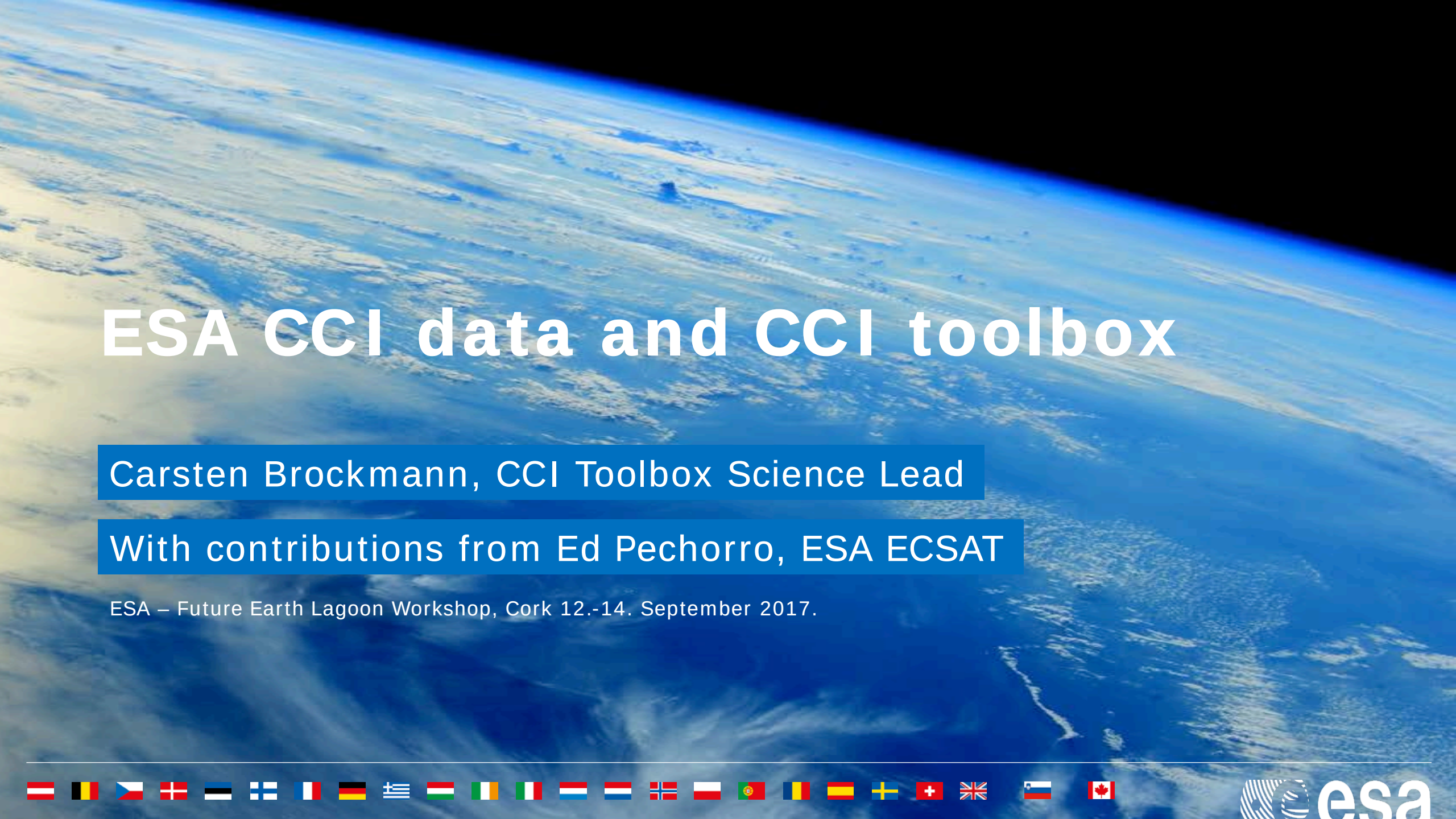
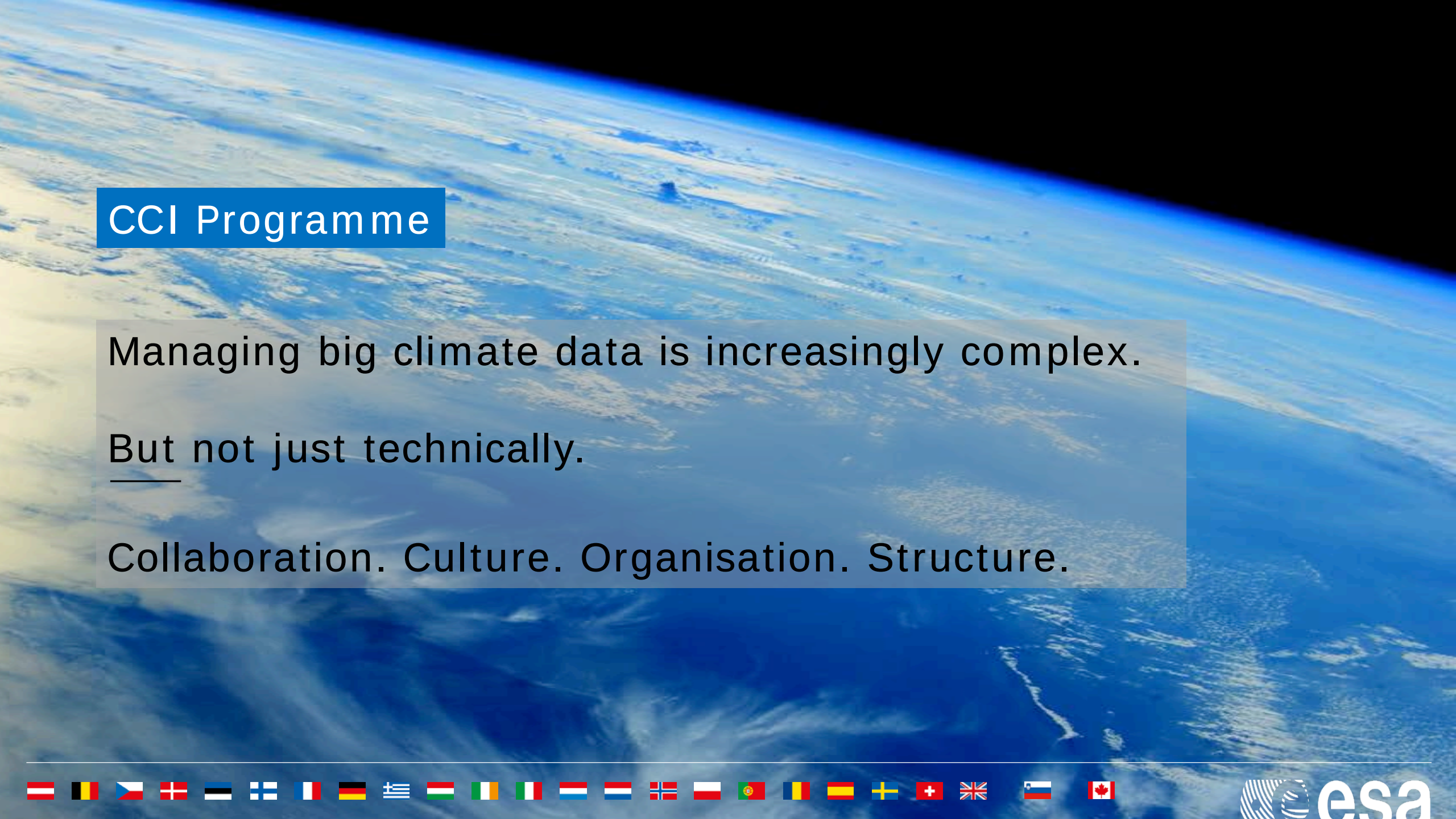


ESA CCI data and CCI toolbox

Carsten Brockmann, CCI Toolbox Science Lead

With contributions from Ed Pechorro, ESA ECSAT

ESA – Future Earth Lagoon Workshop, Cork 12.-14. September 2017.

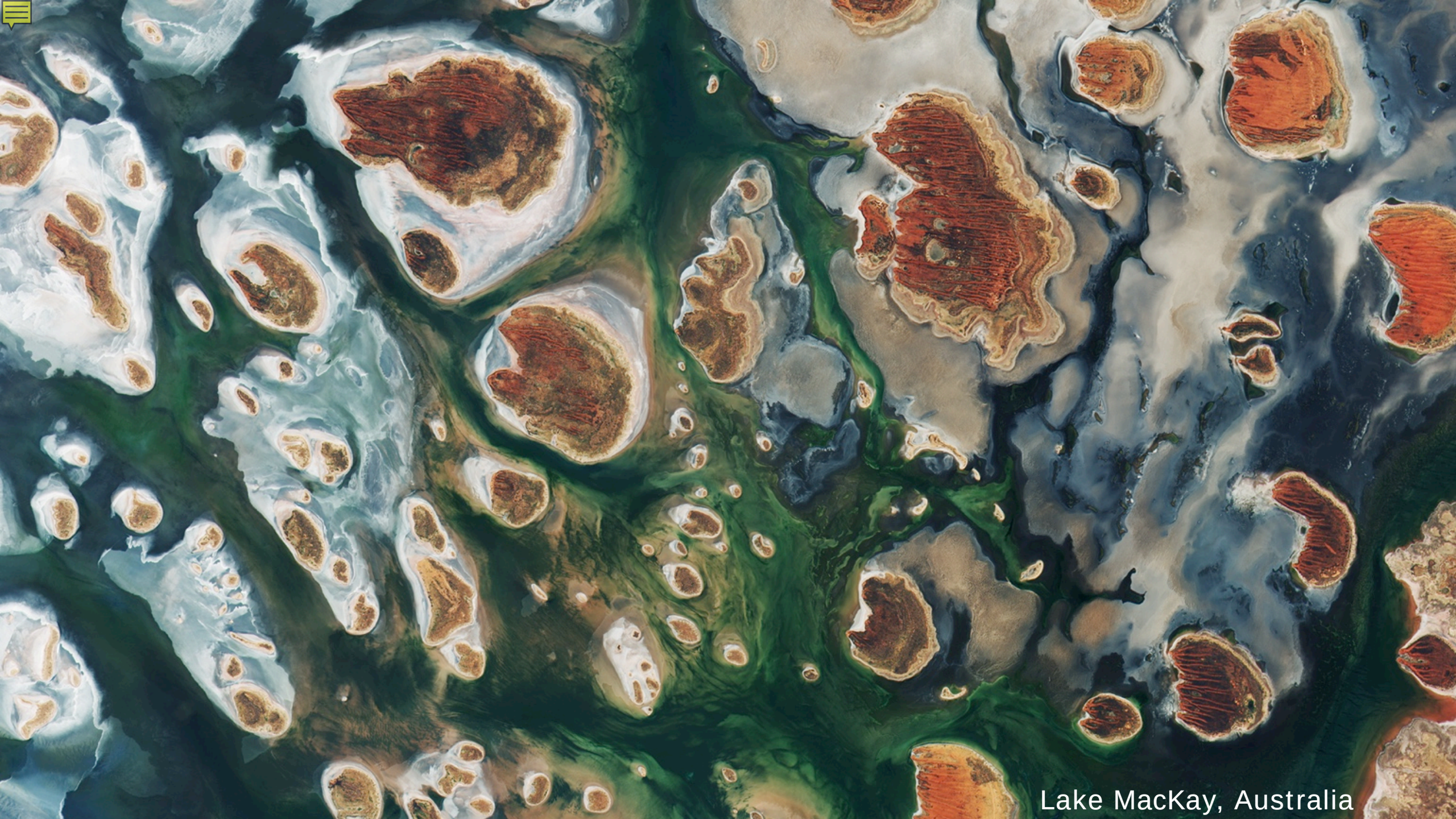


CCI Programme

Managing big climate data is increasingly complex.

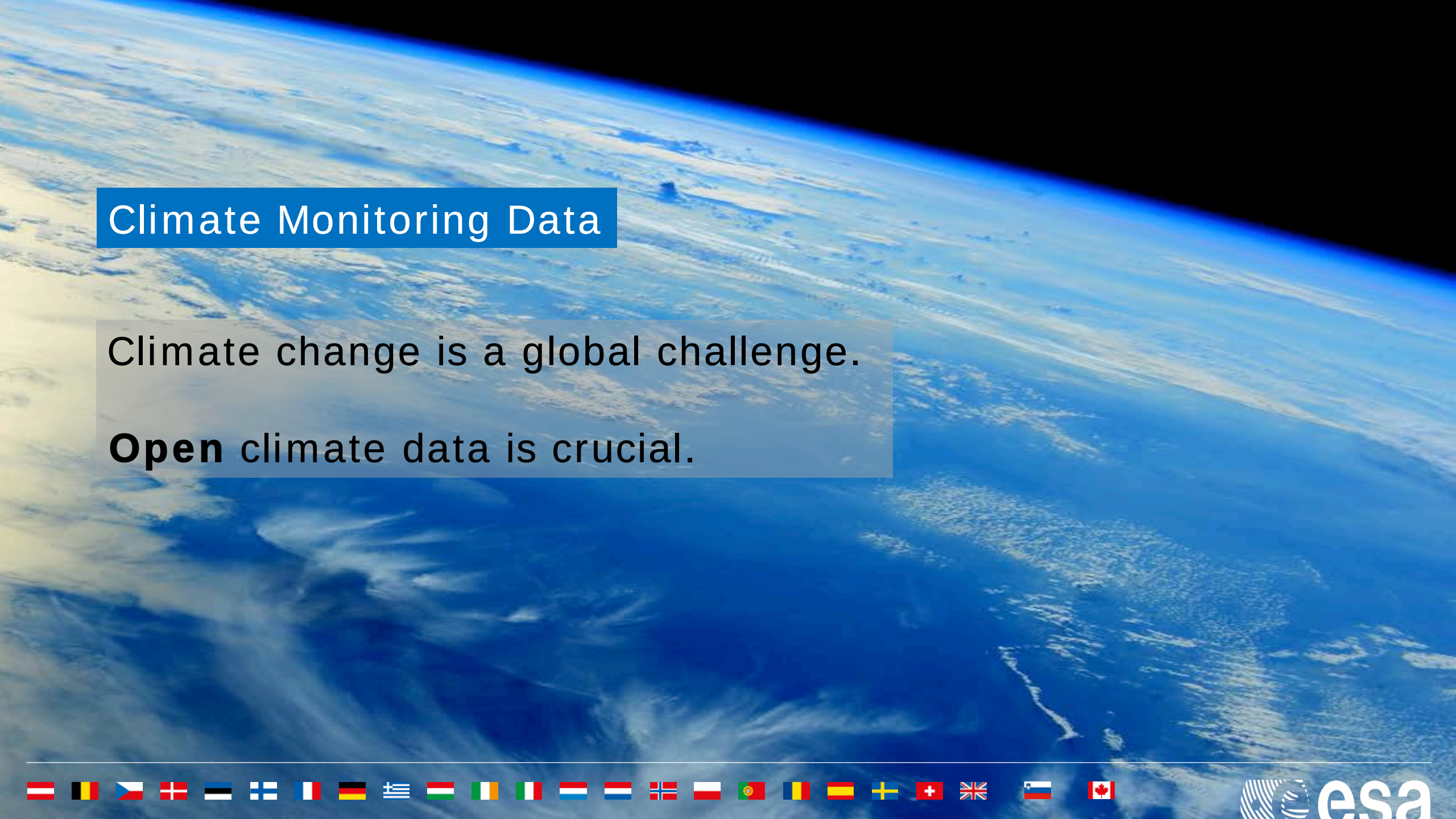
But not just technically.

Collaboration. Culture. Organisation. Structure.


Lake MacKay, Australia


Tonga, Pacific


Karavasta Lagoon, Albania



Climate Monitoring Data

Climate change is a global challenge.

Open climate data is crucial.

ESA Climate Change Initiative (CCI)

The objective of the Climate Change Initiative (CCI) is to realise the full potential of the long-term global Earth Observation archives that ESA together with its Member States have established over the last 30 years, as a significant and timely contribution to the Essential Climate Variable databases required by the United Nations Framework Convention on Climate Change (UNFCCC).

ESA Climate Change Initiative (CCI)

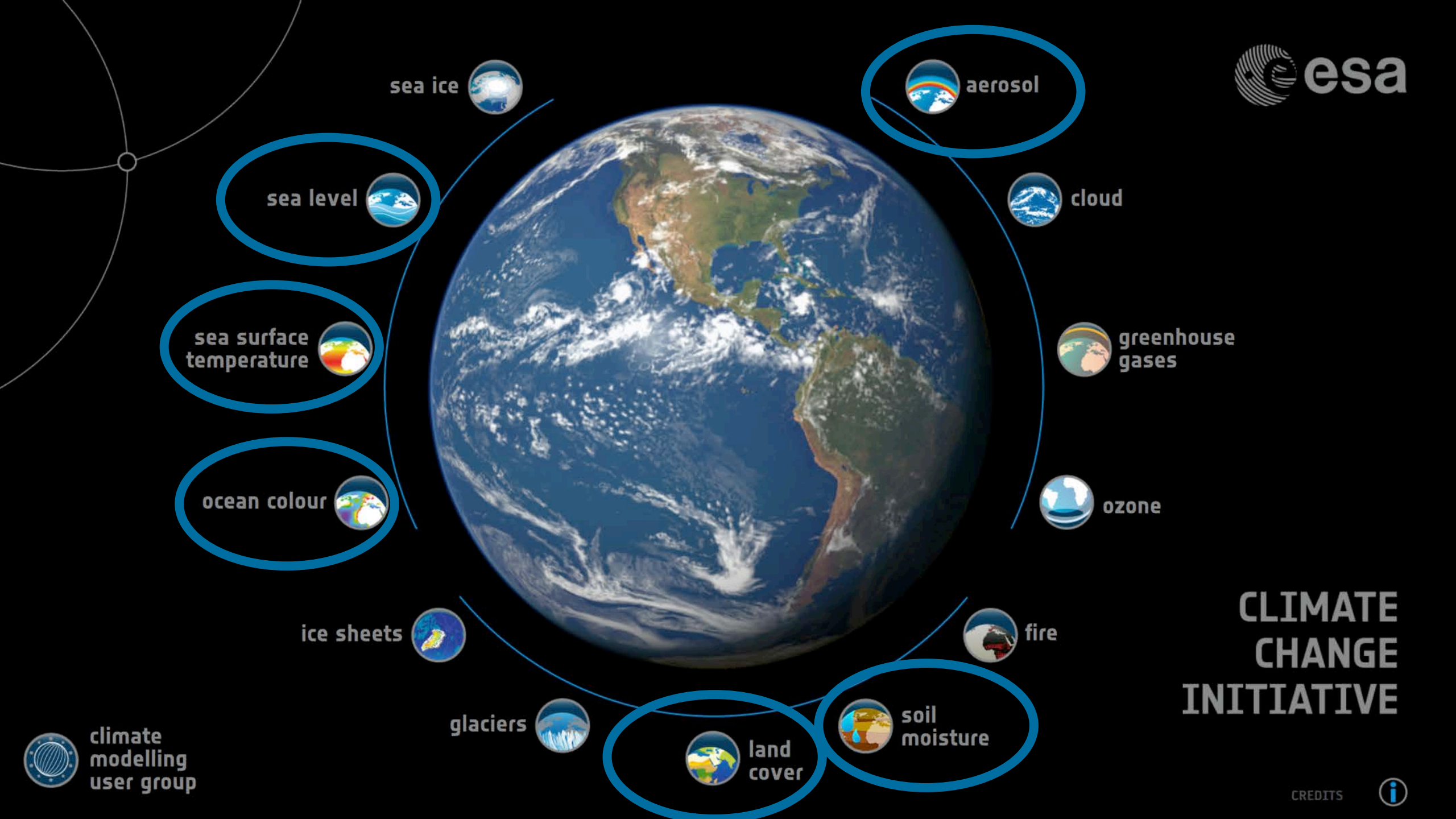
16 projects

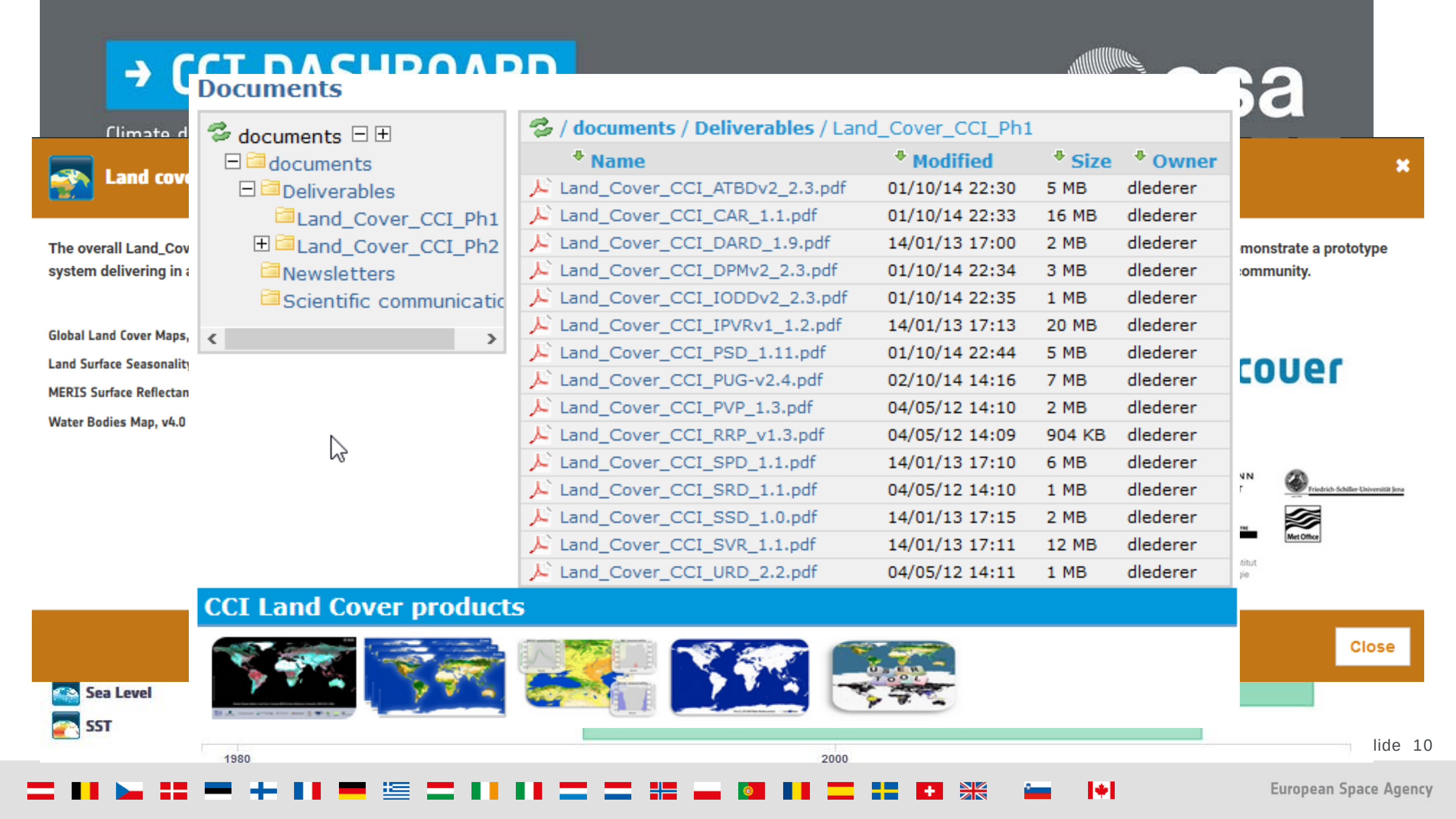
>300 scientists

>100 organisations

18 countries

Since 2009


esa
sea ice
aerosol
sea level
cloud
sea surface temperature
greenhouse gases
ocean colour
ozone
ice sheets
fire
glaciers
land cover
soil moisture
CLIMATE CHANGE INITIATIVE
climate modelling user group
CREDITS


Documents
documents
documents
Deliverables
Land_Cover_CCI_Ph1
Land_Cover_CCI_Ph2
Newsletters
Scientific communicatic
/ documents / Deliverables / Land_Cover_CCI_Ph1
Name
Modified
Size
Owner
Land_Cover_CCI_ATBDv2_2.3.pdf 01/10/14 22:30 5 MB dlederer
Land_Cover_CCI_CAR_1.1.pdf 01/10/14 22:33 16 MB dlederer
Land_Cover_CCI_DARD_1.9.pdf 14/01/13 17:00 2 MB dlederer
Land_Cover_CCI_DPMv2_2.3.pdf 01/10/14 22:34 3 MB dlederer
Land_Cover_CCI_IODDv2_2.3.pdf 01/10/14 22:35 1 MB dlederer
Land_Cover_CCI_IPVRv1_1.2.pdf 14/01/13 17:13 20 MB dlederer
Land_Cover_CCI_PSD_1.11.pdf 01/10/14 22:44 5 MB dlederer
Land_Cover_CCI_PUG-v2.4.pdf 02/10/14 14:16 7 MB dlederer
Land_Cover_CCI_PVP_1.3.pdf 04/05/12 14:10 2 MB dlederer
Land_Cover_CCI_RRP_v1.3.pdf 04/05/12 14:09 904 KB dlederer
Land_Cover_CCI_SPD_1.1.pdf 14/01/13 17:10 6 MB dlederer
Land_Cover_CCI_SRD_1.1.pdf 04/05/12 14:10 1 MB dlederer
Land_Cover_CCI_SSD_1.0.pdf 14/01/13 17:15 2 MB dlederer
Land_Cover_CCI_SVR_1.1.pdf 14/01/13 17:11 12 MB dlederer
Land_Cover_CCI_URD_2.2.pdf 04/05/12 14:11 1 MB dlederer
CCI Land Cover products
Close
Sea Level
SST
1980
2000

Land cover legend

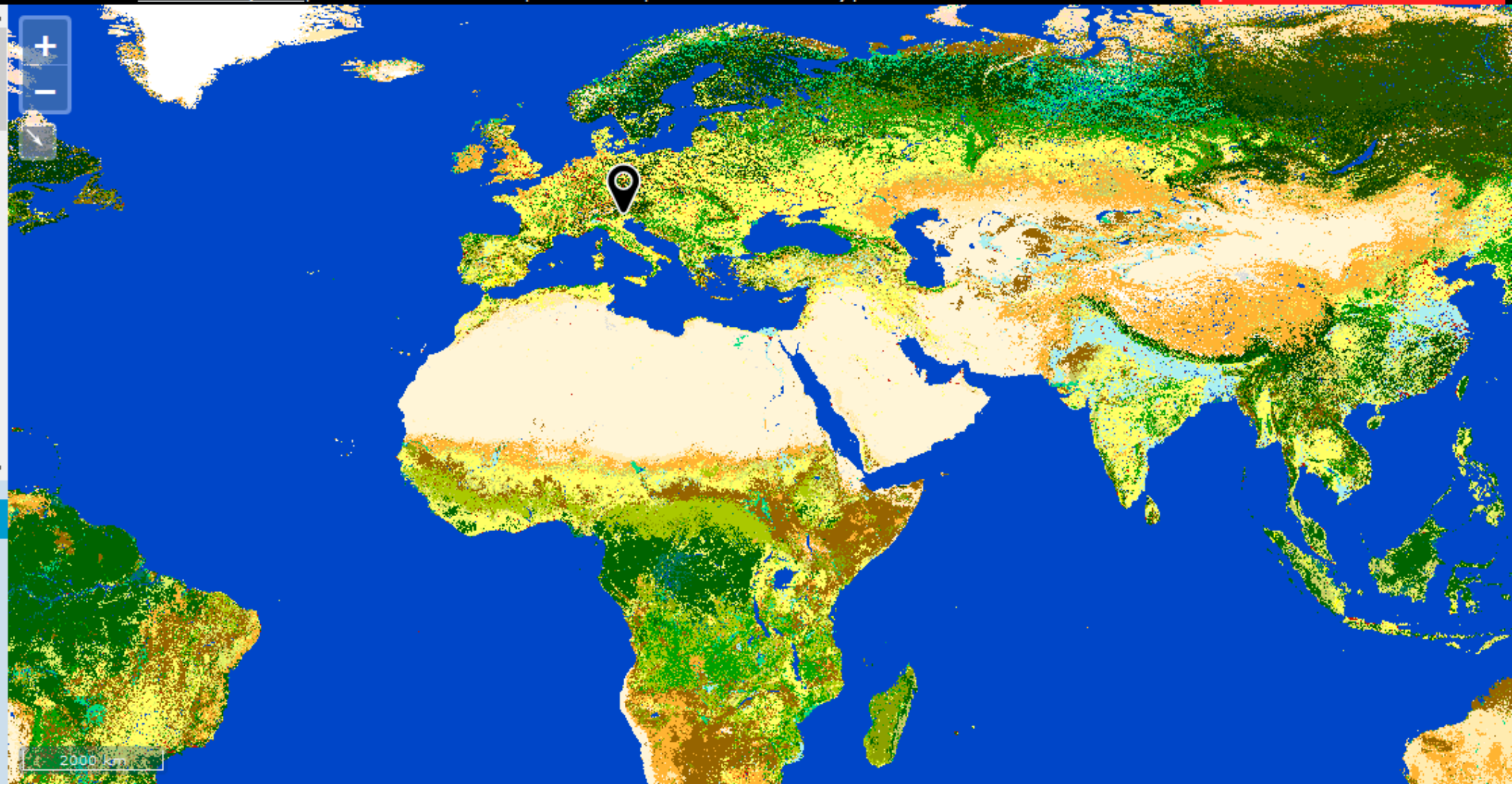
view global (level 1)

- Cropland, rainfed
- - Herbaceous cover
- - Tree or shrub cover
- Cropland irrigated or post-flooding
- Mosaic cropland (>50%) / natural vegetation (Tree, shrub, herbaceous cover) (<50%)
- Mosaic natural vegetation (Tree, shrub, herbaceous cover) (>50%) / cropland (<50%)
- Tree cover, broadleaved, evergreen, closed to open (>15%)
- Tree cover, broadleaved, deciduous, closed to open

Long=12.3047°, Lat=45.5742°

Documentation

- Product User Guide v2
- Quick User Guide for Maps v2.0.7
- Quick user guide Land Surface Seasonality products
- Legend for LC Map v2.0.7
- Preview LC Map v2.0.7 for Year 2015
- Preview MERIS SR Composite



Next Phase 2017 – 2026: CCI+

New ECVs:

Water Vapour

Salinity

Sea State

Lakes

Snow

Permafrost ECV

Land Surface Temperature

High Resolution Land Cover

Biomass

Lakes and Climate

The current effects of changing climate on lakes include:

(i) an increase in the surface water temperature of lakes and streams, especially those at high altitudes and latitudes;

(ii) an increase in temperature at lower levels of large deep lakes;

(iii) a reduction in lake ice-cover;

(iv) the melting of mountain glaciers and permafrost causing changes to discharge regimes in mountain streams.

It is probable that:

(i) with changes in precipitation, there will be an increase in the transport of sediments and nutrients downstream to lakes;

(ii) The lake size and spatial distribution may be altered as lakes appear and disappear or

(iii) existing conditions may change abruptly, e.g., from freshwater to permanently saline lakes or from non-stratifying to stratifying lakes

Lakes: GCOS ECV Requirements

GCOS Requirements

	Lake water level	Lake Extent	LSWT	Lake Ice Thickness Cover	Lake Colour
Accuracy	3 cm for large lakes, 10 cm for the rest	10 % (relative) 5% (for 70 largest lakes)	1K	LIT: 1–2 cm LIC: 10 %	30 %
Stability	1 cm/decade	5%/decade	0.1 K/ decade	LIT: N/A LIC:1 % /decade	1 %/decade
Resolution	100 m	20 m	300 m	LIT: 100m LIC: 300 m	300 m
Frequency	Daily	Daily	Weekly	LIT: Monthly LIC: Daily	Weekly

HR Land Cover: Key Issues for CCI+ (1)

The objectives of HRLC_cci are restricted in area with a focus on:

- understanding regional change in vegetation manifest either in terms of land cover or in terms of vegetation state as it affects classification over time, as driven by climate.
- understanding classification variability across spatio-temporal scales from the moderate resolution previously tackled in LandCover _cci.
- understanding how the Land Cover ECV products at moderate resolution relate to the map products needed for mitigation and adaptation at local scales including forest monitoring and reporting activities as part of the REDD+ mechanism.

HR Land Cover: Satellite Instruments

Taking account of the LandCover_cci (MERIS, VGT, AVHRR, PROBA) heritage, the satellite focus of HR Land Cover is:

- **Optical High Resolution:** Landsat TM, ETM, OLI, SPOT HRV, HRVIR, HRG, S-2 MSI …
- **Optical Very High Resolution:** IKONOS, QUICKBIRD-2, GEOEYE, WORLDVIEW, JSS 56, RAPIDEYE, PLANET ...
- **Microwave High Resolution:** ERS, Envisat, Sentinel 1, Radarsat, JERS-1, ALOS, ALOS-2, TerraSAR, Cosmo SkyMed, ...

Next Phase 2017 – 2026: CCI+

Other Programme Elements

1) New R&D on existing ECVs

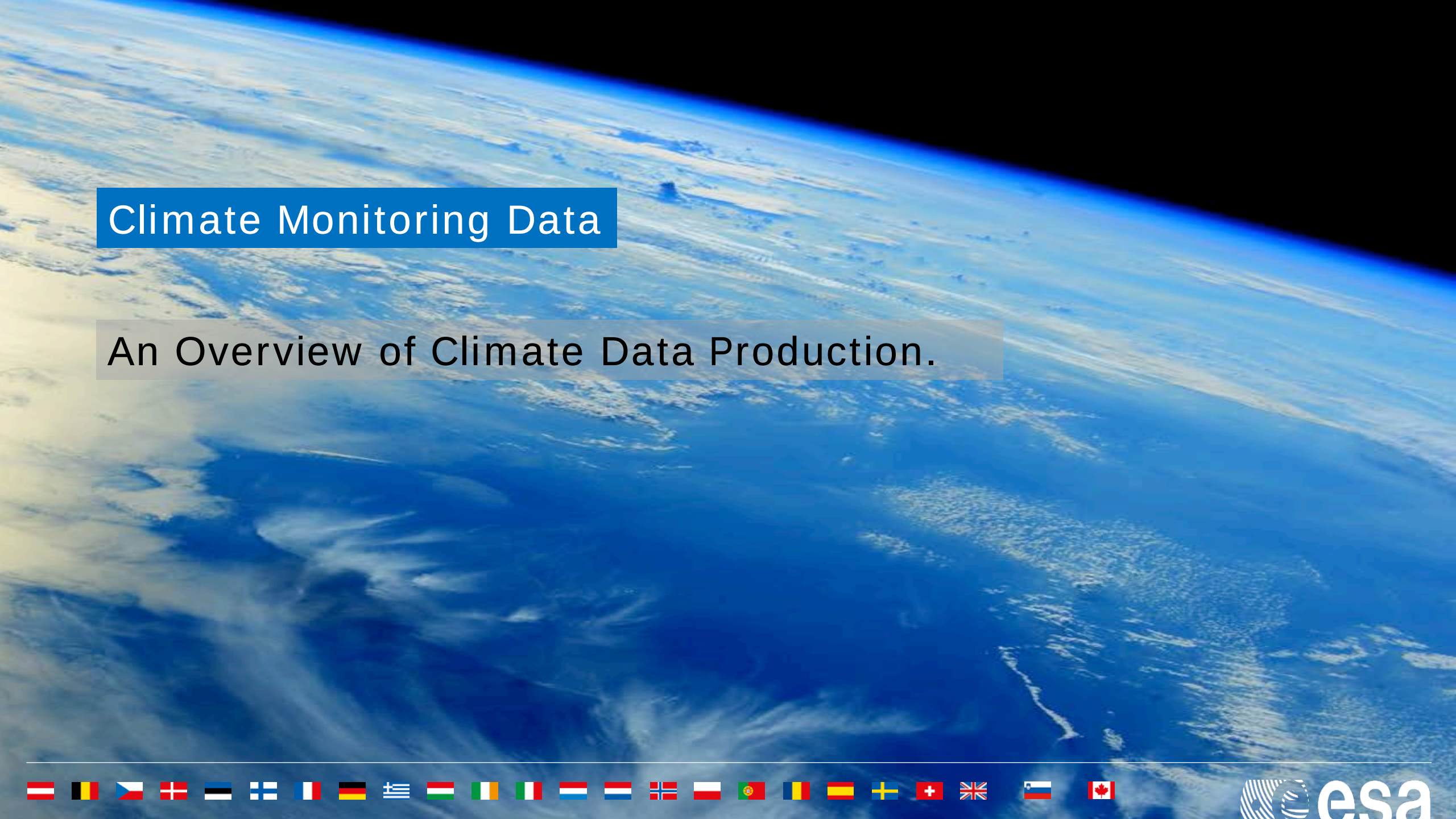
2) Cross-ECV scientific exploitation

- CCI+ CMUG-type activity
- Cross-ECV targeted scientific studies

(E.g. Analysis of multiple ECVs for IMBIE (polar science), sea-level budget closure, carbon-cycle research, *etc)*

- Young Scientist Research Fellowship Scheme

3) Supporting activities on Knowledge Exchange



Climate Monitoring Data

An Overview of Climate Data Production.

Step 1. Deciding what to actually measure.

Essential Climate Variables have been defined by the global science community to support the United Nations Framework Convention on Climate Change (UNFCCC).

Criteria of Essential Climate Variables (ECV)

Relevance. Critical for climate monitoring.

Feasibility. Global measurement is feasible.

Cost effective. Using proven technology.

Satellites can help

Global. Observe entire Earth.

Uniformity. Same instrument everywhere.

Rapid Measurement. Constant watch.

Continuity. Long time series to monitor change in climate.

Step 2. Get the raw satellite data.

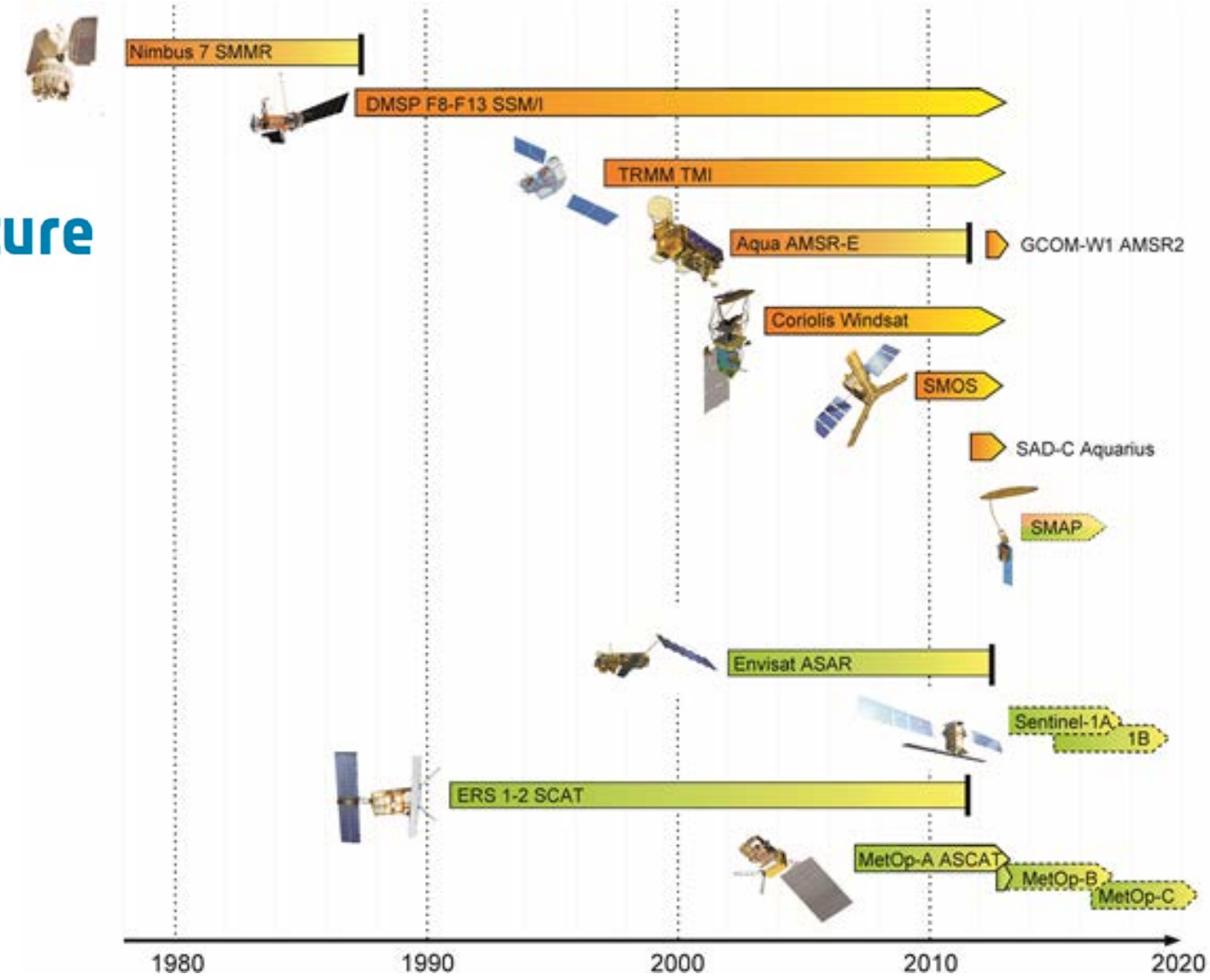
Current data.

Archived data.

Planning for the future.

Example

soil moisture cci



Step 3. Process the data.

Gridding, Homogenisation, Calibration & Validation, Quality.

Scientific processing - application of state-of-the–art algorithms distilled from the very latest scientific reasoning.

Step 4. Distribution of Climate Data Products.

"Just give me the data".

ESA Climate Change Initiative (CCI)

Managing Complexity of Climate Data Production.

Open Data Challenges & Approaches

Managing Open Data Complexity

Meaningfulness & Community.

Managing Open Data Complexity

Ease of Data Access.

Data

Submitted by Cat Downy on Wed, 13/04/2016 - 23:55

open data portal cci

Welcome to the **CCI Open Data Portal**.
A single point of entry to CCI data.
Open, free and easily accessible.

- About CCI
- Data
- Resources
- CCI Events
- Contact Us

Search

CCI Dashboard
The big picture.

CCI Search
Simple & faceted.

CCI FTP
Quick & simple.

CCI Viewer
View. Draw. Catch.

CCI Dashboard


aerosol cci


cloud cci


fire cci


ghg cci


glaciers cci


antarctic ice sheet cci


ice sheets greenland cci


land couer cci


ocean colour cci

Managing Open Data Complexity

Bespoke Open Standards.

Managing Open Data Complexity

Machine & Human Readable Standards.

Managing Open Data Complexity

Interoperability & Collaboration.

Managing Open Data Complexity

Open-source Tooling

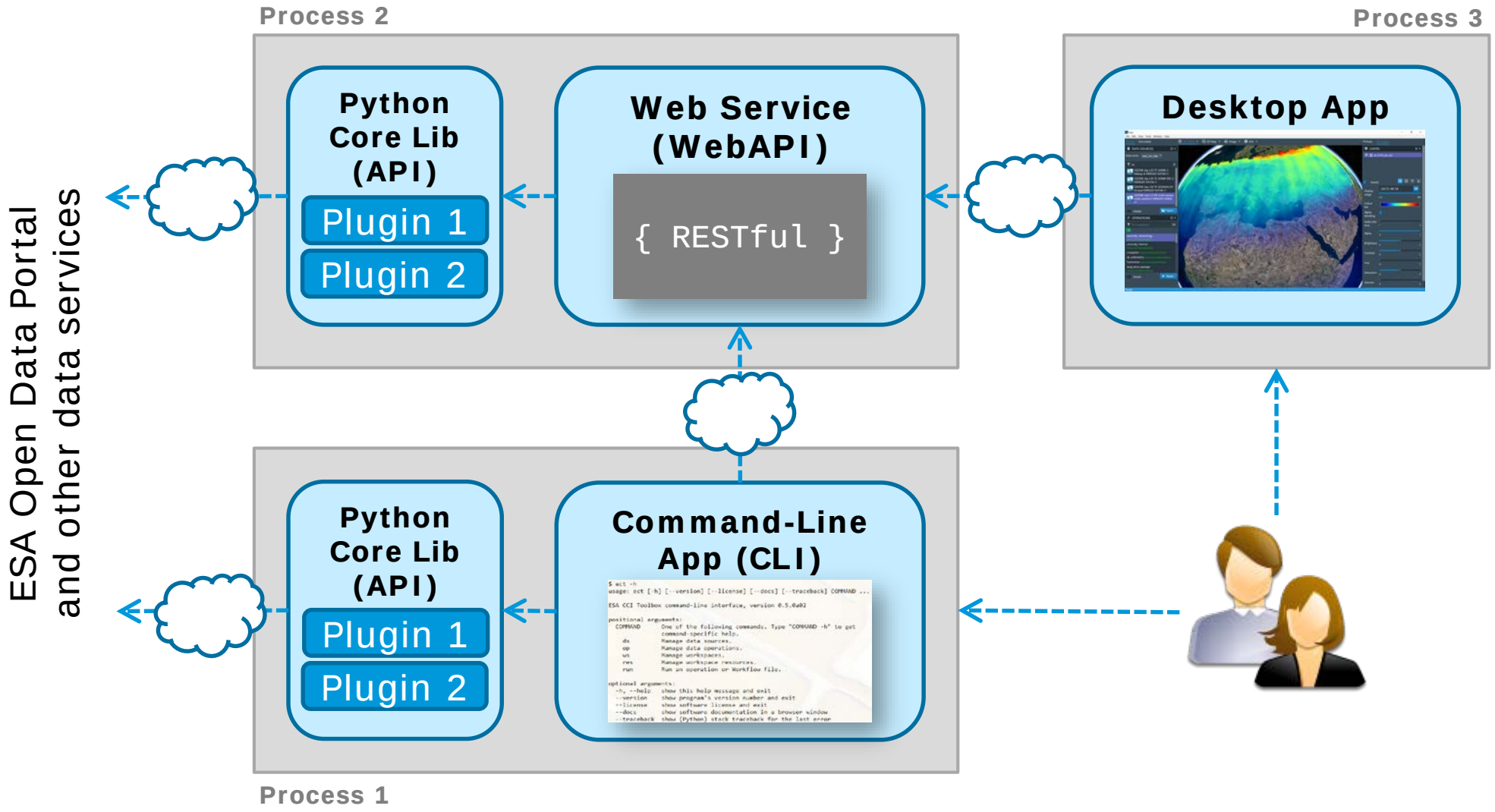
toolbox
cci

CATE

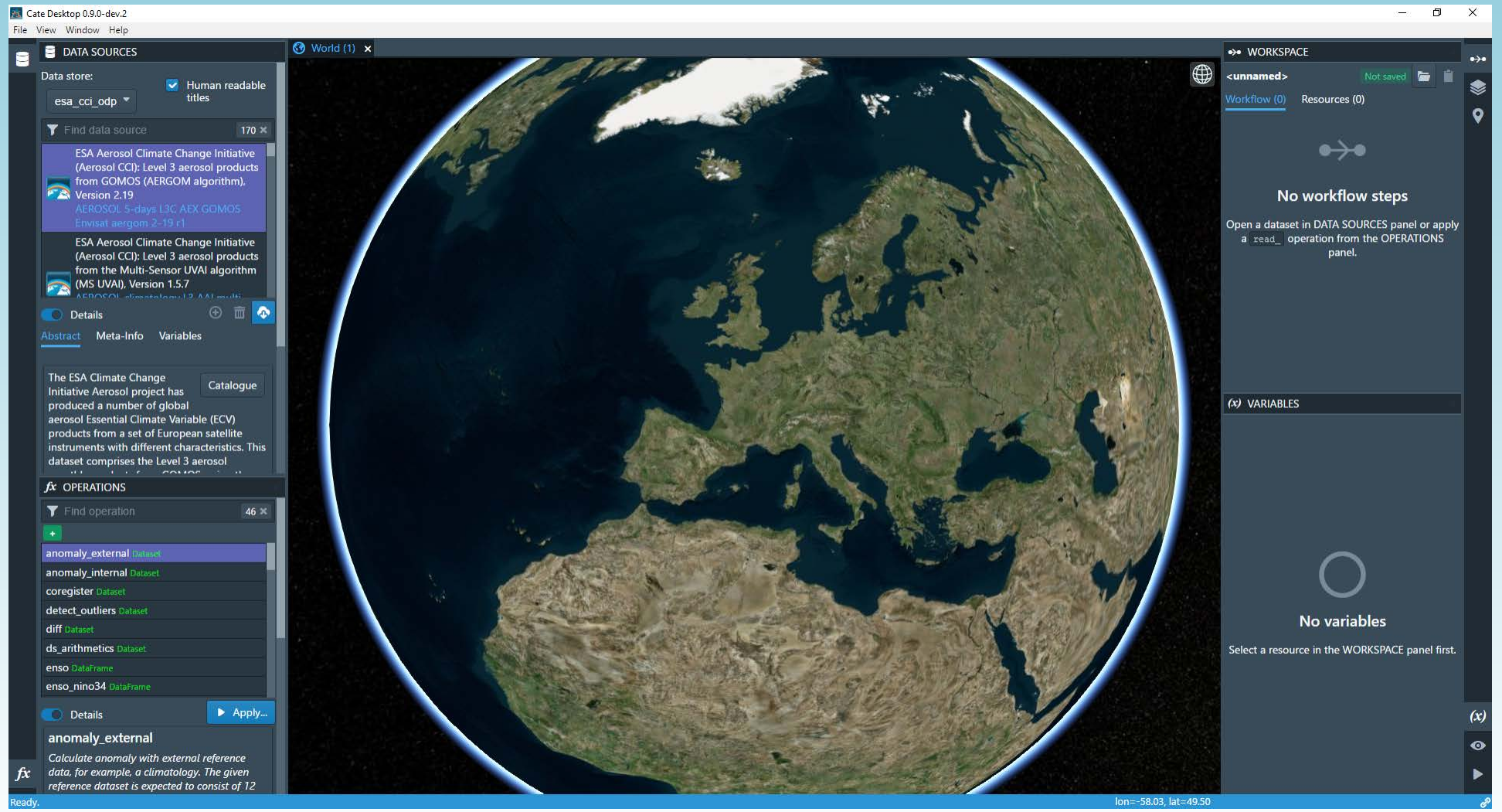
"Climate Analysis Toolbox for ESA"

A software to facilitate processing and analysis of all the data products generated by the ESA Climate Change Initiative Programme (CCI).

esa

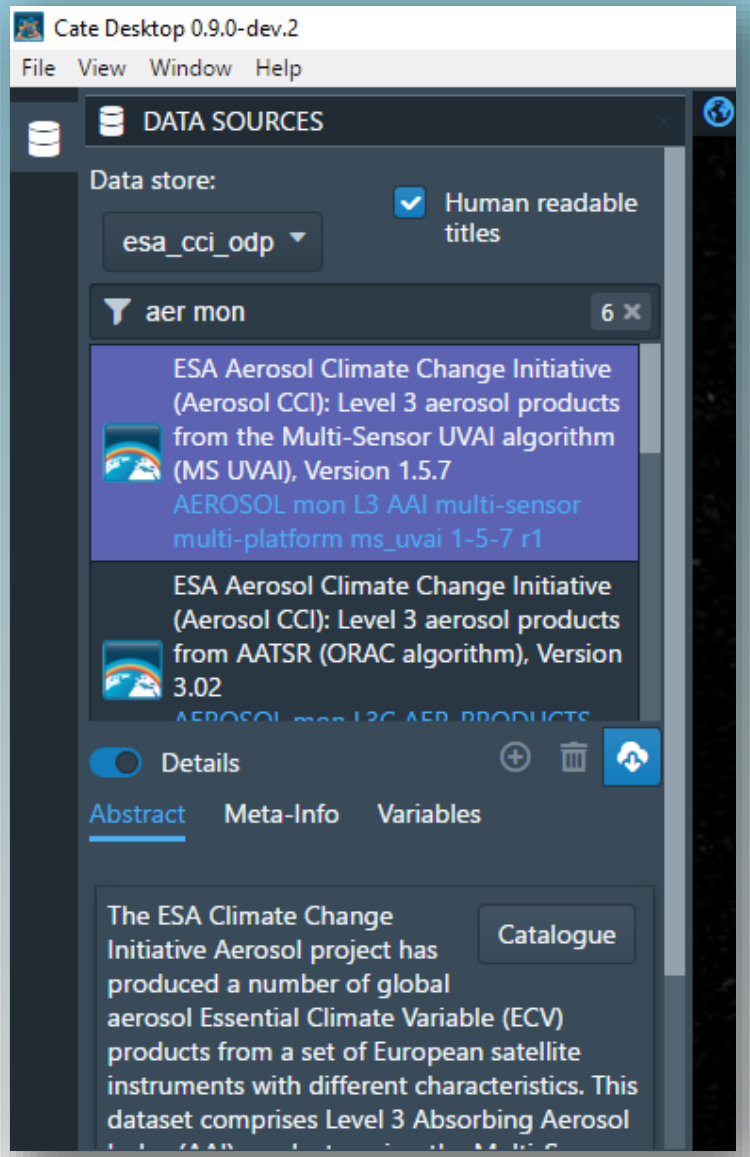

Process 2
Process 3
Python Core Lib (API)
Plugin 1
Plugin 2
Web Service (WebAPI)
{ RESTful }
Desktop App
ESA Open Data Portal and other data services
Python Core Lib (API)
Plugin 1
Plugin 2
Command-Line App (CLI)
Process 1

Cate Desktop

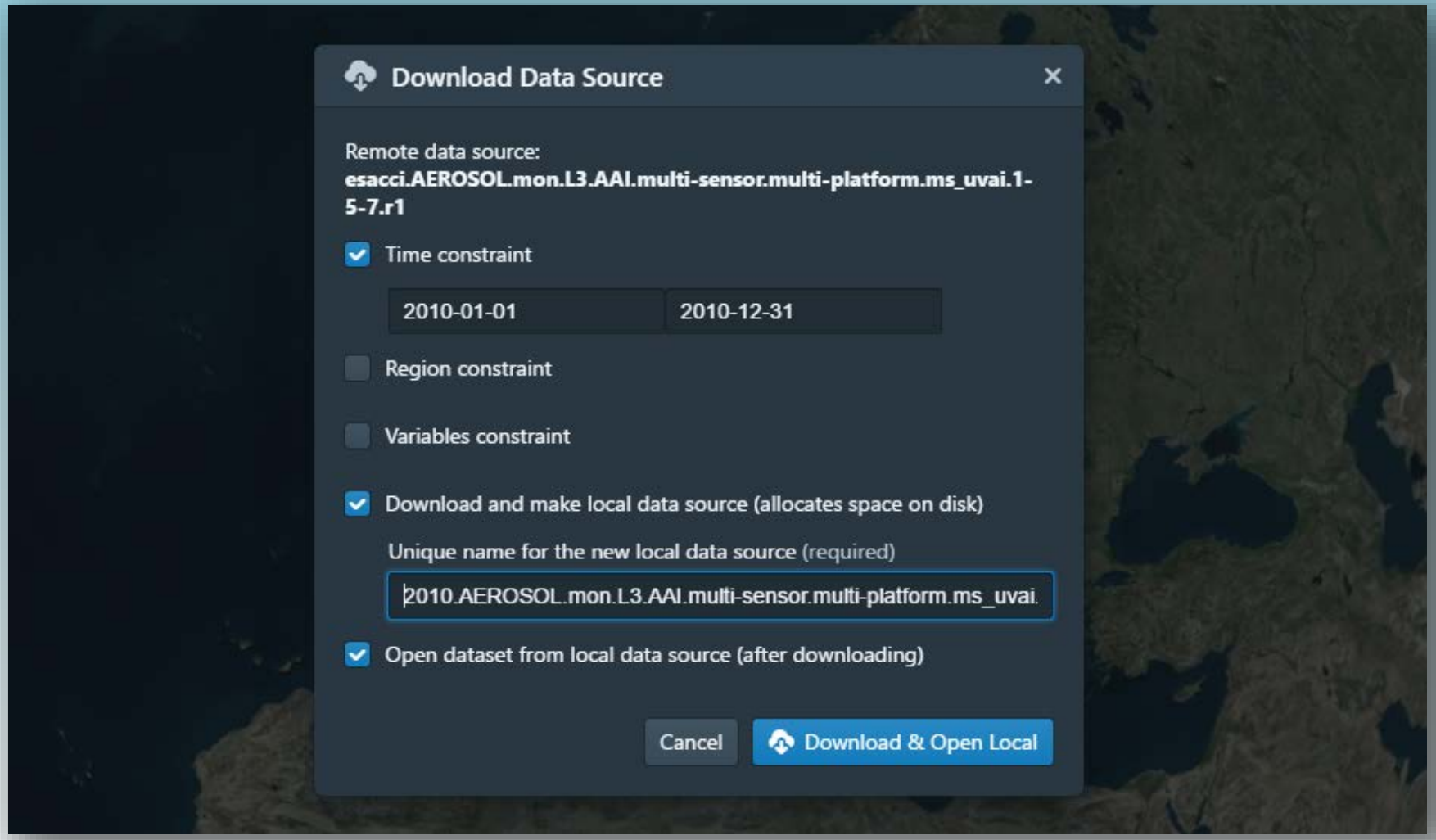


ECV Data Sources

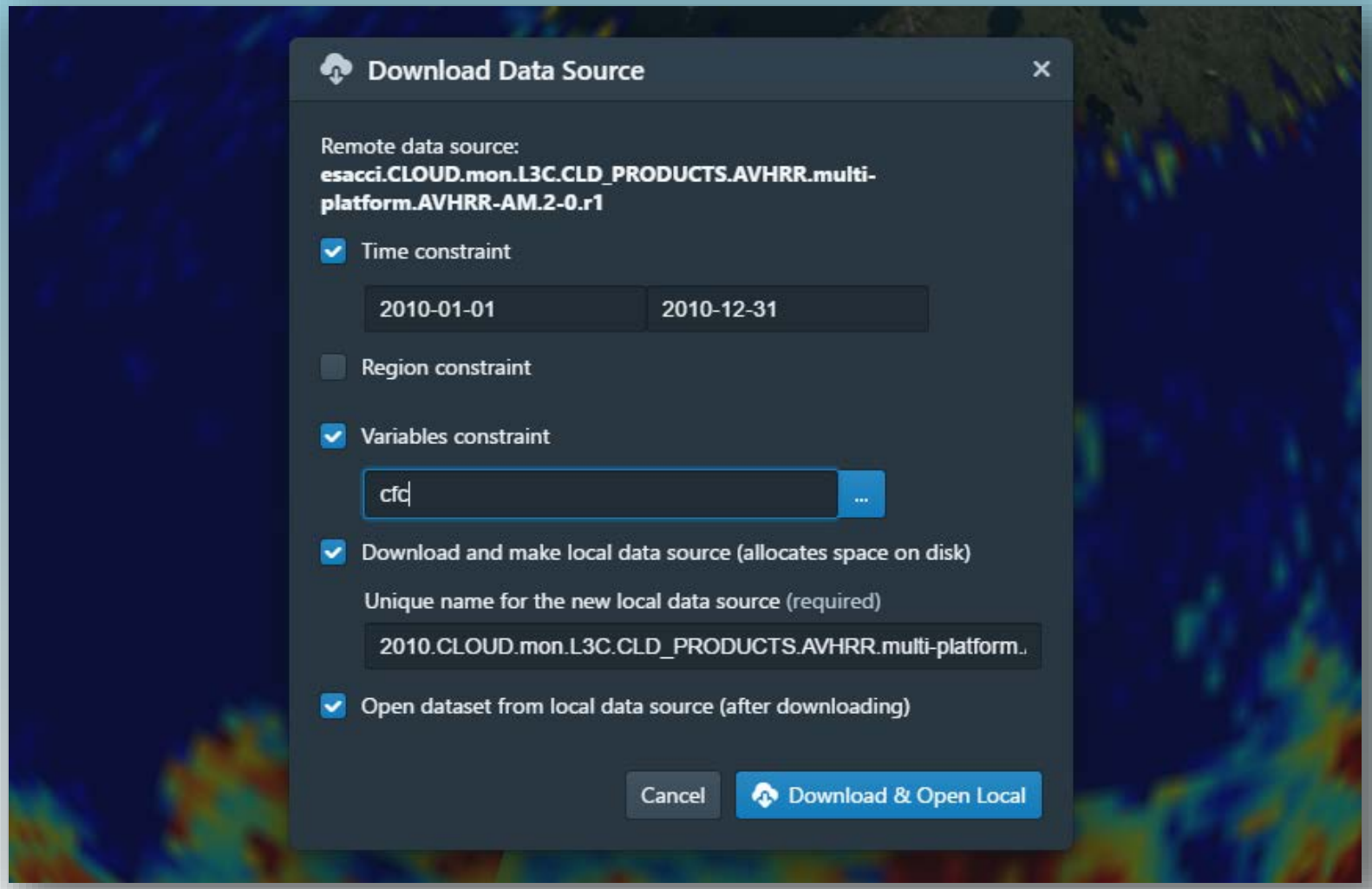
- Browse datasets published by **CCI Open Data Portal**
- Download full datasets or just subsets
  - Temporal subset
  - Spatial subset
  - Variable subset
- Manage also your **local data sources**



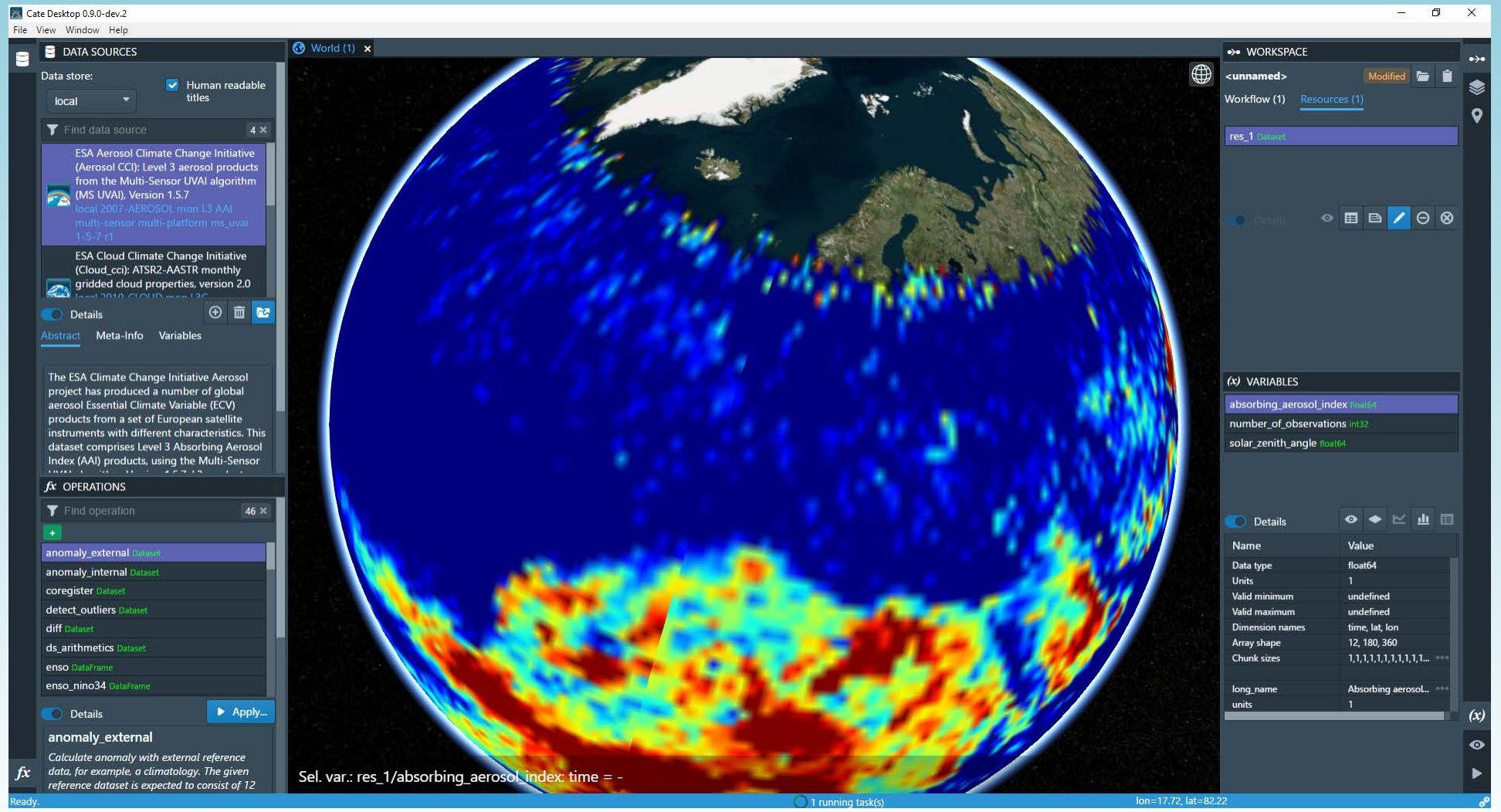
Access CCI Data directly from ODP



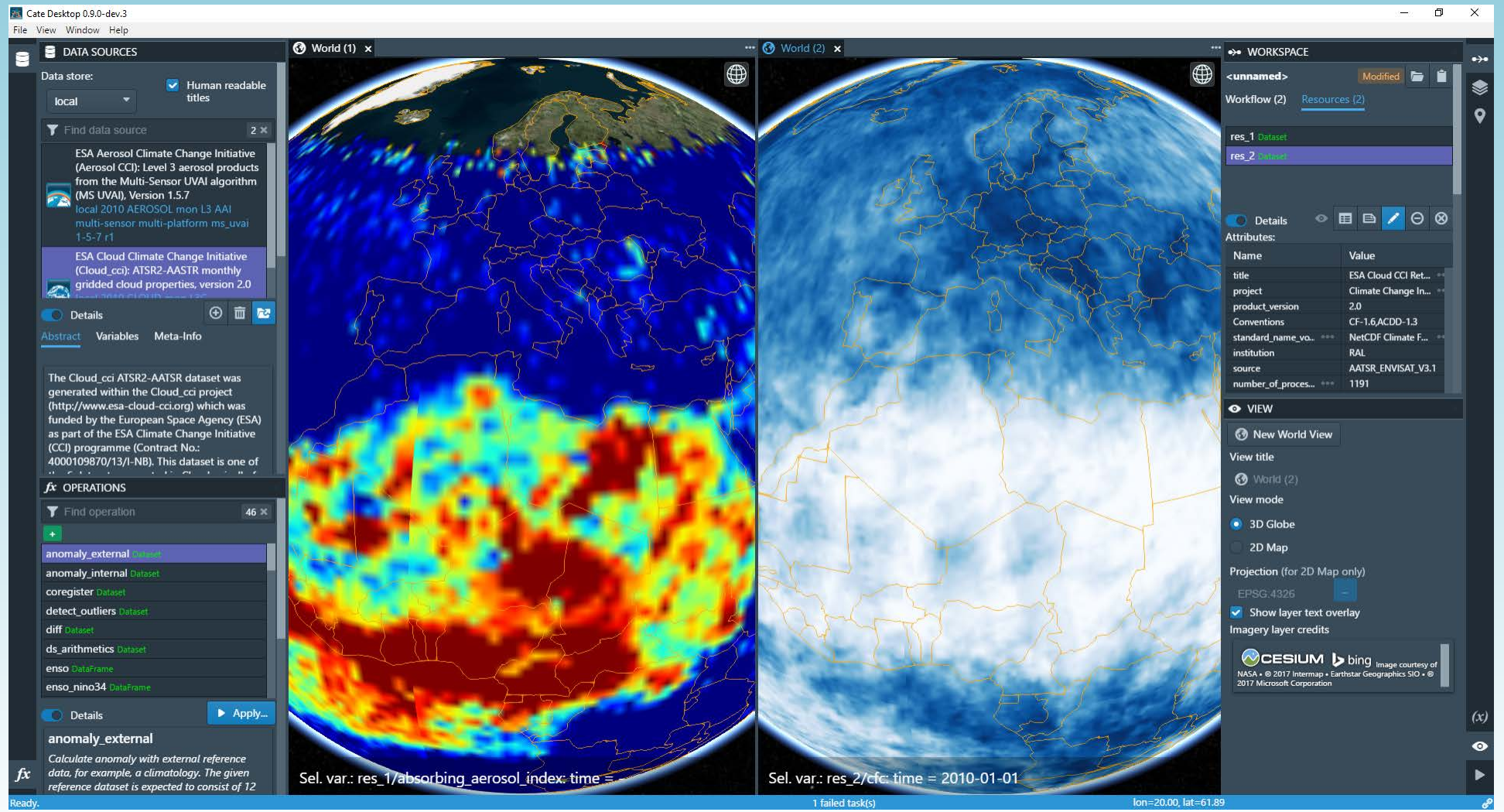
Constraining the Selection



Open and Explore ECV data

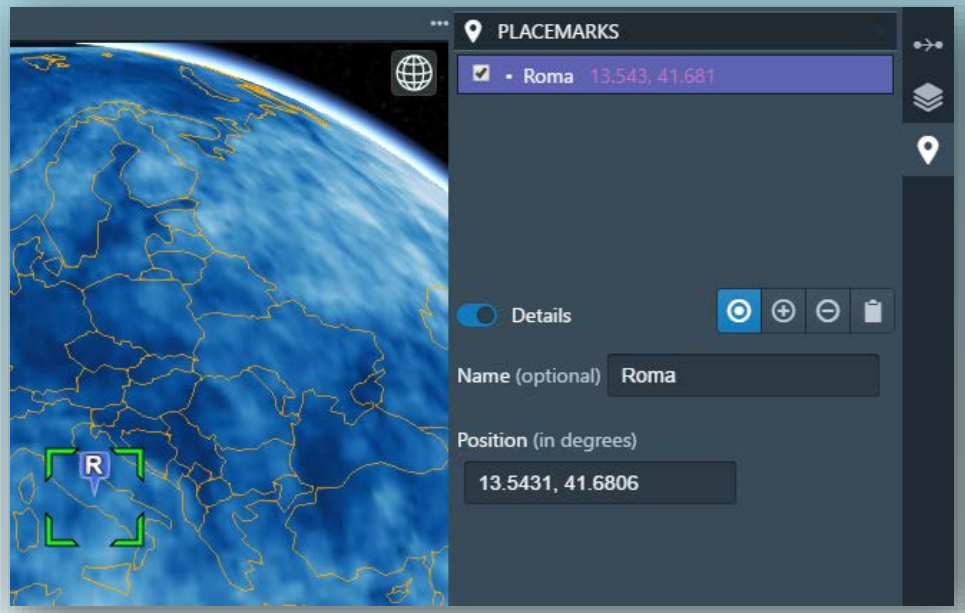


Multiple Views – Compare ECVs



Time Series

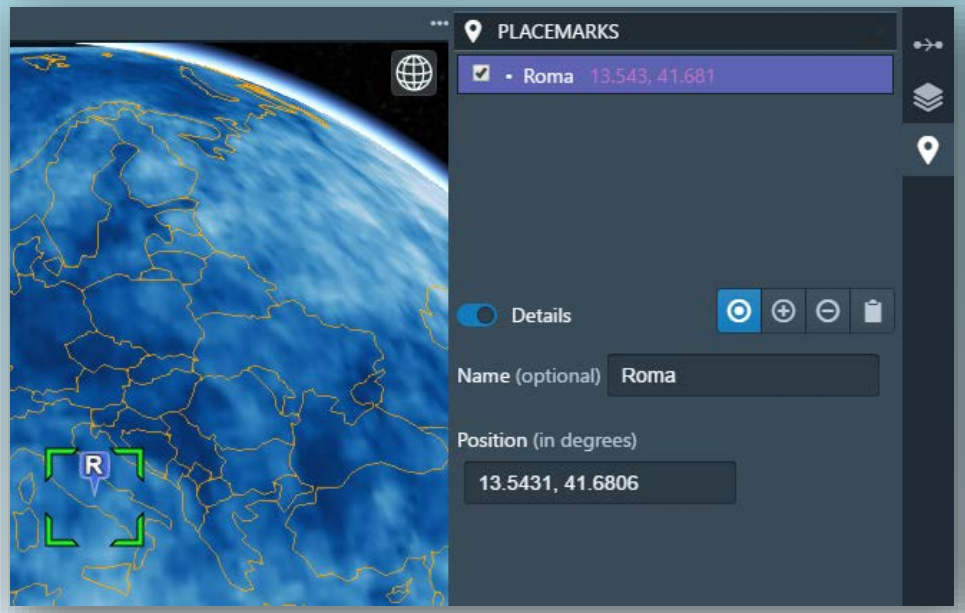
- Create time series plot easily from **selected placemark**



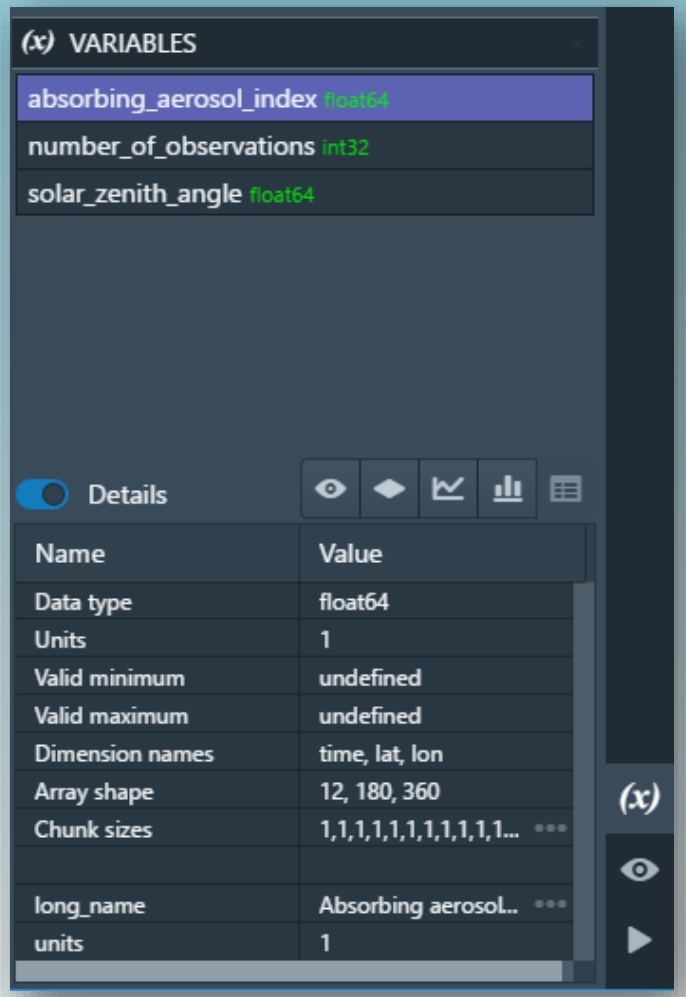
- and **selected variable**

Time Series

- Create time series plot easily from **selected placemark**

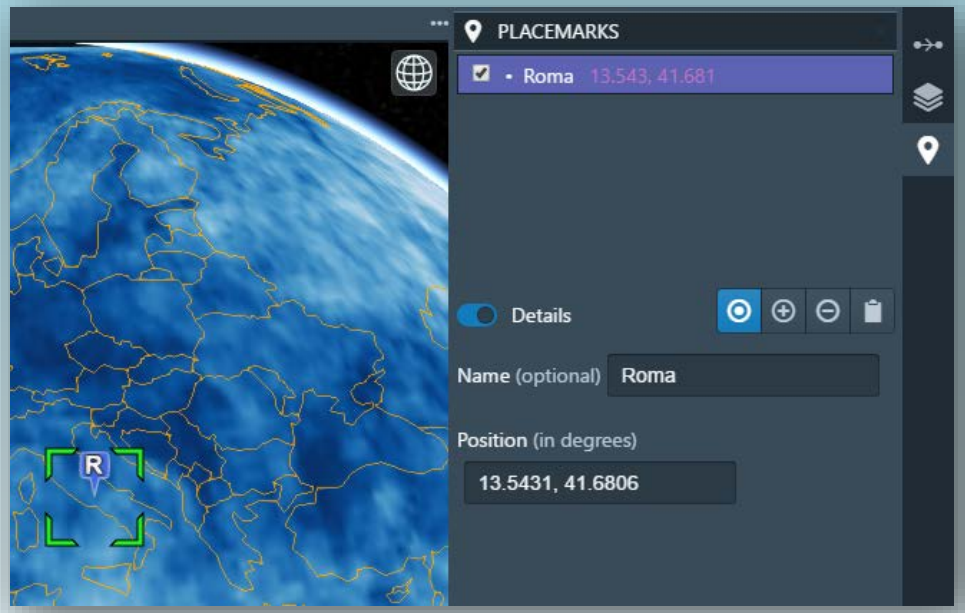


- and **selected variable**

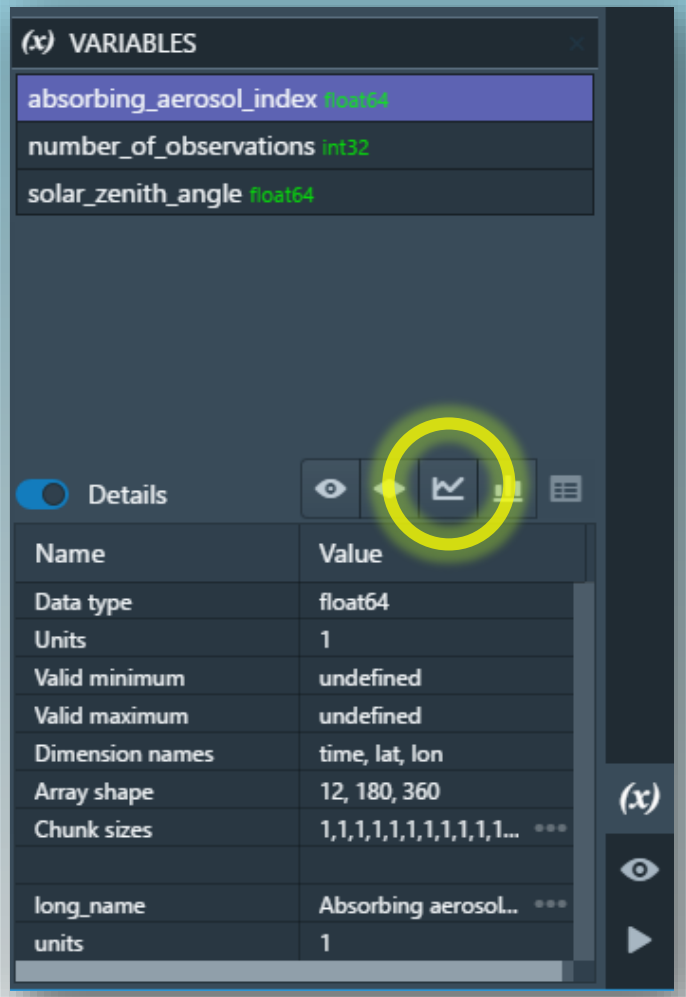


Time Series

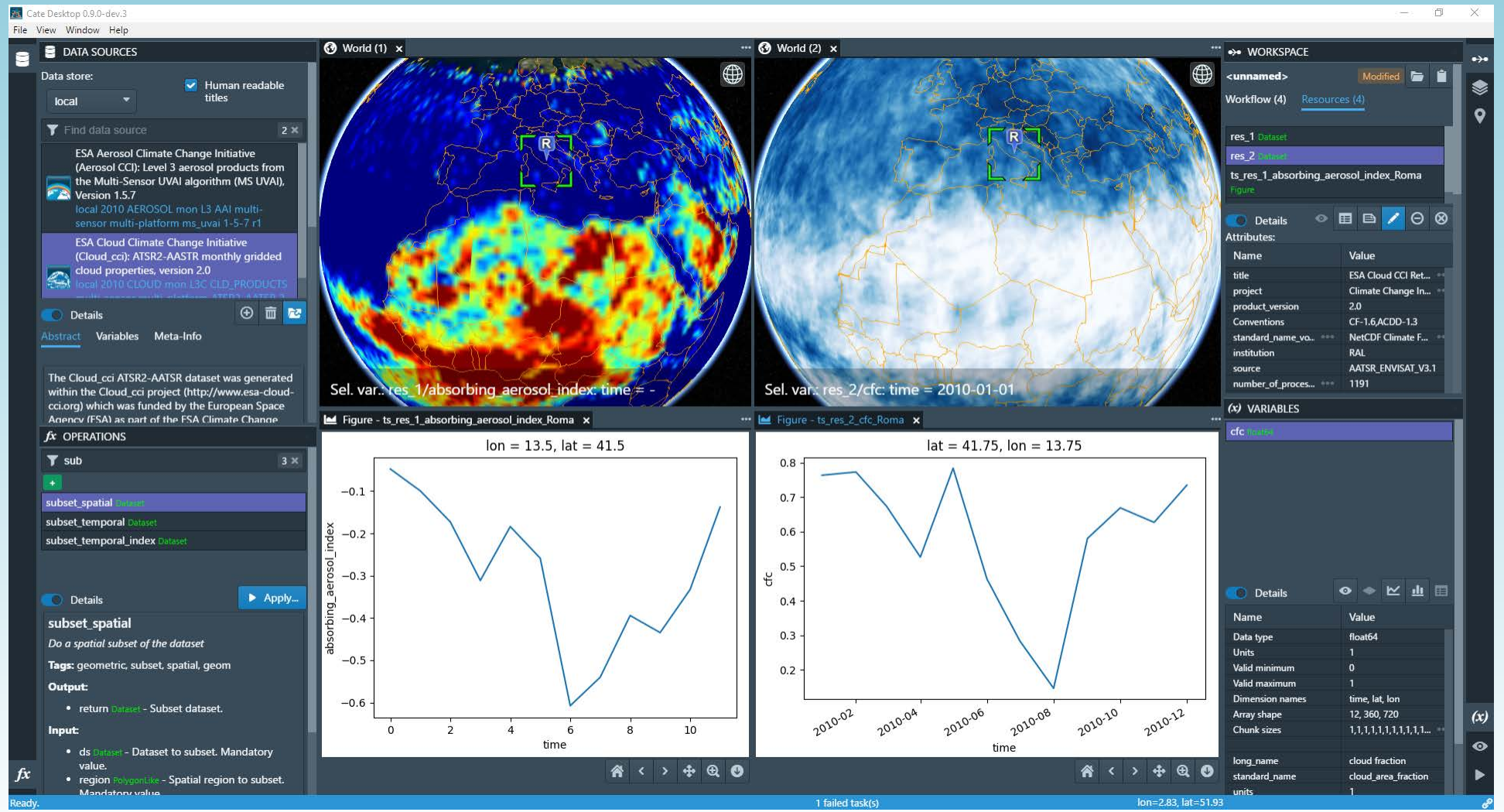
- Create time series plot easily from **selected placemark**



- and **selected variable**

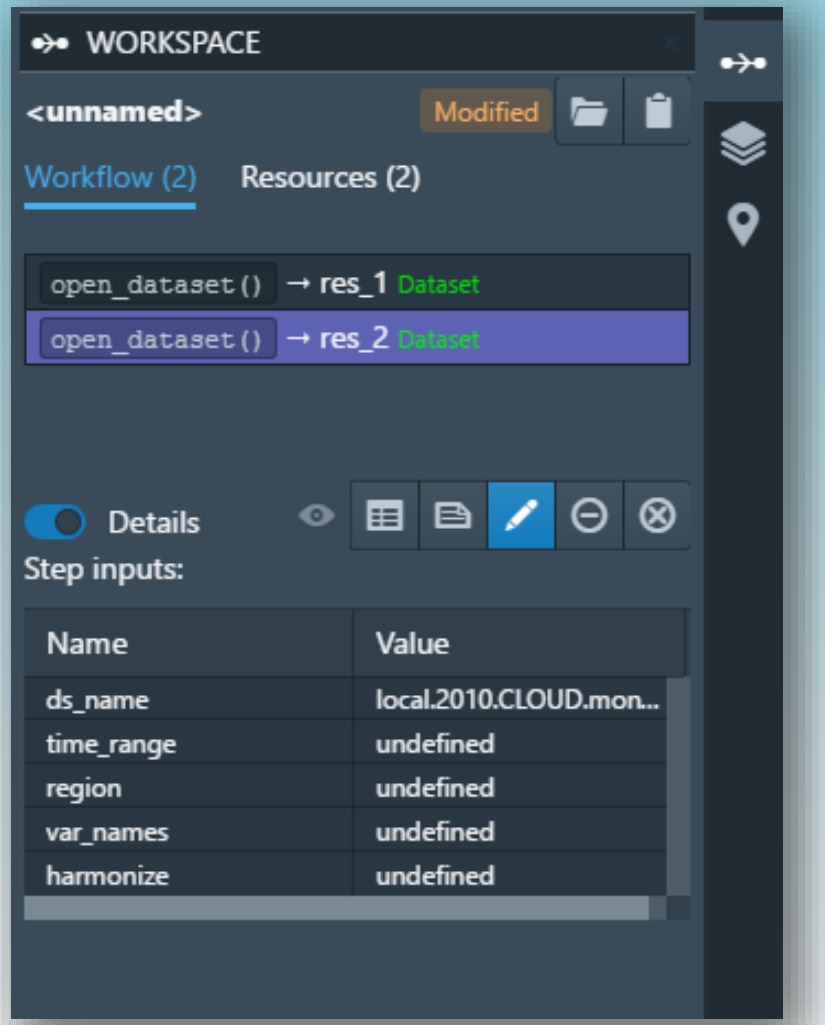


Time Series


Cate Desktop 0.9.0-dev.3
File View Window Help
DATA SOURCES
Data store:
local
Human readable titles
Find data source
ESA Aerosol Climate Change Initiative (Aerosol CCI): Level 3 aerosol products from the Multi-Sensor UVAI algorithm (MS UVAI), Version 1.5.7
local 2010 AEROSOL mon L3 AAI multi-sensor multi-platform ms_uvai 1-5-7 r1
ESA Cloud Climate Change Initiative (Cloud_cci): ATSR2-AASTR monthly gridded cloud properties, version 2.0
local 2010 CLOUD mon L3C CLD_PRODUCTS
Details
Abstract Variables Meta-Info
The Cloud_cci ATSR2-AATSR dataset was generated within the Cloud_cci project (http://www.esa-cloud-cci.org) which was funded by the European Space Agency (ESA) as part of the ESA Climate Change
OPERATIONS
sub
subset_spatial Dataset
subset_temporal Dataset
subset_temporal_index Dataset
Details
Apply...
subset_spatial
Do a spatial subset of the dataset
Tags: geometric, subset, spatial, geom
Output:
return Dataset - Subset dataset.
Input:
ds Dataset - Dataset to subset. Mandatory value.
region PolygonLike - Spatial region to subset.
World (1)
Sel. var.: res_1/absorbing_aerosol_index: time = -
World (2)
Sel. var.: res_2/cfc: time = 2010-01-01
Figure - ts_res_1_absorbing_aerosol_index_Roma
lon = 13.5, lat = 41.5
absorbing_aerosol_index
time
Figure - ts_res_2_cfc_Roma
lat = 41.75, lon = 13.75
cfc
time
WORKSPACE
<unnamed>
Modified
Workflow (4)
Resources (4)
res_1 Dataset
res_2 Dataset
ts_res_1_absorbing_aerosol_index_Roma
Figure
Details
Attributes:
Name
Value
title
ESA Cloud CCI Ret...
project
Climate Change In...
product_version
2.0
Conventions
CF-1.6,ACDD-1.3
standard_name_vo...
NetCDF Climate F...
institution
RAL
source
AATSR_ENVISAT_V3.1
number_of_proces...
1191
VARIABLES
cfc float64
Details
Name
Value
Data type
float64
Units
1
Valid minimum
0
Valid maximum
1
Dimension names
time, lat, lon
Array shape
12, 360, 720
Chunk sizes
long_name
cloud fraction
standard_name
cloud_area_fraction
units
1
Ready.
1 failed task(s)
lon=2.83, lat=51.93

Workspace and Workflow

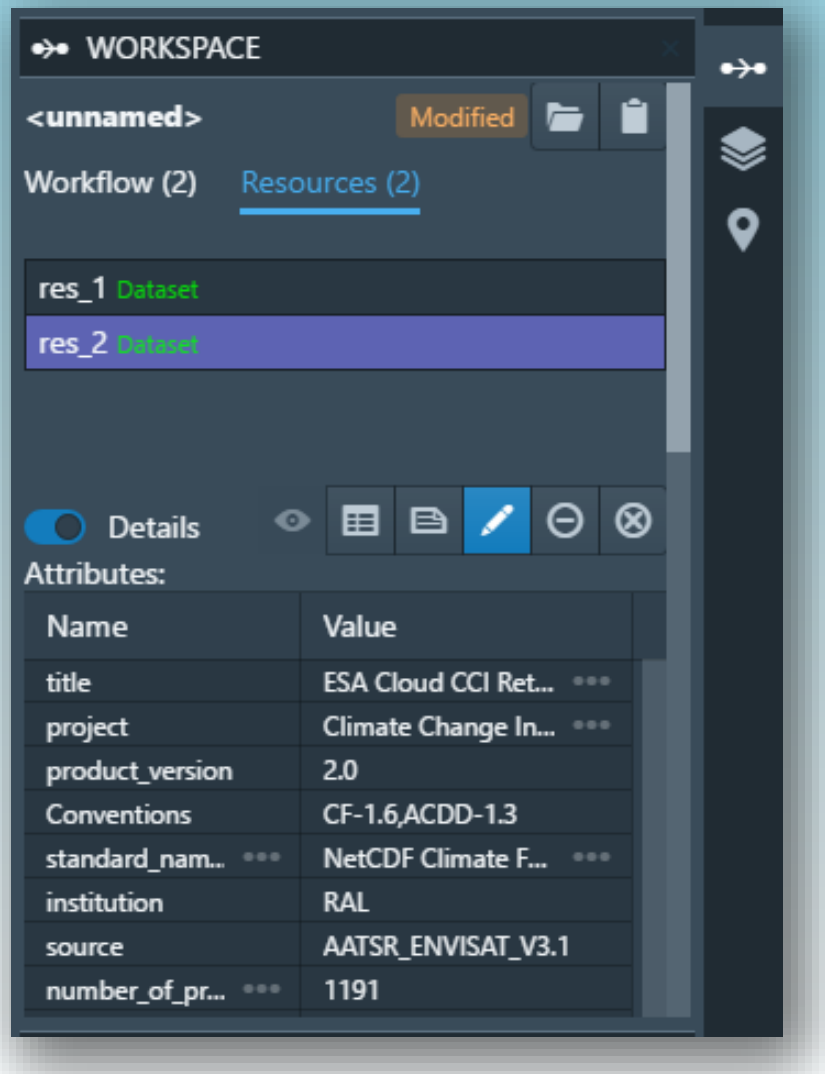
- Every step you perform, is a **step of a workflow** within your workspace



Workspace and Workflow

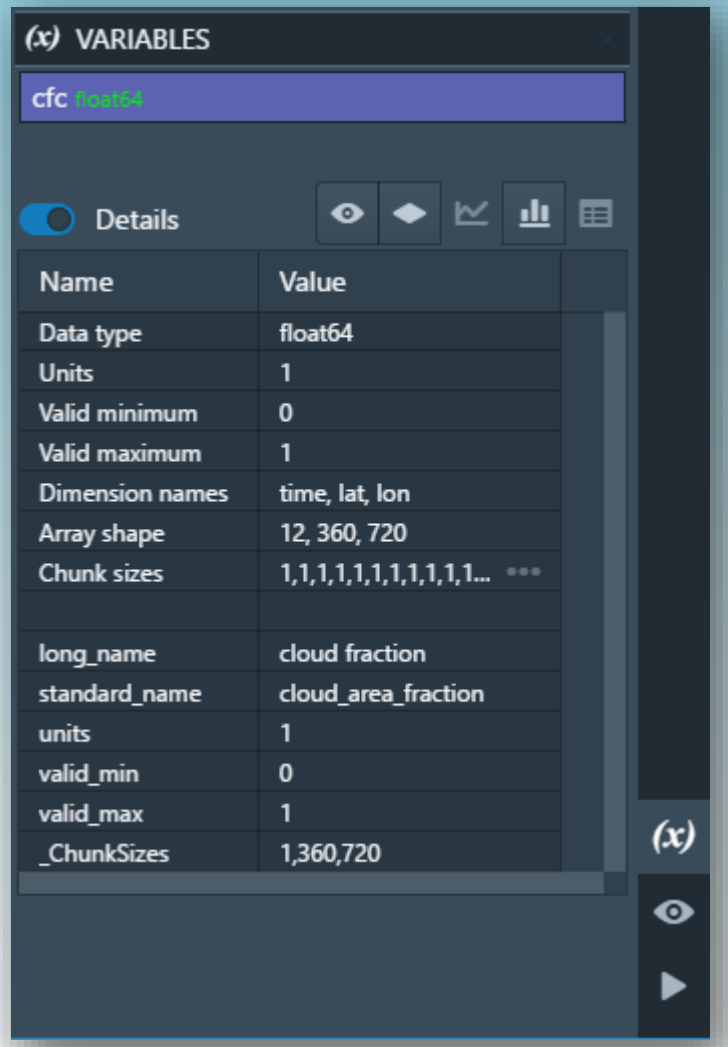
- Every step you perform, is a **step of a workflow** within your workspace

- The result of every step is a **new resource** which can be used as input to another step



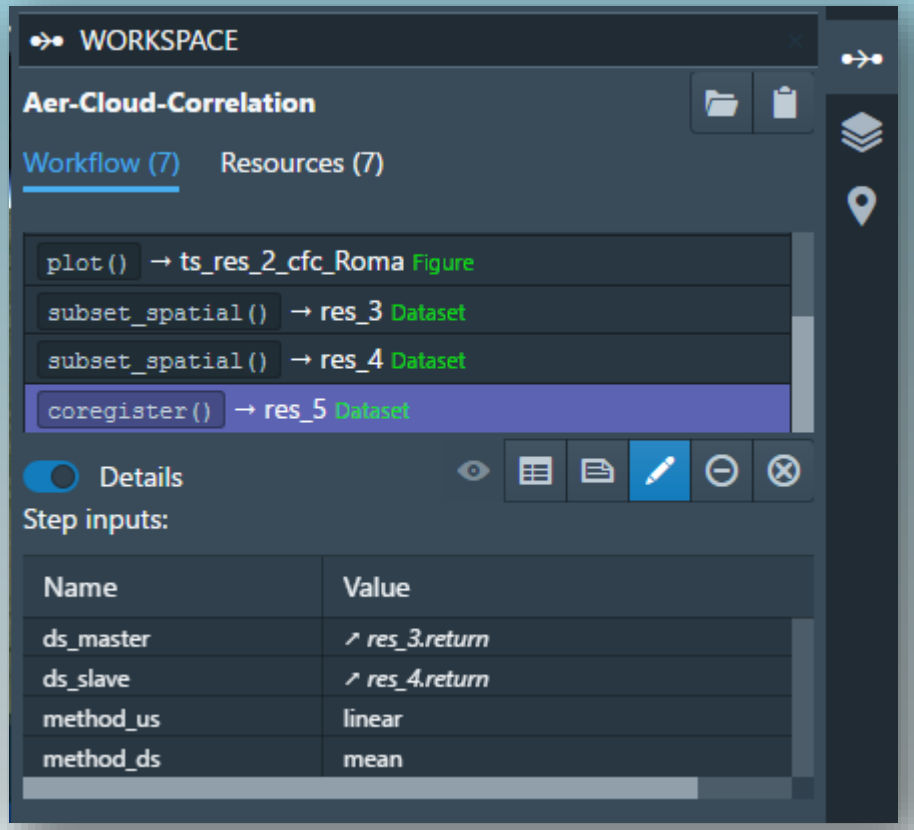
Workspace and Workflow

- Every step you perform, is a **step of a workflow** within your workspace
- The result of every step is a **new resource** which can be used as input to another step
- (NetCDF) dataset resources contain the actual **geo-physical ECVs**



Python Programming & Batch Processing

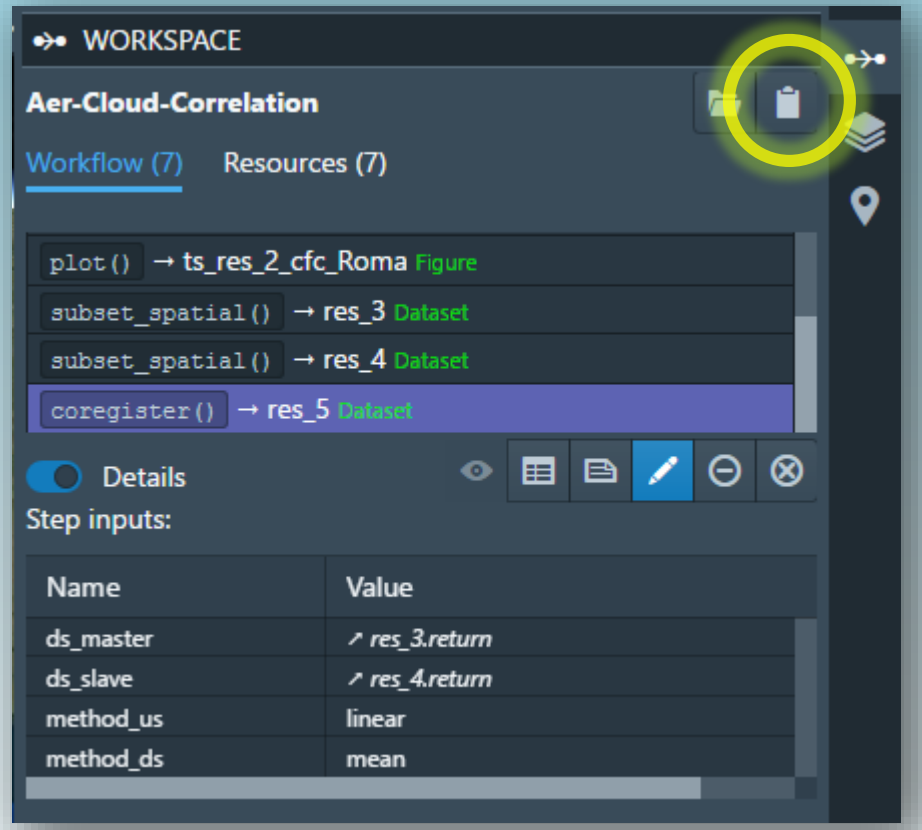
- Remember, every operation is a new **workflow step**



Python Programming & Batch Processing

- Remember, every operation is a new **workflow step**

- Same workflows can be executed from **Python** or from the **Command-Line Interface (CLI)**



Python Programming & Batch Processing

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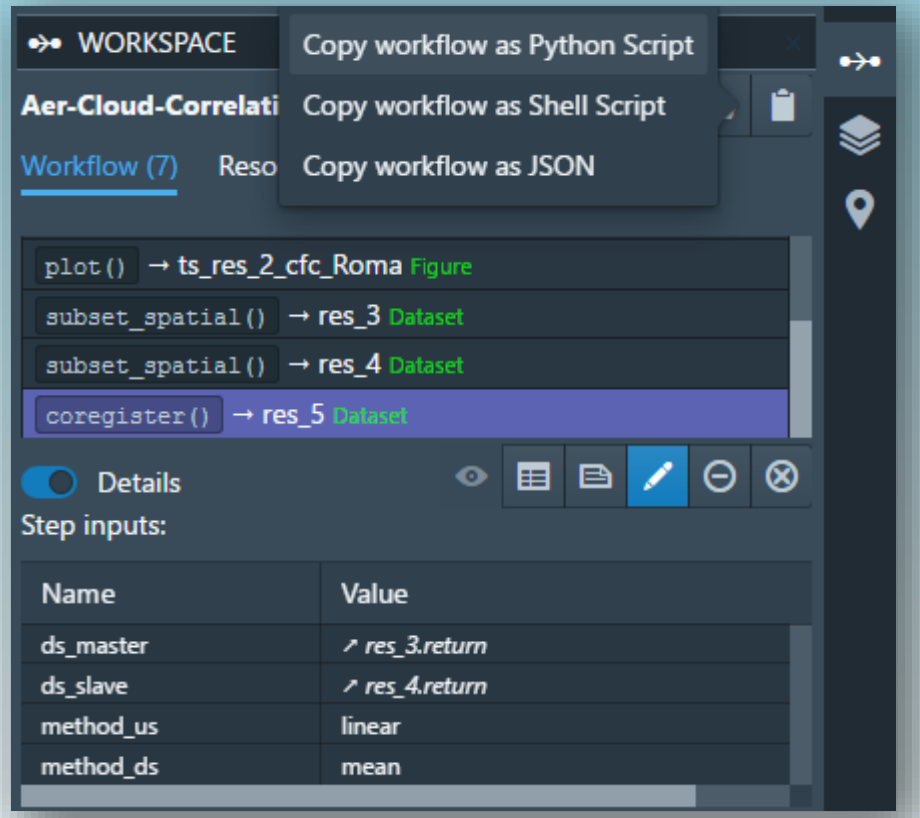
- Same workflows can be executed from **Python** or from the **Command-Line Interface (CLI)**



Python Programming & Batch Processing

- Exported Python Code

```python
from cate.ops import *

# Step 1
res_1 = open_dataset(ds_name="local.2010.AEROSOL.mon.L3.AAI.multi-sensor.

# Step 2
res_2 = open_dataset(ds_name="local.2010.CLOUD.mon.L3C.CLD_PRODUCTS.multi

# Step 3
ts_res_1_absorbing_aerosol_index_Roma = plot(ds=res_1, var="absorbing_aer

# Step 4
ts_res_2_cfc_Roma = plot(ds=res_2, var="cfc", indexers="lon=13.5431, lat=

# Step 5
res_3 = subset_spatial(ds=res_1, region="POLYGON ((30 20, 30 70, -20 70,

# Step 6
res_4 = subset_spatial(ds=res_2, region="POLYGON ((30 20, 30 70, -20 70,

# Step 7
res_5 = coregister(ds_master=res_3, ds_slave=res_4)

```

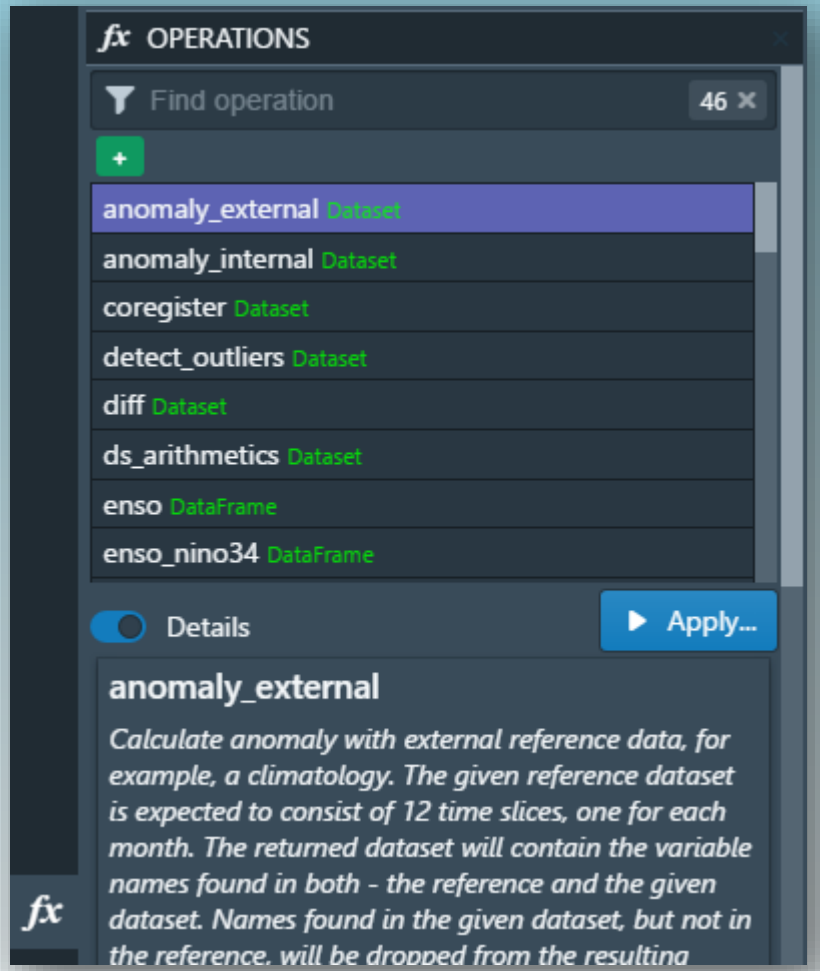
- Exported CLI Calls

```
#!/usr/bin/env bash
cate ws new
cate res set res_1 open_dataset ds_name="local.2010.AEROSOL.mon
cate res set res_2 open_dataset ds_name="local.2010.CLOUD.mon.I
cate res set ts_res_1_absorbing_aerosol_index_Roma plot ds=@res
cate res set ts_res_2_cfc_Roma plot ds=@res_2 var="cfc" indexer
cate res set res_3 subset_spatial ds=@res_1 region="POLYGON ((3
cate res set res_4 subset_spatial ds=@res_2 region="POLYGON ((3
cate res set res_5 coregister ds_master=@res_3 ds_slave=@res_4
cate ws exit
```


esa
cci
→ TOOLBOX
Cate Desktop (GUI)
Cate Programming (API)
Cate Command Line (CLI)
Data Analysis
ESA UNCLASSIFIED - For Official Use
esa

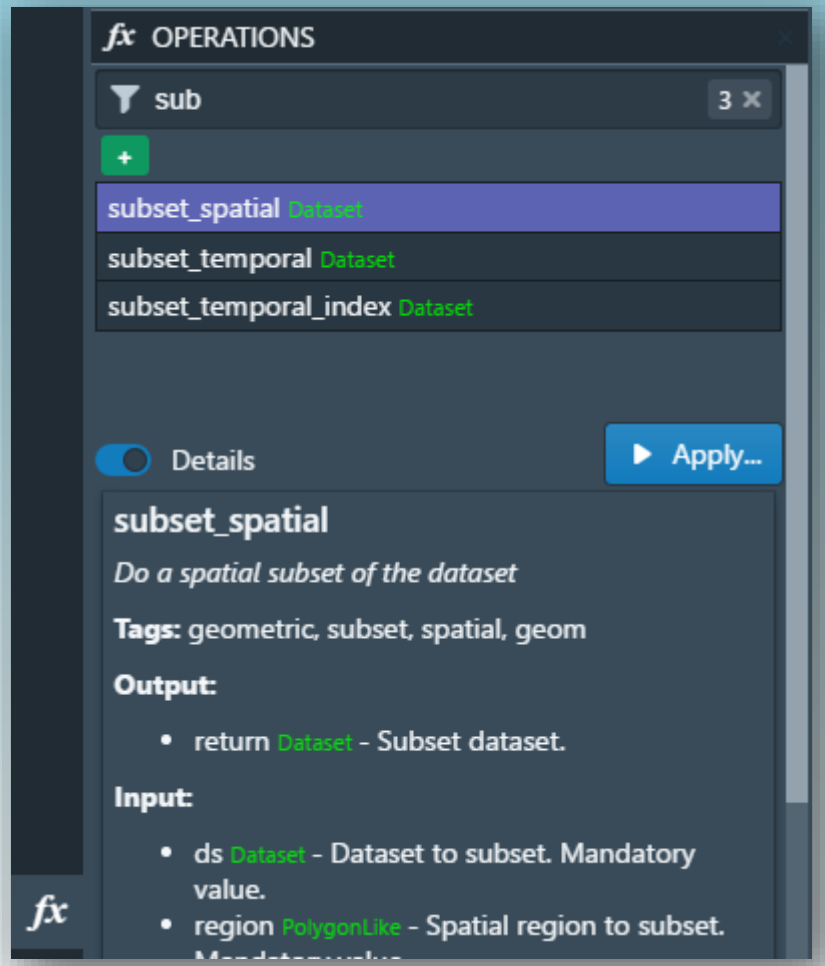
Data Analysis

- CCI Toolbox comes with a **library of operations**



Data Analysis

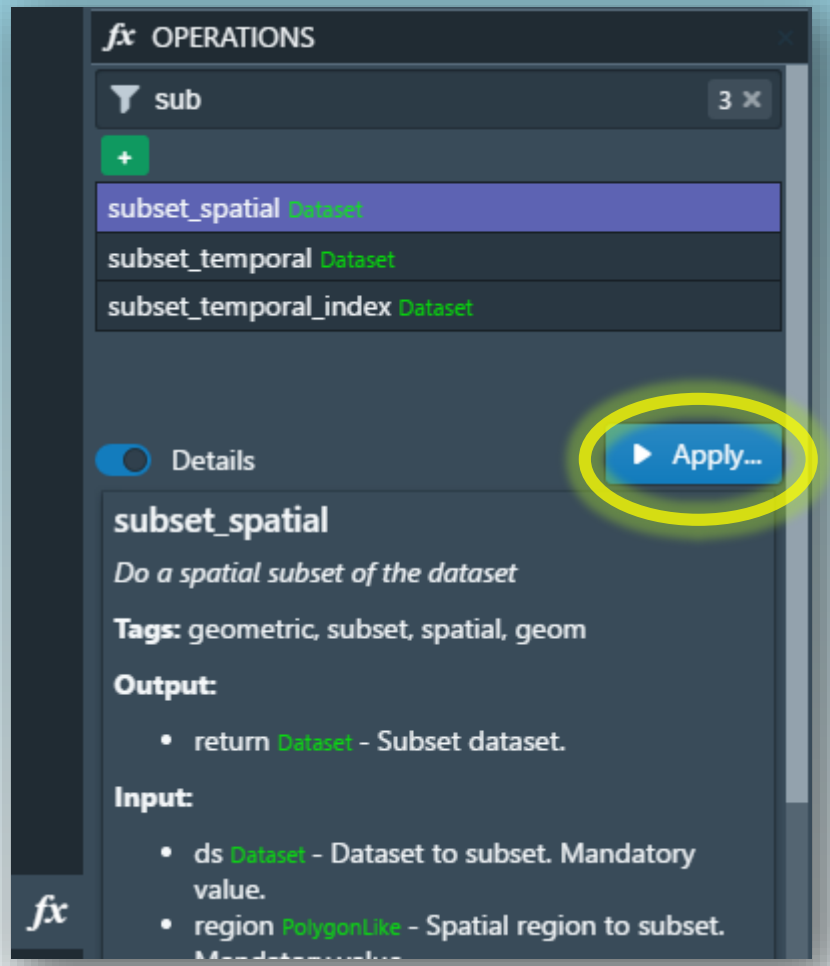
- CCI Toolbox comes with a **library of operations**
- Type to find operations, e.g. **sub**set



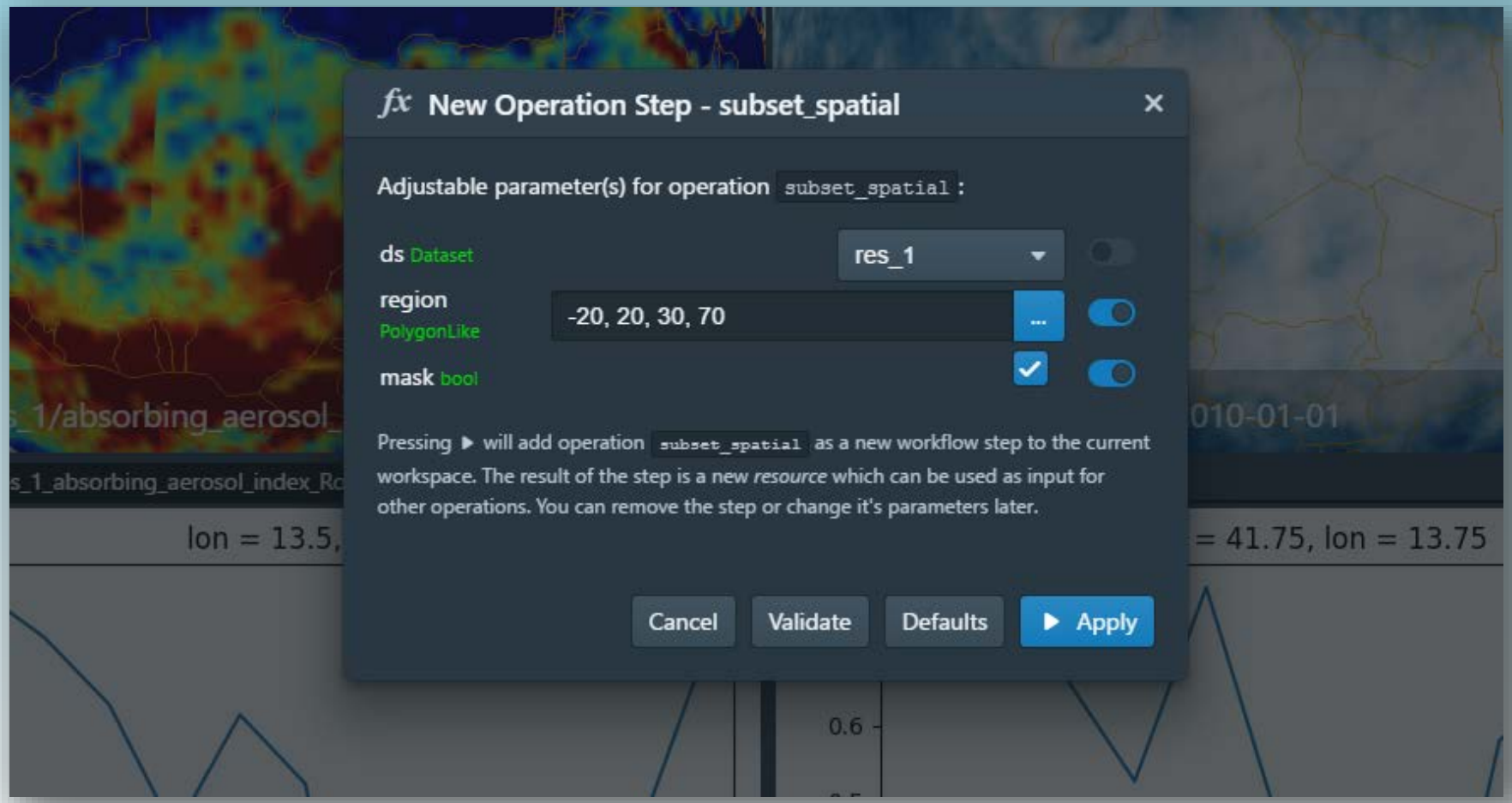
Data Analysis

- CCI Toolbox comes with a **library of operations**
- Type to find operations, e.g. **sub**set

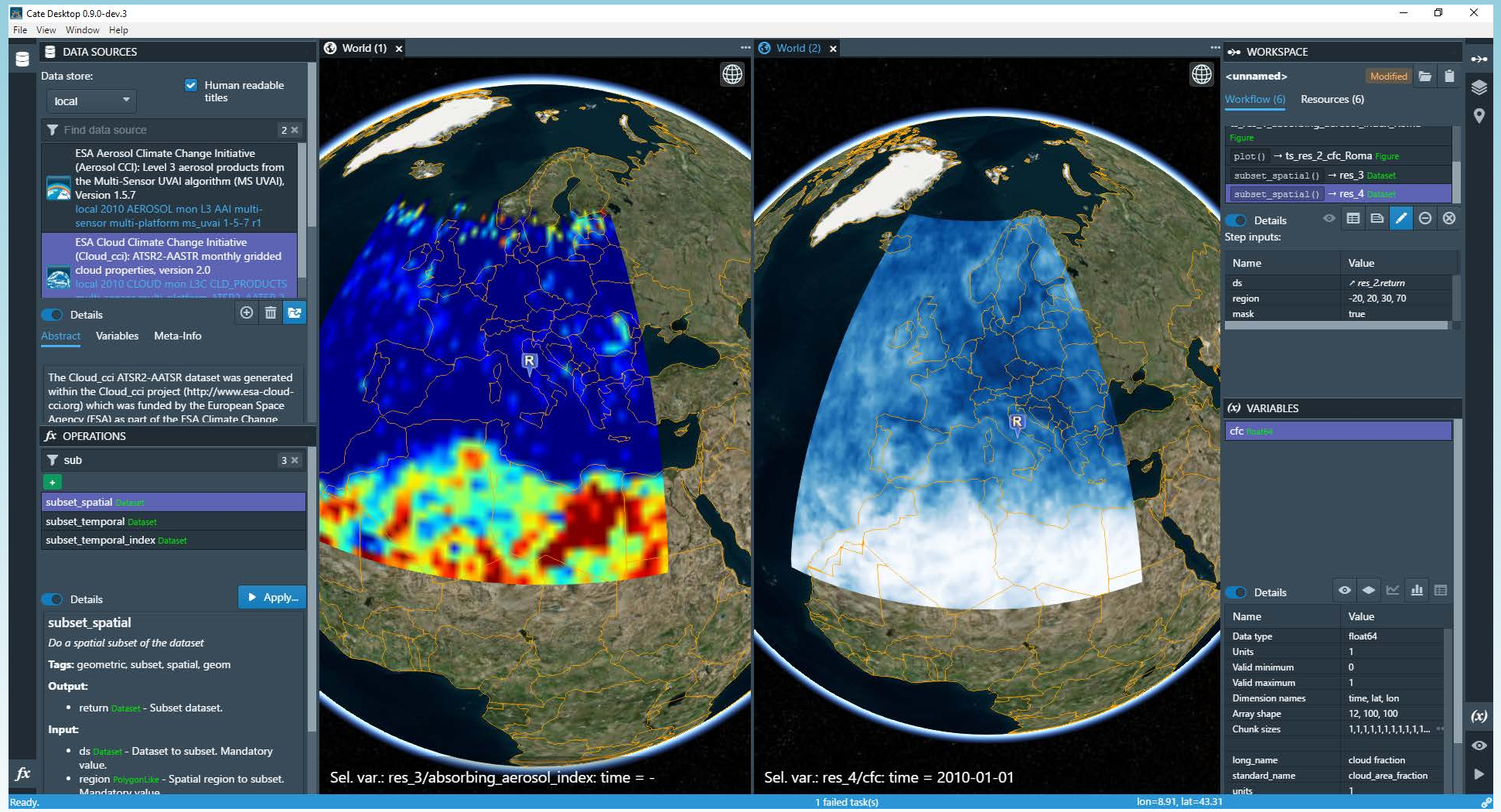
- Operations are usual **Python functions** – it is very **easy to implement your own!**
- An operation's user interface is generated on-the-fly



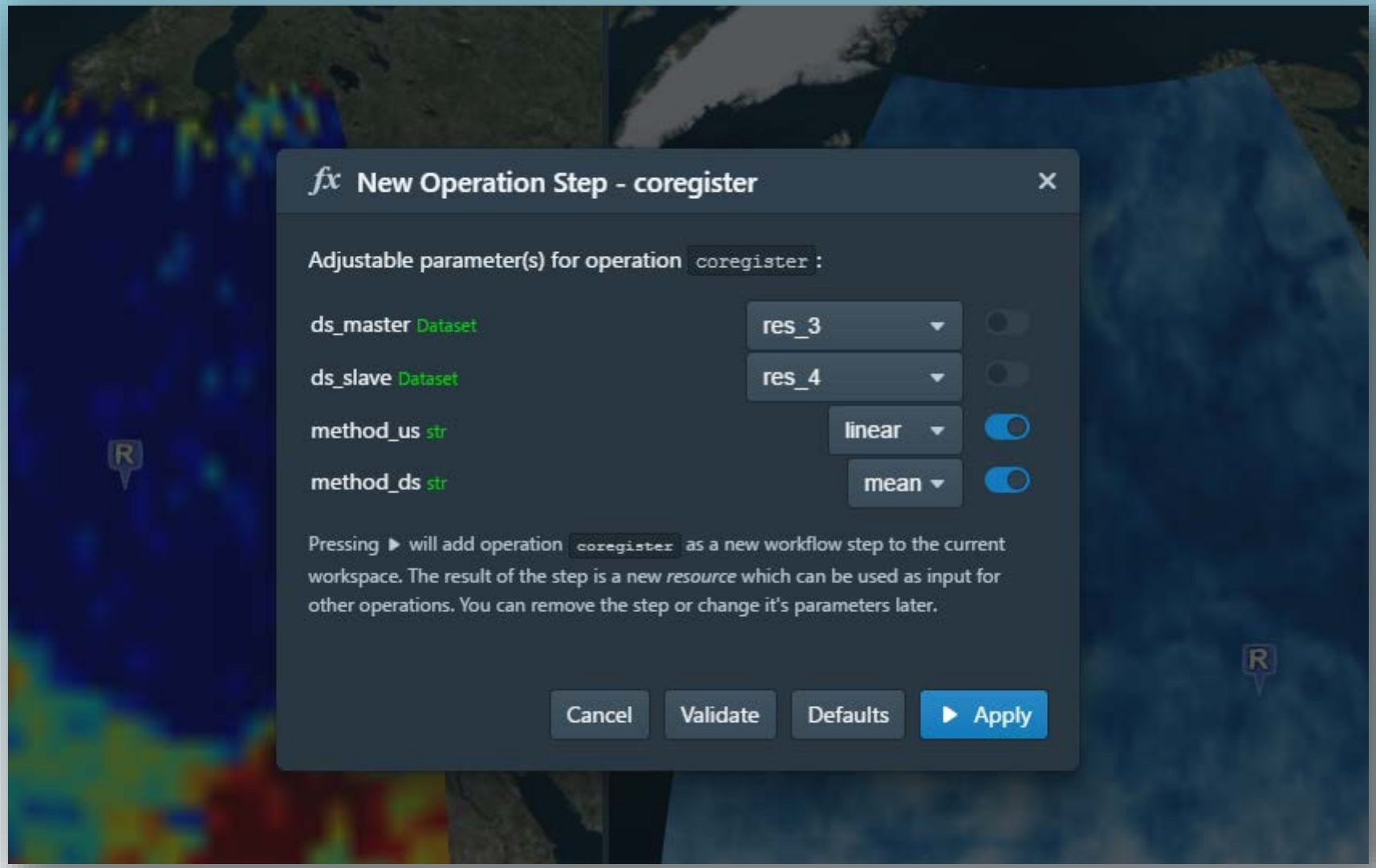
Spatial Subsetting



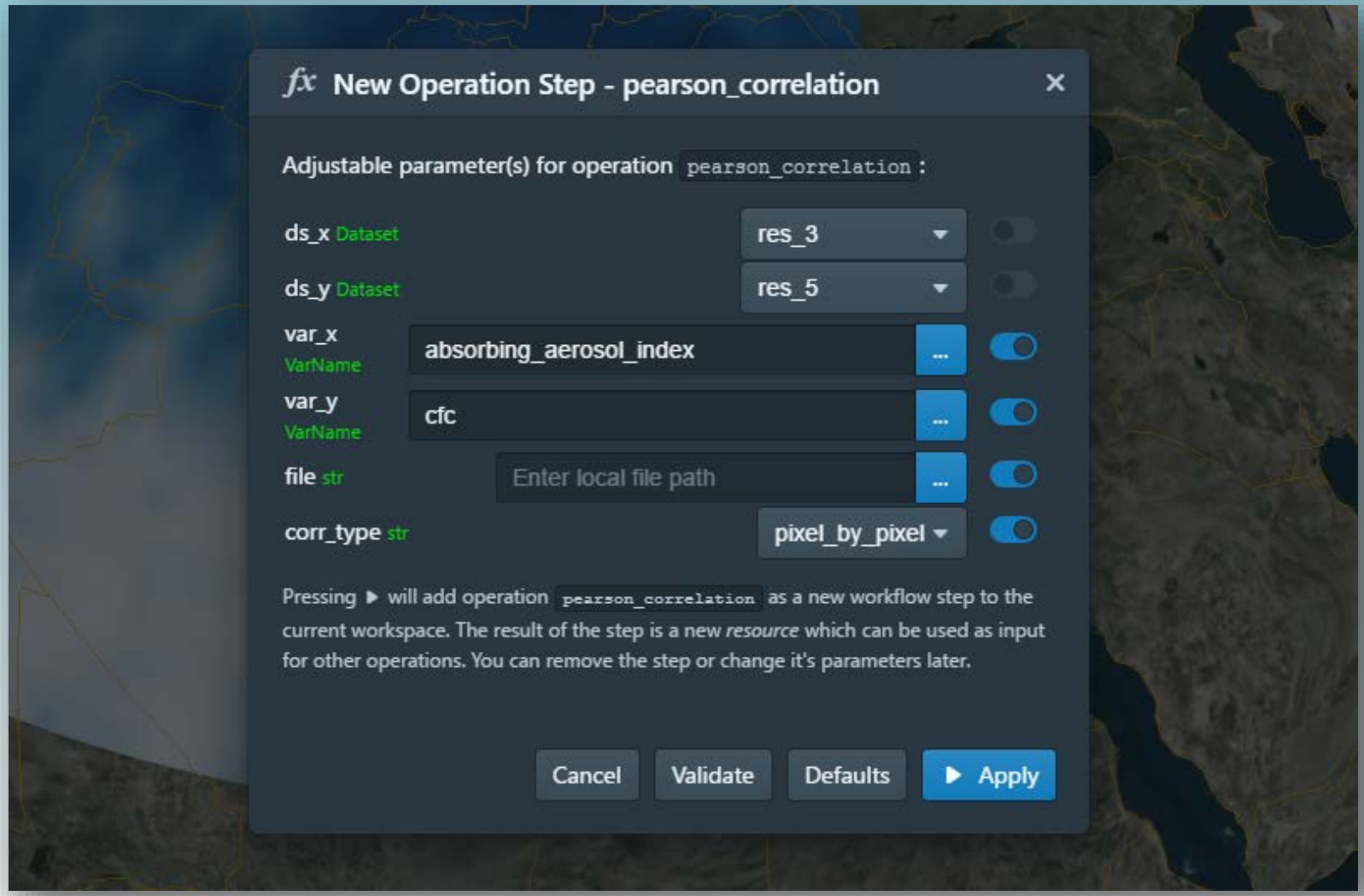
Spatial Subsetting



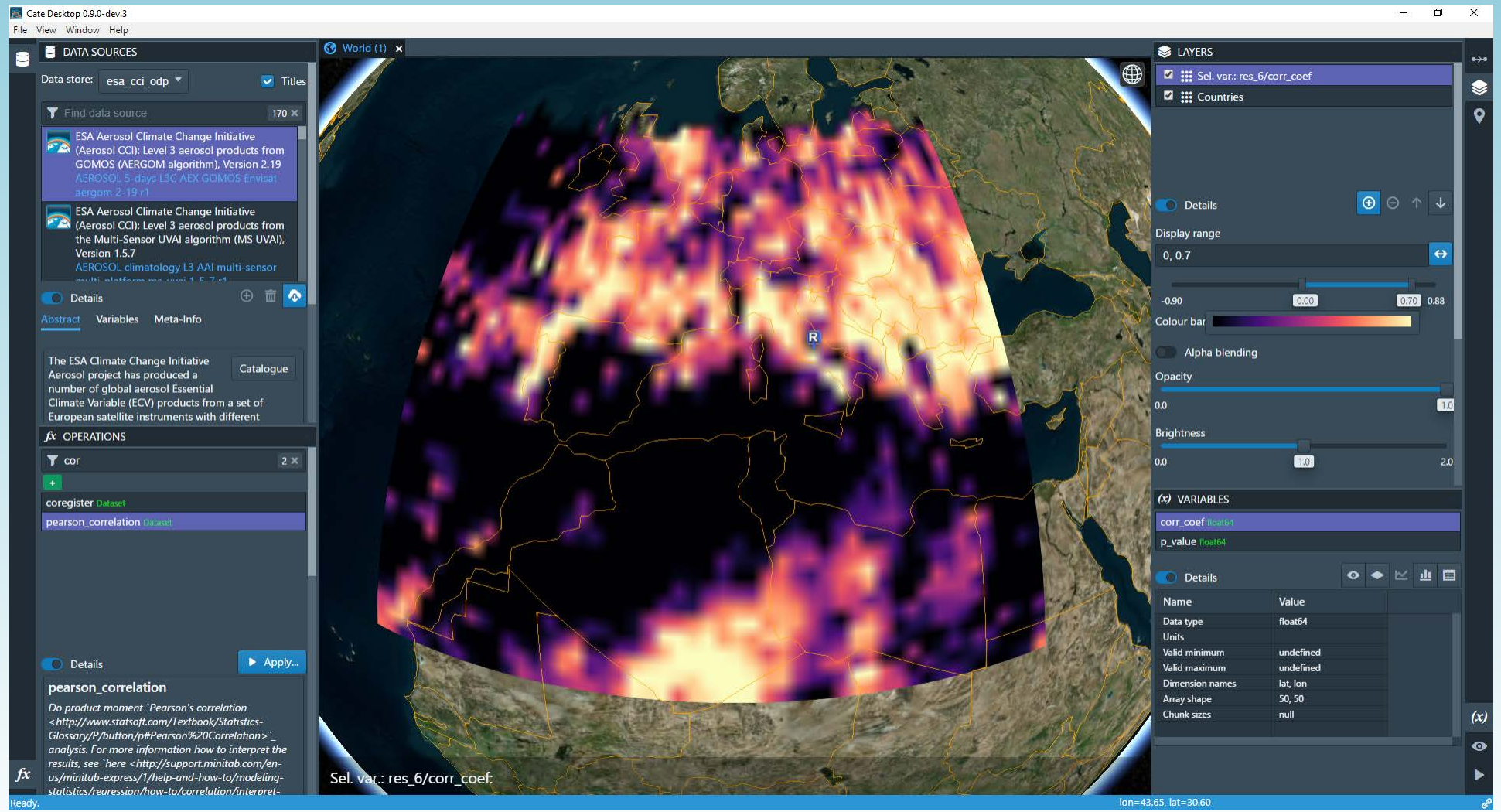
Dataset Co-registerion



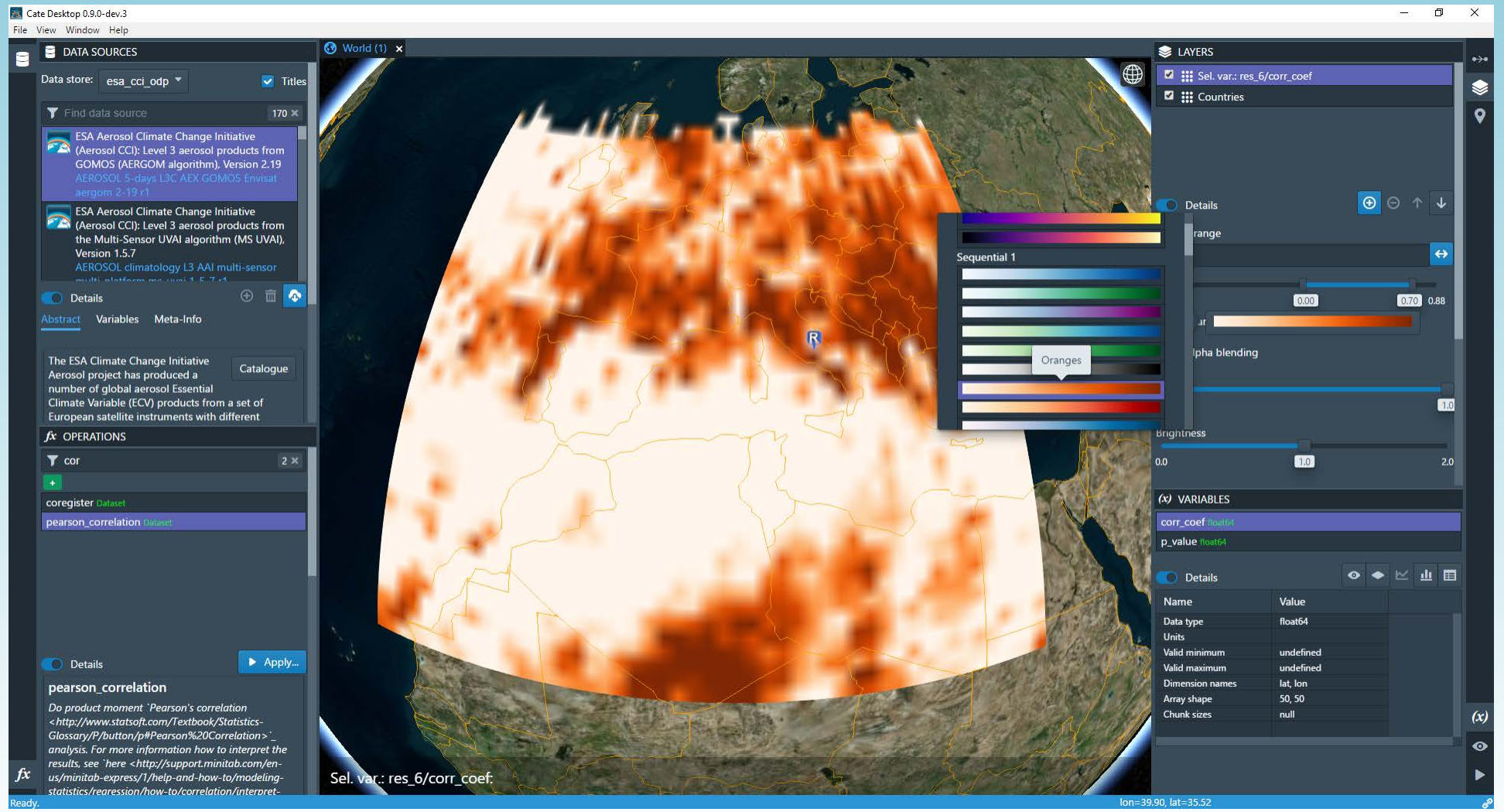
ECV Correlation



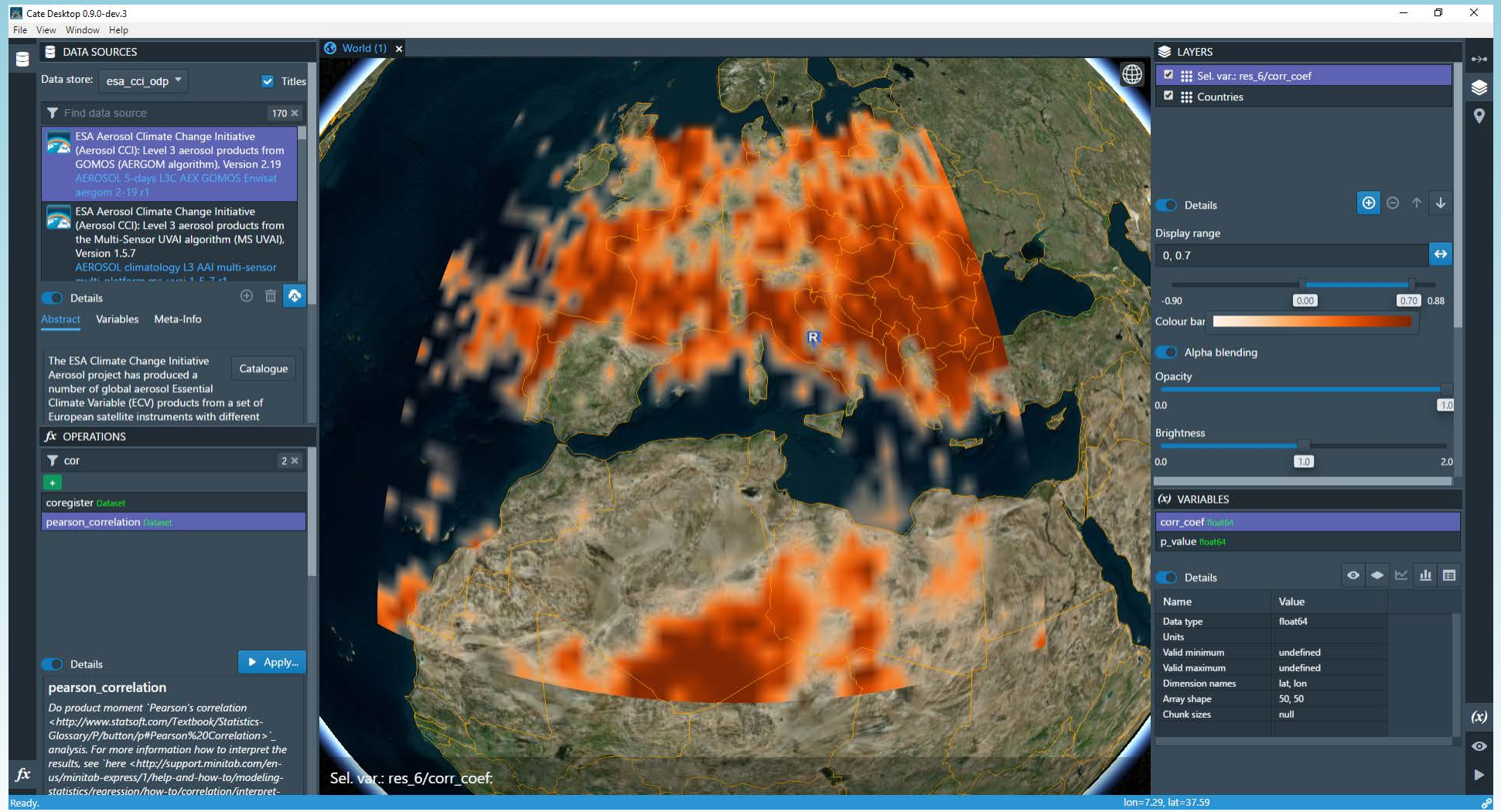
Aerosol/Cloud Correlation in 2010



Aerosol/Cloud Correlation in 2010



Aerosol/Cloud Correlation in 2010



Give it a Try!

- Releases (0.9.0.dev3)
  - https://github.com/CCI-Tools/cate-core/releases
- Source Code (MIT Open Source License)
  - https://github.com/CCI-Tools/cate-core
  - https://github.com/CCI-Tools/cate-desktop (GUI)
- Documentation
  - http://ect-core.readthedocs.io/en/latest/