



Soil Texture Controls the Relative Importance of Vapor Pressure Deficit and Soil Moisture for Ecosystem Water Limitation Globally

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Terrestrial vegetation plays a crucial role for water-energy-carbon interactions between the land and the atmosphere but is experiencing above-average temperature increases due to climate change. This contributes to widespread increases in vapor pressure deficit (VPD). High VPD and low soil moisture are considered the two main drivers of plant water stress, triggering the downregulation of vegetation-atmosphere fluxes, such as transpiration and photosynthesis. While ecosystems are initially driven by energy availability, soil drying below a critical soil moisture threshold (θ_{crit}) shifts them to a water-limited regime. However, the relative importance of VPD versus soil moisture limitation and the relative role of soil versus plant hydraulic conductance are highly debated. Understanding the key mechanisms controlling these relative roles is therefore crucial to predict vegetation-atmosphere exchanges under changing environmental conditions. Here, by analysing global observations of θ_{crit} , we demonstrate the central role of soil texture in shaping the importance of VPD versus soil moisture limitation by mediating the magnitude of soil hydraulic conductance relative to that of the plant. On average, we find that loss in soil rather than plant hydraulic conductance determines the onset of water limitation across climates and biomes globally. This implies that ecosystems in fine textured soils are more sensitive to VPD than ecosystems in coarse textured soils, while ecosystems in coarse soils are more sensitive to soil drying than in fine soils. This is a consequence of the steeper decline in soil hydraulic conductivity in coarse soils, resulting in the dominant control of soil hydraulics in these soils. Our analysis explains the emergent control of soil texture on ecosystem water limitation and unifies long-standing controversies about the relative importance of VPD versus soil moisture and soil versus plant hydraulic limitation. We demonstrate the global relevance of soil texture for land-atmosphere exchanges and open new paths to understanding the impacts of climate change on terrestrial ecosystems.