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Evaluation and Optimization of CMIP5 Data using an Artificial Neural Network for Dynamical Downscaling of rainfall on Oahu, Hawaii

Pao-Shin Chu and Chris Holloway
Department of Atmospheric Sciences, University of Hawaii, Honolulu, Hawaii 96822, U.S.A. (chu@hawaii.edu)

Understanding long-term changes of rainfall is important for water resources planning and development. General Circulation Models (GCMs) such as those used in CMIP5 have undergone significant improvements since the early development of Numerical Weather Prediction. CMIP5's RCP8.5 experiment was comprised of over 20 different GCM configurations using various parameterization schemes and initial conditions to project the future climate in response to anthropogenic warming. However due to coarse spatial resolution and simple parameterization schemes of GCMs, current rainfall estimates and future rainfall projections are often unrealistic, especially for small islands with complex terrains such as the Hawaiian Islands. Recent advancements in mesoscale meteorology have helped develop limited area Regional Climate Models (RCMs) such as WRF-ARW that have the ability to estimate and project high-resolution rainfall at smaller scales, in our case down to 1.1km. RCMs often use GCM output for their initial lateral boundary conditions and prescribed land surface conditions.

In the original WRF system, there is a land surface model but small Hawaiian Islands such as Oahu is not well represented in the land surface datasets of the official WRF model release. Therefore, we made effort to improve land surface characteristics (e.g., albedo, green vegetation fraction) suitable for 1.1 km domain over Oahu. Since high-resolution RCM output is forced by the lateral boundary conditions, we see significant variations in estimated and future projected rainfall depending on which GCM was chosen to force the RCM. To combat this issue we implement an Artificial Neural Network using a simple Sequential Learning Algorithm (SLA) to evaluate the GCM's ability to simulate the current climate, allowing us to choose the optimum lateral boundary conditions that drive the RCM. In our study we use CMIP5's monthly means output from several different models that included both the Historical and RCP8.5 experiments, and compare the Historical output to the current climates represented by monthly mean winds from a global reanalysis. The SLA weights the individual models based on their performance to simulate the current climate and the model with the most significant weight is used to force WRF-ARW for future rainfall projections.