THE RISE OF C4 GRASSES IN ARGENTINA: LINKING GRASSLAND TRANSITION TO THE SOUTH AMERICAN SUMMER MONSOON USING SEDIMENTS, PALEOSOLS, PHYTOLITHS AND ISOTOPES

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The expansion of C_4 grasses is one of the most dramatic ecological changes in the past 65 million years. Beginning in the late Miocene (~10-5 Ma), these tropical and subtropical grasses began to spread and now cover roughly 25% of the Earth's surface. C_4 grasses include economically and ecologically important crops, but the environmental conditions that drove this global expansion are poorly understood. In this study, we aim to determine the drivers of C_4 grass expansion in central South America (Argentina). We hypothesize that this expansion was driven by the strengthening of the South American Summer Monsoon (SASM), which occurred as a result of regional climatic change related to local tectonic and global climatic processes. Using sedimentology/stratigraphy, paleopedology and geochemistry, phytolith and carbon isotope reconstructions, and biomarkers, we present paired reconstructions of environmental and climatic conditions and the abundance of C_4 grasses across 7 sites in northern and central Argentina to assess the timing of this ecological transition in South America during the late Miocene-Pliocene. We find that in the absence of temperature and atmospheric CO_2 changes, regional hydrologic change is likely the driver of C_4 grass abundances in the Miocene. In northwest and central Argentina, our data suggests that increased precipitation seasonality brought about by the intensification of the South American Monsoon drove the expansion of C_4 grasses, at least in the more humid regions. These results are supported by Community Earth System Model simulations that suggest an increase in summer precipitation along the eastern foothills of the Andes in Argentina between 8 and 3 Ma. Our data does not show a correlation between fire frequency and C_4 grass abundance in Argentina, unlike other regions where this may drive the expansion. We also note that we only find moderate to high abundances of C_4 grasses in areas where proxy-based precipitation estimates exceed ~500 mm/yr, and do not observe C_4 grasses at sites with modern elevations higher than ~3,000 feet or behind rain shadows, showing that tectonically driven conditions are important controls on the distribution and spread of C_4 grasses.