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Using the UFL-8 UV fluorescent LIDAR to collect ground truth data for calibrating MODIS based CDOM, chlorophyll and suspended sediment measurements

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Satellite remote sensing of water quality parameters is becoming a routine method in oceanological applications around the world. One of the main difficulties of calibrating satellite images to map water quality parameters is the large number and high spatial coverage of ground truth data needed. The UFL-8 fluorescent LIDAR developed by the Shirshov Oceanological Institute of the Russian Academy of Sciences measures CDOM, chlorophyll and suspended sediment near-surface concentrations optically in situ, on a travelling boat, and so is capable of a large number of widespread measurements very quickly. The registration of the measured values is connected to a GPS, so all measurements are geo-tagged and can be used for interpolating maps of the measured parameters. Since this instrument also has to be calibrated, some water samples have to be collected, but the optical measurements usually show very strong correlation to the water sample data.

This approach was tested on Lake Balaton, Hungary in September 2008. Lake Balaton is characterized by its large area (597 km2), elongated shape and relatively shallow water depth (avg 3,2 m). The lake has a strong trophic gradient from the SW to the NE, the main tributary river carries large amounts of CDOM and suspended sediment concentrations can be very high because the lake is shallow and the sediment is fine grained. We measured in diverse weather conditions, and in an enclosed bay, a narrow strait and a large area of open water. 28 water samples were collected during the LIDAR measurement and the CDOM, chlorophyll and suspended sediment concentrations were measured in the laboratory using classic hydrological methods. These results were used to calibrate the LIDAR measurements with R2 values between 0,90 and 0,95. The relative values measured by the LIDAR were converted to absolute values using this regression, and the point-by-point results were interpolated into a raster with a cell size equal to the spatial resolution of the corresponding MODIS bands.

MODIS TERRA images of the study area on the measurement days were received at the satellite tracking station of the Eötvös Loránd University. After atmospheric correction and geolocation, the band 9 was used for estimating CDOM, the ratio of bands 3 and 4 for chlorophyll, and band 1 for suspended sediment. This allows for a spatial resolution of 1 km for CDOM, 500*500 m for chlorophyll, and 250*250 m for suspended sediment.

The measured CDOM concentrations did not show a strong correlation with the CDOM concentrations estimated from the MODIS images, which is probably caused by the wide range of CDOM concentrations and the low number of satellite data points due to low resolution. Chlorophyll concentrations measured by LIDAR and estimated from MODIS images showed a relatively strong correlation, and the relatively fine spatial resolution makes detection of patterns possible, although cross-track striping artefacts occurring in the used bands have to be corrected. Suspended sediment concentrations measured by LIDAR and estimated from MODIS band 1 show a remarkably strong correlation, and the 250*250 meter spatial resolution shows fine patterns of local currents and eddies.

The successful test measurements and calibrations show that the UFL-8 LIDAR is suitable for quick surveying of high resolution maps of dissolved organics, chlorophyll and suspended sediment spatial distributions, which can be used as ground truth for calibrating satellite measurements. The high accuracy and spatial resolution of the instrument opens the possibility of quickly measuring large numbers of ground truth data during relatively short

expeditions.