

The Effects of Grid-Resolution and Domain Choice on the Quality of Simulations of the South Asian North-East Monsoon Rainfall

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ABSTRACT

We evaluate the performance of an ensemble-based dynamical regional climate downscaling over Sri Lanka in a winter monsoon season for choices in grid resolution and domain extent. We used the ECHAM4.5 global atmospheric general circulation model at a resolution of about 300 km (T42) and the RegCM3 regional climate model (RegCM3) with grid resolutions of 100km, 50km, 25km and 20km grid size, respectively. Sri Lanka is about a size of a gridbox of ECHAM (400x250 km) and has mountain ranges that reach up to 2532 meters in altitude. Two sets of regional model runs were undertaken to assess the effect of grid resolution and model domain size on the downscaling performance in the spatial distribution of precipitation and its seasonal evolution. Our simulations shows that the RegCM3 with 100km grid (which only resolves the peak of the mountains at less than 200m) is still too coarse to capture orographic influences on the monsoon rainfall. The RegCM3 simulation with grid size from 20km to 50km gives fine scale details resulted from the topographic effect on monsoon rainfall associated with the uplift condensation on the windward side. While, the small-domain runs (where only the forcings for the region immediately around Sri Lanka - 4N-11N and 76E to 85E - were used) is computationally more efficient, the results appeared to be overly controlled by the driving GCM - the topographic precipitation is displaced compared to the observed precipitation. The “large-domain” simulation used a domain comprising both land and ocean (approximately 4S-22N and 65E-96E). The large-domain group of simulations produced reasonable spatial distribution of precipitation over both land and ocean regions. Moreover, the ensemble sharpness among the seven realizations is enhanced in the large-domain high-resolution runs. Therefore, fine enough grid resolution (25 km or less) and sufficiently large domain size are both needed to simulate the essential features of precipitation in this tropical and monsoonal region.