

IHY - 2ND EUROPEAN GENERAL ASSEMBLY

SESSION:

IHY AND OUTREACH



Relevance of Cosmic Ray Mountain Records for Space and Earth Weather

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Abstract. The Network of High Mountain Observatories (HMOs) in Europe and Worldwide distributed represents an important tool for cosmic ray data collection at different altitudes, latitudes and geomagnetic conditions, useful both for Space and Earth Weather studies. The possibility of long-term data storing with intercalibrated instruments is also of crucial importance for integration, intercomparison and validation of satellite measurements. An exhibition on this subject, joined to divulgation conferences and media communication, has been realized and presented in various European research and cultural institutions, aimed both to scientist and researchers and to the general public. The historical evolution and geographical distribution of the high-altitude research stations is presented, as well as the actual research activities connected with solar physics and Space/Earth Weather forecasts; the integration of the HMO Network in the Earth Observation System is also stressed.

**The exhibition on High Mountain Research Stations:
Windows on the Universe**

An exhibition, joined to divulgation conferences and media communication, has been realized and presented in various European research and cultural institutions, aimed both to scientists and researchers and to general public. Historical evolution and geographical distribution of high altitude research stations is presented, as well as the actual research activities connected with solar physics and space/earth weather forecasts; the integration of the HMO Network in the Earth Observation system and in the cosmic ray monitoring is also stressed.

Exhibition locations

<p>TORINO (ITALY) 9th of February – 20th of March 2006</p>	<p>BERGAMO (ITALY) 1st of October – 15th of October 2006</p>
<p>SOFIA (BULGARIA) 3rd of July – 21st of July 2006</p>	<p>PARIS (FRANCE) 9th of May 2007 <i>Journée de l'Europe</i> Hôtel de Ville - Paris</p>
<p>CHIERI (ITALY) 23rd of November – 6th of December 2006</p>	

The public

Students from schools and universities, scientists, generic audience and VIP visited the exhibitions

<p><i>Mrs Bush at the Library during her visit at the University of Turin (11st of February 2006)</i></p>	<p><i>Bulgarian Republic President and Bulgarian Academy President (BAS) during their visit to the exhibition (July 2006)</i></p>	<p><i>The Nobel Prize in Chemistry 1995 Paul J. Crutzen visiting the exhibition (12th October 2006)</i></p>
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<p style="text-align: center;">Divulgation conferences</p> <p>1) Astronomy at the high mountain observatories</p> <p><i>Mauna Kea Observatory Hawaii 3400 m a.s.l.</i></p> <p>2) From high mountain observatories to space missions</p> <p><i>2006-Experiment on ISS-386 Km a.s.l.</i></p> <p>3) Physiology at high altitude: from Ande to Himalaya</p> <p><i>Himalayan people Ev K2 obs. 5000 m a.s.l.</i></p> <p>4) Angelo Mosso and human physiology</p> <p><i>1900-Experiment at Capanna Margherita 4500 m a.s.l.</i></p>	<p style="text-align: center;">Historical and modern instruments and documents</p> <p><i>Torrilli universale</i></p> <p><i>Boreola Altimeter</i></p> <p><i>Daniel Challenge Documents</i></p> <p><i>Jimmy Phantom DPNs</i></p> <p><i>Erygrate</i></p> <p><i>Angelo Mosso Instrument</i></p> <p><i>Infrared Solar Ray Monitoring - INAF</i></p>
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This exhibition highlights the past and present importance of High Mountain Observatories Network in space and climate research. At the same time it represents a flexible and attractive medium for science communication.

Introduction

Mountains are generally related to sport, art, and travels, but their contribution to the modern science is almost unknown. In the nineteenth century the peaks of the Alps were conquered first by alpinists, and then by scientists, who shared the same passion, the love for challenge, the spirit of sacrifice.

The High Mountain Observatories (HMOs) were established in Europe at the beginning of the modern science (end of 1800) in order to provide European scientists with suitable and unique places to carry out research in various fields, from astronomy, solar physics, meteorology, to physiology. In the course of time, HMOs have become important laboratories for the European Scientific Community, witnesses of the science development and site of historical data collections. The strategic role of HMOs is still today of crucial relevance for the Earth Observation System, with long-term observation and data collection for many scientific fields. The activities performed at the HMOs concern fundamental science as well as studies related to human life and the environmental change.

The first scientific interest was aimed at man, to his capability of endurance: physicians, biologists, physiologists were the first researchers climbing the mountains with a scientific interest. After the discovery of cosmic rays (Hess, 1912) the study of galactic radiation began and the mystery of the origin of the Universe was investigated. Cosmic Ray Physics was the new frontier for high altitude science: at Chacaltaya laboratory (5230 m, Bolivia) G. Occhialini, C. Powell and C. Lattes discover a new particle (1947: the pion). Today, the High Mountain Research Stations, worldwide distributed, allow to perform contemporary investigations on the "Complex Earth System" at various geographic positions and altitudes, in different conditions of atmospheric and geomagnetic field shielding.

The Laboratories represent essential ground-based facilities [1-2], integrated in the system of Earth observation, together with high altitude aircraft for scientific flights (~ 20 Km), stratospheric balloons (~ 30 km), Low Earth Orbit (LEO) satellites (~ 200 km), International Space Station (ISS: 386 km). Many of the High Altitude Research Stations are participating to the Global Atmosphere Watch (GAW) programme, that coordinates the effort of 22 global and some 300 regional atmospheric monitoring stations to produce data that are relevant for the understanding of the climate change. Also the neutron monitor network [3], presently constituted by almost 50 stations worldwide distributed, is based in most of the high altitude laboratories, where the cosmic ray flux is higher, due to the reduced atmospheric layer.

Finally, the HMOs are crucial for the Space Weather Community [4-8], aiming to providing an early alert for dangerous phenomena (e.g. to avoid damages in instrumentation and risks for aircrew health during space missions). Moreover, Solar Neutron Telescopes (based on scintillation detectors) were installed on appropriate HMOs, for the detection of neutrons related to the solar flare occurrence.

Outreach Initiatives

The outreach activities on the HMO topic concern the preparation of exhibitions, divulgation conferences and the participation to various events addressed to general public, with the aim to stress the crucial role of the HMO in the modern science development.

The first exhibition was organized in the framework of the XX Olympic Winter Games held in Turin during February 2006, sponsored by the Organizing Committee of the Olympic Games (Figure 1). A description of 25 HMOs, widely distributed in the mountain regions of Europe, in the Alps, in the Caucasus, in the Carpathians, in Anatolia, in Armenia, and Worldwide, from North and South America, to Japan, to Antarctica, to Hawaii, was presented (see Table 1 and 2). The exhibition is constituted by posters, illustrating the actual research activity in the HMOs, as well as some historical descriptions. Modern and historical instruments are included, kindly given by the *Università di Torino, Osservatorio Astronomico di MPino Torinese (INAF), Observatoire de Paris, Ev-K2-CNR* Committee; also an historical movie from *Istituto Luce* is shown, concerning a visit of Enrico Fermi to the Testa Grigia Observatory at Cervinia (3456 m a.s.l.), in Italy.

The visitors of the exhibition were both scientists and researchers, students of high school and University and general public.

Table 1 - HMOs in the European mountain regions.

Pic du Midi	2887 m	France
Testa Grigia	3480 m	Italy
Regina Margherita	4559 m	Italy
Angelo Mosso	2901 m	Italy
Ottavio Vittori	2165 m	Italy
LNGS Gran Sasso	2150 m	Italy
Jungfrauoch Sphinx	3454 m	Switzerland
Gornergrat	3012 m	Switzerland
Schneefernerhaus	2650 m	Germany
Sonnblick	3106m	Austria
Lomnicky Stit	2634 m	Slovakia
BEO Moussala	2925 m	Bulgaria
ASEC Aragats	3200 m	Armenia
Nor Amberd	2000 m	Armenia
Terskol Peak	3100m	Russia

Table 2 – Some Worldwide HMOs.

Chacaltaya	5280 m	Bolivia
INCAS	3600 m	Chile
White Mountain	4350 m	U.S.A.
Everest Pyramid	5050 m	Nepal
Yangbajing	4300 m	Tibet
Tian-shan	3340 m	Kazakhstan
Dome Concordia	3200 m	Antarctica
Mauna Kea	3058 m	Hawaii
Norikura	2770 m	Japan
Mount Hermon	2025 m	Israel

After the first exhibition, held in Turin during the XX Winter Olympic Games, the description of the HMO activities and their historical development have been presented in many other scientific and cultural events:

- Academy of Science, Sofia, Bulgaria (Exhibition, 3/7/2006 -21/7/2006), Figure 2.
- Bergamo Scienza Festival, Bergamo, Italy (Exhibition, 1/10/2006-15/10/2006), Figure 3.
- Celebration for the physiologist Angelo Mosso, Chieri, Italy (Exhibition, 23/11/2006 - 6/12/2006), Figure 4.
- Science Communication in the BEOBAL Framework, Borowetz, Bulgaria (Workshop, 3-10/3/2007).
- CF2007 - Comunicare Fisica 2007, Trieste, Italy, (Congress, 1-6/10/2007).
- Alps365, Torino, Italy (Conference, 5/10/2007)
- Celebration of the 50 Anniversary of the Sputnik Launch, Paris, France, at Luxembourg Palais (Round table, 9/10/2007).
- Genoa Science Festival, Genoa, Italy (Round table, 26/10/2007), Figure 5.
- ERA (Exhibition of Advanced Research), Trieste, Italy (Exhibition, 17/11/2007-15/12/2007), Figure 6.

Conferences for Divuligation

Divuligation conferences are also organized to illustrate some of the research activities carried out at the HMOs and the historical steps of the HMO science:

- Human Physiology on High Mountain (Prof. Luciano Bernardi, Pavia University),
- Research in 1900: Angelo Mosso at Regina Margherita Observatory (Prof. Cerretelli, Milan University),
- Research at The Everest Pyramid (Dr. Agostino Da Polenza, Ev-K2-CNR Committee),
- Environmental Radiation in high Mountain (Dr. Alba Zanini, INFN Torino),
- Astronomy in High Mountain Observatories (Prof. Attilio Ferrari, Torino University),
- From High Mountain Research to Space Exploration (Dr. Vincenzo Guarnieri, Alcatel Alenia Space),
- Cosmic Rays in Polar Areas – Relations with High-Altitude Measurements (Dr. Marisa Storini, INAF/IFSI-Roma).

Conclusions

The HMO Network represents an unique integrated system for the collection of contemporary atmospheric and cosmic ray data, being of great importance for Earth and Space Weather Science [9-12]. Moreover, the research activities performed at HMOs are suitable as an excellent subject for a general science communication. It makes aware the general public to topics such as climate change, environment protection and sustainable development.

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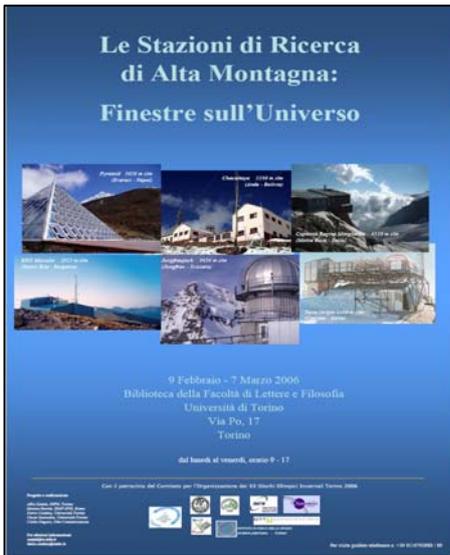


Fig. 1 - Exhibition in Turin, Italy
9/2/2006 -7/3/2006



Fig. 2 - Exhibition in Sofia, Bulgaria
3/7/2006 -21/7/2006



Fig. 3 - Exhibition in Bergamo, Italy
1-15/10/2006



Fig. 4 - Exhibition in Chieri, Italy
23/11/2006 - 6/12/2006



Fig. 5 - Conference in Genoa, Italy
26/10/2007



Fig. 6 - Exhibition in Trieste, Italy
17/11/2007 - 16/12/2007