Understanding the Effects of Fire on Net Radiation and Evapotranspiration Patterns in a Mature Amazonian Forest Using MODIS Remote Sensing Data

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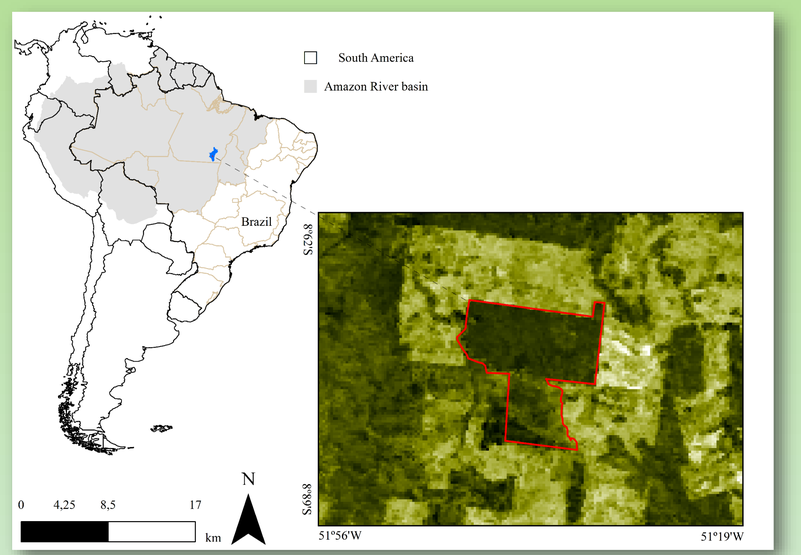
Introduction

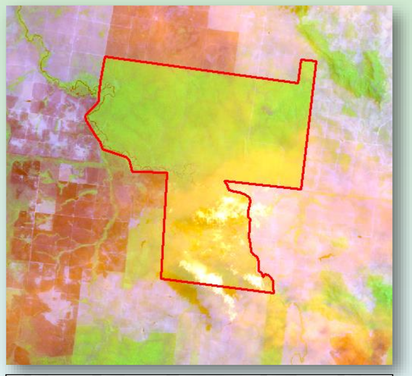
Forest fires are ocurring in great number throughout the Amazon region, affecting the natural cycle of vegetation and ecosystem structure. They also can cause changes in the local and regional climate, and specifically in the surface energy flux patterns. The effects of fire on forest water cycling are not well understood, especially due to the difficulty of obtaining surface flux measurements in fire-affected areas with high temporal and spatial resolution. The present study aimed to characterize and analyse, using MODIS remote sensing data in combination with the SEBAL model, the temporal dynamics of net radiation and evapotranspiration in a 120 km2 mature Amazonian forest plot affected by fire in September 2010 in the state of Para, Brazil.

Study area

→ Municipality of Cumaru do Norte, state of Para, Brazil



Location of the study area.

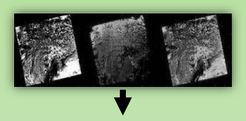


TM image aquired in the time of fire burning.

Materials and methods

Orbital data - TM/Landsat 5

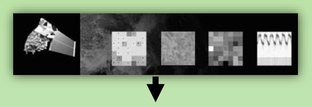
→ Orbit/point → 224/66 → 8/1/2003
→Surface reflectance → Bands 4, 5 and 7
→Spatial resolution → 30 m



Processing steps → ENVI 4.5 (georeferencing) / ArcGIS 9.3 (polygon definition)

Orbital data - MODIS/Terra

→ Tile → H12V09 → 07/ 2007 to 09/2013
→MOD09GQ and MOD09GA → Surface reflectance / MOD11A1 → Surface Temperature / MOD16 → Evapotranspiration



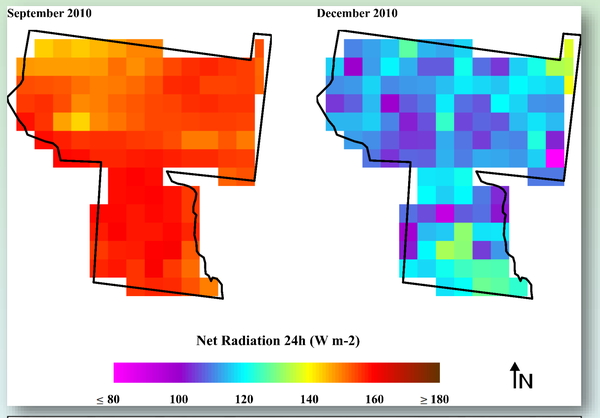
Processing steps → MRTools and Python 2,7

Net radiation estimates

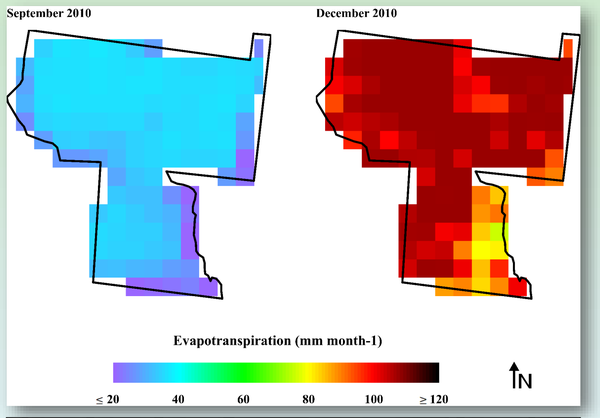
→ Bastiaanssen et al. (1998)
→ Vegetation indices, albedo, termal infrared radiation (inc. / out.), net radiation

S E B A L
Surface Energy Balance Algorithms for Land

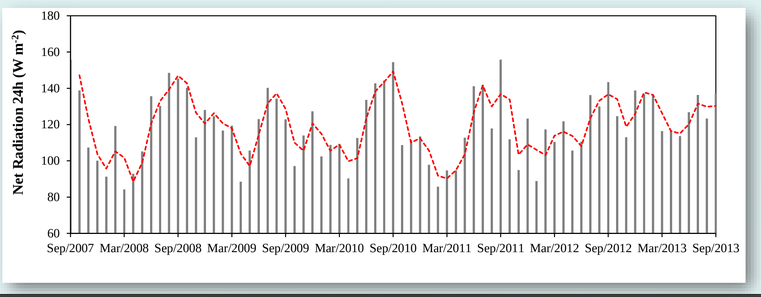
Results

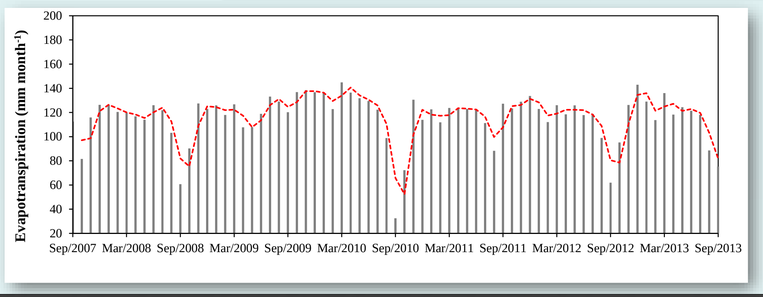


Spatial distribution net radiation 24h in the study area in 09/2010 and 12/2010 through MODIS data and SEBAL model.



Spatial distribution of evapotranspiration in the study area in 09/2010 and 12/2010 through MOD16 data.





→ The analysis of the surface energy fluxes in the month before and in the month after the fire indicated a 25% and 27% decrease in net radiation and evapotranspiration, respectively.

→ The average values of net radiation and evapotranspiration for the 3 years pre-fire were 119.3 W m-2 and 1436.0 mm yr-1, respectively.

→ After the significant decrease was verified immediately post-fire, net radiation values increased at an average annual rate of 3% and evapotranspiration values increased at an average annual rate of 20%.

→ In both cases, the highest increase in rates were verified one year after the fire, corresponding to 5% in net radiation and 58% in evapotranspiration.

→ The average values of net radiation and evapotranspiration 3 years post-fire were 119.2 W m-2 and 1382.6 mm yr-1, respectively, which are quite close to the average values verified prior to burning.

Conclusions

We conclude that 3 years was enough time for this forest plot to recover its original state in terms of surface fluxes. Despite this result, it is important to note that a high severity fire can alter the canopy characteristcs more strongly than a low severity fire, which means that distinct disturbance regimes will affect the energy fluxes after the fire in forested areas quite differently.

References

Bastiaanssen, W. G. M; Menenti, M.; Feddes, R. A.; Holtslag, A. A. M. A remote sensing Surface Energy Balance Algorithm for Land (SEBAL): formulation. **Journal of Hydrology**, v. 212-213, n. 1-4, p. 198-212, 1998.
Mu, Q.; Heinsch, F. A.; Zhao, M.; Running, S. W. Development of a global evapotranspiration algorithm based on MODIS and global meteorology data. **Remote Sensing of Environment**, v. 111, n. 4, p. 519-536, 2007.

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