Earth Observation Programme

The Climate Change Initiative Programme

The ESA Climate Office

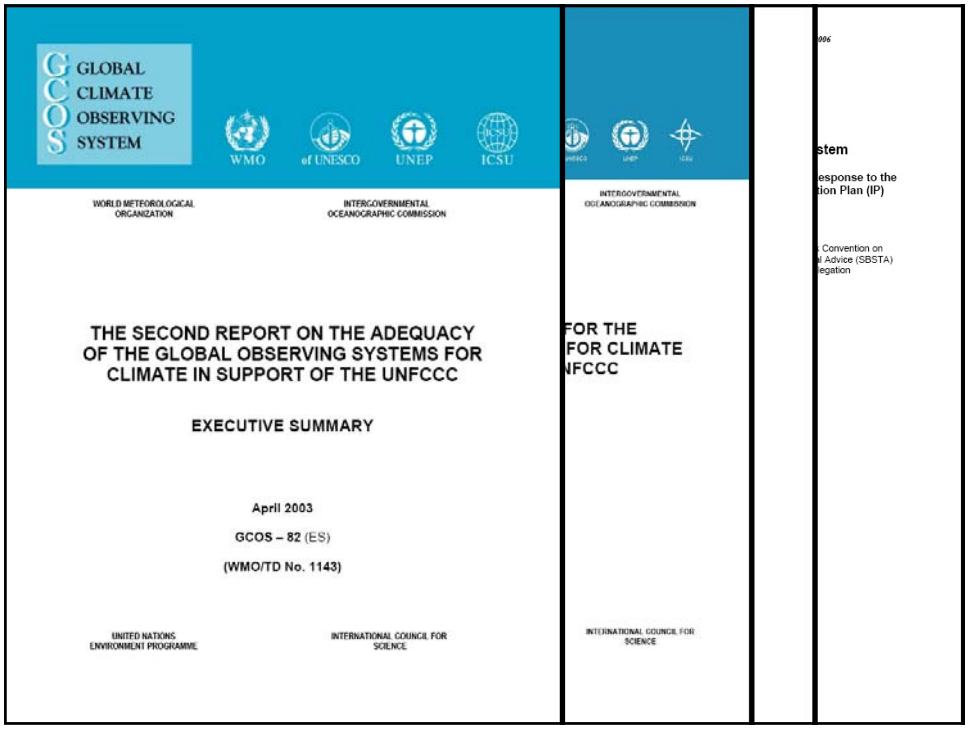
The 2010 ESA Living Planet Symposium

Climate Change Initiative

- The objective of Climate Change Initiative is to realize the full potential of the long-term global Earth Observation archives that ESA together with its Member states have established over the last thirty years, as a significant and timely contribution to the ECV databases required by UNFCCC. It will ensure that full capital is derived from ongoing and planned ESA missions for climate purposes, including ERS, Envisat, the Earth Explorer missions, relevant ESA-managed archives of Third-Party Mission data and, in due course, the GMES Space Component.

Climate Change Initiative

- Based on this analysis the following five main activities will be implemented to achieve the overall objective:
  - Gathering, collating and preserving the long-term time series in ESA's distributed archives.
  - (Re-)Processing periodically the basic EO-data sets from each individual mission and applying the most up-to-date algorithms and cal/val corrections.
  - Integrating the calibrated data sets derived from individual contributing EO mission and sensors to constitute the most comprehensive and well-characterized global long term records possible for each ECV.
  - Assessing the trends and consistency of the ECV records in the context of climate models and assimilation schemes.
  - Developing improved algorithms and data models for production of the required variables from emerging data sources, consistent with the long term record


GLOBAL CLIMATE OBSERVING SYSTEM

WMO · of UNESCO · UNEP · ICSU

WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

THE SECOND REPORT ON THE ADEQUACY OF THE GLOBAL OBSERVING SYSTEMS FOR CLIMATE IN SUPPORT OF THE UNFCCC

EXECUTIVE SUMMARY

April 2003

GCOS – 82 (ES)

(WMO/TD No. 1143)

UNITED NATIONS ENVIRONMENT PROGRAMME

INTERNATIONAL COUNCIL FOR SCIENCE

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

FOR THE
FOR CLIMATE
NFCCC

INTERNATIONAL COUNCIL FOR SCIENCE

stem

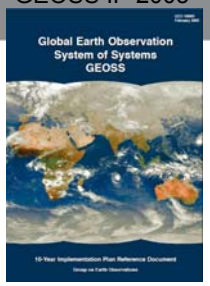
esponse to the
tion Plan (IP)

Convention on
l Advice (SBSTA)
legation

GCOS IP 2004

Part of GEO task CL-06-01

GEOSS IP 2005



ESA CCI: Production of Essential Climate Variables (ECV) according to GCOS requirements

ESA Ministerial Council, Nov 2008:
Approval of 75 M€ for a six year programme that will contribute to about twenty satellite-based ECVs. A strong interaction with the scientific community is an essential part of the programme.

The CCI initiative will ensure that ESA can play a full role in deriving relevant ECVs specified by GCOS, based on ESA current and archived EO data. ESA will work with CEOS agencies to ensure as complete a coverage of the entire suite of ECVs as possible.

Precursor Projects

Climate Change Initiative (CCI)

INPUT FROM
Long Term Archiving Programmes
Multi-mission infrastructure

Re-processing ex archive (e.g. calibration)

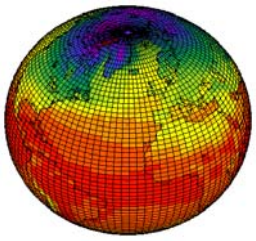
"Gather"

ECV generation (e.g. validation & bias)

"Deliver"

ECV assimilation & assessment

"Exploit"



Re-processing ex archive (e.g. calibration)

Active Feedback Loop

OUTPUT TO
International Climate Programmes
EC & MS R&D Programmes
IPCC Process, UNFCCC

Education & Awareness

"Show"

Satellite-based ECVs

Domain	Essential Climate Variables	
Atmospheric (over land sea and ice)	Surface:	Air temperature, Precipitation, Air pressure, Surface radiation budget, Wind speed and direction, Water vapour.
	Upper-air:	Earth radiation budget (including solar irradiances), Upper-air temperature (including MSU radiances), Wind speed and direction, Water vapour, Cloud properties.
	Composition:	Carbon dioxide, Methane, Ozone, Other Long-Lived greenhouse gases, Aerosol properties.
Oceanic	Surface:	Sea-surface temperature, Sea-surface salinity, Sea-level, Sea state, Sea ice, Current, Ocean colour (for biological activity), Carbon dioxide partial pressure.
	Sub-surface:	Temperature, Salinity, Current, Nutrients, Carbon, Ocean tracers, Phytoplankton.
Terrestrial	River discharge, Water use, Ground water, Lake levels, Snow cover, Glaciers and ice caps, Permafrost and seasonally-frozen ground, Albedo, Land Cover (including vegetation type), Fraction of absorbed photosynthetically active Radiation (fAPAR), Leaf area index (LAI), Biomass, Fire disturbance. Soil moisture.	

GCOS – 107 Systematic Observation Requirements for Satellite-Based Product for Climate Page 81

Satellite-based ECVs

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GCOS – 107 Systematic Observation Requirements for Satellite-Based Product for Climate Page 81

GCOS Essential Climate Variables (ECVs) → EVs

OCEANS	O.1	Sea Ice
	O.2	Sea Level
	O.3	Sea Surface Temperature
	O.4	Ocean Color
	O.5	Sea State
	O.6	Ocean Reanalysis
	O.7	Ocean Salinity

TERRESTRIAL	T.1	Lakes
	T.2	Glaciers & Ice Caps, and Ice Sheets
	T.3	Snow Cover
	T.4	Albedo
	T.5	Land Cover
	T.6	fAPAR
	T.7	LAI
	T.8	Biomass
	T.9	Fire Disturbance
	T.10	Soil moisture

ATMOSPHERE	A.1	Surface Wind Speed and Direction
	A.2	Upper-air Temperature
	A.3	Water Vapour
	A.4	Cloud Properties
	A.5	Precipitation
	A.6	Earth Radiation Budget
	A.7	Ozone
	A.8	Atmospheric reanalysis (multiple ECVs)
	A.9	Aerosols
	A.10	Carbon Dioxide, Methane and other Greenhouse Gases
	A.11	Upper-air Wind

GCOS – 107 Systematic Observation Requirements for Satellite-Based Product for Climate Page 12 and 13

GCOS Essential Climate Variables (ECVs) → EVs

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CCI First Steps (11 + 2 ECVs)

GCOS – 107 Systematic Observation Requirements for Satellite-Based Product for Climate Page 12 and 13

European Space Agency

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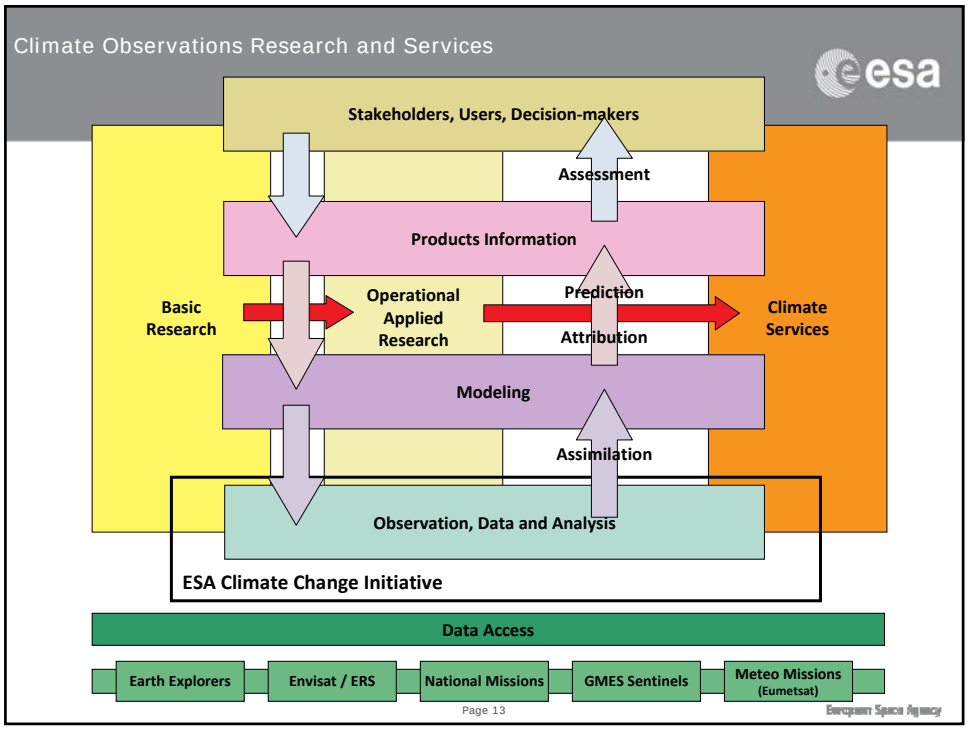
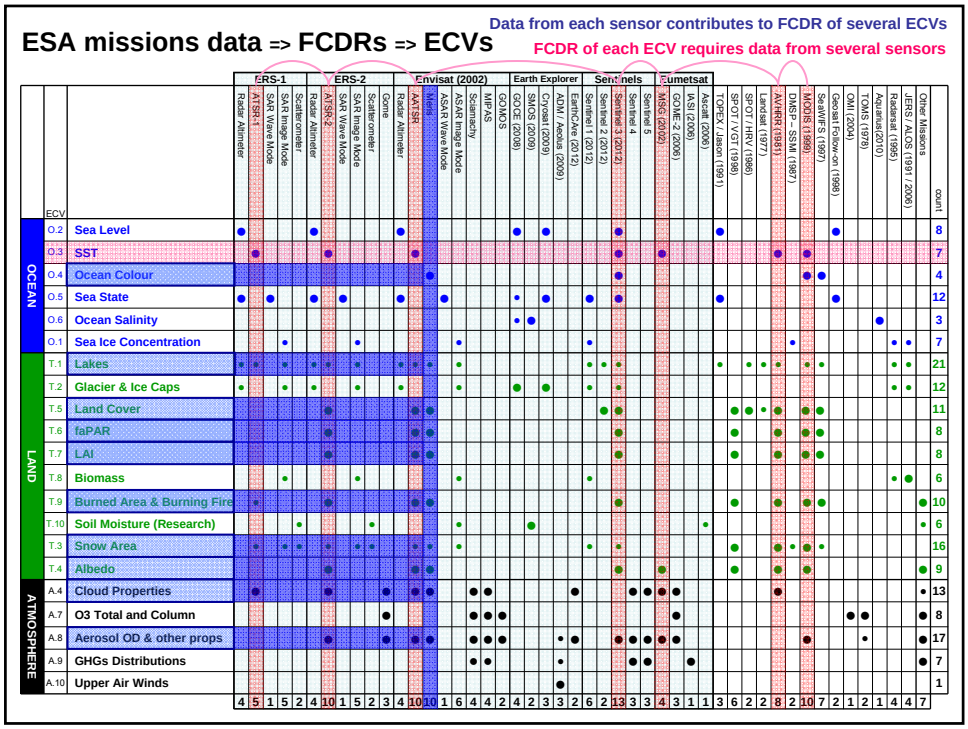
CCI First Steps (11 + 2ECVs)
Later in CCI (8 ECVs)

GCOS – 107 Systematic Observation Requirements for Satellite-Based Product for Climate Page 12 and 13

European Space Agency


Climate Observations Research and Services
esa
Stakeholders, Users, Decision-makers
Assessment
Products Information
Basic Research
Operational Applied Research
Prediction
Attribution
Climate Services
Modeling
Assimilation
Observation, Data and Analysis
ESA Climate Change Initiative
Data Access
Earth Explorers
Envisat / ERS
National Missions
GMES Sentinels
Meteo Missions (Eumetsat)
Page 13
European Space Agency


ESA missions data => FCDRs => ECVs
Data from each sensor contributes to FCDR of several ECVs
FCDR of each ECV requires data from several sensors
ERS-1
ERS-2
Envisat (2002)
Earth Explorer
Sentinels
Eumetsat
Radar Altimeter
ATSR-1
SAR Wave Mode
Scatterometer
Radar Altimeter
ATSR-2
SAR Wave Mode
Scatterometer
Gome
Radar Altimeter
AATSR
Meris
ASAR Wave Mode
ASAR Image Mode
Sciamachy
MIPAS
GOMOS
GOCE (2008)
SMOS (2009)
Cryosat (2009)
ADM / Aeolus (2009)
EarthCare (2012)
Sentinel 1 (2012)
Sentinel 2 (2012)
Sentinel 3 (2012)
Sentinel 4
Sentinel 5
MSG (2002)
GOME-2 (2006)
IASI (2006)
Ascatt (2006)
TOPEX / Jason (1991)
SPOT / VGT (1998)
SPOT / HRV (1986)
Landsat (1977)
AVHRR (1981)
DMSP - SSM (1987)
MODIS (1999)
SeaWIFS (1997)
Geosat Follow-on (1998)
OMI (2004)
TOMS (1978)
Aquarius(2010)
Radarsat (1995)
JERS / ALOS (1991 / 2006)
Other Missions
count
ECV
OCEAN
O.2 Sea Level 8
O.3 SST 7
O.4 Ocean Colour 4
O.5 Sea State 12
O.6 Ocean Salinity 3
O.1 Sea Ice Concentration 7
LAND
T.1 Lakes 21
T.2 Glacier & Ice Caps 12
T.5 Land Cover 11
T.6 faPAR 8
T.7 LAI 8
T.8 Biomass 6
T.9 Burned Area & Burning Fire 10
T.10 Soil Moisture (Research) 6
T.3 Snow Area 16
T.4 Albedo 9
ATMOSPHERE
A.4 Cloud Properties 13
A.7 O3 Total and Column 8
A.8 Aerosol OD & other props 17
A.9 GHGs Distributions 7
A.10 Upper Air Winds 1
4 5 1 5 2 4 10 1 5 2 3 4 10 10 1 6 4 4 2 4 2 3 3 2 6 2 13 3 3 4 3 1 1 3 6 2 2 8 2 10 7 2 1 2 1 4 4 7

ESA missions data => FCDRs => ECVs The time component – the 3rd dimension

	ERS-1					ERS-2						Envisat (2002)								Earth Explorer					Sentinels					Eumetsat																			
OCEAN ECV O.2 SST	Radar Altimeter	ATSR-1	SAR Wave Mode	SAR Image Mode	Scatterometer	Radar Altimeter	ATSR-2	SAR Wave Mode	SAR Image Mode	Scatterometer	Gome	Radar Altimeter	AATSR	Meris	ASAR Wave Mode	ASAR Image Mode	Sciamachy	MIPAS	GOMOS	GOCE (2008)	SMOS (2009)	Cryosat (2009)	ADM / Aeolus (2009)	EarthCAre (2012)	Sentinel 1 (2012)	Sentinel 2 (2012)	Sentinel 3 (2012)	Sentinel 4	Sentinel 5	MSG (2002)	GOME-2 (2006)	IASI (2006)	Ascatt (2006)	TOPEX / Jason (1991)	SPOT / VGT (1998)	SPOT / HRV (1986)	Landsat (1977)	AVHRR (1981)	DMSP – SSMI (1987)	MODIS (1999)	SeaWIFS (1997)	Geosat Follow-on (1998)	OMI (2004)	TOMS (1978)	Aquarius(2010)	Radarsat (1995)	JERS / ALOS (1991 / 2006)	Other Missions	count
2015																											●			●								●		●									4
2014																											●			●								●		●									4
2013													●														●			●								●		●									5
2012													●																	●								●		●									4
2011							•						●																	●								●		●									5
2010							•						●																	●								●		●									5
2009							•						●																	●								●		●									5
2008							•						●																	●								●		●									5
2007							•						●																	●								●		●									5
2006							•						●																	●								●		●									5
2005							•						●																	●								●		●									5
2004							•						●																	●								●		●									5
2003							•						●																	●								●		●									5
2002							•						●																	●								●		●									5
2001							●																															●		●									3
2000		●					●																															●		●									4
1999		●					●																															●		●									4
1998		●					●																															●		●									4
1997		●					●																															●		●									4
1996		●					●																															●		●									4
1995		●					●																															●		●									4

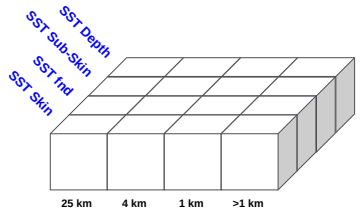
The Cube Concept

The example of

O.3 – Sea surface temperature

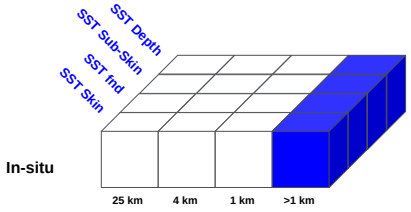
O.3 – Sea surface temperature

- For one ECV, the various FDCR's are of different natures in terms of
  - type of parameters
  - resolution



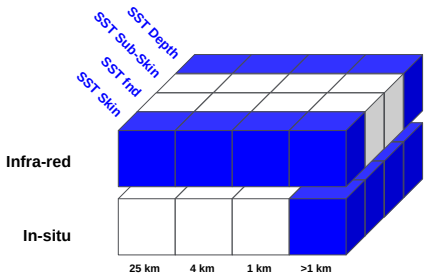
O.3 – Sea surface temperature

- As example in-situ measurements are covering
  - All type of parameters
  - At very low resolution / intermittent observations



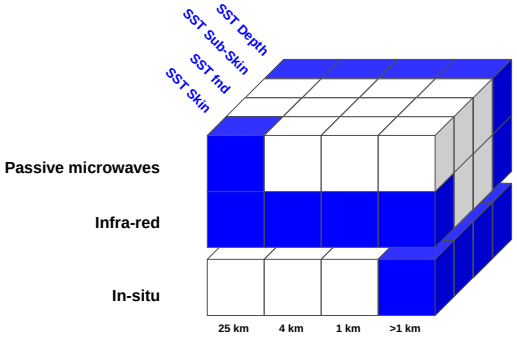
O.3 – Sea surface temperature

- In the vertical axes, one can add the type of sensor
  - First infra-red with their own characteristics



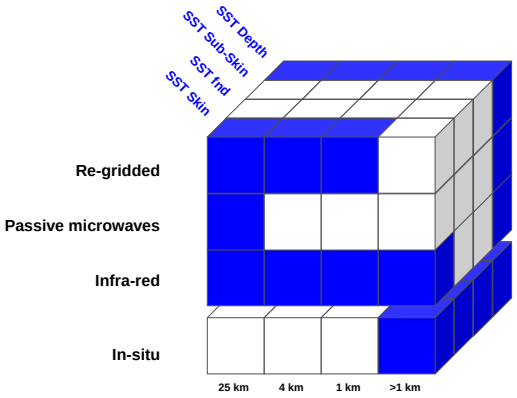
O.3 – Sea surface temperature

- In the vertical axes, one can add the type of sensor
  - First infra-red with their own characteristics
  - Then the passive microwaves



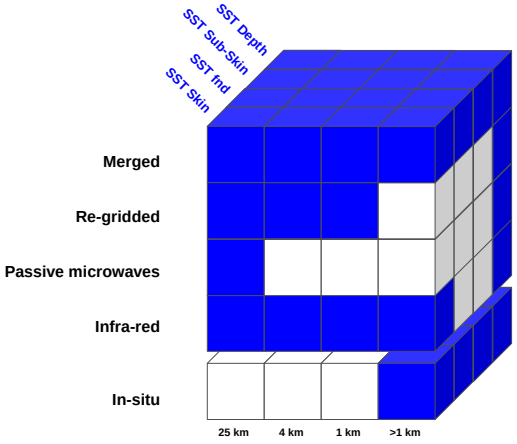
O.3 – Sea surface temperature

- From there one can build re-gridded products …



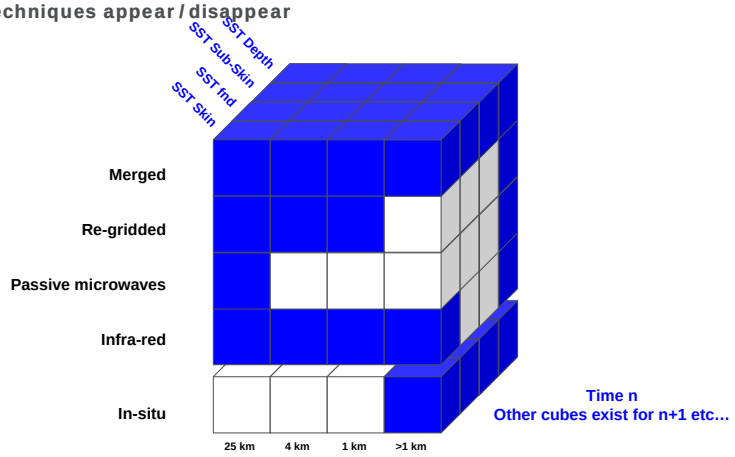
O.3 – Sea surface temperature

- … and process merged products

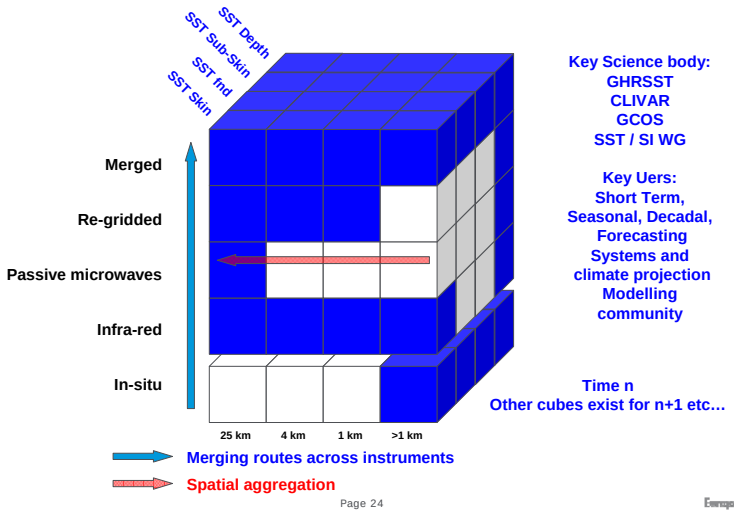


O.3 – Sea surface temperature

- The exact nature of the cube varies with time as new sensors and techniques appear / disappear



O.3 – Sea surface temperature



Key Science body:
GHRSST
CLIVAR
GCOS
SST / SI WG

Key Uers:
Short Term, Seasonal, Decadal, Forecasting Systems and climate projection Modelling community

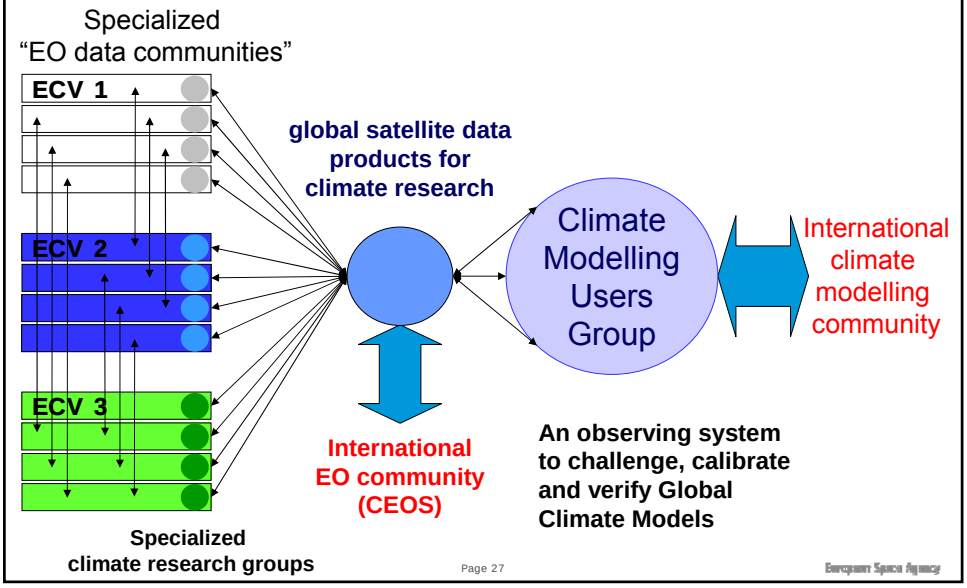
From the ECV perspective

- This type of analysis shall be developed for each ECV to include:
  - Various sensors type,
  - Various product type
  - The temporal evolution of the measurement (sensors) and processing (algorithms) techniques
- The merging routes shall take into account these variabilities.
- To build a proper ECV, each FCDR shall find its place in this analysis

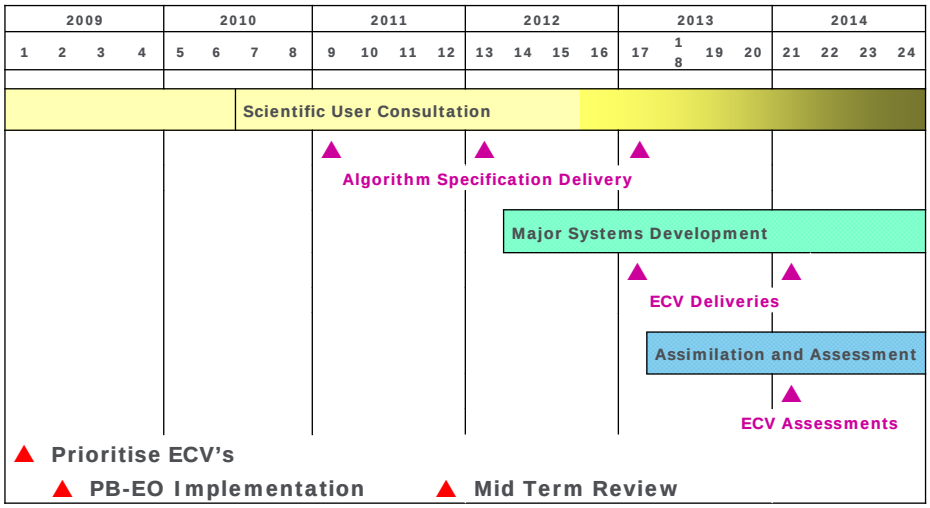
The Climate Change Initiative Programme

Its implementation

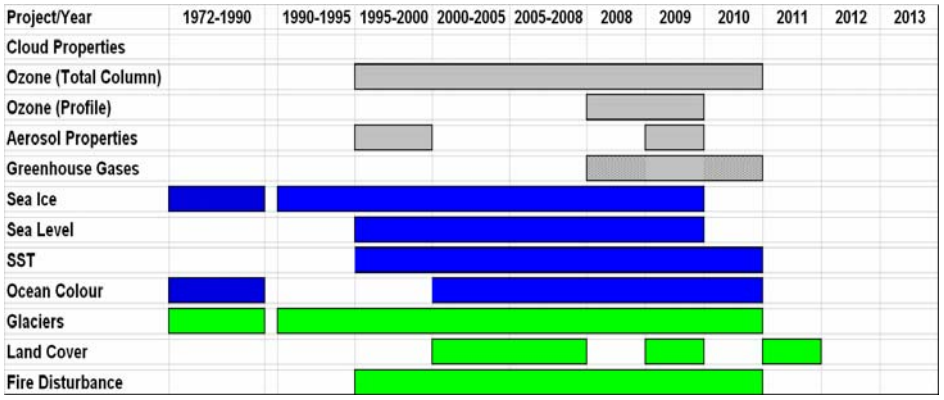
Where we want to go…



CCI Master Schedule



“baseline” data requirement per ECV



The ESA Climate Office

ESA Climate Office

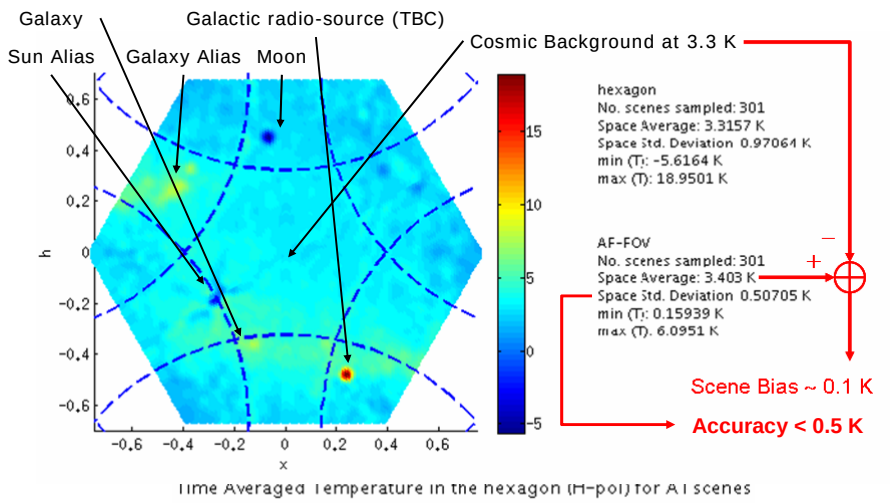
The role of the ESA Climate Office in the context of CCI

- The CCI programme management remains with Mark Doherty in Esrin (Frascati, Italy)
- The ESA Climate Office will be in charge of:
  - Supporting the CCI interfaces to participating ESA Member States
    - Reporting to Delegation
    - Interface between CCI and other ESA programmes especially DUE, STSE and GSTP.
  - Facilitator/Enabler role
    - Interface with the CMUG activities
    - Enabling the interactions / synergies between the various ECV's (e.g. Sea-Ice and SST).
    - Consolidating the Data requirements from the various ECV's and liaises with ESA Facilities, including the Future requirement for the Earth Explorers and Sentinels.

ESA Climate Office

- The ESA Climate Office will be in charge of:
  - Technical role
    - Technical Officer for three of the eleven ECV's part of the first steps:
      - Sea-Ice,
      - Glaciers & ice caps,
      - Fire disturbance.
    - Plus two new ECV's that shall be added soon,
      - Sea Surface Salinity
      - Soil Moisture
    - Foster coordinated ESA activities on Climate Data visualisation (e.g. ECV's, re-analysis)
    - Initiate thoughts on ECV generation Facilities (e.g. GRID, Cloud Computing).
    - Support to the preparation of the CCI Stage 2 Statement of Work

SMOS First Cold Sky Calibration



ESA Climate Office

Other roles of the ESA Climate Office

- Point of contact for ESA Climate Discussions and in particular:
  - Interface between the ESA Climate activities and the EC programmes
  - GEO CEOS coordination for climate activities (e.g. QA4EO, FCT, IGCO, WGCV, CEOS Climate Advisory Group)
  - Interface between Climate ESA activities and the international research programmes such as IGBP and WCRP.
  - Promote the development of Scientific Climate Data Visualisation

The ESA Living Planet Symposium

The ESA Living Planet Symposium

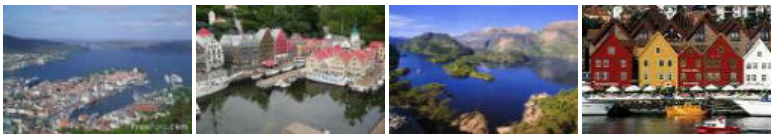
- The event will be held in Bergen, Norway from **28 June to 2 July 2010** and organised with the support of the **Norwegian Space Centre**.
- **OBJECTIVES**
- The objective of the Living Planet Symposium is to present the results of the ESA EO missions in exploitation by:
  - providing a forum for investigators to present results of on-going research project activities using ENVISAT, ERS, GOCE, SMOS, CRYOSAT and ESA Third Party missions data;
  - presenting the development of applications and services including the Global Monitoring for Environment and Security;
  - presenting the ESA Climate Change Initiative.
- In addition, the Symposium will provide an opportunity to present future ESA missions in development (GMES Sentinels, Earth Explorers and meteorological missions) and national EO missions.

The ESA Living Planet Symposium

The event will be held in

Bergen, Norway

from **28 June to 2 July 2010**



organised with the support of the

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