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Andean geodynamics and the evolution of the Amazonian ecosystem

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The evolution of the Amazonian landscape is directly related to the development of the Andean Cordillera and its interaction with climate and other geodynamic processes. The Andean orogeny shaped the climate in South America and changed the precipitation rates across the continent. The continuous increase in erosion rates mainly along the eastern flank of the cordillera amplified the influx of sediments in Amazonia, culminating in the formation of the transcontinental Amazon Drainage Basin nearly 10 million years ago (Ma), connecting the Andean Cordillera and the Equatorial Atlantic Margin. Concomitantly, flexure of the lithosphere due to the load of the Andes and dynamic topography induced by the subduction of the Nazca plate under the western margin of South America modified the landscape in Amazonia.

Due to the complexity of the different processes associated with the geodynamic evolution of northern South America during the last 40 Ma, a natural approach to this study is the use of numerical models that take the interaction of the different geodynamic processes into account. Based on numerical models that combine orogeny, surface processes, flexure of the lithosphere, mantle dynamics, and paleoclimate scenarios, we show how the different habitats in Amazonia probably evolved during the formation of the Andean Cordillera. We observed that the continuous uplift of the Andes created an asymmetric influx of sediments and nutrients in Western Amazonia, inducing the eastward expansion of várzea and terra firme forests during the Miocene. Consequently, the igapó forests retracted and were preserved mainly adjacent to the Guiana and Brazilian shields. Additionally, before the formation of the transcontinental river, large aquatic environments were formed in Western and Central Amazonia, with spatial and temporal extent modulated by climate, sea-level fluctuations, and amplitude of dynamic topography, controlling the transition from the intermittent marine environment to lacustrine conditions, similar to the long-lived lakes of the Pebas System during the Late Miocene. We propose that these landscape evolution scenarios are compatible with the flourishing and extinction of endemic species during the Late Miocene and can explain part of the present pattern of biodiversity observed in the largest rainforest on Earth.