Data Cubes for Water Quality

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DCS4COP

http://dcs4cop.eu

European Commission

DataBee

Brockmann Consult · Cefas · NIVA Norwegian Institute for Water Research · museum Operational Directorate Natural Environment OD Nature I OD Natuur I DO Nature · Starlab Living Science · University of Hull · LOV · Sorbonne Université · cnrs · vito

xcube

Centre for Environment Fisheries & Aquaculture Science

Cefas

Data Cubes for Water Quality

1. What is a data cube
2. Examples of datacubes at Cefas

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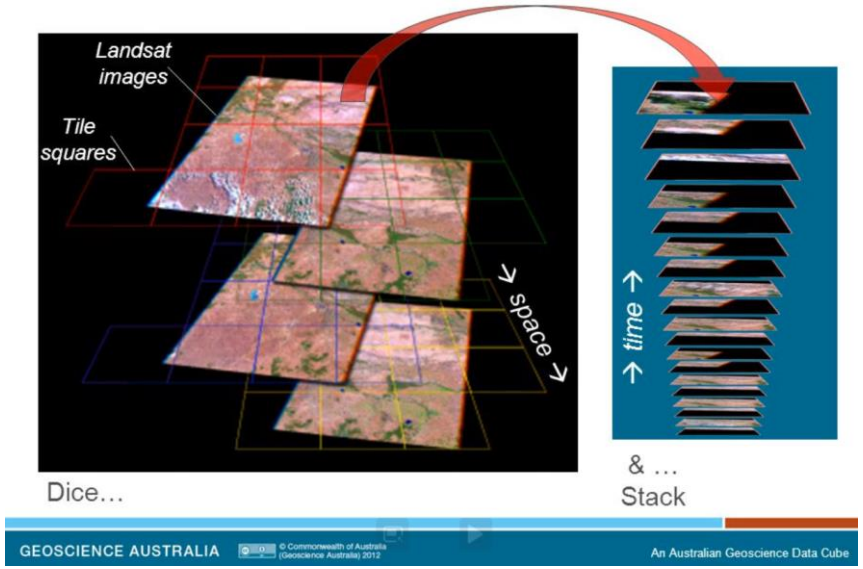
What is a Data Cube?

- A data repository on a shared grid
- Each variable is N-dimensional
- Operators can be applied in any dimension just a as easily
  - `Average('time')`, `Average('latitude')`, etc

Dim.	Array of point sensors	Satellite imagery	Ocean Model
1	Time	Time	Time
2	Location	Latitude	x
3		Longitude	y
4			Depth



Principles of the Data Cube Manifesto

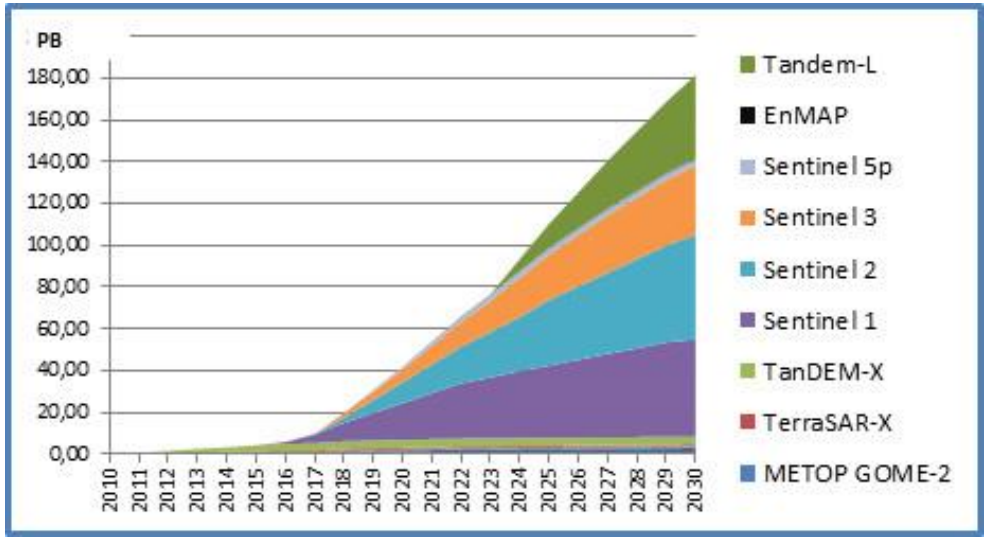
1. Gridded data with N dimensions
2. **All axes have equal treatment**
3. Efficient trimming and slicing in one request
4. **Similar performance across axes**
5. …partitioning (chunks)
6. Language that allows composite extraction, processing, filtering and fusion

https://earthserver.eu/tech/datacube-manifesto/

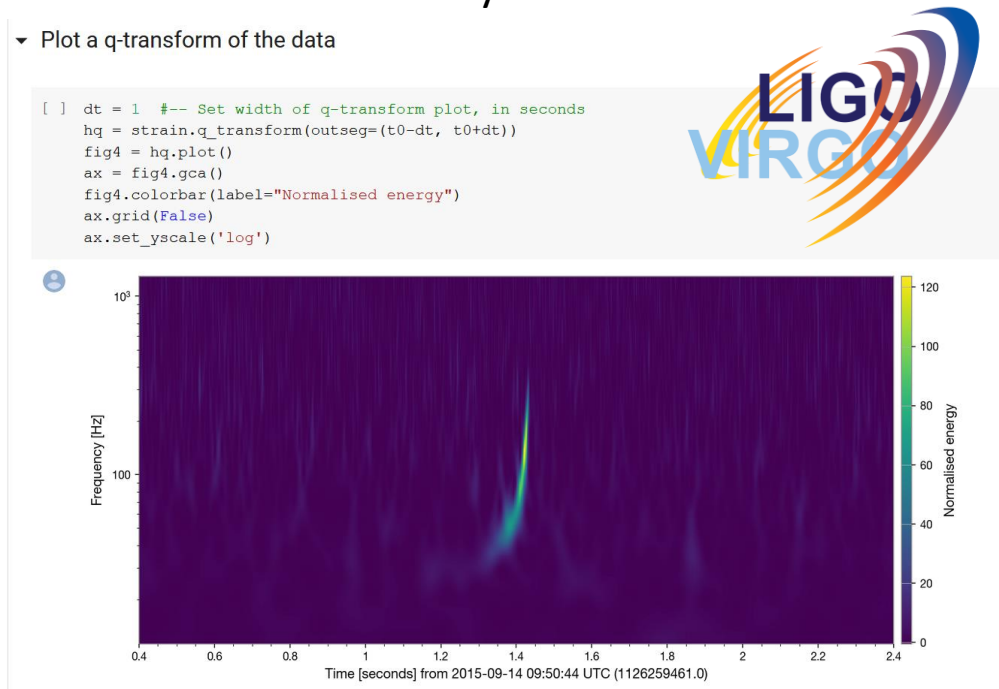
Motivation

- Keep up with data size growth.
  - Progressively harder for users to download and process locally
- Make the most of the data
  - Make it accessible *and* usable by providing the tools
- Reproducibility
  - fragmented workflow makes science impractical to reproduce
  - multiple software tools and environments

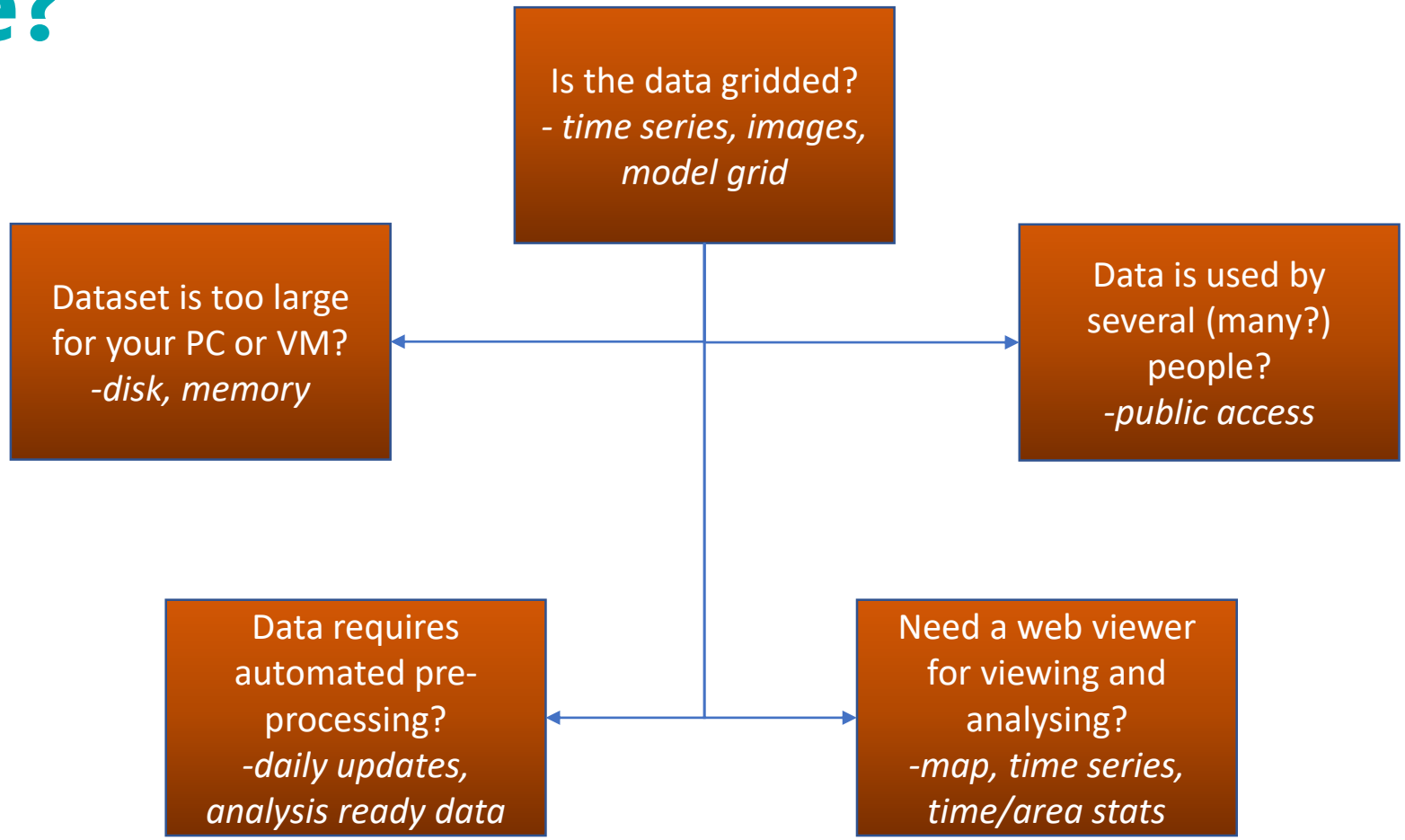
http://dlr.de



2017 Nobel Prize for Physics

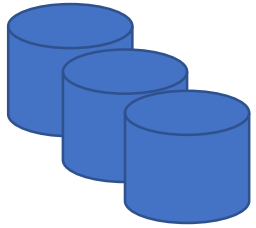


Could you benefit from using a Data Cube?



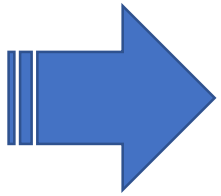
Data Cube Service

Image Files
netCDF, GeoTIFF

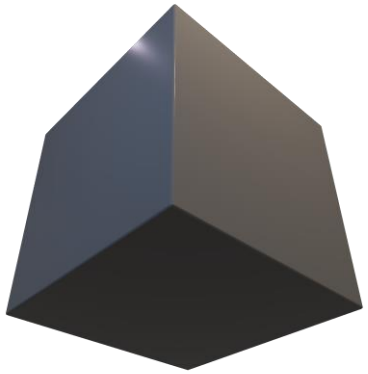


Pre-processing
to produce
Analysis Ready
Data

Generate
datacube



Common grid
Metadata
Chunking



File formats optimised
for cloud
Zarr, TileDB, HDF cloud
One Object has many
files

Data Cube Service

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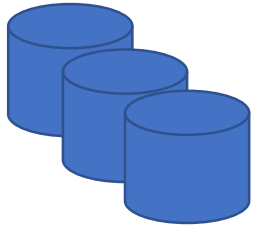

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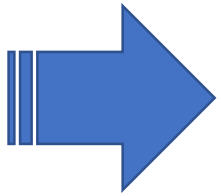

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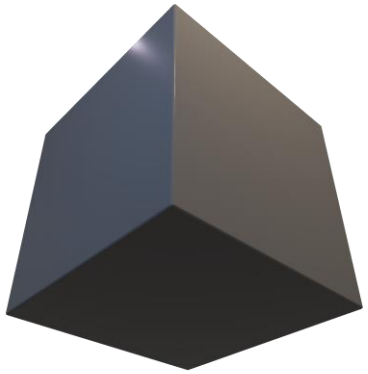

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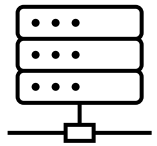
Server



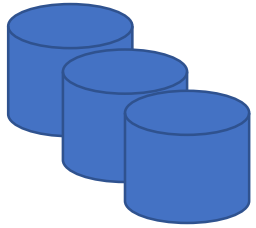
API

Data analysis

One dataset, several users

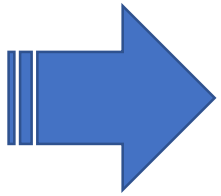
Data Cube Service

Image Files
netCDF, GeoTIFF



Pre-processing to produce Analysis Ready Data

Generate datacube



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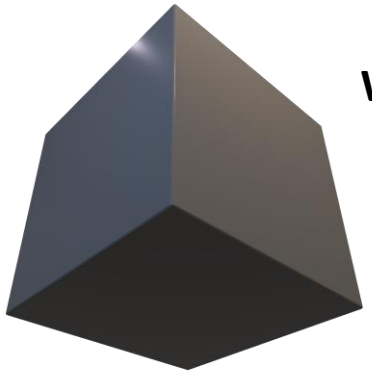

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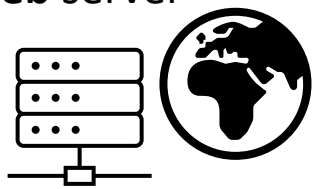
Web Viewer

Web server

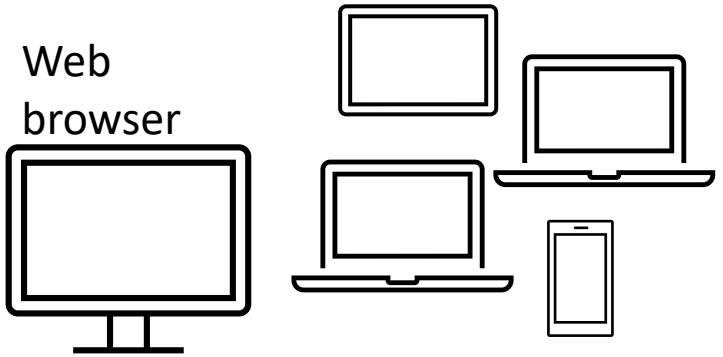


API

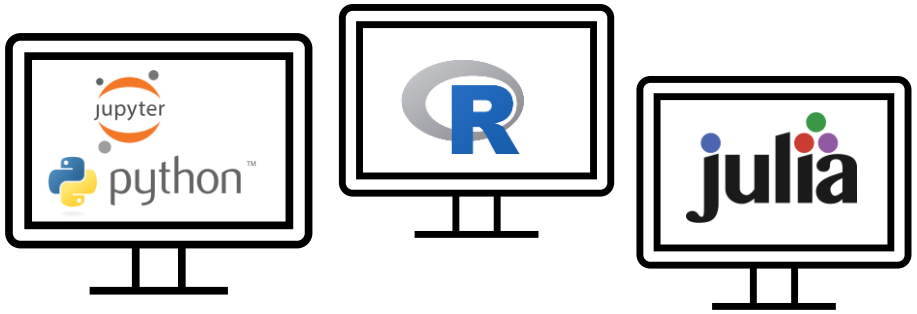
Web API

Data querying

Web browser



Data analysis



One dataset, **many** users for different use cases

earthserver.eu

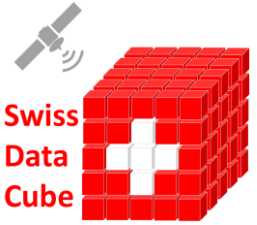
rasdaman
raster data manager

Baumann et al., 1997, 2016

www.opendatacube.org

github.com/opendatacube

Digital Earth
AUSTRALIA



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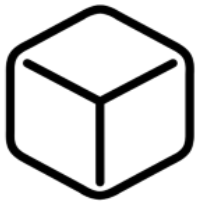


github.com/dcs4cop/xcube

EURO DATA CUBE

EARTHCUBE

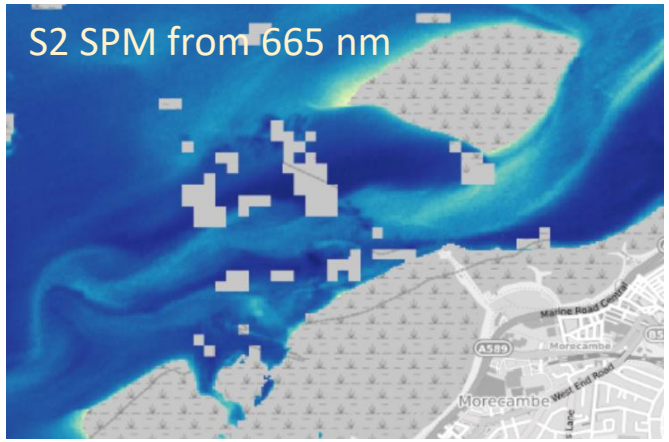
www.pangeo.io
github.com/pangeo-data
Signell and Pothina, 2019

Data Cube Usages in the Marine Domain

- Intertidal cycle, coastline change
- Deal with clouds, missing data: cloud-free mosaics, robust statistics
- Area statistics: environmental assessments
- Temporal classification: water types, river plumes
- Explore multiple algorithms on-the-fly:

  Multiband indexes, fitted inversions
- Combine multiple satellite sensors

Intertidal DEM
Digital Earth Australia



Pixels as set of independent observations

- Vary in time, space, and uncertainty
- Combine them to increase accuracy

Water Quality Data Cubes at Cefas

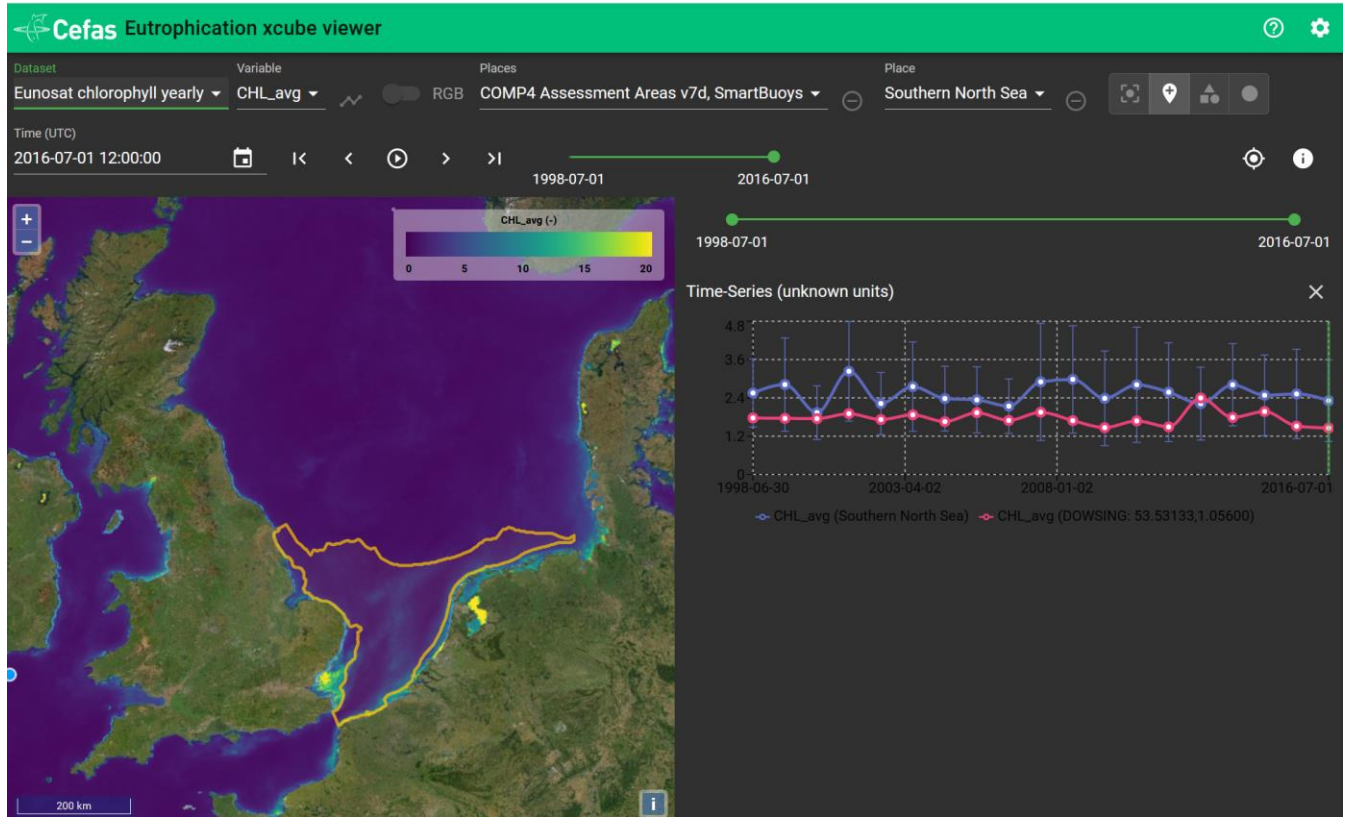
I. MSFD Eutrophication Assessment

II. WFD Eutrophication Risk

III. Marine Discharge Plumes

I . MSFD Eutrophication Assessment

- Chlorophyll observations
  - EUNOSAT coherent algorithm
  - CMEMS standard
- COMP4 Assessment Areas
- SmartBuoy locations



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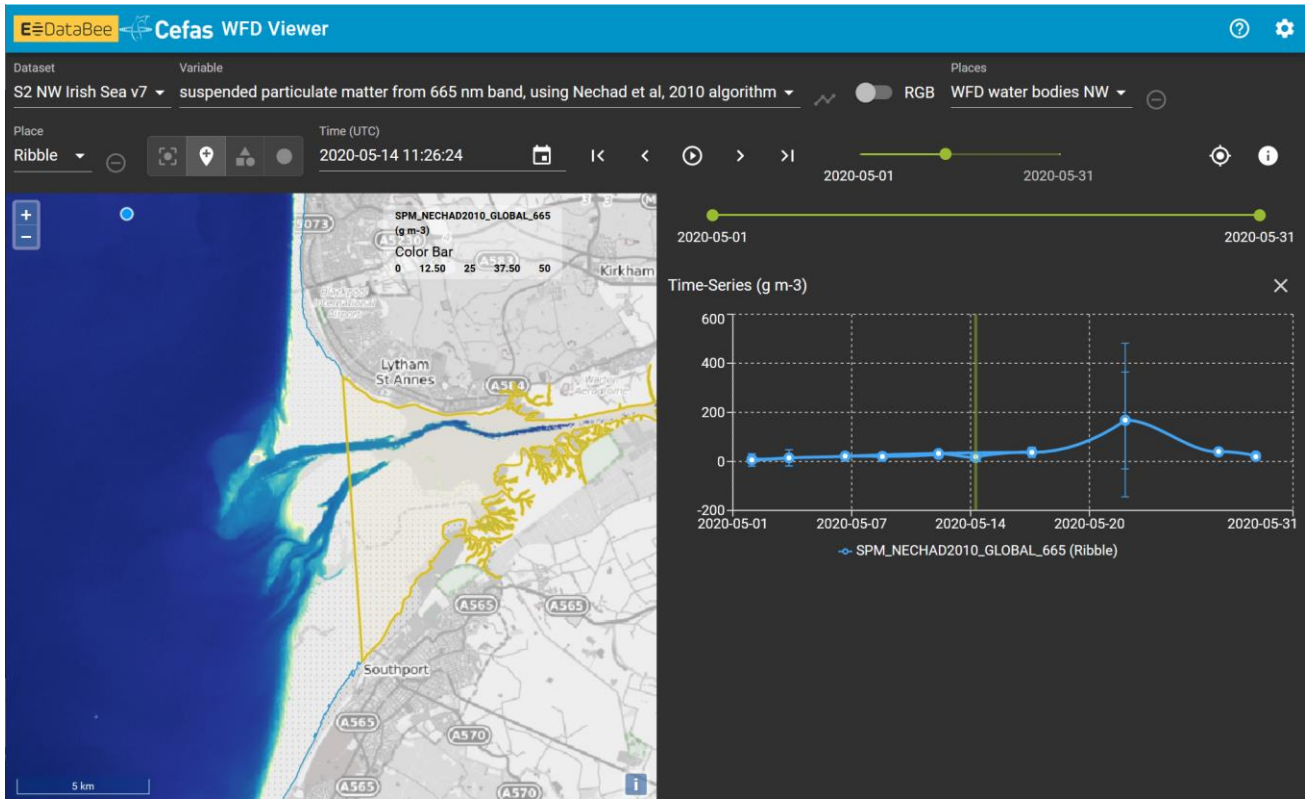
II . WFD Eutrophication Risk

- Sentinel-2 (10 m) Suspended Particulate Matter/Turbidity
  - Multiple bands and algorithms
- WFD Water bodies
- EA Water Quality Data Archive
  - *Aim is to integrate with* in-situ



Environment Agency

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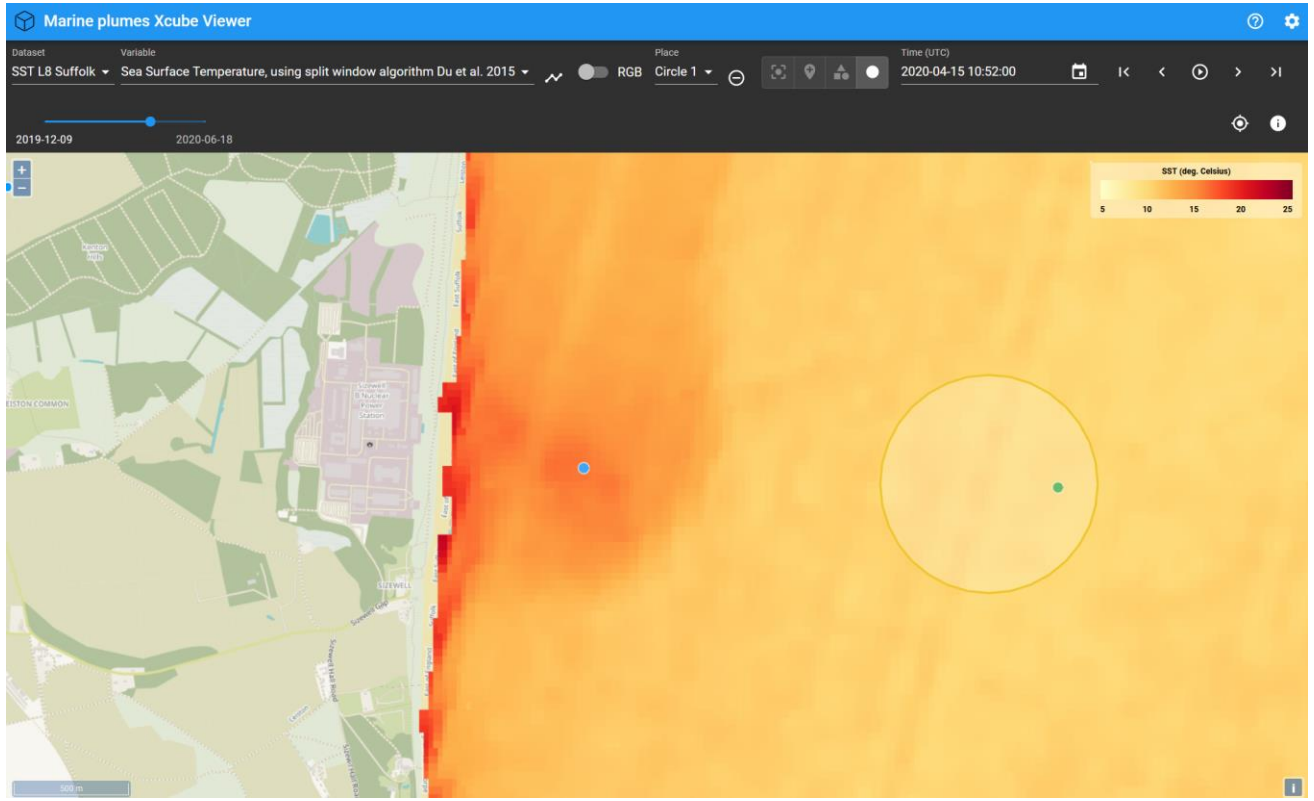
III . Marine Discharge Plumes

- High Resolution Sea Surface Temperature (100 m)
  - *Atmospheric correction*
- Power station Intakes and outfalls
- Protected Areas
- *Automatic detection of plume*
- *In situ* SST



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Thank you for your attention

tiago.silva@cefas.co.uk

Together we are working for **a sustainable blue future**

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