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Above ground biomass estimation from lidar and hyperspectral airbone data in West African moist forests.

Gaia Vaglio Laurin (1,6), Qi Chen (2), Jeremy Lindsell (3), David Coomes (4), Roberto Cazzolla-Gatti (5), Elisa Grieco (1), Riccardo Valentini (1,5)

(1) CMCC Centro Euro Mediterraneo per i Cambiamenti Climatici, IAFENT Division, Viterbo, Italy (laurin@disp.uniroma2.it), (6) University of Tor Vergata, DISP, Rome, Italy, (2) University of Hawaii at Manoa, Geography Department. USA, (3) Royal Society for Protection of Birds, UK, (4) Plant Science Department, University of Cambridge, UK, (5) University of La Tuscia, DISAF, Viterbo, Italy

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The development of sound methods for the estimation of forest parameters such as Above Ground Biomass (AGB) and the need of data for different world regions and ecosystems, are widely recognized issues due to their relevance for both carbon cycle modeling and conservation and policy initiatives, such as the UN REDD+ program (Gibbs et al., 2007). The moist forests of the Upper Guinean Belt are poorly studied ecosystems (Vaglio Laurin et al. 2013) but their role is important due to the drier condition expected along the West African coasts according to future climate change scenarios (Gonzales, 2001). Remote sensing has proven to be an effective tool for AGB retrieval when coupled with field data. Lidar, with its ability to penetrate the canopy provides 3D information and best results. Nevertheless very limited research has been conducted in Africa tropical forests with lidar and none to our knowledge in West Africa. Hyperspectral sensors also offer promising data, being able to evidence very fine radiometric differences in vegetation reflectance. Their usefulness in estimating forest parameters is still under evaluation with contrasting findings (Andersen et al. 2008, Latifi et al. 2012), and additional studies are especially relevant in view of forthcoming satellite hyperspectral missions.
In the framework of the EU ERC Africa GHG grant #247349, an airborne campaign collecting lidar and hyperspectral data has been conducted in March 2012 over forests reserves in Sierra Leone and Ghana, characterized by different logging histories and rainfall patterns, and including Gola Rainforest National Park, Ankasa National Park, Bia and Boin Forest Reserves. An Optech Gemini sensor collected the lidar dataset, while an AISA Eagle sensor collected hyperspectral data over 244 VIS-NIR bands. The lidar dataset, with a point density >10 ppm was processed using the TIFFS software (Toolbox for LiDAR Data Filtering and Forest Studies)(Chen 2007). The hyperspectral dataset, geo-referenced with lidar DEM, was processed to remove noise and for feature extraction with Minimum Noise Fraction and/or Principal Component Analysis. Orthophotos data were also gathered. For corresponding areas of ground truth, lidar metrics and hyperspectral pixel values were calculated and extracted. The ground truth was collected in forest plots during different field campaigns (Lindsell and Klop 2013; CMCC field unpublished data) conducted between 2007 and 2012, and provided information on forest structure and species composition. This presentation illustrates the first results from this massive data collection in West Africa tropical forests. Preliminary findings indicate that estimating biomass with lidar in these areas is a more difficult task with respect to other tropical forests: in Sierra Leone the best results (R2 = 0.65) was obtained with a with power model based on lidar mean plot height. This is possibly due to forest complexity, lack of specific allometric relationships, and field plots geo-location inaccuracies. The preliminary analysis of hyperspectral data and its fusion with lidar is challenging, with different results obtained according to the considered area. Interesting spectral profiles showing green-up of specific trees crowns in the dry season were highlighted with hyperspectral data analysis.

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