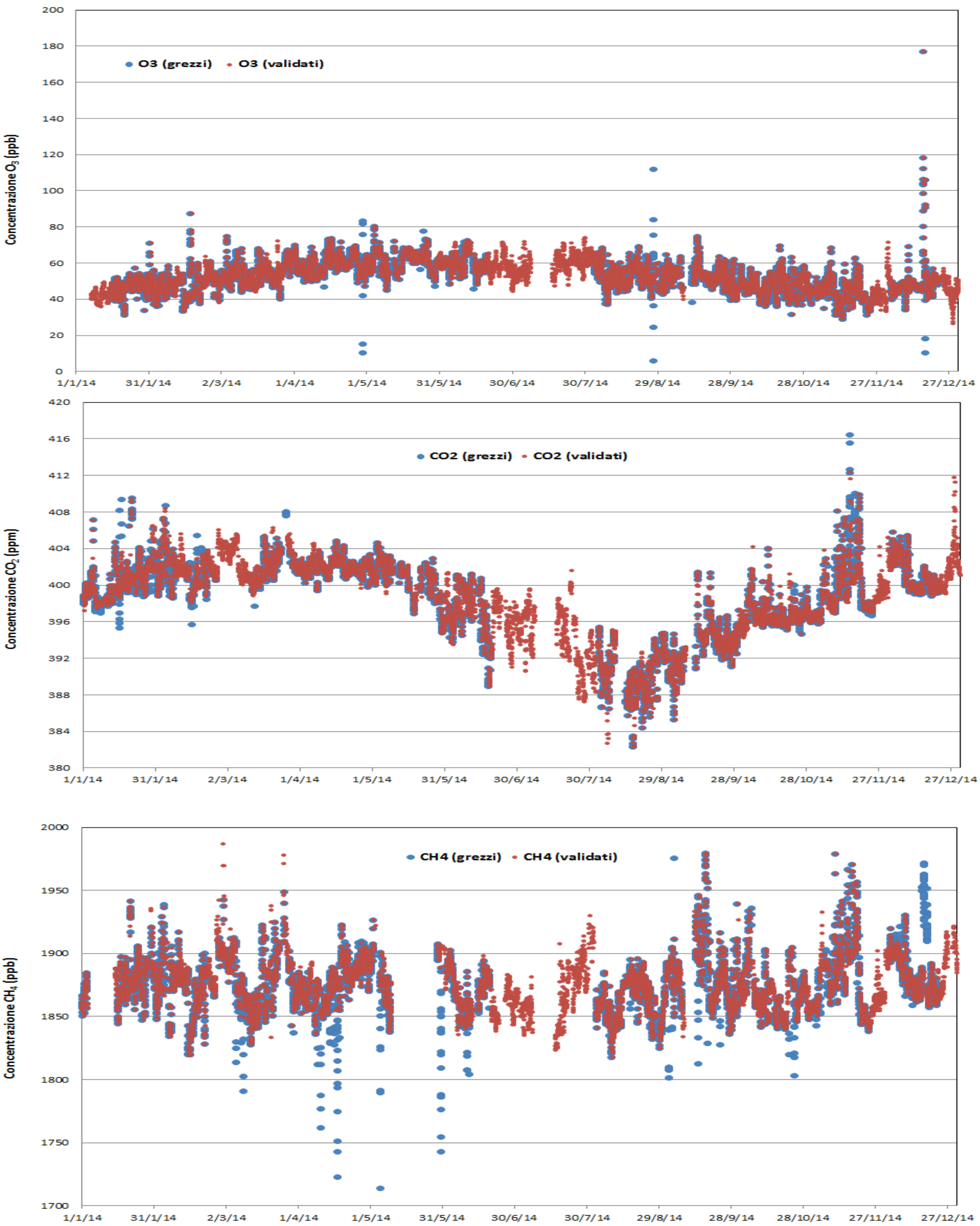

Fig. 1. Average hourly values of O_3, CO_2 and CH_4 at Plateau Rosa, delivered to MACC-2 in NRT mode (blue) and after final validation (red).

ISAC-BO provided a limited support to University of La Paz in the execution/validation of the surface ozone measurements at the GAW/WMO atmospheric observatory at Chacaltaya (Bolivia). In particular, during the reference period, ISAC-BO supported an instrumental reparation and provided scientific advice about ozone data validation and interpretation.
Thanks to the collaboration with ENEA-UTMEA, a surface ozone measurement programme has been activated at the Lampedusa WMO/GAW station (Fig. 2). The ozone instrument (Thermo Tei49i) was intercompared against the reference laboratory (Thermo 48iPS)

installed at the ISAC-CNR laboratories in the framework of NextData Project. ISAC-CNR also implemented the instrument data acquisition system. Surface ozone measurements are activated since July 2014.

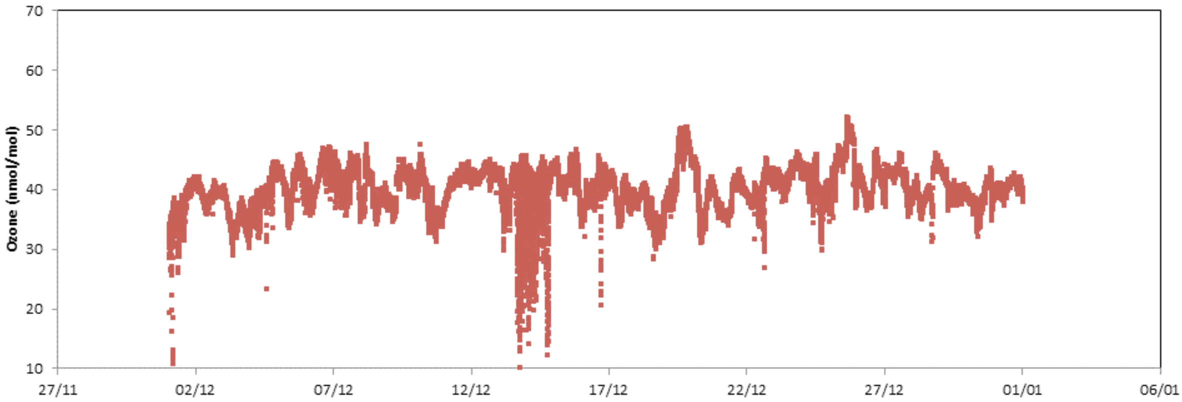

Fig. 2. Time series of 1-minute O_3 average values at Lampedusa for December 2014.

Activities at the Nepal Climate Observatory – Pyramid (NCO-P)

During the year 2014, ISAC-BO, Ev-K2-CNR, ENEA-UTMEA and IRSA-CNR continuously supported (by remote) the local staff for the execution of the measurement programmes running at NCO-P. An instrument "state-of-the-art" for the continuous monitoring of SO2 has been installed on October 2014. The instrument is based on the UV-fluorescence detection technique. The instrument has been equipped by an automatic system for the execution of daily zero checks. The first two months of continuous measurements indicated that the SO2 mixing ratios appeared to be, for the most part of time, below the detection limit (0.10 nmol/mol) of the instrument. With the aim of capitalizing on this instrument, the possibility to move it to the Kathmandu station (WP1.1.) is under investigation. During May 2014, a maintenance campaign was undertaken at NCO-P for the checking and calibration of the experimental set-up. Technicians and researchers from URT Ev-K2-CNR, ISAC BO, CNRS and the Pyramid personnel, participated in this campaign. A complete rearrangement of the NCO-P laboratories has been carried out, allowing a better logistic organization of the instrumentation and technical systems. The ozone analyser was intercompared by using a "twin" instrument sent from Italy. Unfortunately, due to a pump failure, this second ozone instrument was not installed at the observatory as expected. Taking advantage of the scheduled inspection, ISAC-BO personnel also assessed the results of the major technical interventions carried out at NCO-P.

Activities at the Monte Cimone – "O. Vittori" Station (ICO-OV)

According to the "scientific questions" (Deliverable D1.1.1), also thanks to the interaction with the EU Project ACTRIS, the two systems implemented during year 2013 (see D1.2.4) for the measurements and the investigation of NO_x and SO_2 variability were installed at the GAW/WMO Global Station Monte Cimone (Fig. 3 and 4). In particular, an enhanced NO_x 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 titration and dilution. 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 (see D1.2.2).

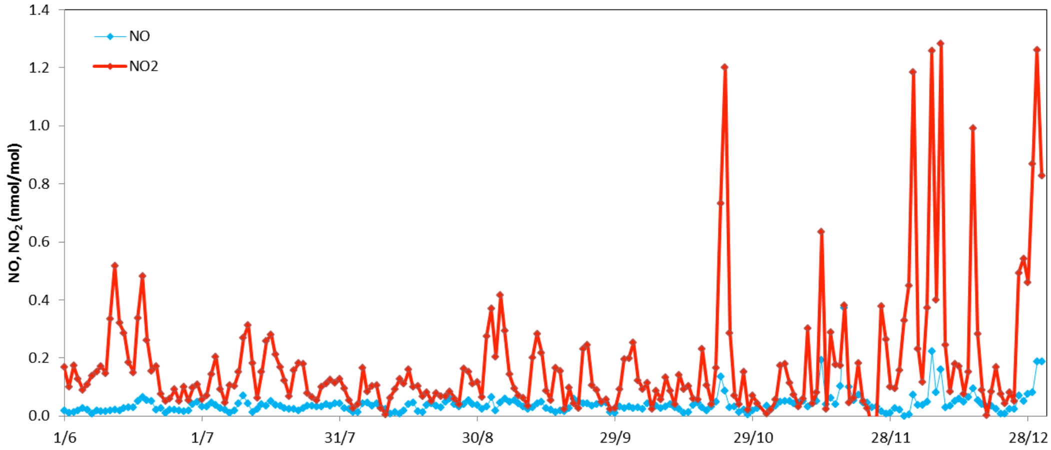

Fig. 3. Time series of daily NO and NO_2 average values at CMN during year 2014.

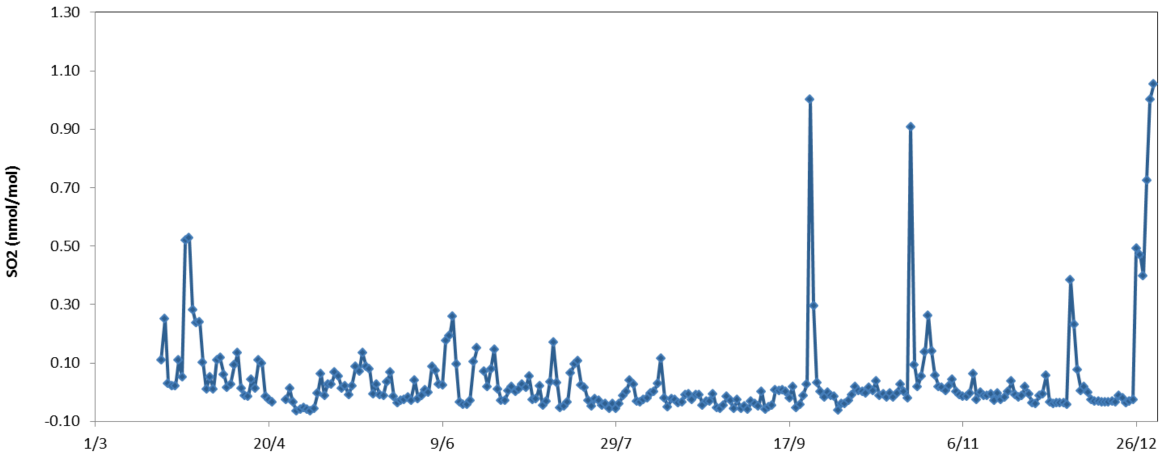

Fig. 4. Time series of daily SO2 average values at CMN during year 2014.

Despite the upgrade of the sampling system carried out during the first year of the Project, several technical issues still affected the PM1-PM10 sampler (SWAM 5A MONITOR, FAI Instrument S.r.L).

On December 2013 (see D1.2.4), a MoU was signed with the Barcelona Supercomputer Center (BSC) for the near-real-time (NRT) provision of aerosol data (PM10, PM1, accumulation and coarse particle number concentrations) to the WMO Sand and Dust Storm Warning Advisory and Assessment System. To this aim, a system for automatic pre-validation and delivery of hourly data has been implemented at ISAC-BO and starting from January 2014 hourly average value of coarse and accumulation aerosol particle number will be send to BSC (see http://sds-was.aemet.es/news/in-situ-measurements-from-mt.-cimone).

Starting from 2013, a NRT data delivery service was made operative at the ICO-OV to provide hourly CO mixing ratio to the MACC-2 UE-Project. Data are automatically pre-elaborated and pre-validated and delivered to ECMWF servers for the NRT evaluation of the Integrated Forecast System for the atmospheric composition variability.

With the purpose of prosecuting the implementation of a continuous monitoring programme for aerosol LIDAR observations, a specific heated window was built on the roof of the station which has been equipped with suitable devices for hosting a LIDAR system. Moreover, a permanent permit to operate (NOTAM) from the National Aviation Authorities was achieved. This will allow to permanently install, at the ICO-OV, the LIDAR developed by ISAC-RM and

tested at ICO-OV during the first year of the Project (see WP1.2, first year). Unfortunately, due to a major problem with the laser source, this system was out of order for the whole year 2103, and the final installation is foreseen for Spring 2015.
Based on the feasibility study carried out during the year 2013 to implement aerosol optical depth (AOD) measurements at the ICO-OV, a PFR (Precision-Filter-Radiometer) sunphotometer was purchased by ISAC-CNR. A proof of concept for the implementation of the sun-tracker able to allow the continuous determination of AOD even in the hash mountain conditions has been developed at ISAC-CNR (see D1.2.7).

Research activity: Influence of summer heat-waves to the O_3 variability at the Italian Climate Observatory "O. Vittori" at Monte Cimone

As reported by Cristofanelli et al. (2007), at CMN significant contributions to high O_3 can be traced back to heat waves (HWs) in combination with efficient transport of polluted air masses on both the regional and the continental scales. A HW is a prolonged period of excessively hot weather over a region and it is a well-known meteorological feature of the Mediterranean summer (Wang et al., 2013). These events are recognized to cause great costs in terms of human health and environmental hazard (e.g. EEA, 2012).
There is not a common accepted definition of HW. Thus to unambiguously identify HWs which affected the north of Italy, we analysed the time series of daily mean and maximum temperature at three ground level locations in the Po valley, i.e. Verona (45° 23′ N 10° 53′ E), Milano (45° 26′ N 9° 17′ E) and Bologna (44° 32′ 11° 18′). In particular, we categorized as being influenced by a HW the warm periods (April-September) falling into both following criteria defined by ECA&D (European Climate Assessment and Dataset) and WMO:
(1) ECA&D: a period of at least 6 days with daily mean temperature above the upper tenth percentile of the temperature distribution for each of the calendar days (Klein Tank et al., 2002);
(2) WMO: a period of at least 6 days with the daily maximum temperature greater than 5°C above the climate normal (CliNo) maximum temperature.

In this work, CliNo was calculated over the 1971 – 2000 reference period with the purpose of taking into account recent variations of the observed global air temperature (e.g. Brunetti et al., 2006). With the aim of minimizing local influences and considering only the events at regional scale, we considered the periods characterised by the simultaneous occurrence of HW at the 3 above-named low-land stations. The application of the selection methodology presented in Section 2.3, led to the identification of 13 HWs during the period 1991 – 2011 (Tab. 1). It is interesting to notice that all the identified events were recorded in the time window 1996 - 2011. Totally, during the period 1991-2011, 115 days were found to be affected by this type of events with frequency peaks in June representing the month for which HWs are most frequent.

Most of the identified HWs (10 out of 13) were characterised by significant O_3 increase at CMN in comparison with the average seasonal levels (Tab. 1), suggesting that these events contribute to the occurrence of high O_3. As shown in previous works (Cristofanelli et al., 2007 and Cristofanelli et al., 2009) these high O_3 values can be explained by considering photochemical O_3 production directly related to anthropic activities or to positive feedbacks between heatwave weather conditions and O_3 production efficiency (e.g., increased biogenic emissions, increased forest fires, decreased O_3 uptake by vegetation). During HWs, the large vertical extension of the PBL could enhance the transport of these PBL air masses to altitudes that would usually be in the free troposphere. Major HWs affected northern Italy and CMN on June 2005-2006, July 2006, April 2007 and May 2008, when very high monthly O_3 anomalies were observed at CMN and significant higher O_3 was observed compared to the other baseline stations (Fig. 2b).

Tab. 1. List of HWs identified in northern Italy from 1991 to 2011. For each year, we report the detected events in terms of start day, end day, time length. Moreover, we report the average O_3 value recorded during each HW (mean ± 1 σ) and, for reference, the corresponding mean seasonal O_3 value (mean ± 1 σ).

Year	Start day	End day	Time length (days)	Average O_3 (nmol/mol)	Mean seasonal O_3 (nmol/mol)
1996	08/06/1996	13/06/1996	5	78.6 ± 16.9	61.7 ± 8.8
2002	16/06/2002	24/06/2002	8	66.0 ± 10.1	58.8 ± 6.0
2003	05/05/2003	09/05/2003	4	58.4 ± 6.5	57.6 ± 7.8
	07/06/2003	26/06/2003	19	67.2 ± 14.2	66.7 ± 10.5
	08/08/2003	14/08/2003	6	79.8 ± 7.3	66.7 ± 10.5
2005	22/06/2005	28/06/2005	6	73.6 ± 8.7	66.7 ± 9.7
2006	17/06/2006	28/06/2006	11	62.2 ± 14.9	65.2 ± 11.9
	20/07/2006	28/07/2006	8	95.6 ± 15.8	65.2 ± 11.9
2007	10/04/2007	18/04/2007	8	73.1 ± 6.3	64.4 ± 11.5
2008	22/06/2008	27/06/2008	6	62.9 ± 6.8	59.4 ± 8.3
2009	18/05/2009	26/05/2009	8	54.3 ± 10.3	56.8 ± 8.1
2011	19/08/2011	26/08/2011	8	68.0 ± 7.3	58.9 ± 8.0
	10/09/2011	17/09/2011	8	58.0 ± 7.1	52.2 ± 7.7

Research activity: Influence of the North Atlantic Oscillation (NAO) to O3 variability at the Italian Climate Observatory "O. Vittori" at Monte Cimone

As reported by Lin et al. (2014), tropospheric O_3 is affected by climatic variability signatures acting from the interannual to the decadal scale. The North Atlantic Oscillation (NAO), i.e. a north-south shift (or vice versa) in the track of storms and depressions across the North Atlantic Ocean and into Europe, has been shown to influence winter and summer climate over the Mediterranean basin (Wang et al., 2013). Due to the NAO effect on circulation patterns and meteorological conditions in the Mediterranean basin, a potential influence on tropospheric O_3 is expected too (see e.g. Pausata et al., 2014; Cuevas et al., 2013). With the aim of pointing out a possible relationship between the NAO variability and tropospheric O_3 at CMN, we investigated the correlation between the seasonal NAO Index (Hurrell et al., 2001) and the anomalies of seasonal O_3 for the period 1996 - 2011 (Fig. 5). We found a positive correlation between the NAO Index and winter O_3 concentrations (r: 0.49 ± 0.18; a: 1.29 ± 0.70, p= 0.05), while a positive but not statistically significant correlation was found for summer (r: 0.44 ± 0.13; a: 1.29 ± 0.70, p=0.09). No clear tendencies were observed for both spring (r: 0.08 ± 0.01; a: 0.21 ± 0.74, p= 0.77) and fall (r: 0.02 ± 0.01; a: 0.05 ± 0.85, p= 0.95). It is noteworthy that the large positive O_3 anomalies observed during winter 2007 and 2008 were both associated to strongly positive NAO index values. These winter values were also characterised by the highest average air-temperature (+5.0°C and +3.7°C, respectively) observed at CMN during the period 1996 – 2011 (average value: 0.85 ± 0.65 °C), suggesting the occurrence of anomalous meteorological regimes at the measurement site. This can be related to the expansion of the Azores anticyclone towards the Mediterranean basin and CMN location (e.g. Pausata et al., 2014), possibly triggering anomalous favourable conditions for photochemical O_3 production and vertical transport even during winter period.

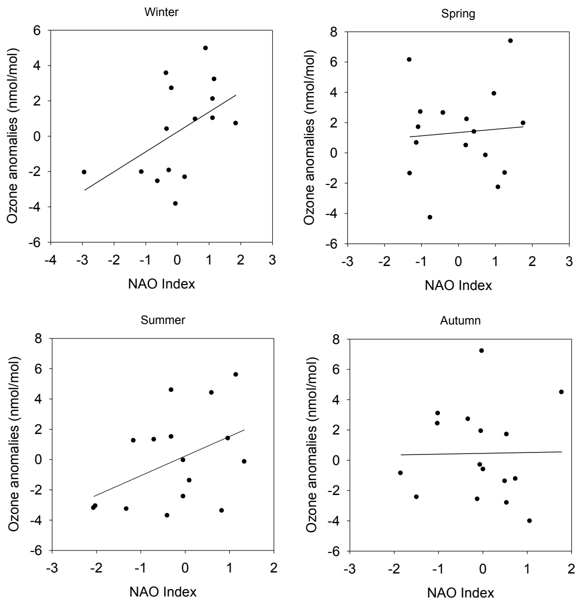

Fig. 5. Correlation analysis between seasonal ozone anomalies and seasonal NAO Index for the period 1996 – 2011 (Hurrell et al., 2001).

Research activity: Influence of stratospheric air-mass intrusions to O3 variability at the Italian Climate Observatory "O. Vittori" at Monte Cimone

In order to investigate the influence of Stratospheric Intrusions (SI) on the long-term O_3 variability at CMN, we selected the days influenced by these events by analysing the behaviour of the following stratospheric tracers available at CMN (see Cristofanelli et al., 2006): in-situ Beryllium-7 (^7Be) and relative humidity (RH), equivalent potential vorticity (PV) of air-masses reaching the measurement site (as deduced by the analysis of 7-day 3D FLEXTRA back-trajectories) and total column O_3 (TCO) over CMN location (as deduced by TOMS and OMI overpass data. Based on the methodologies proposed in Cristofanelli et al. (2006), we identified days with likely influence by SI when PV values of air-masses reaching the measurement exceeded the WMO definition of dynamical tropopause (i.e. PV>1.6 pvu) and by significant increases of daily 7Be, RH, TCO values over their seasonal cycles, as evaluated by applying a three-time repeated 19-day running mean (the so-called "Kolmogorov- Zurbenko" filter, see Sebald et al., 2000). In particular, a specific day was considered as being likely influenced by SI events if at least one of the following criteria was fulfilled:

(i) significant variations of daily TCO value AND the presence of back-trajectories with PV>1.6 pvu;
(ii) presence of back-trajectories with PV>1.6 pvu AND significant 7Be daily value increases;
(iii) presence of back-trajectories with PV>1.6 pvu AND RH values lower than 40%;
(iv) RH values lower than 40% AND significant TCO daily value increases.

It should be noted that while RH and PV data were available from March 1996, TCO value from OMI was available from July 1996 and 7Be from January 1998.

Based on this screening approach, a total of 372 days were found to be potentially affected by SI over the period 1996 – 2011 (6 % of the whole period). Figure 6a reports the frequency of occurrence of SI-influenced days at CMN: on average the highest frequency of SI-influenced days was observed in winter (10%) with a minimum in summer (3%), in good agreement with the earlier work by Cristofanelli et al. (2006). Except that during the summer season, the SI-affected days showed significant higher O_3 values than the remaining days (Tab. 2). Long-term variability of SI-influenced days showed a maximum occurrence during winter-spring 2002 (21.1% and 20.6%) and autumn 2006 (14.2%), when high O_3 monthly anomalies were observed at CMN (Fig. 6). A period characterised by a relatively low number of SI-influenced days was observed from 2009 to 2011, when a prevalence (83%) of negative SI-occurrence seasonal anomalies was detected (10/12). Figure 6b reports the normalized seasonal anomalies (with respect to the 1996–2011 period) of O_3 recorded during detected SI (O_3SI) together with their 12-month running means (O3SI- RM) as well as the running mean of the normalized seasonal anomalies of all O_3 data (O3-RM). No evident correlations existed between O_3SI and O_3 over the period 1996 – 2011 (r: 0.01 ± 2.18; a: -0.05 ± 0.24). Despite a rather stable frequency of SI occurrence at CMN (see Figure 5a), an upward tendency of O_3SI was observed from 2002 to 2010. This leads to a significant positive correlation with overall O_3 (r: 0.48 ± 0.28; a: 0.52 ± 0.25, P<0.05) over the period 2001 - 2006. This correlation is lost when considering the most recent years 2007 - 2011, when a negative (not statistically significant) correlation appeared between O_3SI and O_3 (r: -0.10 ± 0.21; a: -0.31 ± 0.44).

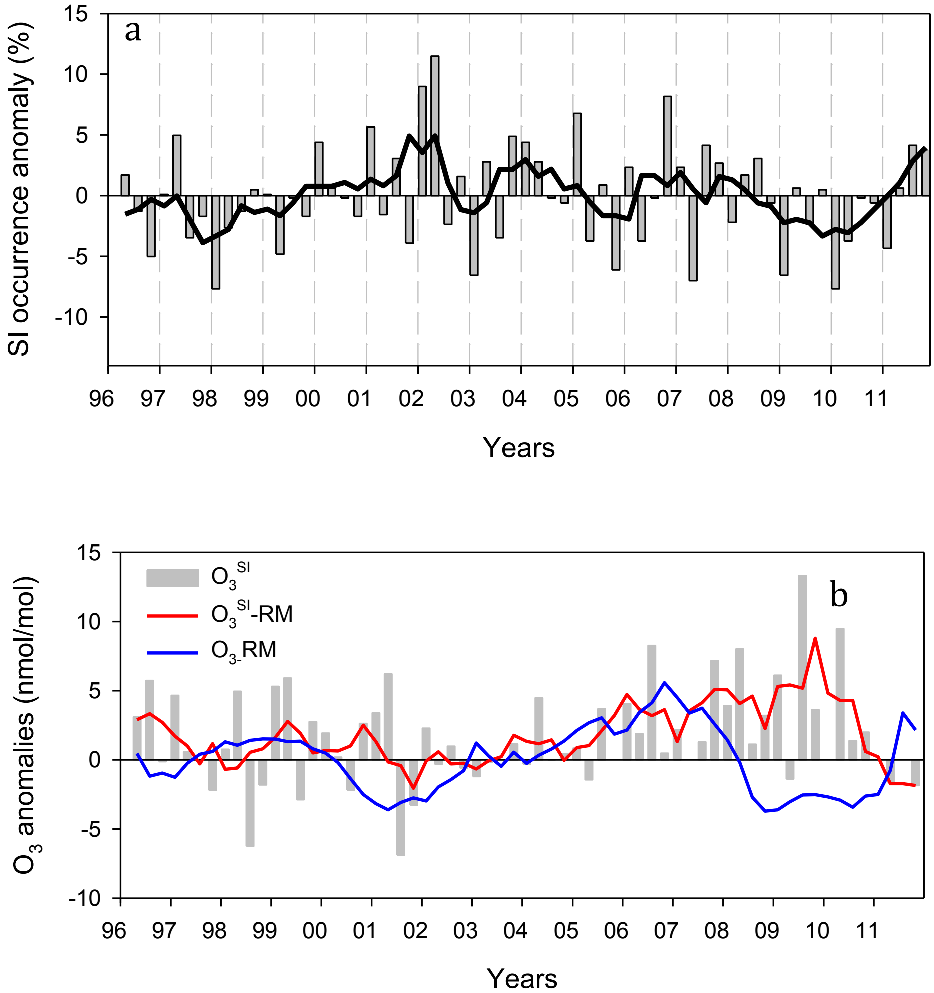

Fig. 6. (a) Normalized seasonal anomalies with respect to the 1996–2011 mean annual cycle of the stratospheric intrusion (SI) frequency (grey bars) together with their 12-month running means (black line). (b) Normalized seasonal anomalies of O_3 during SI (O_3^{SI}) with their 12-month running mean ($O_3^{SI\text{-}RM}$) and 12-month running means of overall O_3.

Tab. 2. Average variations of O_3 in respect to the seasonal values for SI-influenced days (SI days) and remaining days (other days). For each seasons we also reported the expanded uncertainty of the mean (with k=2) and the number of analysed days (N).

Season	SI days	Other days
All	3.2±0.9 nmol/mol N: 372	-0.25 ± 0.8 nmol/mol N: 5188
Winter	2.8±1.3 nmol/mol N: 134	-1.5 ± 0.5 nmol/mol N: 1180
Spring	3.9±1.6 nmol/mol N: 103	-0.7±0.5 nmol/mol N: 1305
Summer	-0.5±2.6 nmol/mol N: 51	0.2±0.6 nmol/mol N: 1399
Autumn	5.6±2.5 nmol/mol N: 84	0.5±0.6 nmol/mol N: 1304

Research activity: seasonal report on atmospheric composition at the Italian Climate Observatory "O. Vittori" at Monte Cimone

With the aim of providing updated and accurate information about the "state of the atmosphere" as seen by the observations carried out at the ICO-OV, the behaviour of atmospheric parameters (trace gases, aerosol, meteorological parameters) was investigated for the year 2014 on a seasonal basis. These informations have been summarized in seasonal reports that were published quarterly on-line (ISSN: 2283-9631) at http://www.isac.cnr.it/cimone/reports.

In particular, for each atmospheric parameter we provided basic statistical information (minimum, maximum and average values) together with a comparison with the climatological reference values for Mt. Cimone. For each observed parameter and for each season, we specifically present:

- the time series of the daily mean values (calculated from 30-minute aggregated values if the daily data coverage is higher than 75%);
- a table reporting the basic statistical parameters (on a 30-minute basis);
- a comparison with the seasonal historical mean values.

In the following an overview for winter-autumn 2014 data is presented.

WINTER 2014:

Winter 2014 did not present high average levels of short-lived climate forcers (SLCF): a value lower than the climatological mean was observed for carbon monoxide, black carbon and fine particles. For surface ozone and coarse particles we reported an average value similar to that recorded in the previous winter seasons. The halogenated gases usually showed values lower than the northern hemispheric background, even if high concentration episodes were sporadically observed. The atmospheric and meteorological regimes were well representative of the clean winter season. However, winter 2013/2014 emerged as the warmest winter season even observed at ICO-OV since 1996. Only 4.4% of the winter days have been affected for a significant fraction of time by transport of polluted air masses, with all of them taking place at the end of February. 11 days (12.2%) were affected by mineral dust transport, with a major event occurring from February 15th to 21st. Air-mass transport from the stratosphere occurred for 16.6% of the period. No event was observed during February. The winter 2013/2014 appeared to be the warmest winter ever observed at the ICO-OV since 1996

SPRING 2014:

Spring 2014 did not present high average levels of short-lived climate forcers (SLCF): values lower than the climatological means were observed for black carbon, while for surface ozone and fine particles we reported average values similar to those observed during the previous spring seasons. Carbon monoxide showed lower values than the climatological reference. Only the coarse particles showed a high average value. The atmospheric and meteorological regimes were well representative of the spring season. Only 8.7% of the spring days have been affected for a significant fraction of time by transport of polluted air-masses, with none of them during May.

10 days (10.9%) were affected by mineral dust transport, with a major event occurring from May 22nd to 23rd. Air-mass transport from the stratosphere was not present during this period, as deduced by our identification methodology.

SUMMER 2014:

Summer 2014 did not present high average levels of short-lived climate forcers (SLCF): a value lower than the climatological mean was observed for carbon monoxide, black carbon, surface ozone and fine particles. Only the coarse particles showed an average value similar to the climatology. This can be related to the anomalous weather conditions (high relative humidity, low air-temperature) which characterized most part of the Summer 2014, preventing the accumulation of pollutants at regional scales and the transport up to Monte Cimone and the free troposphere. Only 3.2% of the summer days have been affected for a significant fraction of time by acute pollution event, all of them during June. The most important pollution event was recorded on June, 12nd, when ozone increased up to 100 ppb (200 $\mu g\ m^{-3}$), possibly in association with long-range transport from continental Europe and the occurrence of the only recorded heatwave (8th to 13th June). 14 days (15.4%) were affected by mineral dust transport, with a major event occurring from July 4th to 6th, when a southerly circulation favored the advection of mineral dust from northwestern Africa. The selection methodology allows the identification of a single event distinctly related with air-mass transport from the stratosphere (7th June).

AUTUMN 2014:

Autumn 2014 did not present high average levels of short-lived climate forcers (SLCF): a value lower than the climatological mean was observed for black carbon, surface ozone and fine particles. While carbon monoxide showed an average value only slightly higher than the climatological one, coarse particle average concentrations were higher than the autumn climatological value. The 12.1% of the autumn days have been affected for a significant fraction of time by acute pollution event, with 10/11 events from September 6th to 17th. September 6th was the most polluted day, with an easterly circulation suggesting a contribution of fire emissions from eastern Europe. Unpolluted conditions were generally observed on October and November. 9 days (9.9%) were affected by mineral dust transport, with the most important dust event occurring from November 28th, associated with the presence of a through over western Europe. The selection methodology allows the identification of 3 events distinctly related with air-mass transport from the stratosphere, with the highest O_3 average on November 2nd. A volcanic plume was possibly detected on 22nd October, as traced by high SO_2 values at Mt. Cimone.

Data availability

Summary of data transmitted to the NextData archives for the "**O. Vittori" GAW/WMO Global Station at Monte Cimone** (part of the data-series were obtained in the framework of SHARE and other Research Projects):

Meteorology: Start date: January 1996; End date: Ongoing; Instrument: IRDAM WS7000: Vaisala WS425; Validated data availability: from January 1996 to December 2013; Data Format: WDCGG Version 1.0; Data provider: ISAC-BO.

O_3 mixing ratio: Start date: January 1996; End date: Ongoing; Instrument: Daisibi 1108 W/GEN; Validated data availability: from January 1996 to December 2013; Data Format: WDCGG Version 1.0; Data provider: ISAC-BO.

SO_2 mixing ratio: Start date: March 2014; End date: Ongoing; Instrument: Thermo 43iTLE; Validated data availability: from March 2014 to December 2014; Data Format: WDCGG Version 1.0; Data provider: ISAC-BO.

NO_2 and NO mixing ratio: Start date: June 2014; End date: Ongoing; Instrument: Thermo 42iTLE with BLC; Validated data availability: validation ongoing; Data Format: NASA_AMES; Data provider: ISAC-BO.

CO mixing ratio (NDIR): Start date: June 2012; End date: Ongoing; Instrument: Thermo Electron Tei 48C; Validated data availability: from August 2010 to December 2013; Data Format: WDCGG Version 1.0; Data provider: ISAC-BO.

CO mixing ratio (GC-RGD and GC-FID): Start date: February 2007; End date: Ongoing; Instrument: customized GC-RGD (RGD2-Trace Analytical) and GC-FID (Agilent 6890N); Validated data availability: from February 2007 to December 2011; Data Format: WDCGG Version 1.0; Data provider: Urbino University/ISAC-BO.

CH4 mixing ratio (GC-FID): Start date: January 2008; End date: Ongoing; Instrument: Agilent GC6890; Validated data availability: from January 2008 to December 2011; Data Format: WDCGG Version 1.0; Data provider: Urbino University/ ISAC-BO.

N2O, SF6 mixing ratio (GC-ECD): Start date: November 2008; End date: Ongoing; Instrument: Agilent GC6890; Validated data availability: from January 2008 to November 2012; Data Format: WDCGG Version 1.0; Data provider: Urbino University/ ISAC-BO.

Greenhouse Gases mixing ratio (halogenated): Start date: June 2001; End date: Ongoing; Instrument: Agilent GC6890; Validated data availability: from June 2001 to September 2013; Data Format: WDCGG Version 1.0; Data provider: Urbino University/ ISAC-BO

NO and NO2 mixing ratio (Chemioluminescence with Mo converter): Start date: August 2010; End date: Ongoing; Instrument: Thermo Tei 42; Validated data availability: from August 2010 to December 2012; Data Format: WDCGG Version 1.0; Data provider: ISAC-BO

Solar radiation (at λ 350 – 1100 nm and λ 280 – 315 nm): Start date: January 2012; End date: Ongoing; Instrument: silicon cell pyranometer (Skye SKS110) and a silicon photodiode (Skye SKU 430); Validated data availability: from January2012 to December 2013; Data Format: WDCGG Version 1.0; Data provider: ISAC-BO.

Size distribution of atmospheric aerosol in the 10 – 500 nm range: Start date: November 2005; End date: Ongoing; Instrument: customized Differential Mobility Particle Sizer (DMPS); Validated data availability: from November 2005 to December 2012; Data Format: NASA-AMES; Data provider: ISAC-BO.

Size distribution of atmospheric aerosol in the 300 – 20000 nm range: Start date: August 2002; End date: Ongoing; Instrument: Grimm 1.108 Optical Particle Counter; Validated data availability: from August 2002 to December 2012; Data Format: NASA-AMES; Data provider: ISAC-BO.

Aerosol scattering coefficient at 525 nm: Start date: May 2007; End date: September 2013; Instrument: M9003 integrating nephelometer (ECOTECH); Validated data availability: from May 2007 to December 2013;Data Format: NASA-AMES; Data provider: ISAC-BO.

Aerosol number concentration: Start date: March 2008; End date: Ongoing; Instrument: condensation particle counter (TSI model 3772); Validated data availability: from March 2008 to December 2013; Data Format: NASA-AMES; Data provider: ISAC-BO.

Aerosol absorption coefficient at 635 nm: Start date: May 2005; End date: Ongoing; Instrument: MAAP, Model 5012 – Thermo Electron Corporation; Validated data availability: from May 2005 to December 2013; Data Format: NASA-AMES; Data provider: ISAC-BO.

Aerosol chemistry: Start date: February 2006; End date: Ongoing; Instrument: PM1-PM0 sampler (off-line analysis at the ISAC-BO laboratories in Italy); Validated data availability: from February 2006 to December 2012; Data Format: NASA-AMES.

Summary of data transmitted to the NextData General Portal for the **Nepal Climate Observatory - Pyramid** GAW/WMO Global Station (these data-series have been obtained in the framework of the SHARE and UNEP-ABC Projects):

Aerosol absorption coefficient at 635 nm: Start date: March 2006; End date: Ongoing; Instrument: MAAP, Model 5012 – Thermo Electron Corporation; Validated data availability: from March 2006 to December 2012; Data Format: NASA-AMES.

Ozone mixing ratio: Start date: March 2006; End date: Ongoing; Instrument: Thermo Electron Tei49C; Validated data availability: from March 2006 to December 2013; Data Format: WDCGG Version 1.0.

SO_2 mixing ratio: Start date: October 2014; End date: Ongoing; Instrument: Thermo 43iTLE; Validated data availability: validation ongoing; Data Format: ASCII; Data provider: ISAC-BO.

Greenhouse Gases mixing ratio (halogenated): Start date: March 2006; End date: Ongoing; Instrument: flask sampling (off-line analysis at the Mt. Cimone GAW/WMO station); Validated data availability: from March 2006 to December 2012; Data Format: WDCGG Version 1.0.

Size distribution of atmospheric aerosol in the 10 – 800 nm range: Start date: March 2006; End date: Ongoing; Instrument: customized Scanning Mobility Particle Sizer (SMPS); Validated data availability: from March 2006 to December 2006; Data Format: ABC-ADAC; Data provider: ISAC-BO/CNRS-LGGE.

Size distribution of atmospheric aerosol in the 300 – 32000 nm range: Start date: March 2006; End date: Ongoing; Instrument: Grimm 190 Optical Particle Counter; Validated data availability: from March 2006 to December 2011; Data Format: ABC-ADAC; Data provider: ISAC-BO.

Aerosol scattering coefficient at 450, 525 and 700 nm: Start date: March 2006; End date: Ongoing; Instrument: integrating nephelometer (TSI); Validated data availability: from March 2006 to December 2006;Data Format: ABC-ADAC; Data provider: ISAC-BO (CNRS-LGGE).

Wet precipitation chemistry: Start date: June 2012; End date: Ongoing; Instrument: rain gauge (off-line analysis at the IRSA-CNR laboratories in Italy); Validated data availability: from June 2012 to March 2013; Data Format: WDCP.

Aerosol chemistry: Start date: February 2006; End date: Ongoing; Instrument: PM1-PM0 sampler (off-line analysis at the ISAC-BO laboratories in Italy); Validated data availability: from February 2006 to December 2006; Data Format: ABC-ADAC.

Solar irradiance (at λ: 200 - 3600 nm): Start date: March 2006; End date: Ongoing; Instrument: Pyranometer CMP21 Kipp&Zonen; Validated data availability: from January to December 2013; Data Format: GAW/WMO.

IR irradiance (at λ 3.5 to 50 \302\265m): Start date: March 2006; End date: Ongoing; Instrument: Precision Infrared Radiometer-PIR Eppley; Validated data availability: from January to December 2013; Data Format: GAW/WMO.

Meteorology (temperature, relative humidity, atmospheric pressure, wind direction and intensity): Start date: March 2006; End date: Ongoing; Instrument: Vaisala WXT520; Validated data availability: from March 2006 to December 2013;Data Format: WDCGG Version 1.0.

Summary of data transmitted to the NextData General Portal for **the GAW/WMO Regional Station at Plateu Rosa**

O_3 mixing ratio: Start date: January 2007; End date: Ongoing; Instrument: Environmental 41M up to June 2011 and Thermo 49i from July 2011; Validated data availability: from January 2007 to December 2014; Data Format: WDCGG Version 1.0; Data provider: RSE SpA.

CO_2 mixing ratio (NDIR): Start date: April 1993; End date: Ongoing; Instrument: Since 2003 Ultramat 5E NDIR Siemens, Since 2008, Ultramat 6E NDIR Siemens; Validated data availability: from January 2000 to December 2014; Data Format: WDCGG Version 1.0; Data provider: RSE Spa.

CH_4 mixing ratio (GC-FID): Start date: May 1991; End date: Ongoing; Instrument: Nira VENUS 301 (since November 2007); Validated data availability: from January 2005 to December 2014; Data Format: WDCGG Version 1.0; Data provider: RSE SpA.

ANNEX 1- PUBLIC DATA AVAILABILITY FOR THE GLOBAL STATION "O. VITTORI" – MONTE CIMONE

"O. VITTORI" – MONTE CIMONE (GAW-ID: CMN)

Measurements	GAW-WDCGG	GAW-WDCA
Carbon monoxide (GC-RGD)	2007-02-01 - 2010-03-01	
Carbon monoxide (GC-FID)	2008-01-01 - 2011-12-31	
Carbon monoxide (NDIR)	2012-06-12 - 2013-12-31	
Surface ozone	1996 - 2013	
Methane	2008-07-01 - 2011-12-31	
Nitrous Oxide	2008-01-01 - 2011-12-31	
Sulfur Hexafluoride	2008-01-01 - 2011-12-31	
Halogenated gases	2001-06-01 - 2013-09-30	
Total particle number concentration		2008-01-01 2012-12-31
Equivalent black carbon concentration/aerosol absorption coefficient 635 nm		2007-01-01 2013-12-31
Aerosol scattering coefficient at 525 nm		2007-01-01 2013-09-30
Size distribution of atmospheric aerosol in the 10 – 500 nm range		2006-01-01 2012-12-31
Aerosol chemistry		2009-02-24 2012-12-31

LEGEND:
♦**GAW-WDCGG**: Global Atmosphere Watch - World Data Center for Greenhouse Gases (http://ds.data.jma.go.jp/gmd/wdcgg/wdcgg.html)
♦**GAW-WDCA**: Global Atmosphere Watch - World Data Center for Aerosol (http://ebas.nilu.no/Default.aspx)

ANNEX 2- PUBLIC DATA AVAILABILITYOF FOR THE GLOBAL STATION NEPAL CLIMATE OBSERVATORY – PYRAMID

NEPAL CLIMATE OBSERVATORY – PYRAMID (GAW ID: PYR)

Measurements	GAW-WDCGG	GAW-WDCA	GAW-WDPC	ABC-DISC	ABC-ADAC	AERONET
Aerosol number concentration and size distribution in the range 250 nm to 32 µm				2006-3-1 2006-12-31	2006-3-1 2011-12-31	
Aerosol number concentration and size distribution in the range 10 nm to 650 µm				2006-3-1 2006-12-31	2006-3-1 2006-12-31	
Total and back scattering coefficient at 450, 550 and 700 nm				2006-3-1 2006-12-31	2006-3-1 2006-12-31	
Aerosol optical depth				2006-3-1 2007-2-28	2006-3-1 2007-2-28	2006-3-27 2013-12-31
Surface ozone	2006-3-1 2013-12-31			2006-3-1 2006-12-31	2006-3-1 2012-12-31	
Chemical mass closure of aerosol				2006-2-20 2006-12-6	2006-2-20 2006-12-6	
Wet/Snow precipitation chemistry			2012-07-04 2012-09-10			
Greenhouse Gases mixing ratio (halogenated)	2006-02-19 2012-12-04			2006-3-1 2007-2-28	2006-02-19 2012-12-04	
Meteorology	2006-3-1 2013-12-31			2006-3-1 2006-12-31	2006-3-1 2012-12-31	
Equivalent black carbon concentration/aerosol absorption coefficient 635 nm		2006-3-1 2012-12-31		2006-3-1 2006-12-31	2006-3-1 2012-12-31	

LEGEND:

♦**GAW-WDCGG**: Global Atmosphere Watch - World Data Center for Greenhouse Gases (http://ds.data.jma.go.jp/gmd/wdcgg/wdcgg.html)

♦**GAW-WDCA**: Global Atmosphere Watch - World Data Center for Aerosol (http://ebas.nilu.no/Default.aspx)

♦**ABC-DISC:** Atmospheric Brown Clouds Data and Information Service Center (http://www.rrcap.ait.asia/abc/data/abc/)

♦**ABC-ADAC:** Atmospheric Brown Clouds Asia Data Analysis Center (http://abc-data.snu.ac.kr/; autentication required)

♦**AERONET**: Aerosol Robotic Network (http://aeronet.gsfc.nasa.gov/cgi-bin/webtool_opera_v2_new)