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UAV based thermal imaging at the leaf scale – A case study in a tropical dry forest

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Leaf and canopy temperature have long been recognized as an important indicators of plant water status. Recently, unmanned aerial vehicles (UAVs) became arguably the superior platform to acquire leaf temperatures due to their low cost and high spatiotemporal resolution and flexibility compared to satellite platforms. However, when interested in absolute leaf temperatures of individual leaves, the resolution of thermal cameras is often not sufficient and UAV overflight height needs to be adjusted. This causes heterogeneous forests to become inherently complex structures with great challenges for generating thermal orthomosaics. In addition, currently applied uncooled thermal sensors are affected by their ambient conditions causing temperature readings to drift during flight operation.
To address these issues, we employed a dual camera setup consisting of a visible and thermal sensor to aid the geometric calibration of the thermal sensor. To account for the temperature drift, we developed an alternative flight planning approach: During the UAV mapping mission ground temperature references are repeatedly captured from above forest clearings to estimate temperature drift and continuously adjust temperature calibration. We compare our temperature calibration approach to the default camera calibration and to a simple pre- and post-flight calibration method under different atmospheric conditions (temperature, wind and cloud coverage). The geometric accuracy of the forests thermal orthomosaics is validated against ground control points.
Accurate calibrated canopy temperatures will allow to compare canopy temperature differences while also providing uncertainty estimates of the temperature data. High resolution thermal maps at the forest leaf scale will open up the possibility to analyze plant water status during seasonal dry forest changes.