CNES-ISRO COLLABORATIONS IN EARTH OBSERVATION :

MEGHA-TROPIQUES, SARAL, TRISHNA AND THE SPACE CLIMATE OBSERVATORY (SCO)

PIERRE TABARY

PROGRAMME MANAGER FOR ATMOSPHERE, METEOROLOGY AND CLIMATE

CNES, DIRECTORATE FOR INNOVATION, APPLICATIONS, SCIENCE

20TH OF NOVEMBER, 2018

ISPRS EVENT ASIDE ISPRS TC V MID TERM SYMPOSIUM : INTERNATIONAL COOPERATION IN EARTH OBSERVATION

CNES in brief

- CNES = French Space Agency
- Founded in 1961 under the impulsion of the Général de Gaulle
- CNES is placed under the authority of two ministries : Defense and Research
- About 2500 staff located on 4 sites (Paris Les Halles, Paris Daumesnil, Toulouse, Kourou)
- 5 main fields of activity : Launchers / Earth Observation / Science / Telecoms / Defense

→ CNES is responsible for proposing and implementing France's space policy at national, European and international levels

→ CNES is also a systems architect and a technical centre responsible for innovating, designing and developing new space systems

CNES
and its Partners

Supervisory ministries

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

Min. of National Education, Higher Education and Research

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

Ministry of the Armed Forces

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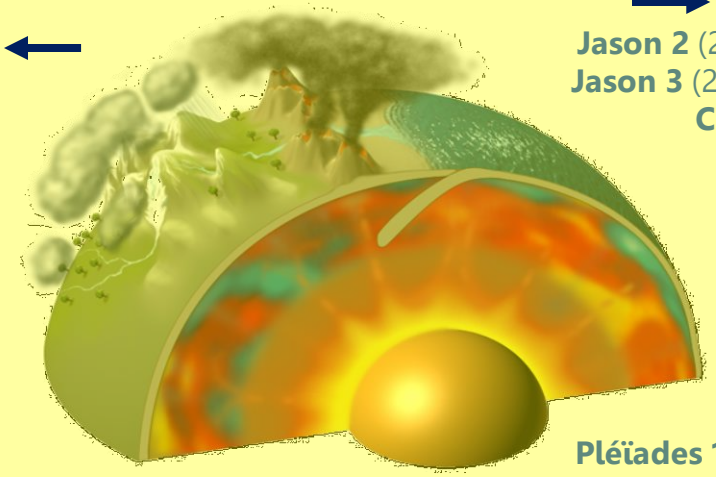
- Ministries:
  - for Ecological and Inclusive Transition
  - for Europe and Foreign Affairs
  - for Social Welfare and Health
  - for the Interior…
- General Commissariat for Investment (CGI)
- National research organisations & Science Laboratories
- International partners (DLR, NASA, JAXA, ROSCOSMOS, CNSA, ISRO, ISA, etc.)
- EUMETSAT
- European Union (Galileo, H2020, Copernicus)
- European Space Agency (ESA) – France, leading contributor, is represented by CNES
- Other space users
- Industry

Overview of the CNES missions in Earth Observation in developpment or operation

Atmosphere
Calipso (2006-) with NASA
Megha-Tropiques (2011-) with ISRO
IASI-A (2006-) with EUMETSAT
IASI-B (2012-) with EUMETSAT
IASI-C (2018) with EUMETSAT
Strateole2 (2018-2024)
Merlin (2021) with DLR
Microcarb (2020) with UKSA
IASI-NG (2021) with EUMETSAT

Solid Earth
SWARM (2013-) with ESA



Ocean
Saral (2013-) with ISRO
Jason 2 (2008) with EUMETSAT NASA NOAA
Jason 3 (2016-) with EUMETSAT NASA NOAA
CFOSAT (2018-) with CNSA

Ocean & Continental Surfaces
SMOS (2009-) with ESA
SWOT (2021) with NASA, CSA, UKSA
TRISHNA (2024) with ISRO

Continental Surfaces
Pléïades 1A (2011-) with several european partners
Pléïades 1B (2012-) with several european partners
Venus (2017) with ISA

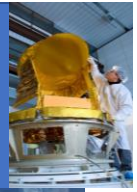
→ A diversity of partners : NASA, EUMETSAT, DLR, ESA, CNSA, ISRO, ISA, …

→ All components of the Earth System are adressed, and their interactions

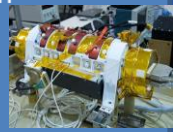
The CNES EO programme also includes contributions to strategic in-situ infrastructure (aircrafts, balloons, observatories, data centres, buoys) and models, phase 0/A studies, R&T, development of applications, support to research activities, …

MEGHA-TROPIQUES

MADRAS: 5 chanels (H/V) 18,7GHz - 23,8GHZ - 36,5GHz - 89GHz -157GHz Stopped in January 2013; 18 months of data.



SCARAB : 4 chanels
-Visible 0,5 à 0,7 µm
-sun 0,2 à 4 µm
-Total 0,2 à 200 µm
-infrared
10,5 à 12,5 µm



SAPHIR: calibration at each scan; 6 bands around the H2O line at 183.31GHz

3 hurricanes observed simulatneously in the Caribbean in 2017

- Mission aiming at studying of water and energy cycle in the tropics
- Launched on the 12th of October 2011. Mission extended to at least 2021
- Part of the **Global Precipitation Mission (GPM) constellation** with NOAA, NASA, JAXA, EUMETSAT
- The mission supports convective process, hydrological and climate studies and operational numerical weather prediction
- The orbit allows a coverage of the tropical zone between 23 °N and 23 °S, each point being revisited 2 to 6 time a day (→ diurnal cycle)
- ISRO → Satellite
- CNES → Saphir & Scarab instruments

MEGHA-TROPIQUES
A GREAT SUCCESS FOR NUMERICAL WEATHER PREDICTION

Consistent beneficial impacts of **SAPHIR** data found across 9 NWP centers, in particular on Tropical wind forecasts (up to 4 days ahead) for centers using a 4D assimilation system.

List of NWP centers assimilating SAPHIR data operationally

Numerical Weather Prediction Center	Assimilation method for SAPHIR	Associated Publication
European Centre for Medium-Range Weather Forecasts (ECMWF)	All-sky	Chambon and Geer, 2017
Fleet Numerical Meteorology and Oceanography Center (FNMOC) – US Navy	Clear-sky	Jones et al., 2017; Karpowicz et al., 2017
Japanese Meteorological Agency (JMA)	Clear-sky	Kazumori, 2016
Joined Center for Satellite Data Assimilation (JCSDA)	Clear-sky	Jones et al., 2017
Korea Meteorological Administration (KMA)	Clear-sky	Lee et al., 2018
Météo-France	Clear-sky	Chambon et al., 2015
National Center for Environmental Prediction (NCEP)	Clear-sky	Jones et al., 2017
National Centre for Medium Range Weather Forecasting (NCMRWF)	Clear-sky	Singh et al., 2017
UK Met Office	Clear-sky	Doherty et al., 2018

SARAL

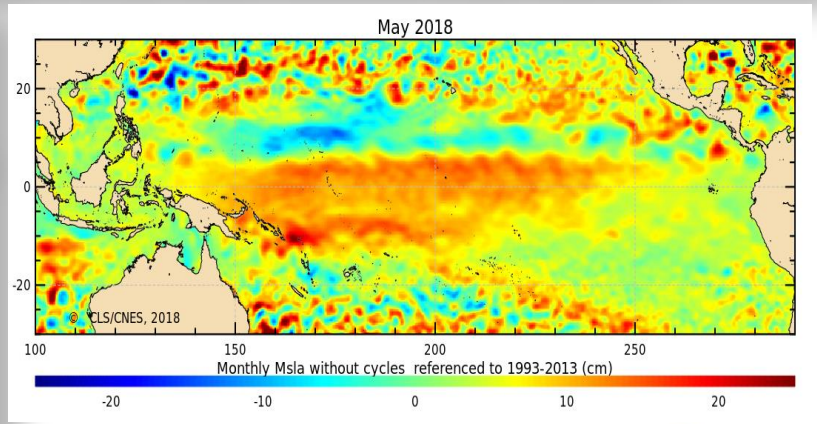
- Cooperation between CNES (France) and ISRO (India)
- Launch date: February, 25th 2013
- Nominal end of the mission: 2020

Mission objectives: High-precision Altimetry and ARGOS

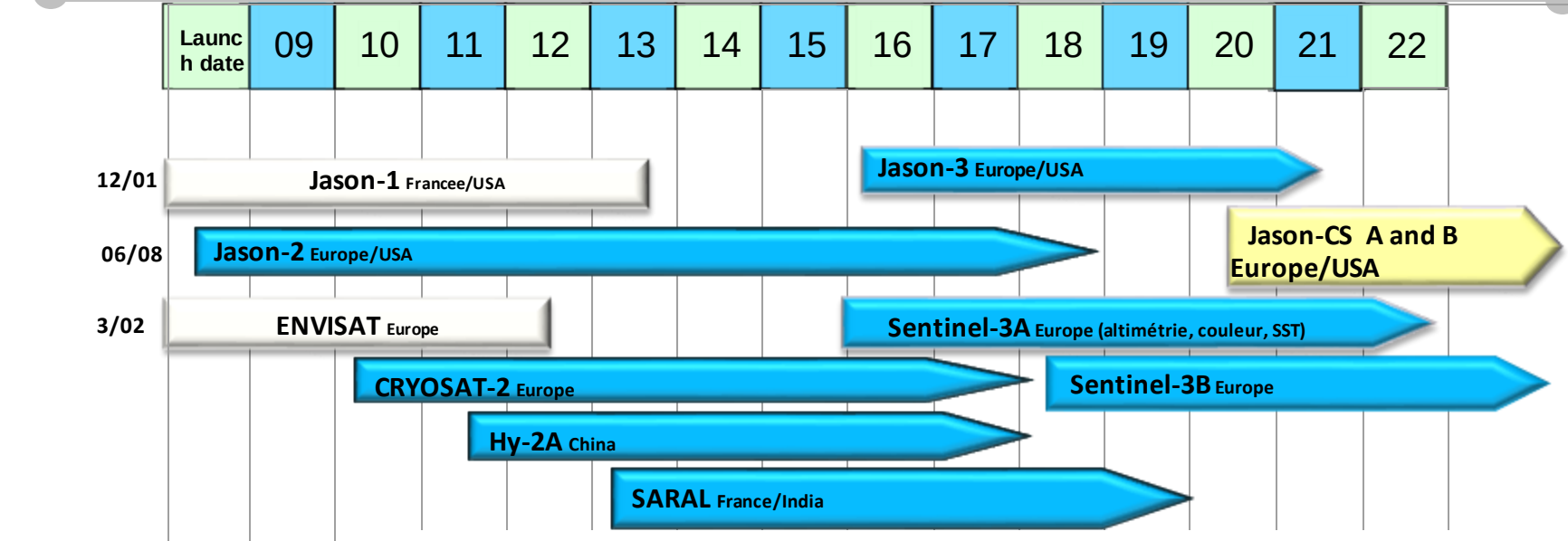
- The AltiKa altimeter provides a continuity to the ocean, inland water, sea and land ice topography time series that were initiated in the nineties with the ERS and ENVISAT missions from ESA
- The ARGOS3 payload complements the constellation which gives a precise localization of thousands of ARGOS beacons for a wide range of applications and carriers (e.g. ships, scientific boys, wildlife)

Main features of SARAL

- Ka-band altimeter demonstrator: unique precision and resolution of the topography, wave height and wind-speed measurement
- High quality of altimeter and radiometer corrections in coastal regions from instrument design
- Unprecedented drifting orbit for very high precision geodetic products (e.g. bathymetry & mean sea surface)



Value of Saral in the Ocean Surface Topography Virtual Constellation



SARAL in OST-VC

- Key contribution to OST-VC
- High latitude coverage
- Filling the critical Gap between ENVISAT and Sentinel-3

SARAL as a « world premiere » (Ka-band Altimetry) :

- New capacities: coastal, inland, ice
- Very good performance over oceans
- Asset for future missions : SWOT, SKIM …

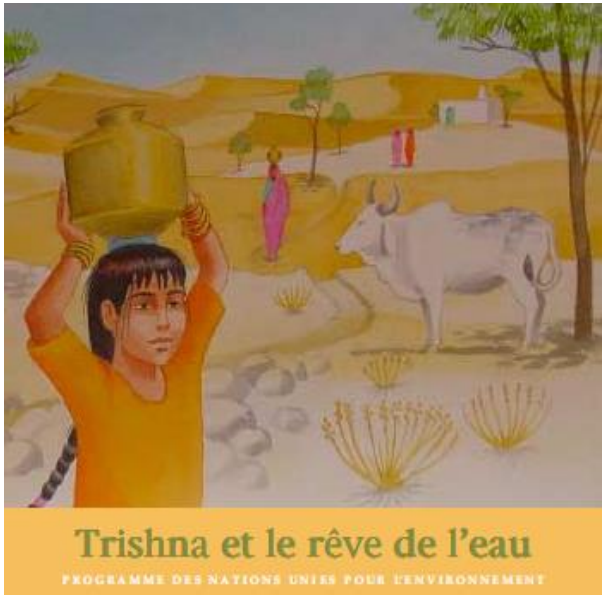
Being developped (C/D)

Operational

TRISHNA stands for : Thermal infRared Imaging Satellite for High resolution Natural resource Assessment

Space borne mission dedicated to the remote sensing of our planet in the thermal infrared (TIR) and visible part of the electromagnetic spectrum :

- at a high spatial scale (resolution of a few tens of meters)
- at a high temporal scale (revisit of a few days)
- with two main objectives driven by scientific requirements:
  - Ecosystem stress and water use monitoring,
  - Coastal areas monitoring and management.
- Secondary objectives
  - Urban
  - Solid Earth
  - Cryosphere
  - Atmosphere



TRISHNA – Global Mission Requirements, System and Workshare

Mission main goals
→Ecosystem stress and water use
→Coastal and inland waters monitoring

Observation Requirements
- High revisit & high spatial resolution for Visible and Infrared observations
- Global coverage
→ Sun Synchronous Orbit 761km @ 1PM
→ 8-day cycle, 3-day revisit
→ 5 years lifetime
→ Launch in 2024

Thermal InfraRed Instrument TIR (CNES)
- Spectral Bands : 8,6µm / 9,1µm / 10,3µm / 11,5µm
- CrGSD : 57m, 1000m over Open oceans
- Cross-track view angle : +/- 34°
- 165kg, 245W, 1300*1000*550mm^3

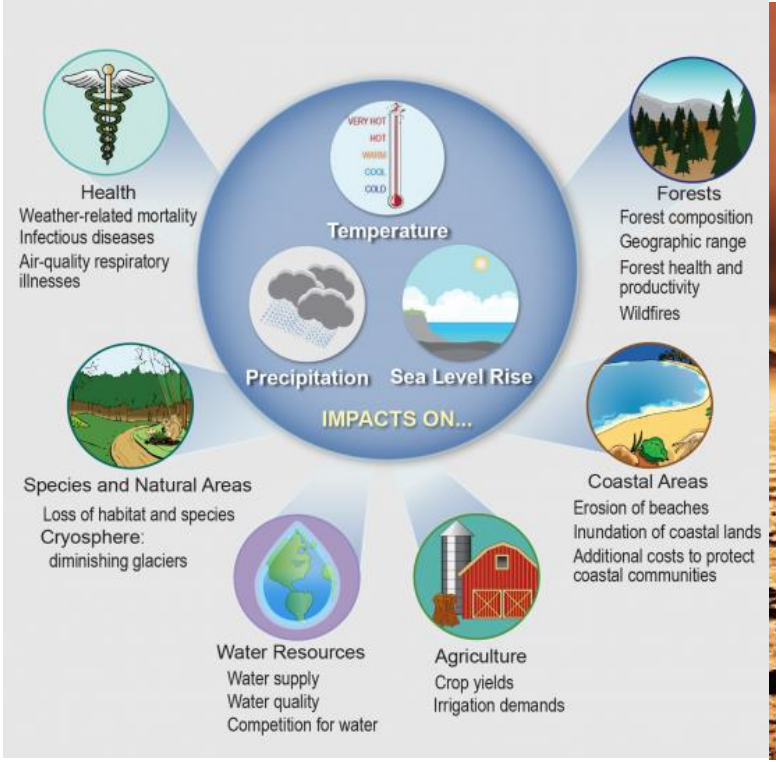
Visible and Swir Instrument, VNIR (ISRO)
- Spectral Bands :
485nm / 555nm / 650nm / 860nm & 1380nm / 1610nm
- GSD : 57m, 1000m over Open oceans
- Cross-track view angle : +/- 34°
- 30kg, 90W, 600*250*300mm3

Satellite (ISRO)
- Three axis stabilized platform (IMS2)
- SADM
- 320 Mbits/s Bande X
- Launcher : PSLV

Ground Segment (CNES & ISRO)
- Ground control station & Operation: ISRO
- TIR data processing up to level 2a : CNES
- VNIR data processing up to level 2a : ISRO

Current Status :
- Mission definition review successful
- Phase A decided : march 2018-July 2019
- Phase B/C/D/E1 objective : 2020-2024
- Launch objective : 2024

Potential effects of climate change



Source. Climate Change Impacts in the United States: The Third National Climate Assessment

The climate change…

International framework

Illustration by David Parkins
Nature 514, 30–31, Oct. 2014

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UN World Conference on Disaster Risk Reduction
2015 Sendai Japan

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

MARRAKECH
COP22|2016|CMP12

COP23 FIJI
UN CLIMATE CHANGE CONFERENCE
BONN 2017

1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

One Planet Summit – Paris, December 11th, 2017

The SCO is one of the 12 One Planet Summit commitments

Space Climate Observatory

Scope

Monitoring climate change

- Atmospheric CO_2 concentration,
- Global temperature, Clouds and Precipitation change,
- Sea level rise, Droughts and floods…

Tracking the impacts of climate change

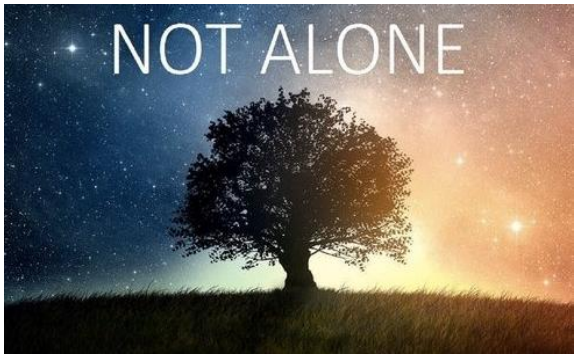
- Environmental impacts
- Social and human impacts
- Biodiversity reduction
- Economical costs

Mitigating and Adapting to climate change

- Resources: land use, agricultural practices, relocation, water use…
- Population: Migration of people, food security…
- Socio-economic development paths

Space Climate Observatory

Principles



Not alone !

- A country, an agency, an institution…
  could not make it for all the World/Planet

Involvement and cooperation of wide range of bodies

- GEO, CEOS, CGMS and UN Agencies
- National organizations, Ministries, local entities…
- Political commitment requires from those partners

Co-construction

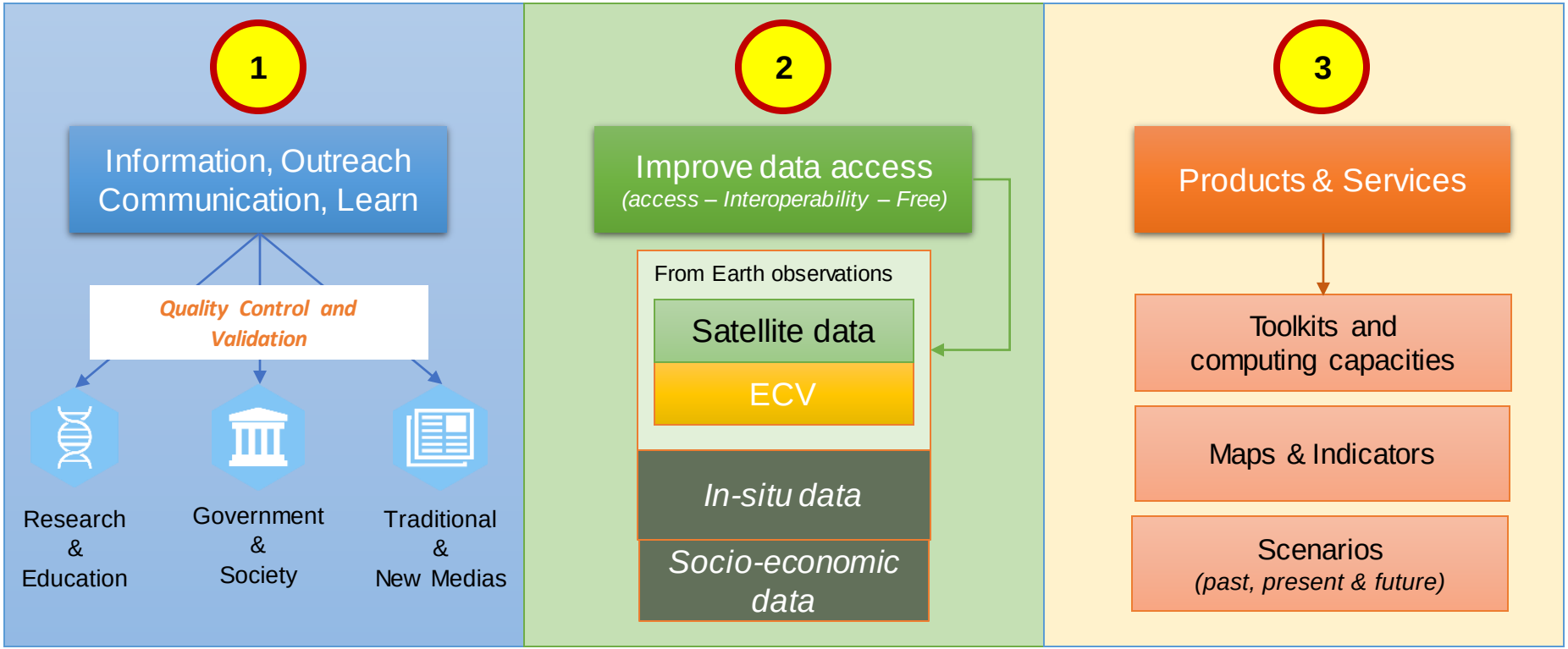
CO DESIGN

- At level of populations
  - Metrics and social indicators to measure the appropriation and acceptance by stakeholders
- Communities of development
- Make available to others, freely
- Exchange of use, best practice

Based on solid, open and state-of–the art scientific foundations

Space Climate Observatory

Three Objectives



Space Climate Observatory

Access

National SCO Data Center

National SCO Products & Services

Space Agencies

Committee on Earth Observation Satellites

CGMS

...

International Organization

GEO GROUP ON EARTH OBSERVATIONS

Copernicus Climate Change Service

WCRP World Climate Research Programme

GCOS GLOBAL CLIMATE OBSERVING SYSTEM

...

but always

but always

SCO – HUB

Data access, Information, Products & associated Services

End Users

Next steps : *Jan. 2019 - First International meeting – Documentation - partnership*

*Mar. 2019 - **Signature of an international charter/agreement, Nairobi***

WHY IS INTERNATIONAL COLLABORATION SO IMPORTANT ?

INTERNATIONAL COLLABORATION

- Climate change is a global issue. One single country / agency alone cannot address all the facets of the question : space-based infrastructure, instruments, science, models, in-situ instruments, data processing and storage, …

→ International cooperation in Earth Observation is not important … it is mandatory

- Cooperation allows sharing the costs, taking the best (technology, science, infrastructure, …) of each partner in a win-win partnership, enhancing the scientific and societal ROI by aggregating scientific and operational communities (1+1 > 2).
- A lot has been achieved over the past decades in various contexts :
  - European construction : ESA, EUMETSAT
  - Establishment of coordination groups (e.g. CEOS, CGMS, GCOS, GEO, GSICS, …)
  - Success stories : A-Train, GPM constellation, Copernicus, coordination of GEO and LEO programmes between EUMETSAT, NOAA, CMA, JMA, …
- … but more should be done on :
  - the infrastructure side (precipitation, water vapour, winds) – satellites + in-situ + models
  - Making satellite products better known and easier to access, especially for non specialists
  - Further integrating EO satellite data with other information such as model, in-situ, socio-economic data, in order to allow informed decision at local level

THANK YOU FOR YOUR ATTENTION

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