GLEX-2012-66353

HEMERA: a European Stratospheric Balloon Research Infrastructure

Giulia Mantovani[1]
1 Istituto Nazionale di Astrofisica (IAPS), Rome, Italy, giulia.mantovani@inaf.it

Philippe Raizonville[2], **Sébastien Payan**[3], **Kristine Dannenberg**[4], **David Hagsved**[5], **Stéphane Louvel**[2], **Pietro Ubertini**[1], **Klaus Pfeilsticker**[6], **Felix Friedl-Vallon**[7], **Marta Albano**[8], **André Vargas**[2]
2 Centre National d'Etudes Spatiales (CNES), France, philippe.raizonville@cnes.fr
3 Centre National de la Recherche Scientifique (CNRS), France, sebastien.payan@sorbonne-universite.fr
4 Swedish National Space Acency (SNSA), Sweden, kristine.dannenberg@snsa.se
5 Swedish Space Corporation (SSC), Sweden, david.hagsved@sscspace.com
6 Heidelberg University (UHEI), Germany, klaus.pfeilsticker@iup.uni-heidelberg.de
7 Karlsruhe Institut fur Technologie (KIT), Germany, felix.friedl-vallon@kit.edu
8 Agenzia Spaziale Italiana, Italy, marta.albano@asi.it

Stratospheric balloons are useful platforms for various research and technology needs. They allow to collect valuable data in many science fields, e.g. atmospheric science, astrophysics, biology etc, and they can be used for demonstrations in preparation of new space and Earth observation missions. The HEMERA Research Infrastructure program started in 2018 within the European Horizon 2020 program. Its objectives are to: provide better and coordinated balloon access to the troposphere and stratosphere for scientific and technological research; attract new users to enlarge the community accessing the balloon infrastructure and foster scientific and technical collaboration; enlarge the fields of science and technology research conducted with balloons; improve the balloon service offered to scientific and technical users through innovative developments; favor standardization, synergy, complementarities and industrialization through joint developments with greater cost-effectiveness. This work gives an overview of the project, its current status and the available opportunities for cost free tropospheric and stratospheric balloon flights that HEMERA offers.

I. INTRODUCTION

HEMRA (Friedl-Vallon et al., 2019, Mantovani et al., 2019) is a Research Infrastructure started in January 2018. It is founded by the Horizon H2020 Research and Innovation Programme of the European Union (grant number 730970). The main goals of this programme is to build a large starting community working in the field of stratospheric balloon-borne research and to give access to the existing balloon facilities to all the scientific teams from European Union, Canada and associated countries. The diversities and complementary capabilities of the HEMERA partners allow free and easy service to the scientific community. With HEMERA, a wide range of scientific and technological themes are addressed, starting from atmospheric physics and chemistry, astronomy, biology climate research and space technology.
HEMERA aims at providing trans national access (TNA) to balloon facilities, enlarging and strengthening the network of the balloon science community and improving the technology and scientific instrumentation. Finally, the programme aims at developing a strong synergy with the European Union programme COPERNICUS, and establishing connections with the other European Commission (EC) infrastructures (e.g. ACTRIS, IAGOS).
In order to pursue these goals, HEMERA provides free access to balloon flights for small and medium payloads at no cost. These flights are performed by the Centre National d'Etudes Spatiales (CNES) and Swedish Space Corporation (SSC) with Sounding Balloons (SB) or Zero Pressure Balloons (ZPB). Moreover, all data acquired during the HEMERA campaigns are collected and accessible on the dedicated web portal on www.hemera-h2020.eu.

II. PARTNERS

HEMERA is a project of a large consortium of partners involved in balloon-borne research and near space access providers. It is composed of 13 partners from seven different countries in Europe and Canada, divided in Space Agencies (Centre National d'Etudes Spatiales, CNES in France; Swedish National Space Board, SNSB in Sweden; Agenzia Spaziale Italiana, ASI in Italy; Deutsches Zentrum fur Luft- und Raumfahrt, DLR in Germany; Canadian Space Agency, CSA in Canada), companies operating these balloons and providing hardware (Swedish Space Corporation, SSC in Sweden;

Andoya Space Center, ASC, in Norway; Airstar in France) and scientist from research institute (Centre National de la Recherche Scientifique, CNRS, in France; Karlsruhe Institut fur Technologie, KIT in Germany; Istituto Nazionale di Astrofisica, INAF in Italy; Heidelberg University, UHEI in Germany; Cranfield University, CU in UK).
Figure 1 shows the location of the 13 HEMERA partners, which are mostly European and from Canada.

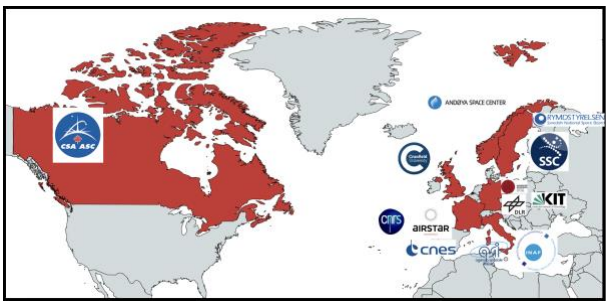

Fig. 1: HEMERA partners among space agencies, space access providers and scientific bodies, such as research centres and universities.

III. HEMERA BALLOONS

HEMERA gives the possibility to all users to fly their instruments on two different types of balloons: Sounding Balloons and Zero Pressure Balloon. These types of balloons allow to fly in the troposphere and stratosphere and collect data related in different science fields. Starting from Earth observations, it is possible to study the chemistry and dynamics of the stratosphere, but also astronomical and astrophysical data can be retrieved. Hereafter, SB and ZPB balloons characteristic will be presented.

Sounding Balloons

Sounding Balloons are the smallest type of balloons provided by the programme (Figure 2).

Fig. 2: Sounding Balloon provided by the HEMERA programme.

The maximum weight of the payload allowed to fly is 3 kg and the balloon will reach the maximum altitude of 30 km. The time of the flight is relatively short of about 2 hours.
Figure 3 shows the graphics of the altitude in meters as a function of time in minutes of the Sounding Balloon flight. The ascent is slower compare to the one of the ZPB and the payloads are not always recovered.

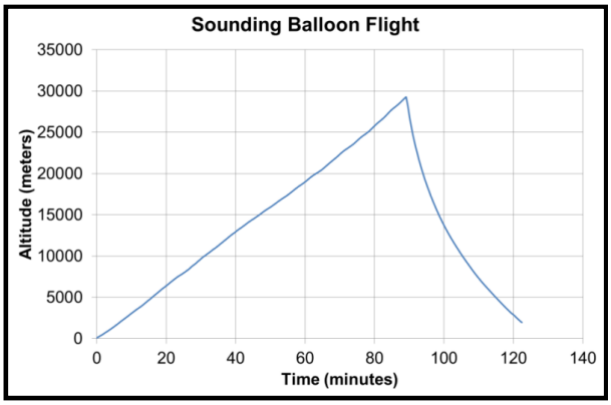

Fig. 3: The plot shows the altitude in meters as a function of time in minutes of the SB provided by the HEMERA programme.

Zero Pressure Balloons

These type of balloons are bigger than the SB and allow a payload of up to 150 kg. The instruments are integrated in a gondola provided by SSC or CNES and are always recovered thanks to the presence of a parachute between the balloon and the gondola.

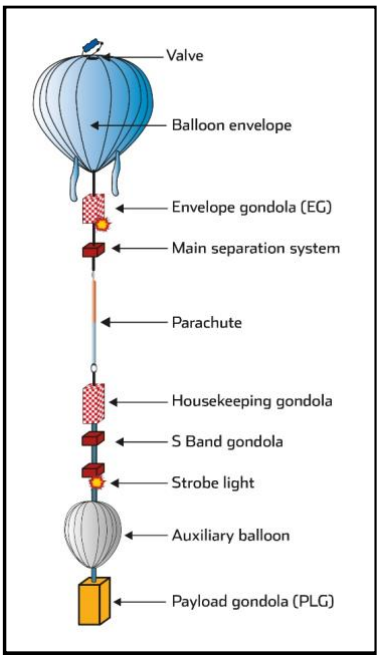

Fig. 4: Scheme of a Zero Pressure Balloon provided by the HEMERA programme

Figure 4 shows a scheme of the ZPB used within the HEMERA programme.
The flight altitude reached with this balloons is up to 40 km and the time of the flight can be up to 24 hours or more, depending on the launch site and seasons. Figure 5 shows the graphics of the altitude during the flight as a function of time in hours for a typical HEMERA flight.

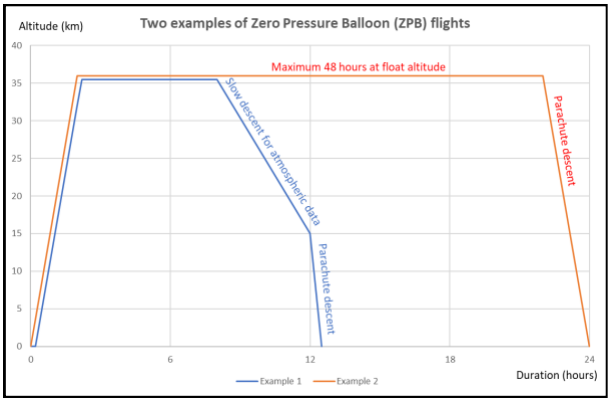

Fig. 5: The plot shows the altitude reached by the ZPB as a function of the time of flight.

III. HEMERA LAUNCHING SITES

Three different launch sites have been selected to be used within the HEMERA programme: Esrange in Sweden, Timmins in Canada, Ontario and Aire Sur l'Adour in France. Figure 6 shows the location of those sites.

Fig. 6: Location of the HEMERA launching sites.

The HEMERA consortium is considering a new launch site in Trapani-Milo in the southern part of Italy. This site will allow medium latitude flight with a typical 24 hours flight duration. The direction of those flights will be toward Spain during summer and toward Turkey in winter.

Esrange (Sweden)
Esrange is the launch site of the Swedish Space Corporation located in the north part of Sweden. It is conducting balloon flights since 1974. Its position offers flights in air space with low traffic density and over a sparsely populated area.

Timmins (Canada)
This site has been selected in 2012 as the Canadian ZPB launch site. It has a favourable latitude, wind and weather conditions, together with low population density in the surroundings and optimal on-site infrastructure.

Aire sur l'Adour (France)
This is the main base of CNES launch and is conduction flights since 1960s. It is located in the southwestern part of France and it is the base for the CNES balloon operations team.

IV. HEMERA FLIGTHS AND CAMPAIGNS

HEMERA plan 6 flights with ZPB, performed by SSC and CNES, and 20 flights with SB performed by CNES from Aire sur l'Adour. The gondolas are provided by SSC and CNES and allow up to 150 kg of weight for ZPB.
Two different campaigns have been performed so far, in 2019 and 2021. The third one has been postponed to 2022 due to COVID pandemic restrictions during 2020.

On the begging of September 2021, the last flight of the 2021 campaign has been successfully launched from the Esrange launch site. The gondola carried 6 different payloads selected within the second Call For Proposals (see Section V, Albano et al., 2021). The flight was very successful and all the instruments were recovered without any damage. Data from the payloads are now under analysis. We present a sneak peek of the preliminary results of the GRASS experiment (Gamma-Ray Astronomical Small Sensor). This is an INAF (Italian National Institute for Astrophysics) instruments, supported by the HEMERA programme, ASI and AHEAD, led by Dr. Lorenzo Natalucci. GRASS is a small, innovative gamma-ray detector aimed at measuring the parameters of the cosmic and atmospheric background in the north pole region. This is fundamental to correctly analyse the high energy data. Figure 7 shows the graphics of the count rate detected by GRASS during the balloon flight. The instrument has been shutdown at an altitude of ~24km during the descent phase.

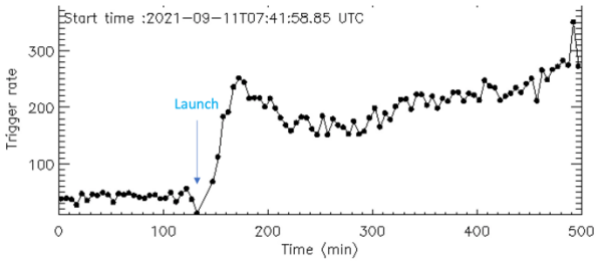

Fig. 7: GRASS count rate during the flight.

The next and last campaign is expected to be in Autumn 2022, just before the end of the programme.

V. CALL FOR PROPOSALS

The selection of the payloads to be flown on the balloons has been done through two Call For Proposals. In these calls, all users who wanted to fly their instruments submitted a proposal with details of the payloads and the science they planned to achieved. The response to the Calls has been important with a medium of 25 proposals each call.

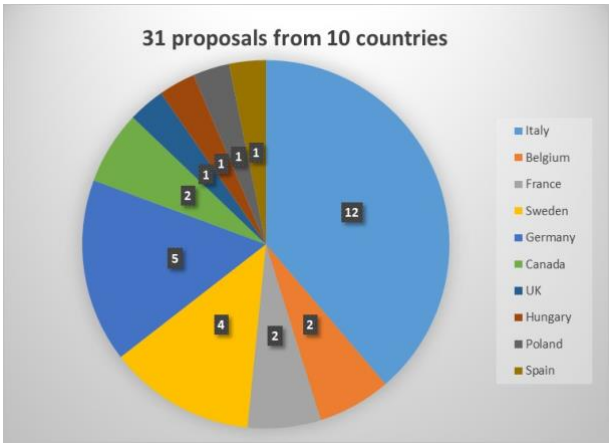

Fig. 8: Proposals received during the second HEMERA Call For Proposal.

For the Second Call For Proposal (see Fig. 8), 31 proposals have been received from 10 different countries. Science fields of these were various: atmospheric science (10 proposals), astrophysics and planetology (4 proposals), radiation and biology (3 proposals), technical research (7 proposals), educational experiments (5 proposals). Most of the principal investigator of the proposals asked to participate in ZPB flights. Half of the proposals were selected by an independent international Peer review group.

VI. HEMERA EVENTS

Two events were planned during the programme time frame: the HEMERA Summer School and the HEMERA Workshop.

The Summer School has been organized in September 2019 in Heidelberg and opened to advanced master students, PhD students and young scientists interested/involved in balloon research, technicians and engineers from the participating agencies and industries. Themes covered during the lectures of the school were:

- The history, early and modern balloon science and industrial opportunities, recent advances and discoveries.
- The atmospheric environment.
- The general logistics of balloon types, flight control, limitations of the ballooning environment, launching techniques and regulations.
- Specific scientific and industrial ballooning operations of the agencies.
- More detail on modern scientific results from ballooning and the instruments involved.
- Future work, opportunities and measurements.

The HEMERA workshop was postponed due to COVID lockdown and restriction. It is now planned to be organized in Rome in Spring 2022. The programme together with the balloon flights results will be presented. Further information about the workshop will be included the HEMERA website www.hemera-h2020.eu.

VII. CONCLUSIONS AND FUTURE PROSPECTIVE

HEMERA is a Research Infrastructure funded within the Horizon 2020 programme by the European Union in 2018. It aimed at integrating a large starting community in the field of tropospheric and stratospheric balloon-borne research. It makes existing balloon facilities available to all users from the European Union, Canada and associated countries. HEMERA offers tropospheric and stratospheric balloon flights at no cost for small to medium payloads.
The programme was extended for a time frame of 10 months by the European Union due to COVID pandemic restrictions and it will end in October 2022 with the last launch campaign in autumn of the same year. Proposals are now evaluated and prepared by the consortium in order to ensure to the European countries and infrastructure for near space, which allows science and technology development.

References

Friedl-Vallon et al., 2019, Stratospheric balloons: low-cost platforms for science and technology development, Proceedings of the SPIE, Volume 11180, id. 111807J 8 pp. (2019)

Albano et al., 2021, HEMERA: The European International Stratospheric Balloons Research Infrastructure, AIDAA in press.

Mantovani et al. 2019, HEMERA: new science opportunities using tropospheric and stratospheric balloons, Memorie della Società Astronomica Italiana, v.90, p.132 (2019)

Acknowledgments

G.M. acknowledge support from the Istituto di Astrofisica e Planetologia Spaziali (INAF-IAPS) via EU grant N. 730970