



Divisão de Processamento de Imagens



Big Earth observation data analytics for land change monitoring

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INPE's operational applications for monitoring deforestation in Amazonia



Clear cut



Early warning



Degradation



www.obt.inpe.br/prodes

www.obt.inpe.br/deter

www.obt.inpe.br/degrad

www.inpe.br/cra/projetos_pesquisas/terraclass2010.php

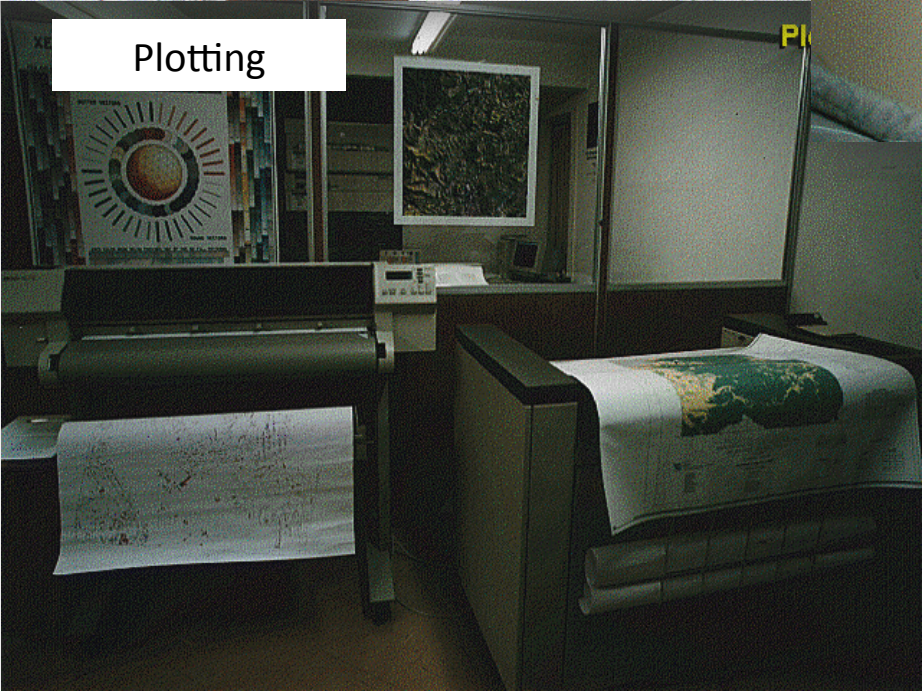
PRODES 90's



Interpretation



Digitalization

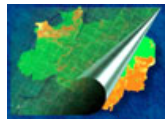


Plotting

PRODES in 2013



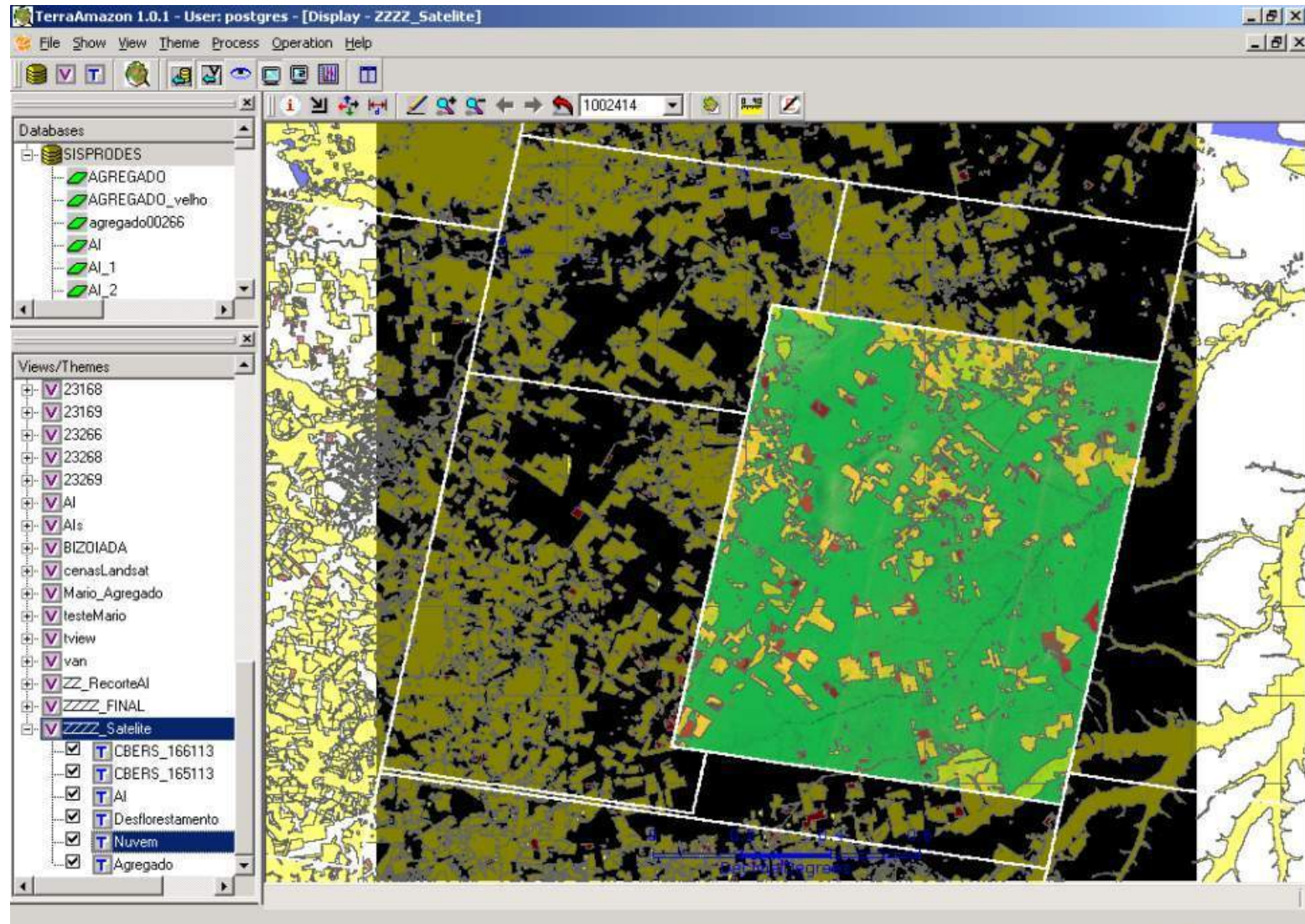
Fifteen years of remote sensing images,
deforestation polygons and in a single information
system



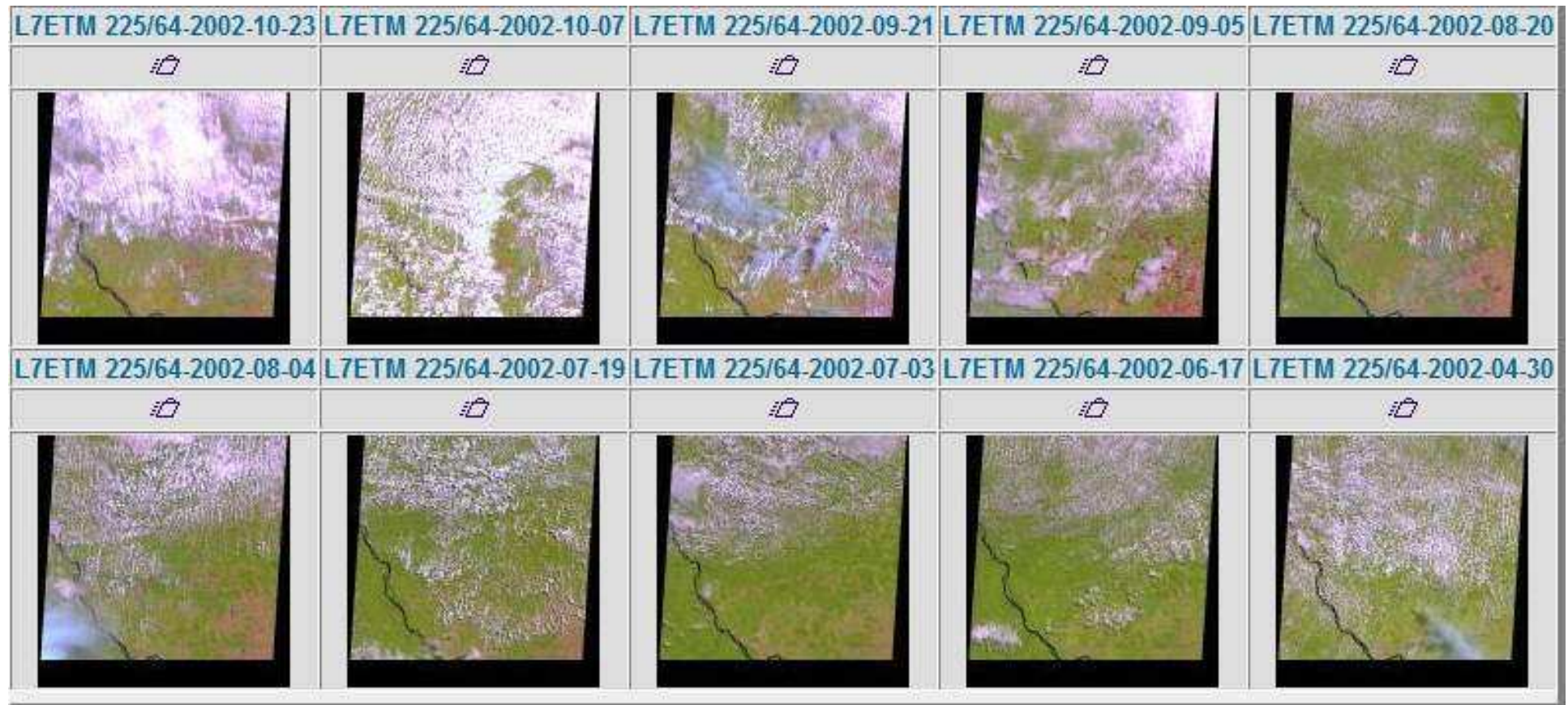
PRODES



TerraClass

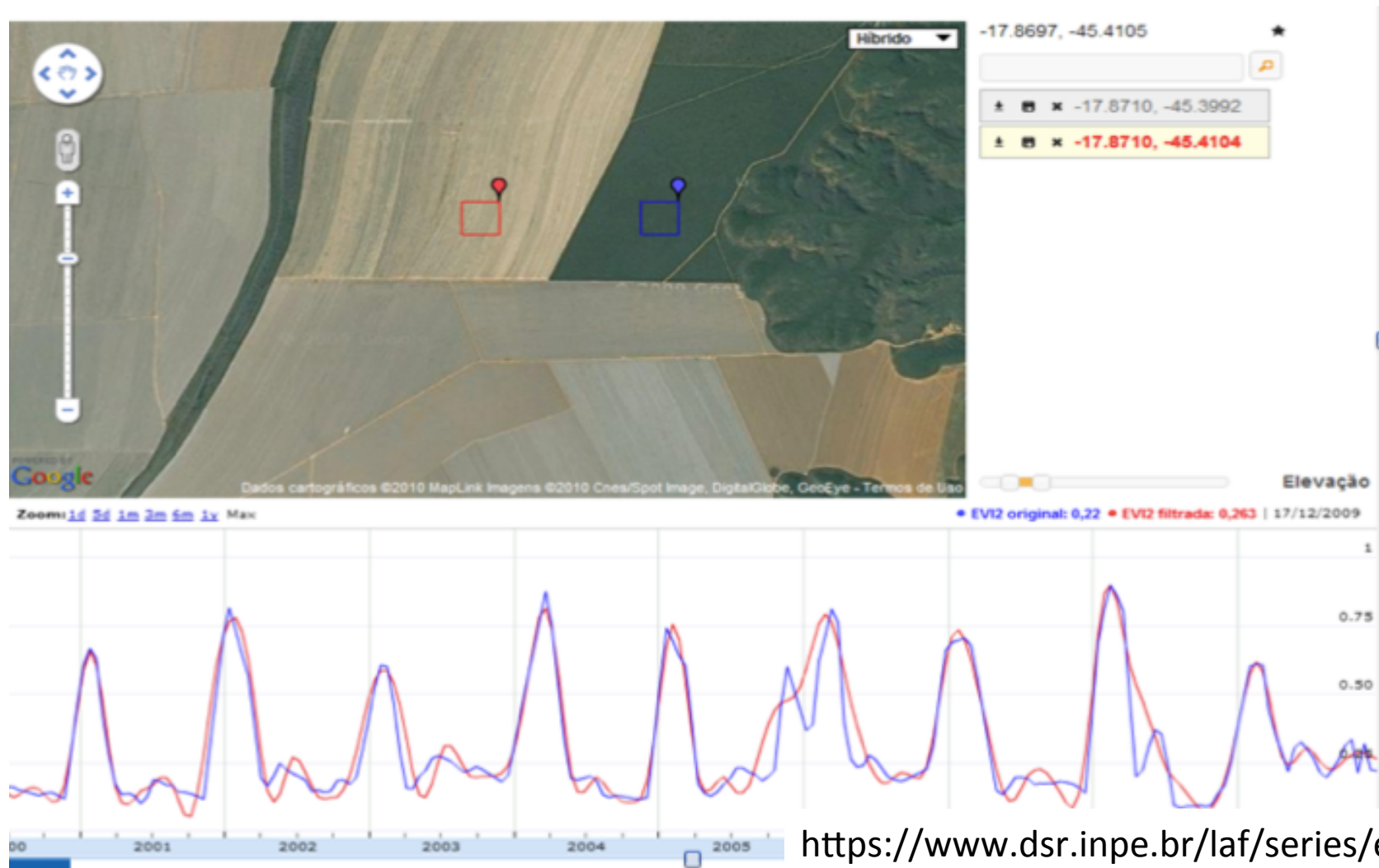


One snapshot at a time



Multi-satellite approach to minimize cloud cover

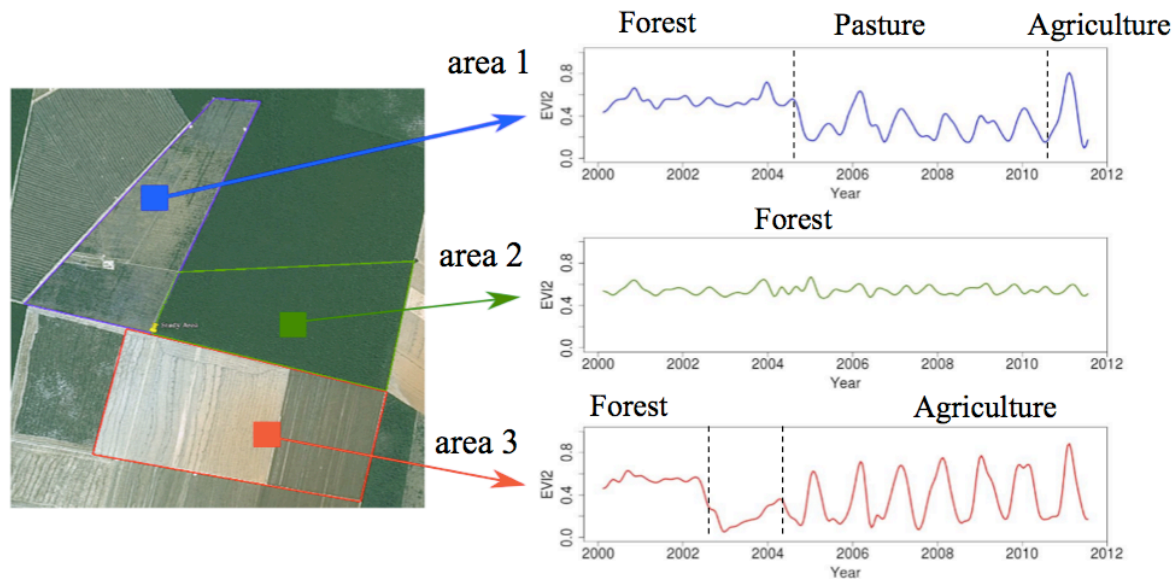
RS images describe dynamics



Using time series

Recent results in the literature show that time series of vegetation indexes can create a detailed classification of croplands by detecting important characteristics of land-cover and land-use change

MODIS vegetation index archive for Brasil from 2002 to 2014 has 12.000 independent files

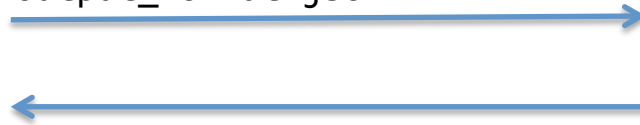


Web Time Series Services

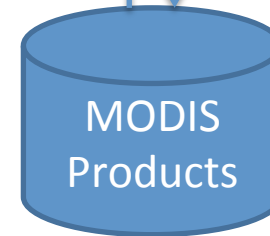


WTSS Client

```
http://www.dpi.inpe.br/wtss/query?  
product=MOD13Q1,datasets=red,nir&  
longitude=-45,latitude=-12&  
output_format=json
```

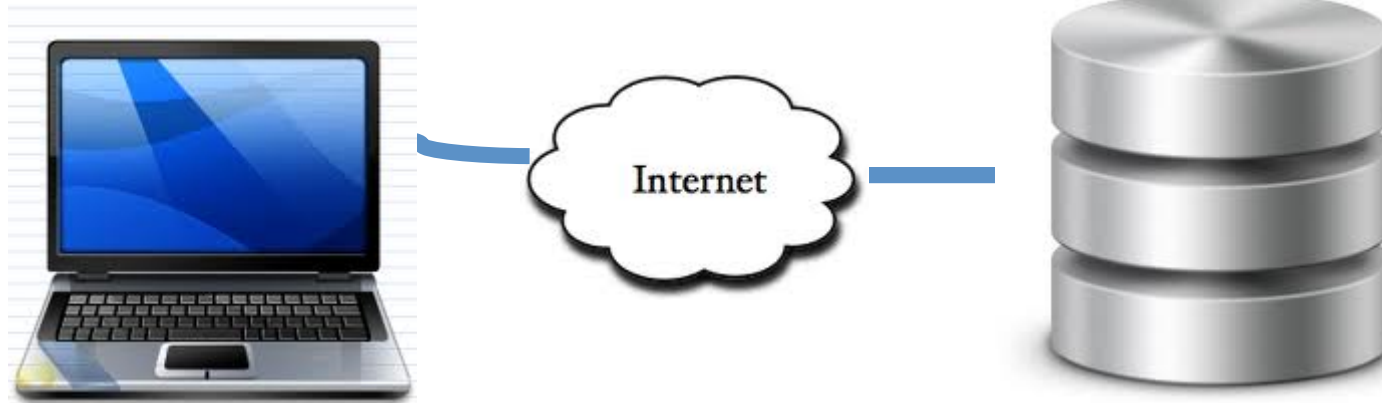


JSON



```
{  
  "query": { "product": "MOD13Q1",  
            "datasets": ["red", "nir"],  
            "longitude": -45,  
            "latitude": -12,  
          },  
  "result": { "datasets": [{ "dataset": "red",  
                            "scale_factor": null,  
                            "missing_value": -3000,  
                            "values": [ 270, 277, ... ]  
                          },  
                ...  
            ],  
            "timeline": ["2000-02-18", "2000-03-05", ...]  
          }  
}
```

Where we want to get to

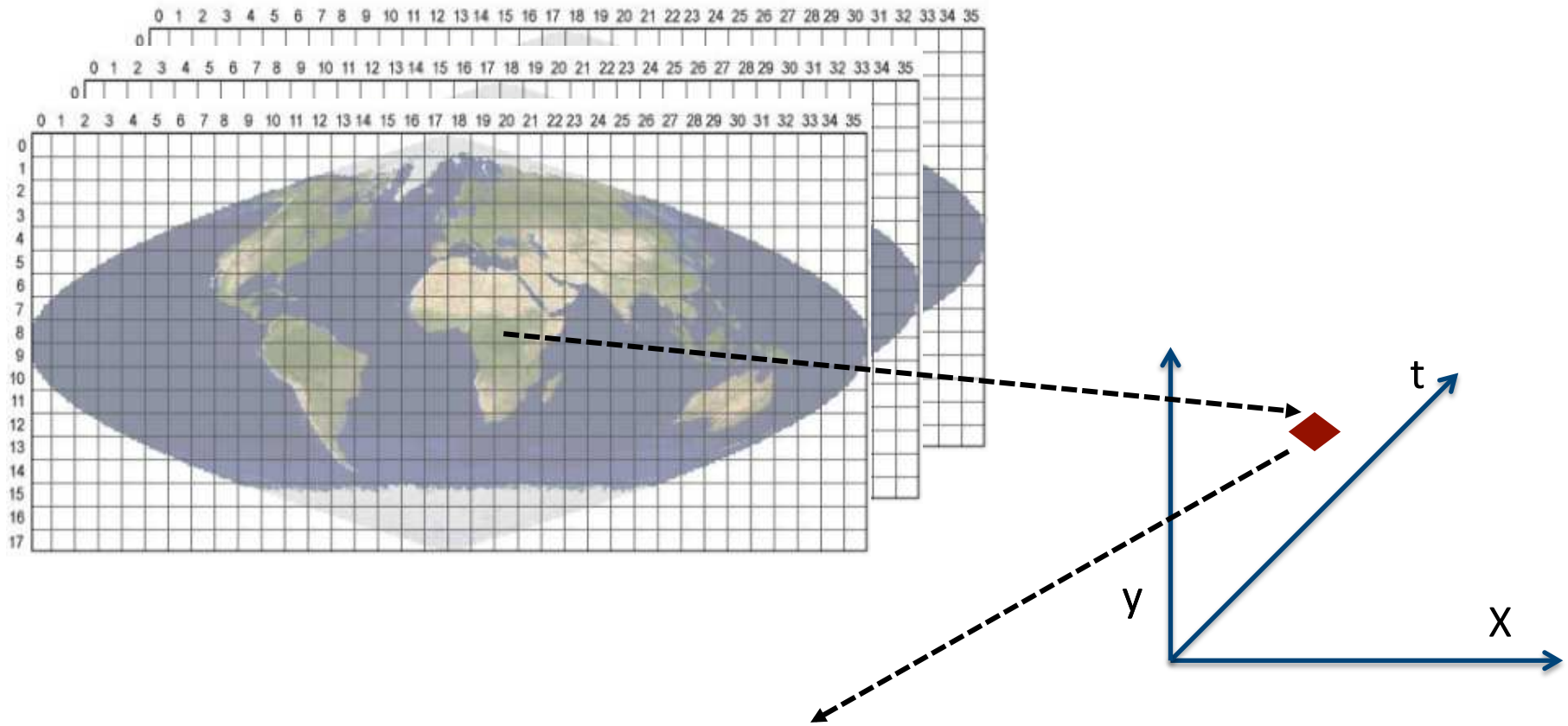


**Remote visualization and
method development**

**Big data EO
management and
analysis**

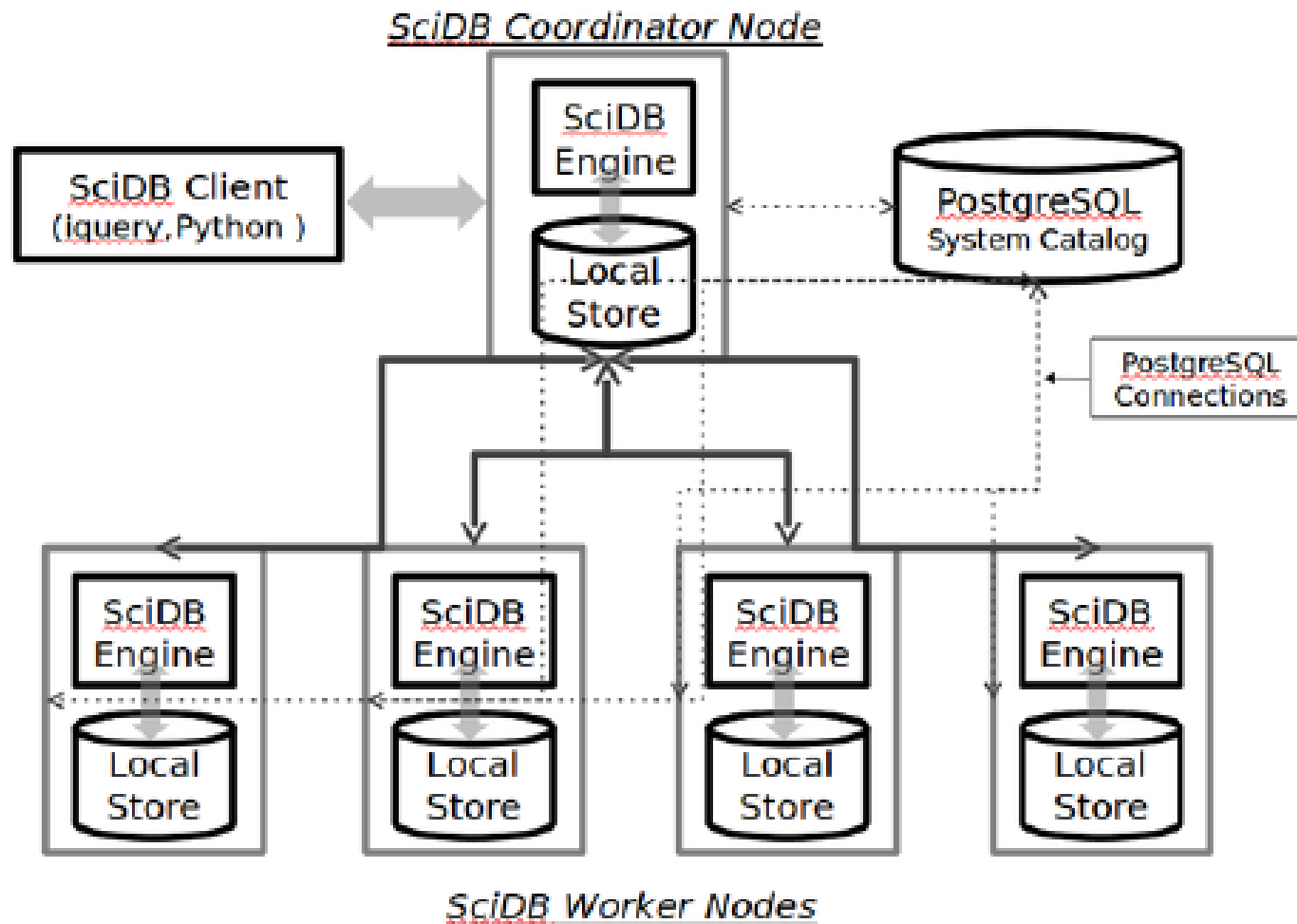
40 years of Earth Observation data of land change
accessible for analysis and modelling.

Array databases: all data from a sensor put together in a single array



result = analysis_function (points in space-time)

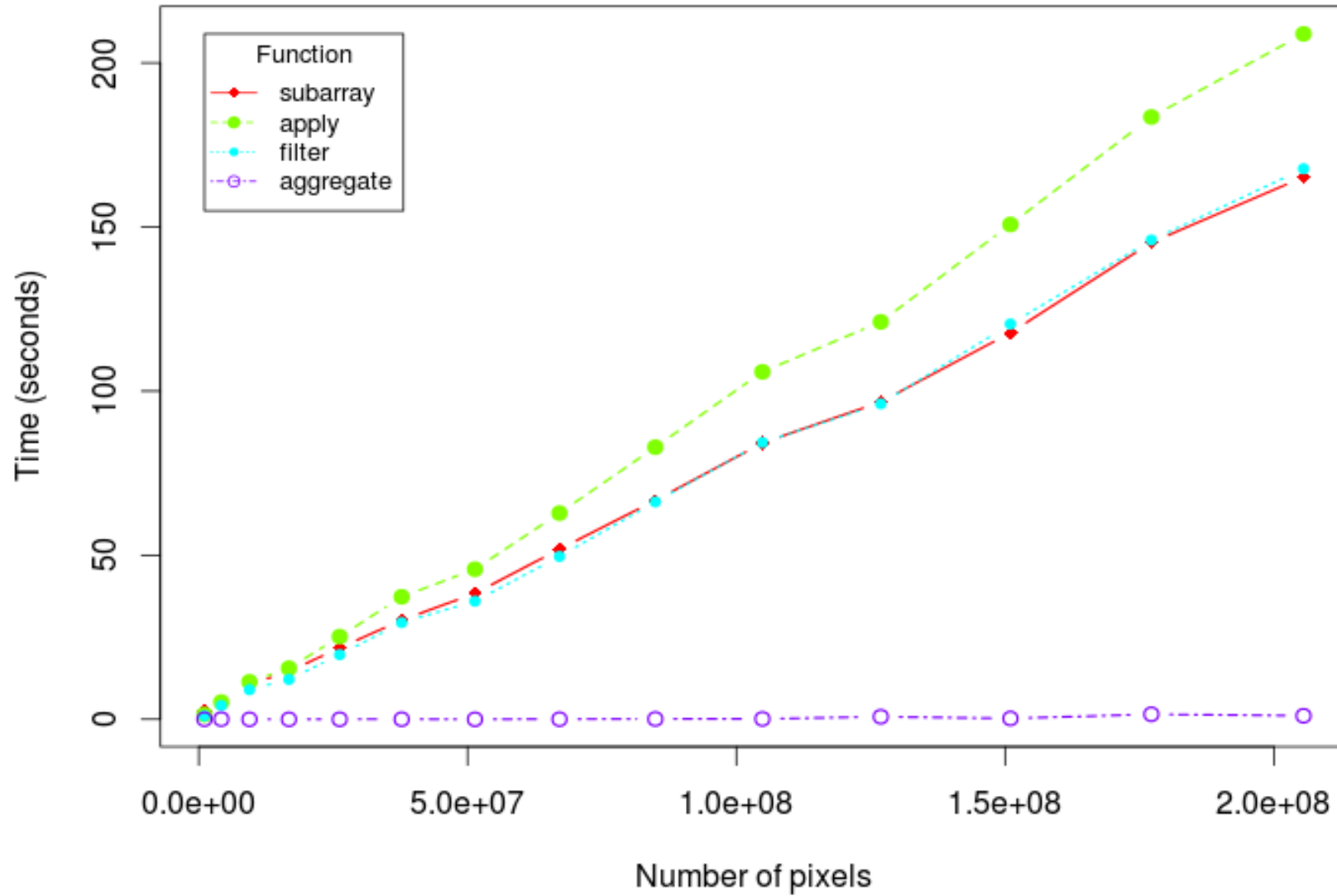
SciDB Architecture: “shared nothing”



Large data is broken into chunks

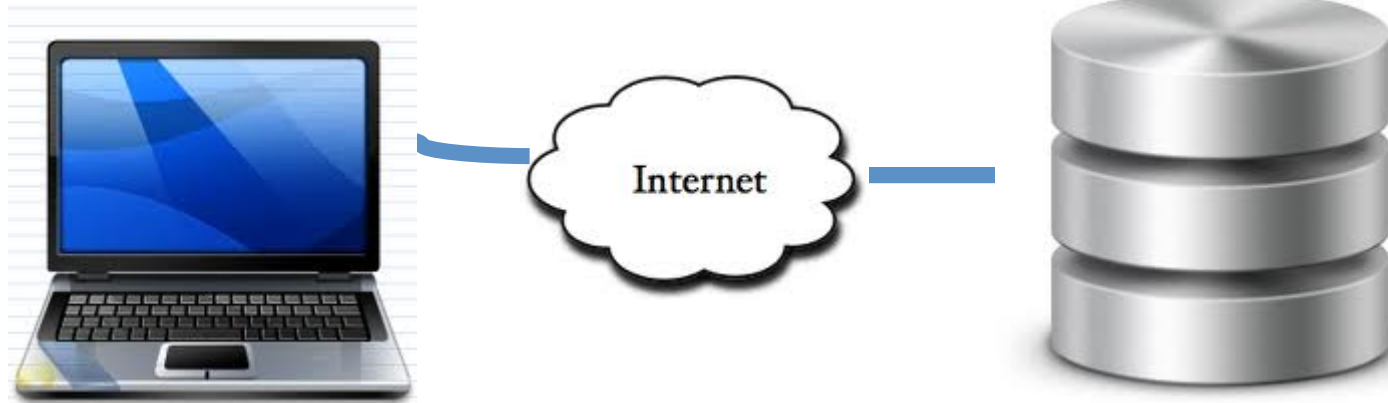
Distributed server process data in parallel

SciDB performance for large images



source: Câmara et al, 2014

Where we want to get to

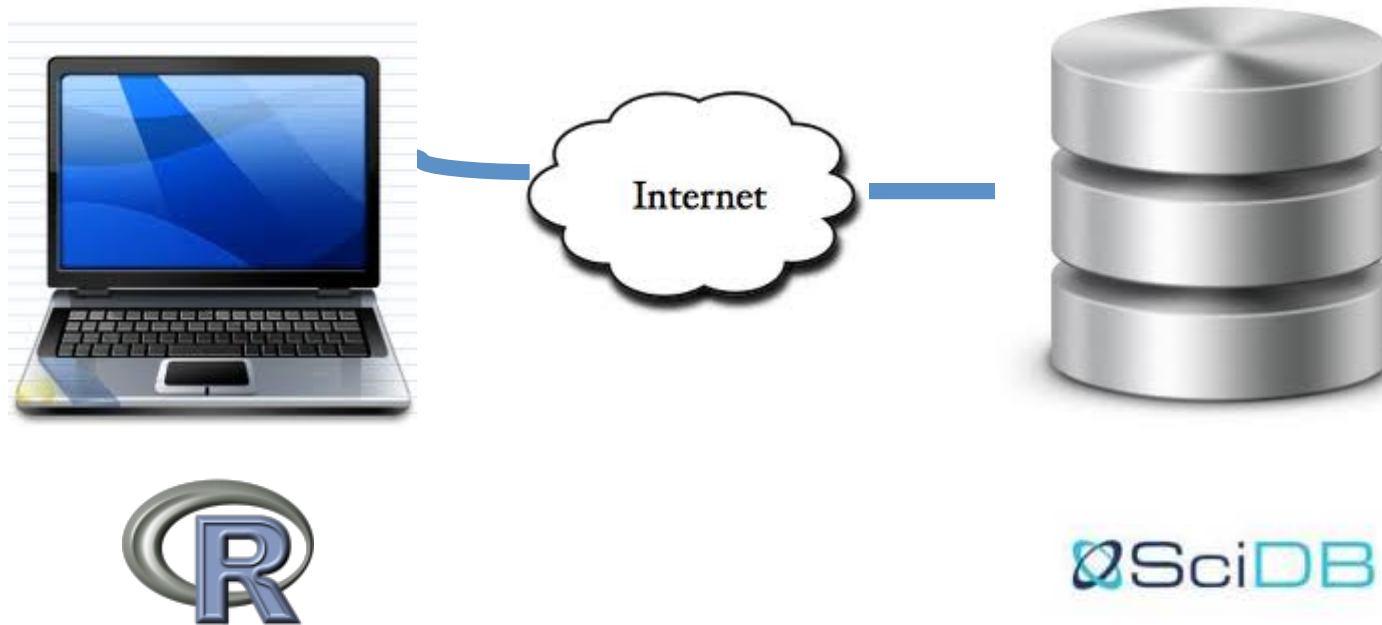


**Remote visualization and
method development**

**Big data EO
management and
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40 years of Earth Observation data of land change
accessible for analysis and modelling.

Land Observatory



spatial analysis, time-series analysis, classification, clustering, and data mining,...

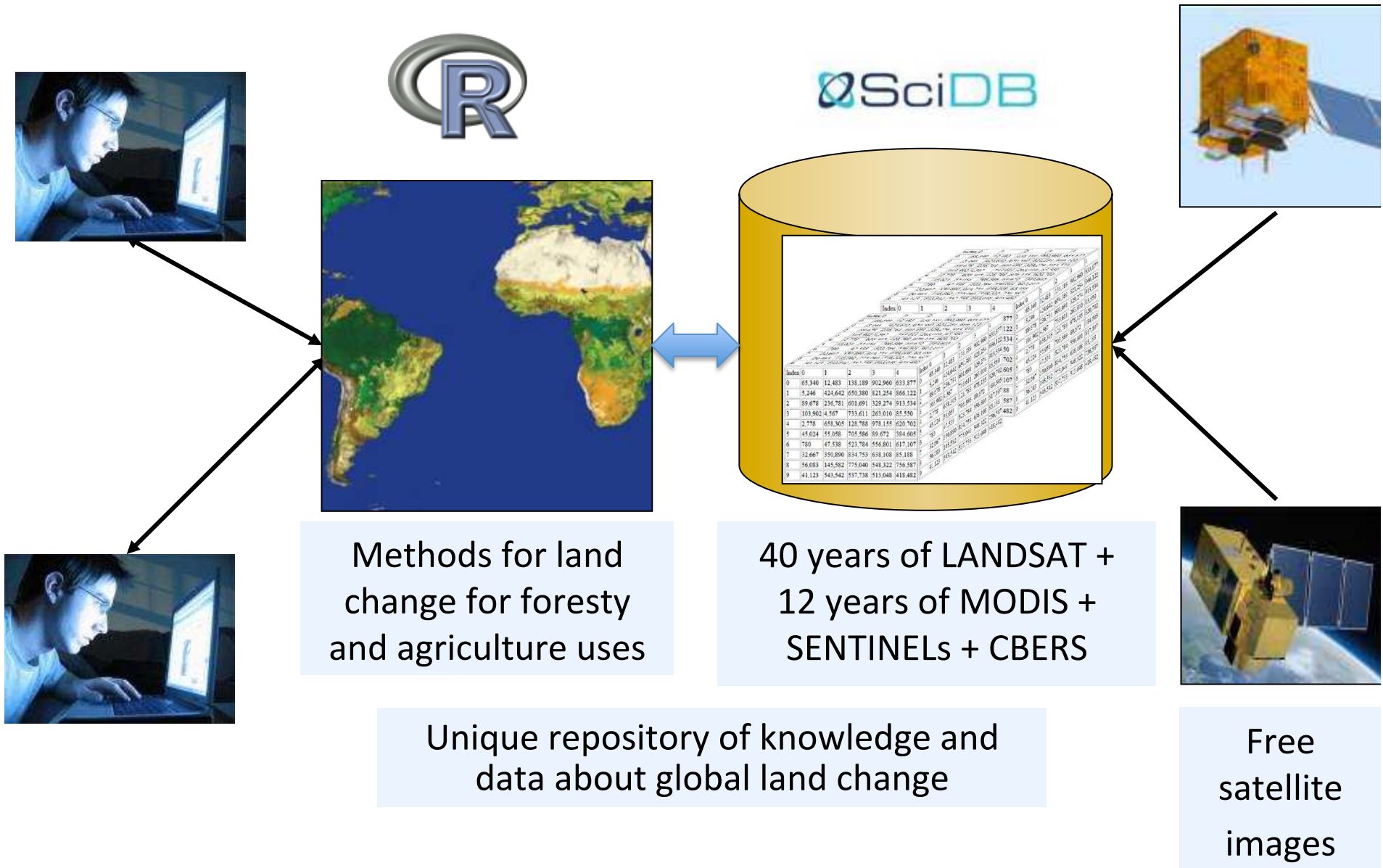
SciDB-R

Program SciDB from R with the *scidb* package for R.

SciDB r_exec

Invoke R from within SciDB queries.

Land Observatory: describing change in a connected world



Initial experiments

Modis Time Series | www.dpi.inpe.br/chronos/timeseries/

Apps | Programacao | Announcements | reference.mapinfo.co | meetings - INPE Boe | ELC117 - Paradigma | Other Bookmarks

Time Series MYD13Q1 for longitude=-55.37595&latitude=-12.49896

Value

Date

- Blue
- Gaps
- EVI2
- NDVI
- Angle/100

Terra vs. Aqua comparison

Aqua

Terra

- EVI2
- NDVI

Map | Satellite

Sorriso

MT-140

MT-242

Map data ©2014 Google Imagery ©2014 TerraMetrics Terms of Use Report a map error

Longitude	-55.37595
Latitude	-12.49896
Go	
Save in csv file	
NDVI Data	
Mean	0.530
Std Dev	0.246
r2	0.957
m	0.989
b	-0.017
Class	
EVI2 Data	
Mean	0.353
Std Dev	0.228
r2	0.937
m	1.008
b	-0.015

Parameter rnb

Date 2014-01-01 MOD13Q1

Navigation: <<< << < Stop > >> >>>

Initial experiments

meetings - INPE Boe ELC117 - Paradigma Other Bookmarks

Time Series

Time Series for longitude=-55.27723&latitude=-12.09062

Value

Date

- Blue
- EVI2
- NDVI
- MIR
- NIR

Terra vs. Aqua comparison

Aqua

Terra

- EVI2
- NDVI

Map Satellite

Google

Map data ©2014 Google Imagery ©2014 TerraMetrics Terms of Use Report a map error

Longitude

Latitude

NDVI Data		EVI2 Data	
Mean	NaN	Mean	NaN
Std Dev	NaN	Std Dev	NaN
r2	0.954	r2	0.959
m	0.966	m	1.004
b	-0.004	b	-0.017
Class		soja>sorgo-1	

Parameter

Date

OBRIGADA
THANK YOU