Architecture for Climate Monitoring from Space
Status and Way Forward

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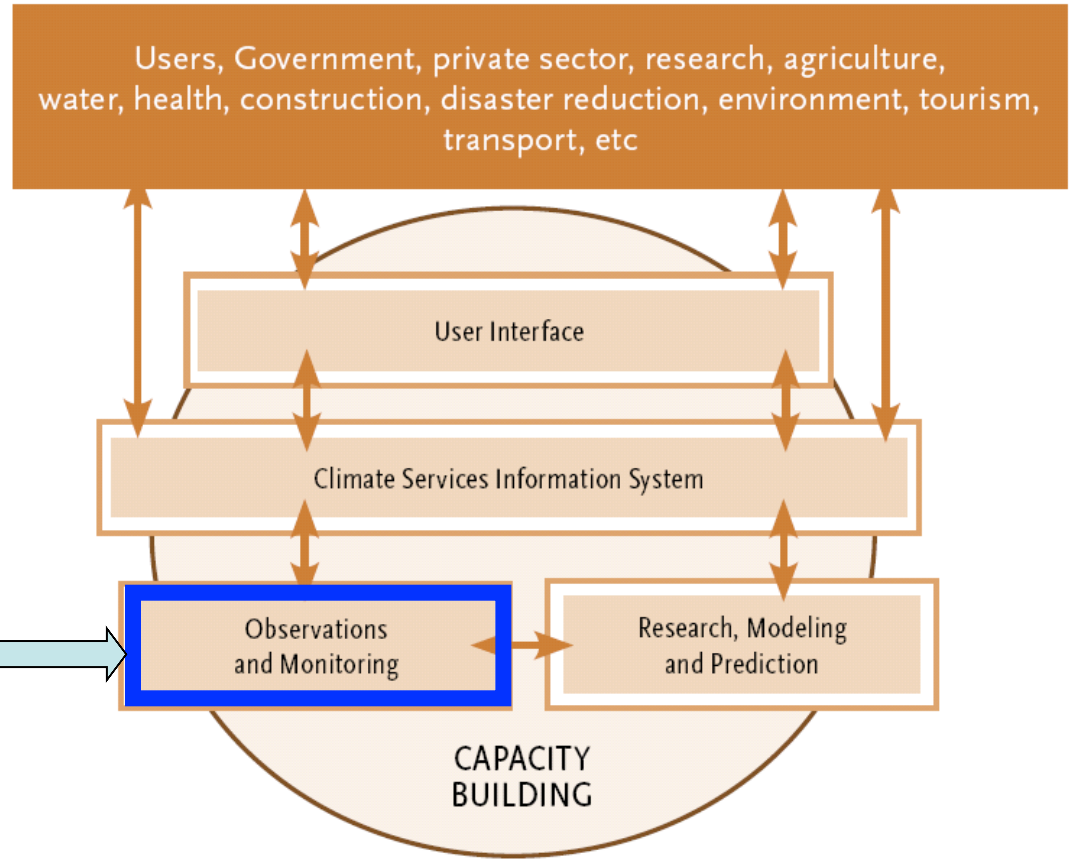
STATUS

- The Implementation Plan and Governance Scheme of the GFCS was approved by WMO Extraordinary Congress in October 2012

- The Architecture for Climate Monitoring from Space (ACMS) will be a major building block for the Obs. & Monitoring Pillar of the GFCS.

STATUS

Space and Surface Architect. for Climate Monitoring

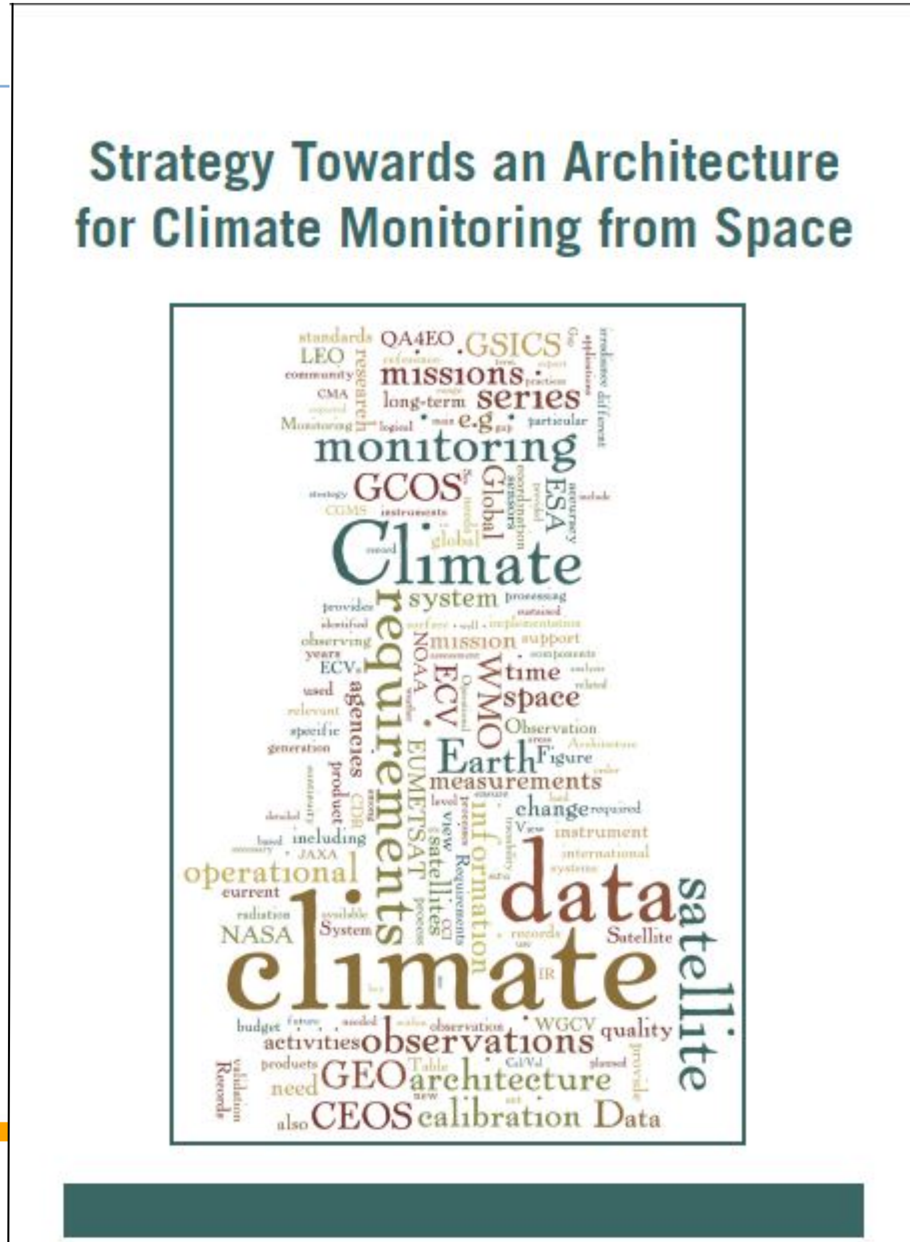


STATUS

- WMO Space Programme, the Committee of Earth Observation Satellites (CEOS) and the Coordination Group for Meteorological Satellites (CGMS) started in January 2011 a process to develop a strategy towards an ACMS.

- As a first step of the architecture a logical view was elaborated and approved by the plenaries of CEOS and CGMS and endorsed by the Executive Council of WMO in 2012. A report was published in 2013. The physical view as the second step will follow.

STATUS


Strategy Towards an Architecture
for Climate Monitoring from Space

STATUS

Table of content:

- Executive Summary and Recommendations
- Introduction and Objectives
- Climate Monitoring Principles, Requirements & Guidelines
- Existing Capabilities and Processes
- Beyond Research to Operations
- Climate Architecture Definition
- Mechanisms for Interaction
- Roadmap for the Way Forward
- Glossary

STATUS

- The approach adopted is intentionally open and inclusive.

- Is designed so that all the relevant entities can identify their potential contributions even if this may be beyond their existing capabilities and programmatic obligations in recognition of the need to obtain the maximum degree of consensus at this early stage in the process.

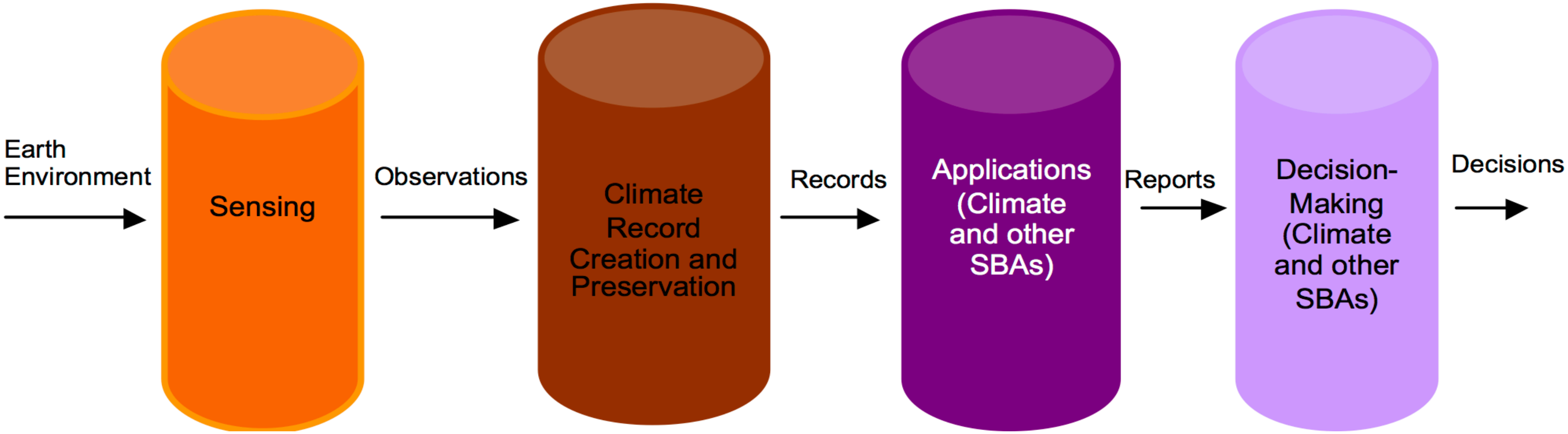
- The level of definition of the architecture is necessarily high-level and conceptual.

STATUS

- **Logical View:** represents the requirements baseline as a set of interlinked functions and associated dataflows (i.e. the target) . Logical view is as stable as the requirements baseline and, once established, should require little maintenance.

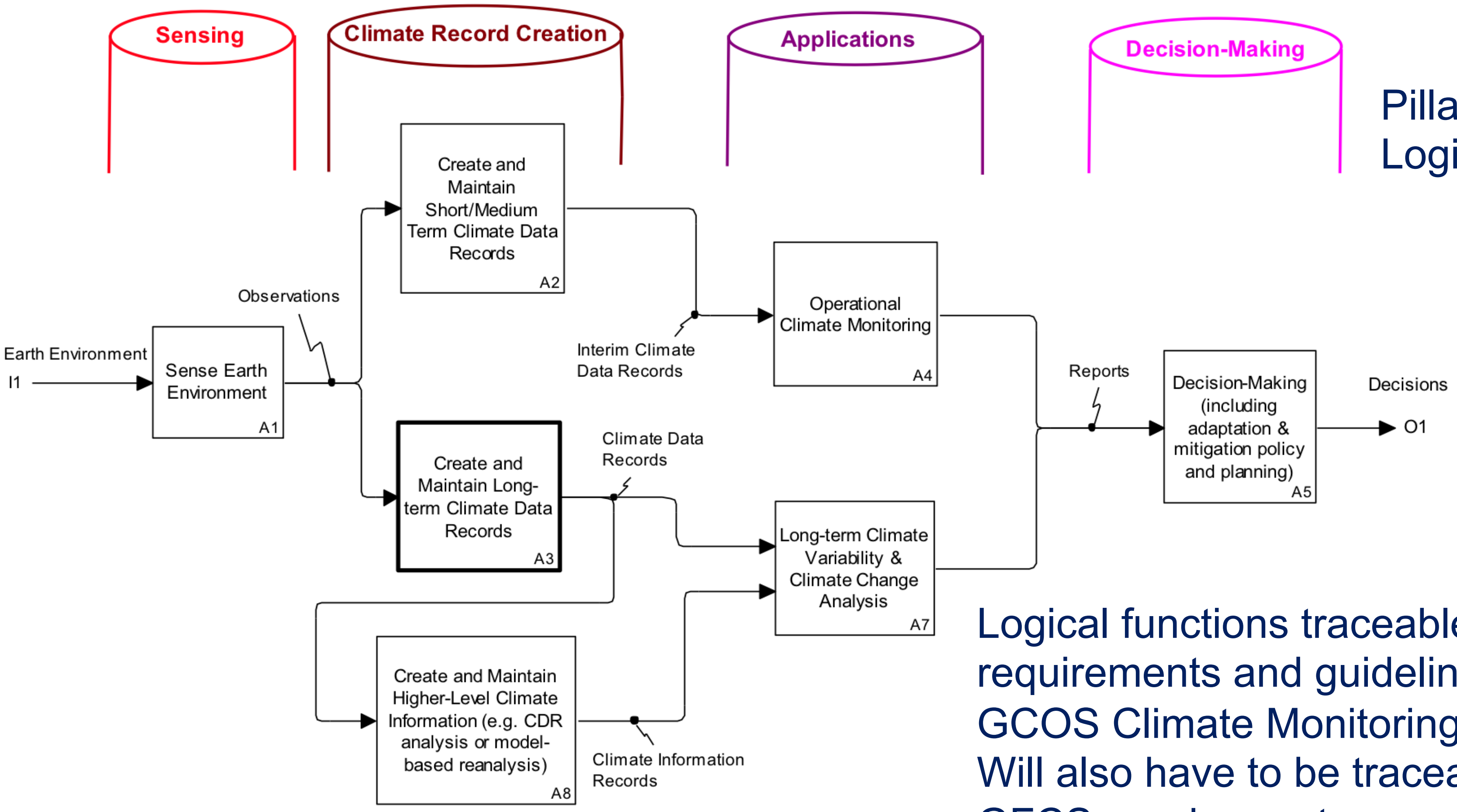
- **Physical View:** describes how the logical view is implemented, i.e. how close we are to achieving the target. Needs to be maintained on a regular basis to make sure it appropriately reflects the prevailing status

STATUS



Pillars of the logical view

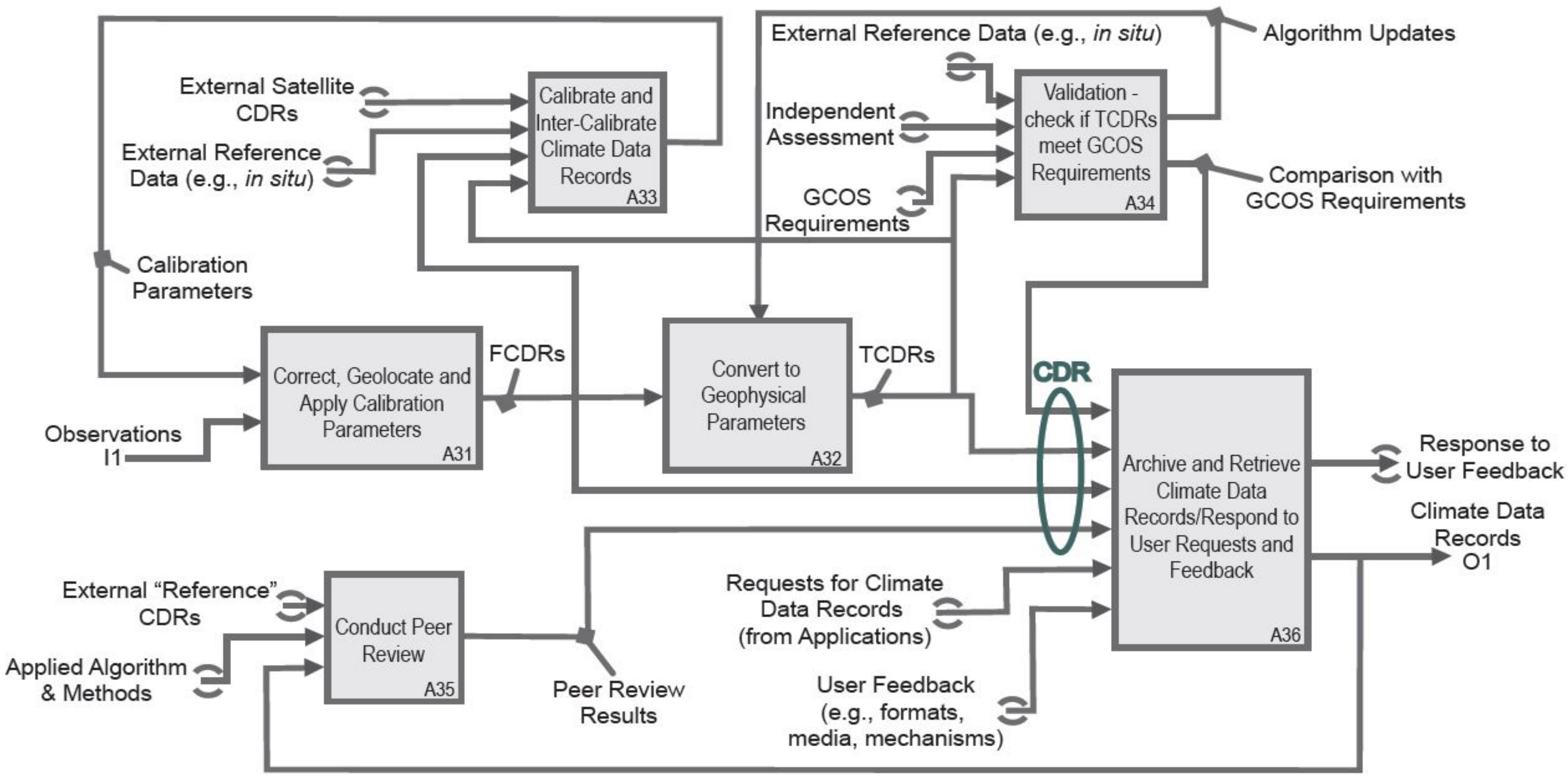
STATUS



Pillars of the Logical View

Logical functions traceable to GCOS requirements and guidelines and to GCOS Climate Monitoring Principles. Will also have to be traceable to GFCS requirements.

STATUS



Decomposition of logical function A3

Physical View

Main Objective:

To systematically expose the ECV-relevant data holdings of space agencies to potential users.

Methodology:

Invite agencies to populate a questionnaires aimed at characterizing the relevant datasets, including:

- Implementation responsibilities for each of the functions identified in the logical architecture
- Anticipated usage (relevant ECV, potential applications)
- Technical properties (accuracy, stability, coverage, frequency, length of record, etc)
- Administrative aspects (access conditions, formats supported, . . . contact points…)

Current and planned missions potentially supporting ECVs

Instrument or mission type	Current or planned satellite missions including measurements of that category		Essential Climate Variable potentially supported
LEO - Multi-purpose VIS/IR imagery and IR and MW sounding	NOAA series (NOAA) Meteor series (Roshydromet) Metop series (EUMETSAT) FY-1 and FY-3 series (CMA) GCOM-C series (JAXA)	EOS-Terra and Aqua (NASA) NPP, JPSS series (NOAA) DMSP and DWSS series (DOD) Megha-Tropiques (ISRO, CNES)	Temperature, Water vapour, Cloud properties, Aerosols, Surface radiation budget, Albedo, Ozone, Methane, CO, CO_2, NO_2, Sea surface temperature, Permafrost, Snow cover, FAPAR, Leaf Area Index, Biomass, Fire disturbance, Precipitation
GEO - Multi-purpose VIS/IR imagery and IR sounding	GOES series (NOAA) Meteosat (MFG, MSG, MTG) series (EUMETSAT) FY-2/FY-4 series (CMA) MTSAT/Himawari series (JMA)	INSAT/ Kalpana series (ISRO/IMD) Elektro-L (Roshydromet) COMS series (KMA)	Water vapour, Cloud properties Wind speed and direction Aerosols, Surface radiation budget, Albedo Sea surface temperature Temperature Precipitation
LEO – Radio-occultation sounding	COSMIC-1, 2 (NOAA) SAC-C and SAC-D (CONAE) KOMPSAT-5 (KARI) Tandem-X (DLR) Meteor-M N3 (Roshydromet) Metop series (EUMETSAT)	FY-3 E, G (CMA) Oceansat-2, 3 (ISRO) Megha-Tropiques (ISRO, CNES) CHAMP (DLR) GRACE (NASA/DLR)	Atmospheric temperature Water vapour Cloud properties
LEO and GEO - Earth radiation	ACRIMSAT (NASA)	Earth care (ESA/JAXA)	Earth radiation budget

ECV INVENTORY QUESTIONAIRE

The joint activity of CEOS, CGMS and WMO started in May 2012 with a first deadline by 5 Oct. 2012 which was prolonged into springtime 2013.

Responses were requested at the dataset level.

Addressing both existing/past missions and future/ planned missions in two separate questionnaires.

ECV INVENTORY QUESTIONAIRE

Essential Climate Variable (ECV) Inventory

Home | View ECV Records | Editor LOGIN | Administrator LOGIN

Search Category: Show All

ECV Record Id	CDR_ECV04_7
Responder name	Rainer Hollmann
Responder email	rainer.hollmann@dwd.de
Data Set Identifier	Yes, new release of CM SAF (CM-05)
Responsible organization	EUMETSAT
International Coordination	yes SCOPE-CM
Assessment body	no
Quality control organization	no
Climate applications	cloud feedback, radiation budget
Essential Climate Variable (ECV)	Cloud amount
Collection organization	NOAA *EUMETSAT*
Calibration organization	NOAA
Intercalibration organization	NOAA
FCDR organization	NOAA
TCDR organization	EUMETSAT *CM SAF (DWD, KNMI, SMHI)*
GCOS Requirements Assessments organization	EUMETSAT *CM SAF*
Independent peer review organization	EUMETSAT *Secretariat*

ECV Records

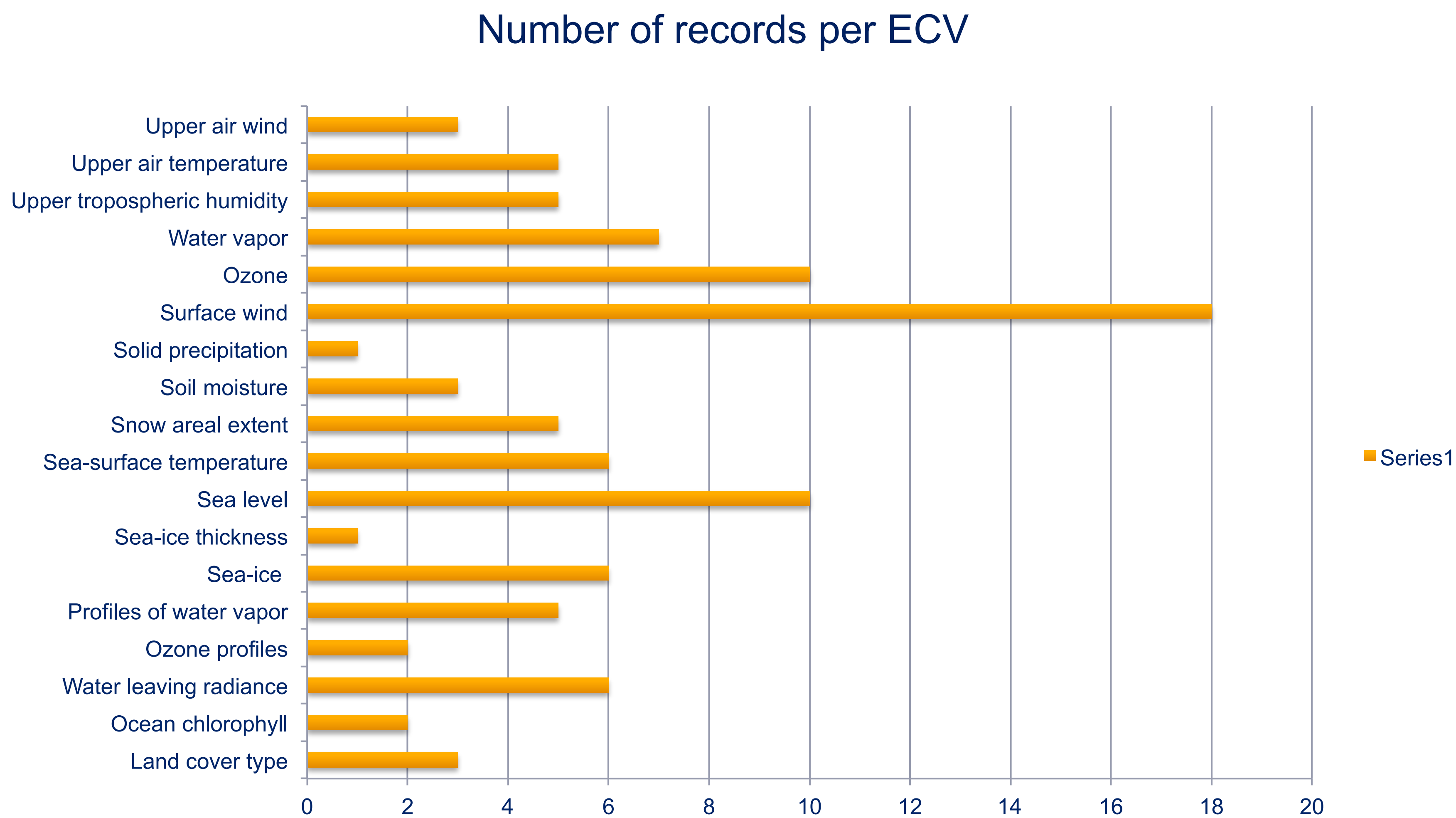
Atmosphere

- CDR_ECV01_10
- CDR_ECV01_11
- CDR_ECV01_12
- CDR_ECV01_13
- CDR_ECV01_14
- CDR_ECV01_15
- CDR_ECV01_16
- CDR_ECV01_17
- CDR_ECV01_18
- CDR_ECV01_19
- CDR_ECV01_20
- CDR_ECV01_21
- CDR_ECV01_3
- CDR_ECV01_4
- CDR_ECV01_5
- CDR_ECV01_6
- CDR_ECV01_7
- CDR_ECV01_8
- CDR_ECV01_9
- CDR_ECV02_1
- CDR_ECV02_2
- CDR_ECV02_3
- CDR_ECV02_4

ECV INVENTORY RESPONSE

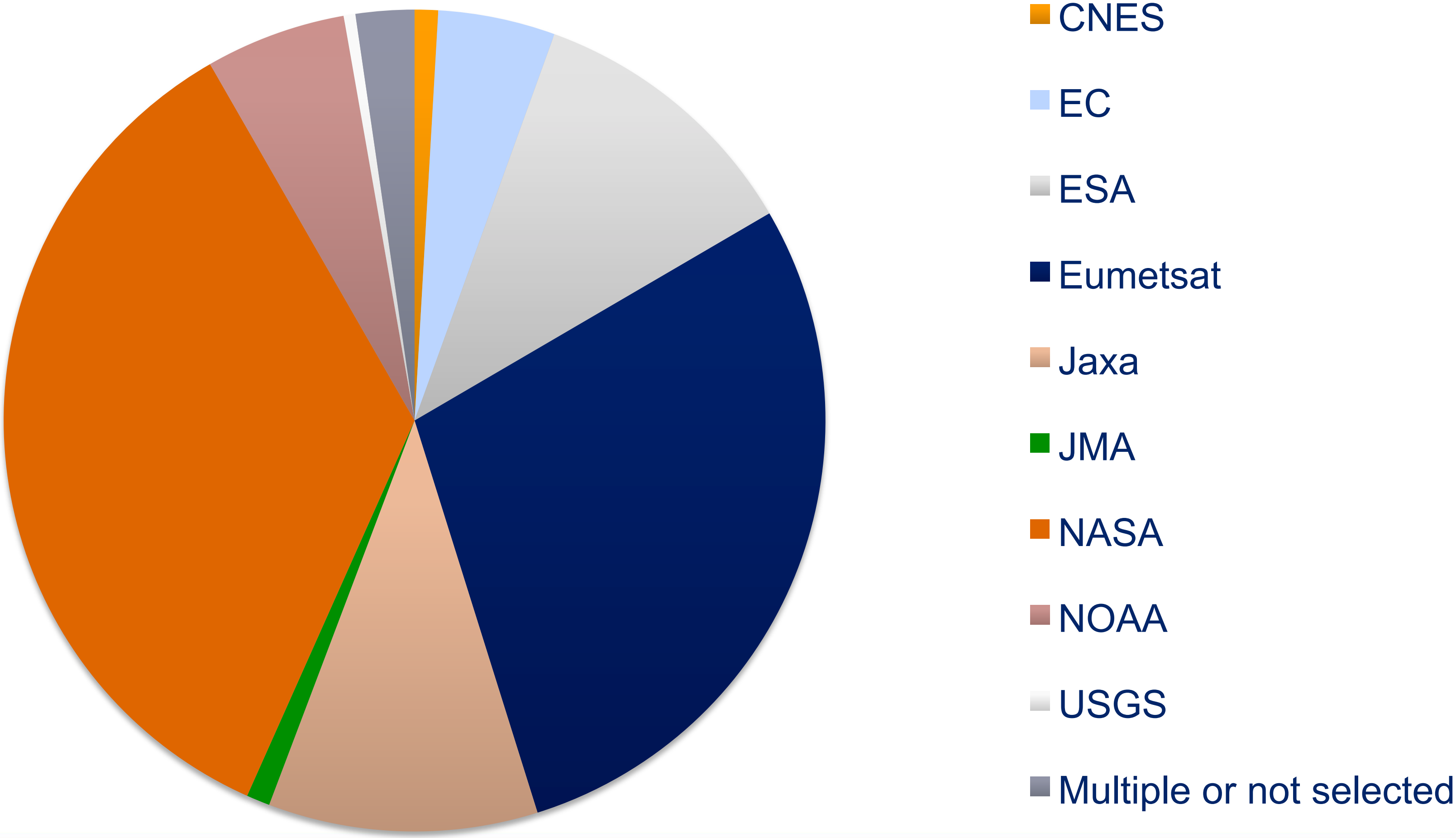
- ECV inventory now contains 220 records submitted for 11 responsible organizations, 25 of satellite-based ECVs submitted,
- No records were submitted for the following ECVs: carbon dioxide, methane, and greenhouse gases; sea state; sea surface salinity; lakes; above ground biomass; ice sheets,
- Some records are incomplete and organizations were encouraged to continue submitting data so we may begin conducting analyses.

ECV INVENTORY STATISTICS



ECV INVENTORY STATISTICS

- Number of records per responsible organization



INVENTORY STATISTICS – ECV TIMELINES

ECV Type	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Glaciers and Ice Caps																							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1													
Aerosol extinction profiles																																																2	2	2	2	2	2					
Aerosol optical depth												1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	8	8	8	8	8	8	8	9	9	9	9	9	9	8	2	2	1	1													
Aerosol single scattering albedo																																																1	1	1	1	1	1					
black-sky and white-sky albedo												1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	6	6	6	6	6	7	7	7	6	6	6	7	4	3	2	1	1												
Cloud amount										1	1	1	5	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	9	9	9	9	9	9	9	9	7	7	6	6	4	4	1	2	1	1	1	1	1					
Cloud effective particle radius									1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1		1	1	1	1	1	1					
Cloud optical depth									1	1	1	1	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	1	1	1	1				1	1	1	1	1	1					
Cloud top pressure and temperature									2	2	2	2	7	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	10	10	10	10	10	10	10	10	5	5	5	4	1	1		1	1	1	1	1	1					
Cloud water path									1	1	1	1	7	7	7	7	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	9	9	9	9	9	9	7	6	6	5	2	2												
CO																																									1	1	1															
Earth radiation budget (top-of-atmosphere and surface)			2	2	2	2	2	2	2	3	3	3	10	15	15	15	15	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	24	24	23	23	23	21	15	13	13	11	11	4												
High-resolution maps of land-cover type, for the detection																																					1	1	1	1	1																	
Ice velocity																						1	1	1	1	1	2	2	2	2	3	3	3	3	3	3	3	3	3	4	3	2	1	1	1													
Ice-sheet elevation changes																							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1													

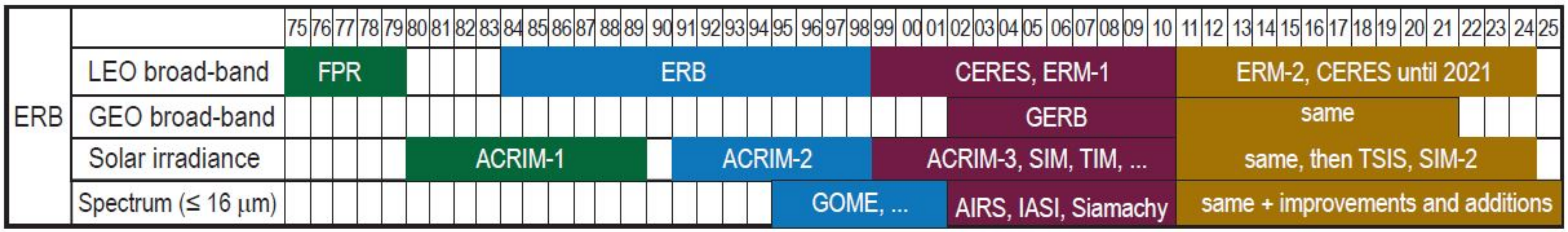
INVENTORY STATISTICS – ECV TIMELINES

ECV Type	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Land-surface temperature														2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1		1	1	1	1	1	1					
Liquid precipitation, solid precipitation										1	1	1	1	1	1	1	1	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	6	6	6	7	4	2	1	1	1										
Maps of burnt area																										2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	1	1															
Maps of LAI												2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	3					1	1	1	1	1	1					
Maps of the FAPAR												2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	4	4	3	4	4	4	4	4	4	4	4	4	3	3					1	1	1	1	1	1					
Moderate-resolution maps of land-cover type																													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					1	1	1	1	1	1	1	1	1	1	1
Ocean chlorophyll																												1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					1	1	1	1	1	1					
Water leaving radiance																												5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					1	1	1	1	1	1					
Ozone profiles										1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2															
Water vapor profiles														1	1	1	1	2	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2	3	1	1	1	1	1										
Sea-ice concentration/extent/edge									1	1	1	1	1	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1		1	1	1	1	1	2	1	1	1	1	1					
Sea-ice thickness			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																			
Sea-level																							1	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6	6	6	2	2															
Sea-surface temperature																1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	4	4	4	4	3	4	1	1	1	1	2	1	1	1	1	1					
Snow areal extent	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	2		1	1	1	1	1	2	1	1	1	1	1					
Soil-moisture map (up to 10cm soil depth)									1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	1	2	1	1	1	1	1										
Solid precipitation																											1	1	1	1	1	1	1	1	1	1	1	1	1																			
Surface wind																		8	8	8	9	10	9	9	9	10	10	12	11	12	12	11	12	12	12	12	12	11	11	11	10	10	4	2	2	1	1	1										
Total column ozone	1	1	1	1	1	1	1		1	1	1	1	1	2	2	3	3	3	3	4	4	3	3	3	3	4	4	4	4	3	4	4	4	4	4	5	5	4	4	5	4	4																
Total column water vapor																		5	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7	7	7	7	7	6	6	5	3	3	3	1	1													
Upper tropospheric humidity									1	1	1	1	2	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	4	4	4	4	4	4	4	4	3	2	2	1	1														
Upper-air temperature									1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	5	5	5	5	4	4																
Upper-air wind										1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	1	1	1	1	1	1	1	1																		

USAGE OF THE INVENTORY

- Describes the current and planned monitoring capability on an ECV basis (allow easier response to e.g. GCOS IP, GFCS IP),
- combined perspective of the logical and physical views should enable the definition of an optimum “macro scale” space system configuration (constellation) and its components used at the ECV/product level to identify gaps and shortfalls,
- formulation of a coordinated action plan to address such gaps and shortfalls,
- trigger for the medium-term activities that need to be undertaken to sustain the long-term implementation of the architecture

GAP ANALYSIS



Gap Analysis

The heritage of ERB missions is quite long-standing, but long-term commitment beyond ~ 2021 are limited to perhaps too simple instruments. The same holds for solar irradiance monitoring. No commitment is available for continuity in GEO after GERB (expected end-of-life: 2021). As for outgoing spectral radiance, the range utilised for operational SW and TIR instruments (~ 0.3-16 µm) is secured, but external to this range (most critical, Far IR) the only plan is CLARREO, still a process study mission.

ECV Earth Radiation Budget is at risk as it concerns all aspects: both continuity and quality, of both broad-band and solar irradiance measurements.

WAY FORWARD - 1

Define, Validate and Obtain Consensus on Overall Approach (including logical representation)

↓

Describe Current and Planned Implementation Arrangements (ECV-by-ECV) within an Inventory

↓

Use the Inventory to Develop a Coordinated Action Plan to Address Identified Gaps/ Shortfalls

Short-term

(within 2 years)

Current status

Medium-term

(2-4 years)

WAY FORWARD - 2

- CGMS- 40 proposed to establish a Joint CEOS-CGMS WG on Climate in Nov. 2012 in order to develop the physical view and the coordinated action plan;
- CEOS SIT endorsed the general approach of a joint WG in March 2013;
- Draft TOR for the joint WG were developed in April/June 2013;
- The draft TOR were endorsed by CGMS-41 in July 2013;
- These TOR will be presented to CEOS Plenary in November 2013 for the final approval;
- Assuming approval by the CEOS Plenary in November, the WG will become active immediately thereafter.