Supplementary Materials

1. Decagon's AccuPAR LP-80 Limitations and Promotions

Decagon's AccuPAR LP-80 is a probe consisting of 80 PAR quantum sensors arranged at 1 cm intervals below the light diffusion shield. Each sensor measures radiation in the 400 nm < λ< 700 nm range. Previous studies have shown that it differs less from the LAI observed by LAI-2000[1].

In our study, Decagon's AccuPAR LP-80 was used to obtain PAR above and below the canopy in a tall forest and to obtain effective LAI. It is often impractical to obtain PAR above and below simultaneously with a single instrument measurement in a tall canopy. Therefore, we chose to use the PAR sensor in an open clearing or a larger forest window in the forest's interior to obtain the incident PARa and obtain the PARb below the canopy to calculate each PARb/PARa pair (τ).

Decagon's AccuPAR LP-80 is more sensitive to light than DHP, LAI-2000. There is significant uncertainty in obtaining an accurate, effective LAI from the incident light[2]. Due to the fast-changing sky conditions in the study area, cloud cover causes sky conditions to be inconsistent in measuring PARa and PARb (Figure S1). The PAR obtained by the sensor varies with the plot-level weather conditions, as shown in Figure S2.

$$L = \frac{[(1-(1/2K))f_b - 1]\ln\tau}{0.9(1-0.47f_b)}, \quad (1)$$

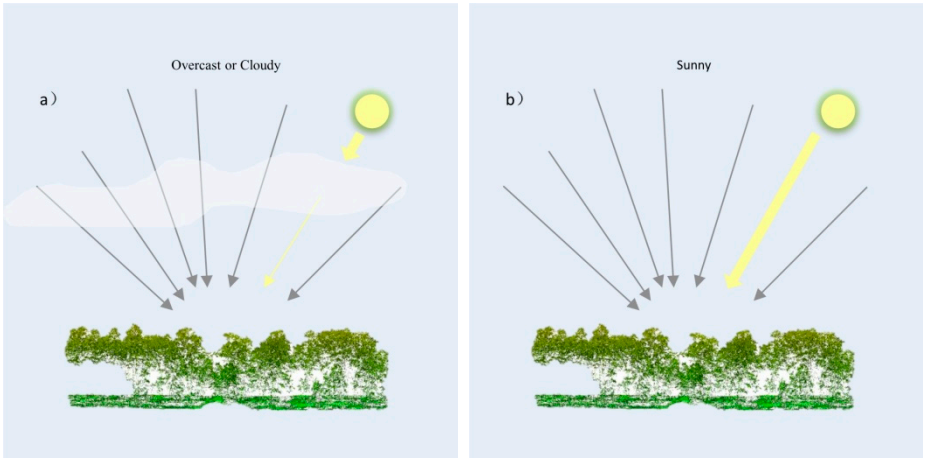

Figure S1. PAR under a) overcast or cloudy and b) sunny sky conditions

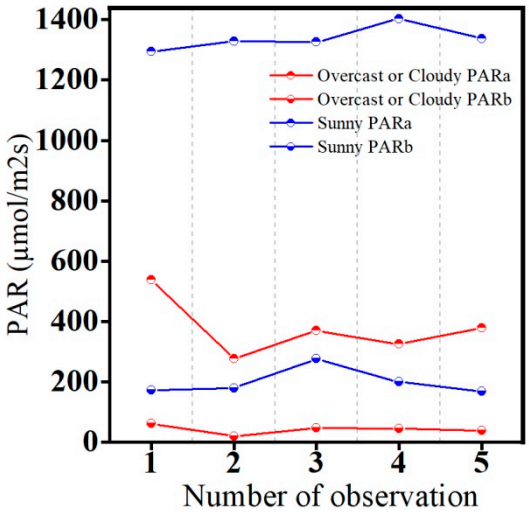

Figure S2. The sensor acquired s PAR changes with sky conditions at the plot-level

As seen from the acquisition of PAR in Figure S2, inconsistent sky conditions can lead to significant deviations τ such that the effective LAI obtained by Equation 1 is incorrect, making model validation difficult.

2. Exclusion of outliers in paired samples analysis

Section 2.5.3 extracted the ACI of all paired samples within the experimental area as an experimental metric. However, the extracted ACI will be abnormal in the following cases.

The first case is due to a partial loss of vertical transect and horizontal transect data in the experimental area, excluding outliers (Figure S3).

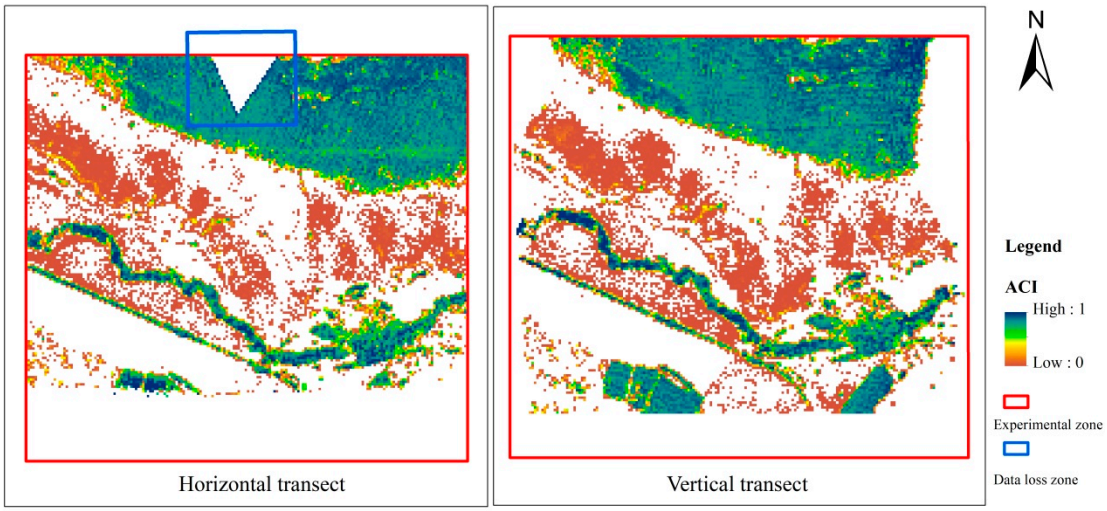

Figure S3. Schematic diagram of data loss in the experimental zone

The second case is within the paired-samples due to differences in point cloud data coverage between vertical and horizontal transects. In addition, differences due to non-complete forest coverage can occur within the paired-samples (Figure S4).

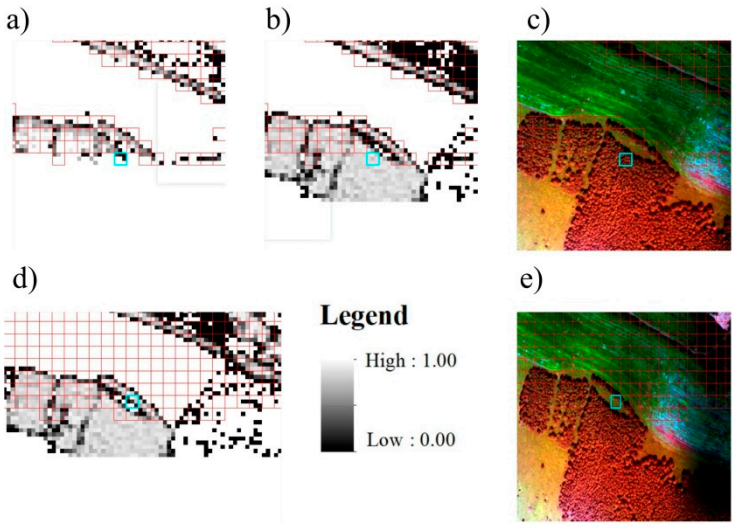

Figure S4. Explanation of anomalies in non-complete coverage areas of paired-samples. a-b-c is the horizontal and vertical transects ACI and RGB image extracted from paired-sample ID-207, respectively. d-e is the vertical transects ACI and RGB image extracted from paired-sample ID-271.

From Figure S4 and the anomalous ACI, it is derived that an ACI greater than 0.5 can exclude samples from non-forested areas, discontinuous forests, and non-fully covered forests. Differences between paired ACIs greater than 0.3 are due to the partial absence of one of the horizontal or vertical transects (Figure S5).

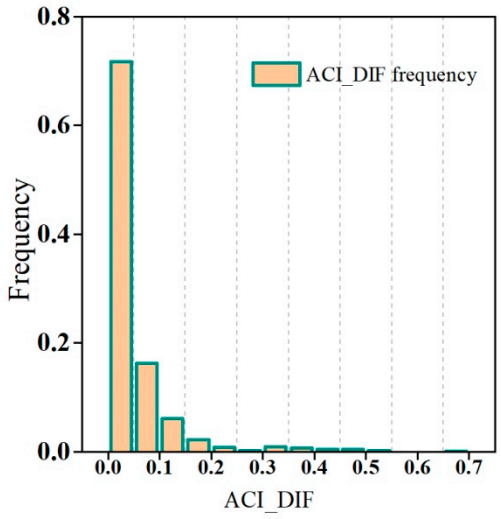

Figure S5. ACI_DIF frequency distribution histogram

3. UAV-LS Specific Information

Table S1. ARS-1000 L UAV-LS system specifications.

ARS-1000L sensor core parameters	
Maximum flight height	1350m
Range resolution	±5cm
Scanning angle	±330°
Angle resolution	0.001°
Pulse frequency	820 KHZ
Laser wavelength	Near-Infrared
Laser beam divergence fraction	0.5mrad

1. Hyer, E.J.; Goetz, S.J. Comparison and sensitivity analysis of instruments and radiometric methods for LAI estimation: assessments from a boreal forest site. *Agricultural and Forest Meteorology* **2004**, *122*, 157-174, doi:10.1016/j.agrformet.2003.09.013.
2. Garrigues, S.; Shabanov, N.V.; Swanson, K.; Morisette, J.T.; Baret, F.; Myneni, R.B. Intercomparison and sensitivity analysis of Leaf Area Index retrievals from LAI-2000, AccuPAR, and digital hemispherical photography over croplands. *Agricultural and Forest Meteorology* **2008**, *148*, 1193-1209, doi:10.1016/j.agrformet.2008.02.014.