Temporal clustering of tropical cyclones and its ecosystem impacts

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Tropical cyclones have massive economic, social, and ecological impacts, and models of their occurrence influence many planning activities from setting insurance premiums to conservation planning. Most impact models allow for geographically varying cyclone rates but assume that individual storm events occur randomly with constant rate in time. This study analyzes the statistical properties of Atlantic tropical cyclones and shows that local cyclone counts vary in time, with periods of elevated activity followed by relative quiescence. Such temporal clustering is particularly strong in the Caribbean Sea, along the coasts of Belize, Honduras, Costa Rica, Jamaica, the southwest of Haiti, and in the main hurricane development region in the North Atlantic between Africa and the Caribbean. Failing to recognize this natural nonstationarity in cyclone rates can give inaccurate impact predictions. We demonstrate this by exploring cyclone impacts on coral reefs. For a given cyclone rate, we find that clustered events have a less detrimental impact than independent random events. Predictions using a standard random hurricane model were overly pessimistic, predicting reef degradation more than a decade earlier than that expected under clustered disturbance. The presence of clustering allows coral reefs more time to recover to healthier states, but the impacts of clustering will vary from one ecosystem to another.

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