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The temperature effect on the Intrinsic quantum yield at the ecosystem level

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The intrinsic quantum yield (φ_0) is a measure of the efficiency of photosynthesis at low light levels and it is a crucial parameter for modelling gross primary productivity using "light use efficiency" (LUE) models. These models often assume that φ_0 is constant, but there is evidence retrieved at leaf level in the lab, that it may depend on temperature in a bell-shaped curve, with a peak around 30°C. This temperature dependence of $\varphi_0(T)$ is still not fully understood, thus, it is still unknown if the shape of $\varphi_0(T)$ is universal or if the responses at the leaf and ecosystem levels widely differ. Here we derived $\varphi_0(T)$ at the ecosystem level for different sites during their growing season. We used sub-daily above and below-canopy measurements of photosynthetic flux density, long-wave radiation measurements to derive surface canopy temperature, and eddy covariance measurements of CO_2 exchange. We then compared our estimations with empirical models found in the literature and propose a new empirical equation. We found that $\varphi_0(T)$ at the ecosystem level also follows a bell-shaped curve, with a rapid increase after 5 °C to peak around 20 °C to 25 °C, and a slight decrease with further increasing temperature. Overall, our estimations show lower values than previous leaf-level observations reported in the literature. The results suggest that this new formulation for $\varphi_0(T)$ may improve the predictions of current LUE models, but further testing is needed.