

THE FRENCH RESEARCH FEDERATION FOR NANOSATELLITES IN UNIVERSE AND EARTH SCIENCES

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Abstract. In January 2023 a research federation for nanosatellites in Universe and Earth sciences was created in France. It includes ~130 members from 14 different laboratories and space centers in the Paris region, and it is planned to be extended in the future to the rest of France. The goal is to organize this community, share technical, financial, and human resources, and better communicate within the community and outside, to be more efficient at developing robust scientific nanosatellites.

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1 Context

Over the last ten years, more and more French laboratories have developed scientific nanosatellites or technologies for such satellites. More and more projects are under study, and more and more universities have their own space center for nanosatellites. This is particularly true in the Paris region. These laboratories and space centers often develop similar tools and technologies, face the same challenges, but unfortunately do not communicate much with each others. This is why the need for a research federation emerged. This federation, called Research Federation for Nanosatellites in Universe and Earth Sciences (or Nanosats Federation) initially concentrates on the Paris region, but it is planned to be extended to the rest of France in a few years.

2 Organization

The Nanosats Federation* has six governing bodies: CNRS, Paris Observatory, Ecole Normale Sup erieure, Sorbonne University, Universit  Paris Cit , and Universit  Paris-Est Cr teil (UPEC). It includes 14 CNRS entities (mostly laboratories) and space centers: LESIA, IMCCE, LERMA, LP-ENS, APC, IPGP, LISA, IAP, LATMOS, Observatoire de Paris, CENSUS (the space center of the PSL university), PSUP (the space center of Universit  Paris Cit ), CS-UPEC (the space center of UPEC), and CurieSat (the space center of Sorbonne University). About ~130 people from these 14 entities are currently registered as members of the federation. Additional employees of these 14 entities can join the federation every year, other entities from the six governing bodies in the Paris region will likely be able to join in 2025, other entities in France should be able to join in 2028.

The federation is led by its director (C. Neiner) and co-director (G. Hulot), with the help of a steering committee and a council. The steering committee is composed of representatives of the six governing bodies, one representative from the French space agency CNES, two representative from academia, four representative from industry, one observer from ONERA, and the federation directors. Its role is to define the strategic directions the federation should follow and it typically meets once per year. The council is composed of six elected and four nominated persons among the members of the federation, and the directors. Its role is to coordinate the actions of the federation and it typically meets every three months.

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*<https://federation-nanosats>

3 Goals

The goals of the Nanosats Federation is to organize the community of the various participating laboratories and space centers. For this we plan to share technical resources, such as test facilities, components off-the-shelf (COTS), pieces of home-made hardware or software. The federation has its own budget which will also allow us to buy common equipment, fund meetings, and publish calls for the community. Ultimately we hope that the various laboratories and space centers will also share human resources, e.g. having an engineer from one laboratory help on a specific task for a nanosatellite project from another laboratory which would not have the required expertise or available manpower otherwise.

In addition, we aim to improve communication and collaboration amongst the community with dedicated workshops, project reviews, common answers to calls, etc. We will also be active in making this community more visible and known to our potential partners, e.g. industrials, and funding agencies.

The final goal is to be more efficient in the development of more robust scientific nanosatellites.

To reach these goals, we have already set up working groups dedicated to specific topics of interest for the federation and its community. In particular, a group is working on the pooling of test facilities: census of existing and already shared resources, of existing resources that could be pooled, and on missing resources that should be bought. Another group is working on interconnecting ground stations of the various entities of the federation and their partners, including industrial partners. Several other working groups are currently being set up, e.g. on sharing technological developments and on having a common catalog and open library of COTS available in our laboratories and space centers.

4 Ongoing nanosatellites projects

Three scientific nanosatellites have already been launched by entities participating in the Nanosats Federation:

- PicSat[†] was launched by LESIA in 2018 with the aim to detect the transit of an exoplanet around the star β Pic and demonstrate tracking with a mono-mode fiber. The science goal was not reached, first because of pointing issues and then because of a high-energy proton hit above the South Atlantic Anomaly that causes hardware damage, but the technological demonstration with the mono-mode fiber succeeded.
- UVSQ-Sat[‡] was launched by LATMOS in 2021 to demonstrate technologies for broadband measurements of Earth radiation budget and for solar spectral irradiance in the Herzberg continuum (200 – 242 nm). It is still flying and providing data.
- Inspire-Sat 7[§] was launched by LATMOS in 2023. It will contribute to the science of UVSQ-Sat but also measure perturbations in the ionosphere of the Earth.

Many more nanosatellite projects are currently under study within the federation. A non-exhaustive list of examples in solar system, astrophysics, and Earth science domains is provided here:

- BIRDY for the exploration of the internal structure of small bodies
- Meteorix for the detection and characterization of meteors and space debris
- TeraCube for the study of planetary atmospheres at THz radio frequencies
- Vamos for the seismic activity of Venus
- NOIRE for radio-interferometric imaging with a swarm behind the Moon
- CASSTOR for UV spectropolarimetry of hot stars
- CosmoCal for the calibration of ground-based and space-based cosmic microwave background measurements
- CIRCUS for the study of the ionospheric dynamics of the Earth

[†]<https://picsat.obspm.fr>

[‡]<https://www.uvsq.fr/uvsq-sat>

[§]<https://www.uvsq.fr/inspire-sat-7>

- IGOSat for the characterization of the gamma environment and high-energy electrons in the South Atlantic Anomaly
- NanoMagSat for the Earth magnetic field
- OGMS-SA for radiations studies in low altitude orbits and testing of safe softwares
- MacroPlastic for the cartography of macroplastics in Earth oceans

These nanosatellites will allow for very diverse and competitive science as well as technological innovation.

5 Conclusions

The Research Federation for Nanosatellites in Universe and Earth Sciences only started in January 2023 and already includes ~ 130 members from 14 laboratories or space centers from the Paris region. In the near future the Nanosats Federation will be open to more French entities. Sharing efforts and resources will allow us to more efficiently develop nanosatellites for solar system studies, astrophysical research, and Earth investigations. French entities wishing to join the Nanosats Federation are encouraged to contact the federation director[¶].

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