

Continuous Records of the Mixed Layer Heat Budget in the Tropical Atlantic Ocean

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Abstract

The tropical Atlantic Ocean and surrounding continents have experienced several extreme climate events during the past two decades that have resulted in once-in-a-century droughts in the Amazon, extreme drought and flooding in Northeast Brazil, and unprecedented hurricane activity in the Atlantic basin. Almost all of these extreme events have been connected to highly anomalous sea surface temperatures in the tropical Atlantic. However, the mechanisms driving the extreme SST fluctuations are poorly known. While earlier modeling studies emphasized the importance of wind-induced evaporative cooling and positive wind-evaporation-SST feedback, recent work has revealed that other mechanisms such as aerosol- and cloud-induced changes in surface solar radiation and oceanic mixed layer dynamics need to be considered.

Empirical analyses of SST variability in the tropical Atlantic usually rely heavily on data from satellites, atmospheric reanalyses, and global hydrographic profiles. Direct measurements from the Prediction and Research Moored Array in the Tropical Atlantic (PIRATA) are used much less frequently, despite the generally higher quality of the atmospheric measurements compared to those from satellites and reanalyses, and the enhanced temporal sampling rate of all PIRATA data. Part of the reason is that data from the PIRATA moorings is more difficult to interpret because of the presence of occasional gaps and biases in the time series.

A powerful quantitative tool for assessing the mechanisms responsible for SST variability is mixed layer heat budget analysis. Proper application of this technique to PIRATA data requires knowledge of several empirical parameters and, because of biases and gaps in the time series, involves collection of data from many independent sources. As a result, quantitative heat budget analyses are often based on arbitrarily chosen parameters, bias corrections, and gap-filling procedures. In this proposal we aim to address gaps and biases in the PIRATA records and avoid inconsistencies in the parameters chosen for heat budget analyses. The resulting product will be a consistent and continuous data set containing the main terms in the mixed layer heat budget of the tropical Atlantic Ocean during 1998-2013. The data set will consist of daily time series of each heat budget component from each of the 17 moorings of PIRATA. The product will be valuable for assessing the causes of extreme climate events in the tropical Atlantic, for validating ocean and climate models, and for diagnosing biases in coupled climate model simulations. A second component of this proposal is to create a gridded heat budget data set that extends back to the beginning of the satellite era (1982-2013), enabling analyses of how extreme events may be changing with time.

The proposed research will address the first goal of NOAA's Next Generation Strategic Plan (NGSP) of "*improved scientific understanding of the changing climate system and its impacts*" by providing a unique data set from which extreme climate events can be identified and their causes assessed. By improving understanding of the tropical Atlantic's past variability and its representation in models used for climate prediction, the proposed research will contribute to the second goal of NOAA's NGSP by providing "*assessments of current and future states of the climate system that identify potential impacts and inform science, service, and stewardship decisions.*" The proposed research addresses one of the key goals of the Climate Observations and Monitoring (COM) Program, which is to provide "*carefully developed and tailored value-added climate products, diagnostics, and indices based on these data.*"