CLIVAR VAMOS Workshop on Modeling and Predicting Climate in the Americas

Seasonal cycle shifts in the Amazon hydroclimatology associated with the land cover change

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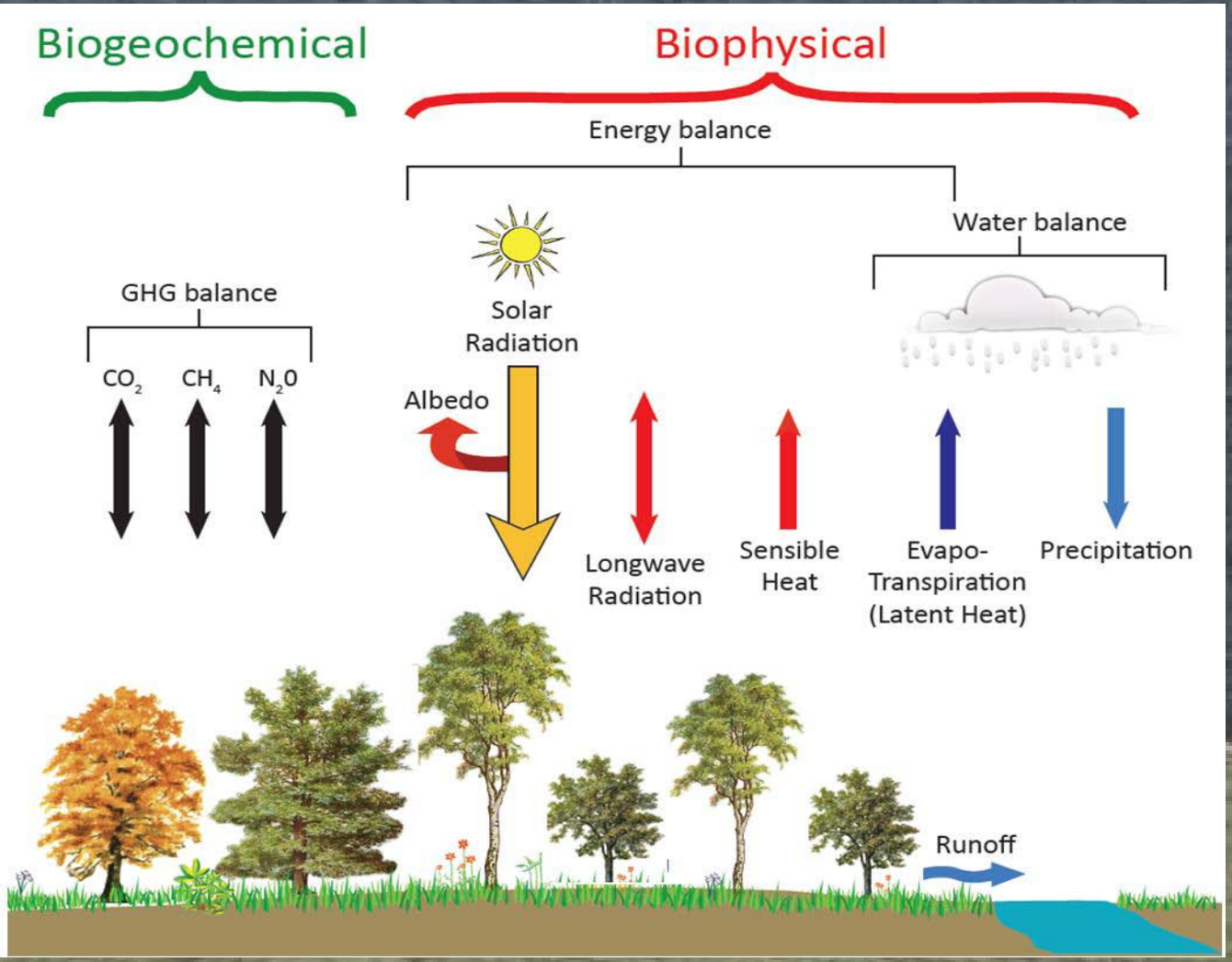
Biosphere-Atmosphere interactions

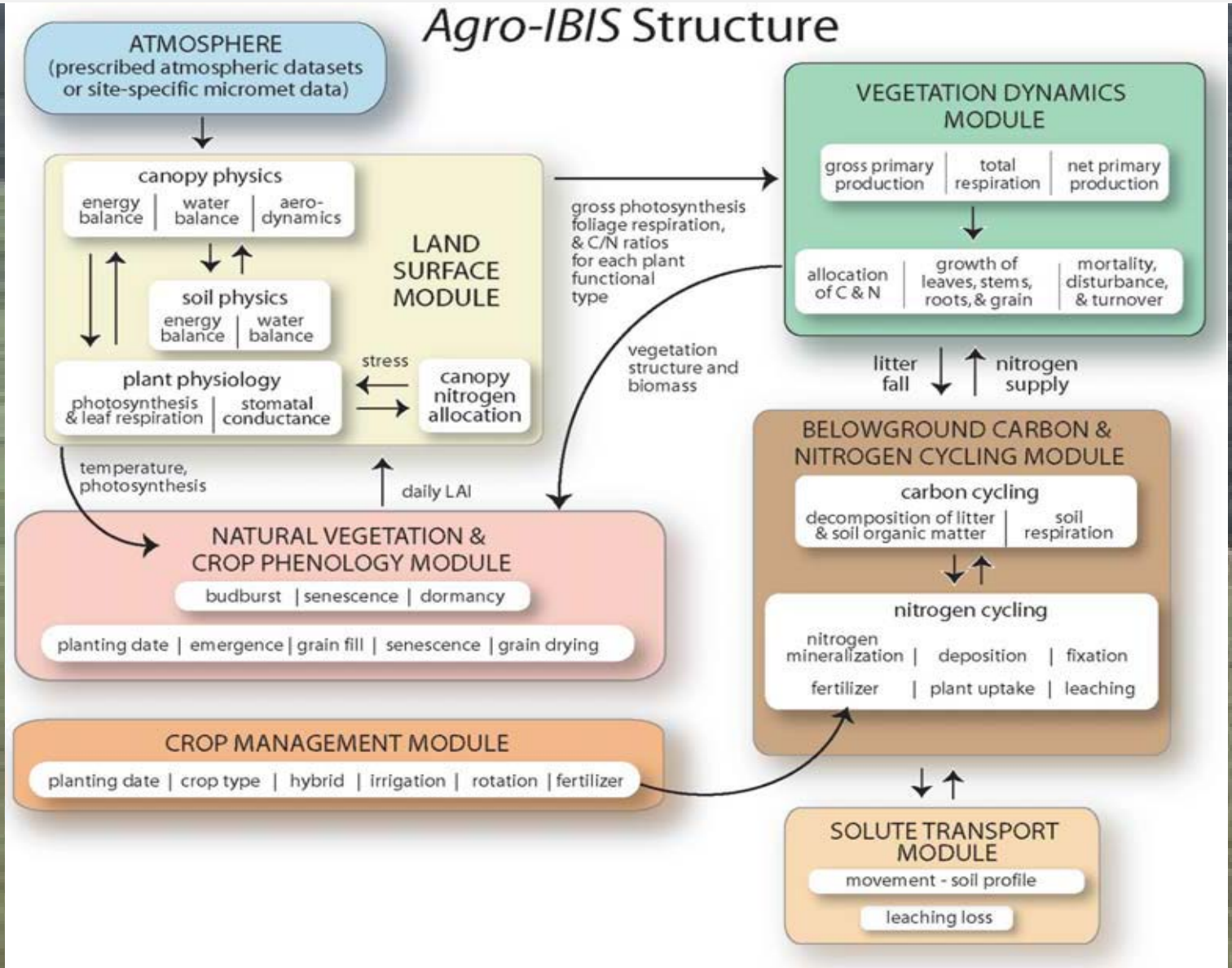
- Land use change can influence the climate through alterations in biogeochemical processes and by changing the physical properties of the land surface – thereby altering the energy, mass and momentum balances at surface.

- These impacts are particularly intense over the tropical region, where there is a strong coupling between the surface energy balance and the atmospheric convection.

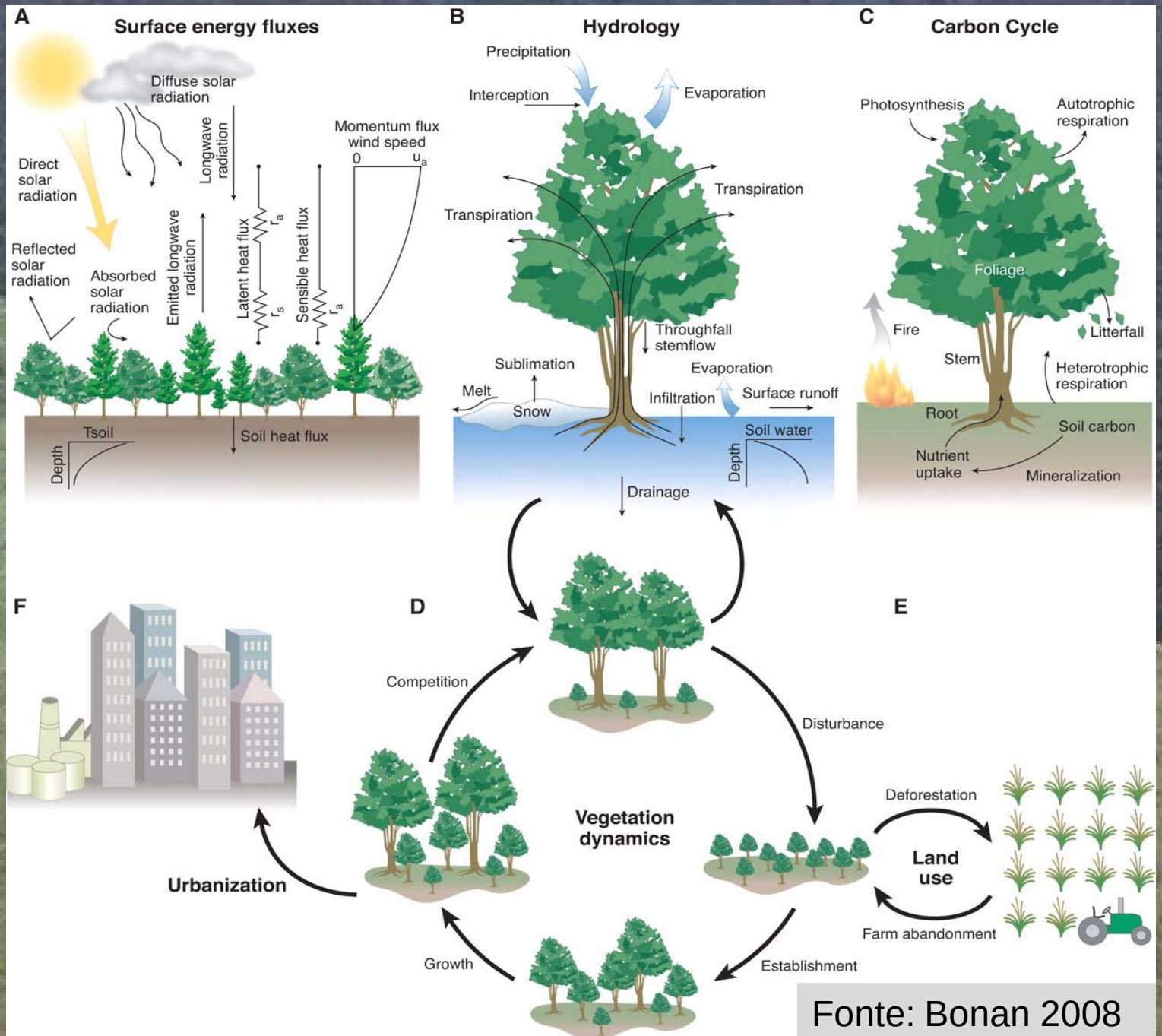


Many studies have been exploring the biosphere-atmosphere interactions through the use of simulation models

(Shukla et al., 1990; Nobre et al., 1991; Hahmann& Dickinson, 1997; Costa & Foley, 2000; Sampaio et al. 2007; Ramos da Silva et al., 2008; Costa &Pires, 2009; Coe et al., 2009).



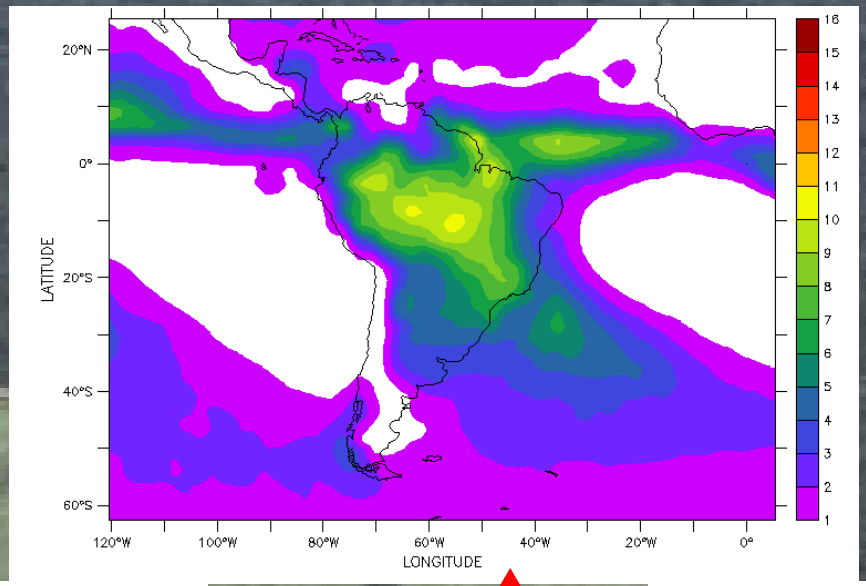
Surface Processes Represented

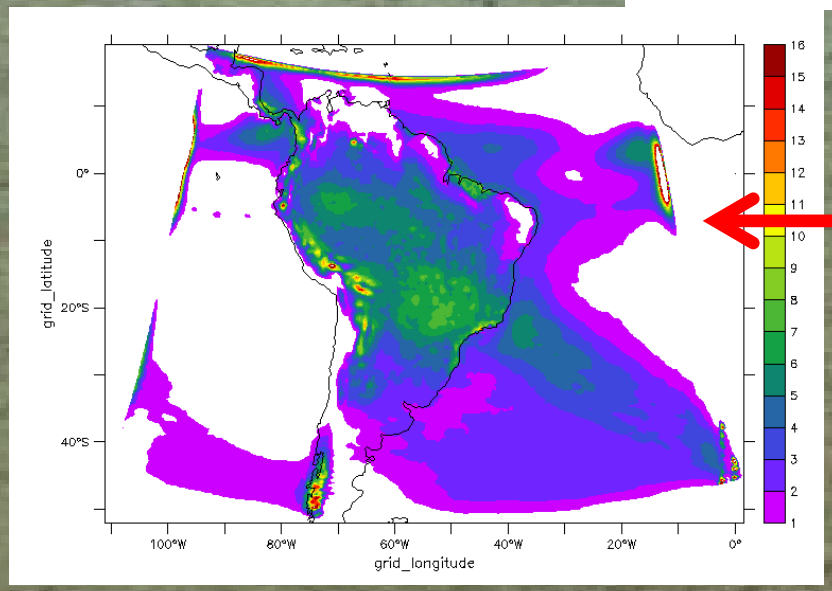


Fonte: Bonan 2008

Impacts of Land Suface system in the rainfall simulation

summer rainfall (mm day^{-1}) climatology (1989-2008)

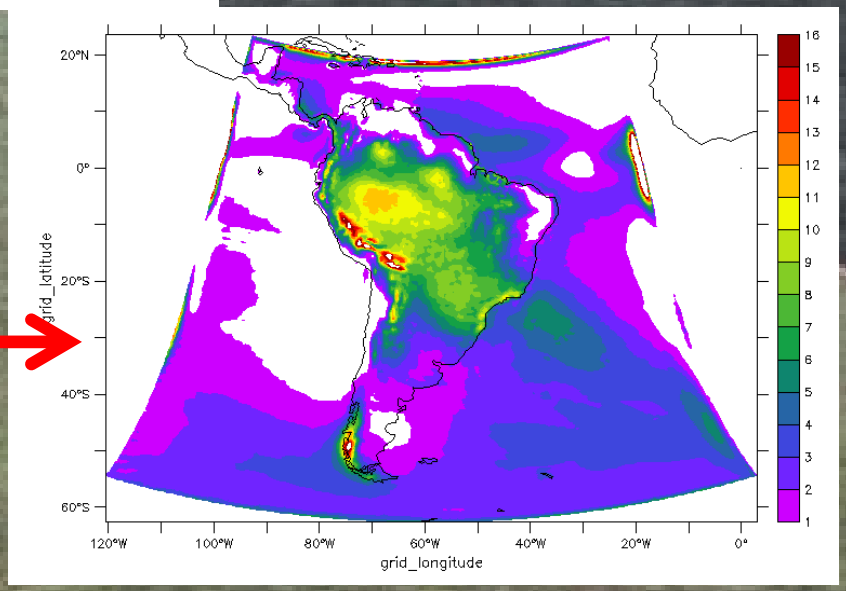




CMAP

RegCM default

RegClaris



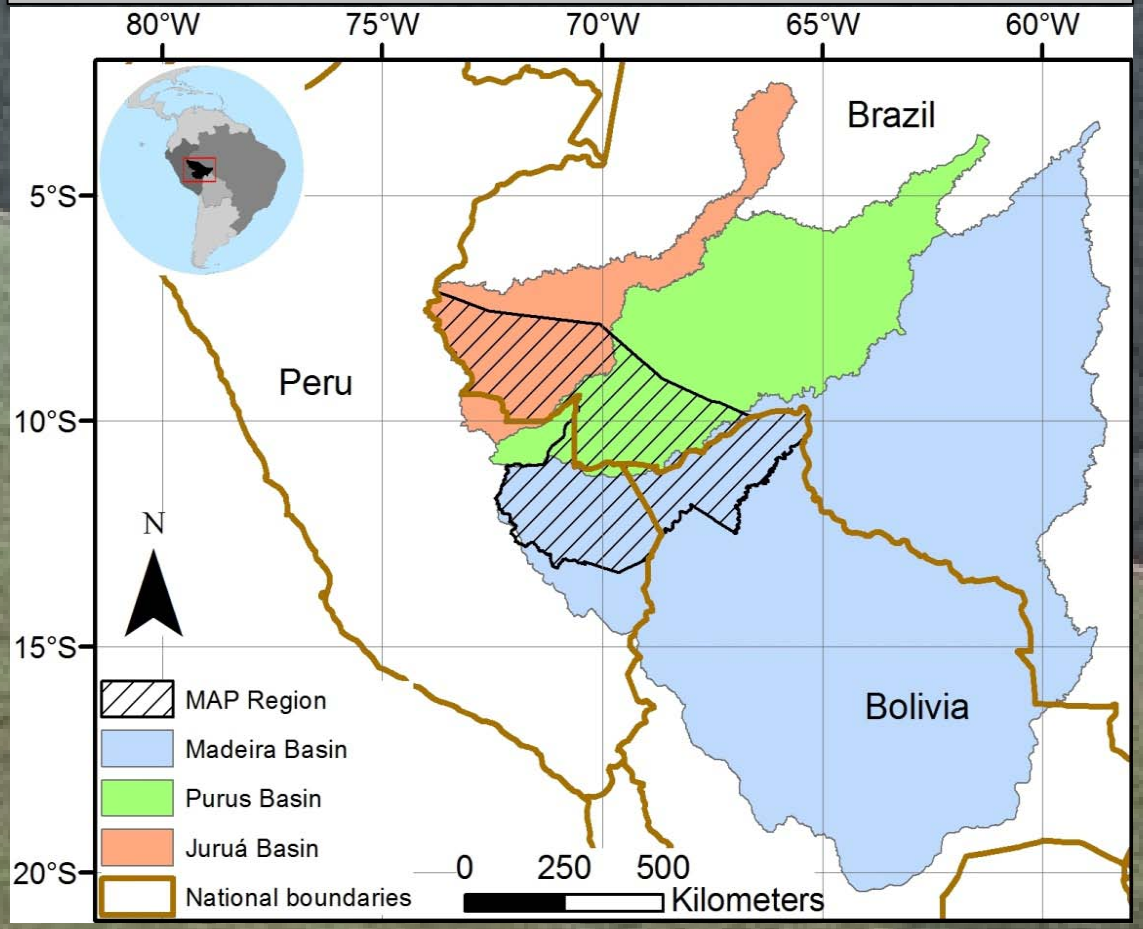
da Rocha et al. (2012)

In this study we explore how deforestation throughout the Amazon impacts the seasonal and annual hydrological cycle over the MAP (Madre de Dios, Acre and Pando) region.

Road paving, hydroelectric power plants and transmission lines are part of the projects underway in the so-called Peru-Brazil-Bolivia hub. Among the possible impacts, it is expected that there will be a considerable expansion of the deforested area (SoaresFilho et al., 2006).

Basins: Juruá, Purus, Madeira, which together drain an area of about 2 million km^2 and provide about 24% of the total Amazon River flux.

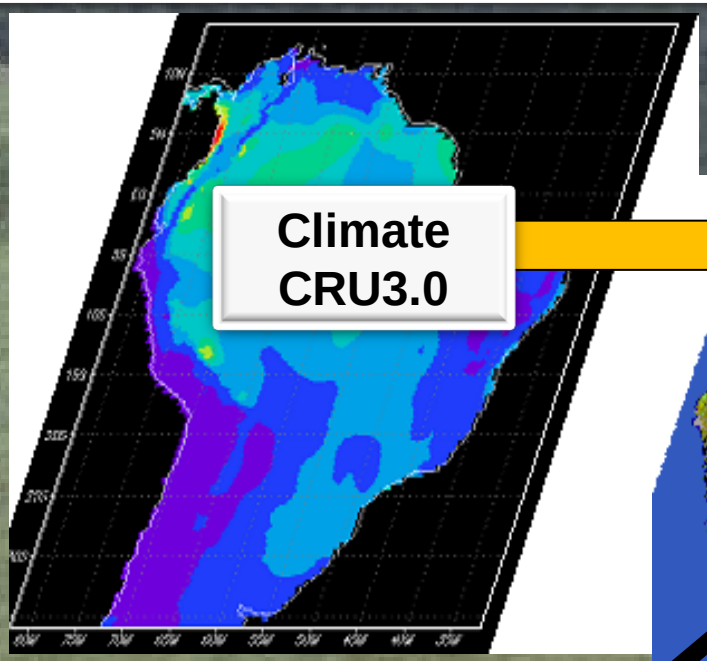
STUDY AREA

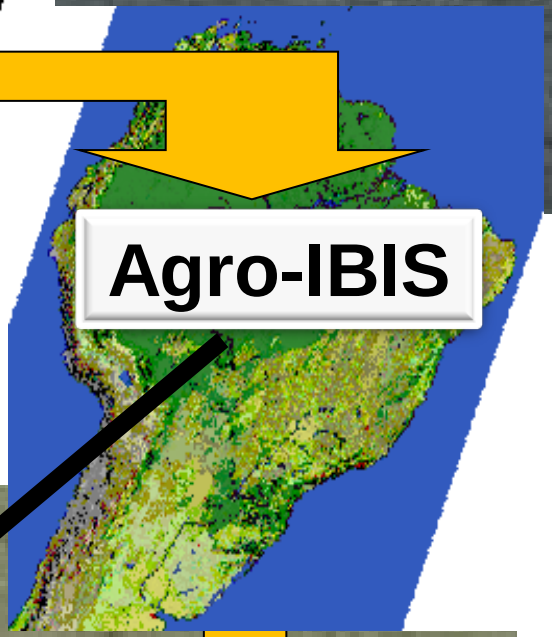


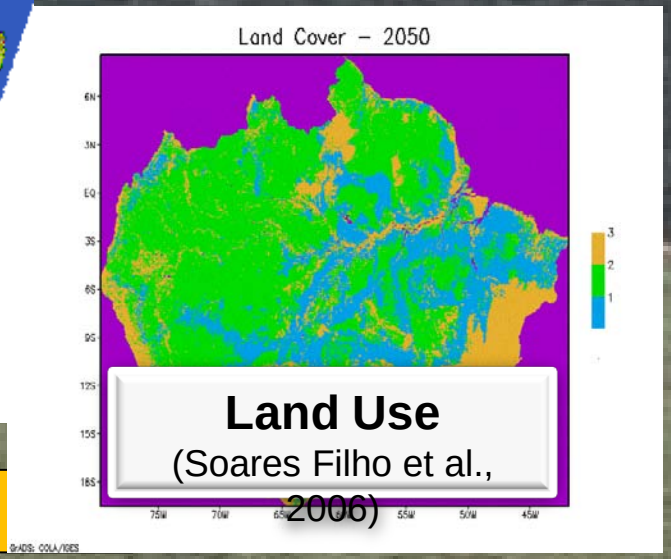
In this study we explore how deforestation throughout the Amazon impacts the seasonal and annual hydrological cycle.

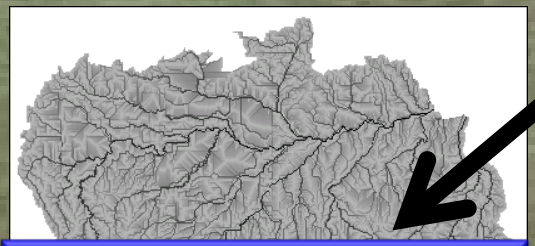
We use the IBIS (integrated biosphere model) in two modes:

(i) offline simulations with IBIS (no climate feedback)







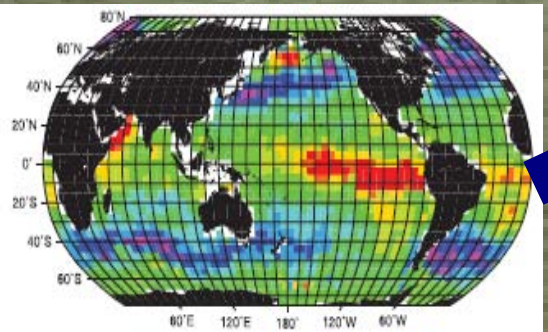


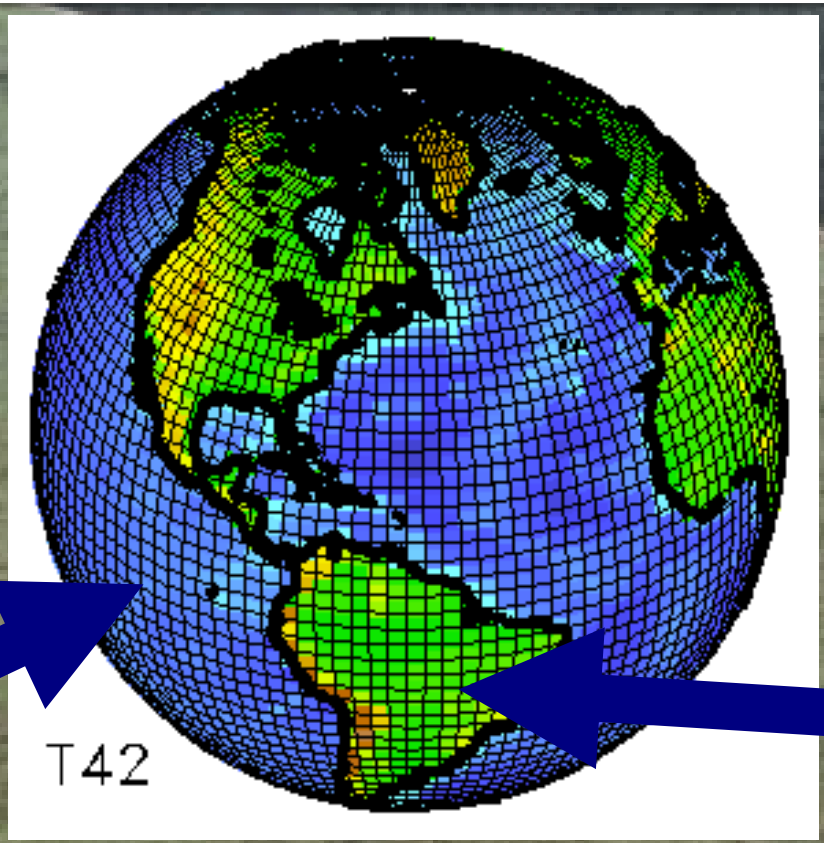
(THMB)
Terrestrial Hydrology Model with Biogeochemistry

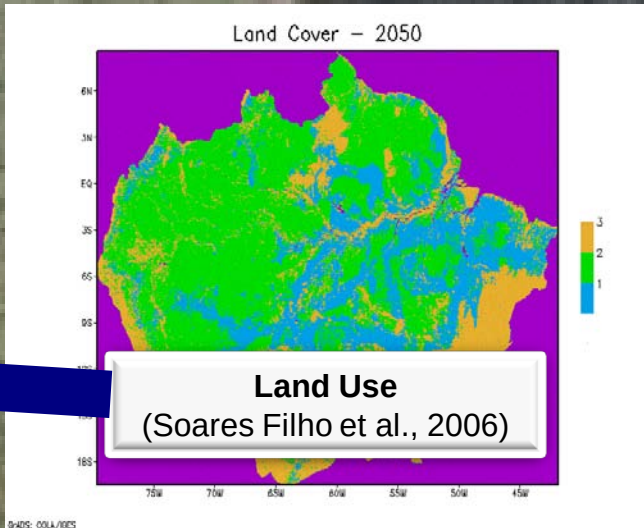
In this study we explore how deforestation throughout the Amazon impacts the seasonal and annual hydrological cycle.

We use the IBIS (integrated biosphere model) in two modes:

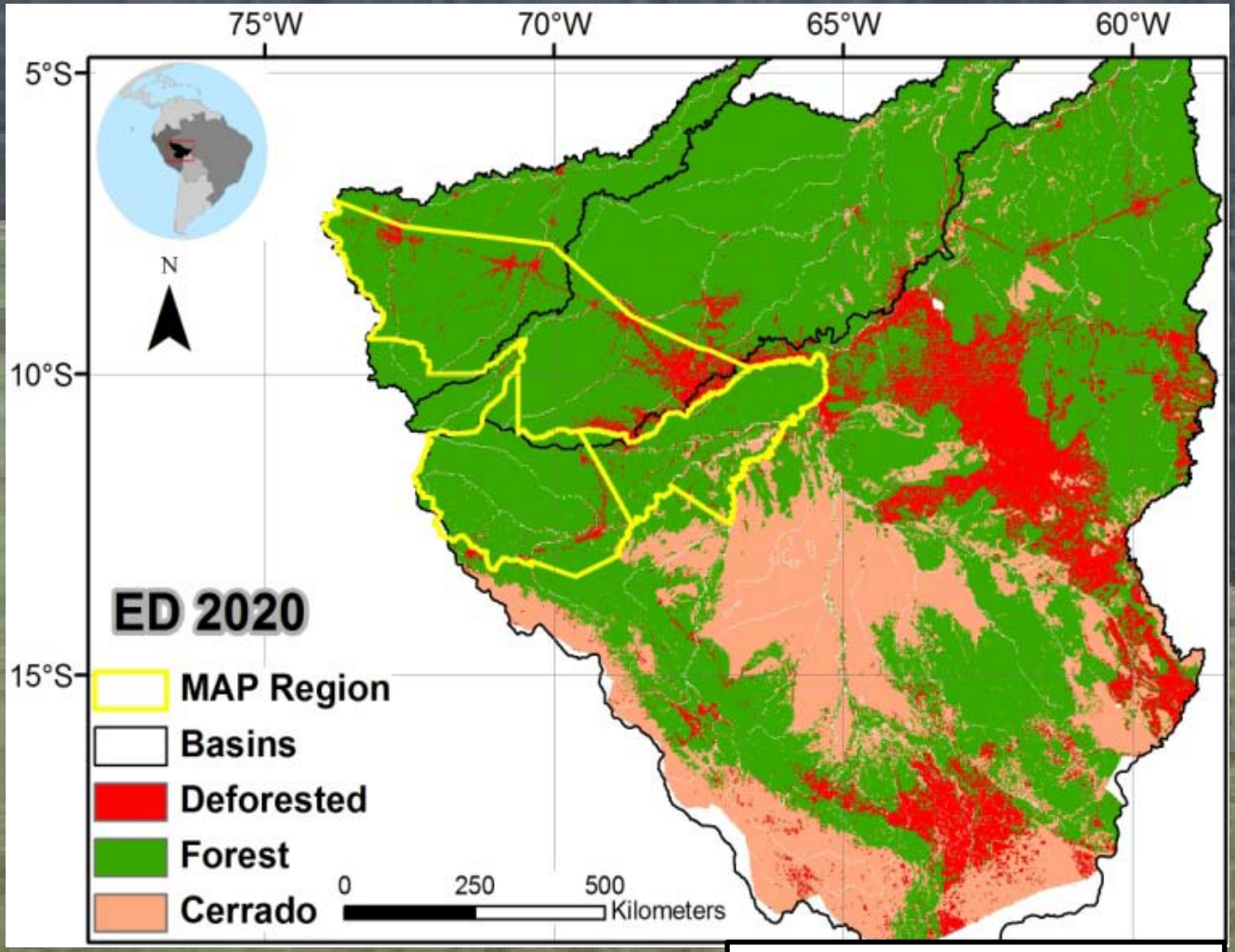
(ii) IBIS coupled to the National Center for Atmospheric Research Community Climate Model 3 (CCM3), to simulate the response of the atmosphere to the land use (climate feedbacks).





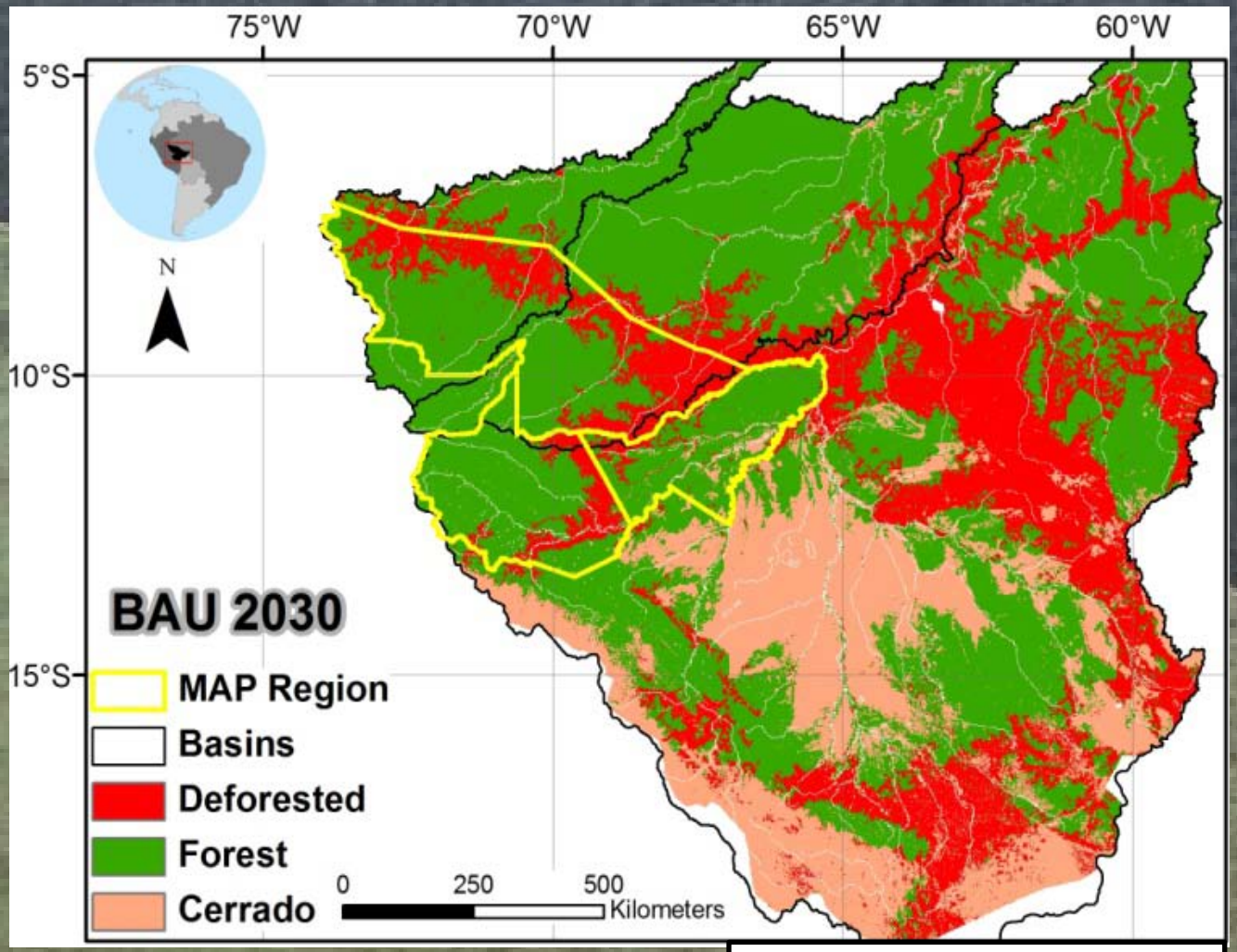


Deforestation Scenarios



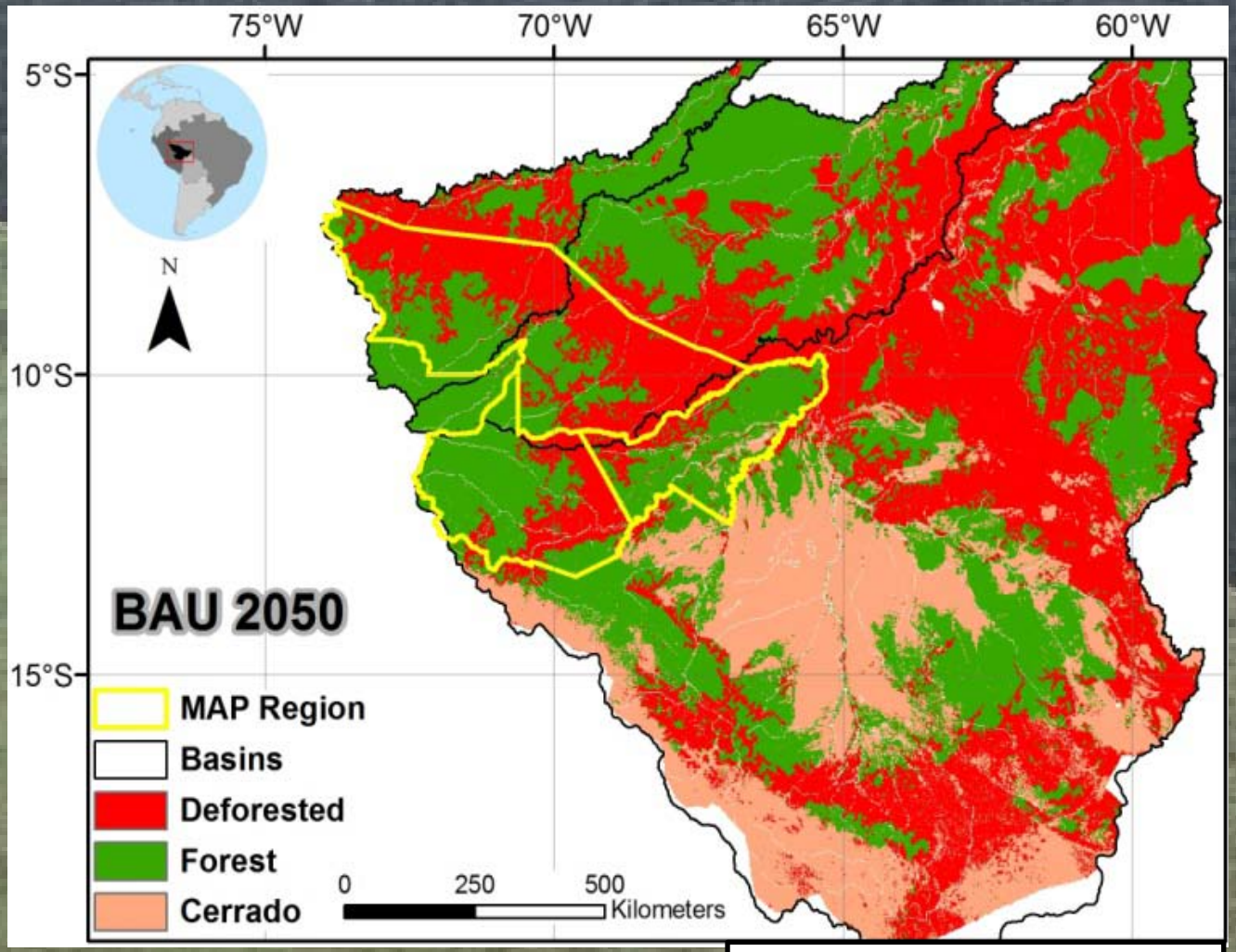
(Soares Filho et al., 2006)

Deforestation Scenarios



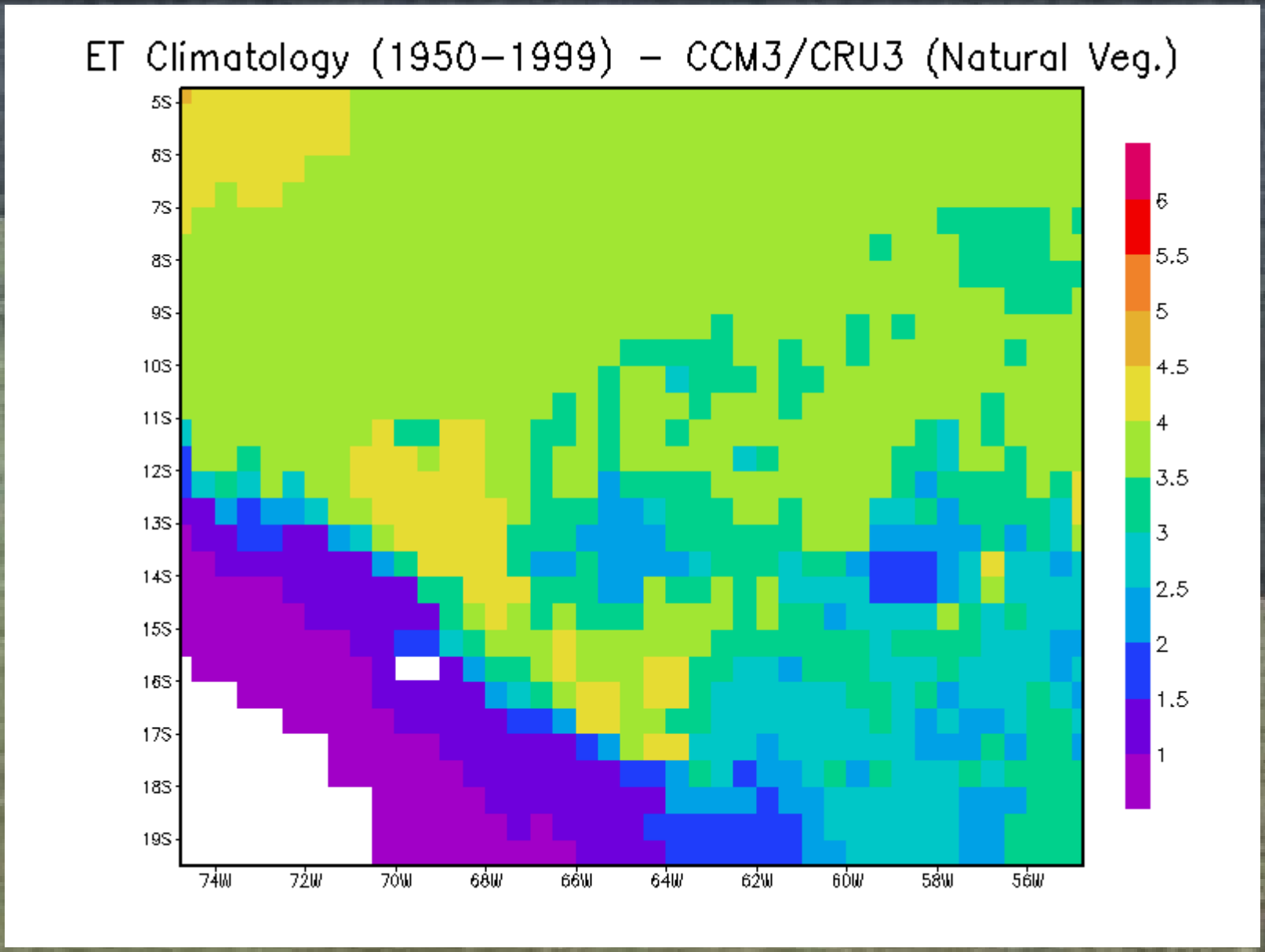
(Soares Filho et al., 2006)

Deforestation Scenarios

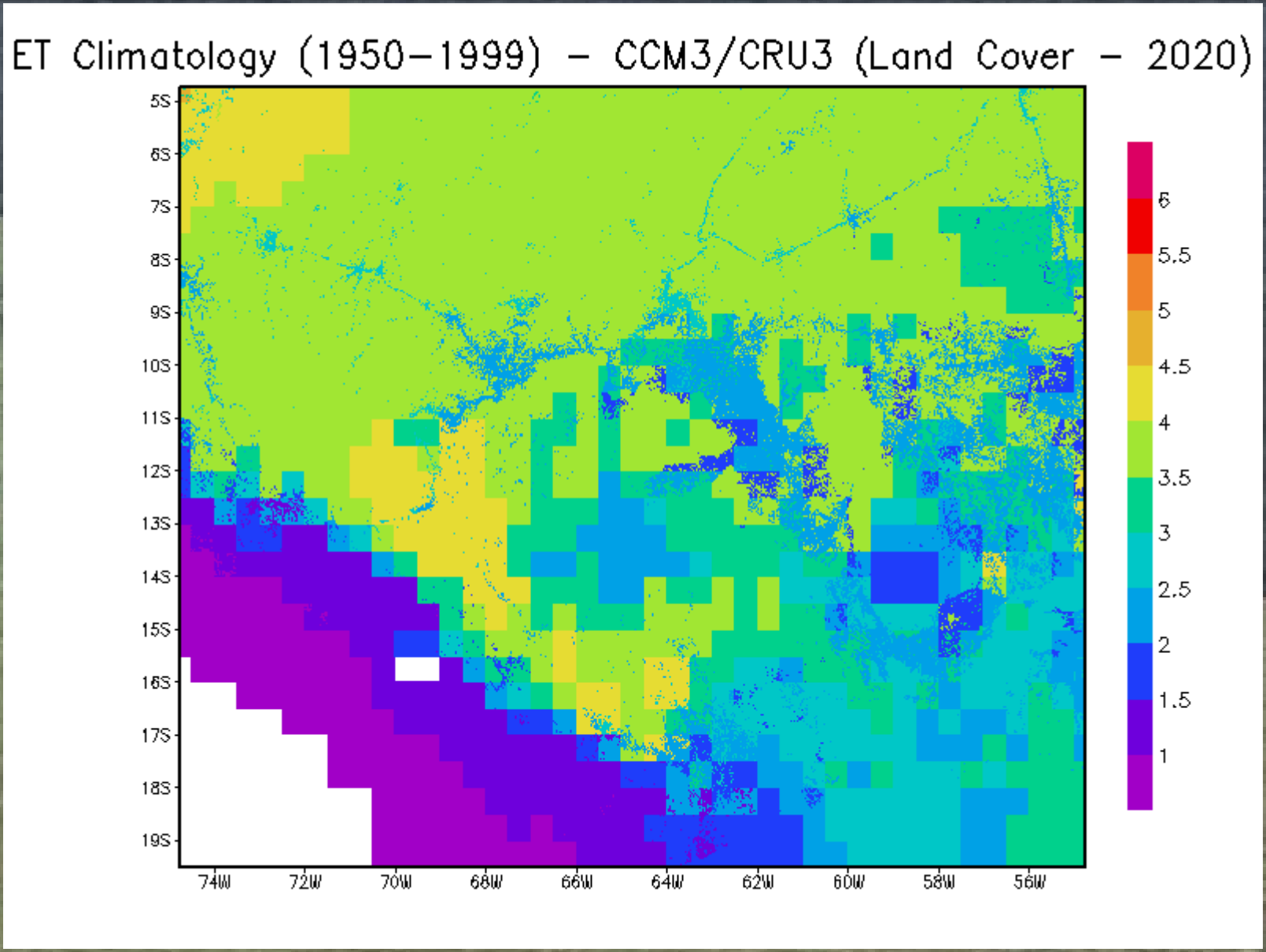


(Soares Filho et al., 2006)

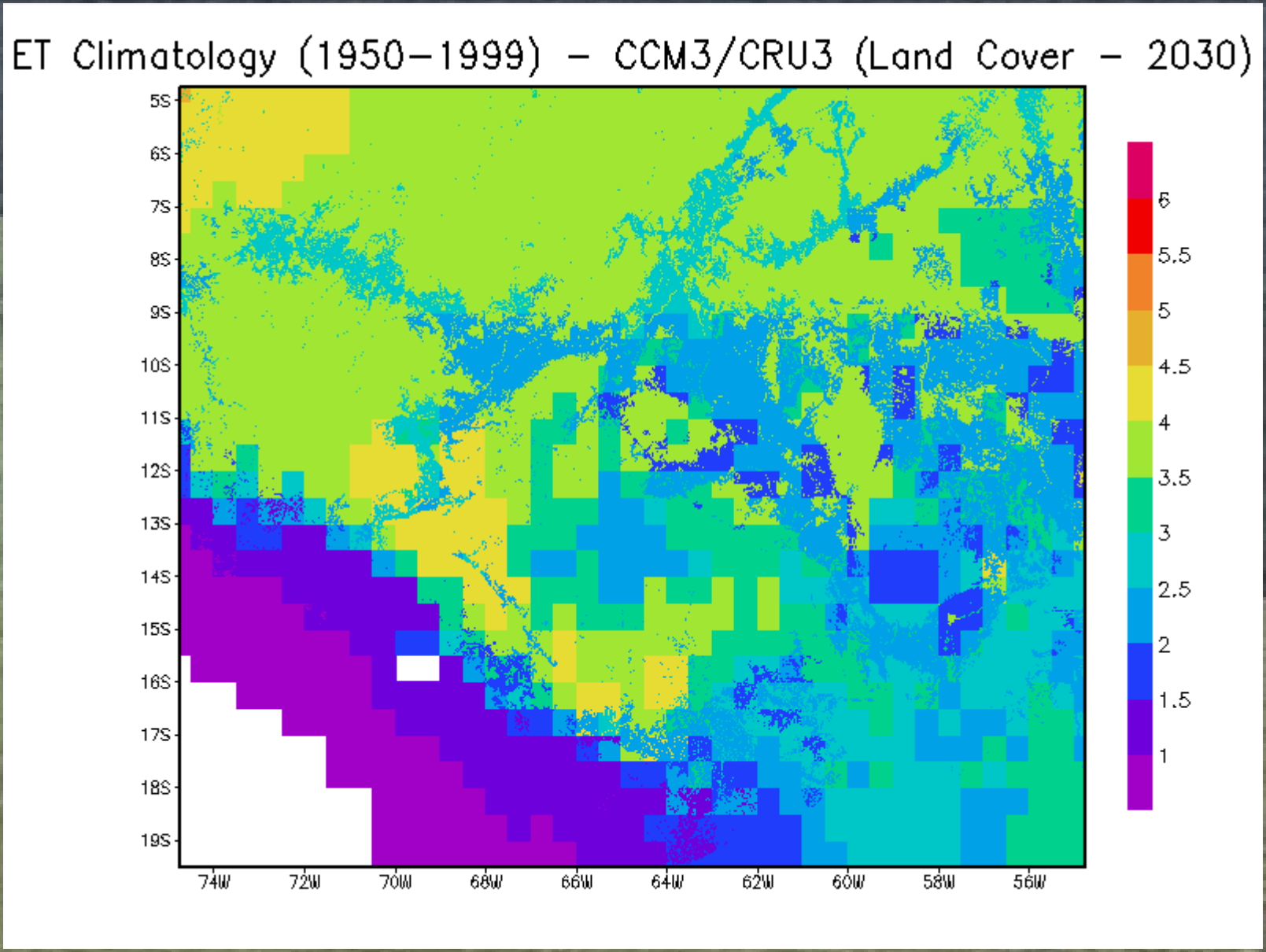
No Climate feedback



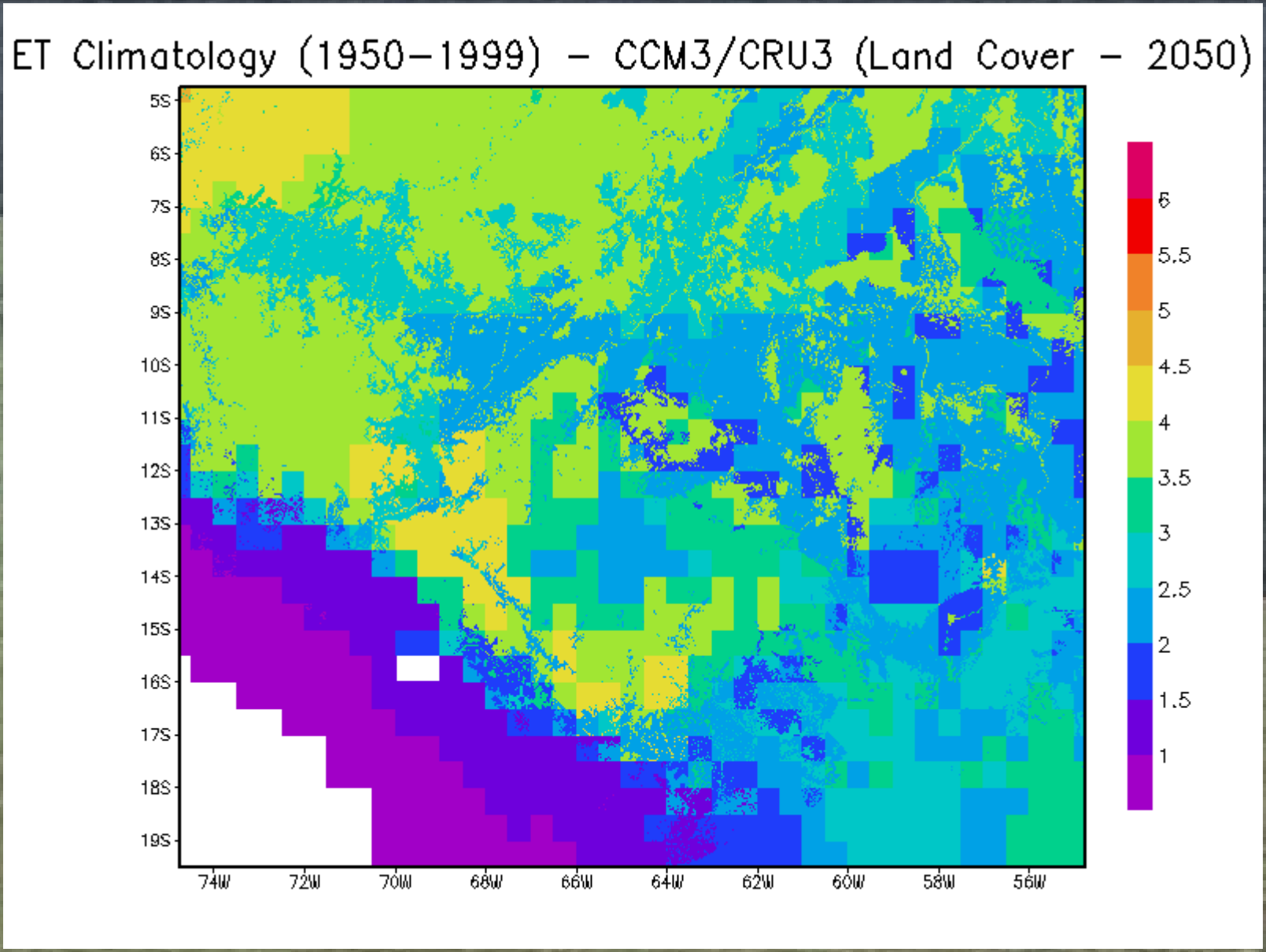
No Climate feedback



No Climate feedback

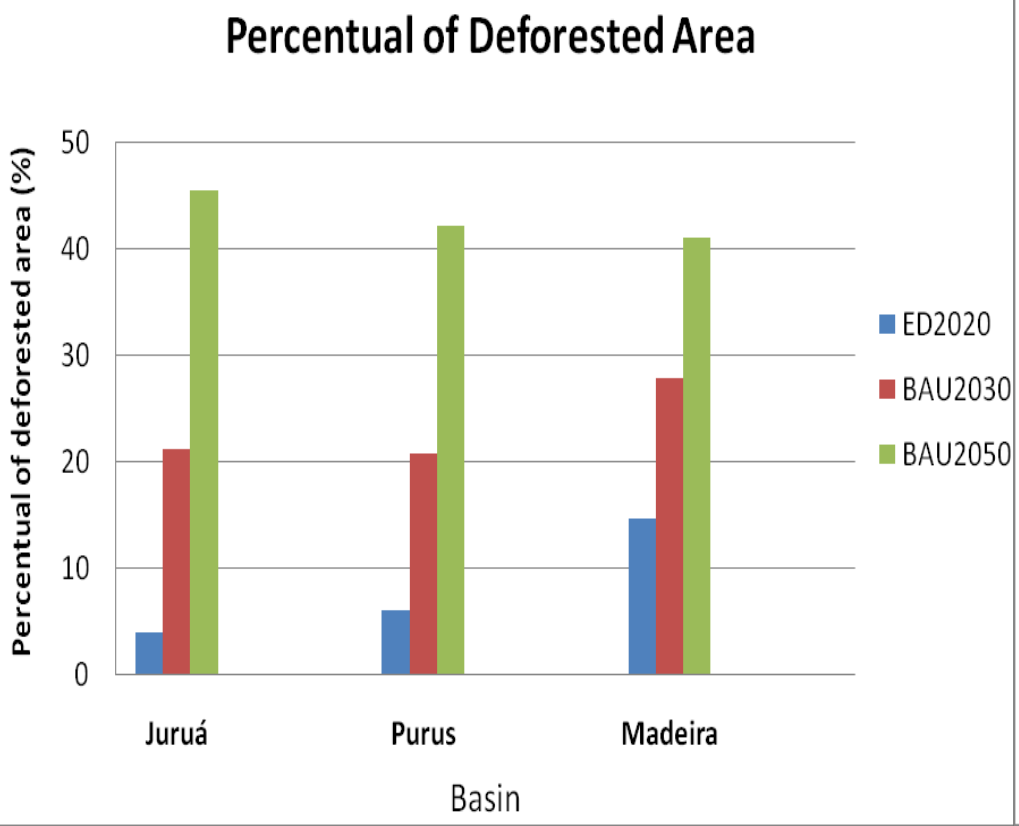


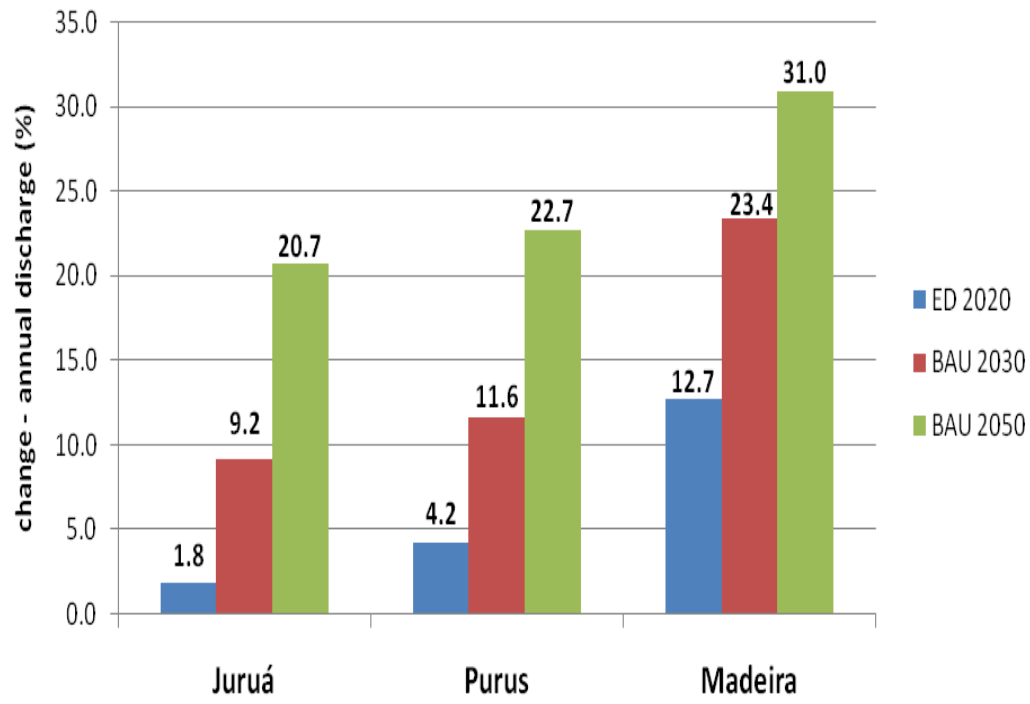
No Climate feedback



No Climate feedback

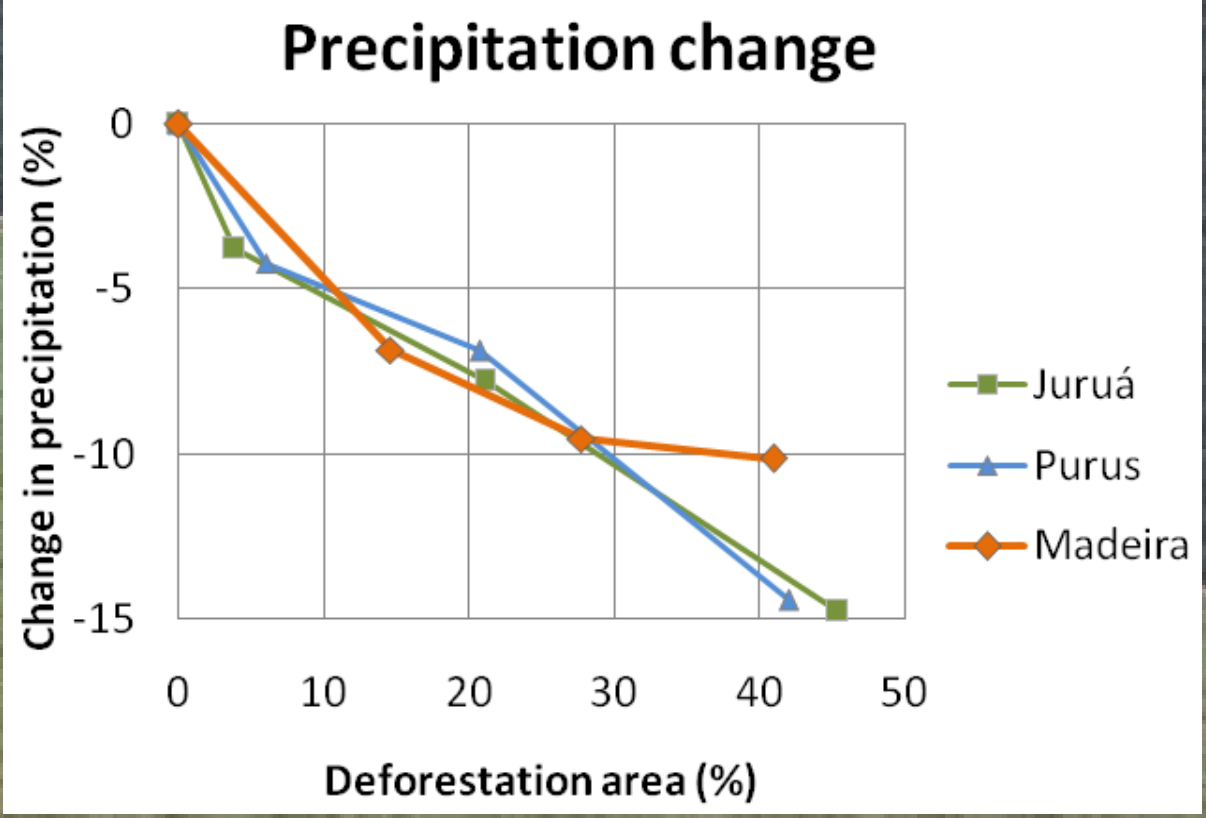
- Simulations with the land cover scenarios show a decrease in ET rates that is proportional to the deforested area in the basin
- In the absence of climate feedbacks river discharge increases significantly in the three basins as a result of ET decrease





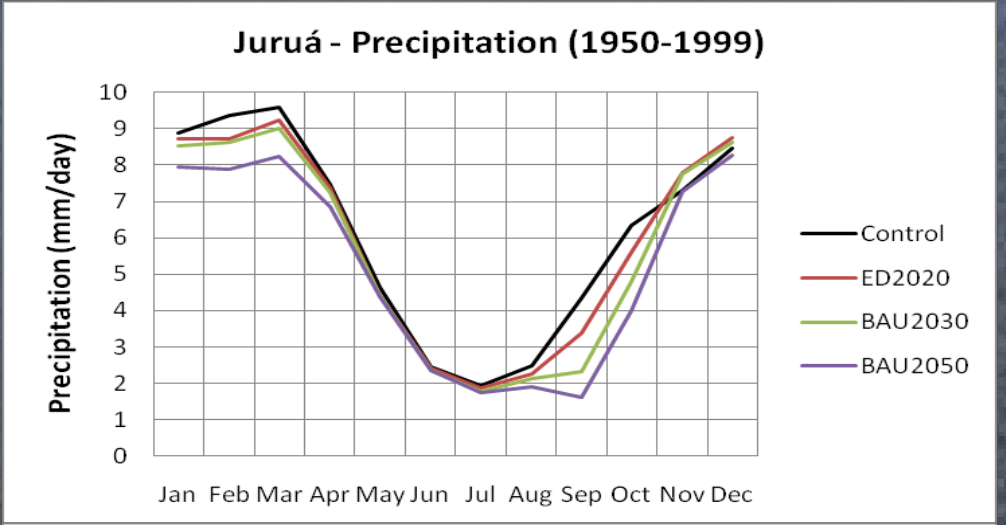
CCM3-IBIS **with** climate feedback

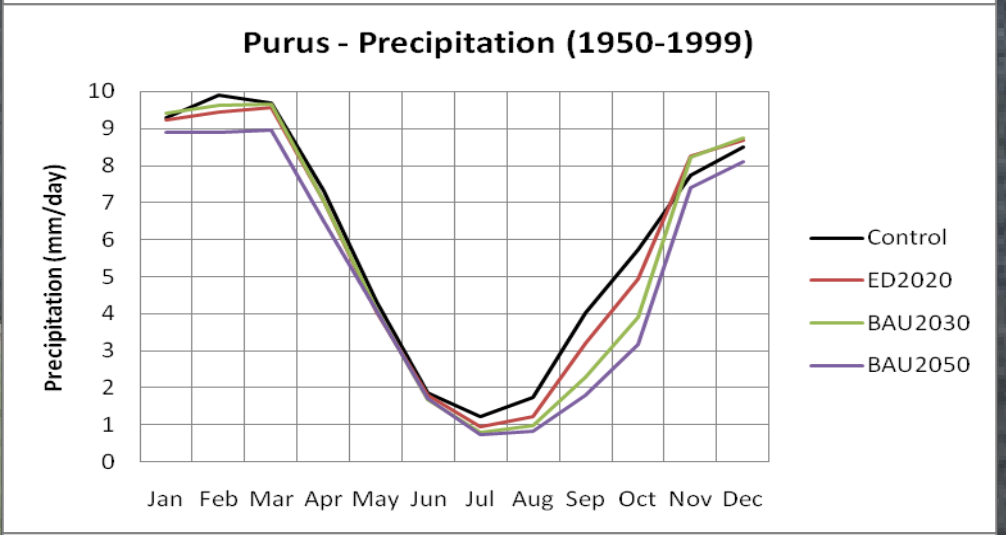
The results of the simulation show a progressive reduction in simulated annual mean precipitation compared to the CTL simulation that is roughly proportional to the deforested area in the Amazon basin in each scenario

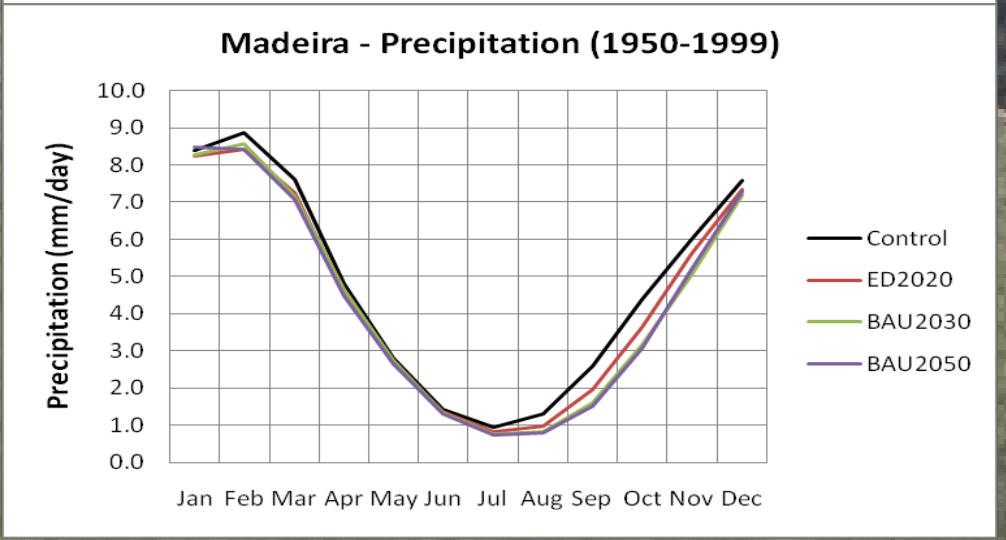


Precipitation: monthly changes
These results refer to the simulations with climate feedback by CCM3

The impacts of deforestation on precipitation rates is greatest during the transition between dry and wet season (September, October and November), when the anomalies are intense for the three basins.

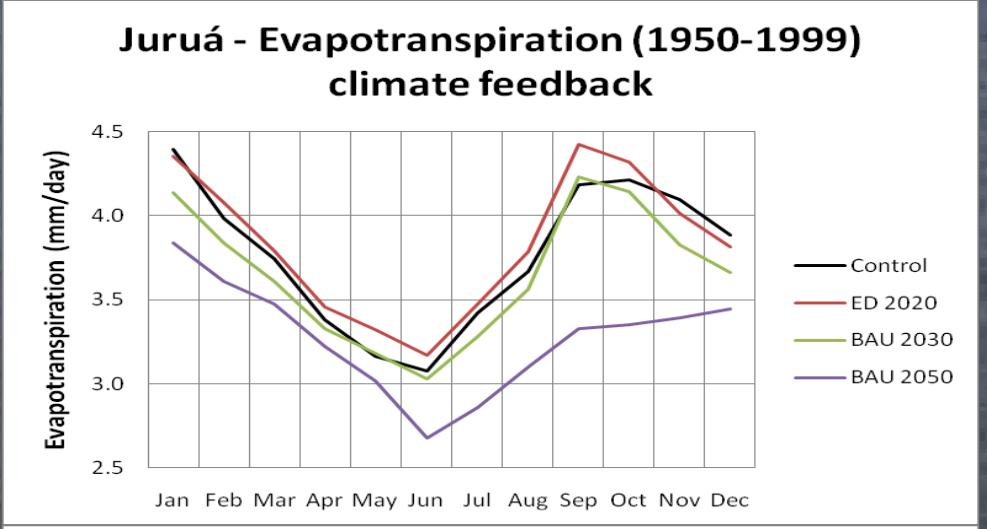


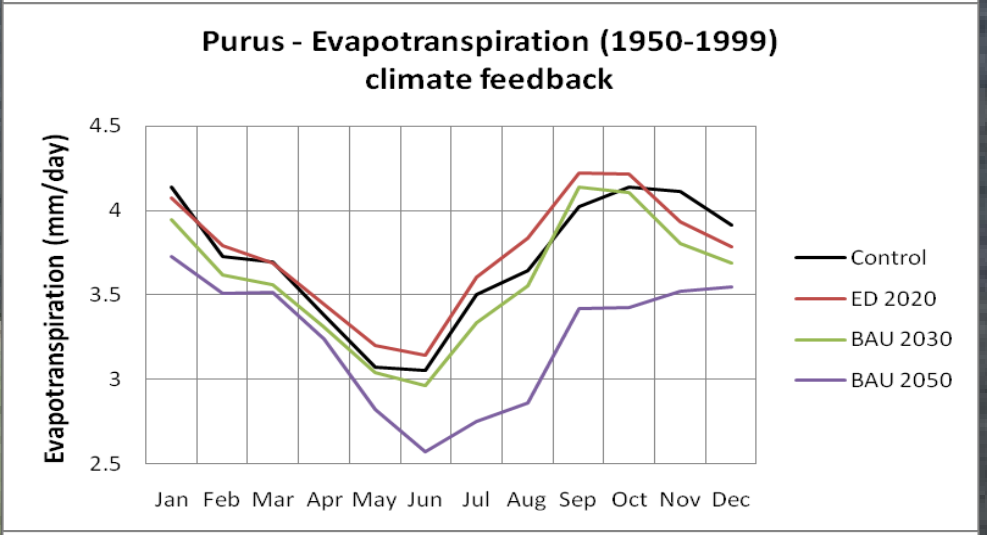


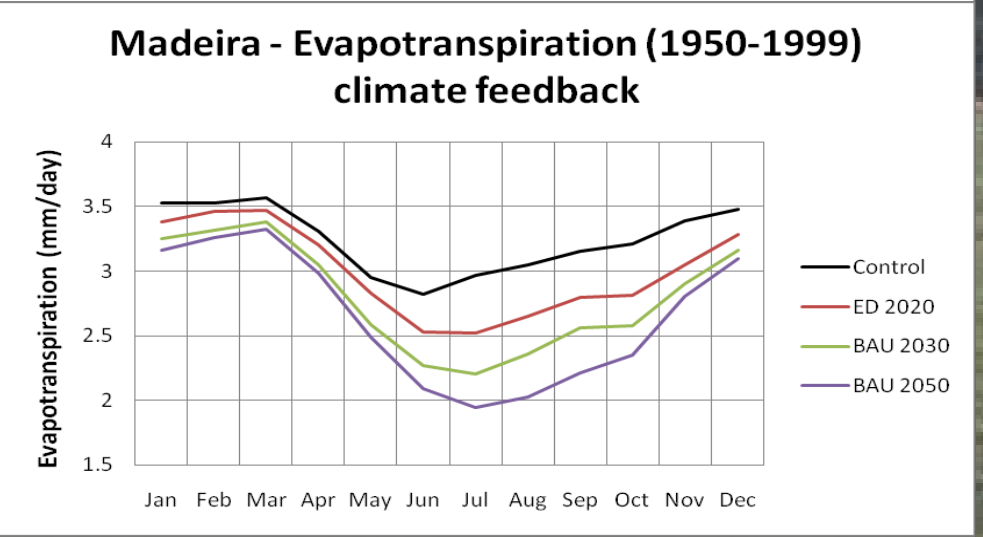


Evapotranspiration: monthly changes

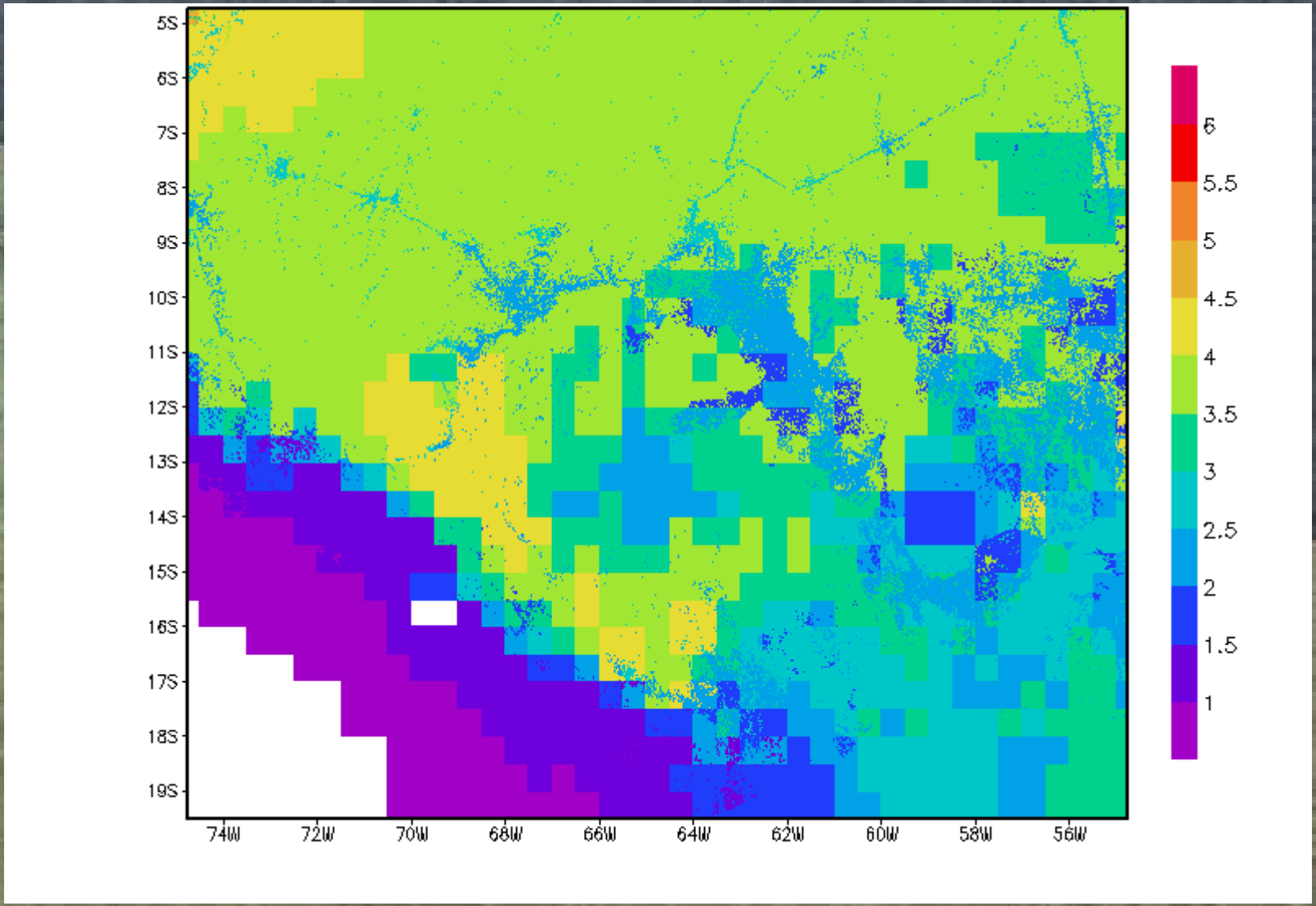
- The simulations show an overall reduction of ET for the three basins.
- The higher evapotranspiration reduction over Madeira basin may be partially explained by the negative temperature anomaly simulated by the CCM3, while over the Purus and JuruáCCM3 simulated positive temperature anomalies.



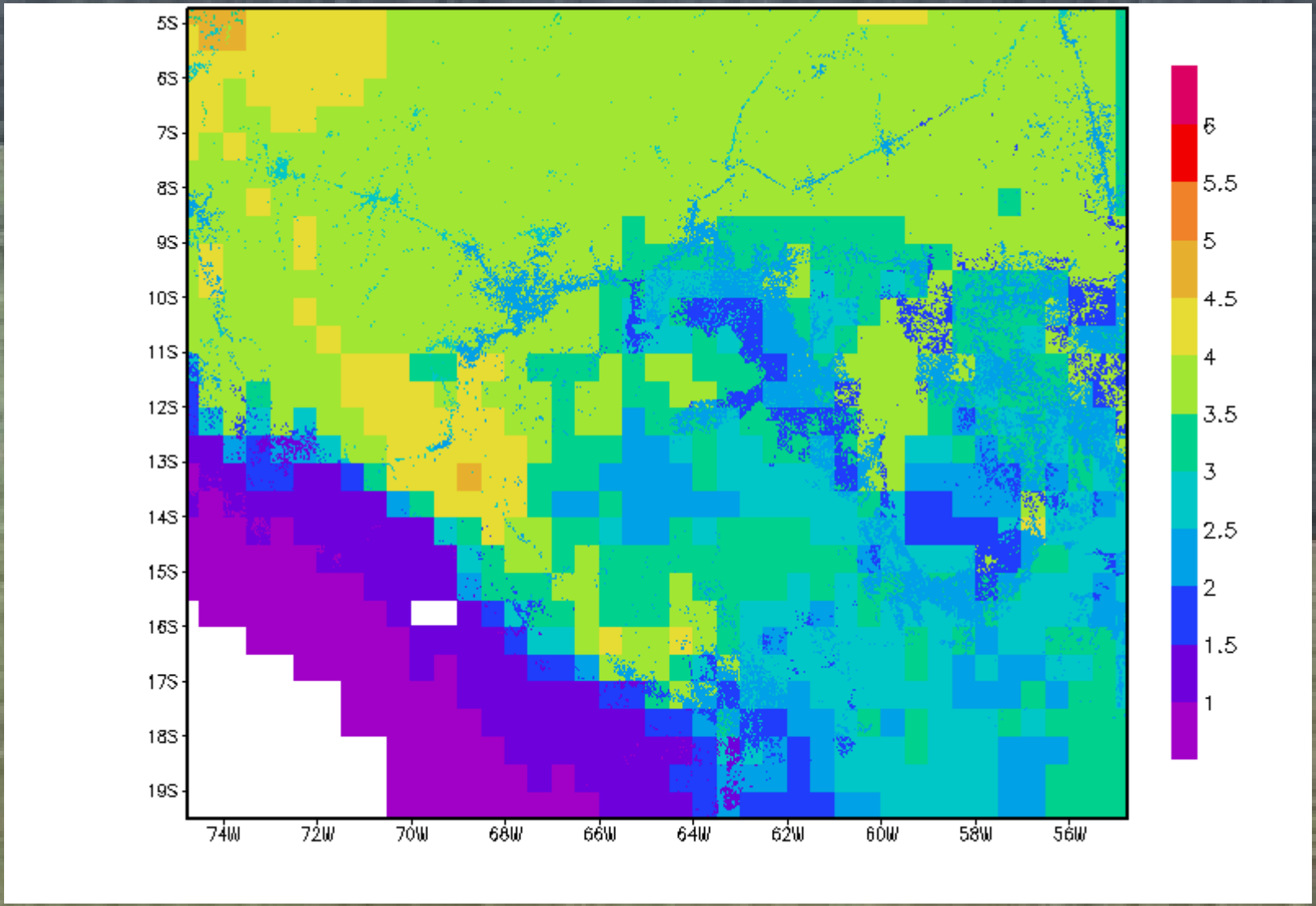




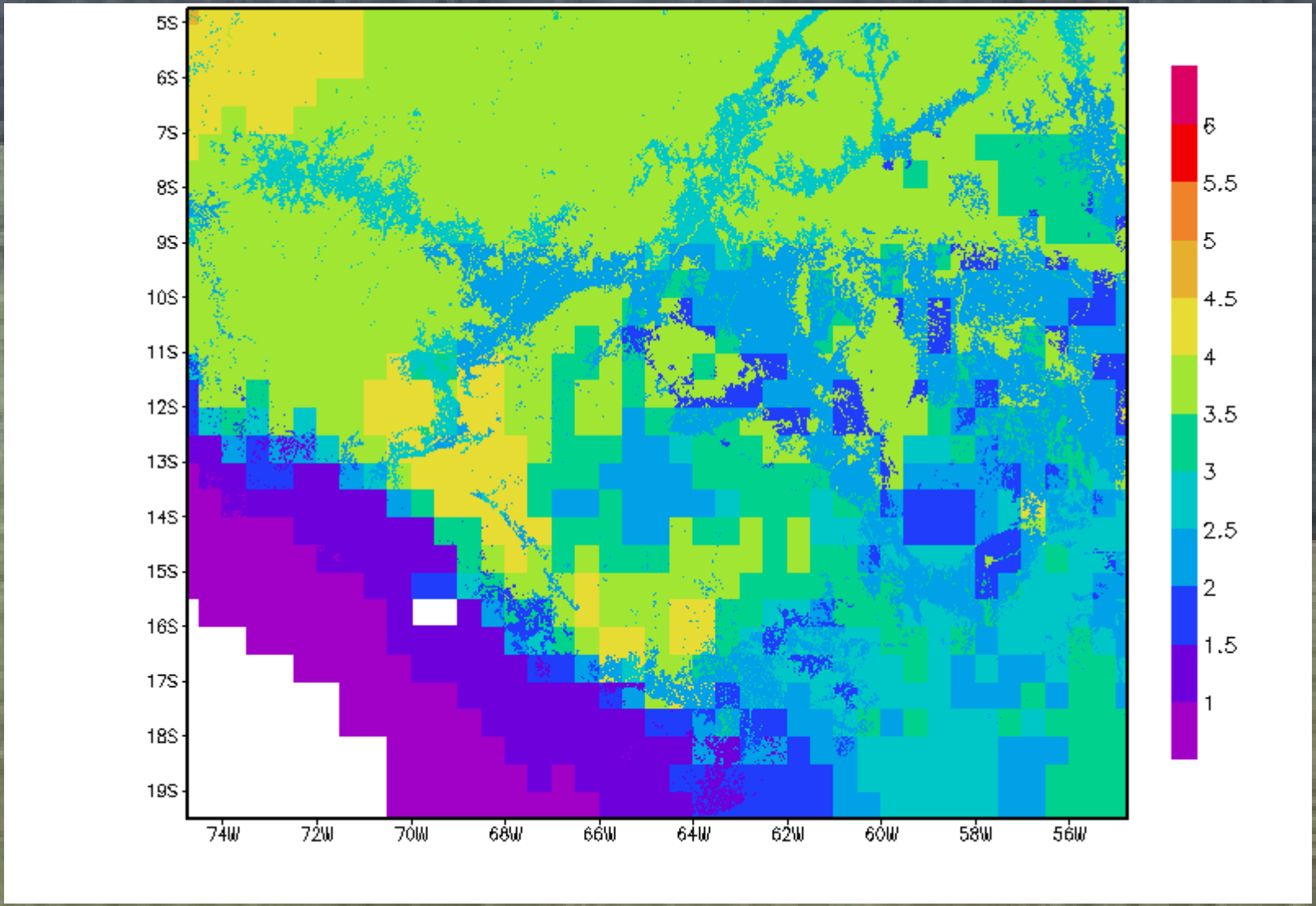
No Climate feedback



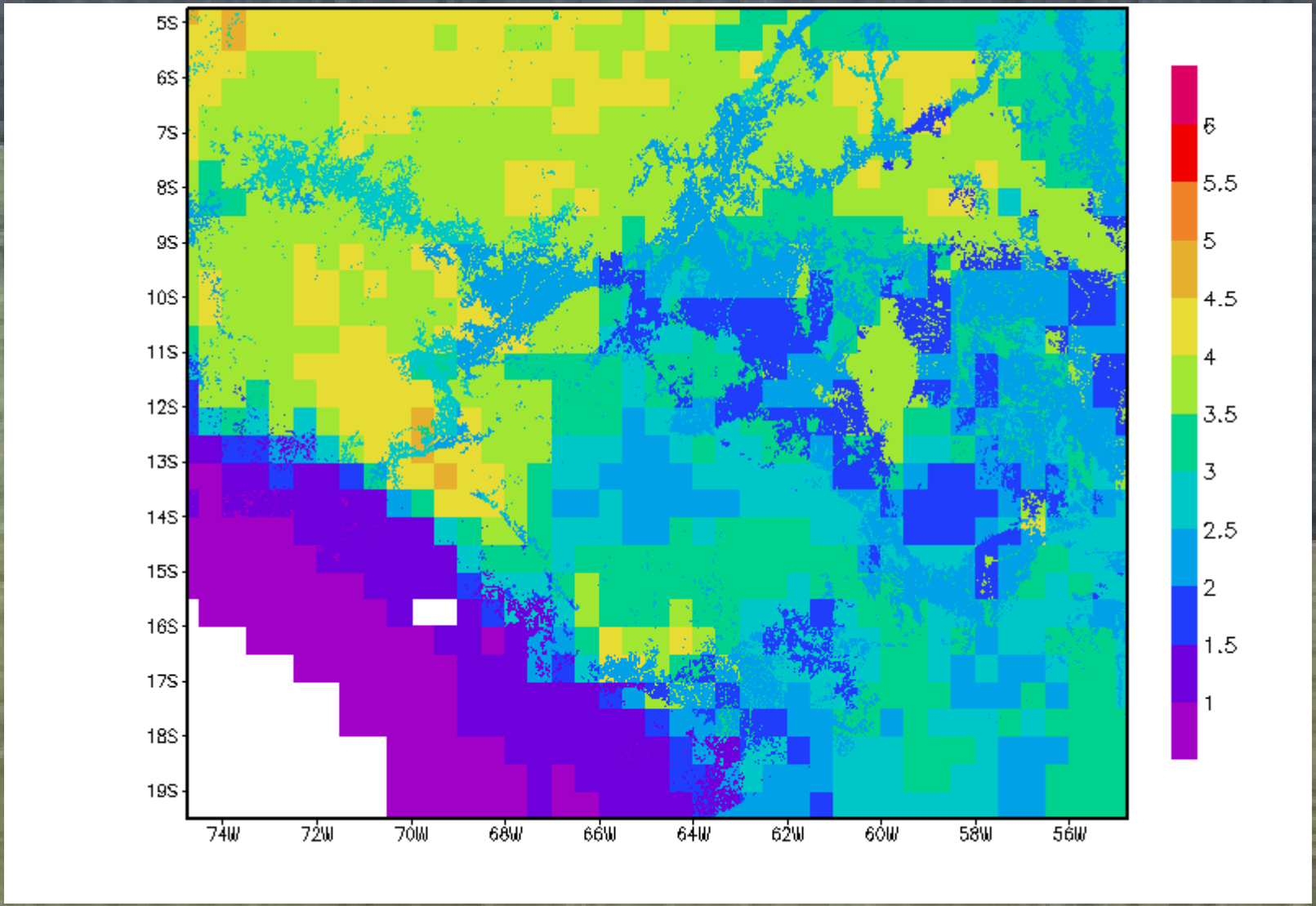
With Climate feedback



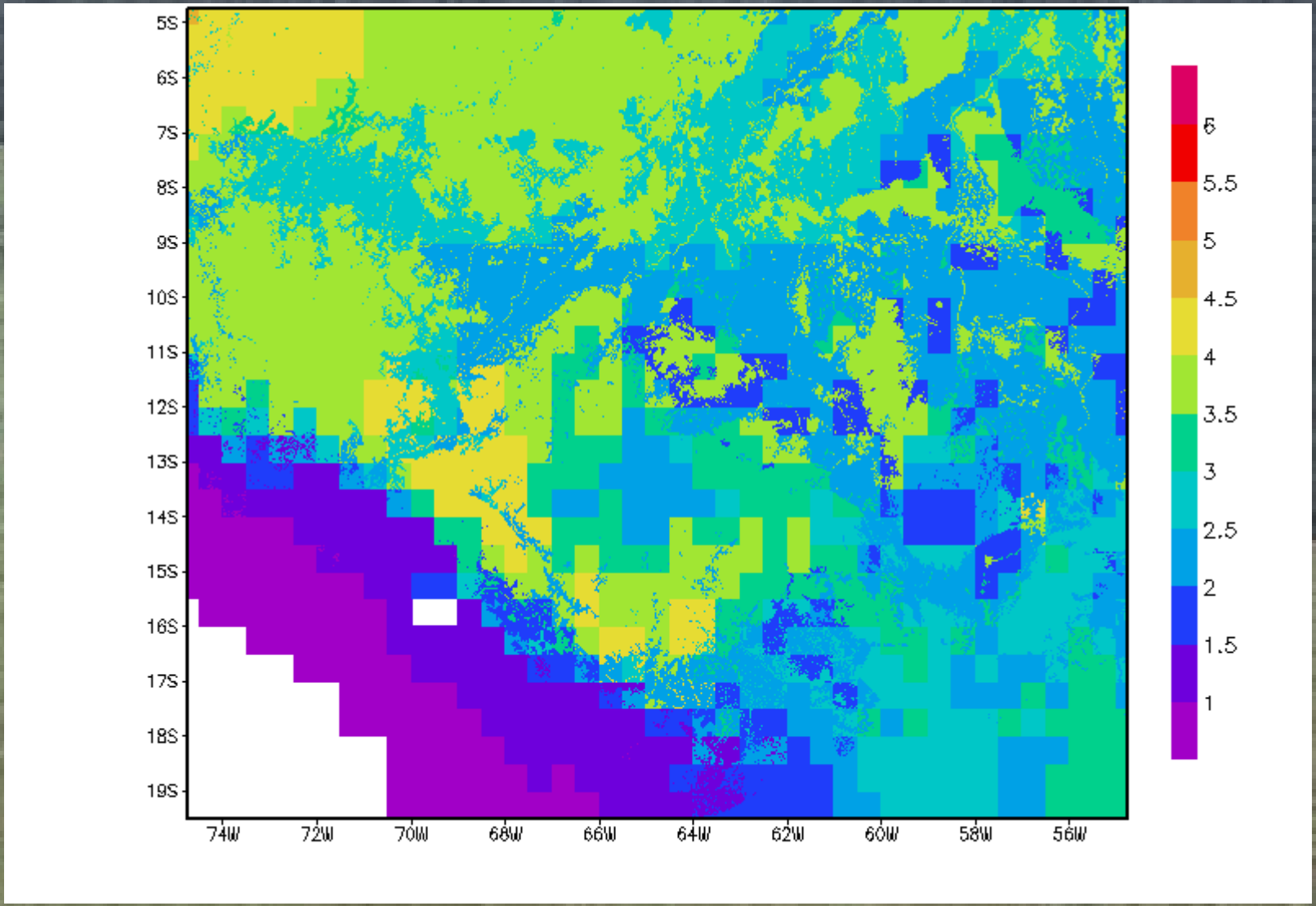
No Climate feedback



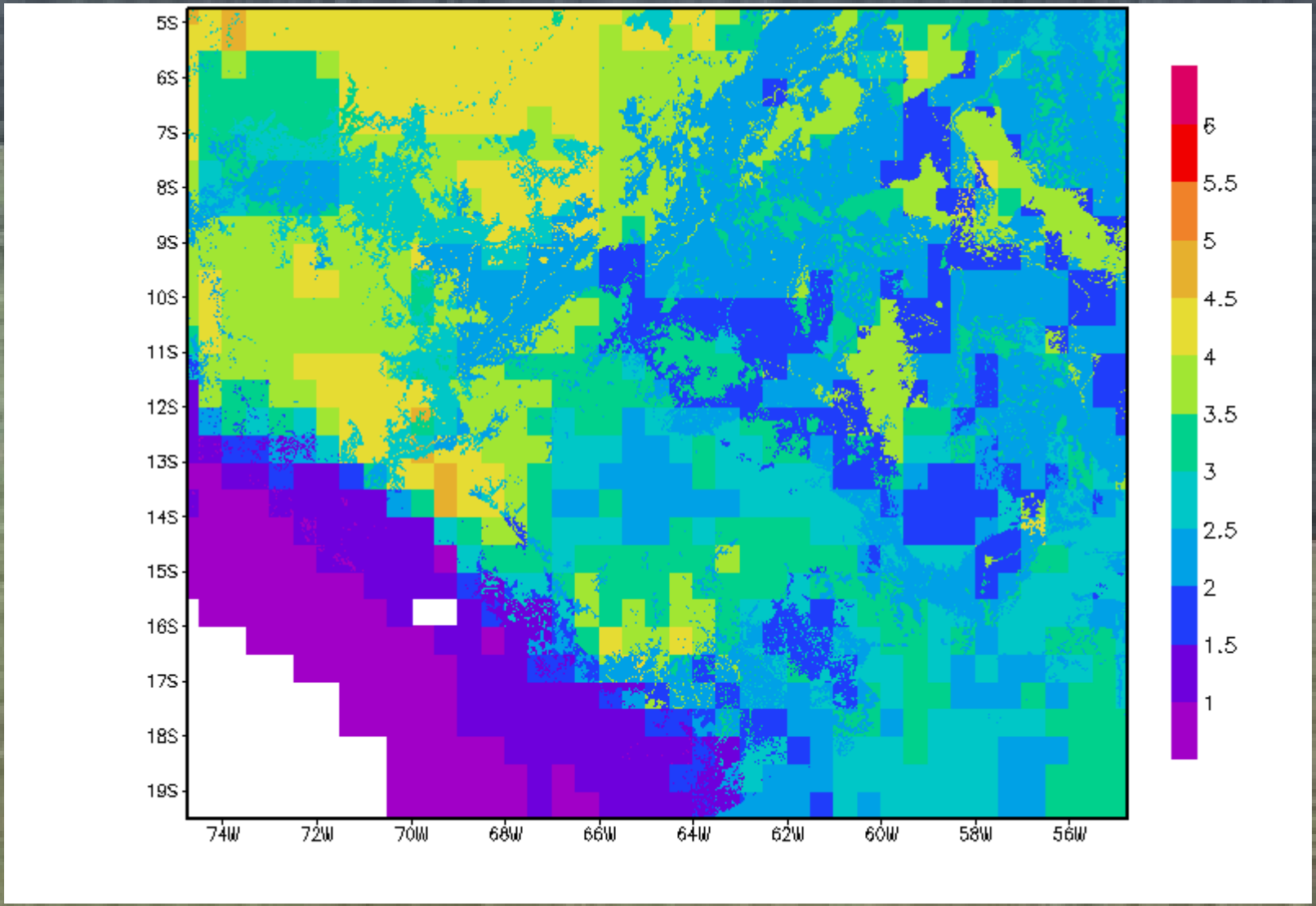
With Climate feedback



No Climate feedback

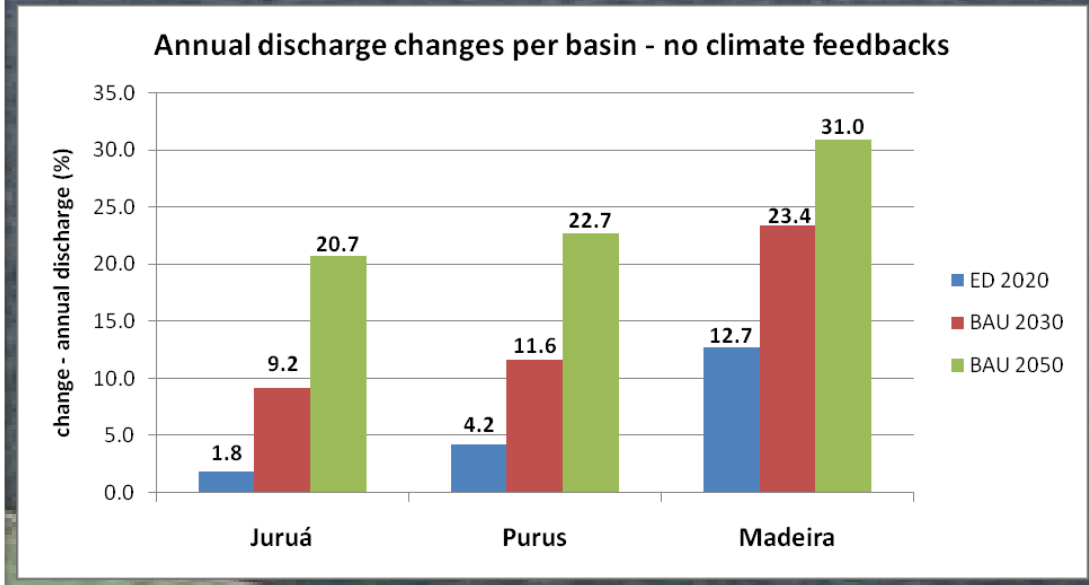


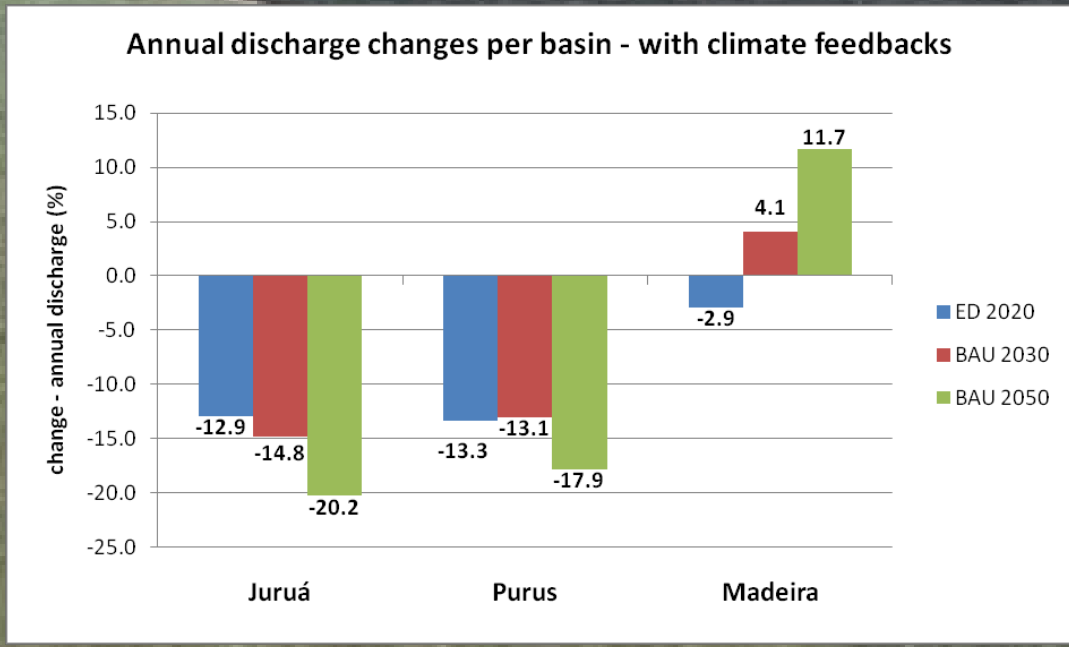
With Climate feedback



Conclusions

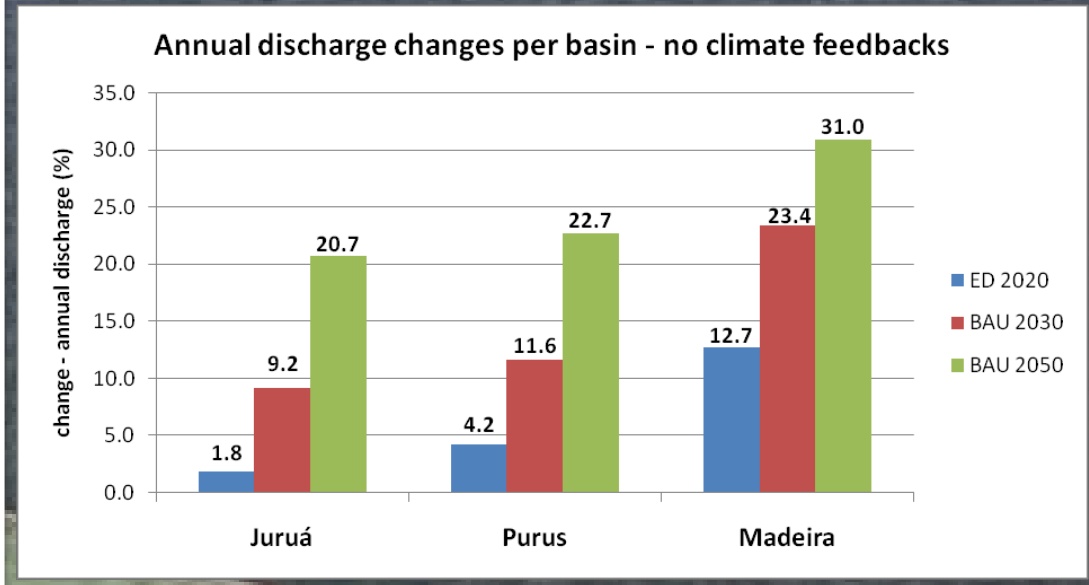
- With climate feedbacks interactions between the land surface and atmospheric circulation and convection over the Amazon basin resulted in complex changes – high spatial variability.
- Usually, the outcome of these impacts in the surface runoff and, consequently, on river regimes are more difficult to predict (Costa & Foley, 2000), because they result from the complex interactions between the precipitation, evapotranspiration and soil moisture anomalies.

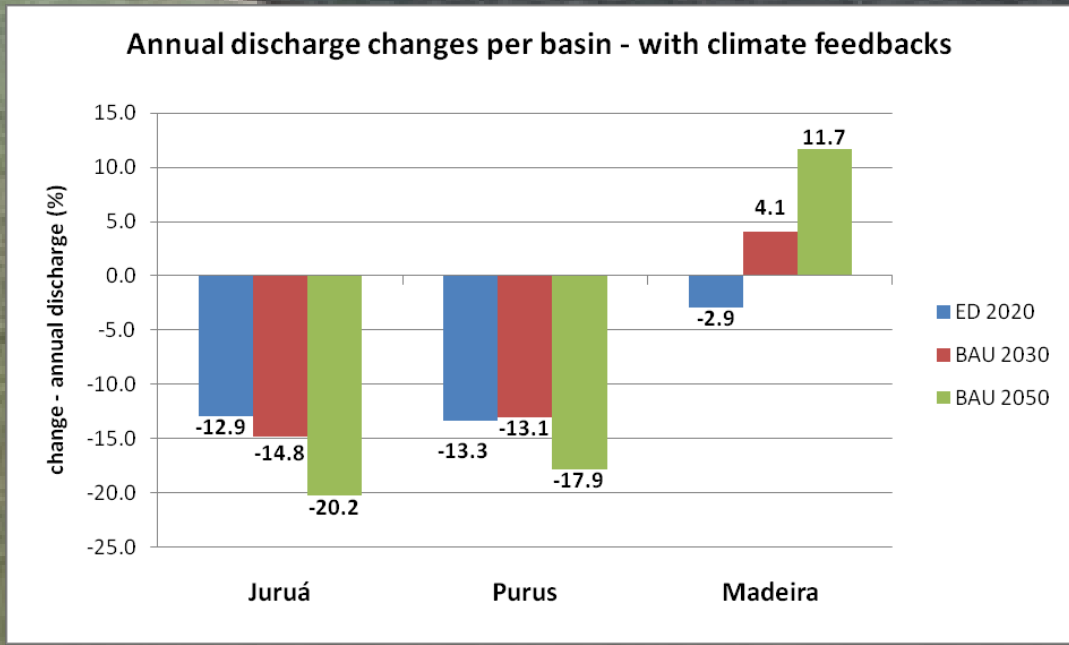




Conclusions

- On a local scale deforestation could cause a direct increase in surface runoff due to the reduction of ET.
- However, on a large scale the climate feedbacks derived from land use changes and atmospheric dynamics could also lead to a reduction in precipitation.
- The net effect of land use changes on river regimes depends on the heterogeneity, extent and spatial pattern of the deforested area.

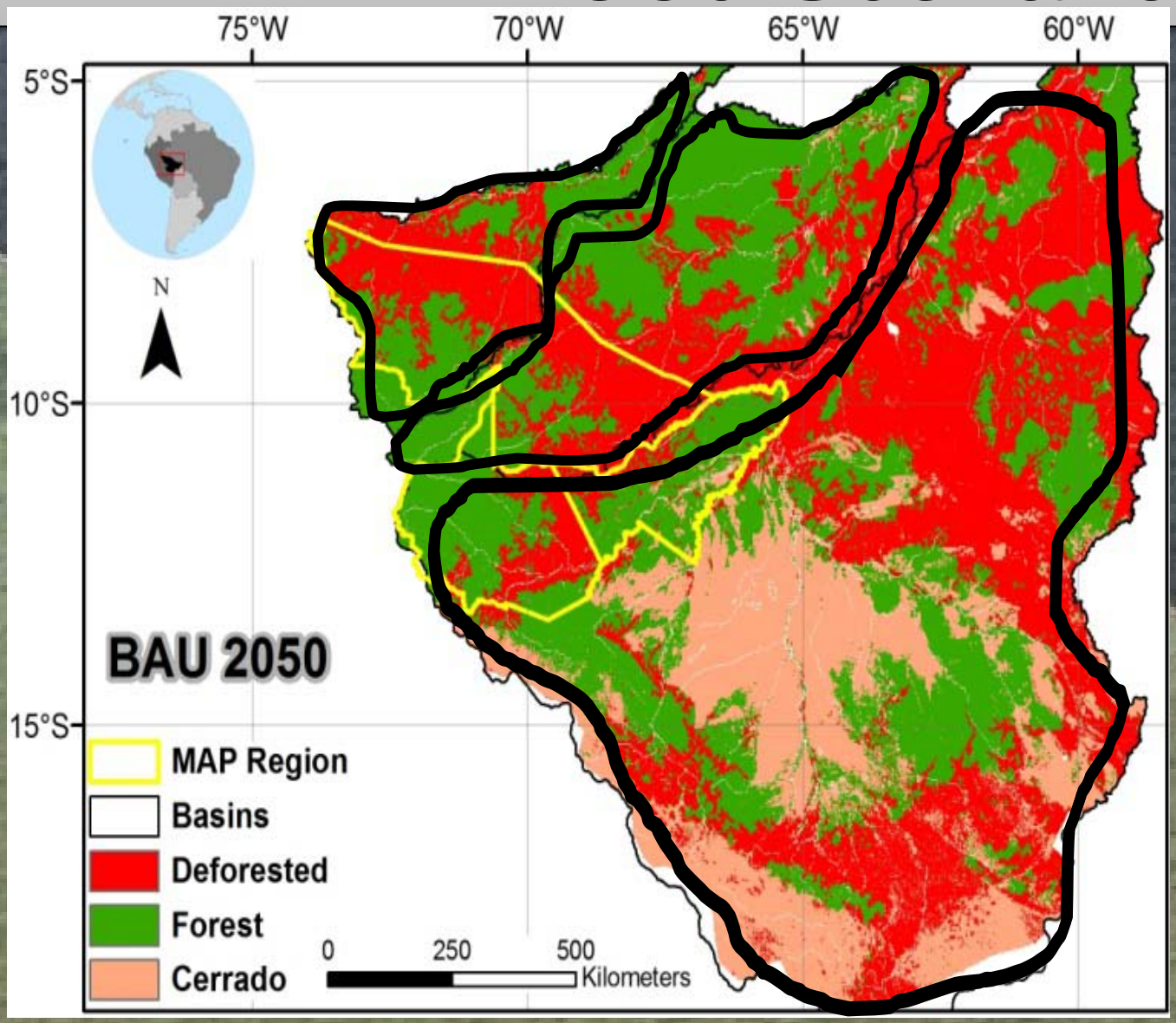




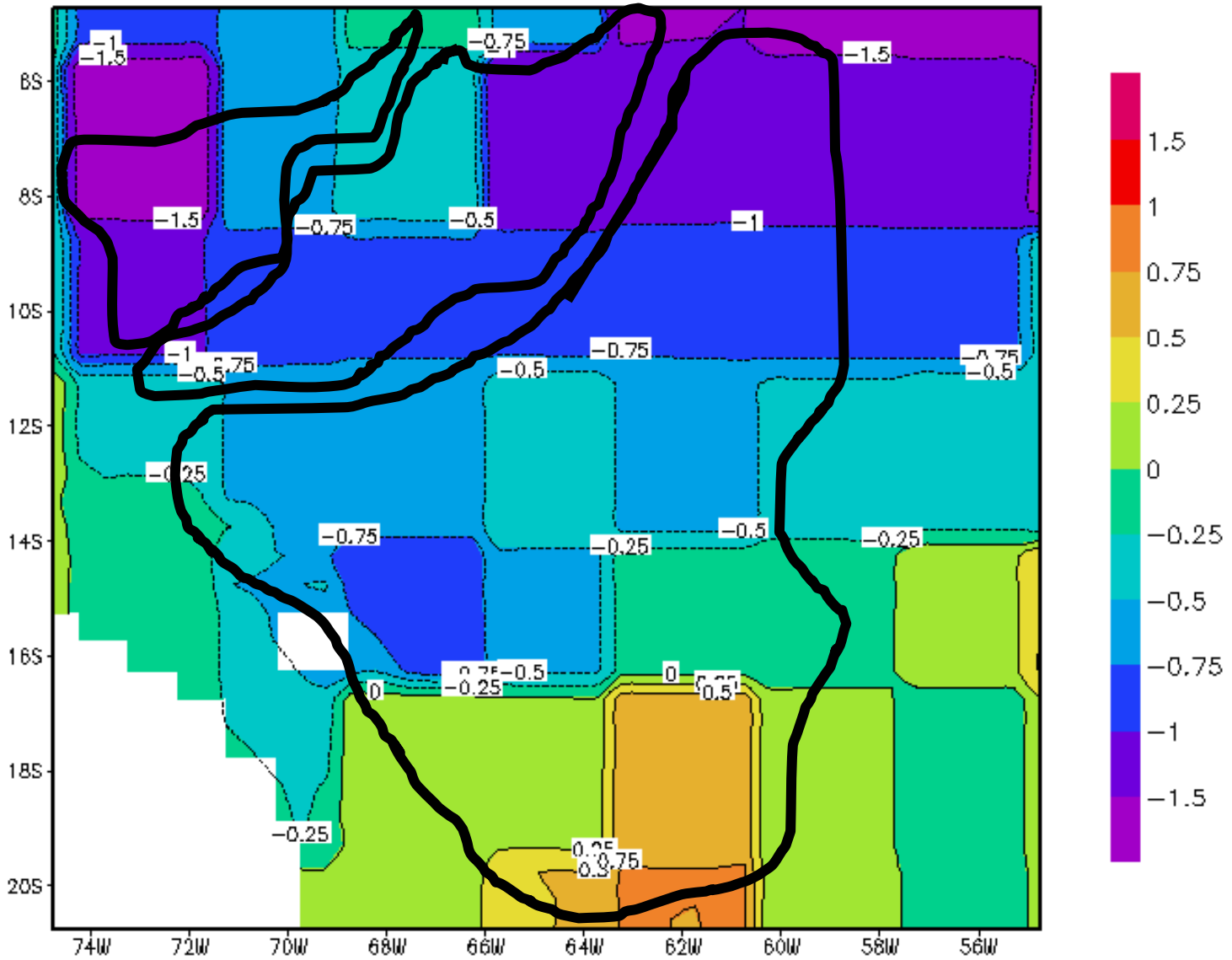
Thanks.

Contacts: santaigosub@gmail.com

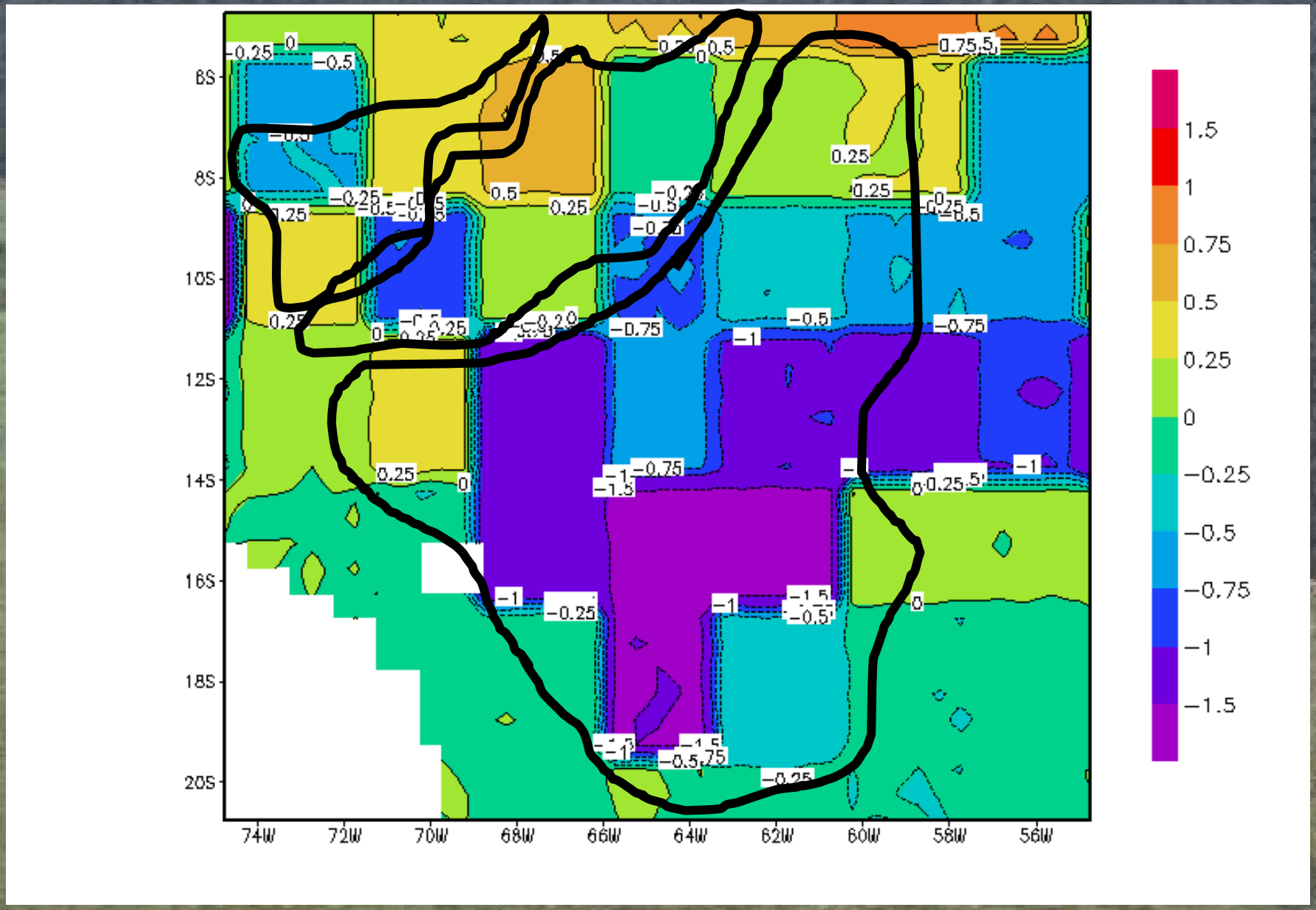
Spatial pattern of Anomalies for the BAU50 Scenario



Precipitation Anomaly



Temperature Anomaly



Evapotranspiration Anomaly