Chapter 17
New Approach Based on Termite's Hill Building for Prediction of Successful Simulations in Climate Models

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ABSTRACT

Quantitative analysis of the failures and crashes in simulation of climate models can yield useful insights to better understanding and improvement of the models results using Intergovernmental Panel on Climate Change (IPCC) class. In this paper, the authors propose a new technique inspired by termite's hill building behavior to analyze a series of simulation in climate models and predict which one was succeeded within the Parallel Ocean Program (POP2) component of the community Climate System Model (CCSM4). The authors' approach is a distance based approach used to predict the success of the values of 18 POP2 parameters. And in order to predict better results, they used for each experiment one of the studies as a training set and two as a test set, then they used two of the studies as a training set and one as a test set. Results of classification were very satisfactory (Accuracy > 0.87). This paper gives a very useful method to quantify, predict, and understand simulation success in climate models.

1. INTRODUCTION

One of the major issues in 21st century is Climate change. The science is unequivocal concentrations of greenhouse gases which are raising faster than that at any other previous era in the earth's history. From

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global food and water supplies, more frequent extreme weather events, sea level rise, ocean acidification, and mass extinctions, to human health from heat stress and vector-borne diseases, climate change presents a set of serious impacts that are already evident and increase day after day.

Unfortunately, with all these evidence, the scale of the systems involved makes the problem hard to understand, and hard to solve. The human being thinks just about business, for example, anthropogenic that is known as the effect of greenhouses and its strengthening through human activities. According to the latest Assessment Report from the Intergovernmental Panel on Climate Change, "most of the observed increase in globally averaged temperatures since the mid-20.

Hence, all these evidence and impacts are increasing; it can be summarized in three main challenges:

1. Mitigation to avoid the worst climate change effects by rapidly transitioning the world to a low-carbon economy;
2. Adaptation to re-engineer the infrastructure of modern society so that we can survive and flourish on a hotter planet;
3. Education to improve public understanding of the inter-relationships between the planetary climate system and human activity systems, and understanding of the scale and urgency of the problem (Easterbrook, 2010).

Meeting these challenges will demand the mobilization of entire communities of expertise: researchers, engineers, policymakers, and educators from many different disciplines. They need to contribute, in general, and for longer term to complete the transition to a global carbon-neutral society by the latter half of this century.

In technology and speed era, software plays a major role in all domains. According to (Easterbrook, 2010), a large part of the massive growth of energy consumption in the past few decades is due to the manufacture, the use of computing and communication technologies, and the technological advances they make possible. Software allows simulating earth system processes, assessing the implications, and exploring possible responses. All these are able by processing vast amounts of geo-scientific data, which help communities of experts to share data, explore scenarios and validate assumptions.

Nature contains a lot of sub-disciplines, a very big number of complex mechanisms that help life keep going on. Understanding these mechanisms is a principal source to inspire different algorithms and solutions for problems in technology era. Over the last few decades, it has stimulated many successful algorithms and computational tools for dealing with complex and optimization problems.

This paper presents a new approach to predict success of simulations in climate in order to analyze failure of parameter-induced the other simulation that crashes in climate models. The approach was inspired by Termite hill building mechanism. It combines three fields of research: machine learning, bio-inspired algorithms, and study of climate models simulation.

The organization of this paper is given as following. Section 2 presents the state of the art in which we gave an idea about the three fields combined in this work. Section 3 is about the hill building behavior of termites to understand better the biological phenomena and the inspiration. Then in the next section, we introduce the proposed approach. In Section 5, experimental results are obtained which are compared with other results obtained by using other algorithms to validate the efficiency of our approach. Finally, the last section shows the major conclusions in this work and gives an idea about future works.