



AMS

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Supplemental Material

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1 **Supplementary Information for “Diagnosing mechanisms of hydrologic**
2 **change under global warming in the CESM1 Large Ensemble”**

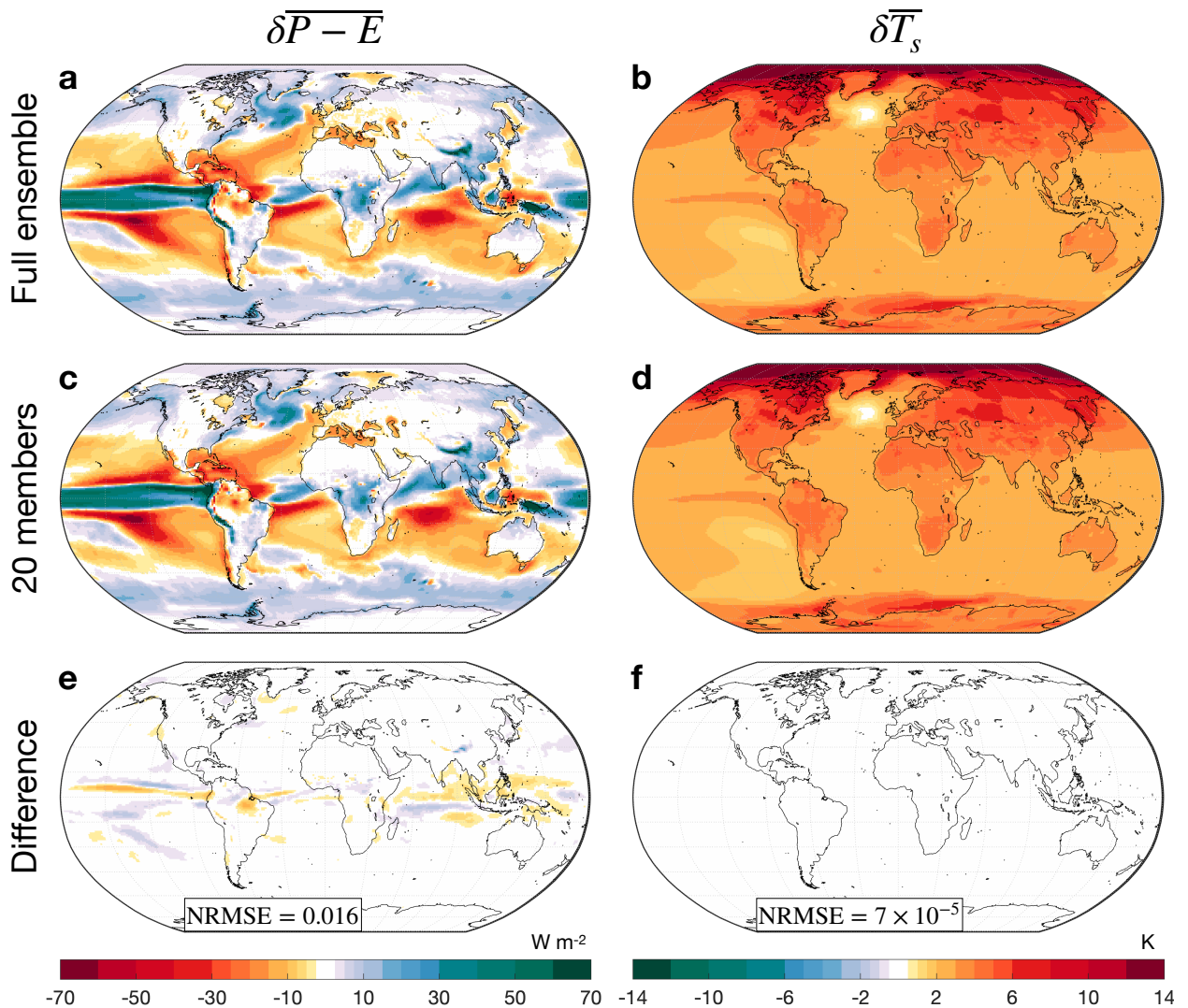
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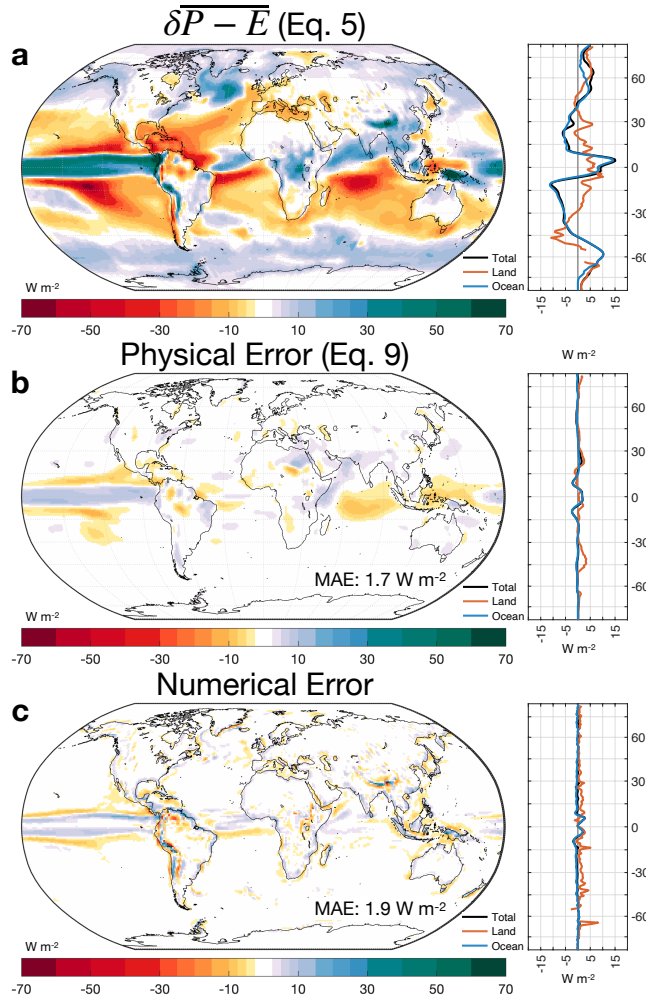
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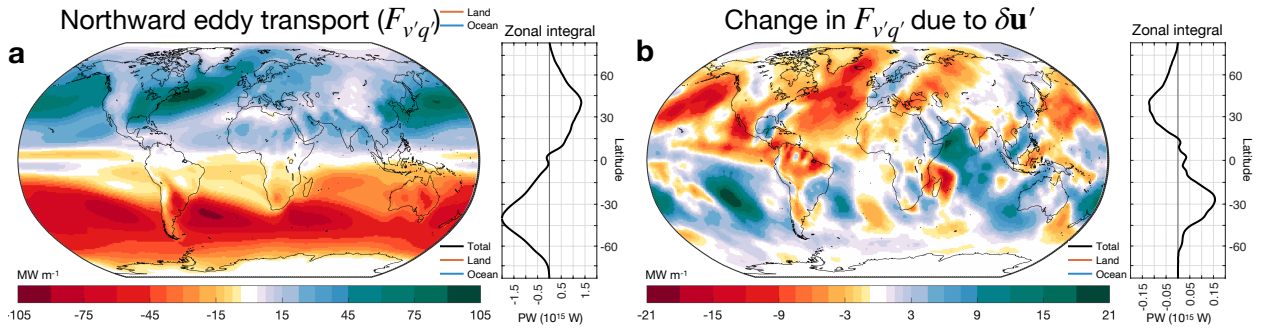
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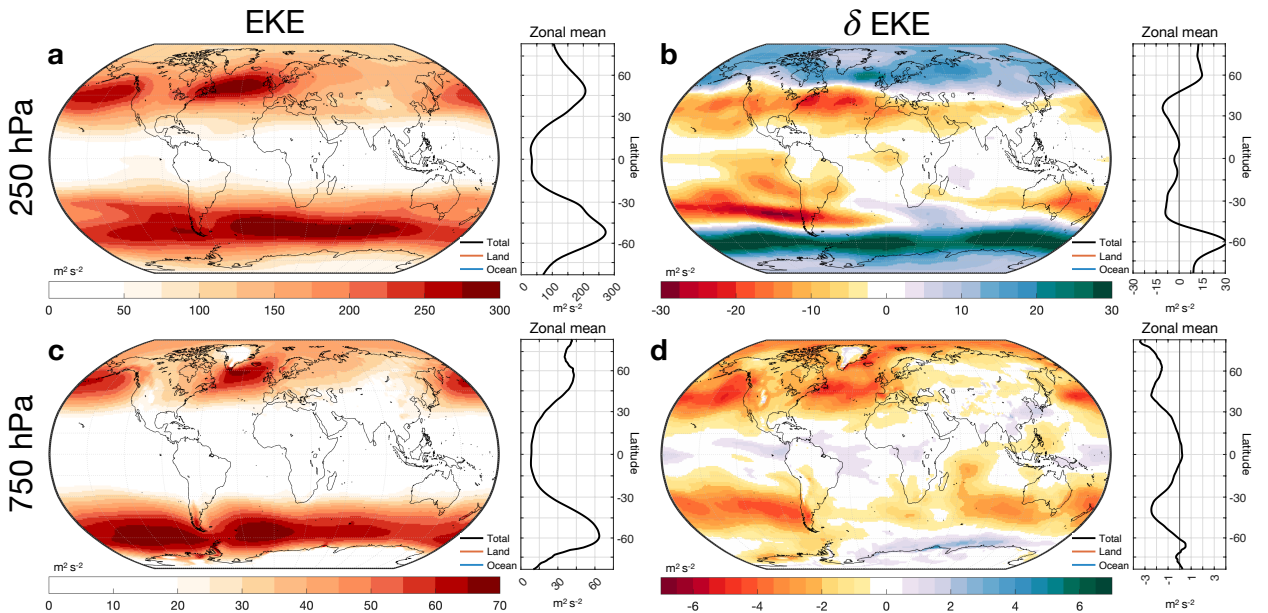
8 FIG. 1. a) The change in annual-mean, ensemble-mean precipitation minus evaporation ($\delta\overline{P - E}$) between
 9 1991-2000 and 2071-2080 simulated by all 40 members of the CESM1 Large Ensemble. b) As in (a), but for
 10 the change in surface temperature ($\delta\overline{T_s}$). c-d) As in (a-b), but among the first 20 ensemble members. e-f) The
 11 difference between the changes in the full ensemble and those in the 20-member subset. The normalized root
 12 mean squared error (NRMSE), shown in the bottom left of (e) and (f), represents the square root of the sum of
 13 the squared differences divided by the square root of the sum of the squared changes. It is equal to 1.6% in (e)
 14 and 0.007% in (f), implying that the ensemble mean of the first 20 ensemble members is a good approximation
 15 of the total ensemble mean.



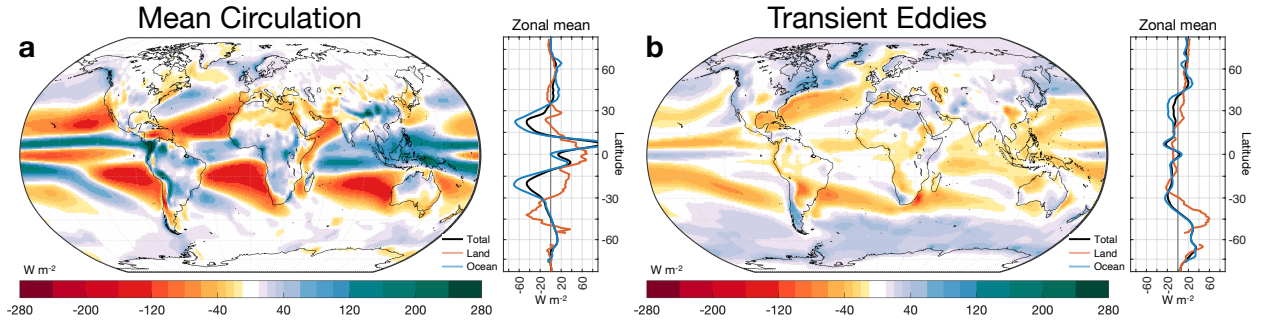
16 FIG. 2. a) $\overline{\delta P - E}$ computed numerically from 6-hourly q and \mathbf{u} using Eq. 5 from the main manuscript. b) The
 17 physical component of the error in our decomposition of $\overline{\delta P - E}$, given by Eq. 9 in the main manuscript, which
 18 has a mean absolute value of 1.7 W m^{-2} (i.e., mean absolute error, or MAE). This is analogous to Fig. 3d in
 19 the main manuscript, but with the residual error computed relative to the pattern of $\overline{\delta P - E}$ in (a) instead of the
 20 true pattern of $\overline{\delta P - E}$ shown in Fig. 1b of the main manuscript. c) The numerical component of the error in our
 21 decomposition, which exhibits a MAE of 1.9 W m^{-2} . The numerical error is largest in the deep tropics and in
 22 high mountain ranges such as the Andes and Himalaya. The sum of (b) and (c) gives the total error shown in
 23 Fig. 3d in the main manuscript.



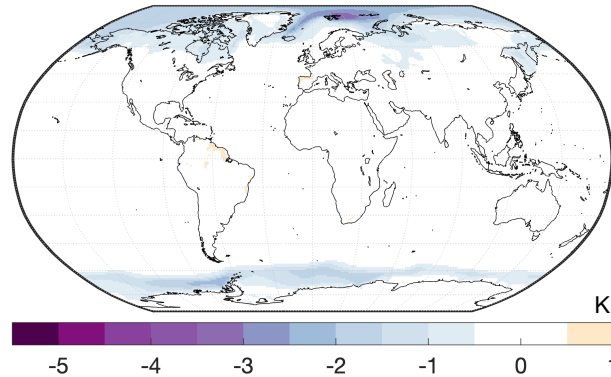
24 FIG. 3. a) The northward component of total column-integrated latent heat transport by eddies ($F_{v'q'}$) over
 25 the decade 1991-2000, in MW m^{-1} (10^{15} W m^{-1}). b) The change in $F_{v'q'}$ between the decades 1991-2000 and
 26 2071-2080 that can be attributed to changes in transient winds ($\delta\mathbf{u}'$).



27 FIG. 4. a) Annual-mean eddy kinetic energy (EKE; in $\text{m}^2 \text{s}^{-2}$) at 250 hPa over the decade 1991-2000, computed
 28 from wind anomalies relative to the mean for each month of each simulation. b) The change in annual-mean
 29 EKE at 250 hPa between the decades 1991-2000 and 2071-2080. c-d) As in (a-b), but at 750 hPa.



30 FIG. 5. A decomposition of annual-mean, ensemble-mean $P - E$ into contributions from (a) the mean
 31 circulation ($\overline{q\bar{u}}$) and from (b) transient eddies ($\overline{q'u'}$), computed from 6-hourly q and \mathbf{u} using Eq. 11 from the
 32 main manuscript.



33 FIG. 6. The change in the annual-mean, ensemble-mean standard deviation (relative to monthly-means) of
 34 near-surface air temperature between 1991-2000 and 2071-2080. The magnitude of the change is at most a few
 35 K—much less than the inverse of the Clausius-Clapeyron scaling factor, $\alpha^{-1} = R_v T^2 / L_v$, which ranges from
 36 about 12 K at high latitudes to 17 K in the tropics. The decrease in standard deviation at high latitudes is likely the
 37 result of eddies mixing across weakened temperature gradients due to polar-amplified warming (Supplementary
 38 Fig. 1b).

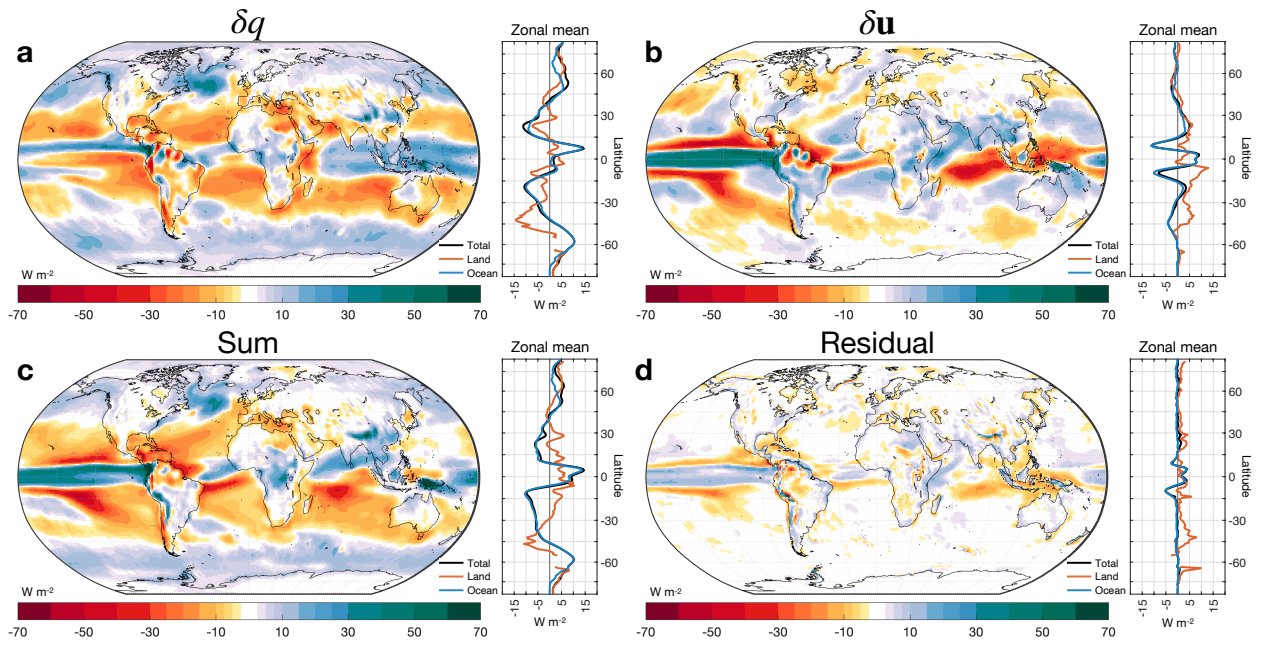


FIG. 7. As in Fig. 3 from the main text, but using only the first 10 members of the CESM-LE.