**Background:** Multiple lines of evidence suggest that forest water-use efficiency (WUE) —the trade-off between carbon assimilation and water loss—has increased in recent decades. Rising atmospheric CO2 has been proposed as the principal cause, but underlying mechanisms and implications for the global water cycle remain uncertain.

**Methods:** This study measured stable carbon and oxygen isotope ratios in 30-year tree ring records along with basal area increment from 12 species in 8 North American mature temperate forests. Analysis attempted to separate contributions of enhanced photosynthesis and reduced stomatal conductance to WUE trends as well as to assess consistency between multiple common methods for estimating WUE.

**Results:**
- Tree ring-derived estimates of increased WUE are consistent with those from atmospheric measurements and predictions based on an optimal balancing of carbon gains and water costs, yet are lower than those based on ecosystem-scale flux observations.
- Both physiological mechanisms contributed to rising WUE; however, enhanced photosynthesis was widespread while reductions in stomatal conductance were modest and restricted to moisture-limited forests.

**Significance:** The findings challenge the hypothesis that rising WUE in forests is primarily the result of widespread CO2-induced reductions in stomatal conductance. The details in this study have important implications for forest–climate interactions and make it clear that additional study of these interactions is needed.

![Comparison of tree-ring δ¹³C and EC-based estimates of WUE and prediction from the carbon–water optimality model.](image-url)