A regional view of the linkages between hydro-climatic changes and deforestation in the Southern Amazon

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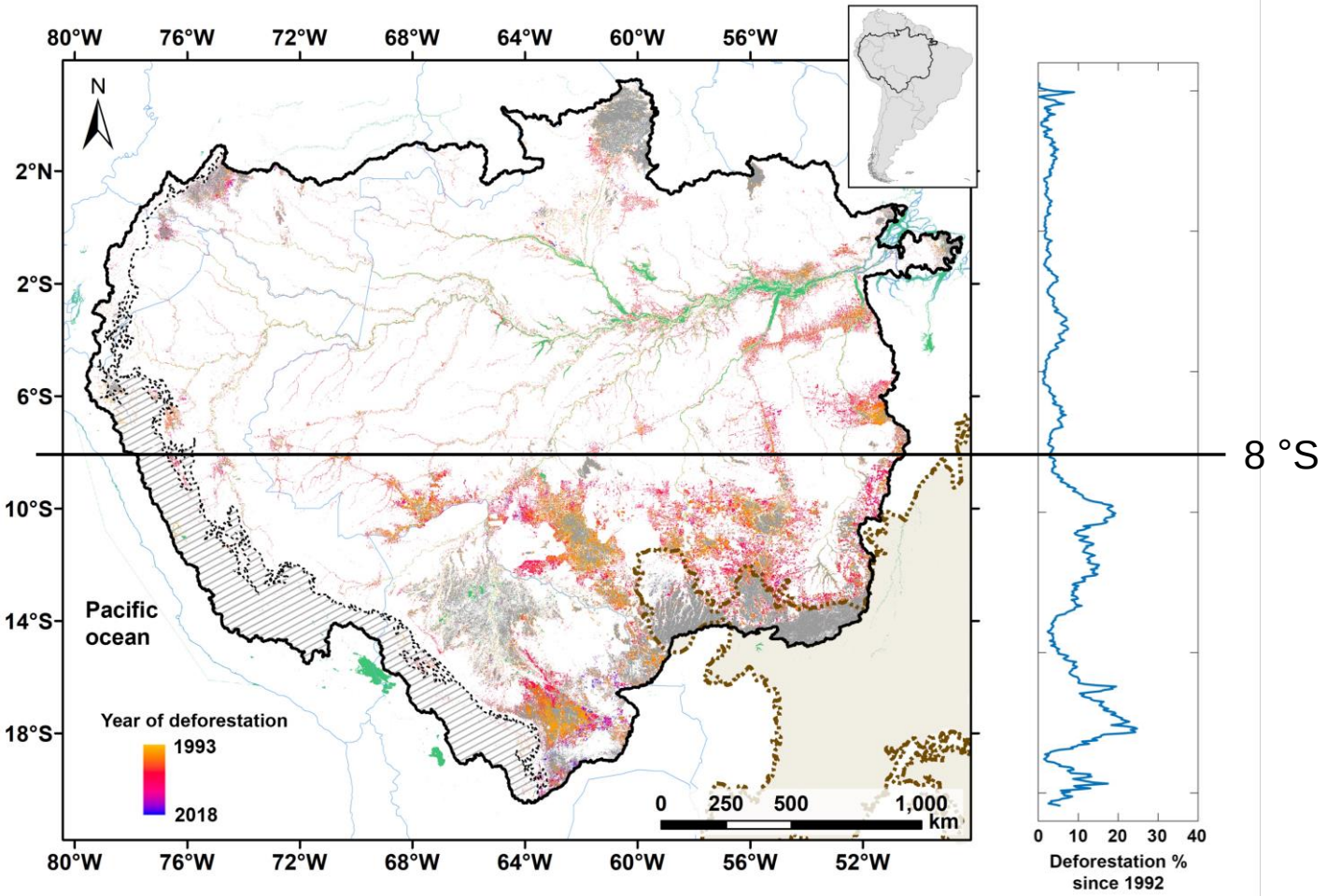
Introduction and context

- Large evidences support the **coupling** between **forest lost** and changes in different components of the **hydrological cycle** (Lawrence and Vandecar 2015; Zemp et al. 2017). Most have limited in space focused in the Amazon Brazilian arc of deforestation.
- The possible **transition of the forest** (tipping point) (Nobre et al. 2009, 2016; Lovejoy and Nobre, 2018) has been mainly studied on a **large scale** and through **hypothetical scenarios of deforestation**.

Scientific question:

Are these relationship between deforestation and hydroclimatology relevant from **local** to **regional** scale?



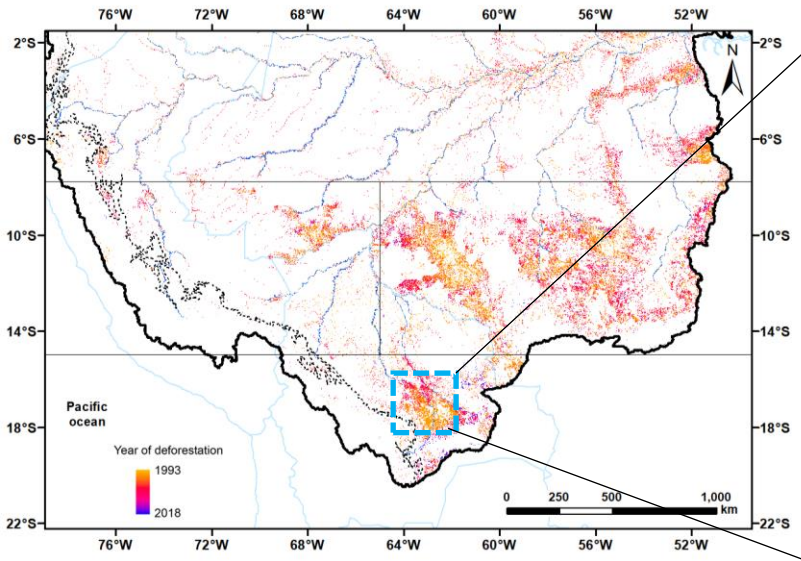
Southern Amazon (south to 8°S) constitutes a peculiar region due to:

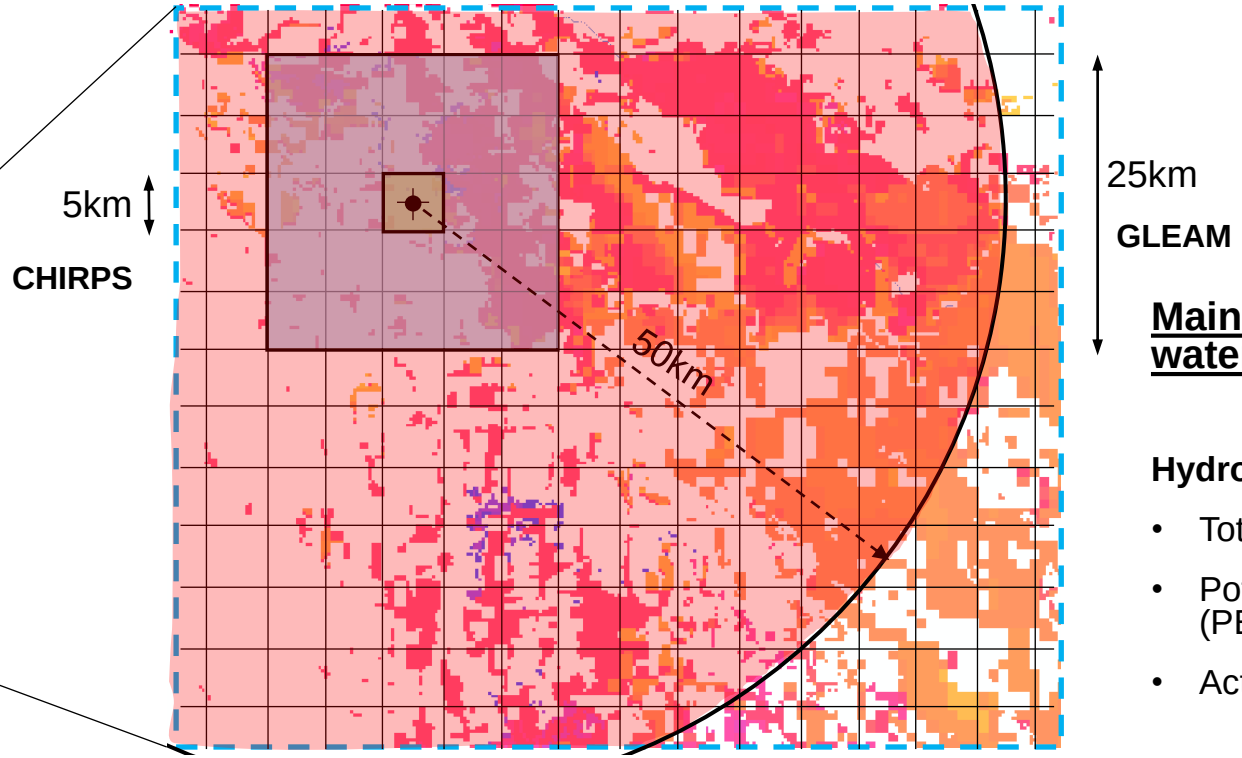
- Highest forest lost.
- Strong rainfall seasonality.

Methodology

1. Deforestation estimate relative based (last year of forest transition) (Hansen et al. 2013).
2. The ratio of the regional deforested area is computed based on Debortoli et al. (2015).

Comparable with hydroclimatic resolution





Main components of the water and energy balance:

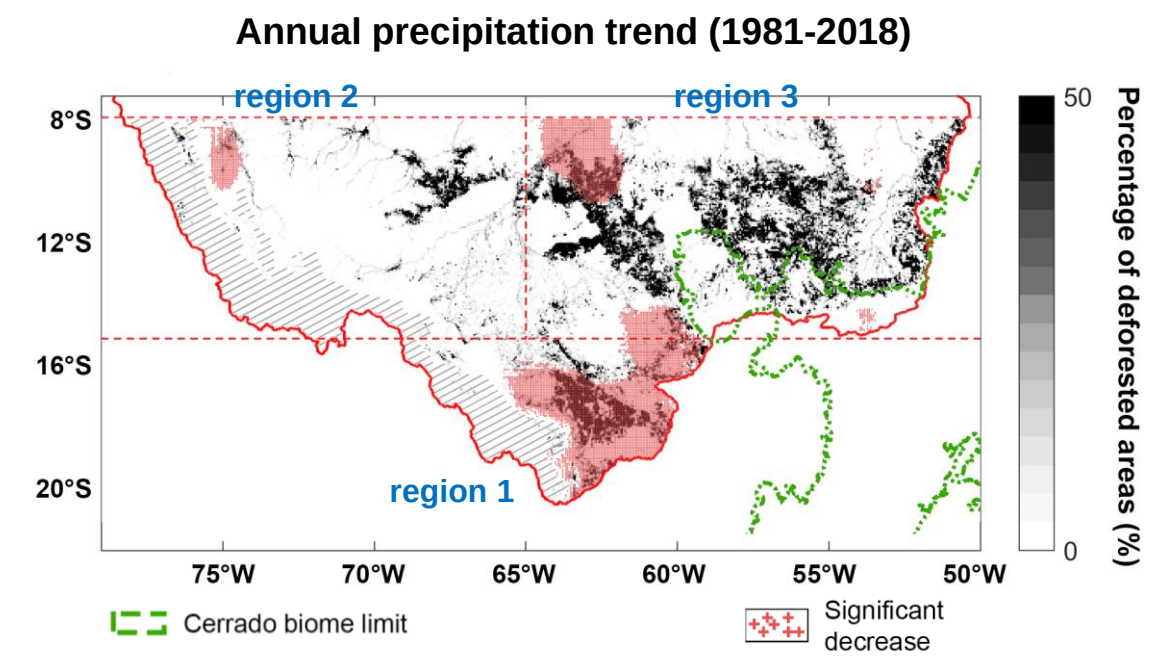
Hydroclimatic variables:

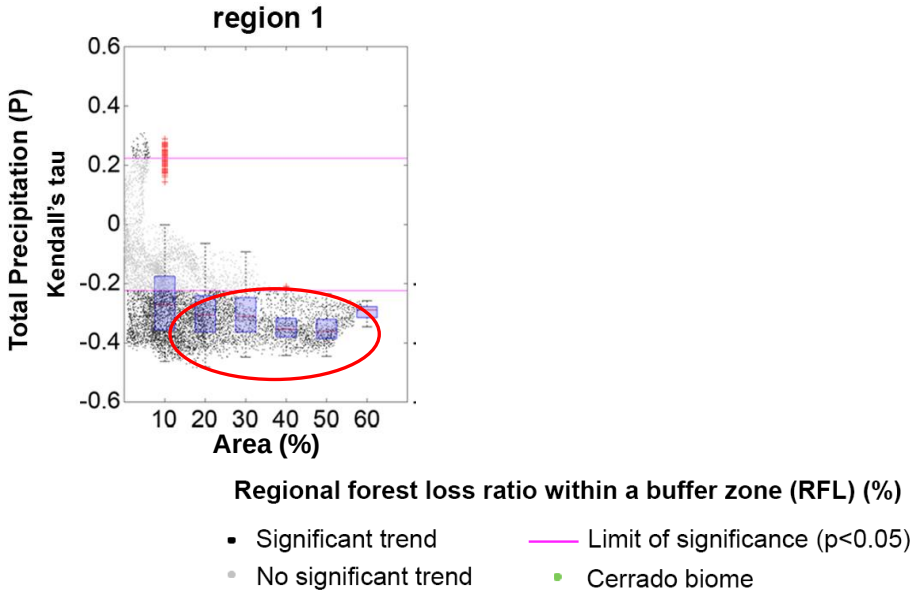
- Total precipitation (P)
- Potential evapotranspiration (PET)
- Actual evapotranspiration (AET)

Results

Precipitation (P)

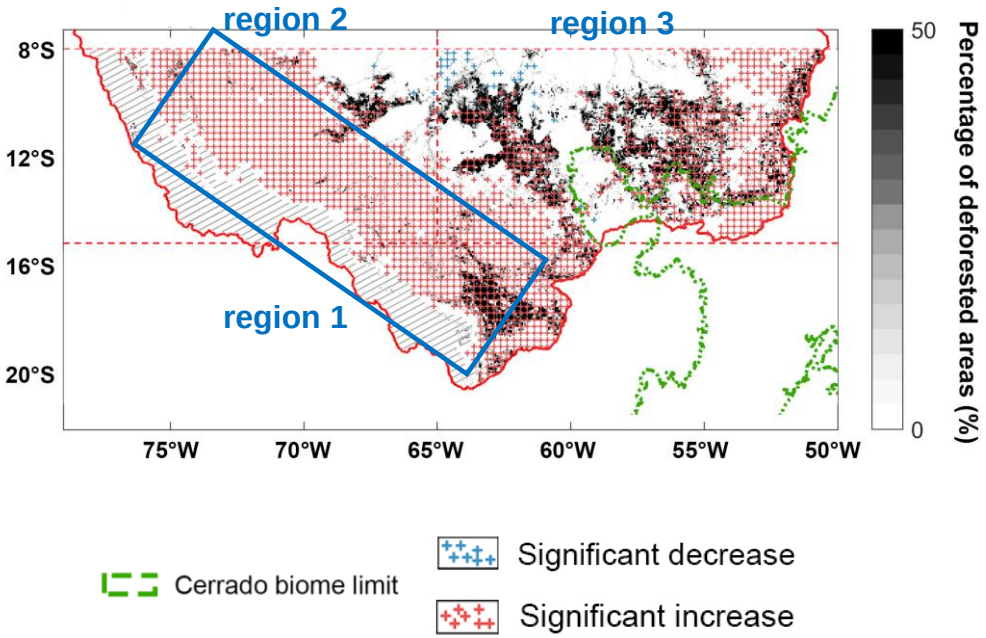
- The **decrease** in the trend of precipitation is systematic in region 1.
- This is **evident** in areas >10% of deforestation ratio.
- For areas **above 40%**, rainfall decrease systematically.
- The regions 2 and 3 **do not show** systematic patterns.

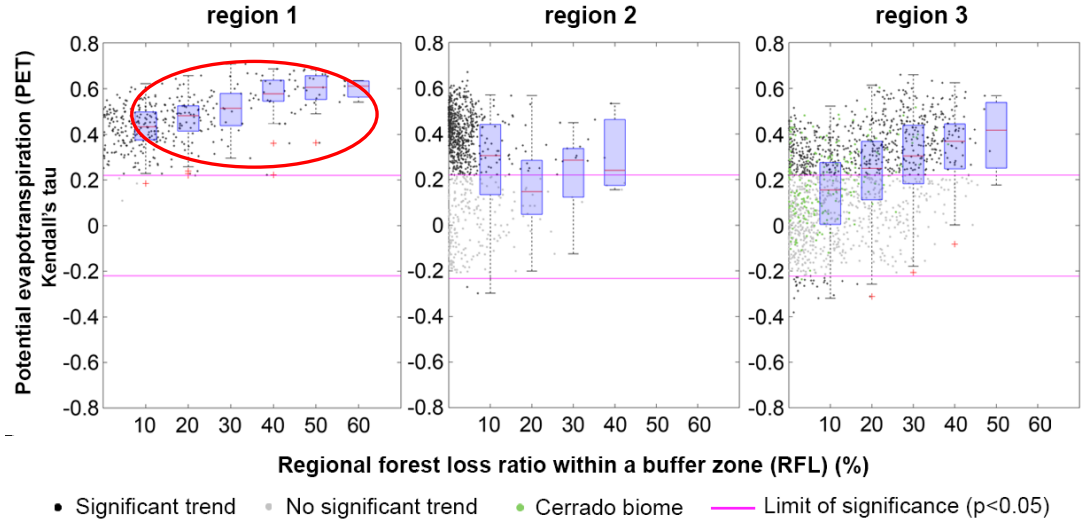




Potential evapotranspiration (PET)

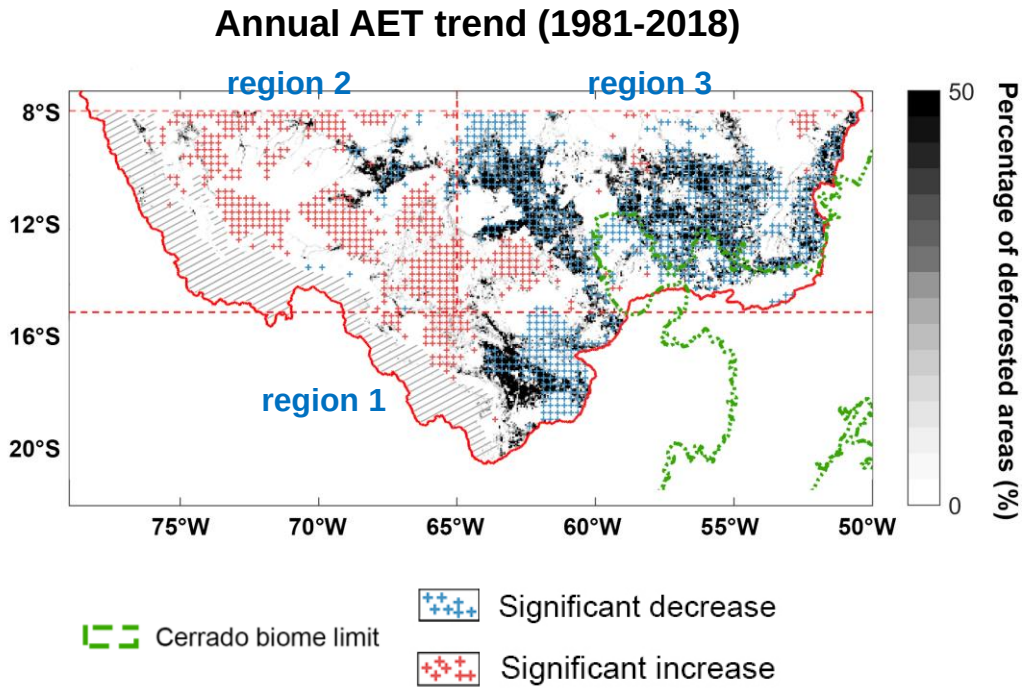
Annual PET trend (1981-2018)

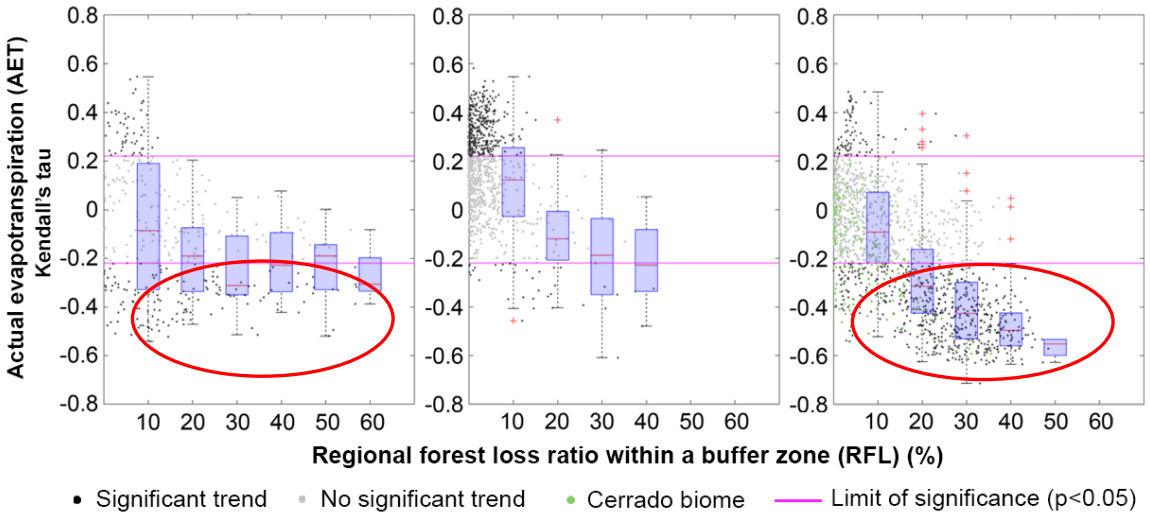




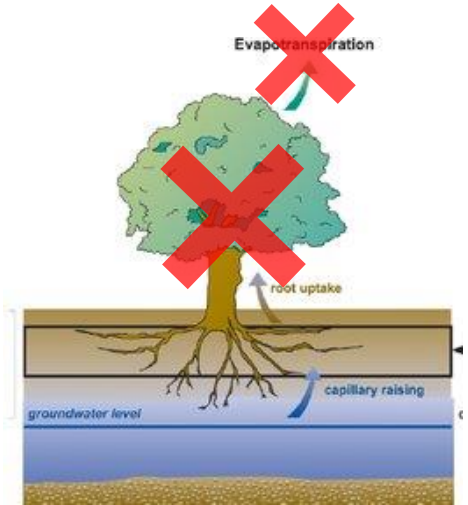
- **Global and large-scale** warming.
- Deforestation (reduced latent heat flux) favors the energy partitioning toward an **increase of the sensible heat flux**.

Actual evapotranspiration (AET)

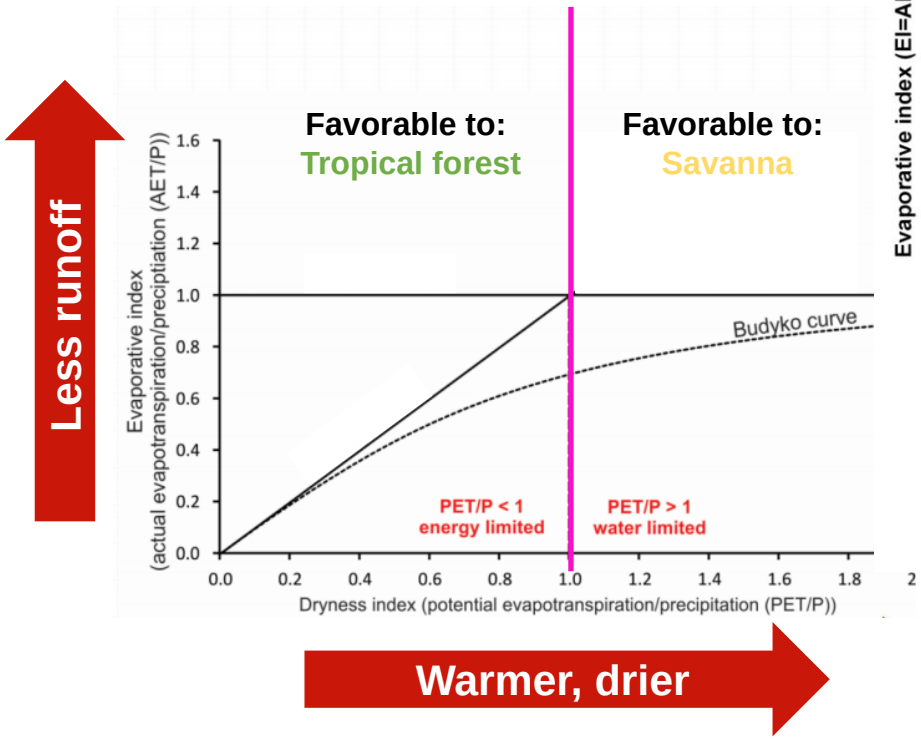




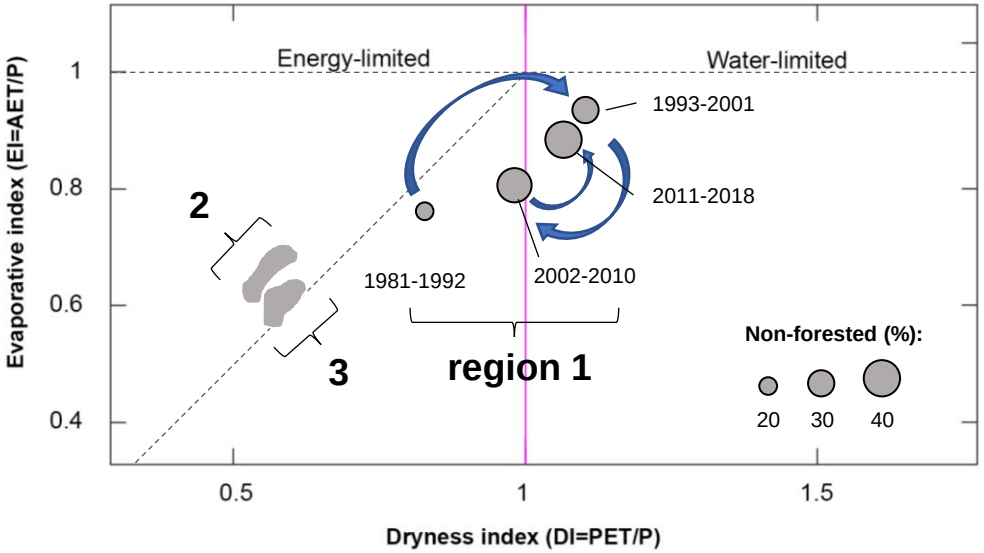
- **Increase** in non-deforested areas following PET trend.
- AET decrease in deforested areas, due to **no access** to soil moisture from the deepest root zone.

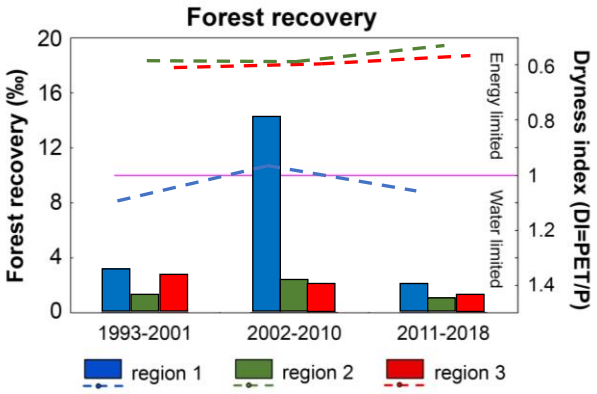


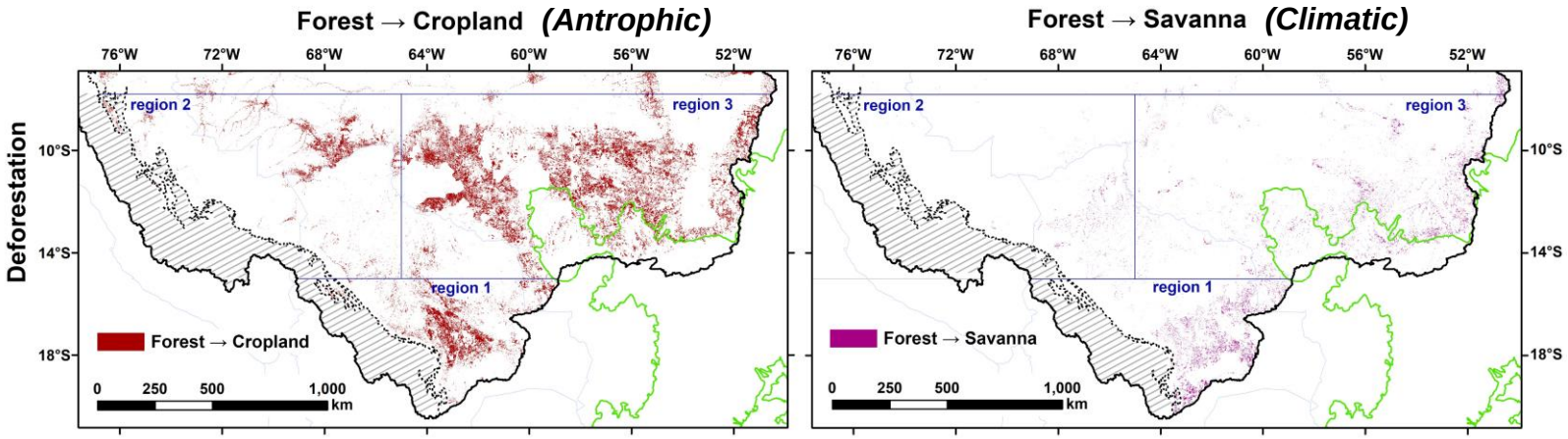
Surface water and energy balance for decadal periods



Horizontal deviations
change in the climatic conditions

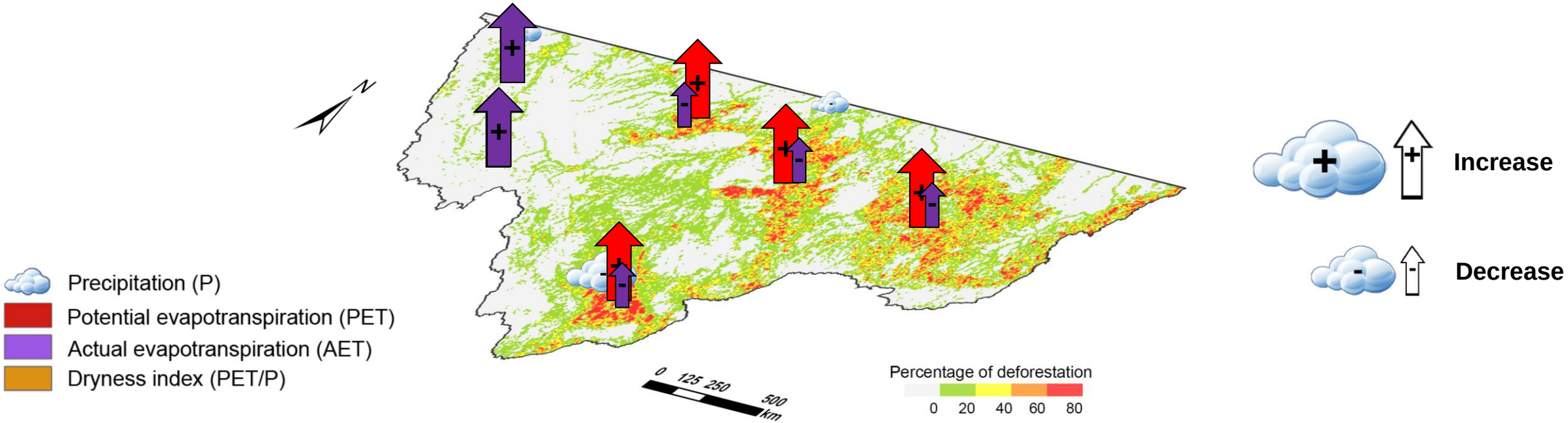






Key messages

- **Decrease** in Precipitation (P) is systematic in Southern Bolivian Amazon (region 1).
- **Increase** in potential evapotranspiration (PET) is related with **changes in temperature** on a continental level but also on a local and regional level at **high deforested areas**.
- **Decrease** in actual evapotranspiration (AET) is systematically related to high deforested areas.



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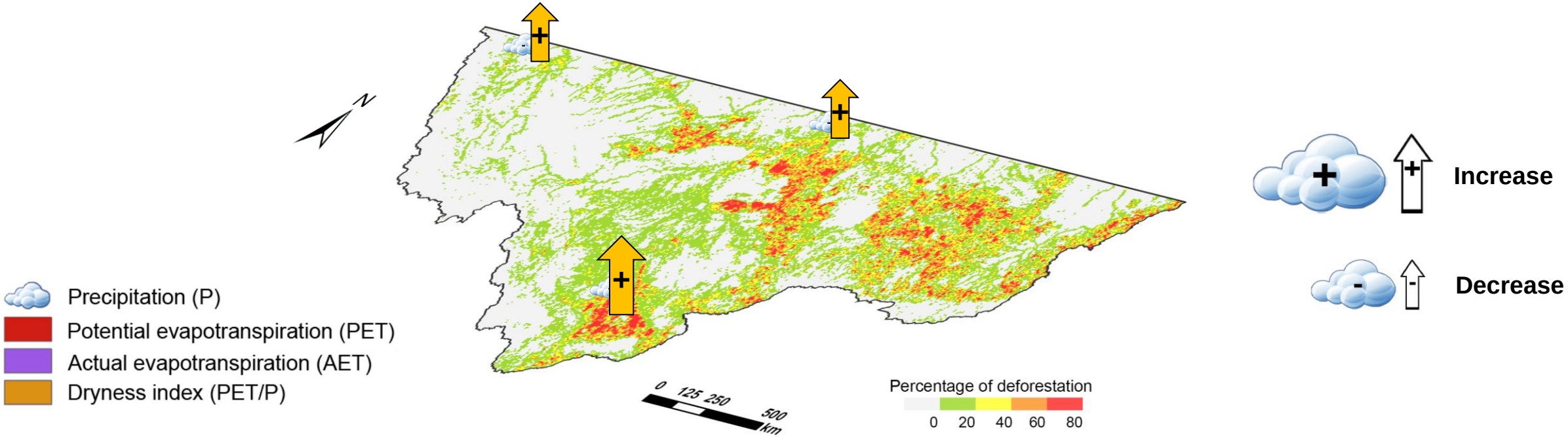
- **Increase** in potential evapotranspiration (PET) is related with **changes in temperature** on a continental level but also on a local and regional level at **high deforested areas**.
- **Decrease** in actual evapotranspiration (AET) is systematically related to high deforested areas.
- **Increase** in DI (**decrease** in P and **increase** in PET) lead Southern Bolivian Amazon to water-limited conditions, which drives a transition from forest to savanna.



Conclusions

- The relationships between forest loss and water budget vary largely **depending on the location**.
- **Large-scale climate** changes may combine with regional **vegetation changes** to produce a **positive feedback** leading to an increased forest loss (e.g. in Southern Bolivian Amazon).

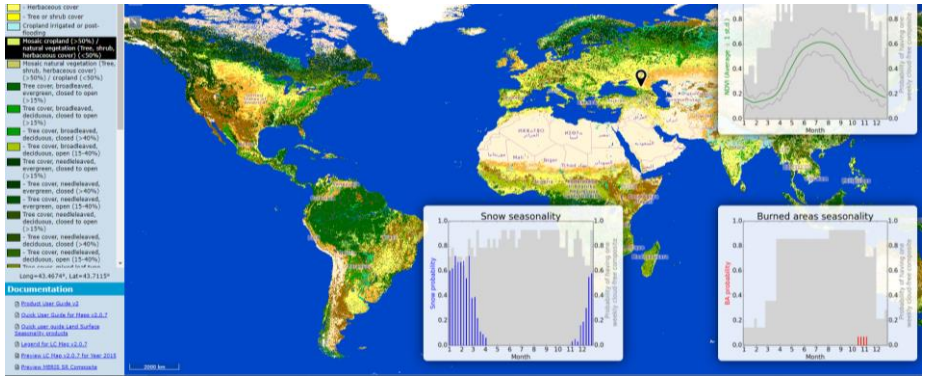
Perspectives

- Analyze **climatic changes** with **realistic scenarios of deforestation** by using models on a local and regional scale.

Datasets

Land Cover maps

- Spatial resolution of 0.002778° (~300m), produced by the European Space Agency (ESA) Climate Change Initiative (CCI). 1992 – 2018.

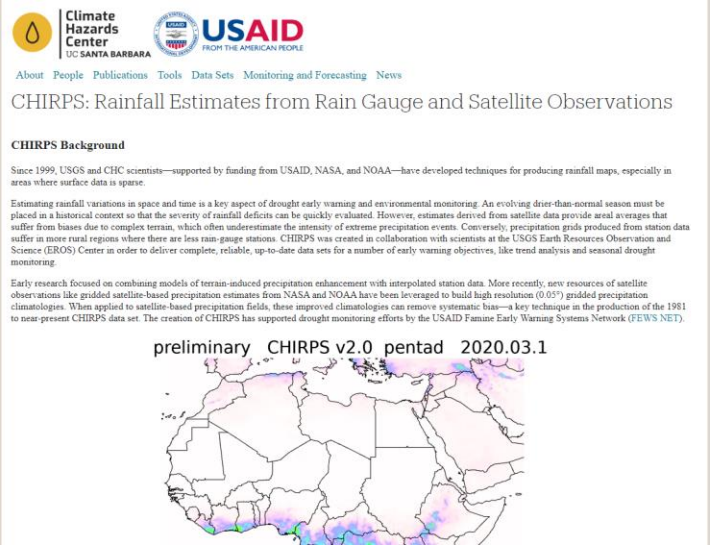


Preciptiation, Potential and Actual Evapotranspiration

- **CHIRPS 2.0**

1981 – 2018

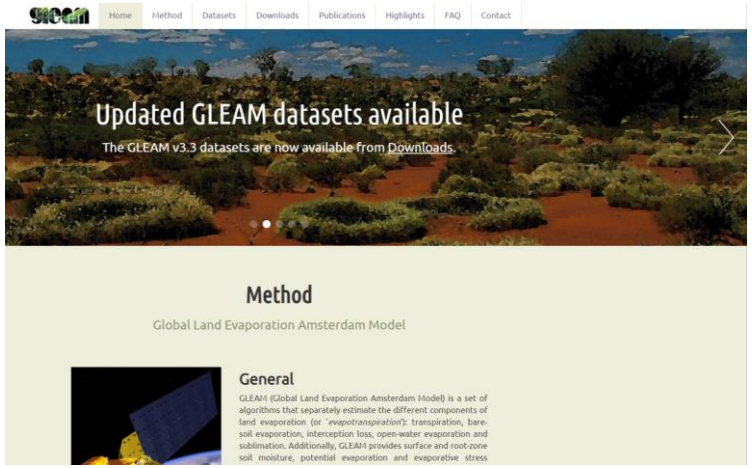
5km



- **GLEAM 3.3a**

1980 - 2018

25km



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Thanks for your attention!