Geophysical Research Abstracts
Vol. 19, EGU2017-19371, 2017
EGU General Assembly 2017

Global trends in biome-level plant water-use efficiency in the past 25 years from rising atmospheric carbon dioxide concentration

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Climate change will likely alter future ecosystems functioning however the magnitude and direction of such changes are unpredictable and difficult to quantify. One notable aspect of ecosystem functioning is the carbon and hydrologic cycles which are closely tied by gas exchange via plant stomata. Uncertainties in the magnitude and direction of the physiological responses of plants to elevated CO_2 at biome level hamper modelling of terrestrial water cycling and carbon storage. One of the important physiological traits is water-use efficiency which is the ratio of water loss to carbon gain. This is a key characteristic of ecosystem function that is central to the global cycles of water, energy and carbon. Many existing studies have focused on long-term centennial effects of elevated CO_2 on plant water-use efficiency of a relatively few species within narrow ecosystem range but short-term effect on much broader ecosystem coverage is unknown. Here we assessed the impact of a short-term (25 years: between 1988/89 and 2013/15) increase in CO_2 (c. 40 ppm) on plant intrinsic water-use efficiency inferred from leaf stable carbon isotope (δ13C), encompassing a broader coverage to include seven world biome and 229 woody angiosperm species. To substantiate the result from the leaf stable carbon isotope data, we also conducted gas-exchange analyses experiments. We show that the magnitude of plant intrinsic water-use efficiency change varied among biomes and plant functional types. Our finding is important because it shows that short-term increase in atmospheric CO_2 can potentially alter hydrologic cycle and its magnitude may differ among biome-plant functional type compositions.