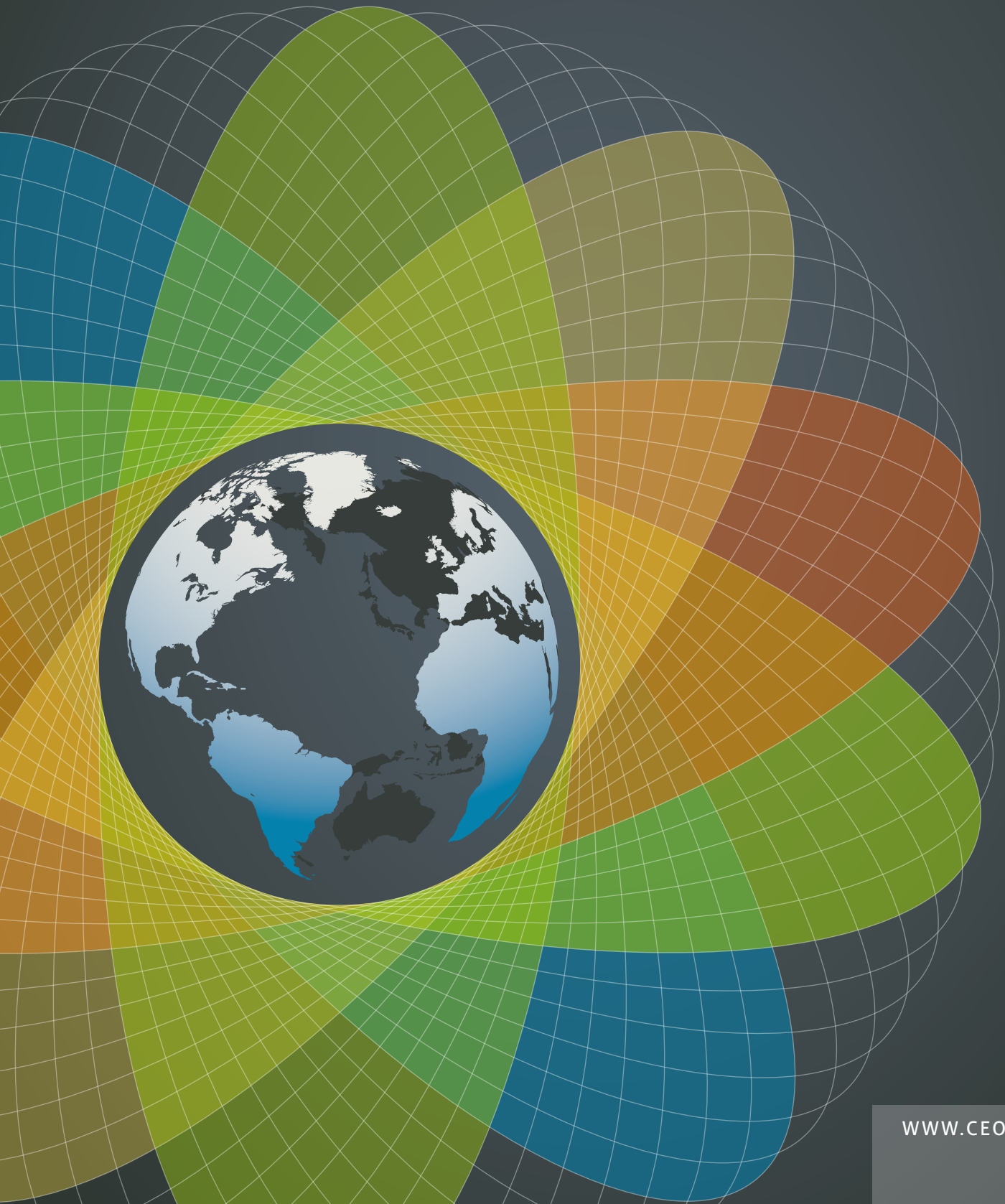
# CEOS AND CLIMATE MONITORING

Committee on Earth Observation Satellites

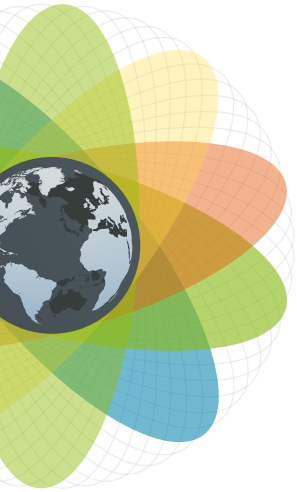


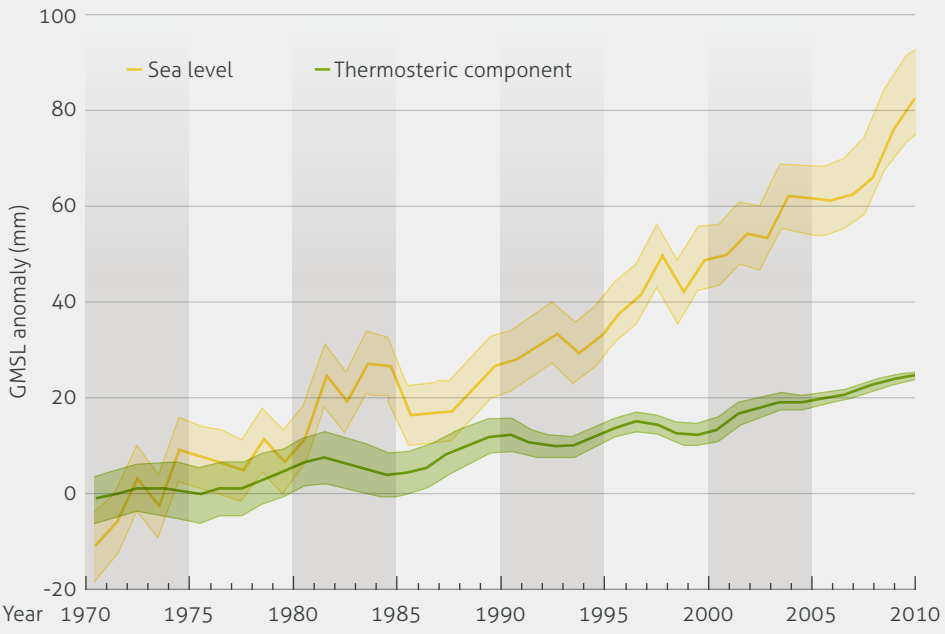
WWW.CEOS.ORG

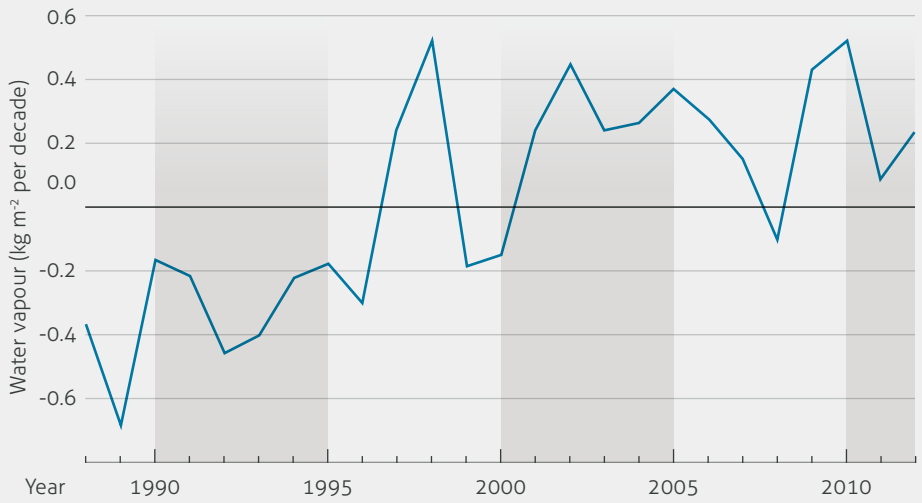
# Climate challenges and the need for observations

Observations play a crucial role in the detection of climate change and the validation of Earth system models used to produce climate projections. In response to this need for observations, the Global Climate Observing System (GCOS) has defined requirements for observations of a set of Essential Climate Variables (ECVs).

ECVs can be directly related to the detection of climate change as illustrated by the following examples showing trends in Sea Level and Water Vapour.






*Source: IPCC AR5 Report*

In view of the relatively slow dynamics of climate change, observations of ECVs have to be accurate, well-calibrated and homogeneous, typically spanning decades, so that the longer-term climate trends can be distinguished from shorter-term effects such as climate variability. Relevant long time-series are referred to as Climate Data Records (CDRs).

In general, Climate Data Records for ECVs are derived from a combination of satellite and in-situ observations, with satellite observations making a significant contribution[1] for a majority of ECVs.

[1] *Source: 2011 GCOS Satellite Supplement*

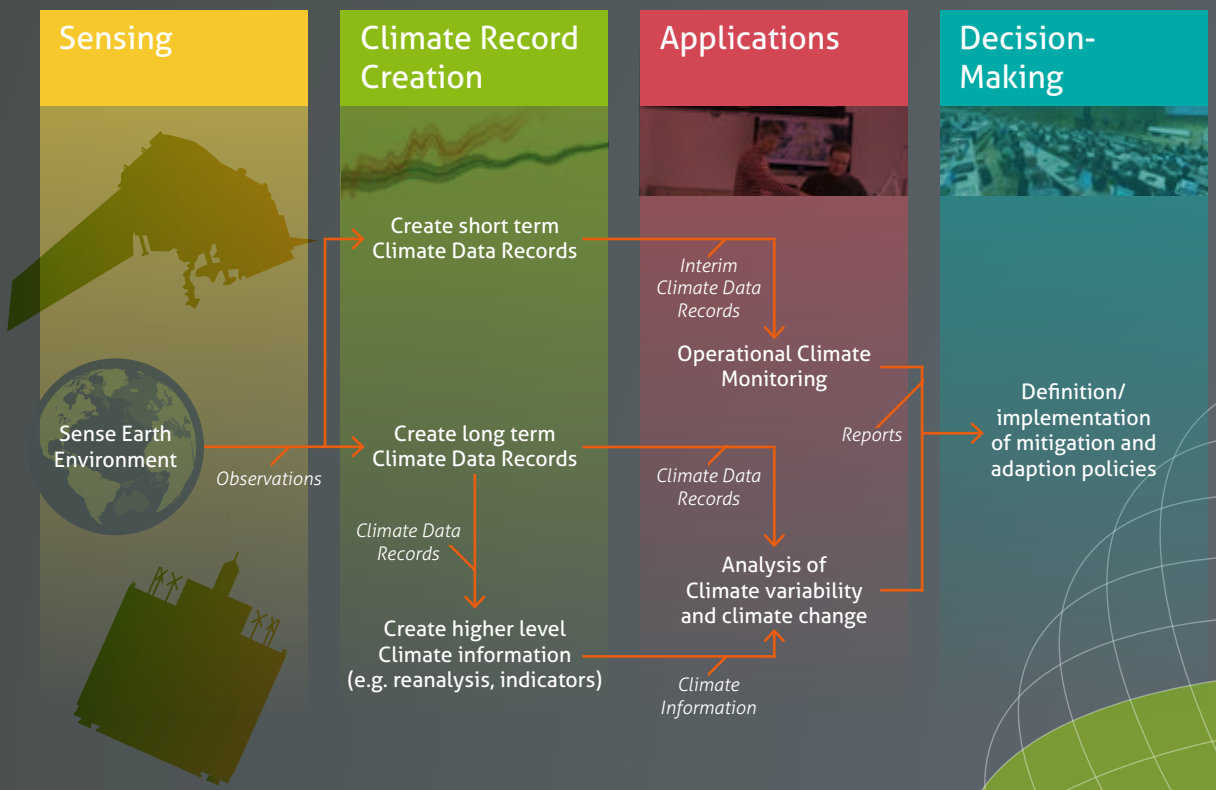
# The CEOS Response

Satellite observations are crucial for understanding the current state of the climate and how it may evolve. CEOS is vigorously responding to this need by taking a leading role in coordinating the availability of sustained, homogenous, high-quality Climate Data Records, based on satellite observations, to provide a reliable basis for decision-making.

## The framework: the Global Architecture for monitoring climate from space

In response to the challenge of monitoring climate change from space, CEOS, together with the Coordination Group for Meteorological Satellites (CGMS) and the World Meteorological Organization (WMO), has developed a global Architecture for Climate monitoring from Space[2] that has been specifically constructed with compliance to the GCOS requirements in mind. The architecture consists of a logical architecture, reflecting the required functions and a physical architecture expected to identify the elements contributing to the implementation of these functions.

*Global Architecture Climate Monitoring from Space (logical architecture) and its articulation with decision making*




[2] *Strategy Towards an Architecture for Climate Monitoring from Space*
*http://www.ceos.org/index.php?option=com_content&view=category&id=345&Itemid=471*

# The joint CEOS/CGMS Working Group on Climate

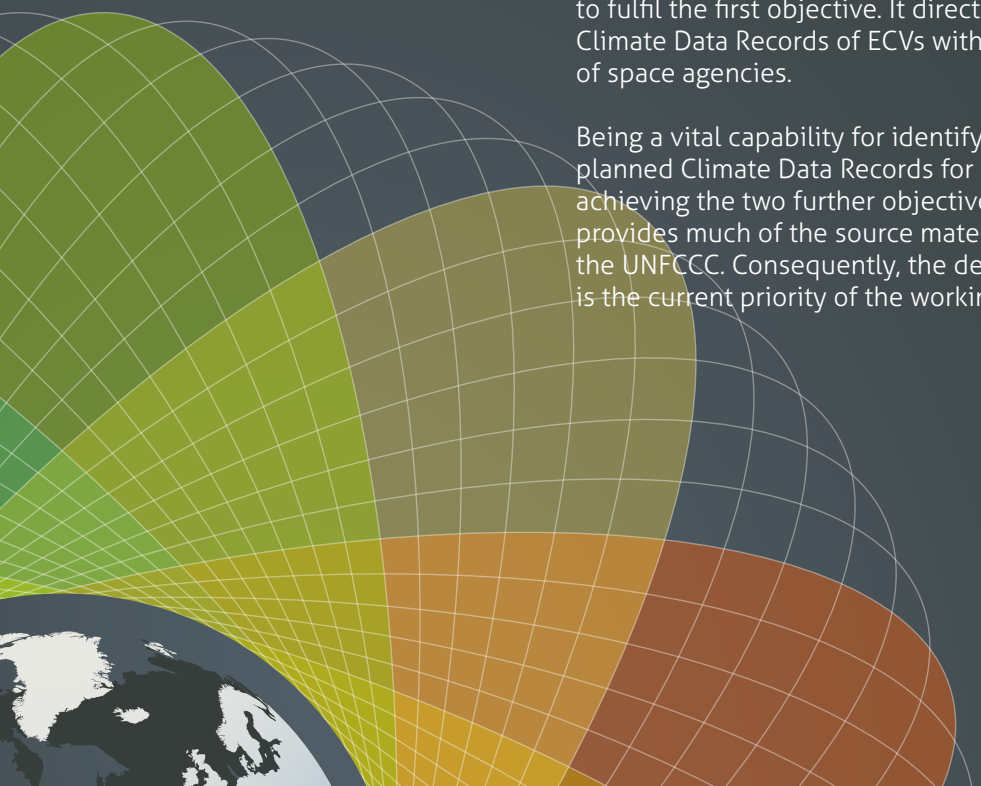
The centre-piece of CEOS's contribution to climate change monitoring is its participation in the CEOS/CGMS joint Working Group on Climate established to implement the Architecture, based on the blending of the capabilities and capacities of both operational and research and development space agencies. As a direct response to the ECV observational needs identified by GCOS, this joint working group has been assigned three overarching objectives:

- Providing a comprehensive andaccessible view as to what Climate Data Records are currently available or planned to be available;
- Delivering further Climate Data Records, including mul-ti-mission Climate Date Records, through best use of available data (e.g. by identifying and targetting cross-calibration or re-processing gaps/shortfalls);
- Optimising the planning of future satellite missions and constellations to expand existing and planned Climate Data Records, in terms of both coverage and record length.

## A comprehensive view on space-based Climate Data Records: the Inventory

The Inventory of Climate Data Records for ECVs[3] provides the mechanism to fulfil the first objective. It directly contrasts the GCOS requirements for Climate Data Records of ECVs with the current and planned data holdings of space agencies.

Being a vital capability for identifying and addressing gaps in existing and planned Climate Data Records for ECVs, the Inventory is a pre-requisite for achieving the two further objectives of the Climate working group. It also provides much of the source material for formal space agency reporting to the UNFCCC. Consequently, the development and population of the Inventory is the current priority of the working group activities.

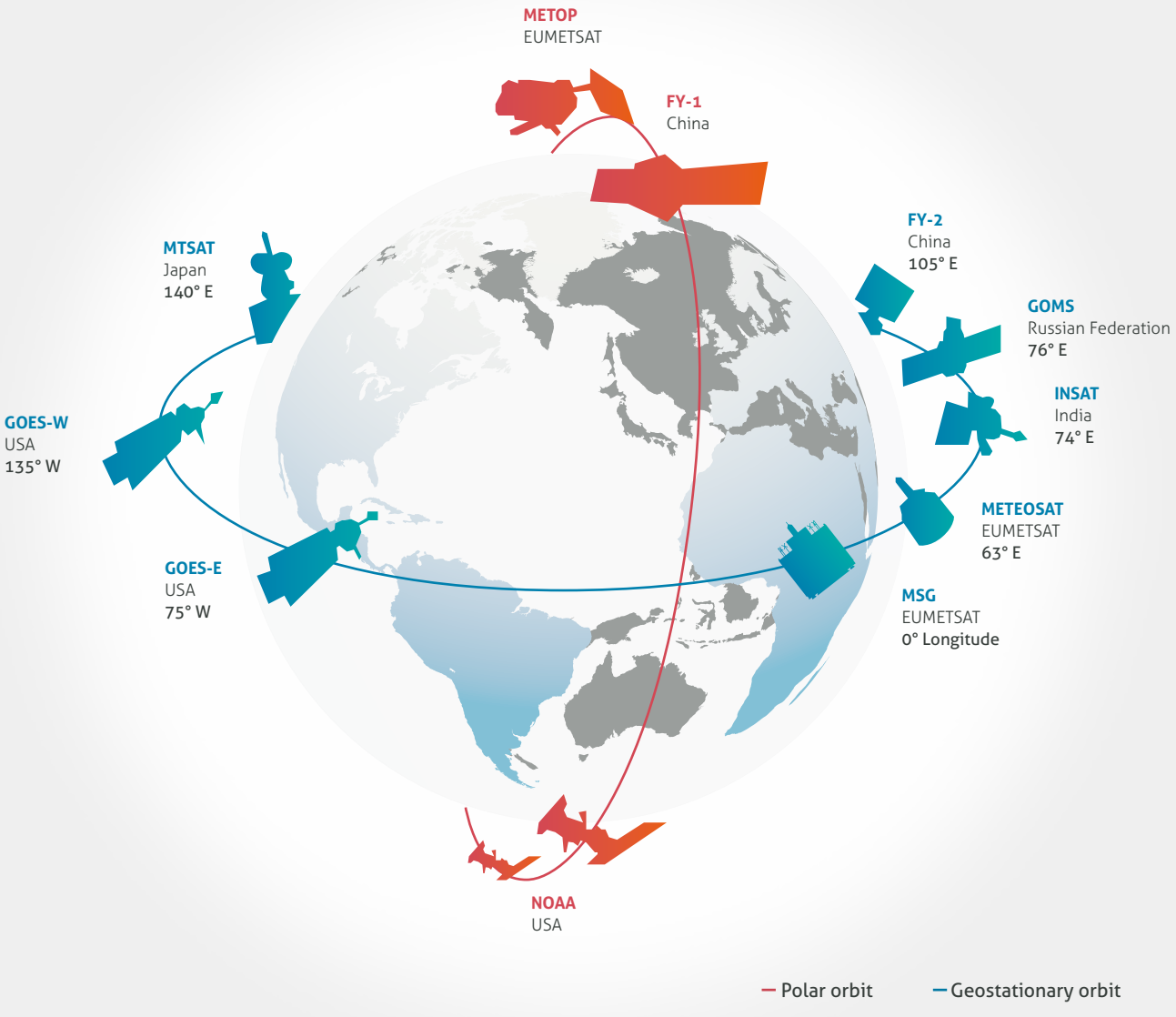


[3] *http://ecv-inventory.com/ecv2/*

# Re-calibrating and cross-calibrating satellite observations for climate monitoring

Consistent calibration is an essential attribute of all Climate Data Records, and the joint working group is supported by the CEOS Working Group on Calibration and Validation that, in conjunction with the CEOS Virtual Constellation teams, provides advice on calibration. Re-calibration and cross-calibration activities also take benefit from the Global Space-based Inter-Calibration System (GSICS), an international collaboration to monitor, improve and harmonize the quality of observations from operational weather and environmental satellites.

## Satellites inter-calibrated by GSICS

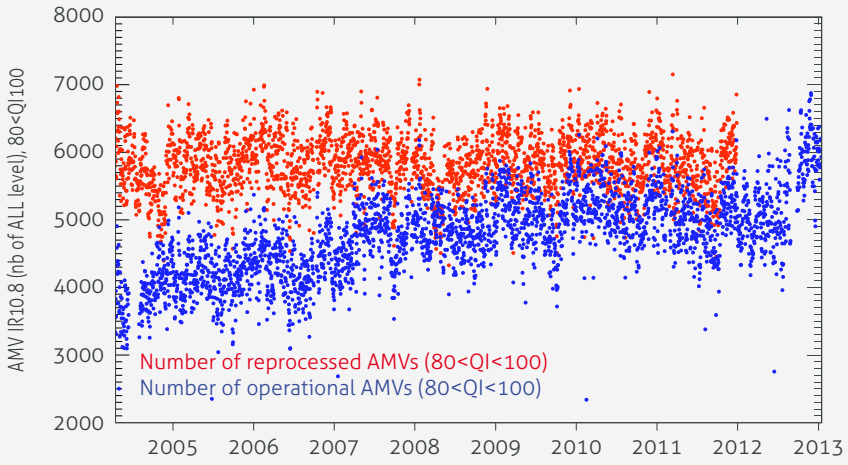


# The value of reprocessing historical satellite data

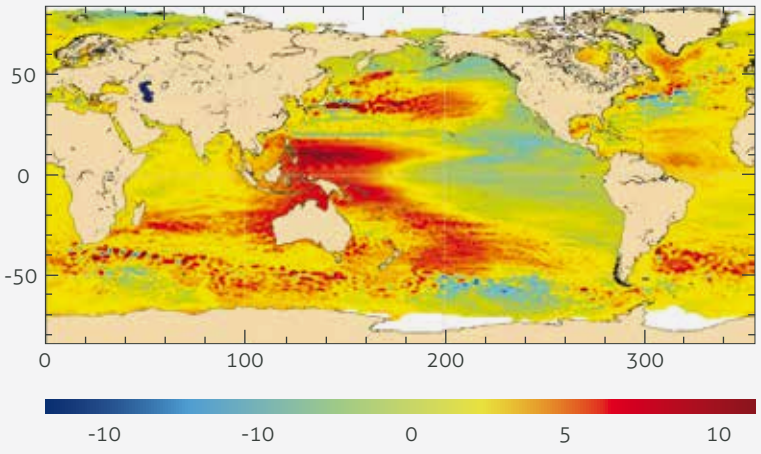
The re-processing of historical observations, to take benefit from improved algorithms, enhanced calibration techniques and additional information sources, plays an important role in improving the quality, quantity and range of Climate Data Records.

The following example shows the benefits of re-processing Atmospheric Motion Vector winds (AMVs) from the Meteosat Second Generation SEVIRI instrument. The graph contrasts the number of AMVs that have passed the required quality threshold before and after re-processing - the red plot shows the number of reprocessed wind vector products extracted from Meteosat geostationary imagery (AMVs), and the blue plot shows the number of those produced in real time at the time of sensing. As is evident from the graph, the number of re-processed AMVs is consistently higher for the re-processing periods, with the operationally-produced AMVs reaching the same level towards the end of the re-processing period as the operational and re-processing systems converge.

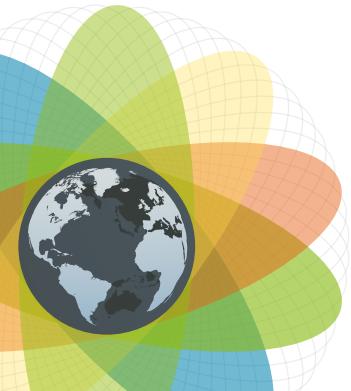
Likewise the reprocessing of observations from successive high precision altimeter missions provides a unique capability to monitor the variation of mean sea level in our changing climate.




*Number of wind vector products extracted from Meteosat imagery with a quality index above 80%, for reprocessed (red) and real time products (blue) in the period 2005-2013*




*Mean Sea Level trends over the period 1993 – 2013 as monitored by successive high precision altimetry missions (Topex-Poseidon, Jason-1 and Jason-2), Source CNES/LEGOS/CLS 2014*

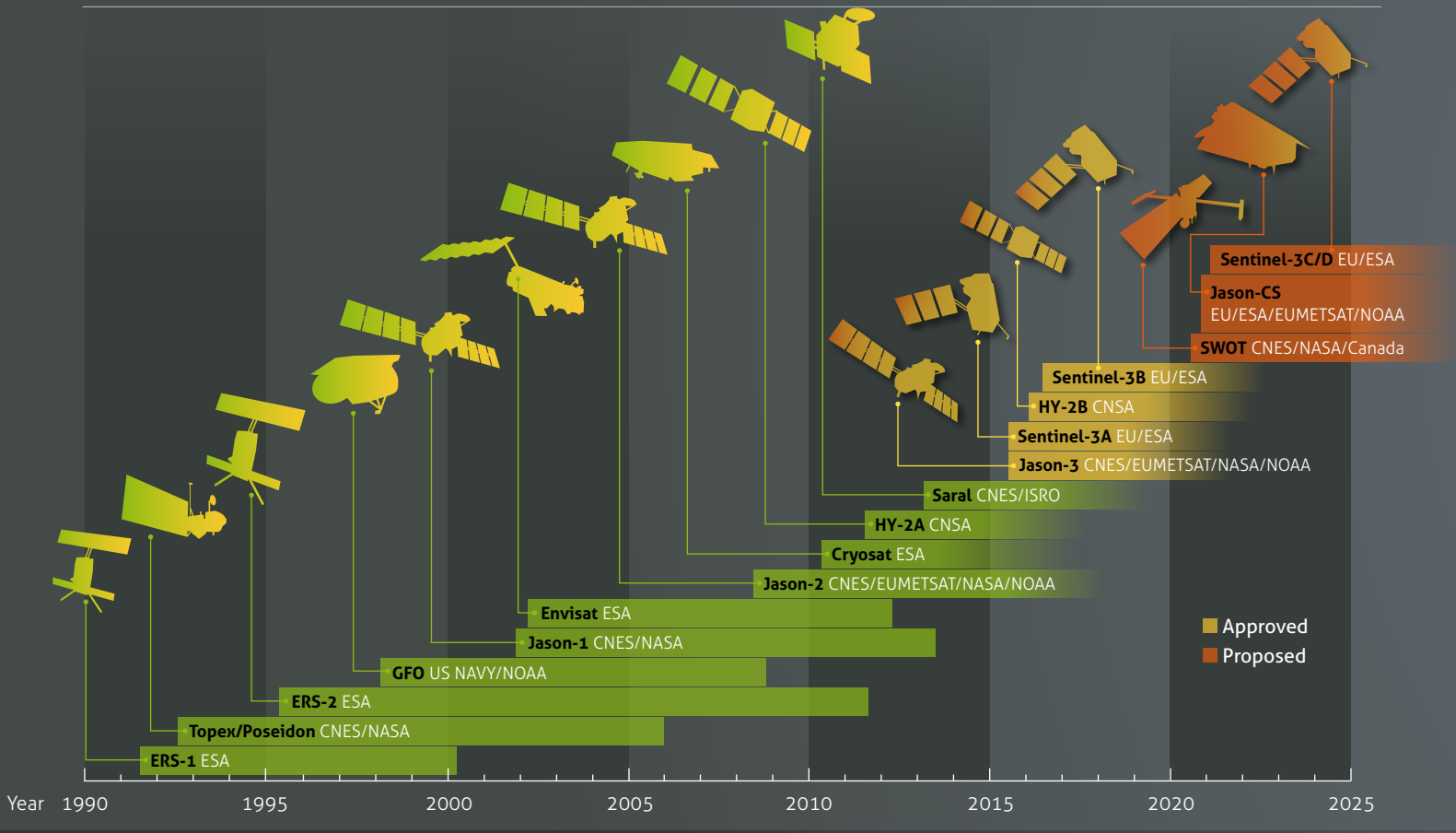


# Planning satellite missions to bridge gaps and expand Climate Data Records

The joint Climate working group is supported by thematic CEOS Virtual Constellation teams that coordinate the availability and planning of the observing systems needed for the generation of Climate Data Records.

For example, the CEOS Ocean Surface Topography Virtual Constellation coordinates altimeter missions that are essential for the assessment of sea level variations at regional and global scales.

**Planning for sustained altimeter observations**




# Contributions to targeted global monitoring initiatives

The CEOS response to the climate challenge also includes:

- Participation in the Global Forest Observations Initiative (GFOI) to facilitate the provision of satellite observations for forest carbon tracking in support of REDD+, and to other Global Initiatives coordinated by the intergovernmental Group for Earth Observations (GEO);
- Development of a CEOS Strategy for carbon observations from space.

CEOS

Committee on Earth Observation Satellites

Established in 1984, the Committee on Earth Observation Satellites (CEOS) coordinates civil space-borne observations of the Earth.

Participating agencies strive to enhance international coordination and data exchange and to optimize societal benefit.

Currently, 55 members and associate members made up of space agencies, national and international organizations participate in CEOS planning and activities.

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