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Impact of atmospheric moisture in a rainfall downscaling framework for catchment scale climate change impact assessment

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A nonparametric stochastic downscaling framework for generation of daily rainfall at multiple point locations for catchment scale climate change impact assessment under enhanced greenhouse conditions is described. Three formulations of the nonparametric downscaling framework are evaluated. In the first case, rainfall is downscaled using a system of variables that combine atmospheric circulation indicators (geopotential height, pressure and derived variables) with time lagged wetness indicators reflecting a continuous rainfall state. In the second and third cases, the above system of variables is augmented using indicators of atmospheric moisture found relevant in defining the downscaling relationship. The atmospheric moisture indicators considered include total precipitable water and dew point temperature depression defined as a difference of atmospheric and dewpoint temperatures at a pre-specified pressure level. The downscaling framework is specified using 43 years of daily rainfall observations at 30 locations near Sydney, Australia, with reanalysis data being used to represent observed atmospheric variables. A single ensemble member of the CSIRO Mark 3 GCM is used to downscale the rainfall for year 2070 conditions. While all the downscaling formulations show an overall similarity in the downscaled rainfall for the current climate, marked differences are simulated for year 2070 conditions. The inclusion of temperature depression as an indicator of atmospheric moisture indicates decreases in winter, autumn and spring rainfall amount and number of wet days. The inclusion of precipitable water, on the other hand, is found to result in a significant increase in the number of wet days, the seasonal rainfall amount as well as the rainfall amount per wet day, especially for summer. Overall, a change of -5% in the frequency of wet days and -3% in the rainfall amount in year 2070 are suggested if only atmospheric circulation

variables are considered. Inclusion of temperature depression projects a drier future climate with a change of -11% in the frequency of wet days and -14% in the rainfall amount. Inclusion of precipitable water, however, reverses the trend with expected increases of +9% in the frequency of wet days and +14% in the rainfall amount in the warmer climate, with most of the increase being confined to summer