Linking long-term leaf transpiration to vegetation greening through $g_{smax}$ - NDVI comparison in Scandinavia

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With increasing CO₂ plants downregulate transpiration rates by reducing stomatal conductance to minimize water loss, thereby affecting continental H₂O fluxes, run-off rates, cloud formation and precipitation. Alternatively, carbon fertilization can lead to more biomass in form of more or denser vegetation and more or larger growing leaves.

Considering the vegetation response to rising CO₂, two contrasting feedback options in the hydrological cycle are discussed:

1. Vegetation cover stays constant owing to limiting factors (nutrients, light, temperature) → runoff will increase.
2. Vegetation cover increases due to carbon fertilization and leads to net transpiration increase → runoff will decrease.

Here we test these contrasting scenarios by directly comparing time-series data of CO₂ induced anatomical maximum stomatal conductance ($g_{smax}$) changes and satellite observations of the NDVI over Scandinavia. By determining the rate of change for stomatal conductance and 'vegetation greenness' we evaluate the role of plants in the hydrological cycle in a long-term perspective.

The transpiration decrease is likely buffered, but not compensated by CO₂ fertilization effects. Vegetation response under changing CO₂ is an important parameter in the hydrological cycle and exact quantification needs more attention in biosphere – atmosphere – hydrosphere modeling.

Resume: A strong CO₂ related decrease in $g_{smax}$ is determined for birch, the second most important canopy tree in Scandinavia. Over the common CO₂ rise, NDVI data from Landsat and MODIS show more intense greenness of the vegetation in the areas studied.

The rates of change, however, are lower in NDVI than $g_{smax}$.