Tree surface temperature in an urban environment

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Trees are essential in a dense urban environment not only because of their aesthetic value, but also for their cooling effect during hot periods, which impacts directly on the local microclimate. However, certain trees cope better with high urban temperatures than others. Here, we report tree crown temperatures of 10 common tree species frequently planted in Central European cities (in part, supplemented with stomatal conductance data, gs). Parts of the city of Basel, Switzerland (7ř410E/47ř340N) were scanned from a helicopter using a high-resolution thermal camera. A histogram of the composite image shows peaks at 18 řC (water), 26 řC (vegetation), 37 řC (streets) and a less obvious one at 45 řC (roofs). At an ambient temperature of c. 25 řC, tree crown temperatures ranged from c. 24 řC (Aesculus hippocastanum trees located in a park) to 29 řC in Acer platanoides trees, located in a street. Trees in parks were significantly cooler (c. 26 řC) than trees surrounded by sealed ground (c. 27 řC). The only coniferous species, Pinus sylvestris did not vary in temperaturewith location (park or street) and exhibited foliage temperature close to air temperature. Generally, small-leaved trees remained cooler than large-leaved trees. Stomatal conductance data collected during similar weather conditions suggest that there was no bias in crown temperatures due to locally different water supply between trees. Although the highest leaf temperatures of individuals of A. platanoides reached over 5 K leaf-to-air temperature difference (dT(L-A)), we do not expect temperature stress to occur in these conditions. In order to estimate possible effects of future temperature extremeson dT(L-A),we evaluated the leaf energy balance fora range of stomatal responses and air temperatures, using leaf size, wind speed and the measured species-specific leaf boundary layer resistance. At an ambient temperature of 40 řC, dT(L-A) ranged from2 to 5 K when gs was assumed to drop linearly to 50% of itsmaximumvalue.When gs was compromised further (20% of species-specificmaxima), the difference in dT(L-A) between species became larger with rising ambient temperature (range 4–10 K). Those species with the lowest leaf temperatures at 25 řC were not necessarily coolest at 40 řC. Speciesspecific differences in dT(L-A) under extreme temperatures as shown here may be useful for urban tree planning in order to optimise management cost and human comfort.

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