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Global stability of T/ET under present and future climate

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Evapotranspiration is the one of the most important terrestrial water fluxes. Detailed knowledge and quantification of the relevant processes is crucial for natural hazard risk management, agricultural yields, water security and climate. However, the partition of the two fluxes (evaporation and transpiration) at the global scale is not well understood. Recent research has highlighted that transpiration is most likely the dominant flux across all terrestrial ecosystems with a contribution to ET >50%, but a mechanistic explanation for this result is still missing. At the same time, increases in temperature, vapour pressure deficit, and atmospheric CO_2 concentrations have a direct effect on stomatal conductance that can alter the dynamics of T/ET. In this study we quantify the relative strength of transpiration to evapotranspiration and its expected changes in a future climate at the global scale using a modelling experiment.

We use the terrestrial ecosystem model T&C that resolves the coupled water and carbon cycles at the land surface to quantify the T/ET ratio for 79 locations worldwide covering all terrestrial biomes. We also construct 5 simplified "climate change" scenarios where: (a) the atmospheric CO_2 concentration, (b) the total precipitation amount, (c) the precipitation frequency, (d) the atmospheric temperature, and (c) the leaf area index are perturbed. The simulations inform on the expected changes in the T/ET ratio under the most commonly projected climate changes.

The main results of the study are:

• The T/ET ratio is very well constrained $\sim$70% globally.
• T/ET is globally constrained under present climate primarily due to the observed correlations between climate statistics (precipitation amount and frequency, temperature) and vegetation properties (leaf area index). Under present vegetation in equilibrium with climate, the "correct" vegetation properties at the "right" climate result to a globally constraint T/ET ratio.
• Minor changes are expected for the T/ET ratio due to climate change, even though the total amount of the fluxes can be substantially altered.
• The most important descriptors for the T/ET ratio are the precipitation frequency and the leaf area index. Changes in CO_2 concentrations, temperature and total precipitation amount do not lead to statistically significant changes in T/ET.