Measuring sea surface height with a GNSS-Wave Glider

Miguel Angel Morales Maqueda (1,2), Nigel T. Penna (1), Peter R. Foden (2), Ian Martin (1), Paolo Cipollini (2), Simon D. Williams (2), and Jeff P. Pugh (2)

(1) Newcastle University, United Kingdom (miguel.morales-maqueda@newcastle.ac.uk), (2) National Oceanography Centre, United Kingdom

A GNSS-Wave Glider is a novel technique to measure sea surface height autonomously using the Global Navigation Satellite System (GNSS). It consists of an unmanned surface vehicle manufactured by Liquid Robotics, a Wave Glider, and a geodetic-grade GNSS antenna-receiver system, with the antenna installed on a mast on the vehicle's deck. The Wave Glider uses the differential wave motion through the water column for propulsion, thus guaranteeing an, in principle, indefinite autonomy. Solar energy is collected to power all on-board instrumentation, including the GNSS system. The GNSS-Wave Glider was first tested in Loch Ness in 2013, demonstrating that the technology is capable of mapping geoid heights within the loch with an accuracy of a few centimetres. The trial in Loch Ness did not conclusively confirm the reliability of the technique because, during the tests, the state of the water surface was much more benign than would normally be expect in the open ocean. We now report on a first deployment of a GNSS-Wave Glider in the North Sea. The deployment took place in August 2016 and lasted thirteen days, during which the vehicle covered a distance of about 350 nautical miles in the north western North Sea off Great Britain. During the experiment, the GNSS-Wave Glider experienced sea states between 1 (0-0.1 m wave heights) and 5 (2.5-4 m wave heights). The GNSS-Wave Glider data, recorded at 5 Hz frequency, were analysed using a post-processed kinematic GPS-GLONASS precise point positioning (PPP) approach, which were quality controlled using double difference GPS kinematic processing with respect to onshore reference stations. Filtered with a 900 s moving-average window, the PPP heights reveal geoid patterns in the survey area that are very similar to the EGM2008 geoid model, thus demonstrating the potential use of a GNSS-Wave Glider for marine geoid determination. The residual of subtracting the modelled or measured marine geoid from the PPP signal combines information about dynamic topography and sea state. GNSS-Wave Glider data will next be validated against concurrent and co-located satellite altimetry data from the Jason-1, Jason-2, CryoSat-2 and AltiKa missions.