Human influence on joint changes in temperature, rainfall and continental aridity

PCMDI Program for Climate Model Diagnosis and Intercomparison

Objective

- To identify human influence on joint changes in temperature (T), precipitation (P) and aridity after 1950

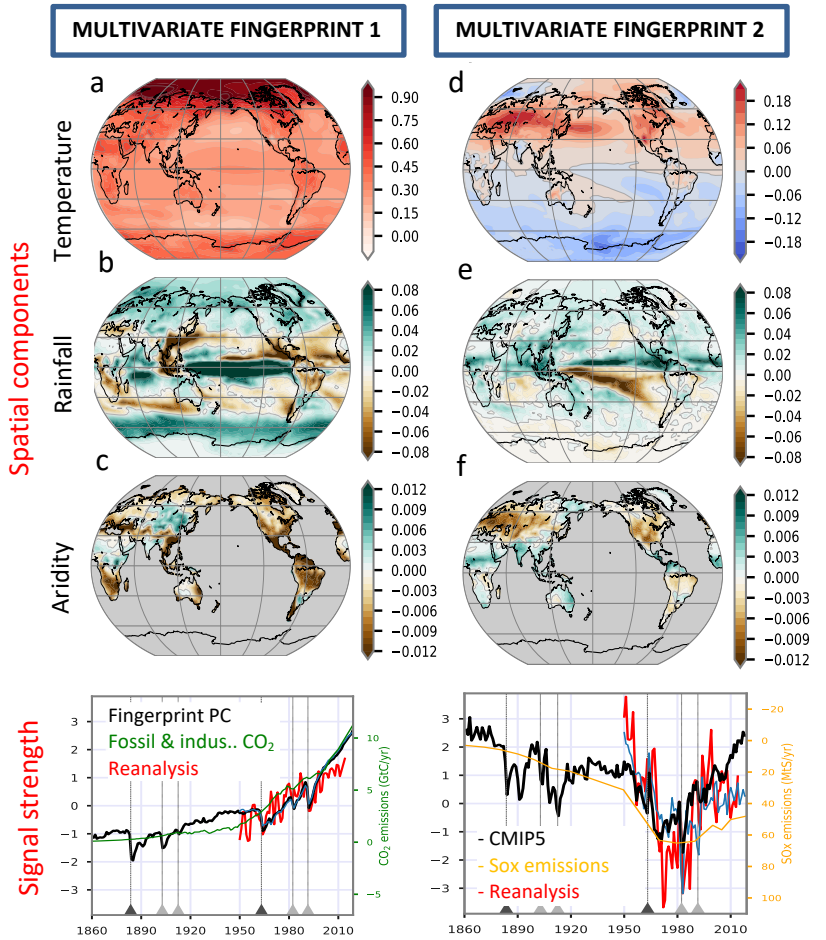
Research

- We developed a novel fingerprint method capable of accounting for the complexity in the time evolution of forcing by well-mixed GHGs and spatially heterogeneous anthropogenic aerosols (AA)
- We used 28 historical runs, 28 × 3 single-forcings runs (GHG, AA, NAT) and CTL runs from 13 CMIP5 models, various CanESM2 Large Ensembles, reanalysis products, and observations.
- We found that the leading and second fingerprints of the joint changes in T, P, and aridity are statistically identifiable in observations:
  - **Fingerprint 1** captures global warming, intensified wet-dry patterns, and global-scale aridification (panels a-c)
  - **Fingerprint 2** captures a pronounced interhemispheric T contrast and shifts in the ITCZ with *complex* temporal behavior (panels d-f)

Impact

- Reliable simulation of observed hydroclimate changes requires combined forcing by GHGs, the effects of anthropogenic aerosols, and large volcanic eruptions.
- Models with a more complete representation of aerosol indirect effects better match the observations.

Greenhouse gas emissions and particulate pollution drive regional drying around the globe in two distinct ways



Both fingerprints are present in reanalysis data. The fingerprints evolve similarly in models and reanalysis.

Reference: Bonfils C., B.D. Santer, J. Fyfe, K. Marvel, T. Phillips, S. Zimmerman (2020) Human influence on joint changes in temperature, rainfall and continental aridity, Nature Climate Change, doi: 10.1038/s41558-020-0821-1