



Supplement of

Mechanistic insights into tropical circulation and hydroclimate responses to future forest cover change

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S1. Avoided deforestation vs afforestation

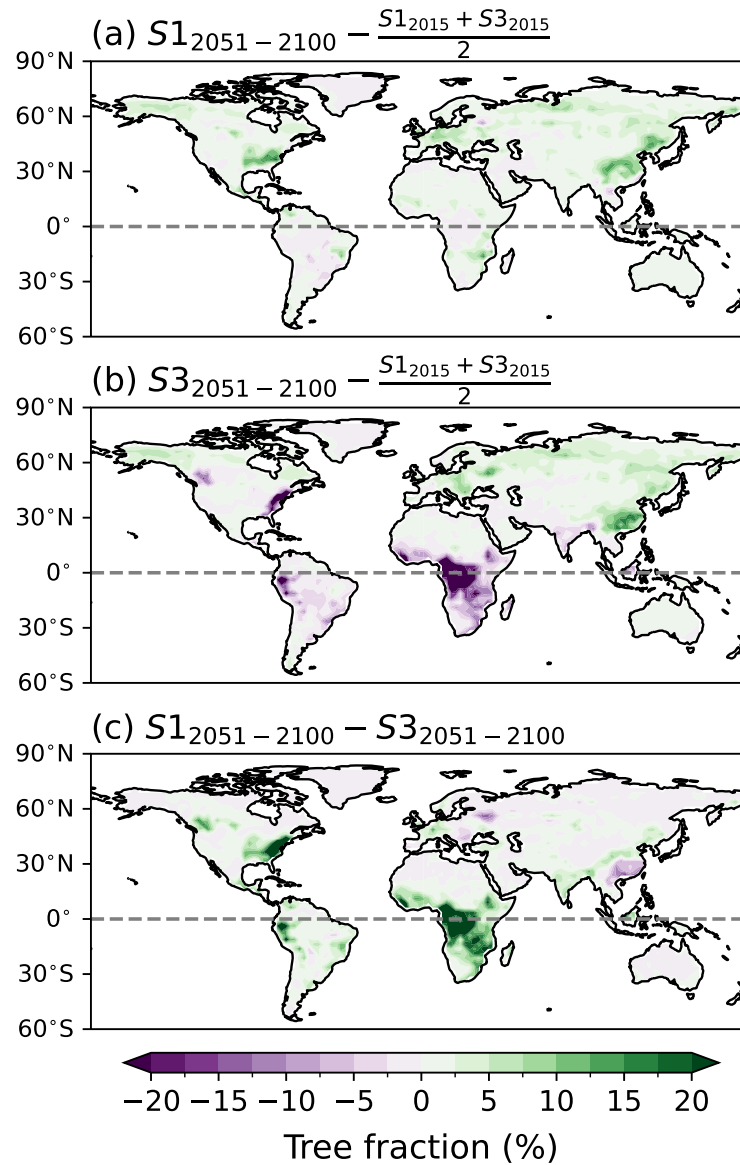


Figure S1. Annual mean spatial pattern of forest cover changes in (a) $S1_{2015-2100} - \frac{S1_{2015} + S3_{2015}}{2}$, (b) $S3_{2015-2100} - \frac{S1_{2015} + S3_{2015}}{2}$ and (c) $S1_{2015-2100} - S3_{2015-2100}$ where the subscripts refer to the years averaged over. Regions of tree fraction increase in (c) are related to avoided deforestation (purple areas in (b)) and afforestation (darker green areas in (a) than (b)). Note that (c) is the same as for AFFOREST in Fig. 1a.

S2. Crop-, grass- and shrubland changes

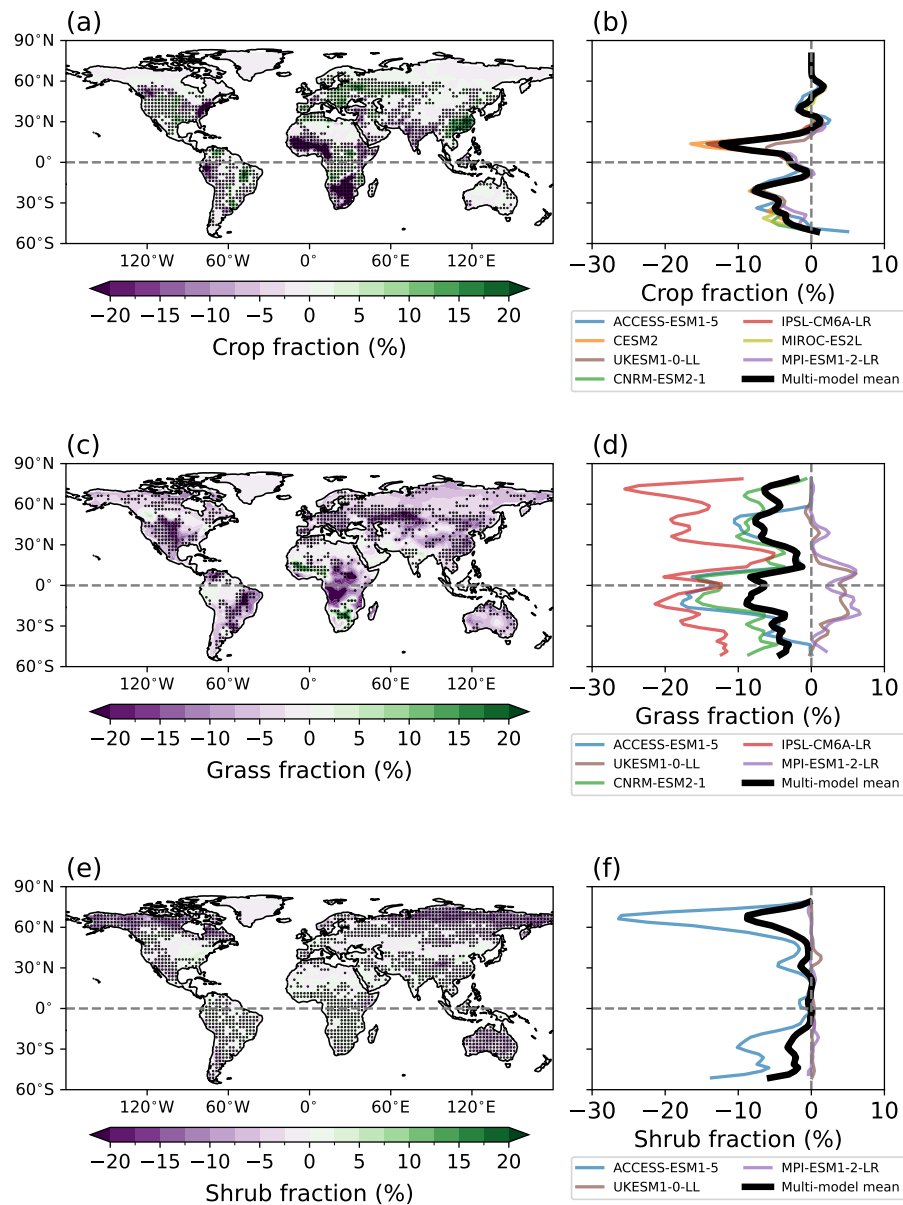


Figure S2. Annual mean spatial pattern and zonal mean over land of (a, b) crop-, (c, d) grass- and (e, f) shrubland changes from 2051–2100 in AFFOREST. Stippling shows where (a) 6 out of 7, (b) 4 out of 5 and (c) 2 out of 3 ESMs agree on the sign of change. Note that not all models provide the relevant land cover data.

S3. Influence of background climate

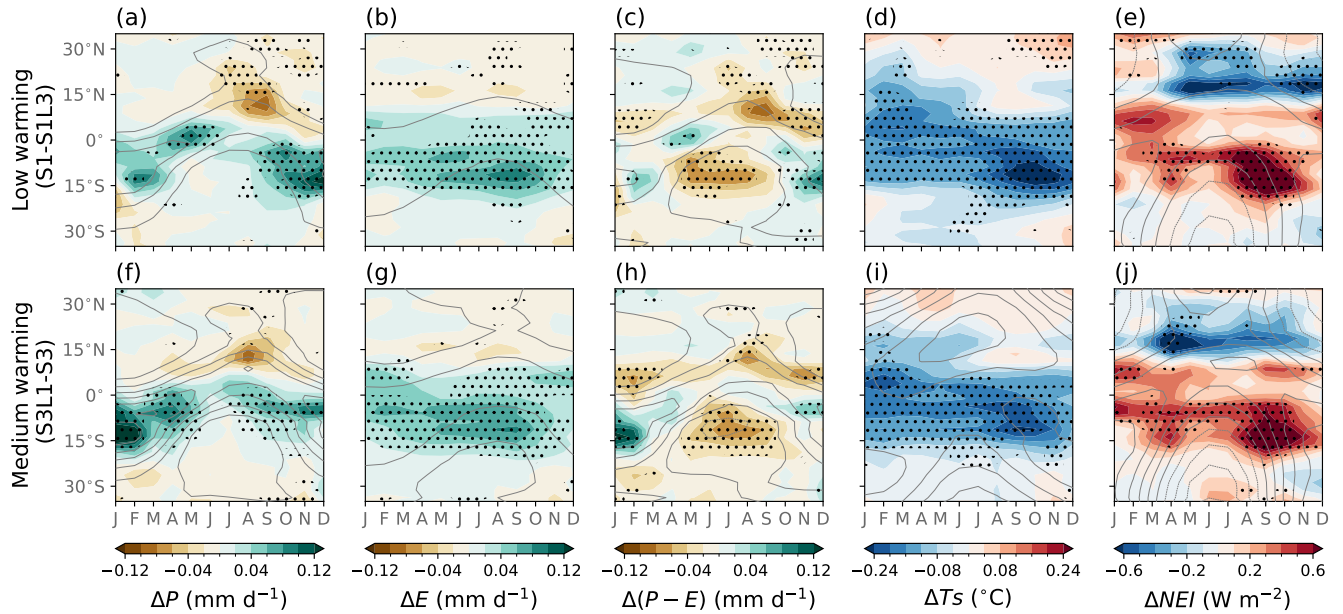


Figure S3. Zonal-mean monthly changes in (a, f) precipitation ΔP , (b, g) evapotranspiration ΔE , (c, h) net precipitation $\Delta(P - E)$, (d, i) Surface temperature ΔT_s , (e, j) net energy input ΔNEI in a low warming (s1-s1L3; upper row) and medium warming (s3L1-s3; lower row) world following AFFOREST. Contours show BASE values with a spacing of 1.5 mm day⁻¹ for ΔP , ΔE and $\Delta(P - E)$, a spacing of 5° C for ΔT_s and of 20 W m⁻² for ΔNEI . Stippling shows where 6 out of 7 ESMs agree on the sign of change.

S4. NEI components

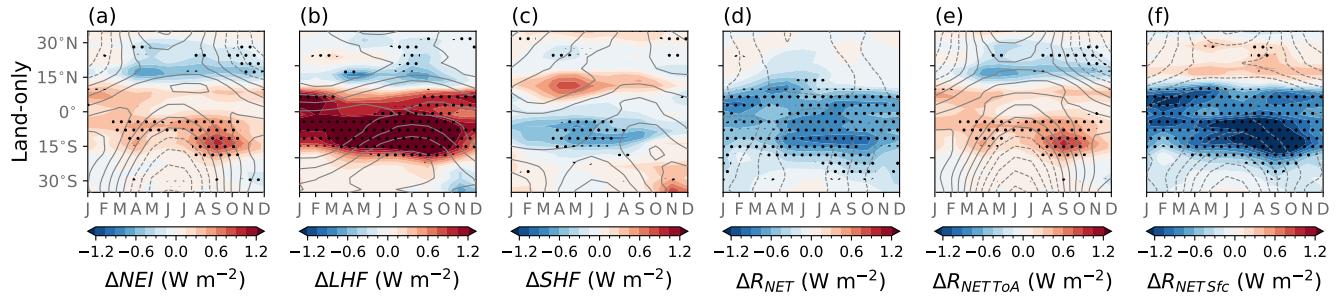


Figure S4. Zonal-mean monthly changes in (a) net energy input ΔNEI , (b) surface latent heat flux ΔLHF , (c) surface sensible heat flux ΔSHF , (d) total net radiative energy flux ΔR_{NET} , (e) net radiative energy flux $\Delta R_{NET ToA}$ at the top of the atmosphere (ToA) and (f) net radiative energy flux $\Delta R_{NET Sfc}$ at the surface over global land in AFFOREST. Contours show the BASE values with a spacing of 20 W m^{-2} and dashed lines show negative values. Stippling shows where 6 out of 7 ESMs agree on the sign of change. Note that the colorbar spacing has been doubled compared to Fig. 2.

5 S5. Global climate response to afforestation

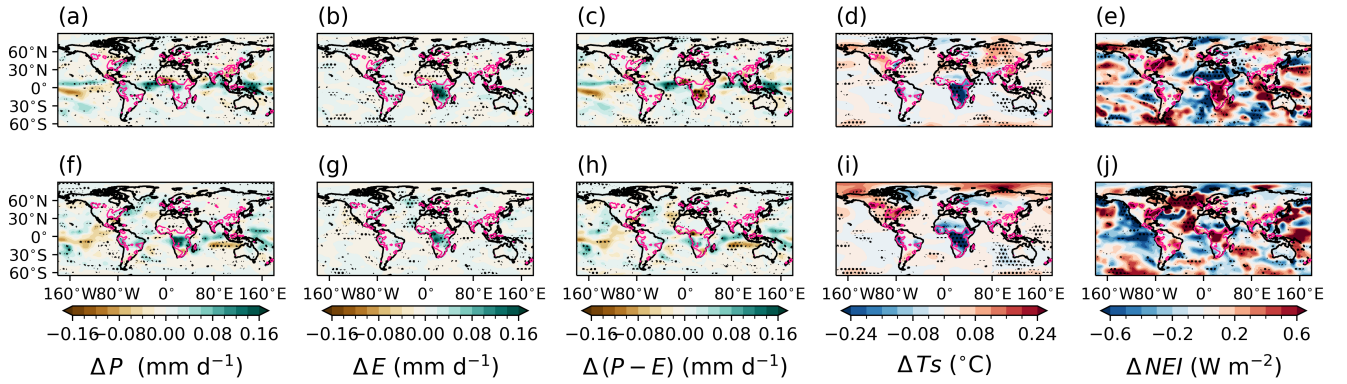


Figure S5. Global spatial maps of changes in (a, d) precipitation ΔP , (b, e) evapotranspiration ΔE , (c, f) net precipitation $\Delta(P - E)$ in MJJAS (upper row) and NDJFM (lower row) to AFFOREST. Pink contours enclose the regions where there is at least 5% of afforestation. Stippling shows where 6 out of 7 ESMs agree on the sign of change.

S6. Moisture flux climatology over Africa

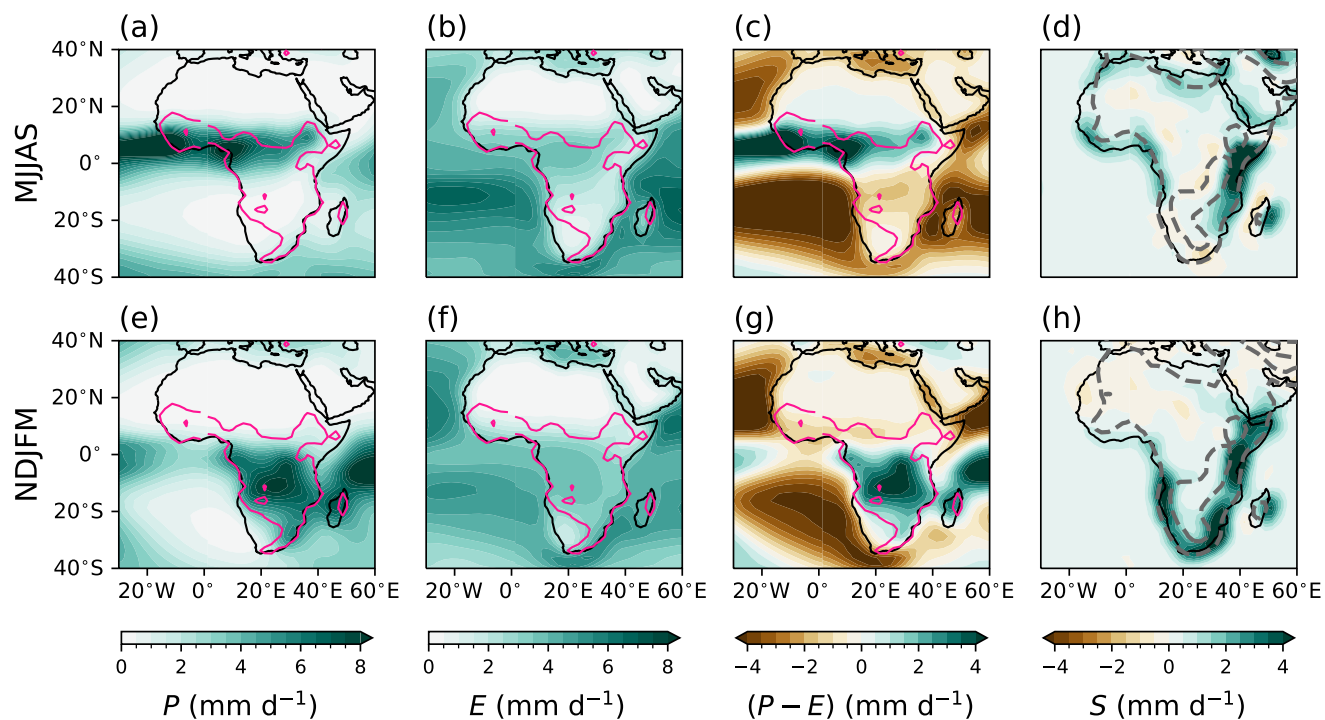


Figure S6. Spatial maps of BASE (a, e) precipitation P , (b, f) evapotranspiration E , (c, g) net precipitation $(P - E)$, (d, h) surface term S in MJJAS (upper row) and NDJFM (lower row) over Africa. Pink contours enclose the regions where there is at least 5% of afforestation. In (d) and (h), dashed grey contours show the 980 hPa and 900 hPa surface pressure climatology.

S7. Moisture budget decomposition for individual models (MJJAS)

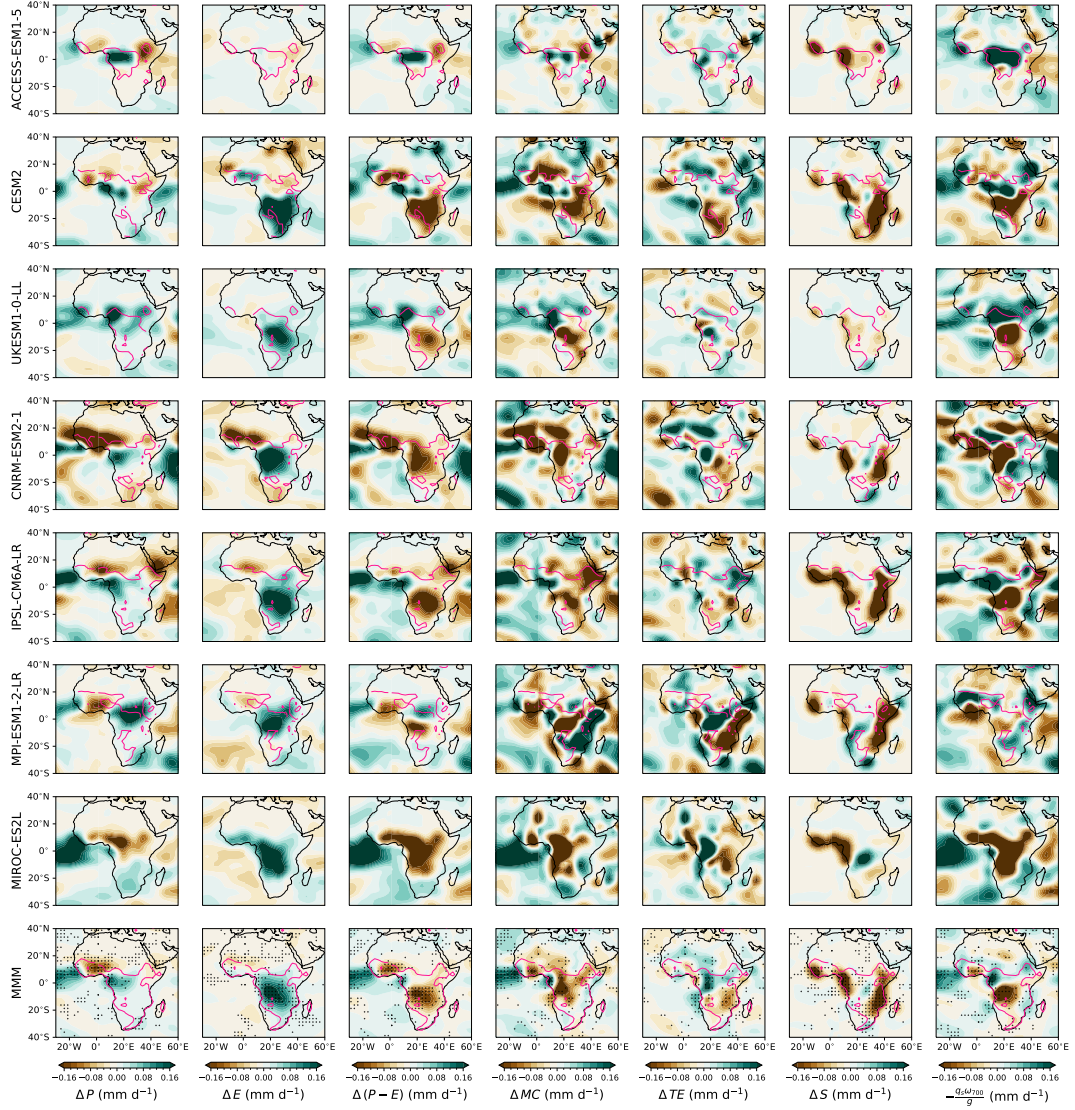


Figure S7. Spatial maps of individual-model ensemble-mean and MMM changes in MJJAS in (first column) precipitation ΔP , (second column) evapotranspiration ΔE , (third column) net precipitation $\Delta(P - E)$, (fourth column) mean circulation moisture flux term ΔMC , (fifth column) transient eddy term ΔTE , (sixth column) surface term ΔS and (seventh column) omega scaling over Africa in AFFOREST. Pink contours enclose the regions where there is at least 5% of afforestation. In the last row, stippling shows where 6 out of 7 ESMs agree on the sign of change.

S8. Moisture budget decomposition for individual models (NDJFM)

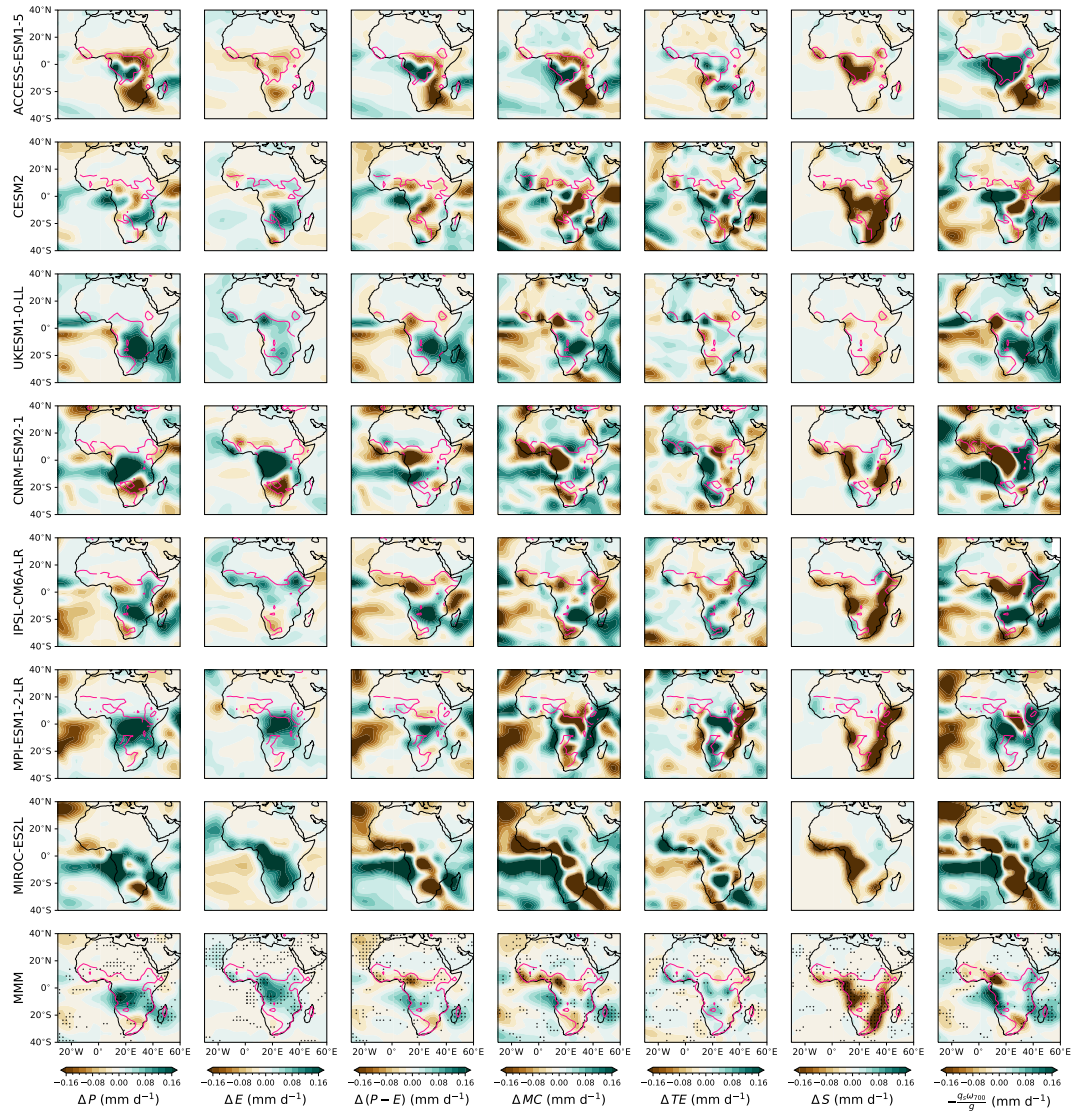


Figure S8. As in Figure S7 but for NDJFM.

S9. Dynamic and thermodynamic ΔMC component

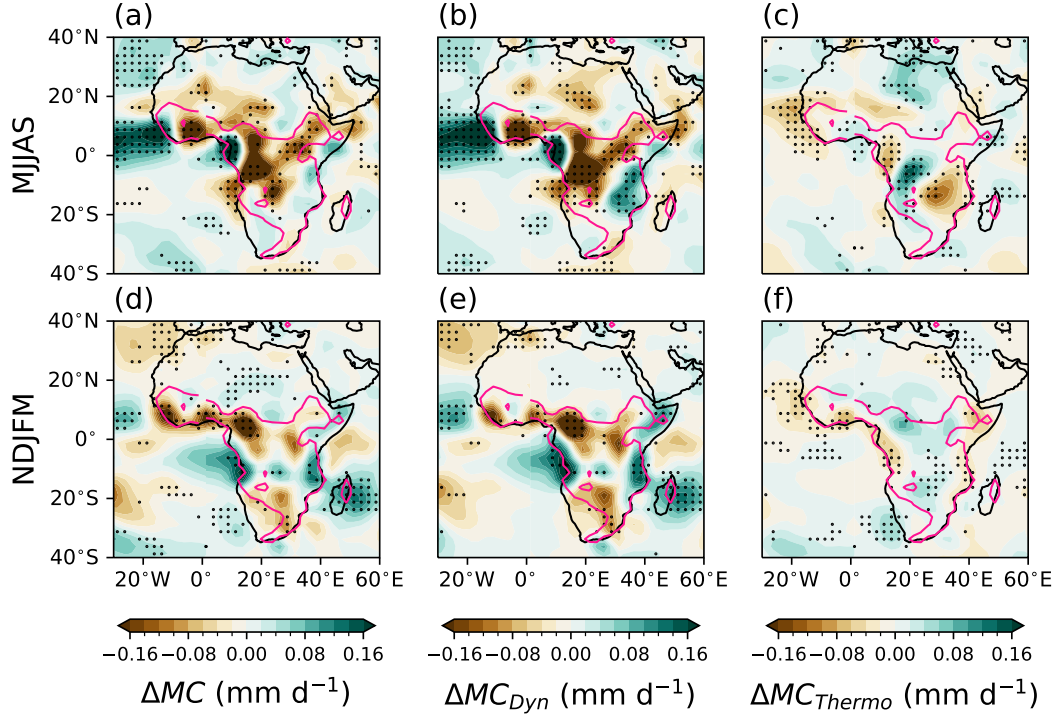


Figure S9. Spatial maps of changes in net precipitation $\Delta(P - E)$ induced by changes in (a, d) mean-circulation moisture flux ΔMC , (b, e) dynamic component of the mean-circulation moisture flux ΔMC_{Dyn} , and (c, f) thermodynamic component of the mean-circulation moisture flux ΔMC_{Thermo} in MJJAS (upper row) and NDJFM (lower row) over Africa in AFFOREST. Pink contours enclose the regions where there is at least 5% of afforestation. Stippling shows where 6 out of 7 ESMs agree on the sign of change.

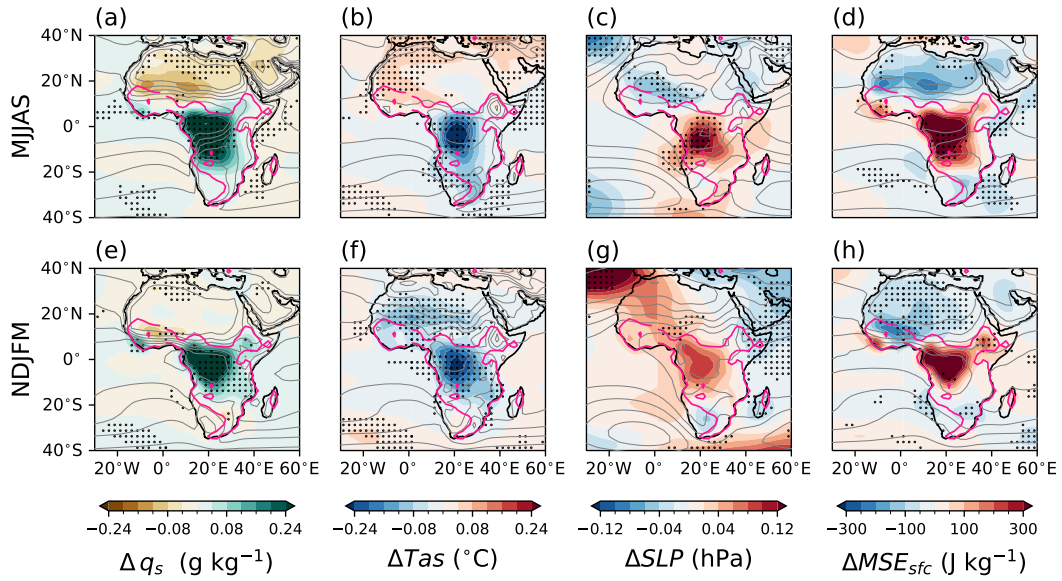


Figure S10. Spatial maps of changes in (a, e) surface specific humidity Δq_s , (b, f) near-surface temperature ΔT_{as} , (c, g) sea level pressure ΔSLP and (d, h) near-surface moist static energy ΔMSE_{sfc} in MJJAS (upper row) and NDJFM (lower row) over Africa in AFFOREST. Contours show the BASE values with a spacing of 2.5 g kg^{-1} for q_s , 3°C for T_{as} , and 2.5 hPa for SLP . Pink contours enclose the regions where there is at least 5% of afforestation. Stippling shows where 6 out of 7 ESMs agree on the sign of change.

S11. Comparison of omega scaling at 850hPa and 700hPa

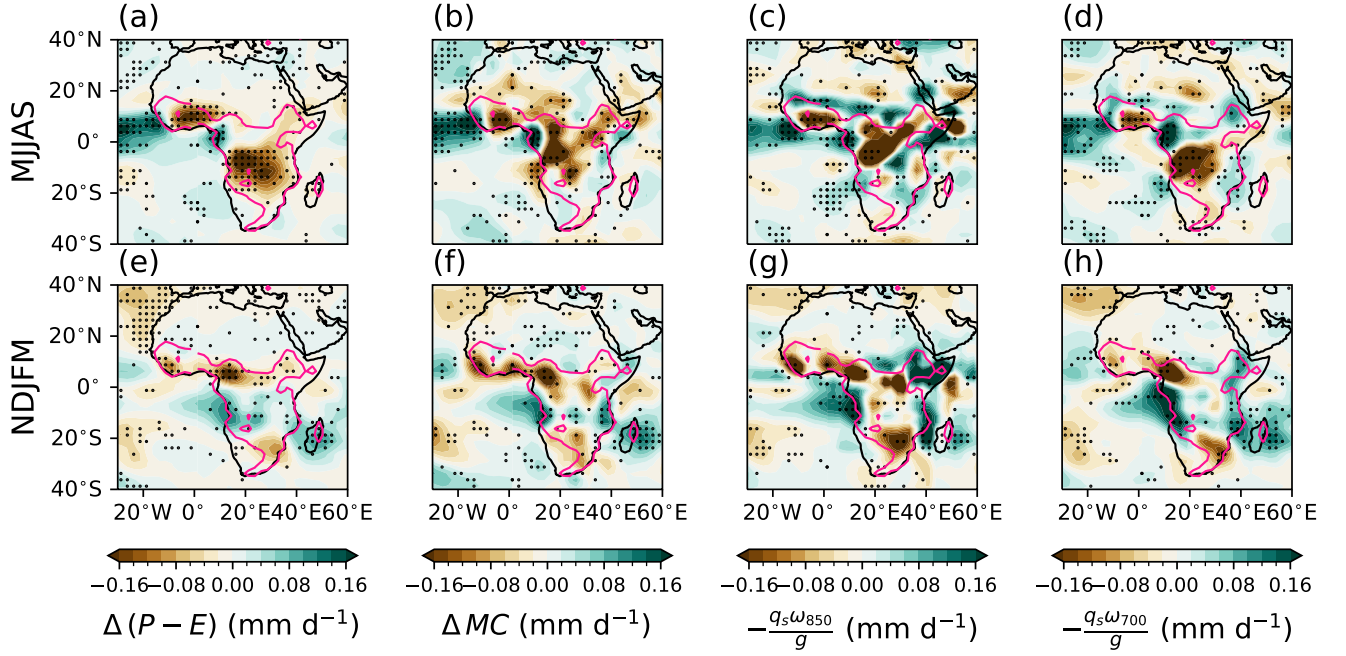


Figure S11. Spatial maps of changes in (a, e) net precipitation $\Delta(P - E)$, (b, f) mean-circulation moisture flux convergence ΔMC , (c, g) omega scaling using omega at 850hPa ω_{850} and (d, h) omega scaling using omega at 700hPa ω_{700} in MJJAS (upper row) and NDJFM (lower row) over Africa. Pink contours enclose the regions where there is at least 5% of afforestation. Stippling shows where 6 out of 7 ESMs agree on the sign of change.

S12. Surface wind speed and wind stress changes

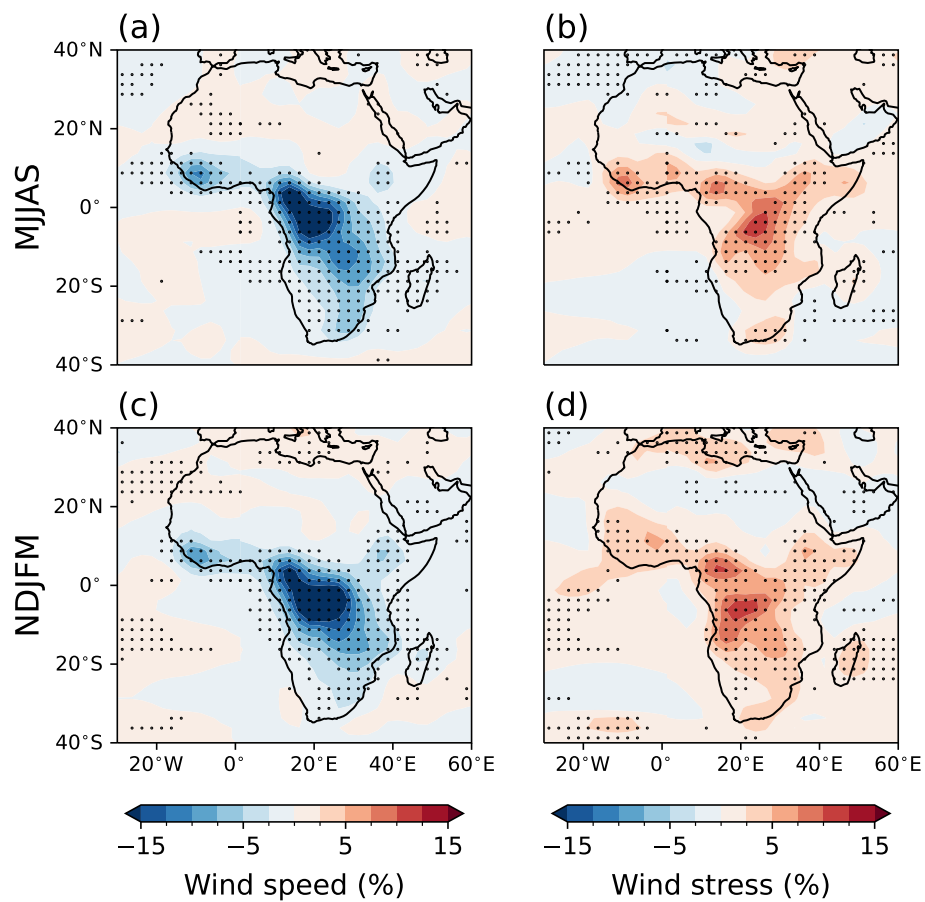


Figure S12. Spatial maps of percentage changes in (a, c) surface wind speed and (b, d) surface wind stress in MJJAS (upper row) and NDJFM (lower row) over Africa. Stippling shows where 6 out of 7 ESMs agree on the sign of change.