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Generating daily weather data for ecosystem modelling in the Congo River Basin

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Daily weather data are an important constraint for diverse applications in ecosystem research. In particular, temperature and precipitation are the main drivers for forest ecosystem productivity. Mechanistic modelling theory heavily relies on daily values for minimum and maximum temperatures, precipitation, incident solar radiation and vapour pressure deficit. Although the number of climate measurement stations increased during the last centuries, there are still regions with limited climate data. For example, in the WMO database there are only 16 stations located in Gabon with daily weather measurements. Additionally, the available time series are heavily affected by measurement errors or missing values. In the WMO record for Gabon, on average every second day is missing.
Monthly means are more robust and may be estimated over larger areas. Therefore, a good alternative is to interpolate monthly mean values using a sparse network of measurement stations, and based on these monthly data generate daily weather data with defined characteristics. The weather generator MarkSim was developed to produce climatological time series for crop modelling in the tropics. It provides daily values for maximum and minimum temperature, precipitation and solar radiation. The monthly means can either be derived from the internal climate surfaces or prescribed as additional inputs.
We compared the generated outputs observations from three climate stations in Gabon (Lastourville, Moanda and Mouilla) and found that maximum temperature and solar radiation were heavily overestimated during the long dry season. This is due to the internal dependency of the solar radiation estimates to precipitation. With no precipitation a cloudless sky is assumed and thus high incident solar radiation and a large diurnal temperature range. However, in reality it is cloudy in the Congo River Basin during the long dry season. Therefore, we applied a correction factor to solar radiation and temperature range based on the ratio of values on rainy days and days without rain, respectively.
For assessing the impact of our correction, we simulated the ecosystem behaviour using the climate data from Lastourville, Moanda and Mouilla with the mechanistic ecosystem model Biome-BGC. Differences in terms of the carbon, nitrogen and water cycle were subsequently analysed and discussed.