Identifying Climate Change and Variability in the Philippines and Indochina Peninsula: The Maritime Continent

Introduction

Environmental conditions on Southeast Asia shape the daily activities of the communities within this region. The communities are not only dependent on rainfall for agriculture but also subject to discomfort caused by high temperatures and humidity. This research project aimed to understand the normal climate and its change/variability through the region. This was done through the analysis of rainfall amounts and temperatures as well as the atmospheric conditions important for the paths of the typhoons and ocean conditions such as temperature and salinity. The hypothesis posed was that *the regional climate of Southeast Asia has been continuously changing since the early part of the 20th century with temperatures of the atmosphere and sea continuously increasing.* A normal climate, that is the long-term mean or climatology, was established and used to determine how climate has changed over the years and how climate varies year after year.

Methods

A Mac Mini, with two 2.4Ghz Intel Core 2 Duo CPUs and 4GB of ram with 64MB of swap space, was linked to a Linux-based cluster consisting of 32 computers, 256 GB of memory, and 4TB of storage space and was utilized during the research. The computer was used to operate and use the open access software called GrADS, which was used to make calculations and display the processed information.

The following flow chart displays the steps taken in this research:

Characterization of the long-term mean climate, or climatology, of the region for the period 1981-2010.

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Identification of changes in the 20th century climate with respect to the normal climate for the period 1981-2010.

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Calculation of the linear trends in atmospheric and oceanic variables (i.e., rainfall, sea surface temperature —SSTs) through the least squares method.

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Calculation of year-to-year variability of the distinct climate variables via standard deviations.

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Identification of the impact of global phenomena, such as the global warming SSTs and El Niño (ENSO), on the regional climate via the least squares method.

Acknowledgements

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Jonathan Bertiz

Findings

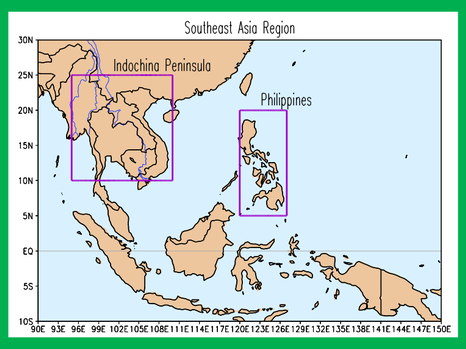

Fig.1. Region of study: "The Maritime Continent". This map emphasizes the regions from which data was extracted through area-average of variables in the domain of the purple boxes: the Philippines and the Indochina Peninsula.

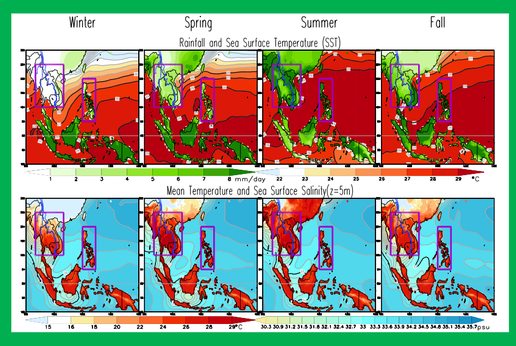

Fig.2. Climatology for the period 1981-2010, or current normal climate. Panels display season means of the normal conditions for rainfall, SST, mean air temperature, and surface salinity. Winter is the mean of Dec, Jan and Feb, spring is the mean of Mar-May, summer is the mean of Jun-Aug, and fall is the mean of Sep-Nov. Darker values indicate higher values in all figures. Note the seasonal warming and concurring increased rainfall from winter to summer, and the low salinity around the Peninsula.

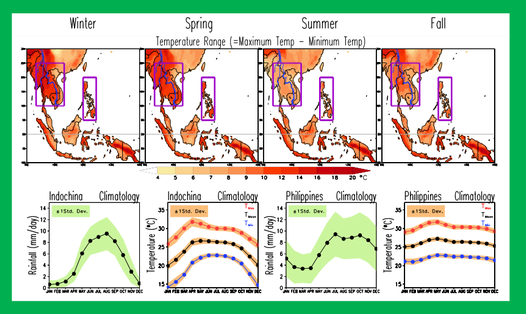

Fig. 3. Continuation of the 1981-2010 climatology and area-averaged monthly climatology over the Indochina Peninsula and the Philippines. Upper panels show the season means of air temperature range (i.e., maximum temperature minus minimum temperature). Lower panels display the area-averaged monthly climatology in rainfall and temperatures (lines) and standard deviations (shading along the lines). Note the largest temperature range is in winter and spring months over the Peninsula and its monsoonal climate, as oppose to the longer rainy season in the Philippines and the almost constant temperatures.

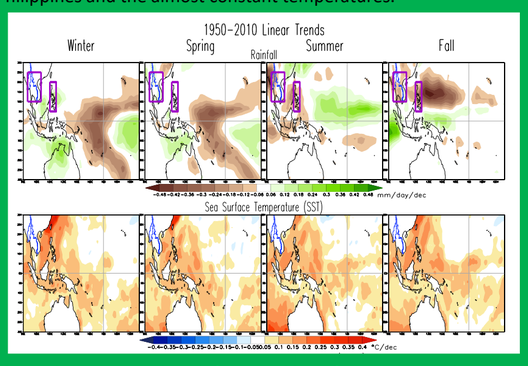

Fig.4. Linear trends in rainfall and SSTs of the broader Southeast Asia region for the period 1950-2010. Green or red values indicate an increase while brown or blue values indicate a decrease. The figures indicate an increase in SSTs throughout all seasons and that certain seasons experience a decrease in average rainfall.

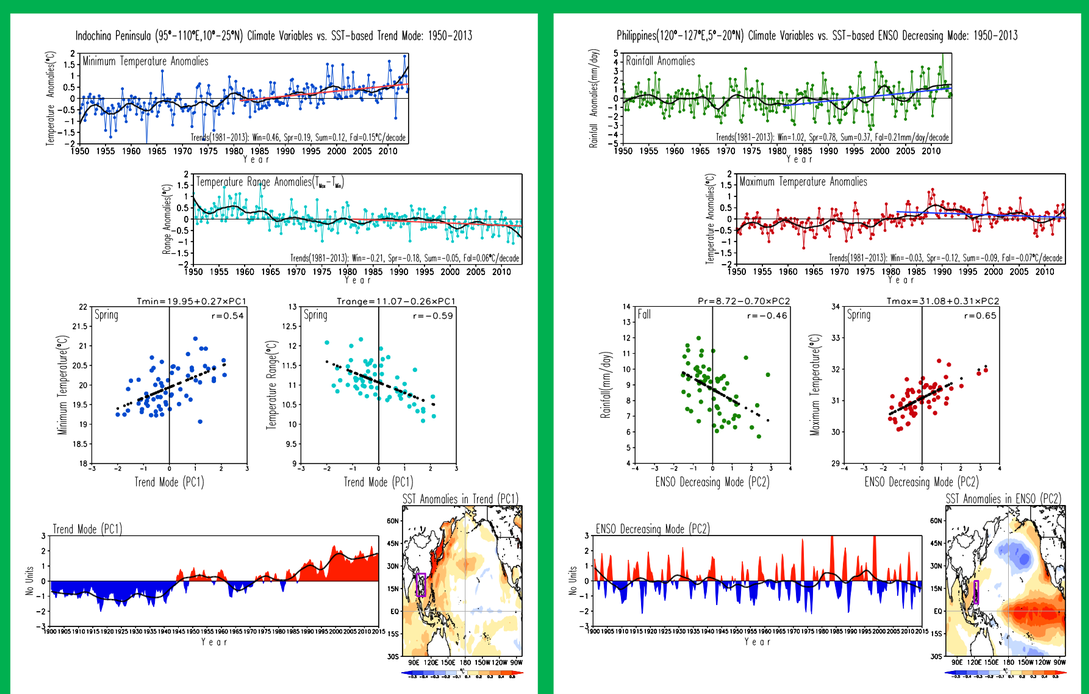

Fig. 5 Impact of global phenomena on the regional climate via scatter plots. These figures showcase the effects both the SST warming trend (left) and the El Niño (right) phenomena on the climate of the Indochina Peninsula and Philippines respectively. Both the warming SST trend and ENSO are characterized from an empirical analysis of global SSTs for the period 1901-2015; their time series and SST anomalies (i.e., deviations with respect to the long-term mean) are shown in the lower panels. Both phenomena are included to indicate that regional climate variability may not all be due to a global warming trend. Note that under the increasing trend in SSTs, the minimum temperature increases and the temperature range decreases, and so the human discomfort increase, in spring over the Peninsula. Also, note than when El Niño is decreasing it forces decreasing rainfall in the Philippines in fall and increases maximum temperatures in spring.

Conclusions

Based on the analysis of the data the initial hypothesis stating that *the regional climate of the Southeast Asia region has been continuously changing in the 20th century* holds true. The project is part of a study on climate variability and change on a region of the world particularly dependent on agriculture, both for economic and social reasons. The findings of this research can have multiple applications, such as for agricultural planning and also for environmental conversation. Another region of the world could be researched using the same methodology utilized during this study.