



BRAZIL DATA CUBE
brazildatadcube.org

Big data, satellite image data cubes
and time series analysis

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National Institute for Space Research (INPE)



MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

MINISTÉRIO DA
CIÊNCIA, TECNOLOGIA
E INOVAÇÕES





National Institute for Space Research (INPE), Brazil

Produce official information about deforestation, fire and land use / cover in Brazil.



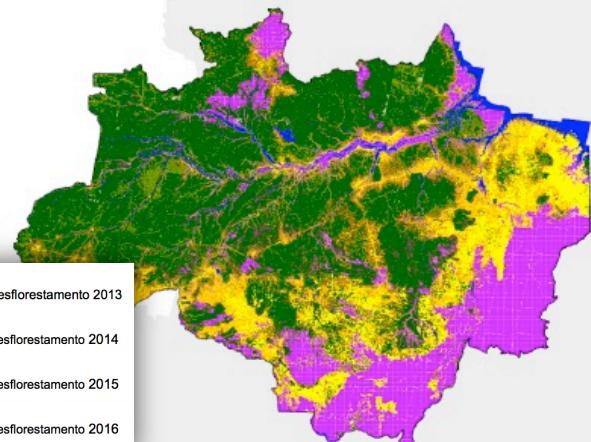
National Institute for Space Research (INPE), Brazil

Identify what the deforested areas detected have become.



Deforestation monitoring

SINCE 1988

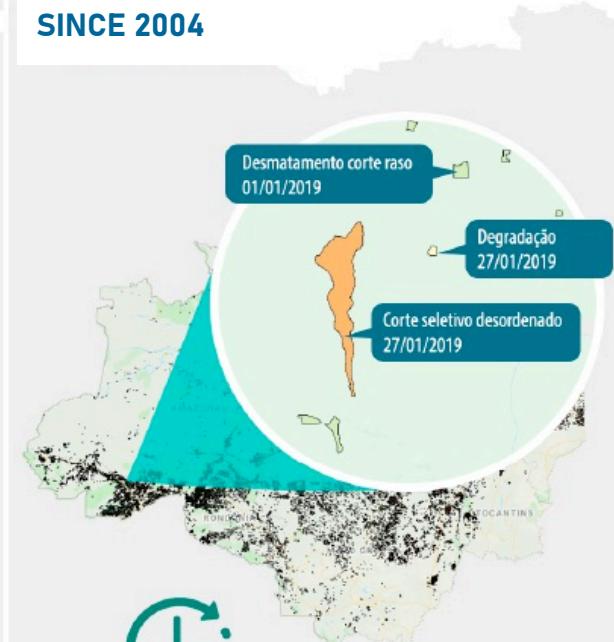


Annual maps



Near real time deforestation alerts

SINCE 2004

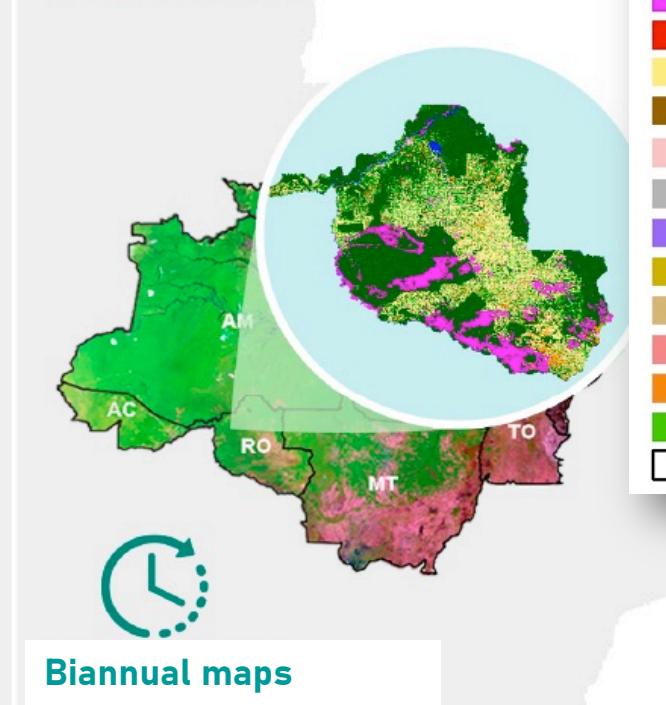


Daily alerts



Land use monitoring in deforested areas

SINCE 2004

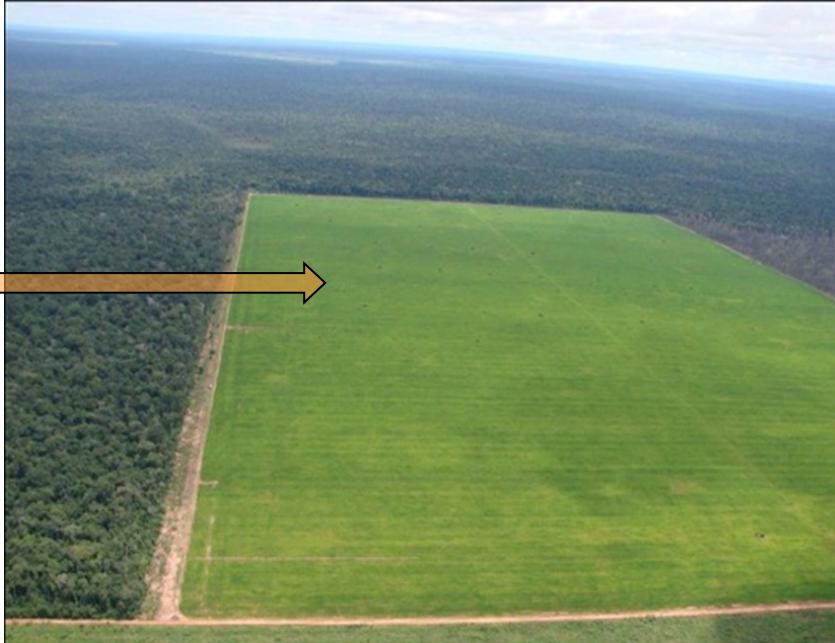


Biannual maps

Legenda
Floresta
Hidrografia
Não floresta
Desflorestamento 2008
Agricultura anual
Agropecuária
Área urbana
Mineração
Outros
Pasto com solo exposto
Pasto limpo
Pasto sujo
Regeneração com pasto
Vegetação secundária
Área não observada



Landsat (30 meters)



Clear-cut deforestation by PRODES

Landsat (30
meters)





National Institute for Space Research (INPE), Brazil

Produce official information about deforestation, fire and land use / cover in Brazil.

Develop innovative software systems for geospatial information management.

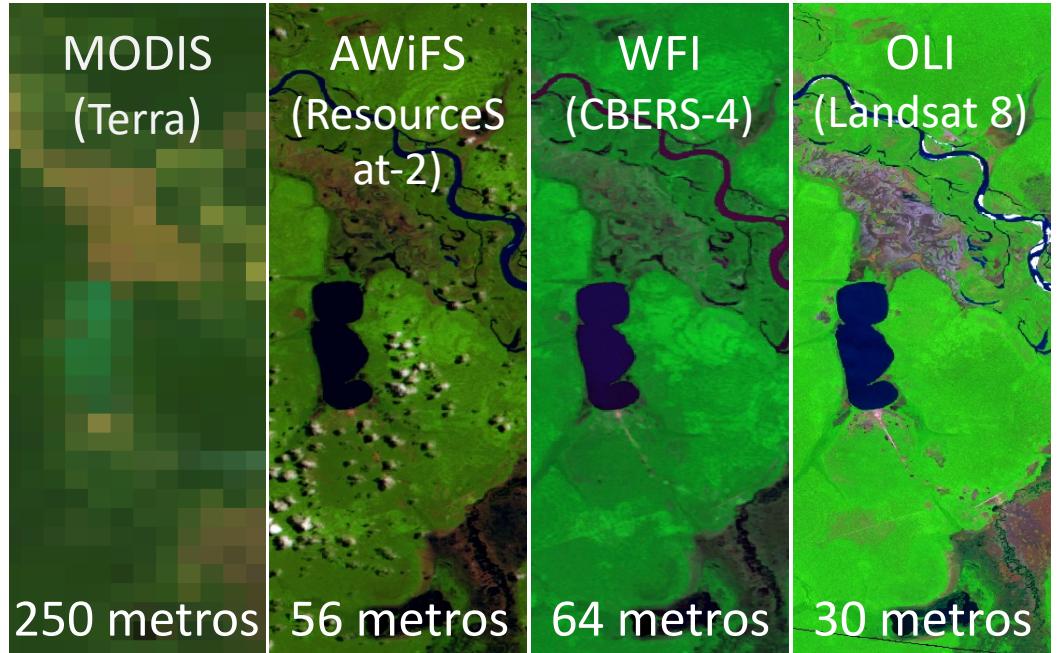
**Open
Data**



open source



Software developed by INPE to produce deforestation and land use/cover data from EO satellite images.



Visual interpretation of EO satellite images with distinct spatial and temporal resolutions.

Polygons of deforested and degraded areas.



Landsat (30 meters)





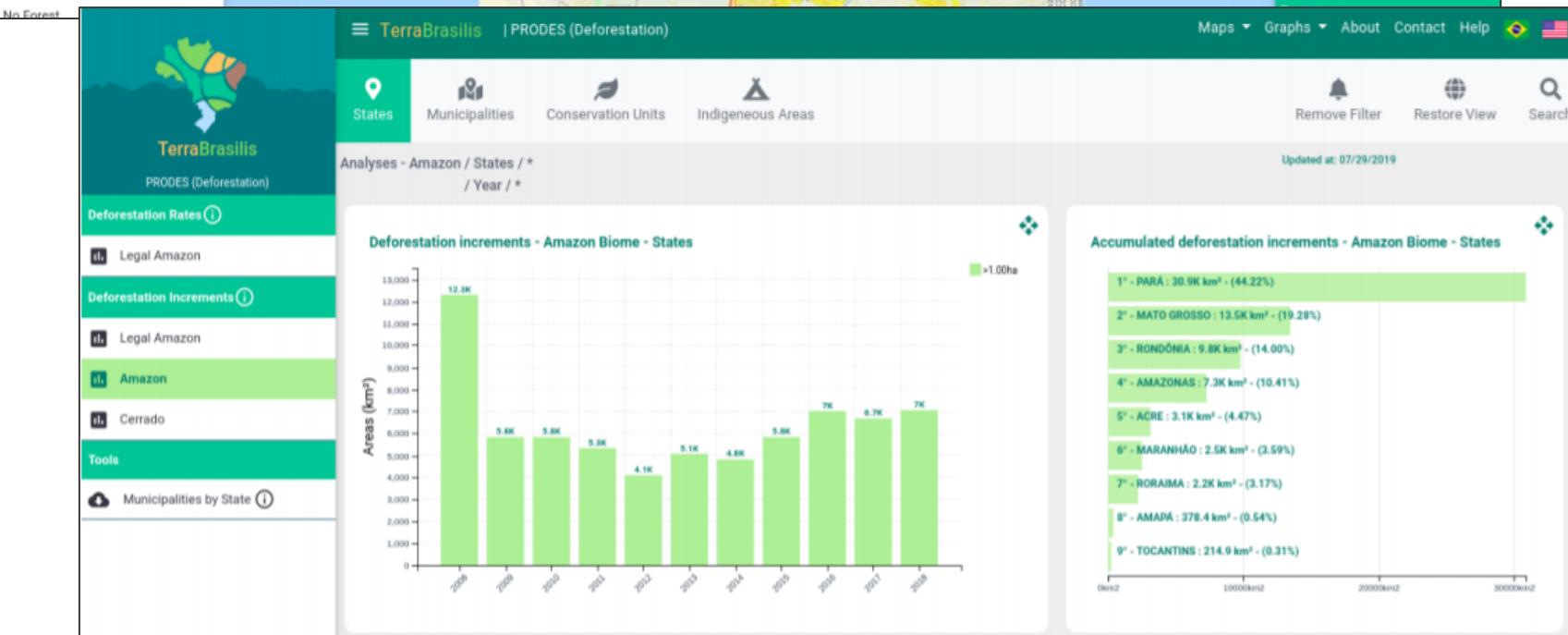
TerraBrasilis

Web portal to disseminate the deforestation data sets produced by PRODES and DETER.

Open data.

Map visualization and dashboards.

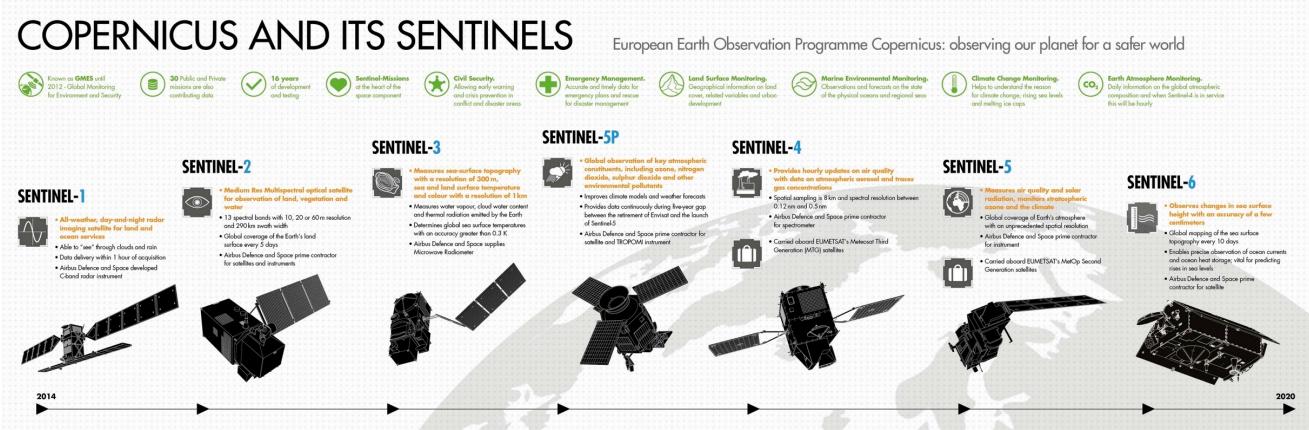
Spatial analysis tools.



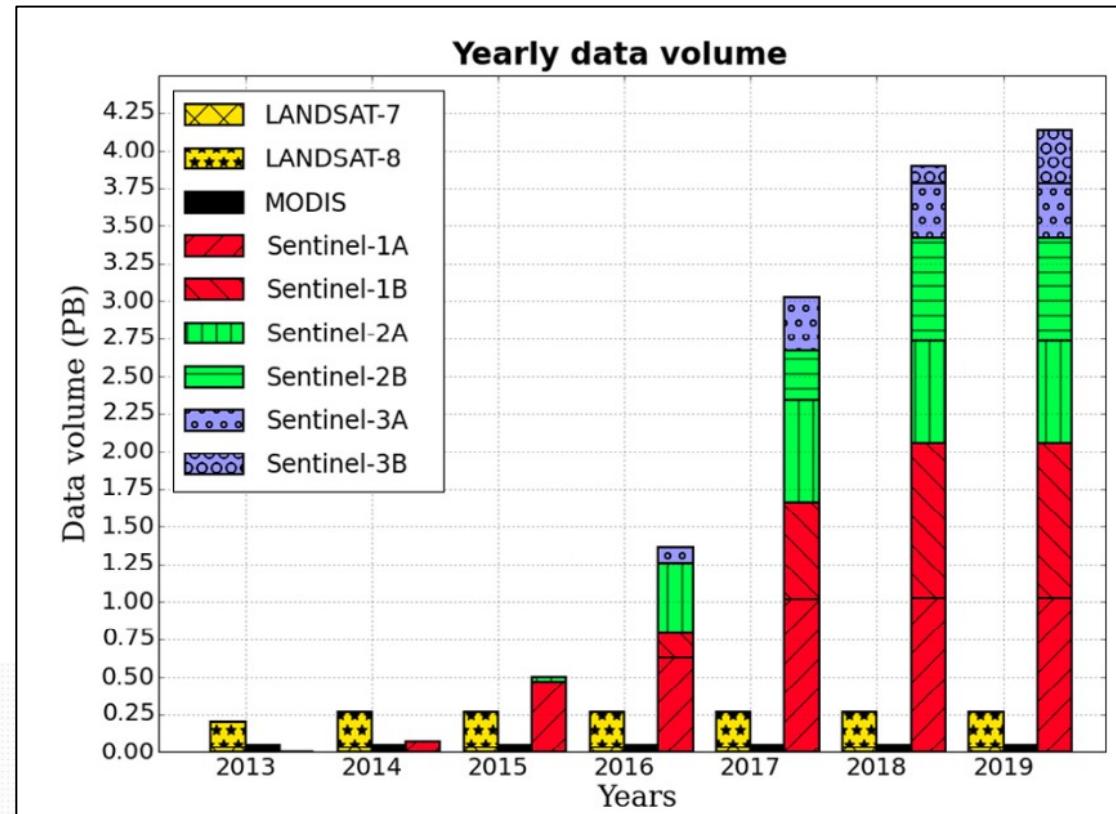
Challenge: Big data sets of EO satellite images



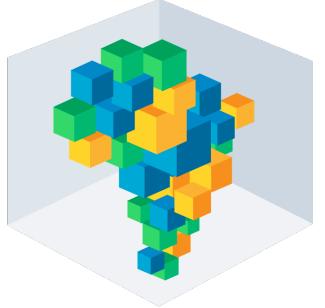
Source: eospso.nasa.gov



Source: www.copernicus.eu



Source: (Soille et al., 2018)

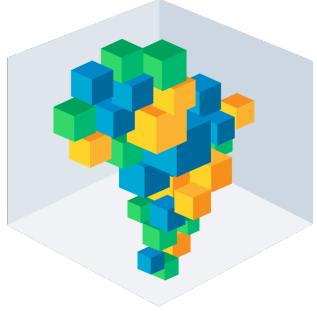


2019

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Produce **technological innovation** for the environmental monitoring projects of INPE.

Potential of **image time series analysis** and **machine learning** to produce land use and cover information from **big EO data**.



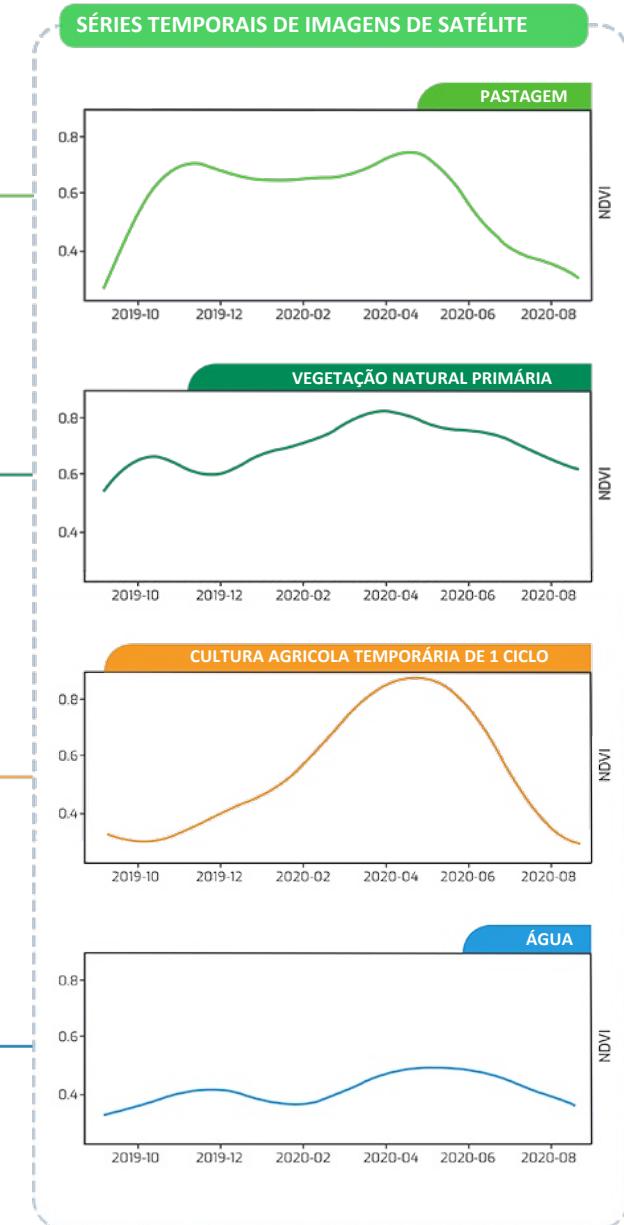
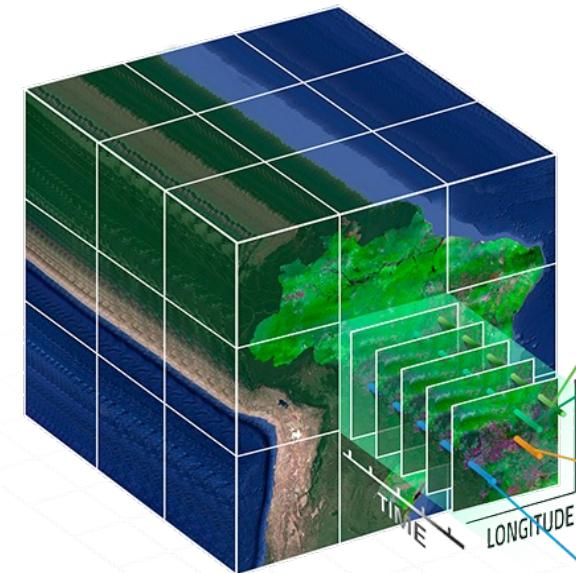
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Big data technologies and
machine learning

Image time series analysis

Land use and cover mapping

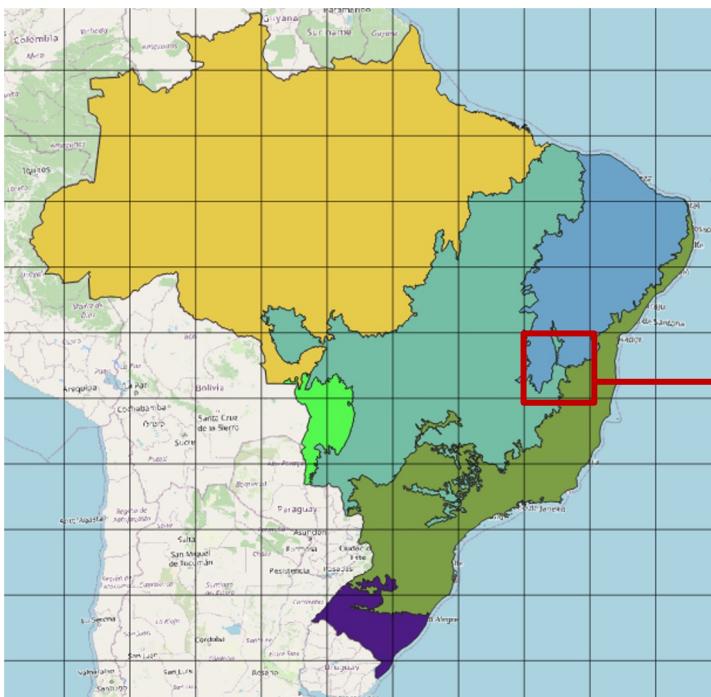
Big data of remote sensing
images modeled as
multidimensional data cubes



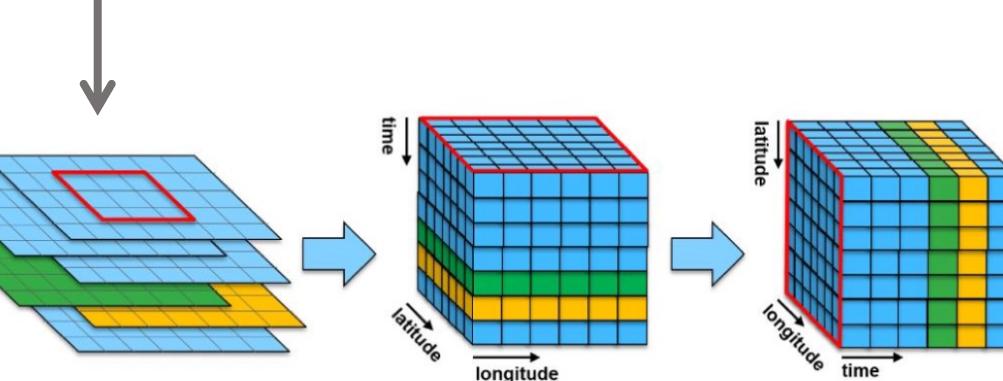
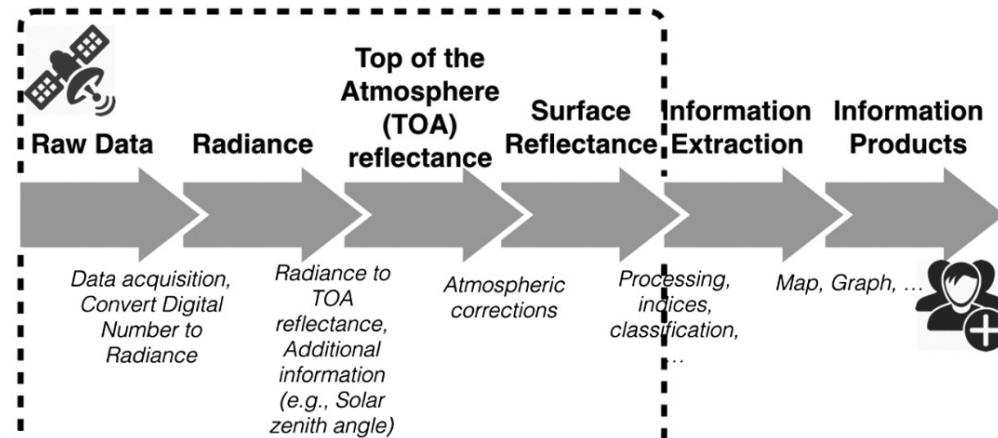


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ARD and EO Data Cubes for the entire Brazilian territory



2 Petabytes (PB)
remote sensing images

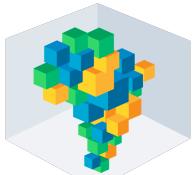


Source: [Kopp et al, 2019]

Sentinel-2
Landsat-8 / -9
CBERS-4 / 4A
(MUX / WFI)

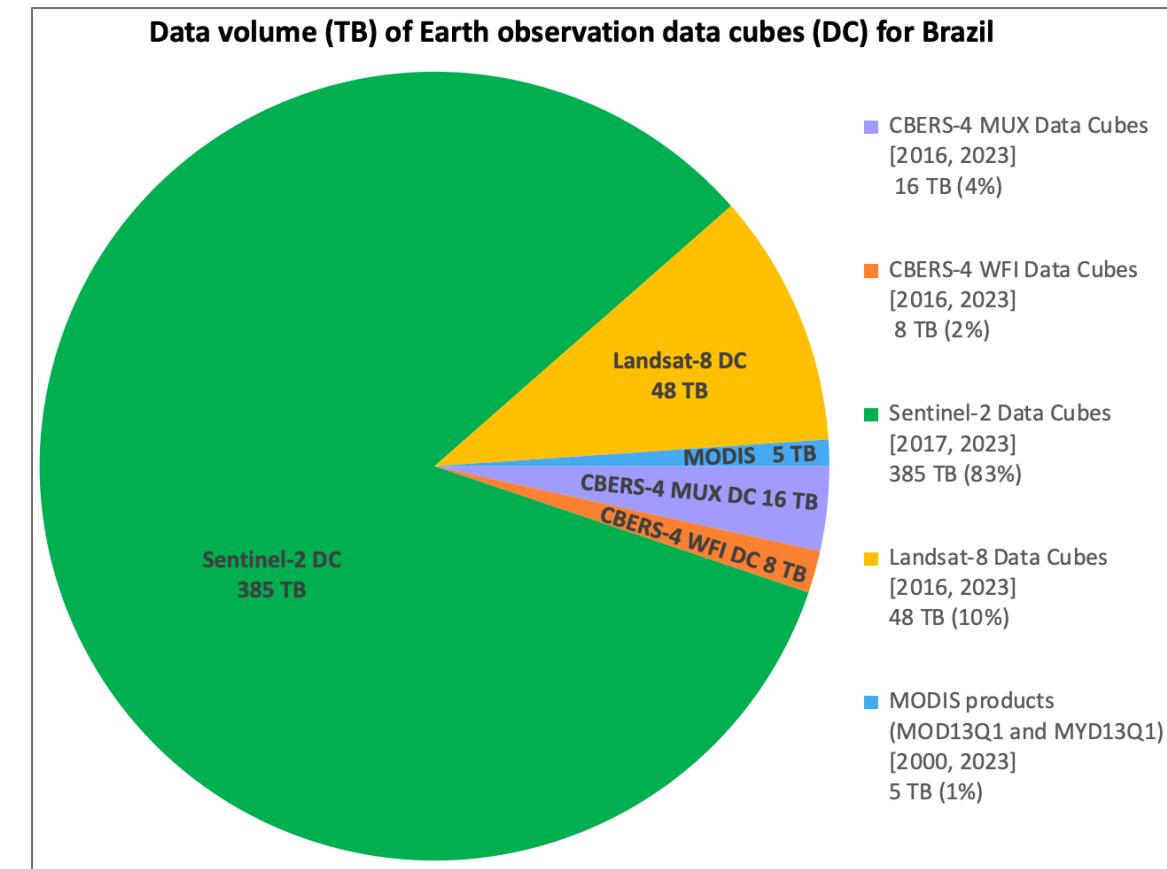
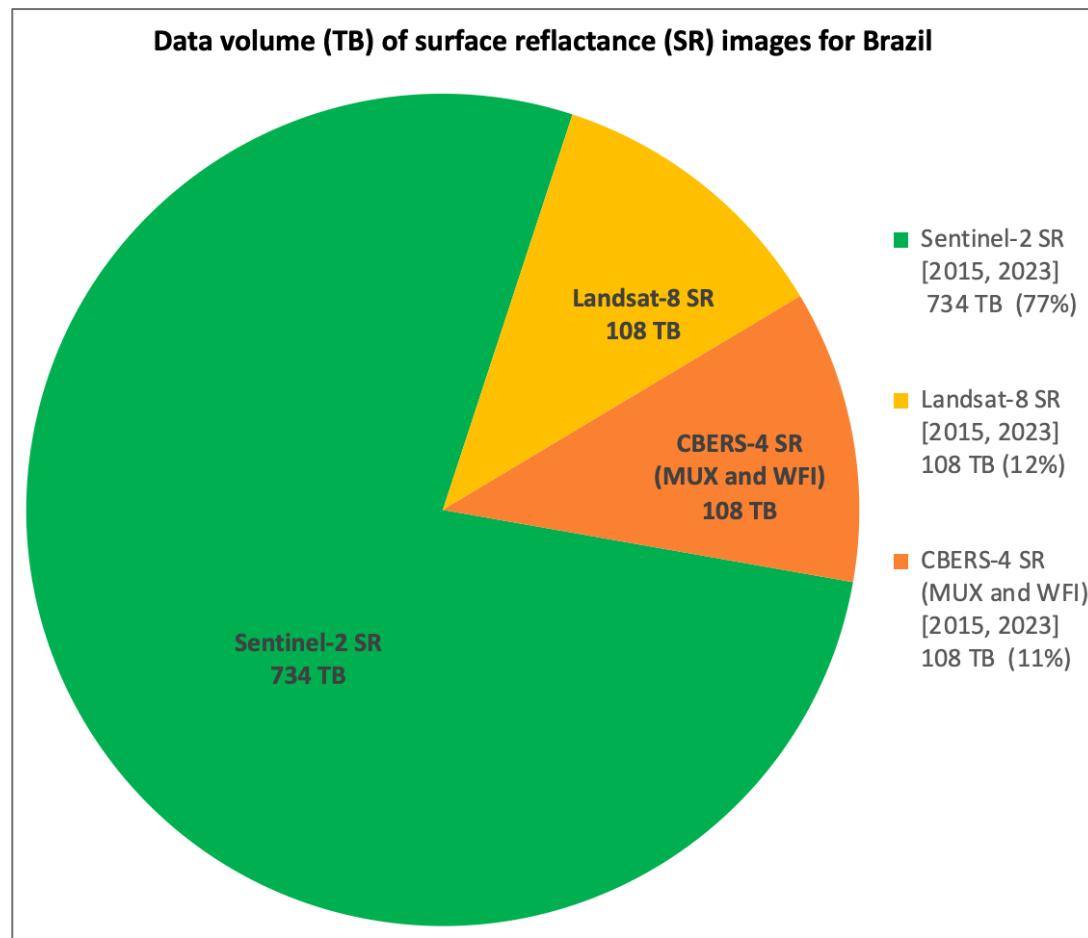


CEOS Analysis Ready
Data (ARD) for Land:
<https://ceos.org/ard/index.html>

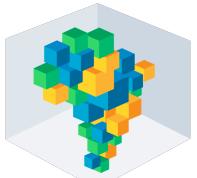


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Big data

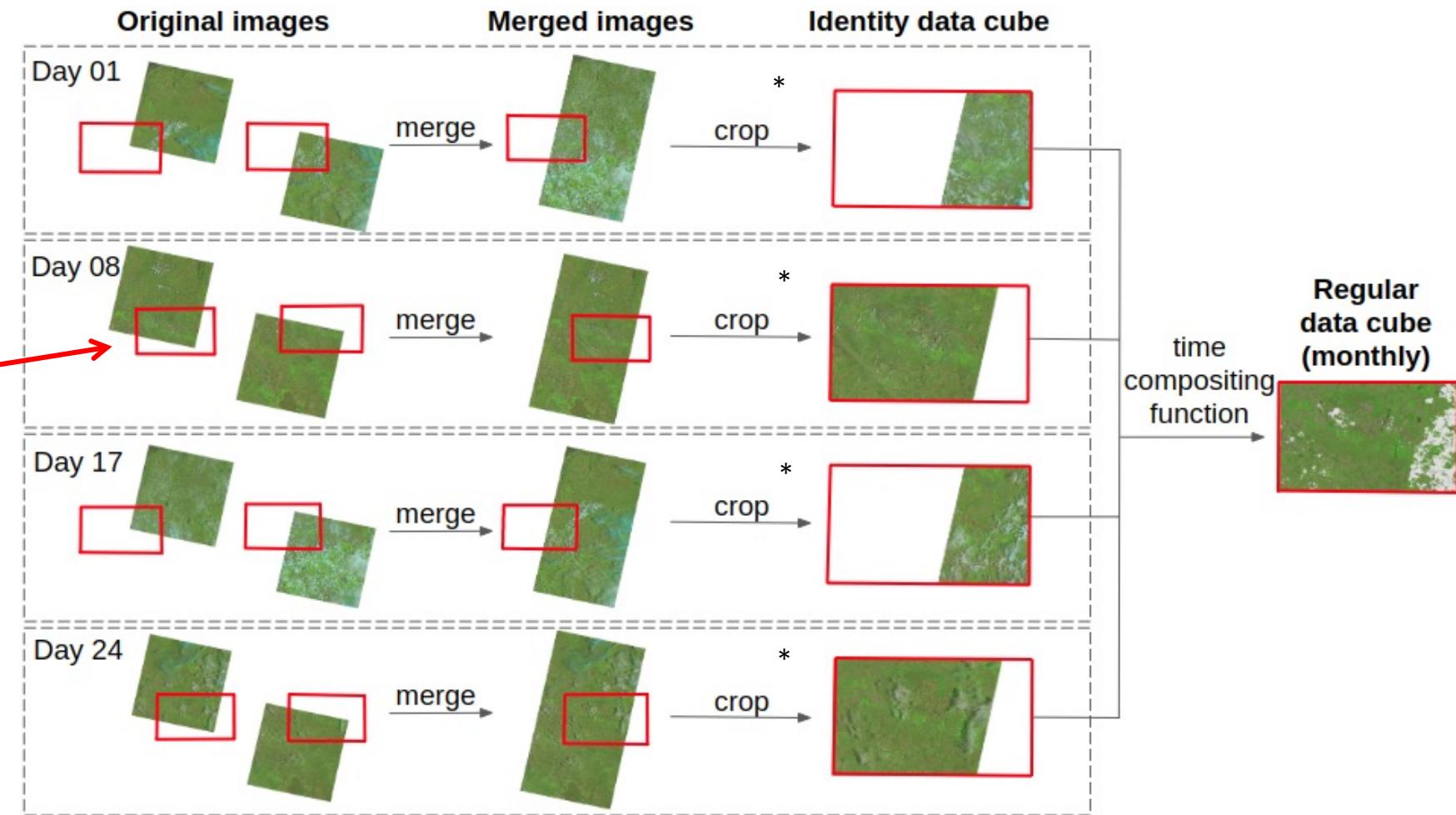
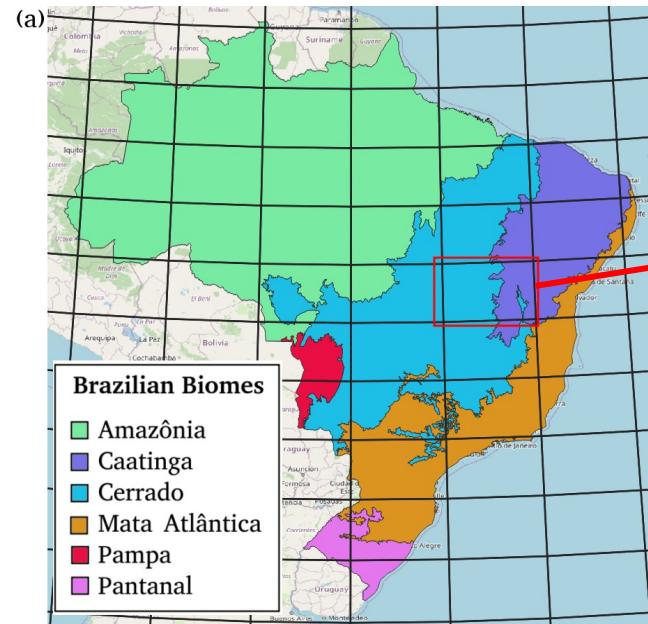


Source: [Ferreira et al., 2022]

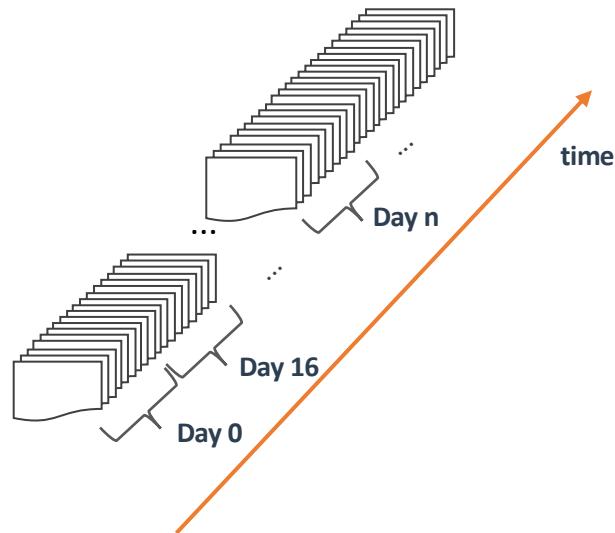


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Building data cubes



*bilinear resampling for better spatial resolution band



brazildatcube.dpi.inpe.br/portal/explore



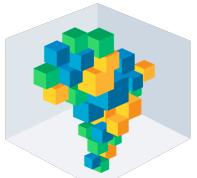
BDC – Small

Each tile: 105600m x 105600m

Sentinel-2/MSI – 10 meters

Each file (band/tile): 400 MB

Each tile: ~ 5.4 GB

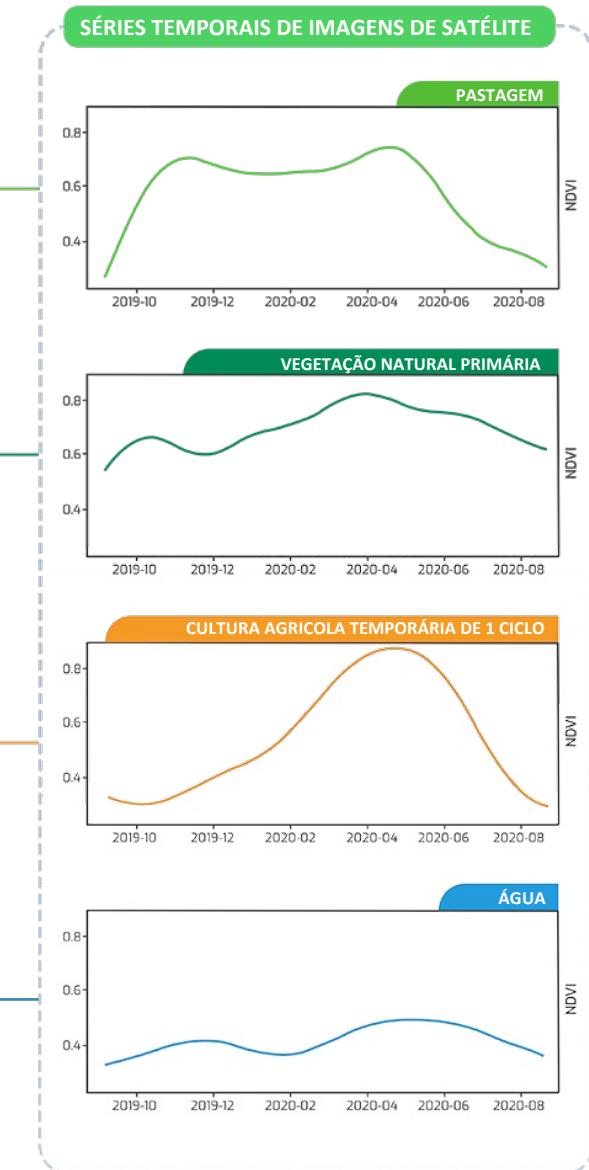
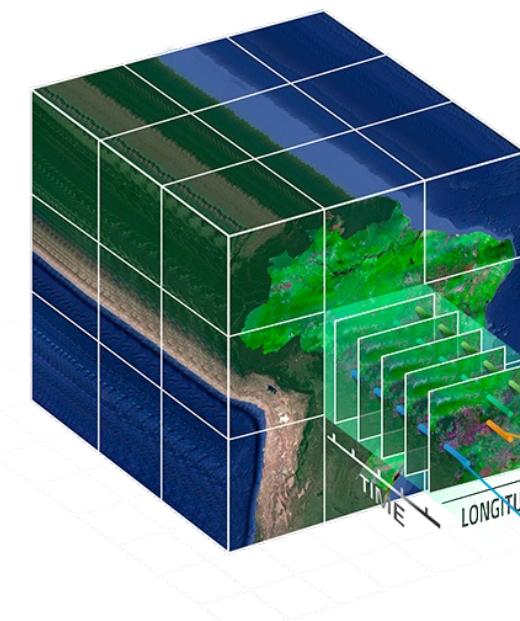


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Why Earth Observation (EO) Data Cubes ?

Multidimensional arrays of satellite images with four dimensions (latitude, longitude, time and attributes), mainly to support **image time series analysis**.

(Appel et al., 2019)



Potential of image time series and machine learning

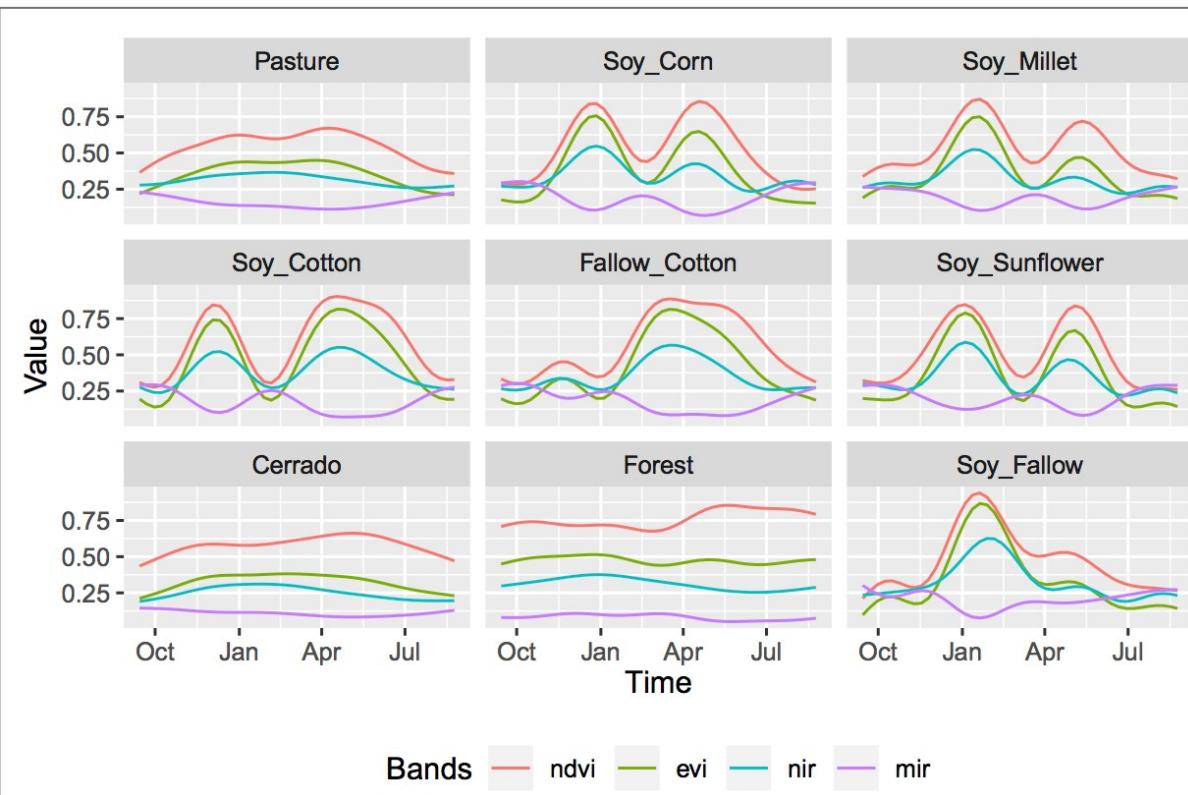
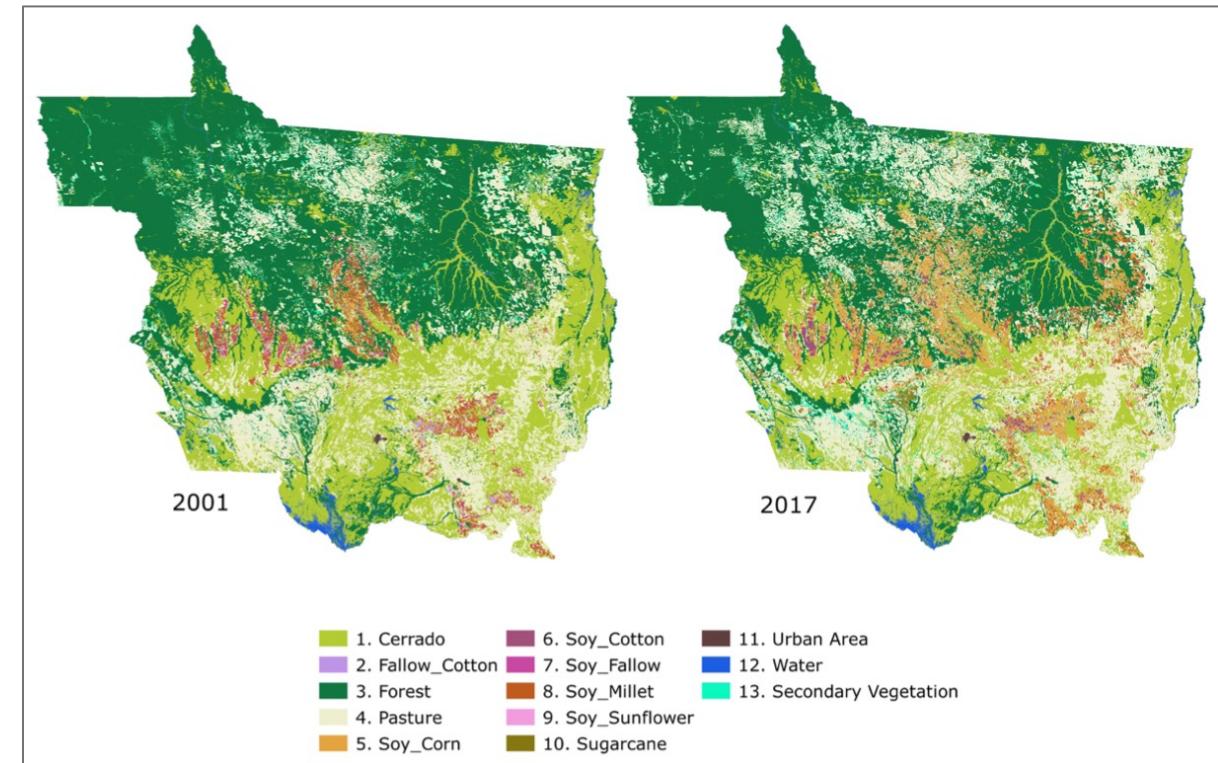


Image time series: NDVI, EVI, NIR, MIR (agriculture year)

MODIS (250 meters) – MOD13Q1 product

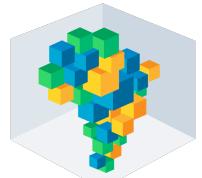
Method – SVM (Support Vector Machine)



Source: [Simoes et al., 2020]

Land use and cover maps for Mato Grosso State in Brazil from 2001 to 2017

Scientific Data, 2020

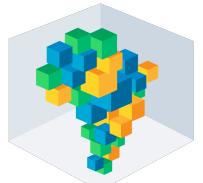


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Satellite Image Time Series Analysis (SITS)

SITS reveal complex underlying processes that would be difficult to assess using bi-temporal or even annual change detection approaches.

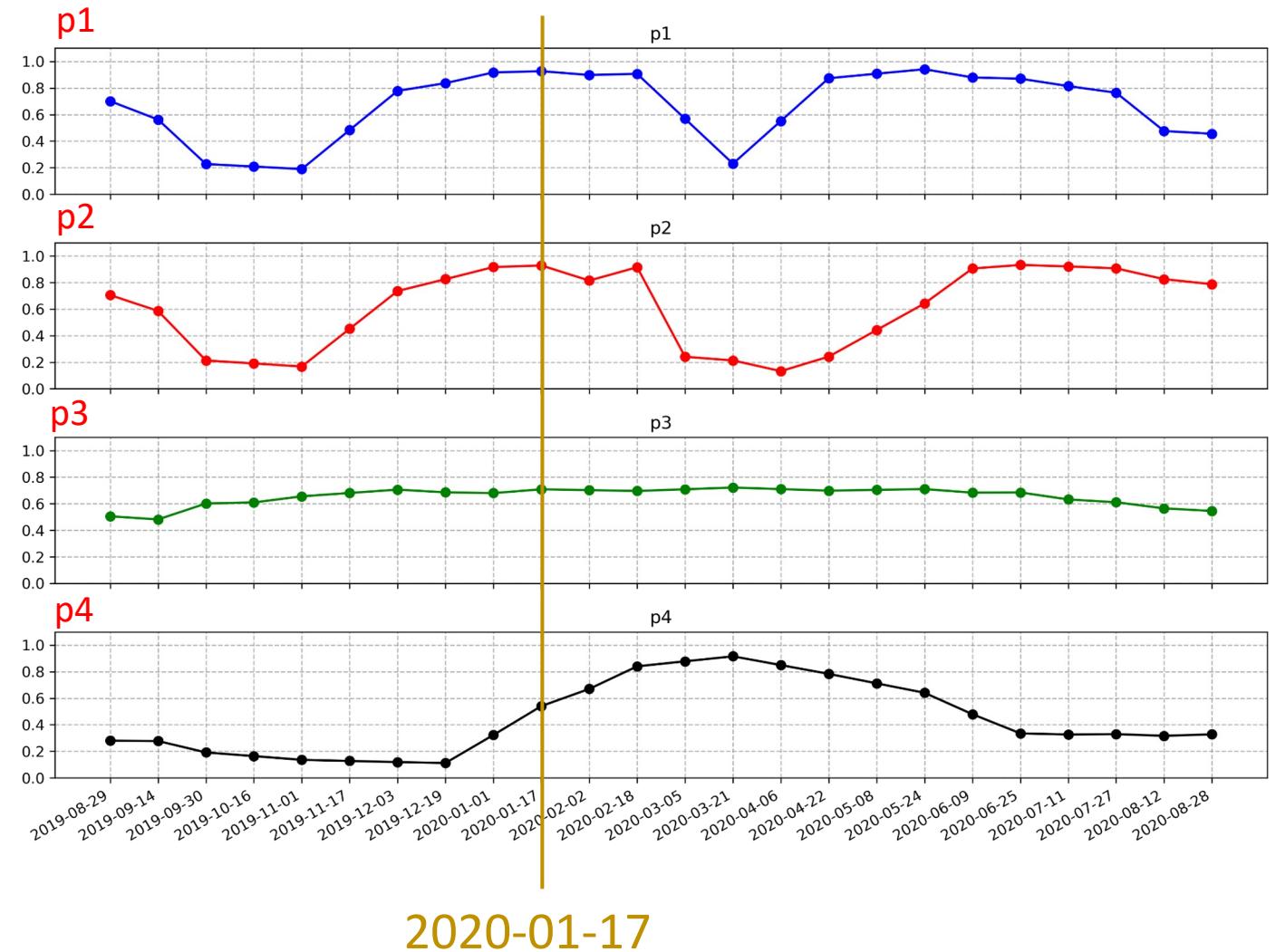
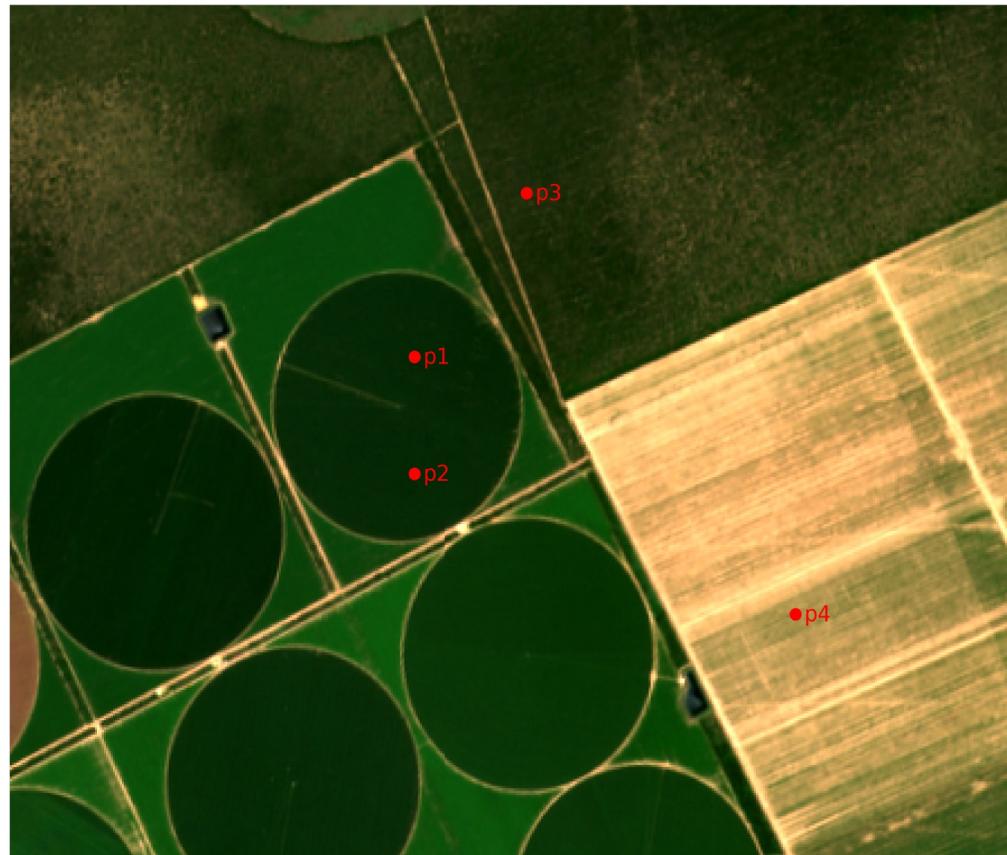
(Pasquarella et al., 2016)

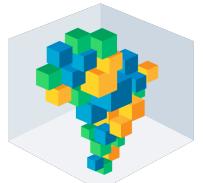


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NDVI Time Series – Sentinel-2 Data Cube (16-days)

Sentinel-2 RGB

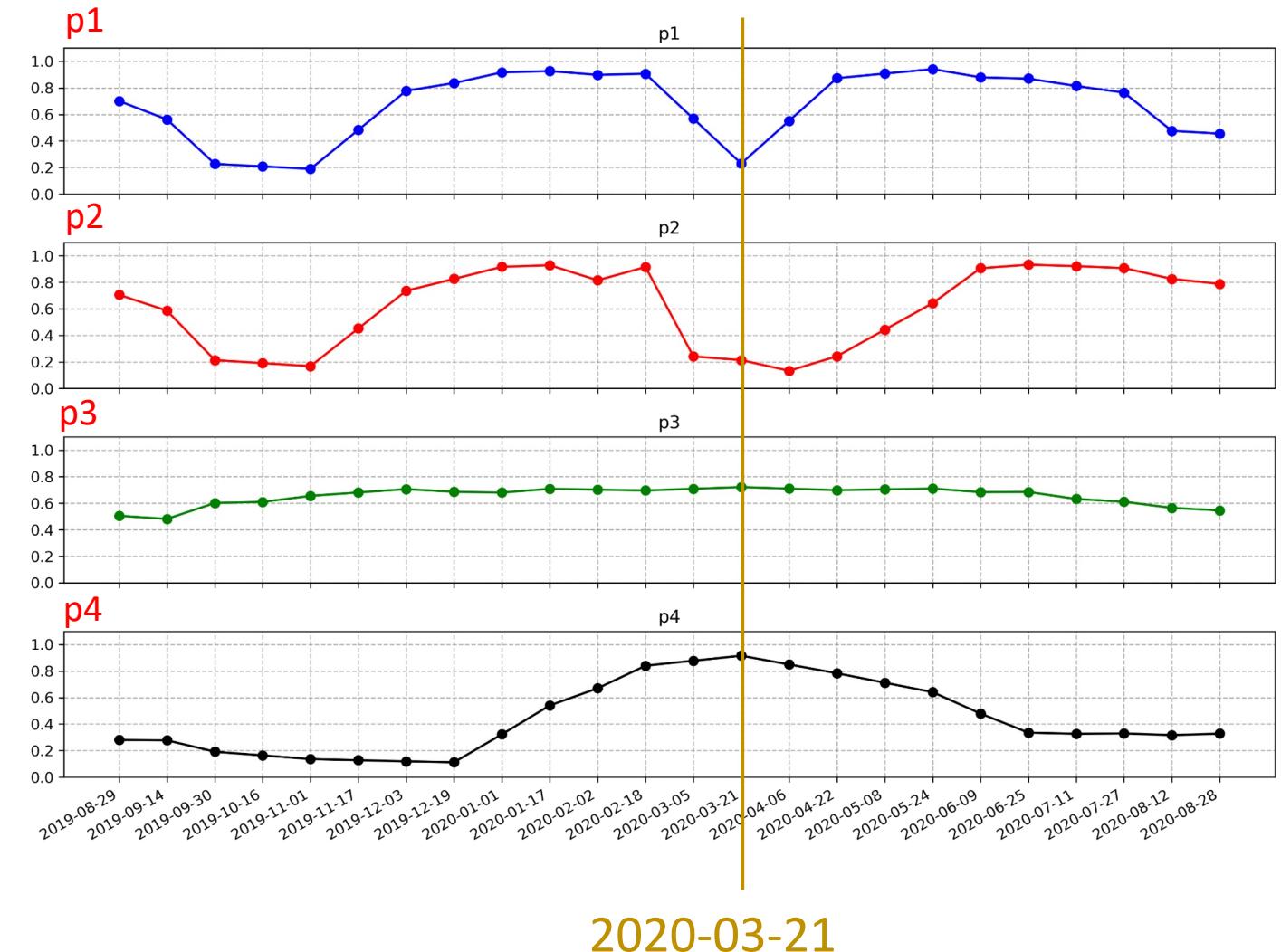
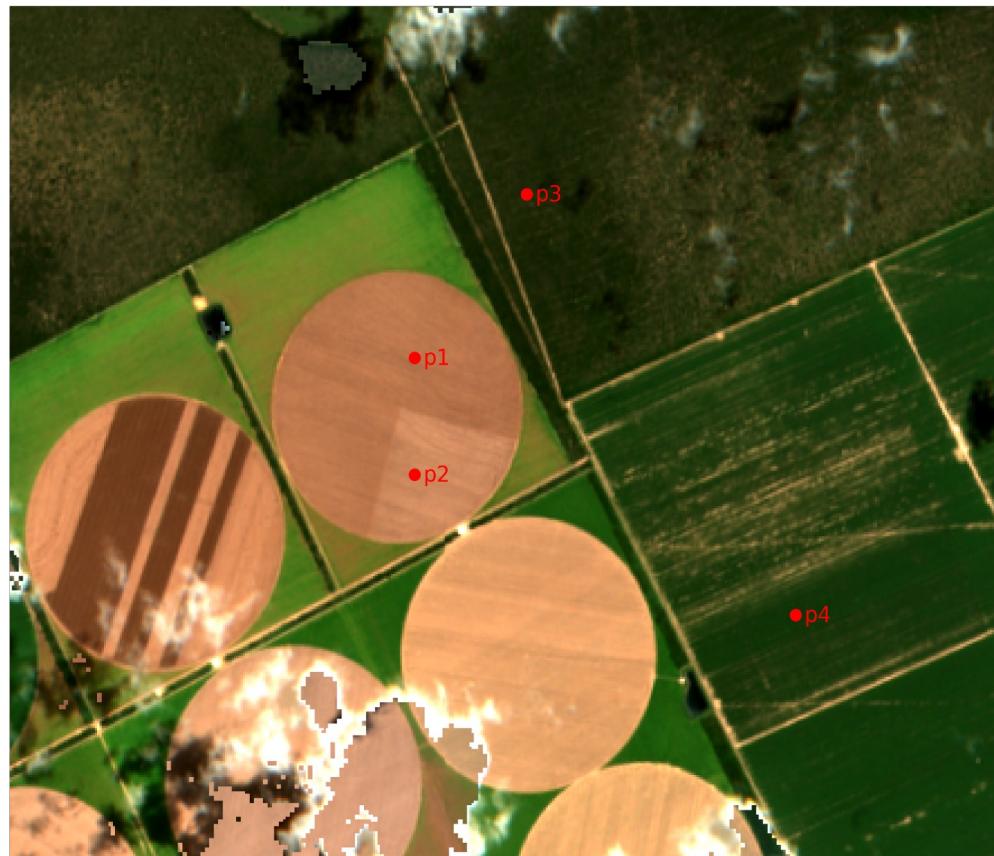


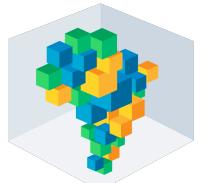


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NDVI Time Series – Sentinel-2 Data Cube (16-days)

Sentinel-2 RGB





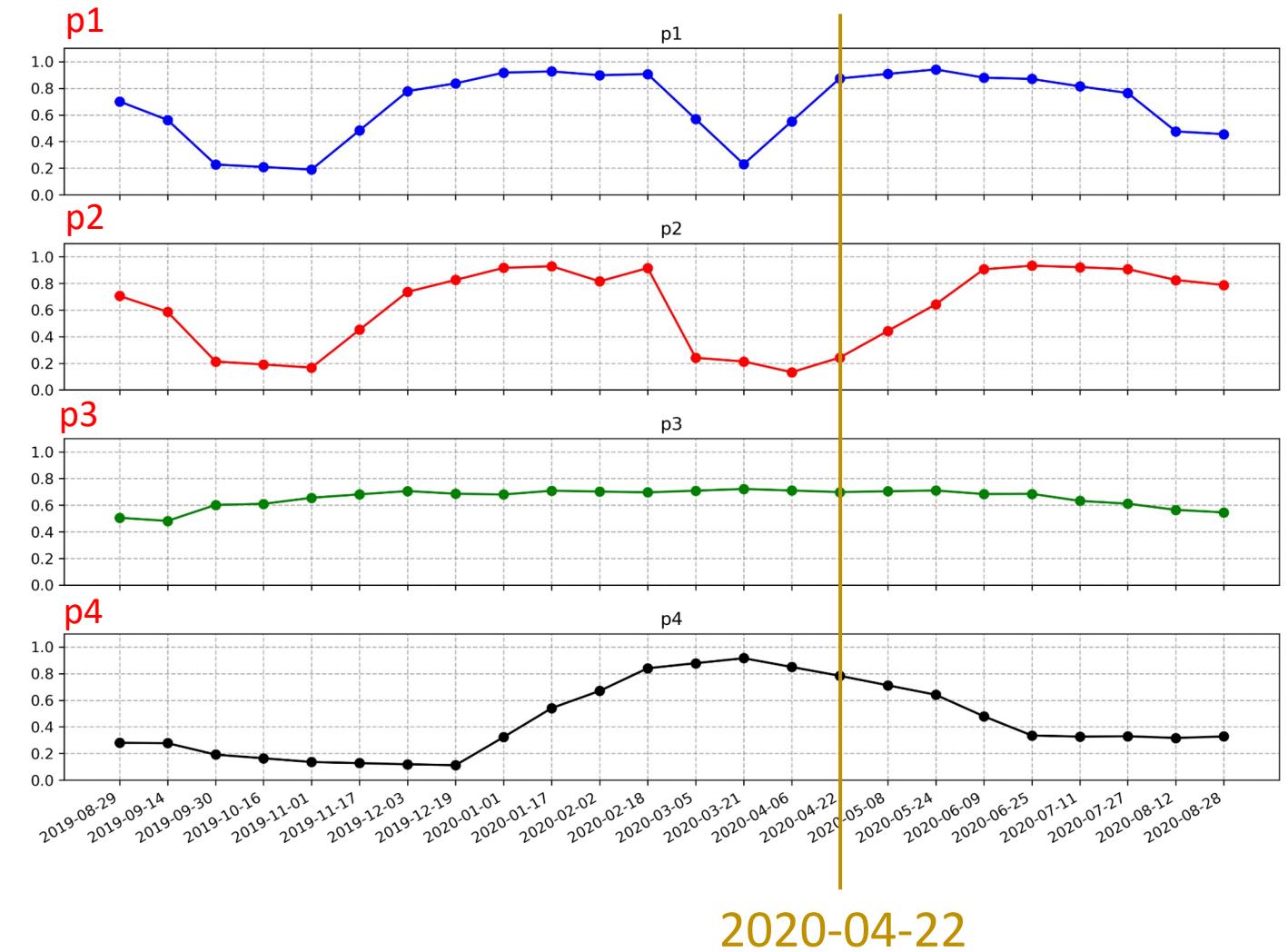
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NDVI Time Series – Sentinel-2 Data Cube (16-days)

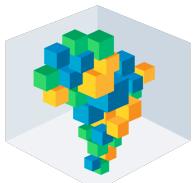
Sentinel-2 RGB



2020-04-22



2020-04-22



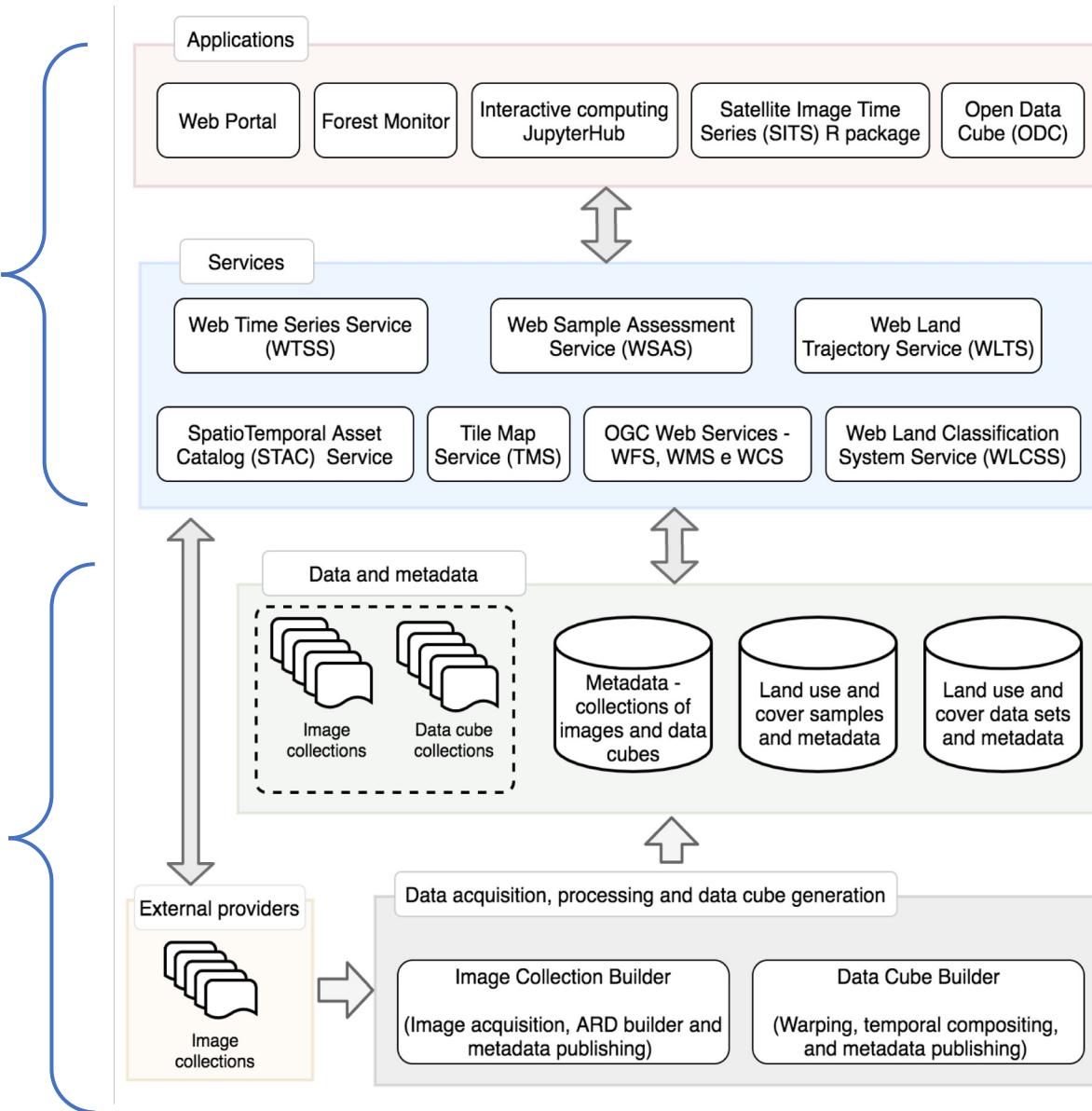
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Brazil Data Cube Platform

Open
Data and
Software
Products

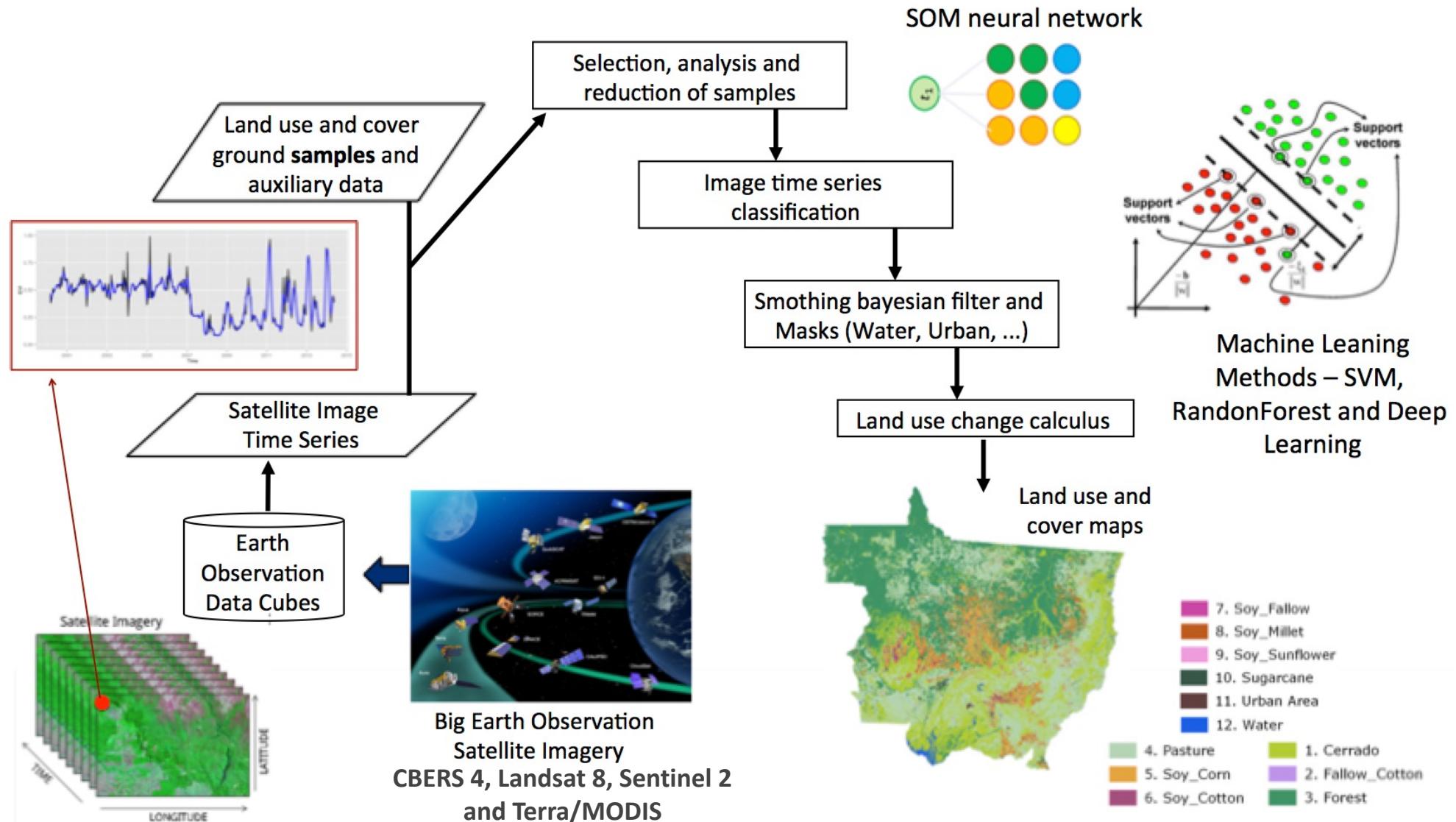
Software

Data and
metadata



Source: [Ferreira et al, 2020]

Source: [Ferreira et al., 2020]



ARD and Data cubes available at:
<http://brazildatacube.dpi.inpe.br/portal/explore>

Land use and cover change maps:
<http://brazildatacube.dpi.inpe.br/portal/explore>



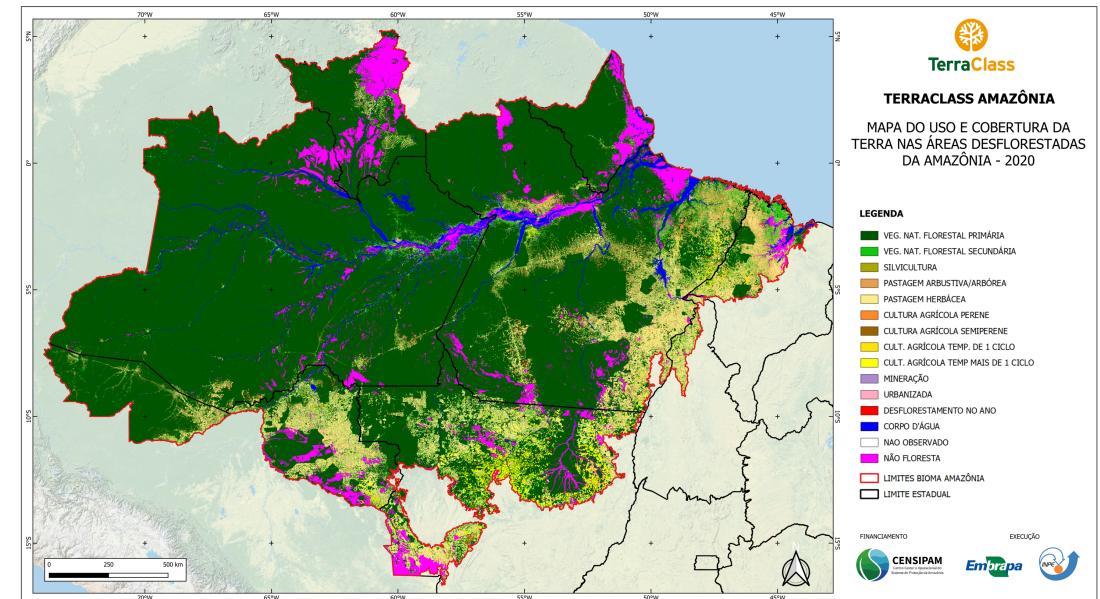
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Land use and land cover maps: TerraClass project

TerraClass Cerrado 2020 (Launched in December 2022)



TerraClass Amazônia 2020



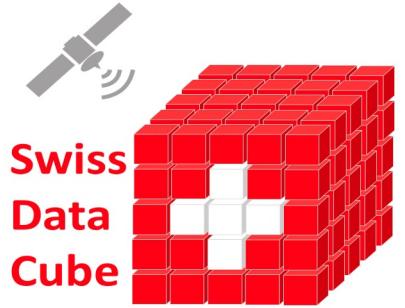
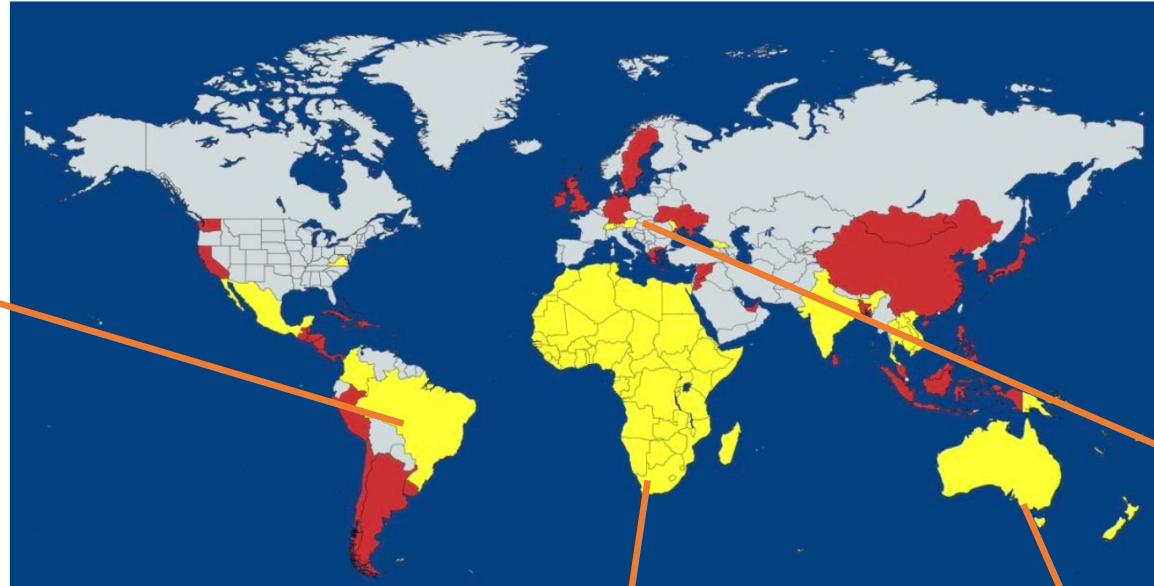
Partnership with international and similar initiatives

Source: [Sudmanns et al, 2022]

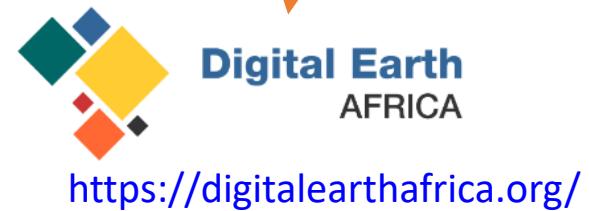
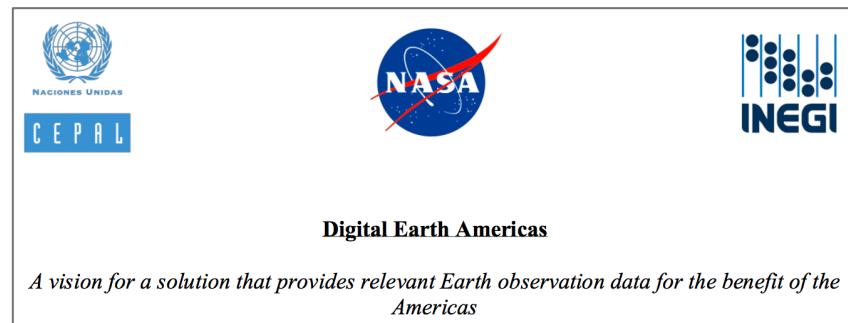
Yellow: operational
Red: under development



<http://brazildatacube.org>



<https://www.swissdatacube.org/>



<http://brazildatadcube.org>

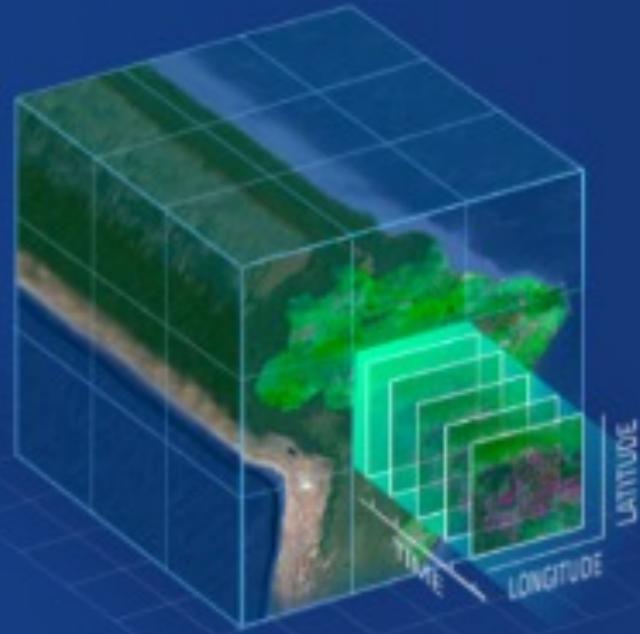
Home About ▾ Data Software Publications News Opportunity  ▾

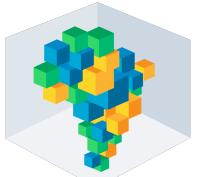
Search ... 

 **Brazil Data Cube**

Production, visualization and analysis of large volumes of remote sensing images modeled as multidimensional data cubes for the entire Brazilian territory.

[Read more](#)





Code Galery

<http://brazildatadcube.org>

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☰ README.md

Brazil Data Cube Code Gallery



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This repository contains a gallery of interesting Jupyter Notebooks, R Markdown and scripts based on Brazil Data Cube data and technologies.

Jupyter Notebooks

Data Access through SpatioTemporal Asset Catalog API (STAC)

- Introduction to the SpatioTemporal Asset Catalog. ([Python](#), [R](#))
- Image processing on images obtained through STAC.

Web Time Series Service (WTSS)

- Introduction to the Web Time Series Service (WTSS). ([Python](#), [R](#)).
- Web Time Series Service (WTSS) examples. ([Python](#), [R](#)).

Web Land Trajectory Service (WLTS)

- Introduction to the Web Land Trajectory Service (WLTS). ([Python](#), [R](#))
- Web Land Trajectory Service (WLTS) examples. ([Python](#)).

Tile Map Service (BDC-Tiler)

- Introduction to the Tile Map Service (BDC-Tiler). ([Python](#))

Packages
No packages published

Contributors [?](#)


Languages


Language	Usage (%)
Jupyter Notebook	96.2%
R	3.8%



sbsr2023-wtss-examples
Updated 2d ago
0 comments · No attached data sources

sbsr2023-wtss-introduction
Updated 2d ago
0 comments · No attached data sources

sbsr2023-wtss2
Updated 12d ago
0 comments · No attached data sources

sbsr2023-sample-quality-control-using-som
Updated 12d ago
0 comments · sits bundle

sbsr2023-machine-learning-for-data-cubes
Updated 12d ago
0 comments · sits bundle

sbsr2023-image-classification-in-data-cubes
Updated 12d ago
0 comments · sits bundle

sbsr2023-working-with-time-series-in-sits
Updated 12d ago
0 comments · sits bundle

Brazil Data Cube

Earth Observation Data Cubes for Brazil at National Institute for S...
São José dos Campos, State of São Paulo, Brazil
Joined 2 years ago · last seen 2 days ago

[Create](#) [Home](#) [Competitions](#) [Datasets](#)

workshop-2021-03-wtss-introduction-python Draft saved

File Edit View Run Add-ons Help

(1) Coverage S2-SEN2COR_10_16D_STK-1

Description: This datacube was generated with all available surface reflectance images processed using Sen2cor (illumination correction and temporal compositing function of 16 days using the best pixel approach (Stack).

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item	int16	{'min': 0.0, 'max': 10000.0}	0.0001	-9999.0
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item	int16	{'min': 0.0, 'max': 10000.0}	0.0001	-9999.0
item	int16	{'min': 0.0, 'max': 10000.0}	0.0001	-9999.0
item	int16	{'min': 0.0, 'max': 10000.0}	0.0001	-9999.0
item	int16	{'min': 0.0, 'max': 10000.0}	0.0001	-9999.0
Clear Observation Count	uint8	{'min': 1.0, 'max': 255.0}	1.0	0.0
Total Observation Count	uint8	{'min': 1.0, 'max': 255.0}	1.0	0.0
covariance value Day of Year	int16	{'min': 1.0, 'max': 10000.0}	1.0	-1.0
item	int16	{'min': 0.0, 'max': 10000.0}	0.0001	-9999.0
item	int16	{'min': 0.0, 'max': 10000.0}	0.0001	-9999.0
item	int16	{'min': 0.0, 'max': 10000.0}	0.0001	-9999.0
item	int16	{'min': 0.0, 'max': 10000.0}	0.0001	-9999.0
Enhanced Vegetation Index	uint8	{'min': 1.0, 'max': 255.0}	1.0	0.0

Thumbnail:

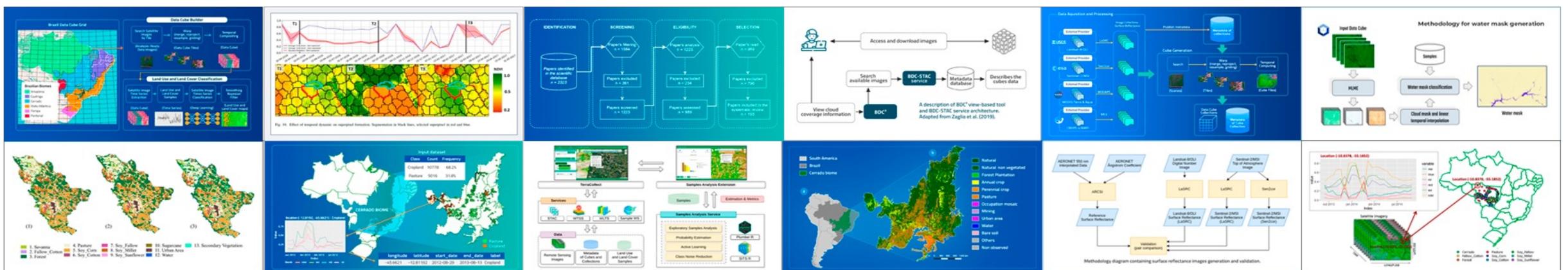
Bands

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B06	rededge	0.0	10000.0	-9999.0	0.0001	int16
B07	rededge	0.0	10000.0	-9999.0	0.0001	int16
B08	nr	0.0	10000.0	-9999.0	0.0001	int16
B09	nr09	0.0	10000.0	-9999.0	0.0001	int16
B08	nr08	0.0	10000.0	-9999.0	0.0001	int16



50 PUBLICAÇÕES

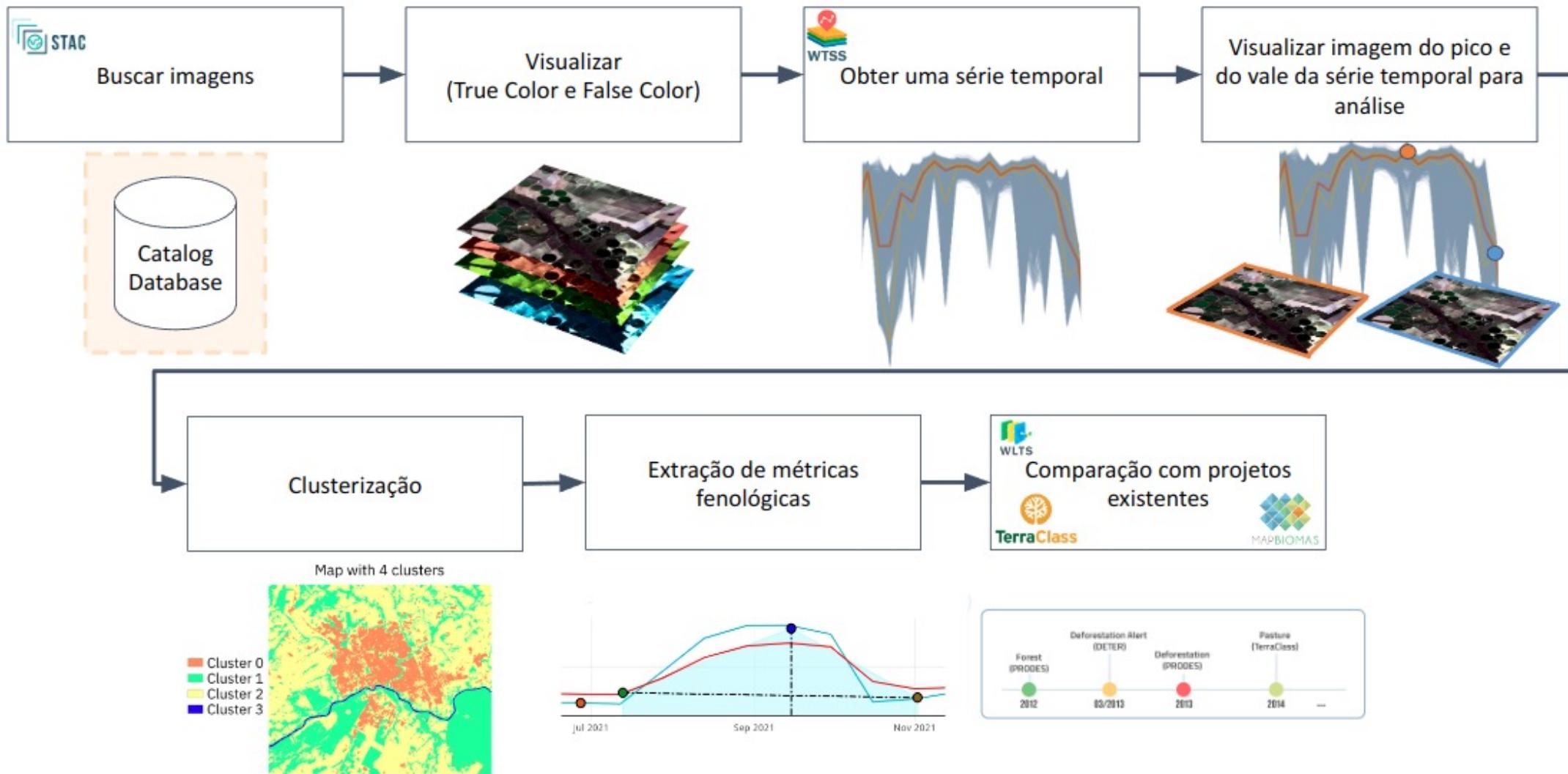
29 – Revistas e eventos internacionais
21 – Revistas e eventos nacionais





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SBSR 2025 - Course



Interoperabilidade

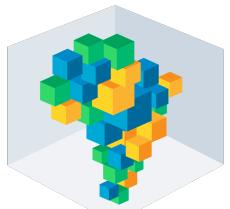


Google Earth Engine



Copernicus Data

Space Ecosystem (CDSE)



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SpatioTemporal Asset Catalog

Especificação que define uma estrutura comum, em arquivos JSON e GEOJSON, para descrever e catalogar dados geográficos.

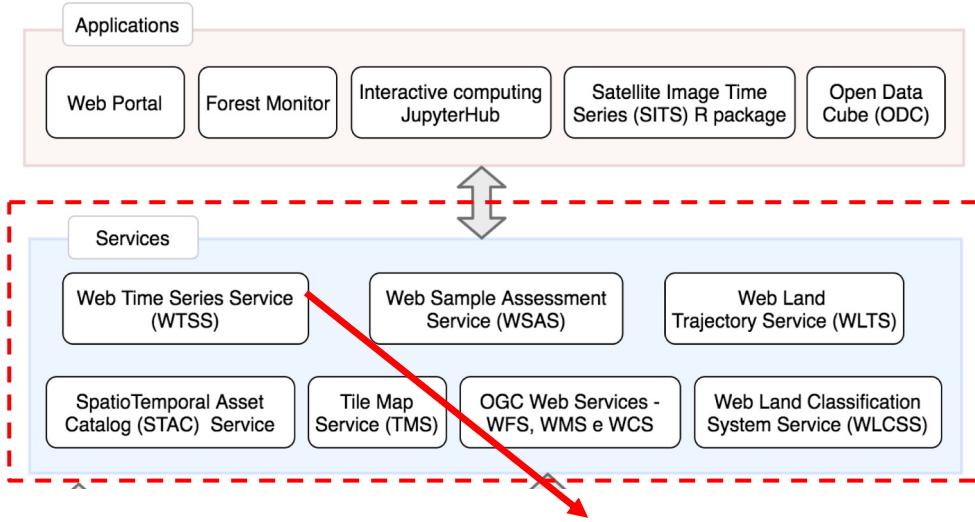
Source: <https://stacspec.org/en>



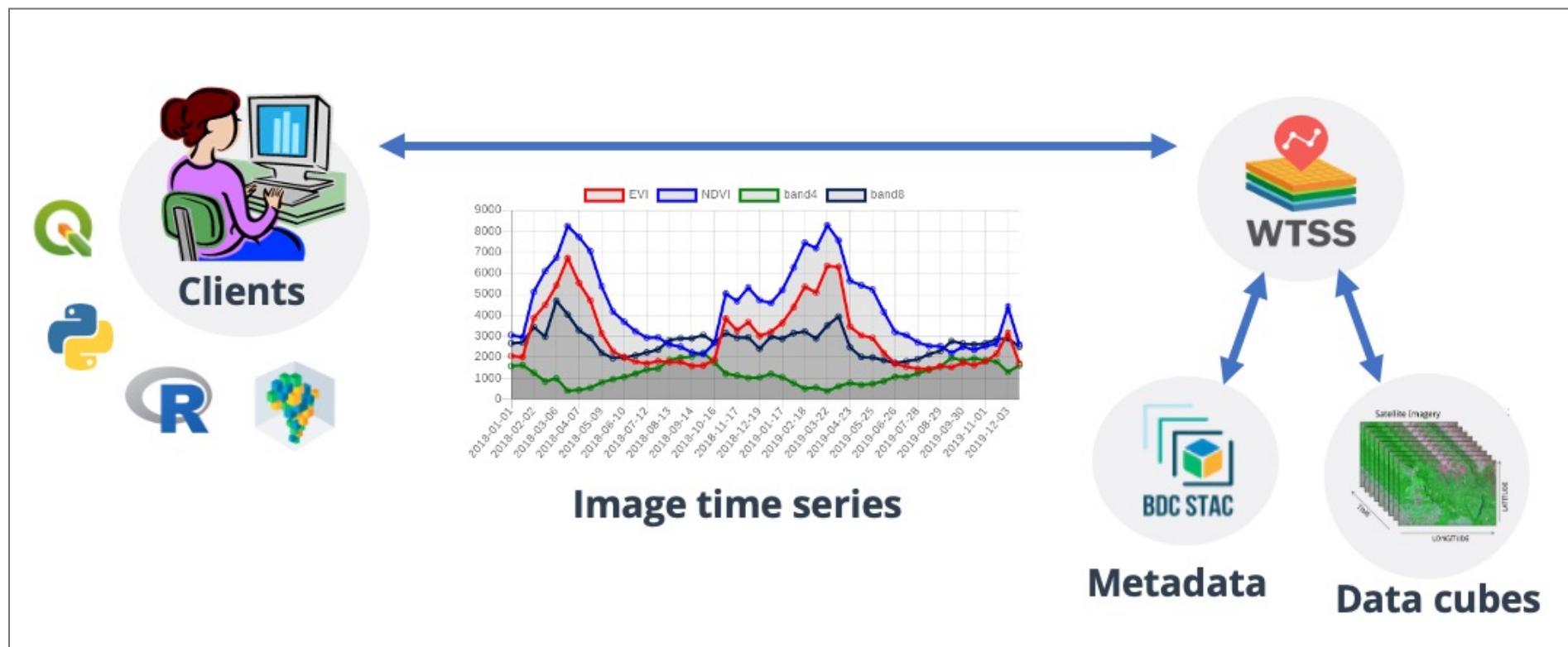
SpatioTemporal Asset Catalog

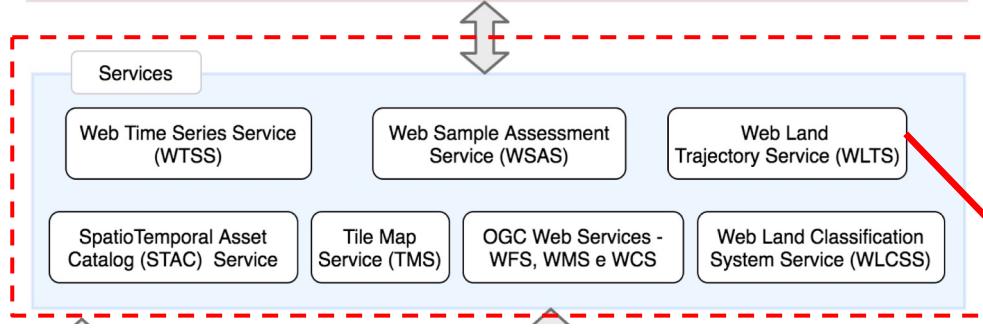
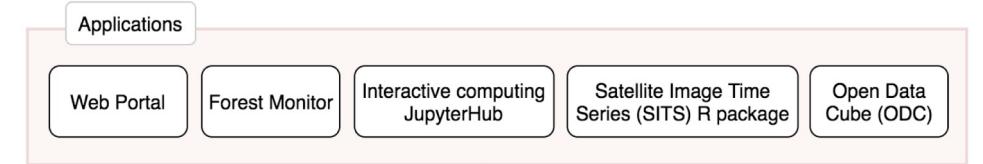
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      "rel": "child",
      "type": "application/json",
      "title": "Sentinel-2 - Yanomami - Mosaic"
    },
    {
      "href": "https://brazildatacube.dpi.inpe.br/stac/collections/CB4-MOSAIC-BRAZIL_64_3M_STK-1",
      "rel": "child",
      "type": "application/json",
      "title": "CBERS-4 - Brazil - Mosaic"
    },
    {
      "href": "https://brazildatacube.dpi.inpe.br/stac/collections/MYD13Q1-6",
      "rel": "child",
      "type": "application/json",
      "title": "MYD13Q1 C6"
    },
    {
      "href": "https://brazildatacube.dpi.inpe.br/stac/collections/MOD13Q1-6",
      "rel": "child",
      "type": "application/json",
      "title": "MOD13Q1 C6"
    },
    {
      "href": "https://brazildatacube.dpi.inpe.br/stac/collections/LANDSAT-MOZ_30_1M_STK-1",
      "rel": "child",
      "type": "application/json",
      "title": "Landsat - Mozambique - Monthly"
    },
    {
      "href": "https://brazildatacube.dpi.inpe.br/stac/collections/LCC_L8_30_16D_STK_Amazonia-TC-1",
      "rel": "child",
      "type": "application/json",
      "title": "LCC Landsat-8 16D STK Amaz\u00f4nia Terra Class"
    },
    {
      "href": "https://brazildatacube.dpi.inpe.br/stac/collections/LCC_S2_10_1M_STK_PA-SPC-AC-NA-1",
      "rel": "child",
      "type": "application/json",
      "title": "LCC - Bahia - S2_10_1M_STK-1"
    },
    {
      "href": "https://brazildatacube.dpi.inpe.br/stac/collections/CB4A-MOSAIC-PARAIBA_55_3M_STK-1",
      "rel": "child",
      "type": "application/json",
      "title": "CBERS-4A - Paraiba - Mosaic"
    },
    {
      "href": "https://brazildatacube.dpi.inpe.br/stac/collections/S2-MOSAIC-PARAIBA_10_3M_STK-1"
    }
  ]
}
```

Source: <https://brazildatacube.dpi.inpe.br/stac/>

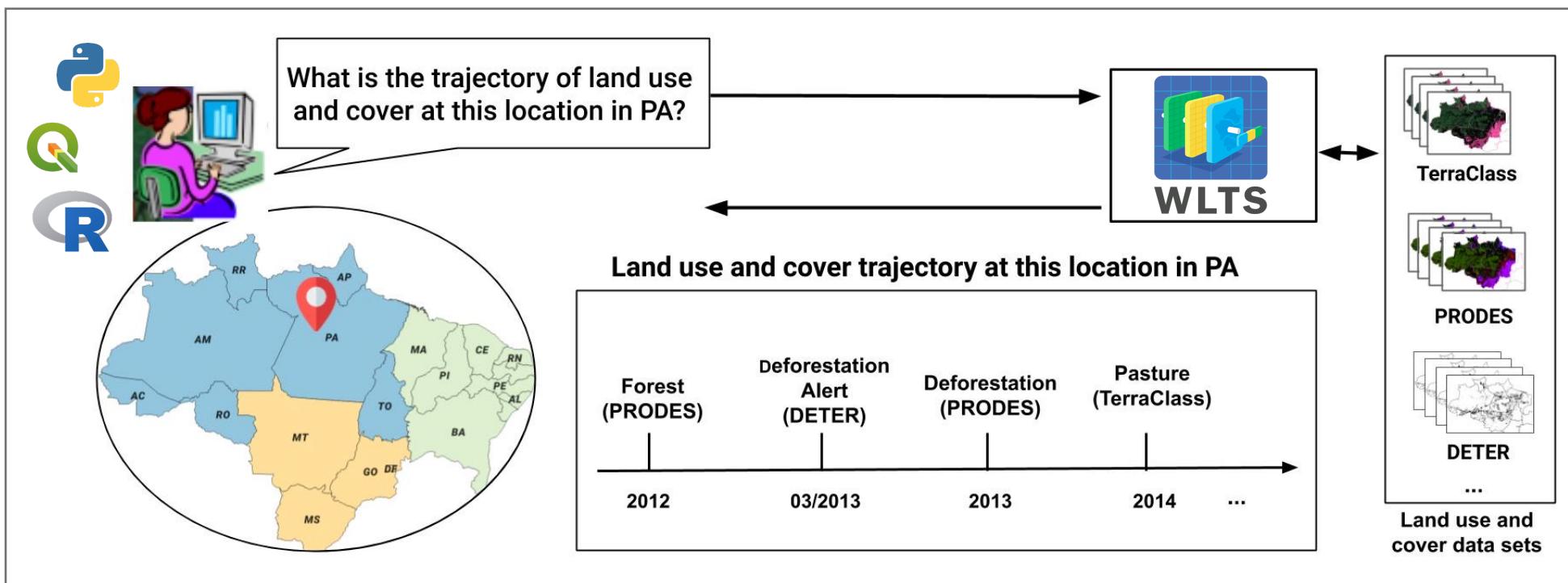


WTSS – Web Time Series Service





WLTS – Web Land Trajectory Service

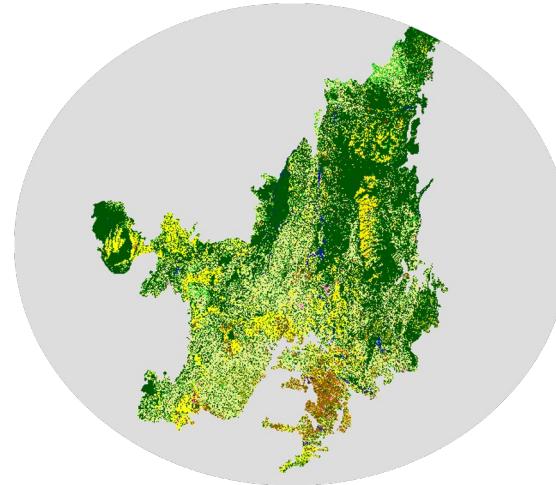


Source: [Zioti et al., 2021]

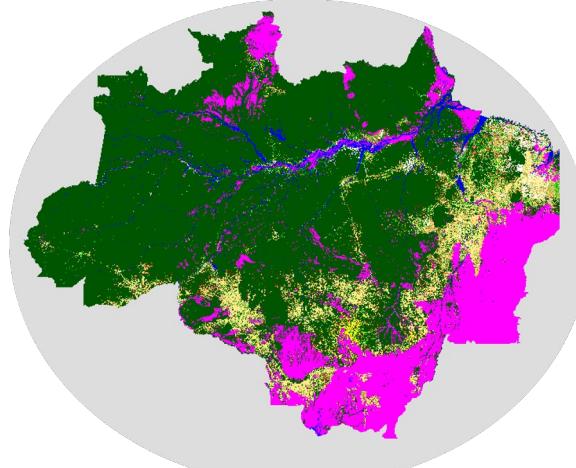
WLTS - Coleções



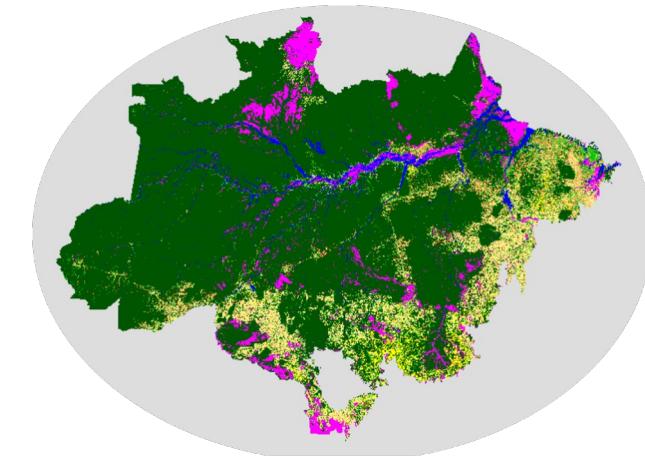
PRODES - Brasil
2007 - 2022
<http://terrabrasilis.dpi.inpe.br/>



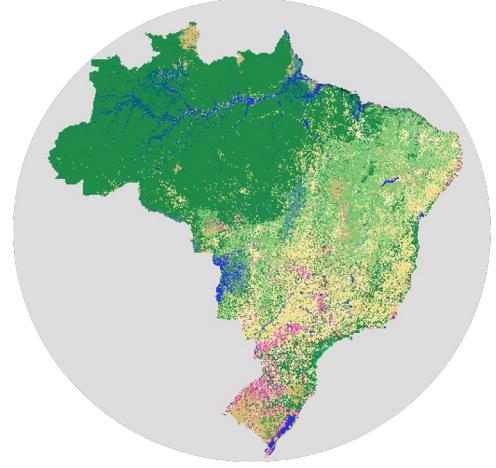
TerraClass - Cerrado
2018 and 2020
<https://www.terraclass.gov.br/>



TerraClass - Amazônia
2004, 2008, 2010, 2012, 2014
<https://www.terraclass.gov.br/geoportal-aml/>



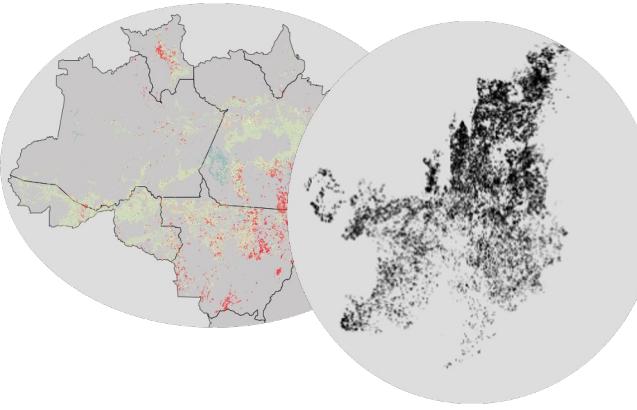
TerraClass - Amazônia
2020
<http://terrabrasilis.dpi.inpe.br/>



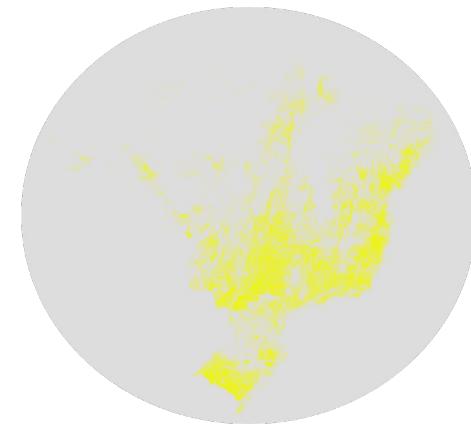
MapBiomas 8.0 - Brasil
1985 - 2022
<https://mapbiomas.org/>



IBGE LULC - Brasil
2000, 2010, 2012, 2014, 2016, 2018
<https://www.ibge.gov.br/>



DETER - Amazônia e Cerrado
2018 - 2022
[http://terrbrasiliis.dpi.inpe.br/](http://terrabrasilis.dpi.inpe.br/)



Lapig Pastagem - Brasil
1985 - 2021
<https://atlasdaspastagens.ufg.br/map>

WTSS e WLTS – Interface gráfica – BDC Explorer e TerraCollect

TerraCollect

TerraClass-Teste

Selected samples

New sample

Classes

- Cultivada-Arbustiva
- Vegetação-Natural-Flor...
- Cultura-Agrícola-Peren...
- Silvicultura
- Corpo-Dagua
- Urbanizada
- Cultivada-Herbácia

Base maps

- 1716 Sentinel- ...
- 40 Planet Ma ...

07/12/2019 02/18/2020 11/01/2023

Lat: -7.08347 | Lng: -53.90645 10 km

Point: -54.73767804680967 -7.326242725066741

Land Trajectory

Time series

Maps

- 9 Grids
- 2 Boundaries
- 14 Mosaics
- 6 External Maps
- 0 Loaded layers

Load new layer

service url

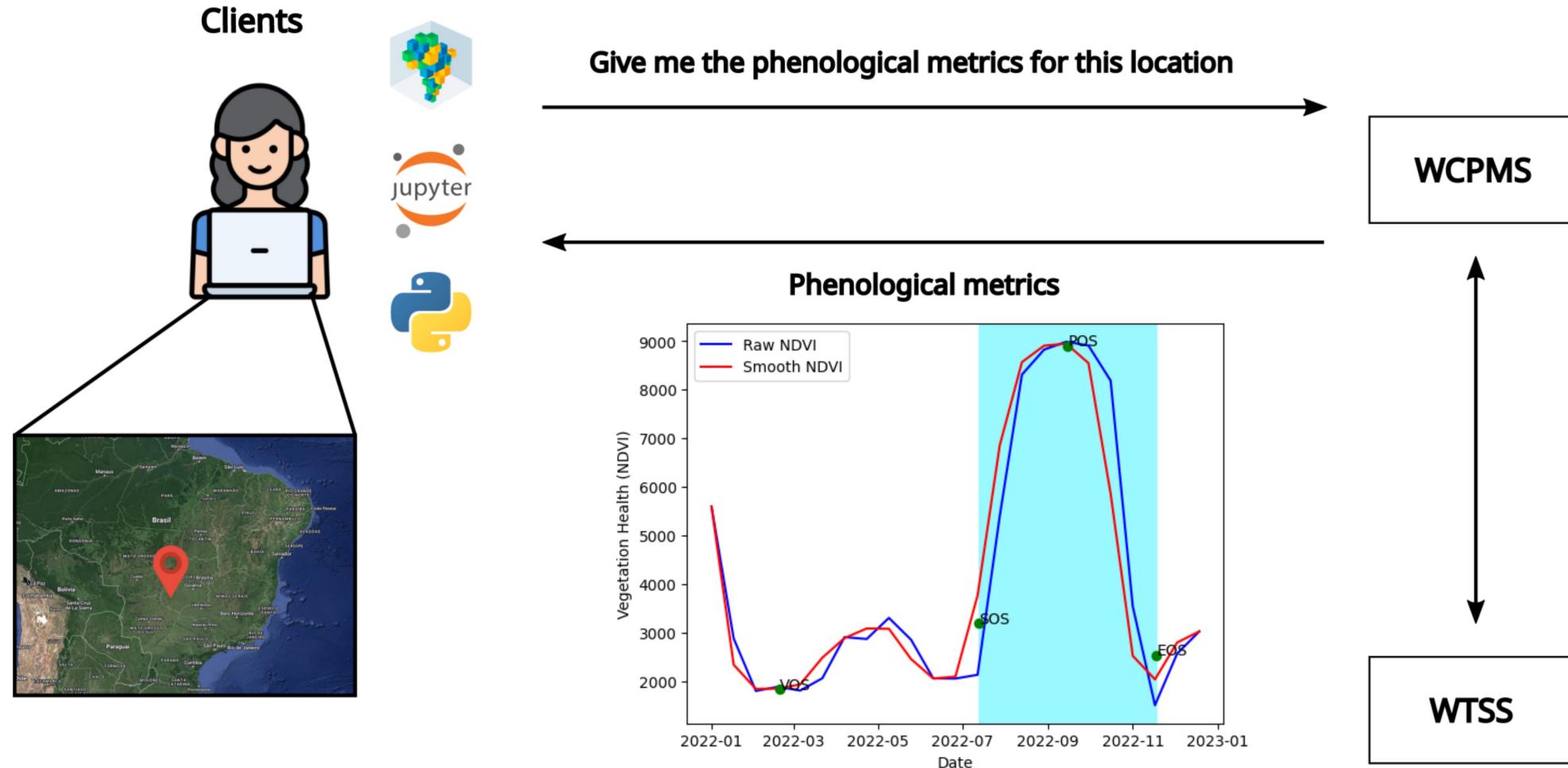
LOAD

EVI:MOD13Q1-6 NDVI:MOD13Q1-6

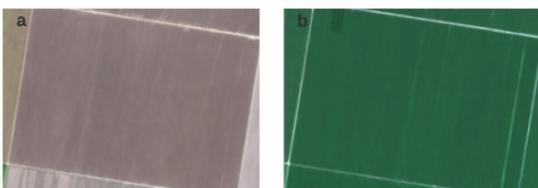
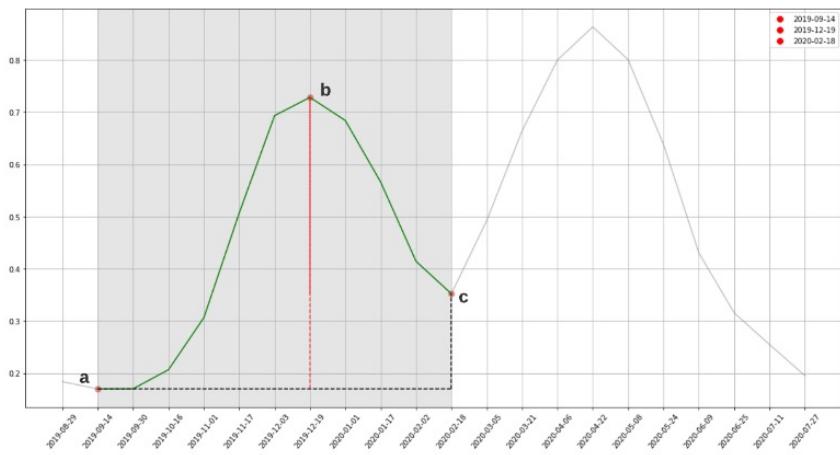
TerraCollect - v0.2.2, Copyright (©) 2021 INPE, Embrapa & IBGE

The screenshot displays the TerraCollect software interface. On the left, a sidebar contains a tree view labeled 'TerraClass-Teste' with sections for 'Selected samples', 'New sample', 'Classes' (listing categories like Cultivada-Arbustiva, Vegetação-Natural-Flor..., etc.), and 'Base maps' (listing Sentinel-2 and Planet datasets). The main area features a satellite map of a rural landscape with roads and settlements like 'Boa Vista' and 'Alvorada da Amazônia'. A timeline at the top shows dates from 07/12/2019 to 02/18/2020, and a date in the top right corner shows 11/01/2023. Below the map is a 'Land Trajectory' chart showing the history of land use from 2000 to 2020 for a specific point, with data points colored by source: Prodes Amazon. (red), Ibge Cobertur. (green), TerraClass Am. (yellow), and Mapbiomas V6 (blue). At the bottom is a 'Time series' graph comparing EVI:MOD13Q1-6 (blue line) and NDVI:MOD13Q1-6 (orange line) from 2016 to 2022.

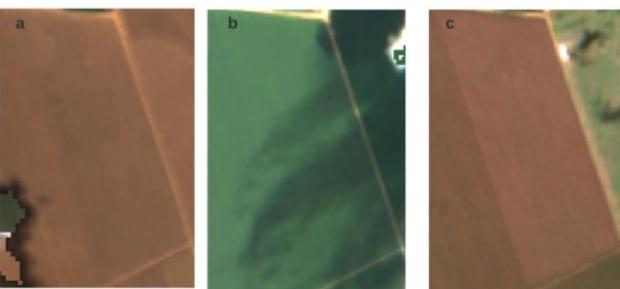
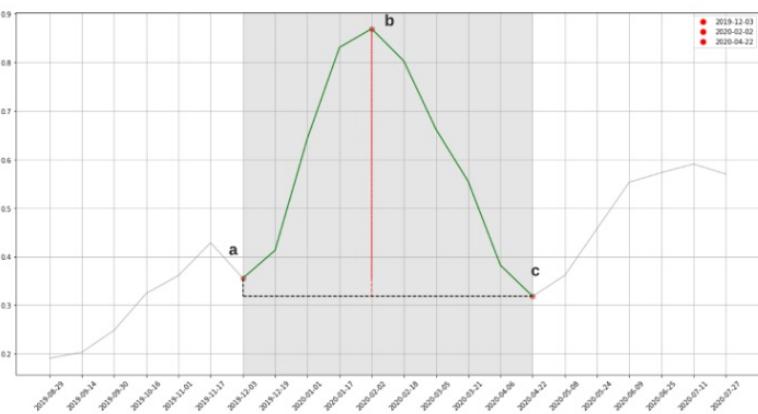
Web Crop Phenology Metrics Service (WCPMS)



(a)

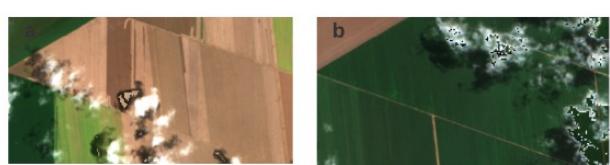
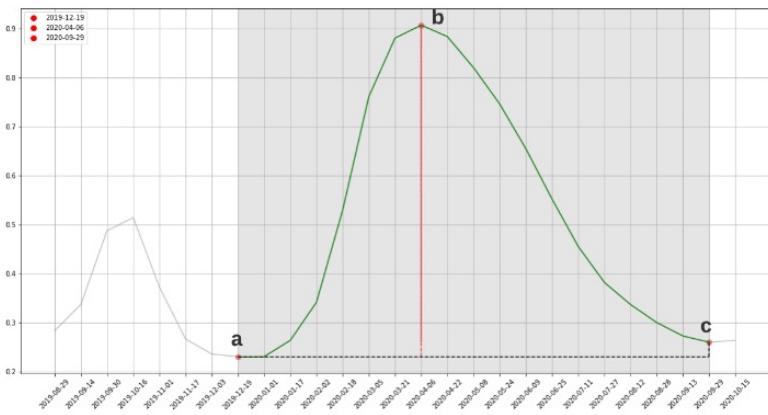


(b)



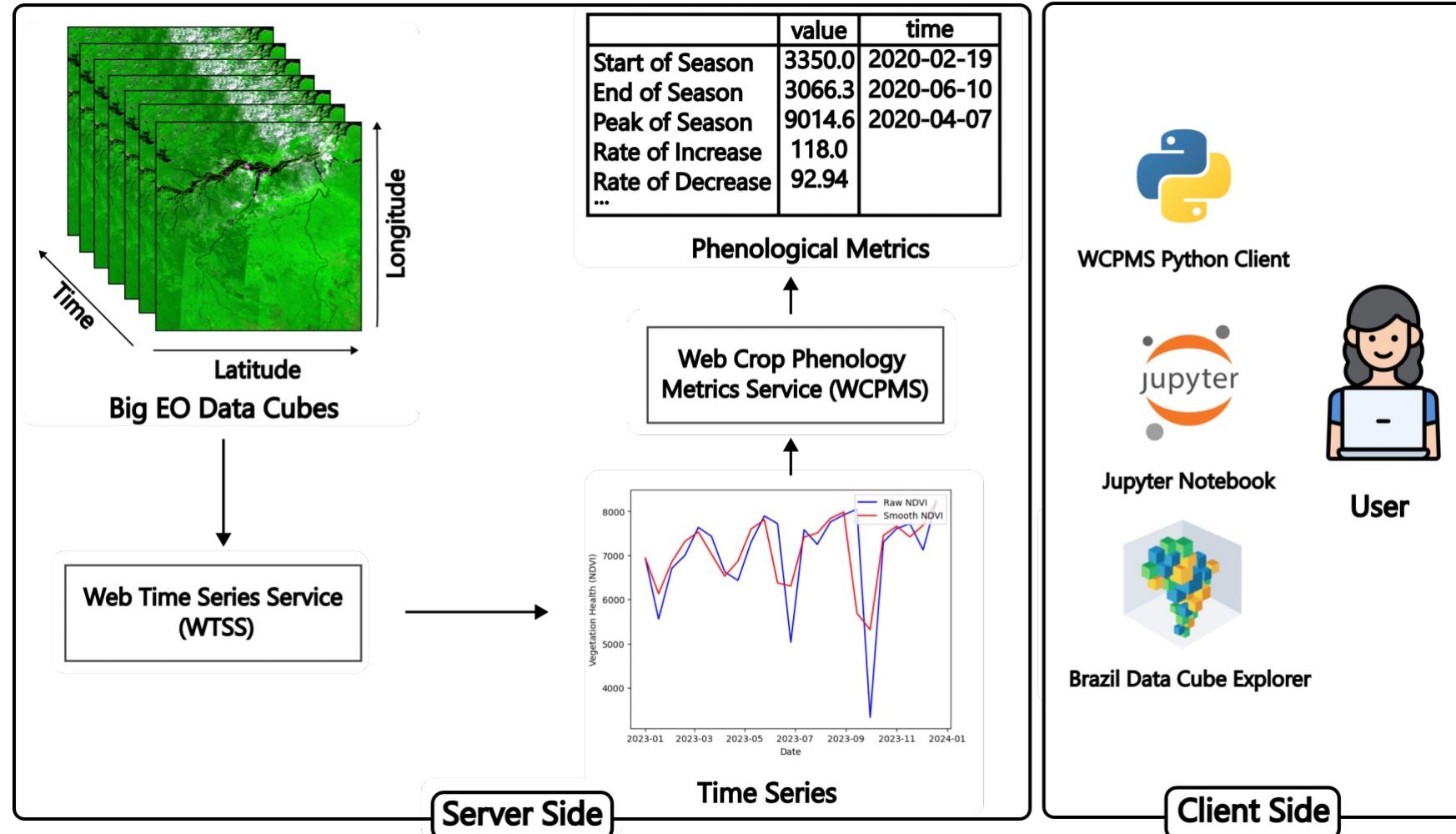
d

(c)



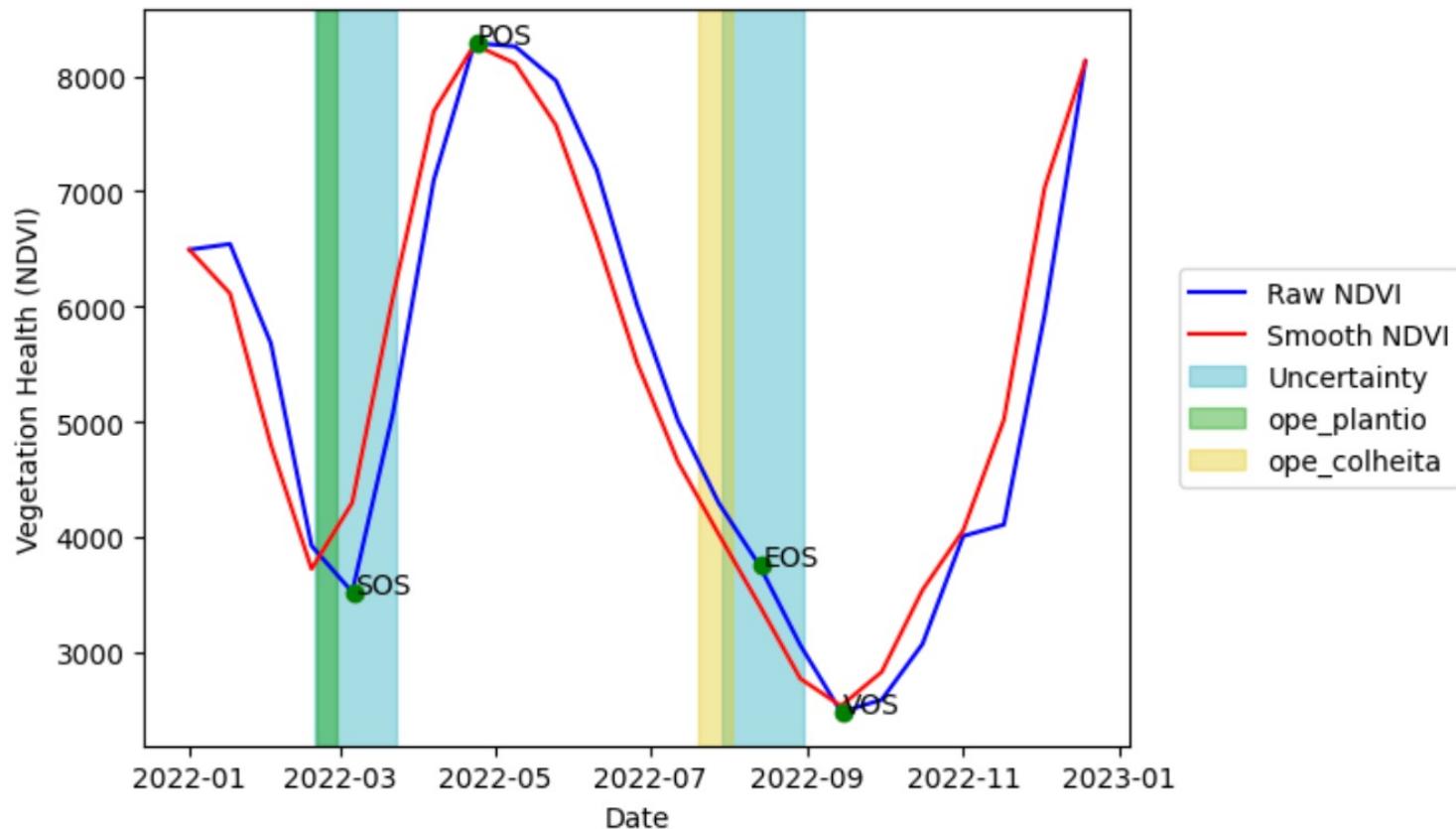
Métricas fenológicas de *início, fim e máximo vigor vegetativo* de plantio extraídas para soja (a), milho de primeira safra (b) e algodão (c) utilizando series temporais NDVI dos cubos Sentinel-2 (16 dias) do BDC.

Web Crop Phenology Metrics Service (WCPMS)

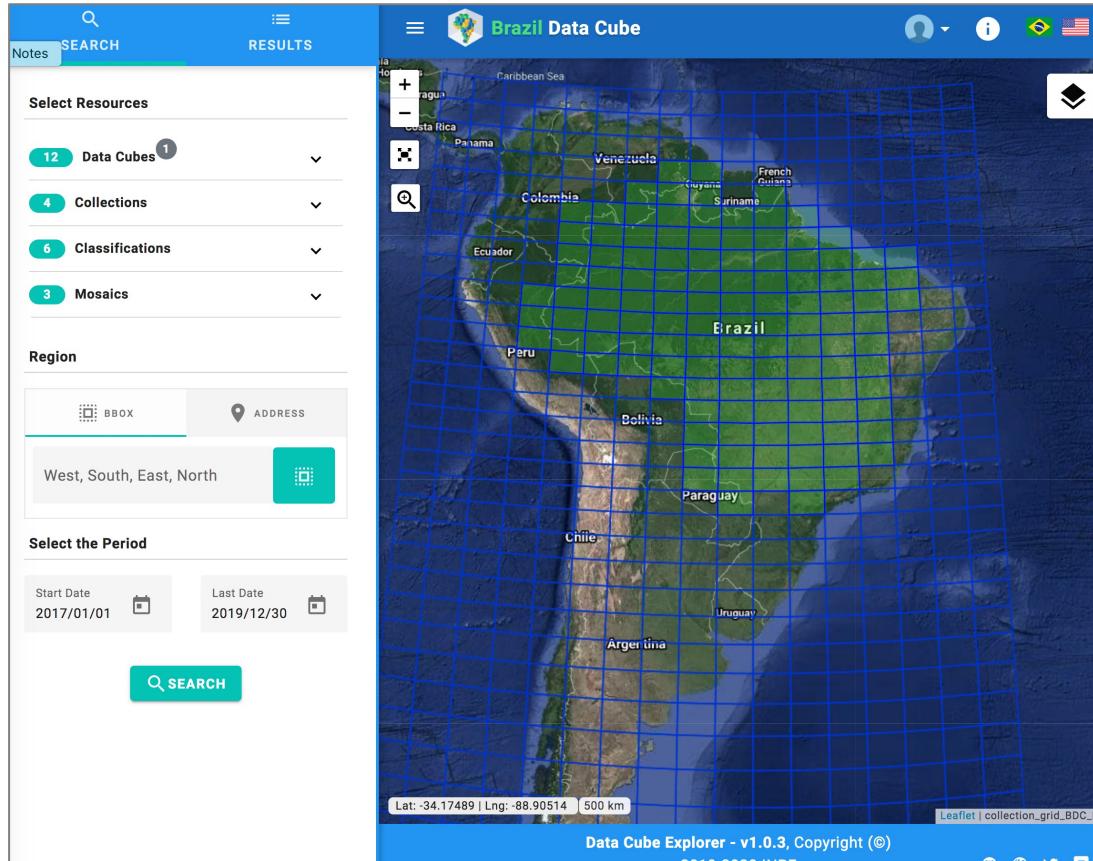


Web Crop Phenology Metrics Service (WCPMS)

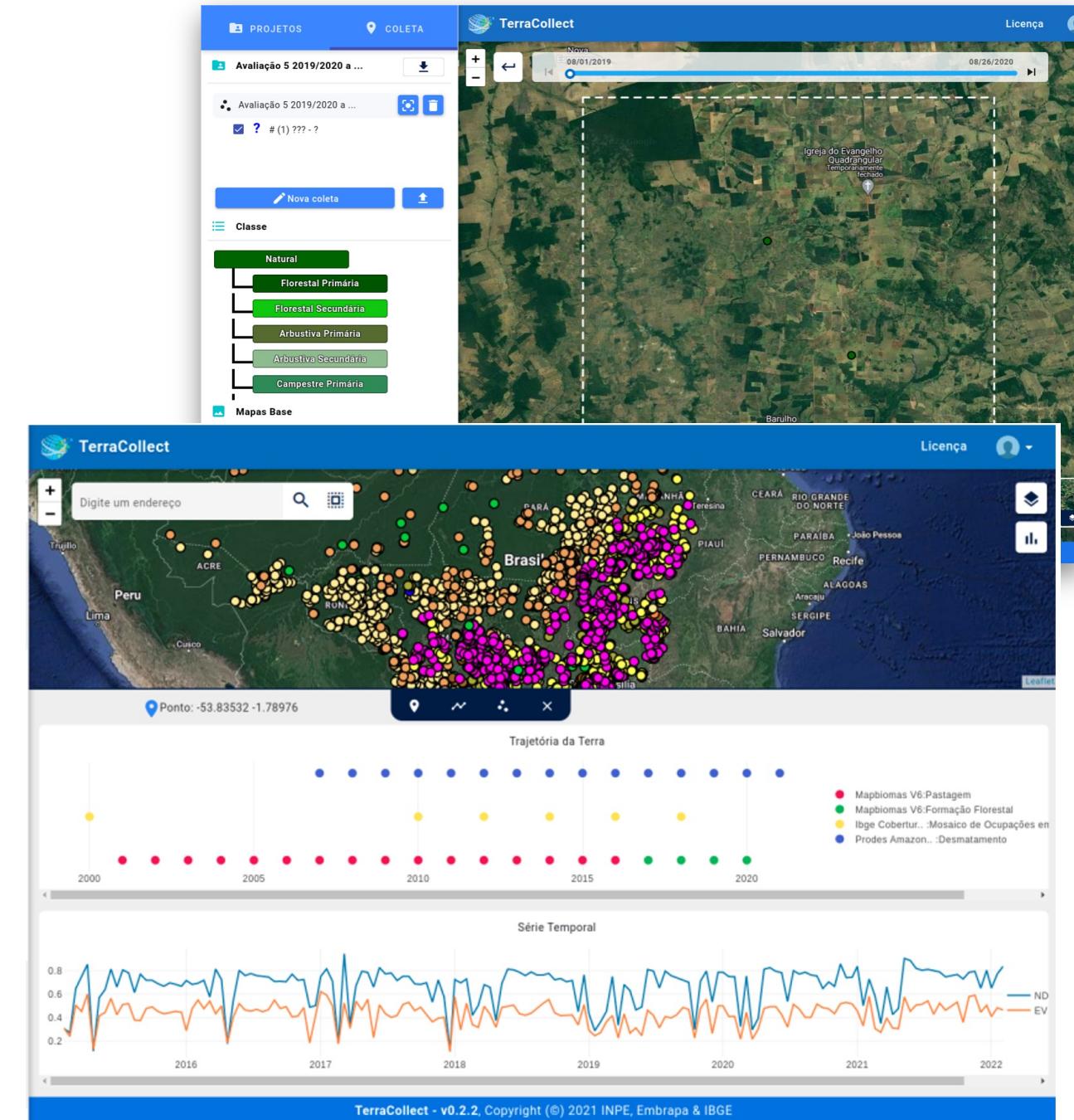
```
plot_advanced_phenometrics(cube=datacube, ds_phenos=pms[9], shape=polygon, start_sowing="ope_início_plantio", end_sowing="ope_fim_plantio", start_harvesting="ope_inicio_colheita", end_harvesting="ope_fim_colheita")
```



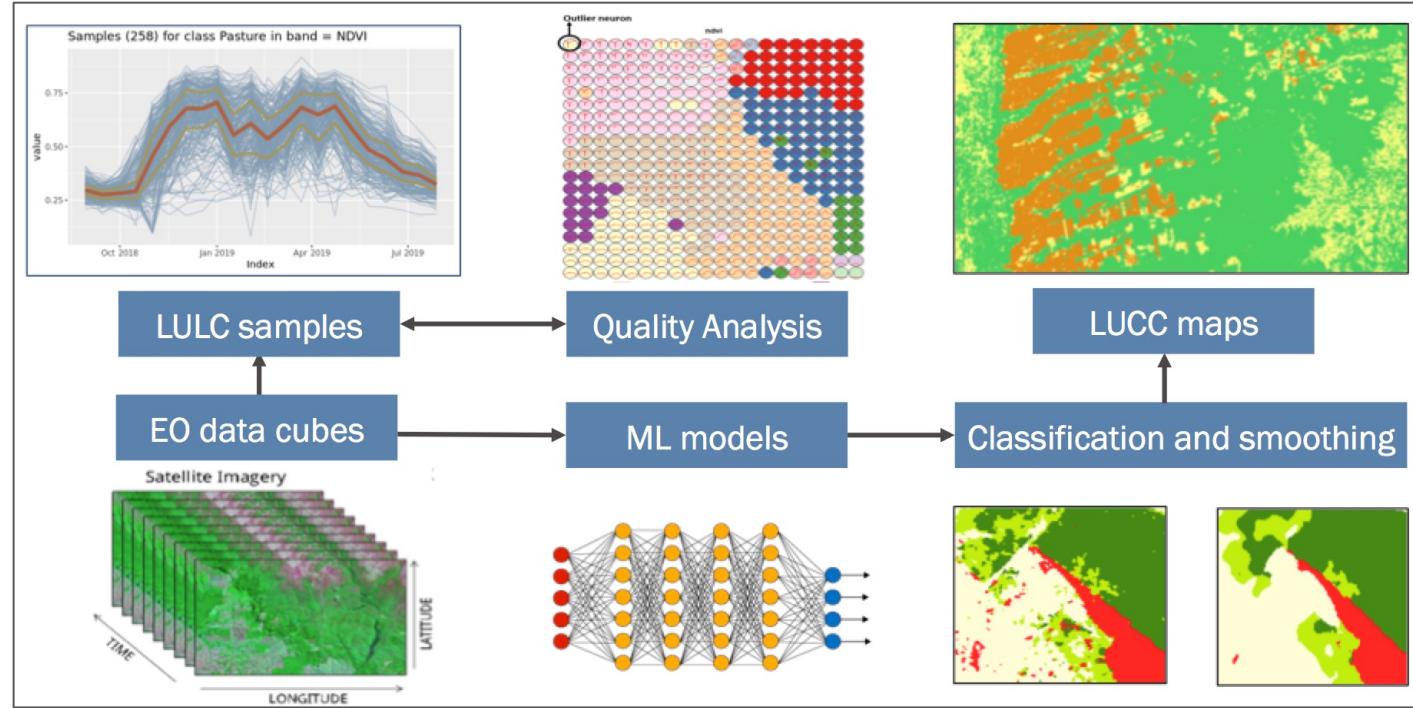
BDC Explorer



<https://data.inpe.br/bdc/explorer/explore>



SITS (Satellite Image Time Series) R package



```
cube <- sits_cube(source = "BDC",
                    collection = "S2_10_16D",
                    name = "s2_cube",
                    bands = c("NDVI", "EVI"),
                    tiles = "022024", start_date = "2018-09-01", end_date = "2019-08-28")

samples <- readRDS(url("https://bdc.dpi.inpe.br/rds/S2_10_16D.rds"))

mlp_model <- sits_deeplearning(layers = c(512, 512, 512, 512, 512), activation = "relu")

dl_model <- sits_train(samples, mlp_model)

result <- sits_classify(data = cube, ml_model = dl_model, output_dir = tempdir())
```

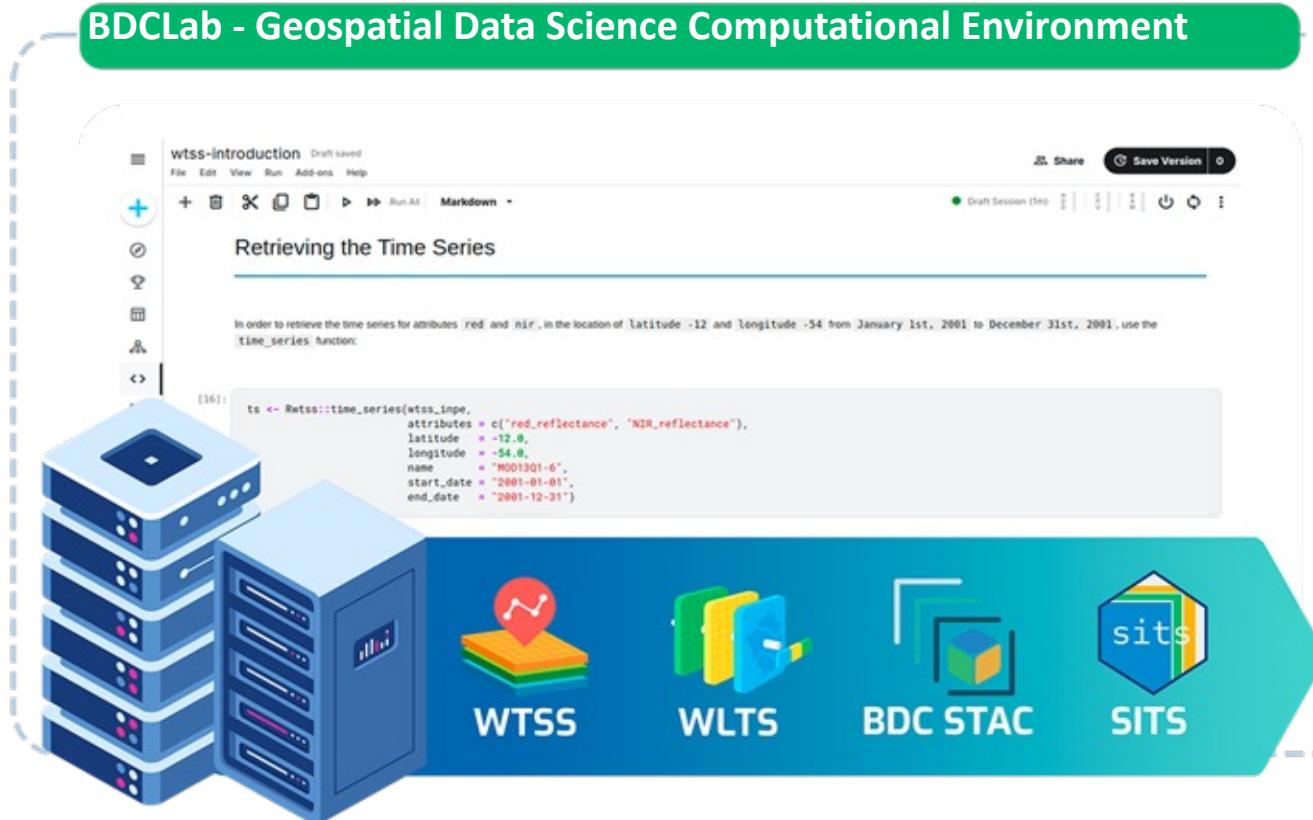
<https://github.com/e-sensing>



BRAZIL
DATA CUBE

BDC-Lab: Geospatial Data Science Computational Environment

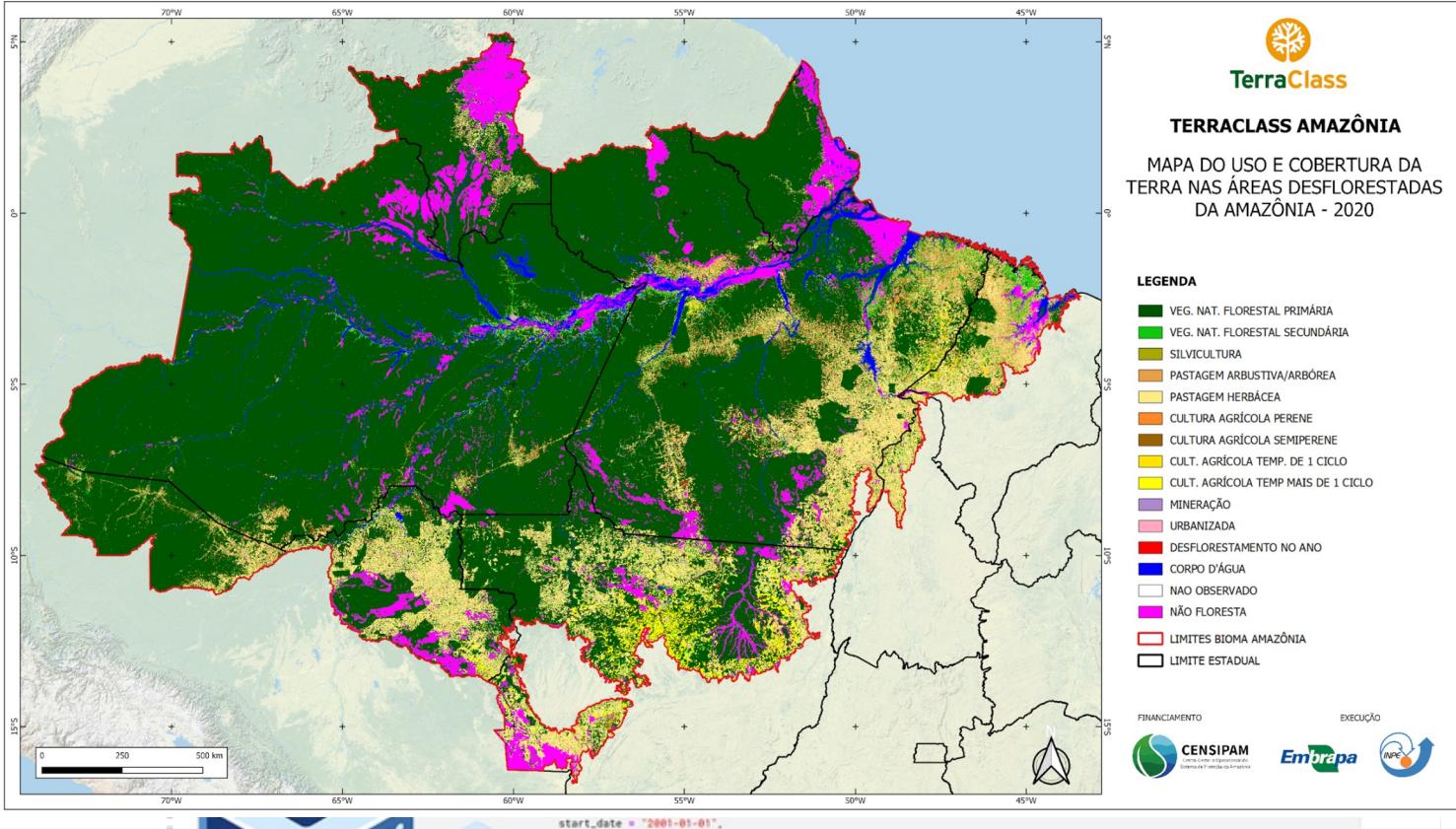
Server-side processing in the INPE's infrastructure, without needing to download images in personal computers.



Embrapa

INPE
UNIDADE DE PESQUISA DO MCTI

IBGE



33 Terabytes (292 tiles)
Sentinel-2 data cubes (16-days)
25,000 samples
Random Forest / tempCNN

Server-side processing in the INPE's infrastructure, without needing to download images in personal computers.



INPE Data Center

Dell EMC HPC egeon



66 processadores e 200 Teraflops
BeeGFS (Alta performance) 500 TB
Dell ME484 (Alta densidade) 1 PB

Cray XE6 and CRAY XC50



880 processadores e ~413 Teraflops
XE6 Lustre (Alta performance) 860 TB
XE6 StorNext (Alta densidade) 2.65 PB
XC 50 Cray Sonexion (Alta performance) 986 TB

Courtesy: Ivan Márcio Barbosa

INPE Data Center

255 Servers, Data Storage with tiers (SSD, SAS and tape library) 12PB online and 4PB tape LTO



Courtesy: Ivan Márcio Barbosa



Ambiente de Computação Interativa: JupyterHub

JupyterLab interface showing a list of notebooks and a preview of the "Land use and land cover classification in the Brazilian Cerrado biome using Brazil Data Cube" notebook.

The preview shows:

- Abstract: This Jupyter Notebook compendium contains useful information about Earth observations data cubes and machine learning (ML) techniques for Earth Observation Data Cubes for Brazil: Requirements, Methodology and Platform.
- Table of Contents:
 - Extracting time series from sample locations
 - Land Use and Cover Mapping from CBERS-4/AWFI Data Cubes

The status bar at the bottom indicates "Saving completed".

JupyterLab interface showing two notebooks: "01_ExtractTimeSeries.ipynb" and "02_CB4_64_16D_STK-1_CI.ipynb".

"01_ExtractTimeSeries.ipynb" (active tab):

Time Series Extraction

CBERS-4/AWFI (16 days 'stack')

The `sits_cube` function can be used to define the working data cube and the interest spectral bands and vegetation indices:

```
[7]: cb4_cube <- sits_cube(
  type = "EDC",
  url = "http://datacube-006.dpi.inpe.br:8010/stac/",
  collection = "CB4_64_16D_STK-1",
  start_date = start_date,
  end_date = end_date,
  bands = c("BAND15", "BAND14", "BAND13", "BAND16", "NDVI", "EVI")
```

In the above cell we provide:

- `type`: Inform that the data is from the Earth Observation Data Cube (EDC).
- `url`: The SpatioTemporal Data Cube URL (`http://datacube-006.dpi.inpe.br:8010/stac/`).
- `collection`: Define the collection name (`CB4_64_16D_STK-1`).
- `start date` and `end date`: Define the time range for the extraction.

Two line plots show NDVI values over time (Oct 2018 to Jul 2019) for different land classes:

- Samples (258) for class Pasture in band = NDVI
- Samples (422) for class Natural in band = NDVI

"02_CB4_64_16D_STK-1_CI.ipynb":

Classify the datacube

This is a time-consuming process

```
[9]: probs <- sits_classify(data = cube,
  ml_model = dl_model,
  memsize = classification_memsize,
  multicores = classification_multicores,
  roi = roi$classification_roi,
  output_dir = output_dir)
```

Using 2 blocks of size 888 x 2725
Starting classification at 2021-03-26 14:54:15
Elapsed time 19.5 minute(s).
Estimated total process time 39 minute(s)...
Classification finished at 2021-03-26 15:33:30. Total elapsed time: 39.2minute(s).

Generate classification label map

```
[10]: probs_smoothed <- sits_smooth(probs, type = "bayes", output_dir = output_dir)
labels <- sits_label_classification(probs_smoothed, output_dir = output_dir)
```

Visualizing classification map

A map visualization showing a classification label map over a geographic area, with colors representing different land classes.



Ambiente de Computação Interativa: RStudio

RStudio Server x + brazildatadcube.dpi.inpe.br

File Edit Code View Plots Session Build Debug Profile Tools Help

Go to file/function Addins

02_CB4_64_16D_STK_1_Classification.... x

```
66
67 **Parameters**
68
69 If you want to download and run this notebook in a workflow as a script, you can perform its
parameterization through the [papermill library](https://github.com/nteract/papermill). The access to
the Brazil Data Cube (BDC) data products requires an access key. To request your access key, please,
contact the BDC team at brazildatadcube@inpe.br. Define the 'BDC_ACCESS_KEY' env variable to access to
use the BDC Services.
70
71 ```{r}
72 classification_memsize <- 20 # in GB
73 classification_multicores <- 20
74
75 start_date <- "2018-09-01"
76 end_date <- "2019-08-31"
77 ```
78
79 **Samples and ROI definition**
80
81 ```{r}
82 # fixed parameters
83 collection <- "CB4_64_16D_STK-1"
84
85 # define the roi and load samples file
86 roi <- readRDS("data/Examples/bdc-article/roi/roi.rds")
87 samples <- readRDS("data/Examples/bdc-article/training-samples/rds/CB4_64_16D_STK_1.rds")
88 ```
89
90 > All the results generated in this document will be saved in your user's `~home` directory, inside
`out` directory
91
93:11 Chunk 3 + R Markdown Jobs
```

Console Terminal R Markdown Jobs

/data/Examples/bdc-article/ ↵

> |

Environment History Connections Tutorial

New Connection Connection Status

Files Plots Packages Help Viewer

New Folder Upload Delete Rename

Home .Name Size Modified

- .Rhistory 246 B Feb 2019
- 00_TableOfContents-copy.Rmd 4.7 KB Feb 2019
- 00_TableOfContents-copy.Rmd.html 21.8 MB Feb 2019
- 00_TableOfContents.Rmd.html 22.6 MB Feb 2019
- 01_ExtractTimeSeries.Rmd.html 26.9 MB Feb 2019
- 02_CB4_64_16D_STK-1_Classifica... 22.7 MB Mar 2019
- bdc-article
- CBERSDataCube_CerradoBiomeCl... 6.2 KB
- examples
- extras
- gkhub-utils
- out
- teste
- work

brazildatadcube.dpi.inpe.br

Time Series Extraction

The sits_cube function can be used to define the working data cube and the interest spectral bands and vegetation indices:

```
cb4_cube <- sits_cube(
  type = "BDC",
  url = "http://datadcube-006.dpi.inpe.br",
  collection = "CB4_64_16D_STK-1",
  start_date = start_date,
  end_date = end_date,
  bands = c("BAND15", "BAND14", "BAND13")
)
```

In the above cell we provided the following arguments

- type : Inform that the data cube will be based on the BDC
- url : The SpatioTemporal Asset Catalog address for BDC
- collection : Defines the use of CBERS-4/AWFI data
- start_date and end_date : The temporal interval of interest
- bands : The list of spectral bands and spectral indices

The sits_get_data retrieves the time series from the defined data cube.

```
cb4_samples_with_ts <- sits_get_data(cube = cb4_cube)
```

If you want to plot the NDVI time series for all the LULC classes, use the following plot function:

```
plot(sits_select(cb4_samples_with_ts, bands = c("NDVI")))
```

Samples (242) for class Crop in band = NDVI

brazildatadcube.dpi.inpe.br

Visualizing classification map

The raster load in this step was generated automatically with sits_label_classification function

```
rst <- raster::raster(paste0(output_dir, "/cube_to_classify_022024_probs_class_2018_8_2019_7.tif"))
```

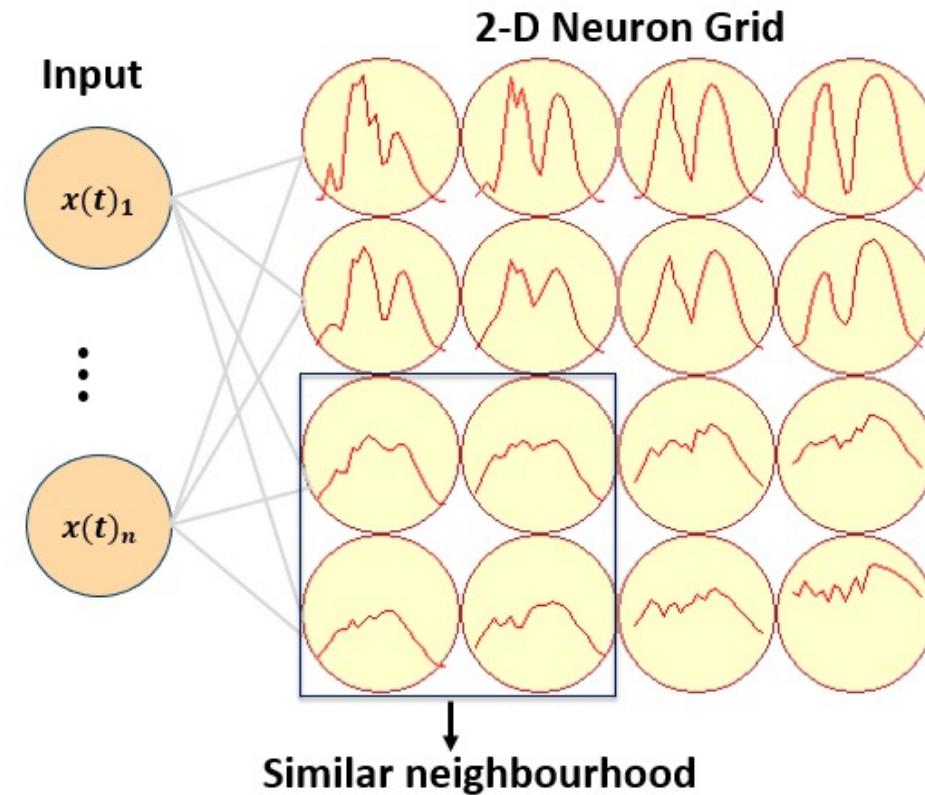
Warning in showSRIOD(projargs, format = "PROJ", multiline = "NO", prefer_proj = ## prefer_proj): Discarded datum Unknown based on GRS80 ellipsoid in CRS definition

```
plot(rst)
```

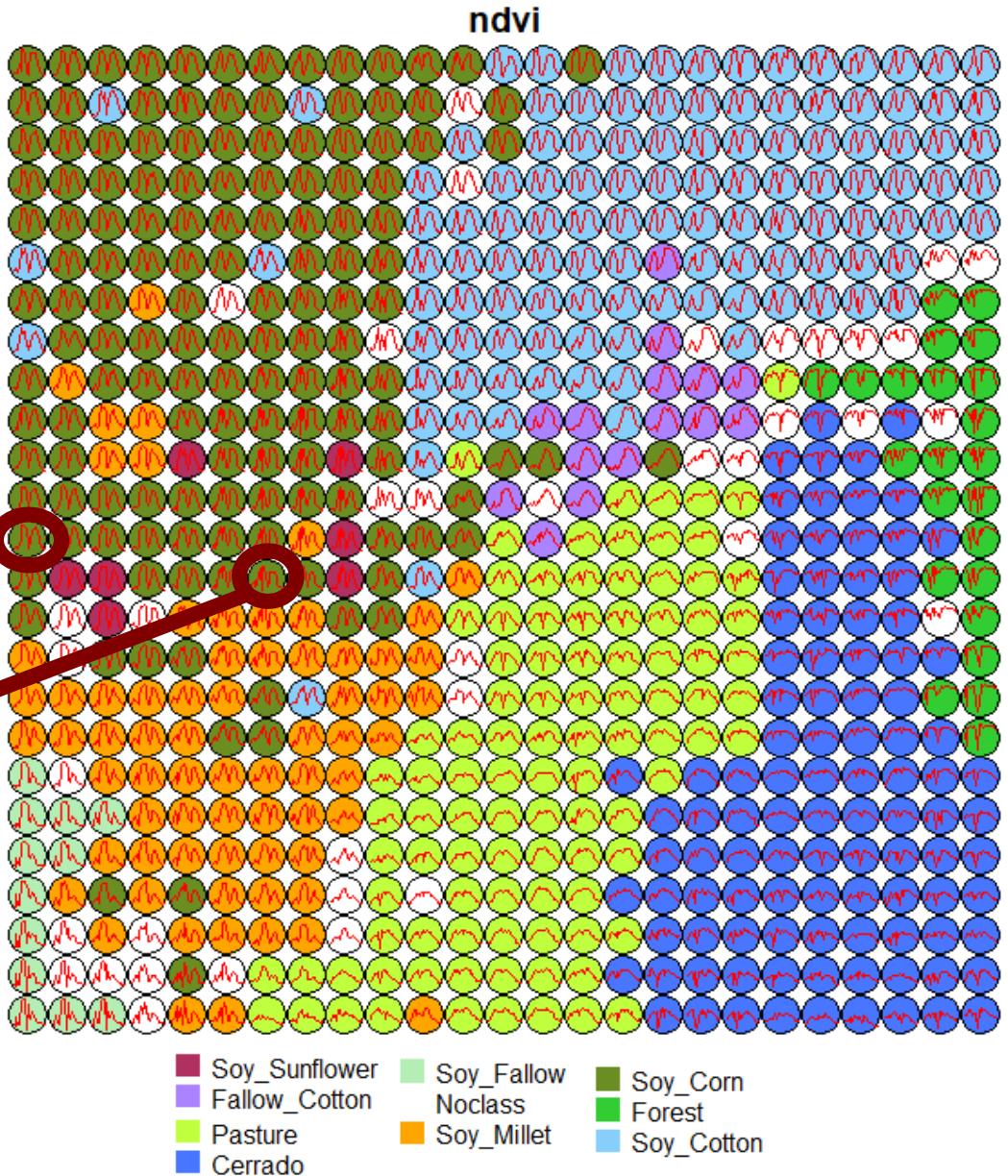
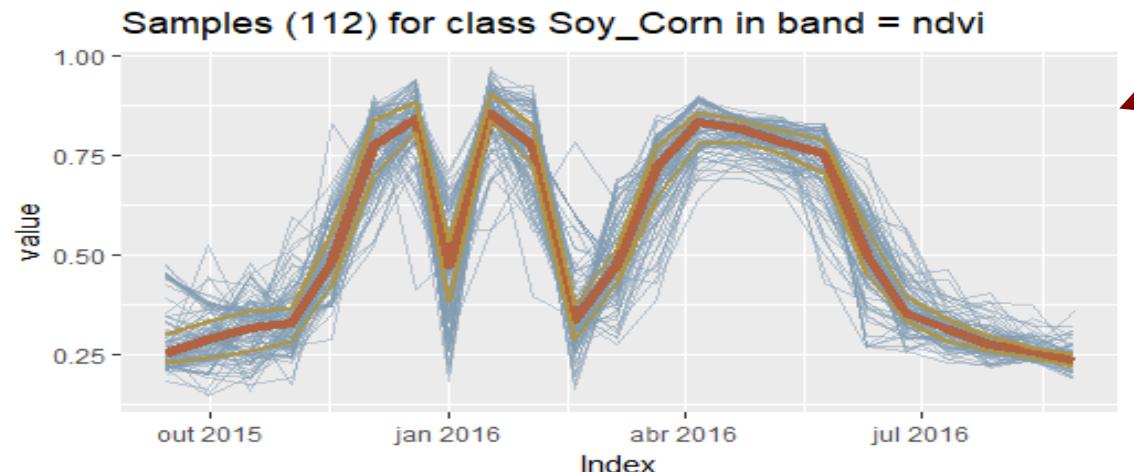
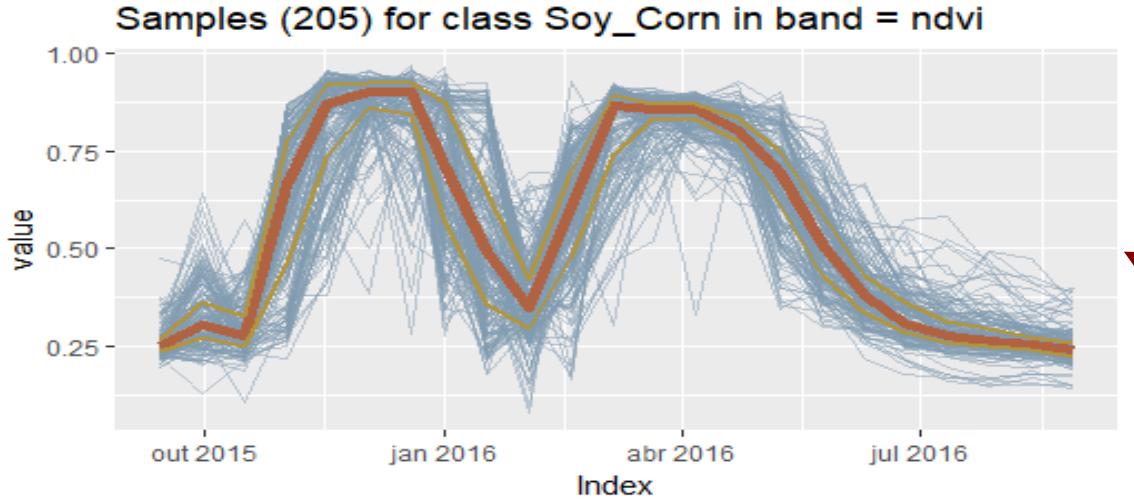
Save the results

Clustering of SITS

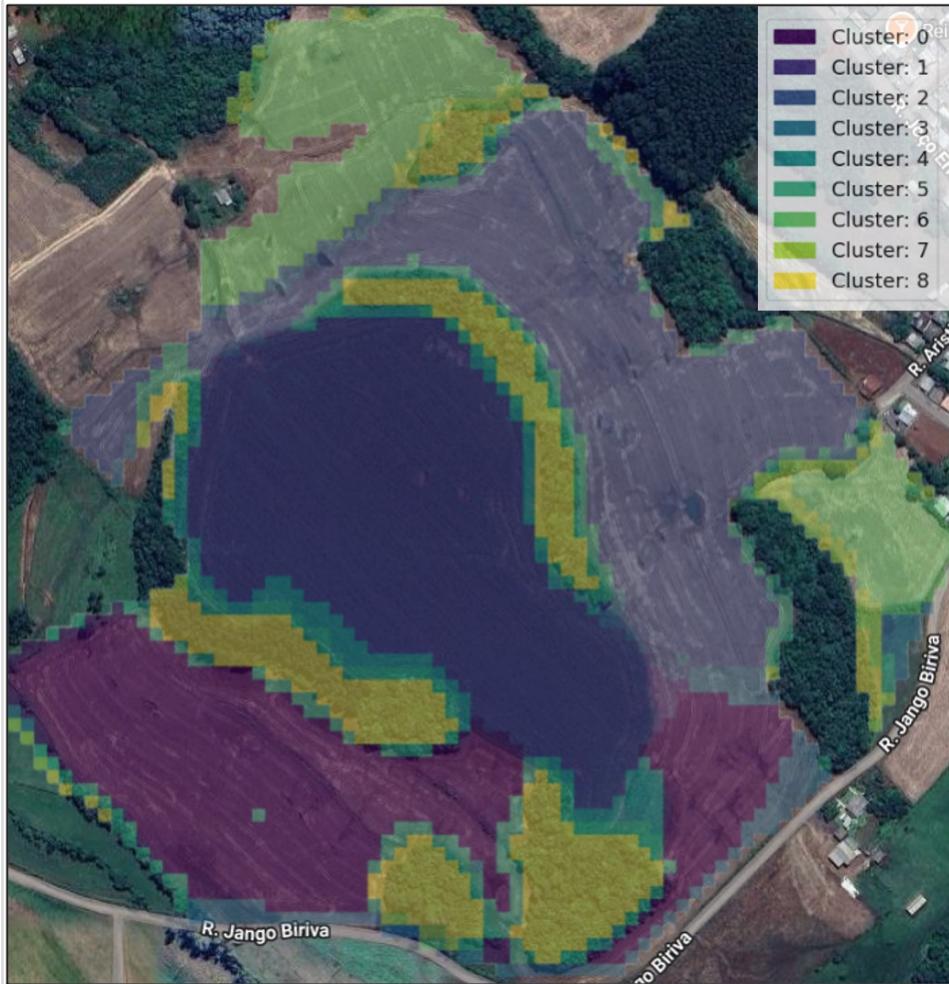
Self-Organizing Maps (SOM) neural network for SITS clustering



SOM to identify different SITS patterns

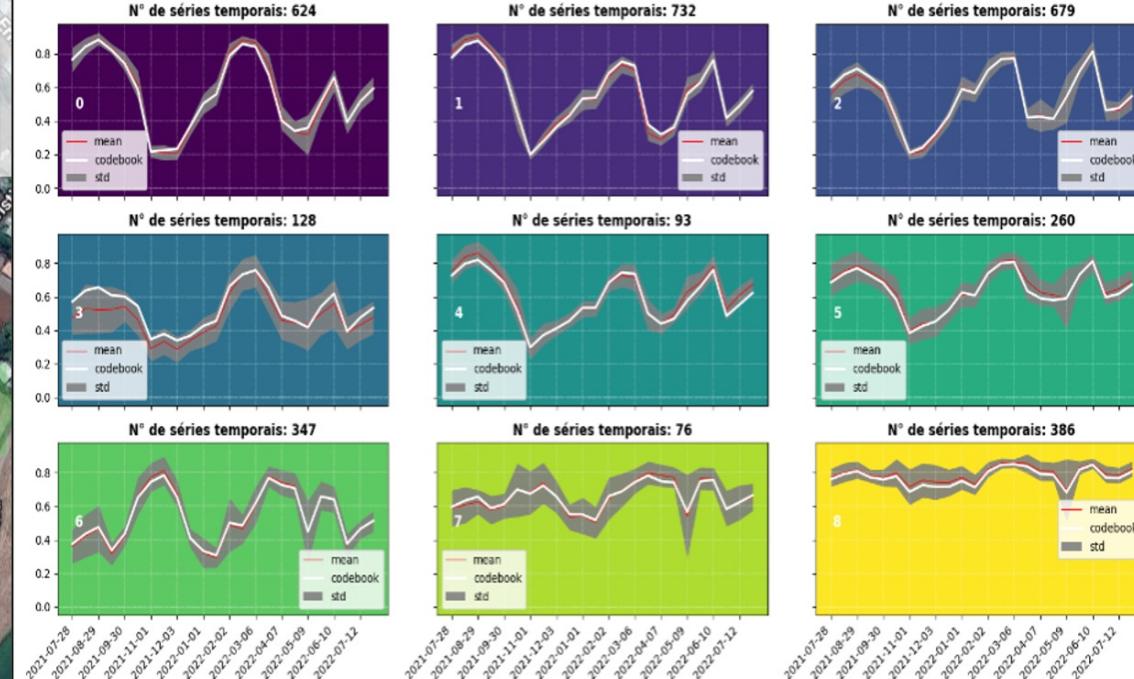


SITS patterns – dentro de uma gleba – Crédito Rural - SICOR



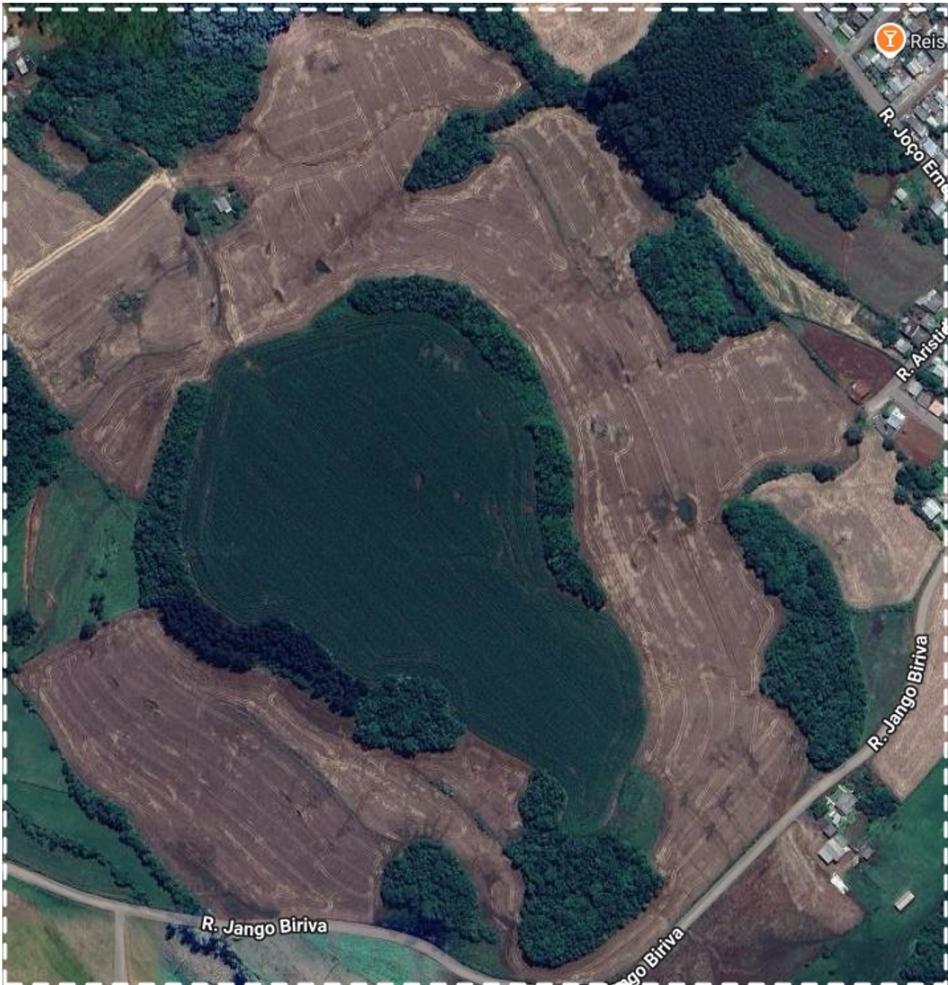
(A)

Vetores de Peso (NDVI) dos Neurônios SOM



(B)

SITS patterns – dentro de uma gleba – Crédito Rural - SICOR

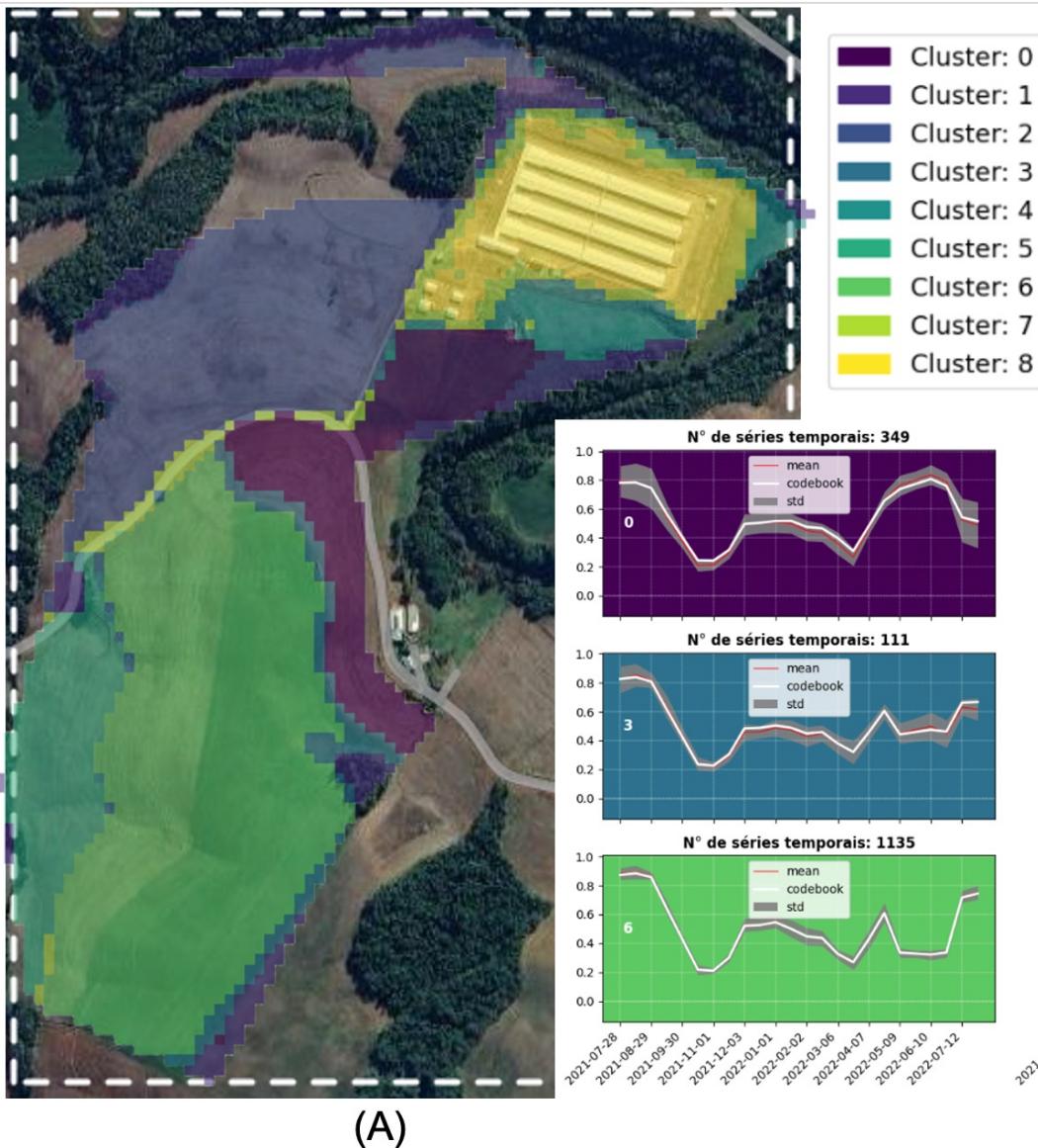


(A)

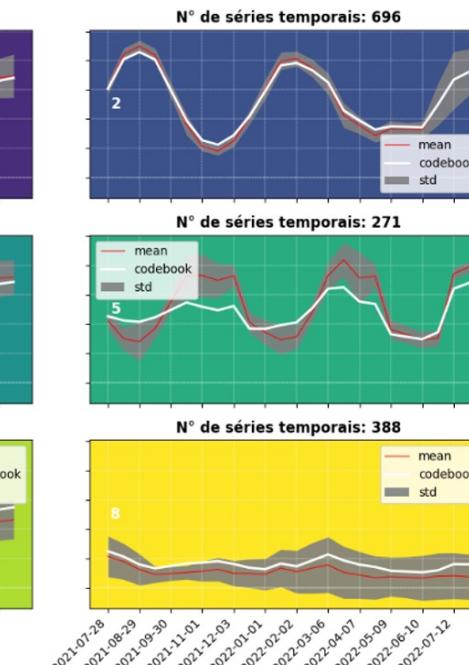


(B)

SITS patterns – dentro de uma gleba – Crédito Rural - SICOR



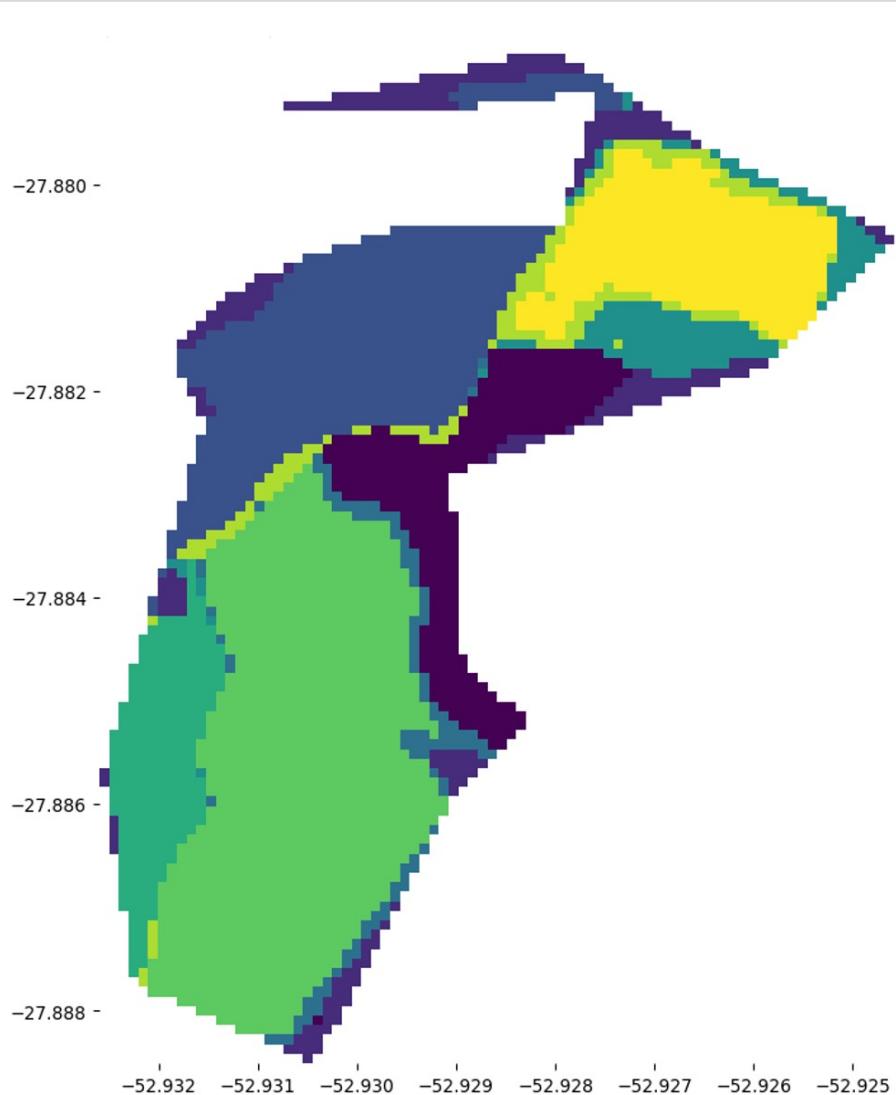
Vetores de Peso (NDVI) dos Neurônios SOM



SITS patterns – dentro de uma gleba – Crédito Rural - SICOR



(A)



(B)



BRAZIL DATA CUBE
brazildatadube.org



brazildatadube.org



brazildatadube.dpi.inpe.br/portal/explore

Karine R. Ferreira

karine.ferreira@inpe.br

OBRIGADA!



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