REGIONAL CLIMATE DOWNSCALING OVER SOUTHEAST ASIA: CLIMATE EXTREMES AND QUANTILE MAPPING BIAS CORRECTION

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ABSTRACT

This presentation summarizes some recent published results of the Vietnam team participating in the activities of the Southeast Asia Regional Climate Downscaling/Coordinated Regional Climate Downscaling EXperiment - Southeast Asia (SEACLID/CORDEX-SEA) project. The SEACLID/CORDEX-SEA was established in 2012 and had successfully gathered members from 18 institutions of 14 countries to carry out high resolution multi-model climate downscaling experiments over SEA. First, we address how simulations of present-day extremes are influenced by the choices of various physical parameterizations of the Regional Climate Model (RegCM) in order to determine which schemes are well suited to simulate extremes over the region. Next, we focus on the use of the quantile mapping (QM) technique to address biases in the simulated rainfall over Vietnam. The QM generally generates more realistic representation of rainfall and its extremes in the baseline period and minimally modifies the future change signal from the original projections.

Keywords: CORDEX-SEA, climate downscaling, regional climate model, climate extremes, bias correction.

1. INTRODUCTION

Today, about 8.6% of the world population is living in Southeast Asia (SEA) (Worldometers, 2019). Any change in the climate system can have unequivocal impacts on the socio-economic structures and living conditions in the region. Given the high exposure and vulnerability of the region to extreme events (Hijioka et al. 2014), it is vital for countries in SEA to implement adaptation measures to lower their risks. Detailed information of future climate scenarios is thus needed for appropriate adaptation measures. However, such information is still lacking in the region or generally based on global climate models (GCMs) that may have large uncertainties in a complex region such as SEA.

In order to fill the gaps, the Southeast Asia Regional Climate Downscaling /Coordinated Regional Climate Downscaling EXperiment - Southeast Asia (SEACLID/CORDEX-SEA) project was established and had successfully gathered members from 14 countries to carry out high resolution multi-model regional climate downscaling experiments (Juneng et al. 2016, Cruz et al. 2017, Ngo-Duc et al. 2017, Tangang et al. 2018). This presentation summarizes some recent published results of the Vietnam team participating in the SEACLID/CORDEX-SEA project.
2. NUMERICAL EXPERIMENTS

The Regional Climate Model version 4.3 (RegCM4.3) (Giorgi et al. 2012) was used to downscale the ERA-Interim reanalysis data for the period 1989-2008 over the SEA domain of 15°S-40°N, 80°E-145°E (Ngo-Duc et al. 2017). Eighteen configurations of 6 convective and 3 ocean flux schemes were carried out. We examined 14 extreme rainfall and temperature indices based on daily data. A statistical omega (Ω) index was used to measure the degree of similarity among the 18 experiments in phase and shape (Koster et al. 2002).

Next, the RegCM4.3 with the best configuration identified above was used to downscale the outputs of five Coupled Model Intercomparison Project Phase 5 (CMIP5) GCMs over SEA at 25 km resolution (Trinh-Tuan et al. 2019). The two 20-year periods selected for the analysis are: (1) the baseline period 1986–2005 and (2) the mid-future period 2046–2065 with two scenarios of RCP4.5 and RCP8.5.

3. RESULTS AND DISCUSSION

In Ngo-Duc et al. (2017), we have shown the Ω index for the 1989-2007 monthly values of the 18 experiments for 2m-temperature and four extreme temperature. One can note a general higher similarity from the Indochina Peninsula northward compared to the rest of the domain. Similar patterns are also observed with rainfall extremes but with a much lower degree of similarity, particularly over the Maritime Continent and the surrounding regions, indicating the high sensitivity of rainfall and its extremes to the different convective and ocean flux schemes (not shown).

Based on an objective score ranking system, we showed that the experiments with the MIT-Emanuel scheme performed better than the other convective schemes (Figure 1). Thus, the RegCM was configured with this cumulus parameterization in the GCM CMIP5 downscaling phase of the SEACLID/CORDEX-SEA project.

![Figure 1. The ranking scores of the 18 experiments based on the statistic values of 1) bias, 2) correlation, 3) rmse, and 4) ratio of standard deviation between model and observation, for the annual values of the 12 extreme indices (gray) and for the monthly values of TXx, TXn, TNx, TNn, Rx1day, and Rx5day (cross-hatched) (Ngo-Duc et al. 2017).](image)

With a focus on Vietnam, we used the Quantile Mapping (QM) non-parametric technique and a reference dataset called VnGP (Vietnam Gridded Precipitation, Nguyen-Xuan et al. 2016) to bias correct the models’ rainfall (Trinh-Tuan et al. 2019). Figure 2 shows that the QM much improves the probability density functions (PDFs) of rainfall over seven climatic sub-regions of Vietnam. The ensemble average of the QM products generally performed better than any individual QM member in capturing the spatial distribution of rainfall. The QM minimally modified the future change signal from the original projections. A drier condition with a longer rainfall break, and shorter
consecutive rainfall events were anticipated over Northern and Central Vietnam during their respective wet seasons in the mid-future (not shown).

Figure 2. PDFs of precipitation averaged over seven sub-regions during the period 1996-2005 for independent validation. The light green and light blue shaded areas represent the range of values from the five models while the green and blue lines are the average of the PDFs from the original RCMs and bias-corrected RCMs, respectively. The black line is the PDF calculated from the observational-based VnGP data set (Trinh-Tuan et al. 2019).

4. CONCLUSION

The SEACLID/CORDEX-SEA 25-km downscaling expriments have been sucessfully conducted and analyzed, allowing for better understanding and more detailed information of regional climate over the area. We are entering the second phase of the project where very high resolution downscaling runs of 5km are being implemented. The outputs of this second phase will be of great importance for further climate impact and adaptation studies over SEA.

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REFERENCE


