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In situ observation of tree leaf photosynthesis under foggy condition

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Two mechanisms have been proposed to explain the direct influences of fog on plant photosynthesis: the 'dimming effect' because of the reduced photosynthetically active radiation (PAR), and the 'wetting effect' caused by the blockage of stomata by fog droplets. While the former is easily provable by experiments/observations, the latter is difficult to be observed independently in the field. Modern commercial portable photosynthesis systems require a dry leaf surface for an accurate operation, therefore limit their applicability in this research. Here we present an automated closed leaf chamber system which was designed for continuous field measurement of leaf photosynthesis and respiration. During the measurement, a transparent cover closes the chamber for the measurement of net assimilation rate (An), then a mask covers the chamber and darken the chamber completely, which allows the measurement of dark respiration rate (Rd). The sum of An and Rd, the photosynthetic rate (Ph), can be calculated and then analyzed against visibility and other meteorological parameters, thus enabling us for the analysis of the influence of fog on photosynthesis.
The system with 6 chambers is operating on the canopy of a Chamaecyparis obtusa var. formosana stand at the Chi-Lan Mountain (CLM) site (24°35'N, 121°25'E) in northern Taiwan. The CLM site is characterized by a very high frequency of fog occurrence and receives about 300 mm fog deposition annually. Using the dataset delivered by the chamber system, it becomes possible to explore the effect of fog on leaf-level photosynthesis. For PAR < 200 μmol m-2 s-1, the quantum yield for foggy and non-foggy conditions was 0.02 and 0.023 μmol μmol-1, respectively, indicating that the wetting of Chamaecyparis obtusa var. formosana leaves by fog droplets won't further decrease the photosynthesis rate. The tree species that dominate the cloud forests may have adapted to the foggy environment by keeping a high stomatal conductance at the presence of fog droplets on the leaf surface.