New Project Proposal for Computing Time on the Supercomputer Mistral

Project title: Tropical Cyclones in the Future
Long title: Changes in the western Pacific Tropical Cyclones in a warming environment
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Allocation period: 01.07.2015 – 31.12.2015
No Project Funding Yet

Abstract

Due to the high socio-economic impacts of tropical cyclones, numerous studies are cropping up in an attempt to understand the effects of climate change on the number and intensity of tropical cyclones. To understand the impacts of a warmer climate on tropical cyclones, global climate models have been employed at varying spatial resolution. Bengtsson et. al., (2007) found that there will be fewer but more intense tropical cyclones in the 21st century in the coupled ECHAM5/MPI-OM global model following the IPCC SRES A1B scenario. In addition, they indicated that increasing the resolution resulted in a more realistic full three-dimensional structure of the storms. Another modelling approach is coupling the global ocean model with a regional atmosphere model. The novel model approach and potential benefits of coupling the MPI-OM (global ocean model) with REMO (regional atmosphere model) are discussed intensively in Sein et al., 2015. They applied this model system (ROM) to downscale climate change scenarios and to investigate the interactions between the North Atlantic Ocean and European shelves as well as their impact on the North Atlantic climate. In the evaluation of ROM, the model improved the simulation of the regional climate especially over the ocean even though some biases still persist.

In this project, we will use ROM to simulate the climate change effects on tropical cyclones in the western Pacific region. The aims of the project are to answer the following scientific questions:

- Which mechanisms are most important for the development of tropical storms in the Western Pacific Ocean?
- Can the number, duration, and intensity of tropical storms in the Western Pacific be simulated with the use of regionally coupled ocean atmosphere general circulation model (ROM)?
- How important are the ocean-atmosphere coupled modes in the Tropical Western Pacific region? How significant is the atmosphere-ocean coupling in this region?
- Which atmospheric/ocean model resolution can be used for the most optimal simulations of the tropical storms in this region? Will higher resolution (25 km) predict the tropical storm activities well or will 50 km resolution be sufficient?

Within the framework of the project, we perform the different simulations to have a better understanding of the Tropical Western Pacific region, improve simulation and prediction of tropical storms in the region, improve the quantification of climate change impacts in the region especially in the tropical storm activity, and to understand the impact of resolution and domain location on the simulation of the tropical storm activity in the western Pacific region. For tracking tropical cyclones, we are going to use the tracking algorithm designed by Hodges, 1994.

As part of the WCRP Initiative on a Coordinated Regional Downscaling Experiment (CORDEX), the Climate Service Center (CS2.0), an institute of Helmholtz Zentrum Geesthacht, contributes to the ensemble of regional climate simulations over various domains including the Southeast Asia using REMO. The CORDEX Southeast Asia initiative has been organized to augment the limited research over the Southeast Asia region. In addition, the CORDEX Southeast Asia is a coordinated work that requires high resolution simulations from regional climate models (WRF, RegCM4, CCAM, and PRECIS) because global climate models are unable to represent the tropical storms well in terms of magnitude, location, and intensity. In addition, the domain is composed of complex topography and small islands, which are not represented well in a coarse resolution. The CORDEX Southeast Asia domain covers the Southeast Asia region and is surrounded by the western Pacific Ocean and Indian Ocean.

With the high-resolution coupled simulations of ROM, we could contribute to the ensemble of high-resolution atmosphere-only simulations in CORDEX-SEA. The models will be evaluated using the global observational datasets CRU (over land) and HOAPS (over ocean). In addition, the Asian Precipitation – Highly-Resolved Observational Data Integration Towards Evaluation (APHRODITE), which is the dense network of daily rain-gauge for Asia will be used.

The high-resolution climate change simulations in this project will contribute to the increasing demand of climate change impact assessment in Southeast Asia. Eventually, this project will foster partnerships leading to various collaborations and application for research proposals such as from BMBF or Horizon2020.

Based on item number 3, the total sum of applied computing time and storage space that will be used in the accounting period for 2015:

Computing time	**589.824 core-hours or 24.576 node-hours**
Storage space (archiv)	**97.300 GB**
Temporary disk space (work)	**30.000 GB**
Long term storage (doku)	**8.000 GB**

Short-listed References:

Bengtsson, L., Hodges, K. I. and Roeckner, E. (2006) Storm tracks and climate change. Journal of Climate, 19 (15). pp. 3518-3543. ISSN 1520-0442 doi: 10.1175/JCLI3815.1

Hodges, K. I. (1994) A general-method for tracking analysis and its application to meteorological data. Monthly Weather Review, 122 (11). pp. 2573-2586. ISSN 0027-0644 doi: 10.1175/1520-0493(1994)122<2573:AGMFTA>2.0.CO;2

Sein, D. V. , Mikolajewicz, U. , Gröger, M. , Fast, I. , Cabos, W. , Pinto, J. G. , Hagemann, S. , Semmler, T. , Izquierdo, A. and Jacob, D. (2015): Regionally coupled atmosphere-ocean- sea ice-marine biogeochemistry model ROM: 1. Description and validation, Journal of Advances in Modeling Earth Systems . doi: 10.1002/2014MS000357