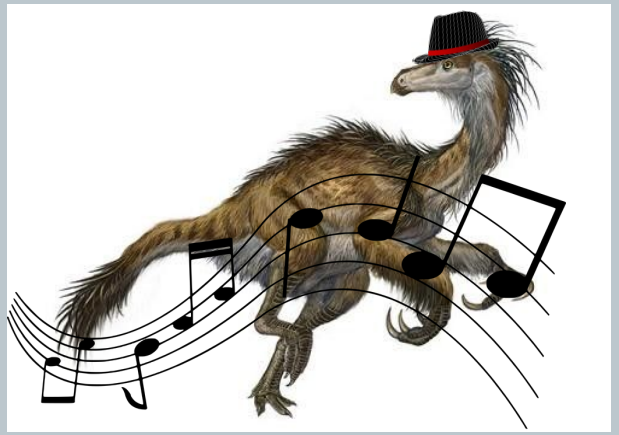
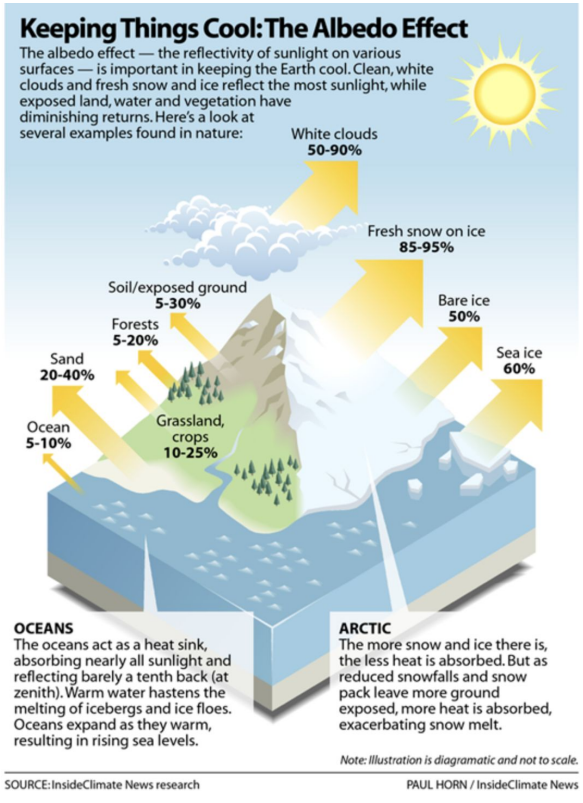
Changes in Land Cover: Albedo and Temperature in Mato Grosso

Beipiaosaurus_Moonwalk_Moderato

Climatematch Academy



Background



What is albedo?

Fraction of the incident radiation reflected
HIGH tendency to absorb radiation → **LOW** albedo

Albedo and climate change

↑ Amount of incident **RADIATION ABSORBED**
Land surface **TEMPERATURE** ↑

Impact of land cover change on albedo

Deforestation → forest cut down → more sunlight is absorbed

In 2018 relative to 2001,
0.00014°C warming of the 100-year mean surface temperature

(Nature communication, 2022, 13(1), 3800; Urban Climate, 2021, 39, 100966)

Land cover change, albedo and temperature

References	Aims	Findings
Munch, Gibson and Palmer (2019)	• **Quantify trends** and relationships between **land cover change** and **surface albedo** in two catchments in Eastern Cape Province, South Africa.	• Grassland changed by woody encroachment and afforestation, had a decrease in albedo. • Urbanisation and cultivation caused an increase in albedo
Houspanossian, Giménez, Jobbágy and Nosetto (2017)	• **Analyze changes** in the **mean annual albedo** in El Chaco region (tropical dry forest) from MODIS imagery (2000–2012) and its relation with the dominant **land use** trajectories. • Quantify the associated radiation budget change.	• Deforestation accounted for 83% of the regional albedo increase observed in Chaco, while Land Use and Land Management changes explain the rest. • Albedo raises increased the mean annual outgoing shortwave energy flux at the top of the atmosphere producing a cooling effect (from –8 W/m2 to –17 W/m2).
Sud, Lau, Walker, Kim, Liston and Sellers (1996)	• Compute a 3-year (1979–1982) simulation of the usual Simple Biosphere Model (SiB) **vegetation cover** and a scenario where all **tropical rainforests are replaced by grassland**. • Compare the simulation results.	• Deforestation decreases evapotranspiration and increases land surface outgoing longwave radiation and sensible heat flux. This warms up and dries the PBL. • This happens despite the reduced absorption of solar radiation due to higher surface albedo.

Aims:

- Examine how **land cover, albedo,** and **temperature** has changed in the period between 2001-2015 for Mato Grosso
- Determine if a **correlation** exists between **albedo and temperature**

Hypotheses:

Changes in land cover in Mato Grosso, specifically the replacement of native forest by agricultural areas, will result in an **increase in albedo** correlating to **decreases in land surface temperature** due to higher reflectance.

Why Mato Grosso?

Photo by Vergueiro, M. (2020)

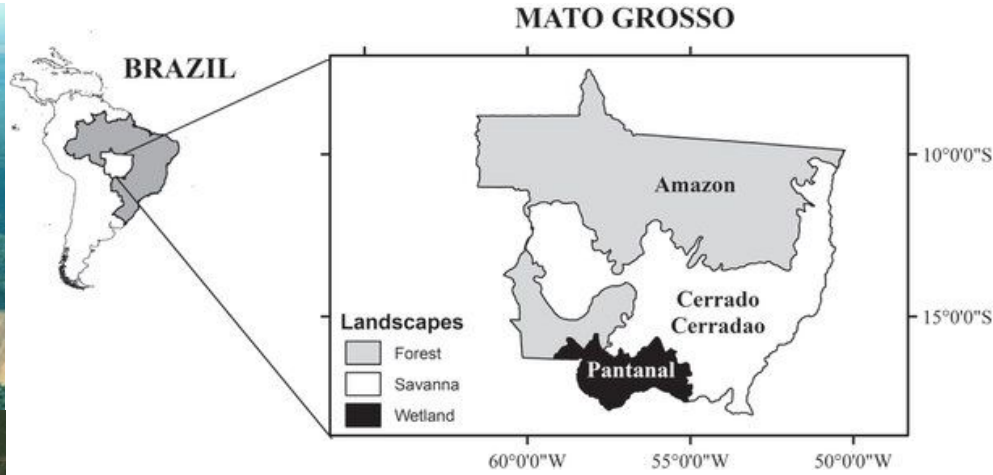


Figure from Lathuillière, Johnson, Galford and Couto (2014)

- Top soybean grower in Brazil
- **1180 km2 of tropical forest** in Mato Grosso cut down between 2009 - 2019 to expand crops and pasture land.
- In 2010, Mato Grosso had **50.7Mha of natural forest**, extending **OVER 56% of its land area**. In 2022, it lost 545kha of natural forest, equivalent to **323Mt of CO_2 emissions**. (source: Global Forest Watch)

Method/Analyses

Datasets

ERA5-Land:

- Spatial resolution of 9km
- Enhanced resolution compared to ERA5
- Contains Albedo and Temperature datasets

GLASS:

- Spatial resolution of 1 km
- Fractional green vegetation cover and land surface temperatures were accessed.

CMIP6

- Spatial resolution: 1.25°x 2.5°
- Modelled data
- Contains Albedo and Temperature datasets

Annual Average for each variable

period 2001 to 2015

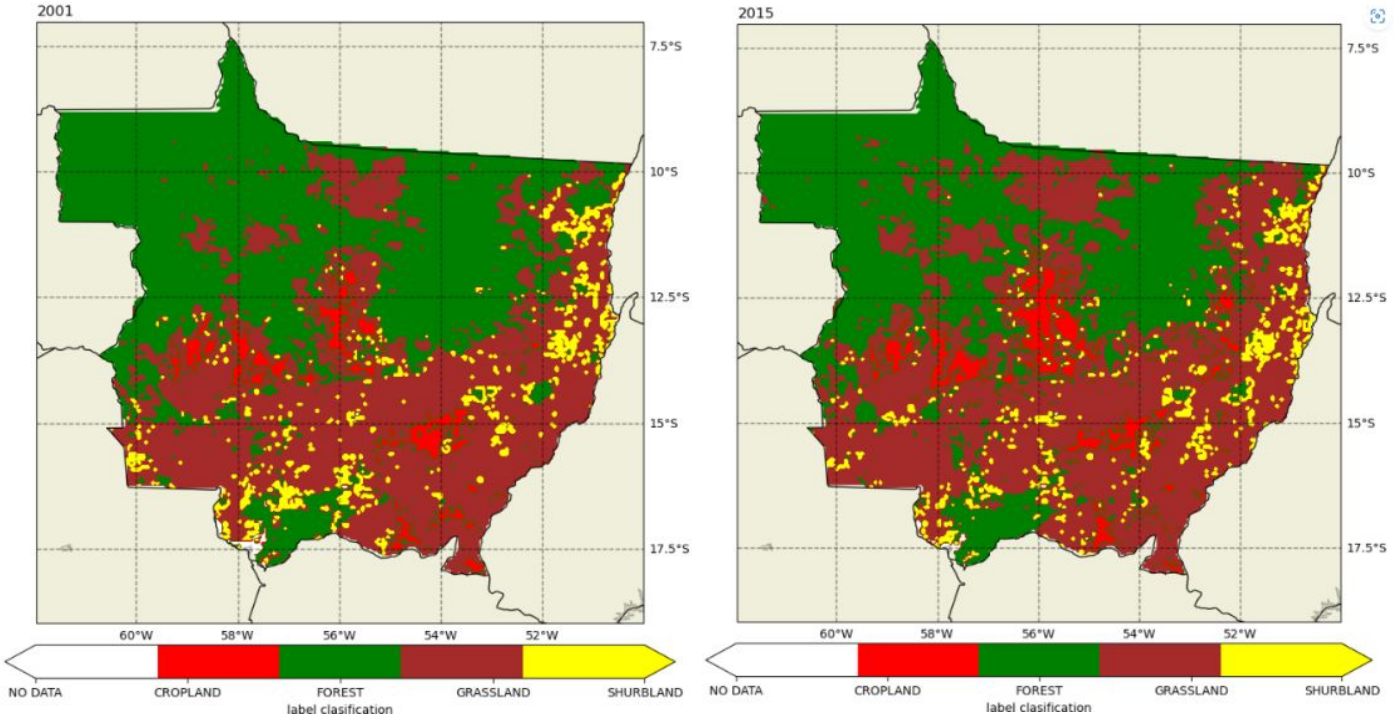
period 2001-2014

Plot the maps

Run linear regression

Results

Land cover change:

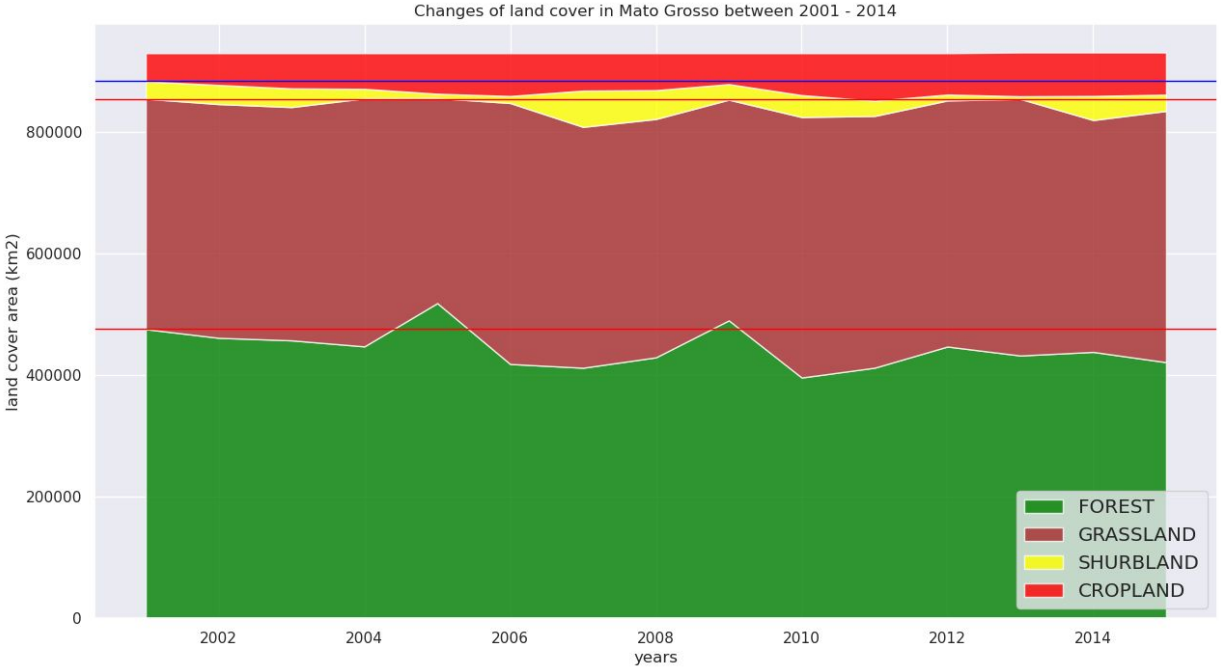


Data Source: GLASS

Area of Mato Grasso:
903,357 km2

Results

Land cover change:



Data Source: GLASS

Inferences:
Mato Grosso lost **54,350 km2** of forest and increased **23,075 km2** of cropland for plantations

In percentages, mato grosso lost **11%** of forest in 15 years (between 2001 - 2015)

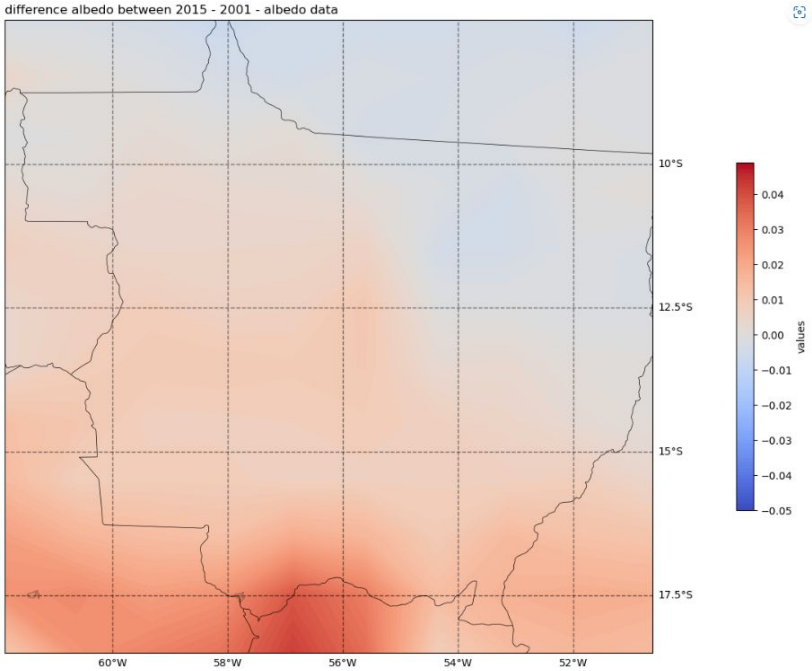
Grassland **9%** increase in land cover

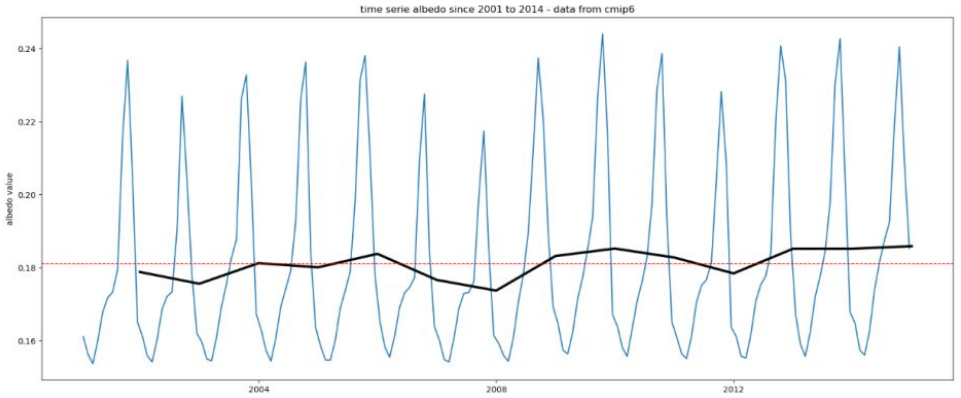
Cropland area **50%** increase in land cover !!!!

Albedo classification (Myhre G., 2002)
cropland: 0.15 - 0.25
grassland 0.15 - 0.25
tropical forest: 0.1 - 0.2

Results - CMIP6

Difference in **Albedo** change between 2001 and 2014

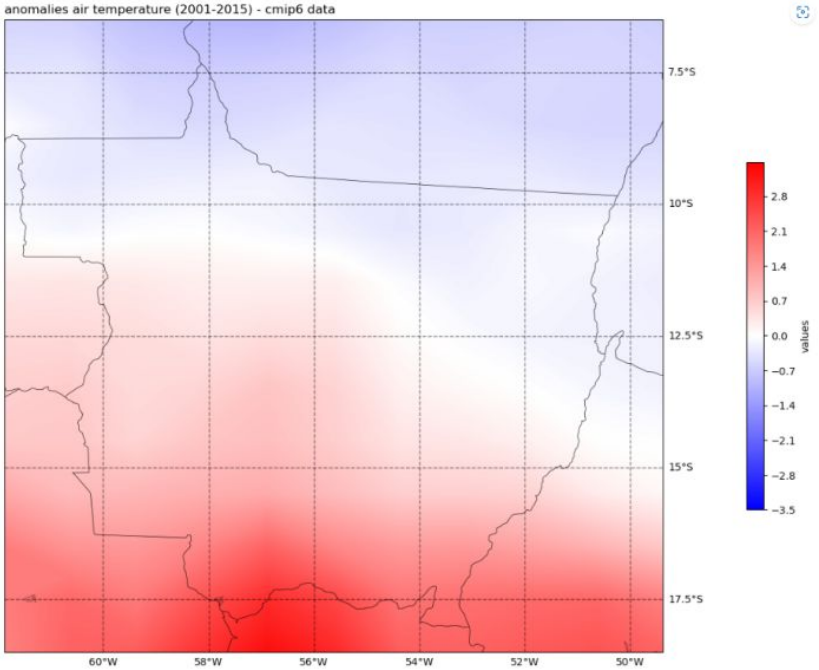


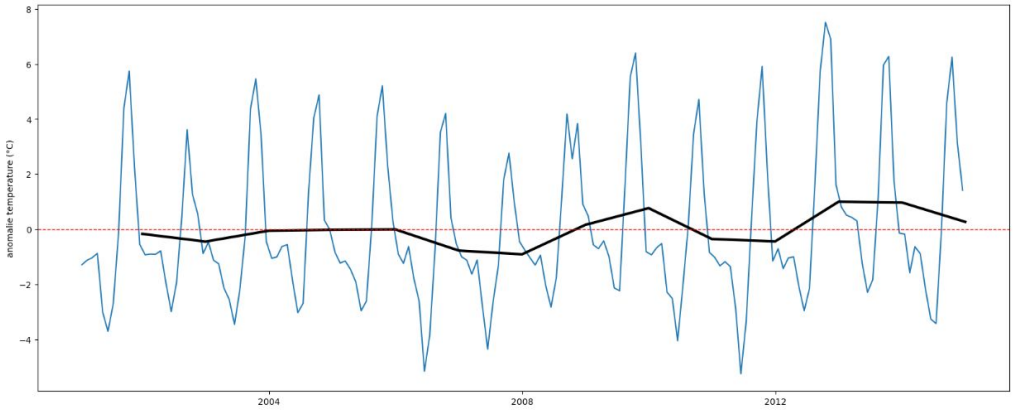


Data Source: CMIP6
Inference: There is a tendency of increased albedo in south site which can be related to land use change. Overall in Mato Grosso there is a **marginal increase** in **Albedo** over the years.
Limitation: Only monthly data available from 2001 to 2014

Results

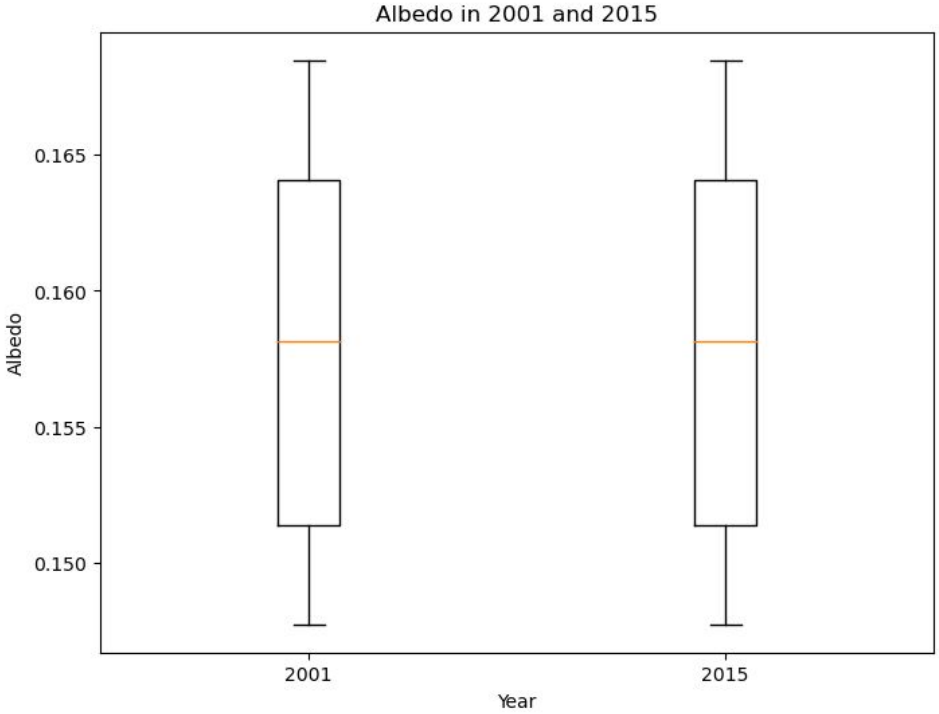
Anomalies in **Air Temperature** from 2001 to 2015



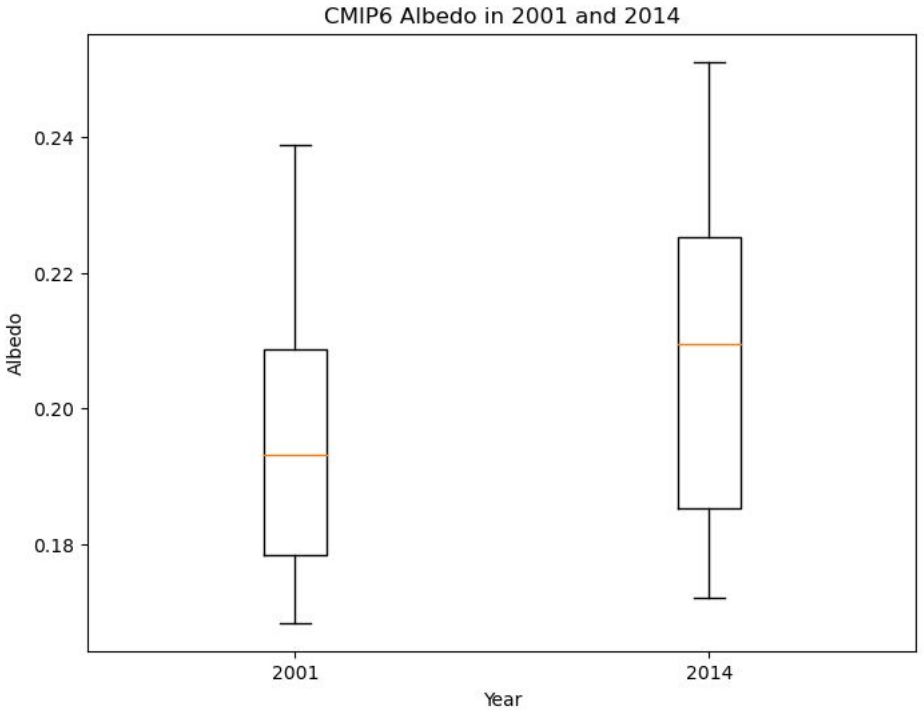


Data Source: CMIP6
Inference: Although there is an increase in albedo, there is also an **increase in temperature** from 2001 to 2015, especially in the south where the land cover is changed to grassland.
Limitation: Only monthly data available from 2001 to 2014

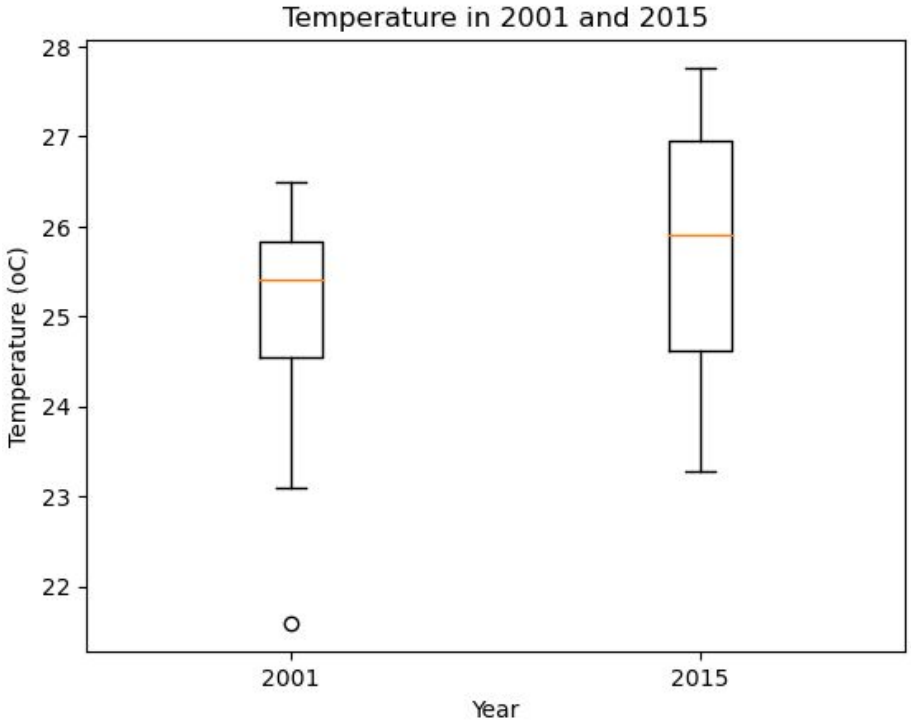
Results - ERA5 vs CMIP6 (Albedo)

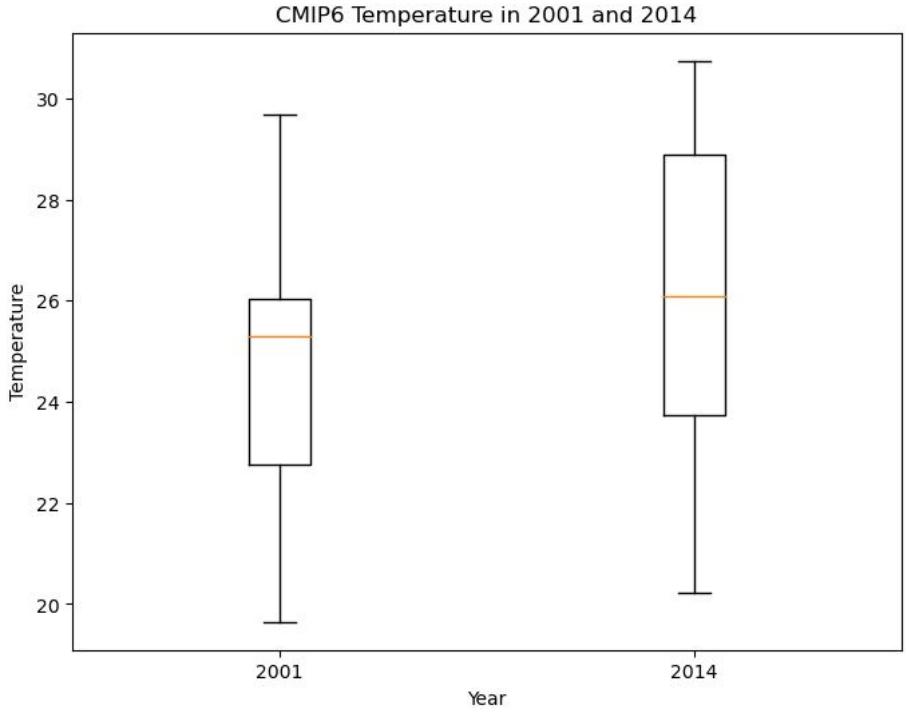


T-statistic: 0.348635857774221
P-value: 0.7339440826632204



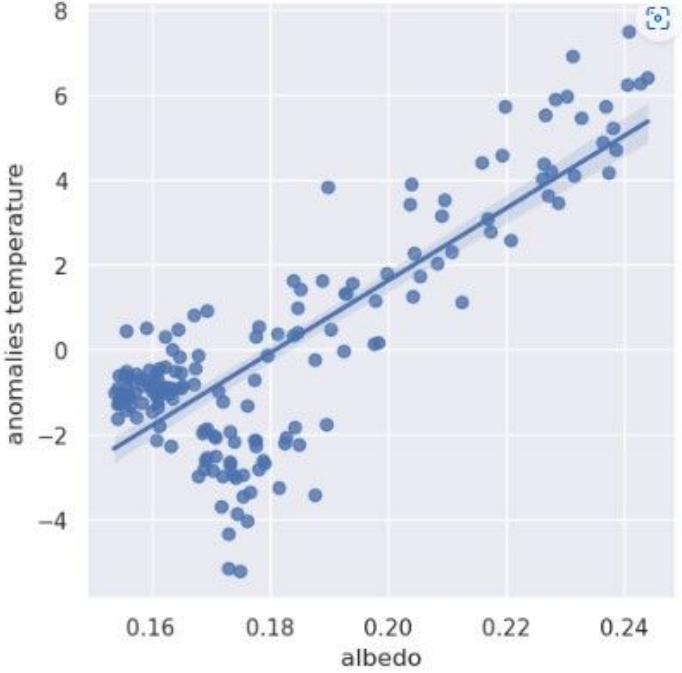
Results - ERA5 vs CMIP6 (Temperature)





Results

Positive correlation between albedo and temperature




```
Pearson's correlation coefficient: 0.8110223386186077
p-value: 1.7006276425246943e-40
Slope: 85.36722750061246
Intercept: -15.464230895552044
R-value: 0.6577572337383956
Standard error: 1.5571108
```

Data Source: CMIP6

Inference: There is a very **strong positive correlation between in albedo and temperature**. However, in theory increase in albedo should reflect in a decrease in temperature. This means that there are other climatic phenomenon that are causing the increase in temperature

Conclusion

- In 15 years, Mato Grosso lost **11%** of Forest, Grassland increased in **9%** and Cropland increased in **50%**.
- Positive anomalies detected in south side of Mato Grosso due to deforestation and land cover change.
- The increase of albedo in Mato Grosso tell us that the tropical forest is reducing. Air temperature is increasing because there is less tropical forest cover (which acts as an energy absorber and temperature mitigator in amazonia).

Deforestation is accelerating in Brazil - CNN

“The global community needs innovative, collaborative solutions – such as the jurisdictional approach – to reduce deforestation at scale. The jurisdictional approach encourages companies, government, and local stakeholders to work together to reduce deforestation and create sustainable development at scale” - UNEP

Next steps?

- Extend the period of time and validate our data

- Quantify land-use and land-cover change (LULCC) using better metrics and statistics

- Expand research scope to include GPP and NPP

- Further examine relationships between variables through modelling (e.g. if temperature and albedo is more of a curve than linear)

- Project into the future using models and determine land use changes for Mato Grosso and wider Amazonian basin