Supplementary Information for

Representation of a two-way coupled irrigation system in the Common Land Model

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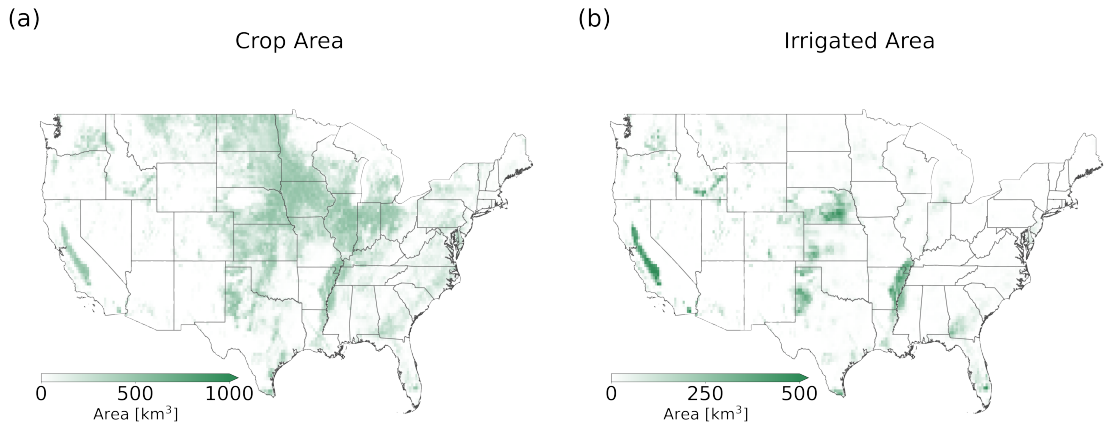


Figure S1. Spatial distribution of crop areas and irrigated areas within the study region. (a) Crop areas. (b) Irrigated areas.

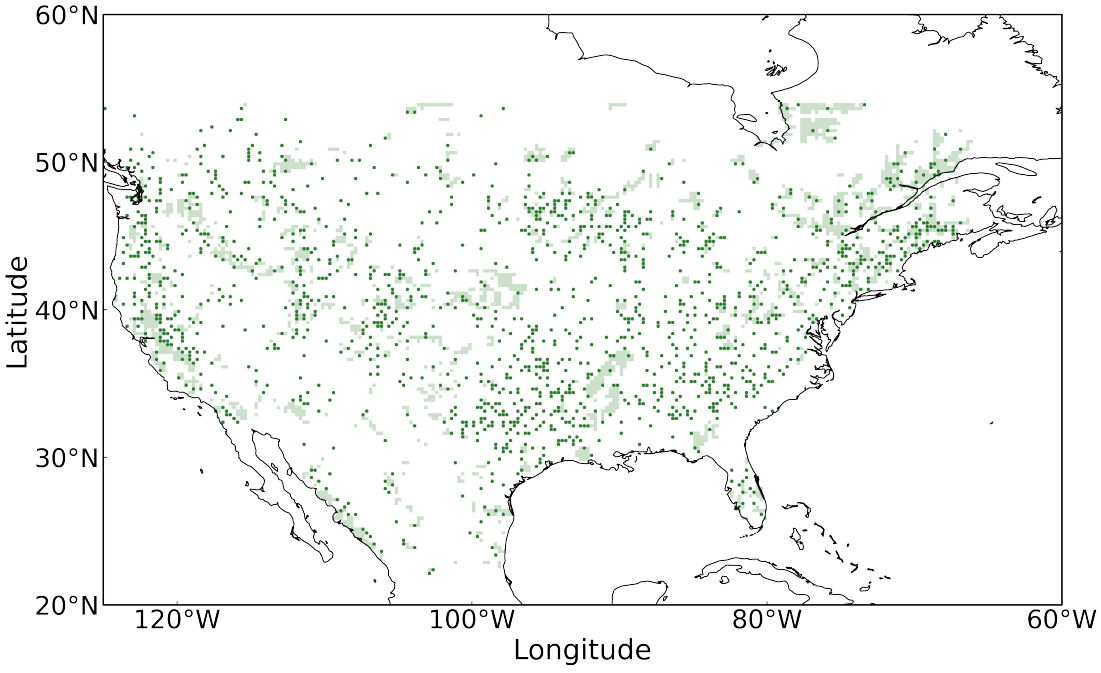
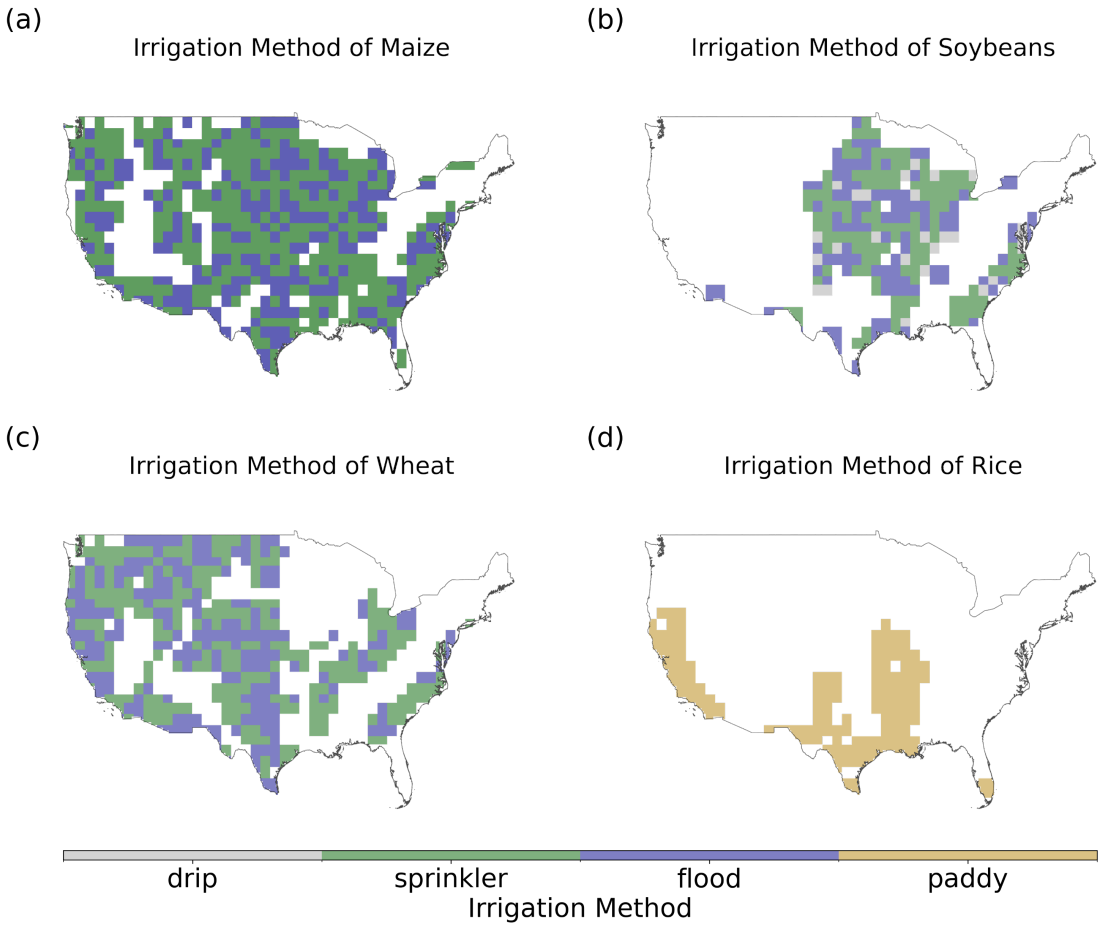


Figure S2. Locations of reservoirs and associated irrigated areas within the study region. Reservoir locations are marked with green dots, and the corresponding irrigated areas are shown in light green.



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20 **Figure S3.** Irrigation methods for four crops across the study region. (a) Maize. (b)
21 Soybeans. (c) Wheat. (d) Rice.

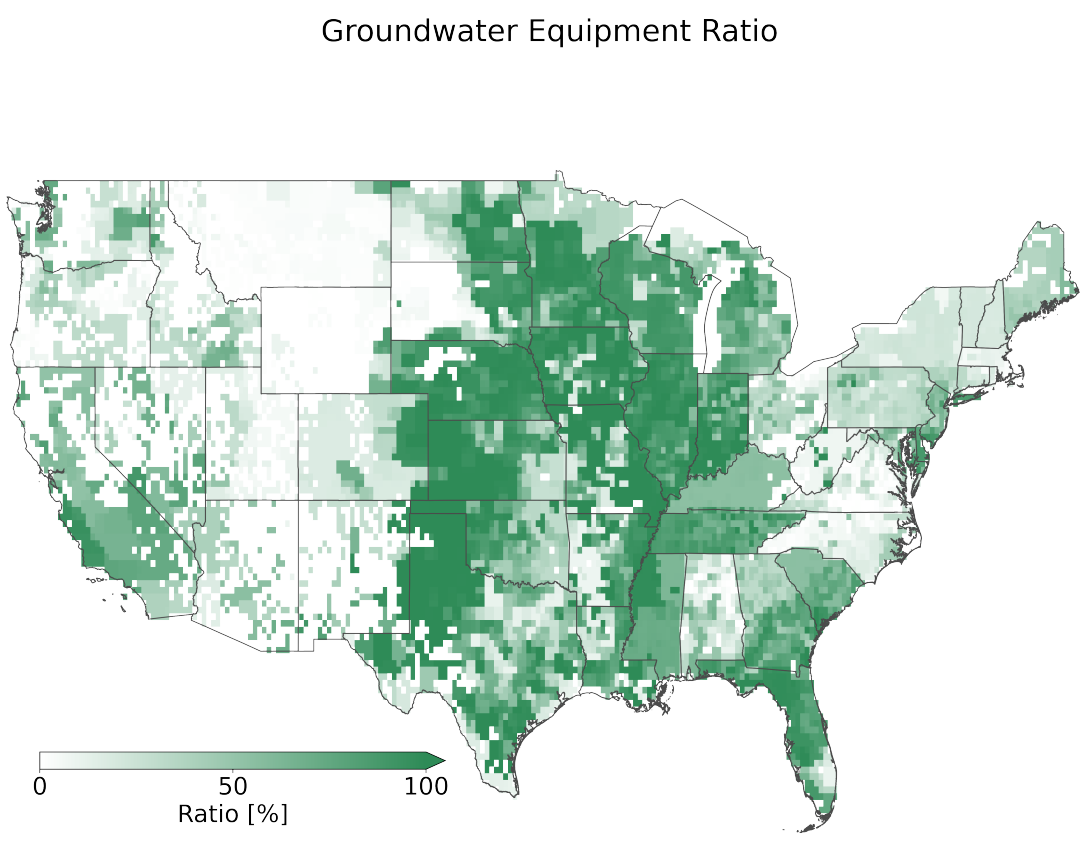

Figure S4. Percentage of area equipped with groundwater irrigation systems within the study region.

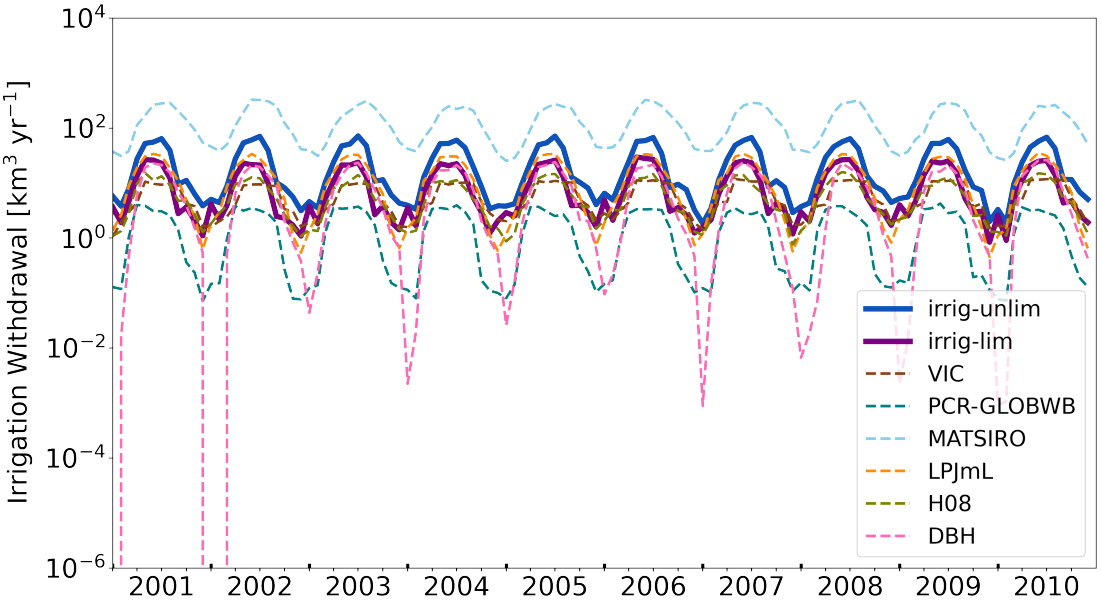

Figure S5. Time series of monthly total irrigation water withdrawal in the United States from 2001 to 2010, simulated by CoLM and the six global hydrological models participating in ISIMIP2a.

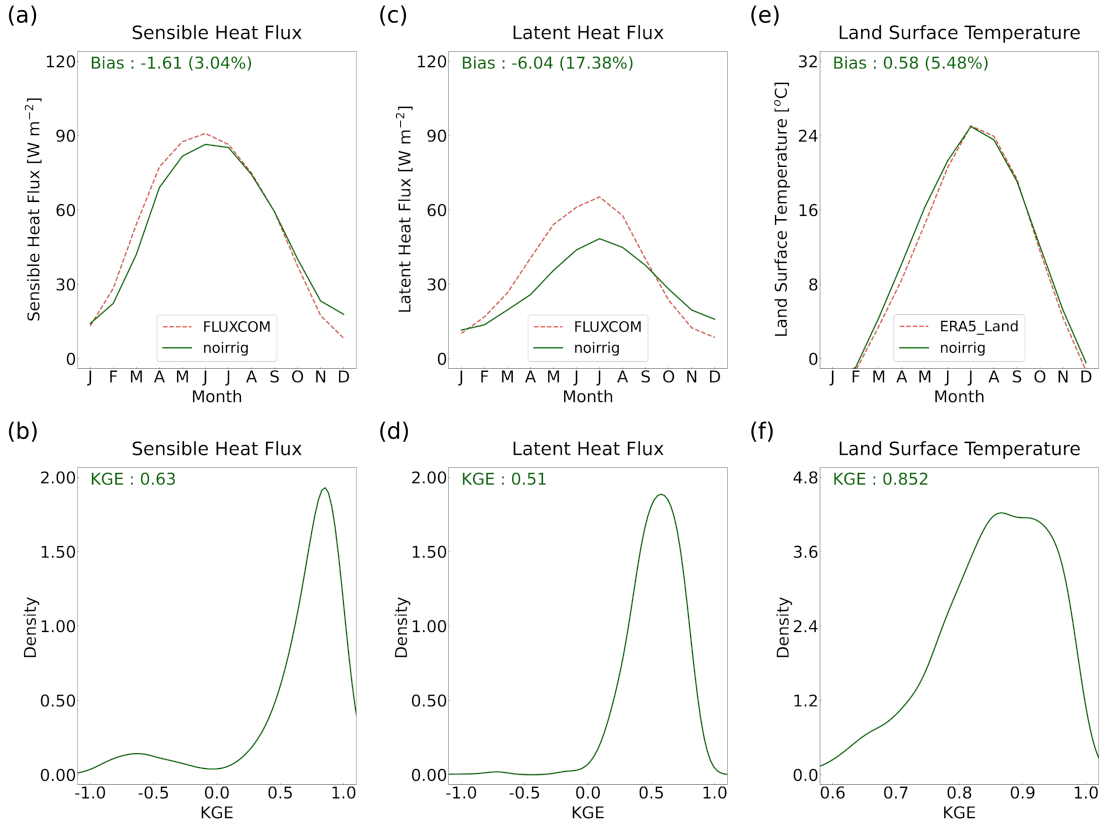

Figure S6. Evaluation of simulated energy fluxes and land surface temperature in the non-irrigation region. (a) Monthly sensible heat flux averaged from 2001 to 2016, based on the FLUXCOM dataset and simulated by CoLM using the noirrig scheme in non-irrigation regions of the United States, with the bias between simulations and observations (i.e., FLUXCOM) indicated in the panel. (b) Same as (a) but for latent heat flux. (c) Same as (a) but for land surface temperature, using data from ERA5-Land reanalysis dataset. (d) Kernel density estimate (KDE) curves for the Kling-Gupta efficiency (KGE) between observed and simulated monthly sensible heat flux for each non-irrigation grid, with mean KGE value indicated in the panel. (e-f) Same as (d) but for latent heat flux and land surface temperature.

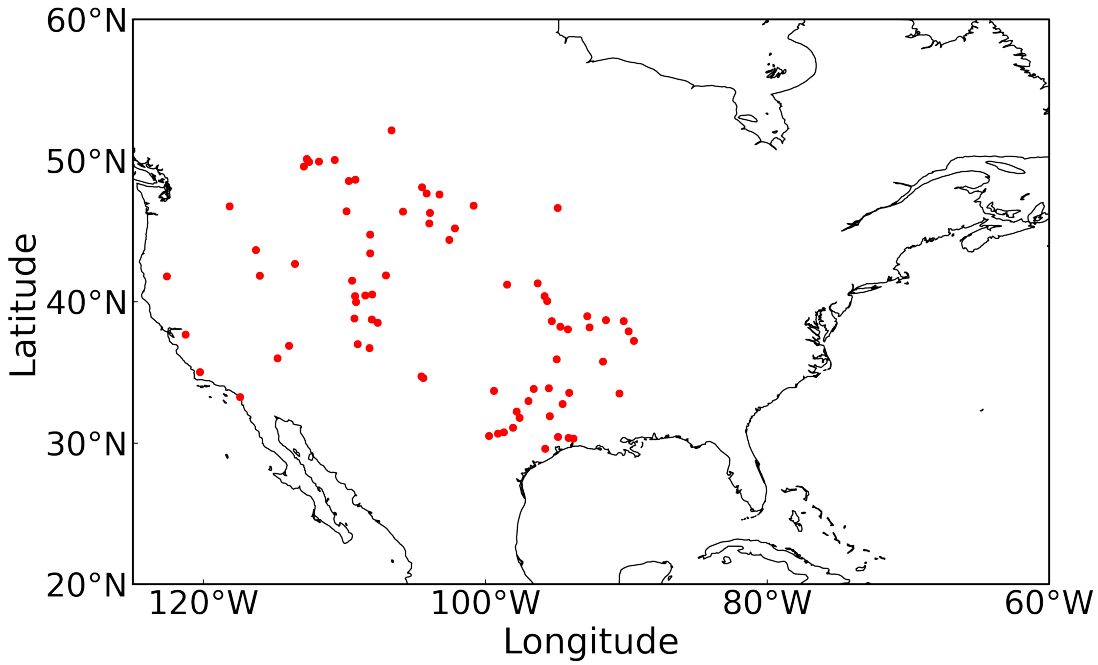

Figure S7. Locations of the catchment outlets for the 77 catchments affected by irrigation.

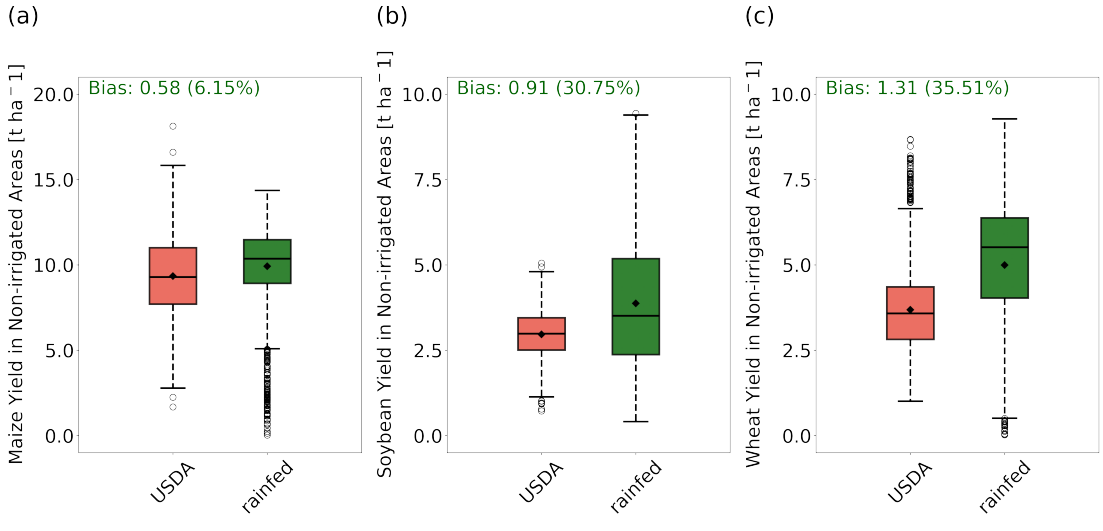

Figure S8. Evaluation of crop yield simulated in the United States. (a) Maize yield in rainfed maize-growing regions of the United States, as reported by the USDA (orange boxes), compared with simulations by CoLM in the non-irrigation region (green boxes). Since reported yields are at the county scale, grid-based simulation results were aggregated to corresponding counties. The boxes represent the interquartile range, black lines indicate median values, black dots show mean values, and dashed black whiskers extend to 1.5 times the interquartile range; points outside the boxes represent outliers. (b-c) Same as (a) but for soybean and wheat yields.

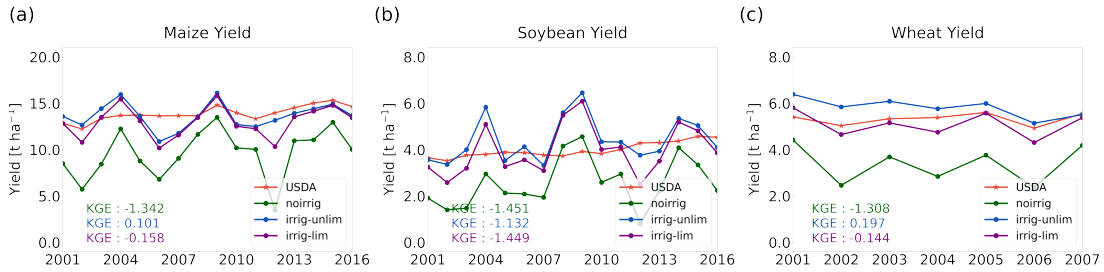

Figure S9. Comparison of observed and simulated annual yield variations for three crops in the United States. (a) Annual maize yield in irrigated maize-growing regions of the United States from 2001 to 2016, as reported by the USDA (orange lines), compared with simulations by CoLM using the noirrig (green lines), irrig-unlim (blue lines), and irrig-lim (purple lines) schemes. KGE values for the three simulation schemes are indicated in the panel. (b-c) Same as (a), but for annual soybean and wheat yields.

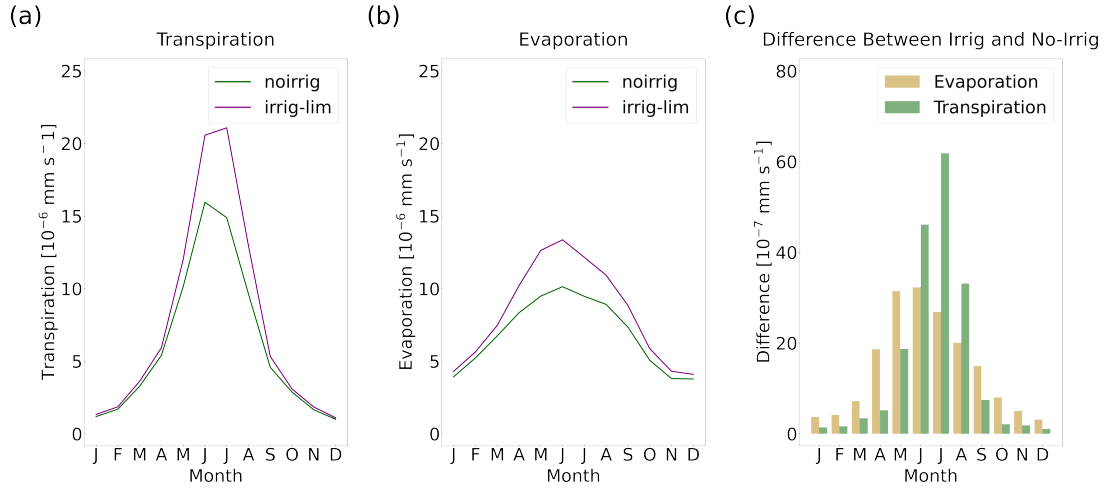

Figure S10. Differences in simulated evaporation and transpiration with and without irrigation. (a-b) Monthly transpiration (a) and evaporation (b) averaged from 2001 to 2016, simulated by CoLM using the noirrig and irrig-lim schemes in irrigation regions of the United States. (c) Monthly average differences in simulated transpiration and evaporation between the noirrig and irrig-lim schemes.

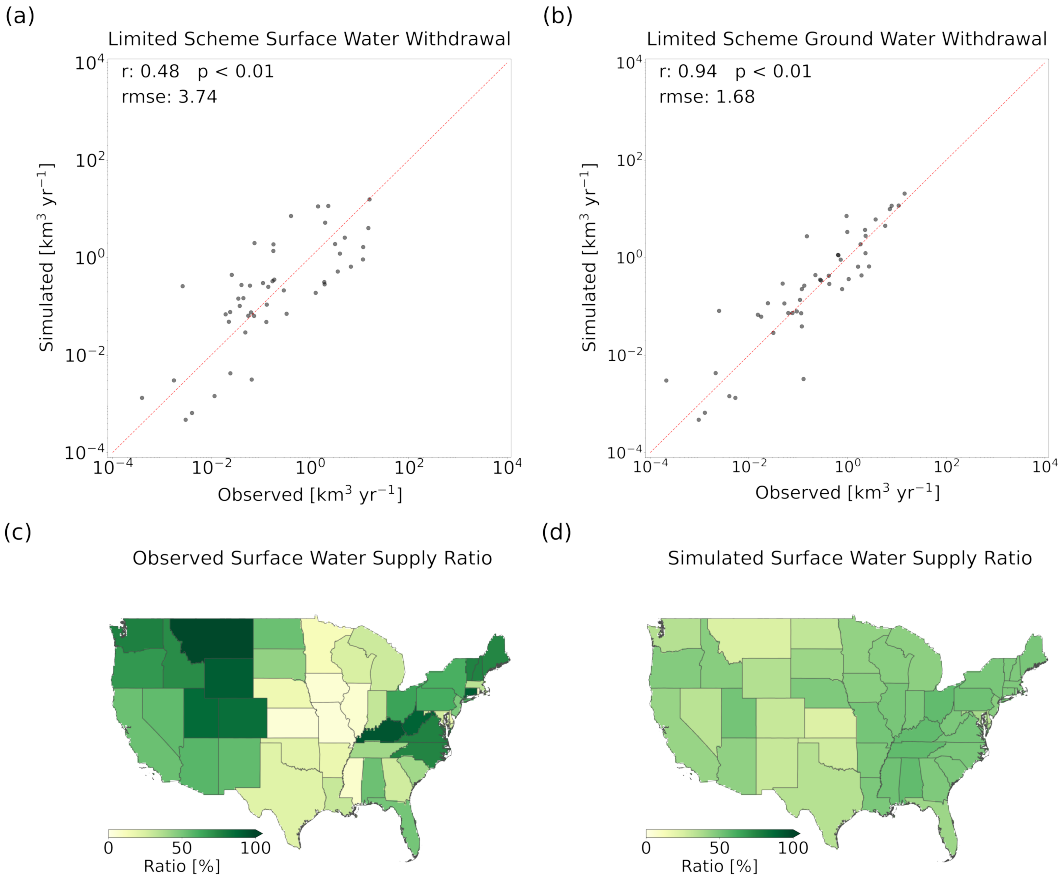

Figure S11. Comparison of reported and simulated irrigation water withdrawal in the United States by water source using a sequential water withdrawal method. (a) Proportion of surface water in irrigation withdrawal based on USGS reports for individual states. (b) Proportion of surface water in irrigation withdrawal simulated by CoLM for individual states using the sequential water withdrawal method. In this approach, water demand is not pre-allocated between surface and groundwater sources but is met sequentially, with surface water withdrawn first, followed by groundwater.

Table S1. Total storage capacity and irrigation area of reservoirs of different scales[1]

Engineering Grade	Reservoir Scale	Total Storage Capacity (billion m³)	Irrigation Area (100,000 mu)*
I	Large (Type 1)	> 10	> 150
II	Large (Type 2)	10 - 1	150 - 50
III	Medium	1 - 0.1	50 - 5
IV	Small (Type 1)	0.1 - 0.01	5 - 0.5
V	Small (Type 2)	0.01 - 0.001	< 0.5

* mu is a unit of area (1 mu ≈ 666.67 square meters).

References:

1. Ministry of Water Resources of China: Standard for rank classification and flood protection criteria of water and hydropower projects, SL 252–2017, http://121.36.94.83:9008/jsp/yishenqing/appladd/biaozhunfile/detail.jsp?bzbh=SL%2B252-2017# (last access: October 2023), 2017