



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

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rasdaman
raster data manager



Technically supported by



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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**!



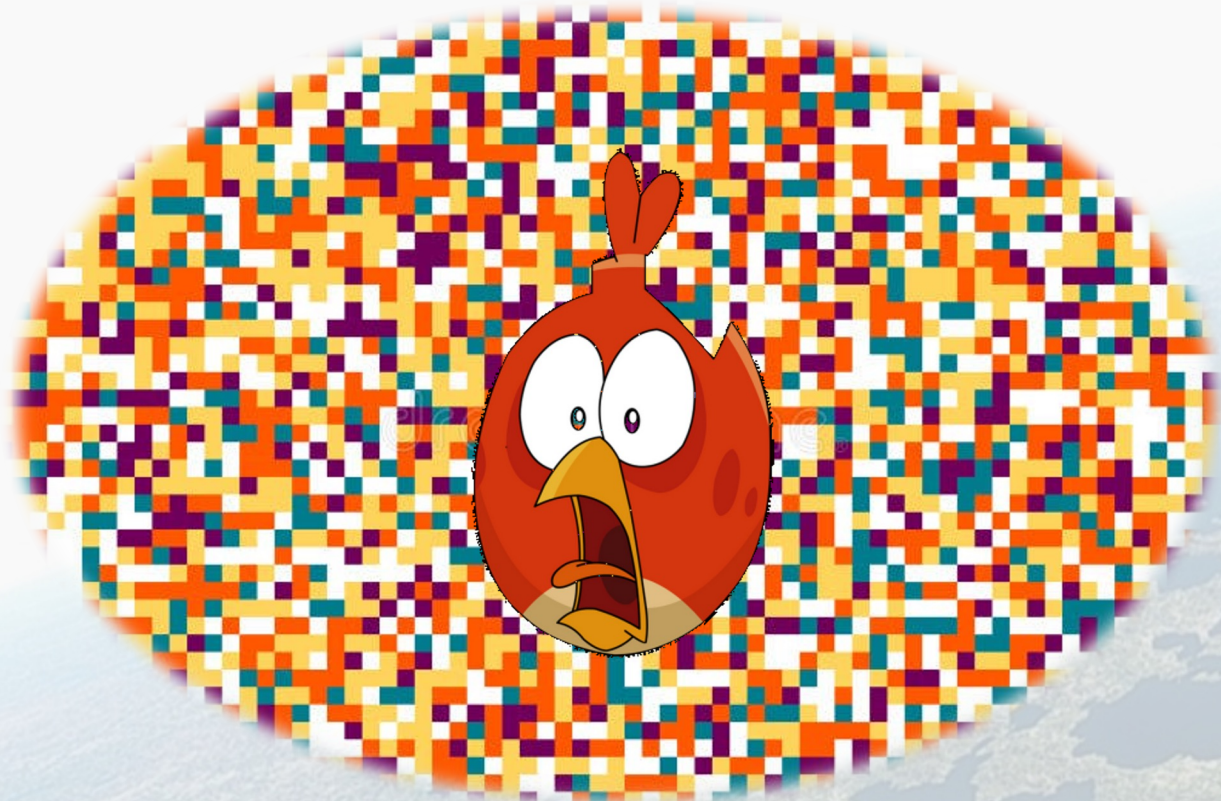
Green Deal Data Spaces

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

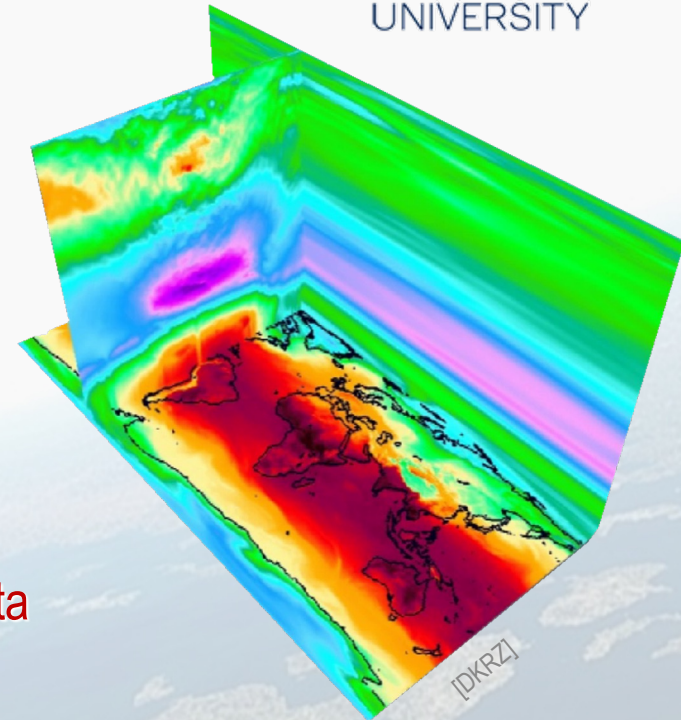
- Data spaces typically overlapping with other data spaces



We Need to Better Understand Our Data!



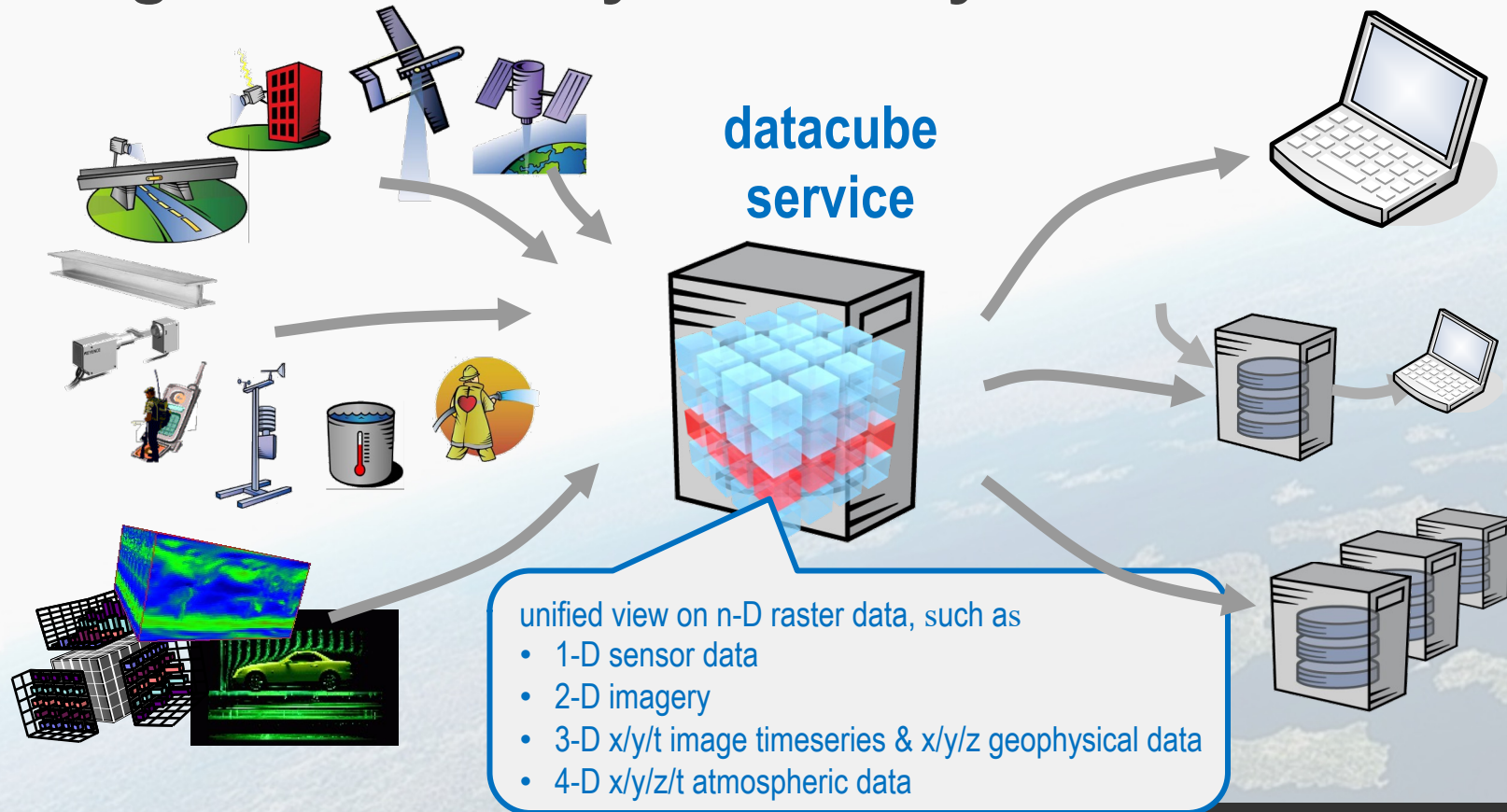
Datacubes?



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

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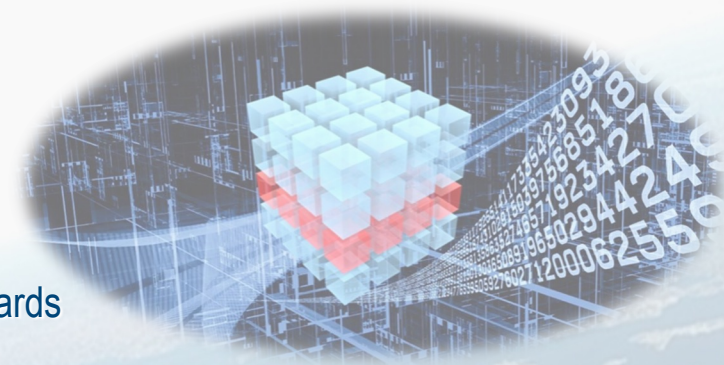
Homogenized, Analysis-Ready Datacubes



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



DATA SCIENCE TECHNOLOGY INNOVATION
OF THE YEAR

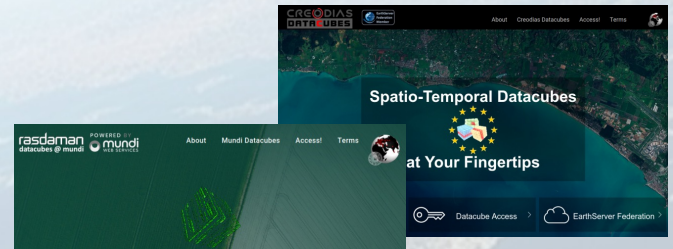


Defence
Innovation



EarthServer

- 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" )
```

- 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 )
```

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



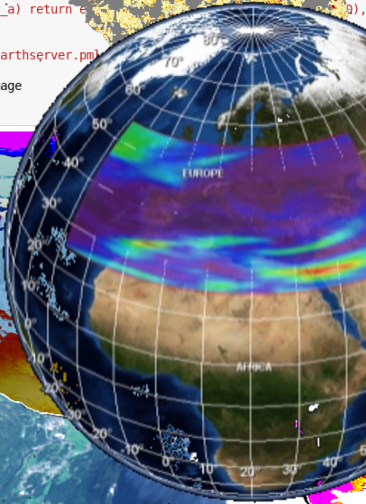
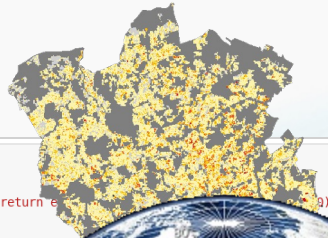
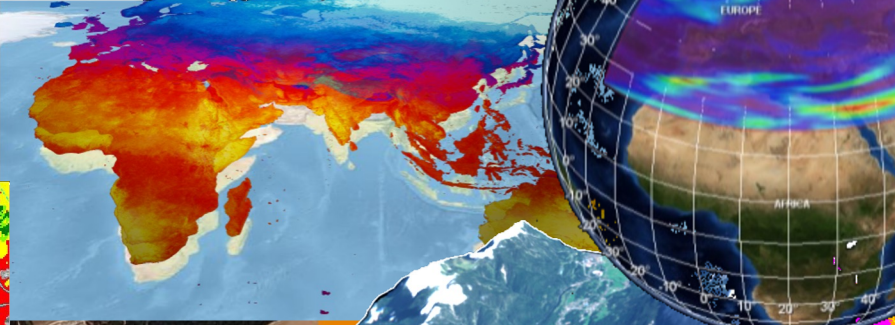
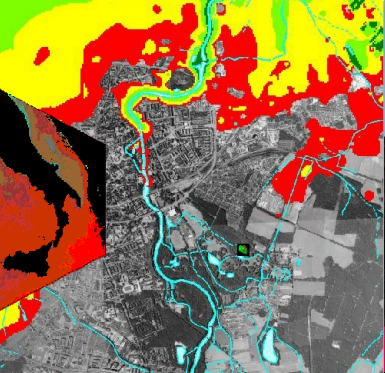
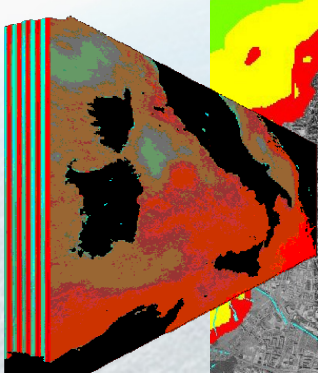
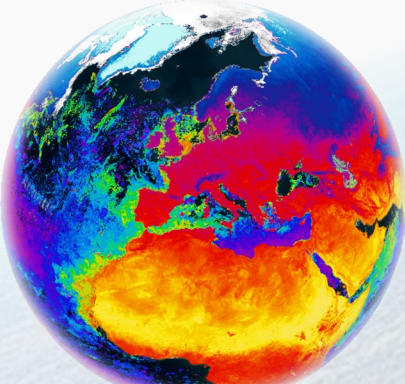
Bring Your Favourite Client

- 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, ...

[rasdaman-based portals]

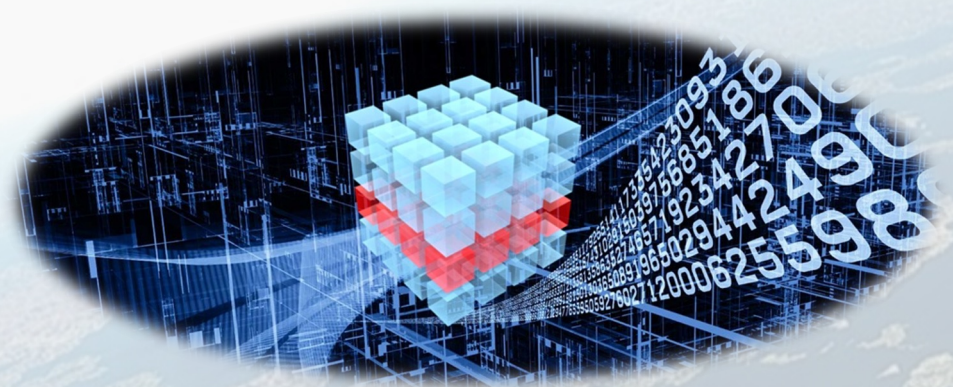
```
In [12]: import requests
        query = """
        for a in (CCI_V2_monthly_chlor_a) return e
        """
        resp = requests.post('http://earthserver.pn
        from IPython.display import Image
        Image(data=resp.content)

Out[12]:
```



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

