Copernicus Climate Change Service and ECV services ; future value of HydroGNSS

Joaquín Muñoz Sabater
European Centre for Medium-Range Weather Forecasts (ECMWF)

Climate Change

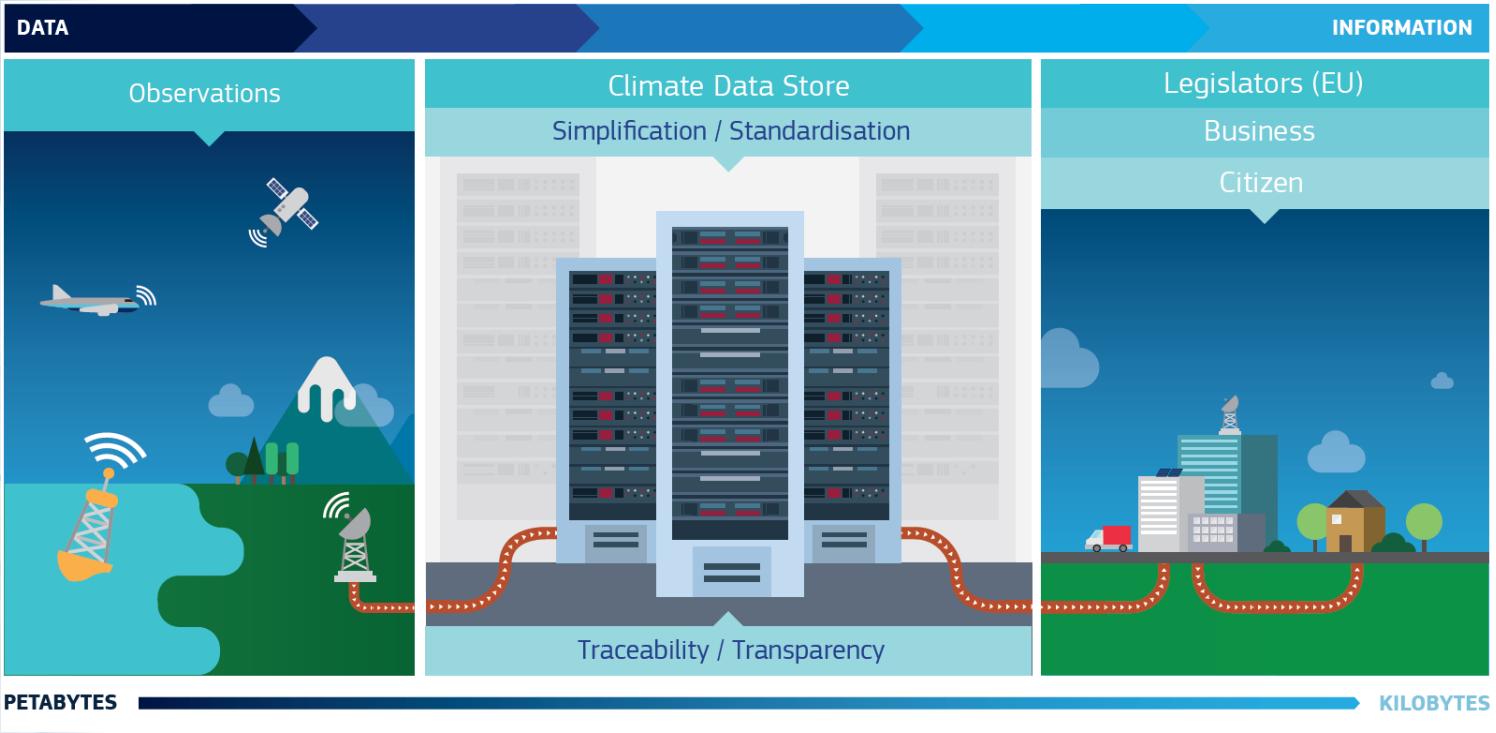
HydroGNSS Workshop
24-25 February 2022

Copernicus Europe's eyes on Earth | European Commission | ECMWF

Open, complete, free

Climate Change

What is the Copernicus Climate Change Service (C3S)?



authoritative quality-controlled data and information based on Earth Observation about the past, present and future climate;

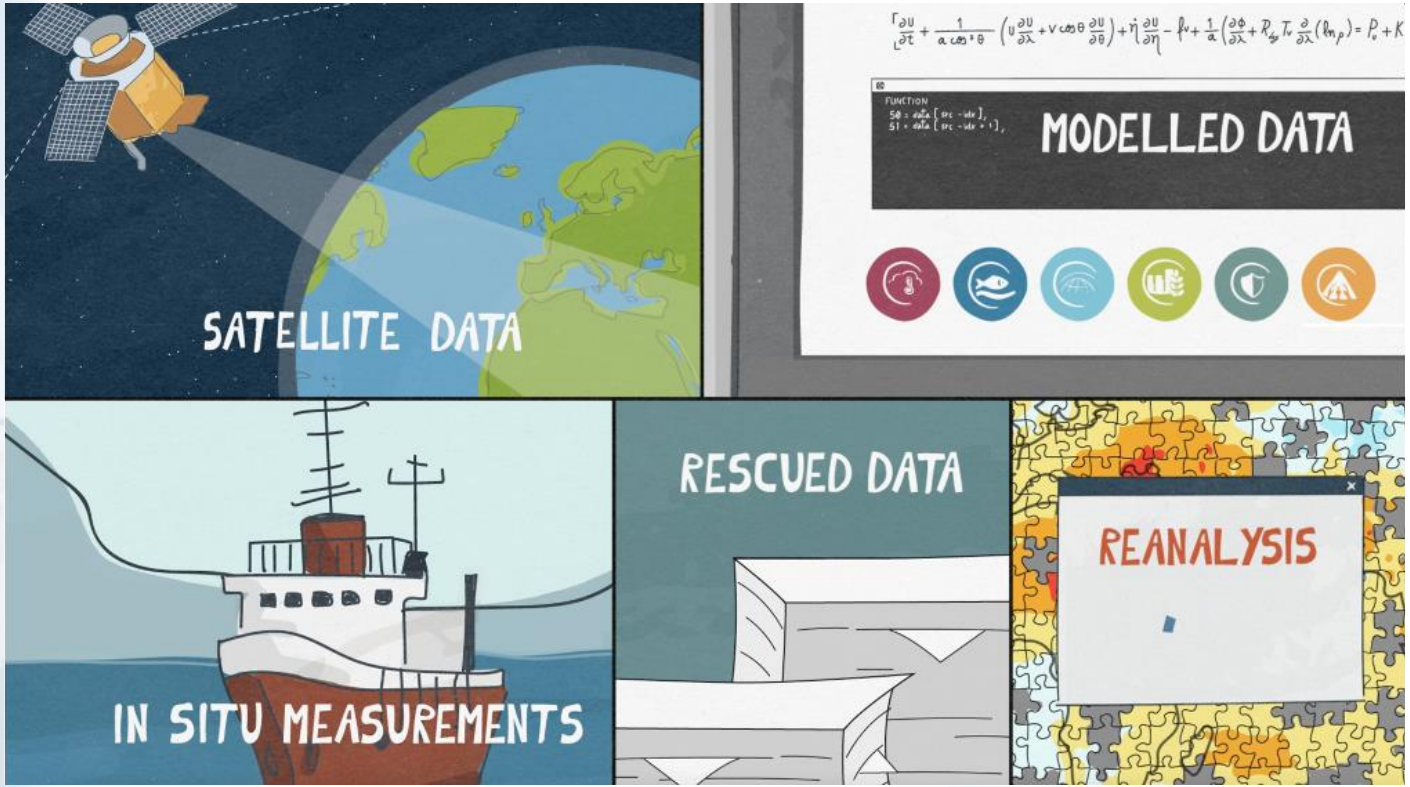
tools to inform climate change mitigation and adaptation strategies by policy makers and businesses;

examples of best practice in the use of climate information.

Copernicus | European Commission | ECMWF

Climate Change

The Climate Data Store – ‘A one stop shop for climate data’



Copernicus Europe's eyes on Earth | European Commission | ECMWF

Climate Change

Essential Climate Variables

We use historical observations from in-situ and satellite sensors to build <u>Climate Data Records of Essential Climate Variables (ECVs)</u>

Required to support the work of the UNFCCC and the IPCC

In total 54 ECVs

ECVs evolution in C3S (satellite data)

Climate Change

			C3S_312a							
				C3S_312b				C3S2_312		
		GCOS	2017	2018	2019	2020	2021	2022	2023	2024
Atmospheric physics										
	Precipitation	4.3.5			Lot 1			Atmospheric Physics		
	Surface Radiation Budget	4.3.6								
	Water Vapour	4.5.3								
	Cloud Properties	4.5.4								
	Earth Radiation Budget	4.5.5								
Atmospheric composition										
	Carbon Dioxide	4.7.1	Lot 6		Lot 2			Atmospheric Composition		
	Methane	4.7.2	Lot 6							
	Ozone	4.7.4	Lot 4							
	Aerosol	4.7.5	Lot 5							
Ocean										
	Sea Surface Temperature	5.3.1	Lot 3		Lot 3			Ocean		
	Sea Level	5.3.3	Lot 2							
	Sea ice	5.3.5	Lot 1							
	Ocean Colour	5.3.7								
Land hydrology & cryosphere										
	Lakes	6.3.4			Lot 4			Land Hydrology & Cryosphere		
	Glaciers	6.3.6	Lot 8							
	Ice sheets and ice shelves	6.3.7								
	Soil moisture	6.3.16	Lot 7							
Land biosphere										
	Albedo	6.3.9	Lot 9		Lot 5			Land Biosphere		
	Land Cover	6.3.10								
	Fraction of Absorbed Photosynthet	6.3.11	Lot 9							
	Leaf Area Index	6.3.12	Lot 9							
	Fire	6.3.15								
			2019	2018	2019	2020	2021	2022	2023	2024

Table 1: From proof-of-concept phase (9 Lots) to operations (5 Lots) of C3S ECV services. The column labelled GCOS shows the relevant section in the GCOS Status Report (GCOS-SR 2015).

Coordination with CM-SAF / ROM SAF / ESA CCI / Uni. Maryland / NASA / NOAA

Coordination with ESA-CCI and other national projects

Coordination with ESA-CCI

Coordination with ESA-CCI, GloboLakes, Arc-Lake, HydroWeb

Coordination with ESA-CCI, CGL, QA4ECV, LSA-SAF

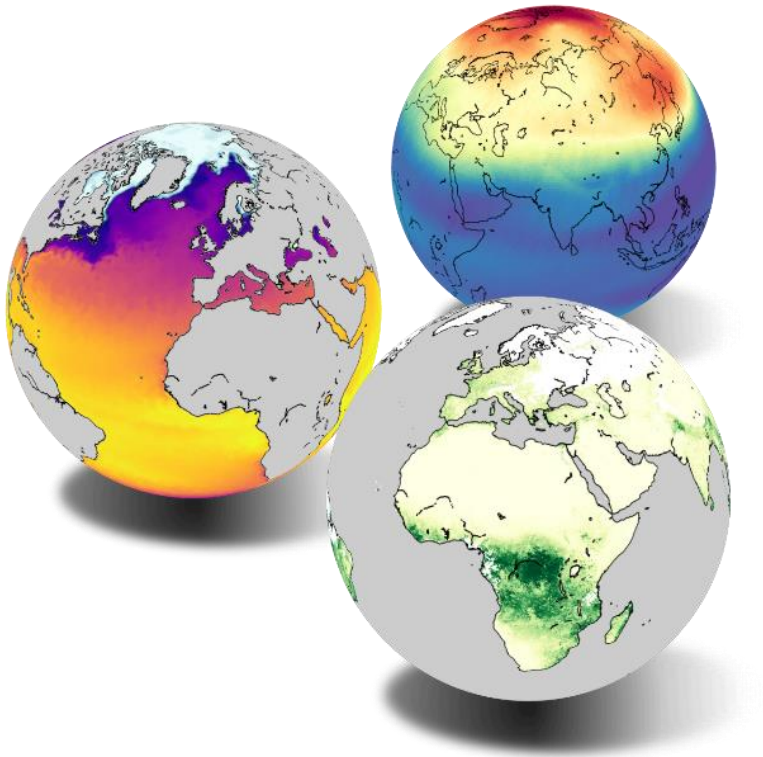
https://cds.climate.copernicus.eu/#!/search?text=satellite

European Commission

ECMWF

Requirements for ECV operational services

Climate Change



ECV products that are

- State-of-the-art
  - ***Coordination with ESA CCI, EUMETSAT/SAFs & other Copernicus services***
- Long-term, consistent , complete (CDR)
  - **Single/Multi sensor approach**
- Regularly extended in time (ICDR)
  - **Frequent updates of data records**
- Gridded, aggregated
  - **Meeting user requirements**
- *Accessible & Tracible*
  - ❑ *Access through the Climate Data Store*
    - ❑ ***Creation of adaptors, integration in CDS Toolbox***
  - ❑ *Documentation*

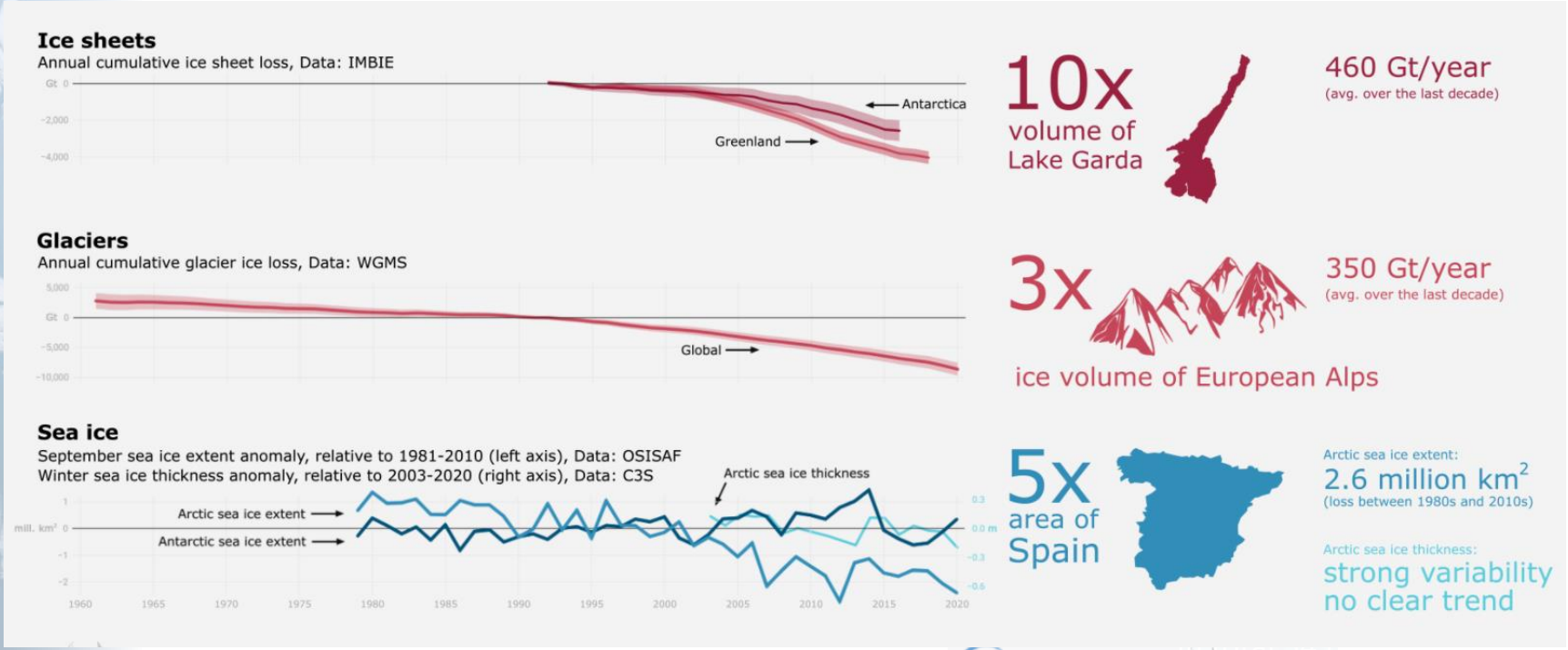
    Supporting documentation (ATBD, PQAD,PUGS, …)
  - ❑ *Evaluation and Assessment*
    - ❑ ***EQC, own QC procedures, benchmarking, cross-ECV consistency***
- User Support
  - ❑ ***Service desks opened for all services***

Copernicus Europe's eyes on Earth | European Commission | ECMWF

Climate Change

ECVs as climate indicators

Generation of long-term indicators based on observations, suited to understand changes in climate & key information tailored for policy makers

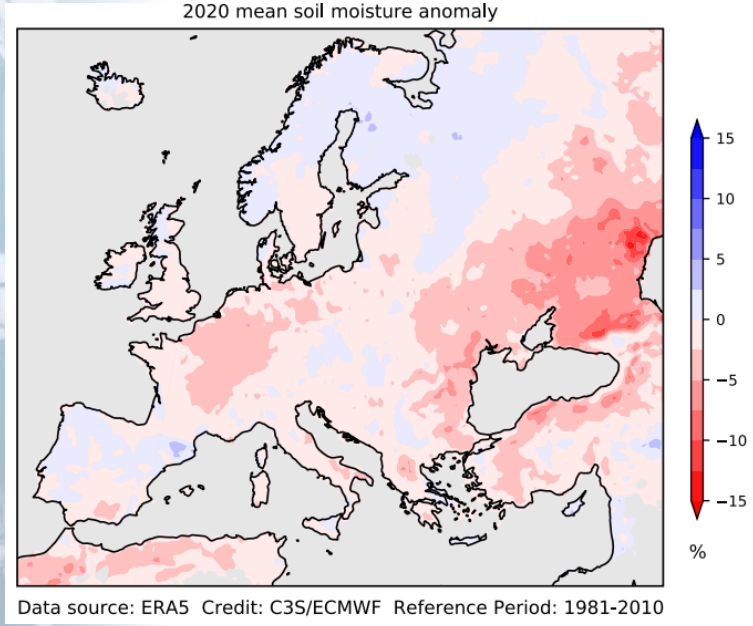


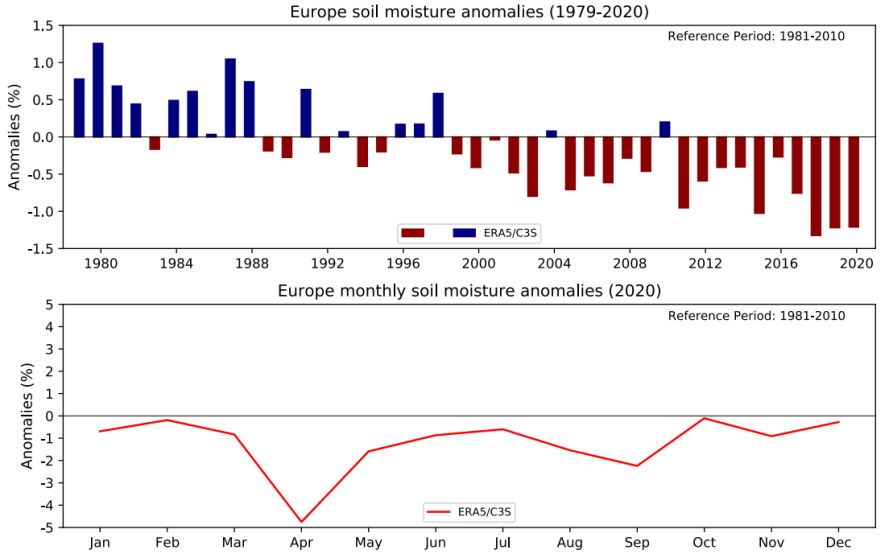
Copernicus Europe's eyes on Earth | European Commission | ECMWF

Climate Change

ECVs as climate indicators

Generation of long-term indicators based on observations, suited to understand changes in climate & key information tailored for policy makers





Future value of HydroGNSS

Climate Change

HydroGNSS is an ESA scout mission, intended to demonstrate the potential of Earth-reflected GNSS reflections to derive information on key terrestrial ECVs to understand the global hydrological cycle.

Soil Moisture

Inundation

Freeze/Thaw state

Forest Biomass

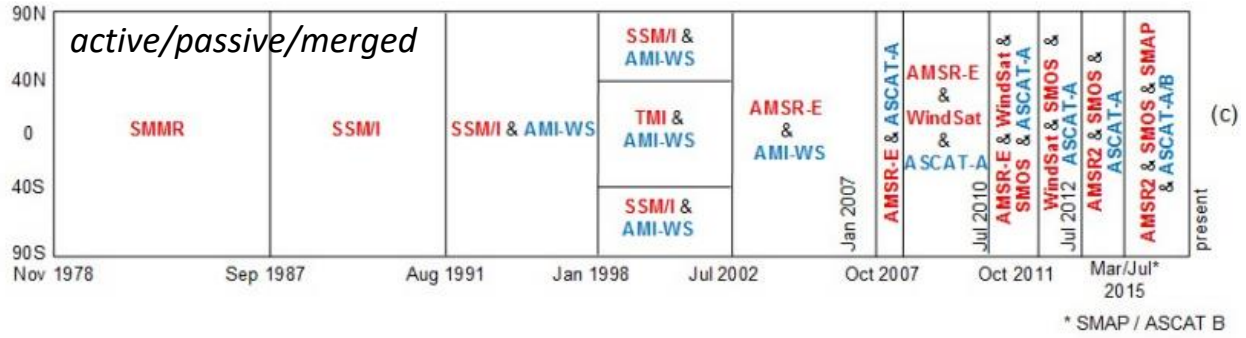
opernicus European Commission ECMWF

Future value of HydroGNSS

Climate Change

Soil Moisture is an existing ECV in the C3S portfolio of ECV products
The generation of soil moisture CDRs follows a multi-sensor approach;

ECV	ECV product	1970's 0 1 2 3 4 5 6 7 8 9	1980's 0 1 2 3 4 5 6 7 8 9	1990's 0 1 2 3 4 5 6 7 8 9	2000's 0 1 2 3 4 5 6 7 8 9	2010's 0 1 2 3 4 5 6 7 8 9	2020's 0 1 2 3 4 5
HYDROLOGY							
Lakes	Lake Surface Water Temperature						
Lakes	Lake Water Level						
Soil Moisture	Soil Moisture						



→ ESA SMOS and NASA SMAP have already provided years of valuable L-band data
→ New candidate Sentinel concepts are still far from launch
→ SMOS or SMAP follow-on missions are still potential projects
→ HydroGNSS could be used as a complementary mission, by filling an observational gap of L-band soil moisture measurements

Copernicus European Commission ECMWF

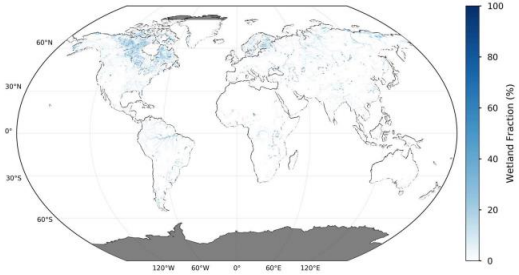
Future value of HydroGNSS

Climate Change

Surface inundation, freeze/thaw (permafrost) are not yet part of the C3S portfolio

Wetlands are provided as auxiliary invariant field of soil moisture products (based on GLWD).

PRODUCT	DEFINITION	FREQUENCY	RESOLUTION	REQUIRED MEASUREMENT UNCERTAINTY	STABILITY	STANDARDS/ REFERENCES
Surface soil moisture	Average water content in topmost soil layer (0-5 cm)	Daily	1-25 km	0.04 m3/m3	0.01m3/ m3/year	WMO (2008b)
Freeze/thaw	Flag indicating whether the land surface is frozen or not	Daily	1-25 km	90%	tbd	
Surface inundation	Flag indicating whether the land surface is inundated or not	Daily	1-25 km	90%	tbd	



Freeze/thaw (permafrost):

- Releases large amounts of GHG
- Reinforces global warming feedback loop
- Active layer deepens & threatens wetlands
- Impacts on terrain stability, coastal erosion, surface and subsurface water, the carbon cycle and vegetation development

Inundation/wetlands

- Affects run-off and flood events
- Impact ecological systems & biodiversity
- Source of CH4

→ For their relevance to climate, C3S aims at including these products as part of the ECV portfolio

In total 54 E

Copernicus | European Commission | ECMWF

Climate Change

Future value of HydroGNSS

Biomass is also not yet part of the C3S portfolio.
Forest biomass can be used in combination with LAI/fAPAR to assess the state of the vegetation.

- The photosynthesis process withdraws CO2 from the atmosphere and stores carbon in vegetation;
- Vegetation cover can influence directly on local, regional and global climate. In particularly it has a direct impact on air temperature and water vapour.

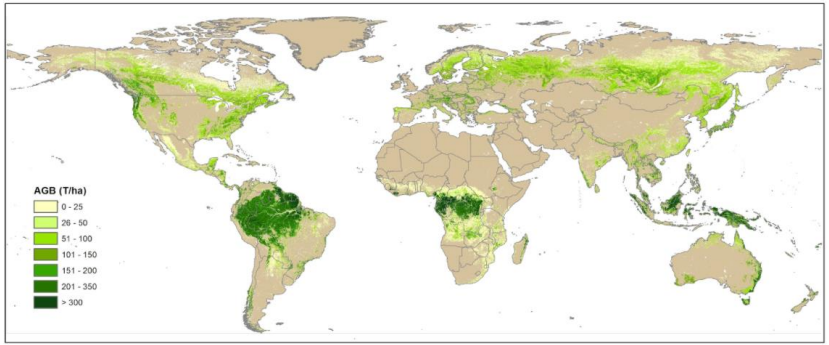


Figure: GEOCARBON global forest above-ground biomass map for 2010 at 0.01° (lucid.wur.nl). Forest areas according to the GLC2000 map (lucid.wur.nl).

→ HydroGNSS could be used as a complementary mission to increase observations sensitive to the state of vegetation. In particular, to the ESA p-band mission Biomass, providing data in areas where Biomass is not operative.

Climate Change

Conclusions

- CDRs of ECVs provide key information for policy makers on the state of the climate through climate observed-based indicators

- Currently C3S provides services for 22 ECVs (access through the CDs, documentation, user support, quality control, etc.), among them soil moisture.

- C3S aims at increasing the offer of ECVs (AGB and permafrost are two good candidates)

- HydroGNSS will be beneficial for the C3S ECV programme by:
  a) Demonstrating the **feasibility of L-band satellite navigation signals** to monitor Earth's key variables of the water cycle;
  b) Providing a **forward-scattering derived product**, complementary to more common backscattering or passive radiative measurements;
  c) Complementing other's mission measurements and increasing density of observations, thus increasing the spatio-temporal resolution of potential Level-4 (fusion) products;
  d) Offering a **low-cost sustainable space-based system** to continue provision of ECV measurements;

In total 54 E

Copernicus European Commission ECMWF

Implemented by ECMWF as part of The Copernicus Programme

News Events Press Tenders Help & Support Search

Copernicus Climate Change Service

About Us What we do Data

close

European Commission | Copernicus | IMPLEMENTED BY ECMWF

Climate Change

We provide authoritative information about the past, present and future climate, as w enable climate change mitigation an strategies by policy makers and busi

https://climate.copernicus.eu

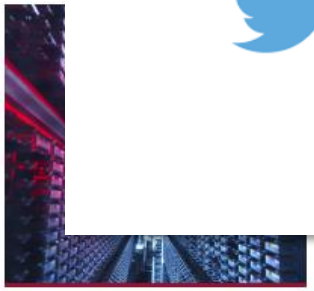
@CopernicusECMWF

@CopernicusEU

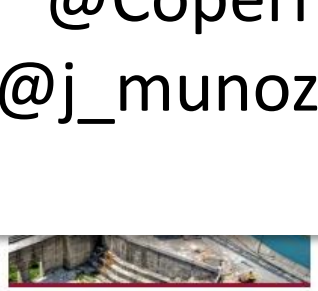
@j_munoz_sabater

Key products and services

Climate bulletins



Climate Data Store



Data in action

future assessments of the environment.

In focus