CEOS & it's Working Group on Climate

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NB: the Climate Monitoring Architecture material shown here Is joint CEOS , CGMS, WMO activity

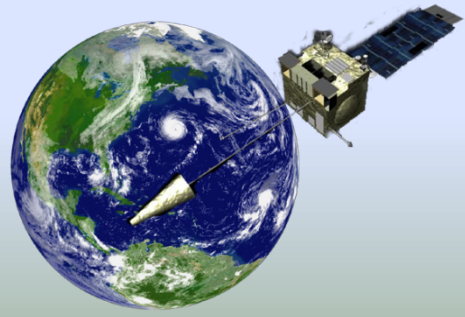
Committee on Earth Observation Satellites

CEOS Background

- Established in 1984 under auspices of G-7 Economic Summit of Industrialized Nations
  - Focal point for international coordination of space-related Earth Observation (EO) activities
  - Optimize benefits through cooperation of members in mission planning and in development of compatible data products, formats, services, applications, and policies
- Operates through best efforts of Members and Associates via voluntary contributions
- 30 Members (Space Agencies), 22 Associates (UN Agencies, Phase A programs or supporting ground facility programs)
- As the space component of the Global Earth Observation System of Systems (GEOSS), CEOS is implementing high priority actions in support of Group on Earth Observation (GEO) Tasks

Primary Objectives of CEOS

1. To optimize benefits of space-borne Earth observations through:
   - Cooperation of its Members in mission planning
   - Development of compatible data products, formats, services, applications, and policies;
2. To serve as a focal point for international coordination of space-related Earth observation activities;
3. To exchange policy and technical information to encourage complementarity and compatibility of observation and data exchange systems.



Persistent request to CEOS from UNFCCC/SBSTA on systematic climate observations.

Rationale for a Concerted Climate Activity in CEOS

- Many Climate Initiatives undertaken by space agencies both in and outside of CEOS
  - SCOPE-CM
  - ESA Climate Change Initiative
  - EUMETSAT Climate Programme
  - Developing NOAA Climate Services
  - ……
- Many relevant existing Scientific Groups
  - IOCCG
  - GHRSST
  - Sea surface topography
  - GEWEX
  - ... etc ...
- CEOS Virtual Constellations contribute in specific ECV areas
  - Ocean Surface Topography
  - Precipitation
  - Ocean Colour Radiomtery
  - Ocean Surface Vector Winds
  - Land Surface Imaging
  - Sea Surface Temperature

- **Need to have overall coherent approach**

CEOS represents agencies with both research and operational mandate

R to O OR R and O ?

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

WGClimate was endorsed as a full CEOS WG at the end of 2010 (the first new WG in 10 years!)) 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 by 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)

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.

Priorities for WGClimate

- Climate Monitoring Architecture
  - Logical architecture, basis for prioritizing WGClimate activities
  - Relation of physical architecture to ECV Inventory
- CEOS/CGMS ECV Inventory:
  - Discussion on maturity matrix model
  - Discussion on climate information stewardship issues
- ECV by ECV analysis -> Assessments
- Outreach/Networking: both internal with other CEOS WGs and VCs & external SCOPE-CM/GSICS and WCRP

CEOS/
CGMS ECV
CDR
Inventory

Climate
Monitoring
Architecture

ECV CDR
Assessments

Stewardship
& Maturity
Model

WGClimate

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 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)

Conclusions of January 2011 WMO/GCOS Meeting

- Agreed to develop a strategy for climate monitoring architecture
- Identified writing group
  - CEOS – Four/Five from Working Group Climate
  - CGMS – Four/Five
  - WMO Secretariat
- Identified review group
  - GEO Secretariat
  - GCOS
  - WCRP
- Develop strategy for developing the architecture

No logo / Badgeless Activity

Writing group representing CEOS, CGMS and WMO

Aimed at badgeless/no logo activity beneficial for all readers

- 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

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 report

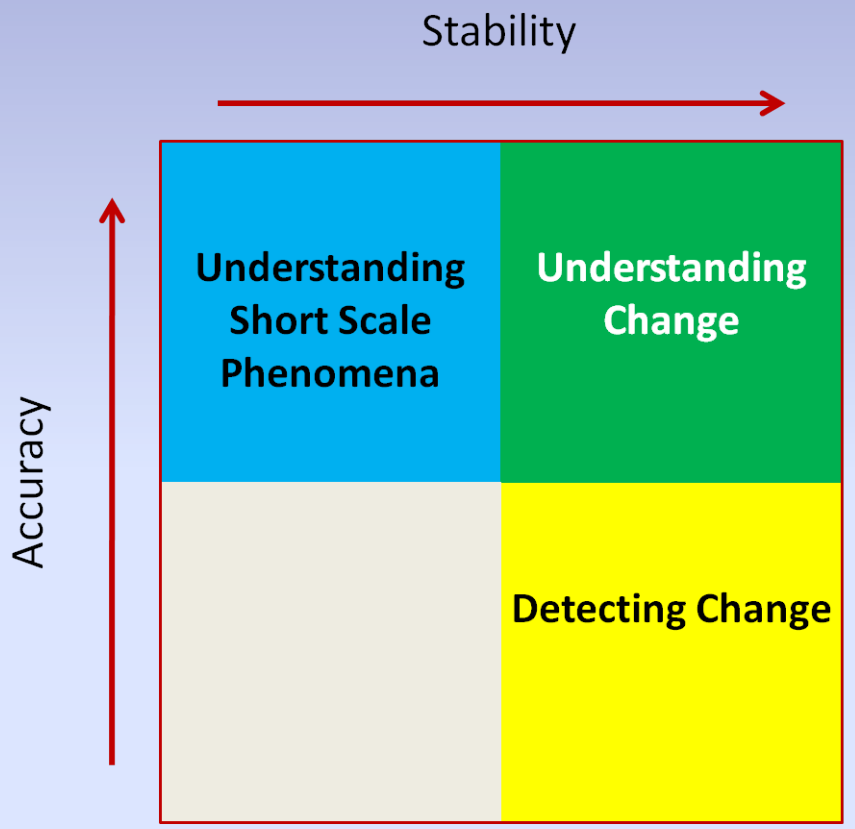
- approach adopted is intentionally open and inclusive
- designed so that all the relevant entities can identify their potential contributions
- even if this maybe beyond their existing capabilities and programmatic obligations
- in recognition of the need to obtain the maximum degree of consensus at this early stage in the process, the level of definition of the architecture is necessarily high-level and conceptual.

Internal review

- Submitted to GCOS, GEO and WCRP in August
- Comments received from GCOS and WCRP
- No comments from GEO
- Both GCOS and WCRP were largely complimentary and provided some specific comments/concerns which were taken into account

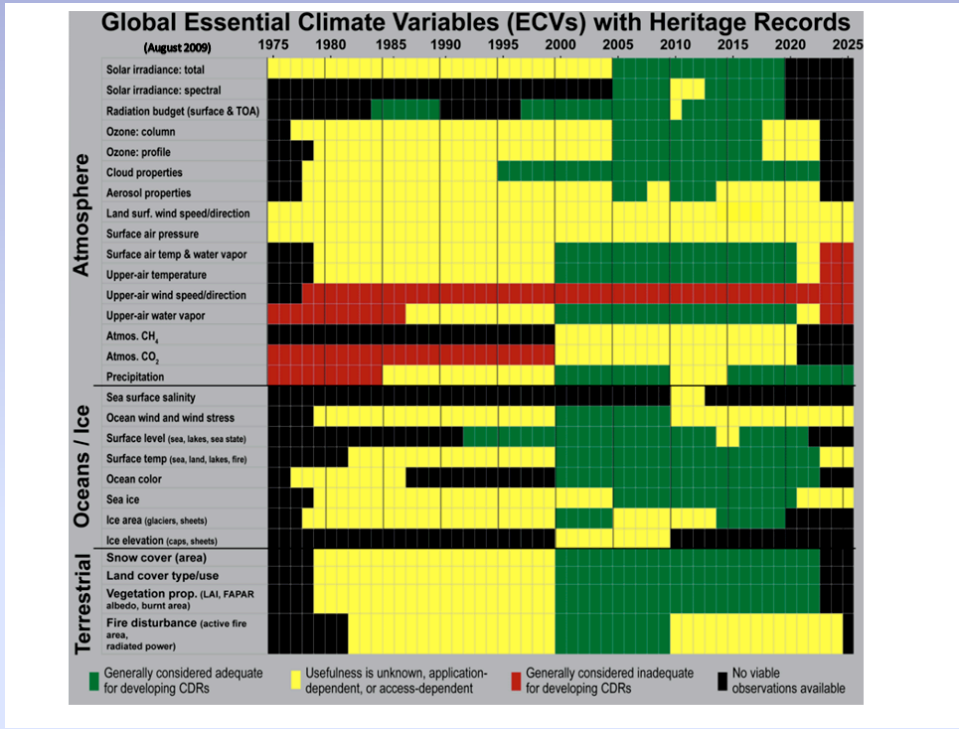
Climate Monitoring Principles, Requirements & Guidelines

- 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, preservation and distribution?



Adapted from Ohring (2004)

Existing Gap Analyses



US Agencies

EU Agencies

8 Gap analysis: Table 5

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

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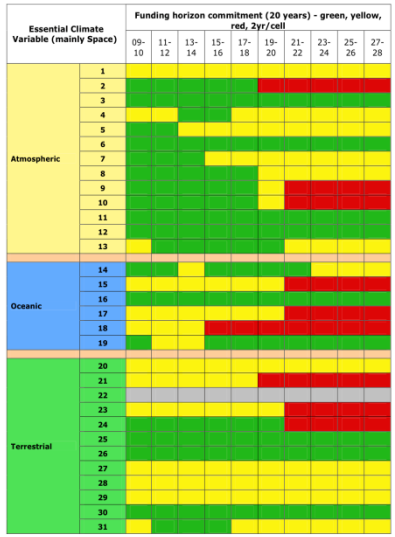

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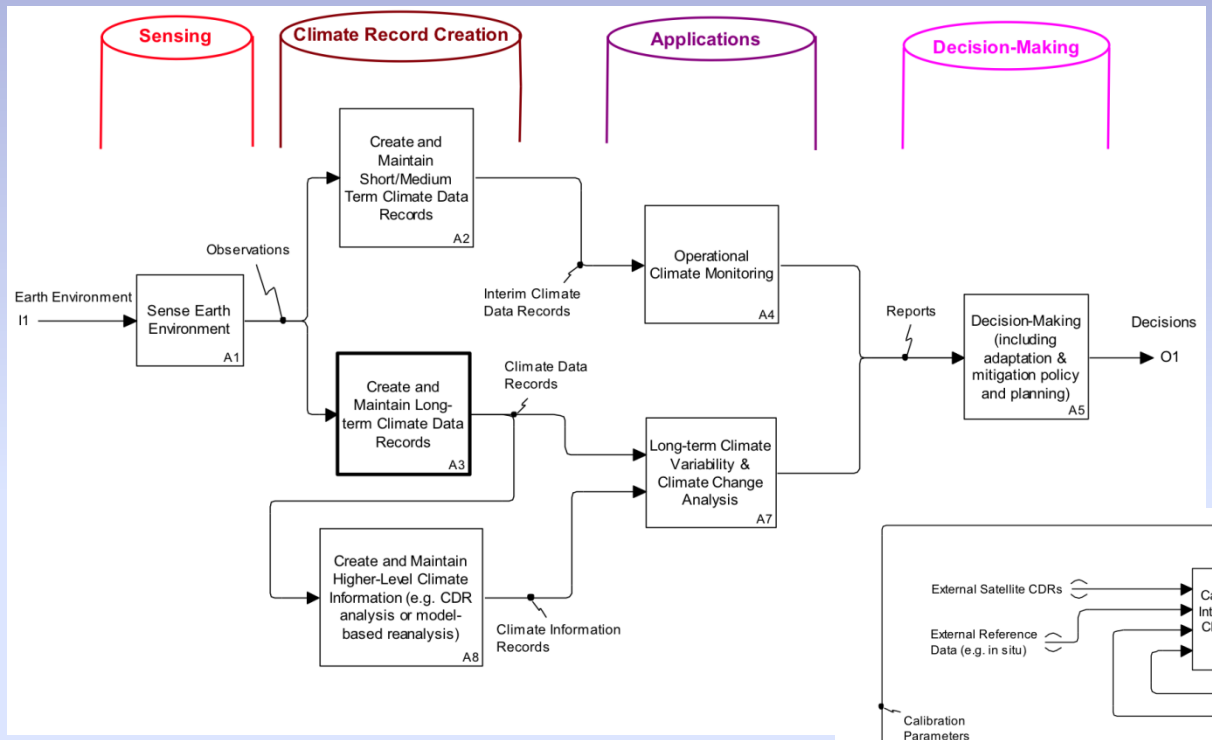
1. **Analysis perform for US & EU … but we need global**
2. **Analysis perform at sensor level … but we need at TCDR level**

Logical and Physical Architecture

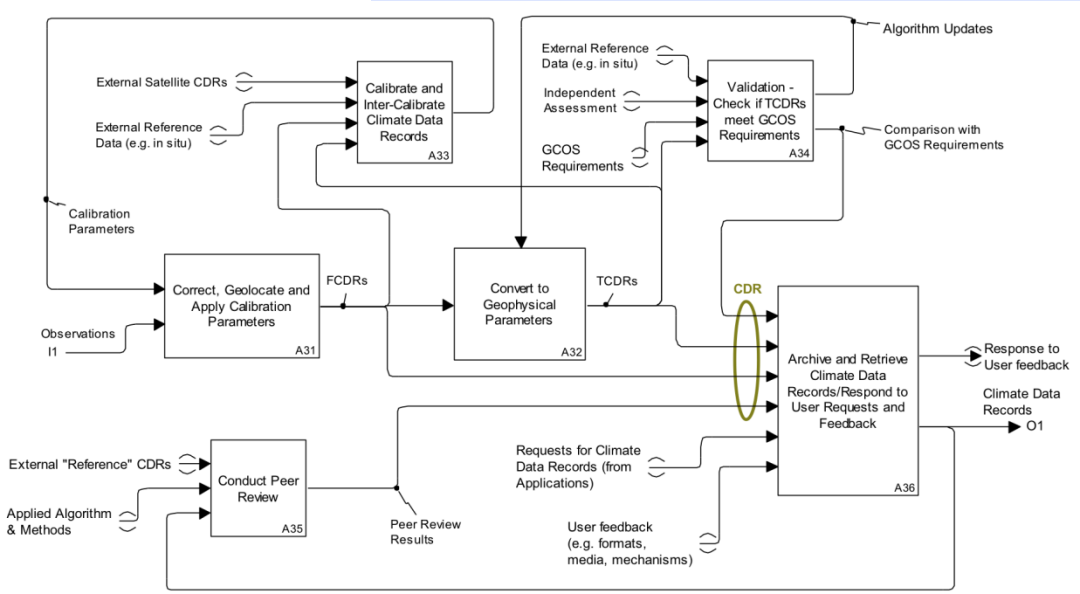
- **logical view**: represents the requirements baseline as a set of interlinked functions and associated data flows (i.e. the target) . Logical view is as stable as the requirements baseline and, once established, should require little maintenance
- **physical view**: describes how the logical view 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 (will take longer to determine)

Logical representation



Traceable **to** GCOS Guidelines and GCOS Climate Monitoring Principles

Traceable **from** ECV Inventory and physical representation of Climate Monitoring Architecture



ECV Inventory Questionnaire

- Joint activity with CGMS and WMO
- Call released with MIM end May, responses expected by October
- Questionnaire form – through a web interface.
- Responses are requested at the dataset level
- Addresses both existing/past missions and future/planned mission in two separate questionnaires
- Areas:
  - General
  - Dataset Usage
  - Dataset Stewardship
  - Dataset Properties
  - Dataset Access

Questionnaire for Populating the CEOS Climate Data Record Inventory

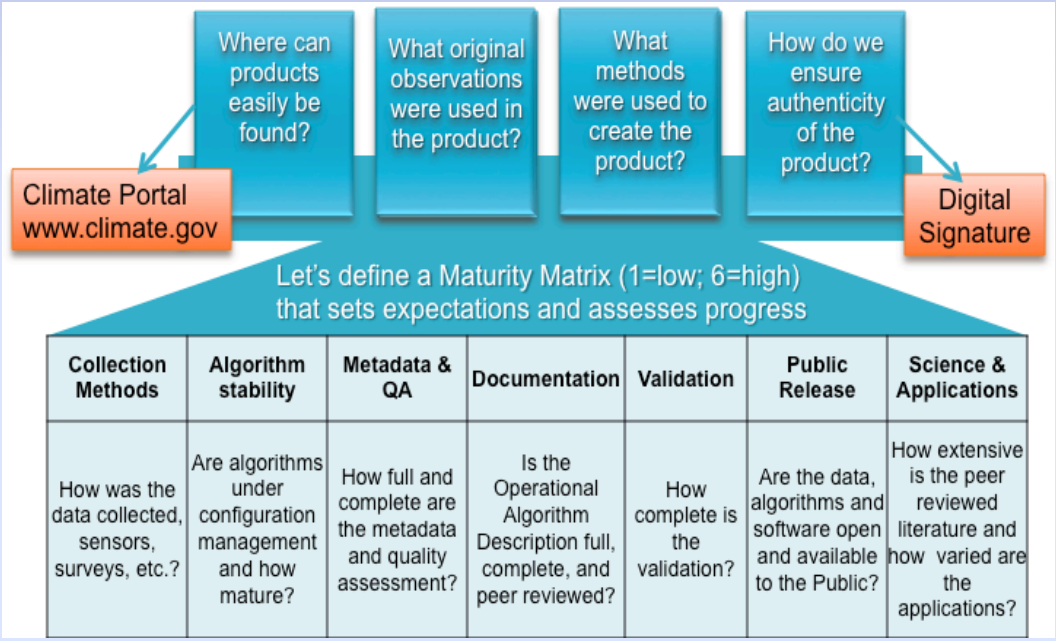
Area	Question	Response
GENERAL	0. Responder Name	Text field
	1. Email contact for individual populating the questionnaire?	Text field
	2. Data Set Identifier of the TCDR?	Text field
	3. Name of organisation with overall responsibility for dataset?	AgencyMenu
	4. Is the TCDR dataset the result of an international coordination activity?	Yes/No; If Yes, ProjectMenu
	5. Has the dataset been produced in conjunction with any external domain-specific generation and assessment body?	Yes/No; If Yes, AssessmentBodyMenu
	6. Have the quality control aspects of the dataset generation process been implemented in conjunction with a relevant international coordination body?	Yes/No; If Yes, ProcessMenu
DATASET USAGE	1. What specific climate applications does this dataset support?	Text field
	2. Which ECV (or ECV product) can be generated from this dataset?	ECV Menu
DATASET STEWARDSHIP	1. Which organisational entity is responsible for collecting the observations?	Agency Menu
	2. Which organisational entity is responsible for calibrating the observations?	Agency Menu
	3. Which organisational entity is responsible for intercalibrating the observations?	Agency Menu
	4. Which organisational entity is responsible for generating and maintaining the FCDR (i.e. correcting, geolocating and applying calibration parameters to the observations)?	Agency Menu
	5. Which organisational entity is responsible for generating and maintaining the TCDR (i.e. conversion of the FCDR to geophysical parameters)?	Agency Menu
	6. Which organisational entity is responsible for checking if the resultant TCDRs meet the relevant GCOS requirements, and identifying any required processing updates?	Agency Menu
	7. Which organisational entity is responsible for organising the independent peer review of the dataset?	Agency Menu
	8. Which organisational entity is responsible for collating, archiving and maintaining the resultant climate data records (e.g. archiving observations, FCDRs, TCDRs and all ancillary information such as processing configurations used in their generation, comparison with GCOS requirements, peer reviews, external reference data, etc)?	Agency Menu
	9. Which organisational entity is responsible for servicing user requests for the dataset?	Agency Menu
	10. Which organisational entity is responsible for responding to user feedback on the use of the dataset?	Agency Menu
DATASET PROPERTIES	1. What is the start-date of the continuous dataset record?	Date Field
	2. What is the end-date of the continuous dataset record?	Date Field
	3. Until when are firm commitments in place to continue this record?	Date Field
	4. What physical quantity does the dataset measure?	TypeMeasurementsWMOMenu
	5. What are the units of the dataset?	AccuracyUnitsMenu
	6. Which satellite/instrument combination is used to generate the dataset?	Satellite Menu Instrument Menu
	7. What is the geographical coverage of the TCDR (if not global specify extent)?	Coverage Menu: See tab for user inputs
	8. What is the Horizontal Resolution of the TCDR (in km)?	Number field
	9. What is the Vertical Resolution of the TCDR (in km)?	Number field
	10. What is the Temporal Resolution of the TCDR (repeat cycle) in days?	Number field
	11. What is the Accuracy of the TCDR?	Number field
	12. What is the Stability of the TCDR?	Number field
	13. Please provide link to document describing the scientific review process related to FCDR/TCDR construction (including algorithm selection), FCDR/TCDR quality and applications?	Link
	14. Please provide the link to the document describing all the steps taken in the generation of FCDRs and TCDRs, including algorithms used, on-board calibration, specific FCDRs used, version management system used and characteristics and outcomes of validation activities.	Link
	15. Please provide link to the document describing the results of the regular assessment of the long-term stability and homogeneity of the TCDR.	Link
	16. Against which satellite/instrument combination has the dataset been intercalibrated ?	Satellite menu Instrument menu
	17. Has the compliance status of the TCDR with the GCOS requirements been assessed?	Yes/No
	18. Has the degree of compliance with the GCOS guidelines been assessed though an independent "Peer Review" process?	Yes/No
	19. Has a quantitative maturity index been applied to the dataset (if so please provide link to document describing the application of the index)	Yes/No
DATASET ACCESS	0. Dataset Contact Name	Text field
	1. Email contact for access to dataset(s)	Text field
	2. Are FCDRs as well as TCDRs available to the user community?	Yes/No
	3. What formats are available for the dataset?	Data Format menu
	4. Please describe data access conditions	Data Dissemination Menu
	5. What dissemination mechanisms are available for the dataset? For example, FTP, internet download, mail.	Text field
	6. Please provide link to documentation provided with the dataset	Link
	7. What is the timeliness commitment of data release to the user community in months?	Number field

How will we use the ECV Inventory

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

Maturity Matrix

- Ultimate ambition – derive a CEOS endorsed Maturity Matrix
- Starting point - NOAA effort
- Create a task within WGClimate, lead by research agencies (EL, PL), to review/modify improve
- One size may not fit all
- It is as much a tool to monitoring progress as it is to provide a snapshot of current capability



Collection Methods	Algorithm stability	Metadata & QA	Documentation	Validation	Public Release	Science & Applications
How was the data collected, sensors, surveys, etc.?	Are algorithms under configuration management and how mature?	How full and complete are the metadata and quality assessment?	Is the Operational Algorithm Description full, complete, and peer reviewed?	How complete is the validation?	Are the data, algorithms and software open and available to the Public?	How extensive is the peer reviewed literature and how varied are the applications?

Source J. Bates

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)

Relationship with WCRP

- There are different activities ongoing within WCRP (e.g. in GEWEX, WOAP -> WDAC) which are extremely compatible with WGClimate priorities:
  - ECV Inventory/Physical Architecture – CEOS lead (?) WDAC support
  - Assessments – WCRP/WDAC lead (?) CEOS support/resources

Discussion points for this meeting (compiled by Joerg Schulz)

1. How can the inventory be extended for in situ data and who should do that?
2. Can WDAC develop a framework for an independent assessment of CDR quality that involves best scientific knowledge?


climate
data
satellite
Climate
monitoring
requirements
operational
observations
architecture
information
measurements
Earth
system
GCOS
GSICS
QA4EO
standards
LEO
missions
series
research
reference
community
long-term
e.g
Monitoring
irradiance different
applications
Gap
term
report
practices
range
CMA
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logical
main
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particular
Global
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sustained
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components
assessment
ECVs
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WMO
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analysis
related
used
ECV
Operational
weather
space
relevant
specific
generation
agencies
Observation
areas
Architecture
Figure
order
EUMETSAT
product
continuity
CDR
among
ensure
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processes
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including
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traceability
instrument
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radiation
available
System
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satellites
records
use
Satellite
NASA
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budget
future
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within
observation
WGCV
quality
activities
products
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also
CEOS
calibration
Data