Performance test of Topcon MC-4 (4-in-1) GPS receivers for use in seafloor geodetic studies

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One approach to measuring positions on the seafloor to centimeter-level precision (a requirement for geodetic studies) is to use a combination of GPS and underwater acoustics. The underwater acoustic component is accomplished by measuring the acoustic travel times between a suitable survey platform at the sea surface and at least three seafloor-mounted precision transponders. The GPS component depends on sampling three positions on the survey platform at a rate high enough to characterize the motion of the survey platform to centimeter-level precision while the acoustic measurements are being made. In the case of using a buoy for such a GPS/Acoustic survey, three GPS antennas are mounted on its surface. To keep the GPS cable lengths short, thereby minimizing the introduction of noise, the GPS receivers are also placed on the buoy. In previous studies, three Ashtech Z-Surveyor receivers were used with good performance. In an effort to reduce the size and weight of the buoy, however, it is necessary to have smaller and fewer devices.

Because of its small form factor (a 13 cm cube) and combination of four GPS receivers in one box with only one external power connection, the Topcon MC-4 is appealing. To evaluate its performance, we placed four GPS antennas (separated by about one meter) on the roof of a building and logged GPS data (P1, P2, L1, L2, and C1) for three days at a 1-second interval on each receiver in the MC-4. The GPS data were analyzed with the same precise-point positioning technique we have used in the past (GIPSY-OASISII). We found that for a four-hour span, the difference in estimated coordinates from one antenna to another was constant to within +-3 cm. In a second test, on a moving survey platform, the MC-4 was used in conjunction with four antennas on board the Japan Coast Guard ship Kaiyo. The antennas were mounted one meter apart on the top of a vertical pole attached to the fantail. GPS data were again logged for three days at a 1-second interval.

A preliminary check of the GIPSY solution was made at an interval of 120 seconds. Over a four-hour span, the difference in estimated coordinates from one antenna to another was constant to within +-4 cm. For comparison, typical repeatability of the Ashtech Z-Surveyor receivers on the buoy is +-1.5 cm.