LIGHT GPS BUOYS FOR THE ENVISAT SATELLITE ALTIMETER CALIBRATION IN THE NW MEDITERRANEAN

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Abstract

A new system is described for the precise measurement of absolute sea level at open sea. It was designed to compare with observations by satellite radar altimeters, and has been used in the ENVISAT absolute range calibration. The system consists on two attached light buoys containing GPS antennas connected by coaxial cables to their receivers in a nearby small boat. Form April to October of 2002, 45 short cruises were performed along 400 km of the NW Mediterranean coast in simultaneity with ENVISAT overpasses.

Keywords: ENVISAT, Satellite altimetry, sea level, GPS, drifting buoys

We describe a newly designed system employed in the calibration of the ENVISAT radar altimeter, using a double GPS receiving system floating freely on the sea surface under the track of the satellite at the moment of the overpass. The sea level is measured at very high precision with reference to the WGS84 ellipsoid, and later compared with the satellite altimetry data. This was part of the joint participation of Institut d'Estudis Espacials de Catalunya and Institut de Ciències del Mar (Barcelona) in the activities coordinated by the European Space Agency during the ENVISAT calibration phase, under ESA contract No. 15349/01/NL/SF.

We designed a two-buoy rigid system with one GPS choke ring antenna each, attached to their corresponding receivers using impermeable low loss coaxial cable and a sustaining rope. The distance to the boat was around 40 meters to avoid possible reflections of the incoming signal on the boat structure, but not longer to avoid excessive signal loss along the cable.

The system was left to freely drift during 3 hours within 1 nautical mile of the nominal point, centred in the ENVISAT overpass, and acquiring two-frequency GPS data at 1 Hz. The boat was also drifting but keeping the possibility of a manoeuvre to avoid tension on the cable that could prevent the two-buoy system to exactly follow the free surface motion. The system oriented spontaneously parallel to the wave front, and its size allowed the antenna centres (the point exactly positioned by GPS) to be always at the same distance from the free sea surface. Careful measurements under controlled conditions (small pond and harbour) were used to precisely determine this distance (some 3.75 cm). Simultaneously to the open sea measurements, on land and near the shore, another fixed system equipped with one antenna and receiver, recorded reference GPS data in order to estimate the tropospheric delay. To avoid the error introduced on the reflected signal due to the differences between the scattering coefficients of the land and the sea surface, that could be both present in the foot print (1), the measuring points at sea were chosen at a 10 miles distance from the coast, under the satellite track.

The strategy was to cover 10 ENVISAT tracks (6 ascending night passes and 4 descending day passes) along 400 km of the NW Mediterranen Catalan coast, between 40º and 42º N. We selected 6 harbours and 10 ground sites for the land station, and hired small boats (between 7 and 12 meter long) to reach the measuring points. All were equipped with good navigation facilities and a cabin, where the receivers were safely installed and campaign notes could be taken.

During the six months calibration phase, from April to October 2002 starting one month after ENVISAT launch, 53 satellite overpasses took place in the study area, and 45 simultaneous GPS data acquisitions were achieved (85% success). The failures were due to equipment malfunctioning, logistic problems and mainly to bad weather conditions. 18 different people were involved in the operations, usually three on the boat and one operating the ground station.

The tight activity schedule, with one operation at sea every 3-4 days without interruption during 6 months, required a constant and careful maintenance at ICM. Work at sea, assembling and disassembling, and transportation by road can produce important stress to the different elements of the two-buoy system, the ground station and the GPS receivers. During all the experiment, we have maintained the system under two main scopes: a general and complete check before each mission, including the buoy water tightness, batteries charge, cables inspection and connectors condition. The second one included repair of the defective components or elements. It was necessary to do 18 repairing interventions, 6 of them on the buoy water tightness and 8 on the cable connections, meaning that 78 % of the maintenance had to be done on the elements of the system subject to the physical effort on the sea. In few occasions the GPS receivers had to be substituted due to malfunctioning.

All the data acquired in the 45 cruises were processed at IEEC, including the Precise Point Positioning technique (2), GIPSY/OASIS software and JPL products, and delivered to ESA that used them for the ENVISAT RA-2 range calibration within the so called regional approach in the whole NW Mediterranean, including different kinds of coastal and open sea measurements and modelling techniques (3).

References

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