Actinia: Cloud based geoprocessing

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Session 3 - Interactive processing and visualisation

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Team of mundialis

Dr. Fabian Löw (EO-Optical) Hinrich Paulsen (Management & Finance)
Till Adams (Community & Sales)
Jan Orzekowski (IT) Sören Gebbert (Cloud & Development)
Stefan Cerfontaine (Design) Charlotte Eberz (Project management)
Anika Bettge (Development) Dr. Hajar Benecaldi (EO-Radar)
Dr. Markus Metz (BigData & Algorithms) Carmen Tawalika (Development)
Dr. Markus Neteler (BigData & Research)

- Founded in 2015, Bonn based
- Focus on geospatial data analysis and Earth observation
- Open Source developers

Our toolbox – open source stack

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SNAP

SNAPPY

GRASS GIS

OSGeo Project

QGIS

actinia

GDAL

docker

GeoServer

ORFEO ToolBox

cnes

CENTRE NATIONAL D'ÉTUDES SPATIALES

scikits learn

machine learning in Python

SHOGun

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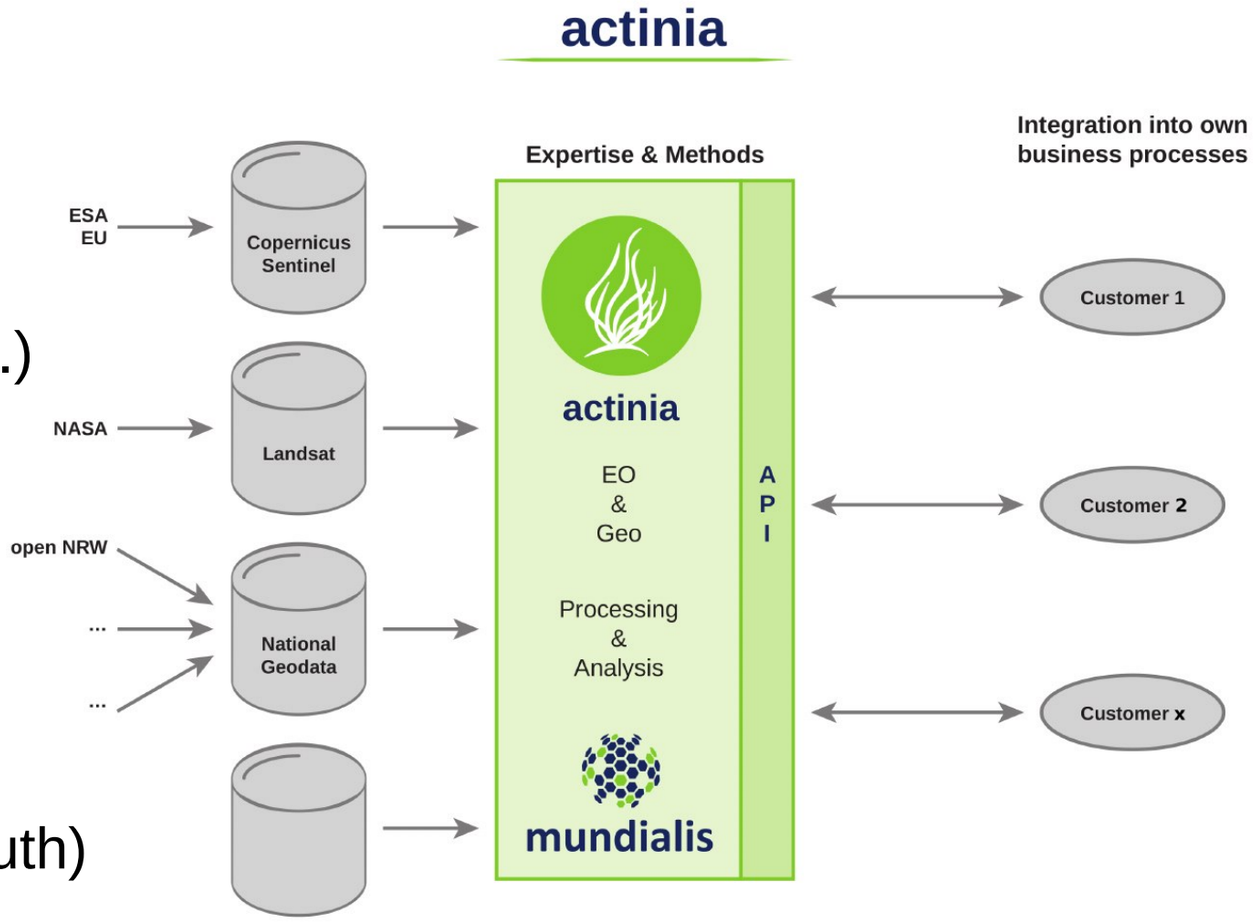
open source geo-processing

actinia – geoprocessing Engine

- **cloud** based geoprocessing API & engine
- focus on **spatio-temporal analysis**
- **scalable** (docker, Openstack, Openshift, ...)
- open documented API (**openAPI**)
- **data catalog**
- **user-owned data** + **EO archives**
  (e.g. Sentinel, Landsat, …)
- job management, Access Control Layer (auth)
- quota management

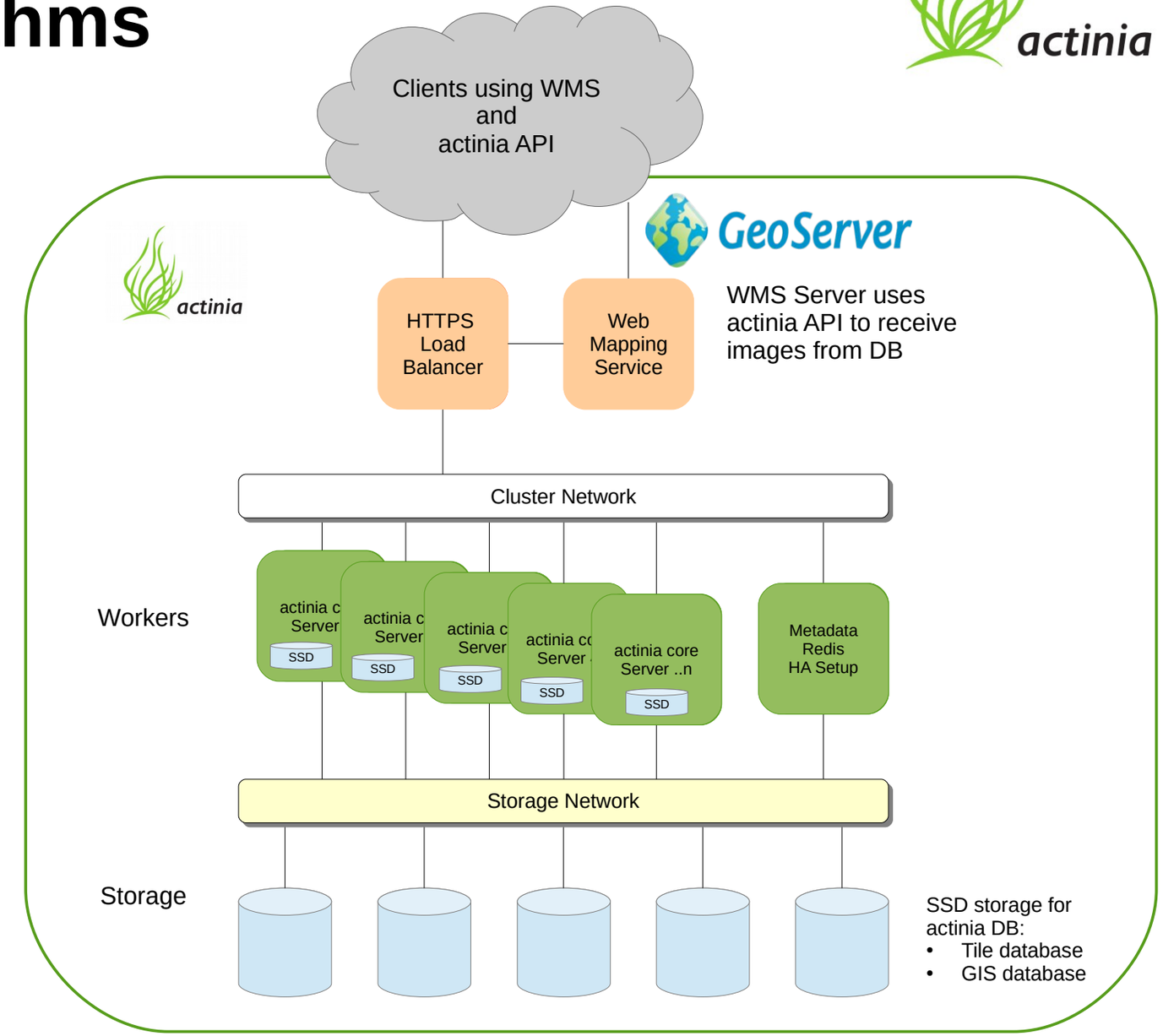


https://actinia.mundialis.de/
https://github.com/mundialis/actinia_core/

actinia – supported algorithms

- most GRASS GIS functionality can be covered
- wrappers for software like SNAP (GPT or SNAPPY)
- Python libraries like scikit-learn
- … (your choice)

- User Defined Functions (UDF)



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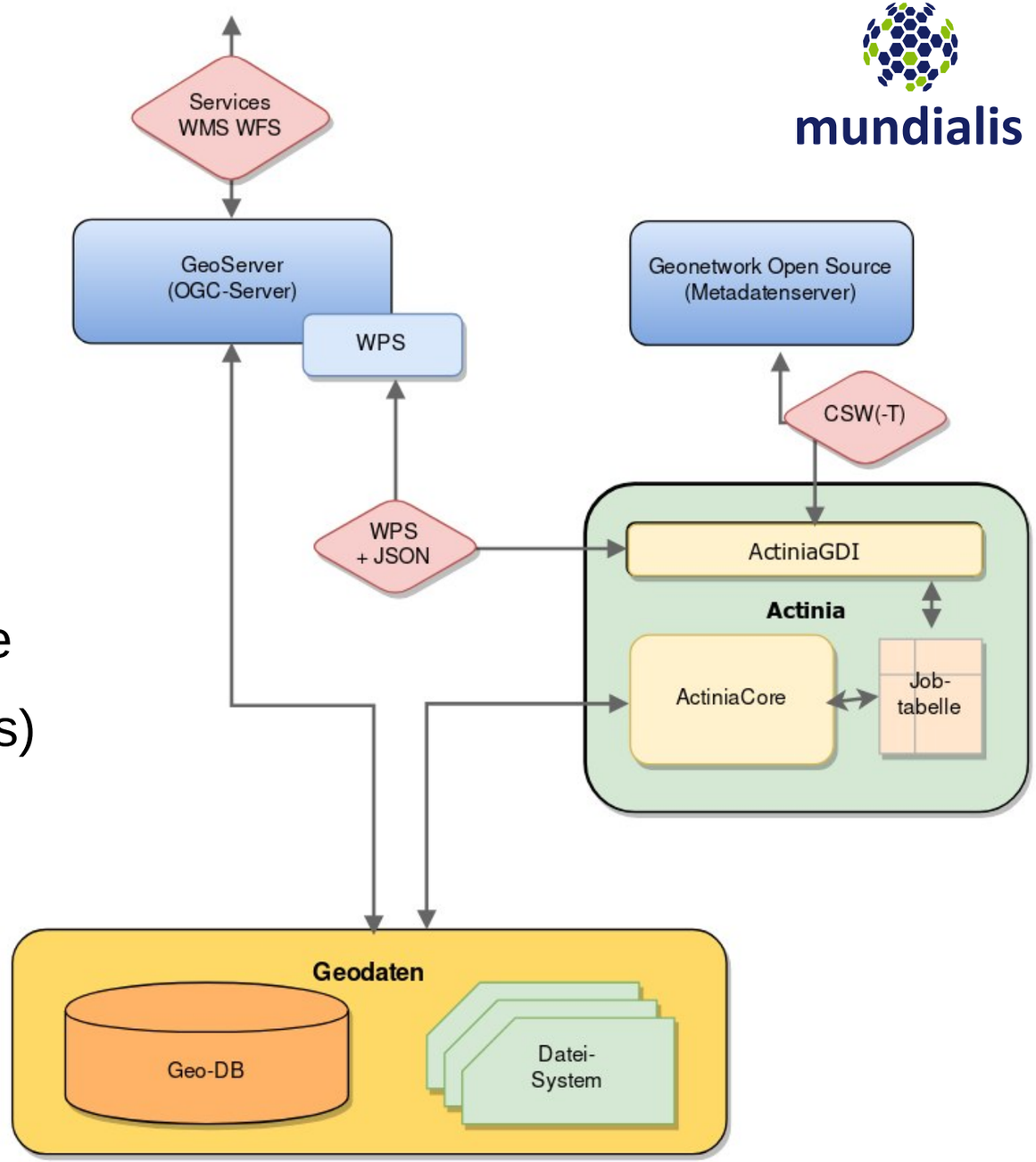
architecture

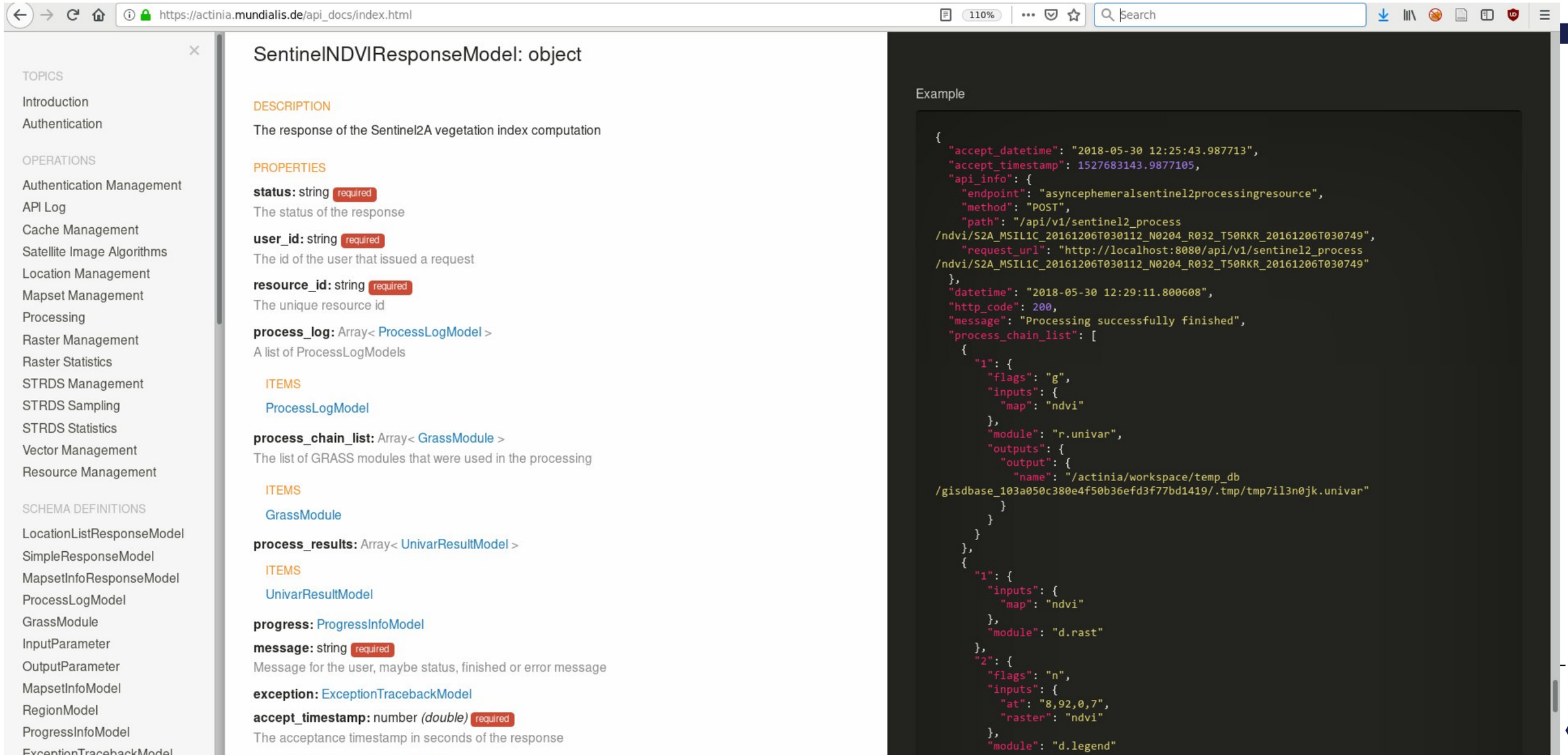
Cloud based processing with actinia

- **Components**
  - actinia-core (on github)
  - actinia-GDI (yet unpublished)
- **Connectors**
  - actinia-GDI ↔ Geonetwork Open Source
  - actinia-core ↔ Geoserver (OGC services)
  - Object-storage and Shared File System
- **Plugins**
  - image classification
  - fibre optic cable planning



actinia REST API docs

https://actinia.mundialis.de



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applications

actinia overview

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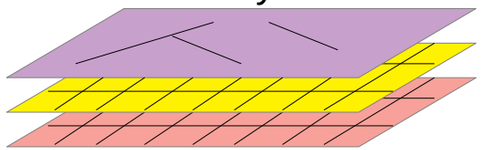
Integration of external data sources

Field data / measuring sites

SOS

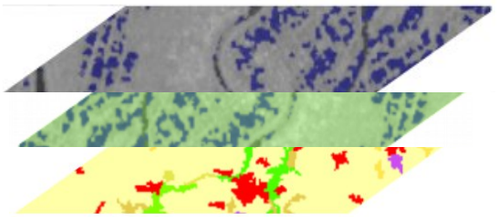
Time series

GIS layers



Raster/Vector

EO layers



Raster/Vector

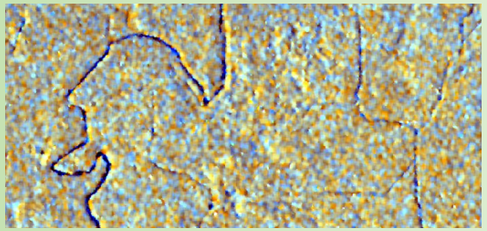
Time series

Flooding SAR + DEM

Source: ITZI

Classification

Forest change analysis



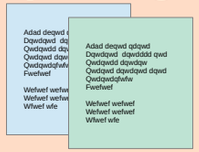
… your method here

Cloud geoprocessing

Time series processing

actinia.mundialis.de

Reporting



Web Services

OGC:
WMST, WFS, ...

Cloud API

REST API

actinia processing chains: Sentinel-1

Pre-processing of **GRD** mode:

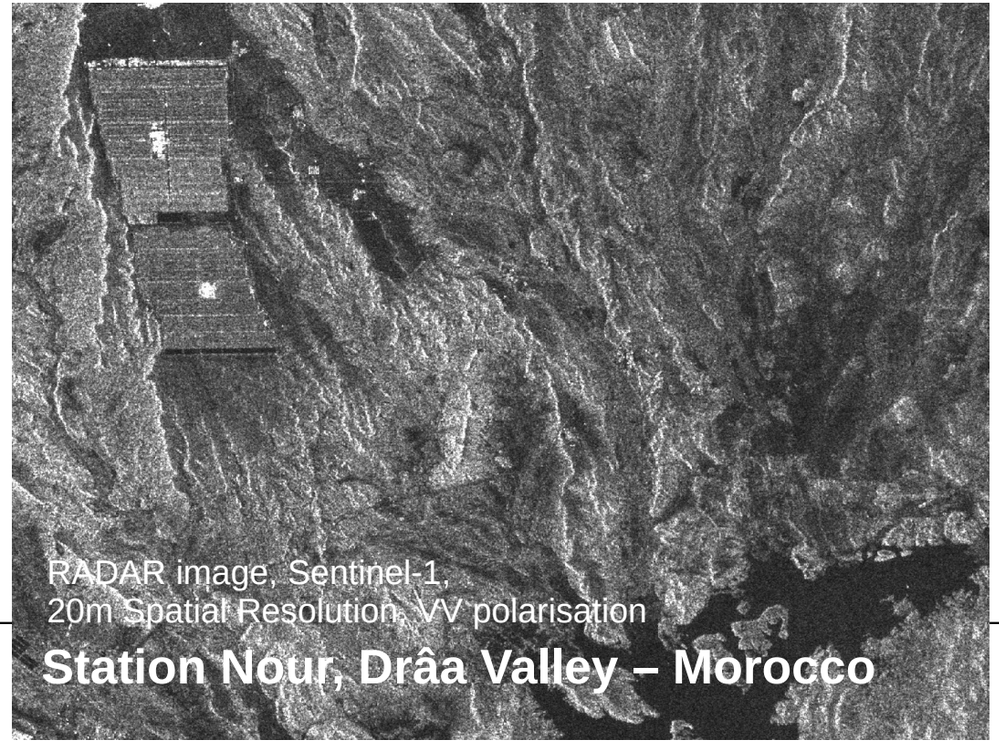
- r.s1.grd.orb (orbit)
- r.s1.grd.rc (radiometric correction)
- r.s1.grd.SpFilter (Speckle filter)
- r.s1.grd.tc (terrain correction)
- r.s1.grd.tnc (thermal noise removal)
- r.s1.grd.bandmath

Processing **INSAR** (*ongoing*):

- coherence, interferogram and all related preprocessing

Pre-pocessing of **SLC** mode:

- r.s1.grd.tss (split subswath of Sentinel-1 SLC mode)



actinia processing chains: Sentinel-2

Pre-processing:

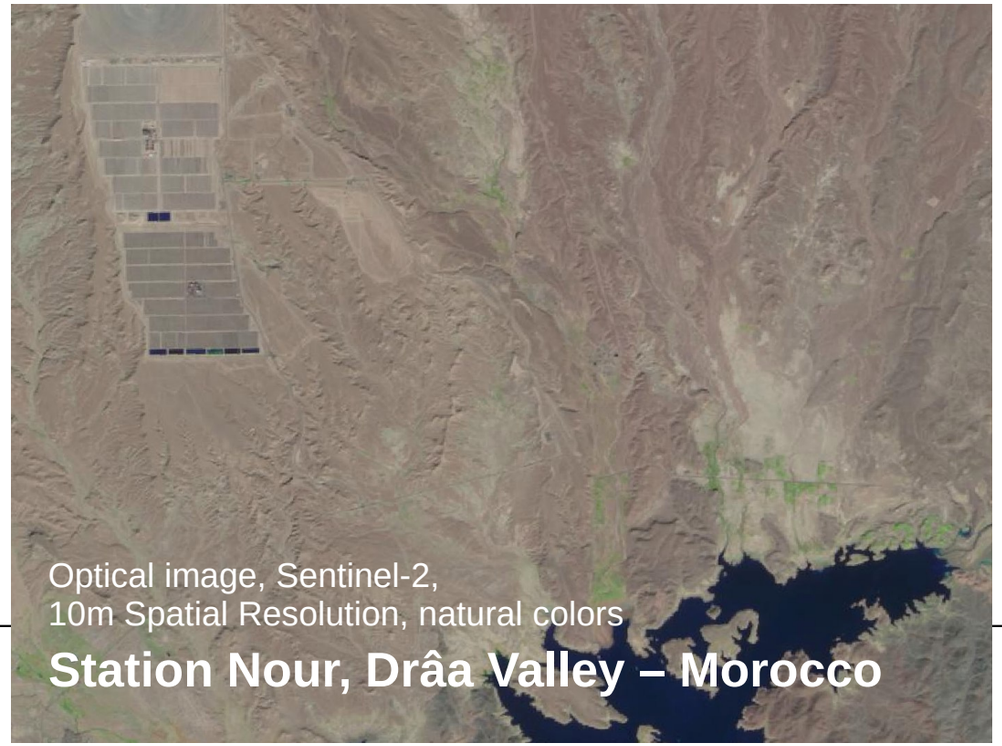
- atmospheric correction of L1C data:
  - i.atcorr (6S based, GRASS GIS)
  - ARCSI (6S based)
  - sen2cor
- optionally reprojection

Processing (*ongoing*):

- vegetation indices
- time series analysis (gap-filling, anomalies, …)
- classification
- change detection

Integration with geospatial data (examples)

- zonal statistics
- fragmentation analysis
- ...



actinia processing chains: topological space-time algebra

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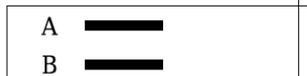
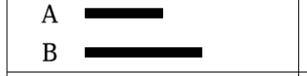
Available data types (each map is time-stamped):

- Space-Time **Raster** Dataset (STRDS) – e.g. daily climatic raster data or Sentinel bands
- Space-Time **Raster-3D** Dataset (STR3DS) – soil or atmospheric volumes
- Space-Time **Vector** Dataset (STVDS) – land cover/land use time series

Temporal relations:

	A in relation to B	B in relation to A
	equivalent	equivalent
	follows/adjacent	precedes/adjacent
	overlaps	overlapped
	after	before
	during	contains
	starts	started
	finishes	finished

=> Topology based spatio-temporal map algebra

actinia processing chains: topological space-time algebra

- new spatio-temporal topological operators (Gebbert et al, submitted)
- implementation in GRASS GIS, exposed through the REST API of actinia:

t.rast.algebra – a topology based spatio-temporal map algebra

- spatially: it uses the smallest common resolution
- temporally: it uses temporal-topological relations (instances can be buffered in time)
  - smallest granularity is 1 sec
  - common extent is calculated from temporal topological relations

→ it allows the application of algebraic expressions to time series of globally scattered satellite images

Future: support of image collections

actinia processing chains: topological space-time algebra

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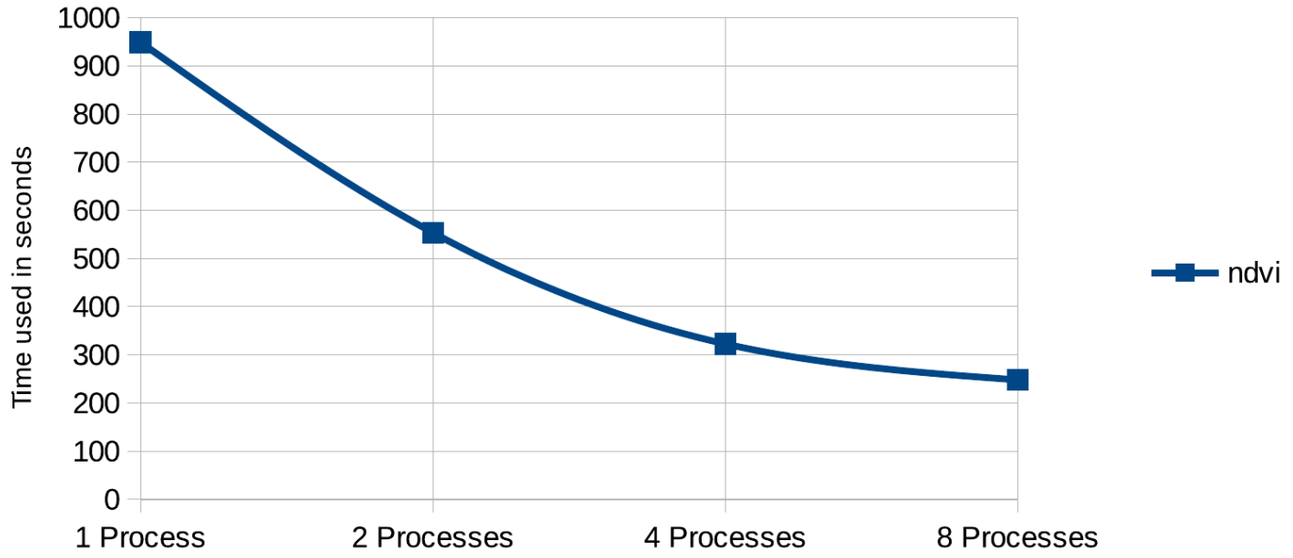
NDVI example: compute the NDVI of an “arbitrary” area on 8 dedicated CPU cores:

```
t.rast.algebra basename=ndvi -s nprocs=8 \
   expression="NDVI=(S2A_B08{-,equal|equivalent,l}S2A_B04) \
                    {/,equal|equivalent,l} \
                    (S2A_B08{+,equal|equivalent,l}S2A_B04)"
```

Computational time needed by t.rast.algebra to compute the NDVI from 100 Sentinel-2 scenes using 1, 2, 4 and 8 CPUs



Gebbert et al. submitted

actinia processing chains: topological space-time algebra

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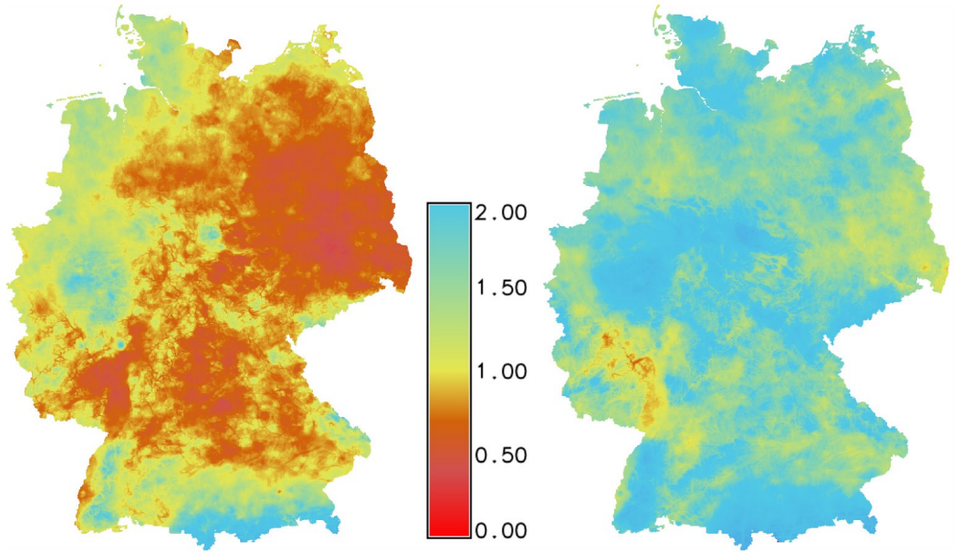
Compute annual hydro-thermal coefficients (HTC) from 60 years of daily climate data

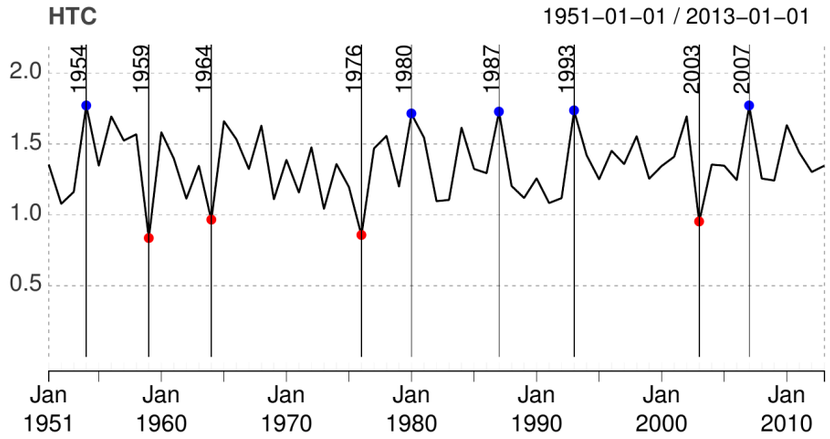
$$HTC = \frac{\sum P_{(T>10°C)}}{\sum T_{(T>10°C)} \cdot \frac{1}{10}}$$

T := daily temperatures,
P := daily precipitation

```
t.rast.algebra "HTC = (D {+,contains,1} if(T >= 10, P, 0)) /
                      (D {+,contains,1} if(T >= 10, T / 10, 0))"
```



HTC for 2003 and 2007



HTC of extreme events for droughts (HTC < 1) in red and humid years (HTC > 1.7) in blue

Gebbert et al. (submitted)

actinia shell: interactive cloud programming

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ace - actinia command execution

The **ace** tool allows on an **actinia REST service** (e.g. https://actinia.mundialis.de/):

- execution of a single command, or a list of commands
- job management, ACL
- map layer query, creation and deletion of data

- processing in ephemeral and persistent databases
- generated outputs becomes available as a REST resource (URL)

Tutorial: https://github.com/mundialis/actinia_core/tree/master/scripts

actinia shell: interactive cloud programming

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ace - actinia command execution

```
GRASS 7.7.svn (sentinel2):~/bin > ace --script ./ace_segmentation.sh
Resource status accepted
Polling: https://actinia.mundialis.de/api/v1/resources/markus/resource_id-a036fabe-a669-4799-97bd-f0e5bfbb69e0
Resource poll status: running
Checking access to URL:
https://apps.mundialis.de/sentinel_2/IMG_DATA/R10m/T34TDR_20180919T093029_AOT_10m.tif
Resource poll status: running
...
Resource poll status: running
Running executable i.segment with parameters ['group=T34TDR_20180919T093029_AOT_10m', 'threshold=0.25',
'radius=1.5' ... 2010_segment_25', 'goodness=T34TDR_20180919T093029_AOT_10m_seg_25_fit'] for 5.01212
seconds
...
Resource poll status: running
Running executable i.segment with parameters ['group=T34TDR_20180919T093029_AOT_10m', 'threshold=0.25',
'radius=1.5' ... 2010_segment_25', 'goodness=T34TDR_20180919T093029_AOT_10m_seg_25_fit'] for 10.0254
seconds
Resource poll status: running
Export vector layer <T34TDR_20180919T093029_AOT_10m_segment_25> with format GeoJSON
Resource poll status: finished
Processing successfully finished
```

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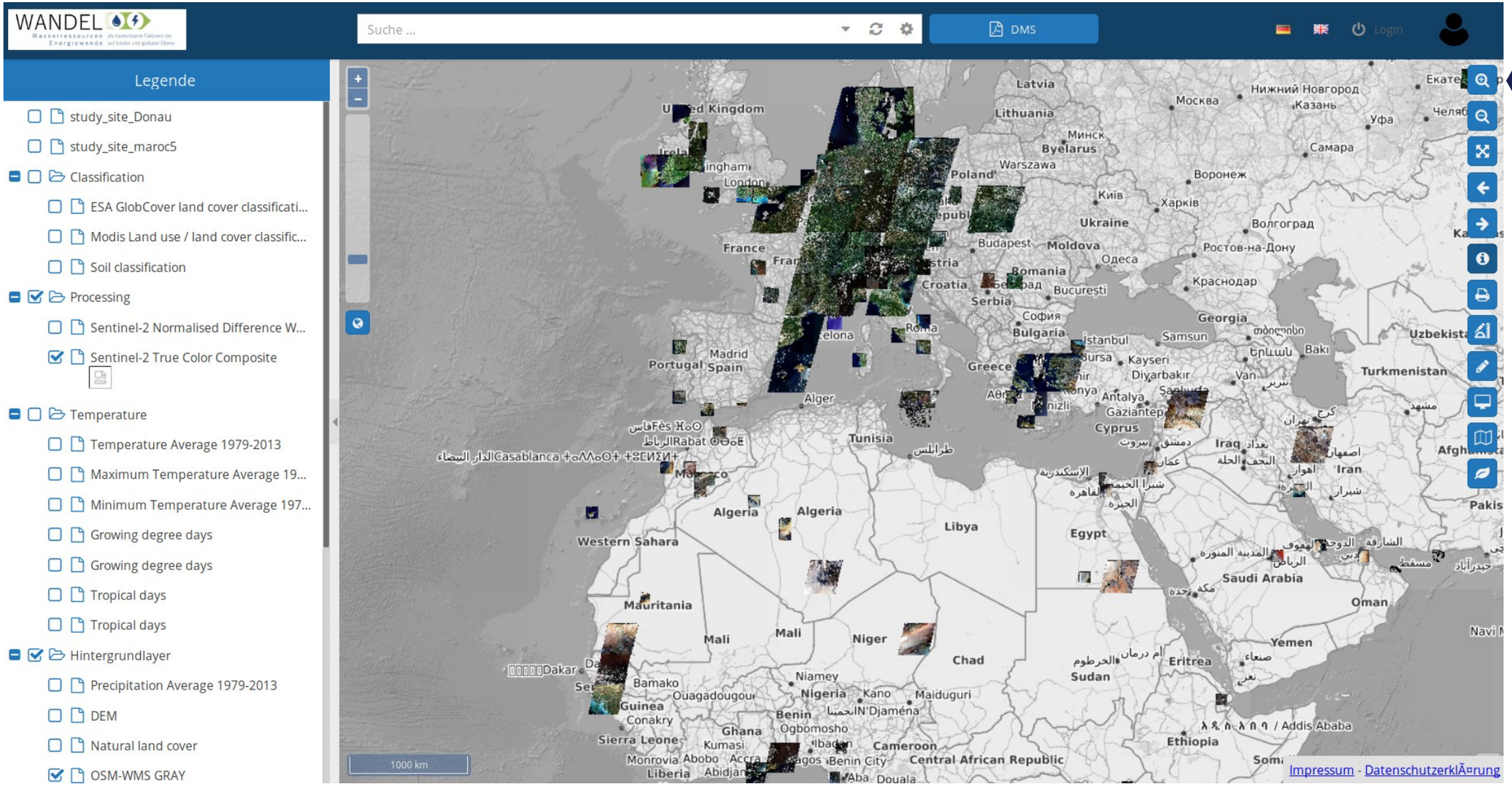
First Adopters

WANDEL: Water resources as a major driver of energy transformation at local and global level



WANDEL users can define their own workspace and process data

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Bundesministerium für Bildung und Forschung

FONA Forschung für Nachhaltige Entwicklung BMBF

Förderprogramm „Forschung für nachhaltige Entwicklung“ (FONA³)

GRoW GLOBALE RESSOURCE WASSER

Fördermaßnahme „Globale Ressource Wasser“ (GRoW)

WANDEL: processing of S1 data in the cloud

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Förderprogramm „Forschung für nachhaltige Entwicklung“ (FONA³)

GRoW GLOBALE RESSOURCE WASSER

Fördermaßnahme „Globale Ressource Wasser“ (GRoW)

The openEO H2020 project

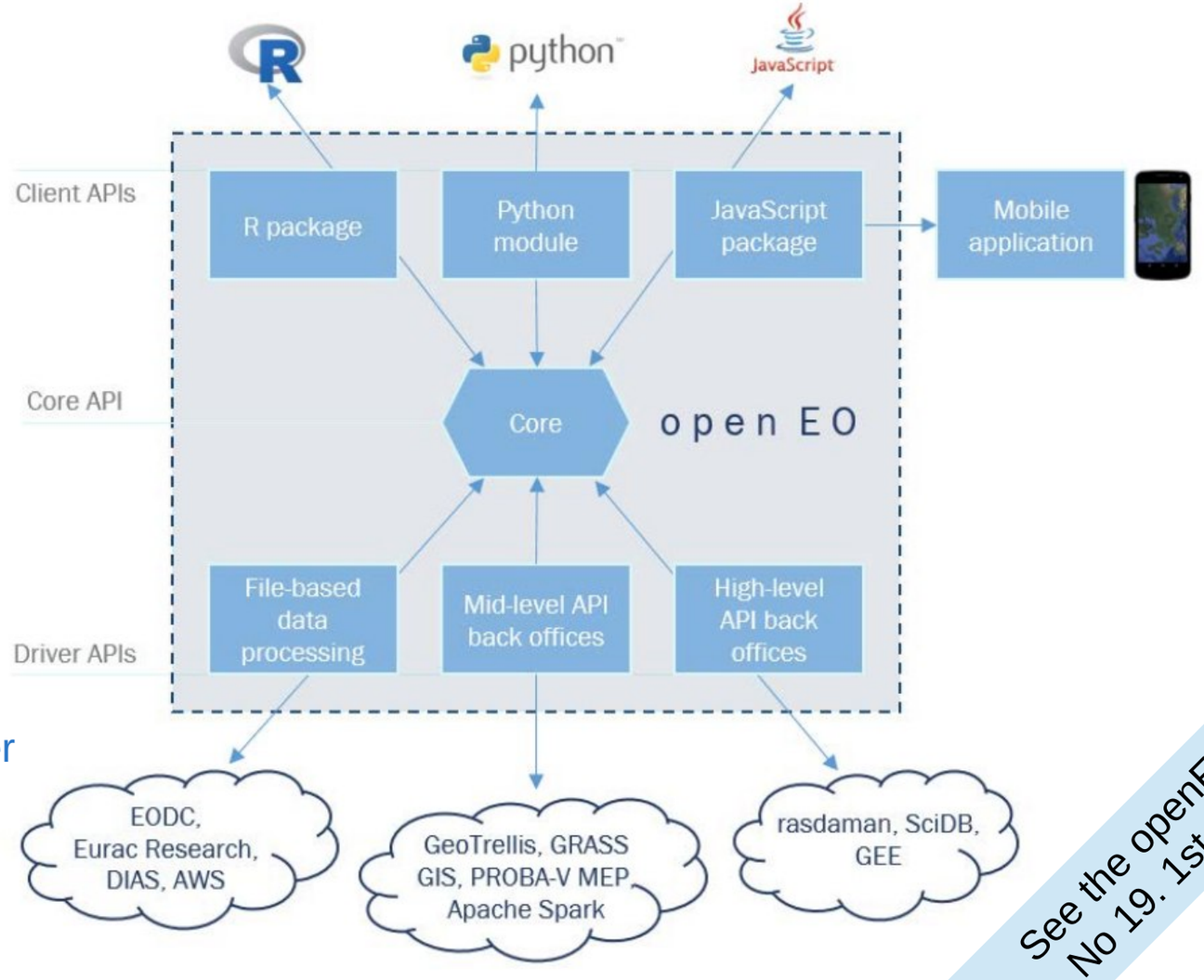
2017-2020 – http://www.openeo.org

openEO - a common, open source interface between Earth Observation data infrastructures and front-end applications

We use actinia as one of the backends of openEO

Source code on github

https://github.com/Open-EO/openeo-grassgis-driver



See the openEO poster! No 19. 1st floor

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outlook & conclusions

Conclusions and what’s next

- actinia: a new proposed cloud based geoprocessing API & engine is available
- deployments
  - initial deployment in Deutsche Telekom cloud running
  - ongoing discussions with CODE-DE (for new BMVI mFund project “incora”)
  - relevant for DIAS?
- interfaces
  - REST API is online at actinia.mundialis.de (demo user)
  - Web: SHOGun framework
  - QGIS plugin planned

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