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High Resolution Climate Change Projection for Sri Lanka

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ABSTRACT

This study mainly investigates the changes in future climate using a variable resolution Conformal Cubic Atmospheric Model (CCAM) developed at CSIRO, Australia. Bias corrected sea surface temperatures (SSTs) and sea ice concentration from several global climate models (GCMs), which were performed for the Intergovernmental Panel on Climate Change (IPCC) fifth assessment report, were used as boundary conditions for the high resolution simulations over Sri Lanka at 8 km resolution.

The first study present statistical and neural network approaches in estimating a serially complete data set of daily maximum and minimum temperature records of Jaffna meteorology station situated at northern part of Sri Lanka. The daily maximum and minimum temperature records from 1966 to 1980 (15 years) were used to develop the models. By calculating the standard deviation between the difference in estimated and measured values it is shown that error in estimating the daily maximum and minimum temperature of both approaches are about ±0.7°C and ±0.9°C respectively. The results shows that both approaches can be applied to estimate the missing daily maximum and minimum temperature data in Jaffna for the period 1981 to 2000 where large gaps in whether observations are reported.

CCAM simulations at 50 km forced by the sea surface temperature and sea ice concentration from six global climate models (GCMs) from the Coupled Model Inter-comparison Project Phase 5 (CMIP5) over South Asia, centered on Sri Lanka were evaluated to select few simulations to carry out downscaling at 8 km resolution. Comparatively, three CCAM simulations CNRM-CM5, GFDL- CM3 and ACCES1-0 show good agreement over the Sri Lankan region. Mean biases, root mean square errors (RMSE) and pattern correlations were calculated by comparing the observations against simulations to assess the performance of the model. Results show that for temperature, biases vary between -1.2 and -2.2 °C. The pattern correlations for temperature vary among the seasons between 0.92 and 0.96. The model tends to underestimate observed temperature values over the selected domain. For rainfall, the variation of pattern correlation is relatively low for the southwest monsoon season which is 0.67 with RMSE about 3.8 mm/day. CCAM simulations show small biases during the northeast monsoon season with a strong pattern correlation of 0.75 with RMSE of 1.7 mm/day.

Projected changes in mean temperature and rainfall are also presented for years 2030, 2050 and 2070 for RCP 4.5 and RCP 8.5. Ensemble mean of area average temperature is expected to increase between 0.8 – 1.6 °C for RCP 4.5. Temperature is expected to increase between 0.9 – 2.5 °C for RCP 8.5. By 2030, the rainfall increase about 40% in the northern part of the country during first inter-monsoon season and about 20% in the south-eastern part of the country during northeast monsoon season. The pattern remains the same in 2050 and 2070.

The extreme rainfall indices, such as, annual highest one-day rainfall, annual highest five-day consecutive rainfall, annual maximum length of wet spells and annual maximum length of dry spells were also analyzed. The projected ensemble mean changes simulated by CCAM for 2050 under RCP4.5 and RCP8.5 suggest that the one-day rainfall and five-day rainfall are likely to increase along the southwestern and southeastern parts of the country and a decrease over the northwestern region. The changes are more prominent for higher emission scenario. The length of wet spells is projected to decrease between 0% and -45% for RCP8.5 and -5 to -43% for RCP4.5. A moderate decrease in wet spells over the northwestern region and a large decrease over the southeastern part of the country have been simulated. For the northeastern region, the model suggests that all four extreme indices will decrease in the future.