Project of Strategic Interest NEXTDATA

Scientific Report for the reference period **01/01/2012-31/12/2012**

Unit CNR-ISAC

CNR-ISAC unit is involved in WP 1.1 and 1.2 (SP1) and in WP 2.5 and 2.6 (SP2) of NextData, as described below.

WP 1.1 - High-altitude climate observation system

1. Scheduled activities, expected results and Milestones (as indicated in the Executive Plan)

According to the Executive Plan, CNR-ISAC activities foreseen in WP1.1 are centred on the continuation of the in-situ measurements of meteo-climatic parameters and atmospheric composition, started in the framework of the SHARE Programme, in the mountain regions considered by the Project (Alps, Italian Apennines, Hindu-Kush Karakorum Himalaya, Rwenzori, Andes), also favouring the technical and scientific implementation of the measurement progammes already activated. In particular, the following activities had been planned:

- feasibility studies concerning the installation of new infrastructures for the execution of climate and environmental monitoring;
- survey to define the current status of technologies for the implementation of transportable systems suitable for use in regions where the installation of standard measurement stations is impossible, unfeasible or unaffordable;
- definition, in a national and international framework, of the scientific questions that will gain advantage from the execution of measurement activities in mountain areas.

Foreseen milestones:
M1 (PM8): Definition of the relevant “Scientific questions”.
M2 (PM12): Results of first year measurements, feasibility studies for new infrastructures and survey concerning the technology for transportable and energetically autonomous measurement systems.

2. Deliverables expected for the reference period

D1.1.1 (PM8): Report on the “scientific questions”.
D1.1.2 (PM12): Report describing the activities, data transfer to archives and to the General Portal.

D1.1.3 (PM12): Report on the technology for transportable and energetically autonomous measurement systems.

3. Activities which have been actually conducted during the reference period

3.1 Research activities

During the first year of activity, CNR-ISAC coordinated the activity within the WP1.1 (High altitude climate observation system) concerning the mountain meteo-climatic measurements in the regions of interest (Alps, Italian Apennines, Hindu-Kush Karakoram Himalayas, Rwenzori, Andes), originally conducted in the framework of the SHARE project (Table 1). CNR-ISAC also provided scientific and technological indications to support the execution of the scheduled actions, also based on the inputs from the national and international scientific community. In particular, thanks to participation in major national and international Projects/Programmes concerning the investigation of atmospheric composition and the environment in mountain areas (SHARE, ACTRIS, UNEP-ABC, WMO-GAW, GEO), in collaboration with URT Ev-K2-CNR, the following "scientific questions" have been defined (SQ):

- SQ1: How can you get more accurate operational atmospheric composition monitoring and forecasting using near real-time data from remote atmospheric observatories?
- SQ2: How can you get a more comprehensive understanding of the atmospheric role of nitrogen oxides using in situ data from remote atmospheric observatories?
- SQ3: Why is it important to know what role black carbon plays in regulating the Earth's climate and in affecting mountain environments?
- SQ4: How reliable are precipitation measurements in high-altitude regions and what strategy should be used to achieve the best information from the available observations?

Moreover, CNR-ISAC participated to the production of the deliverable D1.1.2 "Report describing the activities, data transfer to archives and to the General Portal."

During 2012, CNR-ISAC collaborated with the URT Ev-K2-CNR for the execution of intercomparison exercises at the AWS Periche, Kala-Patthar and Lukla (Himalayas), allowing the identification of possible sensor malfunctioning. For this purpose, collaboration with ENEA-UTMEA was also undertaken in order to define the correct methodology for checking and calibrating the broadband short-wave and long-wave radiation sensors working at the AWSs. In collaboration with URT Ev-K2-CNR, the methodologies and guidelines for the validation of meteorological data have been defined. ISAC-BO also participated to a preliminary study for the definition of the requirements for the traceability to international metrological standards of air temperature and atmospheric pressure measurements in Himalaya.
In the framework of collaborations with local Institutions (ICIMOD - International Centre for Integrated Mountain Development) and the UNEP-ABC and SHARE-EvK2CNR Projects, CNR-ISAC participated in the setting-up of the SusKat (Sustainable Atmosphere for the Kathmandu Valley) ABC field campaign. The aim of this international initiative (to be held in Kathmandu from January to March 2013) is to increase basic knowledge on air pollution in the Kathmandu valley and its possible recirculation to the Himalayas and the free troposphere. In this framework, in January 2013, a new measurement station will be installed at the URT Ev-K2-CNR building in Katmandu. CNR-ISAC also participated to the study to assess the feasibility of this new installation.

In the framework of the activities related to the feasibility study for the installation of a new climatic observatory in Pakistan, scheduled during the second year of the project, CNR-ISAC analysed the data from the NANO-SHARE system which worked at Askole from August to October 2012. Thanks to this system, simultaneous measurements of surface ozone, carbon dioxide, aerosol number particle and meteorological parameters were carried out. The resulting information was shared with URT Ev-K2-CNR in order to contribute to the Deliverable D1.1.3.

Measurement site	Country/Continent		Class	Elevation (m a.s.l.)
Forni glacier (Central Alps,)	Italy	Europe	AWS	2,669
Dosdè Glacier (Central Alps,)	Italy	Europe	AWS	2,740
Gigante Glacier (Western Alps)	Italy	Europe	AWS	3,500
Italian Climate Observatory "O. Vittori" (northern Apennines)	Italy	Europe	ATM	2,165
Osservatorio Portella del Gran Sasso (central Apennines)	Italy	Europe	ATM	
Nepal Climate Observatory – Pyramid (Khumbu valley, Himalayas)	Nepal	Asia	ATM	5,079
Pyramid Laboratory Observatory (Khumbu valley, Himalayas)	Nepal	Asia	AWS	5,050
Pheriche (Khumbu valley, Himalayas)	Nepal	Asia	AWS	4,258
Namche Bazaar (Khumbu valley, Himalayas)	Nepal	Asia	AWS	3,560
Lukla (Khumbu valley, Himalayas)	Nepal	Asia	AWS	2,660
Kala Patthar (Khumbu valley, Himalayas)	Nepal	Asia	AWS	5,600
Changri Nup Station (Khumbu valley, Himalayas)	Nepal	Asia	AWS	5,700
South Col (Mt. Everest, Himalayas)	Nepal	Asia	AWS	8,000
Urdukas (Baltoro glacier, Karakorum)	Pakistan	Asia	AWS	3,926
Askole (Baltoro glacier, Karakorum)	Pakistan	Asia	AWS	3,015
Concordia (Baltoro glacier, Karakorum)	Pakistan	Asia	AWS	4,700
Chacaltaya (Cordillera Real, Ande)	Bolivia	South America	ATM	5,200
Mt. Stanley (Elena glacier, Rwenzori)	Uganda	Africa	AWS	4,700

Table 1. Measurement stations (AWS: automatic weather stations, ATM: observatories for atmospheric composition measurements) installed in the framework of the SHARE Project and now supported by NextData.

CNR-ISAC, in close synergy with WP1.2, shared technical information with CETEMPS – University of L'Aquila for the implementation of a new mountain measurement station at Campo Imperatore – Monte Portella, which operates in the framework of the SHARE-Italia network (Gran Sasso d'Italia, Abruzzo). In particular, based on the Monte Cimone and NCO-P know-how, the technical design of the air intake for trace gas sampling was shared and indications were provided on the wind sensors and instrumentation for monitoring atmospheric aerosol number size distribution, thus contributing to the feasibility study for the station installation. A detailed analysis of the summer ozone variability at Campo Imperatore – Monte Portella, as deduced from

preliminary measurements carried out in August 2009 in the framework of the SHARE Project, has been achieved (Cristofanelli et al., Pure and Applied Geophysics, in press).

3.2 Applications; technological and computational aspects

- Algorithms for the implementation of semi-automatic routines for AWS data validation.
- Prototype for a portable and energetically autonomous system for the measurement of meteorological variables (atmospheric pressure, air temperature, relative humidity) in high mountain sites.
- Execution of in-situ test for the evaluation of the performance of a transportable system for atmospheric composition measurements.

3.3 Formation

PhD Thesis on "Contribution to the comprehension of climate change towards cryosphere and atmospheric analysis: the cases study of Changri Nup Glacier, Nepal Himalayas and of Forni Glacier, Italian Alps".

3.4 Dissemination

None in the reporting period.

3.5 Participation in conferences, workshops, meetings

Adhikary, B., E. Vuillermoz, R. Toffolon, P. Cristofanelli, A. Marinoni, R. Duchi & P. Bonasoni. 2012. SHARE Project: climate observations for environmental monitoring in the Himalayas. *ISCCC – 2012*, Manali, India, 2-4 April 2012.

Adhikary, B., E. Vuillermoz, A. Marinoni, P. Cristofanelli & P. Bonasoni. 2012. Chemical Transport Modeling: a decision support a tool for policy makers for sustainable development planning. *Sixth National Conference on Science and Technology – Economic, Growth through Science, Technology and Innovation*, Kathmandu, Nepal, 25-27 September 2012.

Cristofanelli P., Di Carlo P., et al.: Analysis of summer ozone observations at a high mountain site in central Italy (Campo Imperatore - 2388 m a.s.l.), *Pure and Applied Geophysics*, in press.

Vuillermoz, E., A. Marinoni, P. Bonasoni, GP. Verza, G. Diolaiuti, A. Senese, C. Smiraglia,D. Bocchiola, A. Soncini & U. Minora. 2012. Studying Himalayan glaciers to understand atmospheric dynamic and ongoing climate variations. Data and findings from the Changri Nup Glacier (Nepal, Himalaya). *Conference on Cryosphere of the Hindu Kush Himalayas: State of the Knowledge*, Kathmandu, Nepal, 14 – 16 May, 2012.

Vuillermoz, E., A. Marinoni, P. Bonasoni , GP. Verza, G. Diolaiuti, A. Senese , C. Smiraglia , D. Bocchiola, A. Soncini & U. Minora. 2012. Studying Himalayan glaciers to understand atmospheric dynamics and ongoing climate variations. Data and findings from the Changri Nup Glacier (Nepal, Himalaya). *Sixth National Conference on Science and Technology – Economic, Growth through Science, Technology and Innovation*, Kathmandu, Nepal, 25-27 September 2012.

4. Results obtained during the reference period

4.1 Specific results (Data libraries, Measurements, Numerical simulations, etc)

- Database of measurements and meteo-climatic variables recorded at the AWS stations reported in Table 1.

- Database of surface ozone, carbon dioxide, total particle number, meteorological parameters at Askole from August to October, 2012.

Moreover, the following measurement results have been achieved in the framework of the SHARE project:

- Definition of summer variability of the surface ozone at Campo Imperatore station-Monte Portella (Central Apennines).
- Preliminary assessment of the atmospheric composition variability in the Karakorum regions.
- Investigation of the surface albedo variability at the Chungri Nup glacier.

4.2 Publications

Cristofanelli P., Di Carlo P., et al.: Analysis of summer ozone observations at a high mountain site in central Italy (Campo Imperatore - 2388 m a.s.l.), *Pure and Applied Geophysics*, in press.

4.3 Availability of data and model outputs (format, type of library, etc)

- SHARE network AWS: described in the Deliverable D1.1.2.
- Asokle (August - October 2012): surface ozone, carbon dioxide, total particle number, meteorological parameters (format: Excel; status: preliminary validation; data provider: URT EVK2CNR).

4.4 Completed deliverables

D1.1.1 (PM8): Report on the "scientific questions".
D1.1.2 (PM12): Report describing the activities, data transfer to archives and to the General Portal
D1.1.3 (PM12): Report on the technology for transportable and energetically autonomous measurement systems.

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

No significant deviations have occurred during the first year between the planned activities and those actually performed.

6. Expected activities for the following reference period

- Continuation and upgrade of the in-situ measurement programmes in the regions considered by the Project;
- Activation of new infrastructures for the execution of measurements to support climate and environmental studies in the regions considered by the Project;
- Development of specific procedures for acquisition of information, measurement protocols, data acquisition and transmission;
- Use of transportable systems for the measurements of atmospheric compounds and climate-environmental parameters;
- Integration and exchange of data with other international initiatives on measurement networks.

WP 1.2 - GAW-WMO climate observatories

1. Scheduled activities, expected results and Milestones (as indicated in the Executive Plan)

During the first year, NextData was expected to support the measurement programmes already in place at the two Italian GAW stations in the framework of the SHARE Project: the climatic station at Monte Cimone (2165 m s.l.m., Italian Apennines) and the Nepal Climate Observatory – Pyramid (5079 m s.l.m., Nepal). Additionally, feasibility studies had to be undertaken for the upgrade of (i) GAW-WMO stations, (ii) stations which operate within the SHARE Project. The measurement upgrade strategies have been defined according to national and international strategies (GAW-WMO, GMES, UE Projects).

Milestones:
M1 (PM8): Definition of the "scientific questions".
M2 (PM12): Definition of the measurement strategies. Feasibility studies for upgrading the Regional Stations GAW-WMO, in synergy with the SHARE-Italia network

2. Deliverables expected for the reference period

D1.2.1 (PM8): Report describing the status of GAW-WMO stations managed by Italian Institutions or participating in the SHARE project.

D1.2.2 (PM12): Report describing the feasibility of upgrade actions for measurement stations within GAW-WMO.

D1.2.3 (PM12): Report describing the activities, data transfer to archives and to the General Portal.

3. Activities which have been actually conducted during the reference period

The observations and study activities at the GAW-WMO global station Monte Cimone (GAW ID: CMN) and Nepal Climate Observatory – Pyramid (GAW ID: PYR), already started within the SHARE project, have been continued. Within this framework, activities were carried out concerning instrument calibrations and data validation 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 (until 31 December 2011), data of atmospheric composition were submitted to the GAW-WMO reference databases (http://ds.data.jma.go.jp/gmd/wdcgg/, http://ebas.nilu.no/Default.aspx).
Data will be also shared with the NextData General Portal, once it is available. The status of data availability at the two global stations, is reported in Deliverable D1.2.3. To have a timely update of data behavior and availability at these stations, a near-real time (NRT) visualization system has been implemented at the CNR-ISAC HeadQuarters in Bologna.

In the framework of the activities described in deliverable D1.2.1, the group of CNR-ISAC at Bologna (ISAC-BO) and URT Ek-K2-CNR personnel, performed the inspections of the Global Station "O. Vittori" (Monte Cimone, Italy), Global Station NCO-P (Himalayas - Nepal), Regional Station "R. Sarao" (Lampedusa) and the high-mountain station Campo Imperatore – Monte Portella (Abruzzo). Due to adverse weather conditions, the inspection at Plateau Rosa (Valle d'Aosta) will be undertaken in 2013. However, the fruitful interaction with the station manager led anyway to the drafting of a report (in D1.2.1) on the current status of the station.

Moreover, a series of feasibility studies were carried out during the first year of NextData, to evaluate possible upgrades of the measurement programme at (i) GAW-WMO station managed by Italian Institutions, (ii) stations which operate within the SHARE Project. The following studies are reported in deliverable D1.2.2:

- *FEASIBILITY STUDY FOR THE INSTALLATION OF A WAVELENGTH-SCAN CAVITY RING DOWN SPECTROSCOPY (WS-CRDS) IN REMOTE MEASUREMENT STATIONS.*
- *FEASIBILITY STUDY FOR THE UPGRADE OF A COMMERCIAL CARBON MONOXIDE ANALYZER IN REMOTE MEASUREMENT STATIONS.*
- *FEASIBILITY STUDY FOR THE INSTALLATION OF NOx MEASUREMENT SYSTEMS IN REMOTE MEASUREMENT STATIONS.*
- *FEASIBILITY STUDY FOR THE UPGRADE OF THE SAMPLING SYSTEM OF A COMMERCIAL INSTRUMENT FOR THE ON-LINE MONITORING OF PM1 AND PM10.*
- *FEASIBILITY STUDY FOR THE INSTALLATION OF AN AEROSOL LIDAR AT THE GAW-WMO GLOBAL STATION "O. VITTORI" AT MT. CIMONE.*

3.1 Research activities

At the **Nepal Climate Observatory – Pyramid (NCO-P),** the experimental set-up was strengthened by installing a new system for the monitoring and on-line characterization of PM1, PM10, and the aerosol size distribution in the accumulation and coarse fraction ranges (Figure 1). In collaboration with ENEA-UTMEA, the Partners are redefining the strategy for the measurements of solar radiation fluxes at the GAW-WMO Global Station NCO-P by the acquisition of new instrumentation (pyranometer and pirgeometer).

Figure 1. The NCO-P GAW-WMO Global Station after the upgrade.

During March – April 2012, 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, LGGE-CNRS and the Pyramid personnel, participated in this campaign. Taking advantage of the scheduled inspection, ISAC-BO personnel also assessed the results of the major technical interventions carried out at NCO-P, as also reported in Deliverable D1.2.1.

In December 2012, the purchase of an aerosol LIDAR (Leosphere France) was discussed with the Irish Air Force. A study was performed for the installation of this system at the NCO-P also thanks to the collaboration with the National University of Ireland in Galway (Dr. Martucci). The adoption of a similar instrumentation at this measurement site would greatly upgrade the observing capacity of the station, with particular emphasis on the investigation of aerosol transport to the high Himalayas. It would also respond to the key priority, expressed by GAW-WMO, on the necessity of implementing a global network of aerosol and cloud lidars (see Deliverable D1.2.2).

Also thanks to the interaction with WCC-EMPA personnel and according to the GAW-WMO guidelines and strategic plans (2008-2013), a feasibility study was performed to upgrade the greenhouse gas observations at the GAW-WMO Global Station NCO-P (and at other remote observatories) by installing a CRDS (cavity ring-down spectroscopy) system (see Deliverable D1.2.2). The system will allow simultaneous and continuous measurements of carbon dioxide, carbon monoxide, methane and water vapor. In December 2012, ISAC-BO personnel visited the WCC-EMPA laboratories to discuss the modality of implementation of this instrumentation at NCO-P and at other remote Observatories. Once available, the instrumentation will play an important role in 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 defined in the framework of the ABC-UNEP project.

Also to support these observational activities, from November 2012 a fellowship (1 year) has been activated at CNR-ISAC Bologna (Section 3.3).

At the GAW-WMO Global Station Monte Cimone, the first audit by the WCC ("World Calibration Center for Surface Ozone, Carbon Monoxide, Methane and Carbon Dioxide" of GAW) was hosted on 24-26 September, 2012. ISAC-BO, in collaboration with WCC personnel (hosted by EMPA), managed and coordinated both the preparation of the audit as well as the research activities carried out during the audit at the Italian Climate Observatory "O. Vittori". This activity, which results will be made available in the coming months, focused on measurements of surface ozone, carbon monoxide, methane and nitrous oxide, with special emphasis on the instrumental set-up, calibration scales and QA/QC procedures at the station.

A MoU has been signed with NOAA-GMD (National Oceanic and Atmospheric Administration - Global Monitoring Division) for the adoption of calibrates reference gas cylinders for CO2, CH4, CO and SF6 (primary reference standards of GAW-WMO network), in collaboration with University of Urbino.

According to the "scientific questions" defined during the first project year (Deliverable D1.1.1), also thanks to the interaction with the EU Project ACTRIS, a project was defined for the realization of an advanced monitoring system for the measurement and investigation of NOx at the GAW-WMO Global Station Monte Cimone and at other remote Observatories (see deliverable D1.2.2). The installation of this instrumentation, based on the use of a chemioluminescence analyzer coupled with a photolytic converter, will lead to a significant upgrade of the station. Currently, the procedures for the acquisition of some components of the system (chemioluminescence analyser, multicalibrator system, certified standard cylinders) are ongoing. Moreover, the implementation of SO2 measurements has been planned. The acquisition of some components of the system (UV-fluorescence analyzer, permeation tubes for calibrations) is on going. Once tested at Mt. Cimone, the technical details will be shared with the other remote stations involved in the Project.

In July 2012, at the GAW-WMO global station Monte Cimone, the NDIR system for the continuous monitoring of carbon monoxide concentrations was upgraded. To adapt such instrumentation for working in a remote site like Monte Cimone, according to specific indications from the WCC-EMPA, a feasibility study was performed (see Deliverable D1.2.2), which led to the execution of several modifications to the instrumental set-up as well as to the measurement handling procedures. This allowed for a significant improvement of measurement accuracy.

At the GAW-WMO Global Station Monte Cimone, the experimental set-up for monitoring atmospheric aerosol was upgraded by installing a new system for the online determination of PM1 and PM10 (β-absorption) offering the possibility of storing samples for offline chemical analysis. For this purpose, a study was carried out (see deliverable D1.2.2) to evaluate the feasibility of similar systems at remote Observatories characterized by adverse weather conditions. A series of technical inspections to the station were performed to define the modality of the system installation: this entailed the execution of infrastructural adaptation works by ISAC-BO personnel. The instrument (SWAM 5A MONITOR, FAI Instrument S.r.L), which provides 12-hour average values of PM1 and PM10, was coupled with an optical particle counter (OPC monitor, FAI Instrument S.r.L), which provides the on-line aerosol size distribution in the accumulation and coarse ranges with 1-min resolution. Once connected by means of specific software, these instruments together will provide accurate Near Real Time (with 1-min resolution) information on PM1 and PM10 concentrations in the atmosphere. This allowed a significant upgrade of the capacity of atmospheric composition variability analysis on NRT, in line with GAW-WMO recommendations concerning the adoption of technology for the provision of NRT data. Also with the aim of supporting the new experimental programmes with suitable manpower, a fellowship (duration: 1 year) was activated at CNR-ISAC Bologna in October 2012 (Section 3.3). In this framework, an automatic procedure for the validation of BC data has been developed and applied to the Mt. Cimone time series.

In September 2012, a new surface ozone analyzer (Thermo Tei 49i) was installed at the "O. Vittori" Station. After one year of intercomparison with this new instrument, the UV-absorption analyzer (Dasibi 1108) which has been working at this station from 1996, will be de-activated or used as a back-up instrument.

In October 2012, a LIDAR system (developed at the CNR-ISAC laboratories in Rome) with backscatter (BL) depolarization lidar (DL) with night-time Raman capabilities (RL) was installed at Monte Cimone, with the aim of evaluating the feasibility of use of this advanced instrumentation in remote high altitude observatories. It was positioned on the equipped terrace of the laboratory. 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.

Recently, the atmospheric observatory located at Chacaltaya (La Paz University), joined GAW-WMO thanks to an international consortium (composed of CNRS, LGGE, IRD, LSCE, PSI, CNR-ISAC, Ev-K2-CNR), which supported the re-establishment of atmospheric observations in the Bolivian Andes. On 2-3 April, 2012, ISAC-BO personnel in collaboration with URT Ev-K2-CNR performed the maintenance and set-up of the surface ozone analyzer working at Chacaltaya. During the reference period, ISAC-BO personnel provided to the La Paz University personnel technical and scientific instructions on how to operate the surface ozone measurements correctly.

3.2 Applications; technological and computational aspects

- A feasibility study was compiled for the implementation of greenhouse gas measurements by CRDS systems at remote observatories.
- A feasibility study was compiled for the upgrade of a commercial system for the measurement of atmospheric carbon monoxide at remote sites.
- A feasibility study was compiled for an advanced system for the measurement of NO_X at remote observatories.
- A feasibility study was compiled for upgrading the sampling system of a commercial instrument for the on-line monitoring of PM1 and PM10 at high mountain observatories.
- A feasibility study was compiled for the implementation of aerosol LIDAR measurements at the GAW-WMO global station "O. Vittori".
- Software was developed for the automation of calibration procedures for surface ozone analyzers working at remote sites.
- Software was developed for the automatic validation of black carbon data by integrating despiking functions and QA/QC procedures.

3.3 Formation

- Master Thesis (at University of Turin): "Ozone and black carbon variability in Southern Himalayas: influence of biomass burning emissions", Davide Putero.
- PhD Thesis (at University of Urbino): "Analysis of synoptic-scale mineral dust transport to the Nepal climate Observatory – Pyramid GAW-WMO Global Station", Rocco Duchi.
- During the maintenance 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.
- Participation of 2 station operators in the "22nd GAWTEC Training Course" at the Zugspizte GAW-WMO Global Station (Germany).
- One training fellowship (Borsa di Studio) and one research fellowship (Assegno di Ricerca) were activated.

3.4 Dissemination

None in this period.

3.5 Participation in conferences, workshops, meetings

- Inception Workshop: Reducing the Impacts of Black Carbon and other Short Lived Climate Forcers, 1-3 April, 2012, Kathmandu, Nepal.
- International Expert Consultation on Mountains and Climate Change, 4 April, 2012, Kathmandu, Nepal.
- International Conference of Mountain Countries on Climate Change, 5-6 April, 2012, Kathmandu, Nepal.
- SHARE General Assembly, 30 May 2012, Rome, Italy.
- ACTRIS General Assembly, 3-6 June 2012, Stresa, Italy.

- ABC Science Meeting, 13-14 September, 2012, Beijing, China.
- IGAC 2012, 17 -21 September 2012, Beijing, China.

  - Cristofanelli, P., H.E. Scheel, F. Calzolari, R. Duchi, A. Marinoni and P. Bonasoni, Analysis of surface ozone trends at the Mt. Cimone GAW Global station (Italy), IGAC 2012, 17 -21 September 2012, Beijing, China.
  - Marinoni A., P. Bonasoni, P.Cristofanelli, P. Laj, R. Duchi, E. Vuillermoz, B. Adhikary, T. C. Landi, D. Putero and S. Fuzzi. High level of pollution transported up to 5000 m asl in the Southern-Himalayas: continuous observations since 2006 at NCO-P GAW global Station, IGAC 2012, 17 -21 September 2012, Beijing, China.

- Sixth National Conference on Science and Technology – Economic Growth through Science, Technology and Innovation, 25-27 September, 2012. Kathmandu, Nepal.

  - Bonasoni, P., A. Marinoni, P. Cristofanelli, P. Laj, R. Duchi, E. Vuillermoz, B. Adhikary, T.C. Landi & D. Putero. 2012. High level of pollution transported up to 5000 m a.s.l. in the Southern-Himalayas: continuous observations since 2006 at NCO-P GAW global Station. Sixth National Conference on Science and Technology – Economic, Growth through Science, Technology and Innovation, Kathmandu, Nepal, 25-27 September 2012.

- American Geophysical Union, Fall Meeting, December 1-7, 2012, San Francisco, USA.

  - Adhikary, B., P. Bonasoni, P. Cristofanelli, A. Marinoni, R. Duchi, F. Calzolari, T. C. Landi, D. Putero, S. Fuzzi, S.Decesari, E. Vuillermoz, P. Stocchi, G.P. Verza, Sarika Kulkarni, South Asian Aerosols: Observations and regional scale modeling perspectives from the Nepal Himalayas. American Geophysical Union, Fall Meeting, December 1-7, 2012, San Francisco, USA.
  - Cristofanelli, P., R. Duchi, B. Adhikary, P. Bonasoni , M.C. Facchini, F. Fierli, S. Fuzzi, F. Calzolari, S.Decesari, T. C. Landi ,P. Laj, A. Marinoni, D. Putero, P. Stocchi, Mineral dust transport at the Nepal Climate Observatory – Pyramid" (27°57' N, 86°48' E, 5079 m a.s.l.). American Geophysical Union, Fall Meeting, December 1-7, 2012, San Francisco, USA.

4. Results obtained during the reference period

4.1 Specific results (Data libraries, Measurements, Numerical simulations, etc)

Activities at the GAW-WMO global station Monte Cimone and Nepal Climate Observatory – Pyramid, resulted in a database including meteorological parameters, trace gases mixing ratios and atmospheric aerosol, as reported in the Deliverable 1.2.3.

Additionally, the following scientific results have been achieved in the framework of the SHARE project:

• Assessment of the contribution of biomass burning emissions and anthropogenic pollution to the variability of BC, ozone and carbon monoxide observed at the global station GAW-WMO at Mt. Cimone;

• The influence of biomass burning emissions on inter-annual variability of ozone and black carbon concentrations in the Himalayas, identifying the main source areas and providing a preliminary assessment of their contribution;

• Characterization of the mineral aerosol transport to NCO-P extended to years 2006-2011;

• Analysis of long term surface ozone trend at the "O. Vittori" GAW-WMO Global Station at Monte Cimone.

4.2 Publications

Bonasoni P., Cristofanelli P., Marinoni A., Vuillermoz E., Adhikary B. Atmospheric pollution in the Himdu Kush – Himalayan Region – Evidnces and Implications for the Regional Climate. Mountain Research Development, 32(4):468-479. 2012.

Cristofanelli, P., F. Fierli, A. Marinoni, R. Duchi, J. Burkhart, A. Stohl, M. Maione, J. Arduini, and P. Bonasoni. Influence of biomass burning and anthropogenic emissions on ozone, carbon monoxide and black carbon concentrations at the Mt. Cimone GAW-WMO global station (Italy, 2165 m a.s.l.). Atmos. Chem. Phys. Discuss., 12, 21399-21435, 2012.

4.3 Availability of data and model outputs (format, type of library, etc)

- The data Availability for the "O. Vittori" GAW-WMO Global Station at Monte Cimone is reported in the Deliverable D1.2.3 (part of the dataseries were obtained in the framework of SHARE and of other Research Projects).
- The data Availability for the Nepal Climate Observatory - Pyramid GAW-WMO Global Station at Monte Cimone is reported in the Deliverable D1.2.3 (part of the dataseries were obtained in the framework of the SHARE Project).

4.4 Completed deliverables

D1.2.1: Report describing the status of GAW-WMO stations managed by Italian Institutions or related with the SHARE project.

D1.2.2: Report describing the feasibility of upgrade actions for measurement stations within GAW-WMO.

D1.2.3: Report describing the activities, data transfer to archives and to the General Portal.

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

The technical inspections at the Plateau Rosa station were postponed to 2013. Some delays arose in the implementation/upgrade of the measurement programme at the GAW-WMO Global Station of Monte Cimone, due to administrative problems associated with the adoption of new purchase regulations by CNR.

6. Expected activities for the following reference period

- Continuation of observation and investigation activities at the GAW-WMO Global Station led by Italian Institutions (implementation of measurement programmes and technological facilities).

- Start of 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 resulting data will be shared.

WP 2.5 - Archive of numerical simulations and projections

1. Scheduled activities, expected results and Milestones (as indicated in the Executive Plan)

This report regards the following activities and the milestone indicated in the executive project plan:

A1: Definition of the type of climate simulations to be used in the project
A2: Running different global climate models and creation of numerical archives

M1: Completion of an index of available climate simulations and harmonization of storage protocols; definition of scientific question and of simulation strategies

2. Deliverables expected for the reference period

Deliverable D2.5.1: Report on a census of available climate simulations
Deliverable D2.5.1: Report on the scientific questions

3. Activities which have been actually conducted during the reference period

3.1 Research activities

CNR-ISAC has completed a series of scenario simulations using the EC-Earth global model, a state-of-the-art, high-resolution earth-system model, developed by a large consortium of european research institutions and researchers of which ISAC is a member. The numerical simulations have been performed at T159 horizontal resolution for the atmosphere (about 1.125°) and about 1° for the ocean with version 2.3 of the model. The atmosphere is discretized with 62 vertical numerical levels. The scenario simulations include the historical period (1850-2005) and the RCP 2.6, RCP 4.5 and RCP 8.5 scenarios (2006-2100), following CMIP5 specificified boundary conditions. The initial condition for these runs was a 700 years-long pre-industrial experiment provided by the EC-Earth consortium. The historical and scenario simulations have been performed using CASPUR supercomputing resources. A summary of experimental results and of analyses can be found at http://www.to.isac.cnr.it/ecearth.

A series of decadal prediction experiments following CMIP5 standards with EC-Earth 2.3 have been prepared for 10-yr periods in the range 1960-2005 (with start dates 1960, 1965 ... 2005) at T159L62/ORCA1 resolution. The initialization method is an anomaly initialization based on the EC-Earth CMIP5 historical climatology produced for the start date and the ECMWF Ocean Reanalysis (ORA-S4).

The new EC-Earth release v3 (released in October) has been implemented on the CINECA/Caspur Matrix cluster. This version of the model is based on IFS 36r4, the latest version of the NEMO model (3.3.1) and the LIM3 sea-ice model. It will be run at T255 resolution (about 80 km) with 91 vertical levels. A series of successful test runs and scaling tests has been performed on Matrix (http://www.to.isac.cnr.it/ecearth/ecearth3/scaling.html).

The state-of-the-art non-hydrostatic model Advanced Research Weather and Forecasting Model (WRF) has been used to perform high-resolution simulations (from 500m to 2km resolution) of deep moist convection for an atmosphere in radiative-convective equilibrium in very large domains (up to 800km). The study has allowed to

reproduce a self-organization process of the tropospheric convective fields and to verify the impact of different microphysical parametrizations on the spatial organization of the fields and on their variability (Parodi et al. 2012).

We started the implementation and preparation of a series of extremely high-resolution and numerically intensive dynamical climate downscaling experiments using the non-hydrostatic model WRF. This activity is performed using computing resources provided by the Gauss programme at the German Supercomputing Center LRZ. The focus will be in particular on regions where significant impacts of climate change are expected and where precipitation modeling is particularly challenging due to the formation of intense and complex meteorological structures or to rich and complex orography (The Hindu-Kush-Karakorum-Himalaya, the Alps and the Mediterranean area, and the Caribbean/South American area). To this purpouse the latest version of the WRF model (3.4.1) has been integrated with a modification (CL-WRF) which allows flexible use of GHG scenarios and implemented on the SuperMUC machine at LRZ. A first test experiment has been performed at resolution of 0.22 degrees, using ERA-Interim boundary conditions, for a period of one month.

A modified version of a consolidated stochastic method, the RainFARM procedure developed at CNR-ISAC, has been applied to climate simulations produced by the PROTHEUS regional climate model, developed at the ENEA centre in the framework of a collaboration between ENEA and ICTP. The aim of this study is to investigate whether the precipitation produced by this RCM, stochastically downscaled with RainFARM, is able to reproduce the main statistical properties of the precipitation measured by a network of rain gauges located in north-western Italy. We considered 122 rain gauges located in the Piedmont and Valle d'Aosta regions, spanning the time period from 1958 to 2001 and located at different altitudes, ranging from about 100 m to about 2500 m above sea level. We applied RainFARM also to the large scale driver of the PROTHEUS RCM, the ERA40 global reanalyses to compare the skill of the stochastic downscaling procedure when applied to precipitation fields having different spatial resolution (PROTHEUS $\sim$ 30km, ERA40 $\sim$ 100km) and to emphasize the role of dynamical downscaling.

3.2 Applications; technological and computational aspects

The raw output of the climate simulations performed with EC-Earth has been post-processed and a subset of variables (following CMIP5 reccomended output fields and time frequencies) has been converted to CMOR2 netcdf format, enriching the netcdf files with ample metadata information.
Additionaly, a set of variables of interest for application to the study of snow cover and of precipitation and temperature extremes, and not included in the CMIP5 archives, has been extracted at high temporal resolution (3hr).

The output of existing climate simulations performed by CNR-ISAC at CASPUR using the ECHAM-HAM 5.5 model, including the aerosol dynamics and transport module HAM2, have been collected and made available in a centralized archive at CNR-ISAC.

Starting from the EC-Earth model outputs, specific boundary condition files have been prepared for the periods 1960-2005 (historical) and 2006-2050 (RCP 2.6, RCP 4.5, RCP 8.5) and transmitted to ICTP in order to be used for the production of model simulations with a hydrostatic regional climate model for the HKKH focus area.

A THREDDS server has been installed at ISAC in order to provide access of available

data to the project participants and to prepare for the future indexing of data through a general portal. The server implements the OpenDAP protocol, providing access to complete metadata information on the available gridded fields, an http fileserver in order to allow access to the full files and a data subsetting tool allowing to extract chosen spatial and temporal ranges for selected variables. Technical details on the implementation have been shared with other participants in the WP 2.5.

Available model outputs from EC-Earth and ECHAM-HAM (detailed in the deliverable D 2.5.1 census of available simulations and summarized in 4.3) have been transferred onto the THREDDS server at CNR-ISAC. The EC-Earth CMIP5 simulation data in CMOR2 format have been transferred and made available on the THREDDS server at CASPUR.

The potential use of the downscaling results has also been discussed in meetings at the World Bank and at the InterAmerican Development Bank in Washington DC, USA, in May 2012.

3.3 Formation

A Master Thesis (Laurea Magistrale) has been supervised, on the topics of validation of global EC-Earth precipitation against available satellite and gridded station archives, on the analysis of statistics of extreme precipitation in the historical period and on the role of mid-latitude disturbances on winter precipitation in the Karakorum and the relationship with teleconnection patterns.

A first cycle degree thesis has been supervised on the comparison of precipitation and temperature produced with EC-Earth for the historical period with available station observations and on the analysis of trends and statistics of precipitation and temperature scenario simulations, for the area of North-Western Italy.

On February 2012 a Post-Laurea fellowship was activated, on the development and use of stochastic downscaling techniques applied to climate models.

3.4 Dissemination

Several seminars were given on the general role of stochastic downscaling, both at the level of general public and at specific stakeholder meetings (eg, ARPA Piemonte).

3.5 Participation in conferences, workshops, meetings

Scientific results obtained with model simulations developed in the framework of this WP have been presented in talks at the following workshops and conferences:

- International meeting with EC-Earth contributors/users in Reading, UK. May 30 - 31, 2012.
- ECRA (European Climate Research Alliance) workshop: "Changes in the hydrological cycle", CNR, Rome, 5-6 March 2012.
- Workshop: "Orographic Precipitation and Climate Change", NCAR, Boulder, 13-15 March 2012.
- European Geosciences Union (EGU) General Assembly 2012, Vienna, 22-27 April 2012.
- Workshop: "Contribution of science and cooperation to the sustainable development of the Central Karakorum National Park", Islamabad, 4-7 June 2012.

- 6th HYMEX Workshop, Primosten, Croatia, 7-10 May, 2012.
- ECSAC 2012: CLIMATE CHANGE: marine and mountain ecosystems in the Mediterranean region, XII International Conference on Science, Arts and Culture, Veli Lošinj, Croazia, 27-30 August 2012.
- Conference MED-Clivar 2012: "The climate of the Mediterranean region: understanding its evolution and effects on environment and societies", 26-28 September 2012.

4. Results obtained during the reference period

4.1 Specific results (Data libraries, Measurements, Numerical simulations, etc)

The specific results of this WP consist in:

- An archive of numerical simulations produced with the EC-Earth model for the historical period (1850-2005) and for three scenarios (CMIP5), as described in 4.3.
- An archive of numerical simulations produced with the ECHAM-HAM model.
- A THREDDS Data Server, located at CNR-ISAC, distributing the archives specified above.

The high-resolution precipitation fields obtained by downscaling the PROTHEUS output with RainFARM reproduce well the seasonality and the amplitude distributions of observed precipitation during most of the year, including the extreme events. RainFARM produces better results, compared to the observation, when it is applied to PROTHEUS than ERA40, highlighting the added value of dynamical downscaling. However, the biases of the regional climate model or of ERA40 cannot be corrected by this stochastic downscaling procedure: RainFARM can introduce variability at the scale which are not resolved by the physical models, but it cannot replace the physically-based models, also used to better understand rainfall dynamics.

4.2 Publications

The revised paper: "Emergence of large-scale patterns in moist atmospheric convection", by Parodi A., von Hardenberg J., Provenzale is in preparation for the "Journal of Geophysical Reasearch – Atmospheres".

The paper: "Stochastic rainfall downscaling of a regional climate model over north-western Italy", by D. D'Onofrio, E. Palazzi, J. von Hardenberg, A. Provenzale, V. Artale, S. Calmanti, is in preparation for the "Journal of Hydrometeorology".

4.3 Availability of data and model outputs (format, type of library, etc)

1) EC-Earth v. 2.3 (2011). All runs at T159L62 (Atmosphere) + 1° / ORCA1 (Ocean) resolution. Raw output files are in grib (IFS) + netcdf (NEMO)

Completed runs:

- *Historical run.*
  - Time period: (1850-2005)
  - Approximate size of the raw output archive (grib+netcdf): 15 TB
  - CMOR2 archive available and distributed: 1.5 TB
  - Additional output at 3hr time-resolution: 465 GB (netcdf)
- *RCP 2.6 scenario*

- Time period: (2006-2100)
- Approximate size of the raw output archive (grib+netcdf): 15 TB
- CMOR2 archive available and distributed: 1 TB
- Additional output at 3hr time-resolution: 325 GB (netcdf)

- *RCP 4.5 scenario*

- Time period: (2006-2100)
- Approximate size of the raw output archive (grib+netcdf): 15 TB
- CMOR2 archive available and distributed: 1 TB
- Additional output at 3hr time-resolution: 325 GB (netcdf)

- *RCP 8.5 scenario*

- Time period: (2006-2100)
- Approximate size of the raw output archive (grib+netcdf): 15 TB
- CMOR2 archive available and distributed: 1 TB
- Additional output at 3hr time-resolution: 325 GB (netcdf)

2) ECHAM 5.5 + HAM 2 (Stier et al. 2005, Lohmann et al. 2009).
The following table summarizes the experiments which are available. All data are stored in netcdf format.

Emissions	**Reference period**	**Resolution**	**Dust-scheme**	**Nudged?**
ACCMIP	1999-2009	T42L19	Balkansky	Yes, ERA-Interim
ACCMIP	1999-2009	T42L19	Balkansky	No
ACCMIP	1999-2009	T42L19	Tegen (HAM2)	No
ACCMIP+ Bourgeois et al. mod.	2001-2006	T42L19	Balkansky	Yes, ERA-Interim
ACCMIP+GFED3	2001-2006	T42L19	Balkansky	Yes, ERA-Interim
ACCMIP+GFED3+ Bey et al. mod.	2001-2006	T42L19	Balkansky	Yes, ERA-Interim
ACCMIP+GFED3+ REAS mod. + Bey et al. mod.	2001-2006	T42L19	Balkansky	Yes, ERA-Interim
ACCMIP+GFED3+ REAS mod.	2001-2006	T42L19	Balkansky	Yes, ERA-Interim
Aerocom 2000	2001-2003	T63L31	Balkansky	Yes, ERA-Interim
Aerocom 2000	2001-2006	T42L19	Balkansky	No
Aerocom 2000	2001-2006	T42L19	Balkansky	Yes, ERA-Interim
Aerocom 2000+ Bey et al. mod.	2001-2006	T42L19	Balkansky	Yes, ERA-Interim

Table 1. available experiments and technical characteristics of the simulations performed with ECHAM 5.5 + HAM 2

4.4 Completed deliverables

Deliverable D2.5.1: Report on a census of available climate simulations
Deliverable D2.5.1: Report on the scientific questions

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

We have not identified particular problems or significant deviations from the planned activities.

6. Expected activities for the following reference period

Continuation of global and regional numerical simulation activities, focused on the areas of interest for the project (the Mediterranean, the Alpine region and the HKKH) and analysis of simulation results.
The EC-Earth 3 model will be tested with the aim of obtaining a tuned version which can be used to produce new climate projections at high-resolution (80 km).
EC-Earth simulations will be downscaled dynamically using the WRF non-hydrostatic model and statistics of extreme precipitation will be extracted. The results will be compared with the available results of international initiatives (CMIP5, CORDEX, DRIHM).
The downscaling activities will be focused on:
Application of RainFARM to the future scenarios produced by state-of-the-art Regional Climate Models (produced by ENEA, ICTP and CMCC) over north-western Italy.
Comparison between different statistical and stochastic downscaling techniques, in order to understand their performances, applicability, advantages and disadvantages when applied to specific case studies.
Generation and provision of high-resolution climate data starting from smoother distribution on a larger scale.
Application of the downscaled scenarios to specific impact studies (response of the mountain vegetation, response of mountain hydrological basins).

WP 2.6 - Portal for access to data and pilot studies on data use

1. Scheduled activities, expected results and Milestones (as indicated in the Executive Plan)

CNR-ISAC activities foreseen during the first year are resumed in what follows:

- Contribution to the definition of the characteristics of the General Portal for accessing the databases and the archives generated during the project and of the methods for the harmonization of the procedures for accessing the various subarchives that will be included in the portal.
- Organization of the first annual meeting of all researchers and technicians involved in the project to discuss the needs of data access and to define the pilot studies to be completed during the project.
- Beginning of the first pilot studies, which include: (a) Analysis of water resources in the Himalaya-Karakorum and interaction between monsoon and mid-latitude perturbations; (b) analysis of the changes in terrestrial biodiversity in areas of high altitude in the north-western Italian Alps; (c) estimation of the changes in snow cover and the hydrological cycle of the Alps and the Apennines; (d) effect of aerosols in high altitude areas.
- Identification of a possible structure of summer schools at doctoral and post-doctoral level, devoted to the analysis of climate and environmental change in the mountain environment and the dynamics of the high altitude areas.
- Definition and publications of new public calls to identify new structures participating in the project to perform new pilot studies.
- General Report on the first year activities and results of the pilot studies.

Milestone M2.6.1 (PM12): Preliminary results of the first Pilot Studies.

2. Deliverables expected for the reference period

Deliverable D2.6.1 (PM12): "Report on the results of pilot studies"

3. Activities which have been actually conducted during the reference period

3.1 Research activities

The characteristics of the General Portal for accessing the data have been defined, as illustrated in detail below.

The research activities related to the pilot studies (a)-(d) of the first year started immediately after the beginning of the project. The detailed description of the research activities is given in the individual reports of the various pilot studies and in the Deliverable D2-6-1.

New pilot studies were identified, such as the analysis of climate change impacts on mountain ecosystems.

CNR-ISAC actively collaborated in the definition of mutual agreements and MoU between the NextData project and several international initiatives, such as the HyMeX programme, the European Climate Research Alliance (ECRA) and the GEO/GEOSS Programme.

The start-up meeting of the participants in the NextData project has been organized. It was held at the Department of Earth and Environment (DTA), CNR Rome, on 23 January 2012 and the annual meeting of the project was held in the same location on 17 October 2012. CNR-ISAC participated to other specific workshops for the various pilot studies and for the definition of the project web site and the General Portal.

3.2 Applications; technological and computational aspects

The web site of the NextData project was implemented, www.nextdataproject.it. It includes a full description of the project and the results obtained so far. The web site will include a direct link to the General Portal, which is currently under construction and will be open to the participants at the end of the second year of the project.

CNR-ISAC collaborated actively in the definition of the main characteristics of the General Portal. The General Portal will have two main archives, one for the ground and field data and metadata (based on SHARE GeoNetwork) and one for gridded data (reanalyses and numerical simulations) which will use THREDDS servers. During the first year, CNR-ISAC strictly collaborated with some of the project partners (URT Ev-K2-CNR, CMCC, CASPUR) to define the characteristics of the data portals that will be implemented by the WP partners and that will form the backbone of the General Portal, contributing also to the harmonization of the methodologies for archiving and accessing the data that will be made available through the portals.

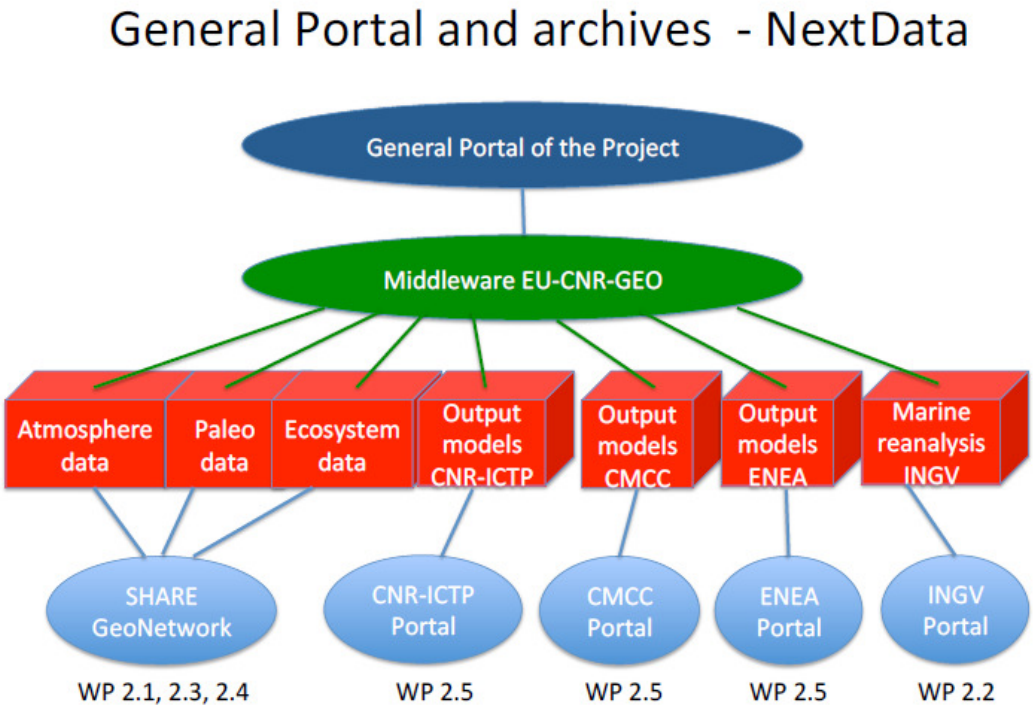

Figure 1. Scheme of the General Portal.

The General Portal (Figure 1) will include an intermediate *Middleware* layer, based on the GEOSS type of approach and which will be able to access both the thematic portals which will be activated by the various project partners and directly the data and metadata archives. Overall, the NextData Project will provide an important Italian contribution to the International Programme GEO/GEOSS. Figure 1 schematically illustrates the structure of the NextData General Portal. The existence of different archives and thematic portals for the numerical simulations (WP2.5) is due to the need

of avoiding huge data transfers (of the order of hundreds of Terabytes); for this reason, the simulation data will be kept at the institutional archives of the partners which generated them. By contrast, the field and measurement data (including paleoclimatic data) will be stored in a single server, which will be mirrored by at least another server (presumably hosted at CNR).

CNR-ISAC has continued the implementation and development of the global climate model EC-Earth and the analysis of the outputs. CNR-ISAC and ICTP have analyzed the outputs of the regional simulations for the Himalaya-Karakoram area produced by ICTP with the RegCM regional climate model. CNR-ISAC has developed a framework for high-resolution non-hydrostatic simulations by using the WRF model with resolution from 22 km down to 3.5 km, nested into ERA-Interim reanalyses and global scenarios produced by EC-Earth, to provide the outputs needed for the pilot studies.

3.3 Formation

Four Post-Doc research fellowships, three Post-Laurea fellowships and one Doctorate fellowship were activated on themes related to the pilot studies of the NextData project.

One Master Thesis on precipitation in the Hindu-Kush - Karakoram - Himalaya was completed.

NextData supported the organization of the course "Climate, aerosols and the cryosphere", XX course of the International School "Fundamental Processes in Geophysical Fluid Dynamics and the Climate System", June 2012, Valsavarenche (AO). The XXI course of the same school, entitled "Climate Change and the Mountain Environment" is being organized for June 2013 as an initiative of the NextData project. This represents the first step towards the creation of a permanent structure for doctoral and post-doctoral courses and schools on climate change and the mountain environment.

3.4 Dissemination

The Project of Interest NextData was presented by the project coordinator and other CNR-ISAC researchers at various scientific meetings and to the general public. The project was presented at the Academy of Sciences of Torino, at the Lincei Academy in Rome, at the Nepal Academy of Sciences and Technology (NAST), at the Italian State TV (RAI Parlament), at the European Climate Research Alliance (ECRA), at the University of Barcelona, at the meeting of the International Group of Funding Agencies (IGFA), to representatives of the Belmont Forum, at the World Bank and at the InterAmerican Development Bank in Washington. The NextData project has been indicated as an important Italian contribution to the international programme GEO/GEOSS. The NextData project was presented in various public lectures in schools and museums. The volume "What is Global Warming" is being translated into English for the free distribution to schools in Nepal (Himalaya) and North Pakistan (Karakoram). Representatives of the project have participated in several public conferences on climate change in the mountains, presenting the NextData project.

3.5 Participation in conferences, workshops, meetings

The activities of the pilot studies were presented at different scientific meetings as listed below:

- Workshop ECRA (European Climate Research Alliance): “Changes in the hydrological cycle”, CNR, Roma, 5-6 March 2012.
- Workshop: “Orographic Precipitation and Climate Change”, NCAR, Boulder, 13-15 March 2012.
- European Geosciences Union (EGU), General Assembly 2012, Vienna, 22-27 April 2012.
- Workshop: “Contribution of science and cooperation to the sustainable development of the Central Karakorum National Park”, Islamabad 4-7 June 2012.
- Workshop "Il valore della biodiversità - L'Osservatorio Regionale della Biodiversità: uno strumento di conservazione attiva." - Aosta, 22 May 2012 - Poster, dal titolo: "A multi-taxa approach to study mountain ecosystems: developing an exportable, long term monitoring programme".
- "Giornate transfrontaliere di scambio tecnico-scientifico - Inventario Biologico Generalizzato Mercantour/Alpi Marittime" - Barcelonette, 17-18 September 2012 – Plenary conference entitled: "Monitoraggio della biodiversità animale sulle Alpi Occidentiali Italiane: un approccio multitassonomico".
- “MEDCLIVAR - The climate of the Mediterranean region: understanding its evolution and effects on environment and societies” conference, Madrid, 26- 28 September 2012.
- Thematic workshop with UTOPIA ed CHTESSEL models developers at CNR-ISAC (Torino) to share information on snow models and how to use the softwares.
- Meeting to define a collaboration between CNR-ISAC, CIMA Foundation (Savona), and ARPA Valle d'Aosta, focused on the comparison between snow models, Aosta, 14 December 2012.
- 3rd International Conference on Earth System Modelling 17-21 September 2012, Amburgo, Germania.

4. Results obtained during the reference period

4.1 Specific results (Data libraries, Measurements, Numerical simulations, etc)

The results of the pilot studies are detailed in the individual reports, and summarized below.

Pilot study 2.6.a

We have analysed precipitation data from various gridded archives (as described in Sect. 3.1), characterized by different spatial and temporal resolutions, for the two specific sub-regions of the entire HKKH range, as mentioned above. For each sub-region and each dataset the following information has been produced (in the form of NetCDF files):
- Spatial average of precipitation over the HKK and Himalaya at the original spatio-temporal resolution of the considered dataset as well as at the monthly resolution.
- Precipitation over the HKK and Himalaya (pixel by pixel) at the original spatio-temporal resolution of the considered dataset as well as at the monthly resolution.
When possible, the separate contribution of rain and snow has been evaluated.

We have analysed temperature and precipitation data from sixteen in-situ stations spread over the upper Indus basin region and we produced time series of these variables at the time-resolution of the original data and at monthly resolution. Correlation matrices between the climatic records (temperature and precipitation) at the various locations have been computed (to asses the spatial coherency of

temperature and precipitation across the UIB region) and are available, together with values of temperature and precipitation lapse rates in northern Pakistan.

We have calculated the North Atlantic Oscillation (NAO) index specifically for the EC-Earth model and the ERA40 and ERA-Interim reanalyses, to be used in the next months to analyse the correlation between the NAO phase and winter precipitation in the HKK region.

Pilot study 2.6.b

- Organisation of the data coming from the previous monitoring campaigns (2007-2008) in a database, useful for statistical analyses and for the comparison with the data that we are being and will be collected in the framework of NextData (2012-2013).
- Statistical analysis of the data coming from the campaigns of 2007-2008 showed that species richness and community composition of arthropods are highly influenced by micro-climate conditions, suggesting their potential vulnerability to changes in temperature. Moreover, we observed that the alpine belt, in comparison with belts located at lower altitudes, presents lower values of species richness, but a higher percentage of species of conservation concern (e.g., microtherm species, highly specialized species with low dispersal capability, rare).
- Conduction of new field campaigns to measure terrestrial faunal biodiversity in three selected protected areas in the north-western Italian Alps. Monitoring has been carried out by the three CNR-ISAC research fellows, helped by Park wardens and technicians (6 from PNGP, 3 from PNOR, 2 from PNVD) and by students from University of Torino, Pavia and Parma (for a total of 5 students). We report here below the sampling efforts for the field activities:
    - Lepidoptera Rhopalocera (butterflies), monitored through linear transect, one per month from May to September, for a total of 375 linear transects, distributed over 78 working days;
    - Orthoptera, monitored through linear transect, with 3 repetitions during mid July and mid September for a total of 225 linear transects, distributed over 49 working days;
    - birds, monitored through point counts, with 2 repetition per plots, for a total of 150 point counts, distributed on 52 working days during mid April and July;
    - surface-active macro-arthropods (Coleoptera Carabidae, Coleoptera Staphylinidae, Araneae, Formicidae), monitored through pitfall-traps. The number of traps set per station was 5, for a total of 375 traps. The number of temporal collections is 10 per station, for a total of 130 working days. Number of obtained traps for the analysis is 3750;
    - Microclimatic conditions through the positioning of 75 temperature data-loggers (iButton DS1922), for 150 days with a total of 3600 temperature data collected for each logger;
    - Macro and micro environmental conditions, through field monitoring for a total of 15 days;
- Analysis and identification of the samples collected during field session. We have performed 20% of the analysis
- Measurements of arthropod biomass, both in terms of weight, and in terms of volume. We have completed 50 % of the analysis.
- Concerning the model simulation of the biological datasets (years 2007-2008) using the MaxEnt software, three temperature scenarios and three environmental predictors were selected and are now ready for future simulations.

Databases
The databases, coming from monitoring activities contain the list of species, with data on relative abundance, for each taxon and each sampling plot. At the moment, only the database of birds is completed. For the other taxa, databases still need the identification of collected specimens.
The data of temperature collected by the data logger are now stored in a database.

Pilot study 2.6.c

We have analysed snow datasets from the various gridded archives (as described in Sect. 3.1), over midlatitudes, especially for two specific sub-regions, the Alps and the entire HKKH range. For each sub-region and each dataset we produced NetCDF files containing snow depth over the Alps and HKKH at the original spatio-temporal resolution of the considered dataset as well as at the monthly resolution.

In particular, the monthly mean snow depth fields obtained by the global climate model EC-Earth have been evaluated over the period 1979-2009 and compared to the ERA-Interim reanalysis. The comparison over the Alps and the Hindu-Kush - Karakorum - Himalaya (HKKH) region has been completed and will be soon integrated using the output of the regional climate models.

In addition to gridded data, we collected also surface station meteorological data (temperature, precipitation, humidity, wind intensity and direction, solar radiation, etc.) in several observation sites in the Alps, to be used for the estimation of the temporal variability of the snow depth, density and water equivalent.

Pilot study 2.6.d

For this pilot study we analysed a series of numerical simulations (present-day, with ERA-Interim and EC-Earth boundary conditions, and the RCP4.5 scenario) performed with the RegCM4 regional climate model. These simulations have been stored at CNR-ISAC, ICTP and CASPUR. The analysis results are described in detail in the corresponding deliverable D2.6.1 and the available output data and further details on the model are described in the deliverable D2.5.1.

AOD data from the Moderate Resolution Imaging Spectro radiometer (MODIS) aboard the Terra satellite starting from 2000 were recovered and archived at CNR-ISAC. Specifically the Aerosol Cloud Water Vapor Ozone Daily L3 Global 1Deg CMG collection products were used. In addition AOD data from the MACC (Monitoring Atmospheric Composition and Climate) project, have been recovered and archived, starting from 2003.

Global aerosol simulations performed with the model ECHAM-HAM have been performed for a series of different anthropogenic forcing datasets and archived at CNR-ISAC. Further details on the ECHAM-HAM simulations are provided in deliverable D2.5.1.

In-situ measurements of AOD from the global network AERONET for the HKKH region have been retrieved and stored at CNR-ISAC.

4.2 Publications

• Palazzi, E., J. von Hardenberg, and A. Provenzale (2013), Precipitation in the Hindu-Kush Karakoram Himalaya: Observations and future scenarios, J. Geophys. Res. Atmos., 118, 85–100, doi: 10.1029/2012JD018697.

• Viterbi R, Cerrato C, Bassano B, Bionda R, von Hardenberg A, Provenzale A, Bogliani G. In Press. Patterns of biodiversity in the northwestern Italian Alps: a multi-taxa approach. Community Ecology.
• In preparazione: "Asian Monsoon and the Elevated-Heat-Pump Mechanism in Coupled Aerosol-Climate Model Simulations" Miriam D'Errico, Chiara Cagnazzo, Pier Giuseppe Fogli, William K. M. Lau and Jost von Hardenberg.

4.3 Availability of data and model outputs (format, type of library, etc)

Pilot study 2.6.a

- Spatial average of precipitation over the HKK and Himalaya at the original spatio-temporal resolution of the various dataset employed and at the monthly resolution.
- Precipitation over the HKK and Himalaya (pixel by pixel) at the original spatio-temporal resolution of the employed dataset and at the monthly resolution.
- Precipitation trends averaged over the HKK and Himalaya sub-regions and spatial maps of precipitation trends.
- Precipitation and temperature trends at the locations of sixteen in-situ station in the upper Indus basin region.
- Monthly North Atlantic Oscillation index for the EC-Earth model and the ERA40 and ERA-Interim reanalyses.

Pilot study 2.6.b

The data from the campaigns of 2007-2008 are available. The data from the 2012 field campaign have been processed for birds, climatic and environmental conditions. The other data will be processed and made available in the coming months.

Pilot study 2.6.c

- Snow depth over the Alps and the HKKH at the original spatio-temporal resolution of the various dataset employed and at the monthly resolution.

- Nivo-meteorological surface station data for some sites in the Piedmontese Alps.

- Temporal evolution of snow depth simulated by UTOPIA, in several locations in the Piedmontese Alps.

Pilot study 2.6.d

The model data outputs provided by ICTP from the RegCM model for the historical period (2000-2009) and for the RCP 4.5 scenario (2040-2050) have been transferred to CNR-ISAC and to CASPUR and are available on the THREDDS dataserver (TDS) provided by CASPUR/Cineca:
(https://bl102.caspur.it:8443/thredds/catalog/NextData/ICTP/RegCM/India-CORDEX/EC-Earth_BC/historical/catalog.html).
The output files are monthly netcdf files and give for each aerosol type the instantaneous concentrations and burden, the average deposition fluxes (drydep, rainout, washout), emissions fluxes and the dry deposition velocity. Outputs of AOD and of radiative forcings are also available, together with atmospheric data, surface data and radiative data. The data on the TDS are distributed over subfolders "3hr", "6hr", "day" and "mon" based on their timebase. The surface data (e.g temperature at 2m, precipitation etc) are available at 3hr time intervals. Daily statistics such as e.g. daily maximum temperature are available at daily time intervals. All other files/variables are available as snapshots at 6hr frequency. For user convenience CNR-

ISAC also created daily averages (in subdirectory "day") and monthly averages ("mon") of all files.

4.4 Completed deliverables

The deliverable D2.6.1 has been completed.

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

We have not met specific problems or had delays from the activities foreseen in the Executive Plan.

6. Expected activities for the following reference period

CNR-ISAC will have a fundamental role in the definition of the first version of the General Portal and opening of the Portal to the researchers involved in the NextData Project. CNR-ISAC will have contacts with the private sector to stimulate the use of the data collected during the project by industries and enterprises. Annual meeting of all researchers and technicians involved in the project, open by invitation to scientists from outside the project, to all groups which are providing data and to specific representatives from the private sector will be organized. Final results of some of the pilot studies on the impact of climate change on the mountain environment will be published and new pilot studies activated, including: (a) Measurement and analysis of precipitation in high-elevation regions; (b) analysis of the effects of climate and environmental change on health in the HKKH; (d) effects of climate change on mountain ecosystems; (e) response of Alpine glaciers to climate change. Two meetings of the researchers involved in the pilot studies will be organized, to assess progress and determine data storage strategies. The formation activities will be continued and the summer school on the mountain environment organized. “Mid term” meeting for the possible modification of some of the project strategies will be organized as well. New public call will be activated for specific themes related to the pilot studies (in particular, on mountain ecosystems and the hydrological cycle in mountain areas). General reports on the activities, dissemination by public conferences and articles will be published. The work to archive, harmonize and provide climate data through the data portals will continue, as a contribution to the General Portal of the project. The production of global and regional numerical simulations as designed in the context of the pilot studies planned within the project will be continued. The analysis and characterization of the mechanisms of climate variability and the investigation of how these might be altered by the anthropogenic climate change will be continued.