Climate Change Service

Status of Earth Observation ECVs

Climate Change

The C3S & ECV teams
Presented by: Joaquín Muñoz Sabater

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European Commission | ECMWF
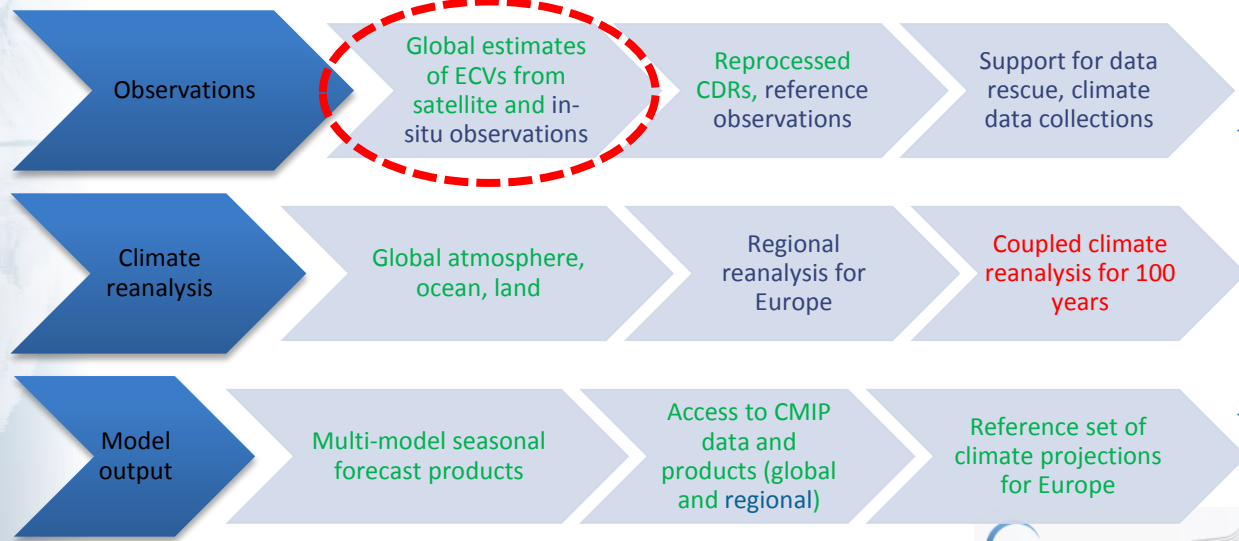
ECV products for CDS

- Initial set of ~ 30 ECVs planned for stages II and III
- Products will become available via the CDS during 2017/2018
- Additional/alternative ECV products to follow (e.g. NOAA CDRs, GPCP, …)

Action engaged

In preparation
(PIN or ITT out)

C3S_312a	ECV products from observations	9 contracts, 12 ECVs	Started 2016Q4
C3S_311a	In situ observations (Lot 4)	High-resolution ECV products for Europe	Likely start 2017Q1
C3S_312b	ECV products from observations	Additional 8-10 ECVs	ITT in preparation
ERA5	Global atmospheric reanalysis	Atmosphere, land, sea state	Started 2016Q1
ORA5	Global ocean reanalysis	Ocean, sea ice	Complete

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	GCOS Status Report	C3S Technical Annex	CDS	Reanalysis	Observations
Atmosphere (surface)					
Air temperature	4.3.1	Stage III	2017	ERA5	C3S_311a
Wind speed and direction	4.3.2	Stage II	2017	ERA5	C3S_311a
Water vapour	4.3.3	Stage II	2017	ERA5	C3S_311a
Pressure	4.3.4		2017	ERA5	C3S_311a
Precipitation	4.3.5	Stage II	2017	ERA5	C3S_311a
Surface radiation budget	4.3.6	Stage II	2017	ERA5	C3S_312b
Atmosphere (upper air)					
Temperature	4.5.1		2017	ERA5	
Wind speed and direction	4.5.2	Stage II	2017	ERA5	
Water vapour	4.5.3		2017	ERA5	C3S_312b
Cloud properties	4.5.4	Stage II	2017	ERA5	C3S_312b
Earth radiation budget	4.5.5	Stage II	2017	ERA5	C3S_312b
Atmosphere (composition)					
Carbon dioxide	4.7.1	Stage II	2017		C3S_312a
Methane	4.7.2	Stage II	2017		C3S_312a
Other long-lived greenhouse gases	4.7.3	Stage III	2018		C3S_312b
Ozone	4.7.4	Stage II	2017	ERA5	C3S_312a
Aerosol	4.7.5	Stage II	2017		C3S_312a

Action engaged

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Status for Oceanic ECVs

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	GCOS Status Report	C3S Technical Annex	CDS	Reanalysis	Observations
Ocean (physics)					
Sea surface temperature	5.3.1	Stage II	2017	ORA5	C3S_312a
Subsurface temperature	5.4.1	Stage II	2017	ORA5	
Sea surface salinity	5.3.2		2018	ORA5	
Subsurface salinity	5.4.2	Stage III	2018	ORA5	
Sea surface currents	5.3.6		2018	ORA5	
Subsurface currents	5.4.3	Stage III	2018	ORA5	
Sea level	5.3.3	Stage II	2017	ORA5	C3S_312a
Sea state	5.3.4		2018	ERA5	
Sea ice	5.3.5	Stage II	2017	ORA5	C3S_312a
Ocean surface stress	NEW		2018	ORA5	
Ocean surface heat flux	NEW		2018	ORA5	
Ocean (biochemistry)					
Inorganic carbon	NEW		2018		C3S_312b
Ocean colour	5.3.7	Stage II	2018		C3S_312b

■ **Action engaged**

■ **In preparation (PIN or ITT out)**

Status for Terrestrial ECVs

	GCOS Status Report	C3S Technical Annex	CDS	Reanalysis	Observations
Land (hydrology)					
Lakes	6.3.4	Stage III	2018		C3S_312b
Soil moisture	6.3.16	Stage III	2017	ERA5	C3S_312a
Land (cryosphere)					
Snow	6.3.5	Stage II	2017	ERA5	
Glaciers	6.3.6	Stage II	2017		C3S_312a
Ice sheets and ice shelves	6.3.7	Stage II	2018		C3S_312b
Permafrost	6.3.8	Stage III	2018		C3S_312b
Land (biosphere)					
Albedo	6.3.9	Stage II	2017		C3S_312a
Land cover (including vegetation type)	6.3.10	Stage III	2018		C3S_312b
Fraction of absorbed photosynthetically	6.3.11	Stage II	2017		C3S_312a
Leaf area index	6.3.12	Stage III	2017		C3S_312a
Fire	6.3.15	Stage II	2018		C3S_312b

Action engaged

In preparation (PIN or ITT out)

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- **All 9 ECV contracts running & services being implemented,**
- **Each lot formed by an European consortium,**
- **Complement with other Copernicus Services and European research efforts (keep the link between R&D in ESA CCI and operational production)**
- **CDS will start to be populated with ECV products from April/May and gradually increasing**

- **All ECV services offering L3 and L4 user support**
- **Data products will be freely available**
- **ECVs will come with estimate of uncertainty**
- **Traceable to the source, accessible documentation through the CDS**

→ **Thematic fair 3 devoted to Earth Observations**

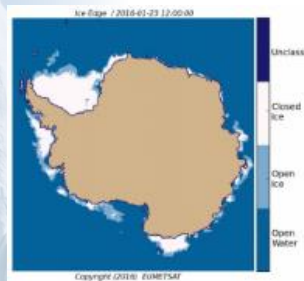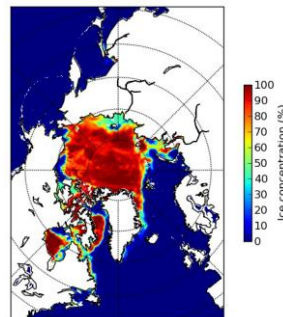**Climate Change**

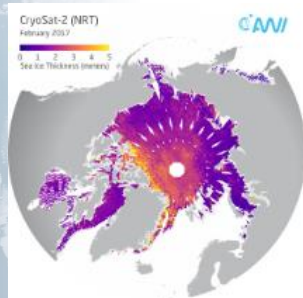## Complementary with EUMETSAT OSI SAF & ESA CCI

Sea Ice Edge:

Distinguish between Open water, Open Ice and Closed Ice
Global coverage
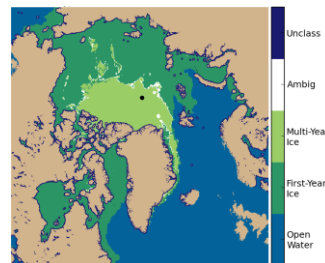10 km resolution

Sea Ice concentration:

OSI SAF CDR (OSI-409) and ICDR (OSI-430)
Global coverage
10 km resolution
Includes uncertainty estimates

Sea Ice Thickness:

Nothern Hemisphere
25 km resolution
Includes uncertainty estimates

Sea Ice Type:

Distinguish between First-Year Ice and Multi-year Ice
Nothern Hemisphere
10 km resolution

- The ECV is derived from **satellite altimetry**

- Strong **interaction and complementarity** with the **Copernicus Marine Service (CMEMS):**
  - **C3S**: retrieval of **long-term variability** and focus on the **Mean Sea Level stability** with a stable altimeter constellation in time.
  - **CMEMS**: focus on the **mesoscale estimation** with all satellites missions available to provide the best sampling.

- Regions of interest: **global ocean**, **Med. sea** and **Black sea**
- **Type of products:**
  Gridded daily maps:
  1/4° (global) and 1/8° (Med. And Black seas) of:
  - **Absolute Dynamic Topography**
  - **Sea Level Anomalies**
  - **Geostrophic velocities**

- The existing Sea Level ECV will be first delivered in April 2017 and the record will be regularly updated.
- A **full reprocessing** will be delivered in March 2018
- **Interactions** with **spaces agencies** will ensure the **service quality and evolution.**
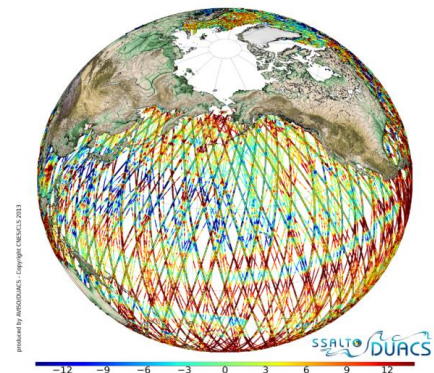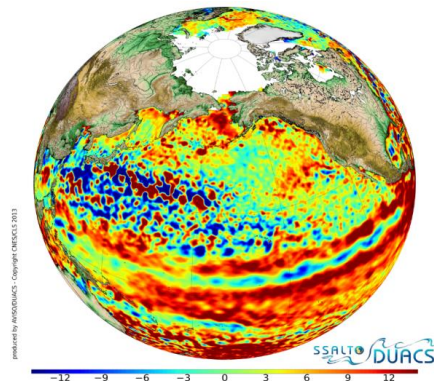
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- The project will setup a pre-operational service to generate L2, L3 and L4 SST products, covering a range of user requirements

- Inheritance from ESA's SST CCI project:
  - Several team members involved in both projects
  - SST CDR service will broker the CCI v2 dataset for the CDS
  - SST CDR service will operationalise components from the CCI production system

- SST ICDR production will start in May 2017 with monthly updates, data ~ 6 months old initially

- Aim is to generate SST ICDR daily with timeliness < 5 days by March 2018

October 2015
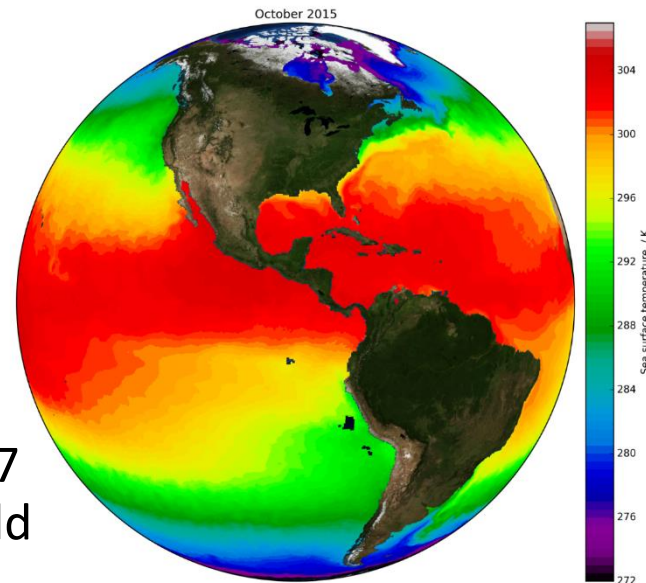
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Lot4: Ozone

Royal Belgian Institute for Space Aeronomy (BIRA-IASB)

Ozone Production Service

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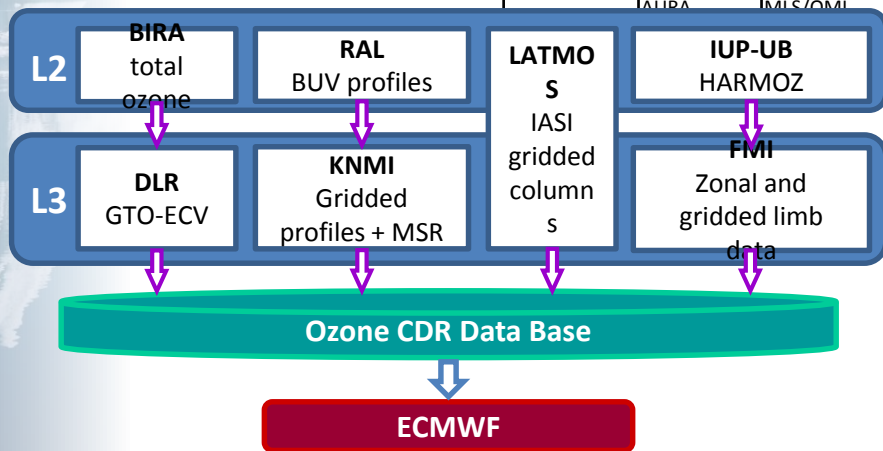## Main platforms and sensors

Agency	Satellite platform	Sensor	Time period																				
			96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
ESA	ERS-2	GOME																				
	ENVISAT	SCIAMACHY																				
		GOMOS																					
		MIPAS																					
EUMETSAT	METOP-A	GOME2-A																				
		IASI-A																					
	METOP-B	GOME2-B																					
		IASI-B																					
SNSB CSA	ODIN	OSIRIS																				
		SMR																					
CSA	SCISAT	ACE																				
NASA	ERBS	SAGE-2	84																			
	UARS	HALOE	91																			
	TIMED	SABER																				
	AURA	MLS/OMI																				

The distributed ozone production system

L2
- **BIRA** total ozone
- **RAL** BUV profiles
- **LATMOS** IASI gridded columns
- **IUP-UB** HARMOZ

L3
- **DLR** GTO-ECV
- **KNMI** Gridded profiles + MSR
- **FMI** Zonal and gridded limb data

Ozone CDR Data Base

ECMWF

Data products

25 ozone data products from various satellites and sensors including
- O_3 total column
- O_3 tropospheric column
- O_3 vertical profile (nadir)
- O_3 vertical profile (limb)

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Aerosol Production Service

Variable	Instrument(s)	Horizontal resolution	Vertical resolution	Revisit, period	accuracy	stability
AOD Dust AOD	ATSR-2/AATSR/ SLSTR POLDER (land, 60S-60N) MERIS IASI (global)	10x10km, 1°x1°	-	6 days, 1995-2018 3 days, 2005-2013 3 days, 2002-2012 0.5 days, 2007-2018	60% within max(0.03; 10%) 68% within max(0.03;10%) TBD (0.1) 0.12	<0.015/dec TBD TBD TBD
SSA	POLDER (land, 60S-60N)	10x10km, 1°x1°	-	6 days, 2005-2013	0.05	TBD
ALH	POLDER (land, 60S-60N) IASI (dust only)	10x10km, 1°x1°	-	6 days, 2005-2013 0.5 days, 2007-2018	1km TBD (2km)	TBD TBD
AEP	GOMOS (10-35km)	5°(lat)x60°(lon)	1km	5 day, 2002-2012	10% (part of altitude range)	TBD
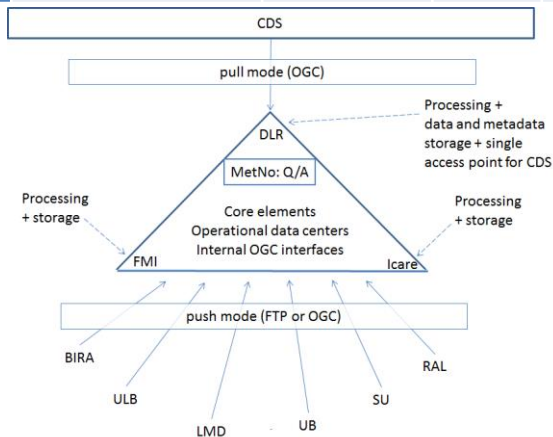
Distributed Processing and Archiving Infrastructure

Data products:
- (Dust) Aerosol Optical Depth
- Single Scattering Albedo
- Aerosol Layer Height
- Aerosol Extinction Profile

quarterly extension

CDS

pull mode (OGC)

DLR

Processing + data and metadata storage + single access point for CDS

MetNo: Q/A

Processing + storage

Core elements
Operational data centers
Internal OGC interfaces

Processing + storage

FMI

Icare

push mode (FTP or OGC)

BIRA

ULB

LMD

UB

SU

RAL

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Lot6: Greenhouse gases

University of Bremen (IUP-UB)

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Pre-cursor products (ESA GHG-CCI):

GHG-CCI CRDP#4

Carbon Dioxide (CO_2) - NH (0°-60°N)

SCIAMACHY/ENVISAT: WFMD(WFM-DOAS) BESD
TANSO/GOSAT: SRFP(RemoTeC) OCFP(UoL-FP)

XCO_2 [ppm]

Michael.Buchwitz@iup.physik.uni-bremen.de 3-Nov-2016 cmp:direct filter:all
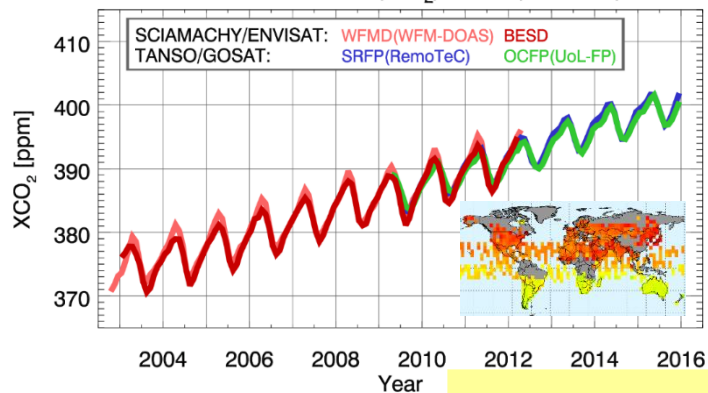
Methane (CH_4)
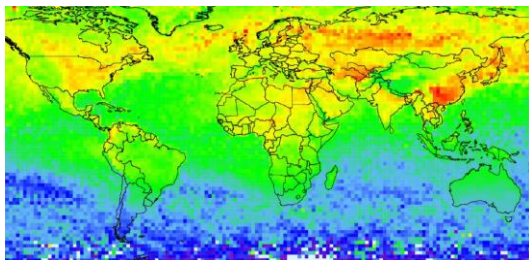
CCI products extended for C3S

Data products:
- Column-averaged CO_2 and CH_4
- Mid/upper tropospheric CO_2 and CH_4

- Level 2, merged L2, merged L3

Satellite sensors:
- SCIAMACHY, GOSAT, IASI, …

Universität Bremen

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Lot7: Soil moisture

Earth Observation Data Centre for Water Resources Monitoring (EODC)

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Service Aims:

- **Maximize** the **temporal/spatial sampling**, **accuracy**, **stability** and **length** of the TCDR based on available observations and state-of-the-art capability and algorithms
- **Extend** the **scope** of the ESA CCI SM processor towards fuller operational capacity
- **Implement** a Climate Data Record Production System (**CPS**)

Product Overview:

- Product **derived** from **active** and **passive** satellite systems
- **Volumetric Surface Soil Moisture** (m3/m3, % of saturation for active merged product)
- **25km** Resolution, **Global** Coverage
- **Daily** Images, 10 day **Update**
- **Building** on the legacy of **ESA's CCI SM** project
- **Extending** current **37 year**, global, TCDR
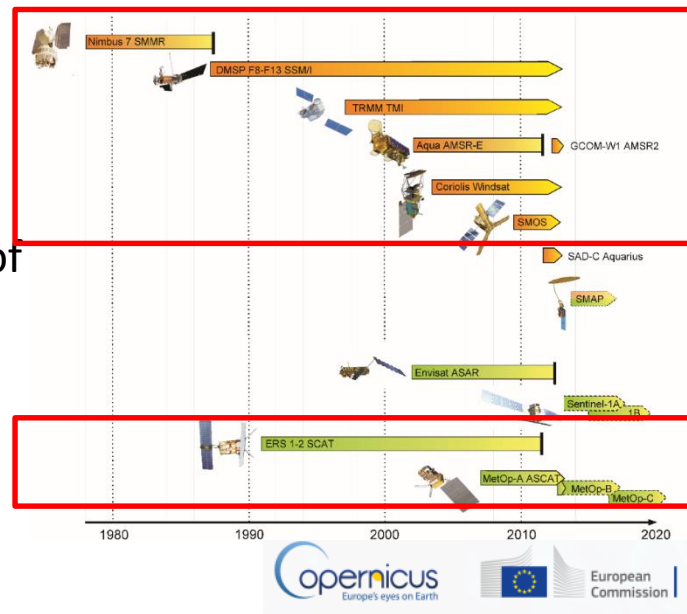
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Lot8: Glaciers

University of Zurich (UZH)

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- **A globally distributed ECV and monitoring concept**
  - Glaciers occur globally and have a wide range of surface/dynamic characteristics
  - Their monitoring is based on a global network of observers and has a >100 yr tradition
  - RS data processing is also globally distributed (GLIMS) & based on scene-by-scene analysis
  - GCOS accuracy reqs. can only be met when manual editing is applied (debris, clouds)

- **The Glacier Distribution and Change Service in C3S is based on**
  - Glacier mapping & change assessm. with optical satellite data (L8/S2) in key regions
  - Utilizing latest DEMs (TanDEM-X, Arctic DEM) to obtain glacier-specific elevation changes
  - Enriching and improving pre-existing datasets (GLIMS/RGI & WGMS database)
  - Collecting and integrating already published data from the community (reach out)

- **Developing of adaptors for integration of glacier data in the CDS**
  - Step 1: Adaptor 1 & 2 brings existing RGI (inventory) & FoG (WGMS) databases into the CDS
  - Step 2: Updating the CDS with new datasets (new, enriched, and collected products)
  - Step 3: Adaptor 3 merges extents & elevation changes for improved calculation of sea level

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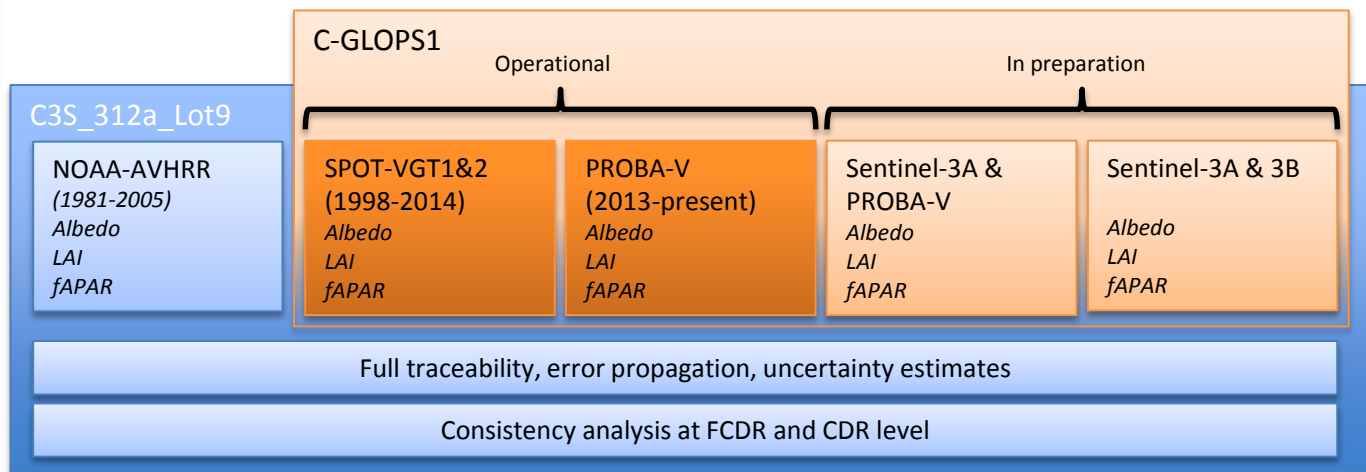# Lot9: LAI, fAPAR, albedo

Flemish Institute for Technological Research (VITO)

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C-GLOPS1

Operational · In preparation

C3S_312a_Lot9

| NOAA-AVHRR *(1981-2005)* *Albedo* *LAI* *fAPAR* | SPOT-VGT1&2 (1998-2014) *Albedo* *LAI* *fAPAR* | PROBA-V (2013-present) *Albedo* *LAI* *fAPAR* | Sentinel-3A & PROBA-V *Albedo* *LAI* *fAPAR* | Sentinel-3A & 3B *Albedo* *LAI* *fAPAR* |

Full traceability, error propagation, uncertainty estimates

Consistency analysis at FCDR and CDR level

- **Maximize the exploitation of the scientific and operational expertise within the Copernicus Global Land Service** (C-GLOPS) and build further on its surface albedo, LAI and fAPAR 1km data sets (1998-present), through bridging the gap with the GCOS and C3S user requirements (traceability, consistency).

- **Extend these time series to the past** using NOAA-AVHRR GAC data (4km, from 1981) and apply the same methods as in C-GLOPS to derive surface albedo, LAI and fAPAR. Here, the FCDR will be processed from level 1B data, such that the products will have full traceability.

- **Secure continuation** of the products by linking with C-GLOPS. The evolutions on these datasets will be reviewed and input on specific C3S user requirements will be provided, such that implementations between C3S and C-GLOPS can be harmonized and only be done once.