Development of Indicators for Changing Sustainability and Resilience through the Analysis of Global High-Resolution Climate Change Simulation

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Sponsor: U.S. Environmental Protection Agency (USEPA), National Exposure Research Laboratory (NERL), Environmental Sciences Division (ESD)

Project Description

The purpose of this project is to develop a high resolution modeling capability to achieve the following:

1) Determine the extent to which high-resolution climate change modeling (HRM) can improve upon global and sub-global (continental to watershed scale) climate change statistics by evaluating the response to short term forcings and examining the ability of the model to properly simulate climate extremes; and

2) Assess and apply the predicted climate response with HRM to produce metrics for sustainability and resilience in a changing climate scenario.

This effort enables current individualized research efforts in each office to collaborate and provide an increased benefit for stakeholders through exchange of mutually beneficial knowledge and discovery. An initial case study at ORNL will establish the degree to which global high-resolution climate simulations with an active atmosphere and land surface within the DOE-funded Community Earth System Model (CESM) can provide sub-global climate change prediction. This will occur by building on a current investigation to determine the ability of the model to capture the climate response to the eruption of Mount Pinatubo (Gaddis et al. 2013), the analysis of which will quantify model predictability over annual time scales. Once the ability of an HRM to respond to a strong climate signal is determined, an extended HRM will be configured and performed to resolve climate extremes. Where possible, recently developed features of the CESM that will be useful for these efforts, specifically regional refinement and the dynamic land surface model options, will be included. The results will be used to inform development of sustainability metrics occurring at the EPA.

Specifically, three scientific questions will be addressed in this research. First, how well does the CESM capture climate extremes using HRM, particularly with a dynamic land model? Secondly, can we predict how the CESM will respond to future land use changes knowing responses to short-term strong forcings? Also, which land model variables provide strong predictability signals in particular regions of the United States? To address these questions, the project will identify atmospheric and land model

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features with high regional predictability using current HRM configurations and analyze these features during climate extreme events within HRM simulations and determine their role in subglobal climate variability. In concert with these efforts, ORNL researchers will work with the EPA to translate the results to produce resilience indicators and develop and configure the CESM to use refined grid over US and dynamic land features and determine additional indicators for near term climate change.

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