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The mediating role of trees – transfer and feedback mechanisms of wind-driven seismic activity

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There are multiple pathways to deliver energy, necessary to drive geomorphic processes, to the Earth surface. However, the role of vegetation – especially trees – in a wind field has received only limited attention. While tree mechanics above the surface are well investigated, there appears to be a fundamental lack of information on the amount of energy transferred to the subsurface. With modern broadband seismometers it is possible to quantify this energy. In a forest close to natural conditions (Serrahn area of the Müritz National Park, northern Germany) two three-component seismometers were deployed over several winter storm periods to record the patterns of seismic activity with respect to meteorological drivers.

Trees emit considerable seismic energy over a broad frequency band (< 0.5 – 50 Hz), in close relation to wind speed (R^2 = 0.6 to 0.8), which must be compensated within shallow depth. However, lateral attenuation is significant: less than 50 m beyond the forest margin the signal virtually vanished. The relationship of wind speed and seismic activity shows a clockwise hysteresis pattern, which appears to be related to stem water content (as indicated by tree diameter measurements). This results in a time lag of tree response to increasing wind speed as well as a recovery time of several hours until the hysteresis is closed again.

These findings show the vital role of vegetation in coupling energy systems (atmosphere and subsurface) and the coupled feedback loops and time-variant properties of wind, trees and ground properties.