GLOBAL CLIMATE OBSERVING SYSTEM

WMO unesco Intergovernmental Oceanographic Commission International Science Council UN environment programme

GCOS SC-30

Doc. 2.2

(16.II.2023)

Item 2.2

GCOS STEERING COMMITTEE

THIRTIETH SESSION

GCOS SC-30, 7–8 December 2022

Virtual Session

ECV RATIONALIZATION

ECV RATIONALIZATION

The Steering Committee is asked to decide that GCOS should implement the workplan described below.

DRAFT DECISION (3)

The Steering Committee decides that GCOS should implement the workplan on ECV rationalization described below, in document 2.2, paragraphs 8-11.

Summary:

This document describes how GCOS shall work towards rationalizing the list of ECV as agreed at the last GCOS Steering committee, reporting to SC31.

Background:

1) In 2021 the Steering Committee discussed rationalizing the ECV.

- DECISION Dec.29/1 The Steering Committee agreed to rationalize the ECVs, presenting similar ECV Products grouped together under one ECV.
- ACTION SC 29/4 Secretariat in consultation with the panel co-chairs to propose a new grouping of ECVs which can be discussed in the panels and the next SC and ideally form the basis of the new IP.
- ACTION SC 29/5 Stakeholders and users, such as in-situ and satellite communities, will be approached to explain to them the idea about the rationalization and reinsure

them that there will be no direct impact on their work. If their reactions to this proposal are positive, GCOS can move on working on this concept.

- ACTION SC 29/6 The GCOS Secretariat, together with the panel chairs and couple of volunteers from the Steering Committee, will work on the rationalization of the ECVs. Michael Zemp volunteered to join the Secretariat and GCOS panels chairs in this task bringing into the discussion its expertise on the cryosphere ECVs.

2) Following the publication of the 2016 GCOS Implementation Plan, GCOS was criticised that there are too many ECVs and that a simplified list of ECVs would be clearer, more transparent and easier to explain to a broader audience.

3) There are currently 55 ECV and over 200 ECV products (see Annex A). However, many of these ECV measure similar properties in different parts of the Earth system, e.g. temperature measured in different places. They are split into the three domains, atmosphere, ocean and terrestrial; a pragmatic split according to where the measurements are made, but do not reflect their similarity or role in the Earth system. In addition, the terrestrial ECV "Albedo" overlaps with the Ocean ECV product "Sea ice surface albedo".

For example, for temperature:

Domain	ECV	ECV Product
Atmosphere	Temperature (surface)	Atmospheric Temperature near Surface
	Temperature (upper-air)	Atmospheric Temperature in the PBL
		Atmospheric Temperature in the free Troposphere
		Atmospheric Temperature in the UTLS
		Atmospheric Temperature in the Middle and Upper Stratosphere
		Atmospheric Temperature in the Mesosphere
	Cloud properties	Cloud Top Temperature
Ocean	Sea Surface Temperature	Sea Surface Temperature
	Subsurface Temperature	Interior Temperature
	Ice	Sea Ice Surface Temperature (IST)
Terrestrial	Land Surface Temperature	Maps of land surface temperature
		Soil Temperature
	Lake	Lake Surface Water Temperature (LSWT)
	Permafrost	Permafrost Temperature (PT)

Notes:

- Unlike the others, sea surface, sea ice surface, and land surface temperatures are estimates of skin temperatures and may be better separated from other "temperatures"
- The others are bulk temperatures measured at different heights or depths. They allow the estimation of the heat contents of the components of the Earth system to be made.

4) Other groups identified in earlier meetings include separate surface and upper air ECV; sea surface and sub-surface ECV; Ocean composition; Atmospheric composition grouped around the IPCC WG1; Ice; and Carbon reservoirs (see Annex B).

5) Combining some of these ECVs into a single ECV could potentially, halve the number of ECVs. The ECV products would remain the same but differently allocated.

6) Grouping the ECV into fewer groups should clarify what is being measured and why, and should also:

- Ensure consistency across ECV products and domains.
- Facilitate the use of the ECVs by different users.
- Improve consistency across climate cycles.
- Strengthen collaboration between GCOS Panels.

7) Finally, the secretariat has noted that while new ECVS are approved by the Steering Committee after consideration and proposal by the panels, there is no formal documented process or statement of requirements. No agreed process exists for approving ECV products. The process to add new ECVs and ECVs product needs to be formalized. Examples of considerations are: is this ECV or ECV product essential in terms of climate; does this product already exists within the other two domains; what are the criteria to assign a product to a certain ECV?

Therefore, it is proposed that:

8) A team with 2 representatives from each panel, appointed by the panel chairs, shall identify how sets of ECV products should best be grouped and make preliminary proposals by June 2023, to be presented at the Joint Panel meeting. Following this:

   - The relevant panel members should refine each ECV group to be presented for approval at SC 32/33. To do this, a workshop with stakeholders (both users and producers of ECVs) will be organized to explain the process and get input from them.
   - The panel chairs shall ensure that a document describing the rationale and process is prepared and distributed among GCOS users.

9) The secretariat should propose to SC 32/33 a publicity plan around these proposals.

10) The panel chairs should propose a group to write a paper, to be published in BAMS, on updating the first Bojinski et al. (2014) paper on ECVs.

11) The panel chairs, with the assistance of the GCOS secretariat, should propose a formal process for the adoption of new ECV and ECV products in future, following current practice as far as possible. This should include:

    a. A justification on how each new ECV and ECV product is significant for climate studies.
    b. A consideration if this ECV or ECV product already exists within the other two domains.
    c. A justification why new ECV products are assigned to a certain ECV.

       A demonstration that they meet the criteria in Bojinski et al. (2014).

    d. Following agreement by all the panel chairs each proposal should be forwarded to the SC for final approval.

Annex A

Current ECV

Atmosphere	
ECV	**ECV Product 2022**
Surface Pressure	Air Pressure (near surface)
Surface Temperature	Air Temperature (near surface)
Surface wind Speed and Direction	Wind Speed (near surface)
	Wind Direction (near surface)
	Wind Vector (near surface)
Surface Water Vapour	Dew Point Temperature (near surface)
	Relative Humidity (near surface)
	Air Specific Humidity (near surface)
Precipitation	Accumulated precipitation
Surface Radiation Budget	Downward Short-Wave Irradiance at Earth Surface
	Downward Long-Wave Irradiance at Earth Surface
	Upward Long-Wave Irradiance at Earth Surface
Upper-air Temperature	Atmospheric Temperature in the Boundary Layer
	Atmospheric Temperature in the Free Troposphere
	Atmospheric Temperature in the Upper Troposphere and Lower Stratosphere
	Atmospheric Temperature in the Middle and Upper Stratosphere
	Atmospheric Temperature in the Mesosphere
Upper-air Wind Speed and Direction	Wind (horizontal) in the Boundary Layer
	Wind (horizontal) in the Free Troposphere
	Wind (horizontal) in the Upper Troposphere and Lower Stratosphere
	Wind (horizontal) in the Middle and Upper Stratosphere
	Wind (horizontal) in the Mesosphere
	Wind (vertical) in the Boundary Layer
	Wind (vertical) in the Free Troposphere
	Wind (vertical) in the Upper Troposphere and Lower Stratosphere
	Wind (vertical) In the Middle and Upper Stratosphere
	Wind (vertical) in the Mesosphere
Upper-air Water Vapour	Water Vapour Mixing Ratio in the Upper Troposphere and Lower Stratosphere
	Water Vapour Mixing Ratio in the Middle and Upper Stratosphere
	Water Vapour Mixing Ratio in the Mesosphere
	Relative Humidity in the Boundary Layer
	Relative Humidity in the Free Troposphere
	Relative Humidity in the Upper Troposphere and Lower Stratosphere
	Specific Humidity in the Boundary Layer
	Specific Humidity in the Free Troposphere
	Integrated Water Vapour
Earth Radiation Budget	Solar Spectral Irradiance
	Downward Short-Wave Irradiance at Top of the Atmosphere
	Upward Long-Wave Irradiance at Top of the Atmosphere
	Upward Short-Wave Irradiance at Top of the Atmosphere
	Radiation Profile
Cloud Properties	Cloud Cover
	Cloud Liquid Water Path
	Cloud Ice Water Path
	Cloud Drop Effective Radius
	Cloud Optical Depth
	Cloud Top Temperature
	Cloud Top Height
Lightning	Total Lightning Stroke Density
	Schumann Resonances
Carbon Dioxide, Methane and Other Greenhouse Gases	CO_2 Mole Fraction
	CO_2 Column Average Dry Air Mixing Ratio
	CH_4 Mole Fraction
	CH_4 Column Average Dry Air Mixing Ratio
	N_2O Mole Fraction
Ozone	Ozone Mole Fraction in the Troposphere
	Ozone Mole Fraction in the Upper Troposphere/ Lower Stratosphere
	Ozone Mole Fraction in the Middle and Upper Stratosphere
	Ozone Total Column
	Ozone Tropospheric Column

	Ozone Stratospheric Column
Precursors (Supporting the aerosol and ozone ECVs)	CO Tropospheric Column
	CO Mole Fraction
	HCHO Tropospheric Column
	SO_2 Tropospheric Column
	SO_2 Stratospheric Column
	NO_2 Tropospheric Column
	NO_2 Mole Fraction
Aerosols Properties	Aerosol Light Extinction Vertical Profile (Troposphere)
	Aerosol Light Extinction Vertical Profile (Stratosphere)
	Multi-wavelength Aerosol Optical Depth
	Aerosol Single Scattering Albedo
	Chemical Composition of Aerosol Particles
	Number of Cloud Condensation Nuclei
	Aerosol Number Size Distribution

Ocean	
ECV	**ECV Product 2022**
Sea-Surface temperature	Sea-Surface temperature
Subsurface Temperature	Interior Temperature
Sea-Surface Salinity	Sea-Surface Salinity
Subsurface Salinity	Interior Salinity
Surface Currents	Surface Geostrophic Current
	Ekman Currents
Subsurface Currents	Vertical Mixing
Sea Level	Regional Mean Sea Level
	Global Mean Sea Level
Sea State	Wave Height
Surface Stress	Surface Stress
Ocean Surface Heat Flux	Radiative Heat Flux
	Sensible Heat Flux
	Latent Heat Flux
Sea Ice	Sea Ice Concentration
	Sea Ice Thickness
	Sea Ice Drift
	Sea Ice Age
	Sea Ice Surface Temperature (IST)
	Sea ice Surface Albedo
	Snow Depth on Sea Ice
Oxygen	Dissolved Oxygen Concentration
Nutrients	Silicate
	Phosphate
	Nitrate
Ocean Inorganic Carbon	Total Alkalinity (TA)
	Dissolved Inorganic Carbon (DIC)
	pCO_2
Transient Tracers	14C
	SF_6
	CFC-11
	CFC-12
Ocean nitrous oxide N2O	Interior Ocean Nitrous Oxide N2O
	N2O Air-Sea Flux
Ocean Colour	Water Leaving Radiance
	Chlorophyll-a concentration
Plankton	Zooplankton Diversity
	Zooplankton Biomass
	Phytoplankton Diversity
	Phytoplankton Biomass
Marine Habitat Properties	Mangrove Cover and Composition
	Seagrass Cover (areal extent)
	Macroalgal Canopy Cover and Composition
	Hard coral cover and composition

Terrestrial	
ECV	**ECV Product 2022**
Groundwater	Groundwater Storage Change
	Groundwater Level
Lakes	Lake Water Level (LWL)
	Lake Water Extent (LWE)
	Lake Surface Water Temperature (LSWT)
	Lake Ice Cover (LIC)
	Lake Ice Thickness (LIT)
	Lake Water-Leaving Reflectance
River Discharge	River Discharge
	Water Level
Soil Moisture	Surface Soil Moisture
	Freeze/Thaw
	Surface Inundation
	Root Zone Soil Moisture
Terrestrial Water Storage[1]	Terrestrial Water Storage Anomaly
Snow	Area Covered by Snow
	Snow Depth
	Snow-Water Equivalent
Glaciers	Glacier Area
	Glacier Elevation Change
	Glacier Mass Change
Ice Sheets and Ice Shelves	Surface Elevation Change
	Ice Velocity
	Ice Volume Change
	Grounding Line Location and Thickness
Permafrost	Permafrost Temperature (PT)
	Active Layer Thickness (ALT)
	Rock Glacier Velocity (RGV)
Fraction of FAPAR	Fraction of Absorbed Photosynthetically Active Radiation
Leaf Area Index	Leaf Area Index (LAI)
Albedo	Spectral and Broadband (Visible, Near Infrared and Shortwave) DHR & BHR with Associated Spectral Bidirectional Reflectance Distribution Function (BRDF) Parameters
Land-Surface Temperature	Land Surface Temperature (LST)
	Soil Temperature[2]
Above-Ground Biomass	Above-Ground Biomass (AGB)
Land Cover	Land Cover
	Maps of High-Resolution Land Cover
	Maps of Key IPCC Land Classes, Related Changes and Land Management Types
Soil Carbon	Carbon in Soil
	Mineral Soil Bulk Density
	Peatlands
Fire	Burned Area
	Active Fires
	Fire Radiative Power (FRP)

[1] This is the only new ECV approved by GCOS Steering Committee in 2020.
[2] Soil Temperature is a new ECV product temporarily included under the ECV Land-Surface Temperature. Its positioning will be subject to evaluation by the TOPC Panel and the GCOS Steering Committee.

Terrestrial	
ECV	**ECV Product 2022**
Anthropogenic Greenhouse-Gas Fluxes	Anthropogenic CO2 Emissions from Fossil Fuel Use, Industry, Agriculture, Waste and Products Use
	Anthropogenic CH4 Emissions from Fossil Fuel, Waste, Agriculture, Industrial Processes and Fuel Use
	Anthropogenic N2O Emissions from Fossil Fuel Use, Industry, Agriculture, Waste and Products Use, Indirect from N-Related Emissions/Depositions
	Anthropogenic F-Gas Emissions from Industrial Processes and Product Use
	Total Estimated Fluxes by Coupled Data Assimilation/Models with Observed Atmospheric Composition – National
	Total Estimated Fluxes by Coupled Data Assimilation/Models with Observed Atmospheric Composition - Continental
	Anthropogenic CO2 Emissions/Removals by Land Categories
	High-Resolution Footprint Around Point Sources
Evaporation from Land	Sensible Heat Flux
	Latent Heat Flux
	Bare Soil Evaporation
	Interception Loss
	Transpiration
Anthropogenic Water Use	Anthropogenic Water Use

Annex B

Potential ECV Groupings

Below, a list of possible grouping as an example:

Temperature

Temperature has 5 'full' ECV and is part of the following 4 different ECVs: cloud properties, ice, lakes, permafrost; with a total of 14 ECV products. The ECV could be merged in a single ECV, Temperature.

Domain	ECV	ECV Product
Atmosphere	Temperature (surface)	Atmospheric Temperature near Surface
	Temperature (upper-air)	Atmospheric Temperature in the PBL
		Atmospheric Temperature in the free Troposphere
		Atmospheric Temperature in the UTLS
		Atmospheric Temperature in the Middle and Upper Stratosphere
		Atmospheric Temperature in the Mesosphere
	Cloud properties	Cloud Top Temperature
Ocean	Sea Surface Temperature	Sea Surface Temperature
	Subsurface Temperature	Interior Temperature
	Ice	Sea Ice Surface Temperature (IST)
Terrestrial	Land Surface Temperature	Maps of land surface temperature
		Soil Temperature
	Lake	Lake Surface Water Temperature (LSWT)
	Permafrost	Permafrost Temperature (PT)

NEW ECV	ECV Product	Panel
Temperature	Atmospheric Temperature near Surface	AOPC
	Atmospheric Temperature in the PBL	
	Atmospheric Temperature in the free Troposphere	
	Atmospheric Temperature in the UTLS	
	Atmospheric Temperature in the Middle and Upper Stratosphere	
	Atmospheric Temperature in the Mesosphere	
	Cloud Top Temperature	OOPC
	Sea Surface Temperature	
	Ocean Subsurface Temperature	
	Sea Ice Surface Temperature (IST	
	land surface temperature	TOPC
	Soil Temperature	
	Lake Surface Water Temperature (LSWT)	
	Permafrost Temperature (PT)	

Surface and upper air ECV or sea surface and sub-surface ECV can be combined:

Domain	ECV	ECV Product
Atmosphere	Surface Water Vapour	Dew Point Temperature (near surface)
		Atmospheric Relative Humidity (near surface)
		Atmospheric Specific Humidity (near surface)
	Upper-air water vapour	Integrated Water Vapour
		Water Vapour Mixing Ratio in the Upper Troposphere and Lower Stratosphere
		Water Vapour Mixing Ratio in the Middle and Upper Stratosphere
		Water Vapour Mixing Ratio in the Mesosphere
		Relative Humidity in the Boundary Layer – free troposphere - UTLS
		Specific Humidity in the Boundary Layer- free troposphere

NEW ECV	ECV Product	Panel
Water Vapour	Dew Point Temperature (near surface)	AOPC
	Atmospheric Relative Humidity (near surface)	
	Atmospheric Specific Humidity (near surface)	
	Integrated Water Vapour	
	Water Vapour Mixing Ratio in the Upper Troposphere and Lower Stratosphere	
	Water Vapour Mixing Ratio in the Middle and Upper Stratosphere	
	Water Vapour Mixing Ratio in the Mesosphere	
	Relative Humidity in the Boundary Layer – free troposphere - UTLS	
	Specific Humidity in the Boundary Layer- free troposphere	

Domain	ECV	ECV Product
Ocean	Sea-Surface Salinity	Sea-Surface Salinity
	Subsurface Salinity	Subsurface Salinity
	Sea-Surface Currents	Sea-Surface Currents
	Subsurface currents	Subsurface currents

NEW ECV	ECV Product	Panel
Salinity	Sea-Surface Salinity	OOPC
	Subsurface Salinity	
Currents	Sea-Surface Currents	
	Subsurface currents	

These below are different kind of grouping. Rather that grouping ECV products under a common umbrella (like for temperature) here we re-group different ECVs into common "themes" like biosphere or fluxes or water storage, without touching the ECV organization internal to each Panel.

ECV: Surface Heat and Water Fluxes

DOMAIN	ECV	ECV PRODUCT
Atmosphere	Surface Radiation Budget	Upward Long-Wave Irradiance at Earth Surface
Atmosphere	Surface Radiation Budget	Downward Long-Wave Irradiance at Earth Surface
Atmosphere	Surface Radiation Budget	Downward Short-Wave Irradiance at Earth Surface
Ocean	Ocean Surface Heat Flux	Latent Heat Flux
Ocean	Ocean Surface Heat Flux	Sensible Heat Flux
Ocean	Ocean Surface Heat Flux	Radiative Heat Flux
Terrestrial	Evaporation from Land	Latent Heat Flux
Terrestrial	Evaporation from Land	Sensible Heat Flux
Terrestrial	Evaporation from Land	Bare Soil Evaporation
Terrestrial	Evaporation from Land	Interception Loss
Terrestrial	Evaporation from Land	Transpiration

ECV: Biosphere

DOMAIN	ECV	ECV PRODUCT
Ocean	Marine Habitat Properties	Mangrove Cover and Composition
Ocean	Marine Habitat Properties	Seagrass Cover (areal extent)
Ocean	Marine Habitat Properties	Macroalgal Canopy Cover and Composition
Ocean	Marine Habitat Properties	Hard coral cover and composition
Ocean	Ocean Colour	Water Leaving Radiance
Ocean	Ocean Colour	Chlorophyll-a Concentration
Ocean	Plankton	Phytoplankton Diversity
Ocean	Plankton	Phytoplankton Biomass
Ocean	Plankton	Zoo plankton Diversity
Ocean	Plankton	Zoo plankton Biomass
Terrestrial	Above-ground biomass	Above-ground biomass
Terrestrial	Fraction of Absorbed Photosynthetically Active Radiation (FAPAR)	Fraction of Absorbed Photosynthetically Active Radiation
Terrestrial	Lakes	Lake Water Leaving Reflectance
Terrestrial	Leaf Area Index (LAI)	Leaf Area Index (LAI)

ECV: Terrestrial Water Storage

DOMAIN	ECV	ECV PRODUCT
Terrestrial	Groundwater	Groundwater storage change
Terrestrial	Groundwater	Groundwater level
Terrestrial	Lakes	Lake water level
Terrestrial	Lakes	Lake Water Extent
Terrestrial	Lakes	Lake ice thickness
Terrestrial	Lakes	Lake Ice Cover
Terrestrial	River Discharge	River discharge
Terrestrial	River Discharge	Water Level
Terrestrial	Snow	Area covered by snow
Terrestrial	Snow	snow depth
Terrestrial	Snow	snow water equivalent
Terrestrial	Soil Moisture	Surface soil moisture
Terrestrial	Soil Moisture	Freeze/thaw
Terrestrial	Soil Moisture	Surface inundation
Terrestrial	Soil Moisture	Root-zone soil moisture
Terrestrial	Glaciers	Glacier Area
Terrestrial	Glaciers	Glacier Elevation Change
Terrestrial	Glaciers	Glacier Mass Change
Terrestrial	Ice Sheets and Ice Shelves	?
Terrestrial	Total Water Storage	Total Water Storage Anomaly

Other possible groupings:

OCEAN COMPOSITION, grouping of the atmospheric composition around IPCC WG1 lines, ICE, CARBON RESERVOIRS

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