CNES Earth Science Program Overview

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Protecting the Earth by observing it from space

When combined with *in situ* observations and numerical simulations, satellite observations help us understand, monitor and predict the state of the planet so that we can adapt to climate change, locally and globally.

- Atmosphere/Weather/Climate
- Oceanography/Hydrology
- Coastal
- Crodosphere
- Land surfaces
- Earth/Environment
- Solid Earth/Geodesy/Geomagnetism
- International Charter on Space and Major Disasters

- COP21 and Climate Change
- Agenda 2030 / Sustainable Development Goals
- Sendai; Disasters and Extreme Events
A consistent set of actions aiming at covering all facets of the Earth System

Collaborations / Partnerships

Necessary combination of satellite + in-situ + model data

From upstream (R&T) to downstream (applications)

Guidance on strategy and level of support provided by scientific committees (CPS / TOSCA)
3 recognized areas of excellence

**Imaging**
- SPOT
- Helios
- Pléiades
- Venus
- Trishna
- CO3D

**Altimetry**
- TOPEX-POSEIDON
- JASON 1, 2 and 3
- ALTIKA-SARAL
- SWOT
- CFOSAT

**Sounding the atmosphere**
- Parasol
- Calipso
- IASI
- Megha-Tropiques
- Microcarb
- IASI NG
- Merlin
Programmes being prepared or developed

<table>
<thead>
<tr>
<th>Year</th>
<th>Programmes</th>
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<tbody>
<tr>
<td>2019</td>
<td>Hemera 1&amp;2</td>
</tr>
<tr>
<td>2020</td>
<td>Biomass</td>
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<tr>
<td>2021</td>
<td>Merlin</td>
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<tr>
<td>2022</td>
<td>Swot</td>
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<tr>
<td>2023</td>
<td>Strateole 2-1</td>
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<td>2024</td>
<td>Trishna</td>
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<tr>
<td>2025</td>
<td>IASI-NG1/Metop SG A1</td>
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<td>2026</td>
<td>3MI/Metop SG A1</td>
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<td>2027</td>
<td>IASI-NG1/Metop SG A2</td>
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<td>2028</td>
<td>3MI/Metop SG A2</td>
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**OBSERVATION**
Challenges in Earth Sciences

- Continuity of data
- New measurements
- Complementarity in-situ - satellite - models
- Increased needs for precision, resolution, revisit time
- Systemic approach (Earth major cycles)
Priority missions for Earth Sciences

**TRISHNA**
Infrared imaging for monitoring water and vegetative cycles

**ACCP: Mescal and C²OMODO**
Aerosol and Cloud, Convection and Precipitation observing systems

**ULID -> SMOS Next**
Feasibility of high-resolution soil moisture measurements

**NanoMagSat**
Geomagnetic observation, from the Earth’s core to space weather

**C³IEL**
4D study of convective clouds

**BIODIVERSITY**
Hyperspectral imaging for studying biodiversity

**MARVEL**
Climate system monitoring using differential gravimetry

**SKIM**
Ocean surface currents monitoring

Marvel
COOPERATION – A global ambition and a key Driver

CNES has adopted a global perspective in making cooperation a key element of its strategy since its inception.

CNES partnerships with other agencies are founded on a relationship of trust, built at the highest levels over many years.

Cooperation with NASA

- 25 years of cooperation in Altimetry Field -> SWOT
- Calipso + A-Train
- ACCP (Mescal and/ or C²OMODO), Mass Change (Marvel)

Cooperation CNES-ISRO

- Megha-Tropiques
- SARAL
- TRISHNA

Cooperation CNES-CNSA

- CFOSAT
- Water Cycle : SMOS Next

Cooperation CNES-ISA

- Venμs
- C³IEL

Cooperation could be sought at academic and industrial

Mock-up of the Eyesat nanosatellite presented by a student from the Janus programme
TRISHNA Mission

- TRISHNA: Thermal infraRed Imaging Satellite for High resolution Natural resource Assessment
- CNES ISRO Cooperation since 2011 (Megha-Tropiques, Altika-Saral)
- CNES Board Decision, March 12th, 2020 to proceed with Phase B,C,D,E1
  - 2 Primary objectives: Agriculture & Coastal Hydrology
    + Urban, Cryosphere, Atmosphere, Solid Earth
  - Global coverage @ 57 m resolution for continental and coastal areas, binned at 1 km over open ocean.
  - 4 TIR bands (NeDT 0.2K) + 4 VNIR bands + 2 SWIR bands
  - 3 Global acquisitions per 8 days period
  - 761 km-8day orbit reducing hot spot constraints in intertropical zone
  - ± 34° scan angle, 1030 km swath, Overpass time: 1 PM ± 15 mn
- Indo-French(*) science mission group, synergies Under development with ECOSTRESS, SBG, LSTM science & application teams, + other European contributors

Launch scheduled 2025

Ground surface temperature and daily evapotranspiration
Small Satellites - Missions under study

C3IEL – Cluster For Cloud Evolution Climate And Lightning
Subject area: Meteorology --- Concept: formation flying – swarm

French-Israeli mission (CNES-ISA) under study since 2018.

Objective: observe clouds in 3D in order to provide measurements of vertical velocities at the top of convective clouds; of interest for weather and climate models. Phase A decided and workshare cooperation agreed

ULID – Unconnected L-Band interferometer Demonstrator
Subject area: Soil moisture and ocean salinity
Concept: formation flying --- swarm demonstrator 3 nanosatellites

Objective: demonstrate the ability for the SMOS follow-on mission to perform interferometric measurements in L-band with unconnected payloads. Phase A ended
SMASH – SMall Altimetry Satellite for Hydrology
Subject area: Nadir altimetry for inland hydrology (lakes and rivers)
Concept: constellation – 10 nanoaltimeters in K_a-band

Objective: nadir altimetry mission providing a daily revisit capability
Phase A : on going