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Current and future activities in education and public outreach at the *Observatoire de Haute Provence*

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Abstract

The Haute Provence Observatory has for primary mission the operation of telescopes, up to two meters in diameter, for the astrophysics community, and the measurements of various upper atmosphere parameters for the geophysics community. An education and outreach program has been developed with several reached: from school pupils to post-doctorate students, teachers, and the general public. In the recent years we put emphasis on the formation of teachers and on the renewal of the general public visit. Given the wide range of education and outreach activities we cover, we had to develop a relation network with individuals, amateurs, teachers and institutions, amplifying our efforts. For the future, we will try to make an optimal use of the resources available in the St Michel l'Observatoire area, taking steps to reach an agreement with the neighbouring "Centre d'Astronomie", a structure devoted to education and public outreach belonging to the local authorities.

Keywords: Education and public outreach; Astronomy; Environmental sciences; Geophysics

1. Introduction

The Haute-Provence Observatory (hereafter OHP – http://www.obs-hp.fr) belongs to the Centre National de la Recherche Scientifique (National Centre for Scientific Research, hereafter CNRS), the main French research agency; it is located in France, approximately 100 km north of the city of Marseille, at an altitude of 650 m near the village of Saint Michel l'Observatoire (Alpes de Haute-Provence). It was funded in 1937, but started its activities in 1943 when the 1.2 m telescope came on line (Véron, 2005). In 1958 its 1.93 m telescope entered into operations. OHP operates routinely 4 telescopes in the range 0.8–1.93 m for spectroscopy and photometry, with a specialization to high resolution spectroscopy and extrasolar planet studies (actually the first extrasolar planet was discovered using the 1.93 m telescope – Mayor and Queloz, 1995). In the seventies, prompted by the discovery of the depletion of the Ozone layer the LIDAR ranging technique was developed to monitor the atmospheric temperature, wind, as well as its minor constituent, mostly Ozone (Mégie et al., 1977). Nowadays OHP hosts one of the main stations of the *Network for the Detection of Atmospheric Composition Changes* (NDACC, http://www.ndacc.org). OHP belongs also to other geophysical networks such as AERONET (AErosol ROboic NETwork; http://aeronet.gsfc.nasa.gov/) for the monitoring of the aerosol content of the atmosphere and PAES (Pollution A l'Echelle Synoptyque, Synoptic Scale Pollution; http://www.aero.obs-mip.fr/PAES/accueil/paes_index.htm) for the study of the pollution at the regional scale; We plan to participate to major initiatives such as the "Mediterranean workshop", a long term campaign for the study of the impact of the global climate change at the regional scale. Table 1 summarizes the main instruments in use at OHP, both for astrophysics and geophysics. We can summarize the first mission of OHP as to give access to telescopes to the community, from stellar physics to extragalactic sources, and to acquire measurements of the vertical column of

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Table 1
Main instruments in use at OHP

Branch	Instrument name	Characteristics	Comments
Astrophysics	Telescope 193 cm	Equipped with high and low resolution spectrographs	Research only
	Telescope 152 cm	With high resolution coudé spectrograph	Research, technological development, and training of students; will be use for laser guide star experiment
	Telescope 120 cm	CCD camera for photometry	Research, training of students
	Telescope 80 cm	CCD camera for photometry	Research, training of students
	BEST[a]	30 cm telescope	Research, detection of extrasolar transits
	Tübingen-OHP telescope	60, 10 cm, with webcams	Remote operated for education
	ROSACE	50 cm telescope with CCD camera	Research, extrasolar transits, Gamma-ray bursts and orbital debris/satellite positioning
	TAROT-Calern[b]	25 cm robotic telescope on plateau du Calern observatory	Research (Gamma-Ray bursts, and secondary science), has been used for EPO
	TAROT-Chile	25 cm robotic telescope at ESO, La Silla (Chile)	Research (Gamma-Ray Bursts and secondary science)
	CARLINA[c]	Interferometry with diluted pupils	R&D
Geophysics	NDACC (Network)	O3 Lidars	Research, O3 atmosphere profiles in stratosphere and troposphere
		Aerosol Lidar	Research, Aerosol and temperatura in atmosphere
		Dobson Spectrometer	O3 in atmosphere
		SAOZ Spectrometer	O3 and NO2 in atmosphere
		Stratospheric balloons	In situ measurement of T, O3, H...
		BrO Spectrometer	Measure of BrO
		UV spectrometer	UV content of Sun radiation at ground level
	AERONET (network)	Spectrophotometer	Aerosols in atmosphere
	PAES (network)	Pollution analyser	Measures of CO and O3 at ground level
	Miscellaneous instruments	H2O Lidar	Research, atmospheric vapor content
		Wind LIDAR	Wind profile in high atmosphere
		Decimetric radar	Research, interface troposphere/Stratosphere
		Interferometer	Monitoring of winds in the thermosphere
		Pyranometer	Used for transfer of radiation in atmosphere
		Cloud camera	High altitude (cirrus) cloud monitoring for radiation transfer

[a] Berlin Extrasolar Transit Telescope, Rauer et al. (2004).
[b] Télescope à Action Rapide pour les Objets Transitoires (Rapid Action Telescope for Transient Objects) Calern OCA and ESO La Silla, Boër et al. (2006).
[c] Le Coroller et al. (2004).

atmosphere (including dynamics) from the troposphere to the mesosphere.

OHP has about 60 employees, including a research group of 10, covering both fields of astrophysics and geophysics. For astrophysics, an independent assessment of the impact of the 193 cm telescope of OHP has been made by Trimble et al. (2005). Among other facilities we can mention mechanical and electrical workshops, a large integration facility, large available space in its historical style building, meeting rooms (up to 80 persons), a guesthouse with 40 beds, including a restaurant. OHP is well connected to the various transportation networks, thanks to a close motorway, linking the OHP to the Aix-TGV train station and to the Marseille airport in about 1 h drive (making Paris at a "distance" of 3 h:30). It is close also (1 h:15 m) to the densely populated area of Marseille, and the Rhone river valley.

Since the fifties, OHP has opened its doors to the general public. However, it is only in the recent past years that a program has been developed for education and public outreach (hereafter EPO). In 1987, a structure devoted to education and public outreach, the "Centre d'Astronomie" (Astronomy Center, http://www.centre-astro.fr; hereafter CA) owned by the territorial authorities (Conseil Général des Alpes de Haute-Provence) and run by a non-profit association has been opened in the neighbouring village of Saint Michel l'Observatoire to popularize astronomy and receive school classes for periods from few days to one week. The CA has 17 FTE, including 7 specialized educators for children and/or in astronomy. It features several small telescopes (up to 60 cm in diameter) and a siderostat which was given by the CNRS. In order to mutually benefit from their expertise and experience, the two structures (OHP and CA) are establishing closer links, as described below.

In this paper we describe the EPO activities of OHP, their development and the problems encountered, as well as the evolution we see for the future. We address successively the different publics targeted by our action.

2. University level

2.1. Graduate, post-graduate and post-doctoral training

Though OHP has always been a site of choice for the training of students, these activities became more organized since the end of the nineties. Today, graduate students from almost all French master classes (European 2nd year of master) attend a one week training session at OHP (Fig. 1). They use the 120 and 152 cm telescopes for photometry and spectroscopic projects, preparing the observations, acquiring data, processing them and drawing conclusions. Since few years, graduate students in atmospheric physics attend also OHP and they use the available instrumentation as a practical introduction on measurements. An interesting feature is that since two years the students of both fields, astrophysics and geophysics, have a one or two day introduction to the other field (geophysics or astrophysics) during their stay (Fig. 2). This is thanks to the multidisciplinary nature of OHP, and they view this experience as a positive opening in their curricula. Apart from French classes, OHP is also attended by graduate students coming from Belgium, England, and Ireland.

OHP has been one of the funding members of the NEON school (Network of European Observatories in the North), aimed at providing a practical experience to European Ph.D. students, selected on the basis of their merit. During this 2 week summer period, which now rotates between 4 institutes in Europe, students develop projects and apply them using the 193, 152 and 120 cm telescopes (see http://www.obs-hp.fr/www/ecole-ete/neon2006. html as an illustration). They have also lectures on several topics. The feedback is extremely good; an illustration is that one of the foreign teachers is coming now with her graduate students; she was motivated by her participation to a previous NEON school she attended while she was engaged in her Ph.D. Finally, OHP hosts for two weeks the ERCA (European Research Course on Atmospherics; http://www-lgge.ujf-grenoble.fr/enseignement/erca/, see also Boutron, 2006). This 6 weeks course is directed towards promising young post-doctoral

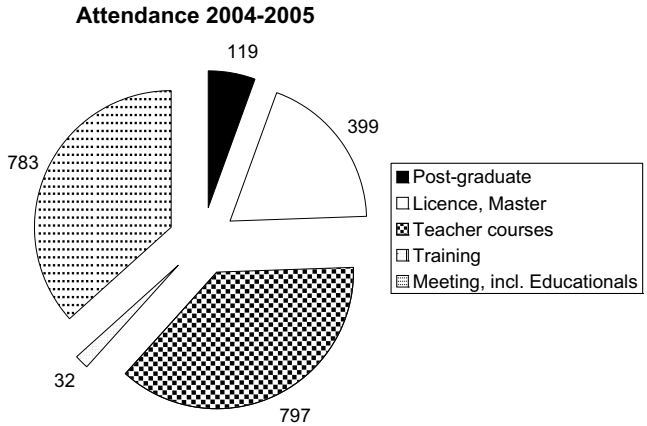

Fig. 1. OHP attendance for teaching activities during the civil years 2004–2005.

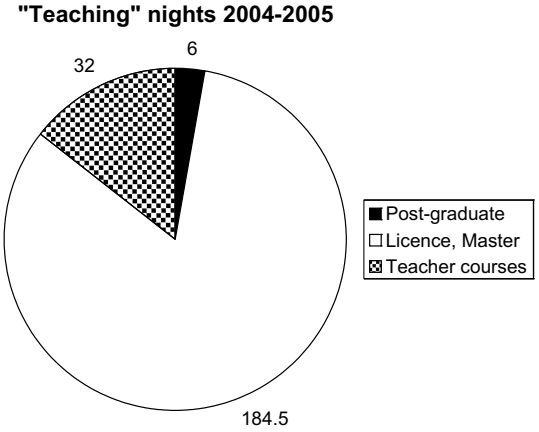

Fig. 2. Nights used for teaching activities at any OHP instrument: for astrophysics we use the 80, 120 and 152 cm, while for atmospheric physics the students have access to the LIDAR station. The simultaneous use of multiple instruments (e.g. LIDAR + 80 cm, ou 80/120/152 cm telescopes) is counted as a single night.

students from the entire world. They use the facilities at OHP for a practical experience on instrumentation and data acquisition. Both NEON and ERCA are supported by the European Commission.

These training sessions are mostly organized by the hosted institution. Until recently, OHP was providing mostly the logistic support, including night assistants, and few lectures. However, since we hired recently a researcher with teaching duties, we are starting now to support better the students during their stay; we are also developing a curriculum in astrophysics, featuring some observational fields (e.g. stellar physics), as well as some approach of interferometry.

2.2. Pre-graduate students

Most of the students come from the neighbouring *Université de Provence*, Marseille. Unfortunately, given the cost of the travel and the financial situation of the French universities, as well as the way the lectures are given, we receive few students at this level. We note however that students from the *Ecole Normale Supérieure de Cachan* (near Paris) started to come since 2 years. We regret this situation, since actual exposure to science has been identified as a major driver for students to start studies in a field. We identified the enhancement of higher education as one of the major axes to develop in our strategic roadmap for the future. However, though we started to define some activities for students, the implementation of this program in French University curricula will depend both on their financial situation and the willingness of their teachers. Beside the organized journey to OHP, we hosts about a dozen of undergraduate trainees each year, both in scientific and technical matters

3. Secondary and primary teaching

OHP receives the visit of a large number of pupils and their professors. At primary level, we focus only on group

visits of OHP. Apart the local area schools, most of the children are hosted by the CA, where they can have specialized activities (both scientific and non scientific). The pupils have an approach to astronomy and space sciences through the making of simple telescopes, visual astronomy, and small rocket construction and launches. The duration of their stay is usually one to two weeks. However, it happens that two or three groups leaded by very skilled and motivated teachers spend some nights at OHP, mostly for photometric observations, with some simple objectives as rough estimates of the flux, planetary observations, and star distances on the sky.

3.1. College

At college level (French 6th–9th grade, i.e. from 11- to 15-year-old), pupils still spend most of their time at the CA. Though emphasis is made on visual observation, they have also more complex activities, like the making of a telescope (eventually a reflector), astrophotography, etc. The spectrum of the Sun can be used as a good illustration of the college physics lectures on light. Students can perform also webcam or CCD astronomy, using simple acquisition and data processing programs, as the one developed in the framework of the Hands-On-Universe initiative (Boër et al., 2001; Pennypacker, 2004). They usually spend one or two nights at OHP, mostly with the 80 cm telescope both for visual and CCD astronomy with more professional material. At this stage, they should prepare their observation run. Also, taking up on the opportunity of the 2005 Venus transit, we invited the college of the neighbouring city of Forcalquier for an extensive visit of our observatory and to perform observations of Venus both with a telescope and simple projection lenses. This visit resulted in collaboration, featuring astronomical optics and an approach to environmental problems through the sounding of the atmosphere (ozone, atmospheric pressure and temperature, vapour content...) taking advantage of our weekly stratospheric balloon launches. At this level, the collaborative work with the CA starts to be crucial, and we are currently trying to enhance the collaboration. The difficulties we have are mostly connected to the lack of time within the French curricula for "Hands-On" activities, the lack of finances in the colleges for such activities, the need to have motivated teachers, and some practical difficulties connected to the very strict rules which apply to minors and the need to get parents cooperation for night outdoor activities. However the evaluations show that the children highly appreciate the time they spend at the CA and OHP, and that at least some of them get more motivation for scientific studies, according to their own opinion, and their results in general examinations after the visit.

We note finally that OHP hosts a dozen of 9th grade students for few days, on the occasion of the "enterprise discovery experience" they have to make at this level for 1 week. During this stay the pupils spend only one night at a telescope, but they discover the various activities held at the observatory, from mechanical workshops to the maintenance of telescopes.

3.2. High schools

This is the level were we were able to get the strongest and most fruitful collaboration between OHP and CA, thanks to the Callisto "experience" (http://www.callisto.free.fr/) started by a team of professors from a high school located in Orange, France (*Lycée de l'Arc*). Though the students spend only a week at Saint Michel, the activities take place along the academic year with the preparatory work, the visit, and its exploitation afterwards. The preparatory work consists of some introduction to astrophysics, Earth and space sciences as an illustration of math or physics lectures. Taking advantage of the technical sections of this high school, the students start also the making of a telescope, including the design of the mount. At this stage this is a collaborative work mostly within the team of teachers. Finally they start preparing their observational projects. During the week they spend in Saint Michel, the pupils have activities both at the CA and OHP. At the CA they test and fix their telescope, they use also several instruments to understand solar spectroscopy, make visual observations, and astrophotography. As part of this stay, the students, with the help of their professor and OHP researchers should prepare a small scientific project which will be performed at OHP, usually using the 80 cm, and sometime the 120 cm telescope. During the first years these projects focussed mostly on planetary astronomy (e.g. mutual events of Jupiter) and variable stars. Since the last years, thanks to the connections we have developed with the community the projects can be more "flexible": e.g. the observations resulted in the participation in a scientific publication about binary asteroids (Behrend et al., 2006). Some follow-up observations of newly discovered variable stars within the framework of a thesis have been also performed. Finally, the work of the Callisto team has been nominated in the 2005 European Southern Observatory (ESO) competition "Catch a Star" (http://www.eso.org/outreach/edu-off/edu-prog/catchastar/CAS2005/winners.html).

Since two years we started also activities in environmental sciences, thanks to the facilities and support available at OHP. At the end of the year the students present their work in the form of an exhibition which takes place in the high-school. Callisto activities are highly appreciated by the teenagers and their teachers, and certainly result in more motivation for the studies along the year. We believe that we achieved a good equilibrium between activities taking place along year and the stay at Saint Michel, simple activities at the CA, autonomous projects at OHP and basic training (on physics, data processing...). Moreover, it is one of the few occasions when students can actually apply what they learn at school in an actual case.

This year (school year 2006/2007), Callisto was extended to 3 other high schools in the region, and we

plan further extension, depending on the support we will be able to get. The difficulties encountered is the need for a team of very motivated teachers and the resources used both at CA and OHP; we should note however that the local authorities and the CNES French Space Agency gave some support in the form of a Ph.D. student (starting as of December 2006), with part of his activities devoted to Callisto. We think that Callisto is a very successful experience which makes profit of the available human and hardware resources available both at OHP and CA.

3.3. Teacher training

Teacher training is probably one of the most important tasks for any effort aimed at long-term public awareness and interest in sciences, as well as to get pupils interested in further scientific or technical studies. In France, as well as in most developed countries, the disaffection of scientific classes is already effective at high school level, and apparently starts at primary level (OECD, 2006). Many factors have been already identified, most of them external to school. However, several discussions with educational authorities (e.g. De Gaudemar, 2004, private communication) show that the lack of primary school teacher scientific culture is certainly one of them. Teachers have also a very scholar training, usually without any research or practical experience of science. In addition, in France the terminal examinations and programs leave little time for "hands-on" experience. In other words, teachers not only have to be motivated, but they should be convinced that practical experience in a geophysical and astronomical observatory will give them an additional leverage for their student education in physics and maths. This has been recognized by the French educational authorities through several initiatives as the laboratory visits by teachers, "Science à l'Ecole" (Sciences in the School; http://eduscol.education.fr/D0109/SCIENACC.htm), or "l'Univers à Portée" (Hands-On Universe France; http://fhou.cicrp.jussieu.fr/) initiatives, albeit with few actual money and human resources.

Educational activities directed towards teachers are somewhat diverse:

- In line with our activities, and from the experience gained with Callisto, we organize now three sessions, including a 3 days stay with observation, focussed on the interest of project learning for students. We use as an illustration astronomical projects, and we try to discuss which parts of the curricula can benefit from this approach. If the teachers overnight, we propose them to build their own project.
- We organize also a "researcher-teacher encounter" where the activities of the observatory are presented, some "hot" topics in planetary sciences and astrophysics; we try to make the teacher aware of the other possibilities offered by the observatory.
- Together with the Paris Observatory we organize two stays for the future teachers at the primary level, where they can have some approach to experimental science. We teach them also some simple experiments they can make with children to illustrate science notions.

In total, about 800 teachers or future teachers have attended a course at OHP during the civil years 2004 and 2005 (Fig. 1).

4. General audiences

OHP opens its doors weekly. Until 2004, this visit was restricted to one afternoon, and to the 193 cm telescope. However, it was appreciated by the public, since it is the only actually running telescope accessible in France, and because of the implication of the staff in this visit. However this visit was (and is still) very consuming in terms of human resources (an average of 3 FTE along the year), and is limited to the instrument, with little scientific content. We decided to renew the visit, a task still in progress, with several objectives: (1) limit the impact of the visit on the observatory resources, (2) limit its impact on the night observations (in summer this is a real problem because of the heat introduced in the dome), (3) communicate on the actual research performed at the observatory and their impact, and more generally on the research performed in the sector of Earth and Space sciences of the CNRS, and (4) host the public in better condition, and let them have some good time at the observatory while having a real approach of research.

Within the framework of the "Year the Physics 2005" we developed an ambitious exhibition, "$E = mc^2$, from Energy to Life" together with the Cadarache centre of the French Atomic Energy Commission (CEA, Commissariat à l'Energie Atomique) and the museum of Quinson on prehistoric studies (Alpes de Haute-Provence, France). It was centred on the relativity theory and the discoveries made at the turn of the XXth century, and their use for the exploration of the universe (mostly planets, including the Earth), the methods of datation using radioactive isotopes, and what is nuclear fusion and how to achieve it (since Cadarache will host the ITER international fusion experimental facility). The exhibition was displayed at the three partner premises (at OHP during the summer season July–August 2005). It is now circulating and booked until the end of 2008. We took the opportunity of the venue of the exhibition during the summer of 2005 to open 2 afternoons weekly instead of 1, and to restructure the visit. The visitors now, at least in summer, can walk on the site, go to the exhibition freely, they can see a movie on astronomy. The dome visit is still restricted at pre-booked times because of the limited number of people we can admit (80 every half hour). In summer 2006 we borrowed an exhibition on environment. We asked also for some participation of the CA staff in the visit, and we developed another approach were the staff does not lead the people through the observatory, but answer to their questions

(or propose help), with the obvious exception of the telescope visit. Since the evaluations are positive, we plan to pursue in this way, and to have a permanent exhibition on the atmospheric physics activities performed at OHP. However, our final plans call for a major financing effort from the local and national authorities.

5. Conclusion and future prospects

In the recent years we tried to develop an Education and Public Outreach program both building on existing activities, mostly outreach and education towards the highest university levels, and creating, or greatly renew, a program directed towards the teachers and high-school students.

The local situation in Saint-Michel l'Observatoire is such that there is a scientific recognized institute, OHP, part of research agency with few activities in the EPO domain (the CNRS), and a dedicated facility, the CA, which belongs to the territorial authorities, but with a somewhat limited scientific expertise. Though some exchange has existed always between both structures, the development of the CA has occurred mostly independently of the OHP (though the CA exists thanks to the OHP presence). This leads to the duplication of efforts, eventually competition, and is certainly not the best way to convert the potential of Saint Michel for EPO activities to actual attraction of public and efficiency. In addition some coherence should be given to the vast palette described above, making profit of the motivation of teachers from neighbouring high-schools, and the network of institutions linked to the OHP. This is why OHP is starting, together with the CA, an initiative for the reunification of the EPO activities from both centres into a single structure. The resulting "meta-OHP" would make profit of the scientific expertise of the CNRS, of the professionalism of the CA, and of a wide network of primary and high-school teachers, as well as academics. In addition, the OHP has large technical surfaces available to accommodate instruments from other parties (such as robotic or remote controlled telescopes, teaching rooms, experiment workshops, etc...), and OHP and CA own in total 100 beds, partly available for children or adults, with an appropriate logistics.

We intend to make profit of our position to have an original project. We are located in an area where geophysical and astrophysical measurements are possible, building on the expertise of a scientific institute: this calls, apart for general public awareness, for project oriented pedagogy. However we are close to major cities in Southern France, well connected to the network of roads, trains and airports, making the access easy and cheap for teachers and students. For the general public we certainly do not intend to build a "science park", but instead we have a more pedagogical approach of making the public aware of the current developments in the fields of Earth and space sciences (including astronomy). Here we make profit again of the close distance from a densely populated area and of the number of people present in the region during the holiday season. Many of the major questions on the evolution of the climate can be addressed at OHP; astronomy, and the quest for planets, is linked to the deepest interrogations of mankind. The already existing attracting powers of OHP, as an observatory, and of the disciplines which are studied there are certainly a lever to make young people interested by scientific and technical issues, a major challenge in education. Having a coherent program in public outreach linked to a deeper educational program is probably where a running (accessible) observatory such as OHP (including the CA) may have a large and sustained contribution to the public awareness of science. Though we do not expect to have a large increase on the short term in terms of financial and human support, we try to rationalize our efforts in the area of Saint Michel, and to use the existing means as a lever to build a major facility for education and public outreach.

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