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Interoperable Workflow Efficiency: Exploring the Integration of OpenEO, CWL , and EOEPCA for Seamless Data Processing and Modeling

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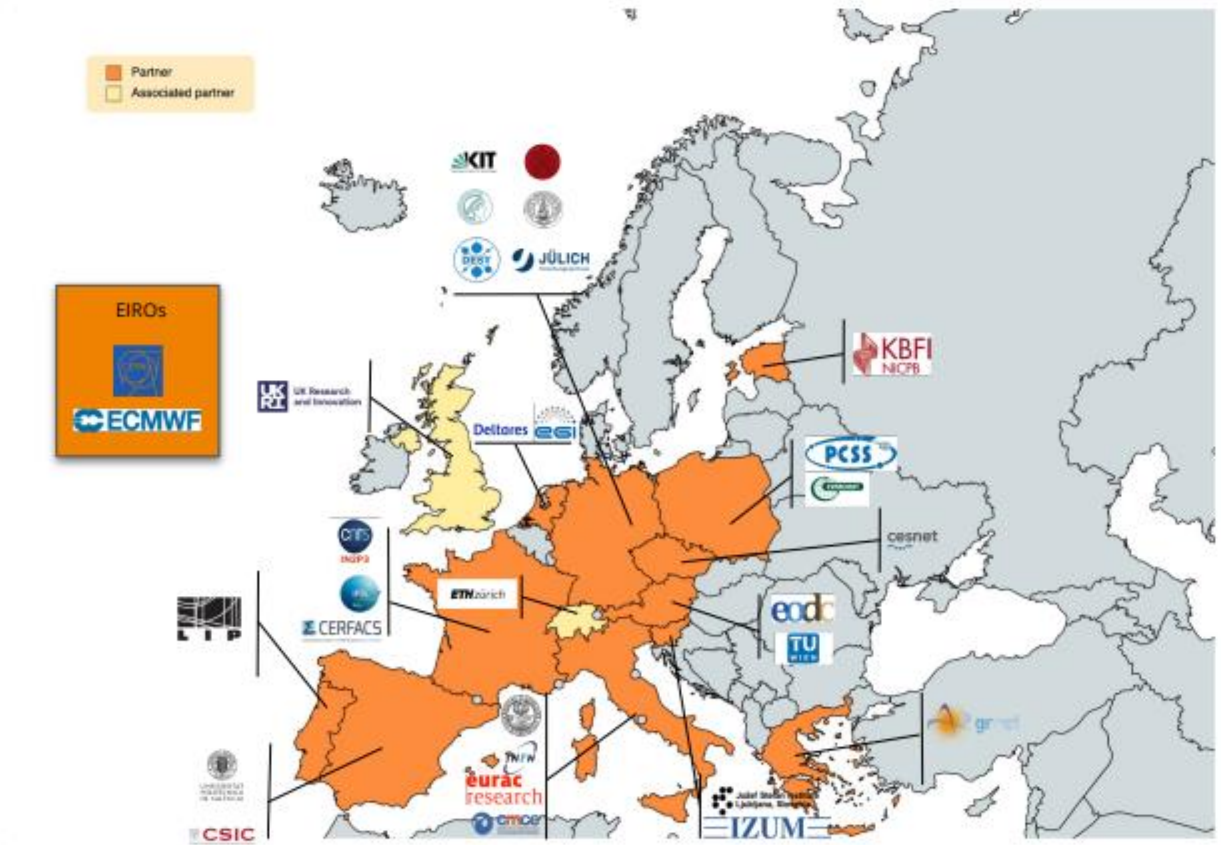
EGI 2024

Agenda

1. OpenEO
2. Interoperable workflows with CWL
3. EOEPCA ZOO-Project-DRU
4. Towards integration
5. Use case example

InterTwin (2022-2025)

An interdisciplinary Digital Twin Engine for science



Source: Andrea Manzi, EuroGeo Workshop 2023

interTwin

egi Advanced Computing for Research

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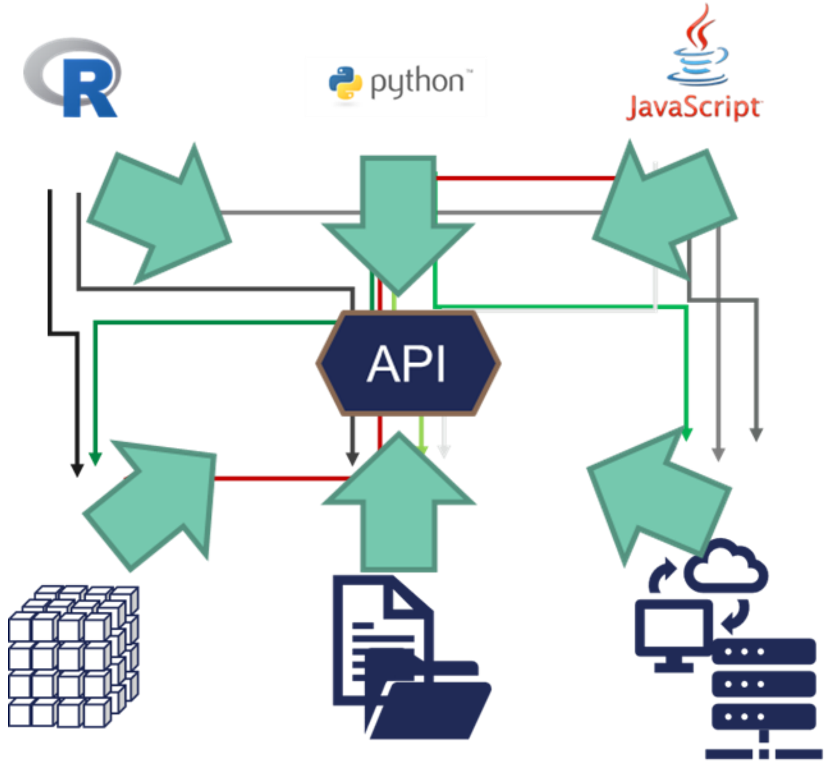
OpenEO

OpenEO API

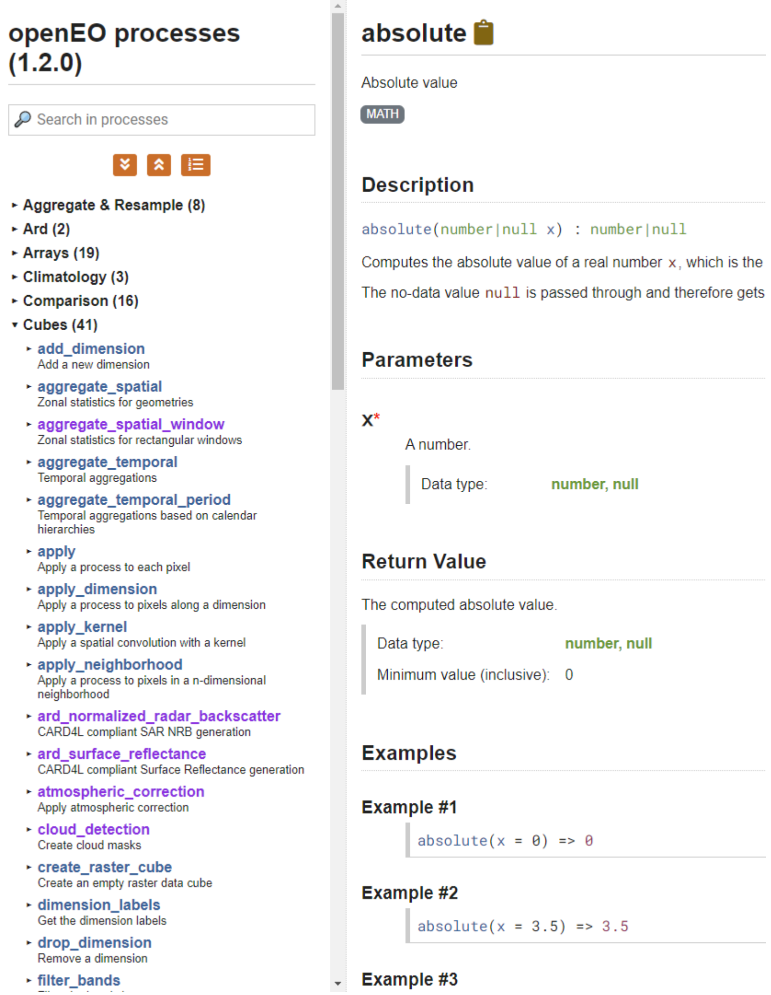
- OpenAPI specification

- Data discovery
- Auth
- Data Processing
- Workflow management
- Data export



OpenEO Processes

- Pre-defined processes
  - processes.openeo.org
  - JSON Schema
- User-defined processes
  - Combining existing processes
- User-defined functions
  - Run custom code (Python, R)
  - Several runtimes available
  - Docker images



openEO processes (1.2.0)

Search in processes

- Aggregate & Resample (8)
- Ard (2)
- Arrays (19)
- Climatology (3)
- Comparison (16)
- Cubes (41)
  - add_dimension
    Add a new dimension
  - aggregate_spatial
    Zonal statistics for geometries
  - aggregate_spatial_window
    Zonal statistics for rectangular windows
  - aggregate_temporal
    Temporal aggregations
  - aggregate_temporal_period
    Temporal aggregations based on calendar hierarchies
  - apply
    Apply a process to each pixel
  - apply_dimension
    Apply a process to pixels along a dimension
  - apply_kernel
    Apply a spatial convolution with a kernel
  - apply_neighborhood
    Apply a process to pixels in a n-dimensional neighborhood
  - ard_normalized_radar_backscatter
    CARD4L compliant SAR NRB generation
  - ard_surface_reflectance
    CARD4L compliant Surface Reflectance generation
  - atmospheric_correction
    Apply atmospheric correction
  - cloud_detection
    Create cloud masks
  - create_raster_cube
    Create an empty raster data cube
  - dimension_labels
    Get the dimension labels
  - drop_dimension
    Remove a dimension
  - filter_bands

absolute

Absolute value

MATH

Description

`absolute(number|null x) : number|null`

Computes the absolute value of a real number `x`, which is the

The no-data value `null` is passed through and therefore gets

Parameters

x*

A number.

Data type: number, null

Return Value

The computed absolute value.

Data type: number, null

Minimum value (inclusive): 0

Examples

Example #1

```
absolute(x = 0) => 0
```

Example #2

```
absolute(x = 3.5) => 3.5
```

Example #3

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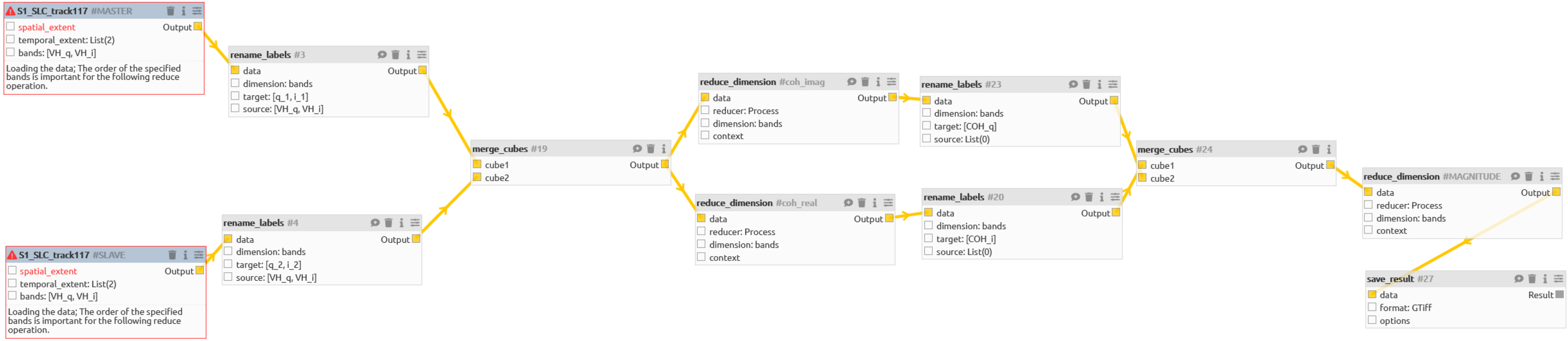
OpenEO Processes Graph



S1_SLC_track117 #MASTER

- □ spatial_extent — Output
- □ temporal_extent: List(2)
- □ bands: [VH_q, VH_i]

Loading the data; The order of the specified bands is important for the following reduce operation.

S1_SLC_track117 #SLAVE

- □ spatial_extent — Output
- □ temporal_extent: List(2)
- □ bands: [VH_q, VH_i]

Loading the data; The order of the specified bands is important for the following reduce operation.

rename_labels #3

- data — Output
- □ dimension: bands
- □ target: [q_1, i_1]
- □ source: [VH_q, VH_i]

rename_labels #4

- data — Output
- □ dimension: bands
- □ target: [q_2, i_2]
- □ source: [VH_q, VH_i]

merge_cubes #19

- cube1 — Output
- cube2

reduce_dimension #coh_imag

- data — Output
- □ reducer: Process
- □ dimension: bands
- □ context

reduce_dimension #coh_real

- data — Output
- □ reducer: Process
- □ dimension: bands
- □ context

rename_labels #23

- data — Output
- □ dimension: bands
- □ target: [COH_q]
- □ source: List(0)

rename_labels #20

- data — Output
- □ dimension: bands
- □ target: [COH_i]
- □ source: List(0)

merge_cubes #24

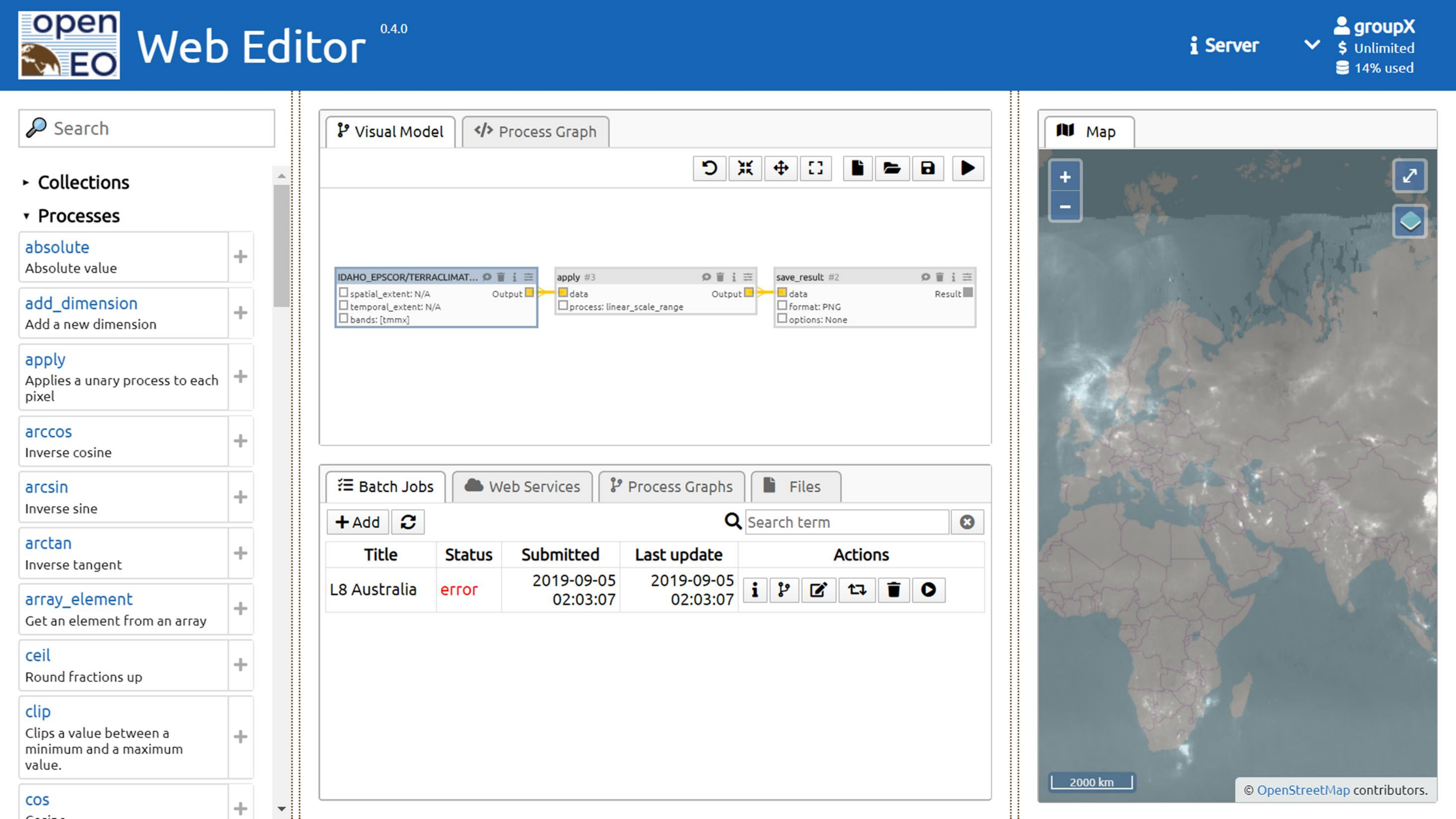
- cube1 — Output
- cube2

reduce_dimension #MAGNITUDE

- data — Output
- □ reducer: Process
- □ dimension: bands
- □ context

save_result #27

- data — Result
- □ format: GTiff
- □ options



absolute
Absolute value

add_dimension
Add a new dimension

apply
Applies a unary process to each pixel

arccos
Inverse cosine

arcsin
Inverse sine

arctan
Inverse tangent

array_element
Get an element from an array

ceil
Round fractions up

clip
Clips a value between a minimum and a maximum value.

cos

IDAHO_EPSCOR/TERRACLIMAT...
□ spatial_extent: N/A
□ temporal_extent: N/A
□ bands: [tmmx]
Output

apply #3
data
□ process: linear_scale_range
Output

save_result #2
data
□ format: PNG
□ options: None
Result

Title	Status	Submitted	Last update	Actions
L8 Australia	error	2019-09-05 02:03:07	2019-09-05 02:03:07	

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Common Workflow Language (CWL)

COMMON WORKFLOW LANGUAGE

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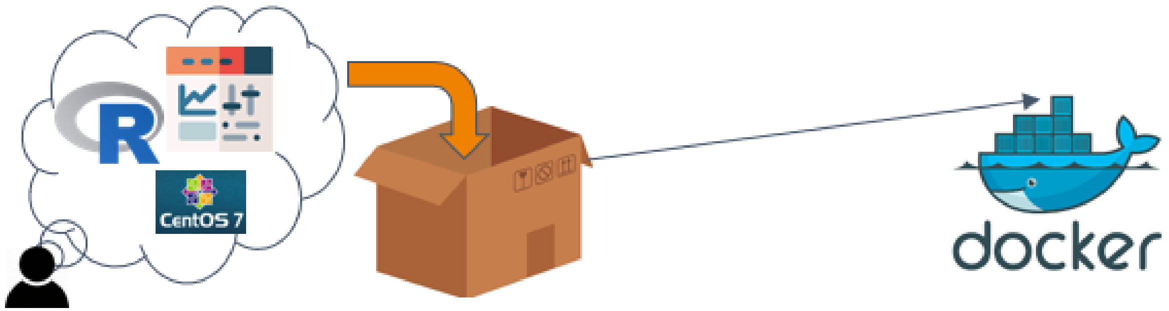
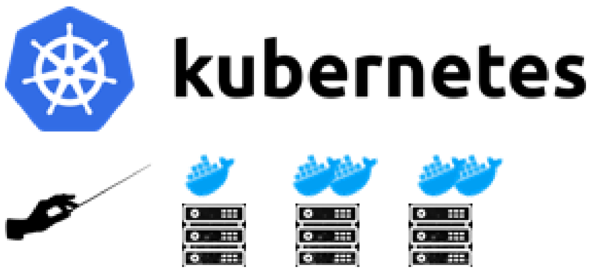
CWL

- Common Workflow Language (CWL) is an **open standard** for describing how to run command line tools and connect them **to create workflows**.

- Using CWL, it is easy to scale complex data analysis and machine learning workflows from a single developer's laptop up to massively parallel cluster, cloud and high-performance computing environments.

OGC Application Package





Container: unit of software, packaging a given code and all its dependencies.

Docker: platform designed to create and manage containers, repos of containers, etc.

Container orchestration tool to execute containers across computing resources.

- ➢ By packaging our applications and wrapping them in CWL we can automatically deploy across various processing infrastructures
- ➢ Container orchestration allows us to scale across the available infrastructure
- ➢ Well defined data input & output through STAC collections

Earth
Observation
Exploitation
Platform
Common
Architecture

EOEPCA
BETTER ACCESS TO EARTH OBSERVATION

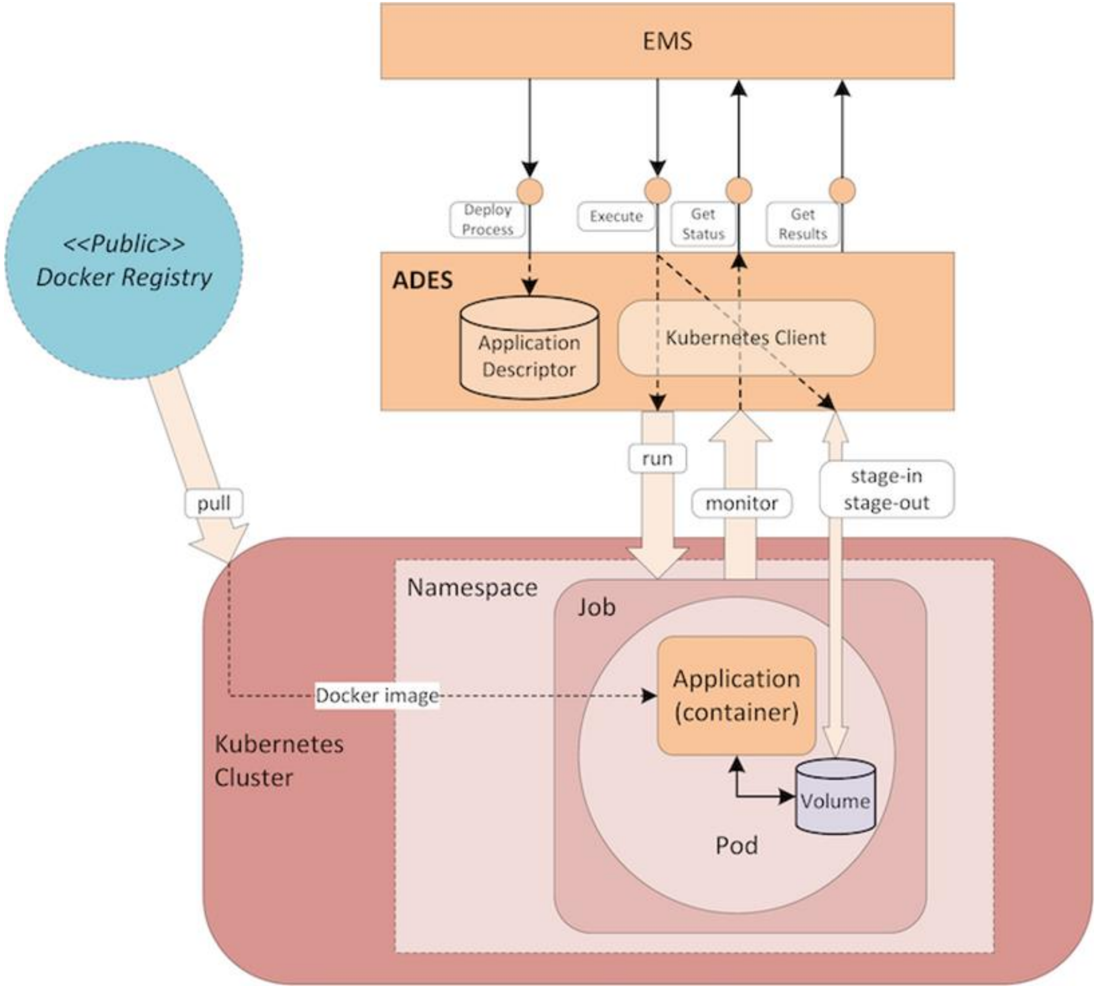
ZOO-Project-DRU

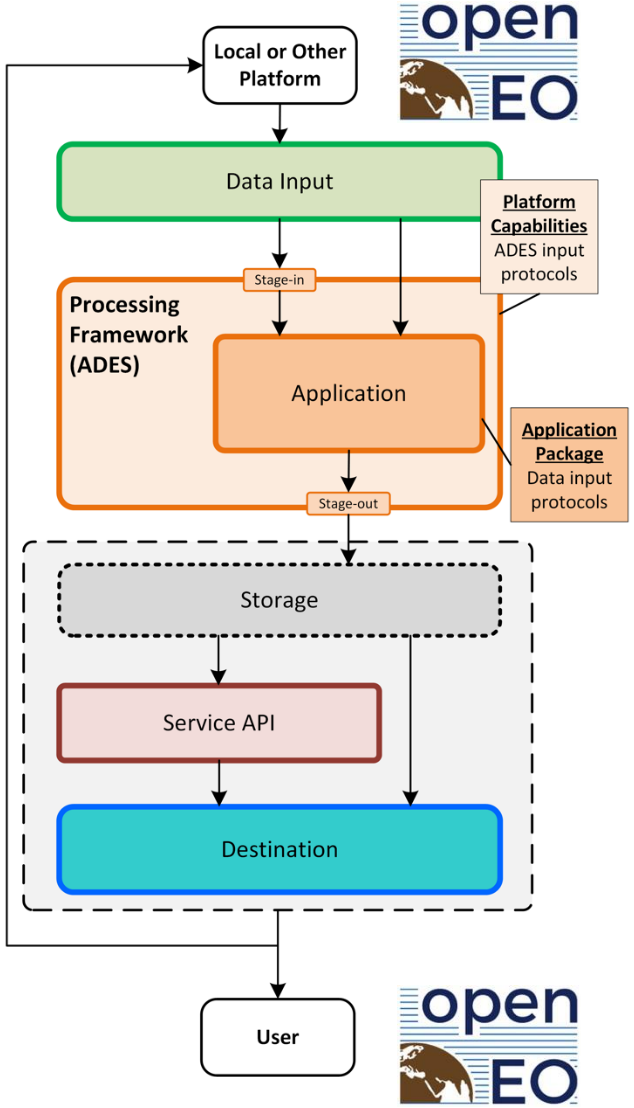
- ➢Developed as part of the Earth Observation Exploitation Platform Common Architecture (EOEPCA)

- ➢The ZOO-Project is an open-source processing platform

- ➢ZOO-Kernel, a server implementation of the Web Processing Service (WPS) (1.0.0 and 2.0.0) and the OGC API - Processes standards published by the OGC.

ZOO-Project-DRU





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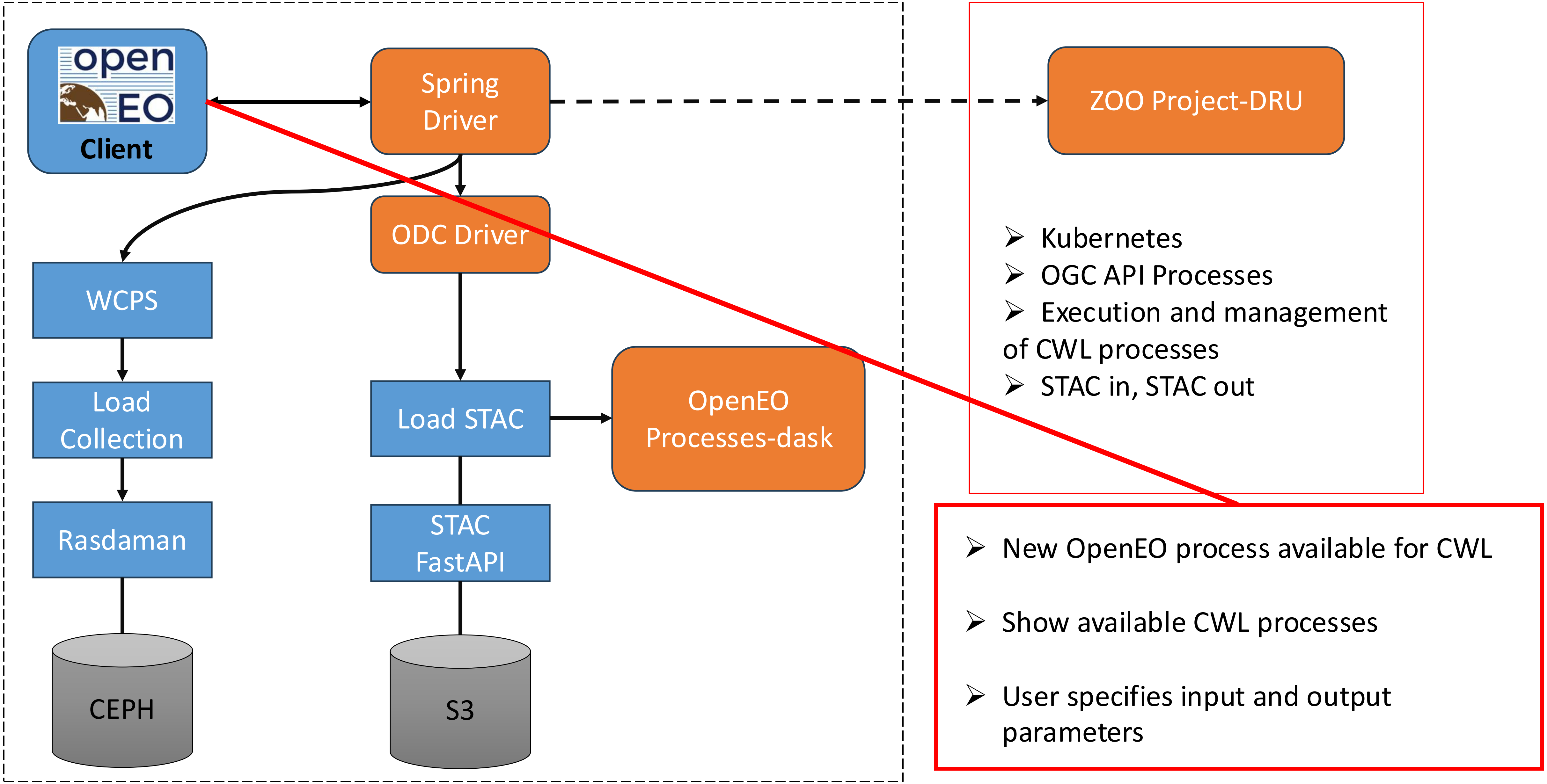
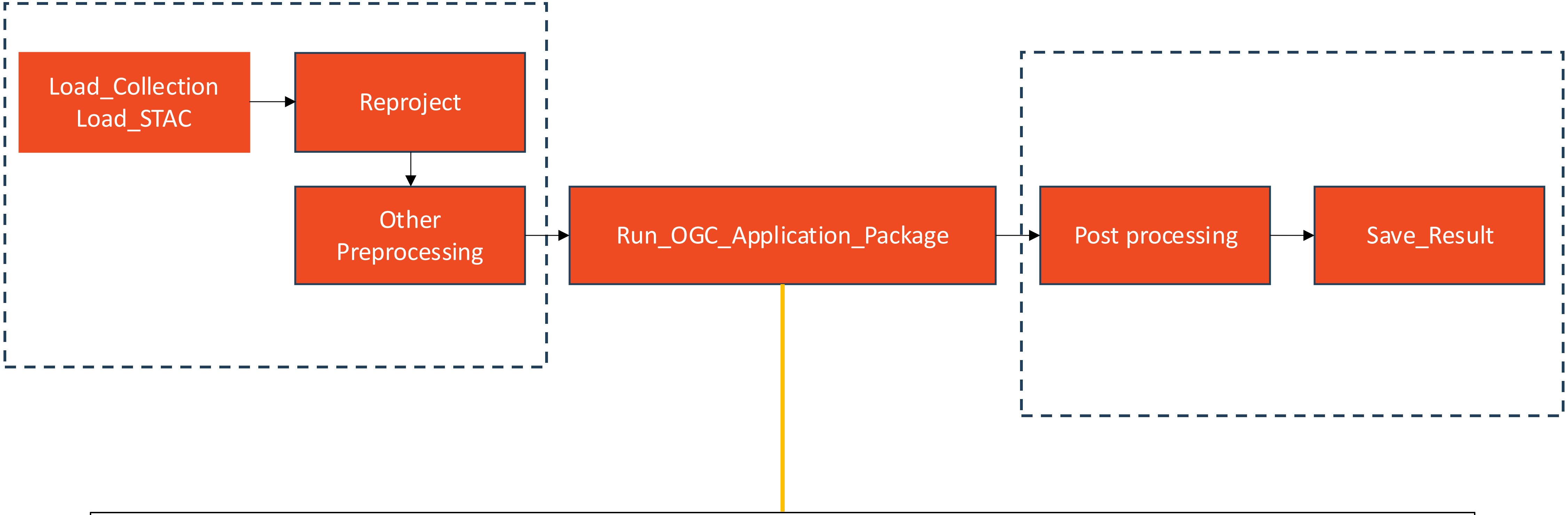
Towards Integration



- Kubernetes
- OGC API Processes
- Execution and management of CWL processes
- STAC in, STAC out

- New OpenEO process available for CWL
- Show available CWL processes
- User specifies input and output parameters

Sample Process Graph



The JSON Process graph is **split**, and the processing is redirected to the CWL executor to run the Application Package, returns a result back to OpenEO for postprocessing

Example use case: HyDroForM

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HyDroForM

- ➢Hydrological Drought Forecasting Model with HydroMT and Wflow

- ➢Preprocess data with OpenEO, and run CWL to build the model

- ➢GitHub [repo]() (WIP)

- InterTwin GitHub: interTwin Community (github.com)
- HyDroForM: interTwin-eu/HyDroForM: Hydrological Drought Forecasting Model with HydroMT and Wflow (github.com)
- Deltares HydroMT: HydroMT: Automated and reproducible model building and analysis — HydroMT documentation (deltares.github.io)
- OGC Application Package Best Practices: OGC Best Practice for Earth Observation Application Package
- Application Package Hands on tutorial: Terradue/ogc-eo-application-package-hands-on: OGC EO Application Package Hands-on (github.com)
- CWL: https://www.commonwl.org/
- EOEPCA: Earth Observation Exploitation Platform Common Architecture - EOEPCA Portal
- ZOO-Project-DRU: https://github.com/ZOO-Project/ZOO-Project

Thank you!