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Comparing airborne LIDAR water surface heights with synchronous Envisat altimetry over Lake Balaton, Hungary

András Zlinszky (1), Philipp Glira (2), Eva Boergens (3), and Norbert Pfeifer (2)

(1) Balaton Limnological Institute, Centre for Ecological Research, Hungarian Academy of Sciences, Tihany, Hungary (azlinszky@gmail.com), (2) Department of Geodesy and Geoinformation, Vienna University of Technology, Vienna, Austria ([philipp.glira;norbert.pfeifer]@geo.tuwien.ac.at), (3) Centre of Geodetic Earth System Research, Deutsches Geodätisches Forschungsinstitut, München, Germany (eva.boergens@dgfi.badw.de)

Recent developments in satellite altimetry, including new sensors and new processing methods are leading to improving spatial resolution, allowing applications not only in the coastal zone but also over inland waters.
Validation of these sensors in the vicinity of the shore remains a challenge: in most cases, point measurements from tide gauges or GPS buoys are used for this purpose, if available. But the process of upscaling from a single or a few point measurements to the points of the radar altimetry footprint might be a source of uncertainty, which is poorly understood in the lack of area-covering altimetry data with higher spatial resolution. Meanwhile, airborne LIDAR has been proven capable of delivering accurate water surface height measurements rapidly over large areas, with accuracies in the centimeter range for single measurements and typical spatial resolutions of one measurement per square meter.
Here we compare airborne LIDAR measurements collected over the surface of Lake Balaton, Hungary with concurrent Envisat RA-2 satellite altimeter heights. Strip adjustment was used for improving relative and absolute georeferencing of the airborne LIDAR data strips, and intensity-based filtering used for removing the effect of specular reflection. Resulting height patterns were checked against a network of shore water level gauges.
Based on RA-2 sensor specifications, the exact area of each altimeter footprint was outlined and LIDAR data from the area weighted according to the sensor response function in order to interpolate comparable lake heights. Because of the smaller size of Lake Balaton it was necessary to retrack the altimetry data before further processing with a threshold-based retracker.
Within the expected accuracy of the satellite altimeter data, LIDAR is shown to deliver reliable lake surface heights, and also highlights the local-scale elevation patterns of the water surface. More importantly, the high spatial resolution and reliability resulting from the large number of measurements, together with the ability to use data exactly within the satellite altimetry sensor footprints suggests that LIDAR can deliver water surface altimetry data directly comparable with satellite altimetry and highly suitable for calibration and validation.