Columbia Basin Project irrigation likely cooled maximum daily summer temperatures in Washington

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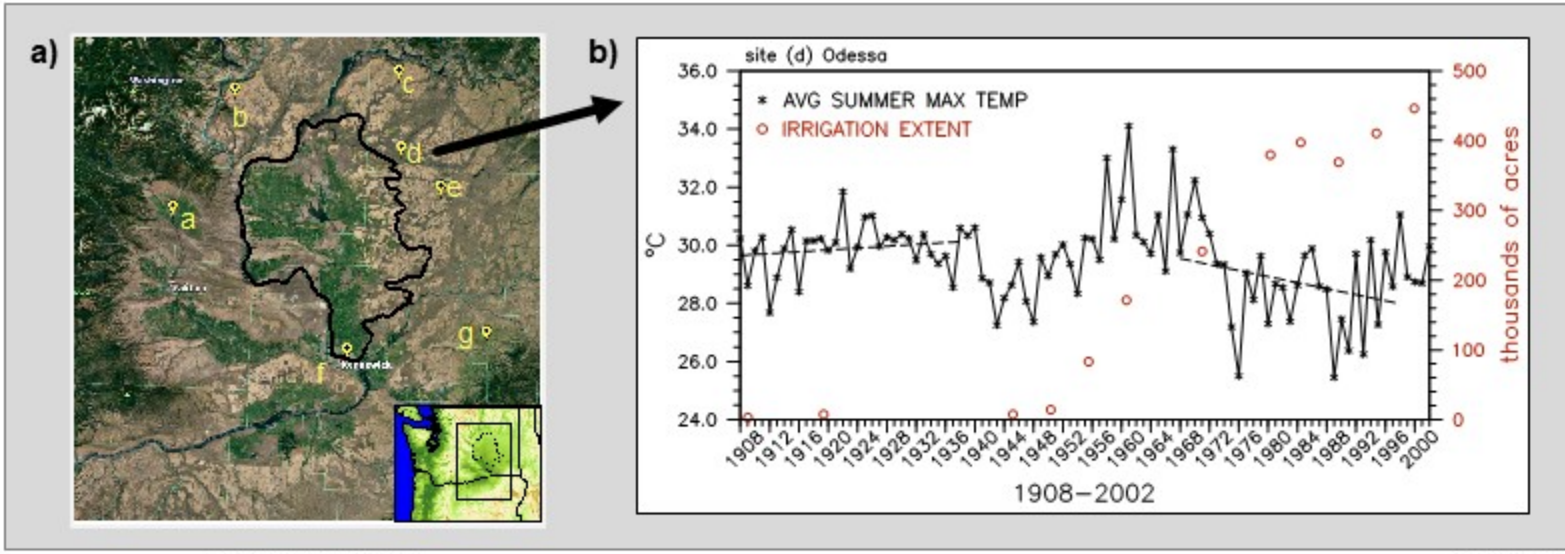

Figure 1

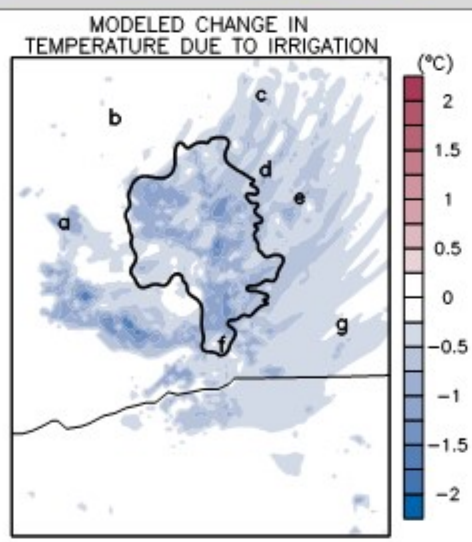

Figure 2

The Columbia Basin Project (CBP) is a series of dams, reservoirs, and canals that, since 1948, have delivered irrigation water to Central Washington (**Figure 1a**). Analysis of historical climate records (**Figure 1b**), satellite remote sensing data, and numerical modeling experiments (**Figure 2**) suggests that irrigation from the CBP has contributed to a reduction in summer maximum temperatures and heat extremes within and downwind of the CBP boundaries, supporting a regional impact of irrigation in the study area.

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References:

Lawston, P.M., J. A. Santanello, B. Hanson, K. R. Arsenault, 2019. "Impacts of Irrigation on Summertime Temperatures in the Pacific Northwest". Submitted to *Earth Interactions*.

Data Sources: Global Historical Climate Network (GHCN) daily maximum temperature (~1900-present), USDA Census of Agriculture irrigation acreage, model simulations using NASA Unified WRF (NU-WRF) coupled to NASA's Land Information System (LIS).

Technical Description of Figures:

The Columbia Basin Project (CBP; black outline Fig. 1a) began delivering irrigation water to Central Washington in 1948. The USDA Census of Agriculture depicts a dramatic increase in irrigation acreage post-1948 (red circles; Fig. 1b), which corresponds with a decrease in maximum daily summer temperatures (TMAX) at the three GHCN sites downwind of CBP irrigation (black line; Fig. 1b). Modeling experiments using NASA's NU-WRF and LIS models support these findings, showing that the irrigation cooling effect can extend as far downwind as the three GHCN stations that showed statistically significant cooling in observations (Fig. 2). Taken together, these results suggest irrigation from the CBP has cooled maximum daily summer (June, July, August) temperatures.

Figure 1: a) Map of Central Washington, U.S., where black line indicates the boundaries of the CBP area and letters mark the locations of 7 GHCN sites with data records beginning in the early 1900's, **b)** Time series of JJA average daily TMAX from the Odessa GHCN site (location letter d in Fig. 1a) and irrigation acreage (red circles) from the USDA Census of Agriculture for Grant County, Washington in the CBP.
Figure 2: Difference in maximum daily temperature (July 23, 3015) from NU-WRF simulations with and without irrigation. Blue shading shows that the irrigated simulation produces cooler maximum temperatures as far downwind as the GHCN sites.

Scientific significance, societal relevance, and relationships to future missions: Although the localized impact of irrigation on soil moisture and fluxes is relatively well understood, to what extent these flux changes impact air temperature and humidity is uncertain. Estimates of irrigation cooling are often model derived and vary considerably across studies. This work used historical observations to quantify irrigation's impact on climate and used modern satellite observations and state-of-the-art modeling to understand the boundary layer processes and feedbacks that link land surface changes to atmospheric impacts. By quantifying the impacts of widespread irrigation implementation on temperature in this region, which features a climate typical of other agriculturally productive regions across the world, the role of human practices that impact the water and energy cycles can be better understood. This is particularly important as these regions tend to be highly dependent on irrigation for food security and are particularly vulnerable to episodes of drought and water scarcity. Such issues are likely to become more common under a changing climate, making the ability to monitor agricultural impacts globally from NASA platforms such as MODIS, VIIRS, SMAP, and ECOSTRESS all the more imperative. Overall, these results underscore the need to consider human water management impacts when analyzing or predicting components of the water and energy cycles, and the critical roles that NASA observations and models play in this assessment.