Assesment Of The Long-Term Changes In Sub-Daily Precipitation In A Tropical Complex-Terrain Region: Extreme Events And Their Relation With Temperature Increase

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Abstract

During the last few years, the debate over the changes in the global average temperature has been one of the most important political issues. A better understanding of the effects of the temperature increase on other variables is one of the main challenges in climate. In the last IPCC report, due in part to the limited rainfall data in the tropics, there is no reliable conclusion about the observed and expected long-term precipitation changes in association with the global temperature increase. Since water resources are essential for energy generation and food production in the Department of Antioquia, Colombia, a better understanding of changes in rainfall in the long term becomes a vital tool for decision making. This research presents an assessment of rain variability at different temporal and spatial scales over Colombia, and more specifically over Antioquia. The data used was corresponds to long-term records of 86 rain gauges, in addition to 9 temperature stations, and TRMM precipitation products. The use of in-situ rain gauge information allows focusing on a spatial scale useful not only for a general understanding of precipitation changes but also for engineering and other practical applications. Analyses reveal that while there are no long-term trends in precipitation at the monthly or longer timescales, relatively short-lived extreme events show long-term changes in intensity and frequency. Results show that the shorter the duration of the intense events, the higher the magnitude of the increasing intensity trend. Similarly, for more intense events, the trends are also larger and more significant from a statistical point of view. Analysis of temperatures shows a clear relationship with extreme precipitation events with scaling features explained via the Clausius-Clapeyron relation, controlling the intensification of precipitation. The long-term rainfall trends are compared with modeling results from the different scenarios of a small set of CMIP runs given that most models do not adequately represent Colombia´s precipitation climatology. The results indicate a substantial reduction of return period of extreme events with implications in engineering: the current hydraulic designs would be obsolete in less than 50 years if the increment in the frequency of intense events is not considered in the design.

Assesment of the Long-Term Changes in Sub-Daily Precipitation in a Tropical Complex-Terrain Region: Extreme events and their relationship with Orography.

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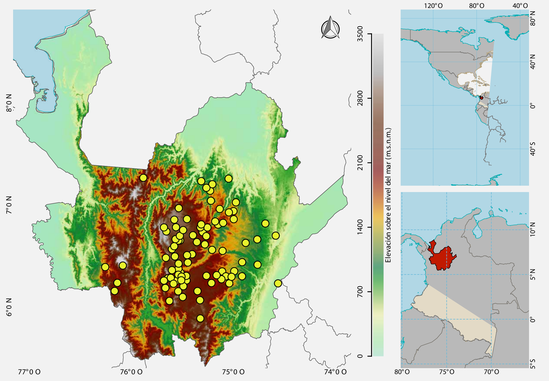
Introduction

During the last few years, the scientific and political debate over the observed long-term changes in the global average temperature has been one of the most intense and controversial. Regardless the outcome, it is necessary a better understanding of the long-term changes in other variables as a potential result of the temperature increments.

In the last IPCC report, it is stated that there is no reliable conclusion about the observed and expected long-term precipitation changes in association with the global temperature increase, in particularly in the tropical regions, due in part to the lack of evidence based on in-situ records.

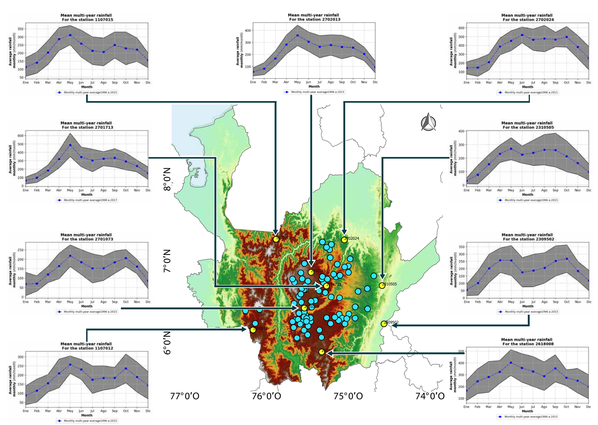


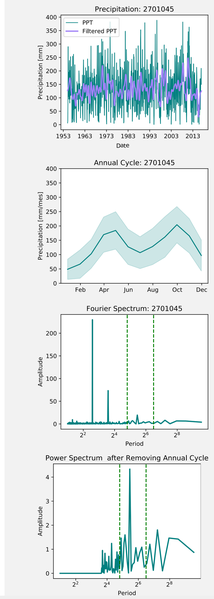
This research presents an assessment of the long-term precipitation variability in a tropical region in Colombia, more specifically in the montanous department of Antioquia, using high temporal resolution in-situ records.

Precipitation Annual Cycle and Interannual Variability

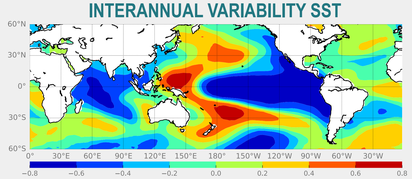
- Precipitation records from 122 15-minute resolution gauges and temperature records from 9 stations in the department of the Antioquia.
- TRMM precipitation products.

Marked annual cycle

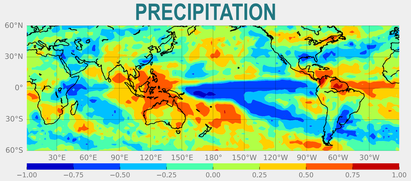




INTERANNUAL VARIABILITY SST



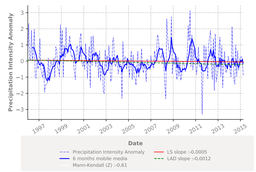
PRECIPITATION

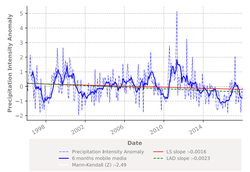


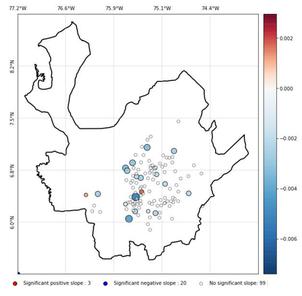
Long-term precipitation trends

The non-parametric Mann-Kendall test is used to determine the statistical significance of long-term trends.
80% of the rainfall records do not exhibit significant trends.
16% show negative trends.

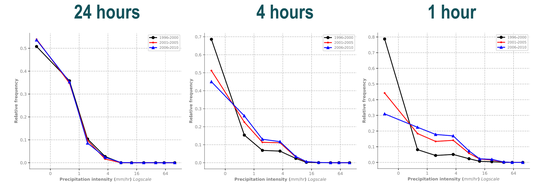
There is no salient spatial pattern of trends.
Linear interpolation (least squares -LS- and least absolute deviation -LAD-) is used to quantify the magnitude of the trend.

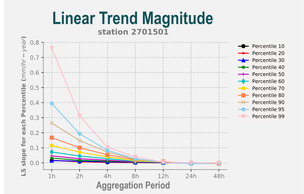




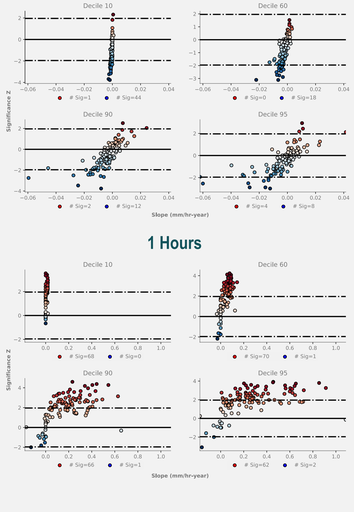


Long-Term Changes in the PDF

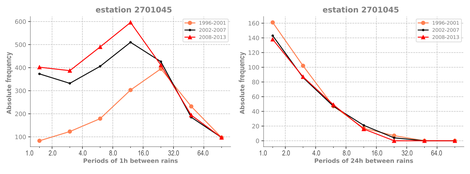




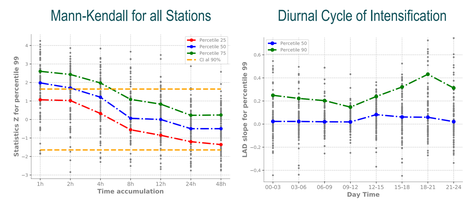
Trend Magnitide vs. significance



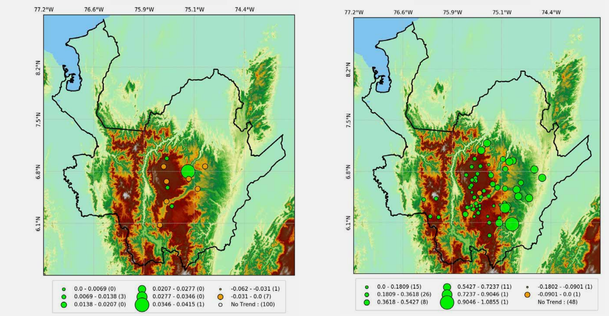
Frequency of Dry Intervals



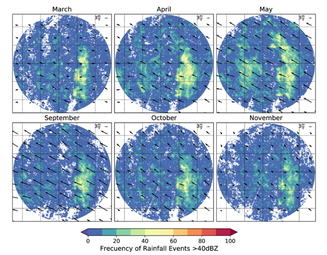
Summary

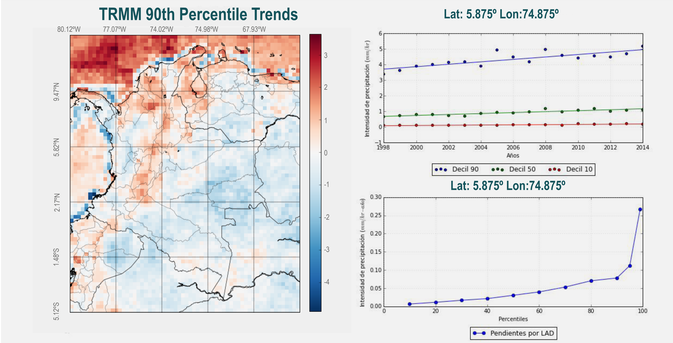


Role of orography

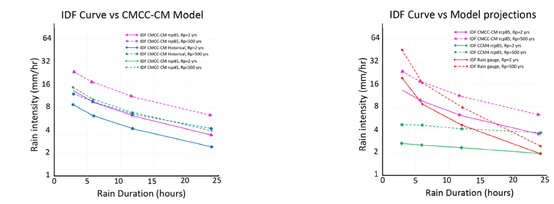


The largest changes in the frequency of intense events appear to be linked to orographic enhancement zones. The effect of increasing temperatures on rainfall intensification is cannot be explained considering just local thermodynamics. Changes in the circulation and orography play a very significant role!!
From López et al (2017)





Climate Model Projections



Acknowledgements

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