@article{Eischeid2023,
  abstract = {A cooling trend in summer (May-August) daytime temperatures since the mid-20th Century over the central United States contrasts with strong warming of the western and eastern U.S. Prior studies based on data through 1999 suggested this so-called warming hole arose mainly from internal climate variability, and thus would likely disappear. Yet it has prevailed for two more decades, despite accelerating global warming, compelling reexamination of causes that in addition to natural variability could include anthropogenic aerosol-induced cooling, hydrologic cycle intensification by greenhouse gas increases, and land use change impacts. Here we present evidence for the critical importance of hydrologic cycle change resulting from ocean-atmosphere drivers. Observational analysis reveals the warming hole's persistence is consistent with unusually high summertime rainfall over the region during the first decades of the 21st Century. Comparative analysis of large ensembles from four different climate models demonstrates that rainfall trends since the mid-20th Century as large as observed can arise (though with low probability) via internal atmospheric variability alone, which induce warming hole-like patterns over the central U.S. Additionally, atmosphere-only model experiments reveal that observed sea surface temperature changes since the mid-20th Century have also favored central U.S cool/wet conditions during the early 21st Century. We argue that this latter effect is symptomatic of external radiative forcing influences, which via constraints on ocean warming patterns has likewise contributed to persistence of the U.S. warming hole in roughly equal proportion to contributions by internal variability. These results have important ramifications for attribution of extreme events and predicting risks of record-breaking heat waves in the region.},
  author = {J. K. Eischeid and M. P. Hoerling and X.-W. Quan and A. Kumar and J. Barsugli and Z.M. Labe and K.E. Kunkel and C. J. Schreck and D.R. Easterling and T. Zhang and J. Uehling and X. Zhang},
  doi = {10.1175/JCLI-D-22-0716.1},
  issn = {0894-8755},
  issue = {20},
  journal = {Journal of Climate},
  month = {7},
  pages = {7319-7336},
  publisher = {American Meteorological Society},
  title = {Why has the Summertime Central U.S. Warming Hole Not Disappeared?},
  volume = {36},
  url = {https://journals.ametsoc.org/view/journals/clim/aop/JCLI-D-22-0716.1/JCLI-D-22-0716.1.xml},
  year = {2023},
}