Global Observations of the “Biosphere” (land and marine)

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Explain changing conditions of the biosphere

- Are the measured ECVs accurate enough to explain changes of the biosphere (for example, species composition, biodiversity, etc.)?

- How are the biosphere ECVs linked to species composition, biodiversity, etc.?

- Are the biosphere ECVs sufficient to measure biological contributions to the carbon and climate cycles?
Biosphere GCOS ECVs

**Biological/ecosystems**
- Marine habitat properties
- Plankton

**Biosphere**
- Above-ground biomass
- Albedo
- Evaporation from land
- Fire
- Fraction of absorbed photosynthetically active radiation (FAPAR)
- Land cover
- Land surface temperature
- Leaf area index
- Soil carbon
- Soil moisture

Source: https://gcos.wmo.int/en/essential-climate-variables/ecv-factsheets
Multi-year of ground-based observations are collected over a series of selected sites organized through regional or international research networks, such as SurfRad, FluxNet, NEON, ARM, BSRN, LTER, TERN, OZFlux, USRCN...
New (pre-)operational products (such as NOAA CDR or C3S) using past or new sensors are now systematically delivered providing longer-time series and higher spatial resolution, respectively.

Zhu et. al., 2016, Nature Climate Change

Intensity of ENSO
Terrestrial Biosphere ECVs Uncertainties

• The accuracy of measured terrestrial ECVs has been improved (better sensors, calibration & retrieval algorithms) and is expected to reach the targets in few years.

• However, past raw data (from ~ 1980 to 2000) still pose stability problems for biophysical parameters (mainly due to instrument drift and inter-calibration).

• The biases between different sensor products can be corrected but the accuracy will never reach the best recent ECVs products.
Monitoring networks are regional and variable

The GOOS regional alliances formed in 1994 under Intergovernmental Oceanographic Commission of UNESCO, and meet every 2 years but are of highly variable capacity and interest and omit large parts of ocean basins.

Observations are often lacking from low latitudes

Zooplankton observations. Black points show continuous plankton recorder (CPR) samples, our longest time series (~80 years); red points indicate some of the long term zooplankton sampling stations (incomplete).
Despite recent progress in sustained observations of ECVs and in building ocean observing networks and analysis systems, these are not yet adequate to meet the specific needs of the UNFCCC.

Spatial and temporal sampling requirements are not met for most ECVs and in most regions, particularly low latitudes and the southern hemisphere.
The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) assesses the state of biodiversity and of the ecosystem services it provides to society, in response to requests from decision makers.

It was established in 2012 by more than 100 governments (https://www.ipbes.net/)

Source: H. M. Pereira et. al. 2013 Science 339 (6117), 277-278.
Relationship between EOVs and EBVs

Source: Muller-Karger et. al., 2018, Advancing Marine Biological Observations and Data Requirements of the Complementary Essential Ocean Variables (EOVs) and Essential Biodiversity Variables (EBVs)
O1: Marine Heatwaves

Trend of annual number of marine heatwave (MHW)

Impact of marine heatwave days on marine habitat ECVs

O2: Changes in distribution and phenology

Distributional shifts of up to 400km/decade

Changes in timing of key life history events of >10 days/decade

1/3 of the global vegetated lands are becoming more 'productive' (intensive human use of land for crops and forests most in China and India.)

→ Earth System Model should have a better realistic representation of the spatio-temporal dynamics of key land-use practices (multiple cropping, irrigation and fertilizer use, fallowing and abandonment of land, afforestation, reforestation and deforestation.)

Source: Chen et al. (2019) China and India lead in greening of the world through land-use management. Nature Sustainability, (2) 122–129.
L2: Land Cover Map (Copernicus GLS 100m)

L3: Moos Phenology

Typical phenological sequence during an average year in the southern part of Finland. (5 moos species)


Each focal moth species were related to explanatory variables using linear mixed effect models (LMM)

Orthosia gothica

Figure 4. Maps of the peak flight periods for Orthosia gothica: predictions made on the basis of the total model including all variables for (A) an average period of 2001–2013, (B) a phenologically late year (2006), (C) a phenologically early year (2007), and (D) an average prediction for 2001–2013 based on an alternative variable (weekly accumulating growing degree days). Model formulae are presented in Table S2. Data sources: Country borders © EIONET, Lakes © SYKE, Biogeographical provinces ©EUMAP and SYKE.
Summary

• Progress in both land and marine global observations of the biosphere;

• Several ECVs are accurate enough to explain some changes of the biosphere;

• Relations (Equations?) between ECVs and EBVs still need R&D.
Questions for discussion

• How GCOS could improve relations between biodiversity community and TOPC/OOPC?
• How to support the development of accurate ECVs by these communities? and help to identify and reduce the uncertainties. Also for EBVs?
• What are the ground-based uncertainties?
• What level of in-situ calibration is required for eg. satellite data?
• Which action GCOS can take to improve the standardization of historic-ECVs?
• Others? Please come to the panel this afternoon!
Any questions?
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