Title: Disentangling the Triad of Soil Moisture, Precipitation, and Fires in Brazil: A Comprehensive Analysis of Climate data, Remote sensing and Modeling

Team: Francina Dominguez, Flavio Justino and Youlia Saito

The relationships between precipitation, soil moisture, and wildfires form a complex web of interactions that influences ecosystems, climate patterns, and human societies. It is essential to understand the interconnected dynamics of these factors to face the challenges posed by changing environmental conditions. This study is an initiative aimed at understanding in more detail the association between atmospheric dynamics related to South America monsoon precipitation, soil moisture (SM) and fire activity. We are in the process of analyzing different datasets. We have begun to analyze: ERA5 (fifth generation ECMWF reanalysis), GLEAM (Global Land Evaporation Amsterdam Model), GLDAS (Global Land Data Assimilation System), and CCI SM (Climate Change Initiative Soil Moisture) for surface soil moisture data and ERA5 precipitation data from January 1990 to December 2020. CCI SM and GLEAM are satellite-based datasets, GLDAS is blended data with observations and modeled reanalysis. Remotely-sensed soil moisture data in the Amazon region has many uncertainties due to the dense vegetation cover of the Amazon, which can interfere with the accuracy of soil moisture data obtained by the satellite, making data interpretation more difficult or requiring specific processing methods.

Currently we are applying several objective methods to analyze climatological conditions of soil moisture and precipitation. We are using Empirical Orthogonal Function (EOF) and Harmonic Analysis. The first identifies spatial patterns of variability and their associated temporal evolution, and the second decomposes a time series into its constituent harmonic components, which include amplitude, phase, and variance. The Mann-Kendall Trend Test has been used to identify significant trends in spatial patterns over time in the results obtained in EOF analysis. The Autoregressive Vector Correlation (AVC) was used to correlate precipitation/soil moisture and the oceanic indexes TAV (Tropical Atlantic Variability), ENSO (El Niño-Southern Oscillation) and SAM (South American Monsoon).

Initial analyses indicate that SM is highly variable in the central part of Brazil, with a dominant seasonal cycle, but it does not exhibit reasonable changes along coastal regions and the Amazon basin. Moreover, based on EOF analysis a dipole pattern dominates the interannual SM variability, that shows out-of-phase characteristics between southern and northeastern Brazil. This dipole is, however, is dependent on the dataset chosen. Additional analyses should be conducted to clarify the differences related to precipitation and soil moisture, and potential impact of fire activity in Brazil. It may be added that those climate variables are also related to oceanic conditions

occurring in the Atlantic and Pacific oceans, allowing for the possibility to identify the impact of oceanic modes in leading environmental changes in Brazil. Anticipated outcomes include a nuanced understanding of spatial and temporal variability in soil moisture, identification of dominant patterns, detection of trends, exploration of associations with precipitation, and a comprehensive analysis of how these factors correlate with fire events in Brazil. The opportunity provided by the Lemann Center for Brazilian Studies is fundamental to carry out the study with higher degree of scrutiny.