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CIÊNCIA, TECNOLOGIA
E INOVAÇÃO



Monitoring in Brazilian biomes, legacies, challenges and future perspectives

INPE Biome Monitoring Program

13/06/2024

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Context : History of PRODES

Image reception and processing since 1973

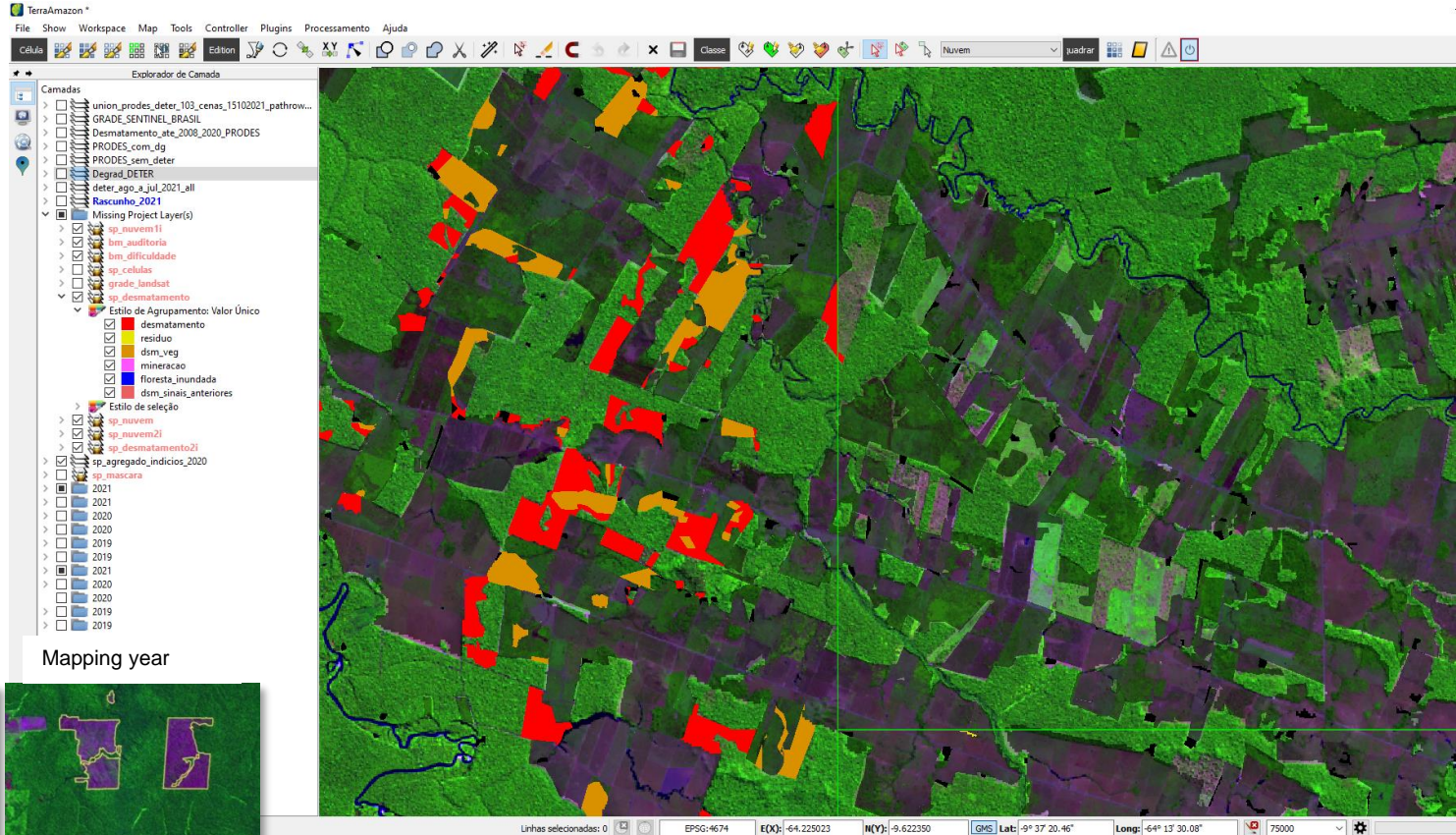


First complete mapping of the Brazilian Amazon



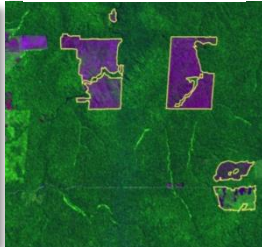
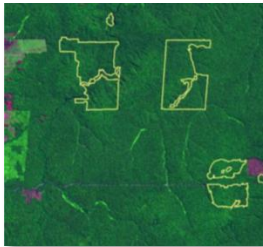
Methodology: PRODES

Almeida *et al.* Methodology for Forest Monitoring used in PRODES and DETER projects. 2022.



Previous year

Mapping year

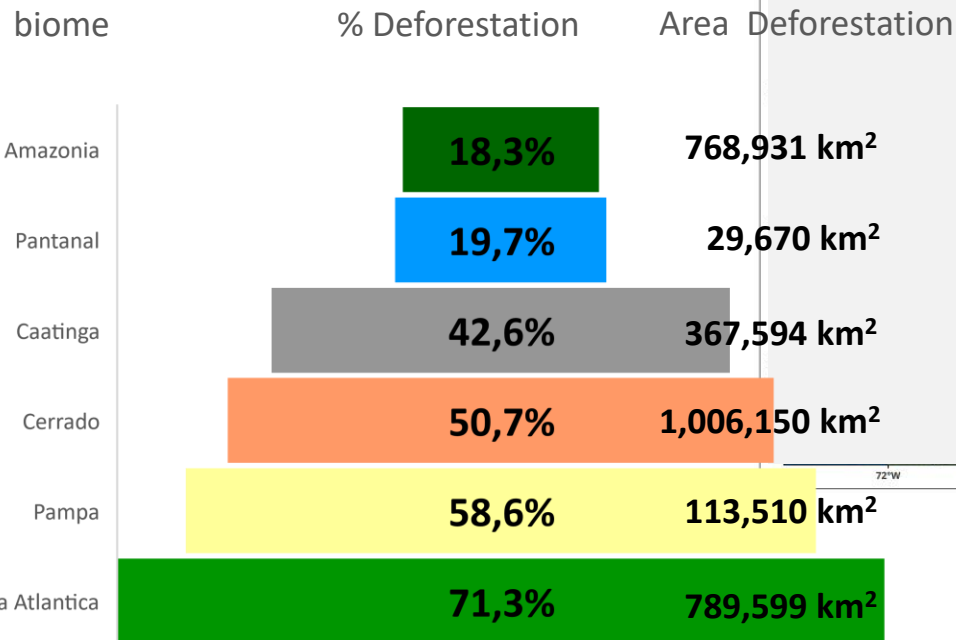
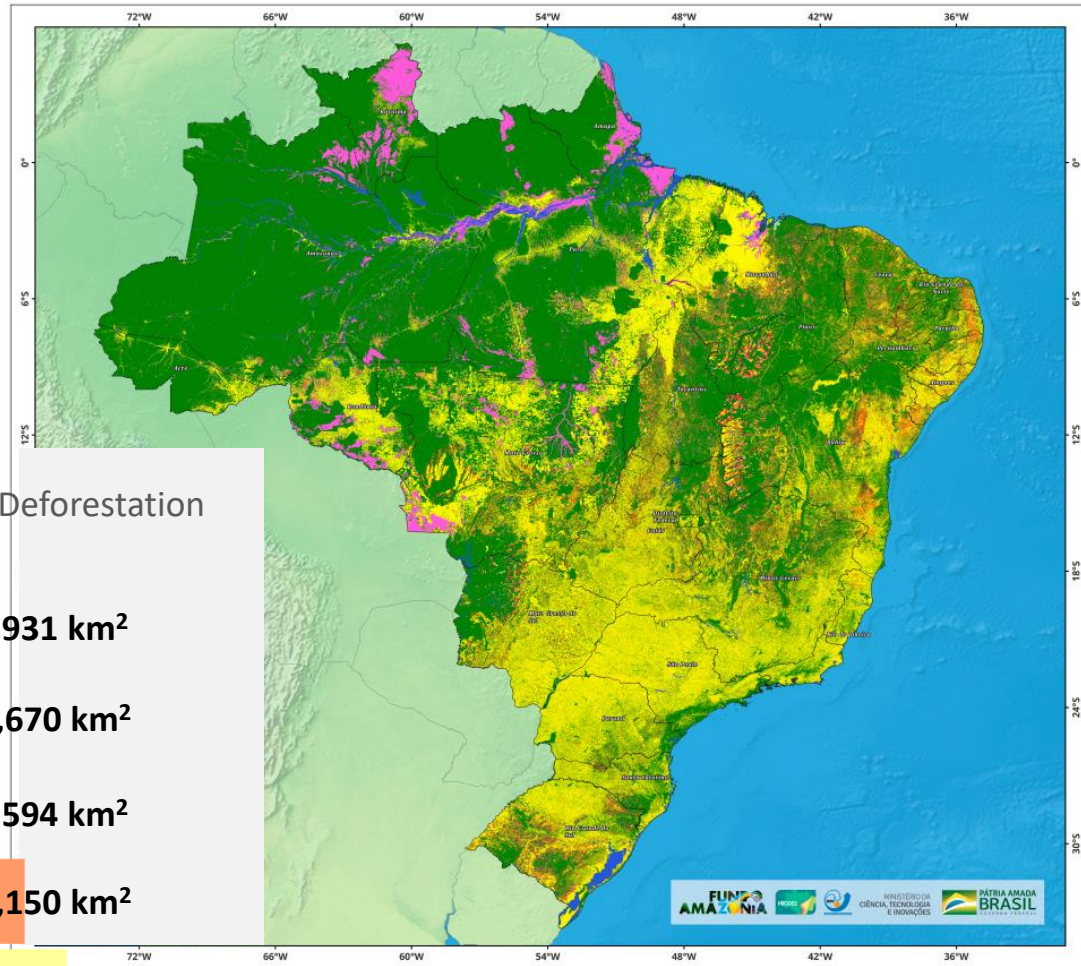


- Incremental system
- Annual increase of deforestation
- Medium spatial resolution (10 m) Copernicus Data
- Minimum Mapping Unit = 1 ha
- Experienced team
- Accuracy >93% (Maurano *et al.* 2019, Parente *et al.* 2021)



Monitoring Systems: PRODES

Deforestation Brazil = 36,11%



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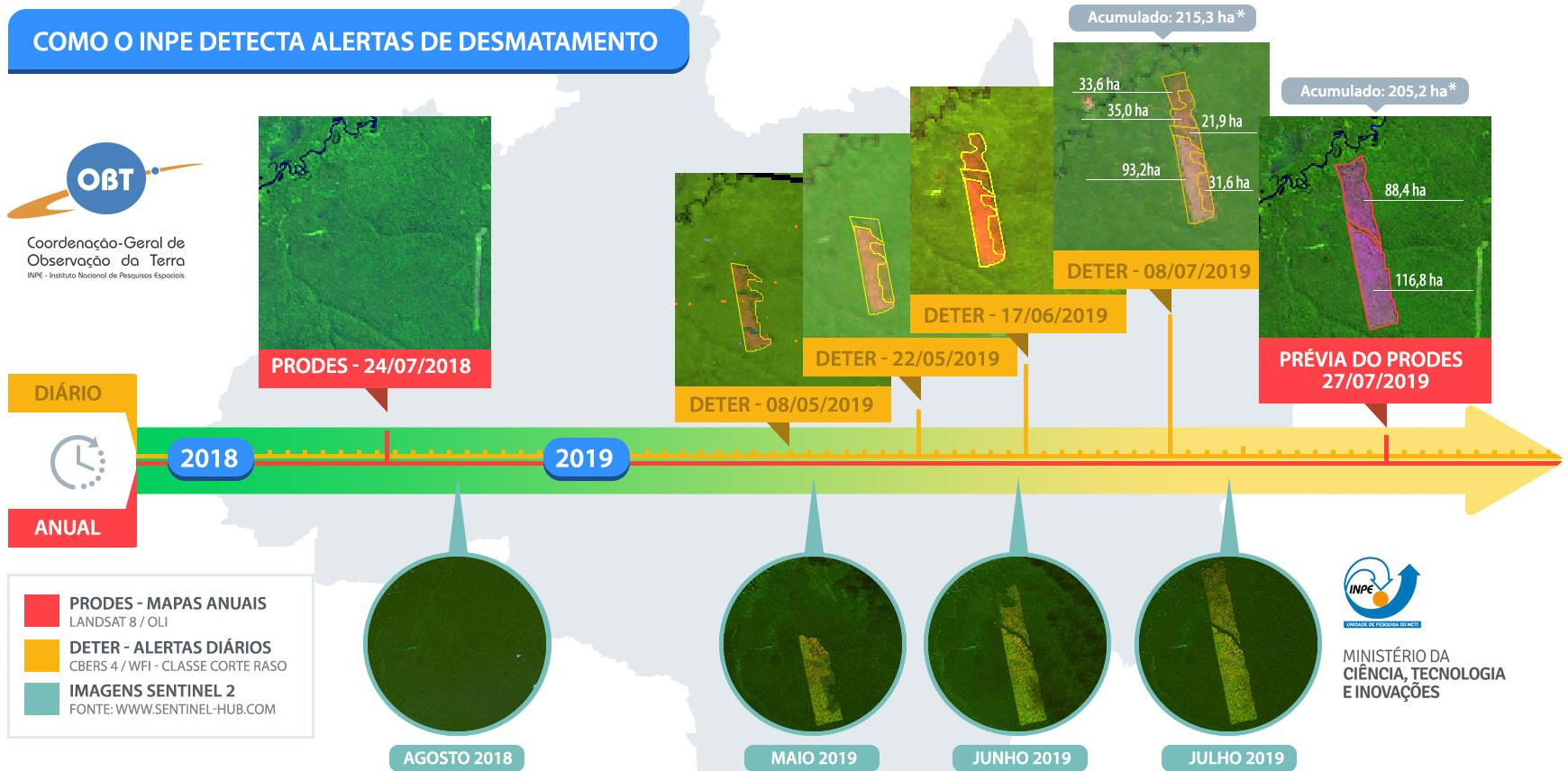
Daily monitoring

Deforestation and Forest Degradation
2004 – 2014 MODIS 250m (>25ha)
2015 – current WFI 64 m (>3ha)

COMO O INPE DETECTA ALERTAS DE DESMATAMENTO



Coordenação-Geral de
Observação da Terra
INPE - Instituto Nacional de Pesquisas Espaciais



HUMAITÁ, AMAZONAS, BRASIL
COORDENADAS: 7.778445° S, 63.480613° W

* Diferença de área acumulada atribuída aos tipos de sensores usados pelo DETER e PRODES.



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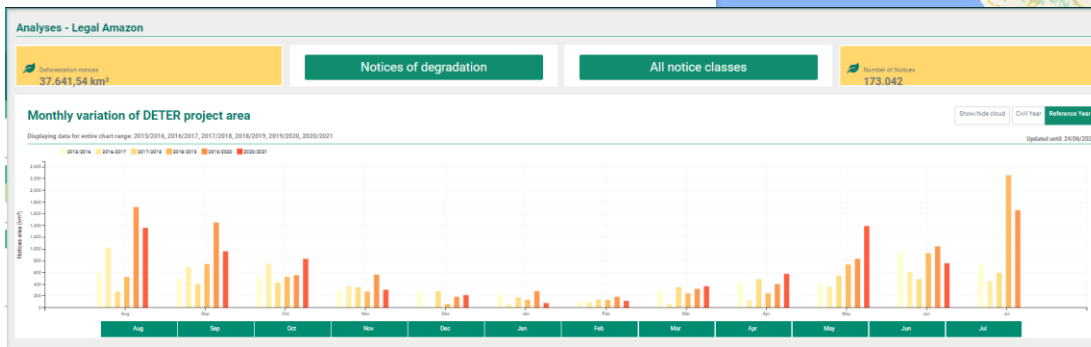
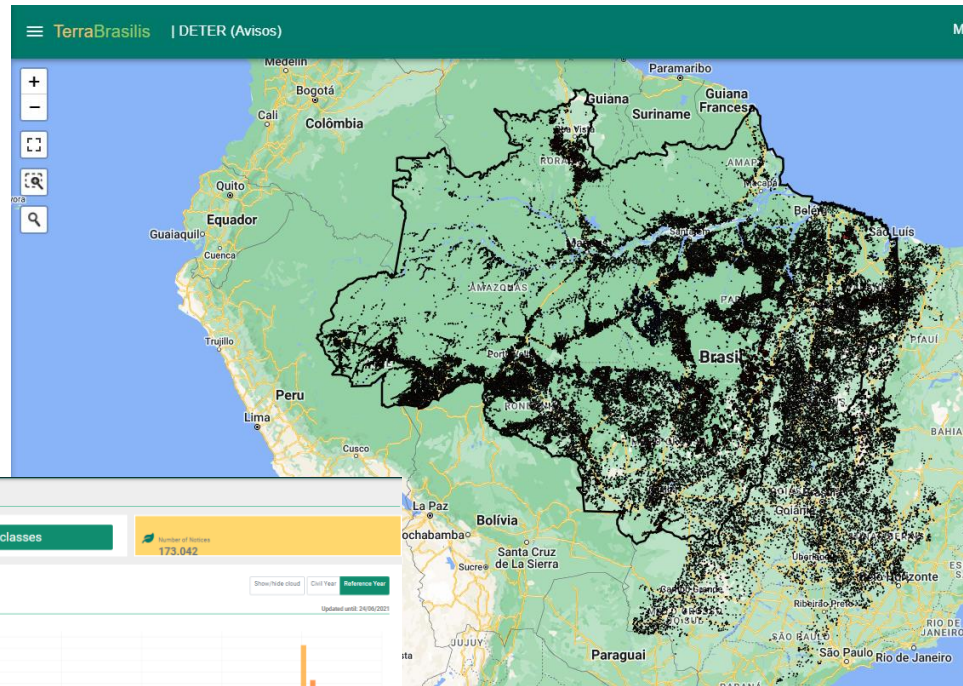
Daily monitoring

DETER System - Results

EVERY DAY

Early warnings sent to control agencies

Data (polygons, tables, graphics) available on TerraBrasilis platform



PRODES processes: implications on data quality

Aspects of **PRODES** quality:

I - Mapping processes requirements

II - External validation

III - Transparency

Image selection and processing

Best detection period
Reduced cloud coverage

Visual interpretation

Multi-disciplinar and experienced team
Legend and protocol standardization
Ancillary data
Information about regional or local specificity

Auditing

Systematic process (100% of territory)
Visual inspection

Post-processing

Consistency and processing rules checking

Map validation

Stratified and random sampling
External staff

Data Dissemination

Transparency (<http://terrabrasilis.dpi.inpe.br/>)
Technical reports
Scientific publications

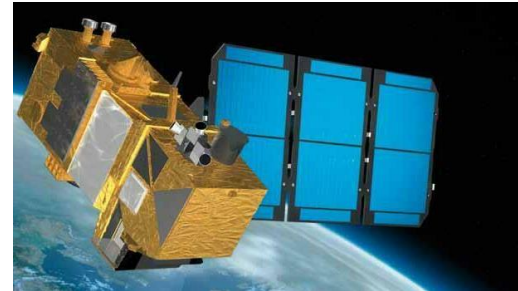


Evolution

Inclusion of new sensors
2024 – Sentinel is the reference Data



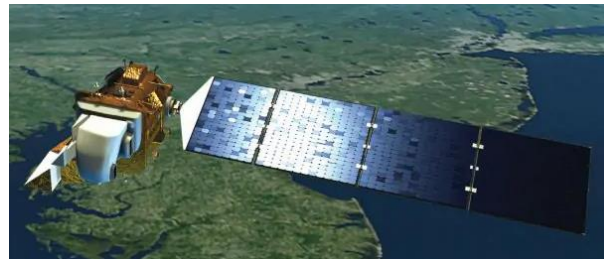
SENTINEL 1



SENTINEL 2



CBERS-4



LANDSAT 8 / 9



CBERS-4A

Sentinel Mirror Site: Legal Framework

[Cooperation Agreement](#) between the European Commission and the Ministry of Science, Technology and Innovation (MCTI) of Brazil in the area of data access and use of Sentinel data of the Copernicus Programme. Signed in March 2018.

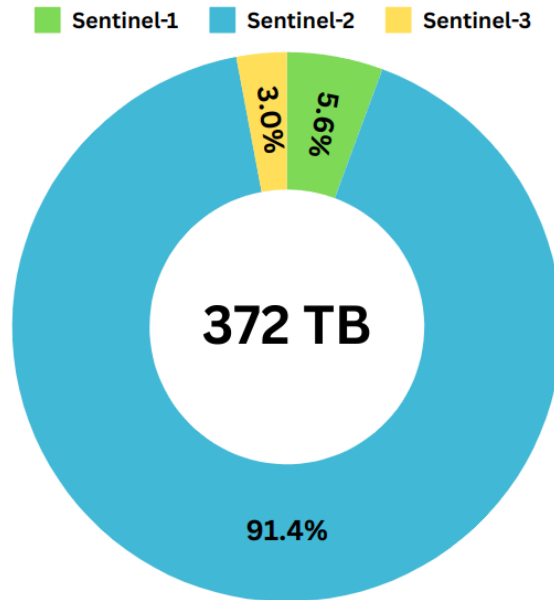
[Technical Operating Arrangement](#) between the European Space Agency (ESA), the Brazilian Space Agency (AEB), and INPE. INPE and ESA will coordinate the promotion of Earth data exchange between Brazil and Europe. Signed in March 2019.

[Technical Operating Arrangement](#) between the EUMETSAT, MCTI and INPE. INPE and EUMETSAT will coordinate the collaboration on data exchange between Brazil and Europe, in the context of the Sentinel missions operated by EUMETSAT. Signed in March 2022.

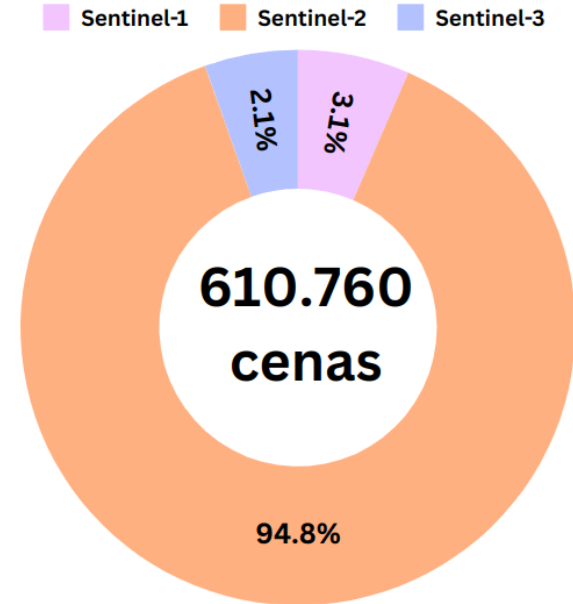
Main result: establishment of local a repository of Sentinel data, **INPE's Sentinel Data Mirror Site**



Mirrored Data Volume: 2022-2024



Number of Scenes 2022-2024



- <https://data.inpe.br/bdc/stac/v1/>
- <https://data.inpe.br/stac/browser/>



Evolution

Inclusion of new technologies

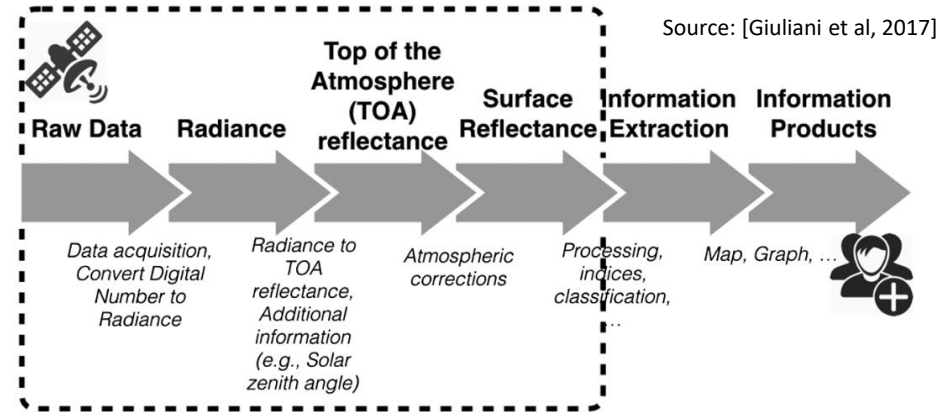
Big Data Analysys



Brazil Data Cube

(1) Analysis-Ready Data (ARD) of medium-resolution satellite images for Brazil: CBERS-4 Landsat 8 Sentinel 2.

(2) Multidimensional data cubes.

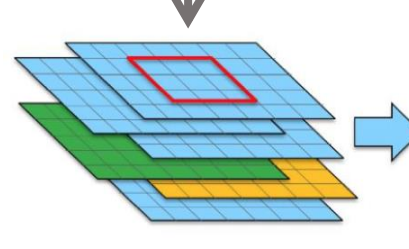


Analysis Ready Data production

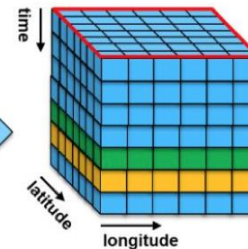


CEOS Analysis Ready Data for Land:

<https://ceos.org/ard/index.html>



Collections of Earth observation satellite imagens – ARD



Source: [Kopp et al, 2019]

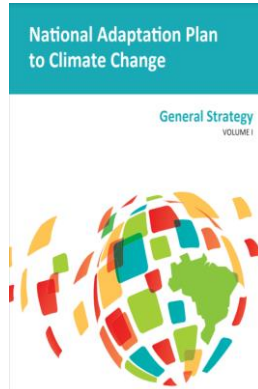
Data cubes – four-dimensional array.



PRODES Data Users

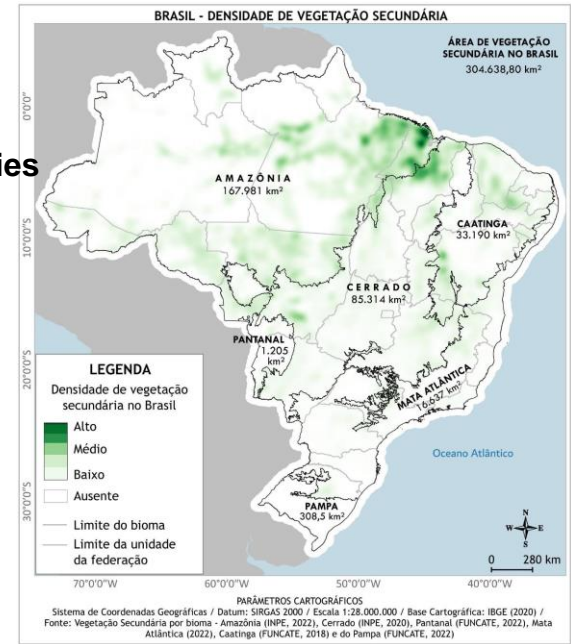
Until feb/2024: 1.611 papers
in 514 indexed journals

Academic studies



Public policies

Reducing Emissions from Deforestation and forest Degradation
+ conservation of forest carbon stocks
+ sustainable management of forests
+ enhancement of forest carbon stocks



Compliance Economic Channels



Thank you for your attention!

www.inpe.br

www.gov.br/mcti

