

"Investigating the Relationship between the MJO and the Indian Monsoon"

Introduction

There is no doubt that the world is entering an age of uncertainty and anxiety driven by a soaring population, low agricultural output, and global warming. Each season, farmers all over the world need to know what the best crops are to plant, and when is the best time to plant them. Increasingly, they and millions of other people are looking to seasonal climate predictions to help plan for the future. Unfortunately, the models used to make these predictions are often unable to accurately simulate climatic variability, and most importantly, oscillations of tropical convection.

Tropical intraseasonal oscillations or the Madden-Julian Oscillation (MJO) are huge regions of convection that erupt in the atmosphere above the Indian Ocean and the tropical western Pacific warm pool every 30 to 70 days. This huge stormy region acts as a deep thrumming engine of climate on our planet. Its pulse affects weather systems and climate variability all over the planet. And forecasters are not able to include this very important piece when attempting to solve the puzzle of future climate.

Recently, the Center for Multiscale Modeling of Atmospheric Processes (CMMAP) has worked to develop a global climate model that has been shown to produce a realistic MJO. This presents us with an amazing opportunity to study the effects of the MJO on global scale circulations that we already know affect the seasonal weather and climate all over the planet.

Motivation

Previous work has suggested that there are possible ties between the MJO and the onset and breaks of the Asian Monsoon. The Asian Monsoon is a huge seasonal change in wind and rain that brings desperately needed precipitation to southeastern Asia. Nearly a third of the world's population depends on the monsoon for their water and agriculture, and long breaks or complete failure of the monsoon can have devastating effects.

On the flip-side of the coin, there has been work showing that the monsoon or other extra tropical influences can affect the period of appearance of the MJO. This suggests a possible feedback between these two global-scale phenomena. There is a strong possibility that the MJO can make or break the Asian monsoon, and the Asian monsoon could create or snuff an MJO. If the feedback were positive, the two systems could feed on each others' energy. Each system would push the other into a stronger state, producing seasons with heavy precipitation over much of the Eastern Hemisphere. If the feedback were negative, the systems would work to dissipate each other's energy. One would moderate the other and produce much less precipitation.

This relationship is not currently well understood, but is obviously important to the climate forecasting community and the world population.

Project Plan

This project begins by proposing two more long runs of the MMF. Both should include the improved physics, dynamics, and land-surface models that have been developed over the first few years of CMMAP's existence.

The first run would be a control scenario where the model would be run with perpetual June controlled boundary conditions for approximately 48 months (June is the typical month for the onset of the monsoon). The second run would be an experimental run, with surface winds held in constant non-monsoonal flow, and the rest of the boundary conditions still set at constant June, for another 48 months.

The first run allows us to determine, using statistical methods of correlation and association, how often the onset of the monsoon is related to the intraseasonal oscillation in the Indian Ocean. The second run will allow us to determine the sensitivity of the flip-side association. Fixing the wind in a pattern typical of non-monsoonal flow will prevent the heavy clouds and convection associated with the monsoon from occurring. The difference in the number of MJOs or period of MJOs in this second run will help us determine how dependent the MJO is on the Asian monsoon.

Finally, similar statistical methods of association can be used with long-term observational datasets. There are several precipitation datasets (such as GPCP¹ and TRMM²) and long term cloud observing datasets (several merged NOAA data products) that we can use to determine the relationship between the occurrence of the MJO in June and the onset of the Asian monsoon. The resulting statistics can be used to validate the model results.

Summary

The results of all of these comparisons will shed light on one of the largest mysteries surrounding tropical meteorology in the Eastern Hemisphere. If the MJO is a missing link in the forecast of the Asian monsoons, our results and the use of the MMF can improve seasonal forecasts and improve the lives of billions of people.

Similarly, if the MJO is affected by the Asian monsoon, we will learn more about the creation of this huge weather system, and improve seasonal forecasts and climate variability in long term climate change forecasts as well. The implications of this feedback are huge, and the results from this study could change our fundamental understanding of the climate of our planet.

¹ Global Precipitation Climatology Project from NASA

² Tropical Rainfall Measuring Mission from NASA