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Intercomparison of global evapotranspiration products over irrigated areas using irrigation auxiliary information and in situ Eddy Covariance tower measurements

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Global evapotranspiration (ET) products are critical for modeling climate, hydrology, land surface processes, and managing water resources. These products are derived using diverse methodologies, including machine learning, energy balance, and process-based models. While many studies have assessed ET products, they typically focus on specific regions or basins. Moreover, no intercomparison has specifically addressed irrigated areas, despite their significant role in regional climate and hydrology. To fill this gap, this study evaluates eight global ET products (FLUXCOM, MOD16A2, ERA5-Land, GLDAS-Noah, GLEAMv4, MERRA2, SSEBOP, PML v2) across 12 irrigated regions in the contiguous United States, Spain, Italy, Australia, China and India, characterized by diverse irrigation practices, climates, and crop types. The analysis examines ET dynamics and magnitudes in relation to auxiliary irrigation data (timing, equipment rates, and climate), includes a spatial evaluation of ET against the Global Map of Irrigated Areas (GMIA), and analyzes the spatial patterns of the ET/ETP ratio. The products are also locally validated using in situ ET measurements from five Eddy Covariance towers located in irrigated fields in California and Italy. Our results reveal substantial discrepancies among ET products in their ability to: i) detect irrigation signals, ii) capture seasonal irrigation patterns, and iii) estimate ET volumes consistent with crop water needs and local climatic conditions. Furthermore, the relationship between ET dynamics and irrigation information differs significantly between regions, sometimes even for the same product. These findings highlight the need to enhance global ET products to better incorporate irrigation dynamics, improving their utility for water management, climate modeling, and assessments of anthropogenic impacts on the Earth system.