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Establishing a baseline precipitation and temperature regime for the Guianas from observations and reanalysis data

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The tropical rainforests of the Guianas, north of the Amazon, are home to several Amerindian communities, hold high levels of biodiversity and, importantly, remain some of the world's most pristine and intact rainforests. Not only do they have important functions in the global carbon cycle, but they regulate the local and regional climate and help generate rain over vast distances. Despite their significance however, the climate and hydrology of this region is poorly understood. It is important to establish the current climate regime of the area as a baseline against which any impacts of future climate change or deforestation can be measured but observed historical climate datasets are generally sparse and of low quality.

Here we examine the available precipitation and temperature datasets for the region and derive tentative precipitation and temperature maps focussed on Guyana. To overcome the limitations in the inadequate observational data coverage we also make use of a reanalysis dataset from the European Centre for Medium-range Weather Forecasts (ECMWF). The ECMWF ERA40 dataset comprises a spatially consistent global historical climate for the period 1957-2002 at a $\sim$125 km2 (1.125 degree) resolution at the equator and is particularly valuable for establishing the climate of data-poor areas. Once validated for the area of interest, ERA40 is used to determine the precipitation and temperature regime of the Guianas. Grid-cell by grid-cell analysis provides a complete picture of spatial patterns of averaged monthly precipitation variability across the area, vital for establishing a basis from which to compare any future effects of climate change. This is the first comprehensive study of the recent historical climate and its variability in this area, placing a new hydroclimate monitoring and research program at the Iwokrama International Centre for Rainforest Conservation and Development, Guyana, into the broader climate context.

Mean differences (biases) and annual average spatial correlations are examined between modelled ERA40 and observed time series comparing the seasonal cycles and the yearly, monthly and monthly anomaly time series. This is to evaluate if the reanalysis data correctly reproduces the areally averaged observed mean annual precipitation, interannual variability and seasonal precipitation cycle over the region. Results show that reanalysis precipitation for the region compares favourably with areally averaged observations where available, although the model underestimates precipitation in some zones of higher elevation. Also ERA40 data is slightly positively biased along the coast and negatively biased inland. Comparisons between observed and modelled data show that although correlations of annual time series are low (<0.6), correlations of monthly time series reach 0.8 demonstrating that the model captures much of the seasonal variation in precipitation. However correlations between monthly precipitation anomalies, where the averaged seasonal cycle has been removed from the comparison, are lower (< 0.6). As precipitation observations are not assimilated into the reanalysis these results provide a good validation of model performance.

The seasonal cycle of precipitation is found to be highly variable across the region. Two wet-seasons (June and December) occur in northern Guyana which relate to the twice yearly passage of the inter-tropical convergence zone whereas a single wet season (April-August) occurs in the savannah zone, which stretches from Venezuela through the southern third of Guyana. The climate transition zone lies slightly north of the distinctive forest-savannah boundary which suggests that the boundary may be highly sensitive to future alterations in climate, such as those due to climate change or deforestation.