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Estimating fluorescence emission of city trees in Valencia: from leaf to canopy level

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Air pollutant concentrations in cities can be very high due to the heavy traffic load. Also, these concentrations vary on a small scale due to differences in traffic density, street layout and the surrounding land uses, leading to local hot-spots for air pollution. These different growing environments can result in a different stress outcome for city trees, which can be measured at different scales. Leaf radiative transfer characteristics such as spectral reflectance and sun-induced chlorophyll fluorescence (F) give information about the physiological status of the leaf and can be measured both at the leaf and canopy scales. The goal of the BIOHYPE project is to develop a passive biomonitoring methodology from leaf to canopy scale based on fluorescence and reflectance parameters as indicators for leaf physiological stress. Field and flight campaigns were set in Valencia during the summer of 2011. Four tree species with different leaf characteristics were selected at 10 locations in the city with different traffic densities. Fluorescence emission was measured with an ASD FieldSpec spectroradiometer in combination with the Fluowat leafclip, a portable device to measure leaf reflectance, transmittance and fluorescence emission under natural conditions. Airborne images were acquired using a CASI-1500 VNIR hyperspectral imager in tandem with an AHS system for SWIR-TIR. Besides fluorescence, the following parameters have been measured and analyzed at leaf level: optical properties, chlorophyll content (Chl), water content and magnetic properties of deposited pollution dust. In this work, relationships of fluorescence with location (i.e. traffic density), pollution and chlorophyll content have been explored.

At leaf level, first results suggest that the up- and down-ward total F yields are related to location for two of the four species, while the fluorescence peaks and their ratios showed a larger influence of location. The ratio F687/F741 for both down- and upward fluorescence showed the highest dependency to location. The relation between fluorescence peaks and Chl was subsequently investigated. It was found that the magnitude of the ratio F687/F741 is affected by the chlorophyll content of the species. Plane tree (Platanus hispanica) had a generally lower Chl compared to the other species and therefore showed a much larger response in F687/F741. Also, the downward total fluorescence yield for this species is closer to the upward fluorescence yield compared to the other species with more Chl.

At the canopy scale, similar measurements were carried out at three different levels (lower, middle and upper canopy) to evaluate the variation in fluorescence emission within a single tree. This will enable us to upscale the results to the CASI imagery. Maps of Chl are already generated. In the near future it is foreseen to be able to retrieve the fluorescence-related products (e.g. F687/F741) over the city of Valencia and interpret these results to plant stress maps.