21st Century High-Resolution Climate Projections for Guam and American Samoa

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Numerical simulations are being performed to project the anticipated 21st century climate changes at fine spatial resolution for Guam and American Samoa. This project will produce basic information about the projected changes in climate (including surface temperature, rainfall, surface winds, incident solar radiation, evapotranspiration) over the next century. Changes in these aspects of the climate will have important implications for adaptation strategies in conservation management, and the forecasts from this project will be of wide interest to managers with concerns about long-term environmental change in the insular Pacific, as well as researchers in other fields (hydrology, ecology, economics..) who may use the projected climate changes as inputs to their own models.

The simulations are being conducted using a multiply-nested atmospheric model, with parameterizations previously modified for simulating the climate of Hawai‘i. Initial efforts are focused on further modifying the model so that it produces the best possible simulation of present day climate in Guam and American Samoa. The climate simulation problem for Guam is similar to that for Hawai‘i - the dry season is characterized by trade winds and a marine boundary layer capped by a strong inversion, while the wet season experiences much more convective rain. However, Guam is further from the center of the northeast Pacific high and over much of the year is directly affected by the monsoon trough and by active typhoons. Both Guam and the main island of Tutuila in American Samoa are similar to Maui and Oahu in that they have a very steep topographic gradients and adequate climate simulation requires a model numerical grid over the islands to have extremely fine horizontal spacing.

Some preliminary results from a one year simulation to evaluate the model performance for present day conditions have been obtained. Fig. 1 shows the model configuration, with outer, middle and inner domains with 20, 4 and 0.8 km horizontal grid spacing, respectively. In this simulation the observed ocean surface temperatures and the observed meteorological conditions around the boundary of the outer domain were imposed. The right panels show the one year annual rainfall simulated for Guam and for the island of Tutuila in American Samoa. The results are in reasonable agreement with the limited station observations available. Notably the expected strong topographic control over rainfall and the resulting large horizontal gradients in rainfall are apparent in the simulations for both islands. An overall bias to somewhat high simulated rainfall amounts for both islands was found, however. These initial results are encouraging and work is underway to improve further the model simulation.
Fig. 1. The triply-nested configuration of the regional atmospheric model designed for detailed simulations of Guam and the island of Tutuila in American Samoa.

Fig. 2. The annual average rainfall rate (mm/day) simulated for the year 1990 over Guam (left) and Tutuila (right). The numbers on the plots show the observed rainfall rates for the same year at individual stations.