

Earth observation data analysis in the age of big data



The age of big Earth observation data



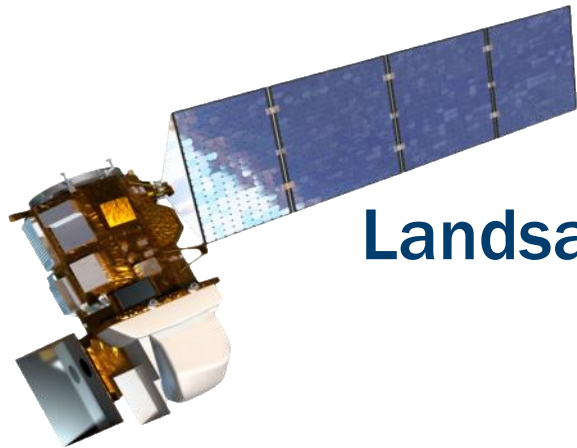
Terra



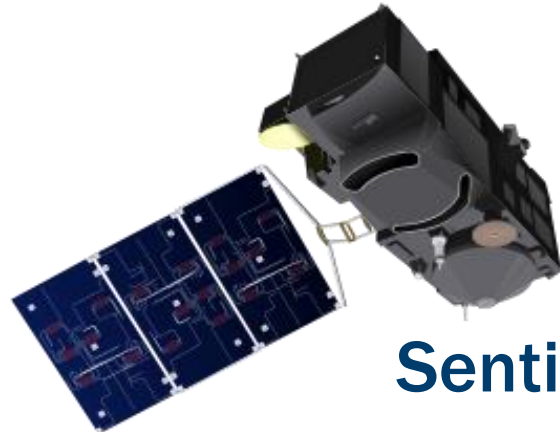
Sentinel-1/1A



Sentinel-2/2A



Landsat-8

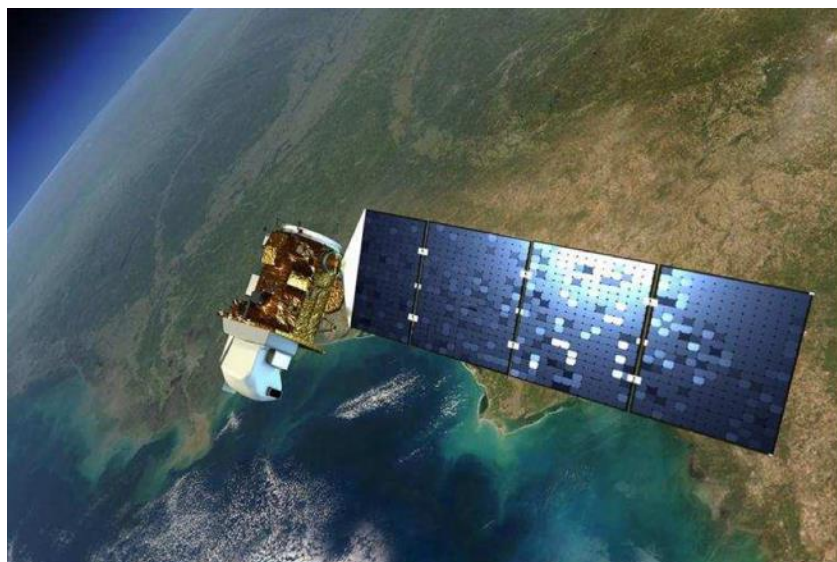


Sentinel-3

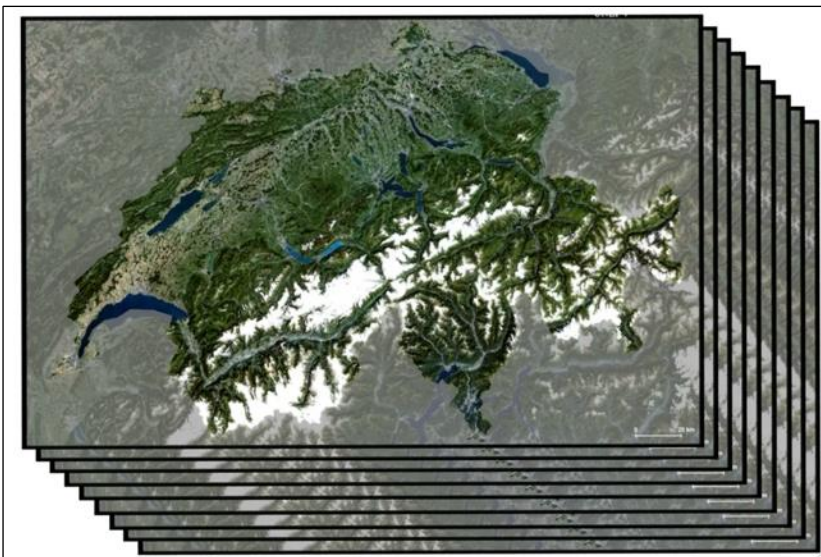


CBERS-4/4A

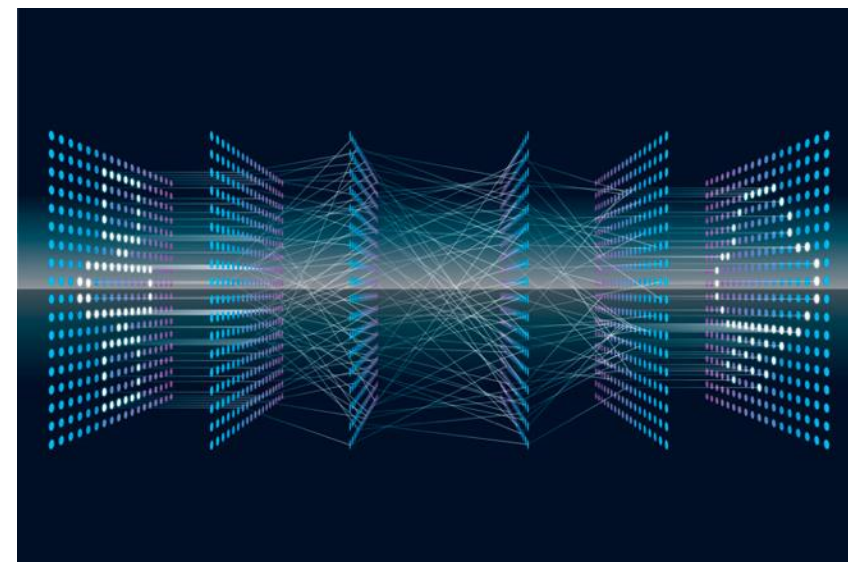
Big EO data for sustainable development



Big satellite data
(2PB per day)



Data in cloud services

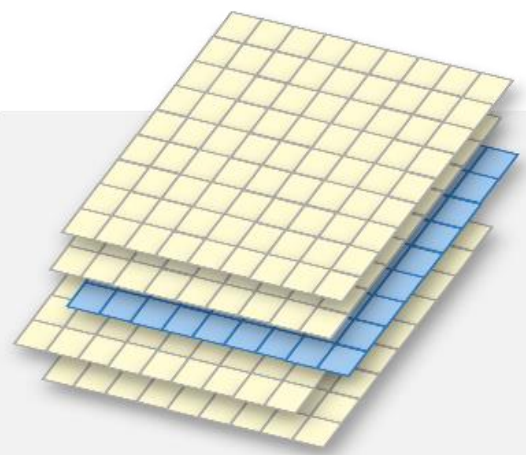


Machine learning
(classification)

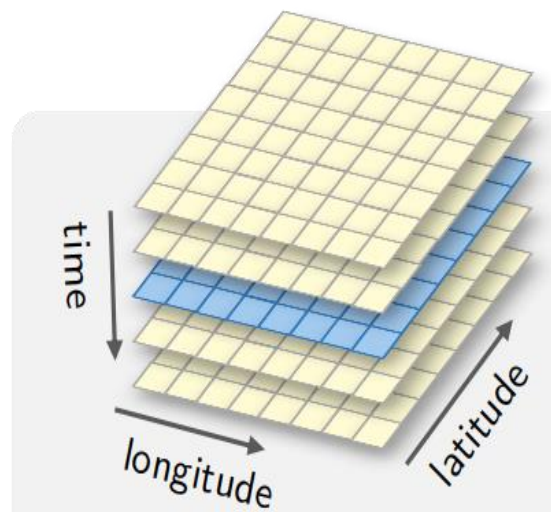


BRAZIL
DATA CUBE

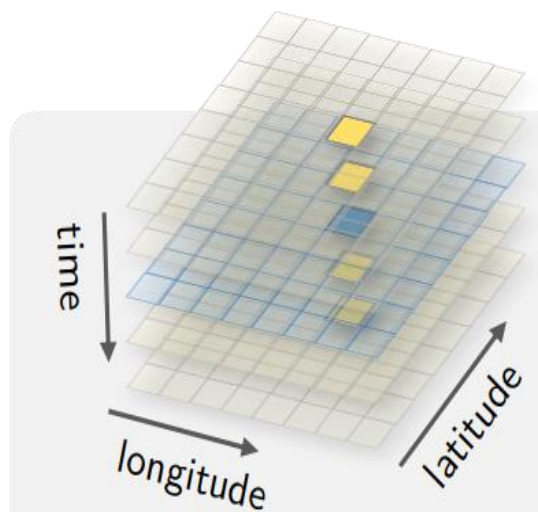
What is an EO data cube?



EO image collection



EO data cube



Time series selection

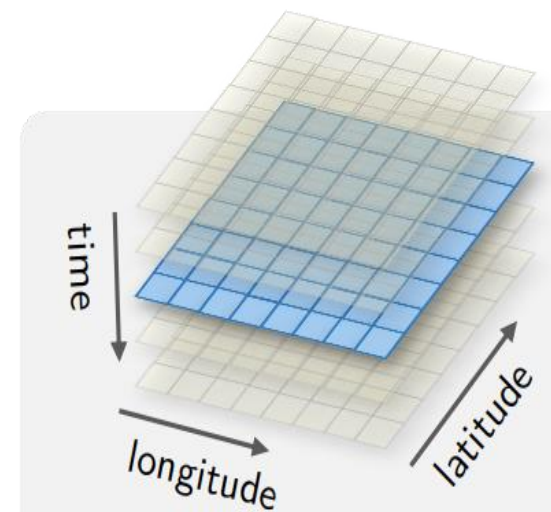
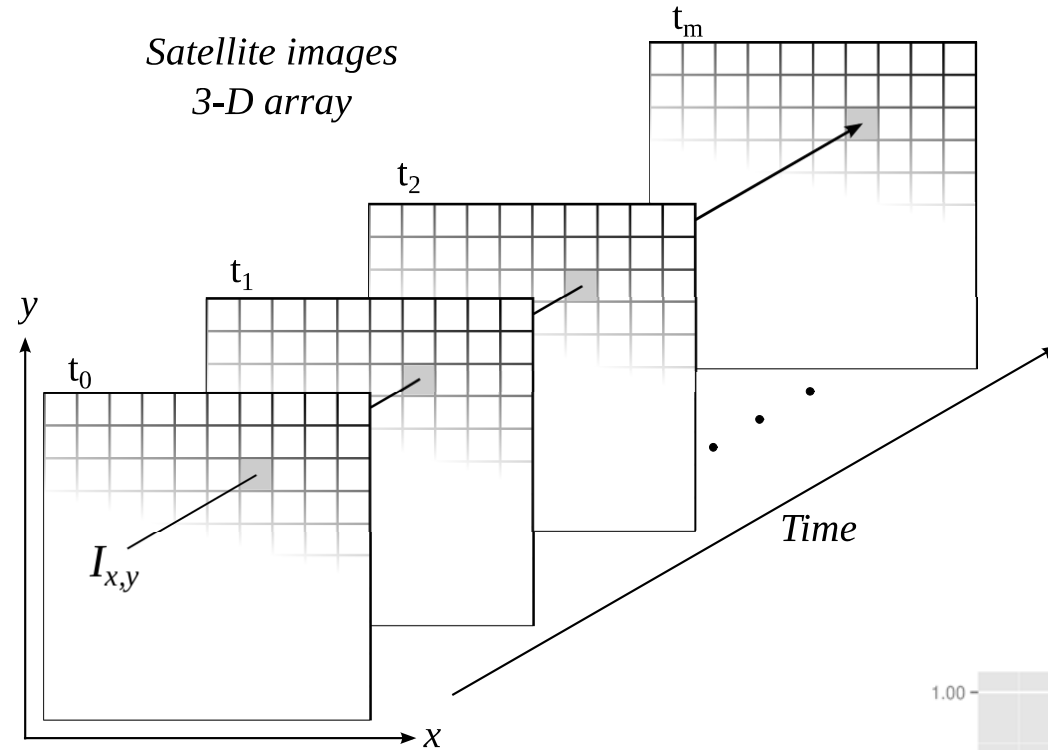


Image selection

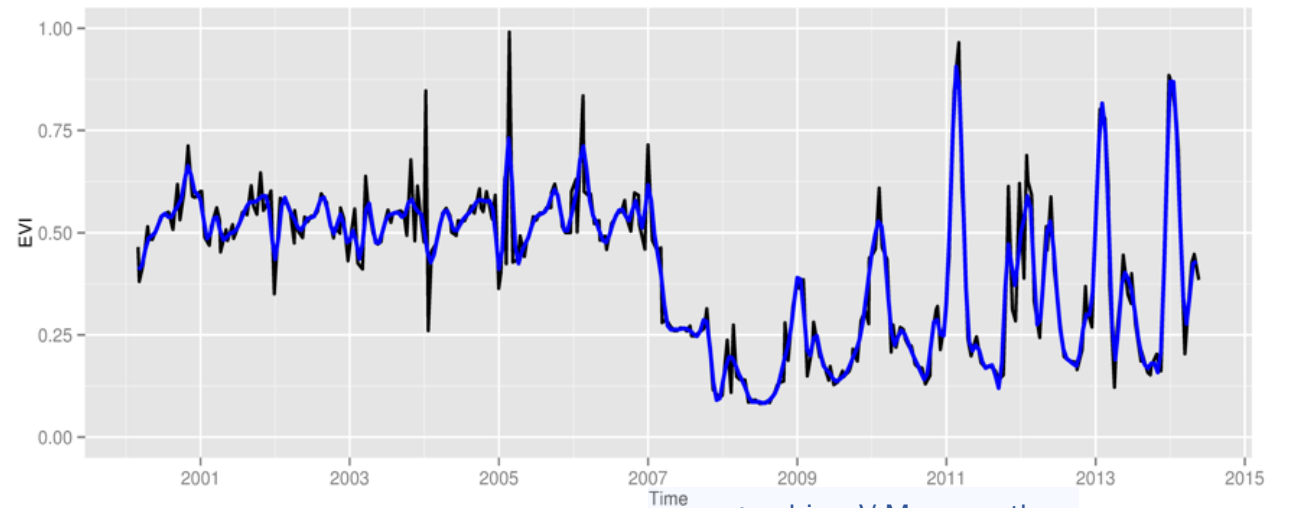
Data cube = regular partitions of space and time

Space first, time later or time first, space later?



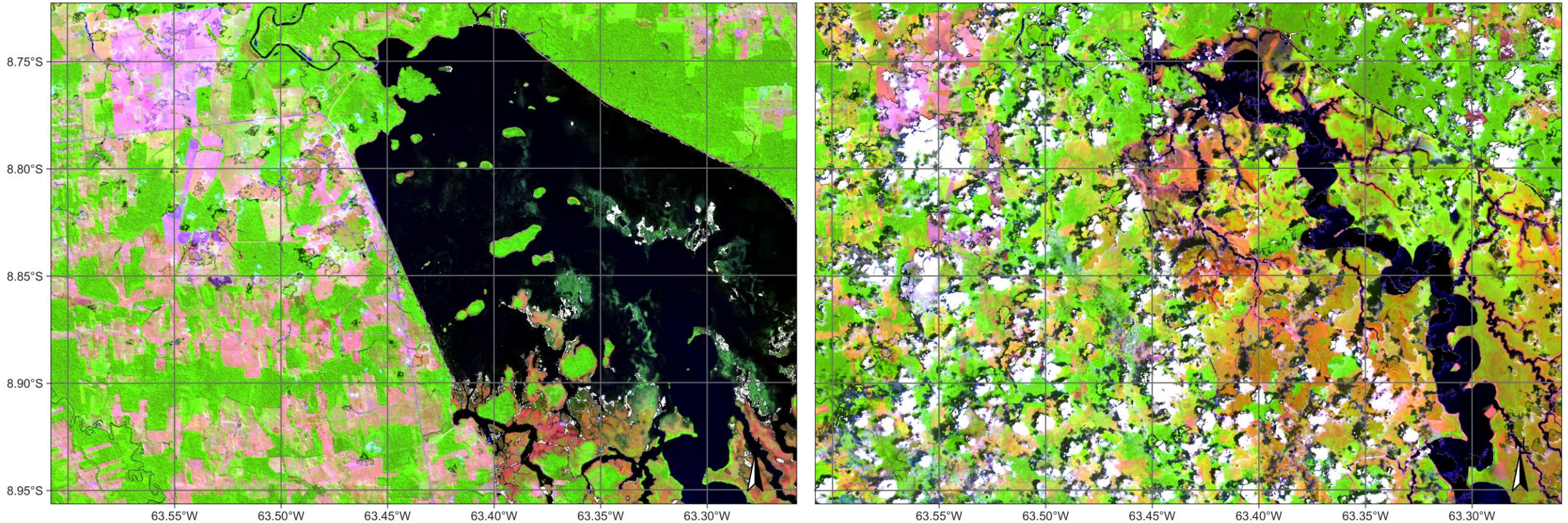
Space first: classify images;
compare results in time

Time first: classify time series;
join results to get maps



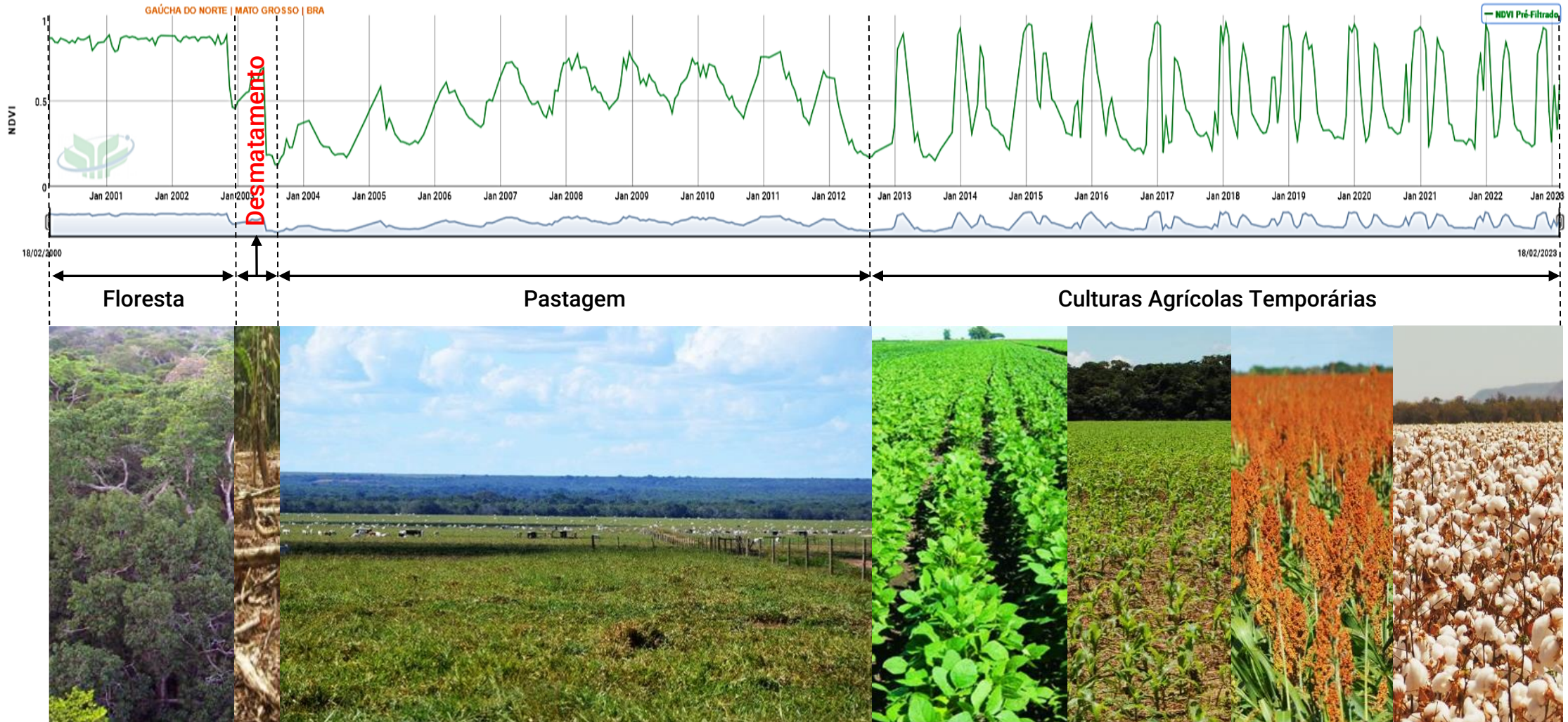
graphics: V Maus, author

What's in an image time series?



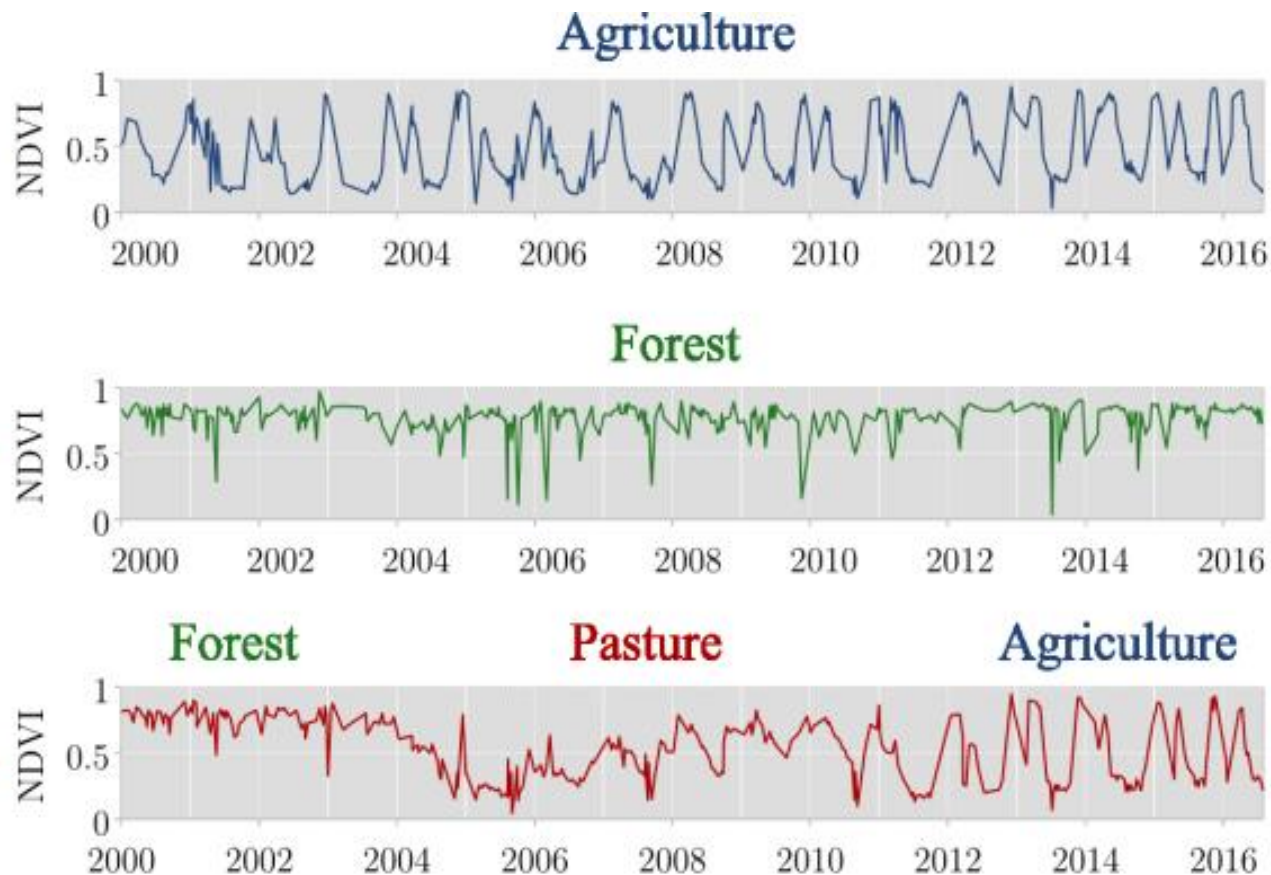
Searching for changes instead of searching for content.
(Camara et al., "What's in an image?", COSIT 2001)

Time Series showing changes



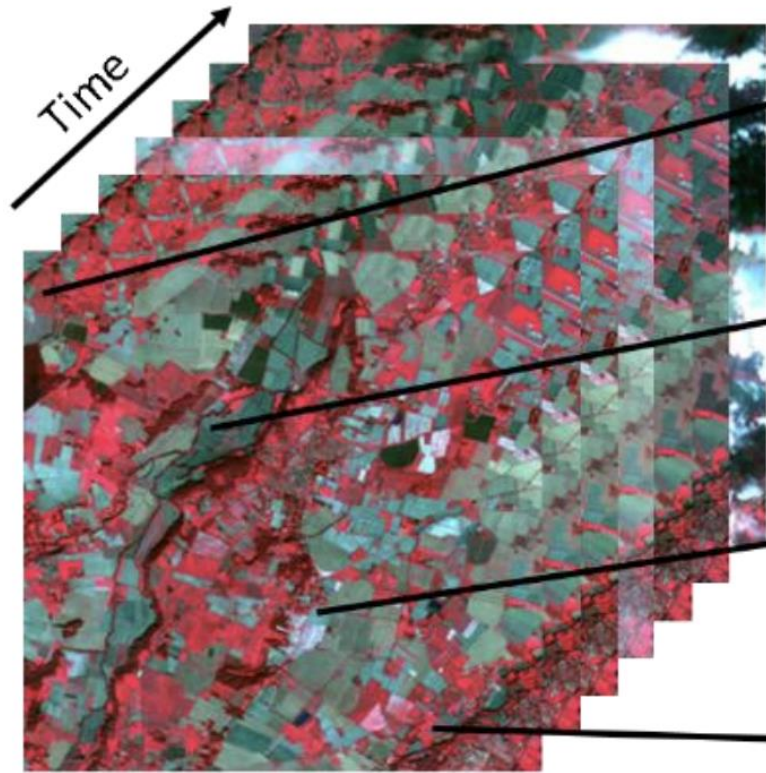


Give users all the data!



Using time series – significant increase in LUCCL accuracy

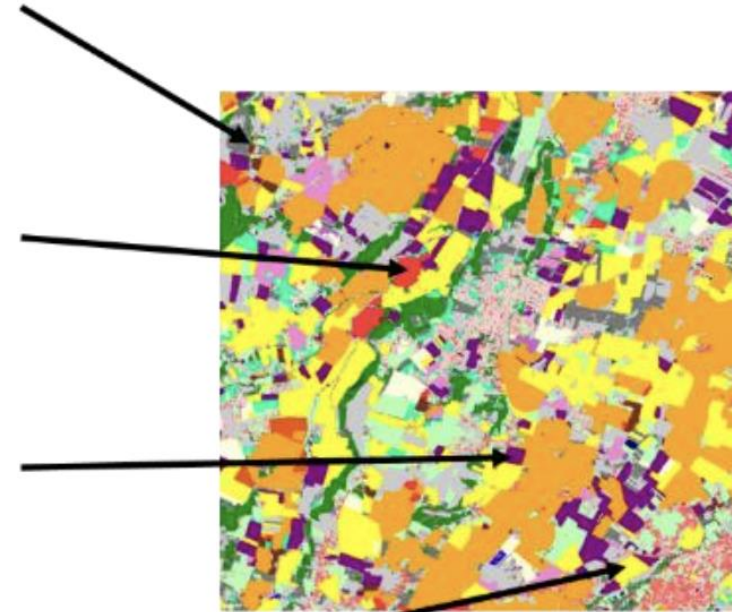
Land classification with image time series



Satellite Image Series



Time Series

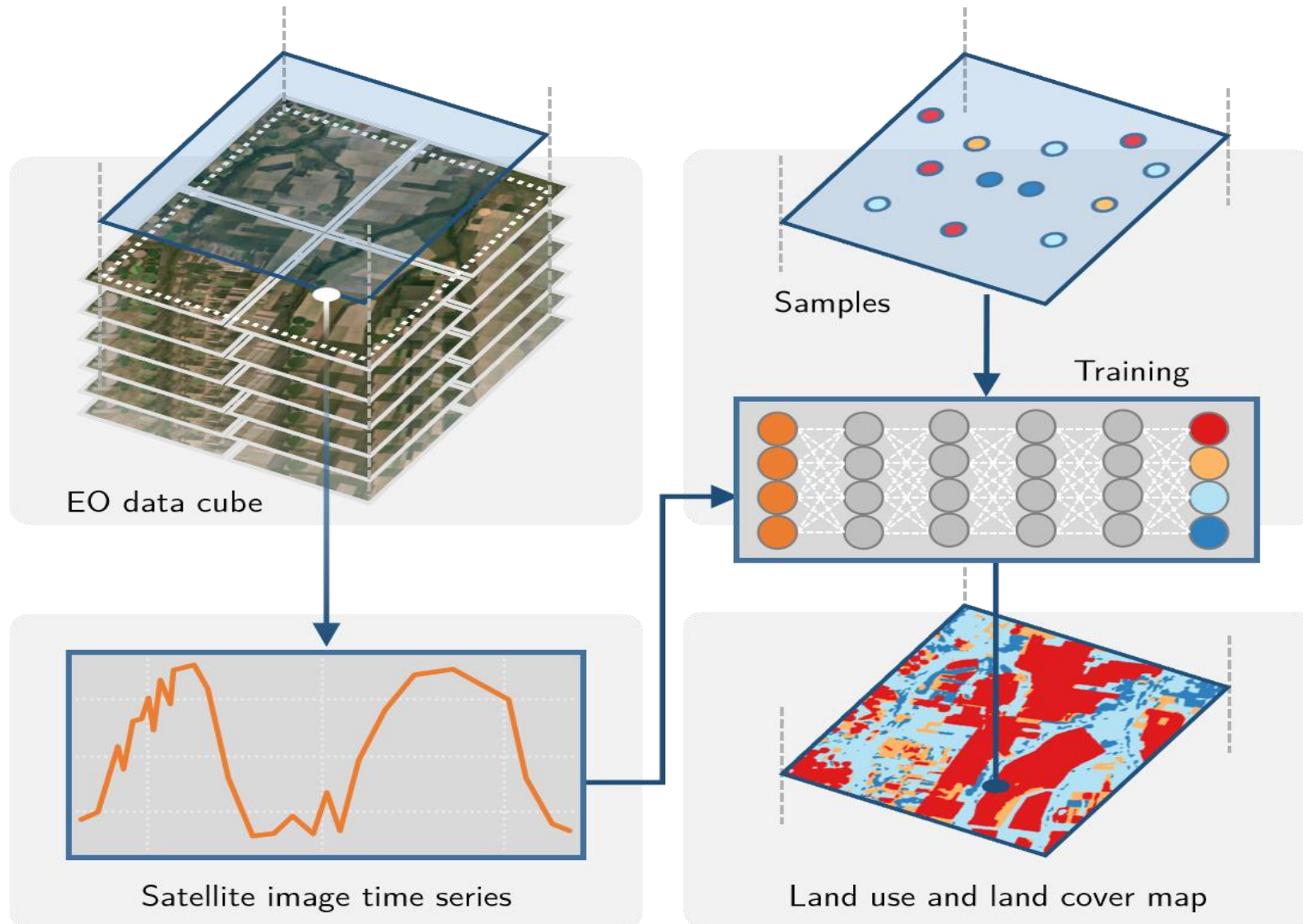


Land Cover Map (Classes)

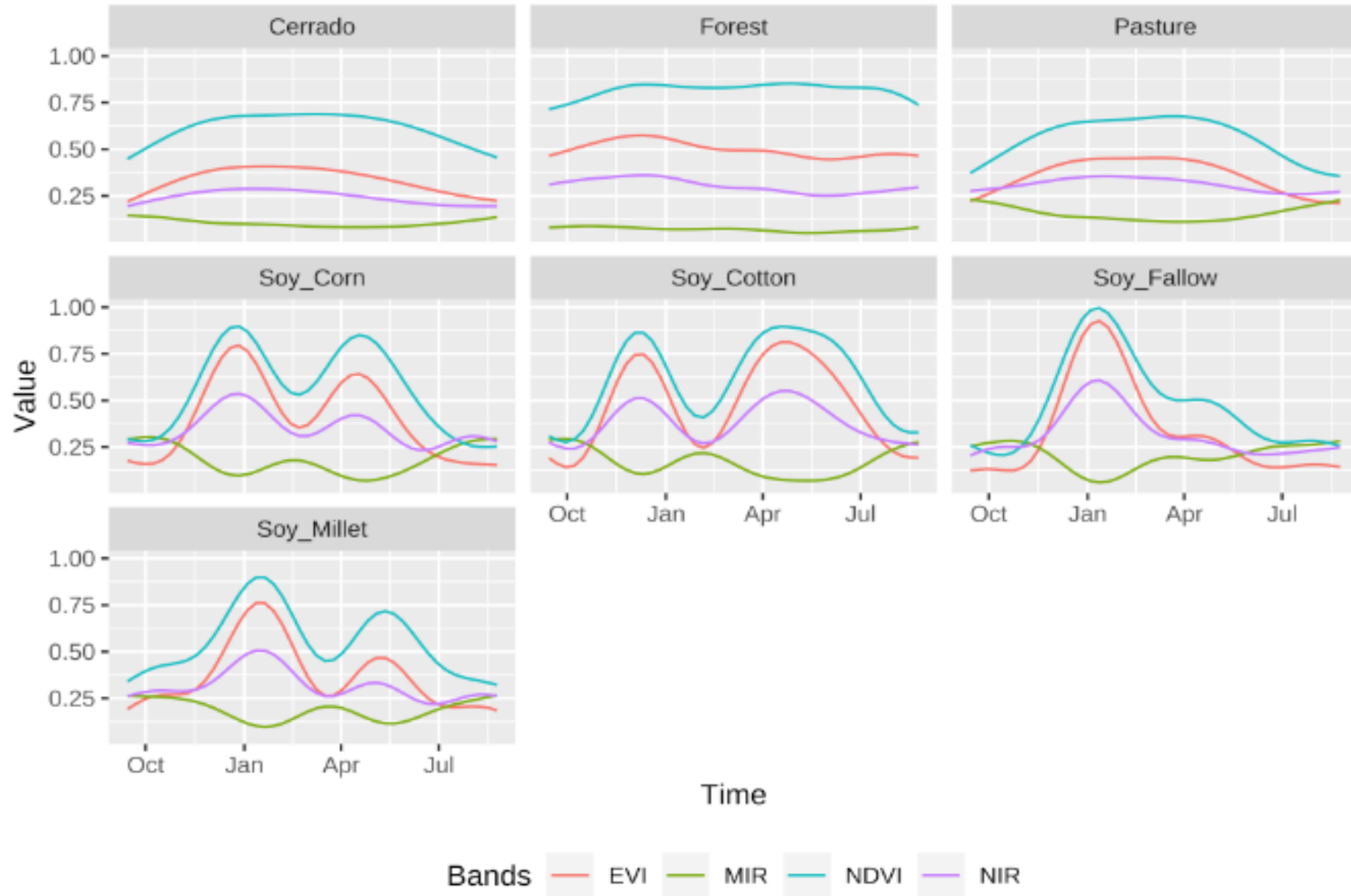
Color	Class
[Orange]	corn
[Light Orange]	corn for silage
[Yellow-Orange]	corn-irrigated corn
[Yellow]	wheat
[Light Yellow]	sunflower
[Light Green]	sorghum
[Green]	sorghum II
[Light Green]	soybean
[Light Green]	barley
[Light Green]	pea
[Light Green]	rape
[Light Green]	broad-leaved tree
[Light Green]	conifer
[Light Green]	poplar tree
[Light Green]	eucalyptus
[Light Blue]	lake
[Light Blue]	water
[Light Blue]	lake
[Light Blue]	gravel pit
[Light Blue]	meadow
[Light Blue]	temporary meadow
[Light Blue]	fallow land
[Light Blue]	wild land
[Light Blue]	high density housing surface
[Light Blue]	specific urban surface
[Light Blue]	low density housing surface
[Light Blue]	mineral surface



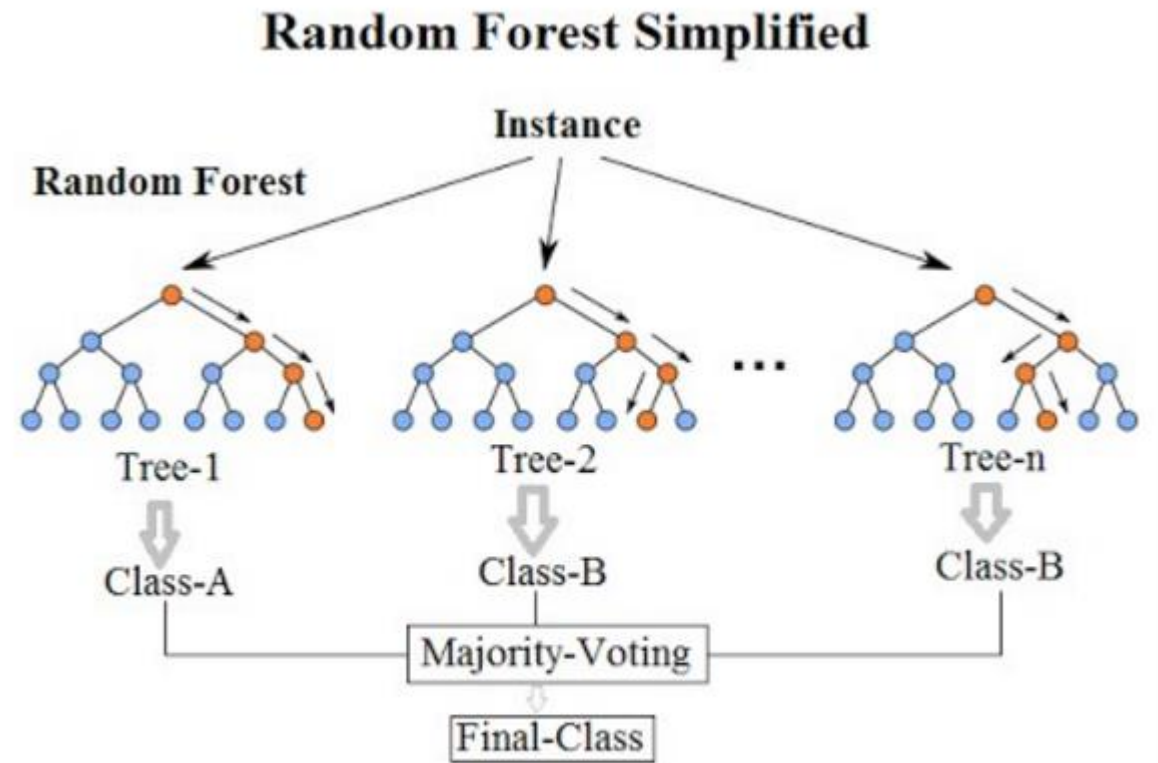
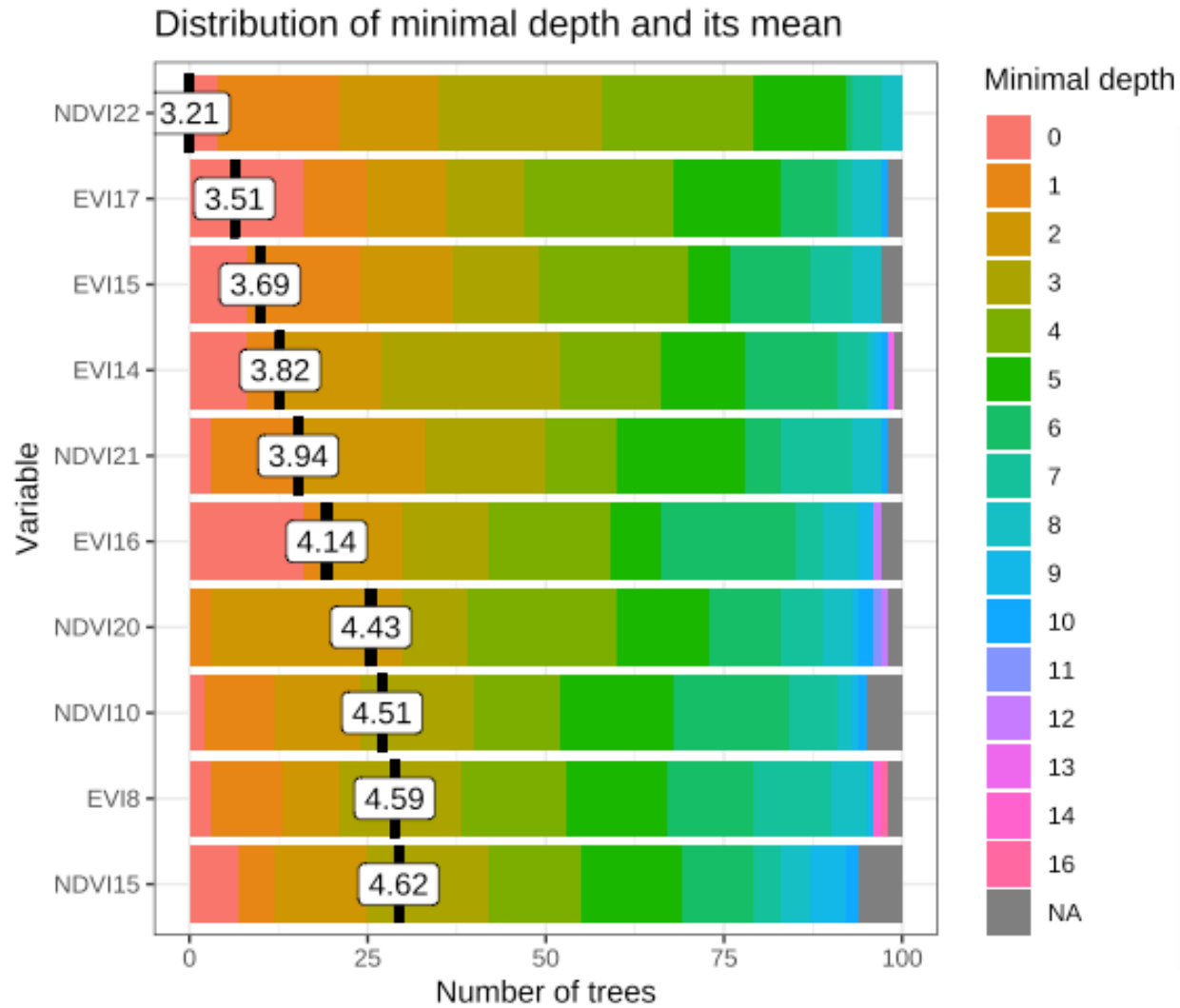
SITS workflow



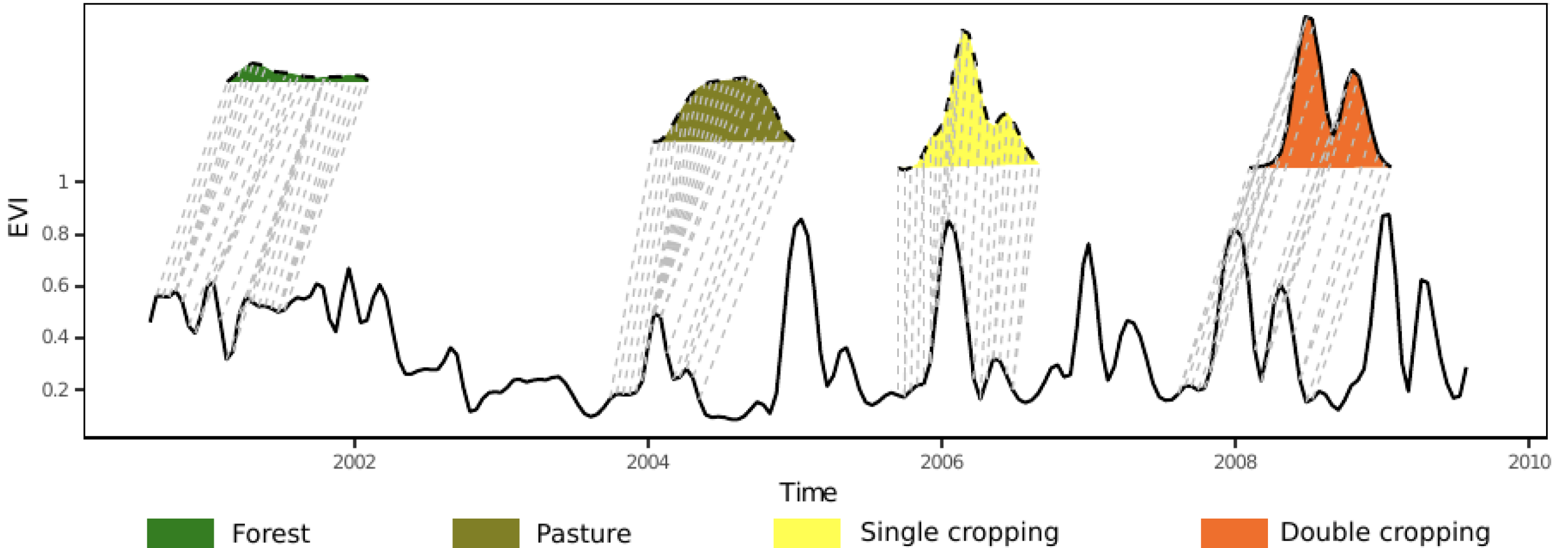
Land cover/land use patterns for Mato Grosso (Brazil)



Random forest method for time series analysis

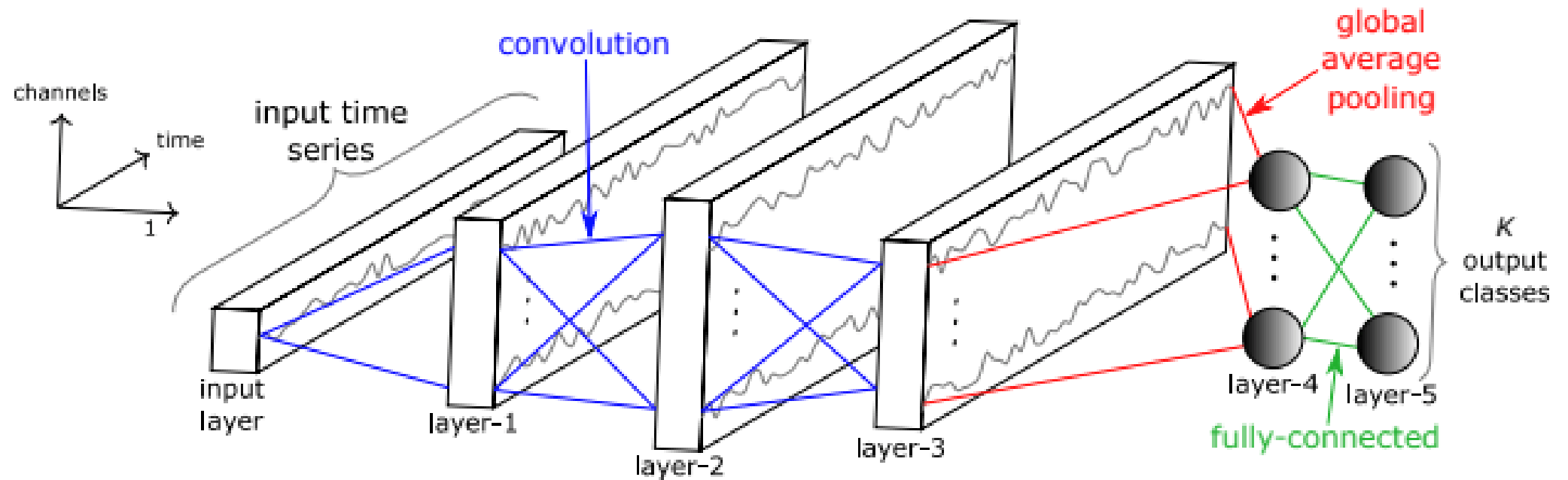


TWTDW method for time series analysis



“A Time-Weighted Dynamic Time Warping Method for Land-Use and Land-Cover Mapping” (Maus, Câmara et al, 2016)
“dtwSat R Package” (Maus et al., 2019)

Temporal Convolutional Neural Network for remote sensing time series classification



TempCNN measures short-term and long-term relations in time series



LULC classification

Cerrado biome (200 million ha)

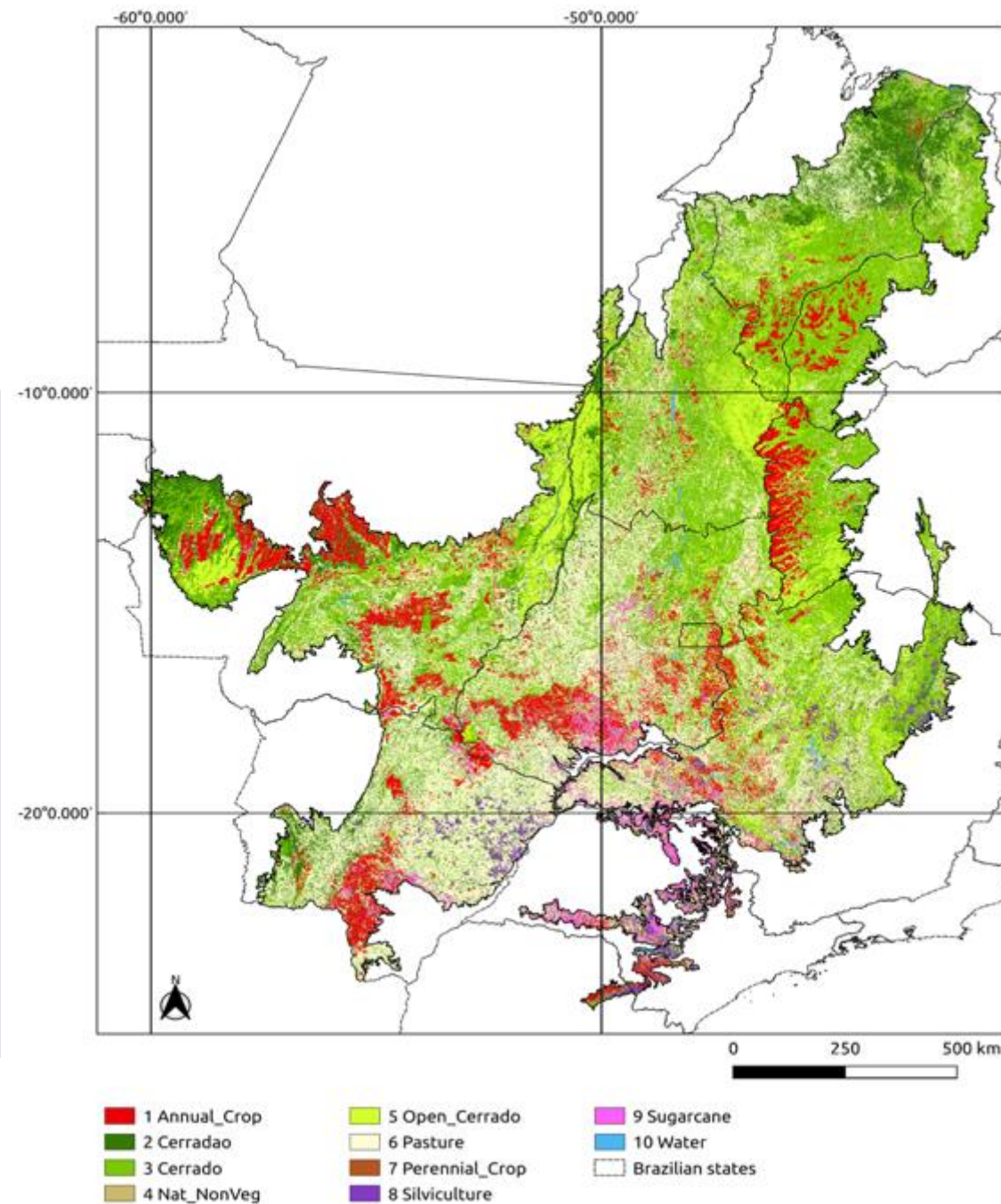
LULC map for year 2018

48,850 samples (TempCNN model)

Landsat-8 16-day time series

8 TB processed in 24 hours

10 LULC classes (86% accuracy)



Natural or man-made landscapes?

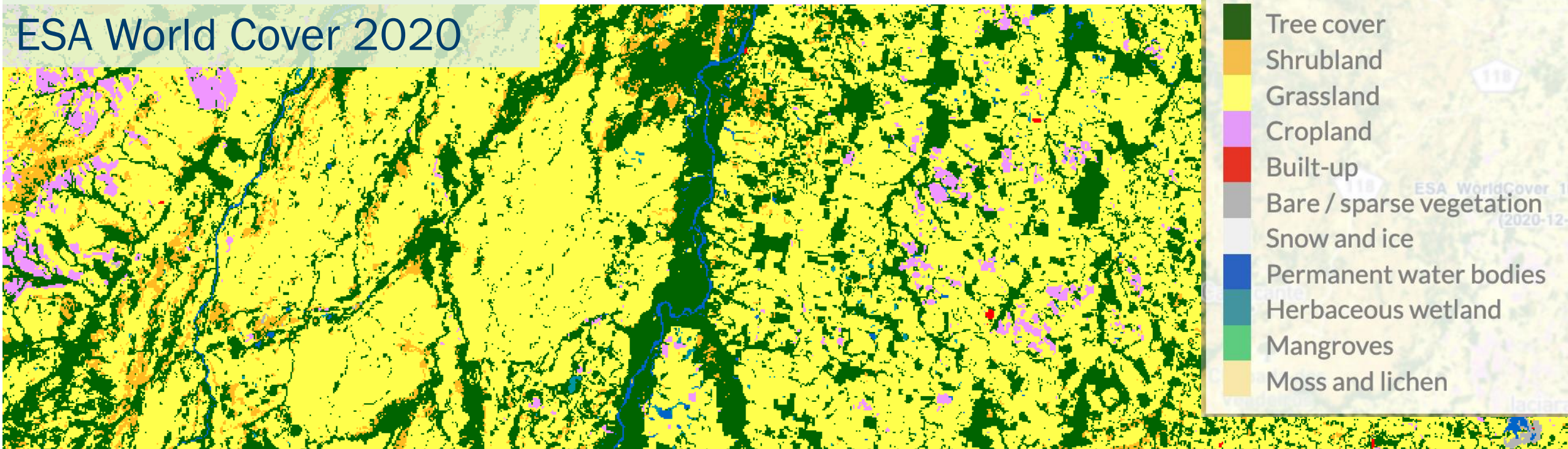


Natural savanna (Brazilian Cerrado)

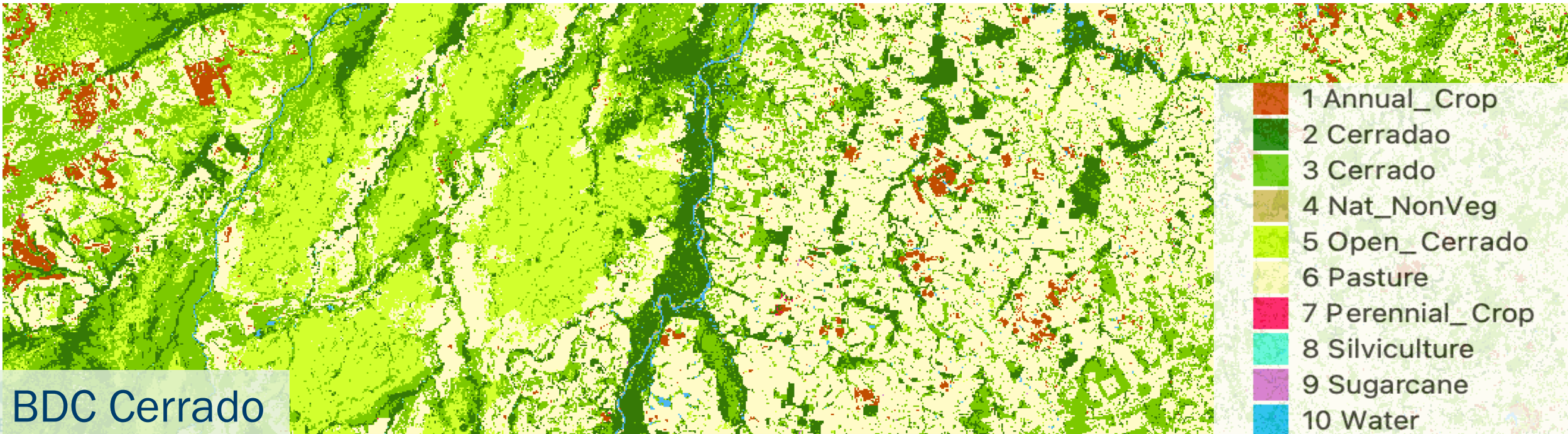


Cattle in pasture (in the Cerrado)

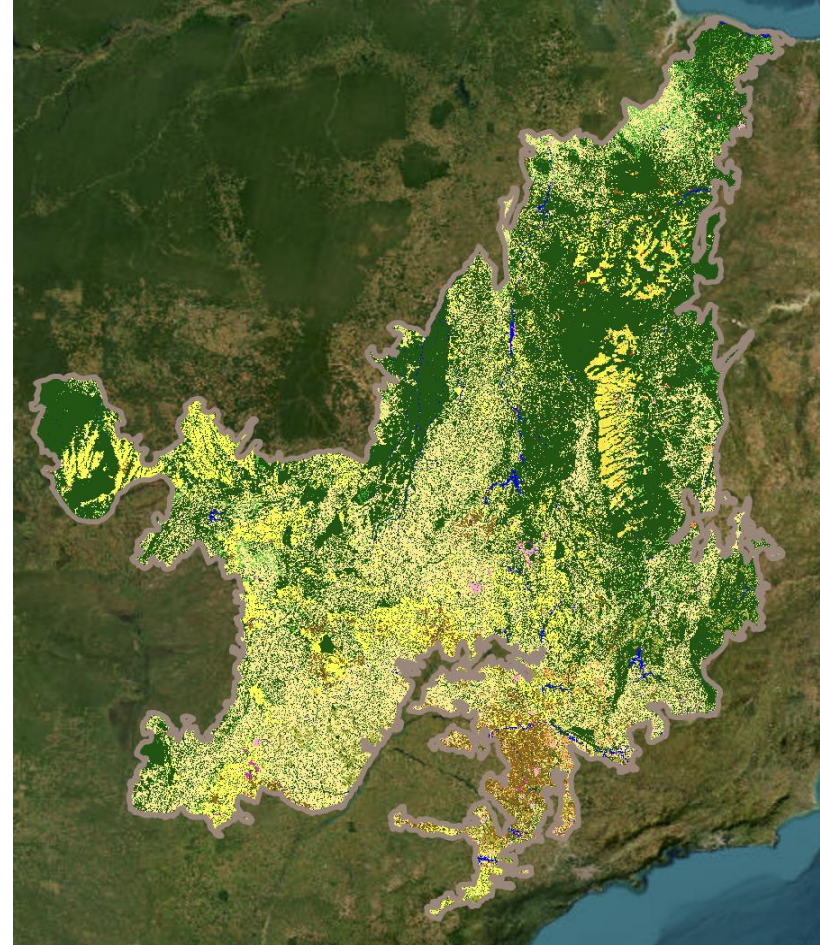
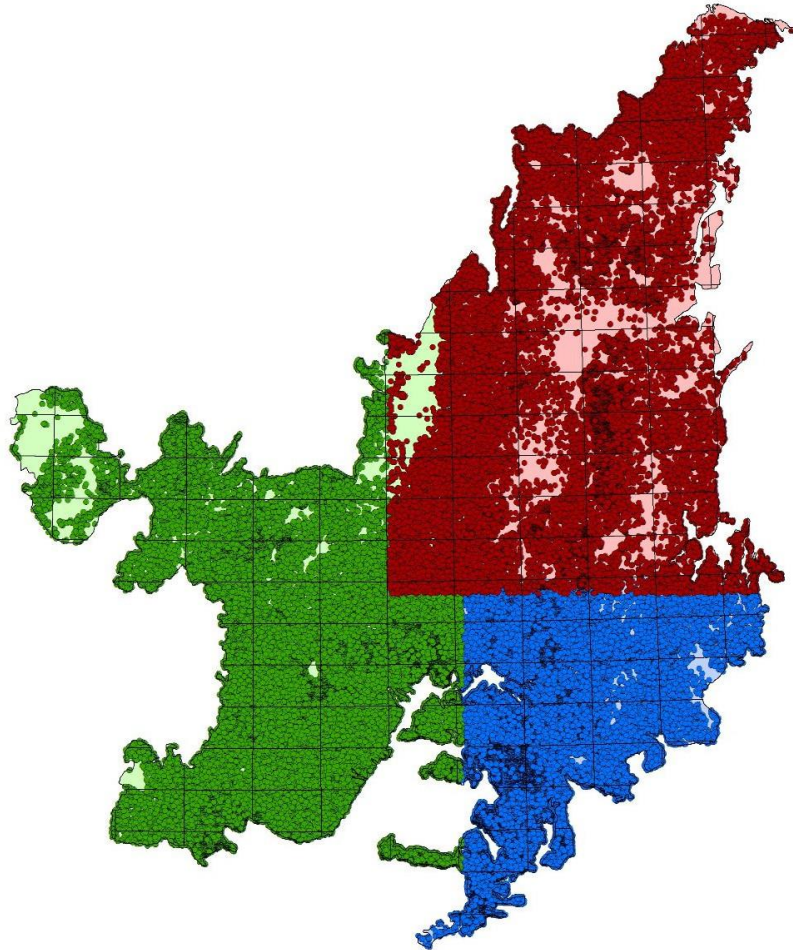
ESA World Cover 2020



BDC Cerrado



TerraClass Cerrado 2022



Sentinel-2, 10bands, 10 meter, 16 days, TempCNN method with 87.500 samples,
Accuracy: more than 91% UA and PA for core classes.

Sentinel-2 (2021)



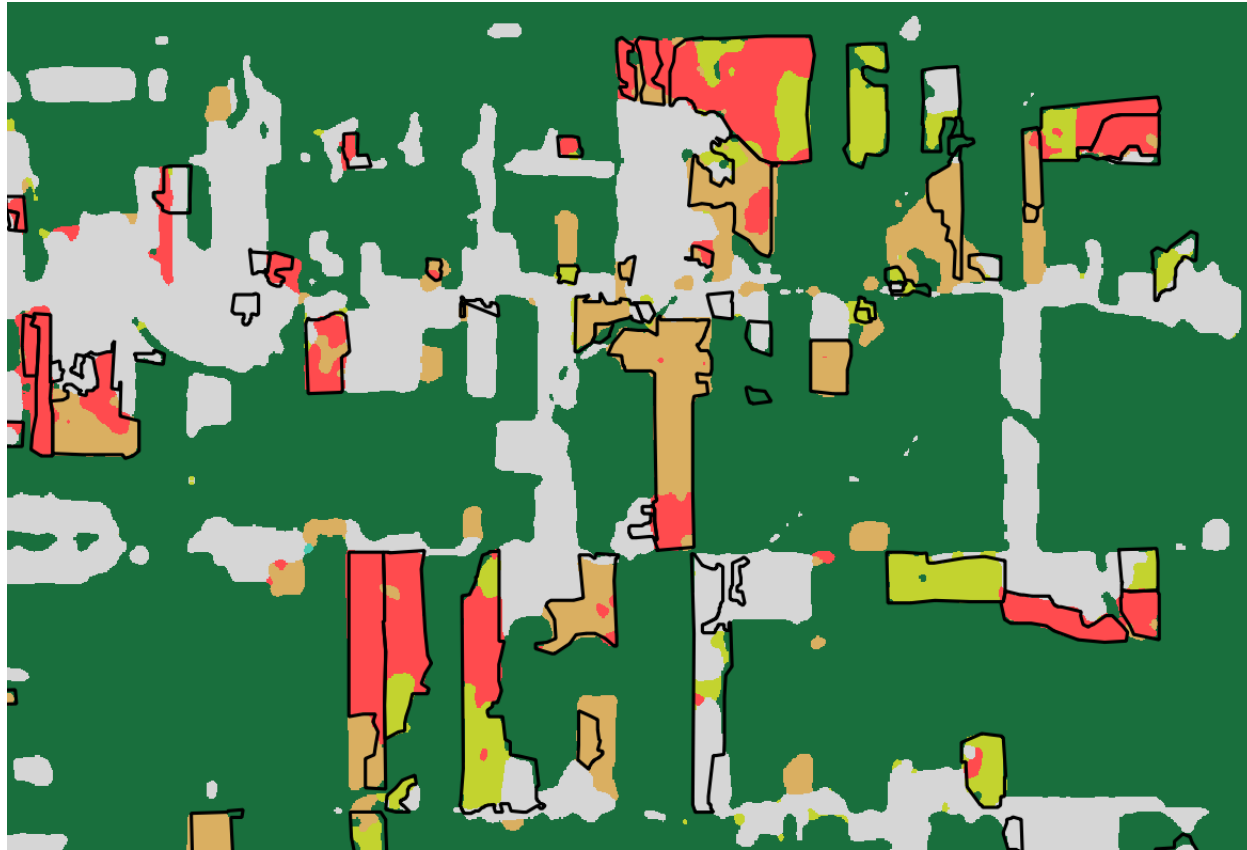
PRODES (2021)



GLAD (2000-2020)



Deforestation mapping: comparing time series analysis with visual interpretation



August/2022

- CorteRaso_SoloExposto
- CorteRaso_Queimada
- Floresta
- CorteRaso_Vegetação
- Água
- Áreas úmidas
- Máscara de desmatamento
- Não Floresta

95% agreement



Accessing image collections with STAC

