Future changes in the seasonal cycle: Mechanisms and Implications

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Project Summary: The current generation of coupled climate models predicts that by the end of this century, the global seasonal cycle of sea surface temperature (SST) and precipitation will be delayed by a few days, compared to the last decades of the 20th century. This delay is a robust feature in all of the CMIP3 models, and thus must be an expression of some simple, fundamental mechanism at play in coupled models in response to increased greenhouse gases. Either this mechanism is at play in nature as well, or all the models are mistaken. In both cases, we ought to understand the origin of this phenomenon.

Another reason to investigate the global delay is its effect on several regional monsoons. In West Africa and the Amazon, for example, the onset of the rains is delayed and the rainy season is shortened. If such a projection is correct, the impact on local agriculture would be severe.

We will conduct a diagnostic study of the CMIP3 simulations (and CMIP4, when available) and perform additional sensitivity experiments with atmospheric GCMs and single column models in order to attain the following goals:

- Validate the CMIP3 simulations with respect to the phase of the seasonal cycle in SST and rainfall.
- Identify the source of the delay in global SST.
- Identify the source of the delay in global precipitation.
- Describe the effect of the delay in the regional monsoons of Africa, Asia, Australia and the Americas.
- Identify the regions where the monsoon onset is delayed more than the demise and the mechanisms responsible for this effect.

In particular, we will test the hypotheses that (i) sea ice loss at high latitudes is the main source of the global delay, (ii) tropical SST delays in turn force similar delays in the global ITCZ and (iii) the interplay between low-level humidity and atmospheric stability controls the asymmetry between the delay in the onset and the demise of the monsoon rains.

Scientific Merit: The change in seasonality of the global climate in response to anthropogenic greenhouse gases has received very little attention so far, but it appears to be the result of a robust, basic response of the climate system and it has far reaching implications for monsoons regions. The proposed research will further our understanding of this important phenomenon.

Broader Impact:

for the scientific community: The project will 'sustain the pool of human resources required for excellence in global atmospheric dynamics and climate research' by (i) supporting the continued employments of a researcher in a soft-money appointment and (ii) contributing to the education of the next generation of climate scientists, namely a graduate student and a post-doc.

for society at large: In many monsoon regions agriculture and pastoralism are rainfed and depend for their success on a rainy season that is sufficiently long for crops to reach maturity. Understanding future changes in the length of the rainy season will provide important information for development planning for these vulnerable regions.