Tree species diversity affects canopy leaf temperatures in a mature temperate forest

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Forest canopies play a major role in biosphere-atmosphere interaction. Their actual temperature may deviate substantially from ambient atmospheric conditions as reported by weather stations. While there is a long tradition of false-colour imagery, new digital technologies in combination with IR transmission lenses and autocalibration routines permit unprecedented insight into the actual temperature regimes in canopies. We report canopy leaf temperature distribution over space and time assessed over a 35 m tall mixed deciduous forest in NW Switzerland by means of a construction crane and a high resolution thermal camera. At an air temperature of 25 degrees C, conifers (Picea abies, Pinus sylverstris and Larix decidua) and deciduous broad-leaved trees with exceptionally high transpiration (Quercus petraea) or very open, low density canopies (Prunus avium) exhibited mean canopy leaf temperatures close to air temperature (0.3-2.7 K above ambient) and the maximum amplitude within a given crown reached 69 K. In contrast, broad-leaved deciduous species with dense canopies (Fagus sylvatica, Carpinus betulus and Tilia platyphyllos) were 4.5-5 K warmer than air temperature and showed within canopy temperature amplitudes of 10-12 K. Calculated leaf boundary resistance was clearly lower for conifers (3-24 m s(-1)) than for broad-leaved trees (33-64 m s(-1)). The study illustrates that mean leaf temperatures in forest trees are not adequately explained by either stomatal conductance or leaf dimensions, but strongly depend on canopy architecture (leaf area density, branching habits) in combination with leaf traits. Aerodynamic leaf and canopy characteristics lead to strongly enhanced vapour pressure gradients (evaporative forcing) and leaf temperatures vary enormously over short distances, calling for statistical temperature models (frequency distribution) rather than the use of means in any flux calculations. The presence/absence of certain tree taxa plays a key role in forest surface temperature. (c) 2007 Elsevier B.V. All rights reserved.
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