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Trends in 20th Century Global Rainfall Interception as Simulated by a Dynamic Global Vegetation Model: Implications for Global Water Resources

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In order to monitor and forecast regions of potential freshwater stress and surplus, a comprehensive understanding and quantification of the global hydrological cycle and its components is needed. Such work should lead to better constrained estimates of freshwater fluxes and facilitate the identification of regions requiring enhanced water management.

The research described here aims to quantify the contribution of climate- and CO_2-induced changes in the physical properties of the land surface, mediated by biological processes. Global climate change is expected to bring about substantial latitudinal and altitudinal shifts in vegetation cover. Shifts in species distribution, the potential of increased leaf area index (LAI) but also reduced stomatal conductance in response to rising concentrations of CO_2, and variability in precipitation, can all influence rates and spatial variability of the interception-throughfall balance. These effects will have implications for runoff generation and the partitioning between 'green' and 'white' water fluxes.

The Land Processes eXchange Dynamic Global Vegetation Model (LPX-DGVM, a development of the LPJ model) was evaluated in terms of its interception component and used to simulate trends in global relative throughfall from 1901-2006, as this is directly relevant for runoff. We estimate that mean global annual runoff was reduced by 164 $\pm$18 km^3/year during the twentieth century as a result of biophysical changes controlling relative throughfall generation. Widespread decreases in relative throughfall of typically between 0 and -1% are evident between 1901-1953 and 1954-2006. Changes of up to $<$-5% are evident in parts of North America and East Asia. Areas of simulated decrease in relative throughfall often lie in close proximity to areas of relative increase, reflecting the effects of vegetation shifts.

It is likely that future global throughfall will generally increase (due to increasing precipitation), but the curtailing of runoff via decreased relative throughfall (as a product of vegetation shifts and increased LAI) may cause the exacerbation of water stress in some regions (including parts of East Asia, North America and the Tropics) and increased flooding in others (for example, other parts of the Tropics and northern Russia). This therefore offers a further indication of the control that vegetation imposes on the global freshwater budget.