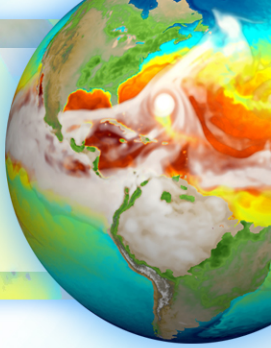
E3SMv1 DECK Future Projections under the High-Emission SSP5-8.5 Scenario



Xue Zheng[1], Qing Li[2], Tian Zhou[3]

Qi Tang[1], Jean-Christophe Golaz[1], Luke Van Roekel[2]

[1]Lawrence Livermore National Laboratory, Livermore, CA 94550

[2]Los Alamos National Laboratory, Los Alamos, NM 87545

[3]Pacific Northwest National Laboratory, Richland, WA 99352

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E3SM Energy Exascale Earth System Model

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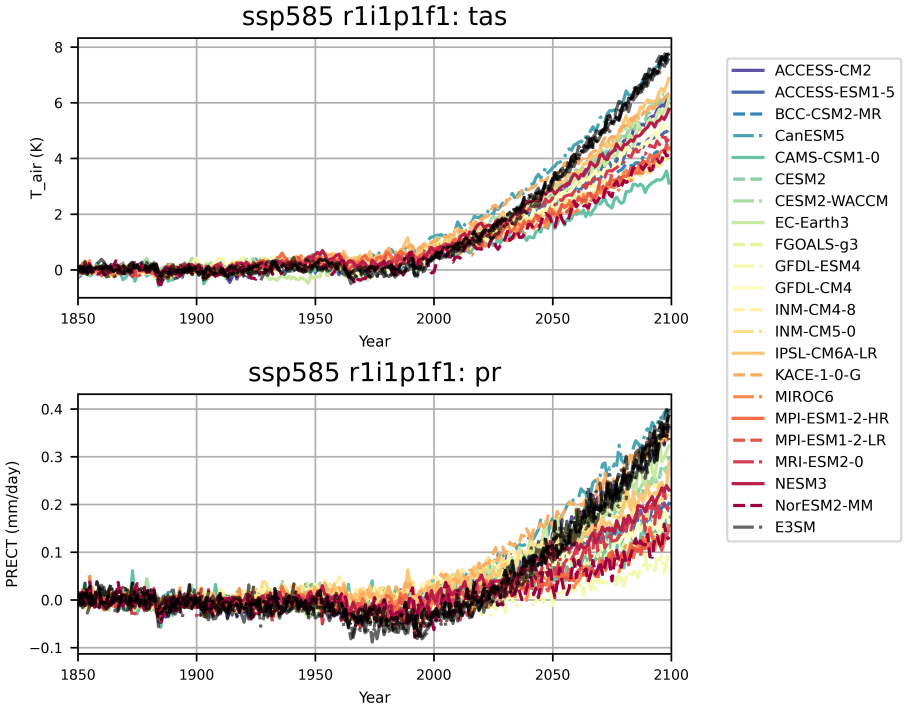
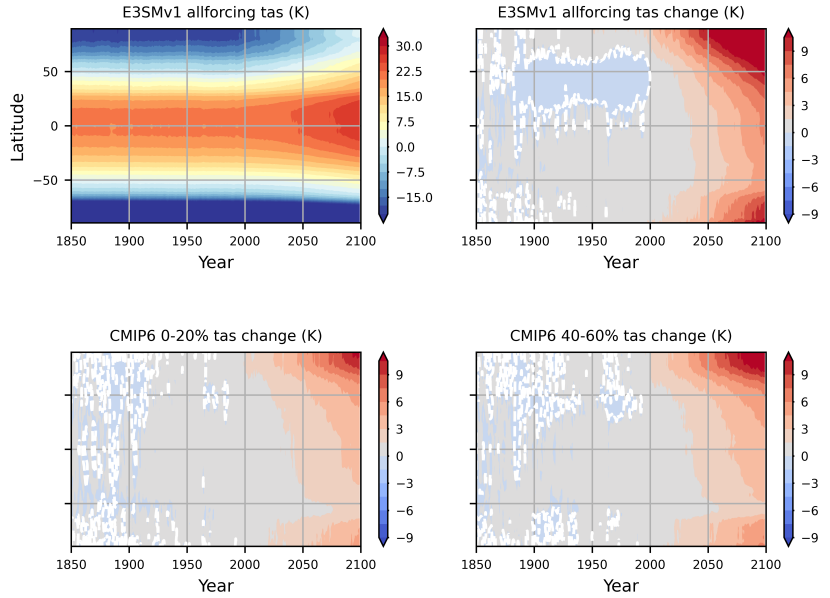
U.S. DEPARTMENT OF ENERGY

Simulations

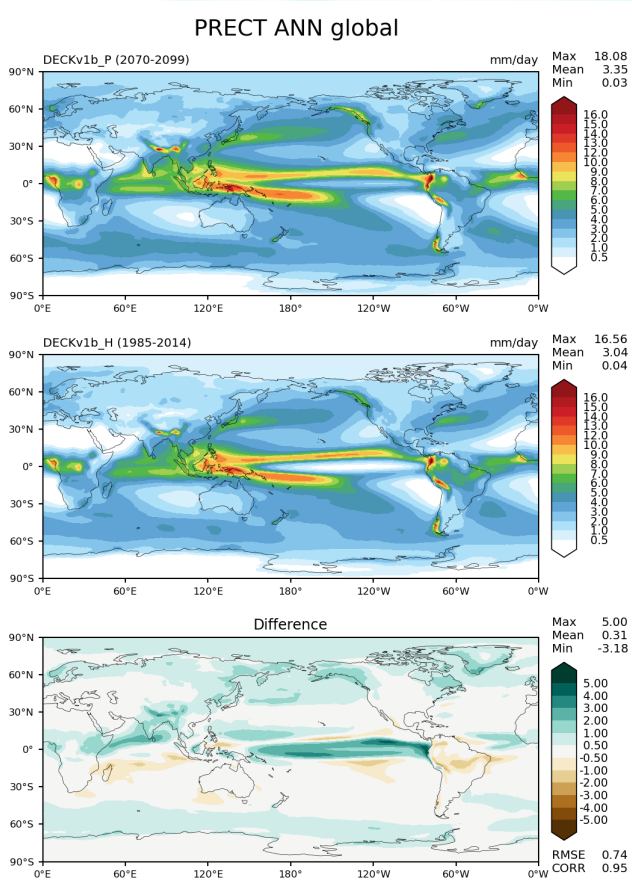
- DECKv1 future projection simulations under the High-Emission SSP5-8.5 Scenario (five ensemble members)
- Two sets of DAMIP simulations (each has three ensemble members)
  - **DECKv1b_H1_hist-GHG**: DAMIP well-mixed greenhouse-gas-only historical simulations with 1850 tropospheric and stratospheric ozone.
  - **DECKv1b_P1_SSP5-8.5-GHG**: DAMIP well-mixed greenhouse-gas-only future projection simulations with 1850 tropospheric and stratospheric ozone.



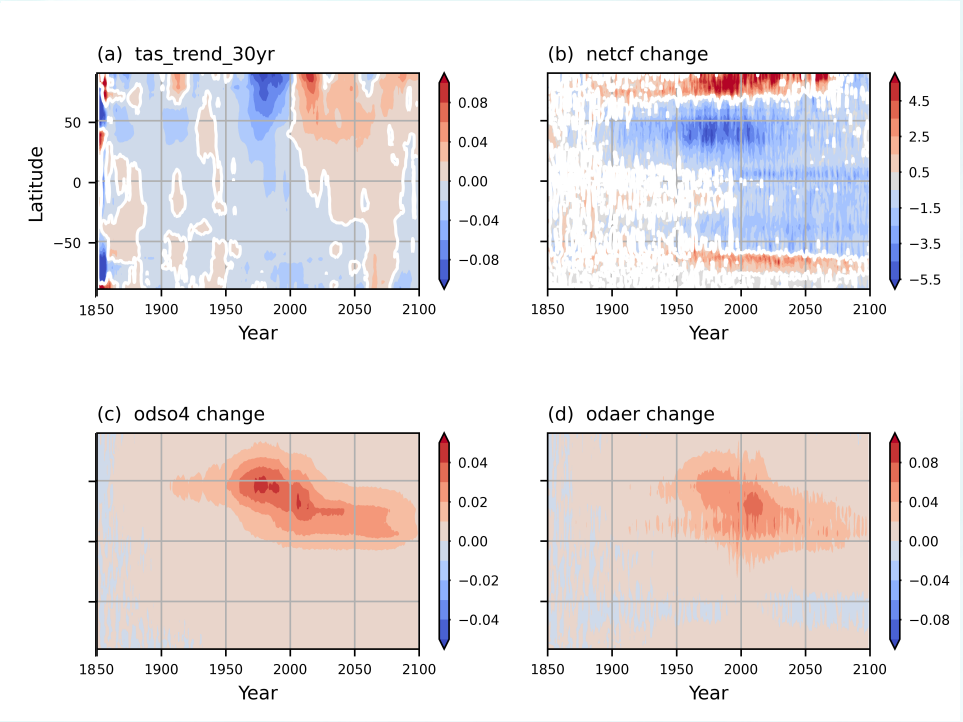
Time evolution of (top) annual global mean surface air temperature anomalies, and (bottom) annual global mean surface precipitation rate anomalies (with respect to 1850–1870) from E3SMv1 and CMIP6 models.



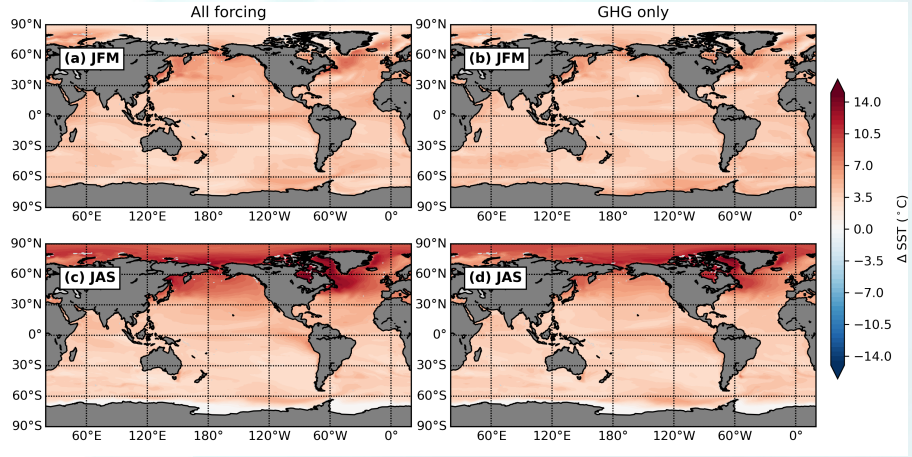
Time evolutions of zonal mean (a) E3SMv1 annual surface air temperature anomalies (T_air). The time evolution of zonal mean annual T_air local changes with respect to 1850-1870 from historical simulations and ssp5.85 future simulations for (b) E3SMv1, (c) CMIP6 0-20 percentile models, and (d) 40-60 percentile models



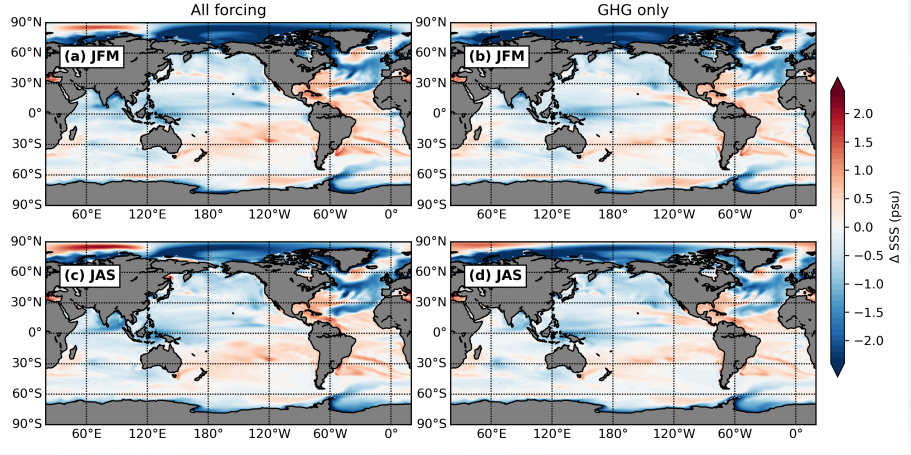
Annual precipitation rate (mm/day) from (top) five SSP5.85 ensemble simulations (2070-2099), (b) five historical ensemble simulations (1985-2014), and (c) the changes in annual precipitation rate between the time period of 2070 – 2099 and the period of 1985-2014.



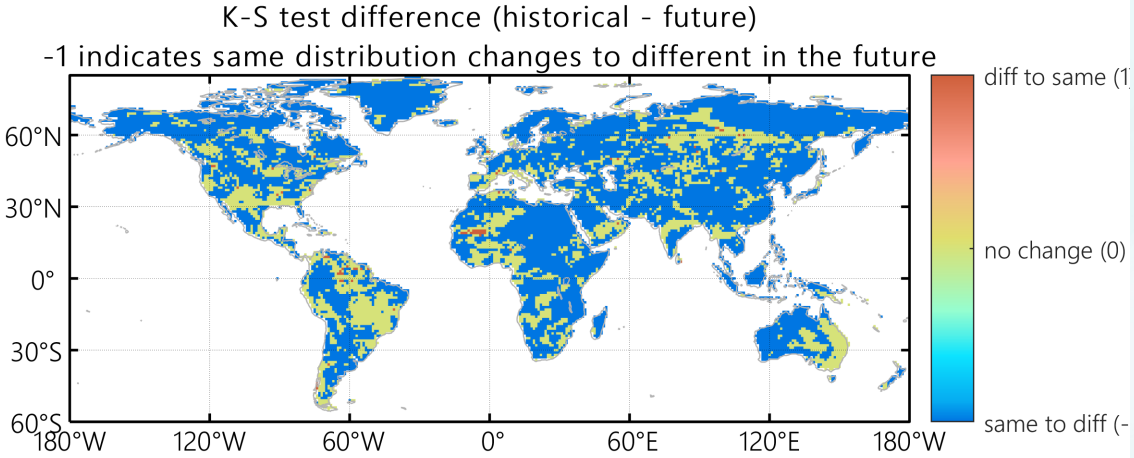
The simulated differences in the zonal mean local (a) T-air trend (K/year), (b) net cloud radiative forcing (W/m2), (c) Sulfate aerosol optical depth at 550nm, and (d) total aerosol optical depth at 550nm between E3SMv1 all forcing simulations and GHG-only simulations

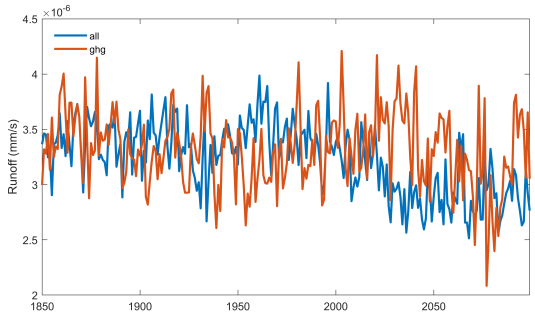


The changes in sea surface temperature (SST) between the time period of 2070 – 2099 and the period of 1985-2014 for Jan-Feb-Mar and Jul-Aug-Sep from E3SMv1 all forcing simulation and GHG-only simulation



The changes in sea surface salinity (SSS) between the time period of 2070 – 2099 and the period of 1985-2014 for Jan-Feb-Mar and Jul-Aug-Sep from E3SMv1 all forcing simulation and GHG-only simulation





The timeseries of the runoff from a basin as an example

The global map of the changes in the difference between all-forcing simulations and GHG-only simulations from the historical time period to the future time period based on the Kolmogorov–Smirnov (K-S) tests for the time series of runoff. Blue indicates the time evolution from the all-forcing simulation is more different from the GHG-only simulation in the future simulation, while red remarks regions the all-forcing simulation is closer the GHG-only simulation in the future simulation compared with the historical simulation.

Summary

- E3SMv1 is one of the strongest warming models between 2050-2099 under the High-Emission SSP5-8.5 Scenario.
- The time evolution of the zonal mean near surface air temperature shows that E3SMv1 has a strong cooling at northern hemispheric mid latitudes between 1900 and 2000, which is consistent with the peak aerosol optical depth.
- Changes in SST, SSS, mixed layer depth (no shown here) from all-forcing and GHG-only suggest that forcings other than GHG have little impact on the oceanic mean climate.
- Runoff analyses: Basin-based analyses found the time series of runoff from ssp585 are more different from ssp585-GHG over the time period 2015-2099 than the time period of 1850-2014, indicating forcings other than GHG have increased impacts over land in the future climate.