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The diminishing contribution of low-level jets to the U.S. Great Plains water budget

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In the semi-arid U.S. Great Plains, nocturnal southerly low-level jets (LLJs) serve critical roles as conveyors of remotely-sourced (i.e., Gulf of Mexico) water vapor and agents of atmospheric instability in the warm-season. Defined by a diurnally oscillating wind maximum between 0–3 km above the surface, LLJs have been studied by meteorologists for over 60-years due to their role in severe weather outbreaks. It is only within the past decade that a subset of LLJs with especially high vertically integrated water vapor transport, termed atmospheric rivers, have drawn the attention of hydrologists.

In this study, changes in LLJ frequency and structure over the period from 1901–2010 are quantified using ECMWF's Coupled Reanalysis of the Twentieth Century (CERA-20C). A new objective dynamical LLJ classification dataset is used to separately quantify changes in the two predominant LLJ types: synoptically coupled and uncoupled. The findings reveal that both the frequency of Great Plains LLJs and their associated precipitation have decreased significantly over the 20th century. Decreases in LLJ associated precipitation range between 10–14% of total present day May–September precipitation. The largest differences observed are attributable to uncoupled jet frequency and structural changes during July and August over the central and northern Great Plains. Overall, the results indicate the contribution of LLJs to the region's water budget has diminished.