ESSENTIAL VARIABLES

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IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System
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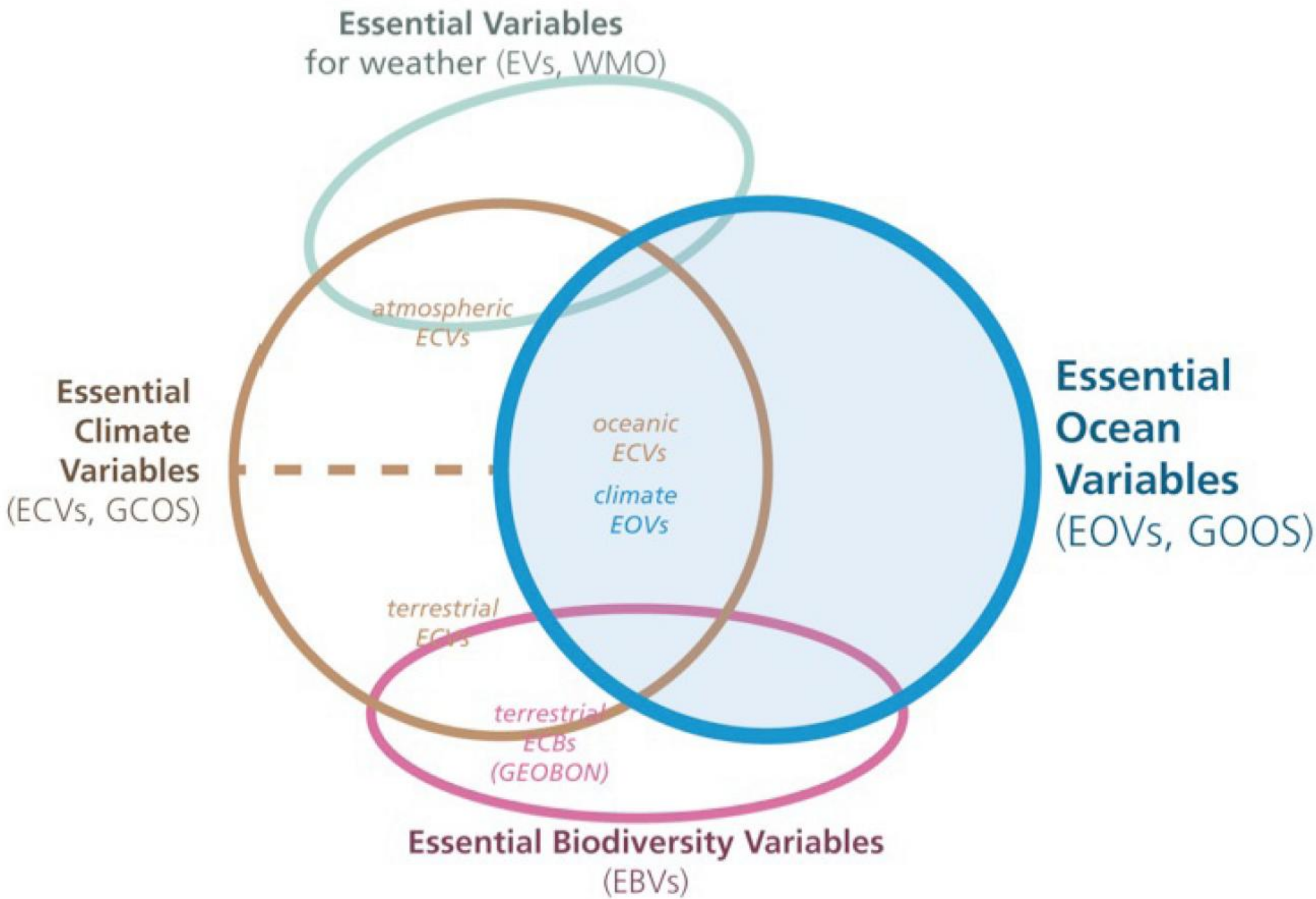
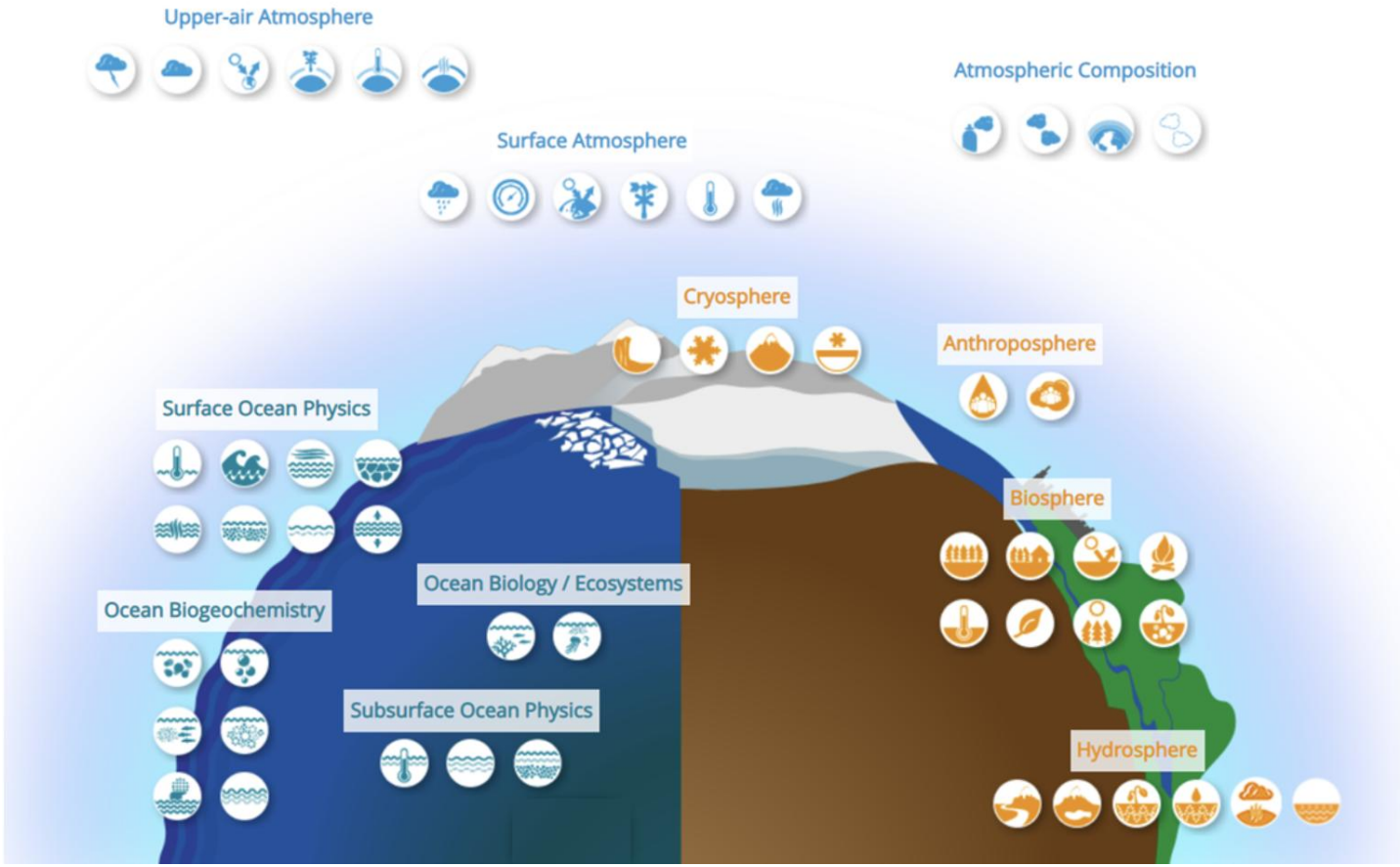

Essential Variables
for weather (EVs, WMO)
atmospheric
ECVs
Essential
Climate
Variables
(ECVs, GCOS)
oceanic
ECVs
climate
EOVs
Essential
Ocean
Variables
(EOVs, GOOS)
terrestrial
ECVs
terrestrial
ECBs
(GEOBON)
Essential Biodiversity Variables
(EBVs)

Essential climate variables

- An Essential Climate Variable (ECV) is a physical, chemical or biological variable or a group of linked variables that **critically contributes to the characterization of Earth's climate**. GCOS currently specifies **55 ECVs**.
- Defined by the Global Climate Observing System (**GCOS**) program in 2003
- ECV datasets provide the empirical evidence needed to understand and predict the evolution of climate, to guide mitigation and adaptation measures, to assess risks and enable attribution of climate events to underlying causes, and to underpin climate services. They are required to support the work of the UNFCCC and the IPCC.

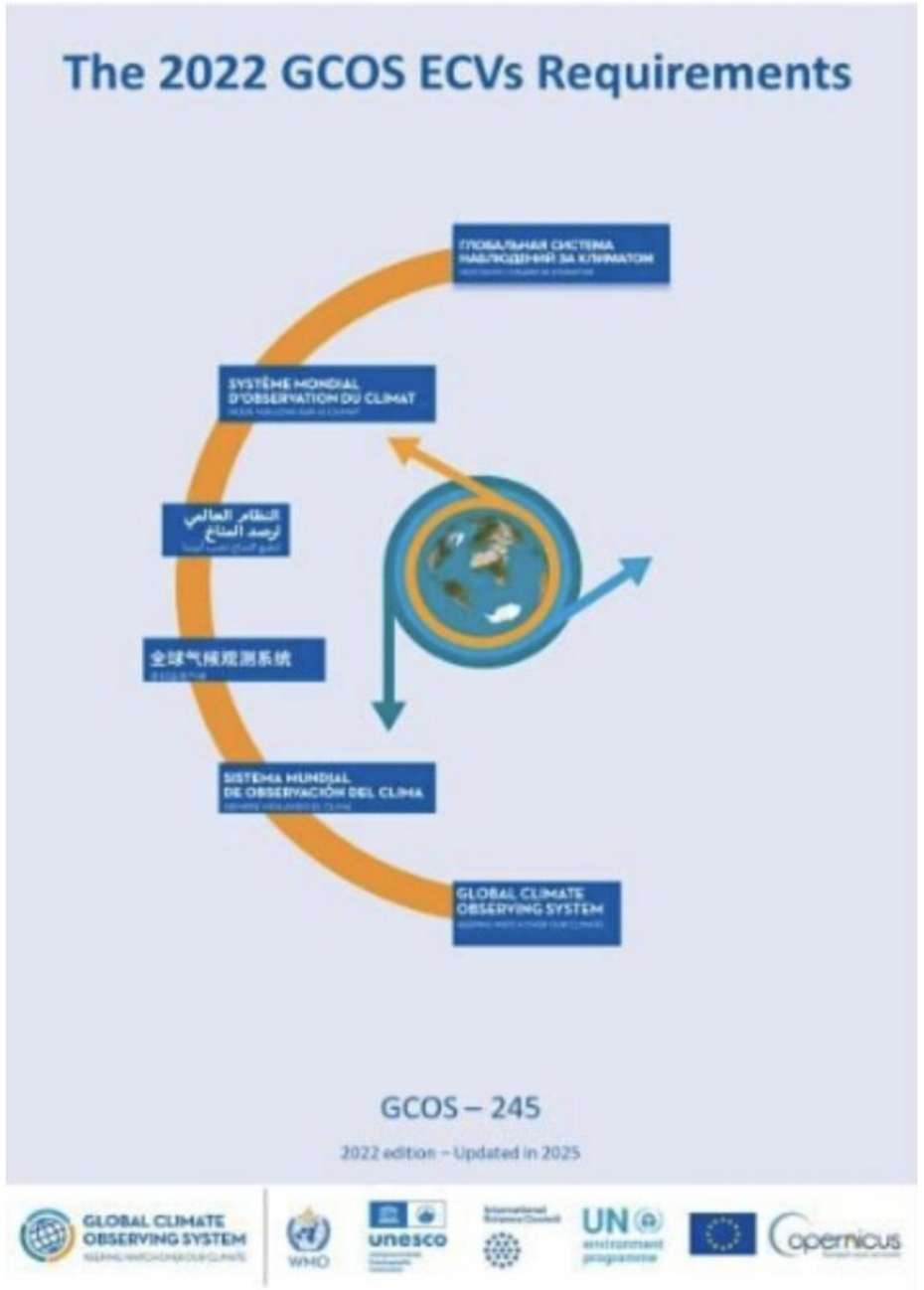


https://gcos.wmo.int/site/global-climate-observing-system-gcos/essential-climate-variables

ECVs are identified based on the following criteria:

- ❑ **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.

To make practical use of the ECVs, guidance and best practices are needed to enable and support the generation of high-quality, traceable ECV data records



Essential ocean variables

Physics	Biochemistry	Biology and Ecosystems
Sea state Ocean surface stress Sea ice Sea surface height Sea surface temperature Subsurface temperature Surface currents Subsurface currents Sea surface salinity Subsurface salinity Ocean surface heat flux Ocean bottom pressure Turbulent diapycnal fluxes (*pilot)	Oxygen Nutrients Inorganic carbon Transient tracers Particulate matter Nitrous oxide Stable carbon isotopes Dissolved organic carbon	Phytoplankton biomass and diversity Zooplankton biomass and diversity Fish abundance and distribution Sea turtles abundance and distribution Seabirds abundance and distribution Marine mammal abundance and distribution Coral cover and composition Seagrass cover and composition Macroalgal canopy cover and composition Mangrove cover and composition Microbe biomass and diversity (*pilot) Benthic invertebrate abundance and distribution (*pilot)
Cross-disciplinary (including human impact)		
	Ocean colour Marine debris (*pilot)	Ocean sound

Inspired by the positive impact that the definition of ECVs had in climate science, the **Integrated Framework for Sustained Ocean Observing (FOO)** suggested the organization of ocean monitoring activities around EOVs, to be defined by panels of experts.

To this aim, the IOC-UNESCO Global Ocean Observing System (**GOOS**) established three panels:

The first two panels focus on abiotic variables and capitalize on existing technology that allows automated sampling (e.g. satellites and remote sensing in general). **The Biology and Ecosystems (BioEco) panel was established in 2015 with the aim to prioritize biological EOVs. => bio-eco EOVs**

Biology & Ecosystem Essential Ocean Variables (BioEco EOVs)

BioEco EOVs were identified by the **Global Ocean Observing System (GOOS)** to meet needs for understanding and forecasting marine life. They provide a framework for coordinating ocean observations, ensuring globally comparable and combinable data.

Global Ocean Observing System

Phytoplankton
Diversity and biomass

Zooplankton
Diversity and biomass

Fish
Abundance and distribution

Sea Turtles
Abundance and distribution

SeaBirds
Abundance and distribution

Marine mammals
Abundance and distribution

Ocean sound
Cross-disciplinary

Corals
Cover and composition

Seagrass
Cover and composition

Macroalgal canopy
Cover and composition

Mangrove
Cover and composition

Microbes
Diversity and biomass
(Pilot)

Benthic invertebrates
Abundance and distribution
(Pilot)

Ocean colour
Cross-disciplinary

GOOS BioEco panel prioritized a set of biological EOVs on the basis of **three criteria** as defined by the FOO:

- **Impact:** relates to the ability of the EOV to signal changes in ocean status and trends in response to human activities;

- **Scalability** (or feasibility): is assessed in terms of the spatial and temporal scales at which variables have been examined in biological observing programmes. Scalability depends on costs, available technology and human capabilities and implies that EOVs can be implemented globally with existing technology and knowledge

- **Social relevance:** requires that EOVs must have direct connection with services that lead to societal goods and benefits which ocean biodiversity provides to humanity and must be able to inform policy decisions.

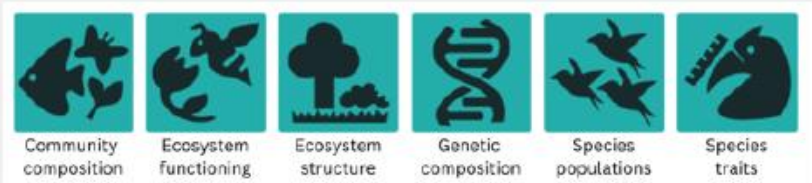
- EOVs sort organisms around trophic levels and each EOV is further characterized by a set of sub-variables, derived products and supporting variables
- Sub-variables are quantities needed to calculate the desired EOV
- Many sub-variables correspond to the Essential Biodiversity Variables (EBVs) identified by the Group on Earth Observations Biodiversity Observation Network (GEO BON)
- Linking ocean EOVs and EBVs is essential to harmonize observations across the global ocean system and to assess progress towards the achievement of the United Nations (UN) Sustainable Development Goal (SDG) 14 (Reynolds et al., 2018)
- It is now recognized that EBVs are subvariables of EOVs (Muller-Karger et al., 2018).

1. EOV information

ESSENTIAL OCEAN VARIABLE (EOV)	Phytoplankton biomass and diversity
DEFINITION	Phytoplankton biomass typically refers to either: weight (mass as the concentration per unit area/volume) and/or abundance or quantity of organisms (number of individuals per volume). Phytoplankton diversity or composition refers to the variability among phytoplankton from all sources including, inter alia, marine and other aquatic ecosystems; this includes diversity within species and between species (e.g., genetic diversity, taxonomic diversity, size, etc.) (https://www.cbd.int/convention/articles?a=cbd-02) Cyanobacteria are primarily addressed here as key members of the phytoplankton, but also addressed in the microbes EOV as members of the Bacteria.
EOV SUB-VARIABLES key measurements that are used to estimate the EOV ***bare minimum**	*Phytoplankton biomass (concentration) *Composition (species, functional types) Number of HAB Events
SUPPORTING VARIABLES - other measurements that are useful to provide scale or context to the sub-variables of the EOV	Nutrients, sea surface temperature, subsurface temperature, sea surface salinity, subsurface salinity, oxygen, inorganic carbon, particulate organic matter concentration, total suspended organic matter concentration, ocean colour and bio-optical variables (remote sensing reflectance, absorption, scattering coefficients, photic or euphotic zone depth), mixed layer depth, surface currents and subsurface currents (vertical, horizontal), primary productivity Complementary: cell size, “biovolume”, nutritional content, density, DNA composition, ocean colour (bio-optics)
DERIVED PRODUCTS outputs calculated from the EOV and sub-variables, often in combination with the supporting variables	Phytoplankton Functional Types Diversity indices: species richness, species evenness, Simpson, etc.

Contributes to (please click on the symbol for more information):

Essential Biodiversity Variables (EBV)



Essential Climate Variables (ECV)

Sustainable Development Goals (SDG)

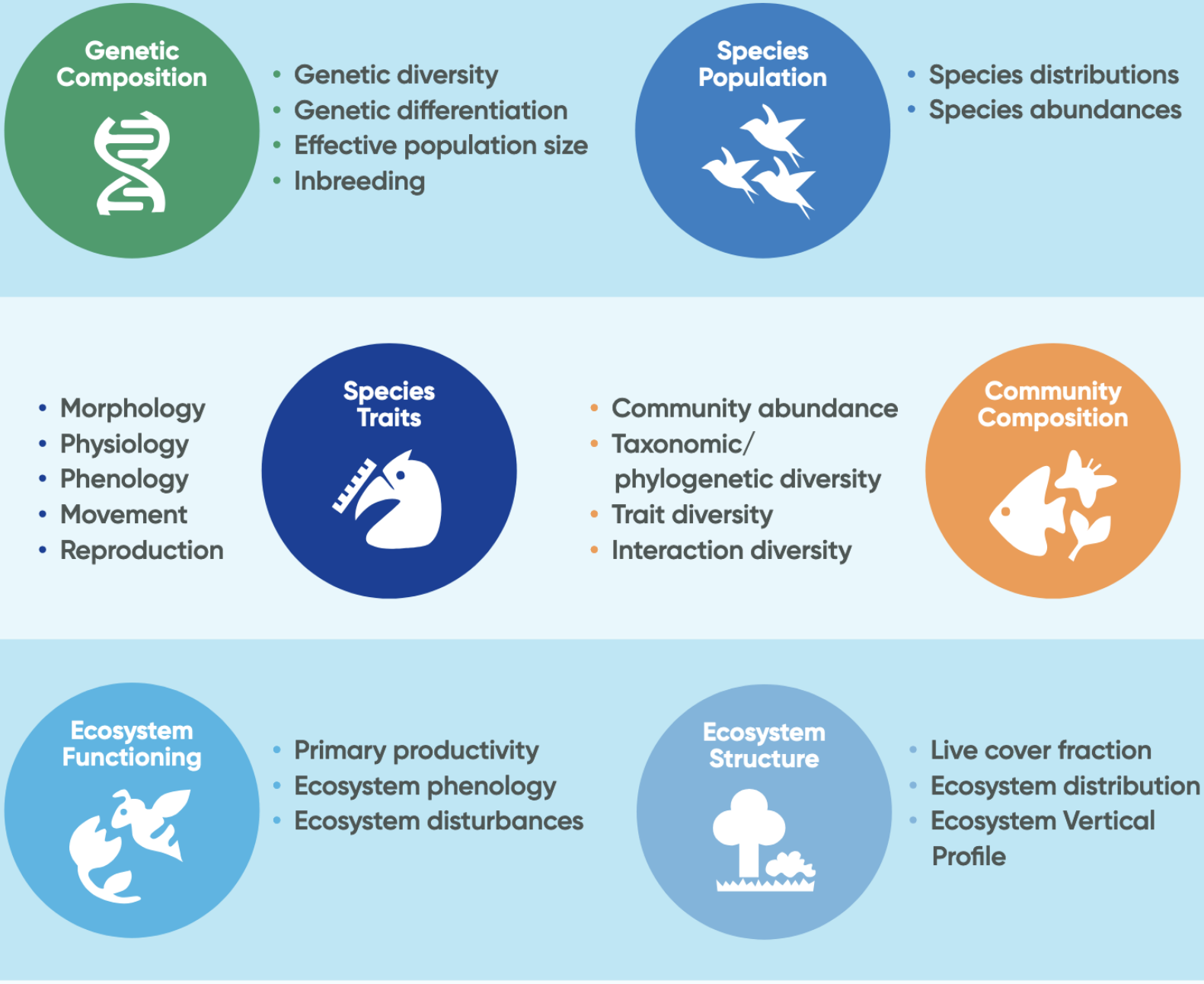
Essential biodiversity variables

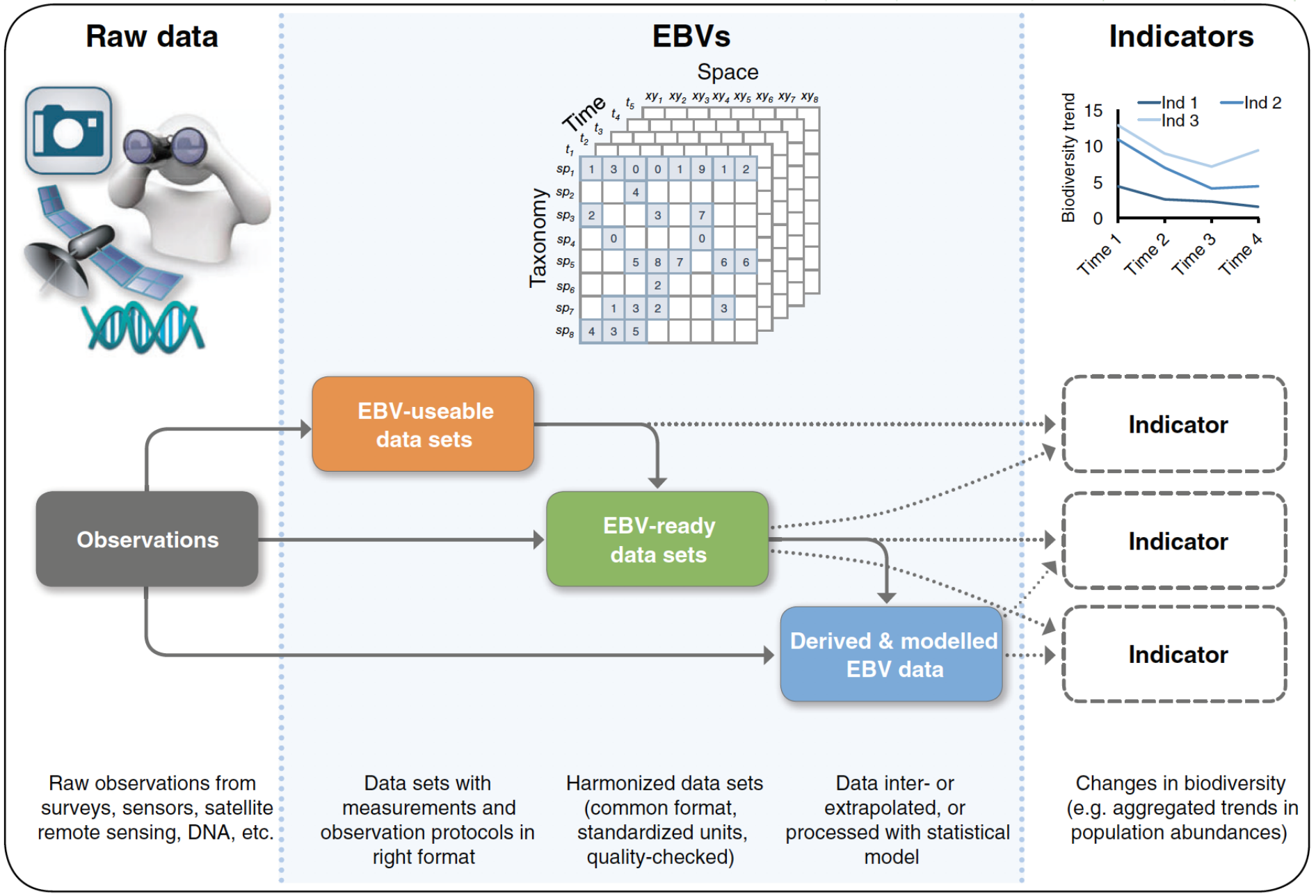
In 2013, the Group on Earth Observations Biodiversity Observation Network (**GEO BON**) developed the framework of EBVs which groups **21 variables** in **six main classes**, each representing a level of biodiversity organization.

(at least one EBV per class)

An ideal EBV should be:

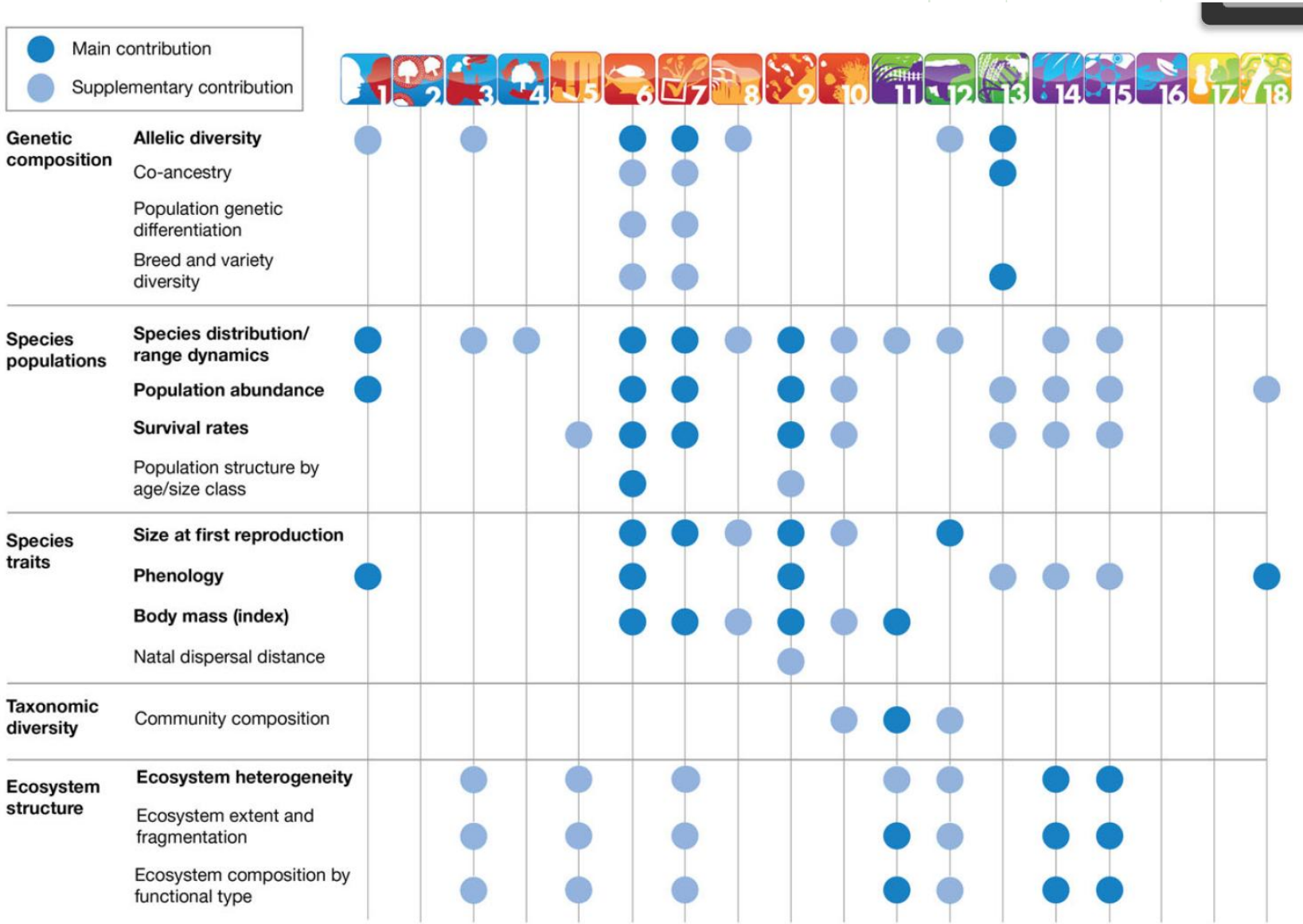
- ❑ able to capture critical scales and dimensions of biodiversity
- ❑ biological
- ❑ a state variable (in general)
- ❑ sensitive to change
- ❑ ecosystem agnostic (to the degree possible)
- ❑ technically feasible, economically viable and sustainable in time


Genetic Composition
• Genetic diversity
• Genetic differentiation
• Effective population size
• Inbreeding
Species Population
• Species distributions
• Species abundances
• Morphology
• Physiology
• Phenology
• Movement
• Reproduction
Species Traits
• Community abundance
• Taxonomic/ phylogenetic diversity
• Trait diversity
• Interaction diversity
Community Composition
Ecosystem Functioning
• Primary productivity
• Ecosystem phenology
• Ecosystem disturbances
Ecosystem Structure
• Live cover fraction
• Ecosystem distribution
• Ecosystem Vertical Profile



Kissling et al., 2018

EBVs would address a large range of conservation issues and contribute to a total of **15 of the 20 Aichi Biodiversity targets** (https://www.cbd.int/sp/targets/) and are, hence, of high biological relevance.



Schmeller et al., 2018

THANKS!

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