"Deforestation and Increasing Diurnal Temperature Ranges in Amazonian Brazil and the Lowlands of Bolivia"

Adrian Tasistro-Hart

Excerpt

Results

In Marabá, where total forest cover loss was approximately 30%, the overall linear weather trends show significant increases in T_{max}, T_{min}, and DTR, since T_{max} has increased faster than T_{min} (Table 2). Figure 1, however, shows trends in temperatures recorded at Marabá before and after 1991, when the rate of deforestation increased. Before 1991, T_{min} was increasing 30% faster than T_{max}, but after 1991 T_{min} stopped significantly increasing while T_{max} continued to increase slightly more slowly than before. DTR trended negatively but insignificantly before 1991 then reversed, trending positively and significantly after 1991. Surface albedo increased insignificantly with time, and precipitation significantly but weakly decreased (Figure 1).

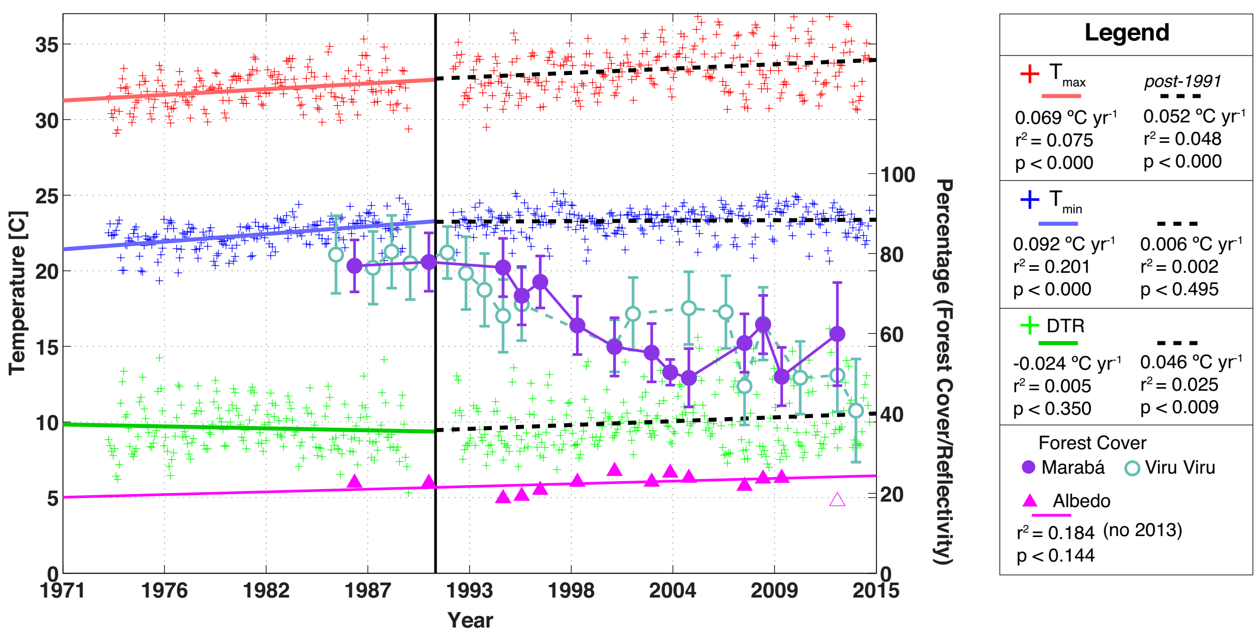

Figure 1: Weather, forest cover, and surface albedo (SAL) data from Marabá, Brazil. Forest cover begins to decrease between 1991 and 1994. Whereas before 1991, T_{min} was increasing more quickly than T_{max} in concordance with the global trend, after 1991 T_{min} shows no strong trend while T_{max} continues to rise. This change in slope is evident in the trends in DTR: before 1991, DTR was decreasing, but after 1991, DTR began to increase. SAL, calculated from Landsat imagery (Equation 2), trends positively but insignificantly with time. The 2013 SAL data point was rejected because the Landsat imagery was not appropriately normalized. Deforestation and SAL data are from within 100 km of Marabá. Also included is forest cover with time within 100 km of Viru Viru. Thus, it is not T_{max} but T_{min} that responds more strongly to deforestation, constituting most of the change in DTR.

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The following paragraph discusses data for Viru Viru that is not displayed in Figure 1 but that exhibits the same trends.

> In Viru Viru, where total forest cover loss was approximately 40%, T_{max} and DTR both increased significantly at rates similar to Marabá post-1991 (Table 2). T_{min} increased significantly within a 90% confidence interval but less than half as quickly as T_{max}. Precipitation did not significantly change with time. In Concepción, where forest cover loss was less than 15% and therefore within the noise of the deforestation data (Table 1), T_{max} and T_{min} both increased significantly. T_{max} increased slightly more than half as quickly as T_{min}, while DTR and precipitation both decreased significantly (Table 3).

Discussion

Studies of global trends in T_{max} and T_{min} have converged on values of around 0.1° C and 0.2° C per decade, respectively (Easterling et al. 1997; Zhou et al. 2008). Thus, T_{min} has been increasing twice as quickly globally as T_{max}. In Marabá and Viru Viru, however, where roughly 30% and 40% of forest cover was lost between 1986 and 2014, respectively, T_{max} has been increasing more rapidly than T_{min}, so DTR has significantly increased. In both regions, the increases in DTR could be attributable to deforestation. Prior to an increase in the rate of deforestation around 1991, T_{min} had actually been increasing 30% faster than T_{max} in Marabá (Figure 1), meaning that DTR had been decreasing. After 1991, however, T_{min} stopped increasing significantly, while T_{max} only slightly slowed and was still four to five times faster than the trend in global T_{max}. In Viru Viru, trends in T_{min} and T_{max} are almost exactly exchanged with trends at Concepción, which is less than 200 km to the northeast. Whereas in Concepción, T_{min} has been increasing twice as fast as T_{max} and also twice as fast as the global trend, in Viru Viru, T_{max} has been increasing more than twice as fast as T_{min}, which is only slightly faster than the global trend in T_{min} (Table 2).

Studies based on climate models propose that decreased evapotranspiration from tropical deforestation is the controlling mechanism over local temperature variability, offsetting the cooling from higher SAL and creating a warmer, drier environment (Bonan 2008; Zhang & Henderson-Sellers 1996; Zhou et al. 2008). Zhang & Henderson-Sellers (1996), after finding only small changes in surface temperature in their model of deforestation, also conclude that sensible heat flux changes insignificantly with deforestation. The trends in T_{max} with deforestation found in this study fit with the model of decreased evapotranspiration, since T_{max} in both Marabá and Viru Viru does not decrease with increasing albedo. However, that T_{min} slowed with deforestation in Marabá and was significantly smaller in Viru Viru than in Concepción cannot be accounted for by decreased evapotranspiration, which acts during the day (Zhang & Henderson-Sellers 1996; Zhou et al. 2008). Thus, I propose, contrary to Zhang & Henderson-Sellers (1996) and building from Englehart & Douglas (2005), that sensitive heat flux does increase with deforestation. This increase in sensitive heat flux most likely results from decreased soil moisture following deforestation, weakening the ability of the surface to dampen daily temperature oscillations.

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Author Commentary

Adrian Tasistro-Hart

The assignment for this paper was to use satellite imagery of any part of the world to explain socioeconomic and/or climatic trends in that area. I decided to use satellite imagery to quantify deforestation in Brazil and Bolivia since the 1980s and study how this deforestation has affected the local range in daily temperatures.

Different types of figures fit into different parts of a paper. The figures early in my paper showed the context of my study with maps and orienting information (relevant for the introduction section) as well as my methodology (for the methods section). The figure in this excerpt shows my results (evidence) and supports a discussion based on those results (analysis), so I have also included paragraphs from the results and discussion sections of the paper that are most closely connected to this figure. This section also included other tables and equations, and I have left references to these in the text to show how other figures feature in the paper, but the tables and equations themselves are not shown.

This figure shows deforestation levels for my two main study areas (purple and teal circles). The rest of the data comes from one study region and shows minimum and maximum temperature (T_{min} and T_{max}), daily temperature ranges (DTR), and surface albedo (SAL), or how reflective earth's surface is in this area. (Results for the other study area were shown in a separate table.) This figure relates to my motive by providing my in-the-data motive. When I first introduce my motive in the paper, I describe how little is known about the actual response of local climate to tropical deforestation, despite modeled results. Many researchers have assumed that mechanisms such as soil moisture or SAL change determine local climate change (like DTR), but this figure shows these assumptions need to be reevaluated. The figure supports my thesis that DTR is not actually sensitive to SAL change with deforestation but most likely to change in soil moisture instead. Additionally, I show that the change in DTR is not due to change in T_{max}, as has been largely assumed, but that DTR change is instead due to a change in T_{min}.

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Fellow Commentary

Abigail M. Kelly

A figure can be a powerful tool in technical writing because it both represents data in a format that is easy to absorb and begins the work of analyzing that data in a way that leads to the thesis. This excerpt opens with a figure that visually displays results from Adrian's research that are key to making his argument. The figure visually displays data (albedo levels, maximum and minimum temperatures, etc.) in a way that makes the data easier for Adrian to reference and for the reader to understand. But while the figure presents evidence, it is also in itself a form of analysis. The variables that Adrian chose to display influence which trends the reader sees and puts these variables and trends in comparison with each other, perfectly setting him up to draw conclusions from the evidence and build his argument.

This excerpt also demonstrates the structuring of evidence and analysis within a scientific paper. In the results section, Adrian presents all his evidence. We see and read about weather patterns, temperatures, cloud cover, and deforestation, and how they changed over time in multiple locations. In the discussion section, Adrian then leads us away from the raw numbers and facts into what this evidence shows and why it is significant. This comes out particularly clearly in the final paragraph included in this excerpt, where he uses his data to reevaluate prior research published by other authors and form his own argument.

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