

- The GCOS program was funded in 1992 by WMO, IOC/UNESCO, UNEP, ICSU, and was mandated to define objectives and recommend coordinated actions for a global observing system for climate, building on and enhancing existing systems.
- The initial plan called for a system based on:
 - Fundamental scientific priorities
 - Prioritized observational requirements, informed by scientific and technical progress and evolving user needs
- Priorities were further elaborated by exploring which physical variables or combination of variables would be most suitable for long-term climate monitoring (Karl 1996, and Trenberth 1996).



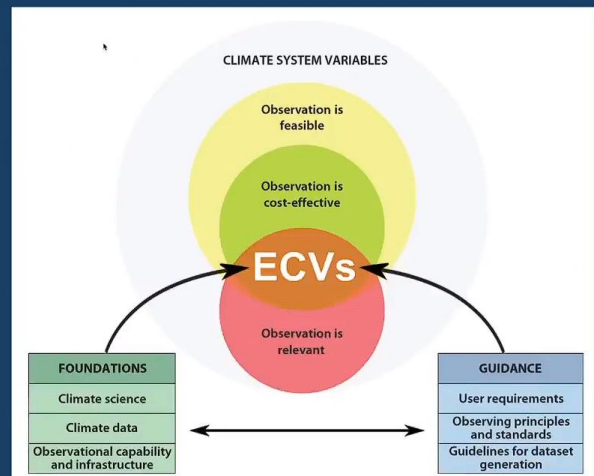
- “Essential Climate Variables (ECVs)” was first introduced by GCOS in 2003 in its report on the adequacy of the global observing systems for climate in support of the UNFCCC.
- GCOS has identified a set of ECVs and updated their observational status every six years in GCOS status report.
- GCOS also publish a subsequent implementation plan for developing a global climate observing system to meet increasing and more diverse needs for data and information.
- Space agencies have responded to the ECV concept:
 - ESA Climate Change Initiative
 - EUMETSAT Climate Monitoring Satellite Application Facility
 - NASA Making Earth System Data Records for Use in Research Environments (MEaSUREs)



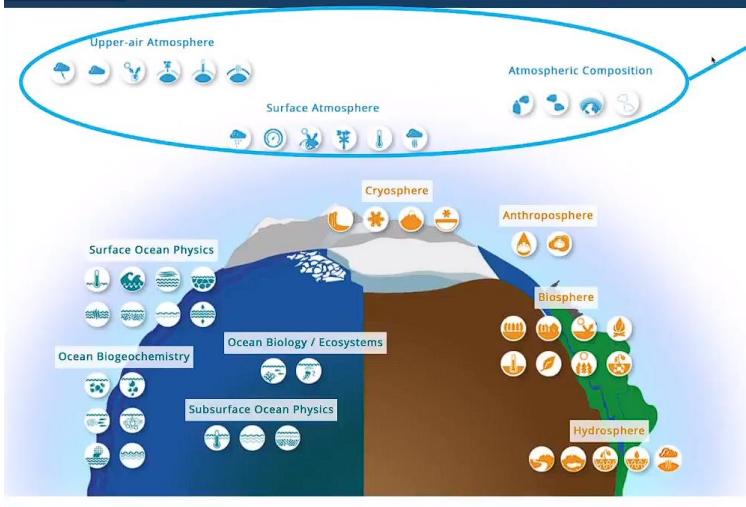
- An ECV is a physical, chemical, or biological variable or a group of linked variables that critically contributes to the characterization of Earth's climate.
- ECV datasets provide the empirical evidence needed to:
 - understand and predict the evolution of climate
 - guide mitigation and adaptation measures
 - assess risks and enable attribution of climatic events to underlying causes
 - underpin climate services
- Most/some of the essential needs for sustained observation identified by the WCRP and enabling the work of the IPCC are based on the ECVs.



- **Relevance:** The variable is critical for characterizing the climate system and its changes.
- **Feasibility:** Observing or deriving the variable on a global scale is technically feasible using proven, scientifically understood methods.
- **Cost effectiveness:** Generating and archiving data on the variable is affordable, mainly relying on coordinated observing systems using proven technology, taking advantage where possible of historical datasets.



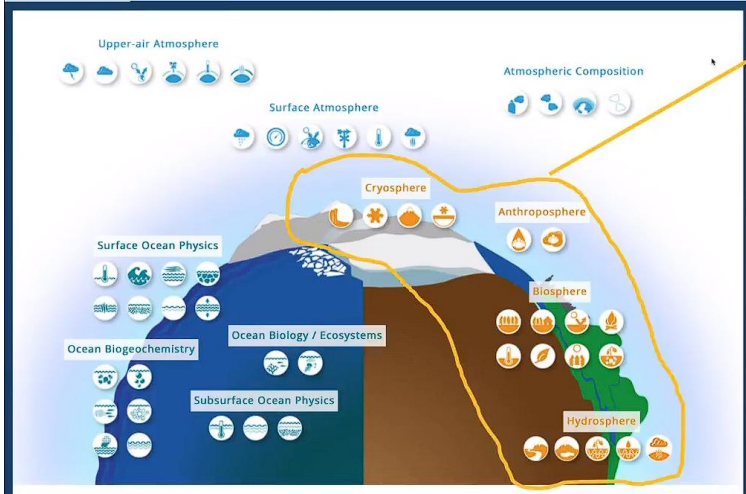
Bojinski et al. (2014)



Atmosphere (16)

- Upper-air
 - Earth radiation budget
 - Lightning
 - Temperature
 - Water vapor
 - Clouds
 - Wind speed and direction
- Atmospheric composition
 - Aerosols
 - Carbon dioxide, methane and other GHG
 - Ozone
 - Precursors for aerosols and ozone
- Surface
 - Precipitation
 - Pressure
 - Radiation budget
 - Temperature
 - Water vapor
 - Wind speed and direction

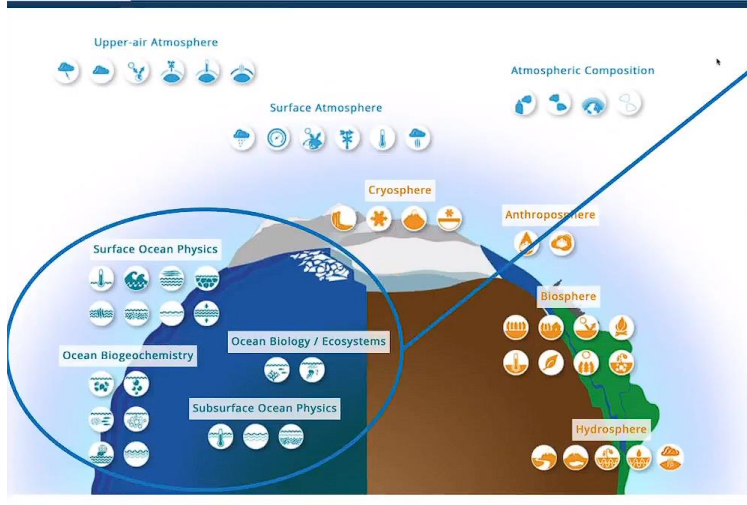
<https://gcos.wmo.int/en/essential-climate-variables/table>



Land (20)

- Hydrosphere
 - Ground water
 - Lakes
 - River discharge
 - Soil moisture
 - Evaporation from land
 - Terrestrial water storage
- cryosphere
 - Glaciers
 - Ice sheets and ice shelves
 - Permafrost
 - Snow
- Biosphere
 - Above-ground biomass
 - Albedo
 - Fire
 - FAPAR
 - Land cover
 - Land surface temperature
 - Leaf area index
 - Soil carbon
- Anthroposphere
 - Anthropogenic GHG fluxes
 - Anthropogenic water use

<https://gcos.wmo.int/en/essential-climate-variables/table>



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- Ocean (19)**
- Physical
 - Ocean surface heat flux
 - Sea ice
 - Sea level
 - Sea state
 - Sea surface currents
 - Sea surface salinity
 - Sea surface stress
 - Sea surface temperature
 - Subsurface currents
 - Subsurface salinity
 - Subsurface temperature
 - Biogeochemical
 - Inorganic carbon
 - Nitrous oxide
 - Nutrients
 - Ocean color
 - Oxygen
 - Transient tracers
 - Biological/Ecosystems
 - Marine habitats
 - plankton

Atmosphere (13)

- Upper-air
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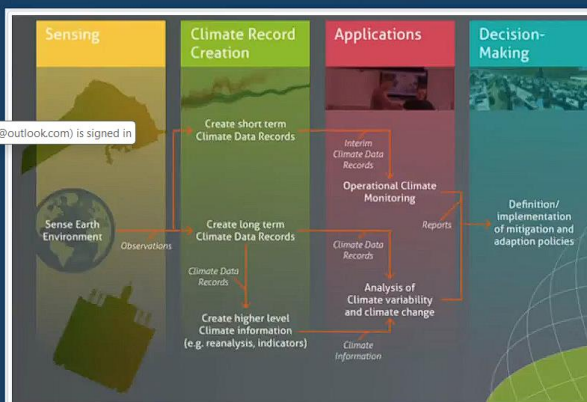
Ocean (9)

- Physical
 - Ocean surface heat flux
 - Sea ice
 - Sea level
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 - Sea surface currents
 - Sea surface salinity
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 - Sea surface temperature
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- The over-arching goal of the joint CEOS/CGMS Working Group on Climate is to improve the systematic availability of Climate Data Records through the coordinated implementation, and further development of the architecture for climate monitoring from space:

Riza Singh (riza.singhbajracharya@outlook.com) is signed in

- Providing a comprehensive and accessible view of existing and planned climate data records;
- Delivering further climate data records, including multi-mission, through best use of available data to fulfil GCOS requirements;
- Optimizing the planning of future satellite missions and constellations to expand existing and planned climate data records.



Record Information		Stewardship	Generation Process	Record Characteristics	Documentation	Accessibility	Applications
Visual display							
ECV and ECV Product	ECV	Groundwater					
	ECV Product	Groundwater volume change					
Physical quantity		Groundwater volume change					
SI units	Units?	1					
	SI units	cm (Equivalent Water Height)					
Satellite/Instrument combination	Satellite	ECV Version	Instrument	Start Date	End Date	Data Level	
	GRACE (2 sats)	4.00	SCA	2002-04-04	2017-06-29	4	
	GRACE (2 sats)	4.00	SuperSTAR	2002-04-04	2017-06-29	4	
	GRACE-FO (2 sats)	4.00	SCA	2018-05-23	*	4	
	GRACE-FO (2 sats)	4.00	SuperSTAR	2018-05-23	*	4	
Satellite/Instrument combination Comments (Optional) GRACE/GRACE-FO K-Band Ranging System data also used (2002-present); Data gap from June 2017 to May 2018.							
Inter-calibration		Satellite	Instrument	Start Date	End Date	Data Level	
Satellite/Instrument combination							
Inter-calibration							
Satellite/Instrument combination							
Comments (Optional)							
Ground-based network calibration	Ground-based network	Tide gauges					
	Link to source						
	North boundary	90					

<https://climatemonitoring.info/ecvinventory/>

- Hydrosphere
 - Ground water: 1
 - Lakes: 6
 - River discharge
 - Soil moisture: 55
 - Evaporation from land: 0
 - Terrestrial water storage: 0
 - Cryosphere
 - Glaciers: 1
 - Ice sheets and ice shelves: 7
 - Permafrost
 - Snow: 7
 - Biosphere
 - Above-ground biomass: 1
 - Albedo: 34
 - Fire: 32
 - FAPAR: 14
 - Land cover: 12
 - Land surface temperature: 22
 - Leaf area index: 14
 - Soil carbon
 - Anthroposphere
 - Anthropogenic GHG fluxes: 0
 - Anthropogenic water use
- Only 1 existing CDRs in the Inventory has a spatial resolution (30 m) meet the GCOS spatial resolution requirement.

- For all land-related actions in GCOS IP 2022, we have teams in place to address them.
- WGClimate invites LSI-VC to review our responses to these actions to ensure they are accurate and comprehensive.

- Generate timely permafrost, land cover change, burnt area, and fire severity/burning efficiency products from high resolution satellite observations (e.g., Sentinel-1 /-2 and LandSat).
- Ensure that the Bidirectional Reflectance Distribution Function (BRDF) parameters are provided together with surface albedo.
- Improve consistency of the inter-dependent land products.

- Improve biomass, land cover, land surface temperature, and fire data with sub-annual observations and improved local detail and quality.

- Surface temperatures of all surfaces (sea, ice, land)
- Albedo for all surfaces (land and sea-ice)