

EARTH SCIENCES - SCIENCES DE LA TERRE

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→ *The fact that satellites can scan the Earth in just a few hours or observe certain points on the globe on a permanent basis makes them an extraordinary tool for monitoring the planet's health.*

Their extremely precise measurements enable us to determine the planet's current status, and to learn more about its ongoing evolution and the interactions between its component envelopes, from the Earth's core to the highest layers of the atmosphere. Combining satellite observations with *in situ* measurements (from the ground, balloons, aircraft and buoys, etc.) and physical models enables forecasts to be made of certain geophysical phenomena, such as in meteorology or oceanography with the Mercator sea-state forecasting system. The issues of human impact on the environment, climate change, the management and mitigation of major catastrophes, etc. are just some of the challenges faced by current and future generations, and satellites play an essential role in this quest for knowledge and for sustainable management of the environment. CNES, alongside its European and international partners, contributes through multilateral cooperation by participating in major European programs such as GMES (Global Monitoring for Environment and Security), now renamed *Copernicus*, and through international coordination activities, particularly within CEOS (Committee on Earth Observation Satellites), the space component and "strong arm" of the major international GEOSS program (Global Earth Observation System of Systems). CNES has superseded NASA as the 2014-2015 CEOS Strategic Implementation Team (SIT) Chair.

■■■ The main French and European achievements in Earth Observation in 2012-2013

Successful launches

2012 was a particularly successful year in the field of meteorology. On July 5, EUMETSAT's third Meteosat Second Generation (MSG-3) was launched in geostationary orbit, followed by METOP-B in a low orbit on September 17. The latter was carrying IASI, an infrared sounder developed by CNES in partnership with EUMETSAT. On December 2, 2012, the second of the two PLEIADES high-resolution optical Earth-imaging satellites (70 cm at nadir) was launched one year after its predecessor, thus enhancing our monitoring capacity. On February 25, 2013, CNES and ISRO launched the satellite SARAL, carrying the ARGOS system and the Ka-band altimetry system, ALTIKA. Lastly, ESA's three SWARM satellites, aiming to measure the Earth's magnetic field, were launched on November 23, 2013, carrying three absolute magnetometers developed by LETI/CEA and provided by CNES.

Balloons campaigns

The French scientific community is involved in a project around the Mediterranean basin. Two balloons campaigns took place in 2012: the BAMED campaign dedicated to hydrology from the Balearic Islands and the TRAQA campaign, launched from the Seychelles, on the origin and impact of particles.

The European GMES (Global Monitoring for Environment and Security) program/Copernicus

GMES, a European Union program set up to meet the needs for operational service for carrying out environmental and security policy, has become the *Copernicus* program and will be financed by the EU from 2014 to 2020.

ESA ministerial Council in Naples

The Council was held late 2012 and included calls for proposals on three ESA's Earth Observation programs:

- (i) the fourth phase of the Earth Observation Envelop Program, aiming to develop BIOMASS, which was selected in May 2013 as the seventh *Earth Explorer* Mission;
- (ii) the third segment of the GMES/*Copernicus* space component, dedicated to the development of SENTINEL-5 for air quality – which will be carried by METOP-Second Generation (METOP-SG) – and of the altimetry mission JASON's continuation, on JASON-CS;
- (iii) METOP-SG in partnership with EUMETSAT for low orbit meteorology.

Mission operations

Data from the SPOT-5, JASON-2 (with EUMETSAT), CALIPSO (with NASA), IASI on METOP-A and B (with EUMETSAT), SMOS (with ESA and CDTI), CRYOSAT (with ESA) and MEGHATROPIQUES (with ISRO) missions is still being exploited. Many missions were completed in 2013, giving us complete satisfaction. SPOT-4's end-of-life operations led to the TAKE 5 experiment for a few months, to simulate SENTINEL-2 by increasing the revisit of certain spots. Early July, contact with JASON-1 was lost. The satellite was already in its graveyard orbit and had perfectly operated for 11 years. Due to its particularly low altitude, GOCE, dedicated to the study of the gravity field, gave in to gravity and its missions came to an end on November 2013, while burning in the atmosphere. PARASOL, designed to study the properties of clouds and aerosols, was deactivated in December, thus completing an almost 9-year operation.



Fig. 1

A national think-tank was commissioned to give some advice on the future of CNES's thematic units. It recommended the creation of four units:

- (i) Solid Earth, which is currently being set up and will be called FORM@TER,
- (ii) an Ocean unit (which is being considered),
- (iii) a Continental Surfaces unit, which already exists and is called THEIA,
- (iv) an Atmosphere unit, which will be created from the merger of two existing units: ETHER, for the study of atmospheric composition, and ICARE, for the investigation of clouds, aerosols, radiations and the water cycle.

Future prospects

GMES/Copernicus, a critical year

SENTINEL-1A was successfully launched on April 3, 2014. ESA is carrying on the development of SENTINEL-1 to 4, units A and B, which were given the green light at the ministerial councils of Berlin in 2005 and The Hague in 2008, as well as the precursor, SENTINEL-5. The second phase of GMES's third segment was opened to contributions by the States Members until June 2014 (in addition to the grant provided during ESA ministerial Council in Naples in 2012), to enable SENTINEL-5 and JASON-CS to enter Phase B2. *Copernicus* regulations will be approved in 2014 and it will mark the official start of *Copernicus* with the EU contribution. SENTINEL-3A and 2A should be launched in 2015 and SENTINEL-1B, early 2016.

Preparing the future

CNES projects (VENµS with Israel and CFOSAT with China) are still in development. IASI-NG, in partnership with EUMETSAT,

will be carried by METOP-SG to provide meteorologists with atmospheric and humidity profiles and researchers with valuable data on the chemical composition of the atmosphere and the climate. It has entered Phase B late 2013. MERLIN, Myriad Evolutions microsatellite, will carry a lidar to assess the concentration of atmospheric methane. It will enter Phase B late 2014. SWOT, a cooperation mission with NASA whose aim is to measure the level of oceans and inland waters with unprecedented accuracy, continues its Phase A with the help of financing from a future-investment funding program, under the major loan process initiated by the French government. Regarding atmospheric sciences, a campaign involving the launch of BSO balloons will take place in Canada in 2014.

Scientific Prospective Seminar in La Rochelle (France)

The CNES Scientific Prospective Seminar took place from Mars 17 to Mars 20, to identify new scientific priorities for the next decade.

Next launching

JASON-3 (with EUMETSAT, NOAA, NASA and backed by the European Commission) will be launched in Mars 2015. ADM/AEOLUS (ESA) should be launched by the end of 2015.

[Fig. 1]

*Artist view of SENTINEL-1.
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