Precipitation Patterns in La Selva and Monteverde, Costa Rica: Observations and Climate Comparisons

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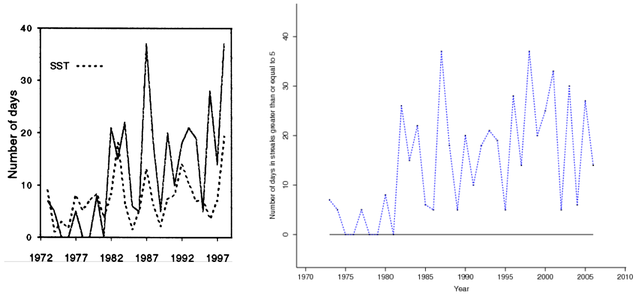
Motivation:

"Minor shifts in temperature and rainfall can have a major effect on plants and animals unaccustomed to variable environments: a slight reduction in average annual rainfall or a slight change in the seasonality of this rainfall can have profound effects on rain forest vegetation." Forsyth and Miyata, *Tropical Nature.*

Alan Pounds, *et al.* analyzed Monteverde precipitation and temperature data for changing patterns, and predicted increased drying in the tropical cloud forest. The solid graph in the figure below at left represents the number of days per year in runs of five dry days (or more) in a row.



Objective:

Our Global Field Program/Earth Expedition Trip to Costa Rica included a stop in Monteverde, as well as a visit to the lowland rainforest of La Selva. My objective was to

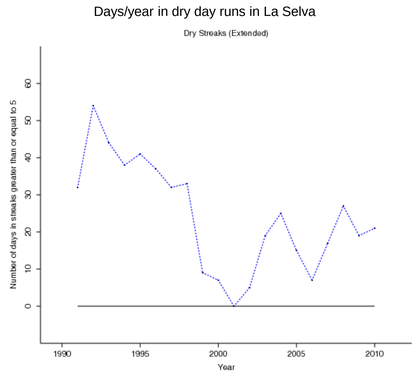
1. replicate and extend the analysis of Pounds, et al. in Monteverde;
2. extend the analysis to La Selva; and
3. compare the climate of the two, in particular looking for evidence of long term changes.

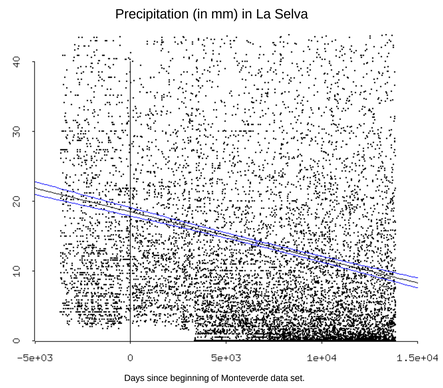
In the graph above (at right), the analysis of Pounds,*et al*. has been extended to include more recent data. Whereas Pounds, *et al*. implied that the drying trend would continue (and it does, indeed, appear higher than the early period), the good news is that it seems to have leveled off.

Analysis:

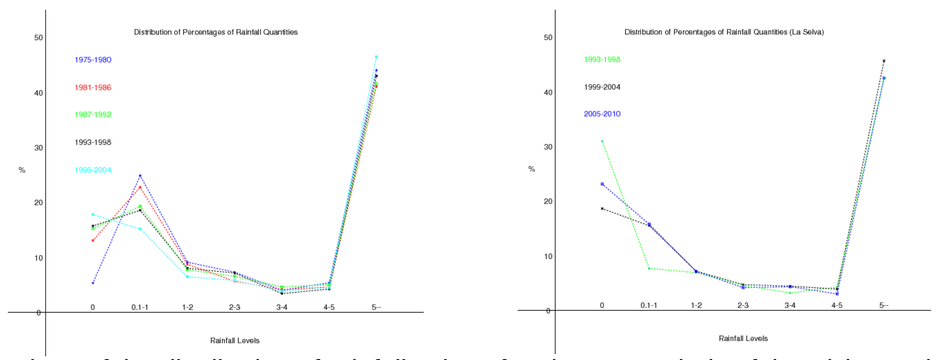
I obtained the rainfall data used by Pounds, *et al*. and was able to replicate the dry day pattern (as well as other facets of Pounds, *et al*.'s analysis). In addition, I obtained rainfall data for La Selva. Unfortunately, the temperature data for Monteverde was unavailable, and hence I was not able to replicate Pounds, *et al*.'s temperature analysis.

The La Selva data set extended over a longer period than the Monteverde data, but it was collected by two (or more) different individuals, in two (or more) different sites. Inspection of the data suggests that there are problems in the data set (at right, below). In the early years of the data set, small values (especially zero values) of rainfall were not recorded, leading to the censoring of lower-end data apparent prior to about 3500 days (post-Monteverde data).





On the graph of the La Selva data (right above), we include a regression model (which is entirely inappropriate, due to the censorship of data in the early part of the data set). This illustrates the danger of working with data without a proper appreciation of the nature of the data: what appears to be a drying trend is artificial. On the left above is the graph of runs of dry days, obtained excluding the early data, and proceeding as in Pounds, *et al*. for the Monteverde data. What we see is that the runs of dry days is actually down in La Selva in recent years (in contrast with Monteverde).



A Comparison of the distribution of rainfall values for six-year periods of time (chosen by Pounds, *et al.*) between Monteverde and La Selva. It appears that there may be a shift to more zero precipitation days, and more high precipitation days in Monteverde, in accord with expectations due to global climate change. The trend is not evident in La Selva.

Conclusions: Drying in Monteverde

I have considered various aspects of the precipitation patterns between the two sites of Monteverde and La Selva. The first set of analyses are suggested by the article by Pounds, *et al*. Results indicate that there may well be a drying trend over time in the Monteverde data, as evidenced by increase in dry day runs.

The total yearly volume of precipitation may be up over time, but the annual number of days in "dry runs" of five days or longer are up in Monteverde – more dry days are occurring in long runs during the year. The total number of dry days appears to be increasing in Monteverde, as well. The effect is not clear in La Selva: dry days were higher in the early 90s, then down in the later 90s, followed by a rise back up in the early 2000s.

One may conclude that both sites are probably experiencing increasing total rainfall(which is in line with theories of global warming), although there are more large precipitation days, and more light rain days. As indicated in Figure 6, we conclude that there is more variation in the rainfall patterns of Monteverde.

Primary Reference:

J. A. Pounds, M. P. L. Fogden, and J. H. Campbell. *Biological response to climate change on a tropical mountain*. *Nature*, 398:611–615, 2006.

Acknowledgements:

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