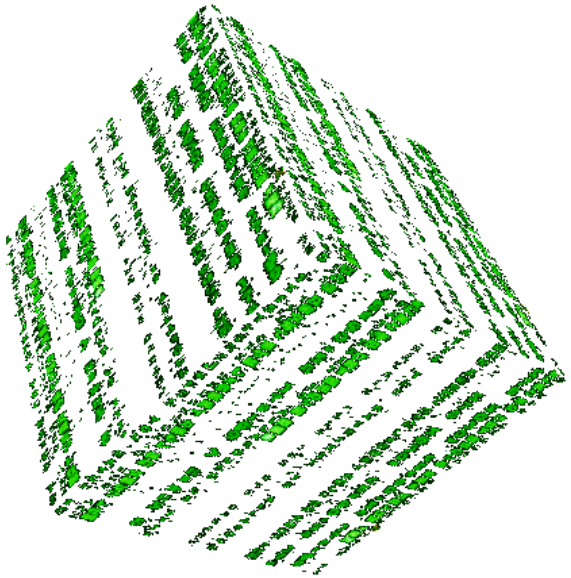


rasdaman: Big Data Analytics auf multidimensionalen Rasterdaten

Open-Source Park, **INTERGEO 2013**

Peter Baumann

Jacobs University | rasdaman GmbH

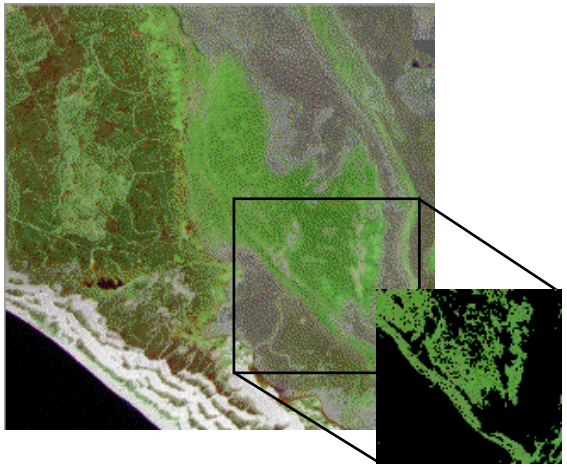
Array DB Research @ Jacobs U

- Large-Scale Scientific Information Systems research group
  - focus: large-scale n-D raster services & beyond
  - www.jacobs-university.de/lsis
- Spin-off company: rasdaman GmbH
- Main results:
  - Array DBMS, rasdaman
  - Geo service standards: Chair, OGC raster-relevant working groups, editor of 10+ stds & candidate stds
    - Geo Array QL standard (adopted)
  - Further: Array SQL

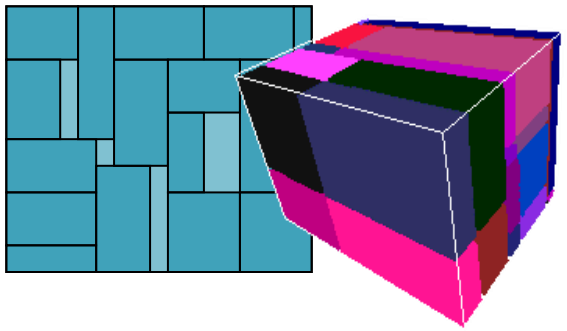
rasdaman
raster data management

- raster data manager
  = Array DBMS for massive n-D raster data
  - SQL + imaging operators

```
select img.green[x0:x1,y0:y1] > 130
from   LandsatArchive as img
where  avg_cells( img.nir ) < 17
```



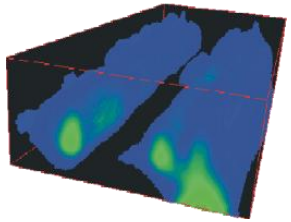
- Flexibility ← query language
- Scalability ← „tile streaming“ architecture, parallelization
- In operational use



Array Query Operators: rasql

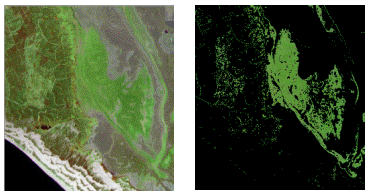
- selection & section

```
select c[ *:*, 100:200, *:*, 42 ]
from   ClimateSimulations as c
```



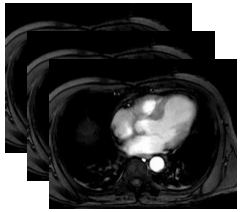
- result processing

```
select img * (img.green > 130)
from   LandsatArchive as img
```



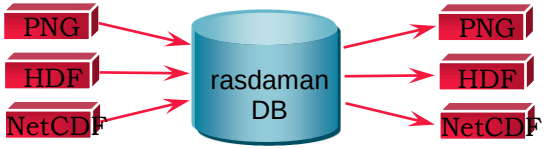
- search & aggregation

```
select mri
from   MRI as mri, masks as am
where  some_cells( mri > 250 and m )
```



- data format conversion

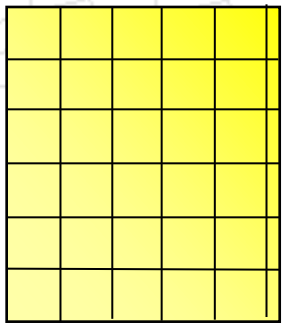
```
select png( c[ *:*, *:*, 100, 42 ] )
from   ClimateSimulations as c
```



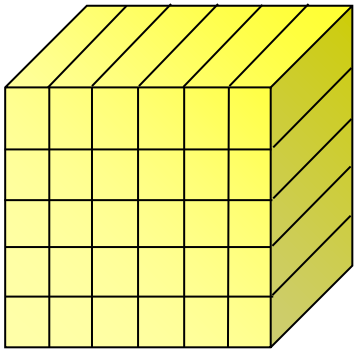
Configurable Tiling

- Sample tiling strategies [Furtado]:

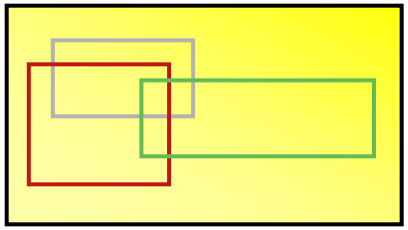
regular

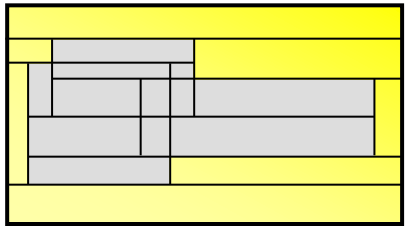


directional



area of interest

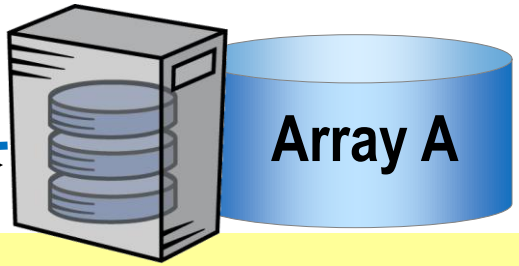


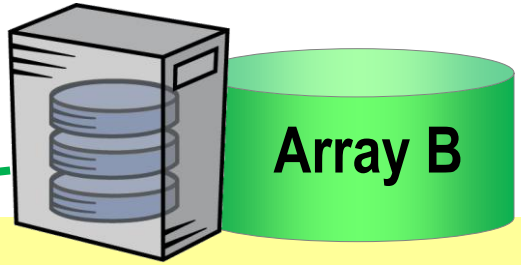


- rasdaman storage layout language

```
insert into MyCollection
  values ...
  tiling area of interest [0:20,0:40], [45:80,80:85]
  tile size 1000000
  index d_index storage array compression zlib
```

Distributed Query Processing






```
select
    max((A.nir - A.red) / (A.nir +A.red))
from A
```

```
select
    max((A.nir - A.red) / (A.nir + A.red))
  - max((B.nir - B.red) / (B.nir + B.red))
from A, B
```

```
select
    max((B.nir - B.red) / (B.nir + B.red))
from B
```

Calling Tools from Database Queries

- UDF = invocation of external code within query
  - Tranparently integrated with tile streaming, optimization, parallelization
- Ex: "*NDVI from raw Landsat subset, orthorectified with Orfeo Toolbox*"

```
select
  encode(
    otb.orthoRectifFilter(
      ((img.red-img.nir)/(img.red+img.nir))[x0:x1,y0:y1],
      outputSpacing, deformationFieldSpacing
    ),
    "png"
  )
from   LandsatRawArchive as img
```

In-Situ Databases

- Traditionally: data imported into database
  - full data control → efficient data organization
- Problem: Large-scale data centers sometimes object to copying
  - Data simultaneously used by other actors (big NO-NO in classical databases!)
- Approach: reference external files, use as tiles; cf [Ailamaki et al 2010]

```
insert into MyCollection
  referencing /my/path/*.tif

update MyCollection
  referencing /oops/forgot/*.jpg
```

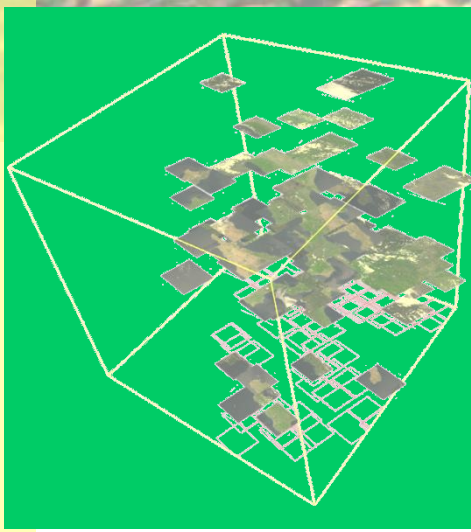
  - Different from storing tiles in files!
  - Challenges: efficiency, consistency, caching, ...

3D Database Visualization

[data courtesy BGS, ESA]

- rasdaman Web client toolkit, and...

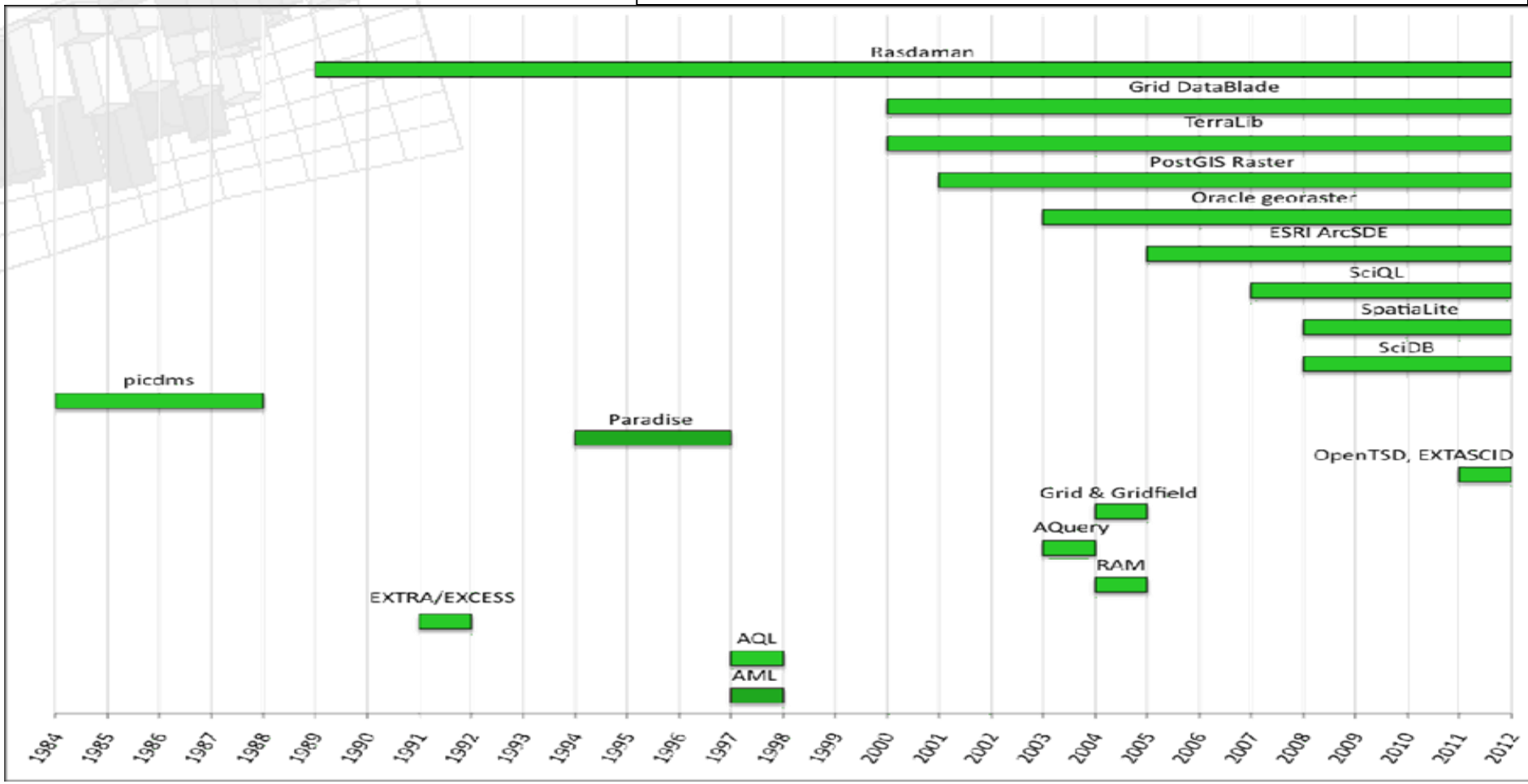
```
select
  encode(
    struct {
      red:   (char) s.b7[x0:x1,x0:x1],
      green: (char) s.b5[x0:x1,x0:x1],
      blue:  (char) s.b0[x0:x1,x0:x1],
      alpha: (char) scale( d, 20 )
    },
    "png"
  )
from SatImage as s, DEM as d
```



[JacobsU, Fraunhofer 2012]

A Brief History of Array DBMSs

first appearance in literature (not first implementation)



Something wrong/missing? Let us know!

EarthServer: *Big Earth Data Analytics*

- Scalable On-Demand Processing for the Earth Sciences
  - EU FP7-INFRA, 3 years, 5.85 mEUR
- 100+ TB databases for all Earth sciences + planetary science
  - Platform: rasdaman

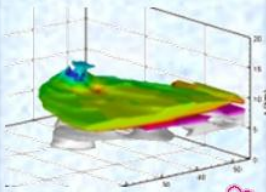
Cryospheric Science
landcover mapping

EOX

Airborne Science
high-altitude long-endurance drones

NASA

Atmospheric Science
climate variables

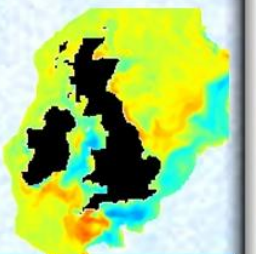


MEEO
Meteorological Environmental Earth Observation

Geology
geological models

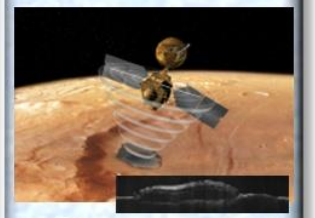
BGS British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Oceanography
marine model runs + in-situ data



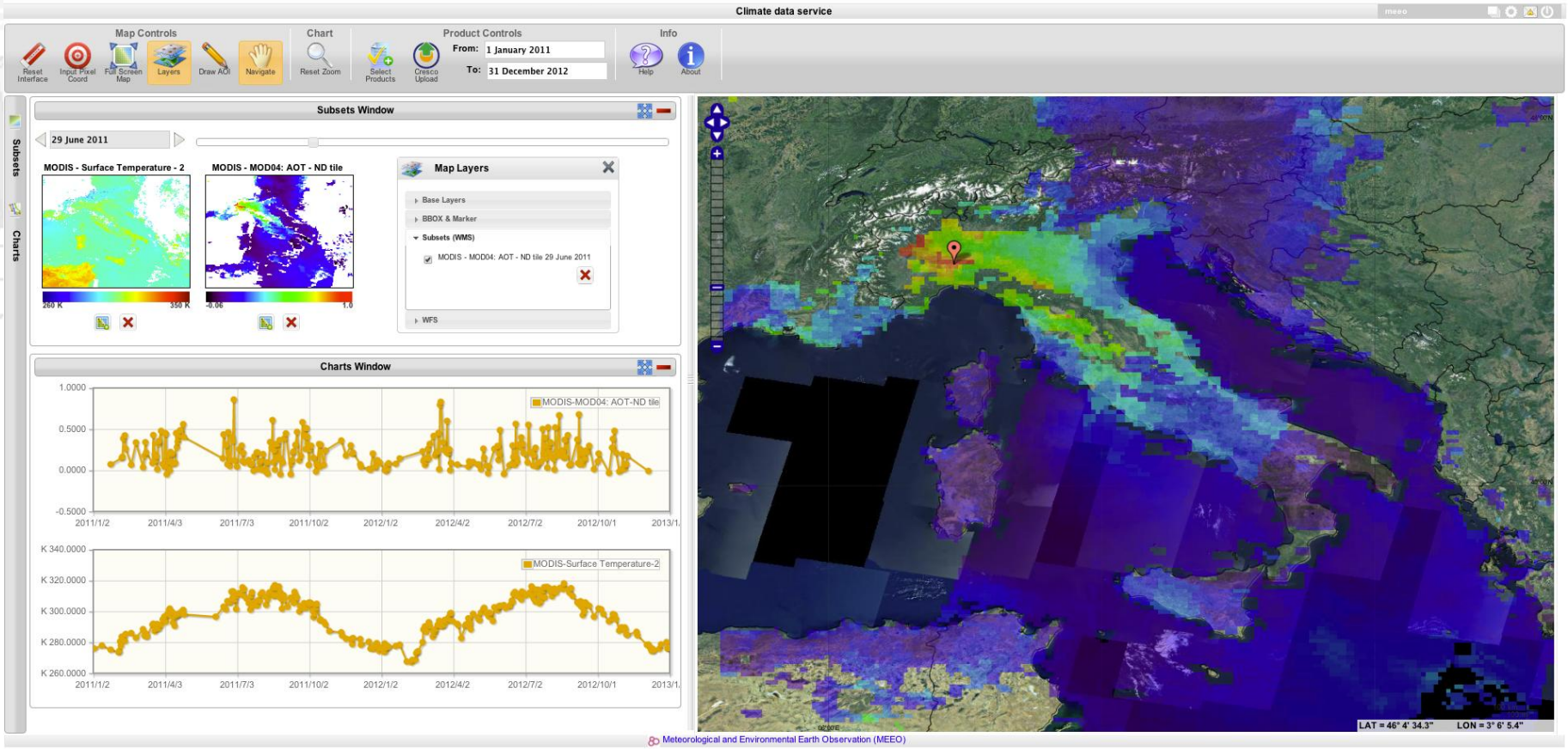
PML PLYMOUTH MARINE LABORATORY

Planetary Science
Mars geology



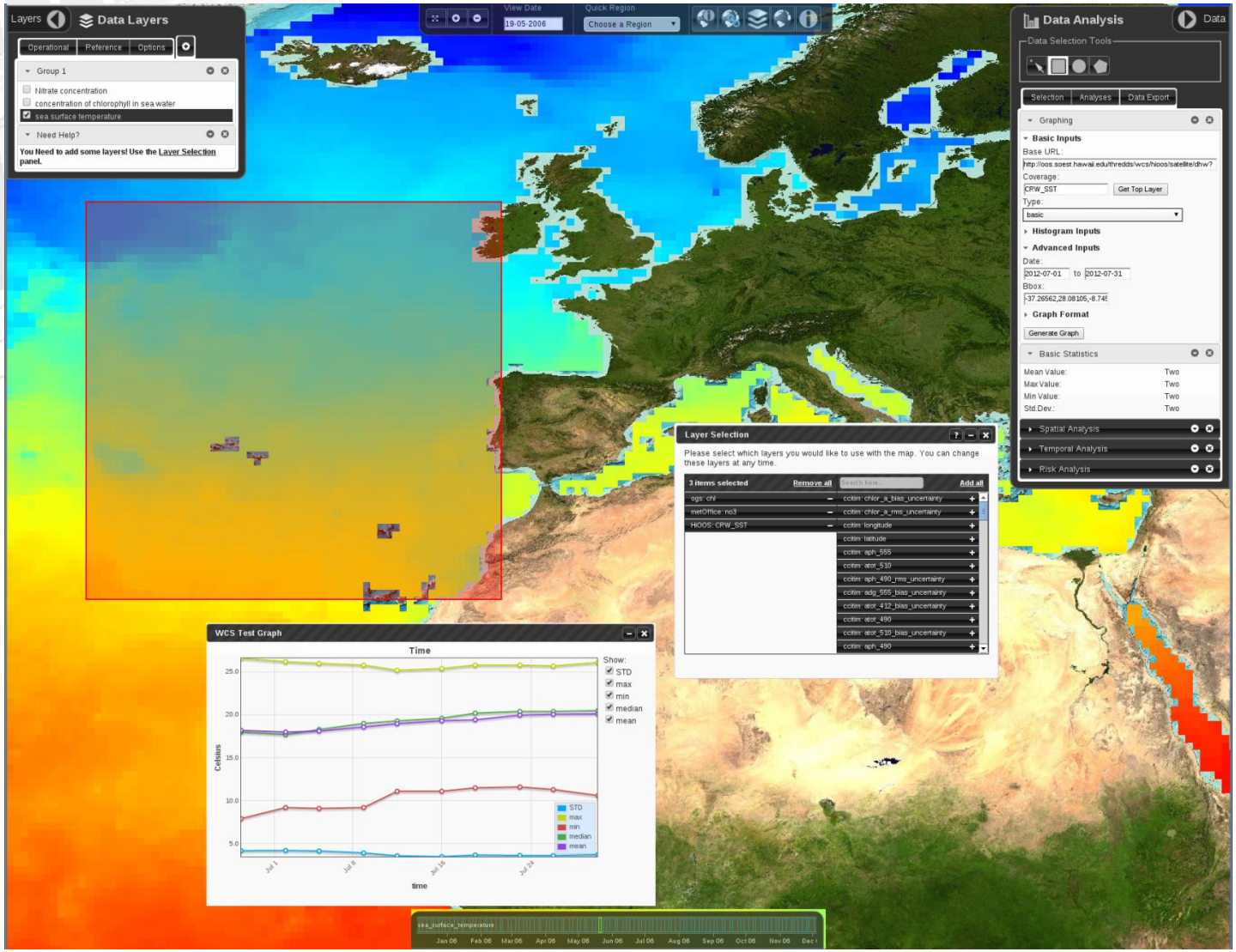
JACOBS UNIVERSITY

Ex: Climate Data Service, MEEO



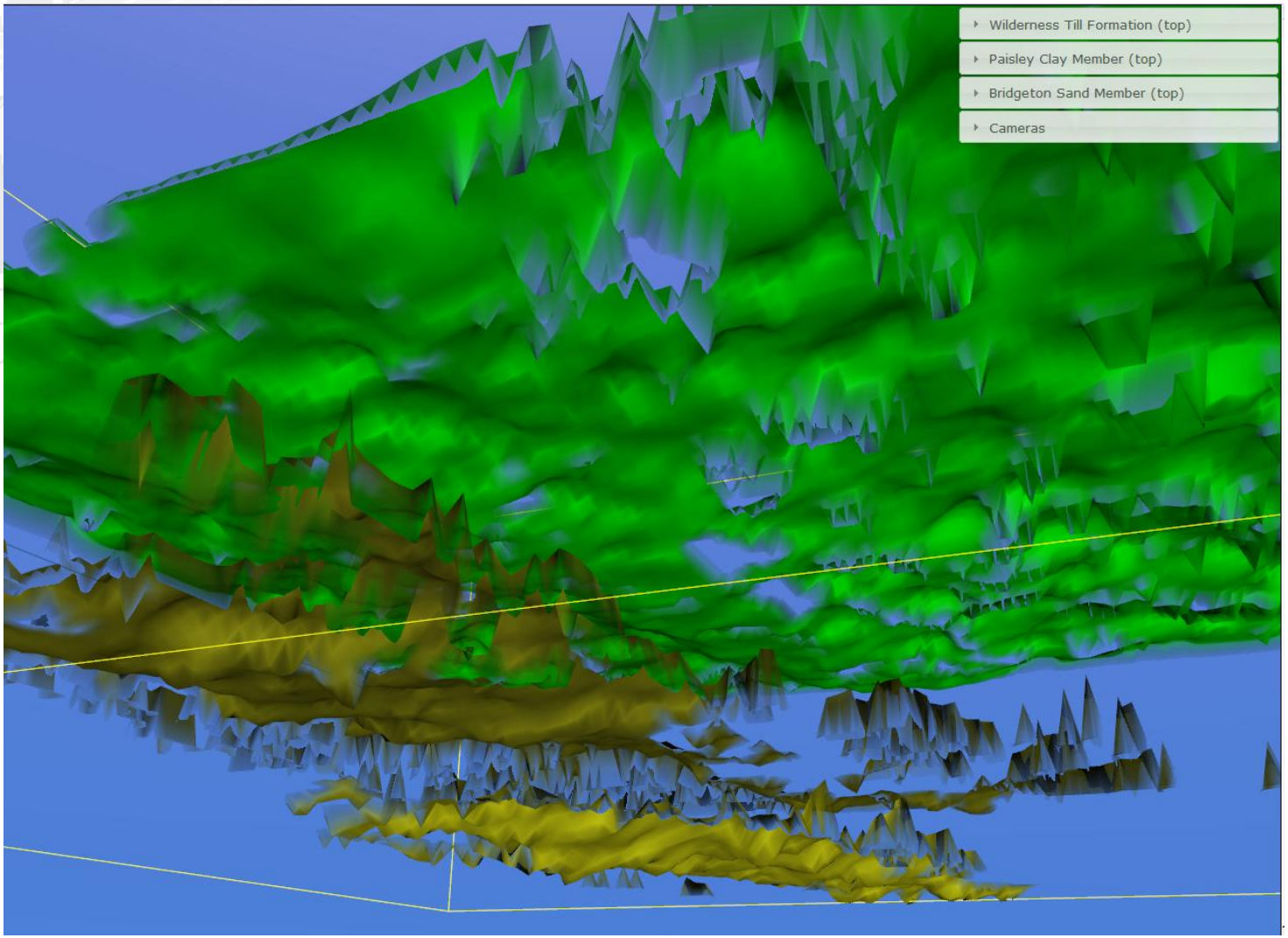
[MEEO 2013]

Ex: Plymouth Marine Laboratory



[PML 2013]

Ex: British Geological Service



[BGS 2013]

Conclusion

- Multi-dimensional Arrays are „Big Data“
  - earth / space / life sciences, business, ...
- rasdaman: Flexibility, scalability, information integration, and more
  - www.rasdaman.org, standards.rasdaman.org

vote for rasdaman