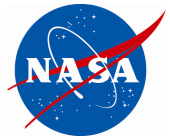
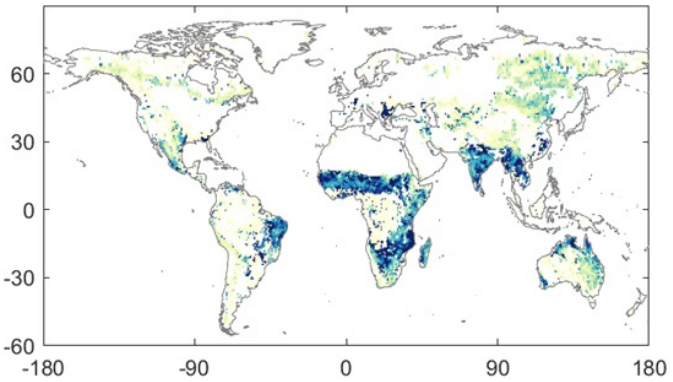


# Observations-Only Benchmark for Coupling Between the Water, Energy and Carbon Cycles

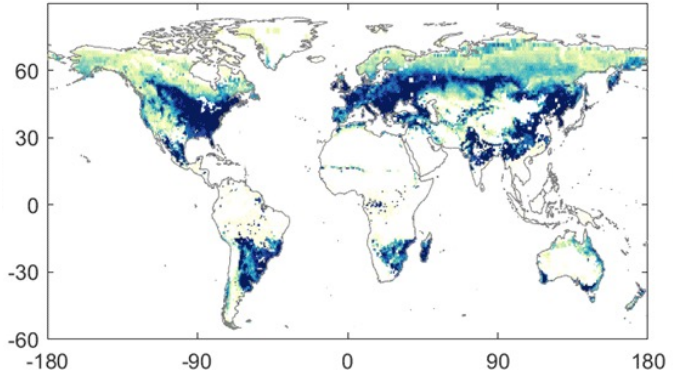


**Problem:** The water, energy and carbon cycles that together maintain the climate system are intimately linked. As a result, perturbations in one can affect the other. How strongly or weakly they are linked determines how modifications of one cycle transfers to another. Earth System models parameterize these linkages. Differences in parameterization approaches across models has resulted in large uncertainties in projecting global change.

Down-regulation of SIF by soil moisture. (73 % of land area with two-regimes\*)



Down-regulation of SIF by PAR for water limitation (41 % of land area with two regimes)



**Finding:** Global data from three different satellite platforms are used to produce global maps of soil moisture limitation and light limitation response of photosynthesis across different climates and ecosystems. We consider a two-regime relationship where there is down-regulation below a threshold and no regulation above the threshold. Down-regulation fields indicate the strength of coupling between the water, energy and carbon cycles.

SIF are from TROPIMI in [ $\text{mW m}^{-2} \text{nm}^{-1} \text{sr}^{-1}$ ] units. Soil moisture is from SMAP in [ $\text{m}^3 \text{m}^{-3}$ ] units. PAR is from MODIS in [ $\text{W m}^{-2}$ ] units.

\*Excludes Greenland and Antarctica

**Impact:** The observations-only benchmark data set on the strength and geographic distribution of the coupling between the water, energy and carbon cycles assesses models relative to one-another and guides their development.