

# Climatic seasonality and land use dynamics in the Amazonia

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# Background

- Modelling analyses have predicted climate change causing increased drought frequency in Amazonia (Li et al., 2006).
- Drought may have direct impacts on vegetation phenology, physiology, structure and composition of Amazonian forests (Laurance & Williamson 2001; Nepstad et al. 2004 and others).
- When these conditions are combined with intense forest degradation by logging and deforestation, the risk of forest fires can increase dramatically in Amazonia (Cochrane et al. 1999; Cochrane & Schulze 1999; Uhl & Kauffman 1990).
- Understand the interplay between climate and land use dynamics is currently a fundamental concern for assessing the vulnerability of Amazonia to climate change.

# Questions

1. How the 2005 drought affected spatial fire patterns in Amazonia?
2. What are the connections among climate, deforestation and fire?



# Where are the most impacted forest areas in the Amazon basin?

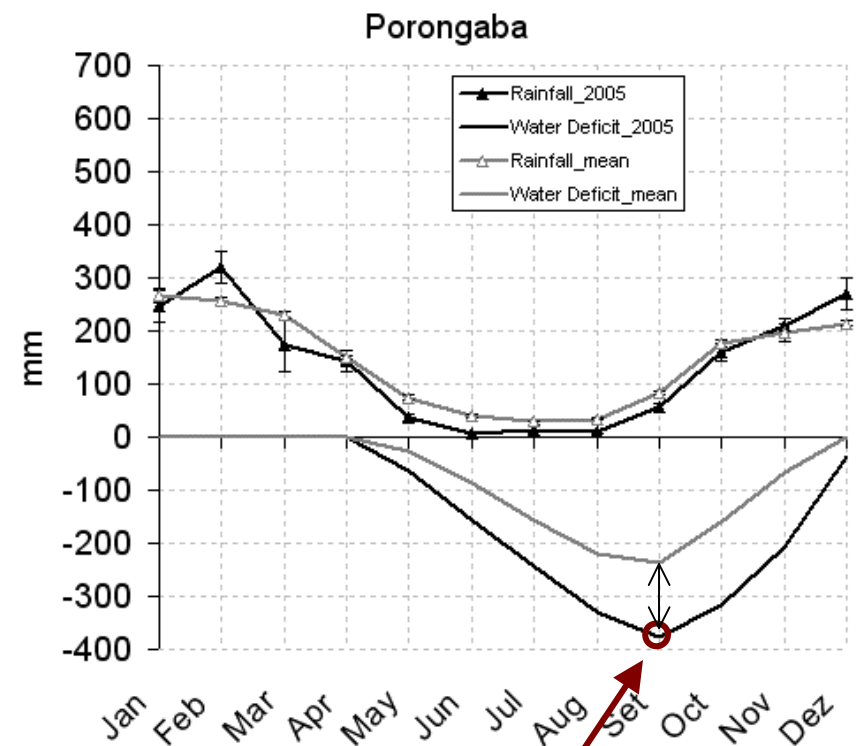
Some areas have such a high background rainfall rate that the reduction in rainfall does not affect vegetation

(The maximum water deficit is a indicator of forest water stress)

$P < 100 \text{ mm month}^{-1}$     $E = 100 \text{ mm month}^{-1}$

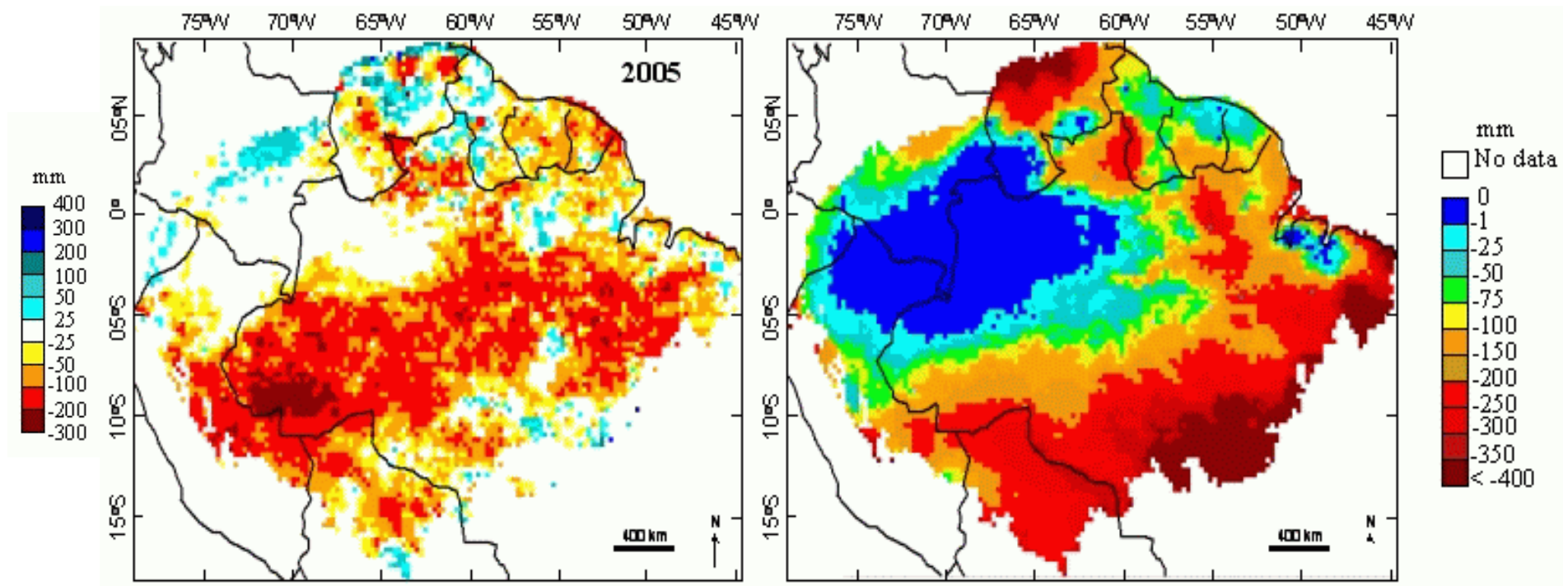


## Cumulative Water Deficit



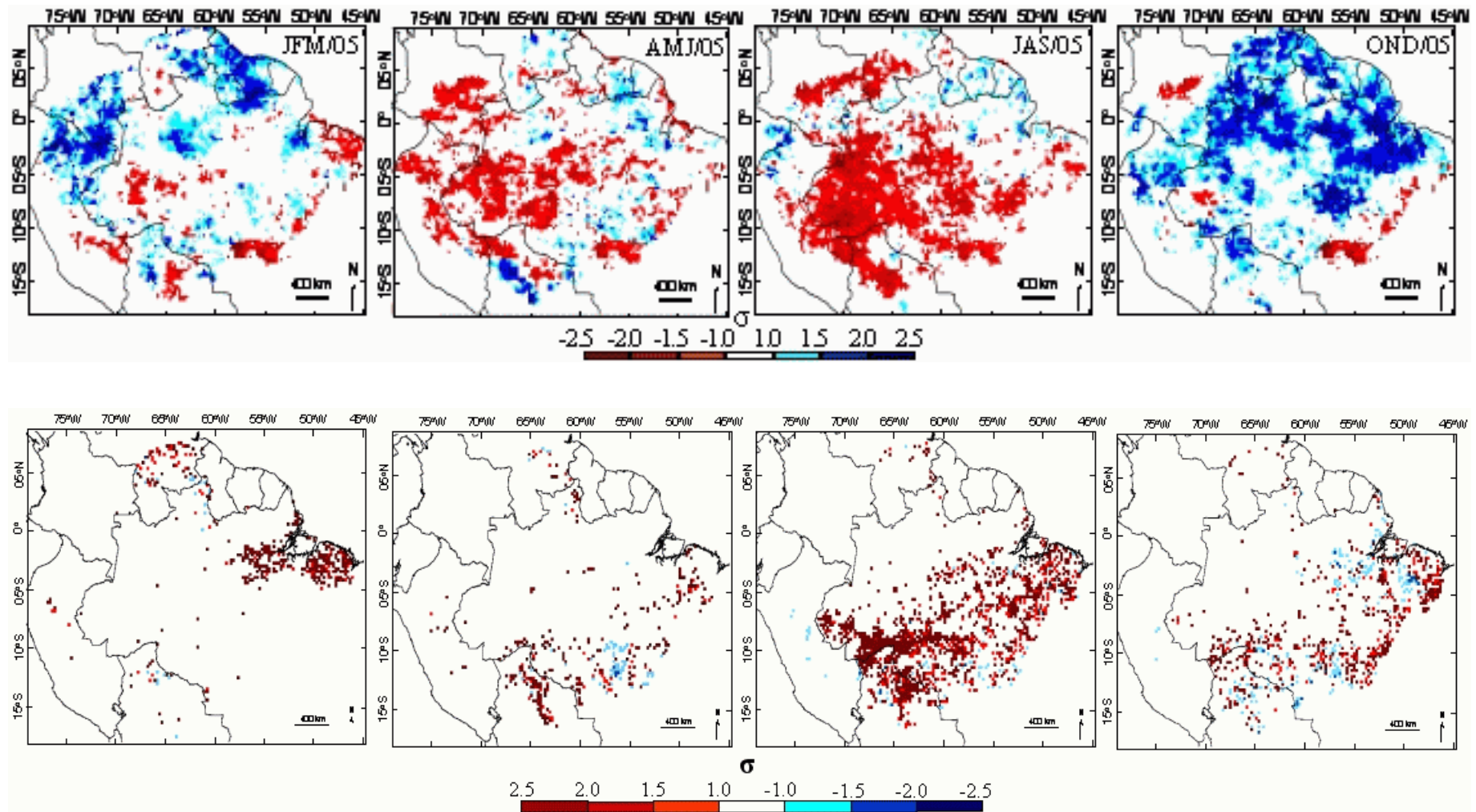
Maximum Cumulative Water Deficit

# Basin-wide water deficit caused by the 2005 drought



$$WD_{year} - WD_{mean} = WD_{difference}$$

# Effect of the 2005 drought on fire patterns

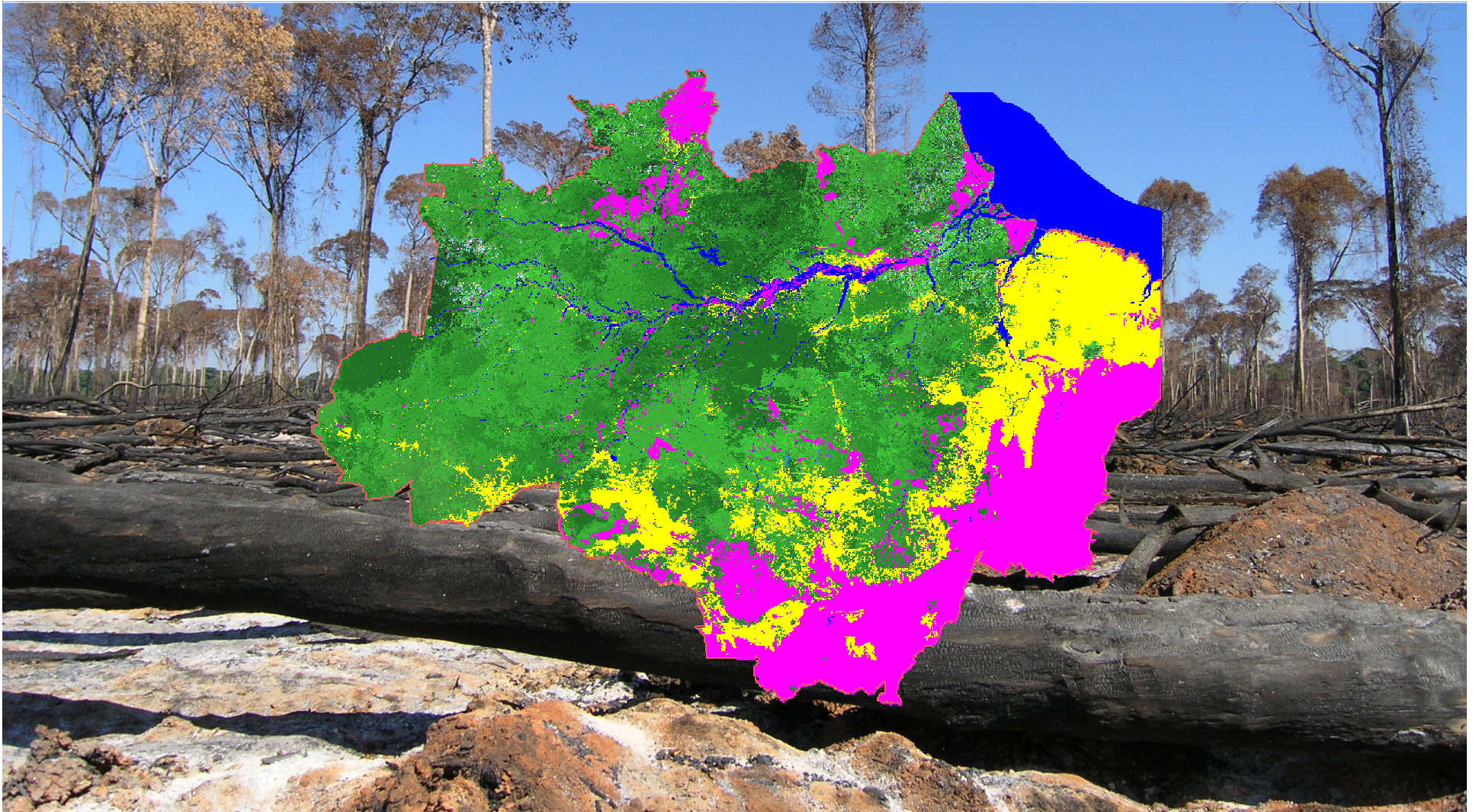


1. The intensification of the drought during the dry season in most of the basin led to an increase of **33%** in the total number of hotspots

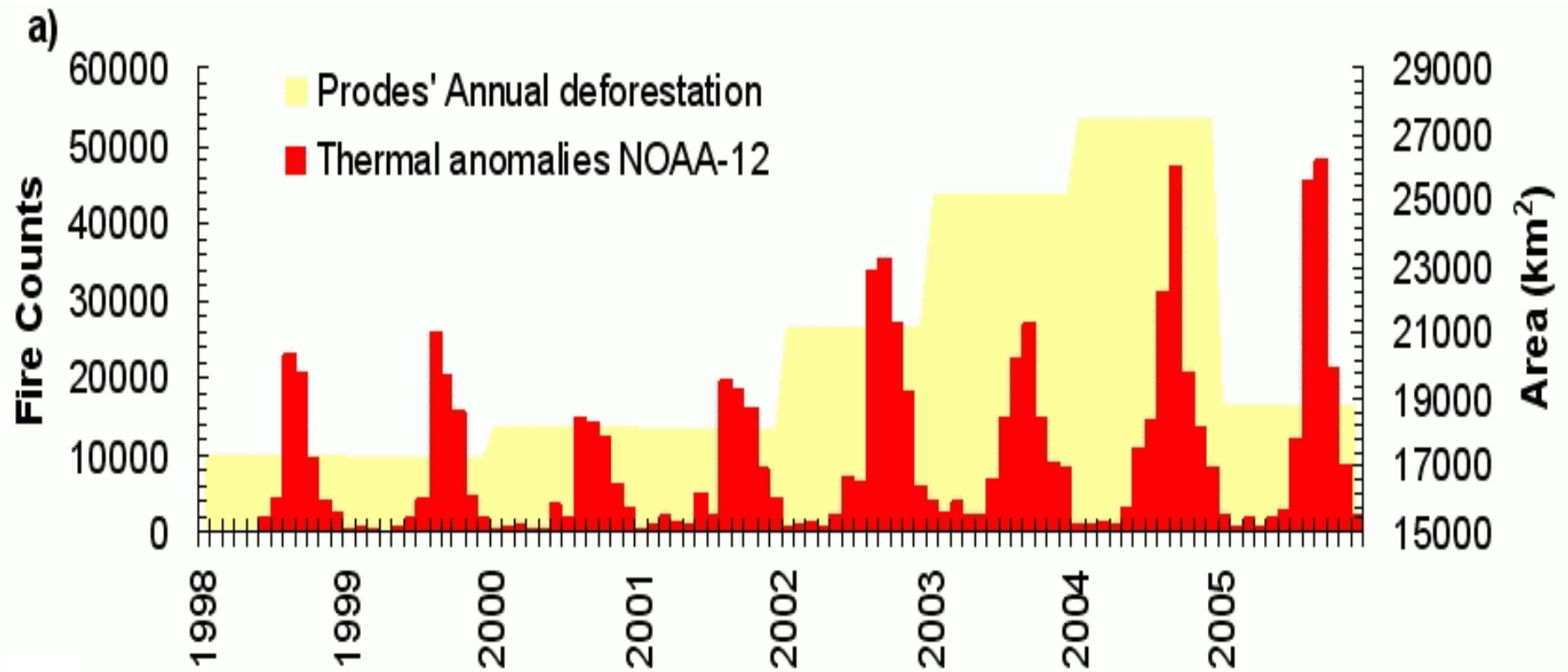


What was the cause of positive fire anomalies during  
2005 in Amazonia?

Deforestation or Drought?



Significant reduction of deforestation rates in 2005 indicates that drought had a major contribution for the positive fire anomalies observed

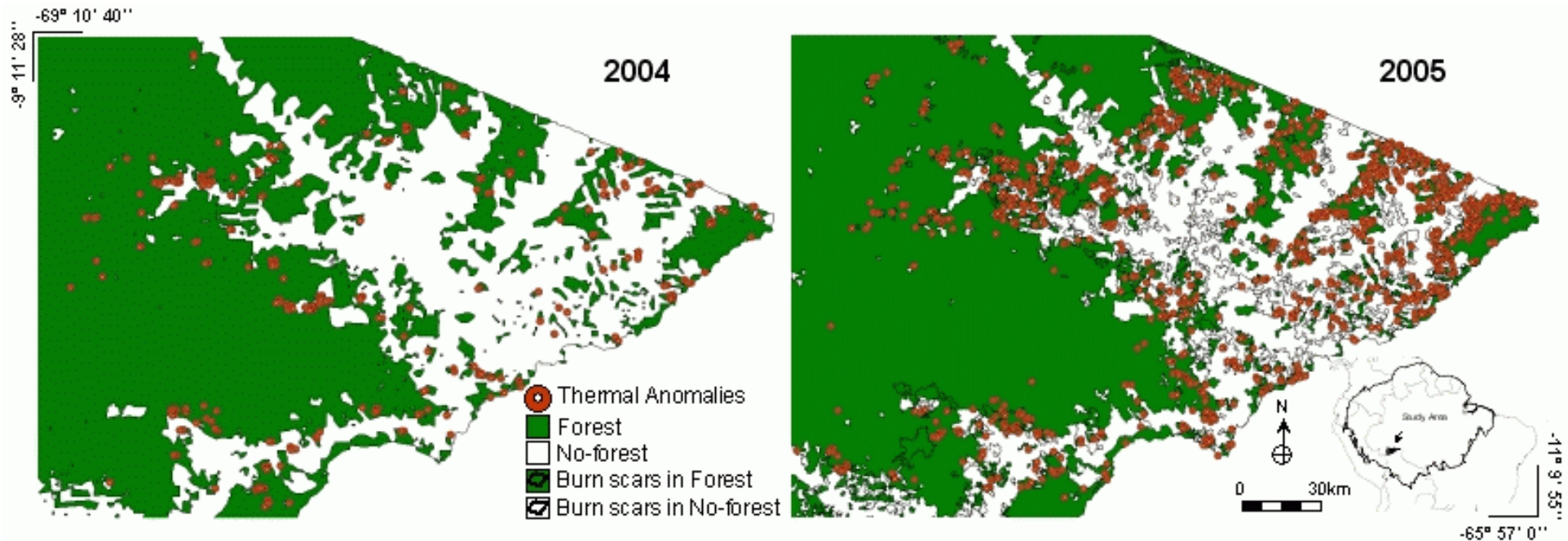


2. During the 2005 drought the total number of hotspots increased **33%**, while, deforestation decreased **13%** in relation the 1999-2005 mean.



# Forest fires in eastern Acre State (Brazil) during the 2005 Amazonian drought

Maximum Water deficits >200 mm and fire anomalies >1.5  $\sigma$  in 2005

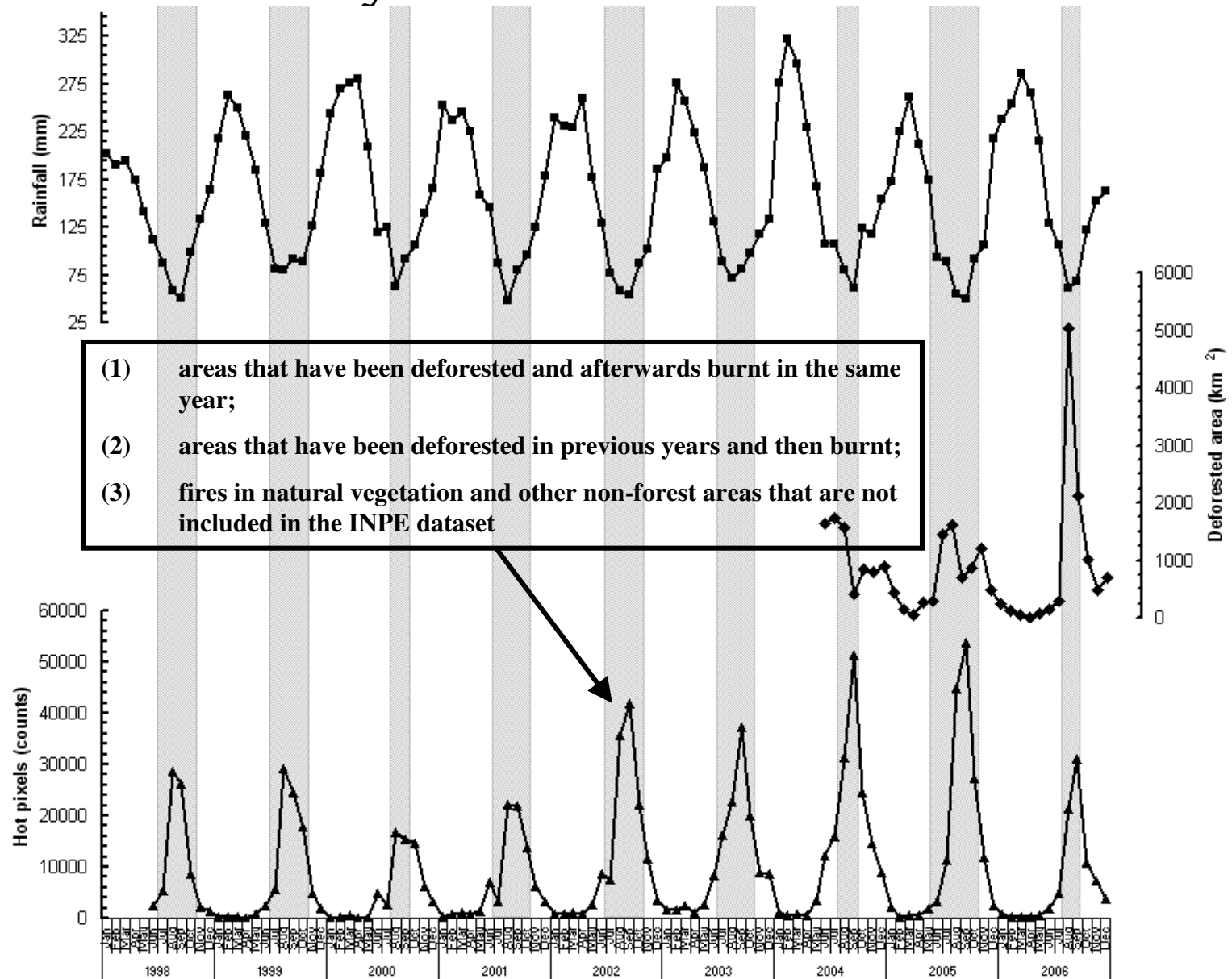


3. The total area of burnt forest in 2005 (Shimabukuro et al., 2006) was **five times greater** than the deforested area.
4. Fire counts within forest edges increased by **280%** from 2004 (286 counts) to 2005 (1086 counts). On the other hand, deforestation within this region decreased **16%** from 2005 to 2004.

# Questions

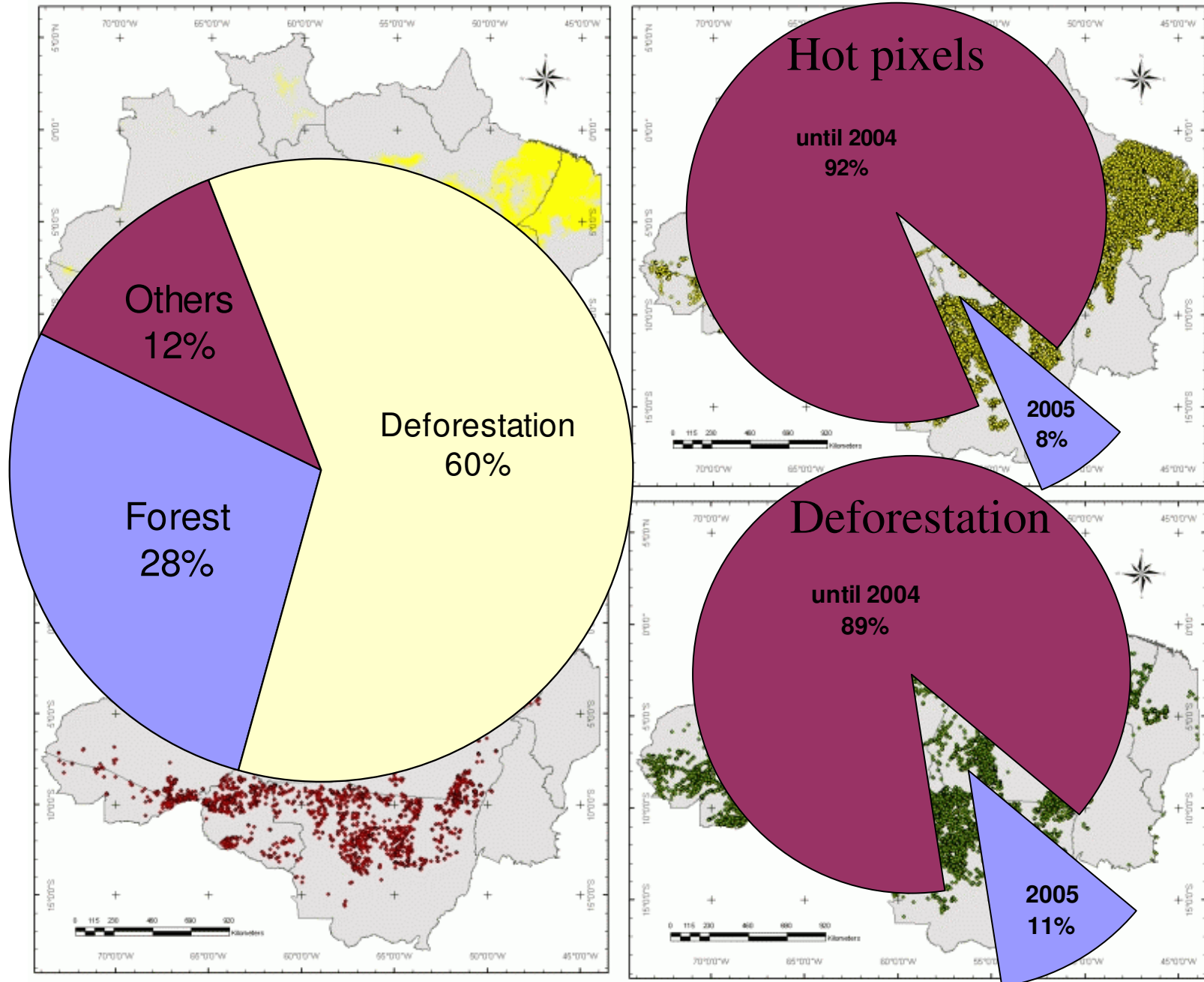
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# Synergism between rainfall and deforestation on fire seasonality in the Brazilian Amazonia

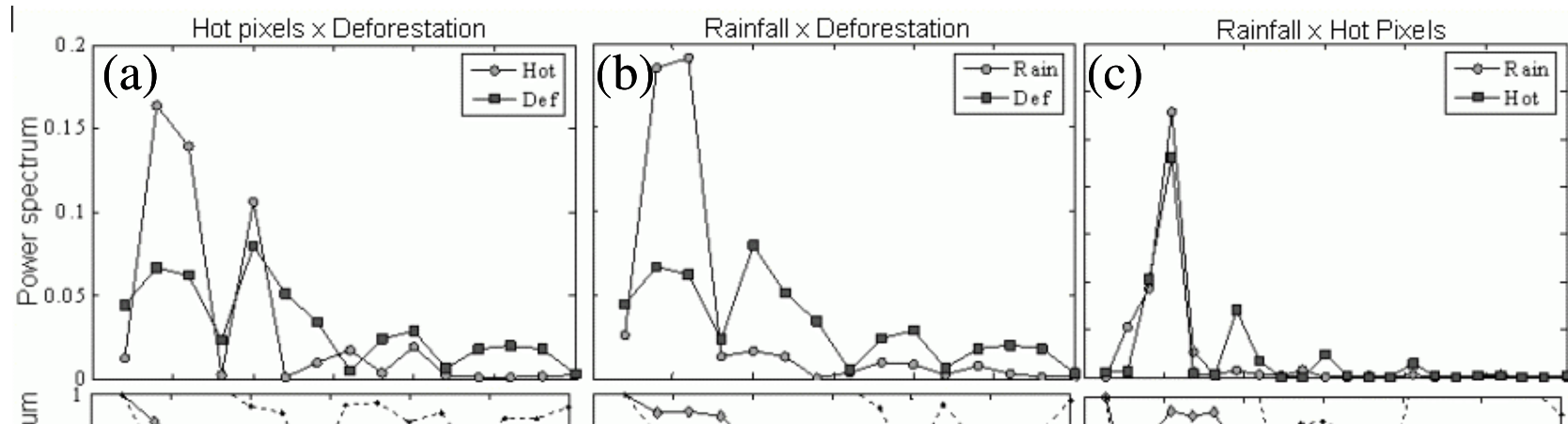




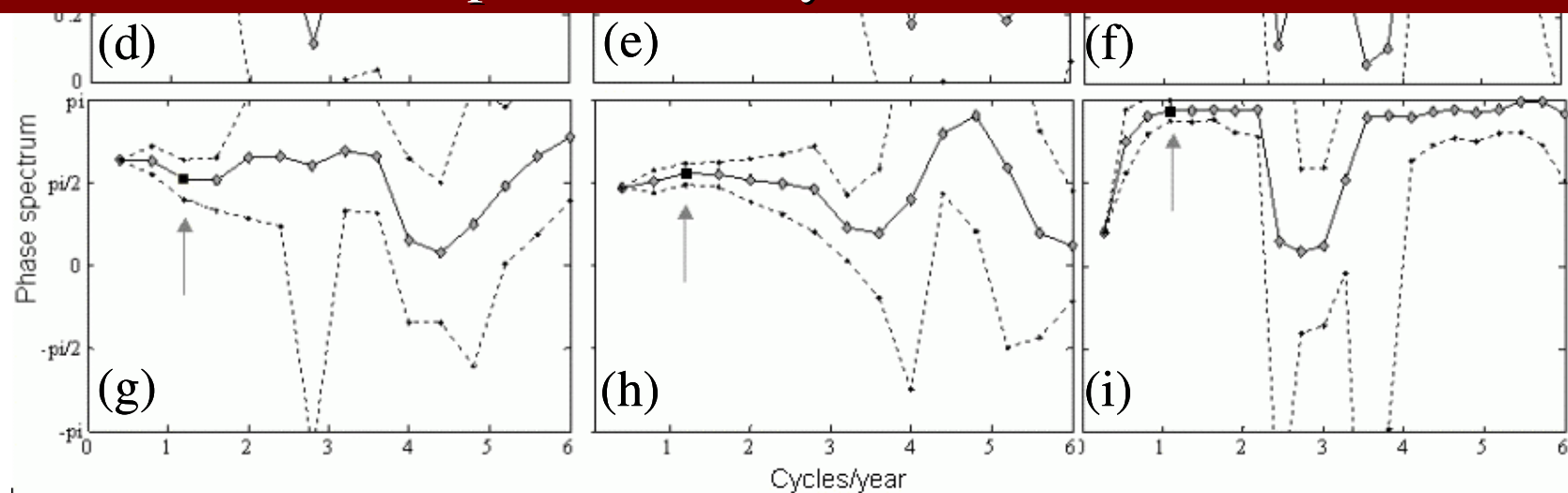
# Which is the dominant type of fire?



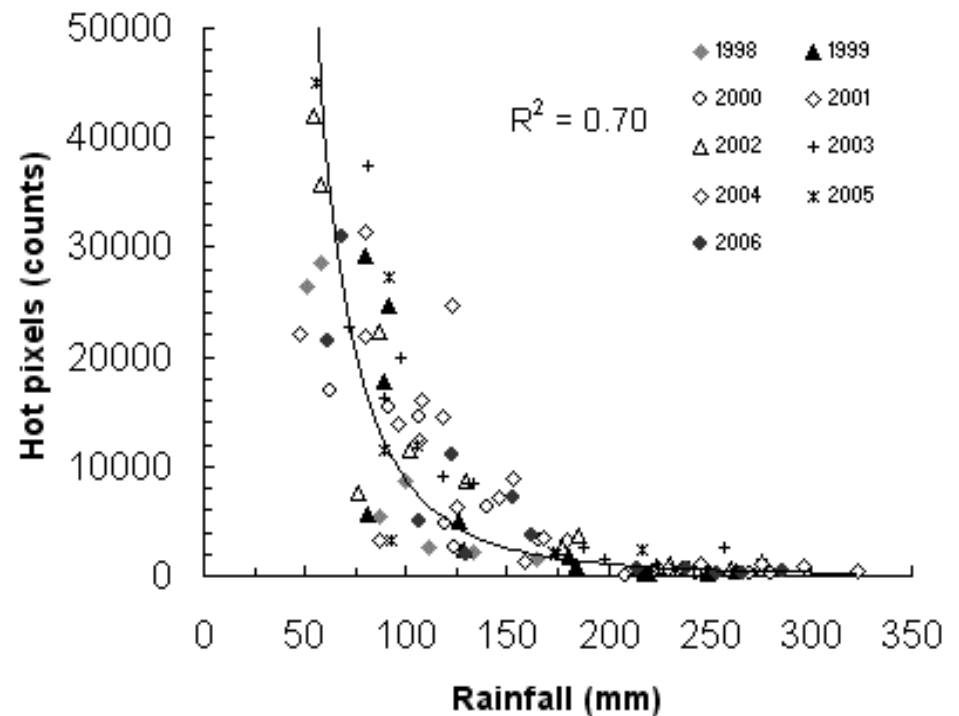
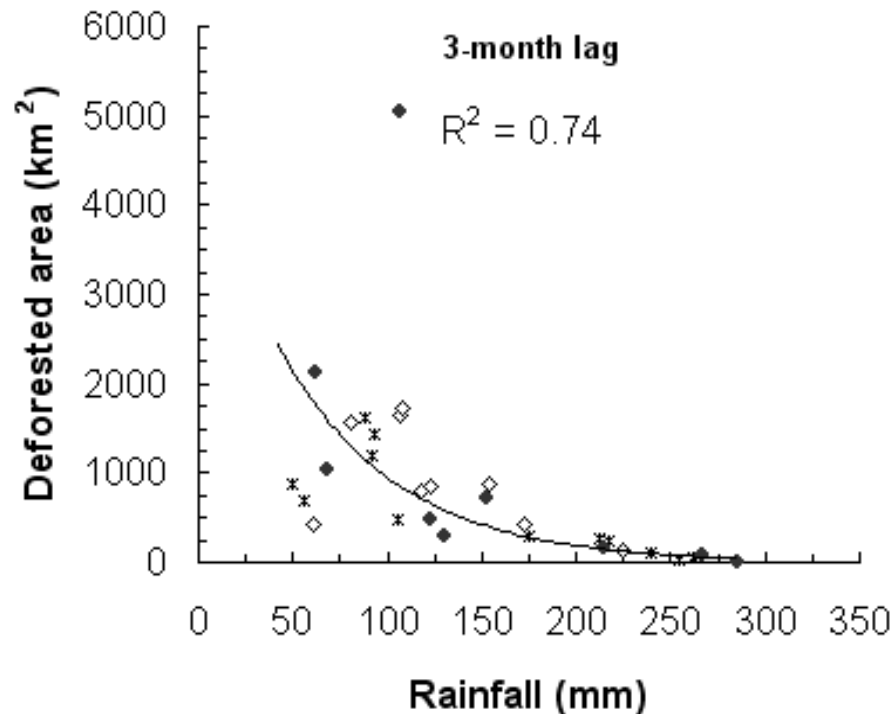
# Quantifying relationships among climate, deforestation and fires (spectral analysis)



The peak of deforestation occurs 3.2 months after the peak of wet season, and fires occurs 3 months after deforestation, which coincides with the peak of the dry season.

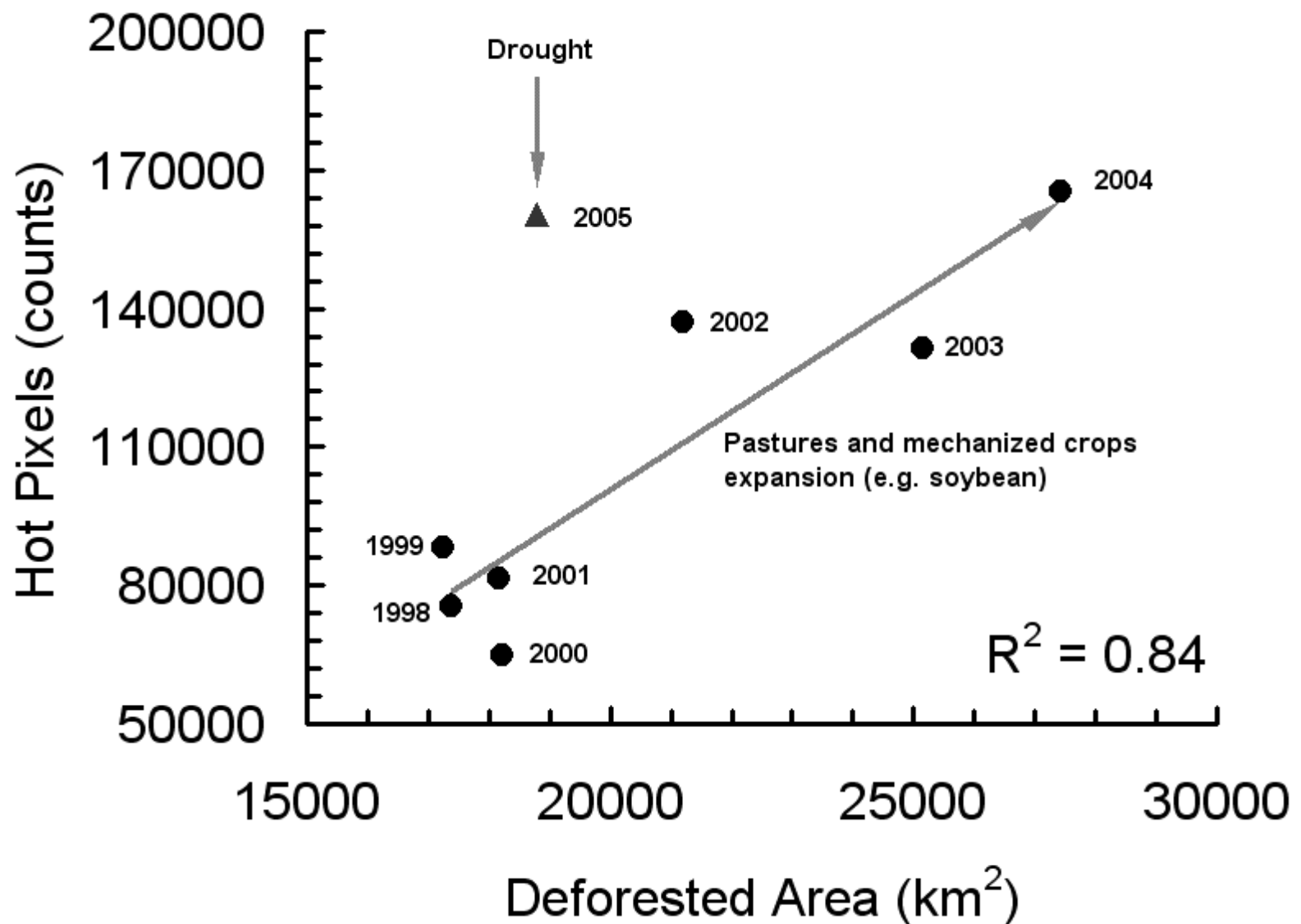


# Deforestation and hot pixels follow seasonal cycle of rainfall and deforestation in Amazonia





However, fire (hot pixels) just relates with deforestation at the annual scale.



# Conclusions

- ✓ The 2005 drought was characterized by its intensification throughout the dry season in south western Amazonia.
- ✓ During 2005 the annual cumulative number of fires in Amazonia increased notably in relation to the 1999-2005 mean being associated to the extreme 2005 drought event.
- ✓ Despite the variability of climate determining the seasonality of fires in the Brazilian Amazonia, we demonstrated here that anthropogenic forcing, such as deforestation, is decisive for such periodicity as well as annual rates of fire occurrence in the region.
- ✓ In the event of increased drought frequency, the leakage of fires to forested areas, due to land management and slash and burning activities, is likely to be the major agent of forest alteration, rather than changes in forest ecology and physiology.
- ✓ However, we still have gaps to fully understand the interactions among these variables and the vulnerability of Amazonia to climate change

# What is the area affected by forest fires?

