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Global variation in the ratio of sapwood to leaf area explained by optimality principles

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The sapwood area supporting a given leaf area (v_H) reflects a coordinated coupling between carbon uptake, water transport and loss at a whole plant level. Worldwide variation in v_H reflects diverse plants strategies adapt to prevailing environments, and impact the evolution of global carbon and water cycles. Why such a variation has not been convincingly explained yet, thus hinder its representation in Earth System Models. Here we hypothese that optimal v_H tends to mediate between sapwood conductance and climates so that leaf water loss matches both sapwood hydraulics and leaf photosynthesis. By compiling and testing against two extensive datasets, we show that our hypothesis explains nearly 60% of v_H variation responding to light, vapor pressure deficit, temperature, and sapwood conductance in a quantitively predictable manner. Sapwood conductance or warming-enhanced hydraulic efficiency reduces the demand on sapwood area for a given total leaf area and, whereas brightening and air dryness enhance photosynthetic capacities consequently increasing the demand. This knowledge can enrich Earth System Models where carbon allocation and water hydraulics play key roles in predicting future climate-carbon feedback.