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Using CMIP5 past, future and idealized simulations together with paleo-data to better constrain projections of future tropical precipitation changes

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CMIP5 simulations show a persistent spread in projections of future tropical precipitation changes. Given the difficulty to find constraining metrics based on the present-day climate or recent past, could we use paleo-data of past precipitation changes to better assess the credibility of these projections? This is possible (1) if models that share a common behavior in past simulations also share a common behavior in future simulations, (2) if there is some commonality between the physical mechanisms underlying this behavior in past and future climates and (3) if the realism of the behavior in past simulations can be evaluated using paleo-data. The CMIP5 archive offers a unique opportunity to investigate these conditions: past and future simulations with the same model versions can be compared, and the mechanisms at play in past and future simulations can be disentangled using the set of idealized experiments.

We will illustrate this methododoly by exploring the possibility to constrain future precipitation changes in tropical South America using Mid-Holocene simulations and data. We show that in the future, most models simulate a dipole of precipitation changes between Northern and Eastern South America, but the sign and magnitude of precipitation changes are model-dependent. Models that show the strongest precipitation shift from Northern to Eastern South America in the future are those that show the strongest Southward displacement of the ITCZ during the Mid-Holocene. To understand the mechanisms at play and the sources of inter-model differences, we use the idealized CMIP5 simulations to interpret the precipitation changes for past and future climates in terms of circulation changes associated with direct CO_2 effect, circulation changes associated with surface temperature changes, thermodynamical effects and changes in evapo-transpiration. Finally, simulations are compared with some paleo-data syntheses.