

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)
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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



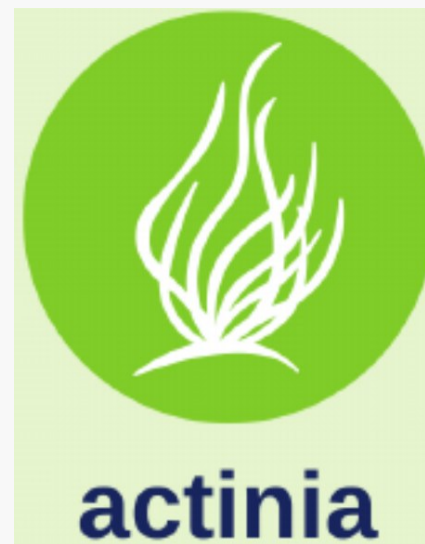
Our toolbox – open source stack



SNAPPY



GRASS GIS

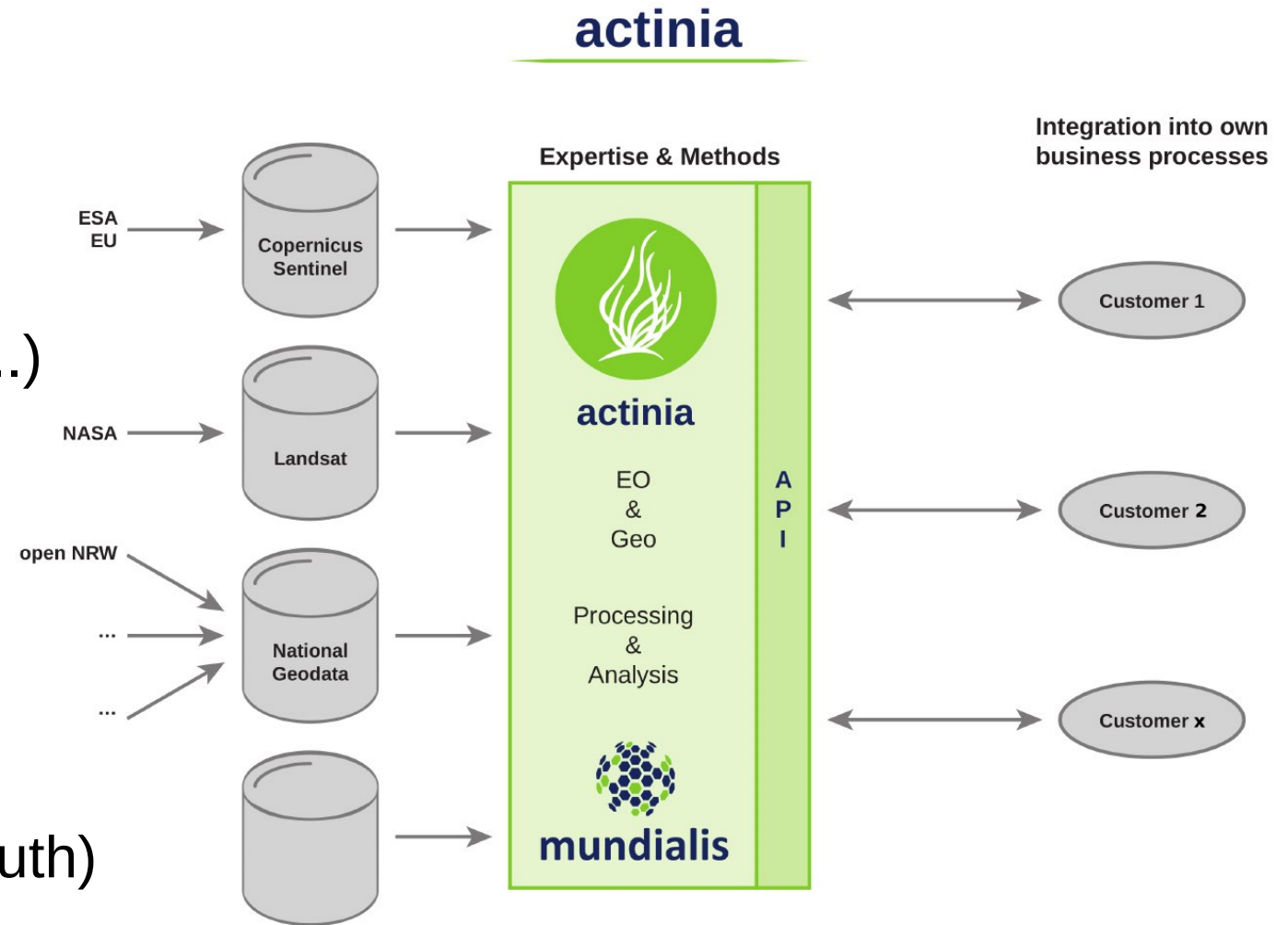


open source
geo-
processing

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



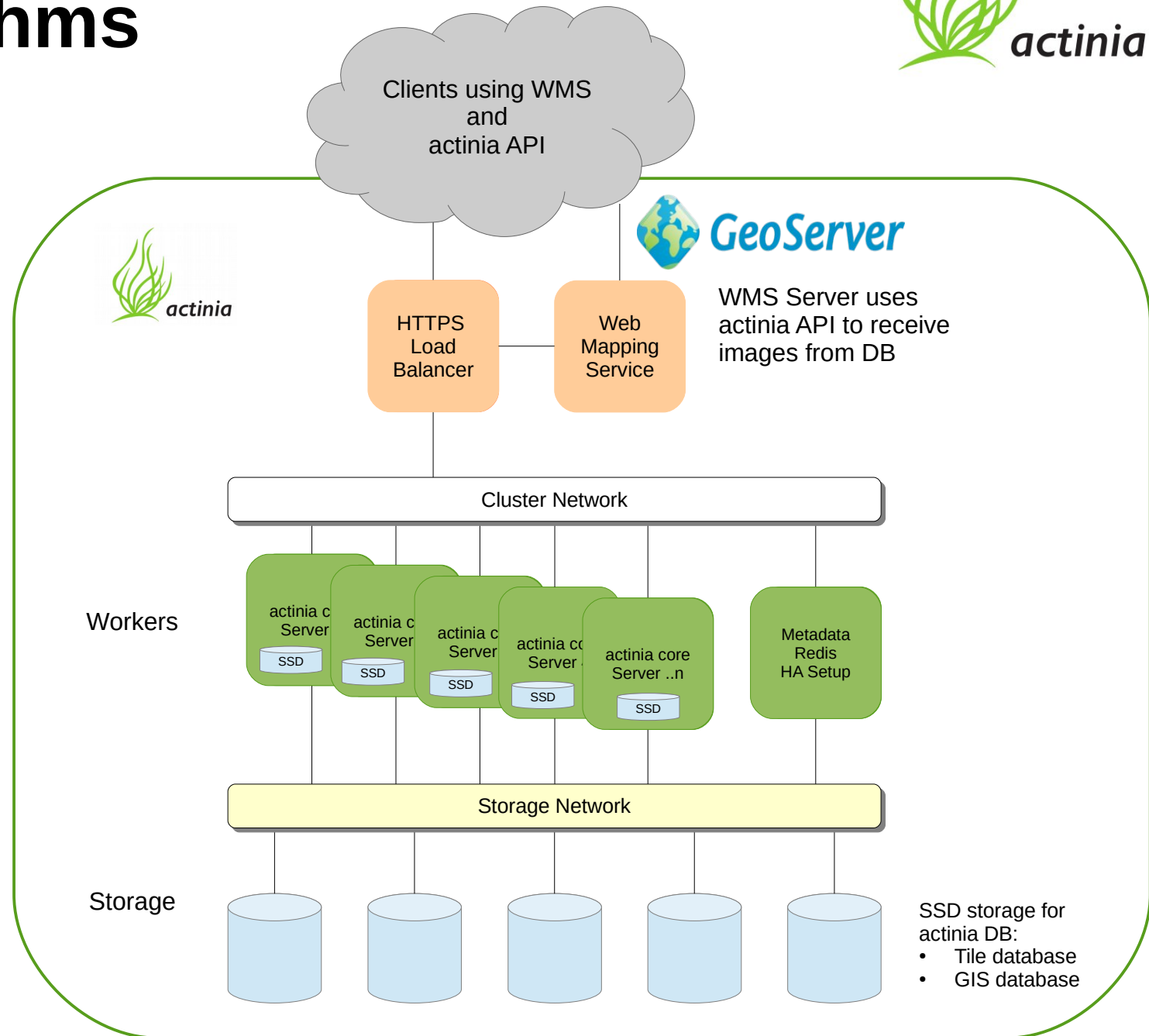
<https://actinia.mundialis.de/>

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)



architecture

Cloud based processing with actinia

■ Components

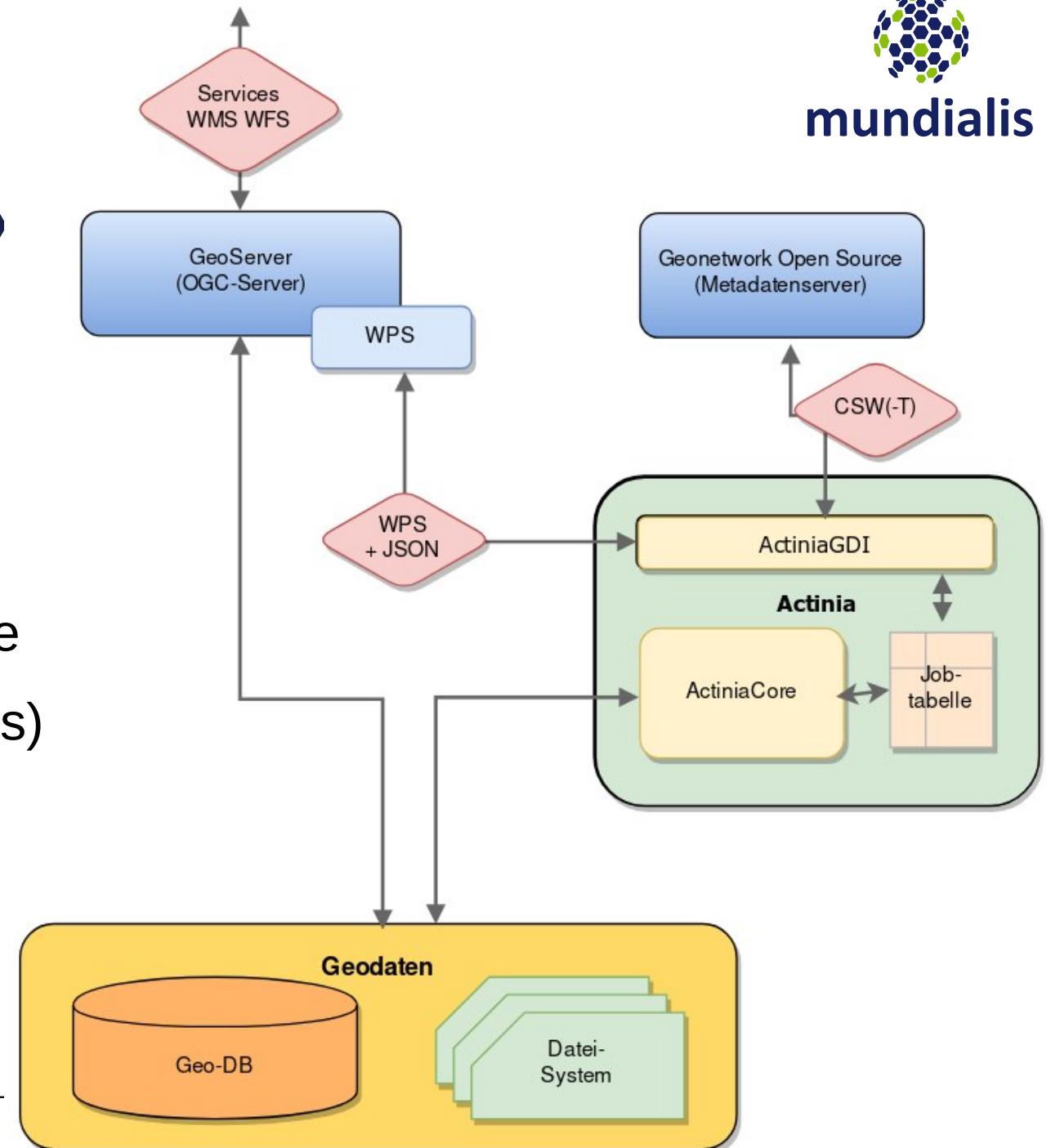
- actinia-core (on github)
- actinia-GDI (yet unpublished)

■ 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>



Browser address bar: https://actinia.mundialis.de/api_docs/index.html

Browser search bar: Search

Browser zoom: 110%

Browser navigation icons: Back, Forward, Home, Refresh, Stop, Print, Full Screen, etc.

Left sidebar (TOPICS):

- Introduction
- Authentication
- OPERATIONS
 - Authentication Management
 - API Log
 - Cache Management
 - Satellite Image Algorithms
 - Location Management
 - Mapset Management
 - Processing
 - Raster Management
 - Raster Statistics
 - STRDS Management
 - STRDS Sampling
 - STRDS Statistics
 - Vector Management
 - Resource Management
- SCHEMA DEFINITIONS
 - LocationListResponseModel
 - SimpleResponseModel
 - MapsetInfoResponseModel
 - ProcessLogModel
 - GrassModule
 - InputParameter
 - OutputParameter
 - MapsetInfoModel
 - RegionModel
 - ProgressInfoModel
 - ExceptionTracebackModel

Main content area: SentinelINDVIResponseModel: object

DESCRIPTION

The response of the Sentinel2A vegetation index computation

PROPERTIES

status: string required
The status of the response

user_id: string required
The id of the user that issued a request

resource_id: string required
The unique resource id

process_log: Array< [ProcessLogModel](#) >
A list of ProcessLogModels

ITEMS

[ProcessLogModel](#)

process_chain_list: Array< [GrassModule](#) >
The list of GRASS modules that were used in the processing

ITEMS

[GrassModule](#)

process_results: Array< [UnivarResultModel](#) >

ITEMS

[UnivarResultModel](#)

progress: [ProgressInfoModel](#)

message: string required
Message for the user, maybe status, finished or error message

exception: [ExceptionTracebackModel](#)

accept_timestamp: number (double) required
The acceptance timestamp in seconds of the response

Example

```
{
  "accept_datetime": "2018-05-30 12:25:43.987713",
  "accept_timestamp": 1527683143.9877105,
  "api_info": {
    "endpoint": "asyncephemeralsentinel2processingresource",
    "method": "POST",
    "path": "/api/v1/sentinel2_process
/ndvi/S2A_MSIL1C_20161206T030112_N0204_R032_T50RKR_20161206T030749",
    "request_url": "http://localhost:8080/api/v1/sentinel2_process
/ndvi/S2A_MSIL1C_20161206T030112_N0204_R032_T50RKR_20161206T030749"
  },
  "datetime": "2018-05-30 12:29:11.800608",
  "http_code": 200,
  "message": "Processing successfully finished",
  "process_chain_list": [
    {
      "1": {
        "flags": "g",
        "inputs": {
          "map": "ndvi"
        },
        "module": "r.univar",
        "outputs": {
          "output": {
            "name": "/actinia/workspace/temp_db
/gisdbase_103a050c380e4f50b36efd3f77bd1419/.tmp/tmp7il3n0jk.univar"
          }
        }
      }
    },
    {
      "1": {
        "inputs": {
          "map": "ndvi"
        },
        "module": "d.rast"
      },
      "2": {
        "flags": "n",
        "inputs": {
          "at": "8,92,0,7",
          "raster": "ndvi"
        },
        "module": "d.legend"
      }
    }
  ]
}
```

applications



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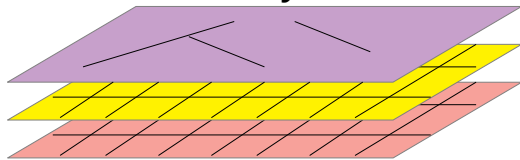
actinia overview

Integration of external data sources

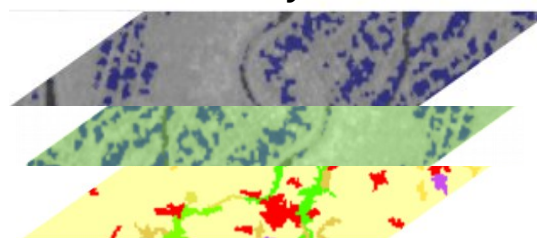
Field data / measuring sites



GIS layers



EO layers



SOS



Time series

Raster/Vector



Raster/Vector



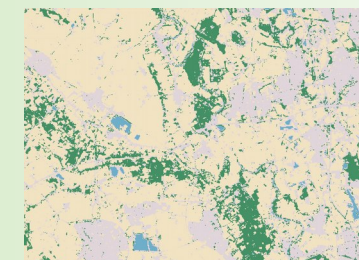
Time series

Flooding SAR + DEM

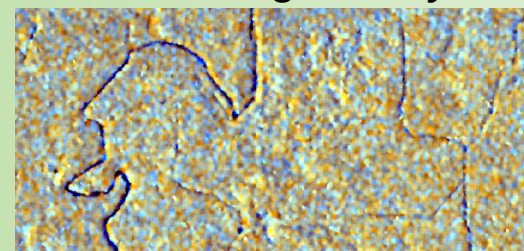


Source: ITZI

Classification



Forest change analysis



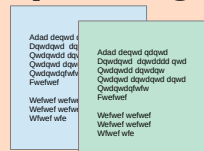
... your method here



Time series processing

actinia.mundialis.de

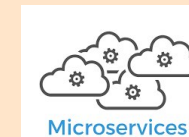
Reporting



Web Services

OGC:
WMST, WFS, ...

Cloud API



REST API

actinia processing chains: Sentinel-1



Pre-processing of **GRD** mode:

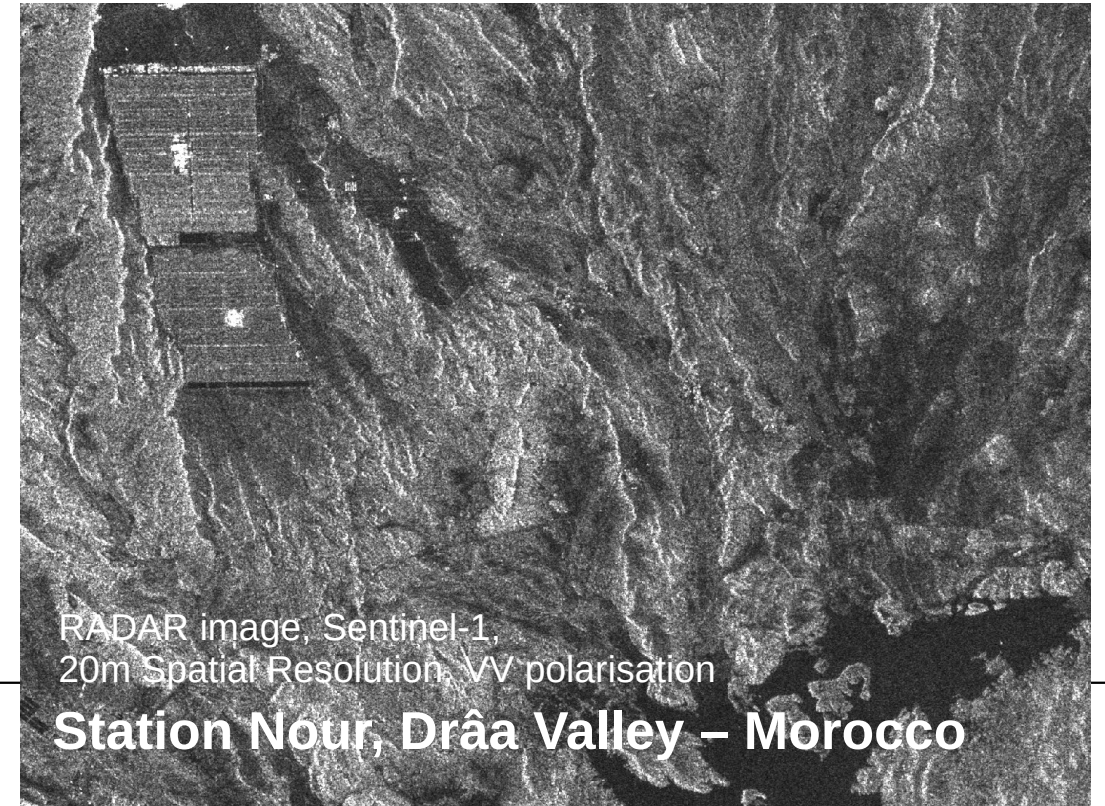
- r.s1.grd.orb (orbit)
- r.s1.grd.rc (radiometric correction)
- r.s1.grd.SpFilter (Speckle filter)
- r.s1.grd.tc (terrain correction)
- r.s1.grd.tnc (thermal noise removal)
- r.s1.grd.bandmath

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

- coherence, interferogram and all related preprocessing

Pre-processing of **SLC** mode:

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



actinia processing chains: Sentinel-2



Pre-processing:

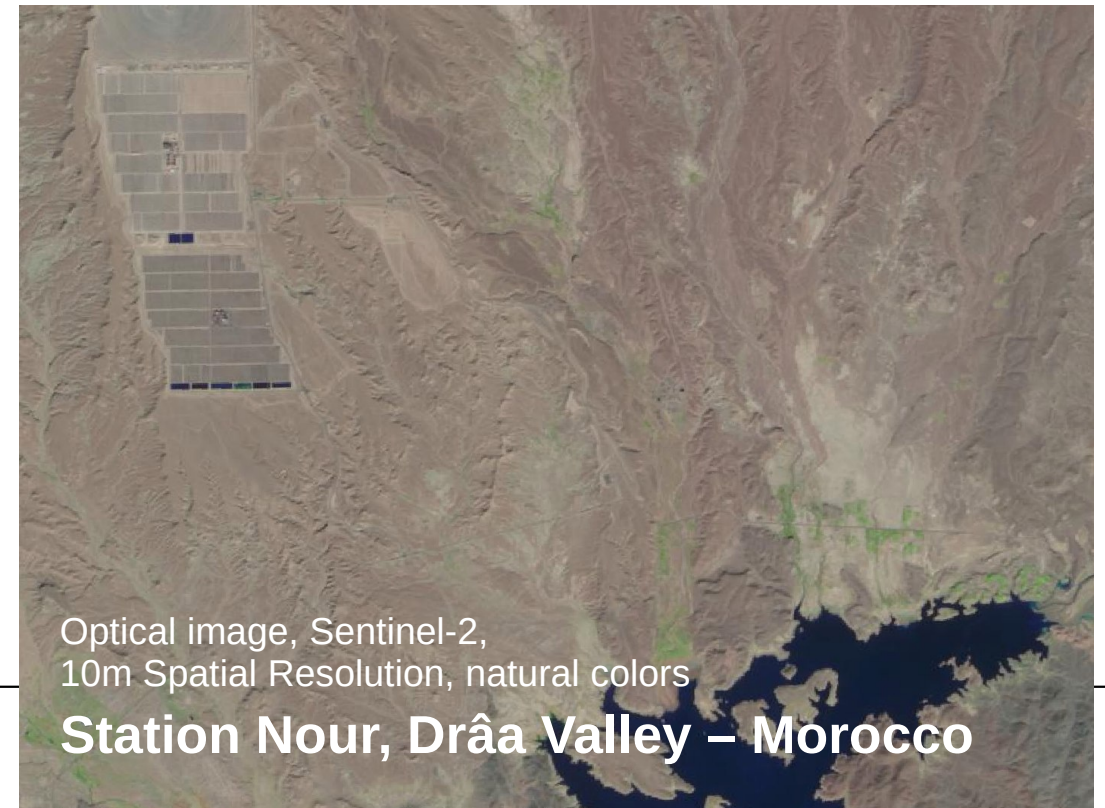
- atmospheric correction of L1C data:
 - i.atcorr (6S based, GRASS GIS)
 - ARCSI (6S based)
 - sen2cor
- optionally reprojection

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

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
A  B 	equivalent	equivalent
A  B 	follows/adjacent	precedes/adjacent
A  B 	overlaps	overlapped
A  B 	after	before
A  B 	during	contains
A  B 	starts	started
A  B 	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

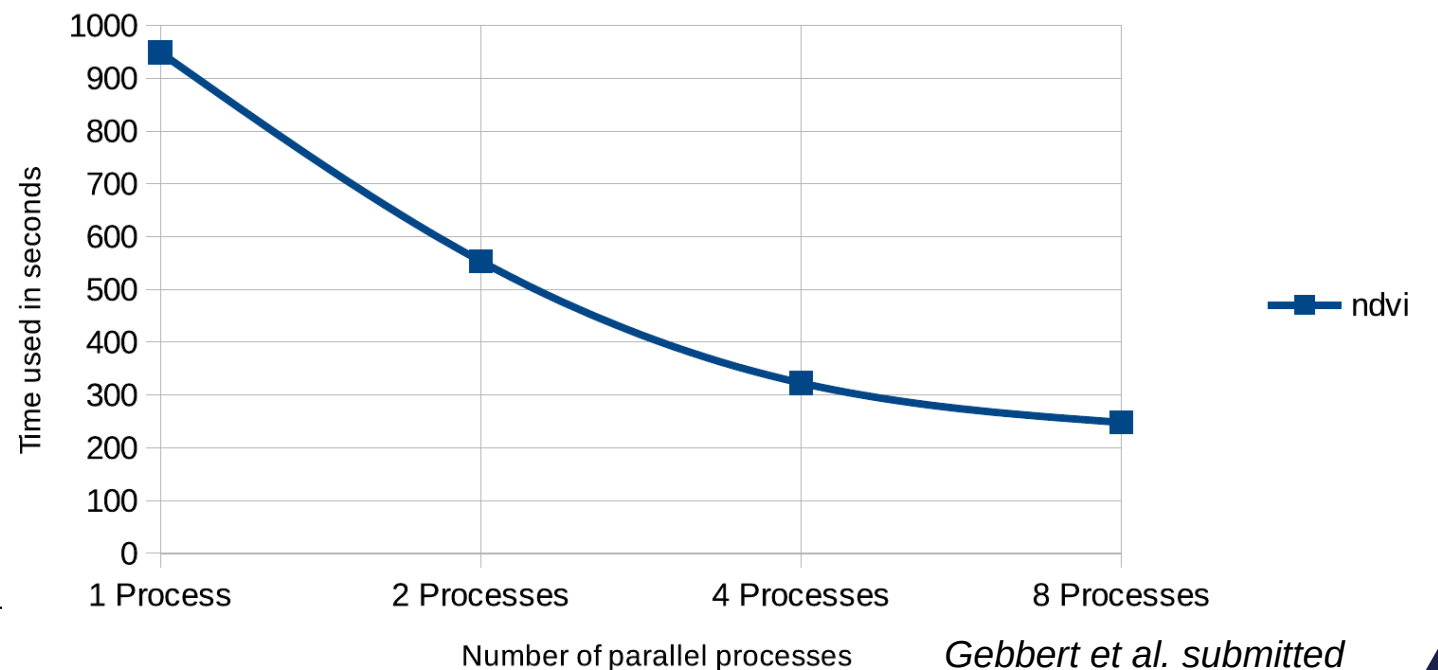
Future: support of image collections

actinia processing chains: topological space-time algebra

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,1}S2A_B04) \  
  {/,equal|equivalent,1} \  
  (S2A_B08{+,equal|equivalent,1}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



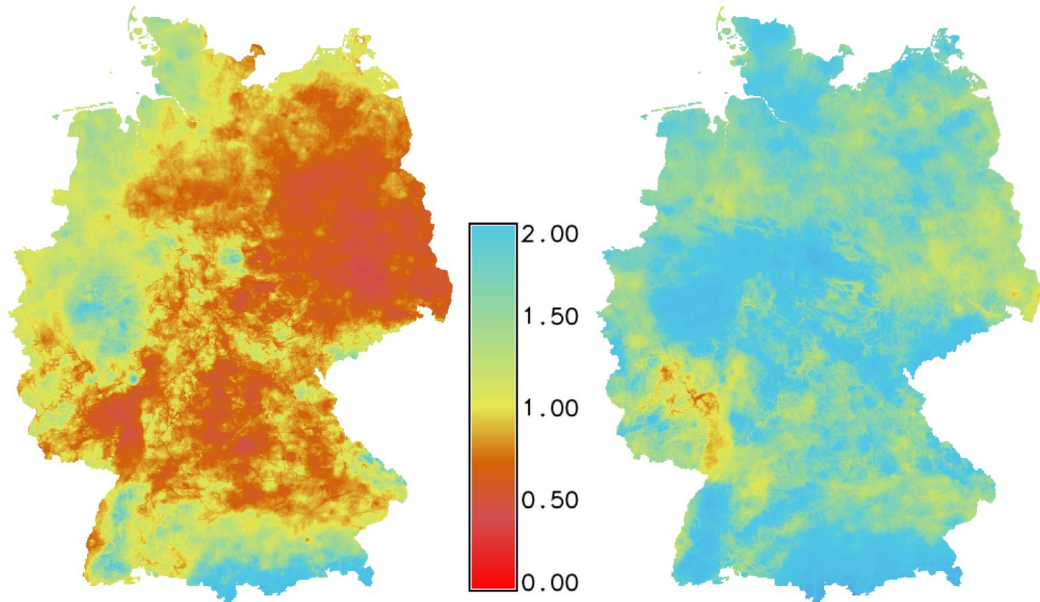
actinia processing chains: topological space-time algebra

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

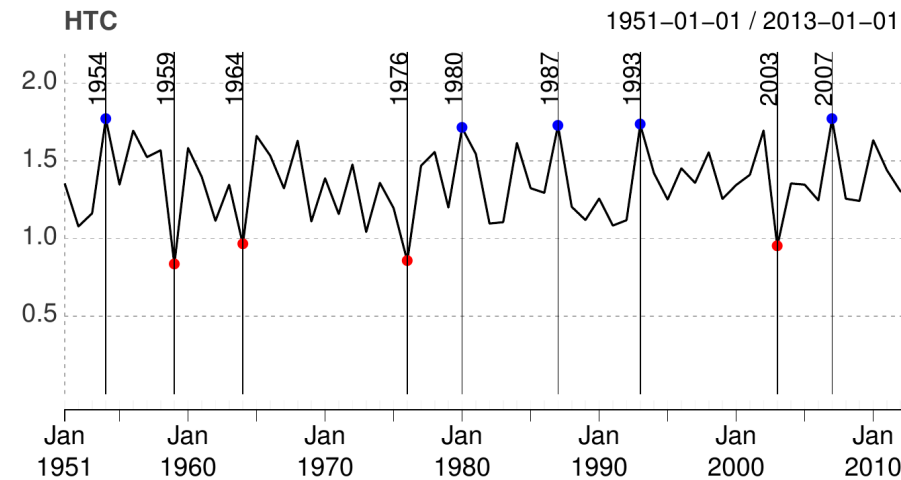
$$HTC = \frac{\sum P_{(T > 10^\circ C)}}{\sum T_{(T > 10^\circ C)} \cdot \frac{1}{10}}$$

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

actinia shell: interactive cloud programming



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



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
```

First Adopters

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



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The screenshot shows the WANDEL web application interface. At the top, there is a search bar with the text "Suche ...". To the right of the search bar are icons for DMS, language selection (German, English), and a login button. Below the search bar is a legend titled "Legende" with several categories and sub-items:

- study_site_Donau
- study_site_maroc5
- Classification
 - ESA GlobCover land cover classificati...
 - Modis Land use / land cover classific...
 - Soil classification
- Processing
 - Sentinel-2 Normalised Difference W...
 - Sentinel-2 True Color Composite
- Temperature
 - Temperature Average 1979-2013
 - Maximum Temperature Average 19...
 - Minimum Temperature Average 197...
 - Growing degree days
 - Growing degree days
 - Tropical days
 - Tropical days
- Hintergrundlayer
 - Precipitation Average 1979-2013
 - DEM
 - Natural land cover
 - OSM-WMS GRAY

The main map area shows a satellite-style view of Europe and North Africa. Various countries and cities are labeled, including London, Paris, Rome, Berlin, Moscow, and Cairo. A scale bar at the bottom left indicates 1000 km. On the right side of the map, there is a vertical toolbar with icons for search, zoom in, zoom out, pan, and other map navigation functions.

WANDEL users can define their own workspace and process data

GEFÖRDERT VOM



Förderprogramm „Forschung für nachhaltige Entwicklung“ (FONA)



Fördermaßnahme „Globale Ressource Wasser“ (GROW)

WANDEL: processing of S1 data in the cloud



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The screenshot shows the WANDEL web application interface. At the top, there is a search bar and navigation icons. The left sidebar contains a legend with various layers like 'Sentinel-1 filter results', 'Your Drawing', and 'study_site_Donau'. The main map area displays a satellite image of Europe with a grid overlay. Two panels are open: 'Satellite Scene Filter' and 'Feature Info'.

Satellite Scene Filter

Sentinel-1

Timerange

From: 2018/09/03

To: 2019/02/13

Orbitdirection: ASCENDING

Polarisationmode: VV VH

Producttype: SLC

Sensoroperation: IW

Search Sentinel-1

Sentinel-2

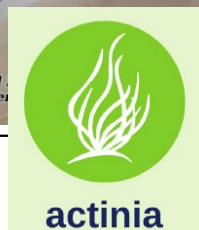
Feature Info

S1B_IW_SLC_1SDV_20181204T165909_201812...

preprocess Sentinel-1

Metadata

Name ↑	Wert
id	6200808
ingestiondate	2018-12-04T21:02:50.726Z
name	S1B_IW_SLC_1SDV_20181204T165909_201...



actinia

GEFÖRDERT VOM



Förderprogramm „Forschung für nachhaltige Entwicklung“ (FONA*)



Fördermaßnahme „Globale Ressource Wasser“ (GROW)

The openEO H2020 project

2017-2020 – <http://www.openeo.org>



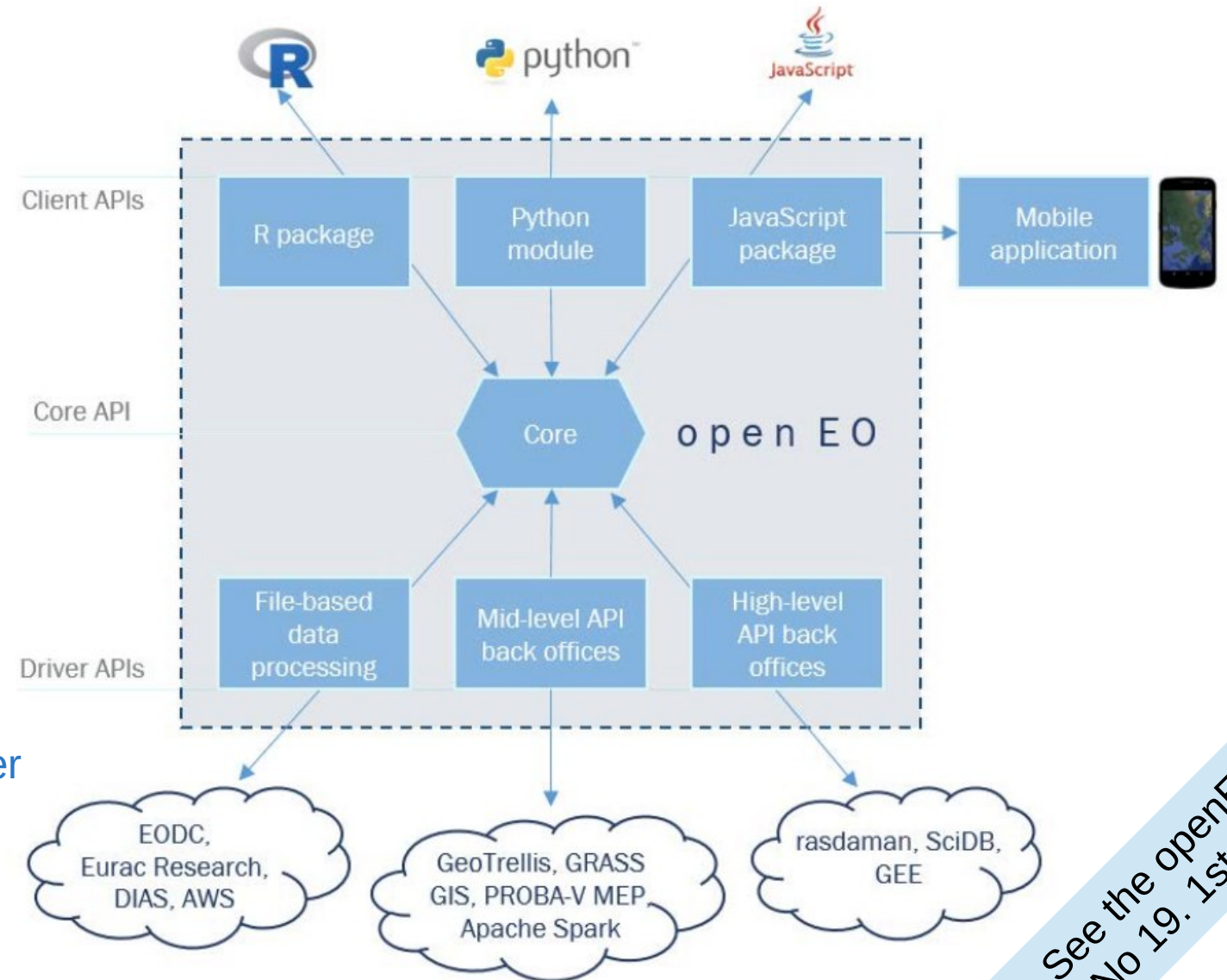
openEO - a common, open source interface between Earth Observation data infrastructures and front-end applications

We use actinia as one of the backends of openEO

Source code on github

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

actinia



See the openEO poster!
No 19. 1st floor

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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