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Copernicus
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Copernicus for Biodiversity Workshop

BIOSPACE, February 2025

Copernicus for Biodiversity Workshop Agenda

- 15.00 Introduction, Michel Massart, European Commission, Directorate General JRC
- 15.05 Copernicus, EO Space Flagship Program, Michel Massart, EC DG JRC
- 15.15 EO Nature protection: an EU policy perspective, Bruno Combal, EC DG ENV
- 15.30 Copernicus Services and Copernicus In Situ component

  State of play of the Copernicus services, the products and their interest for biodiversity monitoring.

  Andreas Brink, DG JRC for Copernicus Land Service, Tina Silovic, MOI for Copernicus Marine Service, Laurence Rouil, ECMWF for Copernicus Atmosphere Service, Samual Almond, ECMWF for Copernicus Climate Change Service, Jose Rubio, EEA for Copernicus In Situ component.
- 16.30 Coffee Break
- 17.00 Panel discussion

  Relevance of the Copernicus service products for biodiversity monitoring, the potential evolution of the products towards new challenges and the strengthening of user uptake.

  Jillian Campbell (UN-CBD), Alice Hughes (GEOBON), Pavel Milenov (EEA), Enrique Montes (NOOA), Steven Ramage (CEOS-GEOBON), Andrea Taramelli (ISPRA), Victor Martinez Vicente (PML)
- 18.30 End

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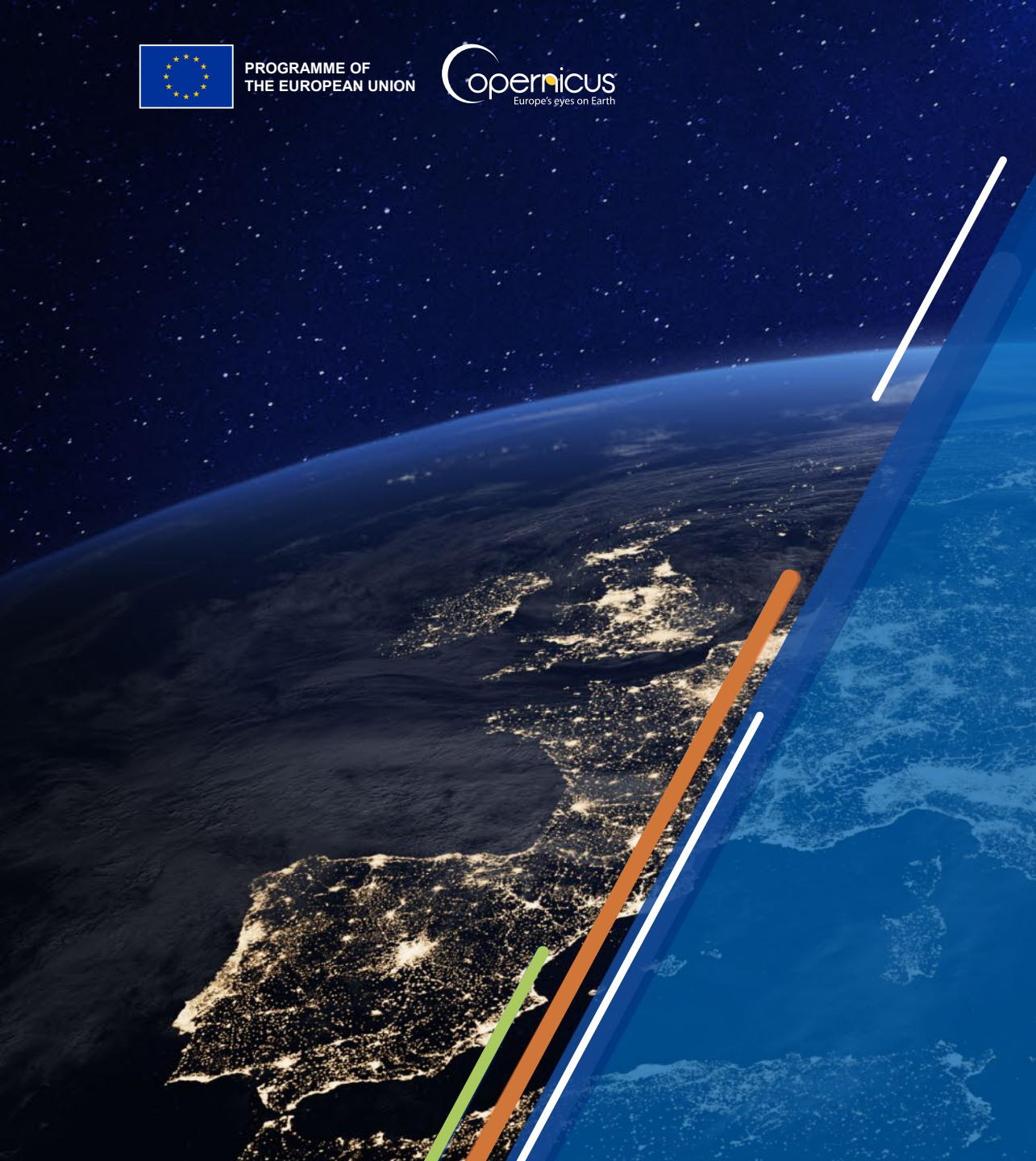

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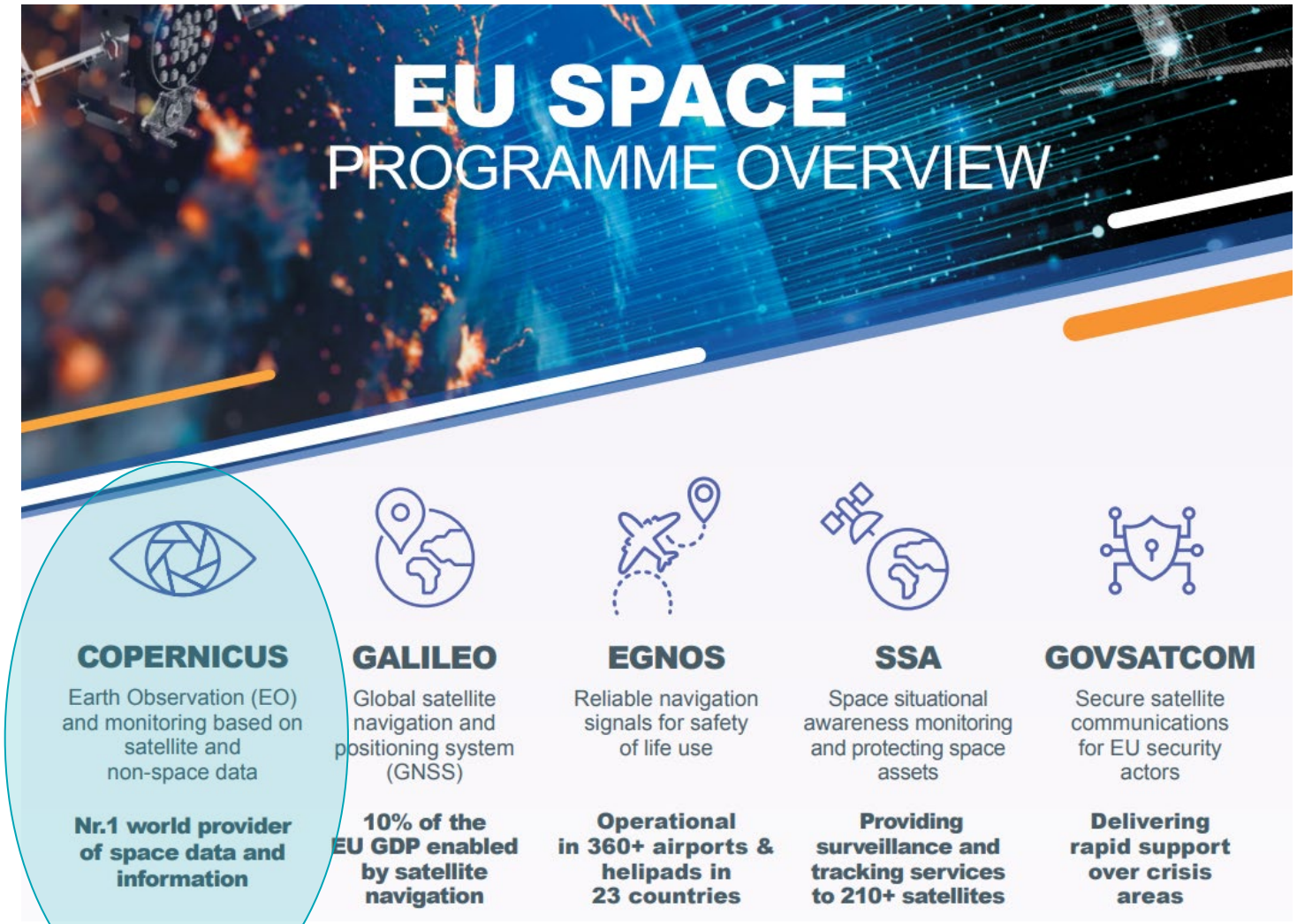
Copernicus for Biodiversity WS

BIOSPACE, February 2025

The EU Space Programme



AN INVESTMENT IN A
FUTURE READY EUROPE

Competitive edge

Completing current satellite constellations, developing and launching the next-generation of satellites

Research **innovation**

Ambitious research and innovation programme benefiting from Horizon Europe

Fighting Climate Change

Monitoring biodiversity, environmental compliance and CO2 emissions (Paris Agreement)

EU as a **global actor**

Supporting disaster relief, humanitarian assistance and security operations

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Copernicus History

1998
Baveno Manifesto

1999
"Global Monitoring for Environment and Security"

GMES

2004
EC-ESA agreement On space component "the Sentinels"

2005
GMES EU's main Contribution to GEOSS

GMES IO

2011
GMES Initial Operations Phase begins

2012
GMES renamed to Copernicus, Start of CLMS, CEMS

2013
EU Regulation: full, free and open data policy.

2014
launch of Sentinel-1A Copernicus Regulation adopted

Copernicus 1.0

2015
launch of Sentinel-2A, Start of CMEMS and CAMS

2016
launch of Sentinel-3A and S-1B Start of CSS

2017
launch of Sentinel-2B, Launch of S-5P, global air quality monitoring

2018
launch of Sentinel-3B and S-1B Start of C3S

2020
launch of Sentinel-6, topography of the global ocean.

Copernicus 2.0

2021
EU Space Programme Regulation

2023
Launch CDSE

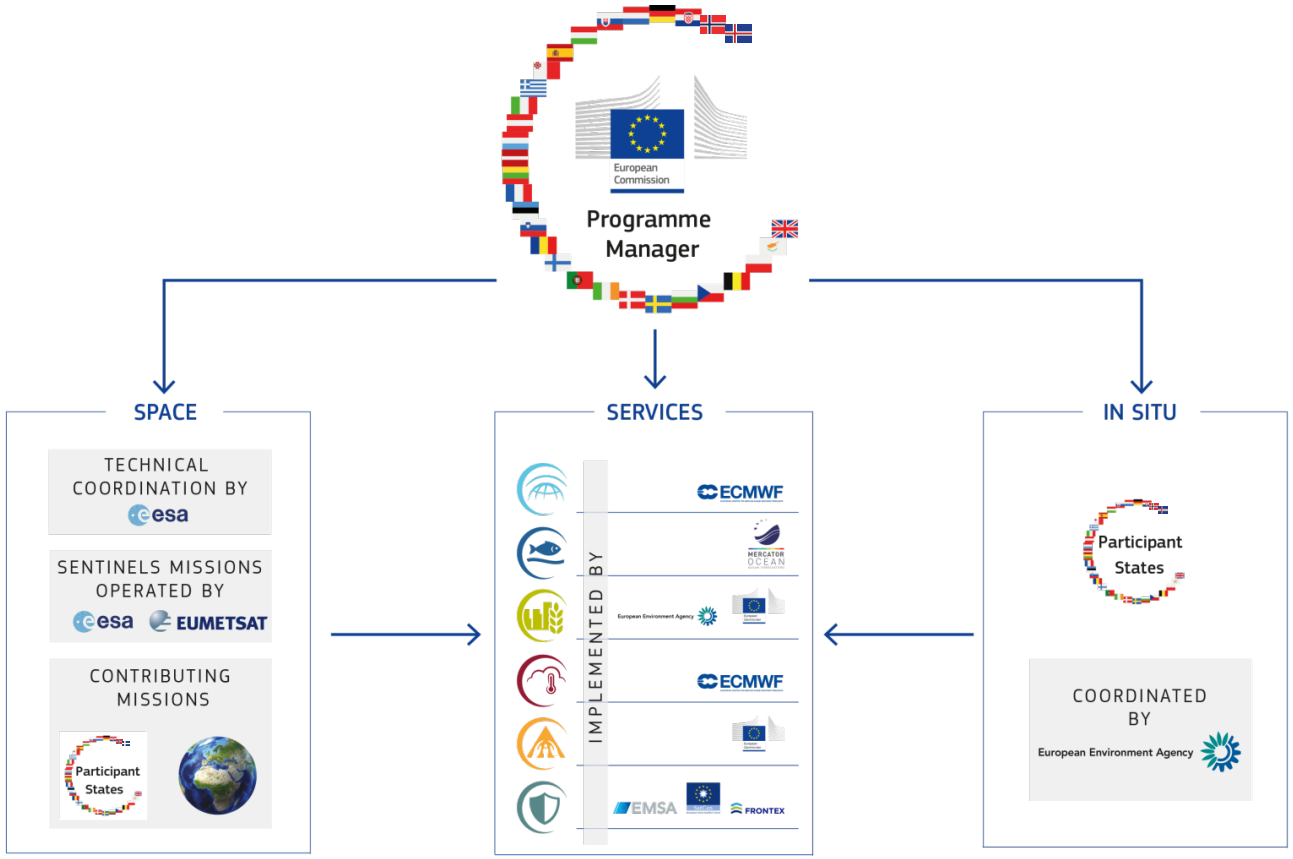
2024
Celebration Copernicus 25 years
Launch of Sentinel 2-C and S-1C

Copernicus 3.0

Copernicus Evolution
MFF 2028-2032

Copernicus Overview

- Copernicus is the European Union programme aimed at developing European information **services** based on satellite Earth Observation and in situ data
- Copernicus is coordinated and **managed** by the **European Commission**
- Copernicus is **implemented in partnership** with the Member States, ESA, EUMETSAT, ECMWF, EEA, EC JRC, Mercator, EMSA, SatCen, Frontex
- Copernicus **Multiannual Financial Framework** 2021-2027 > 5 billion €
- Tool for **economic growth**
- **Operational, Sustainable, Free and Open**



Copernicus Components

Sentinels

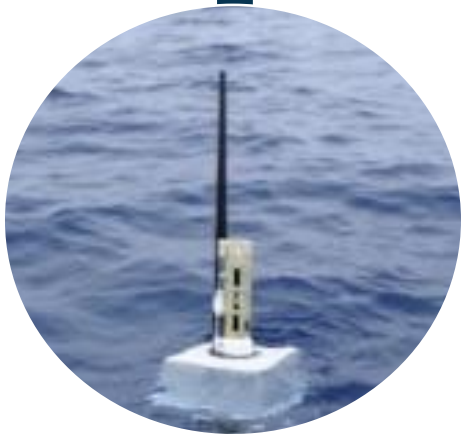
FULL, FREE AND OPEN

Six Copernicus Services

Value-added Services

Contributing missions

In situ data



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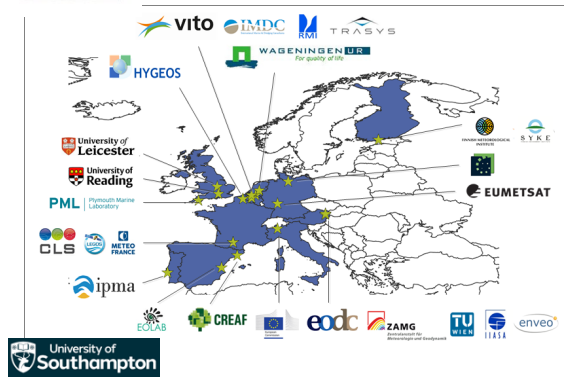
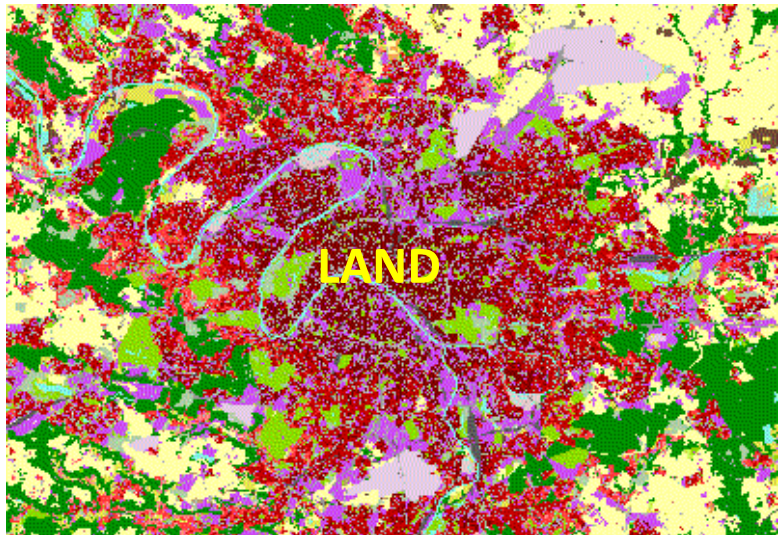
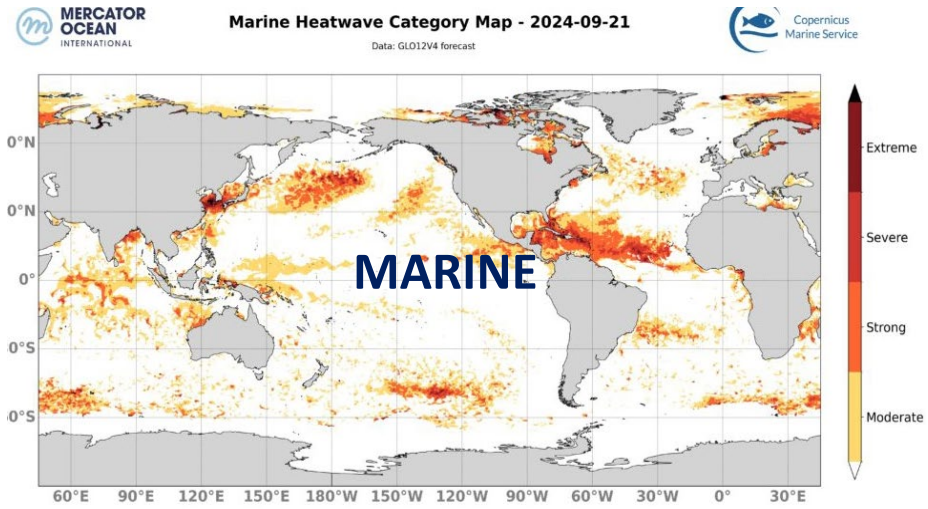
Building on existing expertise

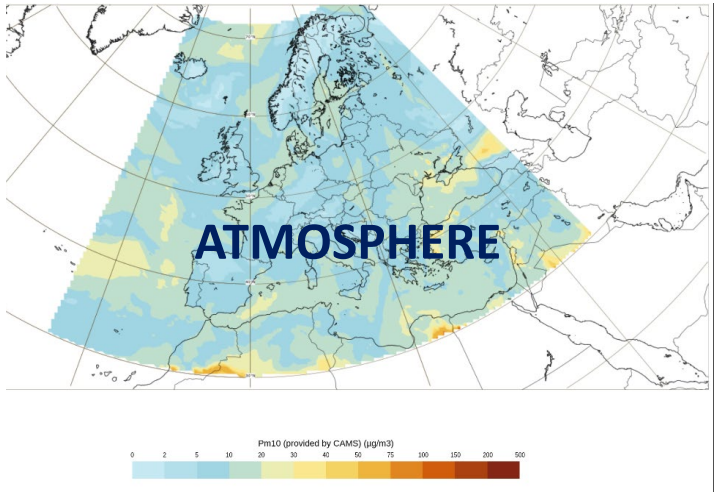
Copernicus Land Service : 65+ industry partners / 350+ experts

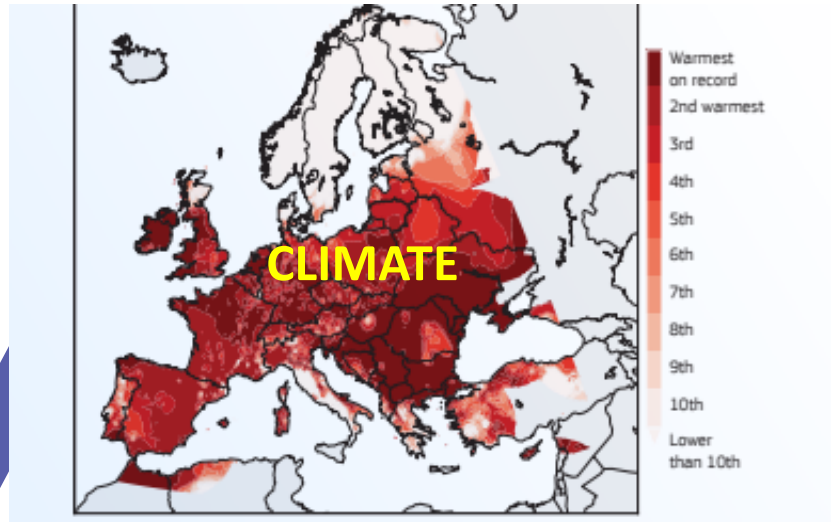


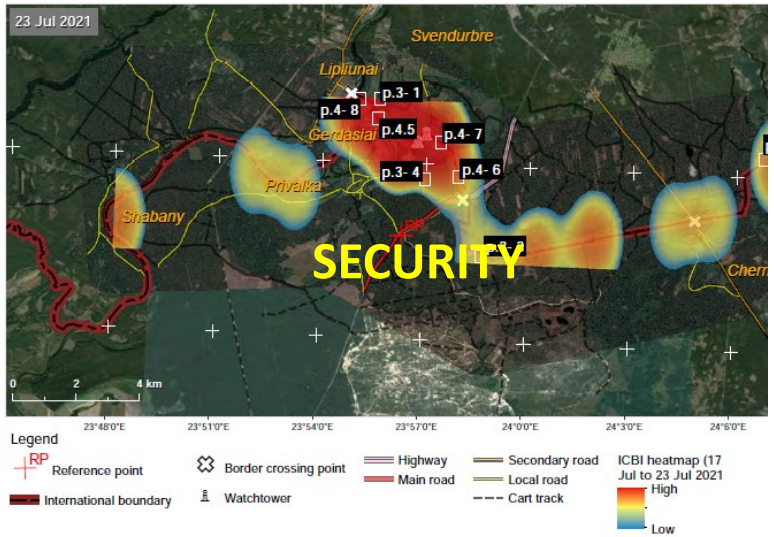
The Copernicus Services











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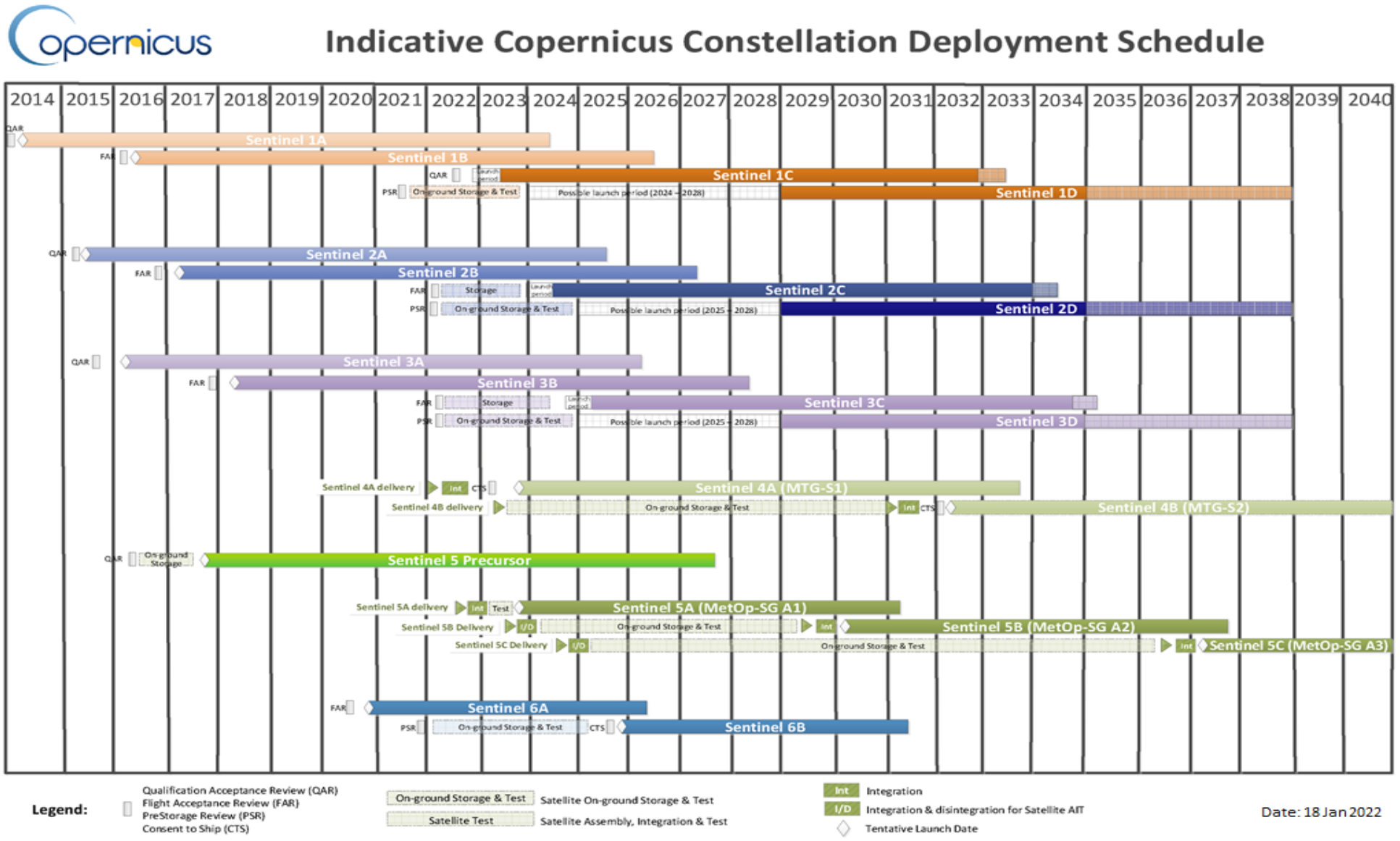
The Copernicus Sentinels

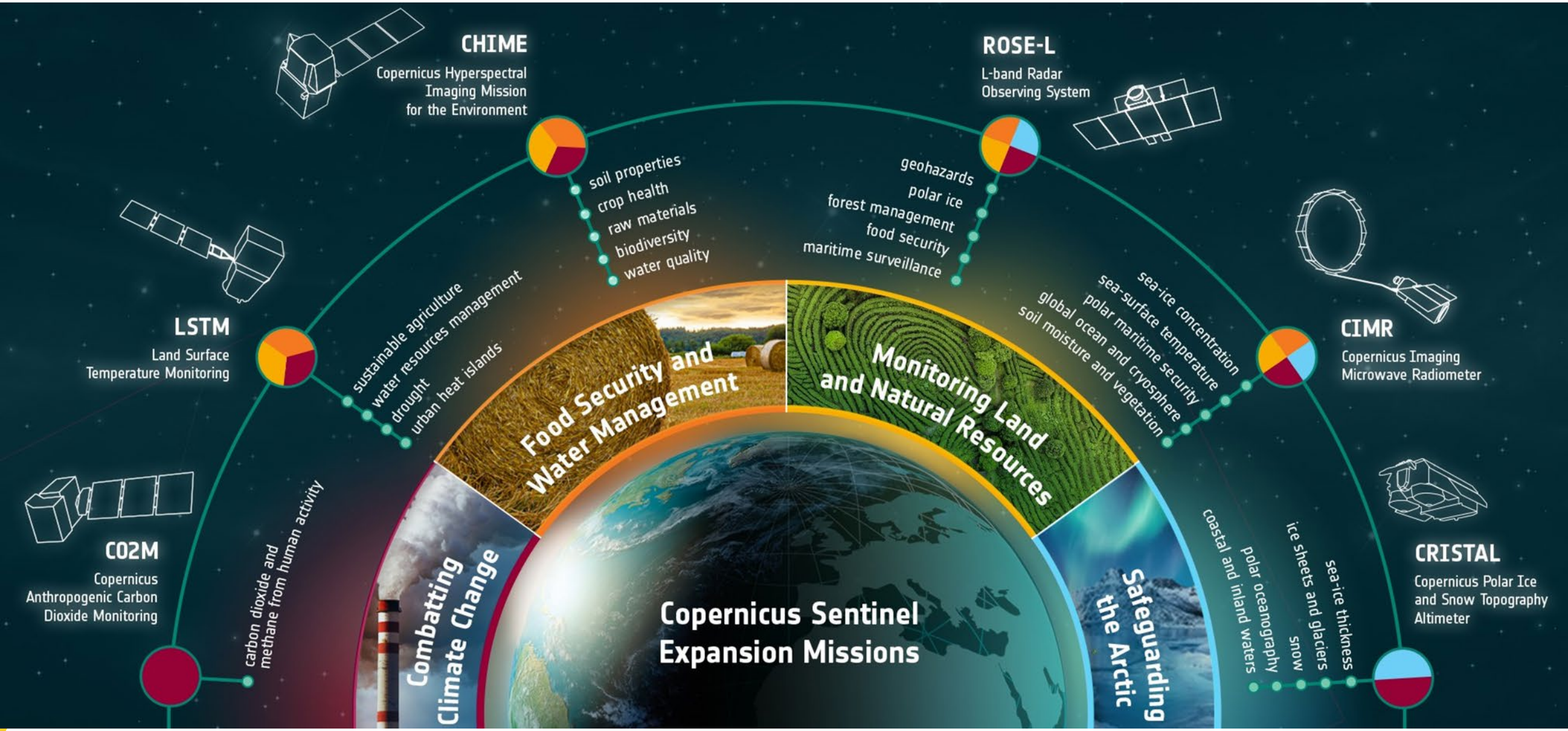
Sentinel Mission and Status	*Key Features*
 SENTINEL-1: 4-40m resolution, 6 days revisit at equator	Polar-orbiting, all-weather, day-and-night radar imaging
 SENTINEL-2: 10-60m resolution, 5 days revisit time	Polar-orbiting, multispectral optical, high-res imaging
 SENTINEL-3: 300-1200m resolution, <2 days revisit	Optical and altimeter mission monitoring sea and land parameters
 SENTINEL-4: 8km resolution, 60 min revisit time	Payload for atmosphere chemistry monitoring on MTG-S
 SENTINEL-5p: 7-68km resolution, 1 day revisit	Mission to reduce data gaps between Envisat, and S-5
 SENTINEL-5: 7.5-50km resolution, 1 day revisit	Payload for atmosphere chemistry monitoring on MetOp 2nd Gen
 SENTINEL-6: 10 day revisit time	Radar altimeter to measure sea-surface height globally

Europe's eyes on Earth

Sentinel Satellite Deployment



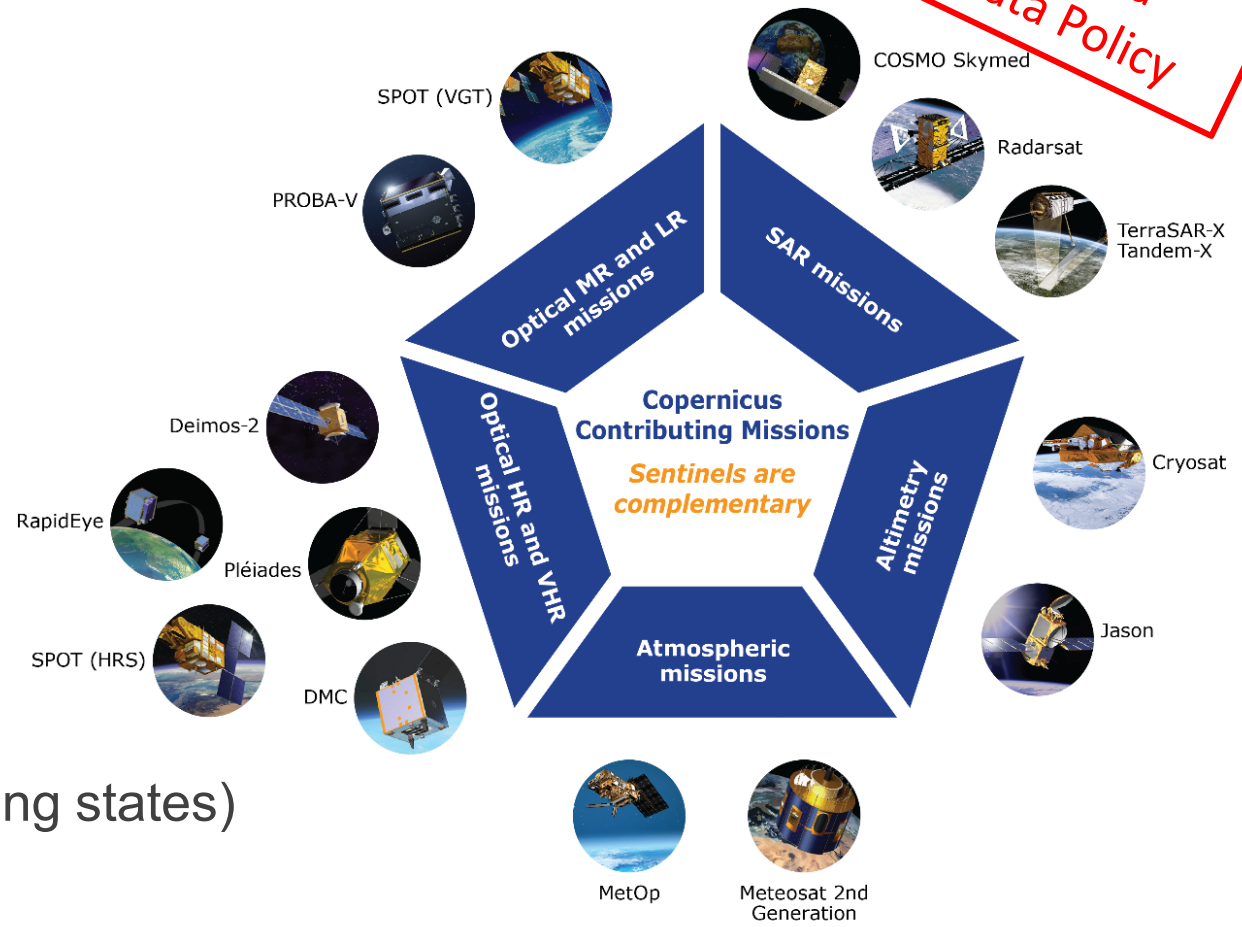
Copernicus Expansion Missions



Copernicus Contributing Missions

Subject to Data Owner's Data Policy

- Emerging Companies
  (EU and Copernicus participating states)
- Established Companies
  (EU and Copernicus participating states)
- Non-EU Companies (Copernicus cooperating states)



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How to access the Copernicus data and products

https://dataspace.copernicus.eu

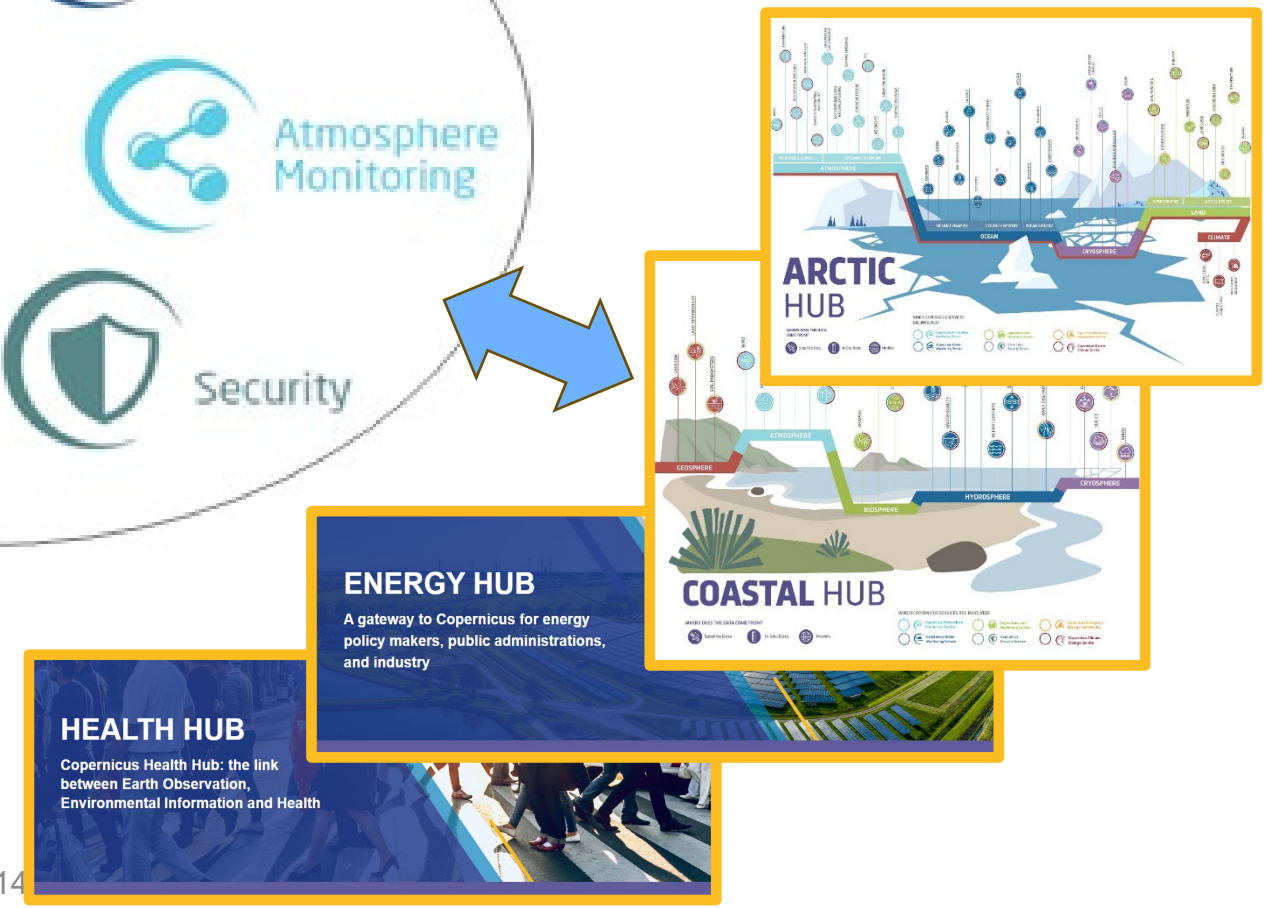
Copernicus Data Space Ecosystem (CDSE) Portal

https://www.wekeo.eu

WEkEO Portal

Copernicus services' portals

Thematic Hubs



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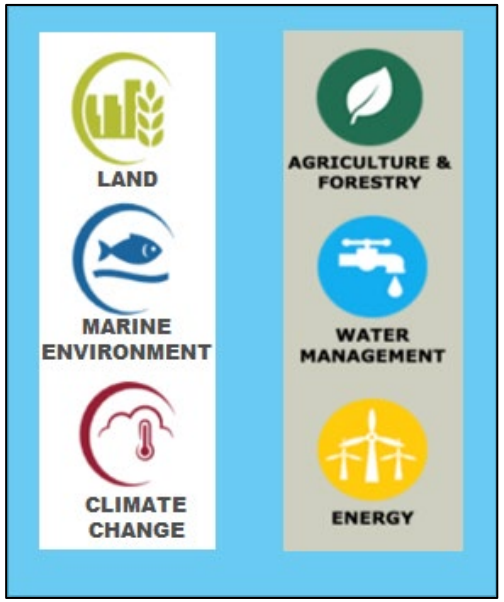
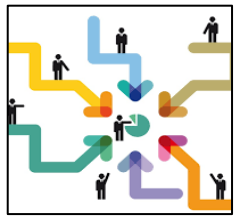
Knowledge Centre on Earth Observation

Pillar 1: Policy Needs, Uptake & Coherence

Pillar 2: Mainstreaming R&I



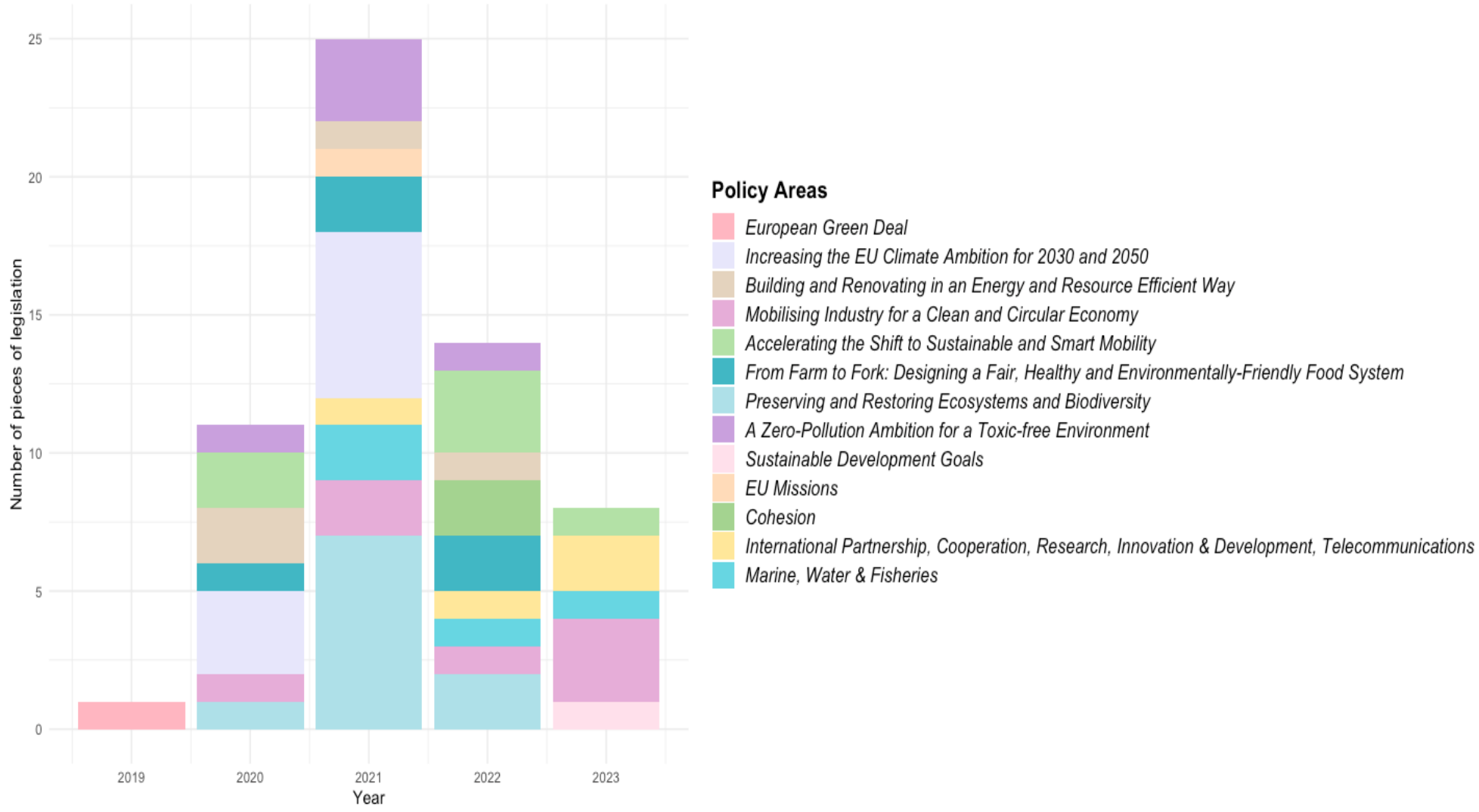
KCEO



Focused entry point

Inclusiveness & Transparency: Dialogue with external partners; international organisation; society

European Green Deal Legislation including Copernicus by policy area over time



Thematic Deep Dive Methodology
Summary of steps

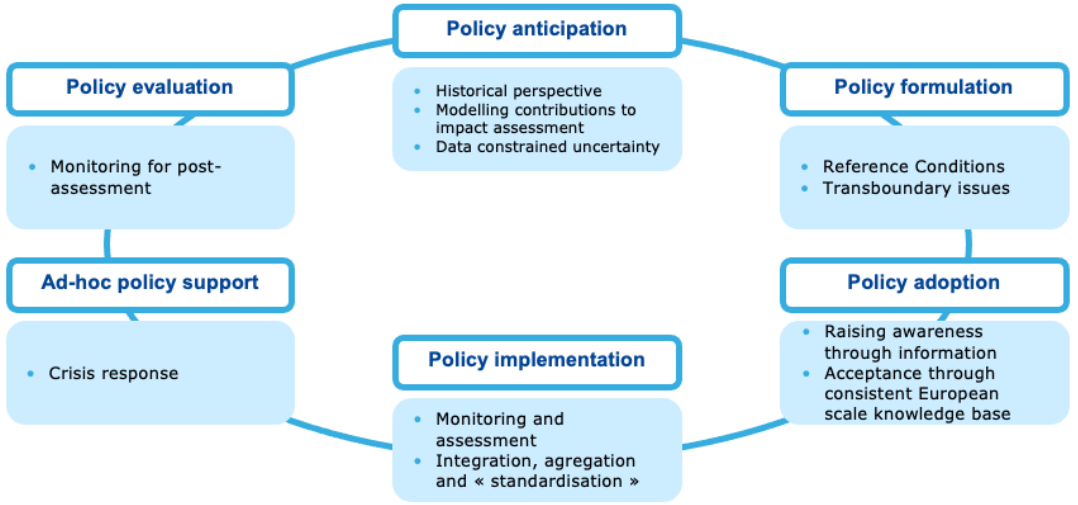
1. Policy needs assessment

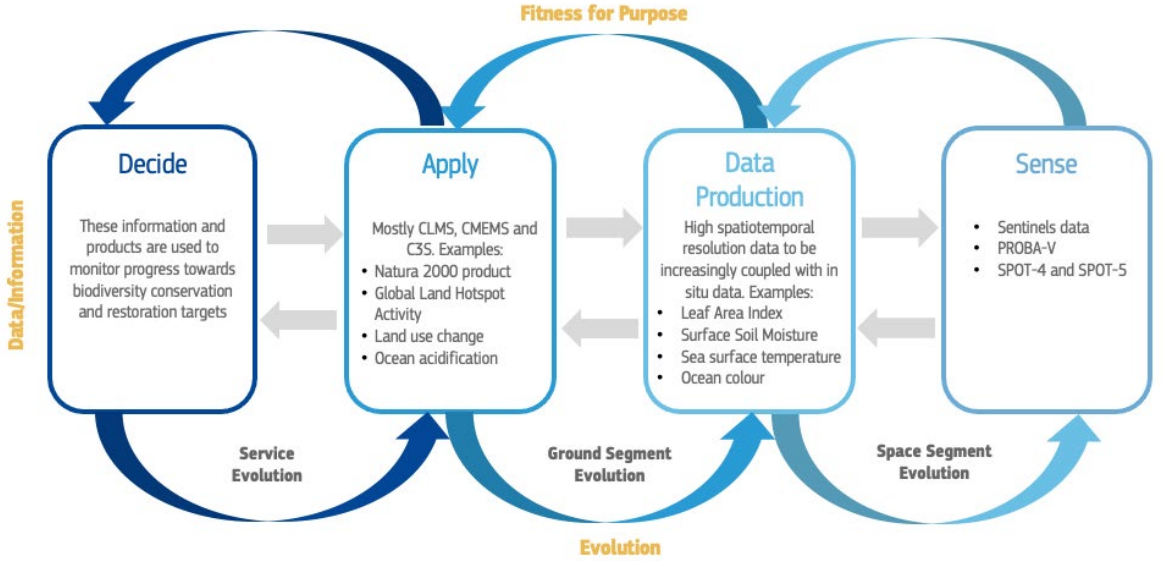
2. Earth Observation Value Chain

3. Translation of needs into quantitative requirements

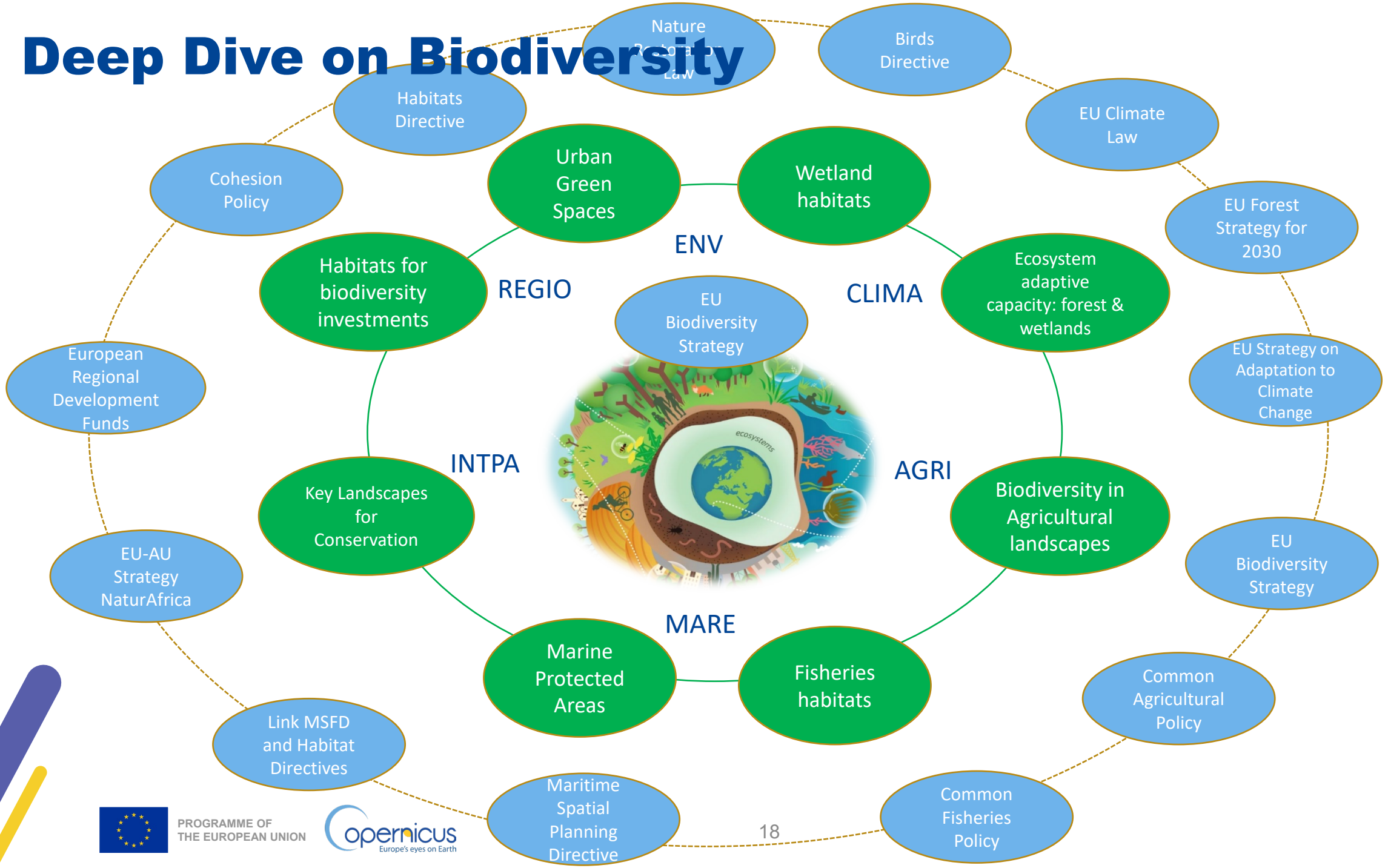
4. Assessment of fitness for purpose with regards to existing products, services, infrastructure, capacities

5. Gap analysis and recommendations for evolution





Deep Dive on Biodiversity



MONITORING OF THE EU BIODIVERSITY STRATEGY (BDS) TARGETS

NEEDS: High-resolution (HR) and long-term indicators on a yearly basis to effectively monitor progress towards the targets outlined.
STATUS: Two online tools for tracking and reporting the progress of the BDS implementation: Actions tracker and Dashboard.
GAPS:

- Lack of yearly HR maps to track changes.
- Absence of suitable ground-based biodiversity data for training and validation.

MONITORING OF URBAN GREEN SPACES

NEEDS: Multitemporal HR maps covering various types of urban green infrastructures.
STATUS: Urban Atlas and Small Woody Features (SWF), among others, partially fulfill the need.
GAPS:

- Inadequacy of temporal frequency, thematic granularity, and spatial coverage.
- Geometric inaccuracy.

MONITORING WETLAND HABITATS

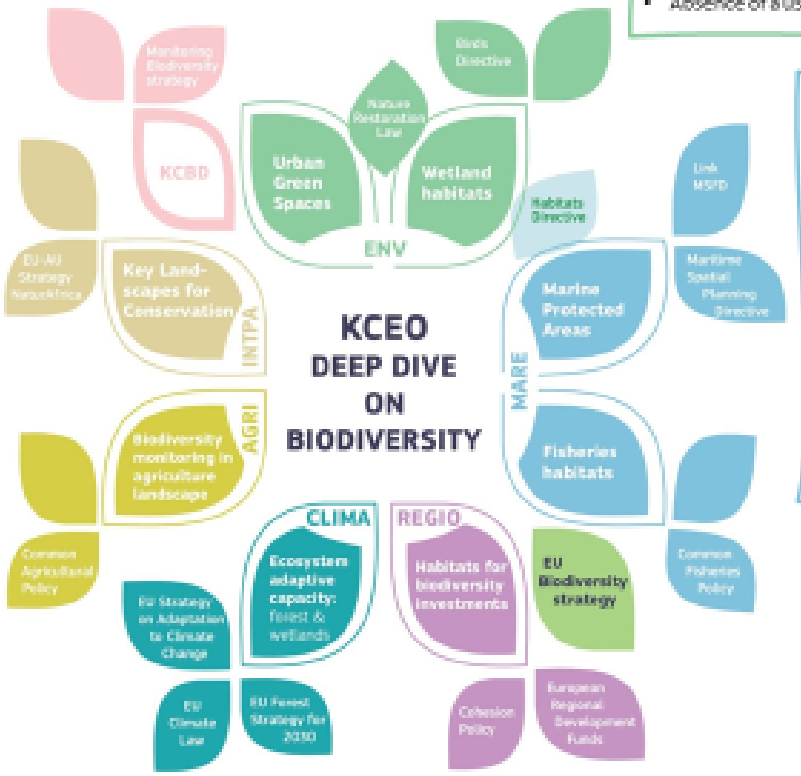
NEEDS: HR maps of delineating wetland habitats and long-term indicators for assessing overall conditions and changes.
STATUS: Land cover map on riparian zones, a dataset on long-term dynamics of surface water, and in-situ soil moisture observations.
GAPS:

- Lack of common definition for wetlands, based on generalized, objective, and measurable criteria.
- Insufficiency in geographic coverage, thematic granularity, spatial and temporal consistency, and a lack of a long-term record.
- Absence of a user-friendly platform to facilitate products accessibility.

BIODIVERSITY MONITORING IN KEY AFRICAN LANDSCAPES FOR CONSERVATION (KLCs)

NEEDS: Detailed indicators, encompassing performance monitoring and accountability measures to support ecosystems conservation while supporting livelihoods and human development.
STATUS: EO products integrated in the AKP provide a baseline for monitoring across the selected KLCs.
GAPS:

- Insufficiency in integrating ancillary data, including socio-economic information derived from UNESCO and EU Delegations.
- Absence of a user-friendly platform to facilitate products accessibility, analysis and reporting.



BIODIVERSITY MONITORING IN AGRICULTURE LANDSCAPE

NEEDS: Indicators for biodiversity monitoring and evaluation to meet the 10% target for High Diversity Landscape Features.
STATUS: SWF and LUCAS Landscape Features module partially address the needs.
GAPS:

- Lack of integration between SWF and LUCAS module.
- Absence of independent and traceable quality assessment of SWF with respect to policy requirements.
- Inadequate frequency and latency of available products.

MONITORING ESSENTIAL FISH HABITATS AND VULNERABLE MARINE ECOSYSTEMS, & MARINE BIODIVERSITY

NEEDS: HR maps for assessing marine protected areas (MPAs), characterising fisheries resources and identifying vulnerable ecosystems.
STATUS: EMODnet and the Copernicus Marine Service partially address the needs.
GAPS:

- Lack of centralized and easy access to satellite and in-situ national data.
- Absence of informative indicators on species richness and abundance hotspots, overlaps between hotspots and MPAs, and areas impacted by cumulative impacts.
- Insufficient spatial and temporal resolutions.

MONITORING ECOSYSTEMS HEALTH TO SUPPORT BIODIVERSITY INVESTMENTS

NEEDS: Monitoring system to guide and assess EU investments in biodiversity and ecosystems.
STATUS: Available EO products partially address the needs.
GAPS:

- Insufficient generation of targeted indicators, such as phenology or productivity indices.
- Lack of operationality.
- Inconsistencies and gaps in the time series.
- Coarse thematic granularity of land cover maps, limiting a comprehensive understanding of ecosystems.

MONITORING SHIFTS IN GEOGRAPHIC RANGES, DISTRIBUTION AND CONDITIONS OF SPECIES POPULATION AS A FUNCTION OF CHANGING CLIMATE

NEEDS: Assessment of the impacts of Climate Change on ecosystems' functions and structures, on species abundance and distribution.
STATUS: Climatic data products are suitable for bioclimatic models.
GAPS:

- Low spatial resolution of available products.
- Lack of operationality in combining bioclimatic modelling technologies with bioclimatic products (under development by C3S).
- Insufficiency in parametrising biological processes to be included in models.
- Inaccuracy and lack of performance assessment of bioclimatic models.

ASSESSMENT AND MONITORING OF EU FOREST HEALTH

NEEDS: A forest monitoring system to alert on disturbances, assess the impact of climate changes on biodiversity, and predict disturbance risks.
STATUS: Copernicus CLC+ Backbone and High Resolution Layer Forest, among others, partially address the needs.
GAPS:

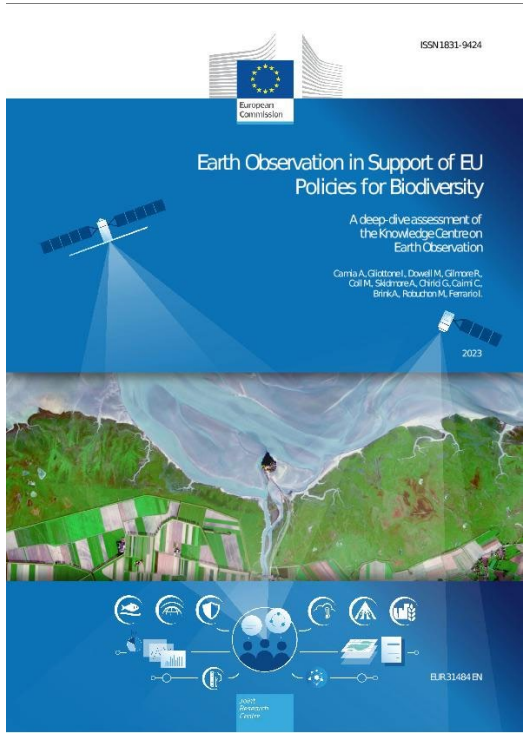
- Lack of HR yearly maps on forest status and changes.
- Insufficiency in delineating forest types.
- Deficiency in integrating ground and satellite data.
- Limited access to and use of training and reference data for accuracy assessment of Copernicus products.

PR
TH

#	RS - Biodiversity Product (*)	EU Biodiversity Strategy Targets																Copernicus Product
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1	Biological effect of fire disturbance	x	x	x	x													Burnt Area
2	Biological effect of irregular inundation	x	x	x	x													Soil Water Index
3	Leaf Area Index		x		x													Leaf Area Index
4	Land Cover	x	x	x	x			x	x	x	x							Land Cover
5	Ice Cover habitat	x	x	x	x													RLIE S1+S2
6	Above ground biomass		x		x													NA
7	Foliar NPK Content						x							x				NA
8	Net primary productivity							x	x									Net primary productivity
9	Gross primary productvity							x	x									Gross primary productvity
10	FAPAR		x		x													FAPAR
11	Fraction of vegetation cover							x	x									Fraction of vegetation cover
12	Plant area index profile		x		x													NA
13	Urban habitat														x			1. Urban Atlas, 2. GHS BUILT, 3. GHS SMOD
14	Vegetation canopy height	x	x	x	x													NA
15	Habitat structure				x													NA
16	Ecosystem Fragmentation	x			x													Corine Land Cover
17	Ecosystem structural variance	x			x													Corine Land Cover
18	Land surface phenology peak							x	x									Vegetation phenology and productivity suite HR VPP
19	Land surface phenology green-up							x	x									Vegetation phenology and productivity suite HR VPP
20	Land surface phenology senescence							x	x									Vegetation phenology and productivity suite HR VPP
21	Carbon cycle		x		x													NA
22	Chlorophyll content and flux	x		x														Chlorophyll content and flux

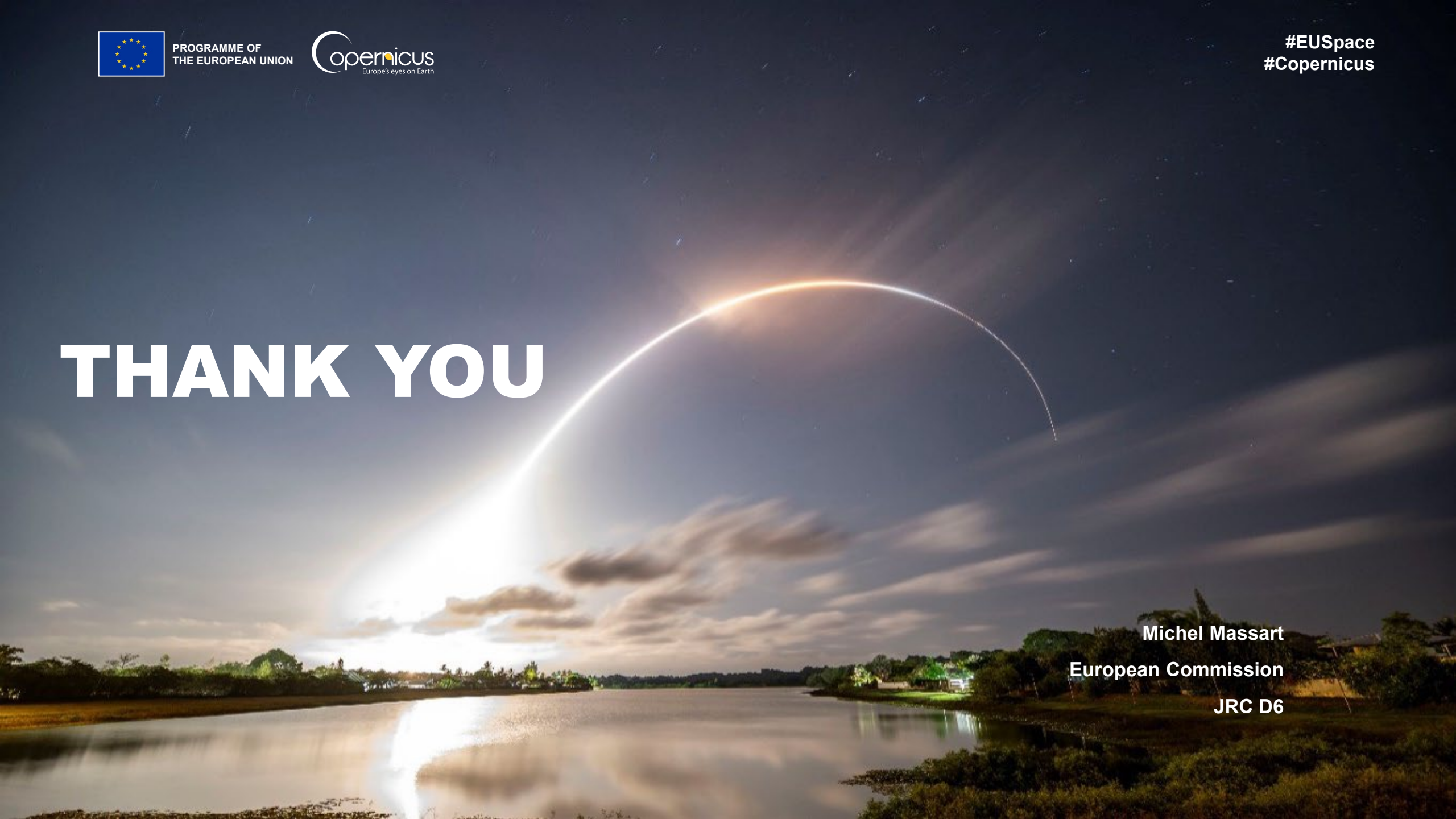
(*) RS products prioritized as EO biodiversity metrics in Skidmore et al. (Nature ecol & evol, 2021)

General recommendations on EO support to EU biodiversity policy



- Sustained assistance to cover the "**last mile**" for an efficient uptake: products need to be tailored
- Efficiency potentially gained addressing **cross-policy needs**
- **Spatial resolution and thematic detail** more important than high time frequency
- **Time series** length, consistency and regular updates to improve e.g., for benchmarking and observing evolutions over time
- **Improving thematic details** of EO products; standard land cover classes not sufficient for many biodiversity applications. Need of a harmonised ecosystem typology classification (other communities are going in this direction).
- Integration of **in situ data** and models is key but far from operational
- **Availability of in situ** data is still a challenge
- **Access to EO products** and services for decision makers to improve

https://publications.jrc.ec.europa.eu/repository/handle/JRC132908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THANK YOU
Michel Massart
European Commission
JRC D6

BioSpace25 - Biodiversity insight from Space
10 - 14 February 2025 | ESA-ESRIN | Frascati - Italy

EO and Nature protection: an EU policy perspective

Bruno Combal (PhD), DG ENV - Nature protection unit

ESA UNCLASSIFIED - For ESA Official Use Only

Natura 2000

Birds Directive (1979, 2009/147/CE)

Protects all wild birds occurring in the EU + regularly migrating species.

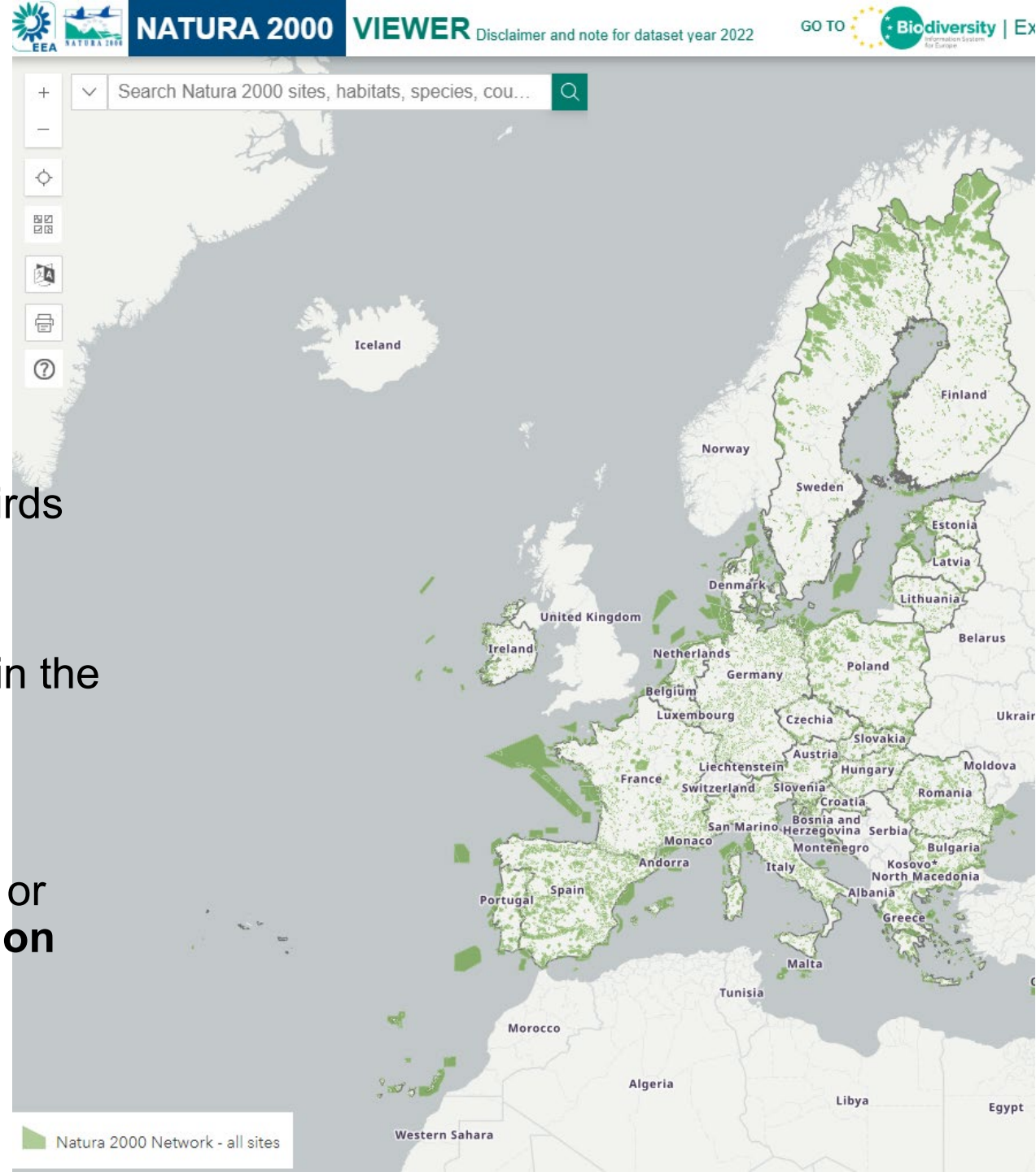
Habitats Directive (1992, 92/43/EEC)

Concerns 232 Habitats types and thousand of non-birds (fauna/flora) species.

→ The directives aim to maintenance of biodiversity in the European territory

→ Both directives requires the Member States to designate protected sites (**Natura 2000**) to maintain, or where appropriate restore, at a favorable **conservation status** habitats and species.

https://natura2000.eea.europa.eu



Nature Restoration Regulation

Restore EU's **land and sea areas**, and define conservation measures

Article 4: Terrestrial, Coastal, and Freshwater Ecosystems

Member States are required to implement restoration measures to improve and re-establish habitats listed in **Annex I of the Habitats Directive**. The targets includes:

- Art 4.1: Restoring at **least 30% of the total area** of these habitats that are not in good condition **by 2030**, with progressive increases to **60% by 2040** and **90% by 2050**.
- Art 4.4: **Re-establish annex I habitats** in areas where it does not occur
- Art 4.7: Ensuring that there is a continuous improvement in the quality and quantity of habitats for species listed in Annexes II, IV, and V of the **Habitats Directive**, as well as for wild birds covered by the **Birds Directive**.

Main usage of geospatial/EO information Habitats directive

Article 4: MS must identify in their territory Habitats to protect in Natura 2000

→ Opportunity to separate habitats mapping from degradation monitoring

Article 17: MS must report on their protected habitats and species **conservation status**, occurring in their whole territory (including outside Natura 2000).

Resource intensive, sometimes not complete

Article 6.2 (compliance): MS take steps to avoid degradations in Natura 2000 sites. The Commission is interested in detecting signs of degradation.

For grasslands intensification and abandonment are the main pressures leading to the grasslands degradations.

Habitats conservation status

Parameters

Range	• Refers to the geographic extent where the habitat occurs. • Criteria: range is stable or increasing.
Area	• The overall surface area occupied by the habitat within its natural range. • Criteria: area is stable or increasing.
Structures and functions	• Assesses the qualitative state of the habitat: vegetation composition, ecological conditions (hydrology, substrate), and overall functionality. • Includes the availability of elements necessary for long-term survival. • Criteria: ecological functions are maintained, with no major pressures.
Future prospects	• Considers trends for the above parameters, as well as threats and conservation measures. • Criteria: integrated evaluation of factors influencing conservation in the medium or long term.

Overall conservation status

FV	Favourable ('green')
U1	Unfavourable – Inadequate ('amber')
U2	Unfavourable - Bad ('red')
XX	Unknown (insufficient information to make an assessment)

Habitat assessments at Member State level

Choose a period, a group and then a country. Optionally, further refine your query by selecting one of the available biogeographical regions for that country.

Period... 2013-2018 | **Group...** Bogs, mires & fens | **Country...** France | **Bio-region...** All bioregions | Filter

Note: Rows in italic shows data not taken into account when performing the assessments (marginal presence, occasional, extinct prior HD, information, etc)

Legend: FV Favourable | XX Unknown | U1 Unfavourable-Inadequate | U2 Unfavourable-Bad

Current selection: 2013-2018, Bogs, mires & fens, France, All bioregions.

Member States reports

Habitat	Region	Range (km²)				Area (km²)								Structure and functions (km²)					Future prospects				Overall assessment						Distribution area(km²)		
		Surface	Status (% MS)	Trend	FRR	Min	Max	Best value	Type est.	Method	Status (% MS)	Trend	FRA	Good	Not good	Not known	Status	Trend	Range prosp.	Area prosp.	S & f prosp.	Status	Curr. CS	Curr. CS trend	Prev. CS	Prev. CS trend	Status Nat. of ch.	CS trend Nat. of ch.	Distrib.	Method	% MS
7110 - Active raised bogs	ALP	15600	22.44	=	≈	1	10	N/A	estimate	c	0.11	=	≈	1 - 6	1 - 4	1 - 10	U1	x	unk	poor	poor	U1	U1	=	U1	=	noChange	noChange	11700	a	26.59
7110 - Active raised bogs	ATL	15000	11.29	=	>	50	100	N/A	estimate	c	26.28	-	>	5 - 20	25 - 50	25 - 50	U2	x	good	poor	unk	U2	U2	x	U2	-	noChange	noChange	15100	a	18.06
7110 - Active raised bogs	CON	23600	19.30	=	x	36	60	N/A	estimate	d	32.28	x	>	N/A - N/A	N/A - N/A	36 - 60	FV	+	poor	poor	poor	U1	U1	=	U1	-	noChange	noChange	19300	a	28.81
7110 - Active raised bogs	MED	2000	23.53	=	x	1	9	N/A	estimate	c	78	-	x	1 - 9	1 - 9	1 - 9	U1	u	good	poor	poor	U2	U2	-	U2	-	noChange	noChange	900	a	15
7120 - Degraded raised bogs still ca...	ALP	5100	24.47	=	x	1	10	N/A	estimate	d	1.30	x	x	N/A - N/A	1 - 10	1 - 10	U1	x	poor	poor	poor	U1	U1	x	U1	=	noChange	noChange	3700	b	26.43
7120 - Degraded raised bogs still ca...	ATL	11000	7.73	=	x	10	50	N/A	estimate	c	4.37	=	≈	10 - 25	10 - 25	10 - 25	U1	x	poor	poor	bad	U2	U2	=	U2	-	noChange	noChange	10800	b	13.06
7120 - Degraded raised bogs still ca...	CON	12500	9.21	-	≈	22.40	26	N/A	estimate	c	11.72	u	<	N/A - N/A	22.40 - 26	N/A - N/A	U2	+	unk	unk	good	FV	U2	x	U2	=	noChange	noChange	11300	b	15.80
7120 - Degraded raised bogs still ca...	*MED*	*N/A*	*0*	*N/A*	*N/*	*N/A*	*N/A*	*N/A*		*N/A*	*0*	*N*	*N/*	*N/A - N/A*	*N/A - N/A*	*N/A - N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N*	*N/A*	*N/A*	*noChange*	*noChange*	*N/A*	*b*	*0*
7130 - Blanket bog (*active only)	ATL	100	0.06	=	≈	0.06	0.06	N/A	estimate	d	0	=	≈	0.05 - 0.05	N/A - N/A	0.05 - 0.05	FV	x	unk	unk	unk	XX	FV	=	FV	N/A	N/A	N/A	100	a	0.08
7140 - Transition mires and quaking ...	ALP	9500	4.18	=	≈	1	10	N/A	estimate	d	0.03	u	>	1 - 5	1 - 2	1 - 10	U1	x	good	unk	unk	XX	U1	x	U2	=	noChange	noChange	7800	b	4.80
7140 - Transition mires and quaking ...	ATL	11818.25	4.33	=	>	1.65	5.70	N/A	minimum	c	1.76	-	>>	N/A - N/A	N/A - N/A	N/A - N/A	U2	x	unk	bad	poor	U2	U2	-	U2	=	noChange	noChange	12100	b	7.98
7140 - Transition mires and quaking ...	CON	23200	6.34	=	≈	13.53	23.70	N/A	estimate	c	0.48	=	x	N/A - N/A	N/A - N/A	13.53 - 23.70	U1	-	poor	poor	poor	U1	U1	-	U1	-	noChange	noChange	18800	b	8.73
7140 - Transition mires and quaking ...	*MED*	*N/A*	*0*	*N/A*	*N/*	*N/A*	*N/A*	*N/A*		*N/A*	*0*	*N*	*N/*	*N/A - N/A*	*N/A - N/A*	*N/A - N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N*	*N/A*	*N/A*	*noChange*	*noChange*	*N/A*	*b*	*0*
7150 - Depressions on peat substrat...	ALP	1400	7.26	=	≈	1	1	N/A	estimate	d	0.48	=	≈	N/A - 0.10	N/A - 0.05	N/A - 0.50	U1	x	good	unk	unk	XX	U1	=	U1	=	noChange	noChange	1200	b	12.77
7150 - Depressions on peat substrat...	ATL	16600	11.18	x	>	N/A	N/A	22	minimum	c	28.81	x	x	21.30 - 21.30	0.40 - 0.40	0.30 - 0.30	U1	x	unk	unk	unk	XX	U1	x	U2	-	noChange	noChange	14900	b	15.54
7150 - Depressions on peat substrat...	CON	12300	18.85	=	≈	8	12	N/A	estimate	d	6.21	-	>	N/A - N/A	N/A - N/A	8 - 12	XX	x	poor	poor	poor	U1	U1	x	U2	-	knowledge	knowledge	10300	b	26.55
7150 - Depressions on peat substrat...	*MED*	*N/A*	*0*	*N/A*	*N/*	*N/A*	*N/A*	*N/A*		*N/A*	*0*	*N*	*N/*	*N/A - N/A*	*N/A - N/A*	*N/A - N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N*	*N/A*	*N/A*	*noChange*	*noChange*	*N/A*	*b*	*0*
7210 - Calcareous fens with Cladium...	ALP	4500	28.18	=	>	N/A	11.60	11.60	estimate	c	75.16	-	>	N/A - N/A	N/A - N/A	11.60 - 11.60	XX	-	bad	bad	bad	U2	U2	-	U1	-	noInfo	noChange	2300	a	26.44
7210 - Calcareous fens with Cladium...	ATL	17000	32.79	=	≈	200	500	N/A	estimate	c	81.50	=	<	100 - 300	100 - 200	100 - 200	FV	x	good	good	poor	U1	U1	=	U1	=	noChange	noChange	16700	a	42.82

Monitoring Annex I habitats

EU Grassland Watch: first attempt to go beyond CLMS specifications (EP funded project, EEA+JRC are partners), for **natural/semi-natural** grasslands

→ Continuous monitoring from 1994 to now, yearly updates

→ Indicators of intensification/abandonment (most important pressure on grassland biodiversity) + last mile application

→ Need for community building with Member States experts: appropriation + co-creation

EU Wetland Watch: Similar approach for wetlands

→ methodology: start from policy needs, define wetlands typical pressures and their proxies

→ Work led by JRC Knowledge Centre on Earth Observation (KCEO)

In situ information are essential!

First objective: Training / Validation

Not enough in-situ data ready to be used

Second objective: combine EO with in-situ data (in particular on species) to better assess conservation status

In situ data: 2 Horizon projects

Biodiversity Meets Data (BMD), KO 4/03/2025

Answer the question: can we create an EU-wide IT platform, for biologists collecting in-situ data, offering data hosting, data processing (imagery, sound, eDNA, etc), and data sharing?

→ Support biodiversity experts, but also EU projects (LIFE, Horizon), national projects, etc.

→ Encourage normalisation (data cube, normalised taxonomy), and good practices

→ Simplify data exchange (and access for Cal/Val), and encourage cross-domain research

BioDiMoBot: KO 5/02/2025 – Robotic solution, long time drifting solution (days/weeks/months), collecting water biodiversity + water properties (physical and chemical) – on-board pre-processing, data transfer to BMD

→ in-situ data intensification

Thank you

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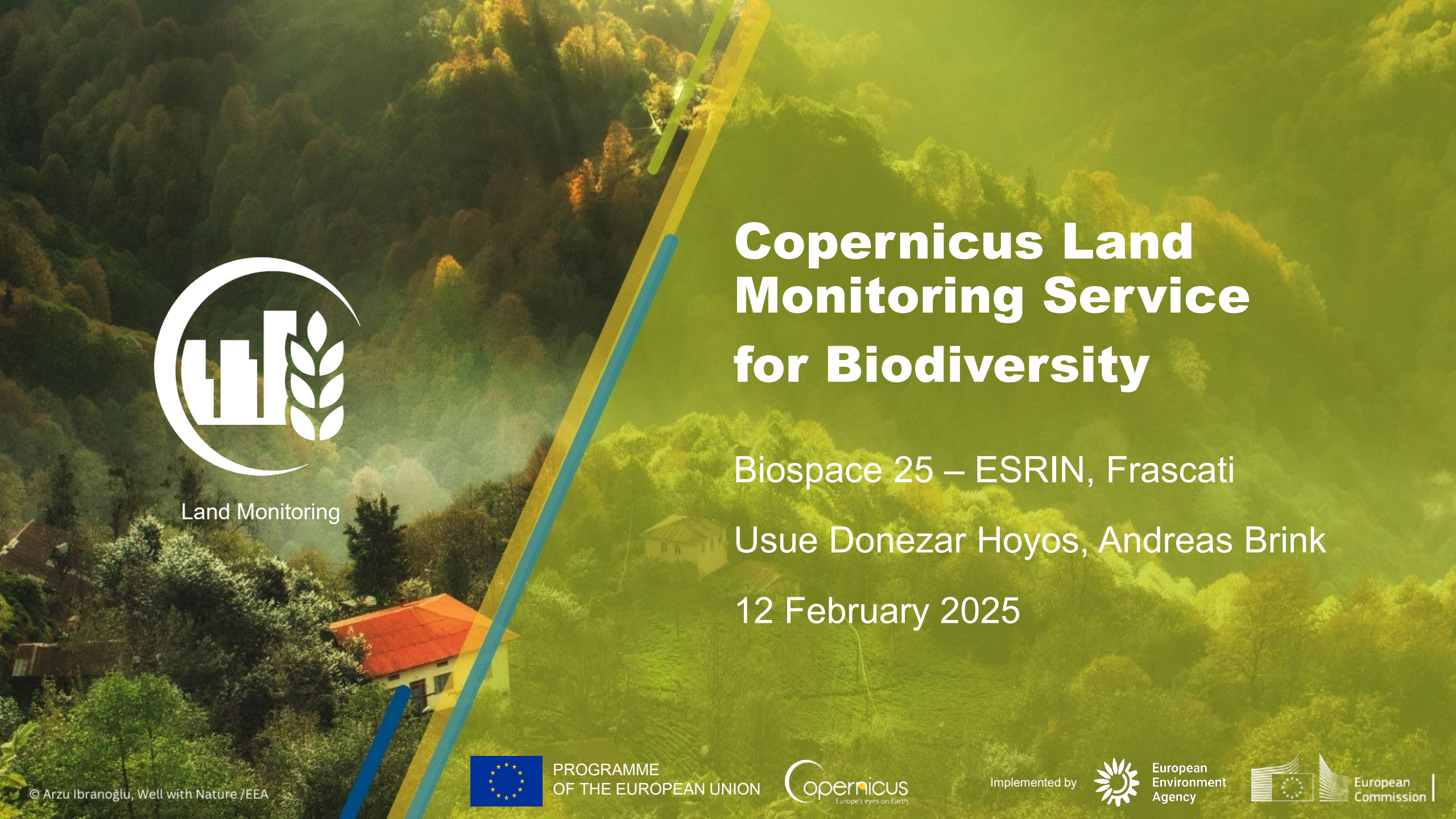


Copernicus Land Monitoring Service for Biodiversity

Land Monitoring

Biospace 25 – ESRIN, Frascati

Usue Donezar Hoyos, Andreas Brink

12 February 2025

© Arzu Ibranoğlu, Well with Nature /EEA

PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

Implemented by European Environment Agency

European Commission

Essential Biodiversity Variables

- variables to measure biodiversity change
- distill the complexity of biodiversity into a manageable list of priorities
- coordinated approach to observing biodiversity on a global scale from Earth Observation and In Situ measurements
- promoted by GEO BON

GEO BON, 2024

Needs and Requirements

Skidmore, A.K. et. al (2021). Priority list of biodiversity metrics to observe from space. Nature Ecology & Evolution, Vol. 5, July 2021, 896–906

Earth Observation based EBV's

FIT4PURPOSE

Criteria	Description
Relevance	Use and user fully identified
Feasibility	Maturity of the science, technology and availability of remote sensing data, the ease of access and the completeness to such data
Remote sensing status: Accuracy	Effectiveness of remote sensing data and techniques to achieve an accurate and precise value of the remote sensing-enabled biodiversity product
Remote sensing status: Maturity	Operational implementation

Modified from: Skidmore, A.K. et. al (2021).

Ranking remote sensing biodiversity products

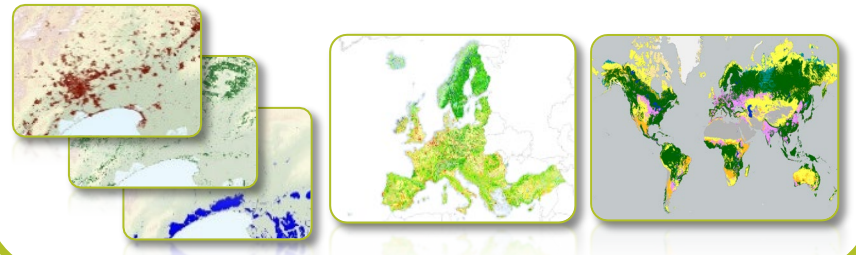
COPERNICUS LAND MONITORING SERVICE

RS biodiversity product	RS -enabled biodiversity variable	EBV class	Rank within EBV class	Rank across all EBV classes
Fire disturbance	Ecosystem disturbance Habitat structure	Ecosystem function Ecosystem structure	1 1	1 1
LAI	Ecosystem physiology Habitat structure Species physiology	Ecosystem function Ecosystem structure Species traits	3 3 1	5 5 21
Land cover (vegetation type)	Habitat structure	Ecosystem structure	3	5
Ice cover habitat	Habitat structure	Ecosystem structure	5	8
Net primary productivity (NPP)	Ecosystem physiology Species physiology	Ecosystem function Species traits	5 2	11 28
Gross primary productivity (GPP)	Ecosystem physiology Species physiology	Ecosystem function Species traits	5 2	11 28
Fraction of absorbed photosynthetically active radiation (FAPAR)				
Fraction of vegetation cover	Habitat structure	Ecosystem structure	7	11
Peak, start, end of season	Ecosystem Phenology	Ecosystem function	8	22
Ecosystem soil moisture	Ecosystem physiology	Ecosystem function	14	28

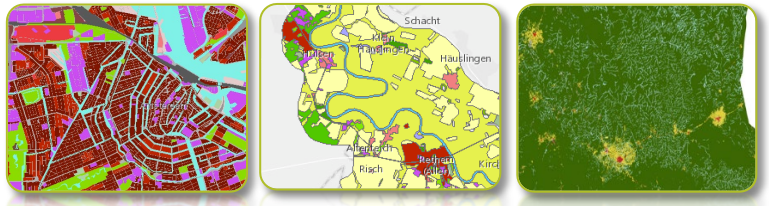
Modified from: Skidmore, A.K. et. al (2021).

Copernicus Land Monitoring Service - products

Land cover and land use mapping

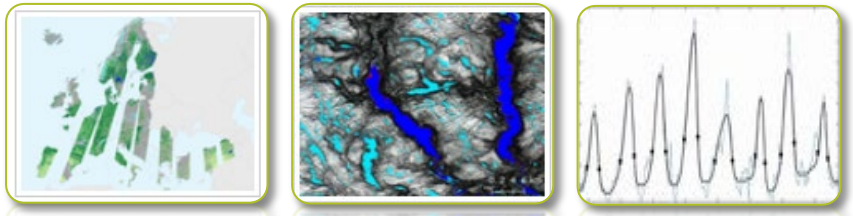


Priority area monitoring

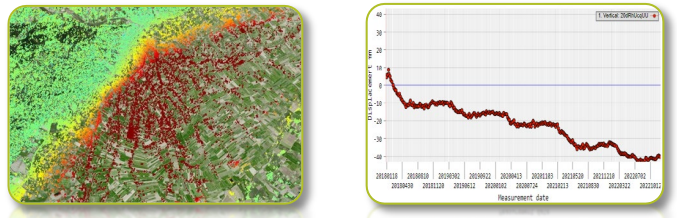


Satellite data

Bio-geophysical parameters

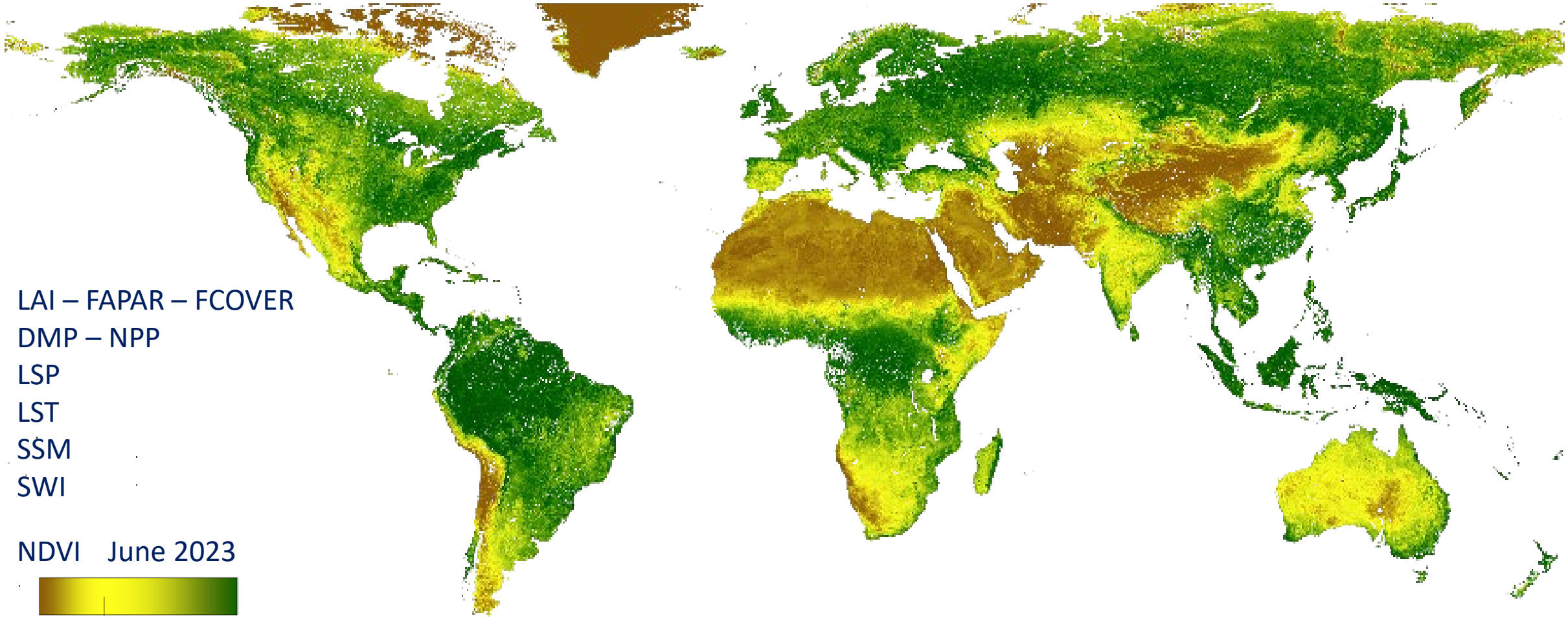


Ground motion monitoring



Reference and validation data

Global biophysical variables

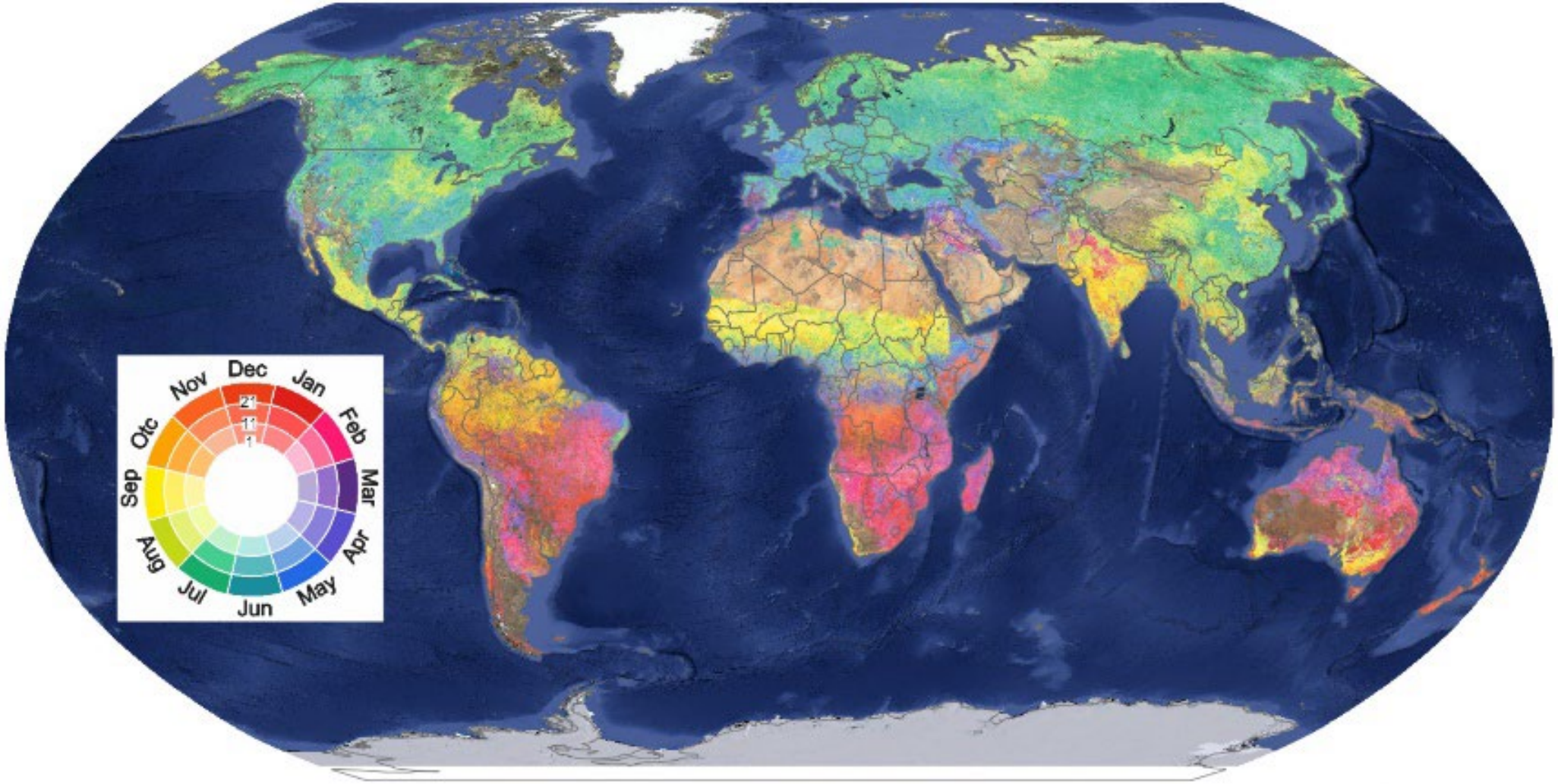


LAI – FAPAR – FCOVER
DMP – NPP
LSP
LST
SSM
SWI

NDVI June 2023

-0.08 0.2 0.92

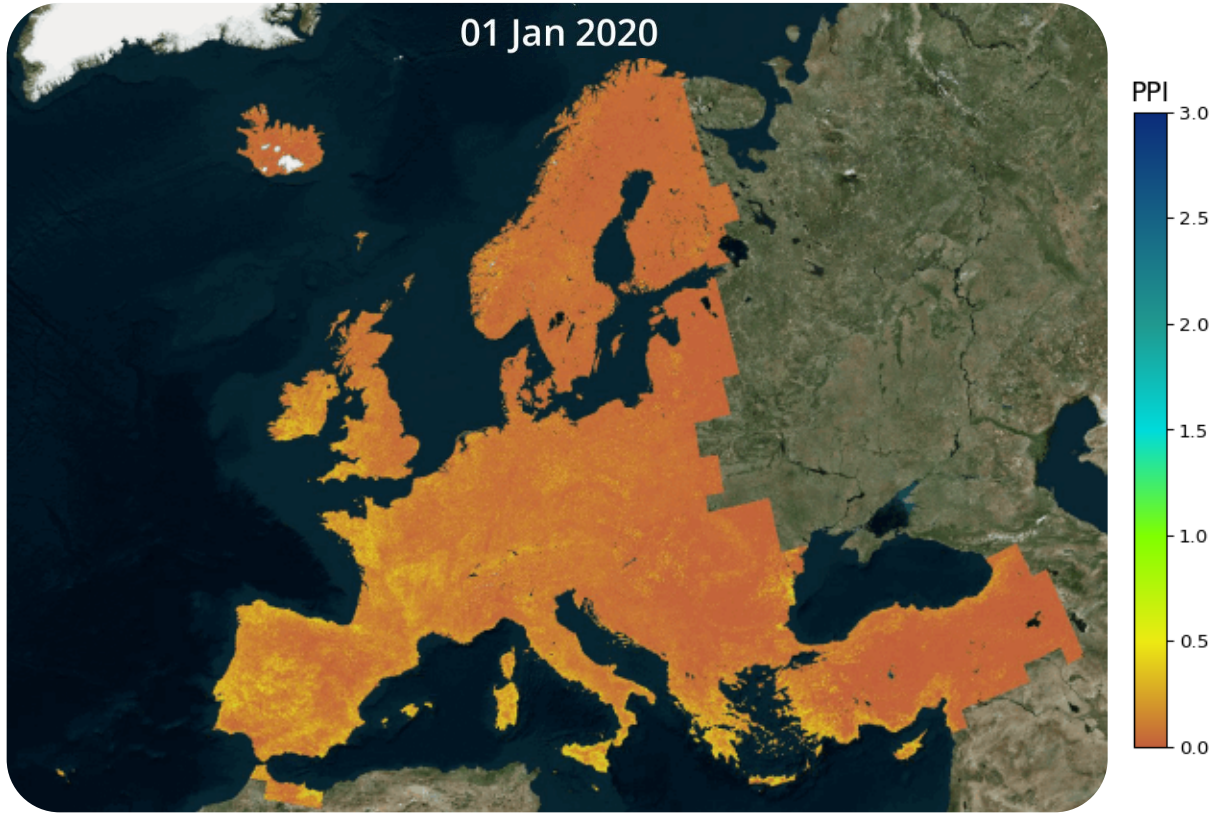
Land Surface Phenology



Date of the peak of growing season - 2023

HR Vegetation Phenology & Productivity

- **10 meter annual** processing of **13 metrics**.
- **Near Real-Time:** vegetation indices & biophysical variables
- **Future prospects**:
  - Tree Cover **Disturbances**
  - **Biomass** Productivity (GPP/NPP)

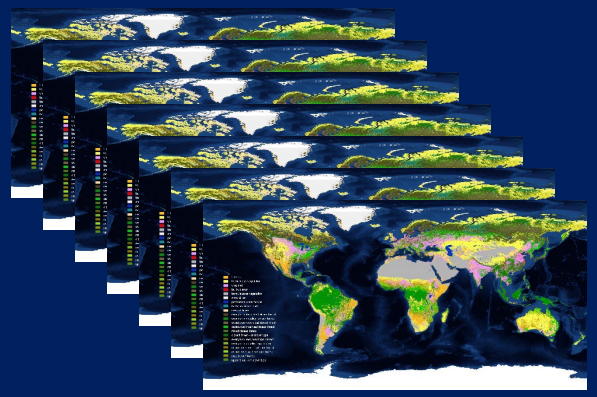


2017 — 2018 — 2019 — 2020 — 2021 — 2022 — 2023 — 2024

Global Land Cover

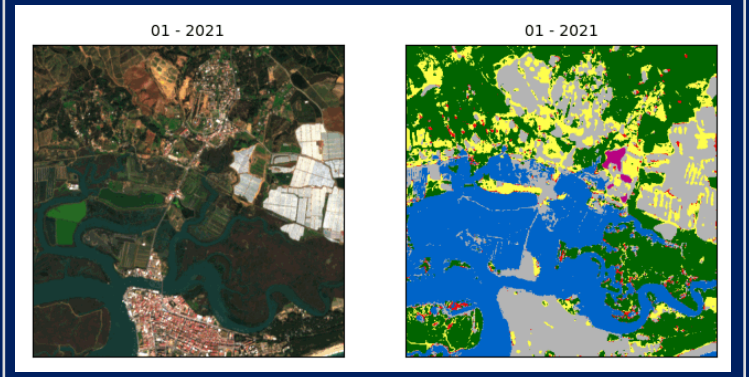
CONTINUE

- Continuation of 100m global LC
- Yearly updates (2020-2026)



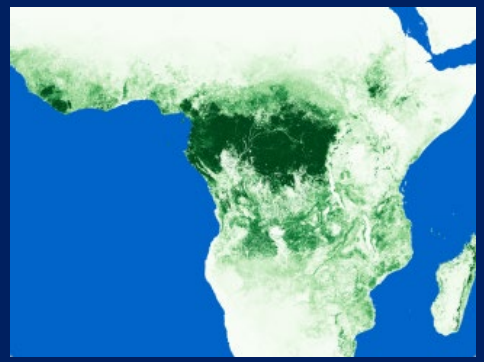
ENHANCE

- Spatial resolution: towards 10 m
- Temporal resolution: towards monthly and NRT
- Improved accuracy
- Consistent change mapping



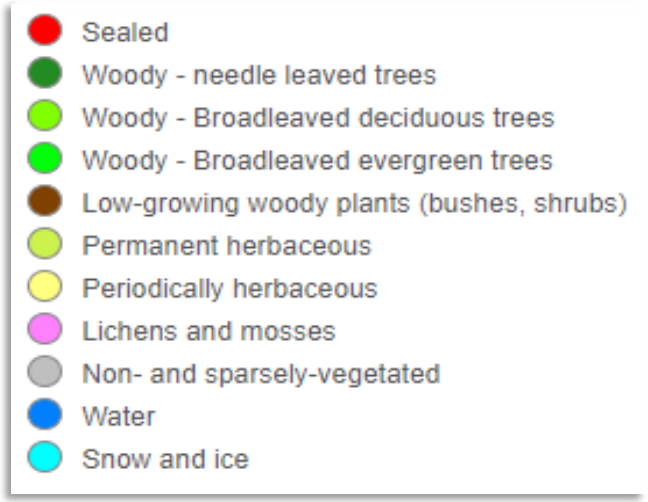
EXTEND

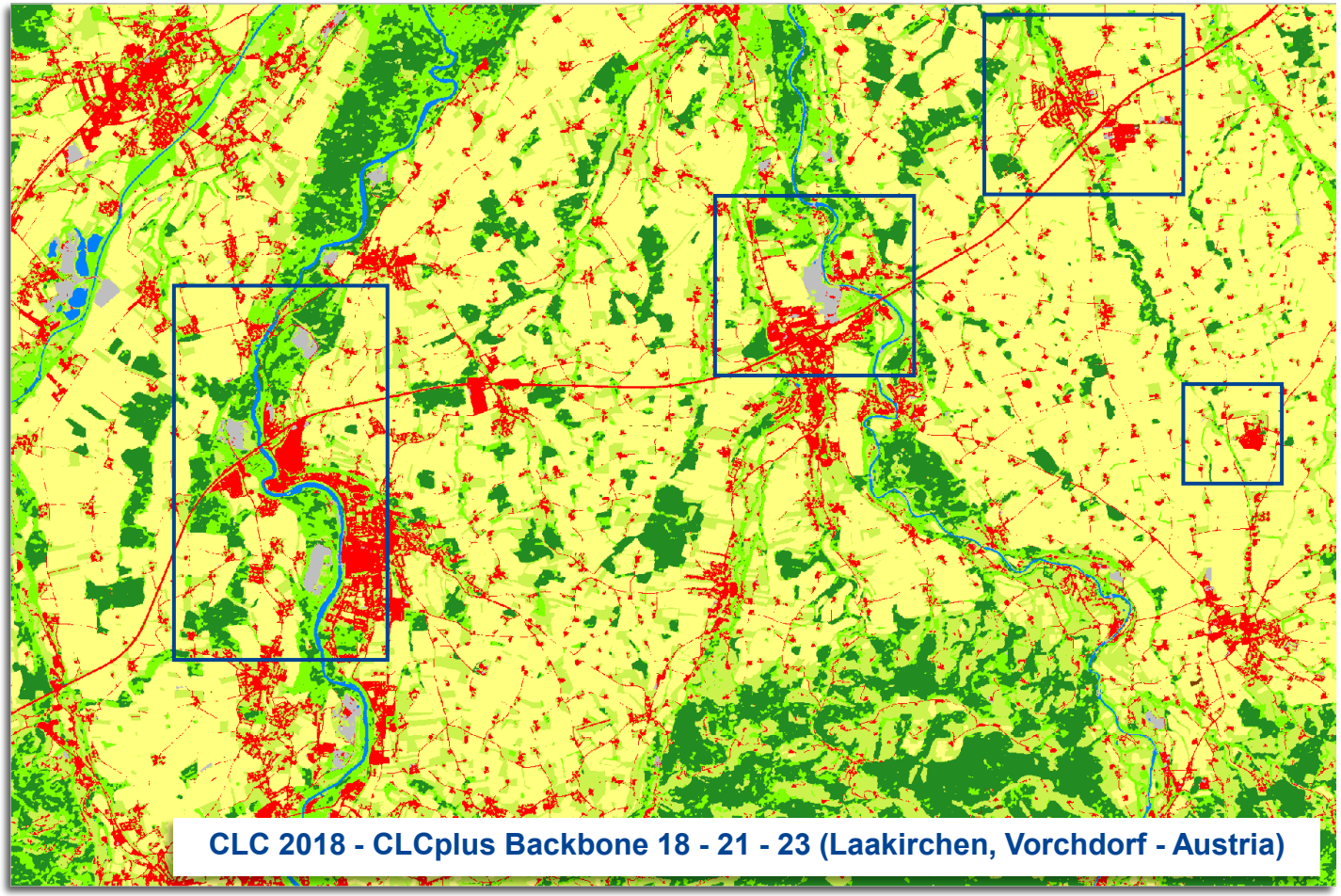
- Sub-annual products
- Specific Tropical Forest Products (TCD, TCPC)



CLCplus Backbone

- High-resolution land cover status (10m)
- Timely availability (reference yr + 1yr)
- 11 basic land cover classes





CLC 2018 - CLCplus Backbone 18 - 21 - 23 (Laakirchen, Vorchdorf - Austria)

2018 — 2021 — 2023 — 2025

HRL – Tree Cover & Forests

- **Tree Cover Density (TCD)**
  - **0 – 100 %** canopy density;
  - **10 meter resolution** for EEA38/9;
  - **Annual;**
  - overall **>90% accuracy** with high spatial consistency.

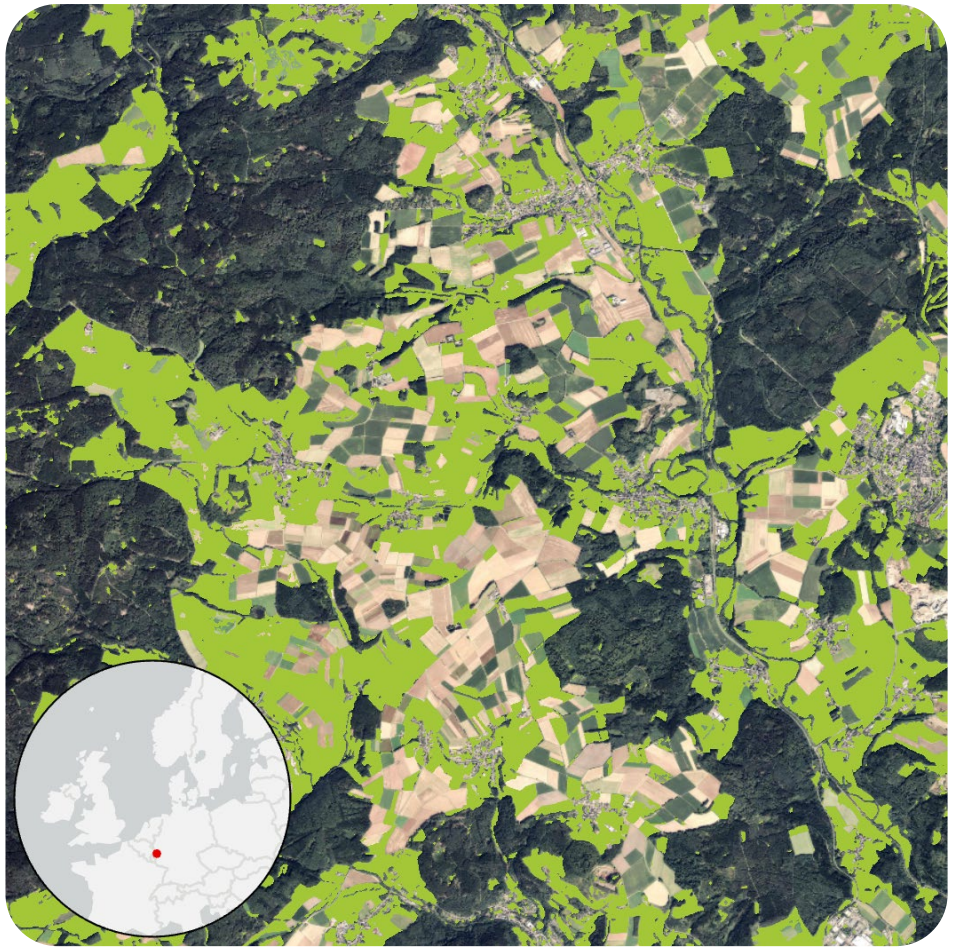
- **Dominant Leaf Type (DLT)**
  - **Coniferous** / **Broadleaved** classification;
  - **10 meter resolution** for EEA38/9;
  - **Annual**

- **Forest Type (FTY)**
  - **Coniferous** / **Broadleaved** classification;
  - **FAO** forest definition, filtering:
    - **>10% TCD**;
    - **<0.5 ha MMU**;
    - **trees in agricultural and urban context** (from CLC and HRL Imperviousness)
  - **10 meter resolution** for EEA38/9;
  - **3 Year**

2012 — 2015 — 2018 — 2019 — 2020 — 2021 — 2022 — 2023 — 2024

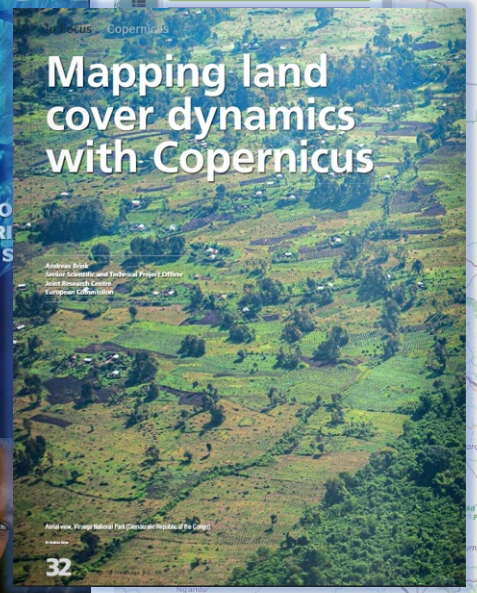
HRL Grassland

- **Grassland Status (GRA)**
  - Binary
  - Annual
- **Herbaceous (HER)**
  - Annual
  - Binary (Permanent & Temporary)
- **Ploughing Indicator (PLOUGH)**
  - Annual
  - 0 – 6+ years since identified last ploughing
- **Grassland Change (GRAC)**
  - 3-yearly
  - Classified (Gain/Loss)
- **Grassland Mowing (GRAM)**
  - Annual
  - **Events (GRAM-E)**
    - 0 – 4+ identified events
  - **Dates (GRAM-D)**
    - Four layers. One for each event
    - Day-of-Year



2012 — 2015 — 2017 — 2018 — 2020 — 2021 — 2022 — 2023

Hot Spot Monitoring - Biodiversity



NaturAfrica

The Green Deal approach for EU support to biodiversity conservation in **Africa**

PROGRAMME OF THE EUROPEAN UNION

opernicus Europe's eyes on Earth

Land Monitoring

Implemented by European Environment Agency

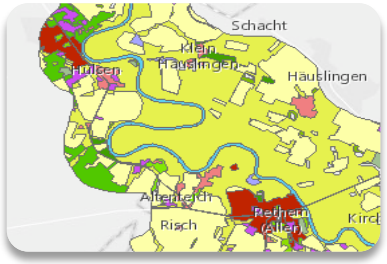
European Commission

Priority Area Monitoring

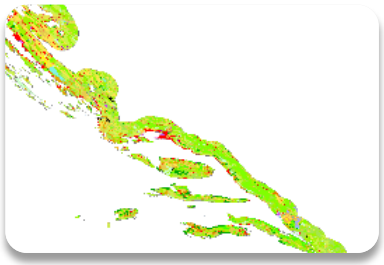
Urban Atlas
2006-12-18-21-24

Protected Areas
2006-12-18-21-24

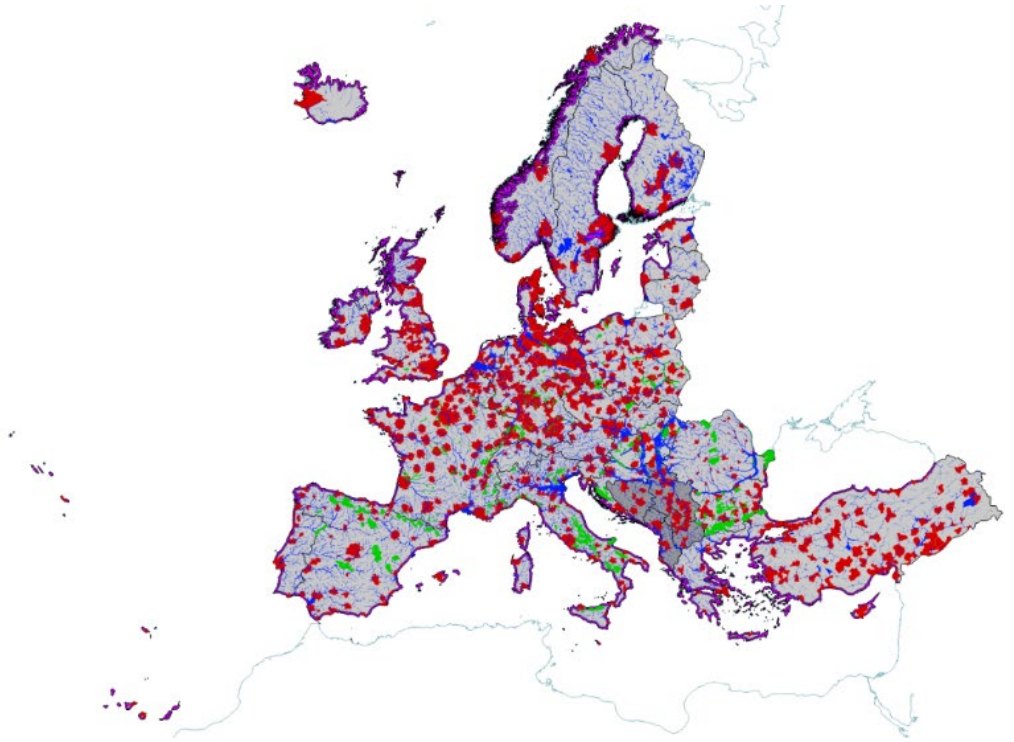
Riparian Zones
2012-18-21-24



Coastal Zones
2012-18-21-24



- Vector based VHR LC/LU mapping of priority areas
- MMU 0.5 ha
- Tailored nomenclature
- Update on a 6/3 year cycle: status and change mapping



PROGRAMME OF THE EUROPEAN UNION

Copernicus
Europe's eyes on Earth

Land Monitoring

Implemented by European Environment Agency

European Commission

Copernicus for CBD GBF Goals / Targets and SDG

FIT4PURPOSE
Relevance – Feasibility – Accuracy - Maturity

EBV class	Remote sensing biodiversity product	Aichi targets	SDG targets
Ecosystem Structure (an ecological structure that can be monitored at a global level)	Fire disturbance	7,9,10,12,14,15	15.2, 15.3
	LAI	5,7,9,10,12,14,15	15.2, 15.3, 15.5
	Land cover (vegetation type)	5,7,9,14,15	15.2, 15.3, 15.5
	Ice cover habitat	5,7,9,14,15	15.2, 15.3, 15.5
Species Traits (trait of an organism of known species that can be monitored at a local level)	Peak, start, end of season	5,7,9,12,14,15	15.4
	Gross primary productivity (GPP)	5,7,9,10,12,14,15	15.4
	Net primary productivity (NPP)	5,7,9,10,12,14,15	15.4
	LAI	5,7,9,10,12,14,15	15.4
Community Composition (composition of a community that can be monitored at a global level)	Peak, start, end of season	5,7,9,12,14,15	15.4
Ecosystem Function (an ecological function monitored over time at a global level)	Peak, start, end of season	5,7,9,12,14,15	15.4
	Gross primary productivity (GPP)	5,7,9,10,12,14,15	15.2
	Net primary productivity (NPP)	5,7,9,10,12,14,15	15.2
	LAI	5,7,9,10,12,14,15	15.2
	Evapotranspiration	5,7,10,12,14,15	15.2
	FAPAR	5,7,10,12,14,15	15.2
	Ecosystem soil moisture	5,7,10,12,14,15	15.2
	Fire disturbance	7,9,10,12,14,15	15.2, 15.3

Modified from: Skidmore, A.K. et. al (2021).

Marine Monitoring

Advancing marine monitoring and protection with Copernicus Marine

Tina Silovic et al.- Mercator Ocean International

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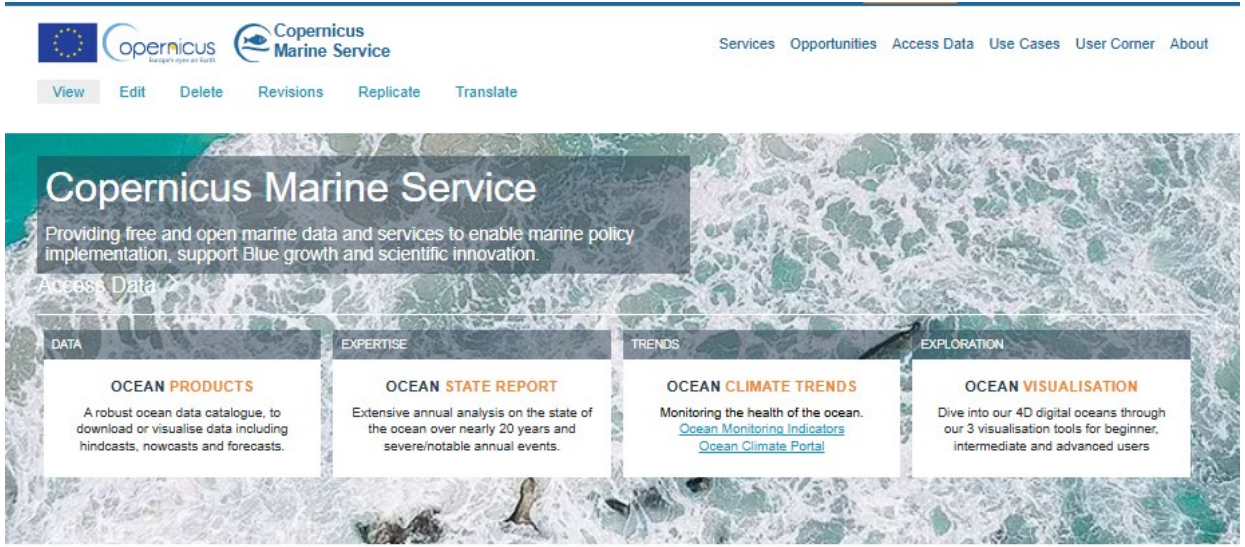
implemented by MERCATOR OCEAN INTERNATIONAL

Copernicus Marine Service



Copernicus Ocean State Report 8 Release

The 8th issue of the EU Copernicus Ocean State Report (OSR) is now available online, along with an interactive Summary for policymakers. The OSR 8 is a flagship report of the EU Copernicus Marine Service, funded by the European Union and coordinated by Mercator Ocean International, and provides a comprehensive overview on the state, variability and change of the global ocean for scientists, members of the blue economy, decision makers and the general public. The OSR 8 has been established under international scientific collaboration, with contributions from over 120 participants.

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In-situ & Satellites

NUMERICAL MODELS
& data assimilation

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COPERNICUS MARINE REGIONAL OCEAN PRODUCT DIVISIONS

1. Global Ocean
2. Arctic Ocean
3. Baltic Sea
4. European North West Shelf Seas
5. Iberian Biscay Ireland Seas
6. Mediterranean Sea
7. Black Sea

Copernicus Marine Products – Green Ocean

MODEL SATELLITE IN SITU

EXAMPLES OF OTHER VARIABLES INCLUDED IN OUR PORTFOLIO:

- REFLECTANCE
- PHOTOSYNTHETICALLY ACTIVE RADIATION
- PHYTOPLANKTON SIZES CLASS TYPES
- DISSOLVED ORGANIC CARBON

100m a 25 km

Hourly, daily, monthly, yearly

10 days forecasts

Time series up to 30 years

Updated daily

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Copernicus Europe's eyes on Earth

Copernicus Marine Service

Implemented by MERCATOR OCEAN INTERNATIONAL

Supporting wide range of applications

von Schuckmann et al., Marine Policy Vol 121, 2020, 104154

Ocean Health

Marine Conservation & Biodiversity

1 POLAR ENVIRONMENT MONITORING

2 CLIMATE & ADAPTATION

3 OCEAN HEALTH

4 MARINE CONSERVATION & BIODIVERSITY

5 SCIENCE & INNOVATION

6 POLICIES & OCEAN GOVERNANCE & MITIGATION

7 EDUCATION, PUBLIC HEALTH & RECREATION

8 EXTREMES, HAZARDS & SAFETY

9 MARINE FOOD

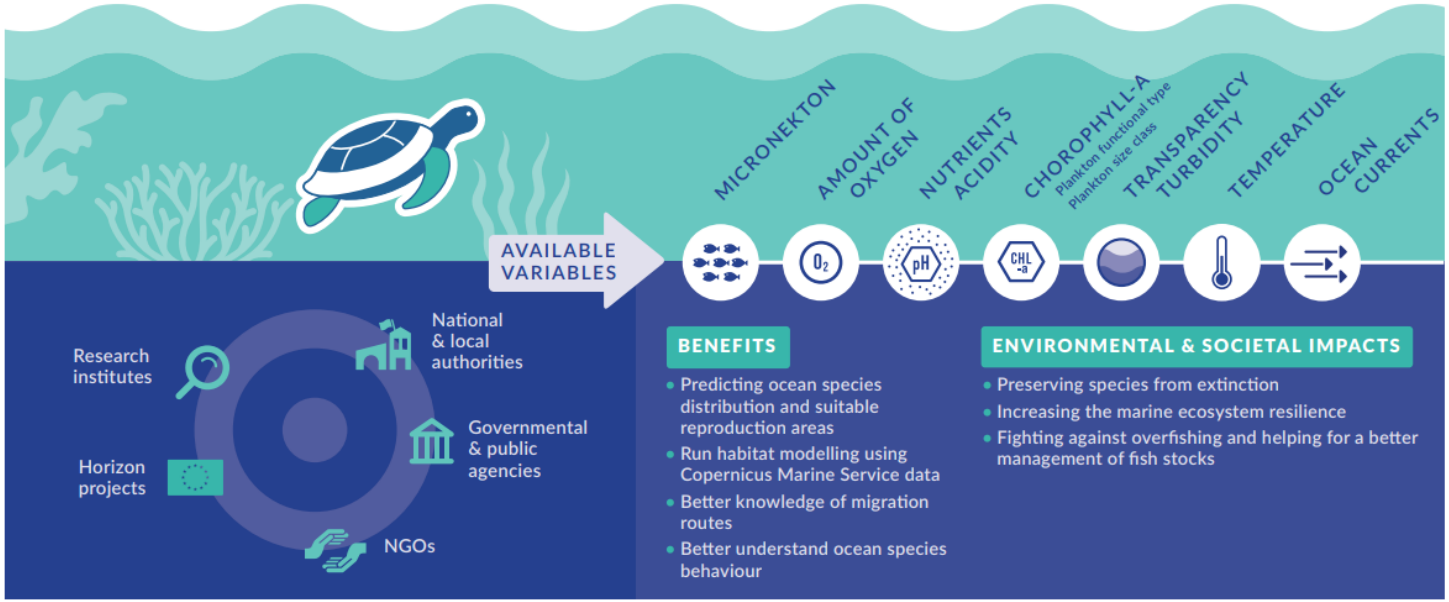
10 COASTAL SERVICES

11 TRADE & MARINE NAVIGATION

12 NATURAL RESOURCES & ENERGY

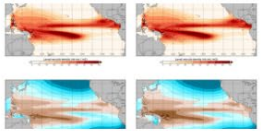
MARINE CONSERVATION & BIODIVERSITY

The Copernicus Marine Service provides key data to monitor marine biodiversity and Marine Protected Areas, preserving at-risk ecosystems.



Conservation & Biodiversity-USE CASES

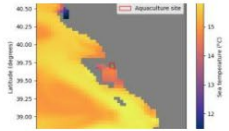
Region: All | Country: All | Markets: Marine Conservation & Biodiversity | Mobile Application | Demo | Search



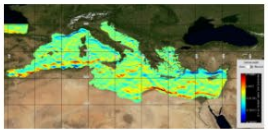
SEAPODYM - Evaluating Conservation Impact of Marine Protected Areas for Pacific Tunas

SEA CLEARLY - A tool to assess ocean plastic transport on and by aquaculture farms

Real-time assessment of MPAs with marine megafauna movements and bio-physical ocean variables



Enhancing traceability and tracking in Aquaculture and fisheries supply chain through the use of blockchain and earth observation

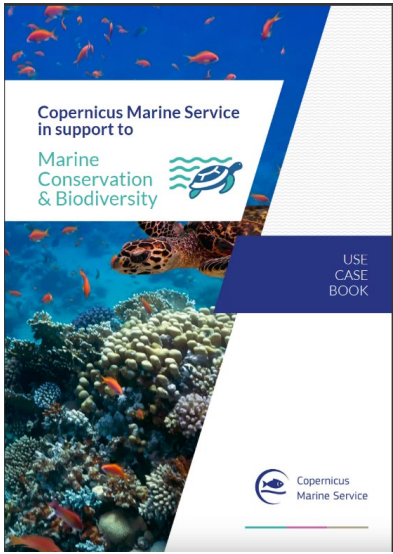


T-MEDNet – Tracking the effects of climate change in the Mediterranean

The MarCOSouth Western Indian Ocean Coral Bleaching Monitoring Service

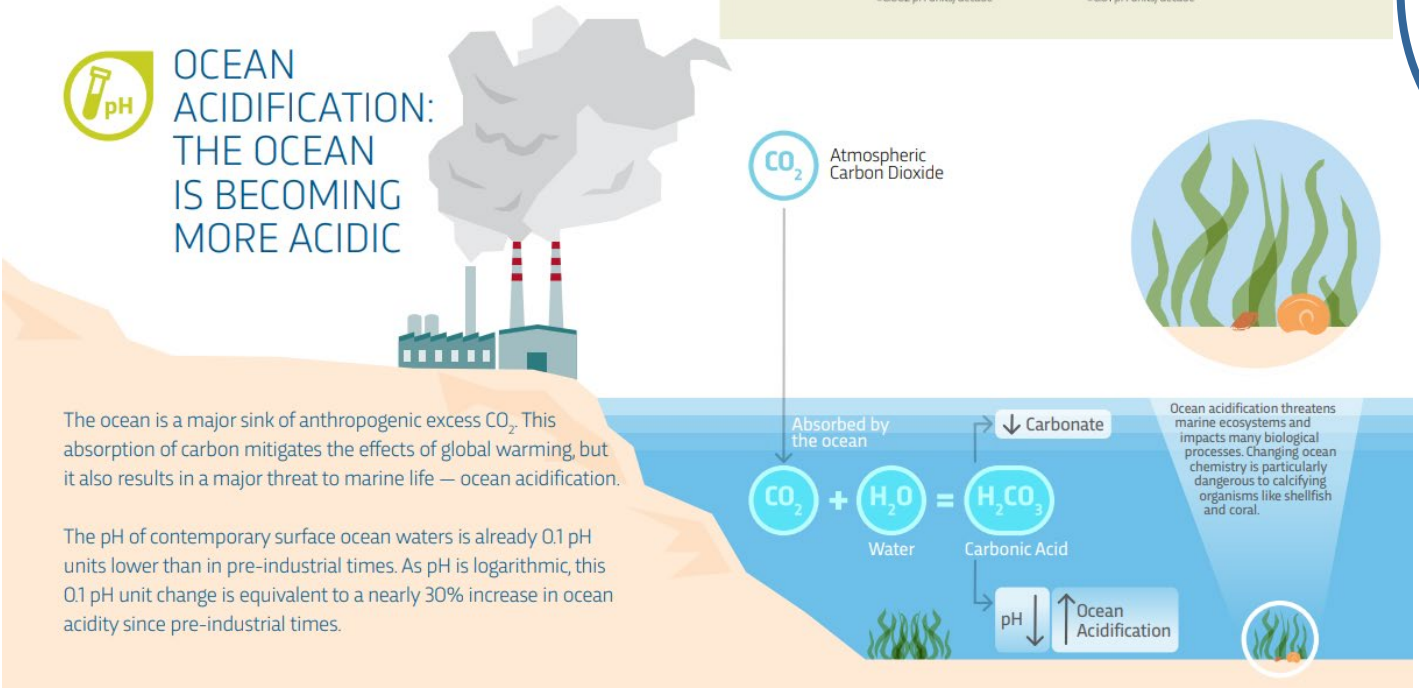
From open data to marine knowledge: A service for augmented data access and reproducible data analysis

TURTLES: Effects of swimming behaviour and oceanography on sea turtle hatchling disp



PROGRAMME OF THE EUROPEAN UNION | Copernicus Europe's eyes on Earth | Copernicus Marine Service | Implemented by MERCATOR OCEAN INTERNATIONAL

Challenges for Conservation & Biodiversity



CHALLENGES:

> Increasing Pollutions
> Over – fishing
> Heatwaves
> De-Oxygenation
> Ocean acidification
> Loss of Habitats

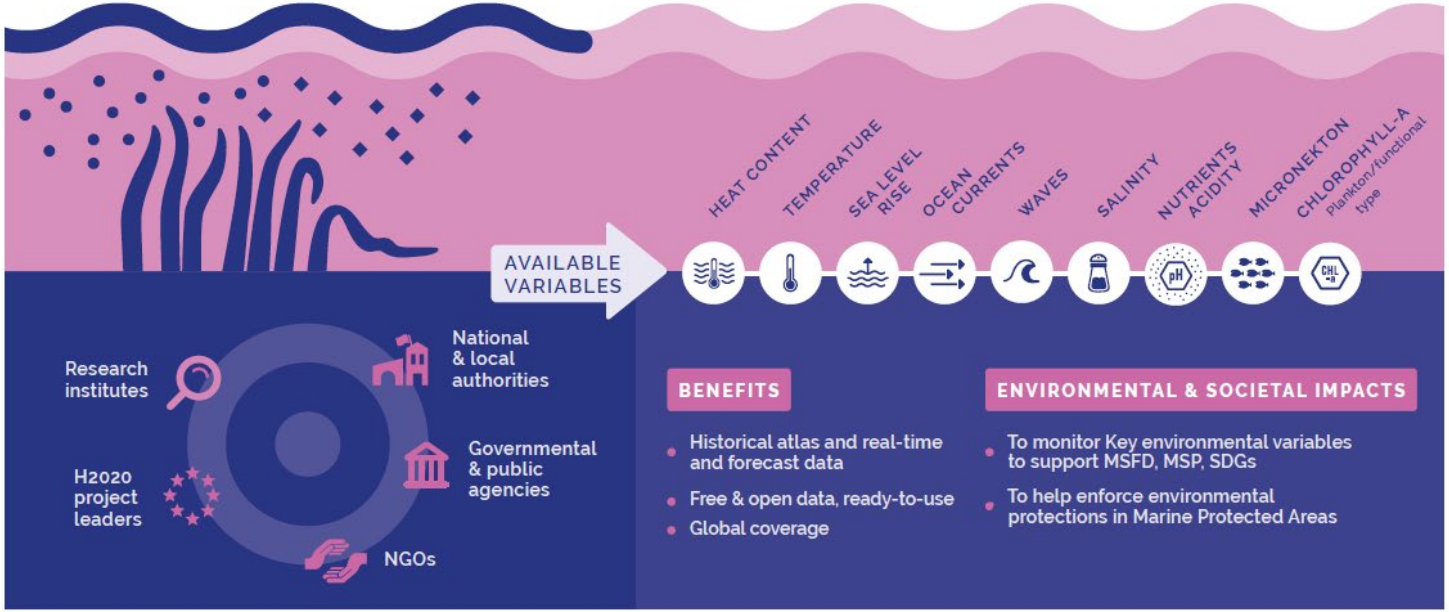
GOALS:

> Protected marine biodiversity
> Sustainable exploitation of marine resources
> Environment policies

Support Policies and Ocean Governance

POLICIES & OCEAN GOVERNANCE & MITIGATION

Copernicus Marine Service provides key data to support European Member States in the implementation of European Directives (MSFD, MSP, SDG). It also supports Marine Protected areas to preserve at-risk and coastal ecosystems.



BLUE OCEAN

Currents, temperature, waves, sea level, ...

WHITE OCEAN

Ice coverage, velocity, concentration, Icebergs ...

GREEN OCEAN

CO2, nutrients, oxygen, primary production, ...

Copernicus Marine Service in COPERNICUS 2 :

Continuity of the Blue/White/Green Offer

+ a series of major evolutions developed depending on priorities & budget

Coastal | **Arctic** | **Marine Biology** | **Ocean Climate** | **Digital services**

Towards a new offer for marine biology

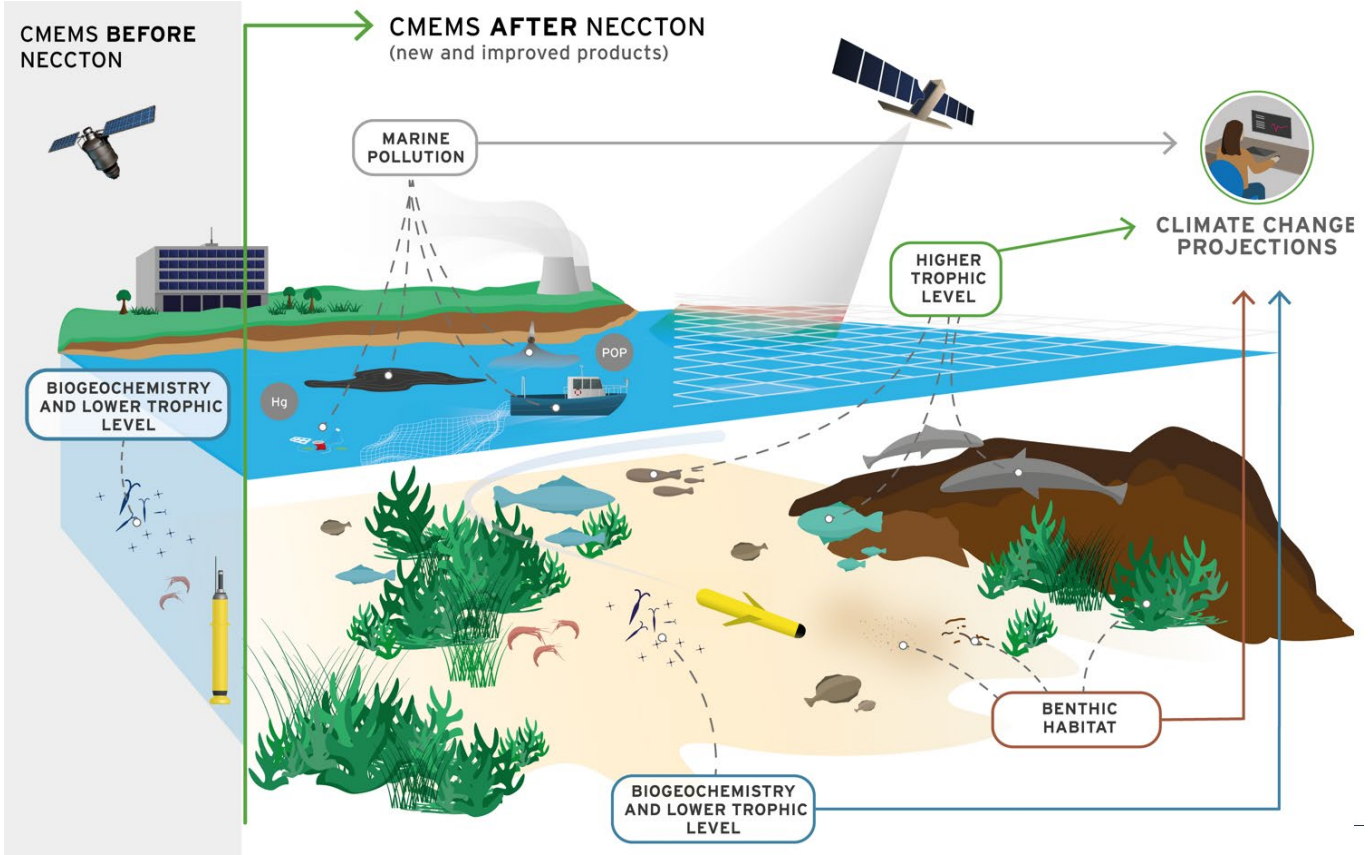
Gathering and processing of new biogeochemical and biology *in situ* and **satellite observations**

- **New processes** in biogeochemical models (benthic/pelagic coupling, riverine inputs).
- **Ecosystem modelling** (low →mid→ high tropic level) – NECCTON project
- **Assessing scenarios** for climate change impacts on stocks and protected species – SEACLIM project
- **Digital Twin of the Oceans** (DTOs) includes ecosystem models and data, what-if scenarios.

Inform marine biodiversity and food resource management

Convention on Biological Diversity

Towards a new offer for marine biology



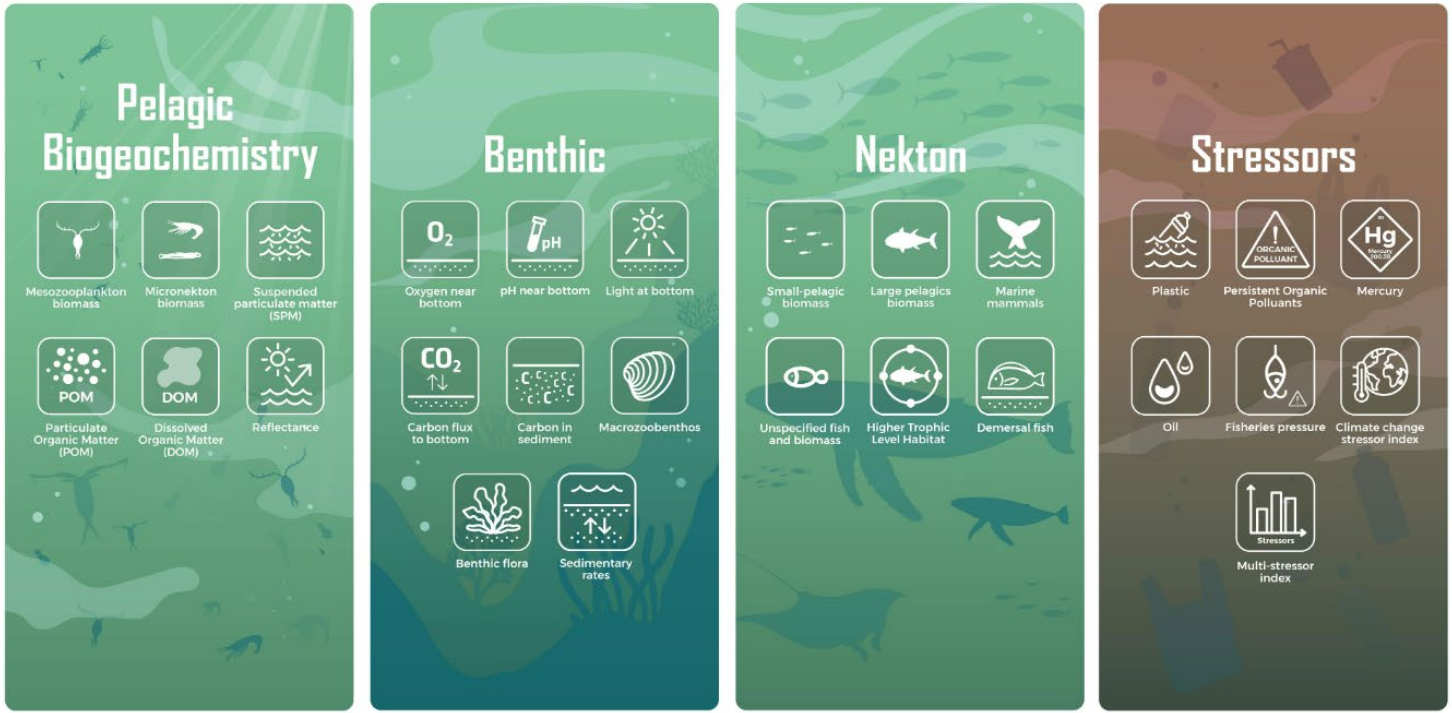
NECCTON

neccton.eu

PI: Stefano Ciavatta, MOi

→ ***enable CMEMS to inform marine biodiversity conservation and food resources management, by fusing innovative ocean ecosystem models and new data***

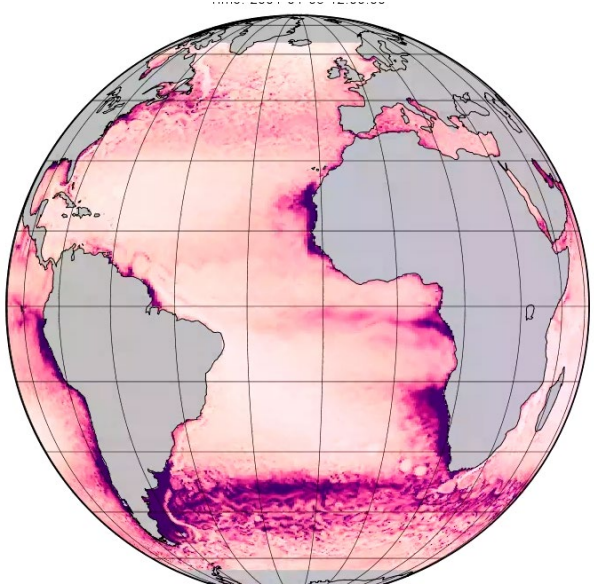
NECCTON products



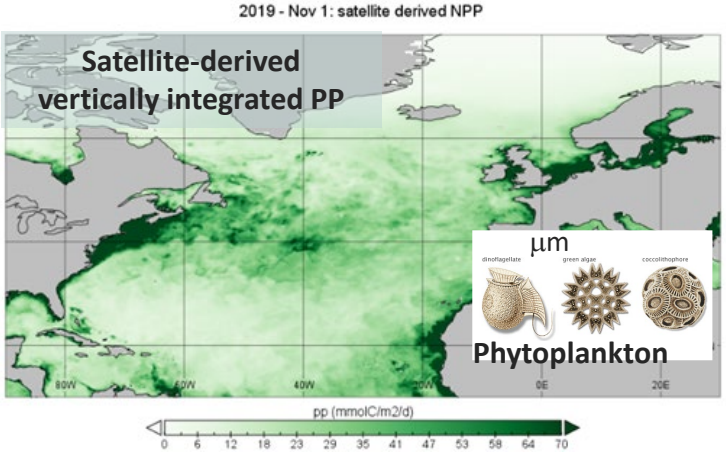
NECCTON
NEW COPERNICUS CAPABILITY FOR TROPHIC OCEAN NETWORKS

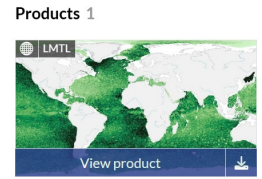
This project has received funding from Horizon Europe RIA under Grant Number 101081273

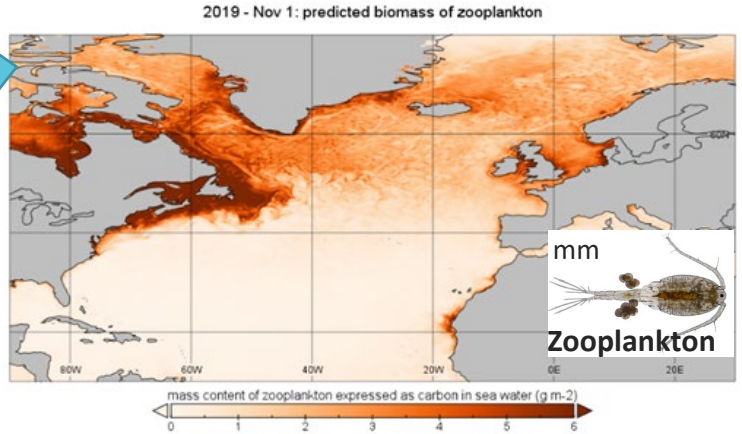
New essential ocean variables (EOVs)



GLORYS Ocean physics reanalysis + PPsat (or BGCH model) = **zooplankton**







Season and year had no effect on 40-Hz calling rates, but prey biomass did, confirming its food-associated function for the first time..

Food talk: 40-Hz fin whale calls are associated with prey biomass

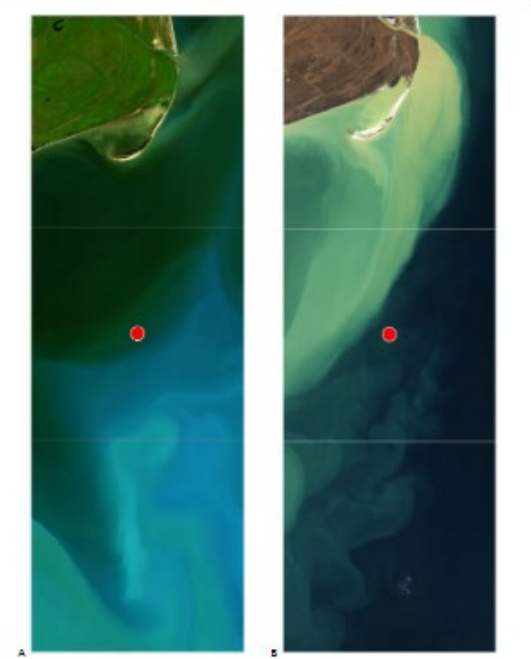
Miriam Romagosa[1], Sergi Pérez-Jorge[1], Irma Cascão[1], Helena Mouriño[2], Patrick Lehodey[3], Andreia Pereira[4], Tiago A. Marques[5,6], Luís Matias[4] and Mónica A. Silva[1]

Towards a new offer for marine biology

NECCTON D4.2 Assessment of L2 PRISMA production chain, outputs and transferability

Braga, Federica (Researcher)[1] ; Profeti, Giuliana (Researcher)[1] ; Lazzari, Paolo (Researcher)[2] ; Álvarez, Eva (Researcher)[3] ; Marco Scarpa, Gian (Researcher)[1] ; Manfè, Giorgia (Researcher)[1] ; Gonzalez Vilas, Luis (Researcher)[1] ; Skakala, Jozef (Researcher)[4] ; Brando, Vittorio (Researcher)[1]

Show affiliations



DOI 10.5281/zenodo.14551764

- ✓ PRISMA (PRecursore IperSpettrale della Missione Applicativa) is a hyperspectral imaging mission launched by the Italian Space Agency (ASI)
- ✓ **covers a spectral range of 400–2500 nm with high spatial resolution**
- ✓ **potential** for enhancing the understanding of aquatic ecosystems through hyperspectral imaging, (→advanced atmospheric correction algorithms tailored for marine and coastal environments are necessary
- ✓ PACE compared with in situ hyperspectral data from WATERHYPERNET to test the transferability of the validation approach
- ✓ **outcome:** integration of PRISMA data with biogeochemical models can enhance the description of plankton and optically active properties

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Copernicus Europe's eyes on Earth
Copernicus Marine Service
Implemented by MERCATOR OCEAN INTERNATIONAL

The Copernicus Marine Service for biodiversity policy: the future

Major evolutions planned in Copernicus 2 (2021-2028) via R&D projects (Horizon) will **expand marine biodiversity** monitoring and protection supporting **EU policy needs**

- ✓ Gathering and processing new biogeochemical and biology in situ and **satellite observations**
- ✓ **Data assimilation** of new satellite products (including biogeochemistry and biology)
- ✓ **Habitats for key protected species** (e.g. marine mammals), **Marine Protected Areas** design.
- ✓ Assessing scenarios for climate change impacts on stocks and protected species.
- ✓ **Critical role** of present (S2, S3) and future **(CHIME, S2NG, S3NG) Sentinel missions** and in-situ observations (e.g. acoustic data, plankton imaging, omics, pollutants, plastic, fish surveys and landings)
- ✓ **Digital Twin of the Oceans** (DTOs) includes ecosystem models and data, MPAs DTO, what-if scenarios

NECCTON
NEW COPERNICUS CAPABILITY FOR TROPHIC OCEAN NETWORKS

DIGITAL TWIN

Marine Monitoring

THANK YOU

Copernicus Marine Service

Newsletter

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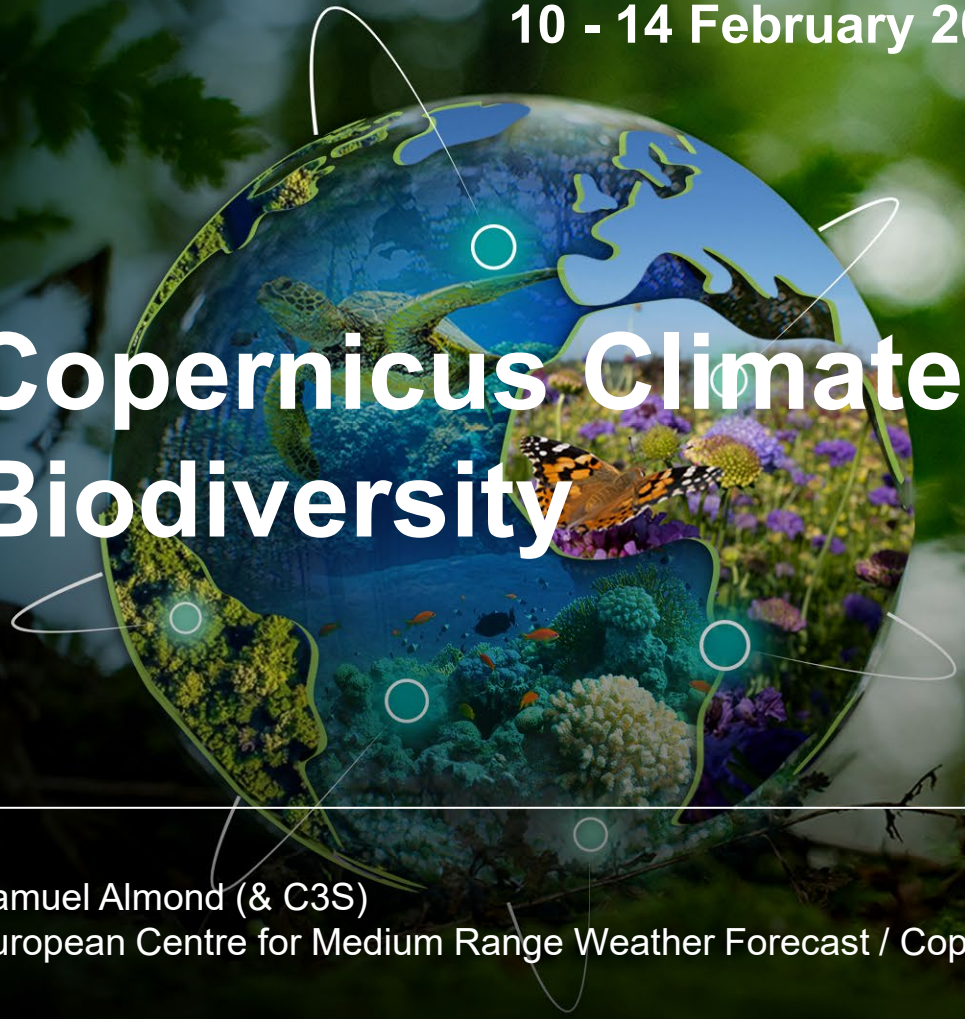
Implemented by MERCATOR OCEAN INTERNATIONAL

tsilovic@mercator-ocean.fr

BioSpace25 - Biodiversity insight from Space
10 - 14 February 2025 | ESA-ESRIN | Frascati - Italy



Copernicus Climate Change Service (C3S) for Biodiversity

Samuel Almond (& C3S)
European Centre for Medium Range Weather Forecast / Copernicus Climate Change Service (C3S)

Climate Change

Climate Change & Biodiversity – Context

- Climate change is playing an increasingly important role in the decline of biodiversity.
- Large changes in biodiversity are expected to occur if climate change continues at its current pace
- Climate change has shown to impact the health of ecosystems, influencing shifts in the distribution of plants, pest & disease, animals, and even human settlements.
- Climate change affects:
  - ecosystem dynamics, ecosystem structure, function and health
  - Distribution and abundance of species and habitats
  - Intensity and frequency climatic extremes - fires, storms & periods of drought.
- Ecosystem structure, landscape phenology, community composition, ecosystem function and species populations are all essential biodiversity variables (EBVs) which can be monitored with remote sensing biodiversity products (Skidmore et al. 2021) and Copernicus products
- Copernicus Climate Change Service, and its data can play a key role in adaptive ecosystem management

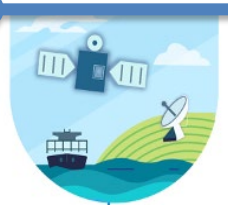
CLIMATE DATA FOR BIODIVERSITY

Climate Change

Past — Present — Possible futures

C3S PRODUCTS

Observations



Reanalysis

Seasonal to decadal predictions

Climate projections

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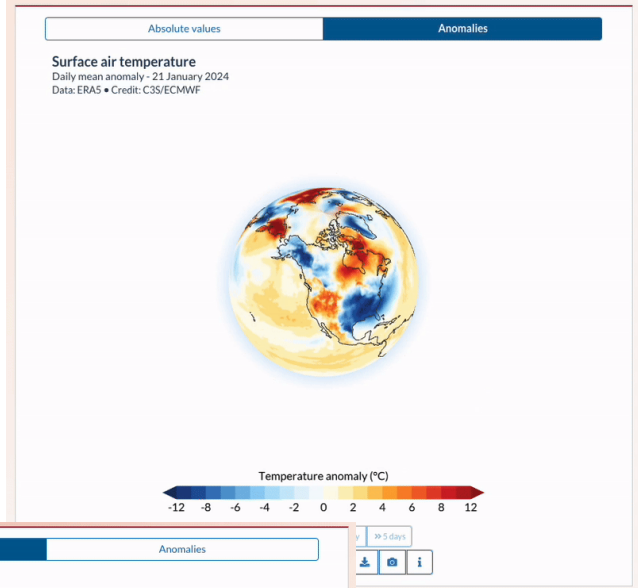
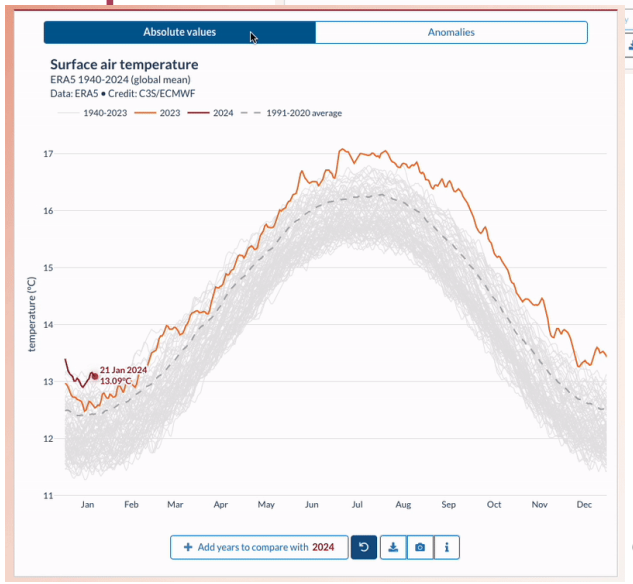
Copernicus Europe's eyes on Earth
IMPLEMENTED BY ECMWF
Copernicus Europe's eyes on Earth
European Commission
ECMWF

C3S Global reanalysis: ERA5

Climate Change

ERA5: Full-observing-system global reanalysis for the ***atmosphere*, land and *ocean waves***





ERA5 Surface air temperature from Climate Pulse app, including (absolute values and anomalies).

- Most popular dataset in the CDS
- > **100 TB** daily downloads
- No gaps in space/time, integrator of all observations
- Over 100 billion observations used so far
- Hourly snapshot 31 km resolution up to about 80 km height
- Available from **1940 onwards**
- Daily updates 5 days behind real time
- It relies on external gridded products: SST and sea-ice cover; GHGs, aerosols, TSI, (diagnostic) ozone

https://doi.org/10.1002/qj.3803

The ERA5 scientific journal paper (2020) has now topped 10,000 citations

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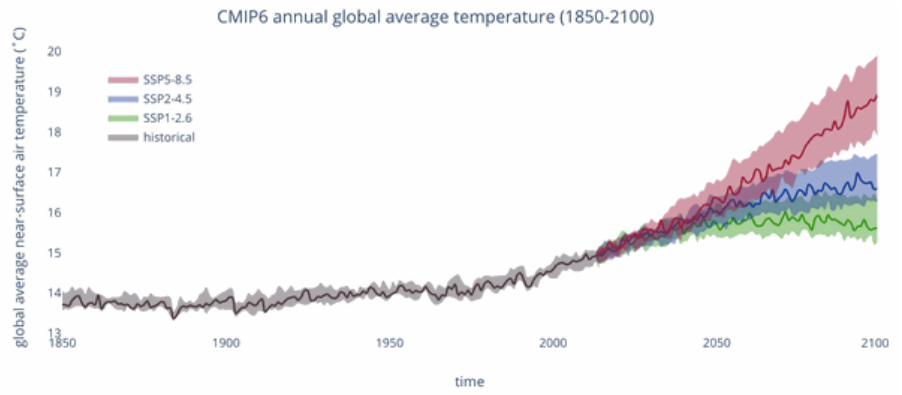
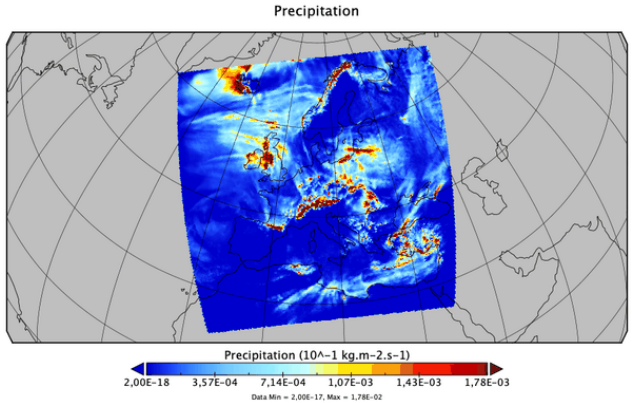
Climate projections: Global, Regional & the IPCC Climate Atlas

Climate Change



CMIP6 annual global temperatures 1850 - 2100

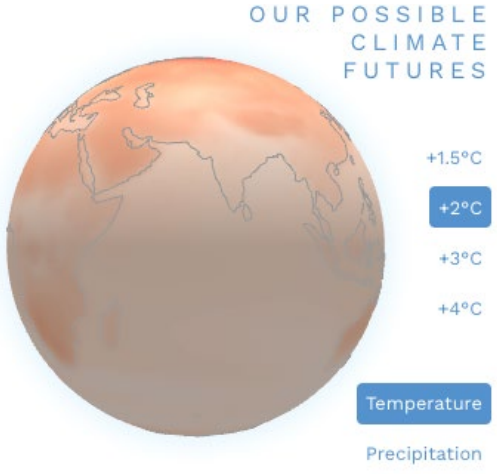


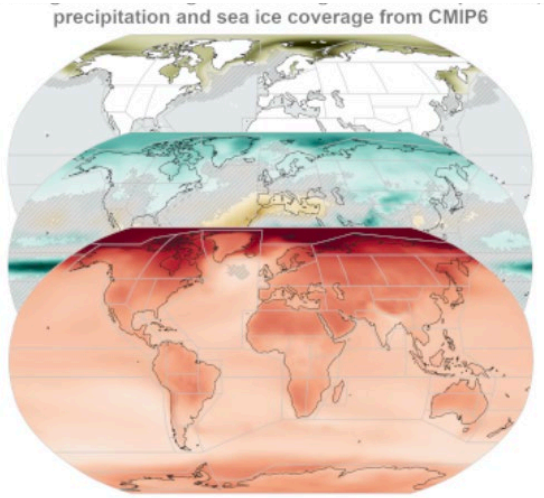
Downscaled Euro-CORDEX projections

Gridded monthly climate projection dataset underpinning the IPCC AR6 Interactive Atlas

Dataset | Global | Atmosphere (surface) | Atmosphere (upper air) | Climate projections

This catalogue entry provides gridded data from global (CMIP5 and CMIP6) and regional (**CORDEX**





A novel tool (data and viewer) for IPCC AR6 for flexible **spatial** and **temporal** analyses of observed and projected climate change information

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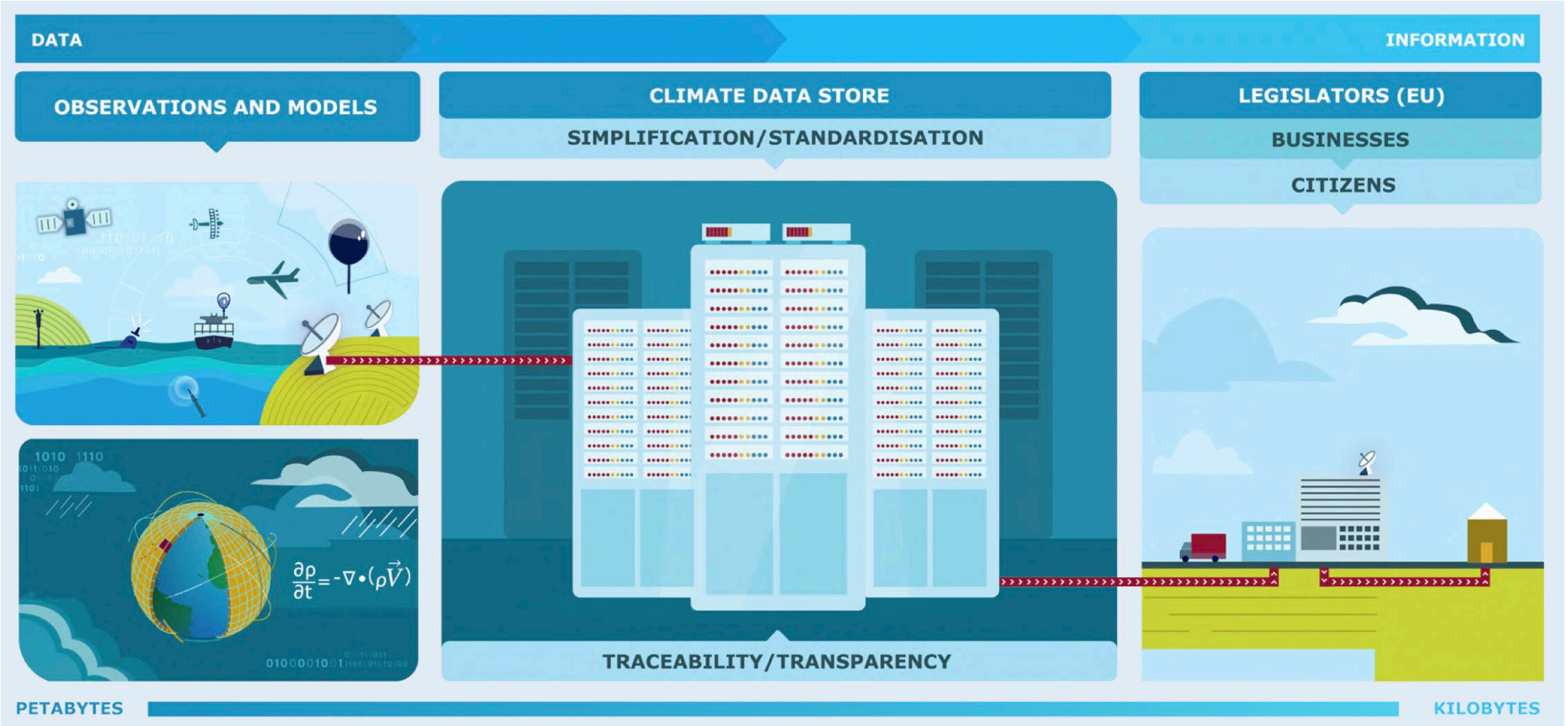
Climate Change

More Than Climate Data..... Climate Information



Typical download: 70 TB /day

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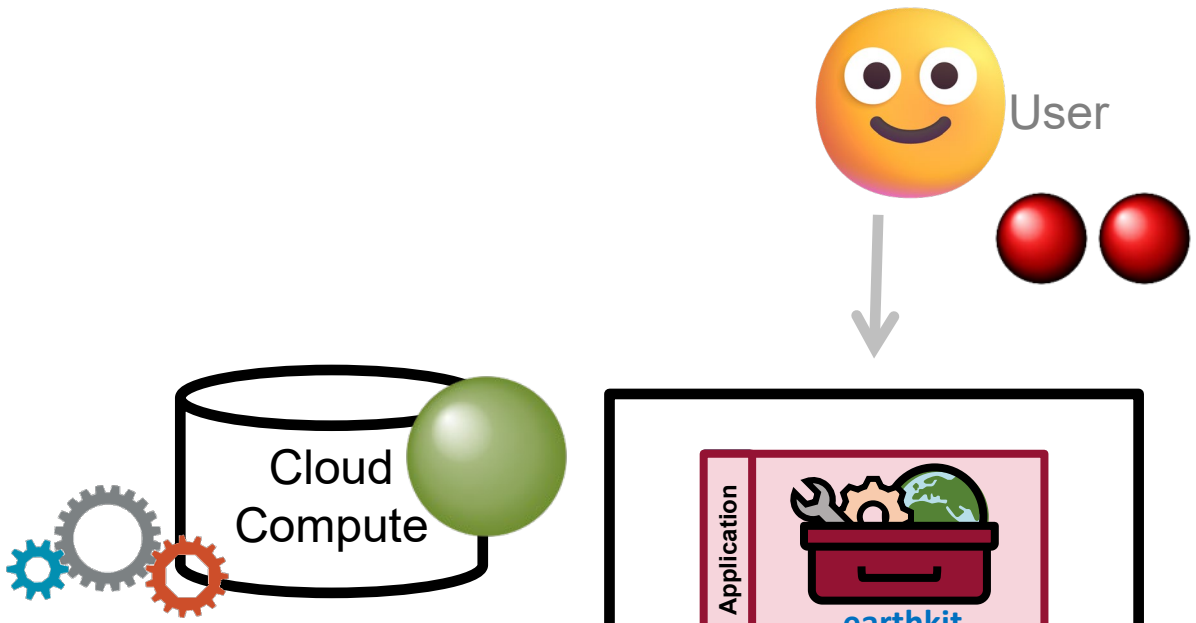
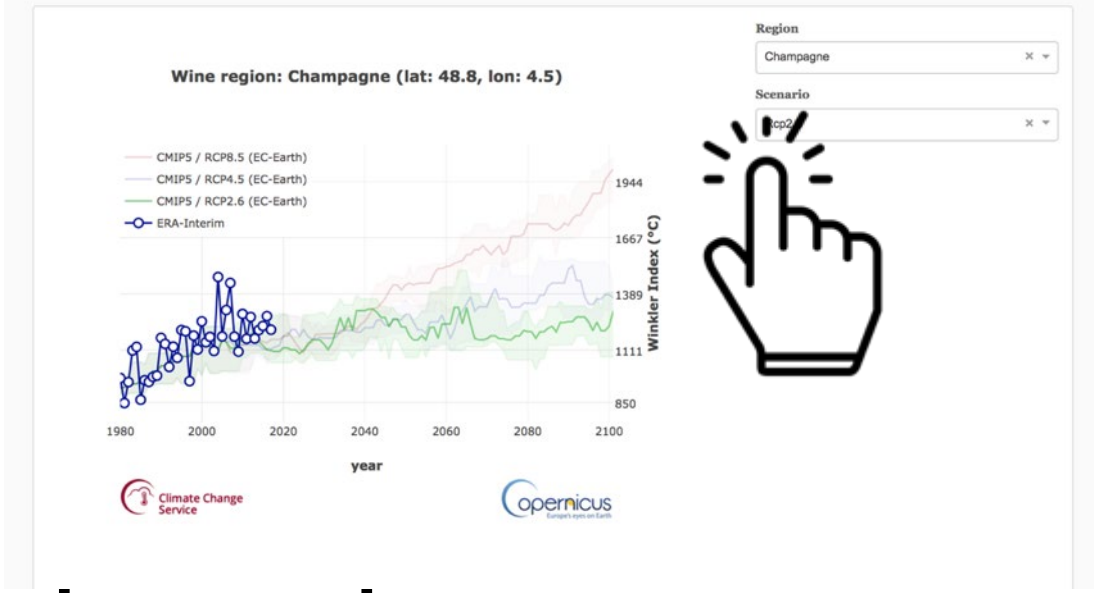
The C3S Application Strategy

Climate Change





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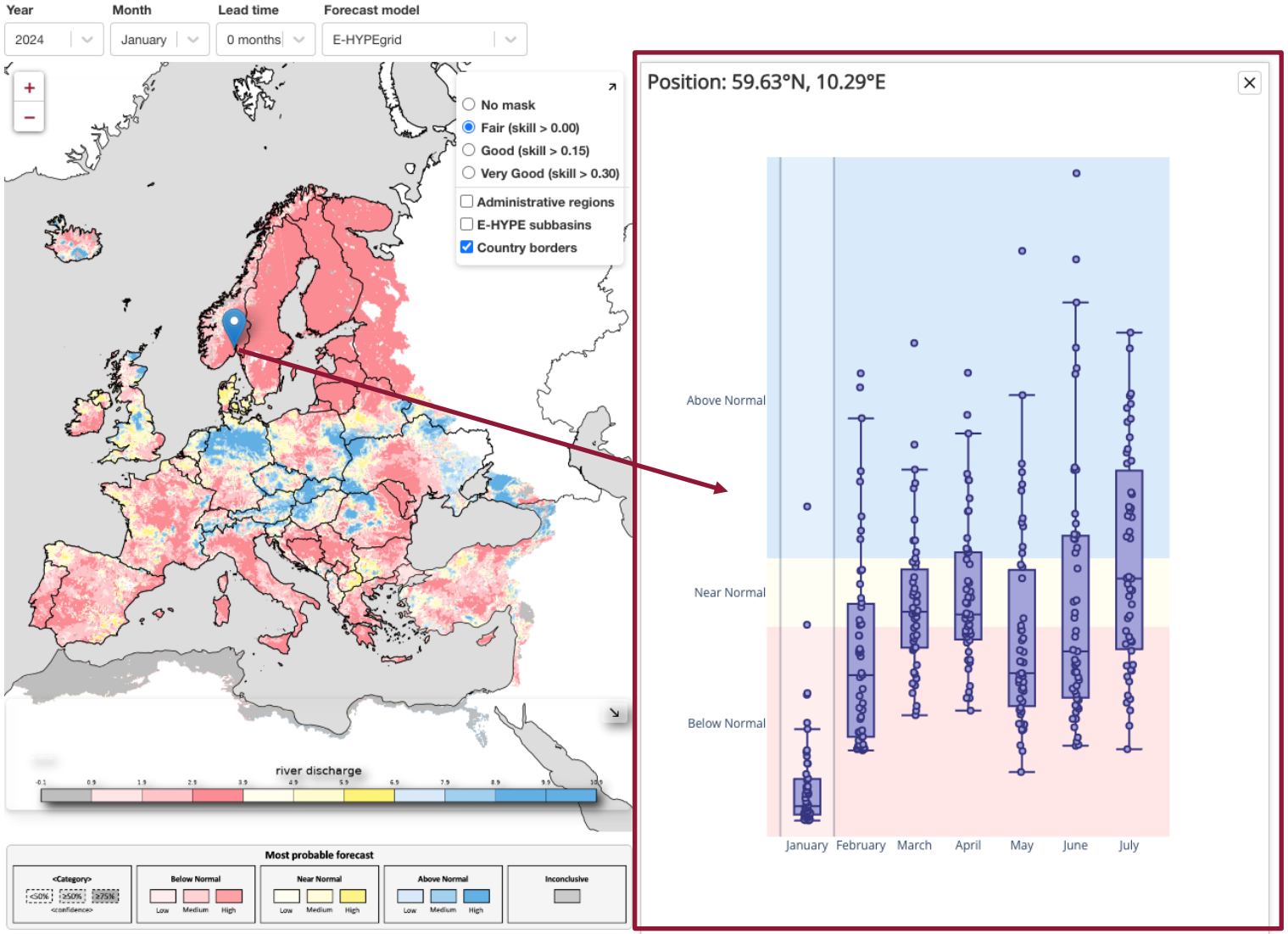
Operational water sector: C3S European hydrology seasonal forecasts

Climate Change



C3S operational multi-model seasonal hydrological prediction service for Europe – *soon to include more climate and hydrological models*

Example: 7-month river discharge forecast from **January 2024** for **River Drammen in Norway**

Below normal river flow expected 4 of the next 7-months

Also provide hydrological model output forced with ensemble climate projections

SMHI

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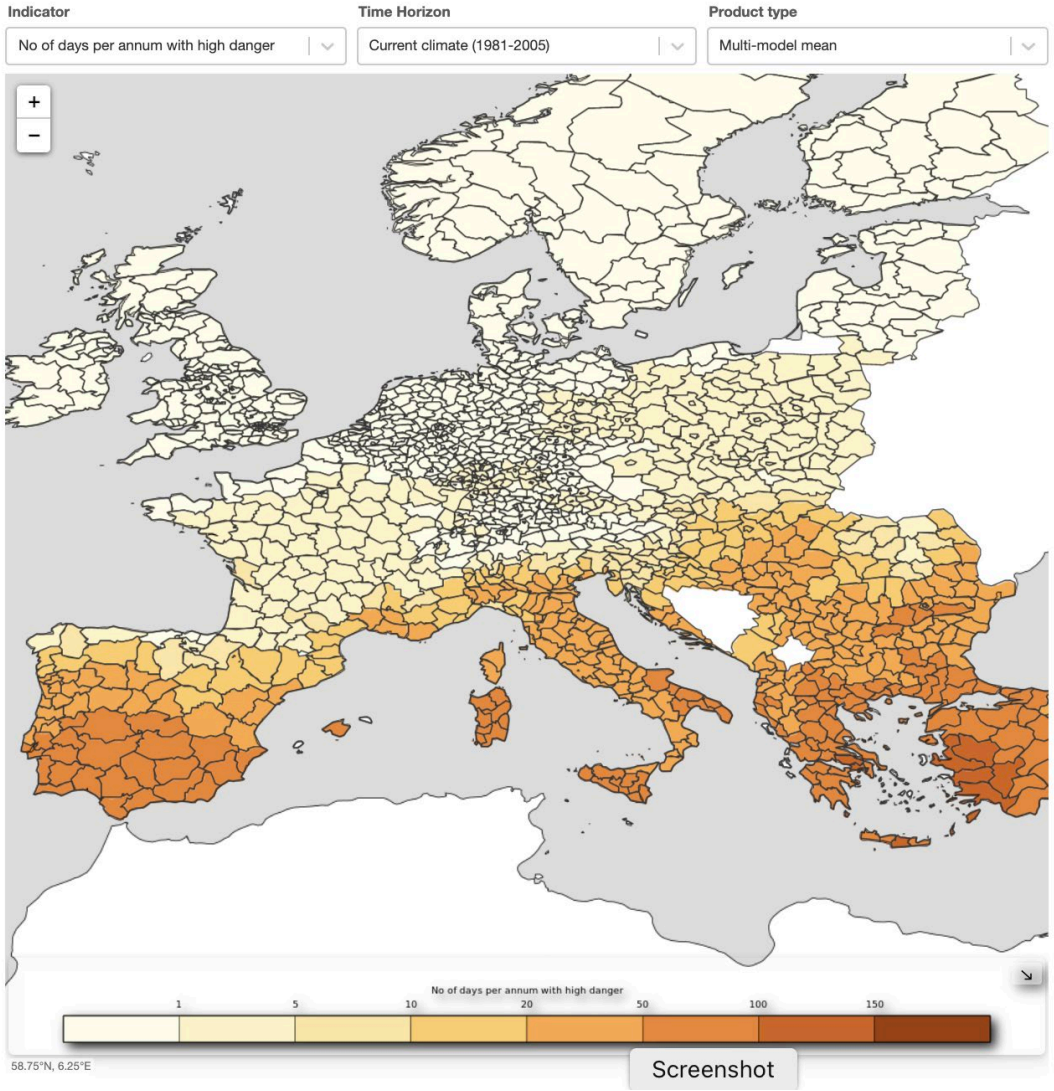
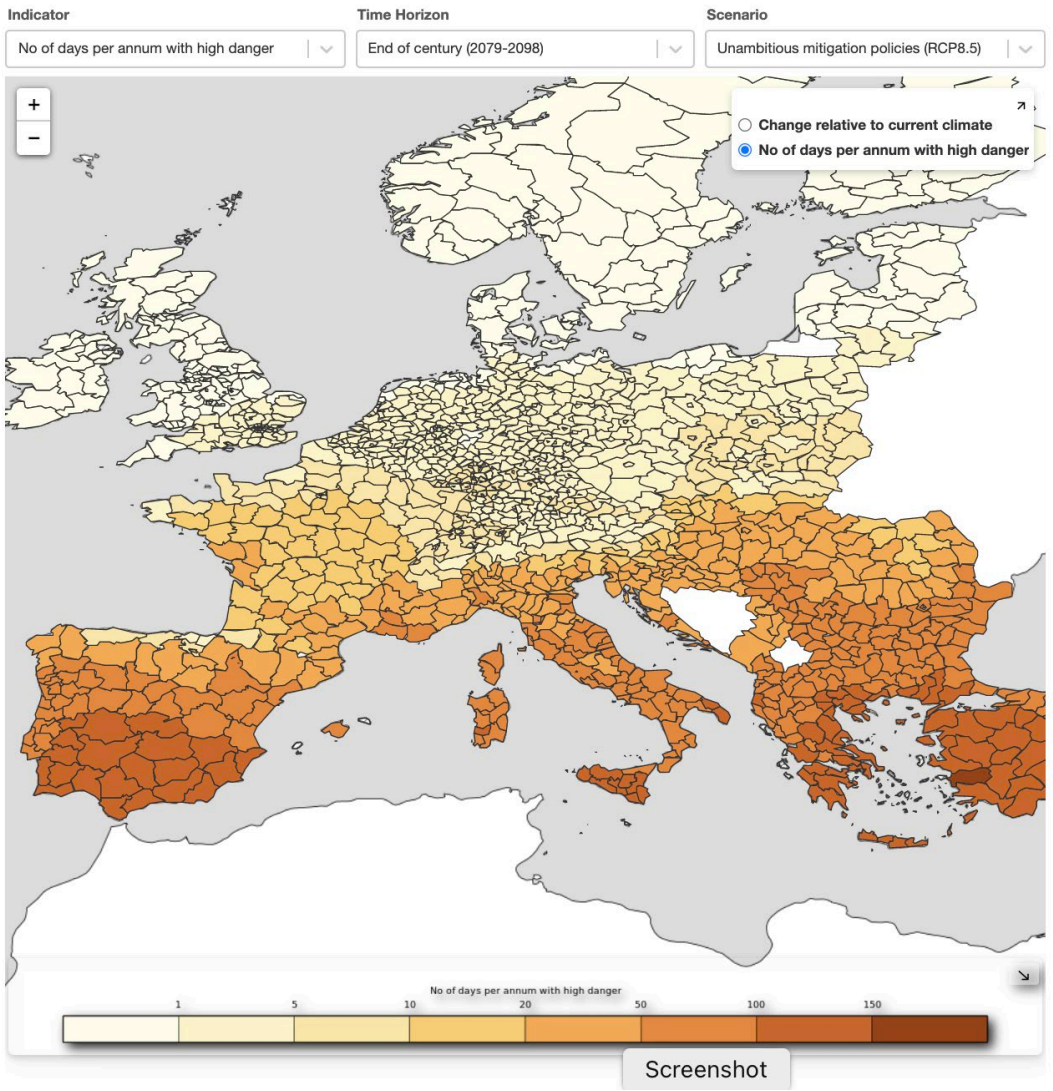
Climate Change

Europes' Evolving Fire Risk



Screenshot



Screenshot

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Climate Change

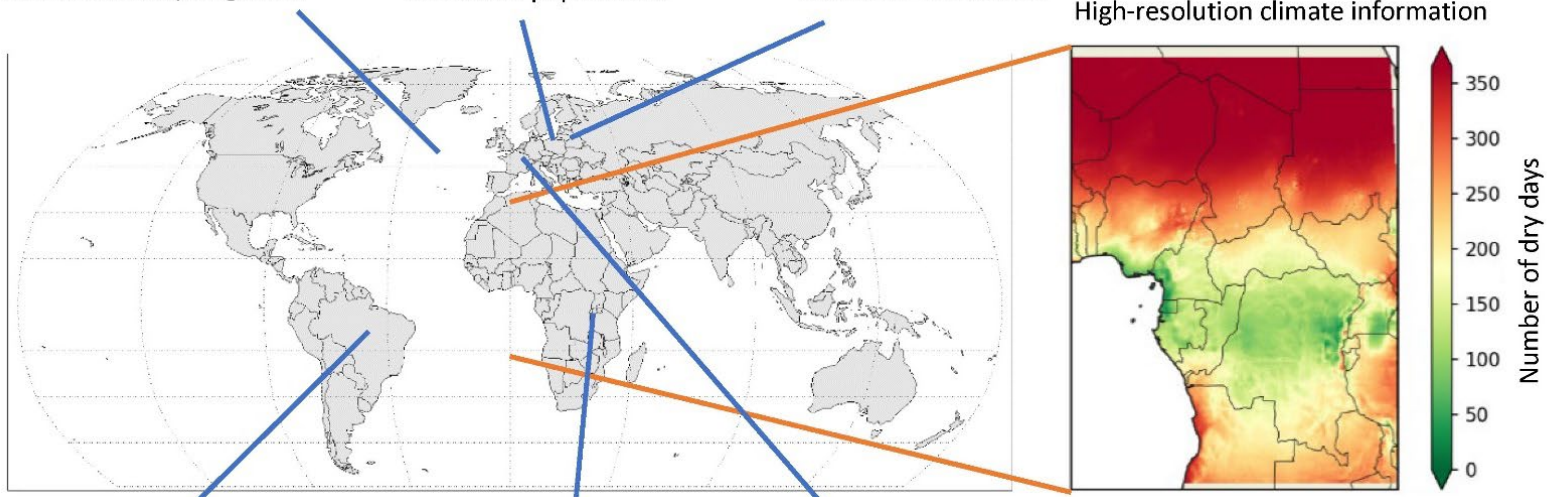
Biodiversity: Demonstrator Service

North Atlantic pelagic fish

Baltic seal populations

Grassland ecosystems

- habitat suitability
- species distribution
- species fitness and reproduction
- ecosystem services



High-resolution climate information

Goldenheaded lion tamarin

Tropical forest biodiversity

Hedgerow ecosystems

- The service provides **two datasets of 79 customized bioclimate indicators** for the past, present and future.
- The indicators are derived climate datasets, i.e. ERA5 for historical reconstruction and CMIP climate projections data
- The service also offers **bioclimate data at a 1km x 1km** grid for selected locations, which responds to **high-resolution** requirements of specific biodiversity challenges

https://climate.copernicus.eu/sites/default/files/2021-07/C3S_Biodiversity_factsheet_20210616.pdf

vito

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European Commission

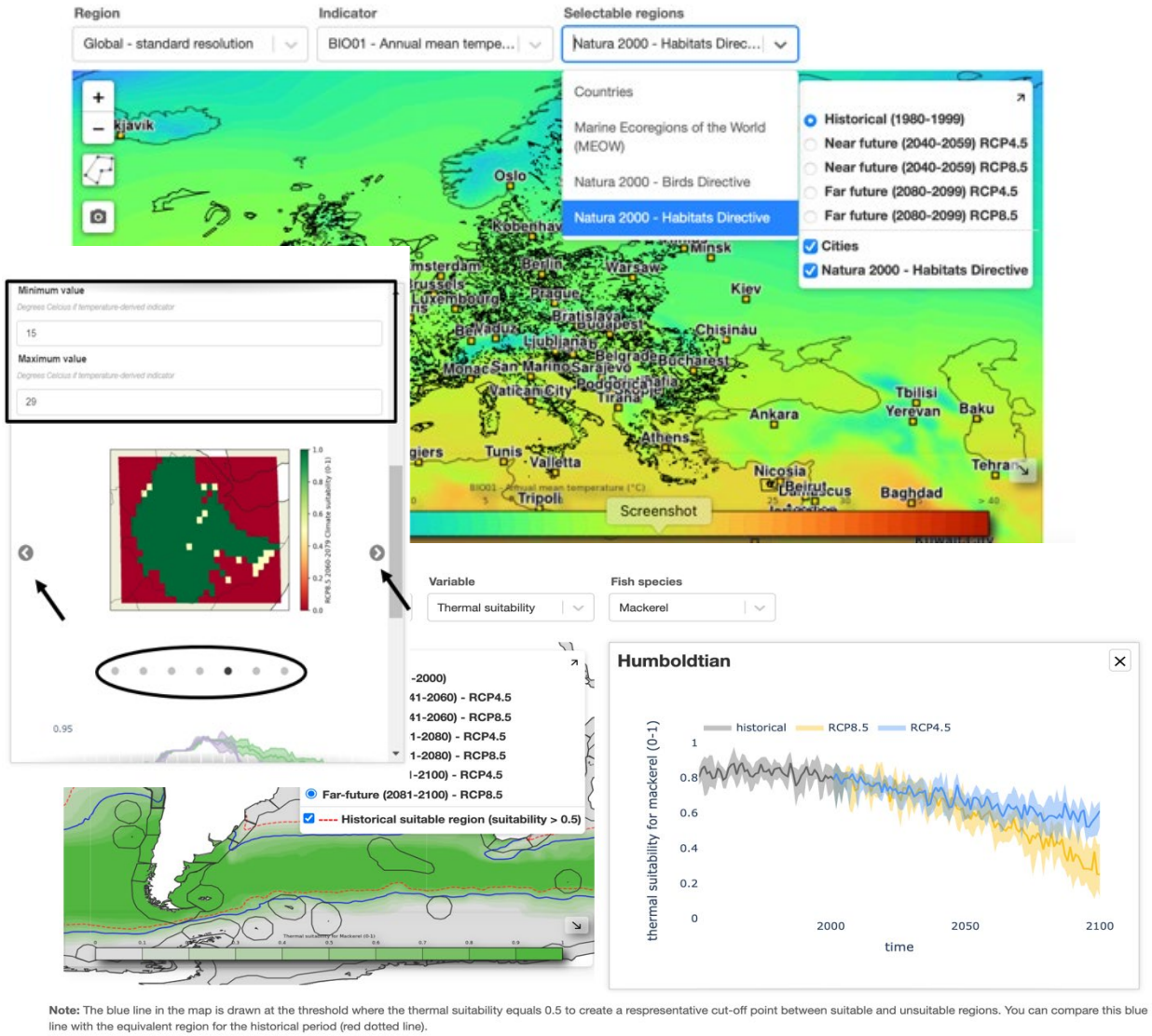
ECMWF

Applications to Support Biodiversity: Assessment of Climatic Suitability

Climate Change

- Interactive applications to visualize and explore 75 key bioclimate indicators (Europe & Global)
- Data developed for biodiversity community in Climate Data Store (CDS)
- Explore per country or by Natura 2000 site*
- User can use a species 'climatic envelope' to help identify when climatic conditions are no longer suitable (leading to stress, dispersal, extinction, …) *
- Dedicated case studies for:
  - European grasslands,
  - Hedge species (flora)
  - Marine fish species & Marine Protected Areas (MPA)

  Exploring the impact of climate suitability on key species & European landscapes



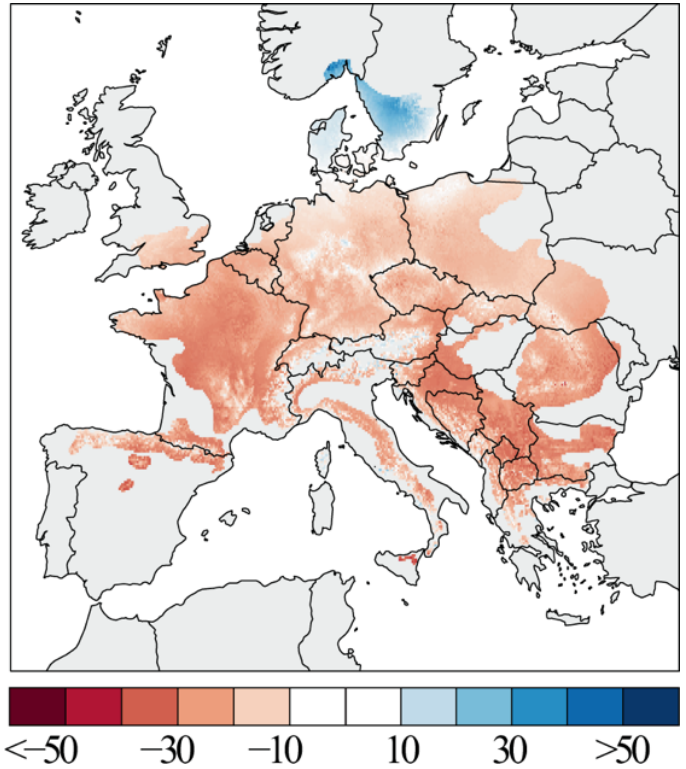
Note: The blue line in the map is drawn at the threshold where the thermal suitability equals 0.5 to create a respresentative cut-off point between suitable and unsuitable regions. You can compare this blue line with the equivalent region for the historical period (red dotted line).

* Application was developed in old infrastructure

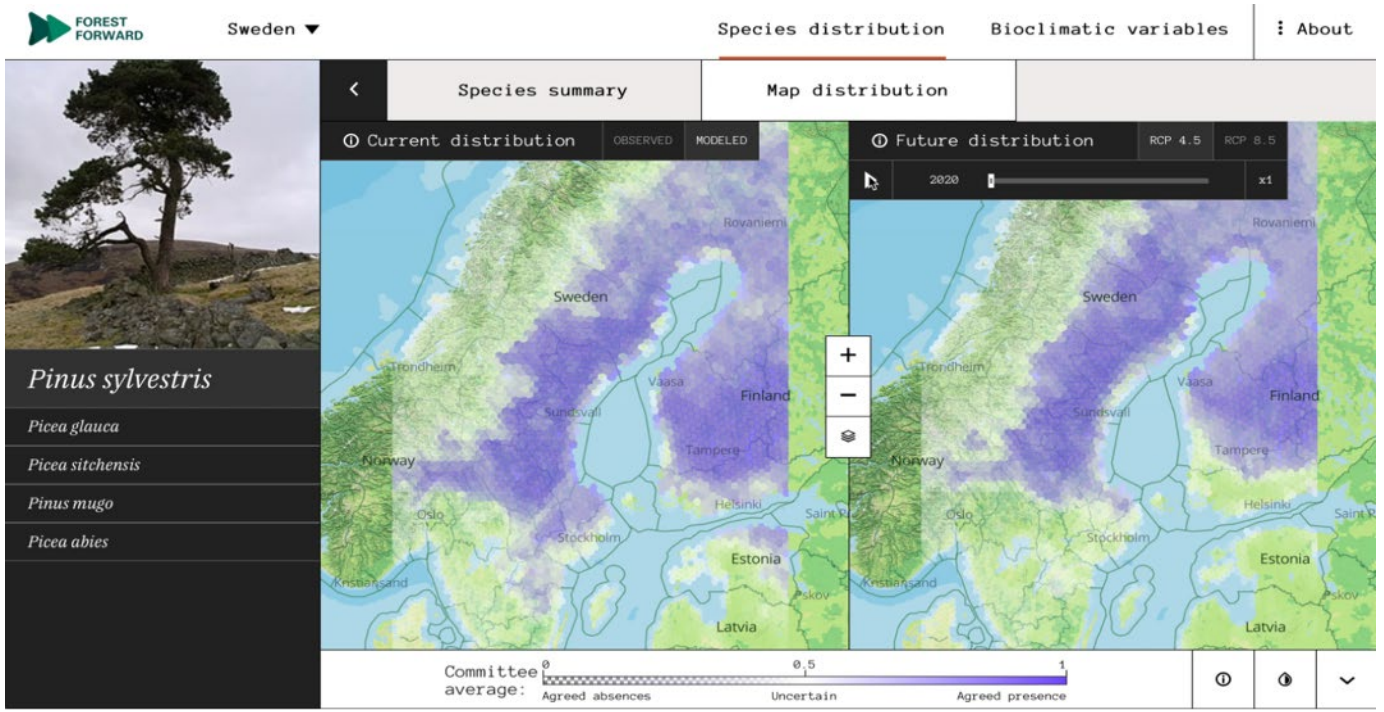
Climate Change

Example Application: Climatic suitability of key European tree species

Climate data can help inform future species distribution and productivity – supporting biodiversity applications



Beech tree growth changes from 1986 to 2016 relative to the 1955–1985 period mean. Source: **Martinez del Castillo et al, 2022.**



C3S data enabled Tecnalia (Spanish SME) to provide distribution maps for key European tree species. Such info can support establishing climate resilient forest (EU Forest strategy 2030)

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Thank you for your attention

Climate Change

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Copernicus Atmosphere Monitoring service: supporting BIODIVERSITY

Laurence ROUIL (ECMWF)

Director of CAMS

Biospace 2025 – ESA/ESRIN – 13th Feb 2025

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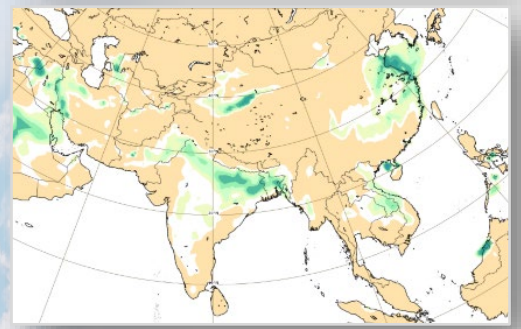
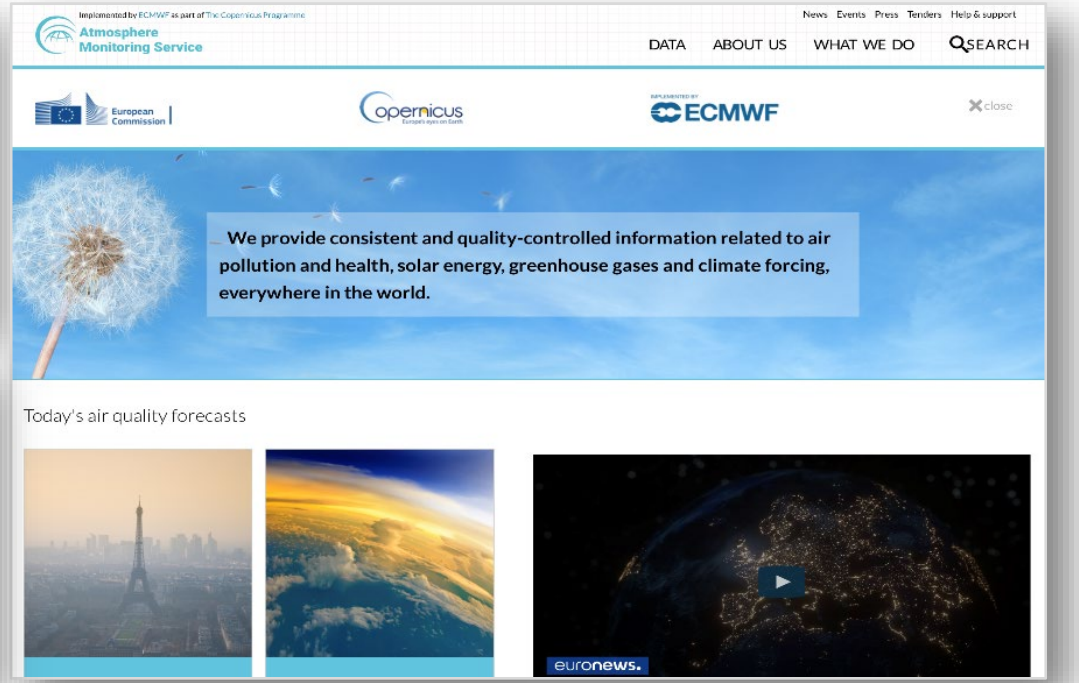
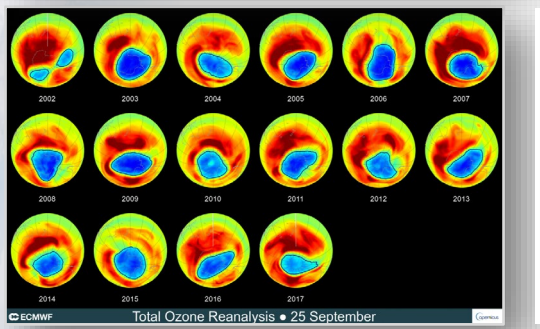
IMPLEMENTED BY ECMWF

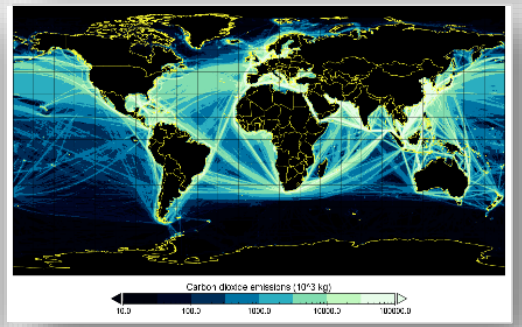
CAMS SCOPE – Atmospheric Composition

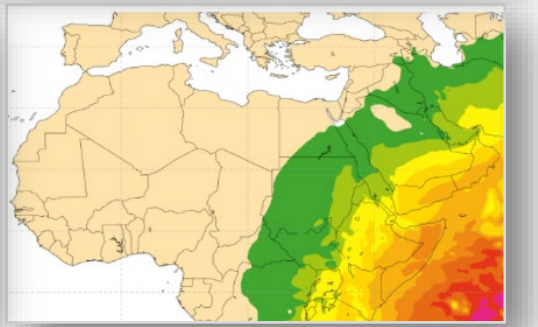
Atmosphere Monitoring











CAMS provides open & free information products based on Earth Observation about:

- past, current and near-future (forecasts) global atmospheric composition;
- the ozone layer;
- European air quality;
- emissions and surface fluxes of key pollutants and greenhouse gases;
- solar radiation;
- climate radiative forcing.

http://atmosphere.copernicus.eu
http://ads.atmosphere.copernicus.eu

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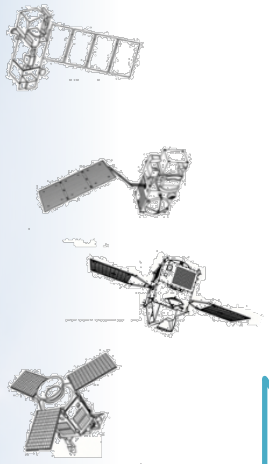
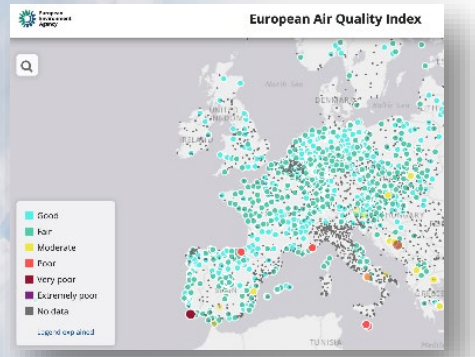
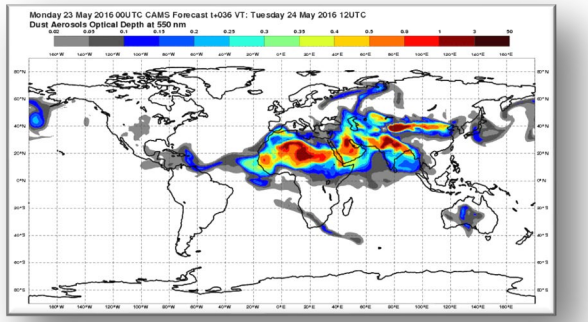
CAMS WORKFLOW (Combining observations with models)

Atmosphere Monitoring



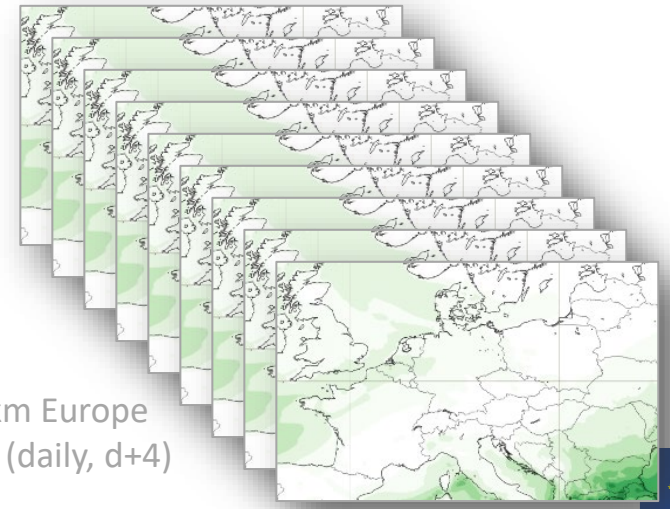
Earth Observation from satellite (>80 instruments) and in-situ (regulatory and research)



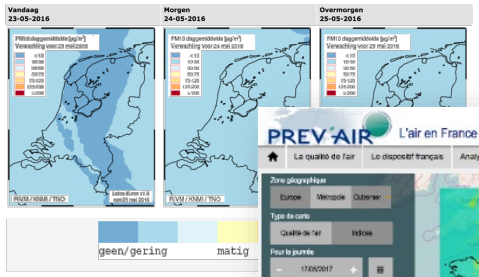


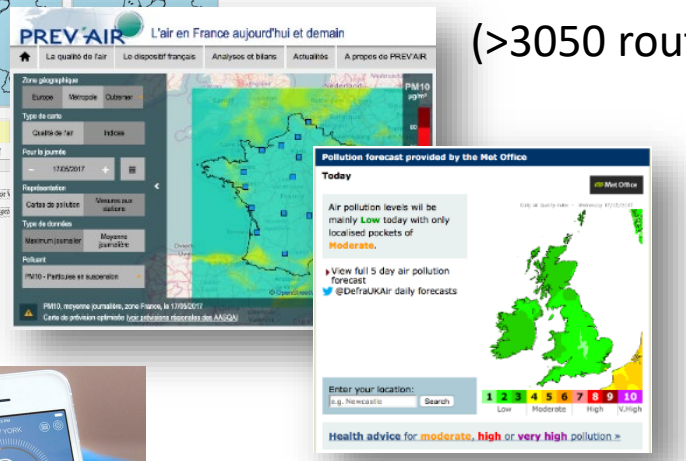
40km Globe (twice daily, d+5)

CAMS main operational **data assimilation and modelling systems**

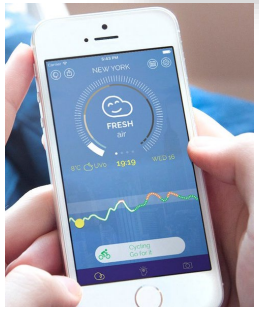


10km Europe (daily, d+4)





CAMS users
>23500
(>3050 routine)



Major multiplication factor
(100Mil+)

Windy.com

The Weather Channel

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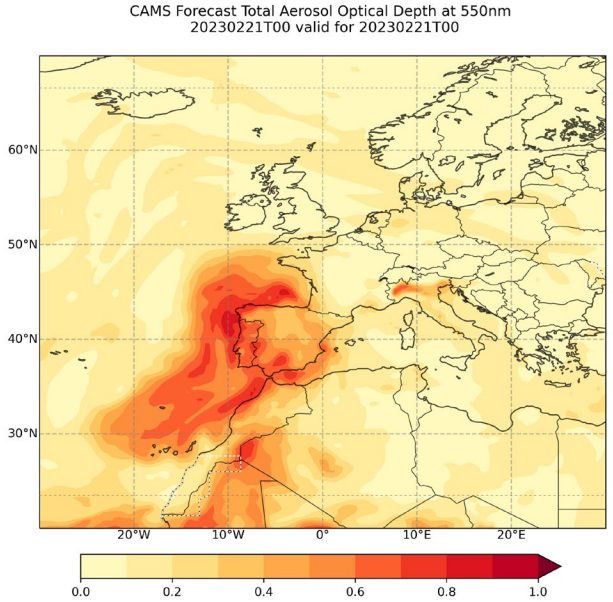
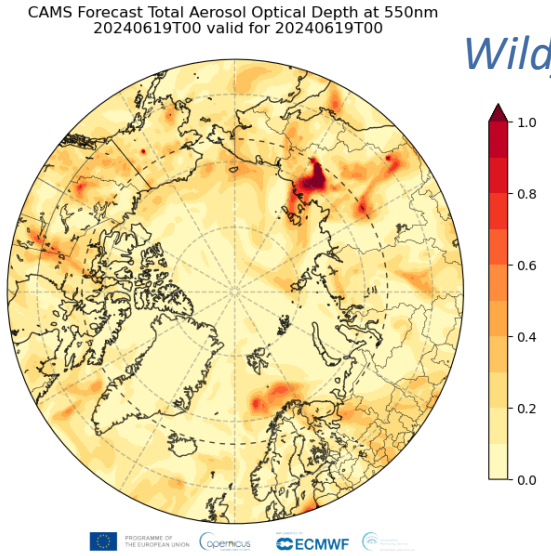
ECMWF

Example of services related to air pollution

Atmosphere Monitoring

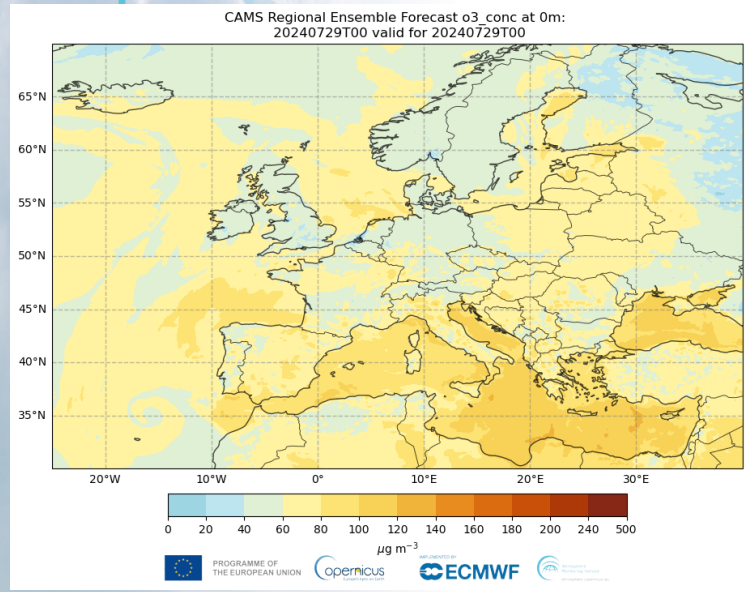
Dust plumes





Wildfires

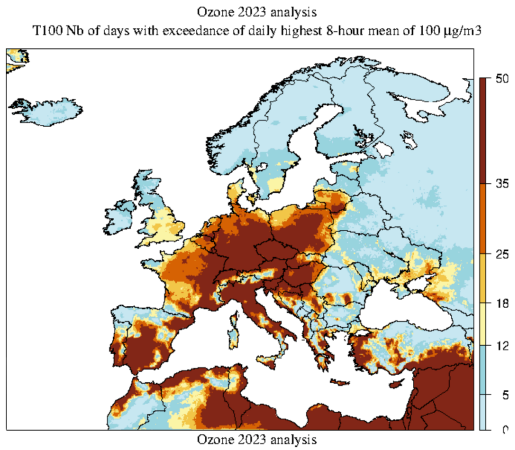
- https://atmosphere.copernicus.eu
- https://policy.atmosphere.Copernicus.eu
- https://ads.atmosphere.copernicus.eu/cdsapp#!/search?type=dataset

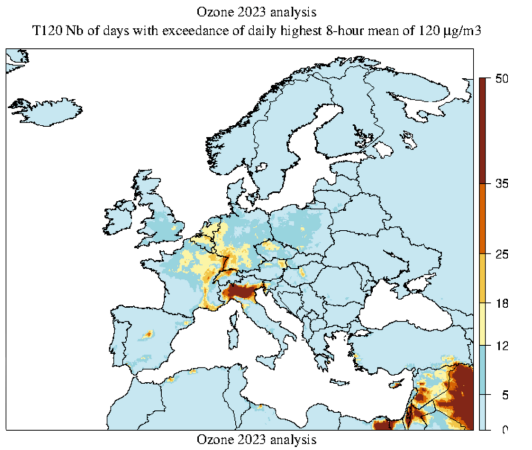


Air pollution episodes

***Reanalyses** of air quality metrics (since 2013)*

PM_{10}	$PM_{10,\ exc}$	$PM_{2.5}$	O_3	$O_{3,\ exc}$	SOMO35 (O_3)	AOT40 (O_3)	NO_2	SO_2	CO_{max}





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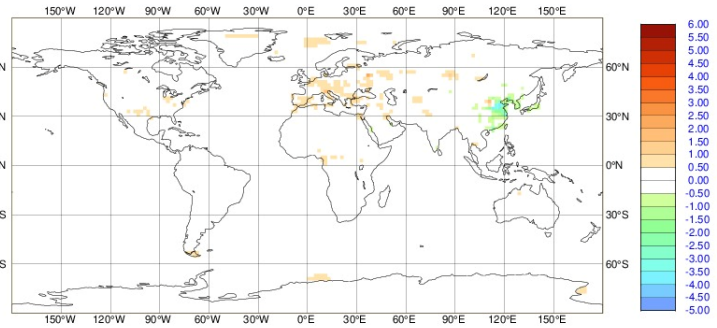
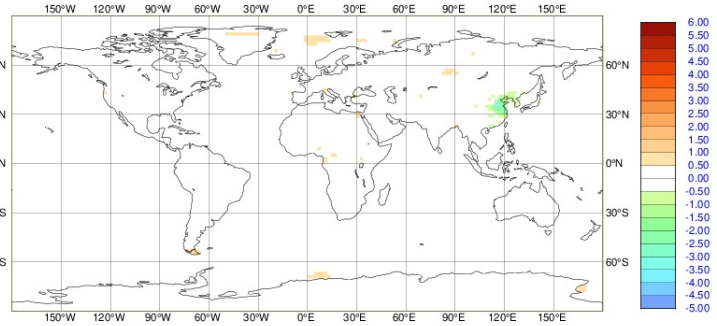
Re-analyses: the best estimate

Example : Tropomi tropospheric NO2

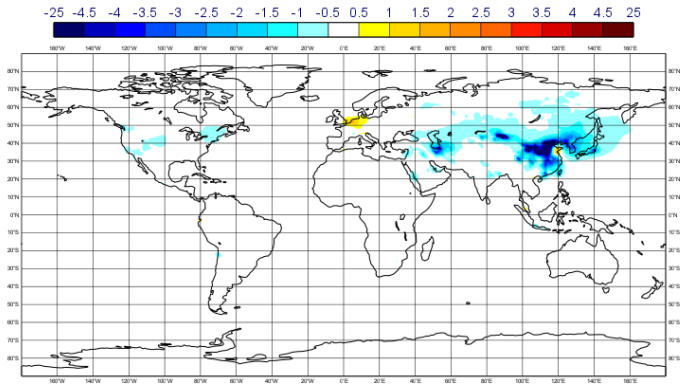
S5P NO2 **first-guess** departures



S5P NO2 **analysis** departures

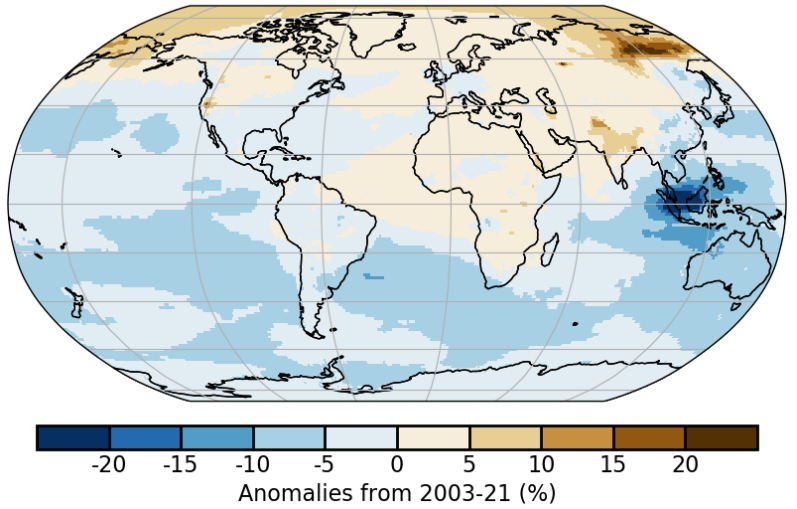


ASSIM minus CONTROL



Using CAMS re-analysis (2003-NRT) of atmospheric composition

Ex: 2021 CO anomaly



Assimilation of TROPOMI NO2 data reduces the CAMS NO2 analysis over Asia and improve the quality of the assessment

Active since 12 Oct 2021

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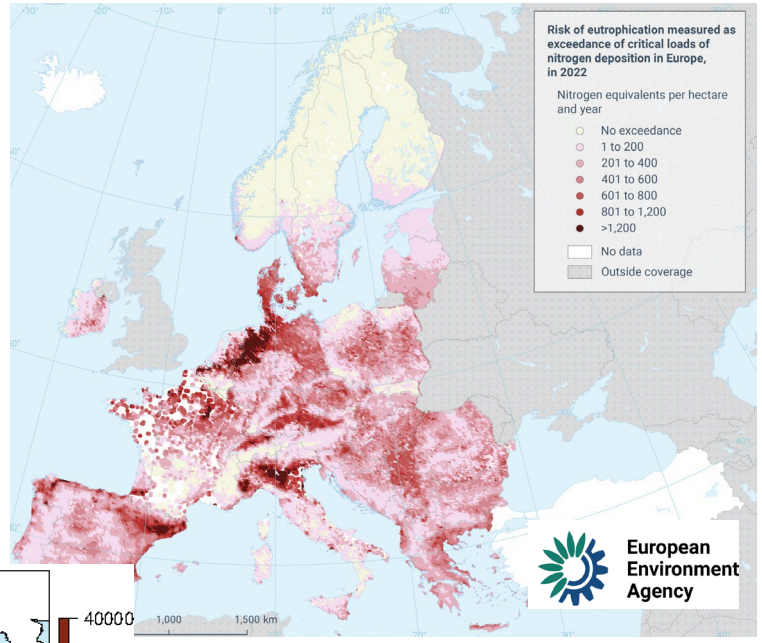
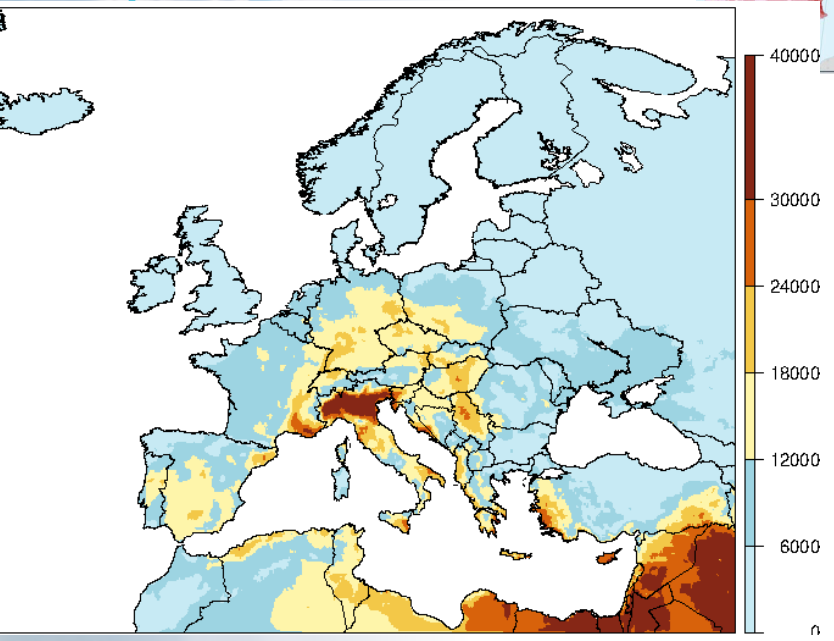
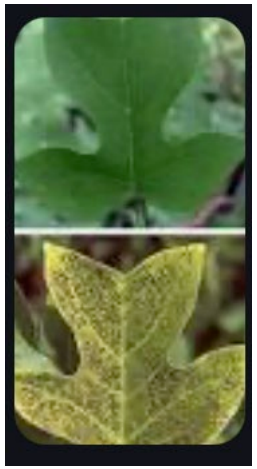
Air pollution and biodiversity

Atmosphere Monitoring

AOT40 : to measure impact of O3 on ecosystems
CAMS reanalysis for 2022







ELSEVIER

Science of The Total Environment
Volume 753, 20 January 2021, 141791

Assessing critical load exceedances and ecosystem impacts of anthropogenic nitrogen and sulphur deposition at unmanaged forested catchments in Europe

Martin Forsius [a], Maximilian Posch [b], Maria Holmberg [a], Jussi Vuorenmaa [a], Sirpa Kleemola [a], Algirdas Augustaitis [c], Burkhard Beudert [d], Witold Bochenek [e], Nicholas Clarke [f], Heleen A. de Wit [g], Thomas Dirnböck [h], Jane Frey [i], Ulf Grandin [j], Hannele Hakola [k], Johannes Kobler [h], Pavel Krám [l], Antti-Jussi Lindroos [m], Stefan Löfgren [j], Tomasz Pecka [n], Pernilla Rönnback [j]...Milan Váňa [q]

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https://doi.org/10.1016/j.scitotenv.2020.141791

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UNECE Air convention :
https://unece.org/environmental-policy-1/air

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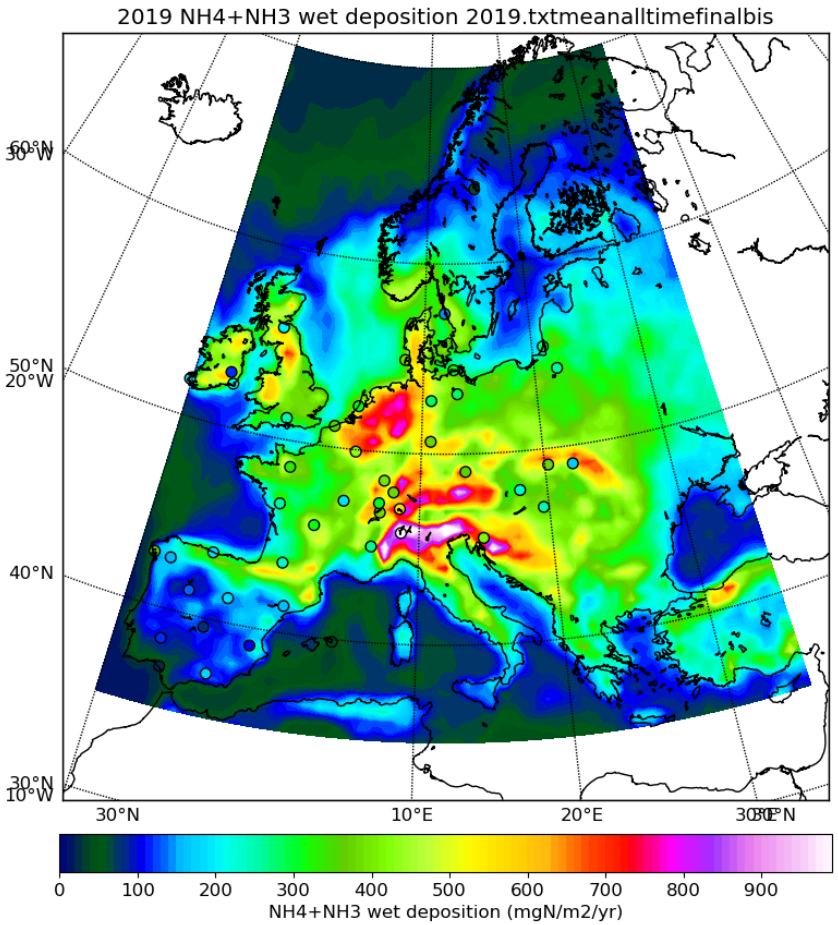
In preparation within CAMS : deposition products

Atmosphere Monitoring



CAMEO H2020 project : https://www.cameo-project.eu/

- Deposition flux products to be improved by:
  - DA of improved AQ retrievals from Geostationary GEMS, Sentinel4, TEMPO missions: high-temporal resolution over Asia, Europe and North-America
  - Utilise satellite-based emissions inversion framework (CO2MVS) in global CAMS system for deposition flux correction
  - Improved DA methodology
  - Increased number of in-situ observations for evaluation
  - Improved emission data and inventories (more timely, activity better and variability)
  - Observation based correction of surface fluxes
  - Provision of uncertainty information

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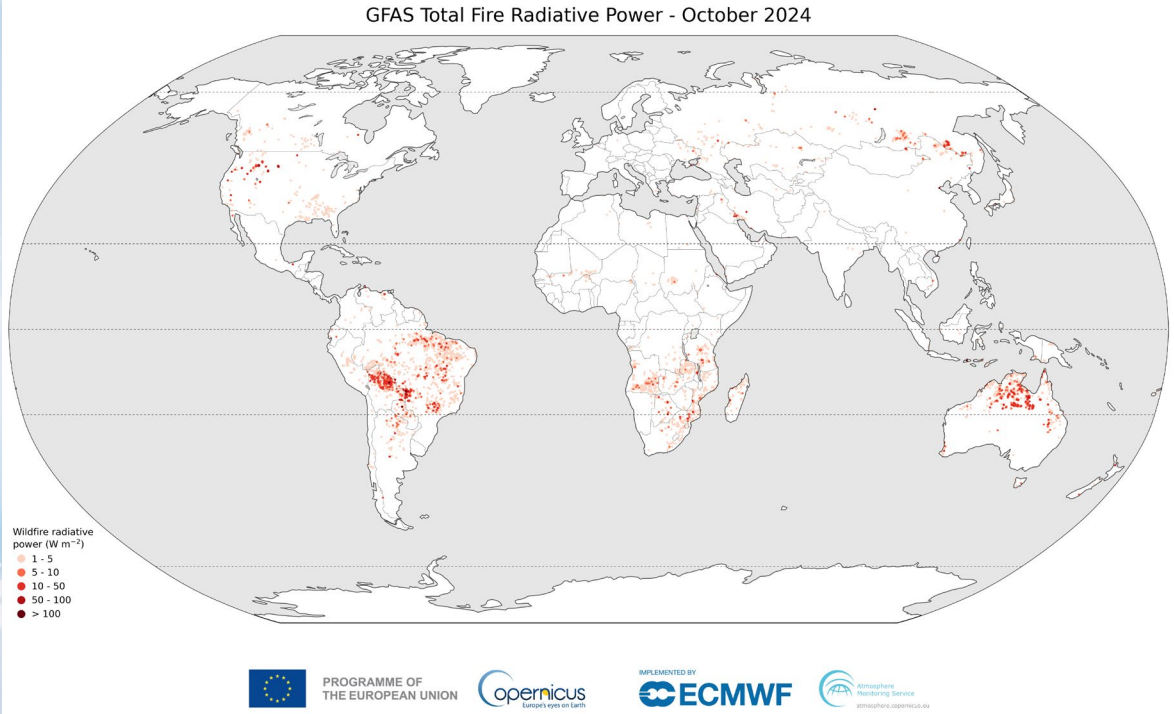
Fire emissions monitoring in CAMS: Global Fire Assimilation System (GFAS)

Atmosphere Monitoring



Global Fire Assimilation System (**GFAS**); see https://ads.atmosphere.copernicus.eu/cdsapp#!/dataset/cams-global-fire-emissions-gfas?tab=overview

Uses satellite observations of Fire Radiative Power (FRP)

- Currently Aqua and Terra MODIS FRP observations
- FRP from VIIRS, Sentinel-3, and geostationary satellites are being tested and implemented

Global Coverage at ~10km Resolution

- *Daily Output: 1-day behind NRT*
- Hourly Output (+24-h means): 7-hours behind NRT

Emissions of aerosols and gases are estimated using factors dependent on vegetation type.

Injection heights calculated using *Plume Rise Model* and IS4FIRES schemes

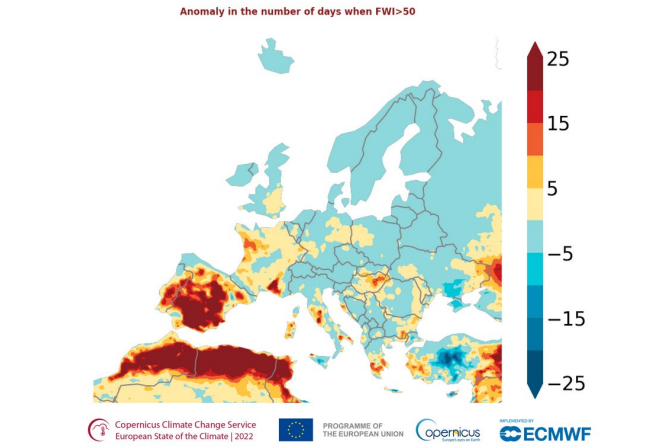


Figure 2. Anomaly in the number of days in 2022 with Fire Weather Index > 50, relative to the average for the 1991–2020 reference period. These conditions are when 'critical' fires, those above 10,000 ha, can develop. Data source: FWI based on ERA5. Credit: Copernicus EMS/ECMWF.

- Application : Summary of forest fires in Europe, combining C3S, CAMS and EFFIS (European Forest Fire Information System) information, published for each year in the European State of the Climate report.
  - 2023 report: https://climate.copernicus.eu/esotc/2023/wildfires

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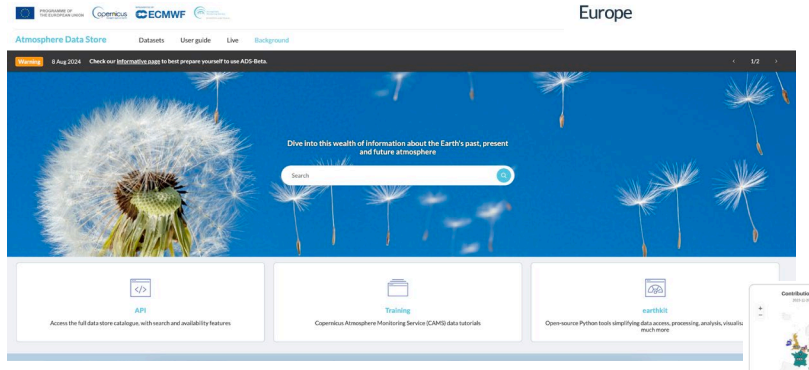
Atmosphere Monitoring

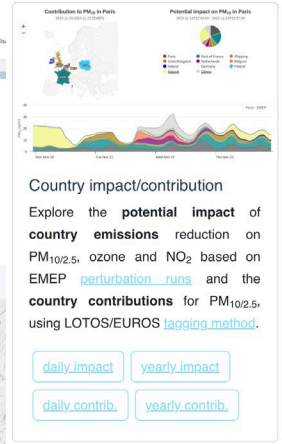
Ressources :

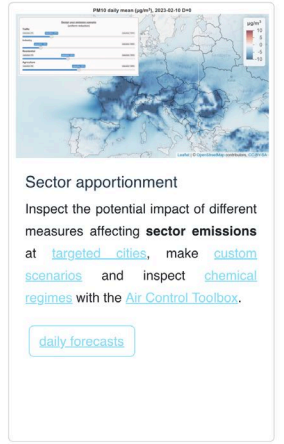
- **CAMS website and news :** https://atmosphere.Copernicus.eu

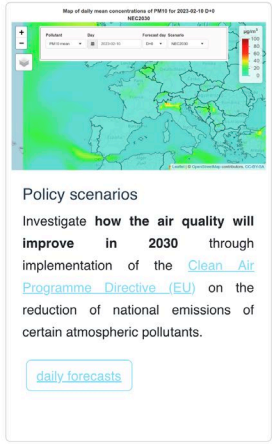
- **Datasets provided by the CAMS services freely available on the Atmosphere datastore:** https://ads.atmosphere.eu



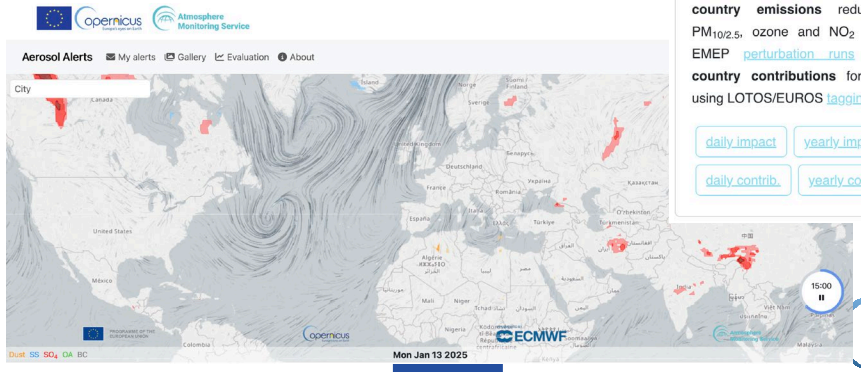
- **Policy services:** https://policy.atmosphere.Copernicus.eu







- **Aerosol alert service:** https://aerosol-alerts.atmosphere.copernicus.eu



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Thank you !

Laurence.rouil@ecmwf.int

Atmosphere Monitoring

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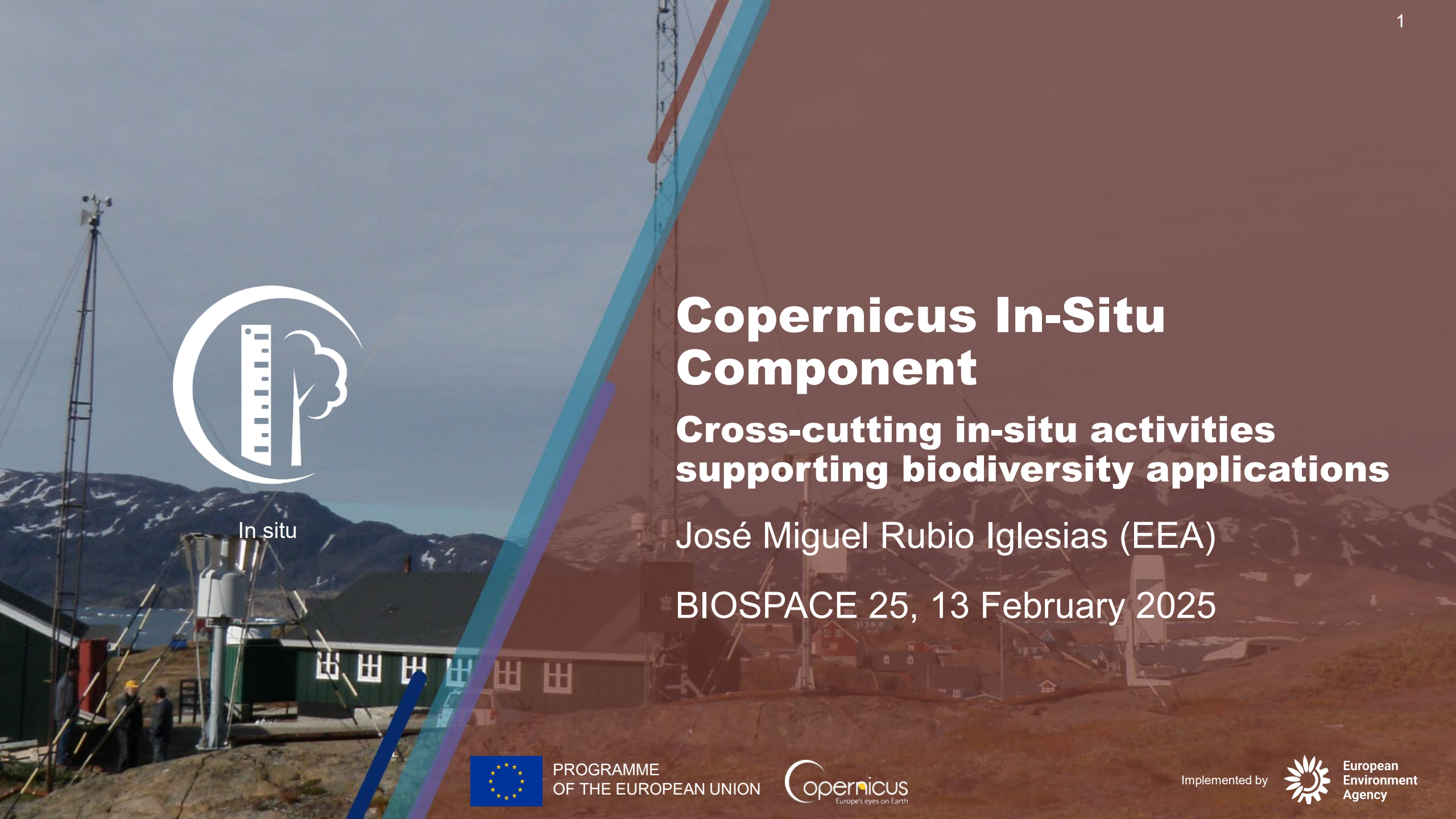

In situ

Copernicus In-Situ Component

Cross-cutting in-situ activities supporting biodiversity applications

José Miguel Rubio Iglesias (EEA)

BIOSPACE 25, 13 February 2025

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Implemented by European Environment Agency

In-situ data in Copernicus

In situ

Copernicus in-situ data: observations, **geospatial reference** and ancillary data licensed or provided for use in Copernicus

What for?

- **Production and validation** in Copernicus services
- As stand-alone **observation** products
- **Cal/Val** of satellite sensors

Without in-situ data, Copernicus simply cannot deliver its data, products and services

Where does in-situ data come from?

In situ

In Situ data comes from a **myriad of data providers** and networks at national, regional and global level.

European networks and countries

eurogeographics
EUMETNET
EuroGOOS
European Global Ocean Observing System
EIONET
EuroGeoSurveys
The Geological Surveys of Europe

Research Infrastructures

eLTER
ACTRiS
emso ERIC
IAGOS
Euro-Argo
ICOS
Integrated Carbon Observation System

International organisations, other countries

WMO
FAO
FLUXNET
PGN
GEO
NOAA
UNESCO
United Nations Educational, Scientific and Cultural Organization
Intergovernmental Oceanographic Commission

Governance of the Copernicus In-Situ

In situ

Entrusted Entities access and manage in situ data directly according to their operational needs on a day-to-day basis.

The **EEA** intervenes when a coordinated approach to accessing in situ data is required at a programmatic level: “cross-cutting activities”

Cross-cutting coordination activities (2021-2028)

In situ

- State of Play report
- Copernicus In-Situ Data Requirements (CIS^2)
- Factsheets

STATE OF PLAY

- Copernicus Reference Data Access Portal (CORDA)
- Access to specific in situ data

DATA ACCESS

- Licensing agreements
- Use cases
- Inventory of data providers

ENGAGING WITH DATA PROVIDERS

- In Situ Working groups
- Thematic Reports, inventories
- GEO, R&D

SUPPORT AND ADVICE

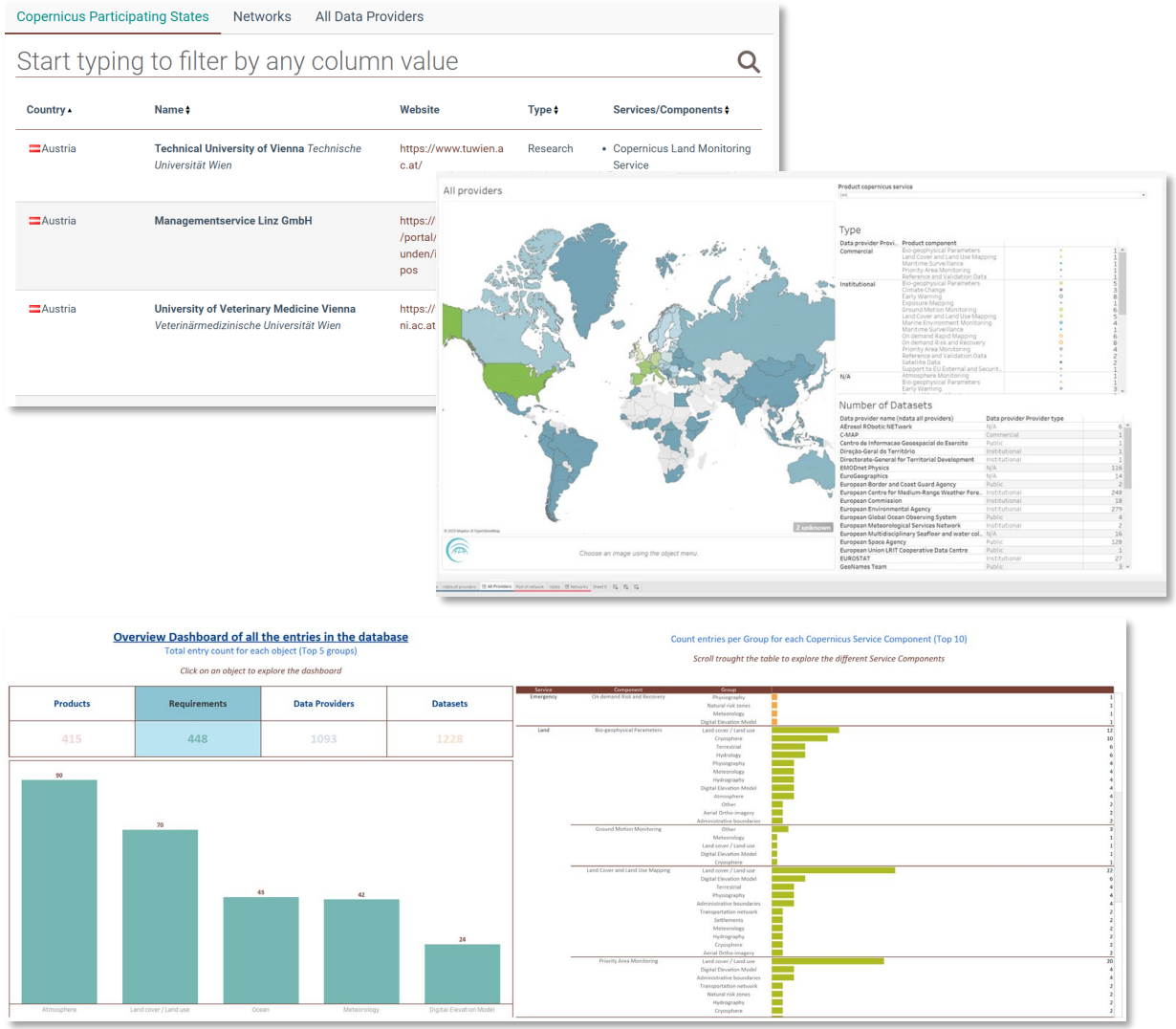
Copernicus in-situ data requirements

In situ

Capturing data requirements: the CIS² database

- Overview of Copernicus in situ data requirements and how these are met
- **Comprehensive list of products, data providers (European and global) and key datasets**
  - 330 Copernicus products, 357 in situ requirements, 900 data providers and networks
- Ongoing reviews and updates with support from Entrusted Entities, two versions per year
- Dashboards under development

https://cis2.eea.europa.eu/



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Implemented by European Environment Agency

State of Play : key issues encountered

In situ

- Access conditions and use restrictions
- Insufficient spatial coverage
- Uncertain sustainability of critical networks
- Fragmentation and heterogeneity
- Lack of alignment with data providers
- Insufficient acknowledgement
- Not long enough historical high time series
- More data needed on specific areas
- Increasing demands in frequency and resolution
- Rapid accessibility

State of Play: Areas for evolution

In situ

Closing **data gaps**

Strengthening **partnerships**

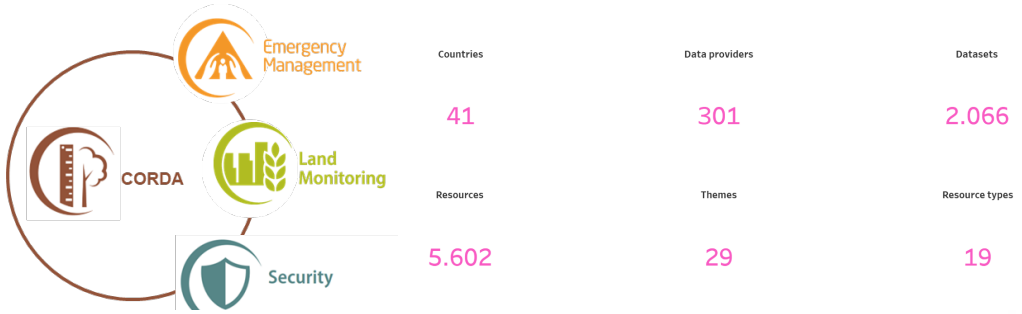
Long-term **evolution**

More information on https://insitu.copernicus.eu/state-of-play

Access to geospatial data: CORDA

In situ

- Single entry point node to national and regional geospatial data
- Data hosted in origin by default
- Continuous monitoring and update
- Semantically harmonized multi-country databases for key topics
- Restricted for Copernicus service providers and data providers https://corda.eea.europa.eu/



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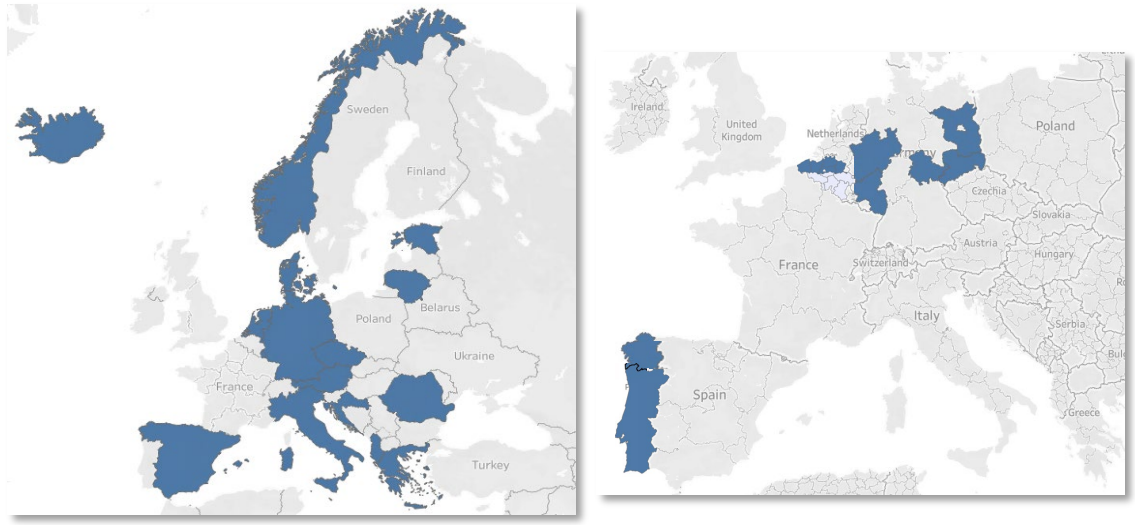
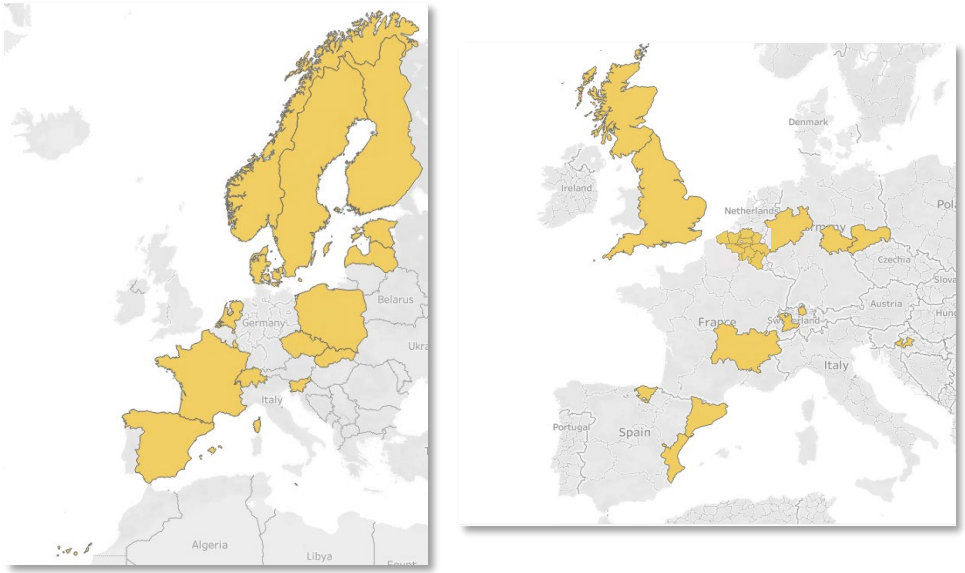
Examples of downloadable data in CORDA

In situ





Wetlands

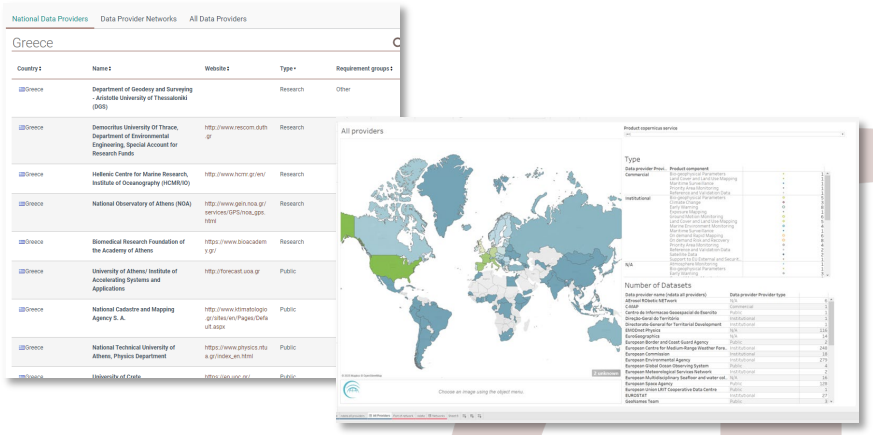
- 15 national datasets
- 8 regional datasets

LiDAR

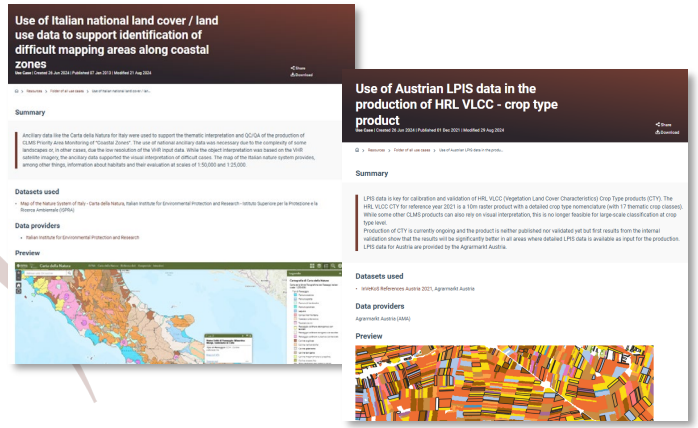
- 15 national datasets
- 16 regional datasets

Engaging with data providers

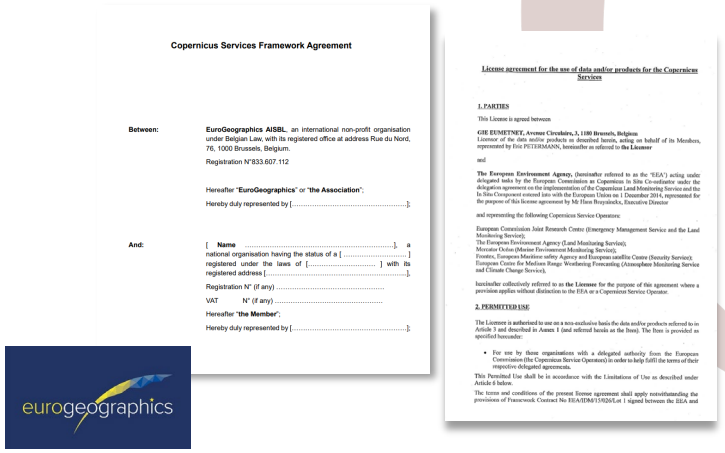
In situ



Comprehensive inventory of **data providers and networks**



Use cases of national data in Copernicus



Overarching **licensing agreements** for Copernicus use

Engagement with **thematic communities, programmes and initiatives**

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Use cases of in-situ data in Copernicus

In situ

Validation of the Copernicus Land Monitoring service's bio-physical products.

Use Case | Created 09 Aug 2024 | Published 27 Aug 2024 | Modified 13 Jan 2025

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Resources > Folder of all use cases > Validation of the Copernicus Land Mon...

Summary

The Copernicus Land Monitoring Service (CLMS) performs systemati
terrestrial cryosphere variables, i.e., the bio-geophysical status and e
portfolio focuses on land temperature and reflectance observations t
surfaces.

This results in a continuous timeseries of Vegetation indicators, Lanc
Reflectance observations suited for environmental analysis and deci
comprehensive view of the Earth's energy dynamics, enabling inform
mitigation, sustainable land use, water management, and biodiversity

Importantly, validation against in-situ or ground-based observations i
CLMS are consistent, fit for purpose, and meeting key user quality re

Geographical distribution of stations and networks used by the Copernicus Land Monitoring Service for validation of biophysical products. Credit: Copernicus Land Monitoring Service (CLMS)/ Joint Research Centre (JRC).

Lake water quality

Use Case | Created 09 Aug 2024 | Published 27 Aug 2024 | Modified 13 Jan 2025

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Resources > Folder of all use cases > Lake water quality

Summary

Lake water quality information helps manage valuable ecosystems for nature and human activities and documents the impact of climate change and pollution. Lake water quality is vital to understanding not only the quality of the water in the lake, but also changes in land use as well as water chemistry, temperature and quality of contributing streams and rivers. It is of critical importance to aquatic ecology, and often to water supply. Changes to optical properties can indicate the influence of land use change, changes in water quality.

The Copernicus services produce several water quality related product

- Turbidity (water clarity);
- Trophic state index based on chlorophyll-a;
- Lake surface reflectances measuring the apparent colour of the w

The next generation of products is expected to include additionally:

- Total suspended matter concentrations;
- Chlorophyll-a concentration as a direct measure of phytoplankton
- Harmful algal blooms of cyanobacteria.

Satellite data, such as those provided by Copernicus Sentinels, greatly
can reduce the potential for 'accessibility bias', whereby in-situ observa
rather than the best scientifically. Additionally, satellite observations ca
networks.

Use of national habitat types in Iceland to support the production of CLC+ raster product

Use Case | Created 26 Jun 2024 | Published 12 Jan 2017 | Modified 14 Jan 2025

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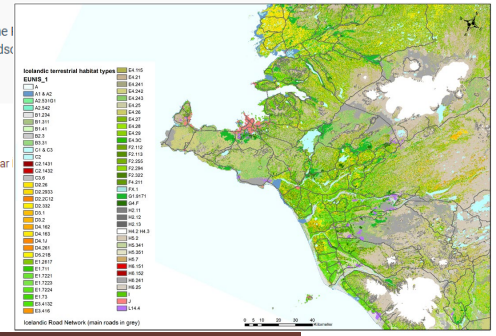
Resources > Folder of all use cases > Use of national habitat types in Iceland...

Summary

In the CLMS Land Cover and Land Use Mapping production of the CLC+ Backbone l
habitat map was used for sample point interpretation especially for complex landsc
herbaceous areas which are difficult to differentiate on satellite images.



Datasets used

- Icelandic Terrestrial habitat types (EUNIS classification) map (Kortasjá Náttúrufræðistofnunar Náttúrufræðistofnun Íslands

Data providers

- Icelandic Institute of Natural History (IINH)

Use of Spanish national data in supporting post-wildfire damage assessment

Use Case | Created 26 Jun 2024 | Published 16 Aug 2023 | Modified 13 Jan 2025

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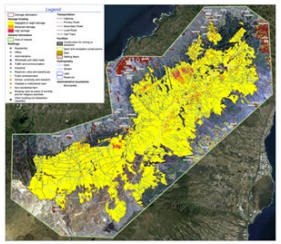
Resources > Folder of all use cases > Use of Spanish national data in suppor...

Summary

On 15th August 2023, a wildfire broke out on Tenerife, Canary Islands, Spain, particularly affecting Arafo and Candelaria municipalities, with potential risks of spreading to other areas. The affected region en
Forestal Natural Park, and poses a threat to the Teide National Park, hc
Mapping service was activated with the EMSR685 code to monitor the
over 12,000 hectares, and about 207 buildings were identified as poten
Mapping was activated to produce the P07-Wildfire delineation and gra
population. The Spanish national data (The Forest Map) was used as a
(i.e. agriculture production and crop, forest stand information etc.) con

AOI 01: TENERIFE



P07 - Wildfire delineation and grading

	Unit of measurement	Destroyed	High damage	Moderate damage	Negligible to slight damage	Total affected
Burnt area	ha	0.0	87.2	825.6	11052.7	11965.6

P14 – Impact assessment on assets and population
Affected areas by fire severity

	Unit of measurement	High damage	Moderate damage	Negligible to slight damage	Total affected	Total in AOI
Burnt area	ha	87.2	825.6	11052.7	11965.6	26,730.86
FFN classification (Level1N)	111-Monte arbolado. Bosque	ha	71.89	747.93	8,940.19	9,760.01	14,295.52
	112-Monte arbolado. Bosque de plantaciones	ha	15.03	64.10	275.99	355.13	483.52
	115-Monte arbolado. Ribera arbolada	ha	0.00	0.00	0.00	0.00	5.57
	116-Monte arbolado. Bosquete pesuños	ha	0.00	0.00	0.00	0.00	37.91
	121-Monte con arbolado raló. Bosque	ha	0.00	0.00	135.52	135.52	507.01

P15 – Impact assessment on selected aspects
An extraction from the affected forest classification table (based on National Forestry Map classes)

Data providers

- Spanish Ministry for the Ecological Transition and the Demographic Challenge

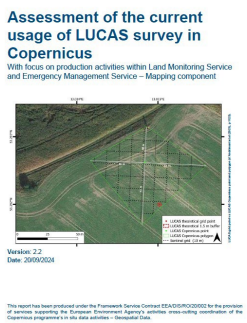
PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

Agency

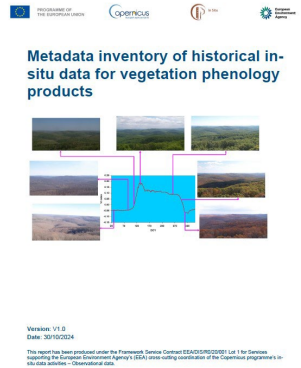
Relevant reports and inventories

In situ



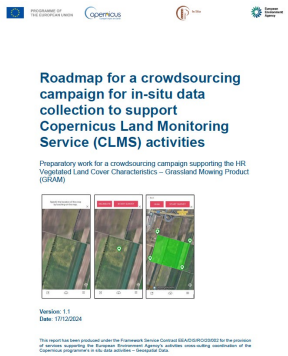
Assessment of the use of LUCAS in Copernicus Land production activities

https://insitu.copernicus.eu/resources/library/assessment-of-the-current-usage-of-lucas-survey-in-copernicus-january-2024



Metadata inventory of historical in-situ data for vegetation phenology products

https://insitu.copernicus.eu/resources/library/global-phenology-inventory



Crowdsourcing approaches for the collection of grassland mowing events

https://insitu.copernicus.eu/resources/library/crowdsourcing-campaign

Assessment of the availability of wetlands dataset for CLC+

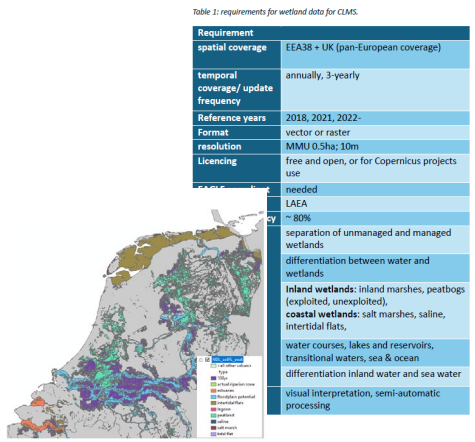


Table 1: requirements for wetland data for CLMS.

Requirement	
spatial coverage	EEA38 + UK (pan-European coverage)
temporal coverage/ update frequency	annually, 3-yearly
Reference years	2018, 2021, 2022-
Format	vector or raster
resolution	MMU 0.5ha; 10m
Licencing	free and open, or for Copernicus projects use
	needed
	LAEA
	~ 80%
	separation of unmanaged and managed wetlands
	differentiation between water and wetlands
	inland wetlands: inland marshes, peatbogs (exploited, unexploited), **coastal wetlands:** salt marshes, saline, intertidal flats,
	water courses, lakes and reservoirs, transitional waters, sea & ocean
	differentiation inland water and sea water
	visual interpretation, semi-automatic processing


In situ
insitu.copernicus.eu
copernicus.insitu@eea.europa.eu
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Ongoing in situ support activities

In situ

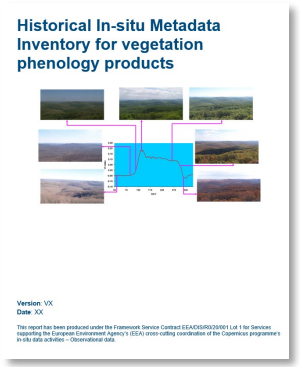
Design of a crowdsourcing campaign

Design a **pilot crowdsourcing-based campaign** in support of CLMS (grassland mowing events under HR VLCC).

Support on the future of LUCAS survey

Inventory of phenology datasets

Creation of **inventory of in-situ historical metadata of data** relevant for vegetation phenology products: citizen science, phenocams and ecological observatories.



Inventory of phenology datasets

Requirements for in-situ data at global level

In situ

Feedback from the EEA, tasked with the coordination of Copernicus' access to in situ data. Some of these results may also be reported by the individual Copernicus Services.

Entity	Signed	Status / Impact
United States – U.S. State Department	**October 2015**	Nothing to report.
Australia – Geoscience Australia	**November 2015**	A Technical Operating Agreement was signed May 2017 by the EEA and Geoscience Australia. The purpose of the agreement is 'to facilitate dialogue and data sharing between Geoscience Australia and Copernicus'.
Brazil – Ministry for Science, Technology, Innovation and Communication of Brazil	**March 2018**	Within the frame of the Cooperation Arrangement and based on a specific request, climate and meteorological observations have been delivered by the Brazilian Meteorological Institute (INMET) to Copernicus.
Chile – Undersecretariat of Telecommunications of the Republic of Chile	**March 2018**	Within the frame of the Cooperation Arrangement and based on a specific request, historical and real time meteorological observations have been delivered to Copernicus via the National Weather Office of Chile and University of Chile.
Colombia – Institute of Hydrology, Meteorology and Environmental Studies of Colombia	**March 2018**	Dialogue has been initiated and concrete in situ data requirements defined by the Copernicus Services have been passed on to the Institute of Hydrology, Meteorology and Environmental Studies of Colombia (IDEAM). No concrete results have been achieved.
India – Department of Space of India	**March 2018**	Dialogue has been initiated and concrete in situ data requirements defined by the Copernicus Services have been passed on to the Indian Space Organisation (ISRO). No concrete results have been achieved.
Ukraine –Ukraine State Space Agency	**May 2018**	Nothing to report.
Serbia – Ministry of Education, Science and Technological Development of Serbia	**June 2018**	Nothing to report.
African Union – African Union Commission	**June 2018**	Nothing to report.
Canada – Canadian Space Agency	**May 2022**	Within the frame of the Cooperation Arrangement and based on a specific request, a large amount of climate and meteorological observations have been delivered to Copernicus by Environment Climate Change Canada.
Panama – National Authority for Government Innovation	**December 2022**	Nothing to report.
Japan – Ministry of Economy, Trade and Industry of Japan	**January 2023**	Dialogue has been initiated (April 2023) and concrete in situ data requirements defined by the Copernicus Services have been passed on to the Ministry of Economy, Trade, and

More than 10 International Arrangements with non-EU countries

Emergency

Atmosphere

Climate Change

Land

Hydrology

- River discharge
- Reservoir volumes

Atmosphere

- Concentrations of major air pollutants (NOx, PM10, PM2.5, CO, SO2, HCHO, Pb, TSP, C6H6, among others).
- Improved observation of size resolved chemical composition of aerosol.
- Improved global observations of greenhouse gas concentrations and related species (CO2, CH4, N2O, 14C, …).
- Vertically resolved concentration data of pollutant gases and aerosol.
- Solar radiation and UV.

Climate

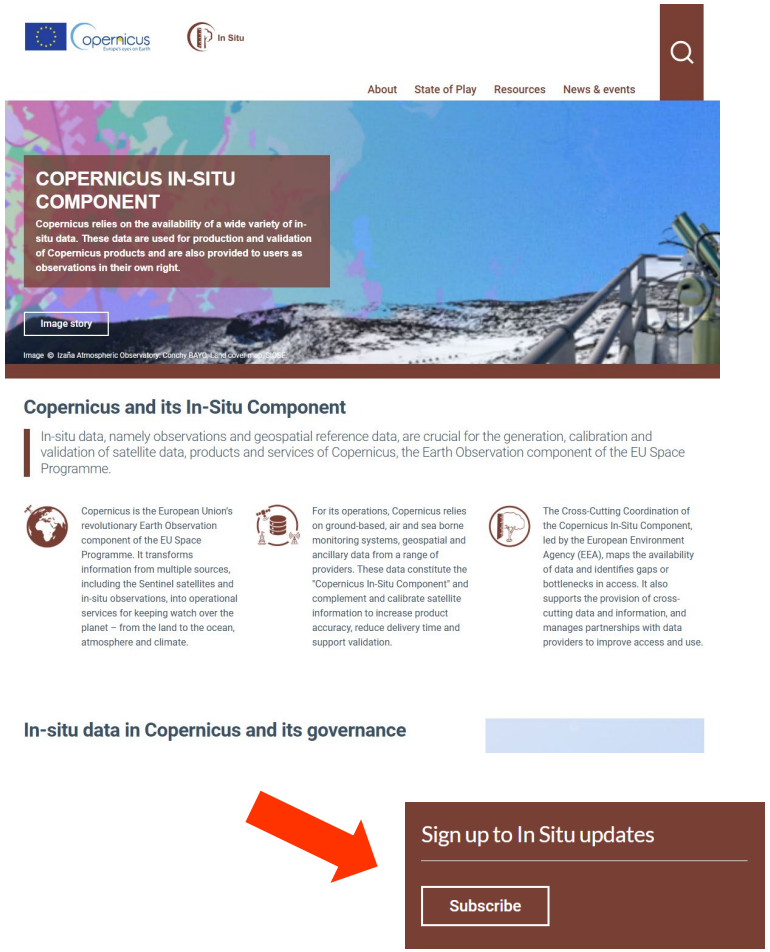
- Surface observations from all stations registered in WMO Oscar/Surface

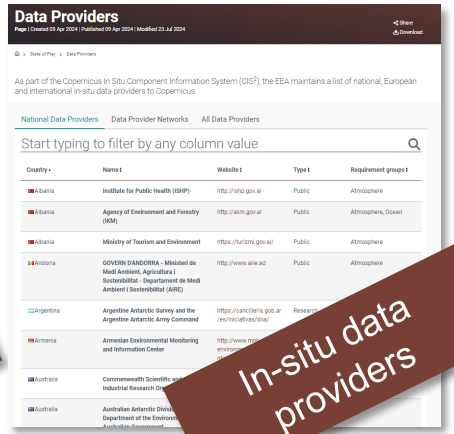
Land

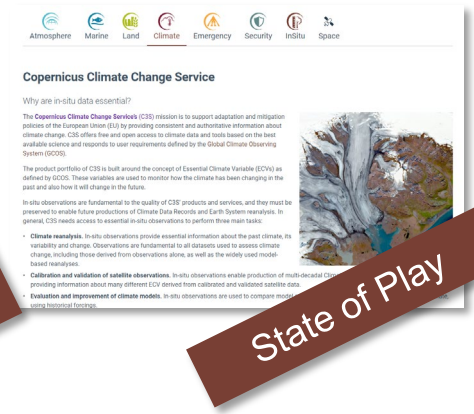
- Land cover ground observations, and for some specific areas of interest, crop type observations
- Water quality observations
- Water level observations
- Soil moisture information
- GBOV complementing stations

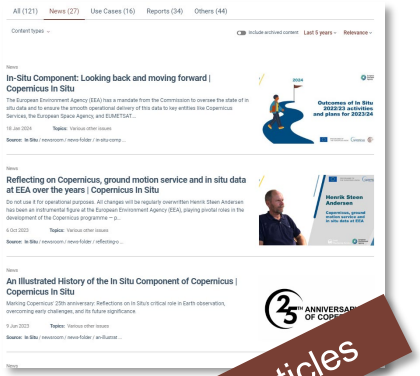
New Copernicus In-Situ website – subscribe!

In situ









https://insitu.copernicus.eu

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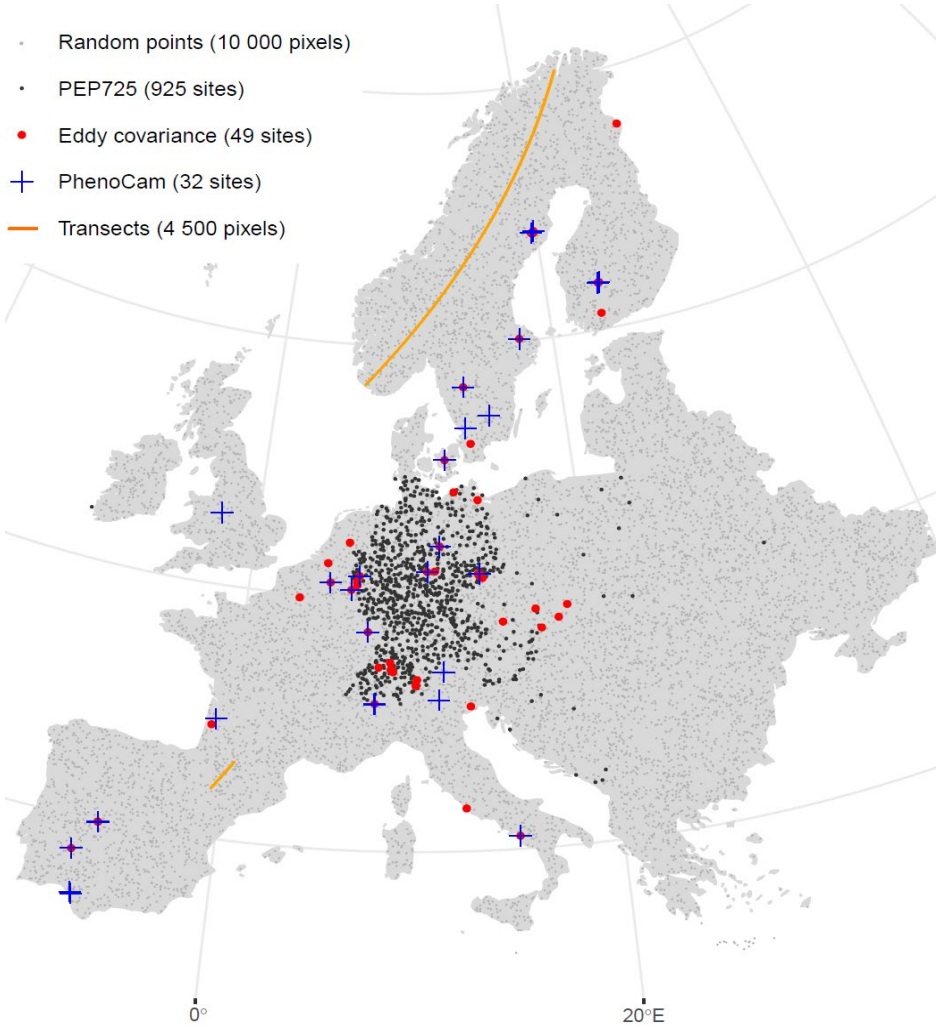
Copernicus Europe's eyes on Earth

Implemented by European Environment Agency

Calibration against reference data

Reference datasets

- **GPP**: from eddy covariance (flux towers): 49 sites
- **PhenoCam:** greenness from phenological camera images: 32 sites
- **PEP725 ground phenological observations:** manual field observations: 925 sites
- **Agricultural crop data** (Belgium, Austria): 150 + 278 + 600 fields



Tian, F., et al., 2021, Calibrating vegetation phenology from Sentinel-2 using eddy covariance, PhenoCam, and PEP725 networks across Europe. Remote Sensing of Environment, 260, 112456.