Initial Progress of the CEOS Working Group on Climate

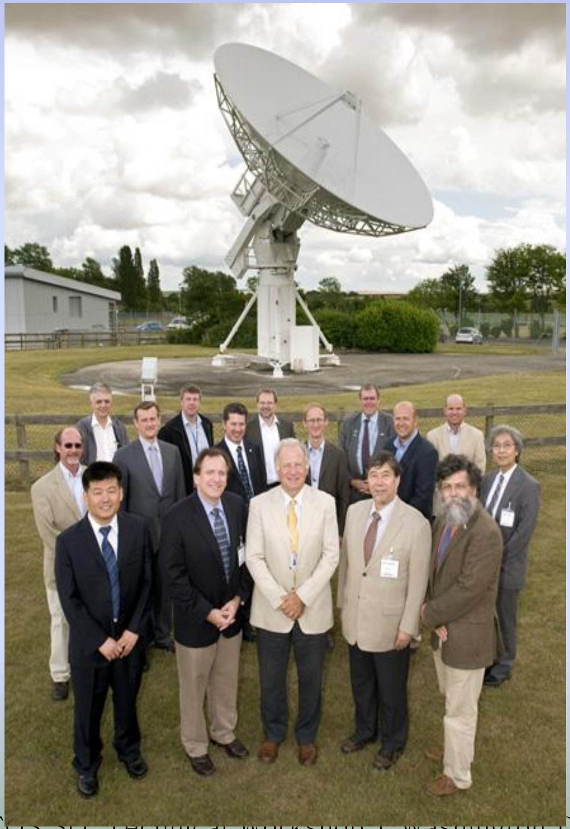
Mark Dowell

EC/JRC

Committee on Earth Observation Satellites

Committee on Earth Observing Satellites Working Group on Climate (WGClimate)

WGClimate was endorsed as a full CEOS WG (joining WGISS, WGCV and WGEdu) and will coordinate and encourage collaborative activities between the world's major space agencies in the area of climate monitoring



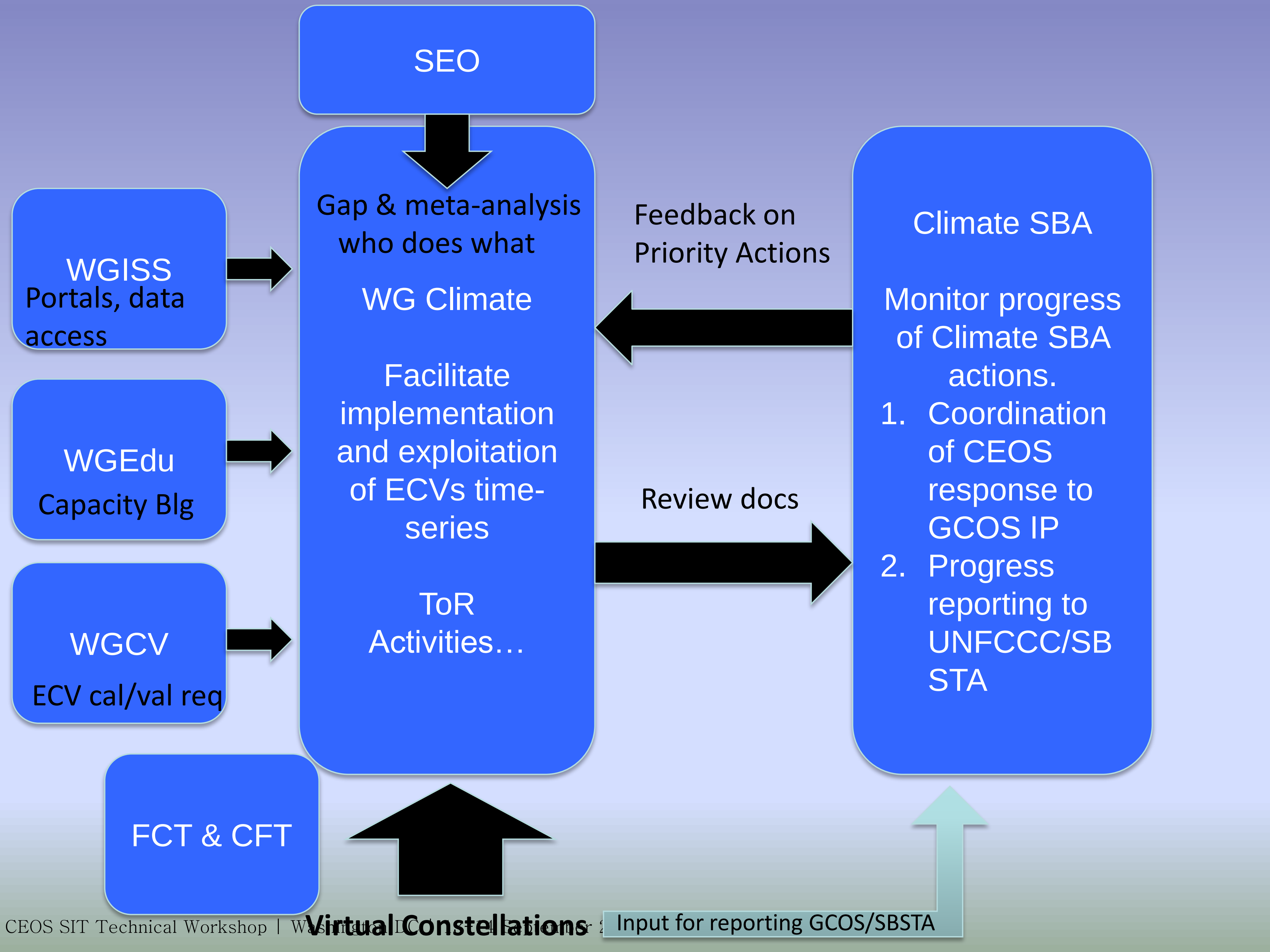
The Mission of the Working Group Climate (WGClimate) is to facilitate the implementation and exploitation of Essential Climate Variable (ECV) time-series through coordination of the existing and substantial activities undertaking be CEOS member agencies. This includes the numerous iterative steps involved in the creation of ECVs and ensuring ECV life cycle information is gathered, organized, and preserved for future generations

Chair of CEOS WGClimate
Mark Dowell (EC/JRC)
Vice Chair John Bates (NOAA/NCDC)

Membership

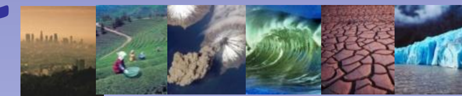
- Mark Dowell - EC/JRC (Chair)
- John Bates – NOAA (Vice Chair)
- Tamotsu Igarashi - JAXA
- Joerg Schulz - EUMETSAT
- Yang Jun - CMA
- Andy Shaw - UKSA/NCEO
- Pascal Lecomte - ESA
- John Dwyer - USGS
- Eric Lindstrom - NASA
- Didier Renaut - CNES
- Daniel Alejandro Vila - INPE
- Stella Melo - CSA
- Albrecht von Bargen - DLR
- Robert Husband - EUMETSAT
- Mitch Goldberg – NOAA (Climate SBA)
- Brian Killough – NASA (SEO)
- Shelley Stover – NASA (SEO)
- Kerry Sawyer – NOAA (DCEO)
- Carolin Ritcher - GCOS
- Barbara Ryan - WMO
- Jerome Lafeuille - WMO
- Seonkyun Baek - GEO

Membership of CEOS VCs and WGs (?)


SEO
Gap & meta-analysis who does what
WG Climate
Facilitate implementation and exploitation of ECVs time-series
ToR
Activities…
WGISS
Portals, data access
WGEdu
Capacity Blg
WGCV
ECV cal/val req
FCT & CFT
Virtual Constellations
Feedback on Priority Actions
Review docs
Climate SBA
Monitor progress of Climate SBA actions.
1. Coordination of CEOS response to GCOS IP
2. Progress reporting to UNFCCC/SBSTA
Input for reporting GCOS/SBSTA
CEOS SIT Technical Workshop |

CEOS
Committee on Earth Observation Satellites

Terms of Reference



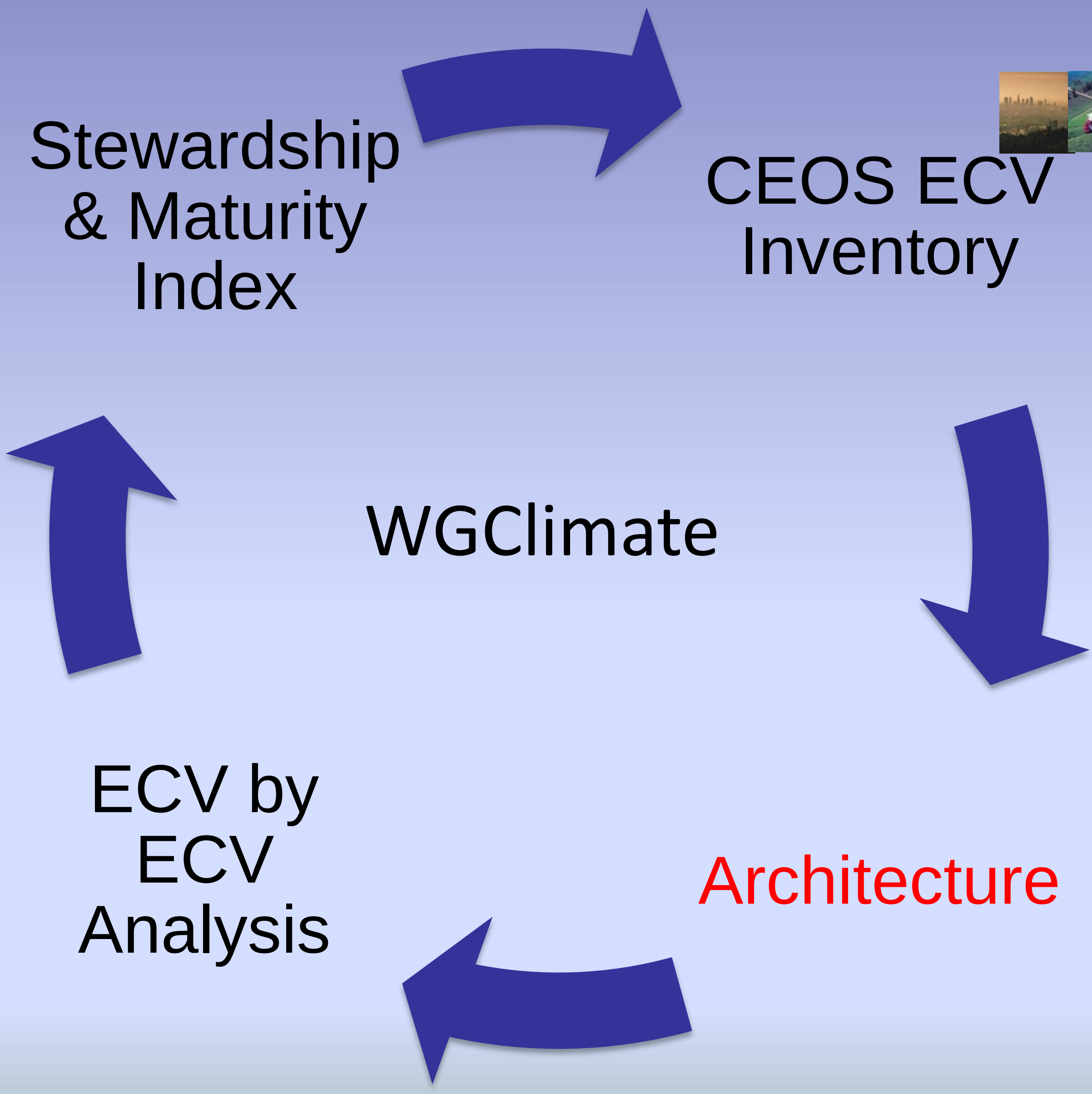
- The CEOS Climate Working Group will:
  - Review and assess, on behalf of CEOS, the generation of Fundamental Climate Data Records (FCDRs) and derived Essential Climate Variable (ECV) climate products supported by Member space agencies, complementary with existing entities and roles;
  - Contribute to the review of compliance of satellite missions and products with the GCOS Climate Monitoring Principles and with the “Guideline for the Generation of Datasets and Products meeting GCOS Requirements” (GCOS-143);
  - Identify multi-agency implementation teams for each product and review their actions, and ensure that a coherent implementation plan exists for each and every product taking full account of other pertinent international initiatives such as SCOPE-CM and science programmes;
  - Make recommendations to the above teams and receive recommendations from them, for transmission to CEOS Agency Principals;
  - Ensure coherence of climate product generation supported by space agencies, including with other relevant international initiatives, in particular SCOPE-CM, and);
  - Undertake any other relevant activities as instructed by CEOS Chair.

First WGClimate meeting

- May 26-27 – Frascati
- Co-located with SIT
- Almost all WG members
- + good involvement from other SIT participants

Activities discussed at first meeting

- CEOS ECV Inventory:
  - Discussion on maturity index
  - Discussion on climate information stewardship issues
- Climate Monitoring Architecture
- ECV by ECV analysis/assessment
- Outreach/Networking: both internal with other CEOS WGs and VCs & external SCOPE-CM/GSICS and WCRP CMIP


Stewardship & Maturity Index
CEOS ECV Inventory
WGClimate
Architecture
ECV by ECV Analysis

Representation at meetings

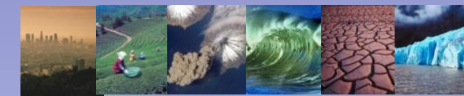
- Jan 2011: GCOS Satellite Supplement Update meeting
- Jan 2011: WMO-GCOS Continuity and Architecture Requirements for Climate Monitoring meeting
- Feb 2011: WGClimate technical meeting to discuss SEO support and Architecture (Dowell, Bates, Killough, Stover, Lecomte, Husband)
- Mar 2011: CEOS-CGMS Climate monitoring Architecture writing team meeting
- Apr 2011: WCRP-GCOS WOAP meeting
- Oct 2011: WCRP Open Science Conference

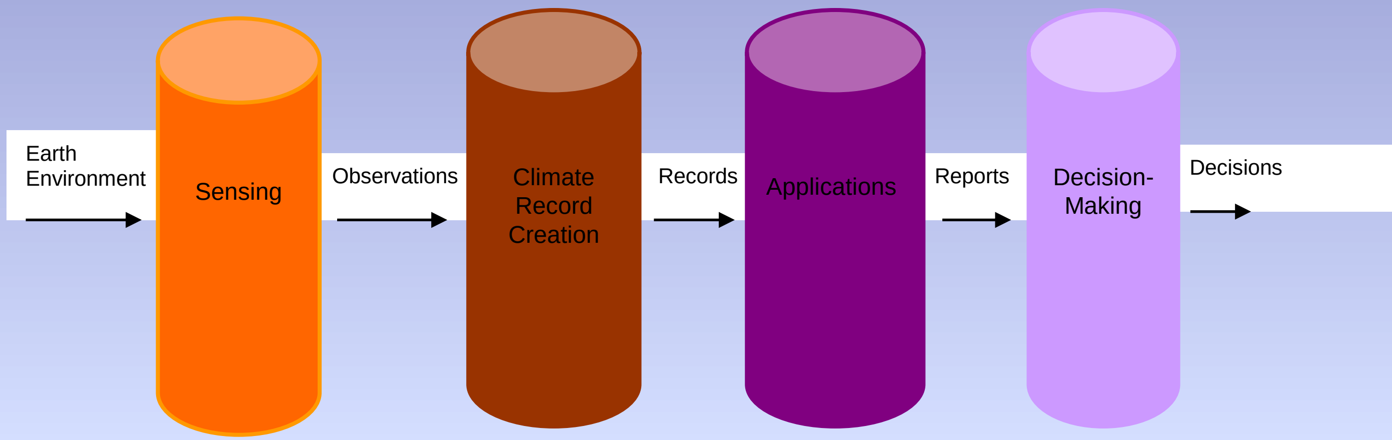
Why do we need a Climate Monitoring Architecture?

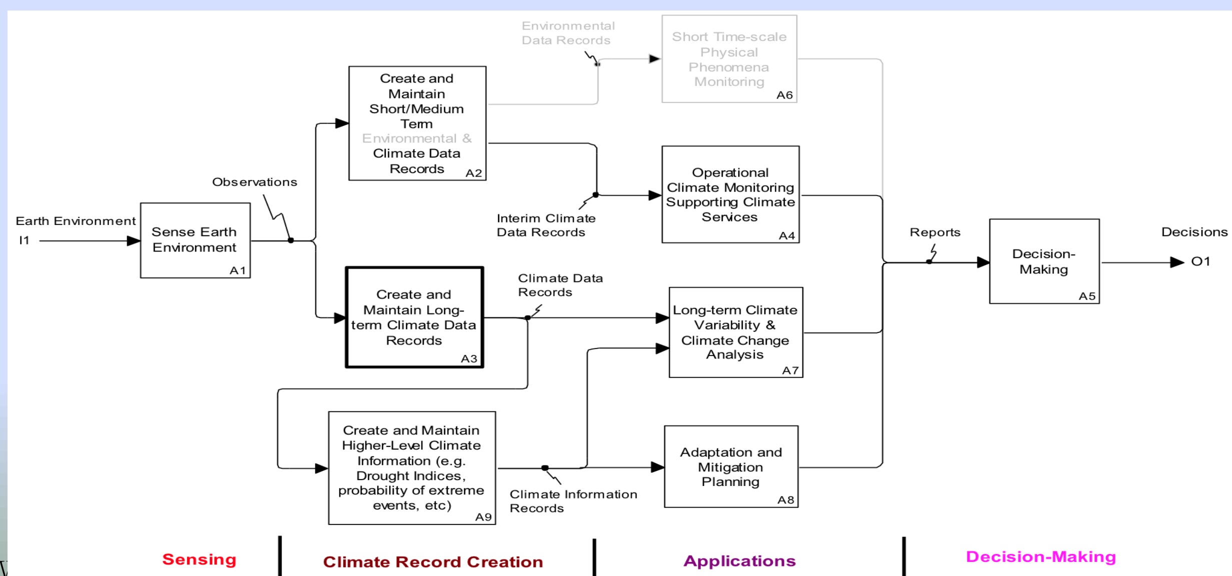
Based on discussions three main "needs/usage scenarios" have emerged for a climate monitoring architecture:

- A Assist **in promotion of a common** understanding of the implementation implications of meeting the various space-related climate monitoring requirements (e.g. from GCOS)
- B To support **an assessment of the degree to which the currently implemented systems meet the requirements** (and the generation of an action plan to address identified shortfalls/gaps/duplication)
- C To improve our **understanding of the end-to-end information flows** and dependencies (i.e. from sensing through to decision-making)

Architecture / conceptual framework





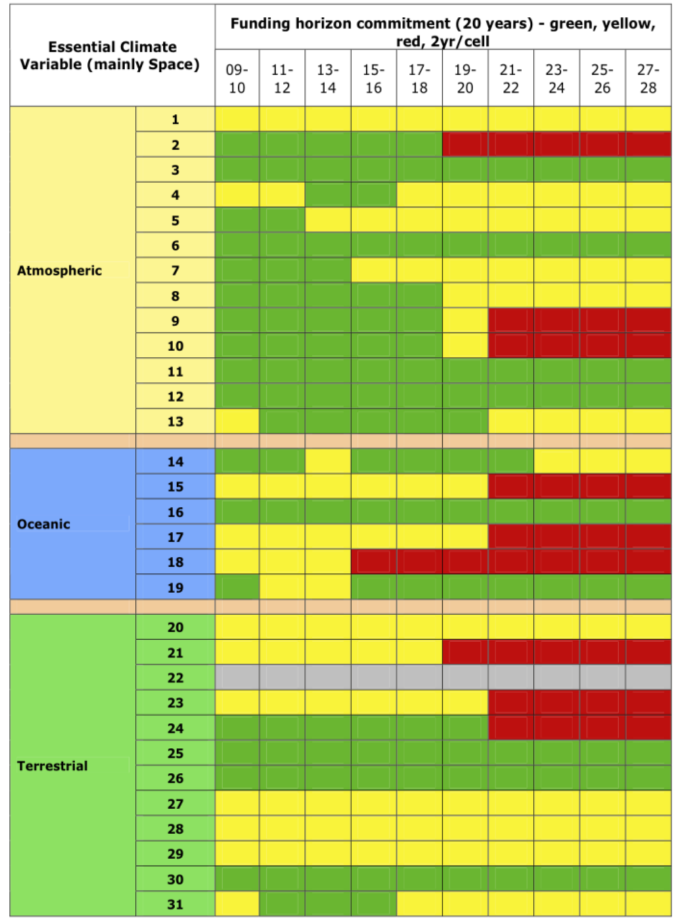


Example ECV Gap Analysis

8 Gap analysis: Table 5

Essential Climate Variable (mainly Space)			Fundamental Climate Data Record	GCOS Horiz. Res. Goal
Atmospheric	1	***Precipitation***	Passive microwave radiances, High frequency geostationary IR, Active radar (for calibration)	100 km (1 km for extreme events)
	2	***Earth Radiation Budget***	Broadband radiances, Spectrally resolved solar irradiances, Geostationary multi-spectral imagery	100 km
	3	***Upper-air Temperature***	Passive microwave radiances, GPS radio occultation, High spectral resolution IR radiances for re-analyses.	100 km
	4	***Upper-air Wind***	VIS/IR imagery, Doppler wind lidar	100 km
	5	***Surface Wind Speed and Direction***	Passive microwave radiances and scatterometry	10 km
	6	***Water Vapour***	Passive microwave radiances, UV/VIS Radiances, IR imagery/soundings in 6.7um band, Microwave soundings in 183 GHz band	10 - 50 km
	7	***Cloud Properties***	VIS/IR imagery, IR and microwave soundings	99 - 100 km
	8	***Carbon Dioxide***	NIR/IR radiances	10 - 250 km
	9	***Methane***	NIR/IR radiances	10 - 50 km
	10	***Other GHGs***	NIR/IR radiances	
	11	***Ozone (tropospheric)***	UV/VIS radiances, IR/Microwave radiances	5 - 50 km
	12	***Ozone (stratospheric)***	UV/VIS radiances, IR/Microwave radiances	50 - 100 km
	13	***Aerosol Properties***	VIS/NIR /SWIR radiances	1 – 10 km
Oceanic	14	***Sea-Surface Temperature***	Single & multi-view IR and microwave imagery	1 km
	15	***Sea Level***	Altimetry	25 km
	16	***Sea Ice***	Passive Microwave imagery (DMSP, AMSRE), SAR, TIR & VIS imagery	12 – 100 km
	17	***Sea State***	Altimetry, scatterometer, SAR	25 km
	18	***Ocean Salinity***	Microwave radiances	15 - 100 km
	19	***Ocean Colour (IOP + Chl_a)***	Multispectral VIS imagery	1 km
Terrestrial	20	***Snow Cover (Extent, Snow Water Equivalent)***	VIS/NIR/IR and passive microwave optical imagery	100 m – 100 km
	21	***Glaciers and Ice Caps***	VIS/NIR/SWIR optical imagery, Altimetry	30 m
	22	***Permafrost and seasonally -frozen ground***	-	250 m
	23	***River Discharge***	Altimetry	10 km
	24	***Lake level/properties***	VIS/NIR imagery radar imagery, Altimetry, IR imagery	1 - 4 km
	25	***Albedo***	Multispectral and broadband imagery	1 km
	26	***Land Cover***	multispectral VIS/NIR imagery	250 m
	27	***fAPAR***	VIS/NIR imagery	250 m
	28	***Leaf Area Index***	VIS/NIR imagery	250 m
	29	***Biomass***	L Band / P Band SAR, Laser altimetry	10 m
	30	***Fire Disturbance***	VIS/NIR/SWIR/TIR multispectral imagery	250 m
	31	***Soil Moisture (surface and root zone)***	Active and Passive microwave (Scatterometer and SMOS)	50km

34



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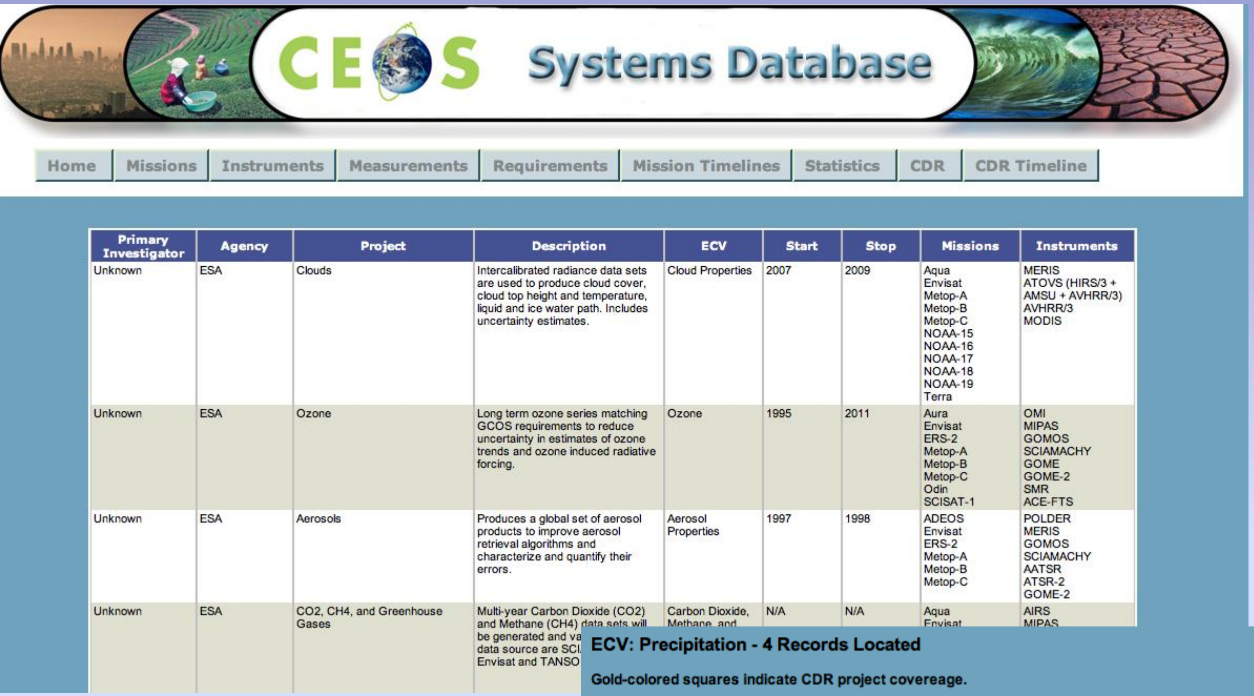
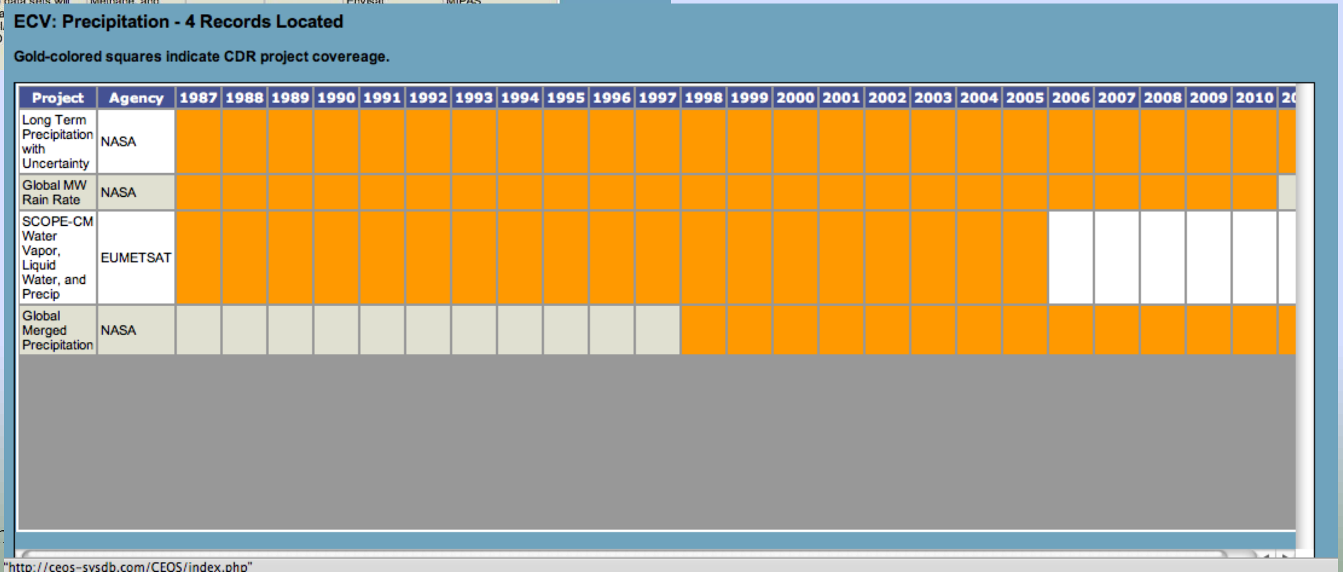
Prototype SEO CEOS ECV Inventory



Primary Investigator	Agency	Project	Description	ECV	Start	Stop	Missions	Instruments
Unknown	ESA	Clouds	Intercalibrated radiance data sets are used to produce cloud cover, cloud top height and temperature, liquid and ice water path. Includes uncertainty estimates.	Cloud Properties	2007	2009	Aqua Envisat Metop-A Metop-B Metop-C NOAA-15 NOAA-16 NOAA-17 NOAA-18 NOAA-19 Terra	MERIS ATOVS (HIRS/3 + AMSU + AVHRR/3) AVHRR/3 MODIS
Unknown	ESA	Ozone	Long term ozone series matching GCOS requirements to reduce uncertainty in estimates of ozone trends and ozone induced radiative forcing.	Ozone	1995	2011	Aura Envisat ERS-2 Metop-A Metop-B Metop-C Odin SCISAT-1	OMI MIPAS GOMOS SCIAMACHY GOME GOME-2 SMR ACE-FTS
Unknown	ESA	Aerosols	Produces a global set of aerosol products to improve aerosol retrieval algorithms and characterize and quantify their errors.	Aerosol Properties	1997	1998	ADEOS Envisat ERS-2 Metop-A Metop-B Metop-C	POLDER MERIS GOMOS SCIAMACHY AATSR ATSR-2 GOME-2
Unknown	ESA	CO2, CH4, and Greenhouse Gases	Multi-year Carbon Dioxide (CO2) and Methane (CH4) data sets will be generated and va data source are SCI Envisat and TANSO	Carbon Dioxide, Methane, and	N/A	N/A	Aqua Envisat	AIRS MIPAS



Inventory

- Harmonization
  - GCOS Guidelines and GCMP
  - Logical Architecture
  - Maturity Index
- Align with existing MIM information requests
- Input for physical architecture

ECV by ECV analysis

- Identifying roles and responsibilities
- Establish role of VCs
- Define common “ECV strategy” template
- Interagency assessments
  - Do we need an "independent assessment" bodies?
  - Establish role of WGCV
- Identify pilot ECVs for assessment – SST (?)

ECV Assessments

- Independent assessments.
  - May look to WCRP for cooperation on this
  - Also other thematic scientific bodies e.g. IOCCG

Planned documents

- WGClimate guidance document defining governance of WG – draft of this is available
- 2-3 year Workplan – will be prepared by Plenary

- Strategy doc for Climate Monitoring Architecture

Representation

- WGClimate chair and vice chair would like to prioritize representation at various relevant meetings
- 2011 focus on WCRP/WOAP, GCOS, SCOPE-CM, WMO
- Do not plan to attend COP-17 – suggest focus efforts for 2012 (COP-18) – this will coincide with CEOS response to GCOS IP

Writing group on Architecture for Space-based Climate Monitoring

Mark Dowell

EC/JRC

January WMO-GCOS meeting

- Agreement that climate architecture is needed
- Fully integrated architecture needed
  - *In situ* observations must be included
- It’s complex but shouldn’t stop us from moving forward
- WMO lead is positive and commendable
- Discussion on GEO Tasks
  - General consensus is that coordinated activities led by WMO will contribute eventually to re-scope/ leverage/strengthen existing GEO Task CL-09-02

Key Discussion Points con't

- Discussion about applying GCOS Climate Monitoring Principles (GCMPs)
  - To the extent possible, space agencies will apply GCMPs
- Each organization or group to focus on its relevant activities and respective mandates
- Research to operations paradigm is too simplistic in climate context and to the extent we can avoid these words, we want to talk about a continuum

Conclusions of January Meeting

- Agreed to develop a strategy for climate monitoring architecture
- Identified writing group
  - CEOS – Four/Five from Working Group Climate
  - CGMS – Four/Five TBD
  - WMO Secretariat – Barb Ryan, Jerome Lafeuille
- Identified review group
  - GEO Secretariat
  - GCOS
  - WCRP
- Develop strategy for developing the architecture (draft due end of August 2011)

No logo / Badgeless Activity

CEOS
Committee on Earth Observation Satellites

List of Participants

- EC – Mark Dowell, Chair
- ESA – Pascal Lecomte
- EUMETSAT – Joerg Schulz, Robert Husband
- JMA – Yoshihiko Tahara
- NASA – Richard Eckman (Eric Lindstrom)
- NOAA – John Bates, Suzanne Hilding, Chuck Wooldridge, (Mitch Goldberg)
- INPE – (Daniel Alejandro Vila)
- WMO – Jerome Lafeuille, Barbara Ryan, Tillmann Mohr, Hye Jin Lee

- Review Group:
  - GCOS
  - GEO
  - WCRP

Meeting of writing team 3-4 March 2011 (Geneva)

CEOS
Committee on Earth Observation Satellites

Timeline

how we spent out summer

- 15 April – Drafts of extended chapter outlines to be sent to Mark Dowell.
- 04 May– First draft of entire extended outline to be sent to Writing Team for review.
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climate
Climate
data
satellite
requirements
monitoring
GCOS
WMO
ECV
Earth
information
observations
architecture
calibration
Data
CEOS
GEO
EUMETSAT
operational
missions
series
GSICS
ESA
Global
NOAA
NASA
agencies
activities
quality
Satellite
measurements
satellites
space
time
system
mission
research
Requirements
Records
validation
provide
accuracy
coordination
sensors
irradiance
different
applications
Gap
QA4EO
LEO
standards
community
Monitoring
CMA
CGMS
product
continuity
CDR
view
process
processes
Operational
Observation
Architecture
Figure
change
required
instrument
international
systems
traceability
WGCV
Table
need
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budget
products
radiation
current
JAXA
including
System
CCI
IR
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relevant
specific
generation
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provides
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support
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gap
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strategy
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identified
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well
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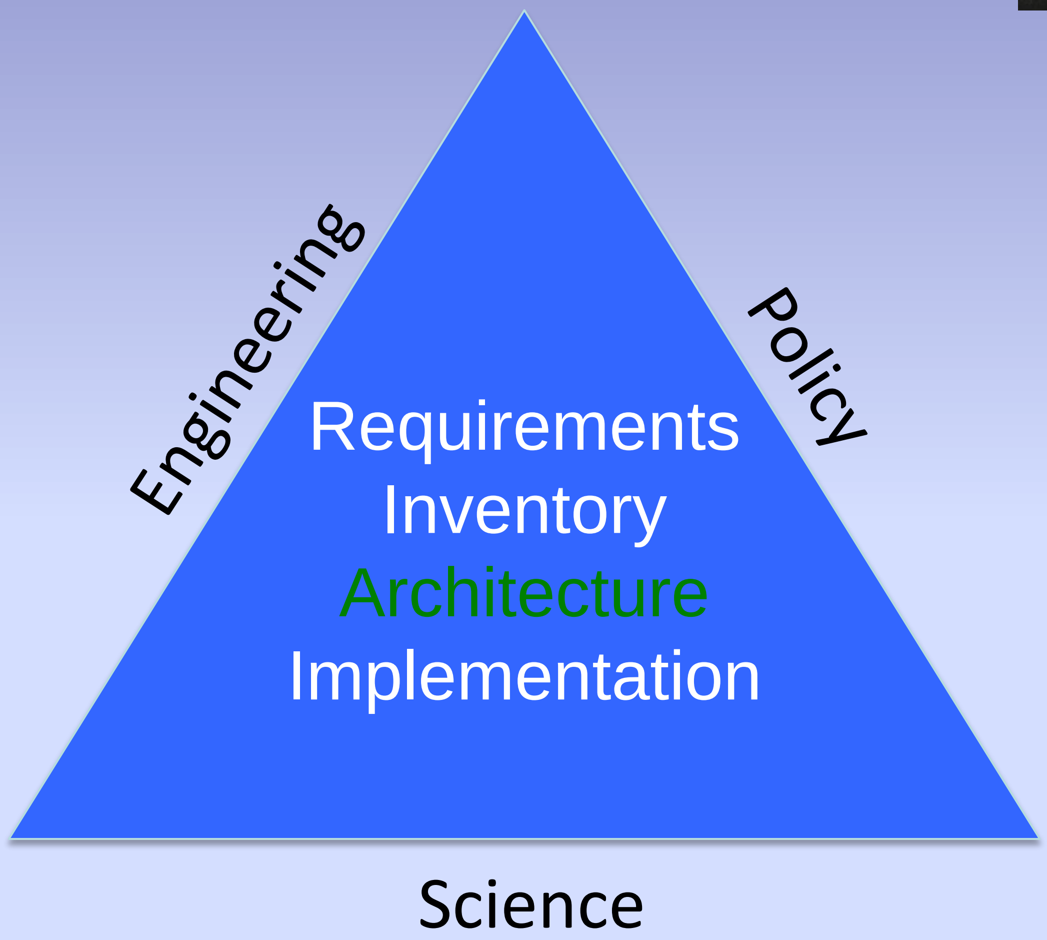
Outline

- **Executive Summary and recommendations**
- **Introduction, Objectives & Targets**
- **Climate Monitoring Principles, Requirements & Guidelines**
- **State of the Art**
- **Beyond research to operations**
- **Climate Architecture definition**
- **Mechanisms for Interaction**
- **Roadmap for way forward**
- **Recommendations**

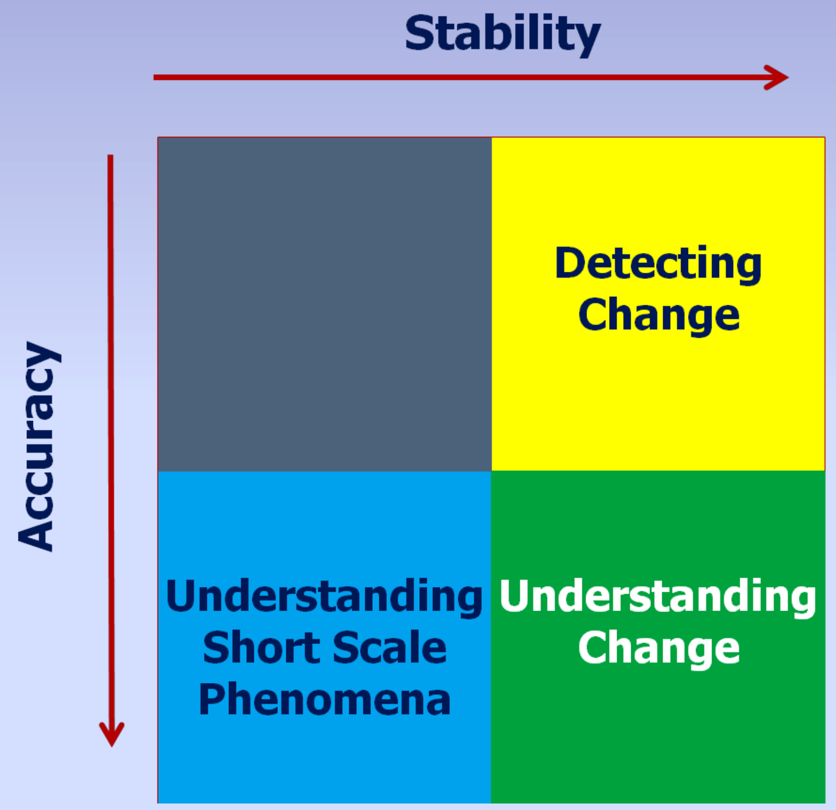
Positioning the current report

- approach adopted is intentionally open and inclusive
- designed so that all the relevant entities can identify their potential contributions
- even if this maybe 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.


Engineering
Policy
Requirements
Inventory
Architecture
Implementation
Science

Climate Monitoring Principles, Requirements & Guidelines

- Why are specific requirements necessary?
- What requirements are relevant?
- What is the source of requirements?
- What is the impact of user requirements on instrument requirements and satellite operations?
- What requirements result for data processing, archiving and distribution?

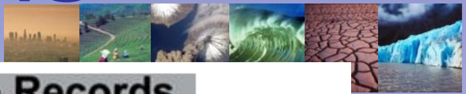


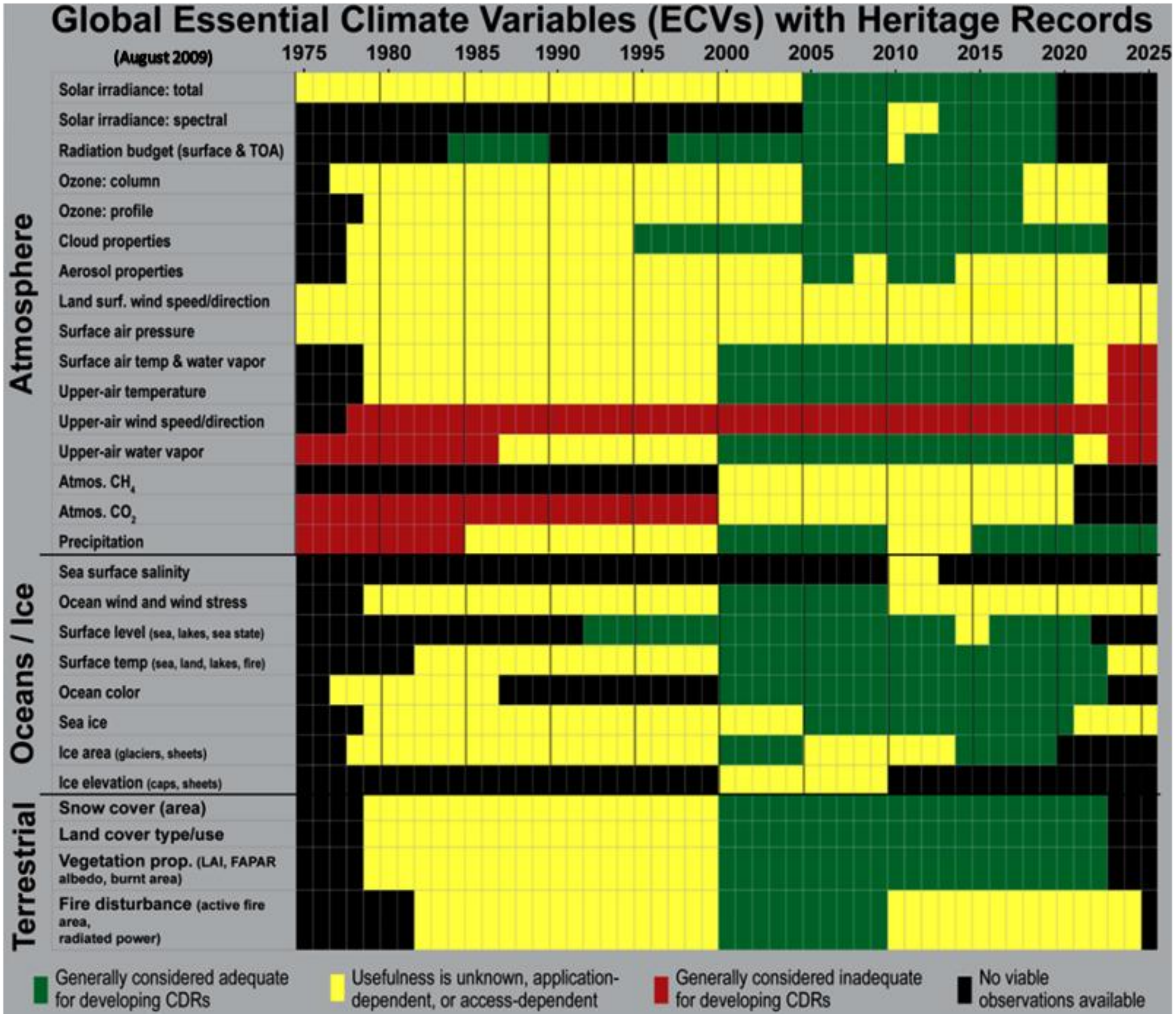
Stephens (2003)

State of the Art

- Heritage of past satellite missions
- Current and planned satellite missions for climate
- Gap analyses of satellite missions compared with GCOS requirements for ECVs
- Satellite instrument calibration activities
- Processing of Climatic Data Record
- Existing multi-agency mechanisms e.g. VCs & SCOPE-CM

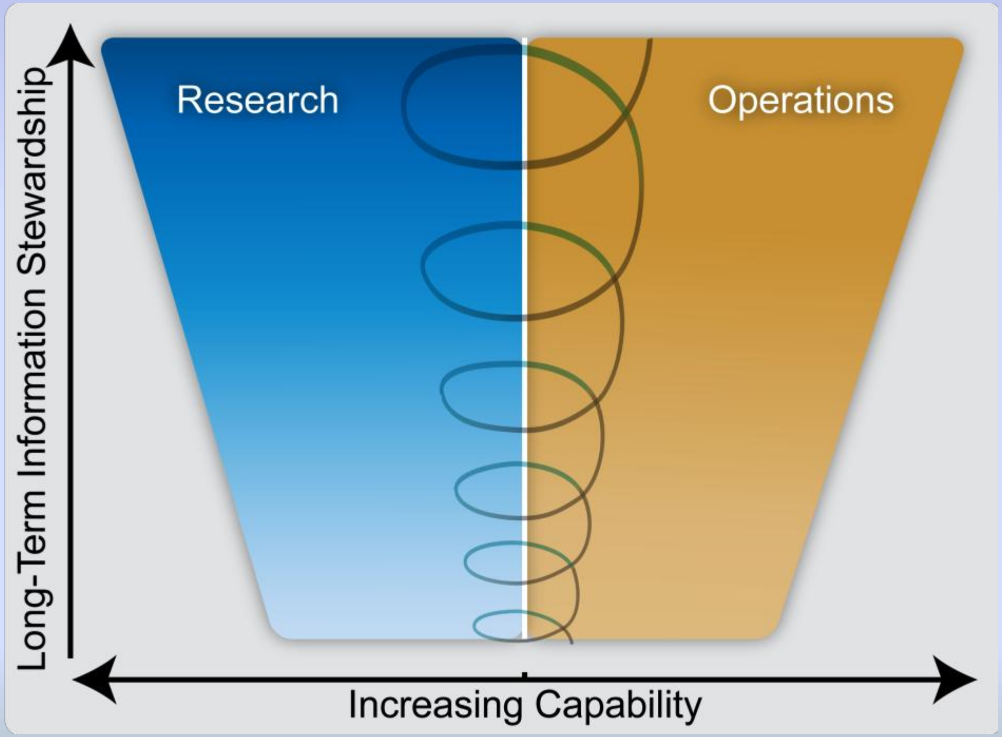
Example gap analysis





Research AND Operations

A holistic view of the interdependency of research and operations needed for sustained and routine climate monitoring.



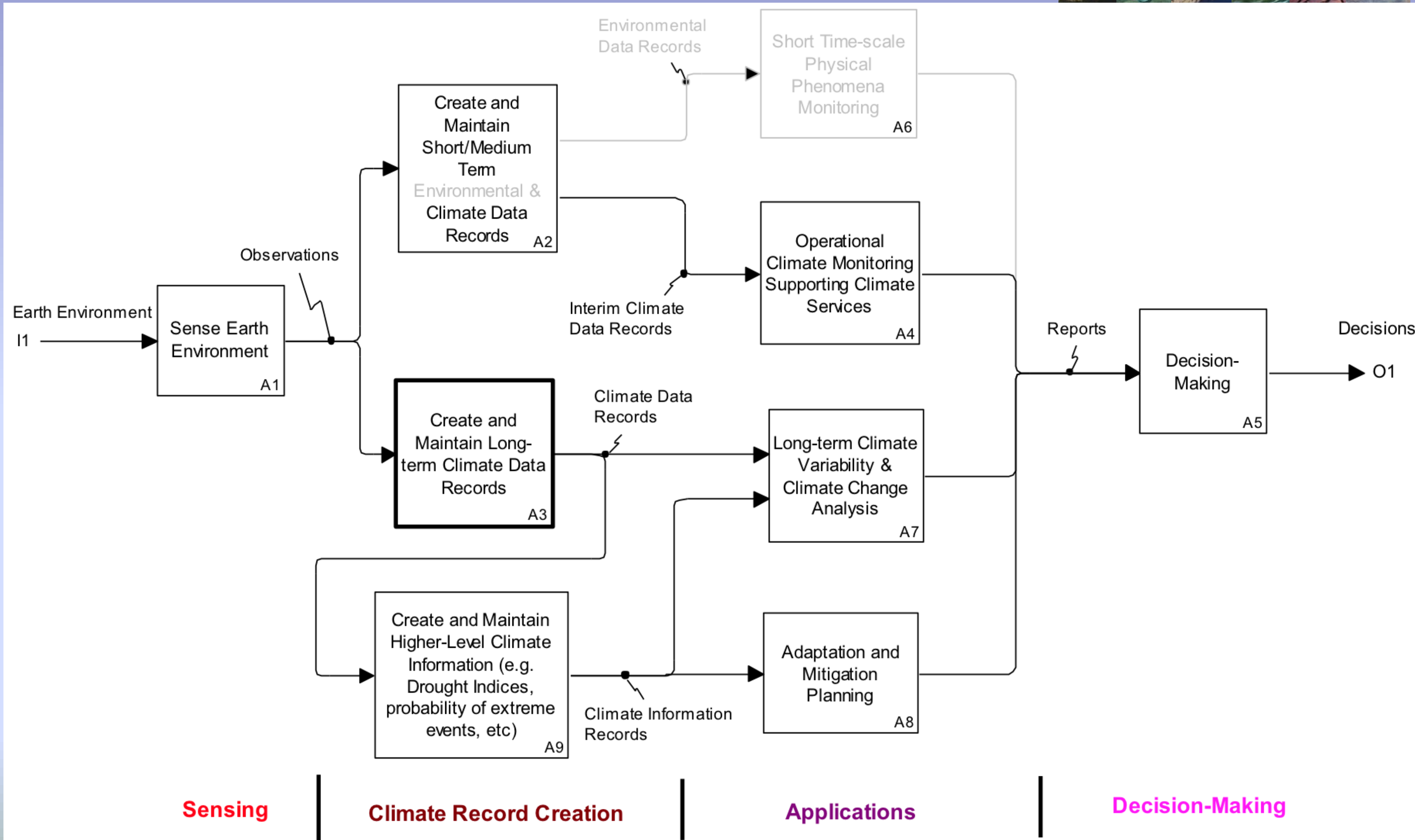
2 part Architecture

- The proposed architecture consists of two parts
  - a generic (ECV-independent) logical architecture that represents the functional components of the assumed requirements baseline (based on GCOS documentation)
  - a companion physical architecture that is designed to capture the current and planned physical implementation arrangements on an ECV-by-ECV basis.

Logical and Physical Architecture

- **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 maintained on a regular basis to make sure it appropriately reflects the prevailing status (will take longer to determine)

Logical Architecture



Way Forward

Define, Validate and Obtain Consensus on Overall Approach

↓

Describe Current and Planned Implementation Arrangements (ECV-by-ECV) within the Physical Architecture

↓

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

Short-term

(within 2 years)

Medium-term

(2-4 years)

Internal review

- Submitted to GCOS, GEO and WCRP in August
- Comments from GCOS and WCRP last week
- No comments from GEO
- Both GCOS and WCRP were largely complimentary and provided some specific comments/concerns

GCOS and WCRP comments

- GCOS
  - “addressing upstream planning processes (e.g. requirements addressing the phasing of programmes to ensure sensor overlaps) will not be represented in the architecture.”
  - “GFCS observational requirements may differ from those of GCOS because of regional and local targets that GCOS lacks. The regional and the local are of concern to GCOS, and received increased emphasis in the 2010 revision of the Implementation Plan, as recognized and welcomed by UNFCCC/SBSTA.”
- WCRP
  - “It may be strategically useful to emphasise the need for independent or at least collaborative assessment of datasets. We now have more than one version of most ECVs. “

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Towards Plenary

- Agencies will be asked to review the document and provide feedback by Plenary (the same request is being made of CGMS)
- We will subsequently revise the document based on the feedback received both by CEOS and CGMS – final version Q1 2012.
- Discussion on the use of the Architecture development as a framework for the work of WGClimate