



UNIVERSIDADE ESTADUAL PAULISTA
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The role of land use change over the Amazon Forest in simulating climatology and extreme hydroclimatic indices

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Motivation

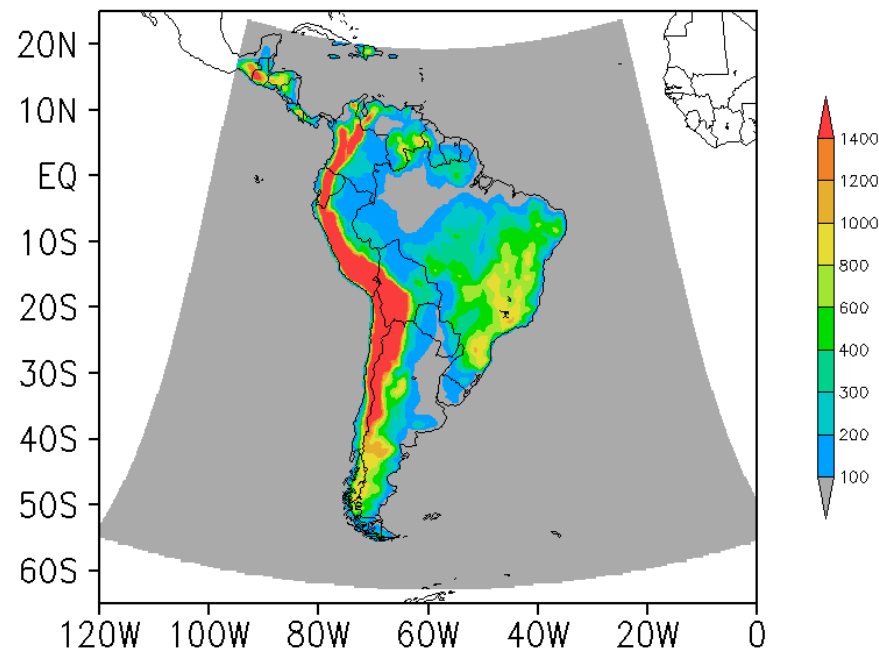
- The most important anthropogenic influences on climate are the emission of greenhouse gases and **Land Use Change (LUC)**.

Objectives

- The goal of this work was to analyze the simulated Amazon Basin deforestation and its impacts on the regional climate, under current day conditions, using idealized experiment over South America (SA) CORDEX domain
- and analyze the changes of different hydroclimatic extreme indices under LUC conditions

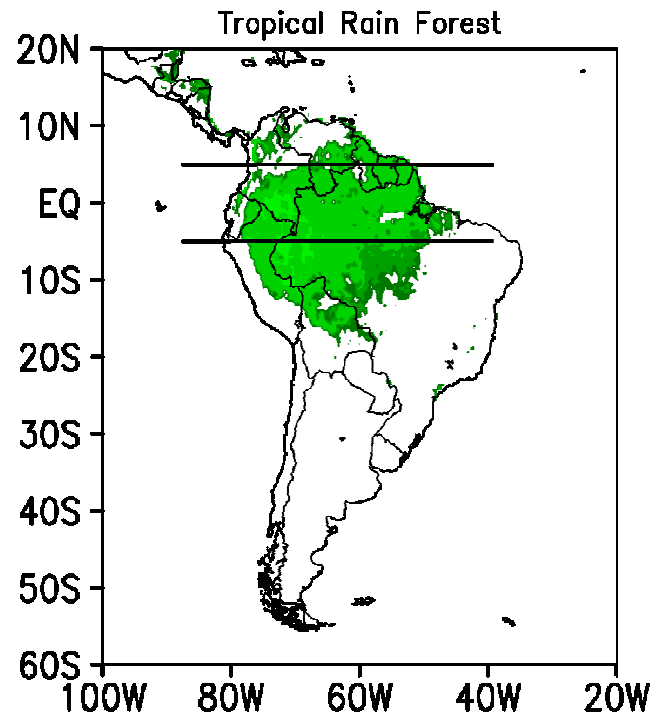
Experiments set-up

- **R**egional **C**limate **M**odel RegCM4 (Giorgi et al., 2012) coupled to the version 4.5 of the **C**ommunity **L**and **M**odel (CLM4.5 - Oleson et al., 2013) over CORDEX SA domain



Experiments set-up

- Default land cover map (Ctrlexp) and Deforestation scenario (LUCexp), i.e., we shifted all broadleaf evergreen trees tropical (tropical rain forest) to C_3 grass.

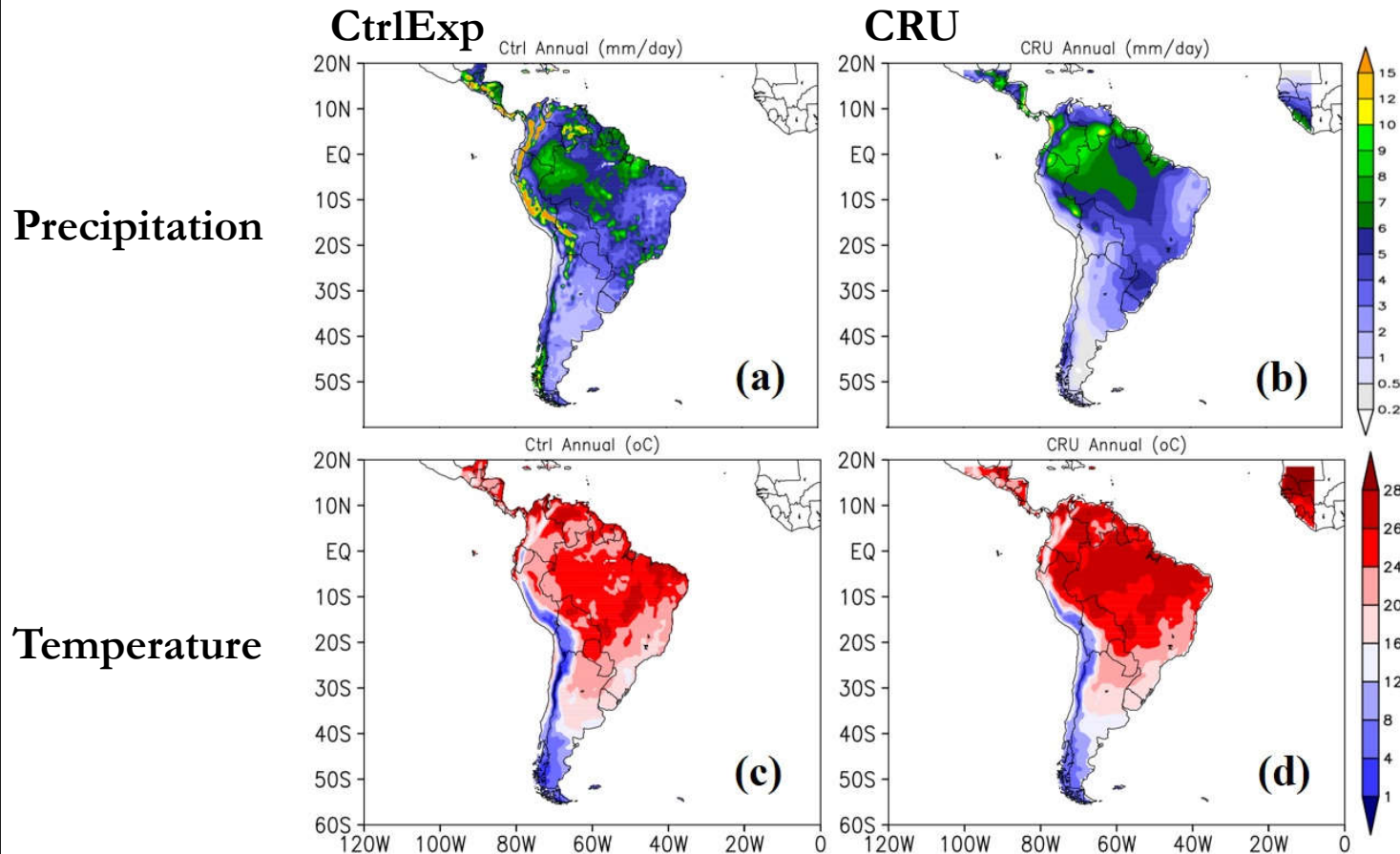


- Green colour represents the broadleaf evergreen tropical trees that was replaced for C_3 grass in LUCexp
- The horizontal black bars indicate the cross section (5°S-5°N) selected for more detailed analysis

Experiments set-up

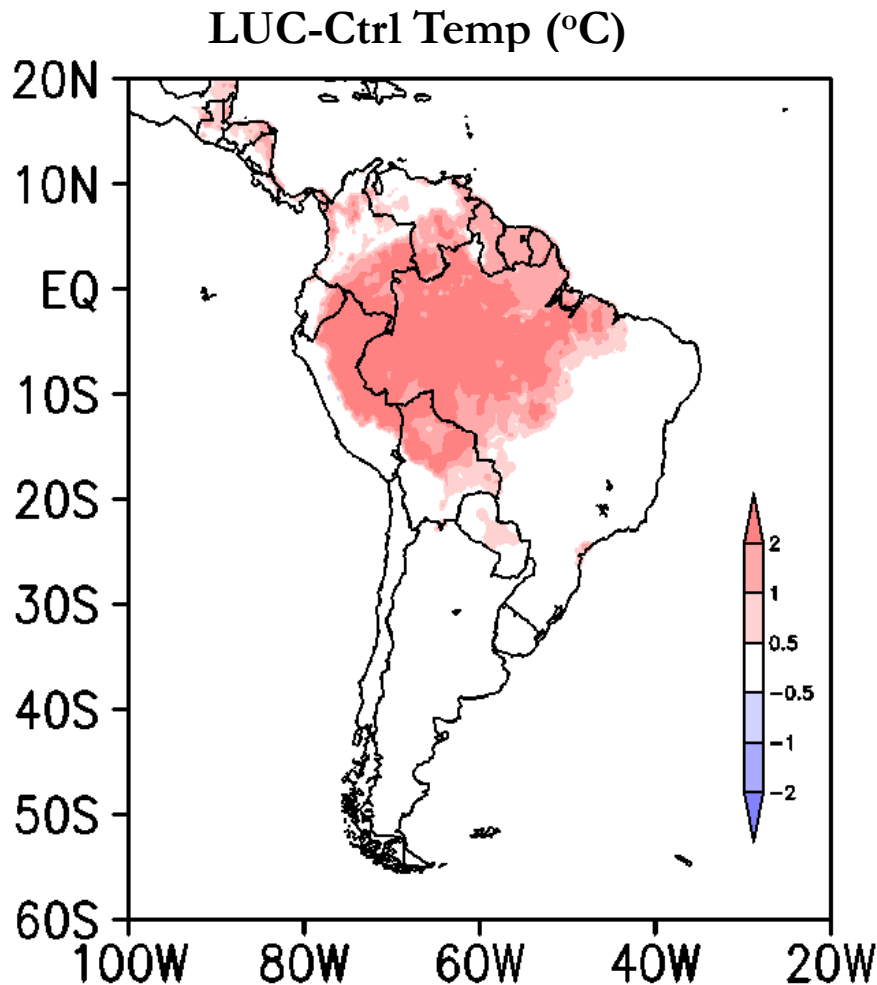
- Both simulations were driven by Era Interim reanalysis (Dee et al., 2011) from 1979 to 2009
- Ctrlexp is validated by comparison with the observational data from CRU
- The climate change signal due to deforestation is evaluated by comparing the climatology of the LUCexp with that of the Ctrlexp.
- We analyze 3 indices of temperature and precipitation extremes, defined as: Heat Wave Day Index (**HWD**), Maximum Consecutive Dry Day index (**CDD**) and Heavy Precipitation Index (**R95**)

Model Evaluation – Ctrlexp



- ✓ Ctrlexp captures (with some bias) the SA climatology (prec and temp)

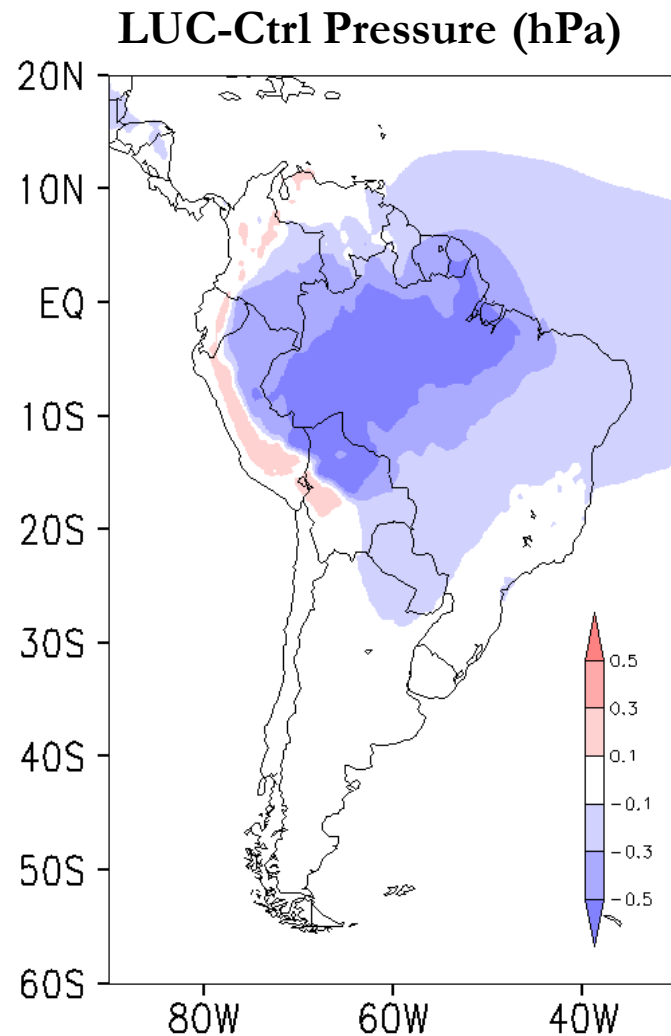
Regional Effects of deforestation



- ✓ The changes in annual mean temperature indicate a warmer anomaly over the deforested areas

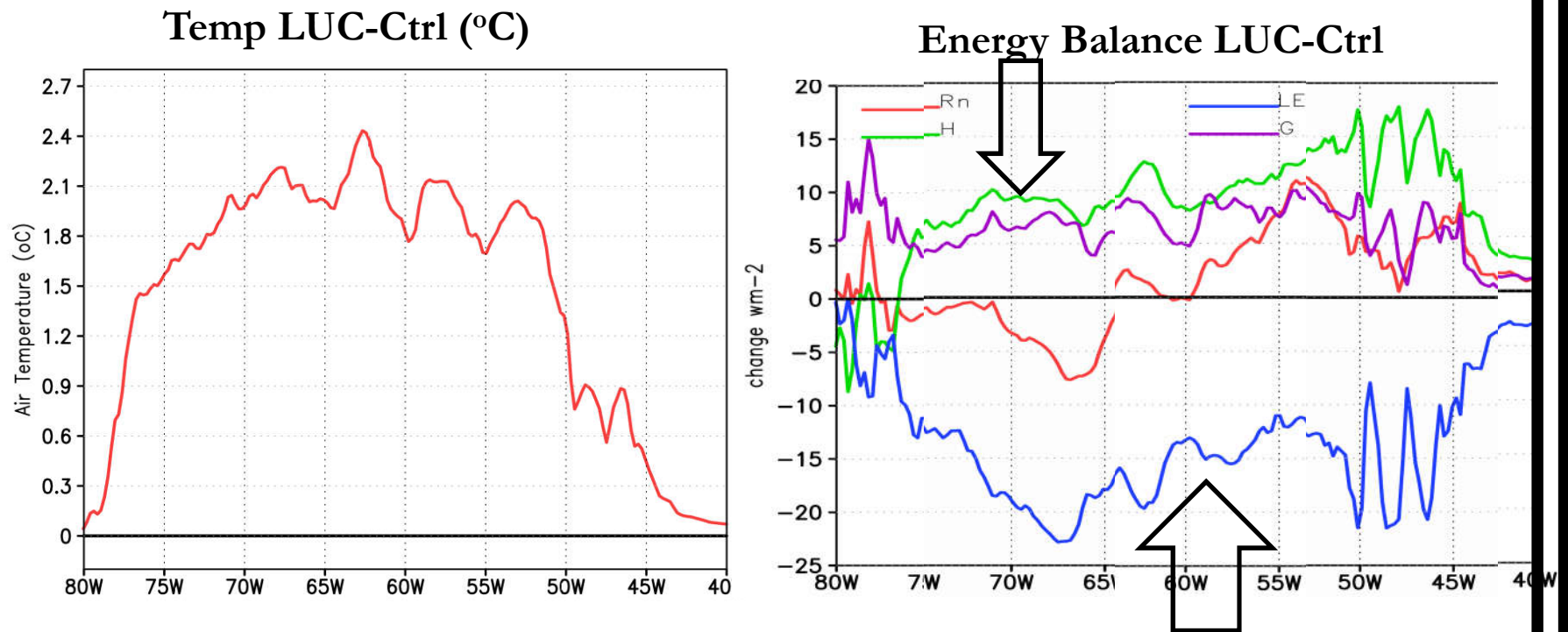
- ✓ This signal was also found by other deforestation studies over SA (Lejeune et al., 2014, Silva et al., 2015)

Regional Effects of deforestation



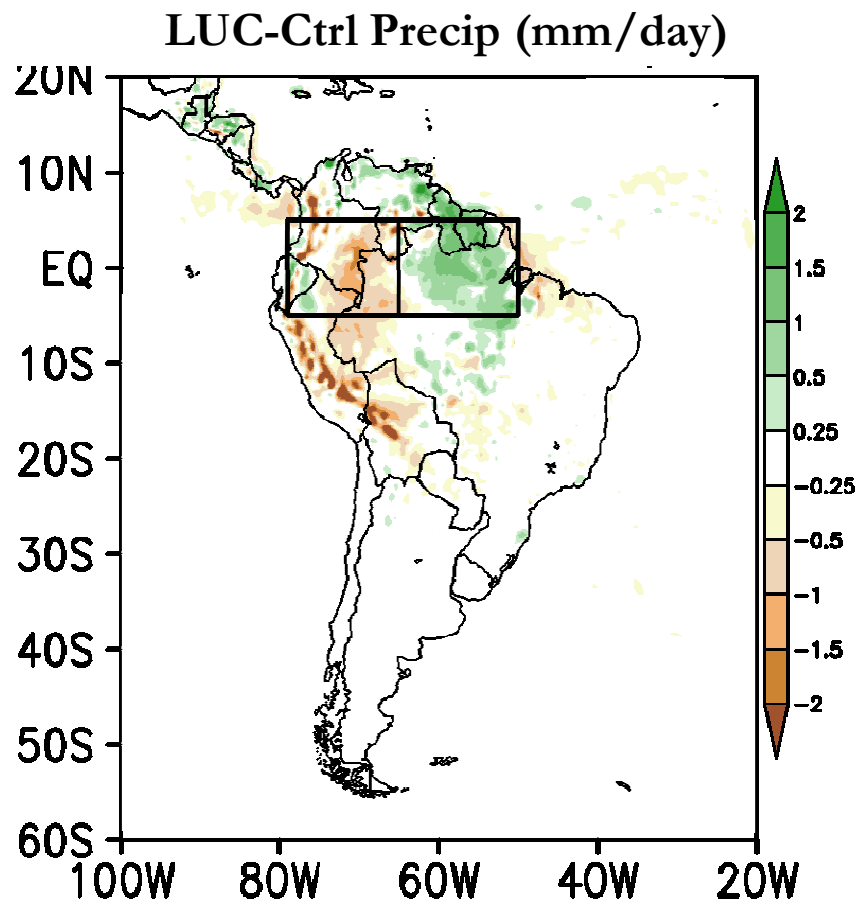
- ✓ And it contributes to decrease the surface pressure and, as a consequence, a thermal low is formed

Why this increase in air temperature?



- ✓ Increase of Sensible Heat Flux (green line)
- ✓ Decrease of Latent Heat Flux (Blue line)

Regional Effects of deforestation

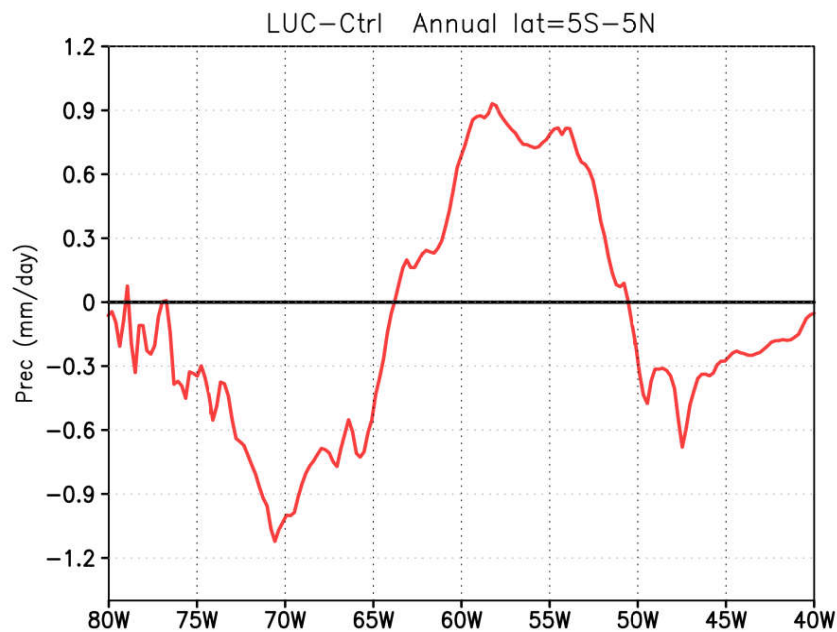


✓ Dipolar response consisting of reduced precipitation over western AMZ and an increased precipitation over eastern AMZ

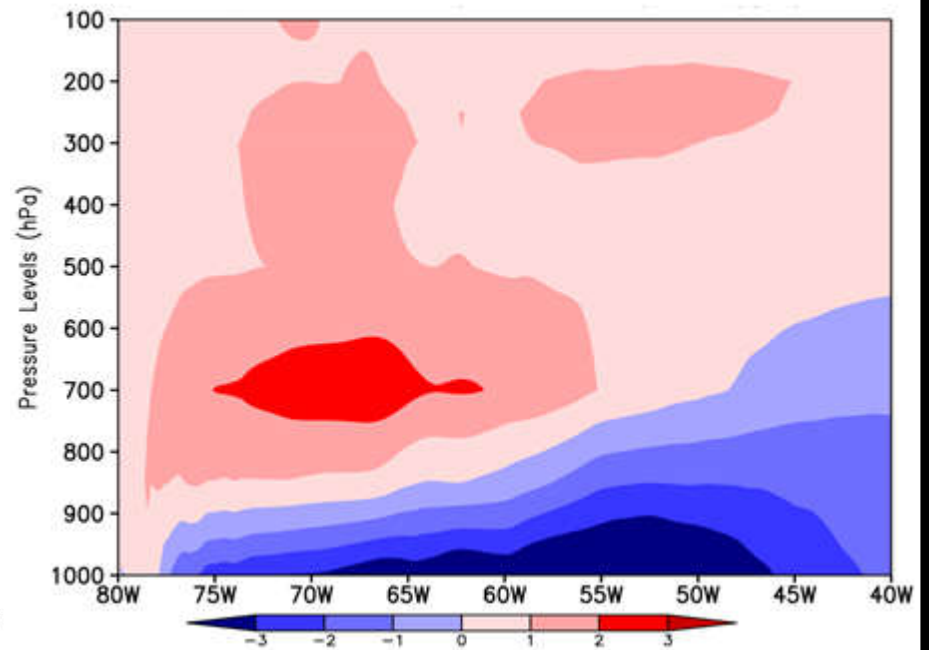
✓ This signal was also found by other deforestation studies over SA (Lejeune et al., 2014)

Why this dipole pattern in precipitation?

Precipitation LUC-Ctrl (mm/day)

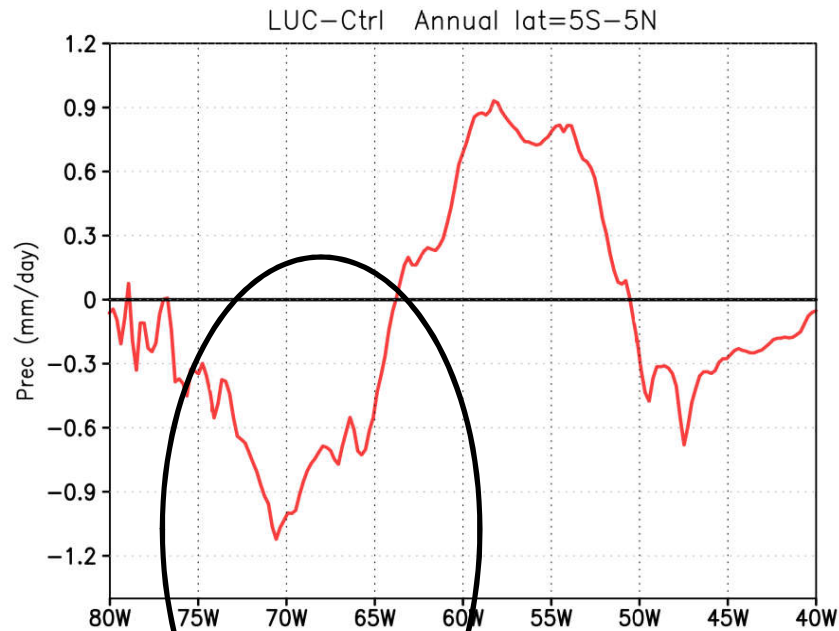


Geopotencial Height LUC-Ctrl (m)

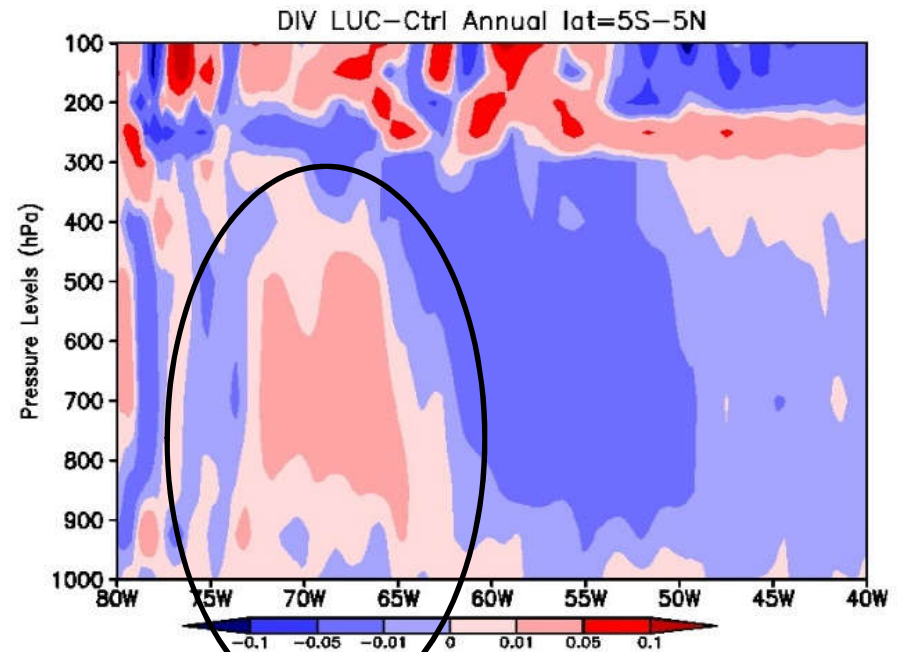


Why this dipole pattern in precipitation?

Precipitation LUC-Ctrl (mm/day)



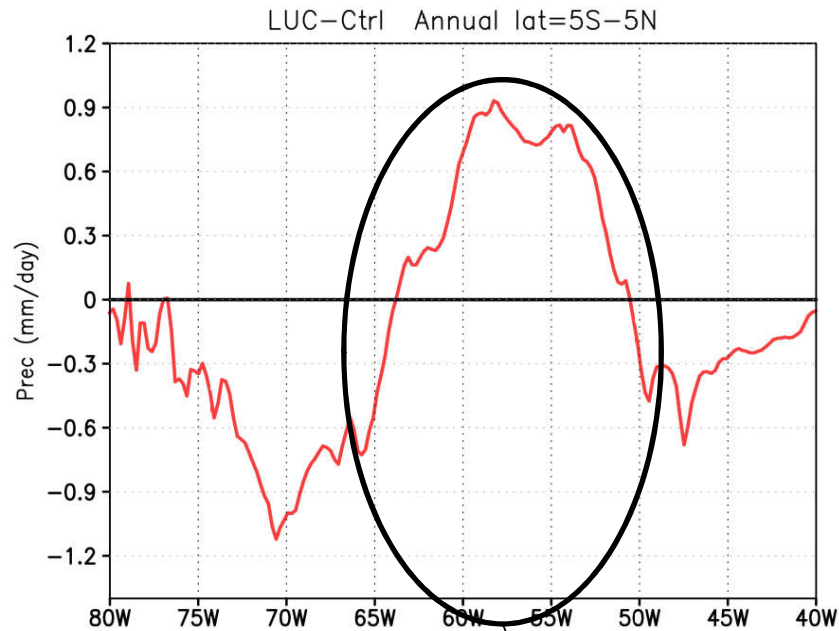
DIV 10^{-5} s^{-1} (LUC-Ctrl)



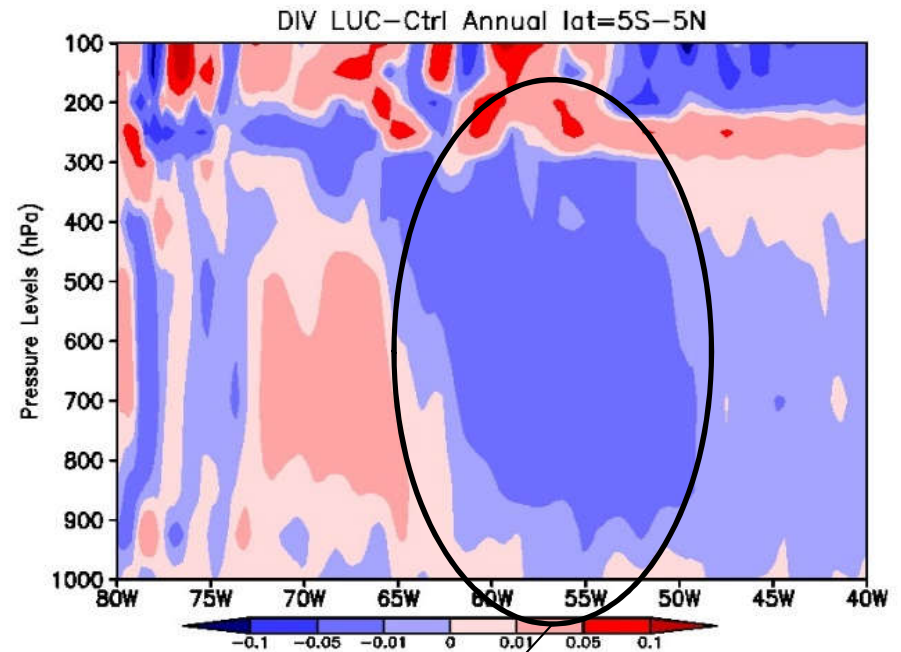
Divergence

Why this dipole pattern in precipitation?

Precipitation LUC-Ctrl (mm/day)

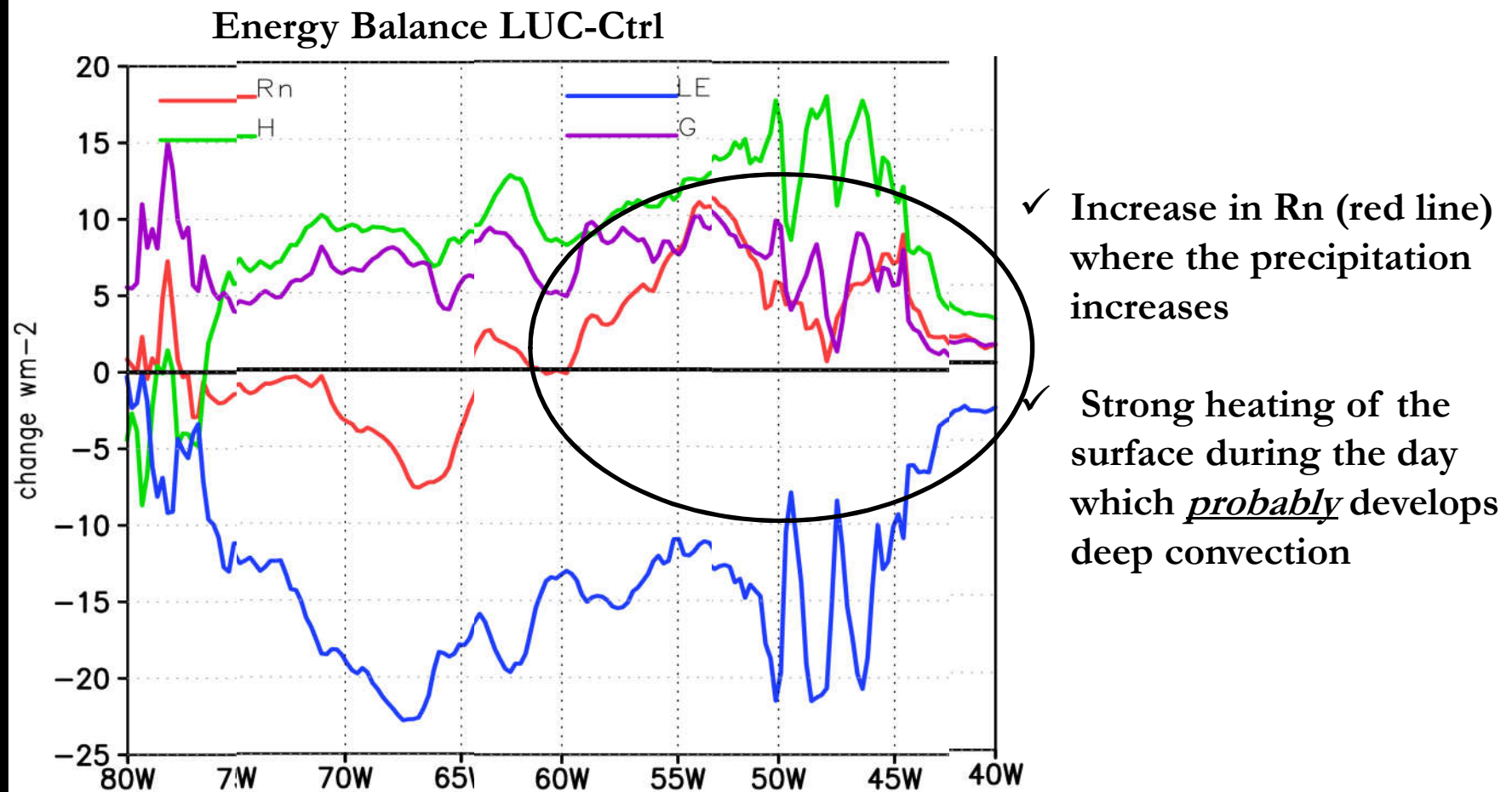


DIV 10^{-5} s^{-1} (LUC-Ctrl)



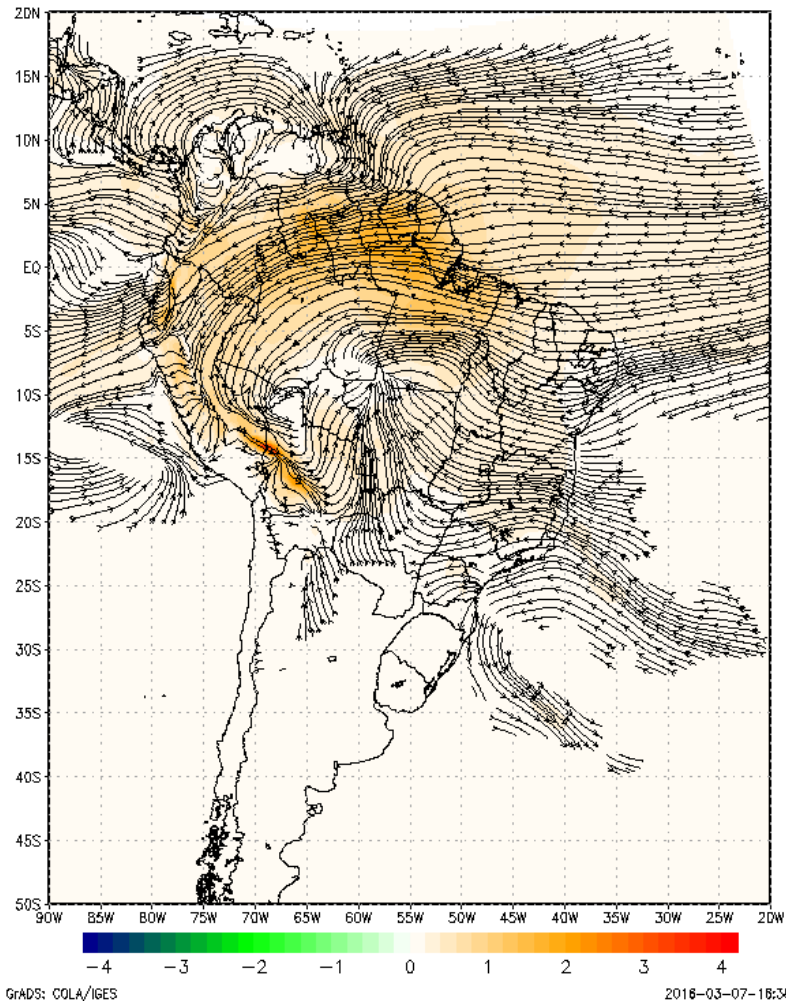
Convergence

Why this dipole pattern in precipitation?



Why this dipole pattern in precipitation?

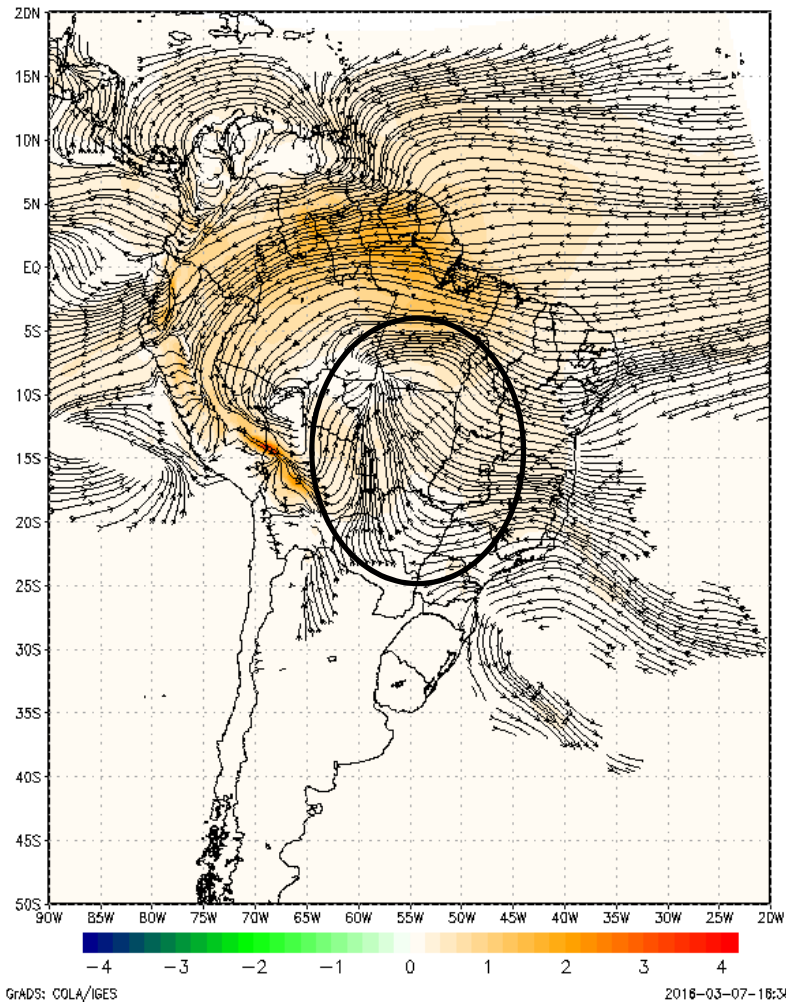
LUC-Ctrl Wind at 850 hPa (m s^{-1})



- The changes in land use cause a reduction in the surface roughness, an increase of the thermal gradient between tropical Atlantic Ocean and the land, with a consequent intensification of the flow at low levels (850 hPa), mainly on the eastern region.

Why this dipole pattern in precipitation?

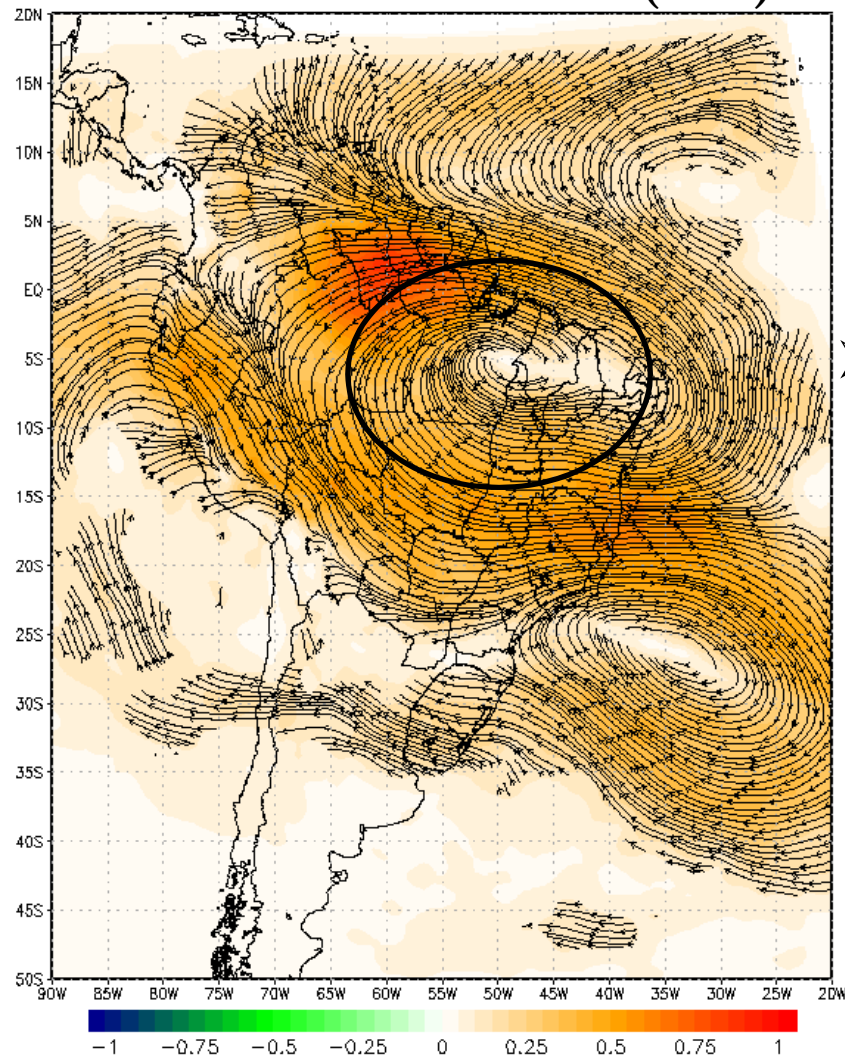
LUC-Ctrl Wind at 850 hPa (m s^{-1})



- Due to the thermal low, there is a cyclonic anomaly which decreases the moisture flux transport to south

Why this dipole pattern in precipitation?

LUC-Ctrl Wind at 250 hPa (m s^{-1})

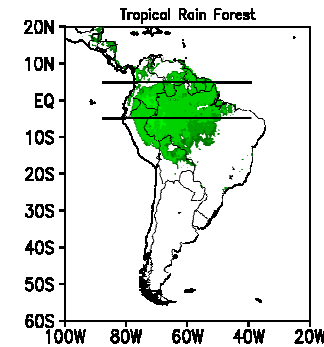
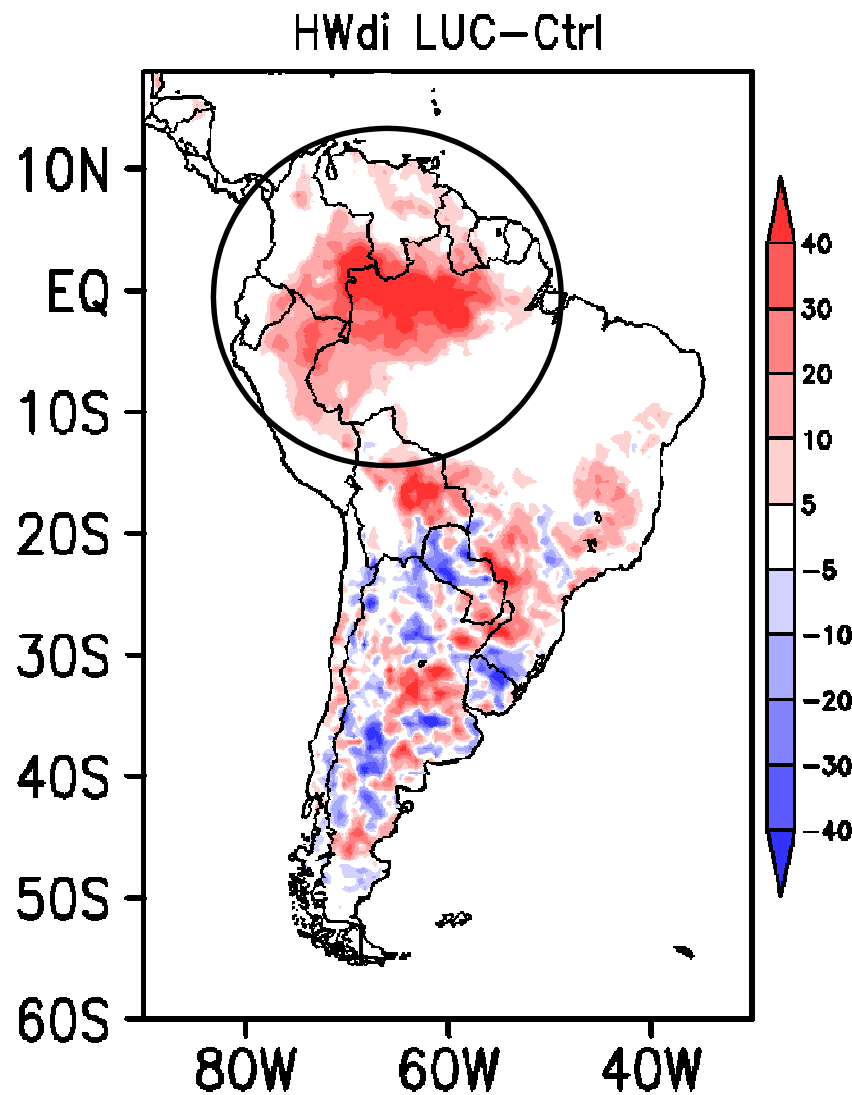


GrADS: COLA/IGES

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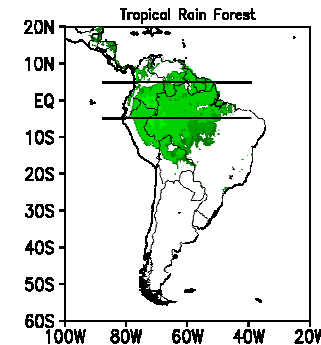
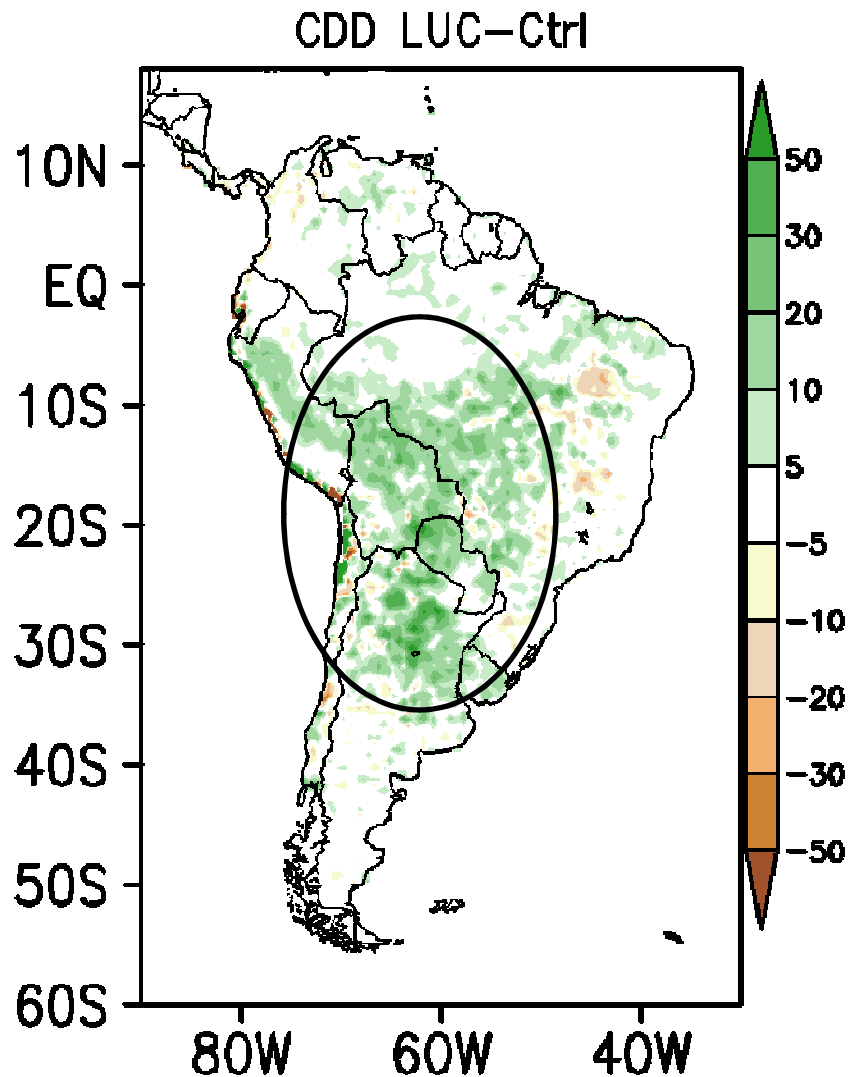
- At high levels (250 hPa) develops a weak anticyclonic circulation in LUCexp due to the increase of the precipitation over this area

Hydroclimatic Indices



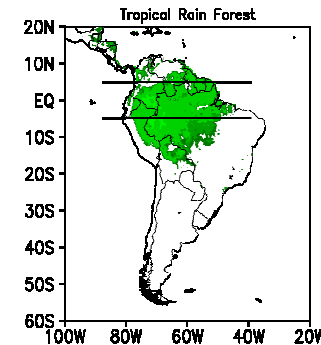
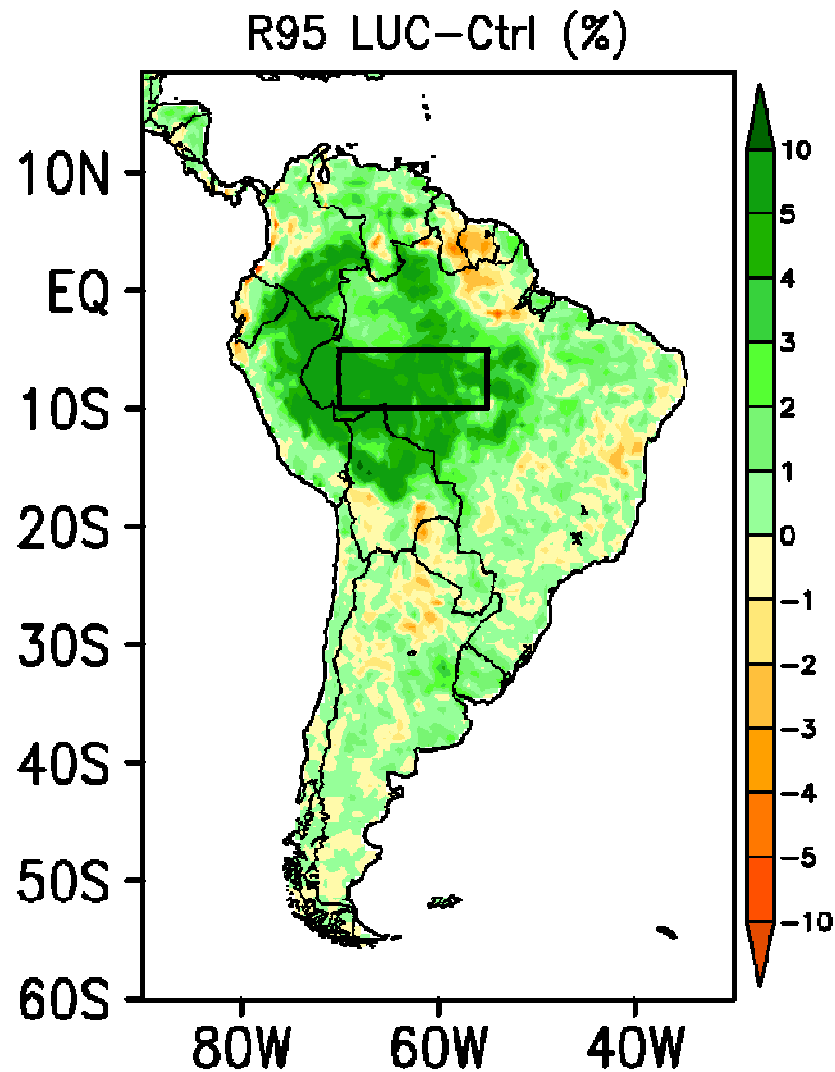
➤ The changes in land use increase the Heat wave day index (HWD) over the deforested area

Hydroclimatic Indices



- The changes in land use increase the Maximum Consecutive Dry Day Index (CDD), but not over the deforestation area
- Probably due to the decrease of the moisture flux transport to south

Hydroclimatic Indices



- The changes in land use increase the extremes events of Heavy Precipitation Index (R95), with a strong signal over the AMZ region
- Deep convection

Conclusions

- A dipolar response consisting of reduced precipitation over western AMZ and an increased precipitation over eastern AMZ due to the changes in the circulation
- Concerning the temperature we found a predominant positive signal over all deforested area due to an increase in the sensible heat flux and a reduction in the evapotranspiration
- The extreme indices analysis shows increase in HWD, CDD and R95, implying a regime shift towards more intense and less frequent rain events and increasing risk of heat wave in LUCexp.



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Thank you!



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- **Heat Wave Day Index (HWD):** number of heat wave days, where a heat wave occurs when for at least N_d consecutive days the daily maximum temperature exceeds the long term average at least N_t degrees
- **Maximum Consecutive Dry Day index (CDD):** Maximum number of consecutive dry days, where a dry day is defined as having precipitation below 1 mm/day
- **Heavy Precipitation Index (R95):** Fraction of precipitation above the 95th intensity percentile, R95.