EUROGEO WORKSHOP 2023

The EarthServer Data Space: Analysis-Ready AI-Cubes for the Green Deal

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COMMITTEE ON DATA CODATA Germany

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eurac research

Institute of Atmospheric Pollution Research
National Research Council of Italy

European Commission

Green Deal

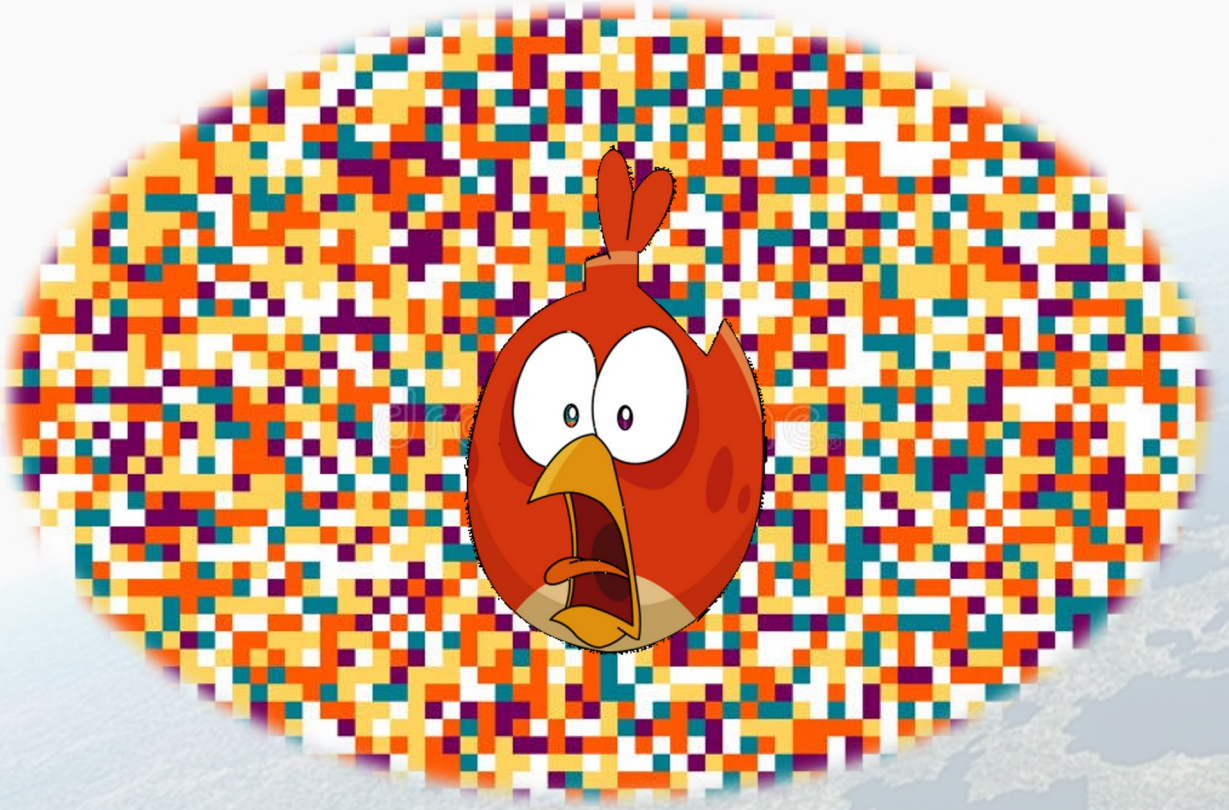
- European Green Deal:
  EU's plan to become climate-neutral by 2050
  - emissions reduction targets in aviation, cars, etc
  - climate-aware rethinking of land use, forestry, agriculture
  - Emissions Trading System

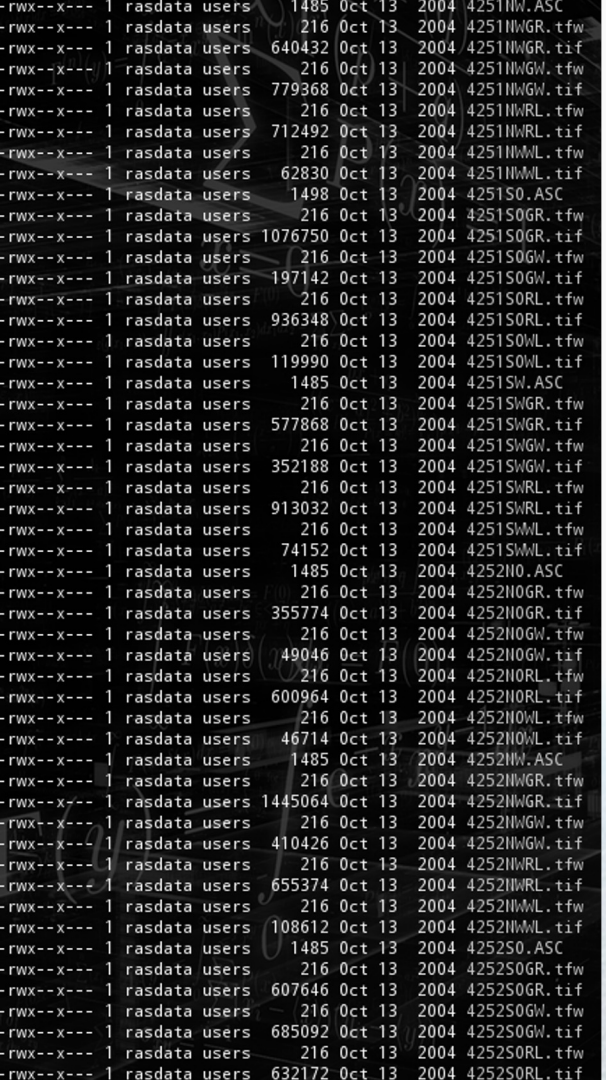
- Key question: how is the climate & environment impacted, what does each proposed measure yield quantitatively?
- Digital Twin of climate & Earth
  - Actionable integration of all relevant data – an archetypical Big Data challenge!

Green Deal Data Spaces

- Data Space: agglomeration of data relevant for a particular topic
  - Diverse & time-variant
  - Decentralized & autonomous
  - Connected & federated
- Data spaces typically overlapping with other data spaces

We Need to Better Understand Our Data!





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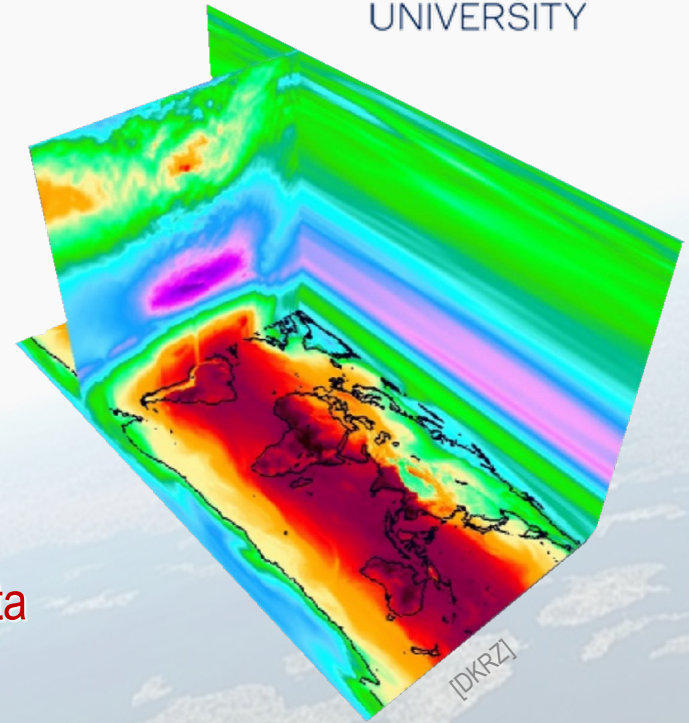
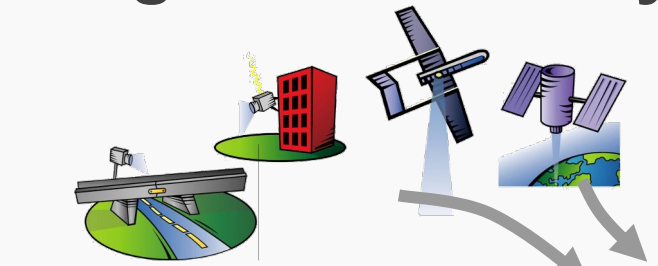
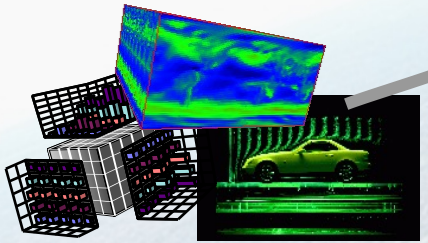
Datacubes?



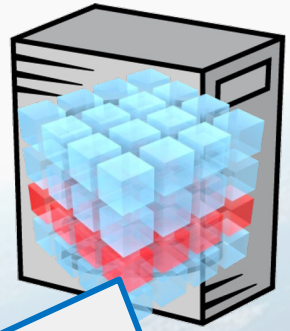
- Sensors & simulations
  -> gridded („raster“) data
- natural paradigm
  for spatio-temporal, n-D data
- Avoid undue complexity
  -> data + service on high semantic level

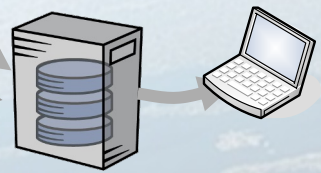
Homogenized, Analysis-Ready Datacubes

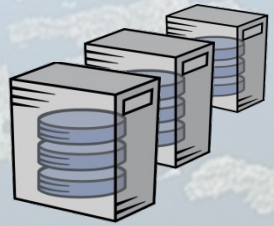




datacube service







unified view on n-D raster data, such as

- 1-D sensor data
- 2-D imagery
- 3-D x/y/t image timeseries & x/y/z geophysical data
- 4-D x/y/z/t atmospheric data

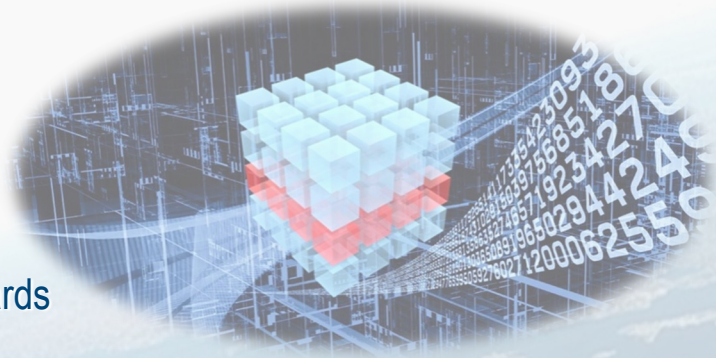
rasdaman

= „raster data manager“: actionable n-D datacubes

- pioneered actionable datacubes; 200+ publications, patents

- Big Datacube Management & Analytics engine
  - full-stack implementation, parallel, federated, secured, standards
  - Scaling: nanosat – laptop – cloud – planetary-scale federation

- ISO SQL/MDA standards blueprint, reference implementation



EarthServer

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- datacube provider federation
  - 160+ PB location-transparent data space
  - Open standards, zero-coding
- Open, free, transparent, democratic
  - Open & private; free & commercial
  - Have data offerings? Join!

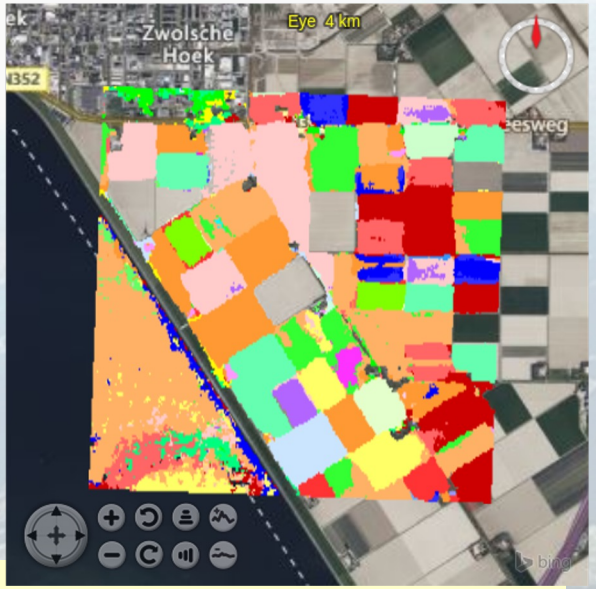
https://earthserver.eu

AI + Datacubes

- Goal: seamless integration of ML in datacube engine
  - Tech: extend OGC WCPS via UDF

```
for $c in (Sentinel_2a),
    $m in (CropModel)
return encode( nn.predict( $c[…], $m ),"tiff" )
```

[O. Campos, ConstructorU,
R. Knapen, WageningenR]

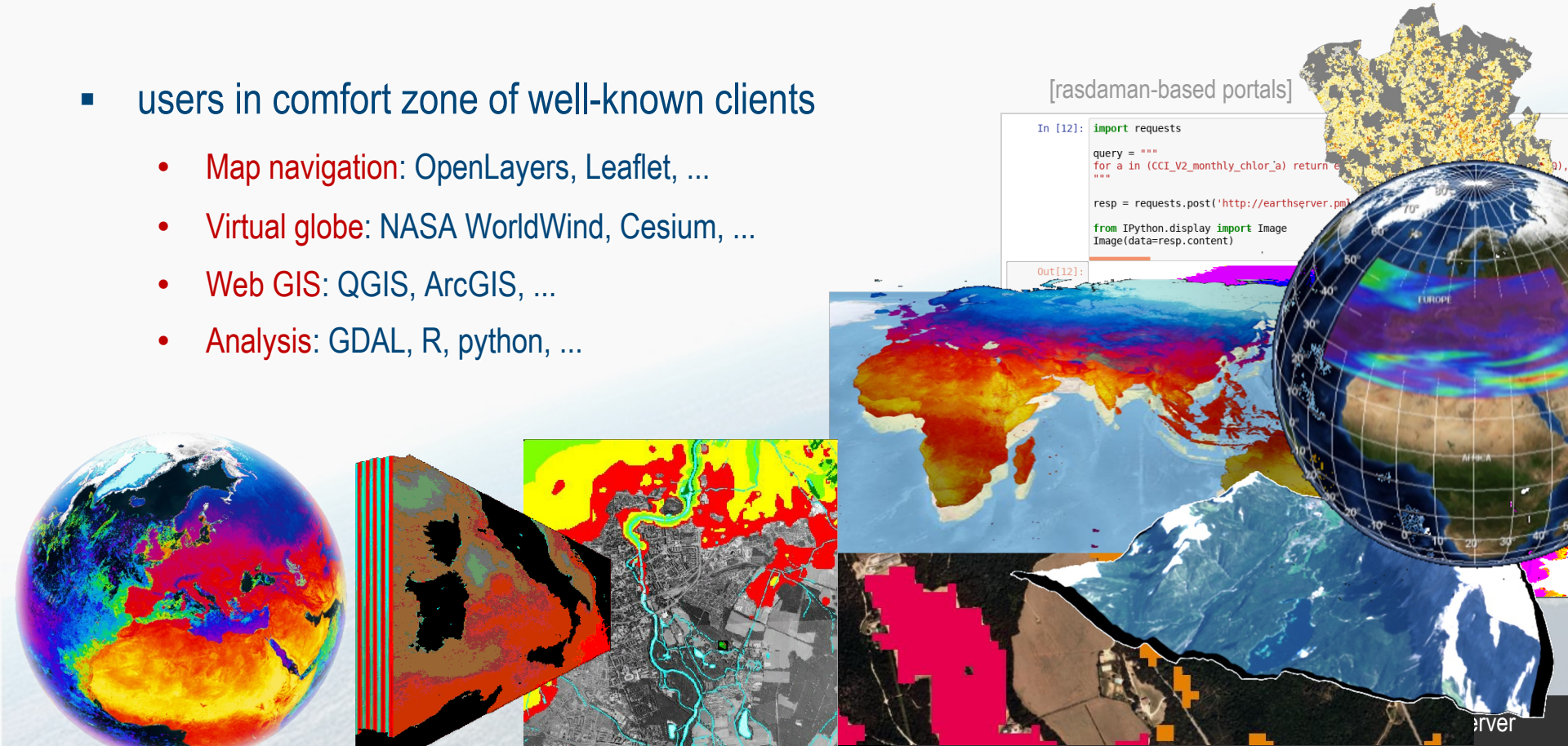


- ML + Natural Language Processing in datacube engine
  - Based on RSVQA by TU Berlin / Begüm Demir
  - Tech: WCPS UDFs
    - *Extra string parameter for question text*
    - *Text output parsed for further processing in query*

```
for $c in (Sentinel-2a),
    $m in (RsvqaModel)
return rsvqa.predict( $c[…], "Are there artificial areas and water bodies?", $m )
```

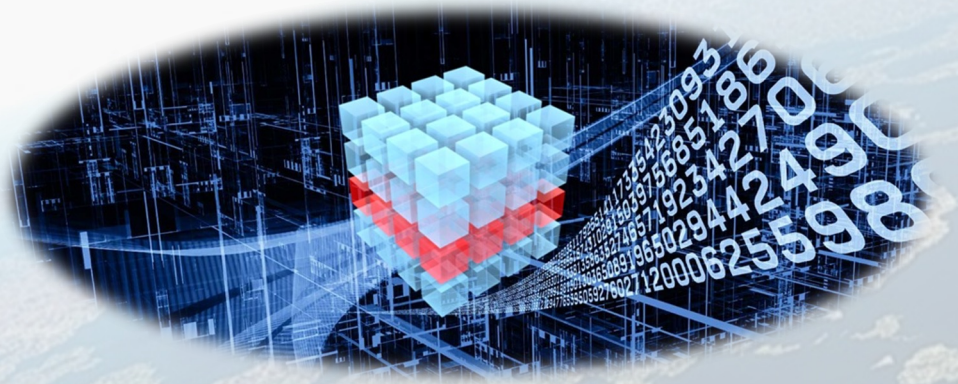
Bring Your Favourite Client

- users in comfort zone of well-known clients
  - Map navigation: OpenLayers, Leaflet, ...
  - Virtual globe: NASA WorldWind, Cesium, ...
  - Web GIS: QGIS, ArcGIS, ...
  - Analysis: GDAL, R, python, ...

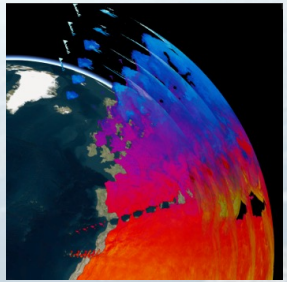


Actionable AI-Cubes

- Parametrized WCPS UDFs + annotated model libraries
- Admin can build up own libraries, integrate with STAC, etc
- „huggingface with datacubes“
- In prep



Selected Further Projects



- Societal Benefit:
  - AgriCube (Germany / Taiwan): climate & vegetation analytics
  - DeepRain (FZ Juelich): ML for Improved local rain prediction for mountaneous areas
  - DynAWI (JKI): Weather Indicators for Extreme Weather Forecasts in Agriculture
  - LANDSUPPORT (U Napoli): Land Management
- AI:
  - AI-Cube (TU Berlin): space/time CBIR
  - ML-Cube (NASA): ML on US/EU federated sat datacubes
  - CENTURION (OPT/NET): AI Knowledge Packs on Datacubes