Scientific report

LABEX OSUG@2020

http://www.osug.fr/labex-osug-2020/

1. PROGRESS OF THE PROJECT

1.1 Governance (initiation, organization and project governance, management and monitoring systems, way of involvement of concerned research units' directors)

Six research Institutes (ISTerre, IPAG, LGGE, LTHE, LEGI, LECA)[1] and six research teams constitute the core of the Labex OSUG@2020 since its inception and no evolution is foreseen. OSUG@2020 has created a strong dynamism as it includes all major institutes focusing on Space, Earth and Environmental Sciences, including ecology and related social sciences, in Grenoble. LEGI and LECA joined OSUG in 2011, and Irstea-Grenoble joined in 2013. Finally, the Alpine environmental studies unit (UMS SAJF) became member of OSUG in 2014. As a result, OSUG currently constitutes an interdisciplinary cluster of research units totaling about 400 academics, 300 Ph.D. students and post-docs, and 350 technical and administrative staff.

The management of OSUG@2020 relies strongly on the organizational structure of OSUG itself, which facilitates coherence in the global scientific strategy. The director of OSUG is the coordinator of OSUG@2020 and is assisted by three deputy-directors in charge of Research, Observation, and Training/Education components respectively. The OSUG directorate is responsible for the overall and day-to-day management of OSUG@2020: preparation of strategic decisions, and the execution of decisions of the Scientific Council and the Steering Committee. The Steering Committee, composed of the directors of all research units and the OSUG directorate, meets on a monthly basis and is the main decision-taking body. Project calls are managed (drafting of calls, evaluation and ranking of projects) by four committees: Research, Observation, Training-International, Dissemination and Technology Transfer. Final decisions on funding projects are taken by the Steering Committee. A Scientific Council was created in 2012 and advises on decisions regarding the major strategic objectives of OSUG@2020. It is composed of six scientists who are not members of OSUG and meets once a year. At a higher level, the Strategic Committee comprises representatives of all universities or national organizations to which the research units are affiliated: U. Grenoble Alpes, U. Joseph Fourier, CNRS, IRD, Irstea, U. Savoie-Mont-Blanc, G-INP, Météo-France, IFFSTAR. All those institutes participate in the newly created Federative University Grenoble Alpes and (except for U. Savoie-Mont-Blanc) in its recently submitted IDEXbid. The Strategic Committee is in charge of validating that global decisions meet the objectives of the OSUG@2020 project.

[1] See Appendix 1 for a list of used acronyms.

All funded projects, as well as the composition of the committees and Labex news (calls, meetings, etc.), are publicly available on the OSUG@2020 website (www.osug.fr/labex-osug-2020/). The conclusions of the Steering Committee are accessible for all members of the participating research labs through the OSUG intranet. All funded projects are required to deliver a short activity report including a summary budget for internal monitoring by the OSUG directorate and the committees. More than 90% of the projects funded through the open calls in the first three years of OSUG@2020 delivered scientific reports. These reports are also available on the web site and, clearly, the objectives of the proposals submitted by the OSUG researchers were successfully executed.

1.2 Research

The research activities conducted within OSUG@2020 are related to the overarching topic of developing new and innovative strategies for the observation and modeling of natural systems. The supported research projects contributed to three major topics concerning the exploration of the universe, solid-earth processes and the impact of climate change and anthropogenic activities on the Earth system. (cf. section 2-A)

OSUG@2020 funded research projects of different sizes to address the three major scientific axes with a very high priority: 2.4 M€ invested, i.e. 55% of the total budget (NB this sum does not include financial support for PhD scholarships). A major fraction (70%) of the financial support for research projects was dedicated to the acquisition of new equipment and instrumentation. Most funded projects are based on proposals submitted in response to regular open and thematic project calls; a smaller funding allocation is decided directly by the Steering Committee for strategic priorities. The selection of projects was based on two overarching criteria. (1) Only projects rated as scientifically excellent were funded. The scientific quality of the projects was evaluated based on external and internal reviews and recommendations by the laboratories of the principal investigator. (2) OSUG@2020 fosters interdisciplinary research: 70 % of the total available budget was dedicated to projects involving at least two laboratories. The OSUG Research committee organized the evaluation and ranking of projects and assured the application of the two priorities outlined below, while the Steering Committee supervised the overall selection process.

1.3 Training

Research-driven higher education (WP-HE) is central to OSUG@2020. The objective was to dedicate about 1/3 of our budget to higher education, including international activities. A total of 1.4 M€ was thus devoted to this WP, out of the overall budget of 4.4 M€ for the first 4 years of the Labex. About 30% of this sum was dedicated to PhD students, 30 % to undergraduate training and 30% to international activities.

A primary objective was to acquire **up-to-date equipment and software** for the students at the Bachelor and Master levels, because practical training is essential to create a new generation of researchers and engineers in the domains of the Earth and Environmental Sciences as well as in Astrophysics and Planetary Sciences.

- A first axis is to develop experimental training in the field. Two main sites were equipped: the Grenoble campus (hydrology, geophysics, atmospheric chemistry) and the unique inter-disciplinary mountain field station SAJF at Col du Lautaret (snow studies, meteorology, ecology …).

- A second axis is to obtain modern lab instrumentation. For example, a geophysical lab was fully equipped with up-to-date 3D-seismic software including the necessary powerful computing facilities.

Recently the call was opened to **new teaching methods such as e-learning**. The Labex has contributed to the creation of two MOOCS, which are both posted on the dedicated site of the French ministry of higher education FUN: one on the dynamics of controlled rivers (Des rivières et des hommes, www.france-universite-numerique-mooc.fr/courses/grenobleinp/19001/Trimestre_4_2014/about) and another on extrasolar planets (opening in 2015).

At the doctorate level the **Labex maintains a PhD research program.** The choice was made to co-fund (at 50%) 3 new PhD's per year to enforce a leverage effect with collaboration from industry or foreign research institutions and promote collaborations. All PhD students registered at the graduate schools associated with the Labex (not only those directly funded by the Labex) can request financial support to spend time in a foreign country to complete their training and enhance their autonomy. Université Grenoble Alpes provides an opportunity for PhD students, called "label", to complete their training with a different task (e.g. teaching, consulting), corresponding to approximately 200 h/year, to enhance student skills. The Labex has funded 3 of these labels for observational tasks and participation in the construction of a MOOC (more details in section 2-B).

Another important objective of this WP is to **develop international collaborations for students as well as for researchers.** Several tools were developed, including funding for PhD students to spend time abroad (see above). The Labex has helped Grenoble researchers to organize international workshops, summer schools and congresses; this has been very successful. More than 20 events were funded, enhancing the attractiveness of Grenoble and offering students good opportunities to participate in international level events. A major example is the European Research Schools on Atmospheres (ERCA): the 23rd session ran in 2015 and, in 23 years, more than 1000 students from more than 50 countries attended this course. At the Master level, the Labex funded 4-5 students/year from abroad to attend one of three international masters associated with OSUG: Environmental Fluid Mechanics, Earthquake Engineering and Engineering Seismology, Hydrohazards.

Relationships with developing countries are particularly favored. Achieving this objective was aided by the fact that several OSUG laboratories have a long experience in this field due to their association with the French IRD. Numerous actions were supported, mainly in Africa but also in South and Southeast Asia and South America, including mobility of PhD students and academics from France or from abroad, and dedicated field schools.

1.4 Result exploitation

The main impact of the science undertaken in the research laboratories is the publication of scientific papers. The total number of peer-reviewed papers (ACL) published by the OSUG@2020 labs and research teams is about 1000 publications/year, with about 10/year in highly cited journals such as Nature and Science. A more detailed study of papers published in 2011 and 2012 shows that ~7% resulted from collaboration between two or more research labs of the Labex, which implies almost 300 co-authored papers in 4 years. Furthermore, about 60% of the papers are co-authored with a foreign research laboratory (up to 90% for IPAG). Obviously, not all research undertaken in the OSUG laboratories is directly funded by the Labex, but the vast majority of the research work contributes to its objectives.

Outreach and knowledge dissemination are described hereafter (sections 1.5 and 3.4). Two other main tasks, technology transfer to industry and advice to local policymakers, are described in more detail in section 3.1.

1.5 Visibility, outreach, sharing and promoting actions of the Labex

Outreach, research dissemination and promoting actions are important objectives of the Labex OSUG@2020 and about 175 k€, including mainly salaries, were dedicated to these objectives during the first four years. A few prominent actions are described below.

- The web portal "OSUG@2020" was created as an essential tool to present and promote the Labex to internal and external audiences. This portal has been encorporated in the pre-existing OSUG website, ensuring the Labex to be quickly and efficiently perceived as a major scientific program within OSUG. With such a structure, web visitors have the opportunity to discover the Labex through the OSUG website, and *vice versa*. Lists and details of all projects that have been financed by the Labex are available online (Example of the Lidar project: www.osug.fr/labex-osug-2020/actions-soutenues/recherche/instrumentation/lidar-terrestre-adapte-au-suivi-glaciaire-et-nival.html).
- To promote the Labex beyond the local scale of Grenoble, bilingual posters and brochures were distributed during the international conferences, workshops, and schools that were sponsored by the Labex. Promotional items (e.g., 2500 notepads and pencils) were distributed during 44 workshops and schools held between 2011 and 2014.
- Instructions for PIs of granted projects were systematically given regarding the acknowledgment of OSUG@2020 and the ANR. Several templates for scientific presentation with series of adequate logos are also available.
- Dedicated actions were undertaken to promote the Labex to specific audiences. For example, a one-page advertorial was published in March 2013 in "Le Nouvel Observateur". This weekly magazine is distributed to 147000 readers (general audience, entrepreneurs, and regional decision-makers) in the Alps. Several other promoting actions were shared with other UGA Labex projects (see section 2-D).

2 / Label and associated funding impact

A) Scientific achievement description

The research activities conducted within OSUG@2020 are related to the overarching topic of developing new and innovative strategies for the observations and modeling of natural systems. Innovative science often comes at the interface between different disciplines and the Labex is ideally placed because of its multidisciplinary construction (from astrophysics to ecology). It was then decided to support projects that enhance interdisciplinarity falling within the three following major topics. The first topic concerns the exploration of the universe regarding a better understanding of the extremes of the universe, the formation and evolution of stars and planets, and the characterization of the solar system and the specific place of the Earth in this system. The second topic mainly deals with solid Earth processes. The projects increased our knowledge of deep earth processes and contributed to a better understanding of earthquakes, landslides, and volcanic eruptions. Finally, the impact of climate change and anthropogenic activities on the Earth system was studied. These projects were related to the

climate system from the global to the regional scale, to the studies of pollution of soil, water, and air, and to changes of ecosystems associated with a changing climate.

A large majority of the projects contributed to the development, acquisition, and application of novel observational techniques and instruments (WP-R1). These observations contribute to improving the understanding of the Earth system and the universe. Important processes were studied and quantified to be implemented in models of high complexity. This enhanced understanding of complex processes will help to develop a new generation of models describing the Earth system as well as the formation and properties of the universe (WP-R2). Furthermore, some aspects of changes in the Earth system have been advanced so that the impact on the societal and economic sector can be addressed and evaluated (WP-R3).

Excellence in science is a prerequisite for all funded projects. Regular project calls open to the entire community of the participating laboratories and research teams were regularly launched to invite proposals addressing the research priorities of OSUG@2020. The projects were selected by the OSUG Committees based on external reviews for large project, internal reviews, and recommendations of the laboratories of the project PI. The final selection is always approved by the Steering Committee. Interdisciplinary projects involving two or more different laboratories were favored and received about 70% of the total available budget.

A.1 OBSERVING WITH NOVEL INSTRUMENTATION (WP-R1)

1 - Enhancing the observing capacity of current long-term observing programs and their national and international integration

OSUG is heavily involved in national observing programs, coordinated by INSU. We are particularly active in instrumentation facilities for large telescopes and seismic, climate, and hydro-meteorological observing networks. OSUG initiated and/or coordinates several of these national services, for which an important mission is to provide data access to the scientific community. Most of these networks or projects contribute to European or International monitoring activites. Support from the Labex consolidated and reinforced our observing networks and our capacity to implement them or to build instruments. The objective is to guarantee the quality, stability and the homogeneity of these long-term observations while developing new approaches. We developed a strategy to optimize avaialble resources: sharing of human resources, sharing of field sites to reduce maintenance and running costs as well as to improve the synergy between different kinds of data, sharing equipment (calibrations and developing tools), harmonizing the instrumentation for the detection of a given type of physical parameter (easier maintenance and expertise sharing). The Labex allowed us to progress significantly on these different approaches.

The impact of OSUG@2020 is in terms of visibility allowing to increase the role of our teams in large national and international consortia. This is the case for different scientific fields.

- Earth Sciences: the Labex contributes to several local services d'Observation" (RAP GPS network, RLBP seismological network,…), which form the cluster RESIF at the national level. RESIF, coordinated at ISTerre, is the French component of the European EPOS.
- Ocean-Atmosphere: OSUG supports the SO Oraure (Atmospheric composition survey), which is part of the European project ACTRIS.

- Astrophysics: all local SOs (Rosetta/Concert, SPHERE …) are integrated in international institutions: ESO, ESA, CFHT,…

National observing systems are often nodes of larger distributed European Research Infrastructures (RIs). OSUG@2020 contributed to strengthen the Grenoble nodes of some RIs through direct financial support, but also by encouraging stronger interactions among each other. A direct result is the key role of OSUG Environmental RI nodes in the new EU-H2020 program **ENVRI^{plus} (Environmental Research Infrastructures providing shared solutions for science and society**). Research Infrastructures ANAEE (Col du Lautaret station), EPOS/RESIF (seismic station network), and ACTRIS (GAW stations in Nepal and Bolivia) have joined forces to lead a very ambitious WP in ENVRI^{plus} aimed at developing new technologies related to operating observing stations in remote areas and extreme conditions.

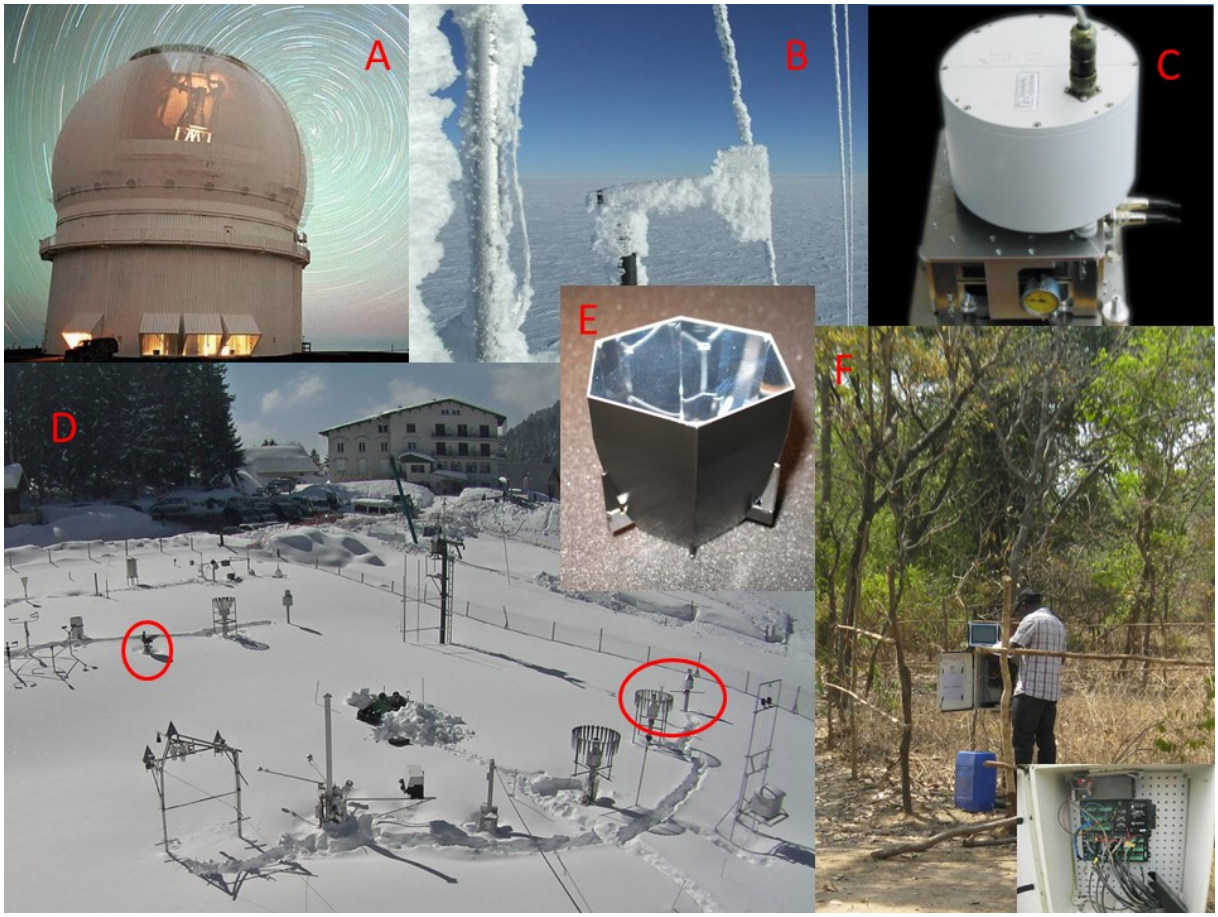


Fig. 1: A: CFHT, which will host SPIROU. B: Meteorological sensors (anemometers) at Dôme Concordia (Antarctica) on a 45 m high tower to study properties of the atmospheric boundary layer (GLACIOCLIM, CENACLAM). C: Calibration table for seismic sensors (SISMOB). D: Col de Porte field site with the Micro Rain Radar on the left and the pluviometers for the international inter-comparison experiment SPICE on the right. E: Prototype of a light concentrator for the CTA (Cerenkov Telescope Array). F: Installation of a new CR1000 data acquisition unit for AMMA-CATCH in Benin.

2. Developing and sharing new technologies

Because instrumentation is essential for observing the Earth or the Universe a large part of the Labex OSUG@2020 funding was allocated to the acquisition or upgrade of instruments to be implemented in our observing networks. Several projects were also funded to consolidate not only the observing networks themselves, but also our capacity to develop new instruments and stations and to operate them. We have for example funded a turbulence simulator, critical for adaptive optic system characterization in astrophysics, or a new calibrator for seismic sensors allowing much faster and more regular calibrations for a large park of sensors and leading to better data quality on the long-term. During four years about 1.3 M€ were allocated to instrumentation and a few examples are given below.

A significant part of funding was dedicated to R&D actions as, for example, R&D developments within the CTA project (**Cerenkov Telescope Array,** Fig. 1F**)** for critical pieces of equipment like a light concentrator. This will increase the opportunity that the participating laboratory plays a significant role in the project consortium if this technical solution is chosen. One of the largest single funding (80 k€) was used to support the project **SPIROU (SpectroPolarimètre InfraRouge)** to design and construct an IR spectro-polarimeter performing unprecedented high-resolution and stable measurements of the stellar radial velocities. The major scientific objectives of SPIRou are related to the search of earth-like extra-solar planets especially in habitable regions and the study of the influence of magnetic fields during the process of the formation of stars and planets. The Labex had a strong leverage effect on the project, realized in the frame of a French-Canadian-Taiwanese cooperation with a total budget on the order of 3.7 M€. The construction of the instrument started in 2014 and the installation at the CFHT (Fig. 1A) is expected in 2017.

Sharing the equipment was crucial in the project selection. A Micro-Rain Radar (MRR) has been acquired for the OHM-CV, surveying flashfloods in the Cévennes-Vivarais region. After operations during a HyMex campaign, it has been used at Col de Porte. More generally this helps improving our local expertise for meteorological equipment in extreme environments such as Antarctica of high altitudes stations (Fig. 1B, 1D). The instrumentation of the Alpine site Col de Porte close to Grenoble has, thanks to the LabEx, been recognized as a reference site in the project “Solid Precipitation Intercomparison Experiment” **(SPICE/WMO)**, allowing to compare conventional sensors with specific ones provided by several partners. Precipitation measurements (quantity, phase) in high-altitude regions still represent an unresolved challenge for many scientific and operational applications. It is also a good example of equipment sharing.

A further large project concerned the acquisition of a LIDAR system working at a wavelength of 1064 nm. This wavelength allows the determination of the **surface topography in snow- and ice-covered regions**. The instrument working with a frequency of 10 kHz has a maximum range of 3 km and can determine the topography with a precision of up to 4 mm for a maximum horizontal resolution of 2 cm. Since 2013 the instrument has been used during more than 50 field measurements by researchers from LGGE, LTHE, CEN, and IRSTEA and is essential for a current PhD project at LGGE. The high-resolution measurements were used to quantify changes in glacier volume especially of debris-covered glaciers, to monitor the evolution of a seasonal snowpack to improve the estimate of melt water formation, to investigate erosion and redistribution of snow during blowing snow events, to determine the roughness of snow surfaces that determine energy fluxes between the snow and the atmosphere, and to map the displacement of geophysical objects (avalanches, seracs) to

estimate the volume and frequency of such phenomena. Besides this instrumentation, a photogrammetric station was acquired for the processing of very high spatial resolution data such as photographs, satellite and LIDAR data for GLACIOCLIM to provide Digital Terrain Models allowing to derive precise glacier mass balances. This equipment is also used by many other research projects applied to various regions worldwide and specific observing campaigns were funded.

Having the capacity to **analyze and characterize all kinds of natural samples** is essential. OSUG@2020 contributed to the acquisition of basic, but expensive and highly specialized instruments: ICP-MS, camera and recording software for an automatic texture analyzer of birefringent materials (ice), microscope to determine bio-physico-chemical properties of environmental samples, etc. A major example is the contribution to the acquisition of a high-resolution X-ray tomograph used to record 3-D images of all types of environmental samples with a resolution of 0.3 μm (Fig. 2). It allows the determination of morphologic and topologic properties of different phases, grains, and particles present in the investigated material as well as their temporal evolution. It will be used to study a wide variety of properties ranging from optical properties of extraterrestrial samples like meteorites and asteroids, the transport and filtration of water and heavy metals in porous soil samples, the mechanic properties of different wood types, and the mechanic, radiative, and transport properties of snow and ice samples. The instrument was installed in 2014 and is managed by a large consortium of scientists from different institutions and universities in Grenoble. The OSUG@2020 proposal was supported by scientists from seven different Institutes or research teams and received funding in the order of 40 k€ for a total budget of 540 k€.

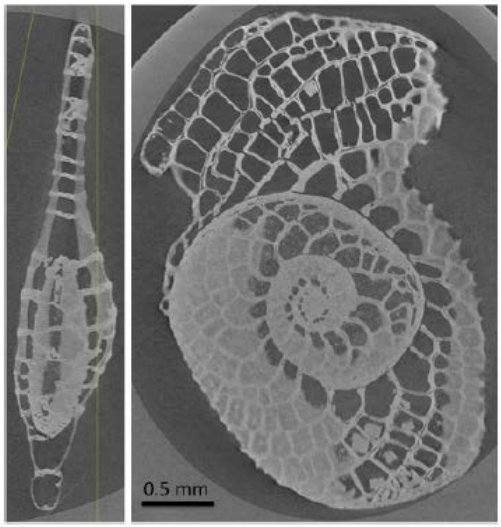


Fig. 2 Image of a longitudinal and a cross section of foraminifera with a pixel size of 0.3 μm obtained with the high-resolution X-ray tomograph.

Finally, existing equipment must be regularly replaced to maintain and augment our observing and analytical capacity on the long term. An example is the replacement of a part of the equipment providing transmission spectra and the surface bidirectional reflectance system used by GhoSST. Laboratory experiments providing reference spectra are crucial for the interpretation of data obtained with various space probes studying small bodies and other planets in our solar system. For example, such data play an important role in the analysis of the surface of the P67/Churyumov-Gerasimenko comet by the **ROSETTA** mission after a 14-year successful trip within the solar system. OSUG@2020 contributed to the development of the CONSERT radar instrument. Such capabilities are important for the planetology community and need to be maintained.

3. Initiating new observation services

The impact of anthropogenic activities on environmental systems like the atmosphere and the hydrosphere can be detected in all regions of the globe. While in industrialized countries monitoring systems regarding air and water quality are often in place, such long-term observations are often insufficient in developing countries. This lack of observations further creates severe gaps in a number of global monitoring networks. Therefore, initiating new observing activities in crucial, but underrepresented regions is an important objective of OSUG@2020. Because these activities are often integrated in national observing systems, the Labex was essential to consolidate a strategic action plan of CNRS, IRD, and IPEV.

Leading an international consortium, we have contributed to the implementation of a monitoring station concerning the atmospheric composition at the high altitude site of Chacaltaya in Bolivia. Located at 30 km from La Paz and at an altitude of 5300 m, the station is at the highest altitude within the GAW-WMO network and delivers crucial observations for this sensitive region. The long-term objective is to turn this station into an international reference point for the monitoring of greenhouse gases, reactive gases, and particles in the atmosphere. A project linked to the atmospheric observations in La Paz concerns the installation of first instruments monitoring the impact of anthropogenic activities on the hydrological system including the chemical composition of surface waters in the region around the Titicaca lake. Furthermore, a research project supported the acquisition of two high precision calibration units for the measurements of atmospheric mercury. These units installed at two mercury monitoring stations in the high latitudes of the southern hemisphere are crucial to generate quality-controlled year-round measurements of atmospheric mercury in this vast, but under sampled region. The measurements were realized in the frame of the European project GMOS with the ambition to turn the established network into a global monitoring system for atmospheric mercury.

We further supported a new observatory to study and monitor cliff erosion and rock falls in the Chartreuse mountain range. Multidisciplinary observations (seismology, photogrammetry, meteorology) are performed regularly. A catalogue will be elaborated based on reference measurements and new observations allowing unprecedented precision. This observatory is intended to be included in the national multidisciplinary observatory for slope instabilities (OMIV), in which OSUG is heavily involved.

A.2 INTERTWINING DATA AND MODELS (WP-R2)

OSUG Data Center (OSUG-DC)

The observation of the Earth and the Universe is a core mission of OSUG. Large amounts of data are collected, archived, and made accessible for the scientific community to understand and model complex natural systems. Much of this data is collected by the “Services d’Observation” (see WP1) and are part of national and international networks. It was, therefore, crucial to implement a data center facilitating access to the data for a large community. The missions of the OSUG data center are threefold: to store and archive large amount of data, to provide access to these data for the OSUG community (and through this, to increase the collaboration among the OSUG units) and for the entire scientific community, and to couple data processing and modelling. This project couldn’t have started without the Labex which helped in building the infrastructure and coupling between data and modelling. A major node is the RESIF data center (French seismology and geodesy network), which is mostly funded by the Equipex RESIF-CORE. The national node of the national infrastructure

RESIF, which is the most important French contribution to EPOS, relies on the infrastructure built at the OSUG level. The Labex allowed the co-construction of such infrastructure to establish RESIF in Grenoble in the long term and to play a major role in the Solid Earth Data Center at national and international levels.

The infrastructure is currently being implemented (servers, storage) and contributes to the IT infrastructure implemented at the UJF. The data center will be a major equipment of the "Maison Climat Planète" to be constructed in 2017, which will host one of the two major data centers on the UJF campus. The infrastructure will not only allow current projects to increase the scientific use of data, but it will also provide a solid infrastructure and technical expertise for work packages concerning data access within new projects (ANR, …).

Large volumes of data are available from a variety of sources and databases, while the data processing and modeling tools are developed by many teams. Combining the two is, therefore, a major issue. In this context, OLES (Online Laboratory for Environmental Sciences) is an ambitious project, which has been developed to answer these questions in an innovative way in the domain of hydrology and climate. OSUG laboratories are heavily involved in the understanding of the water cycle, providing water and mass balances for multi-scale basin sizes, and evaluating the hydrological impacts of the evolving climate under contrasted regions, in particular West Africa and the Mediterranean region, and related to glaciers worldwide. To improve this understanding, the objectives of OLES are twofold: 1) building an integrated cyber-infrastructure to provide access to data and to share tools and models that enable the understanding of the water cycle and 2) increasing interactions between the research community and water agencies or diverse stake holders. A prototype has been developed thanks to the Labex and allows various possibilities like data access from different databases, data and tool sharing, and easy data pre-processing. This new tool will not only help researchers to work in a more efficient way, it will also change the way researchers are working together sharing data and tools.

High Performance Computing

The Labex has contributed to the implementation of a new high performance computer Froggy, also financed by the Equipex Equip@meso. Froggy is a new intensive computation platform of the mesocenter in Grenoble. Co-funded by the national project Equip@Meso (2010) and the Rhône-Alpes region (Region-State program CPER CIRA) for a total budget of more 1 M€, the Froggy platform has heavily been used by the OSUG community since July 2013. This new infrastructure with a nominal power of 46 TFlops distributed over 2176 computing cores multiplies the computing capacity available for the Grenoble community by a factor of three. It promotes numerous activities performed at OSUG. Teams working in many fields of the Labex (mostly seismology, fluid dynamics, planetology, astrophysics, climatology, oceanography, hydrology, glaciology, geophysics, natural risks) have used Froggy intensively since 2013 with 41 on-going projects concerning mostly high-performance simulations and modeling. This platform has also been an excellent opportunity to stimulate training actions and scientific animation on modeling activities and numerical simulations.

Modelling and data analysis

Newly acquired data obtained with advanced observational techniques and enhanced capacities in data analysis allow a better understanding of the Earth system and the universe. Such advances are often related to a new combination of observations and models. In a range of projects, OSUG@2020 supported new approaches in using high-resolution data and improved models to better explore the universe, to examine the Earth system and to assess

different aspects of climate change and the impact of human activities. For example, optical interferometry was used to analyze properties and activities of stars with masses several times the mass of the sun or multi-angular spectrally-resolved images to determine the chemical composition of planets. In the latter case, a non-linear spectral unmixing model was used taking into account a priori information regarding topography and photometry and after correction of atmospheric effects. The new method was applied to determine the spatial distribution of the three different minerals basalt, palagonite, and tephra based on a sequence of multi-angular images of a small crater on Mars.

Further projects dealt with new techniques related to plate tectonics and seismology in Indochina, the Middle-East, or South America to better understand mechanical and geochemical properties of the Earth crust and deeper continental or marine layers. For instance, the development of a new method was supported to treat long time series of images obtained with interferometric synthetic aperture radar (InSAR). Such time series allow the analysis of the deformation of the Earth crust. With the new generation of high-resolution satellite radar data a much more precise determination of complex deformation processes related to gaps, volcanoes, and glacier movements is possible. The new method allowed the mapping of the velocity field along the Haiyuan fault system at the north-eastern boundary of the Tibetan plateau and the improvement of the modeling of average creep rates.

Geophysical flows were examined using newly-developed laboratory experiments that are analyzed with high-resolution models to better understand for example internal waves important for wave momentum generation or wave breaking in oceanic flows and other stratified media. Developing the next generation of Earth system models requires a better understanding of key processes, which currently exhibit large uncertainties. Some of the supported projects address important processes in the hydrological cycle like precipitation or evapotransporation and the interaction between the hydrological cycle including glaciers on erosion processes. These projects have in common that field measurements are used to derive better parameterizations useful for future model developments.

A.3 PREDICTING AND ADVISING (WP-R3)

A main objective of all our studies of planet Earth is to provide tools to support decision makers in the assessment of local, regional, and global environmental risk and in the evaluation of natural hazards. This implies on the one hand high-quality observational and predicting tools. On the other hand a strong expertise is required in geophysical and chemical processes as well as in human and social sciences. The Labex was essential to initiate interdisciplinary studies and to link the different disciplines present in the OSUG@2020 community. Most of these studies imply large international collaborations because the addressed issues occur worldwide and vulnerable areas require more attention.
Mountainous regions are especially vulnerable since they are susceptible to undergo strong and fast changes on different temporal and spatial scales, while also exposing additional hazards. Many supported projects concerned a better understanding of hazards in mountainous regions like landslides and seismic risks. Several projects aim to better characterize the frequency and strengths of past seismic events in such different regions like the Himalayas, the Alps, Venezuela or North Anatolia. In some cases the vulnerability of certain sectors of the human society with respect to seismic hazards was studied, for example by establishing an inventory of the stability of buildings in Beirut regarding local seismic activity.

Understanding eruptive dynamics of explosive dome-forming type volcanoes is a challenge for volcanology. Dome collapses produce pyroclastic flows that may devastate large regions and cause considerable human and economic losses. VELI (Volcans Explosifs Laboratoire Indonésien) has set up a geophysical multiparameter observation platform on several Indonesian volcanoes to address some typical aspects of the catastrophic activity of this type of eruptions. VELI has focused its observation and research activities on Merapi, one of the most active dome volcanoes in the world. The DOMERAPI project (http://www.domerapi.ird.fr/) proposes a multi-disciplinary approach that involves petrological, geochemical and geophysical methods with the participation of several French and Indonesian research teams.

A major focus of selected projects was further related to observing changes in climate and the related monitoring and measurement of glaciers and snow in the French Alps. Additional measurements concerned the improvement of data on precipitation and soil humidity in the Mediterranean and North African region. Several projects contributed to a better understanding of precipitation extremes and related hazards like flooding and drought periods. While all projects examined the inherent risks in the climate system, some projects integrated also the vulnerability of concerned societies for example regarding agricultural practices in North African regions. The AMMA-CATCH (Analyse Multidisciplinaire de la Mousson Africaine - Couplage de l'Atmosphère Tropicale et du Cycle Hydrologique) coordinated at LTHE is a good example of such a work, but also the SO OHMCV (Observatoire Hydro-Météorologique Cévennes Vivarais) where close collaborations with a social research team about floods are carried out.

A-4 AN INTEGRATED ALPINE RESEARCH SYSTEM

In the context of global climate change there are specific challenges for the Alpine space and Grenoble is ideally placed to address those challenges in an interdisciplinary approach. The overall strategy of OSUG@2020 is to maintain and enhance the leadership of our community in many areas of research dedicated to the Alps. This strategy is fully imbedded in the regional research strategy designed and financed by the region Rhone-Alpes, which identified the Alpine Area as one of its seven Smart Specialization priorities. OSUG@2020 research institutes are involved in several projects funded under the French CPER or international FEDER or INTERREG programs.

Since the beginning of OSUG@2020 observations and the study of processes in the Alps emerged as a major research topic in numerous projects. They concerned novel instrumentation at dedicated field sites like Col du Lautaret to study properties of snow and the fluxes between the soil, vegetation, snow, and the atmosphere. Further observations concerned seismic activities in the Italian and French Alps using either specific measurements or long-term observations as well as the analysis of the retreat of glaciers in the French Alps. Furthermore, geophysical and environmental hazards related to the collapse of seracs, landslides, rockfall, debris avalanches, or the deposition of mercury were studied at specific alpine sites. In some cases these studies were based on paleo-environmental archives like lake sediments or using dendro-geomorphological studies. After consulting the OSUG external Scientific Committee a thematic project call was launched starting with the fourth project call (AO4) to foster interdisciplinary research concerning the Alps (structure and evolution of the Alps, regional climate, glaciers, snow, ecosystems, risks, …). A significant fraction of the annual budget was and is reserved for this thematic call. As a result five projects were funded in 2014 concerning new observational methods and prediction of future developments in the

Alps and contributing, thus, to the major research axes of OSUG@2020. These observations are related to snow properties using remote sensing data at a high spatial resolution of 250 m, the impact of the past and future retreat of glaciers on the erosion in the Mont Blanc Massif, and the monitoring of landslides. Further projects aim to evaluate the impact of regular pollution episodes related to particles on the health of local communities in alpine valleys and to advise ski resorts in handling future changes in snow properties important for tourism. All projects funded through this thematic call involved research teams from at least two different laboratories.

The funded research projects strongly contribute to an interdisciplinary approach to better understand the environmental system of the Alps, how it underwent past changes, and how future changes will impact the local environment and society. They address a broad range of disciplines from geophysics to social sciences. This thematic focus will further be developed with the aid of OSUG@2020 to create a strong interdisciplinary approach helping in maintaining national leadership, in attracting international collaboration, and in generating additional funding well beyond the time span of the Labex project. The OSUG@2020 teams were jointly involved in the response to CPER initiative in 2014 to propose action plans (SAFE_MONTAGNE and MONTAGNE 4.0) to be developed under CPER funding.

B) Human resources

About 1M€, i.e. 25% of the total budget, were dedicated to human resources during the first four years of OSUG@2020. The OSUG Human Resources service is in charge of the management of these collaborators: help with recruitment, support for employees, relations with the University for contract and administrative tasks.

PhDs

The largest part of the HR budget is for funding PhD students. As stated earlier (section 1-3) we decided to mostly co-fund. In the first four years, eleven students were financed at 33 (1), 50 (9) or 100 % (1). Co-financing was assured by different international and national agencies and projects (ESO, CNES, ANR, EU, Irstea, Météo France), private partners or foreign universities in the UK, USA, or Switzerland. The objective is for the student to work in collaboration with an outside public or private institution, in France or internationally. The selection of candidates is done at the Steering Committee level, based on the quality of the candidate, the proposed thesis project and the co-financing. The ranking of candidates performed by the UGA Graduate Schools is taken into account.

In order to help PhD students, independently of them being funded by the Labex, and to prepare their future we have developed two different tools, which are complementary of those of the Graduate Schools: (1) We encourage international mobility of PhDs to provide them opportunities to create collaboration outside their lab. Fifteen training periods in a foreign laboratory or an international school were funded so far. (2) We use the “Label” opportunity created by Université Grenoble Alpes, which allows a PhD student to acquire complementary experience in a field that is not strictly linked to his/her research. The student is paid about 200 h/year. Most labels funded by the university concern teaching tasks; the Labex has allowed developing complementary “Observation” and “Outreach” labels. Three labels were funded so far and 2 others are in preparation. Two “Observation” Labels have been funded for PhD students to work within the RAP network (seismology) and on the GhoSST database (planetology). The experience has been successful, both for the students (acquisition of new

expertise, integration within a technical team) and for these services. In addition to their task, an important objective was to get the students acquainted with the notion of long-term monitoring. Their label task was followed and evaluated independently from their thesis advisor. An “Outreach Label” is dedicated to the development of the MOOC on exoplanets, which gives the student the opportunity to collaborate with experts in this field and to obtain significant experience in knowledge transfer to a general audience.

Technical expertise for observation and research

In our research field there is a very strong need of technical expertise, especially for observation systems (cf section 2-A). The good quality of observations and their continuity is essential. However, technical manpower in the research labs is an issue. It was thus decided to dedicate part of the Labex budget for recruiting technicians or engineers for observation tasks (WP1). In most cases the funding had a leverage effect for other sources and the selection of candidates is done at the research lab level. Sharing of expertise was favored by the Labex. At least one of these positions has since been transformed into a permanent position by CNRS.

A 3-year position was funded for a project closely linked to the OSUG-DataCenter. The objective is to develop a new tool to easily access various large databases in the field of hydro-meteorology (OLES project, cf. section A-2, WP-R2).

Training

As outlined in section 1.3, a significant investment was made to acquire state-of-the-art equipment for training. This equipment needs maintenance by qualified technicians. Three part-time technicians were so far recruited by the Labex for this task. They work in close collaboration with academics but also with research teams to provide the highest-level equipment and expertise to the students. These fixed-term positions also represent a very valuable work experience for the recruited technicians.

Communication and outreach

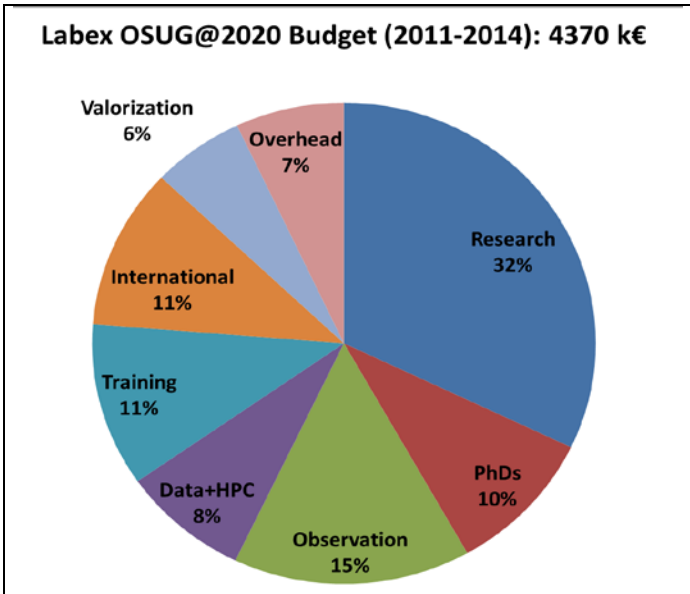
At OSUG, one permanently appointed expert is in charge of communication. For Labex needs it was decided early on to reinforce the communications team with a second technician. A second recruitment was decided in 2013, with a particular objective to provide better information on undergraduate training delivered at Grenoble in the field of Earth and Environmental Sciences (including Ecology and Physical Geography) and Astrophysics. The choice was to recruit newly formed young people issued from specialized schools in communication. These appointments provide them with a first experience that is essential for their future career. Those recruitments proved to be very valuable for OSUG and the University; in particular, we have seen an increase in student numbers in the Earth Sciences in the last year.

Accompanying Young Researchers

After 4 years it remains difficult to assess whether the Labex has a strong effect on recruitment of young researchers. The OSUG research labs are already very attractive: 37 young researchers were recruited during the last 4 years in the Labex labs by different institutes: CNRS, Universities, Meteo-France, Irstea, IRD. Labex provides those young researchers with a small starting grant when they arrive, to help them to start their research work in good conditions.

C) Financial resources, leverage effect

The OSUG@2020 funding is about 1.1 M€/year, totalizing so far 4,4 M€.



Main axes of Labex funding:

- Research, Observation, Data and HPC (High Performance Computing), are described in section 2-A (WP-R).
- Higher Education (WP-E including Training with an important International aspect and PhDs) is mainly described in section 1.3.
- PhDs are listed apart because they can be considered as investment in Training as well as Research
- Outreach and Technology Transfer (WP-V) is mainly described in section 3.
- The 7% Overhead costs are deducted at the University level

The total annual budget of the Labex research laboratories is about 24 M€/year without salaries of permanent personnel and 76 M€/year with permanent personnel. The Labex has been essential in many cases to obtain additional funding at the research lab level.

A few examples of leverage effects are given below:

- Spectro-Photopolarimètre-InfraRouge SPIRou (cf. 2-A, WP-R1): the Labex and University Grenoble Alpes were the first to fund this project. Other institutions followed in France and internationally, which was essential to obtain the final positive response from ESO. Labex funding is 80 k€ for a total of about 4 M€.
- High Resolution X-ray-tomograph (cf. 2-A, WP-R1): collaboration between different universities (G-INP and UJF), different labs and 3 Labex: OSUG@2020, CEMAM and TECXXI. OSUG@2020 contributed for about 10% (40 k€/550 k€).
- High Performance Computer Froggy (cf. 2-A, WP-R2). The OSUG@2020 contribution is 0.2 M€ for a total of 1.5 M€.
- PhD (cf 2-B) funding is another example since the choice was made to co-fund instead of funding 100% of the grant. Thus, 11 PhD students have completed or are doing their PhD funded by OSUG@2020 instead of only 6 if full grants were funded.
- International meetings (cf 1-3): Labex funding of international meetings varies from a few percent to more than 50%. The average is about 10% but several scientists told us clearly that without an initial help from the Labex they would never have taken the decision to organize such events.
- Miniaturized spectroscopic technology (SWIFT, cf. 3.1): OSUG@2020 funded (50 k€ total) an optical bench for a PhD thesis that provided significant R&T advances. This project was finally supported by an EDF chair, and was also awarded by the ANAgRAM FUI (6.5 M€).

D) Labex Impact on its ecosytem policy

Research
Grenoble boasts an excellent ecosystem in the fields of Geophysics, Environmental Sciences and Astrophysics, as consistently indicated by international rankings:

- **Shanghaï 2014 :** UJF: world top 150, 5th in France;
  World top 51-75 for *Natural sciences and Mathematics.*
- **US News & World report 2014-2015**
  2nd in France for *Geosciences* (world 30th) and *Environment/Ecology* (world 38th).
- **QS World university Rankings 2014-2015**
  World 51-100 for *Earth and Marine sciences* (2nd France);
  World 101-150 for *Environmental sciences* (1st France) and for *Physics and Astronomy*.
- **Taïwan 2014**
  World 46th for *Environment/Ecology* (1st France), 50th for *Geoscience* (2nd France), 72nd for *Natural sciences*.

Interdisciplinarity is at the forefront of innovative and excellent research. OSUG@2020 proved to be a crucial tool as our policy was to favor interdisciplinarity and through this to maintain the excellence already achieved by the OSUG research labs and teams.

Even before the project was accepted, the Labex had a strong impact on the Grenoble organization because building the project together was a main trigger to enhance relations with research units in the domain of ecology and in the social sciences. Thus, LECA and two research teams of Irstea, which all have major activities in ecology, joined OSUG. In 2014, the Station Alpine Joseph Fourier also joined OSUG and, today, we are forming a very structured group at Grenoble that includes all the main research units in the field of the Earth Global System.

This excellence is being recognized at the university level. The recently created UGA is composed of 6 research departments (“poles”) which are one of the main components of the new Idex project submitted in 2015 “University Grenoble Alpes: a world class innovation university”. One of these research poles is “PAGE” for Physics of Particles, Astrophysics, Geosciences, Environment and Ecology. All the research labs of the Labex are members of this pole and the Labex OSUG@2020 is involved in several committees of the pole.

The Idex project identifies four main interdisciplinary research challenges and, for two of them, the OSUG consortium is strongly involved: “Sustainable planet and Society” and “Digital world” through our modelling and big-data activities. Funding common equipment with other Labex or Equipex is a clear signal of the potential and reality of these interdisciplinary axes. Two examples are the co-funding of an X-ray tomograph with the Labex TECXX1 (mechanics and materials) and CEMAM (bio-materials), and co-funding of the High-Performance Computer Froggy with the Equipex Equip@meso.

Enhancing collaboration with social sciences is another objective of the Labex because we feel this is essential for studying our Planet Earth as a whole. It is the reason the social-sciences research team RCC was associated with the Labex since its inception. This team is expert on the societal response to natural hazards and works in close collaboration with hydrologists from LTHE (extreme events) or seismologists from ISTerre (earthquake readiness). The Labex organized an interdisciplinary day on natural hazards in 2012. In 2015 the Labex is partner of an UGA initiative led by OSUG researchers concerning COP-21.

Meetings are organized with local policymakers and will be part of our outreach and dissemination axis. Again the Labex is used to strengthen collaborations with social sciences at a moment when the three Grenoble universities (Science-U. Joseph Fourier, Social Science-U. Pierre Mendes France and Humanities-U. Stendhal) are bound to form a single university. The merger of the three universities is planned for 2016 and is also an important objective of the UGA IDEX project.

Training

In the training domain, the Labex has also an impact in the university because all the teaching departments propose new programs in 2016. As an example, a new multidisciplinary program "Building and Hazards in Mountain Environments", which was part of the initial Labex proposal, will open in 2016 and will provide students with combined expertise in natural-hazard assessment and civil engineering. An interdisciplinary one-day OSUG meeting on undergraduate training was organized by the Labex in 2013, with the objective to begin to prepare the future and develop new ideas. More than 200 people attended the meeting. As outlined in section 1-3, a significant amount of new training equipment was funded. As a result, the new undergraduate programs can be constructed based on state-of-the-art equipment (data acquisition tools, software for data interpretation and hardware for computing). An example is a new professional degree on water management that makes use of hydrological equipment funded by the Labex. Another example is the SAJF Col de Lautaret site, which has been dedicated to ecology for more than one hundred years. The objective is now to develop interdisciplinary research and training there and a new building is being built amongst others to host student groups. The Labex funded equipment for snow-hydro-meteorology studies, including a Ground Penetrating Radar, and, thanks to this investment, we are now able to propose a one-week training session on snow studies that is unique in France.

The MOOC initiatives funded by the Labex also have an impact because they participate to building expertise (with both human and technical resources) at the UGA level. In 2015, the MOOC on exoplanets is one of two MOOCS being developed by UJF. This MOOC is co-funded with another Grenoble Labex, FOCUS. Finally, the great effort allowed by the Labex to provide better information about the programs in Earth, Space and Environmental Sciences in Grenoble is obviously integrated in the overall University training offer. The Labex effort mainly involves human resources (cf. section 2-B) but also new websites and a dedicated mobile information stand used in Student Fairs and information meetings.

Communication and outreach

The Labex OSUG@2020 was involved in many events organized by UGA to promote all the locally managed Labex programs (about 20): poster session at the "Forum on Science & Technology through European Research & Innovation Grants" (Fostering ERC) organized in December 2013; brochure "Grenoble : les projets d'avenir en Recherche et Formation" edited by UJF in octobre 2013; UGA's Labex internet portal opened in 2014, and several dedicated newsletters.

The Geoscience exhibit museum (cf. section 3-4), which will open in 2015, is a project that is fully integrated in the new Campus plan and was supported with a high priority by the University. It is located at the entrance of a teaching building and thus fully integrated in the Campus training resources. The University Grenoble Alpes, OSUG and its Labex are also involved, mainly by making human resources available, in a very ambitious project at the Grenoble Metropole level. The future exhibit center « Moulins de Villancourt », which

should open in 2019, will be dedicated to Science and Arts in the fields of Geosciences, Environment, Planetology and Astrophysics and will include a Planetarium, a « garden of sciences », permanent and temporary exhibition rooms, a conference room, a terrace for observation of the sky and surrounding mountains on a total area of about 2500 m^2. Labex researchers are strongly involved in the preparation of this project, with the idea to work in collaboration with communication experts to showcast the ongoing research in our labs.

In 2015, in the framework of the UGA-COP21 initiative, the Labex co-funds a series of conferences on the IPCC conclusions. The first was held in February 2015, on IPCC WP-1 (Physical Science Basis) by its president T. Stocker. About 700 people attended the conference, which was followed the same evening by two further conferences given by researchers from Labex labs at the Grenoble museum on snow, glaciers and ice sheets (200 people). The next conference will be on WP-2 (Impacts, April), followed by WP-3 (Mitigation, October), and a last one will concern political negotiations (November) just before the Paris meeting.

3 / SOCIO-ECONOMIC IMPACT

3.1 *Partnerhips with social and economic actors and established agreements; start-up creation; hosting of industrial actors in the Labex for instance…*

OSUG@2020 has developed actions for industrial application of research, and for advising public policies with respect to natural hazards.

The objective of OSUG@2020 has consisted in making the OSUG community more aware of these dissemination and technology-transfer issues, triggering proposal submission through an annual call and to guide applicants within the UGA technology-transfer structure. UGA is deeply involved in technology transfer and has developed powerful facilities to help disseminate research activities to industry and policy makers. In this respect, the OSUG@2020 directorate participates in the monthly “Club Valorization” meetings held by UGA, which gather Labex representatives who share experiences and concerns.

Projects are evaluated by a committee composed of the vice-president in charge of technology transfer of University Joseph Fourier, the deputy director of OSUG and three researchers with complementary skills in natural hazards and industrial applications. Since 2012, OSUG@2020 has funded 5 projects that aim at building a national FUI fund (1), licensing or patent submission (4), and advising public authorities in matters of economical impact due to climatic change (1). The themes and issues are very diverse. The FUI project for instance relied on a very innovative miniaturized spectroscopic technology (SWIFT) and aimed to implement fiber networks with Bragg sensors that are very sensitive to weak mechanical constraints. This action, led by an astrophysicist (IPAG) and a seismologist (ISTerre), aimed at providing a very innovative approach of interest for assessing mechanical motions in natural environments and sensitive buildings (e.g. nuclear plants). OSUG@2020 funded an optical bench for a PhD thesis that provided significant advances in R&T. This project was subsequently supported by an EDF chair and was awarded by the ANAgRAM FUI. Another project aimed at promoting the emergence of a platform at UGA focused on mineral-resource exploitation, which is becoming a major concern in Europe. The PI of this project also leads a national CNRS program on this issue. This platform would be highly specialized in mineral-

resource valorization, and so be complementary to the existing structure. It would promote patent submissions, but also industrial contracts or PhDs co-funded by industrial companies.

OSUG@2020 also funded an action for applying a new concept disdrometer. Contacts revealed the interest of at least one company, which required a patent. The researchers have thus been working with FLORALIS and the Brevalex patent company to submit a patent mid-2015. OSUG@2020 also funded an action devoted to advice the Conseil Général de la Drôme on impacts of climatic change. The objective here is to identify the main impacts of climatic changes and to advice an adaptation policy regarding agriculture and tourist issues.

Industrial partnership for training: an important training project was co-funded with TOTAL. To provide students with access to 3D-seismic processing tools a room was equipped at ISTerre with 15 terminals provided by TOTAL, Globe Caritas and OpenTec software funded by the Labex (35 k€) and a high-performance computer server also funded by the Labex (35 k€).

3.2 *Relationship with the SATT (Tech-Transfert Societies)*

The Grenoble SATT, recently created in July 2014, comprises a funding agency (GIFT) and a portal (GATE1) dedicated to guide applicants. The Grenoble SATT is the only one in France (with Saclay) whose prime objective is to create Start-Up companies. However, other technology transfer issues are considered. It gathers all partners of the site (Universities, CNRS, INRIA, etc.). OSUG@2020 is tightly connected to this SATT. As it was only created 6 months before the term of the reporting period, it is currently too early to evaluate the impact of the relationship with the SATT.

3.3 *Commercial relations with European public-private partnership research institute, within the Framework Programmes, etc.*

Not applicable for OSUG@2020

3.4 *Promotion measures for knowledge dissemination; schedule, durability of the measures (excluding publications in scientific journals)*

Dissemination of acquired knowledge in Earth and Planetary Sciences, Environmental Sciences, and Astrophysics is within the mission statement of each OSU in France (28 *Observatoires des Sciences de l'Univers* as of today). Our action at OSUG is therefore not only integrated in a local context but also in a national network. Thanks to the LabEx, it was possible to hire two persons to reinforce the Communication Team (previously consisting of a single CNRS personnel) at OSUG to reach this objective.

Several activities within OSUG relate to issues of fundamental importance to the general science-interested public (i.e. biodiversity, climate change, natural hazards, natural resources, origin of the universe, of stars and planets, origin of life). Therefore OSUG has been organizing, for many years, a strong outreach activity toward the general public including school visits, events during the "fête de la science", undergraduate-level outreach courses, telescope observations, geological hikes. Local and national journalists often approach OSUG for its expertise on natural events or breakthrough discoveries. A few examples of outreach activities, for which OSUG@2020 personnel support was essential, are given below.

The website was completely renewed in 2011-2012. The communication team also helped OSUG research teams to develop their own websites by providing integrated ready-to-use web kits. LGGE, ISTerre, LECA, IPAG but also scientific projects such as RESIF and OSUG-DC are already using these tools. An important part of the OSUG website is devoted to general public outreach ("Sciences pour Tous"): more than 120 podcasts, books, documentaries, etc., are referenced so far (http://www.osug.fr/sciences-pour-tous/ressources-a-consulter/).

OSUG scientific news is regularly transmitted towards the public media through devoted web-pages (http://www.osug.fr/sciences-pour-tous/le-coin-des-medias/). Our scientific results are also publicized in local and national media through press releases (newspapers, radio, TV). For example, in 2014 LGGE was cited in international media thanks to the paper "*Retreat of Pine Island Glacier controlled by marine ice-sheet instability"* in *Nature Climate change* (Favier *et al.*, 2014); IPAG appeared in approximately 50 news reports thanks to its implication in the instrument Consert on board Rosetta; ISTerre is regularly consulted for its scientific expertise on earthquakes felt in France and in Europe (European Share Program). With the aim to enhance our efficiency, we have developed our presence on social networks: Twitter (https://twitter.com/OSUG_fr), Scoop.it! (http://www.scoop.it/t/osug), Facebook (https://www.facebook.com/pages/OSUG/743785079032691).

Hiring two new personnel thanks to the LabEx allows the OSUG communication team to provide a strong support to scientists during many events beneficiating to a large audience. For example, IPAG is deeply involved in the Rosetta mission and based on the collaborations of several OSU communication teams, it has been possible to organize several public events (e.g. in Grenoble and in Paris) for Philae's landing on November 12th, 2014. More recently, OSUG played an important role in organizing the public conference given by Dr. T. Stocker (IPCC WP-1 president) on the Grenoble campus (700 participants). In 2011 and 2013, OSUG was very active in the "*Oufs d'Astro!*" biennial events in Lyon which were successively devoted to Gravity and Time; 20 OSUG researchers were present and about 7000 persons attended this event. At the "*Moulins de Villancourt*", a local contribution to the national science fair "*Fête de la Sciences*" is organized every two years. The 2013 session was focused on Water. A photography exhibition, conferences, and demonstration stands with physical experiences (7) were all presented by OSUG researchers from 5 laboratories during 3 days. More than 1000 visitors attended this event including 17 classes from secondary schools. Moreover, since a few years OSUG is involved in the conception and realization of a museum on campus. It will open in September 2015 and will be devoted to all the scientific fields covered by the Labex OSUG@2020. 200 m^2 will be devoted to 25 exhibits such as an interactive globe with simulations of oceans' dynamic, or a simulation modeling the horizon of a black hole... Finally, the "*Moulins de Villancourt*" is a long-term project for an ambitious regional exhibit center (opening scheduled in 2019) in which OSUG is involved (see section 2-D).

FREE COMMENTS

Publications:

As we consider that all the research activities carried out in the OSUG research laboratories contribute to the OSUG@2020 general objectives, the main indicator is the total number of international publications which is about 1000/year. The number of other publications is not relevant because some research laboratories do not consider those publications: it is then largely under-estimated.

Each OSUG@2020 project PI receives a letter asking him to acknowledge the Labex funding with the following sentence: *"This work has been supported by a grant from Labex OSUG@2020 (Investissements d'avenir – ANR10 LABX56)."* It is impossible to check if this is done before the paper is published and we think that many authors forget to thank the Labex but it appears clearly that the number of publications citing the Labex is increasing: 1 in 2011, 8 in 2012, 28 in 2013, 74 in 2014 and already 21 in 2015 (cf list of publications with an explicit reference to the Labex).

Co-funding

For the same reason as above it can be considered that most part of the funding in the research laboratories contribute to OSUG@2020. Even for a Labex funded project, it is often impossible to know what is co-funded by other sources because laboratories resources (logistic, human, instrumentation, tools, computers …) can be used but are not quantified. The choice was made to:

- Give examples of co-funding when possible (cf chapters A and C)
- Give total budget of OSUG laboratories (76 M€, chapter C)
- Give the list of main research labs grants: only those more than 50k€ (cf ANR web site)

APPENDIX 1 : List of acronyms

ACTRIS : Aerosols, Clouds and Trace gases Research InfraStructure network
AMMA-CATCH : Observatoire du Cycle de l'eau en Afrique de l'Ouest
ANAEE : Infrastructure européenne de plateformes d'expérimentations et d'analyses des écosystèmes
AO : Appel d'offre
CEMAM : The Centre of Excellence of Multifunctional Architectured Materials
CEN : Centre d'Etudes de la Neige (Météo France)
CENACLAM : Atelier SO, Climatologie des échanges neige-atmosphère, de la couche limite atmosphérique et du manteau neigeux
CFHT : Canada France Hawaii Telescope
CIRA : Calcul Intensif en Rhône Alpes
CNES : Centre Nationale d'Etudes Spatiales
CONSERT : Radar COmet Nucleus Sounding Experiment by Radiowave Transmission (mission ROSETTA)
CPER : Contrat Plan Etat Région
CTA : Cherenkov Telescope Array
EDF: Electricité de France
ENVRI : Common Operations of Environmental Research Infrastructures
EPOS : European Plate Observing System
ERC : European Research Council
ERCA : European Research School on Atmospheres
ESA : Agence Spatiale Européenne
ESFRI : European Strategy Forum on Research Infrastructures
ESO : European Southern Observatory
ESRF : European Synchrotron Radiation Facility
FAME : French Absorption spectroscopy beamline in Material and Environmental science

FEDER : Fonds européen de développement régional
FOCUS : FOCal plane arrays for Universe Sensing
FROGGY : Calculateur HPC du mésocentre CIMENT
FUI : Fond Unique Interministériel
FUN : Plateforme ministérielle France Université Numérique
GATE : GRENOBLE ALPS TECHNOLOGY AND ENTREPRENEURSHIP
GAW-WMO : Global Atmosphere Watch – World Meteorological Organization
GhoSST : Grenoble Astrophysics and Planetology Solid Spectroscopy and Thermodynamics database
GIFT: Grenoble Alpes Innovation Fast Track
G-INP: Grenoble- Institut National Polytechnique
GLACIOCLIM: Service d'Observation des glaciers (Alpes, Antarctique, Andes)
GMOS: Global Mercury Observation System
GRAVITY : Instrument de deuxième génération pour le VLTI
HyMeX : Hydrological Cycle in the Mediterranean Experiment
INSU : Institut National des Sciences de l'Univers (CNRS)
IPAG : Institut de planétologie et d'Astrophysique de Grenoble
IPCC : Intergovernemental Panel on Climate Change
IPEV : Institut Polaire Paul-Emile Victor
IRD : Institut de Recherche et Développement
Irstea : Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture
ISTerre : Institut des sciences de la Terre
LabEx : Laboratoire d'excellence (Investissement d'avenir, ANR)
LAME : Laser, Molécules et Environnement (équipe du LSP)
LECA : Laboratoire d'écologie alpine
LEGI : Laboratoire des écoulements Géophysiques et Industriels
LGGE : Laboratoire de Glaciologie et de Géophysique de l'Environnement
LIDAR : Light detection and ranging
LTHE : Laboratoire d'Etudes des Transferts en Hydrologie et Environnement
MOOCs : Massive Open Online Courses
OHM-CV : Observatoire hydrométéorologique méditerranéen Cévennes-Vivarais
OLES : Online Laboratory for Environmental Sciences
OMIV : Observatoire Multidisciplinaire des Instabilités de Versant
ORAURE : Atelier SO, Observation des aérosols (SOERE)
OSU : Observatoire des Sciences de l'Univers
OSUG : Observatoire des Sciences de l'Univers Grenoble
OSUG-DC : Centre de données de l'OSUG
PACTE : laboratoire étudiant les sciences politiques, géographie, aménagement et urbanisme
PAGE : Pôle Physique des particules, Astrophysique, Géosciences, Environnement et Ecologie
PI : Principal investigator
RAP : Réseau Accélérométrique Permanent
RCC : Risques, Crises et Catastrophes (équipe de PACTE)
RESIF : Réseau sismologique français (Très Grand Equipement CNRS)
RLPB : Réseau Large Bande Permanent
ROSETTA : Mission spatiale de l'ESA pour l'observation de la comète Tchourioumov-Guerassimenko
SAJF : Station Alpine Joseph Fourier
SATT : Sociétés d'Accélération du Transfert de Technologies
SigmaPhy : Signal Image Physique (équipe de Gipsalab)
SISMOB : réseau de sismologie mobile
SO : Service d'Observation labellisé de l'INSU
SPHERE: Spectro-Polarimetric High-Contrast Exoplanet Research (VLT)
SPICE : Solid Precipitation Intercomparaison Experiment
SPIROU : Spectropolarimètre proche Infrarouge pour le CFHT
SWIFT : Micro photo-spectrometre
UJF : Université Joseph Fourier, Grenoble
UGA : Université Grenoble Alpes
UMS : Unité mixte de service
VELI : Volcans Explosifs Laboratoire Indonésien