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Performance of an autonomously deployable telemetered deep ocean seismic observatory

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We describe a transformative technology that can provide near real-time telemetry of sensor data from the ocean bottom without a moored buoy or a cable to shore. The breakthrough technology that makes this system possible is an autonomous surface vehicle called a Wave Glider developed by Liquid Robotics, which harvests wave and solar energy for motive and electrical power. For navigation, the wave glider is equipped with a small computer, a GPS receiver, a rudder, solar panels and batteries, AIS ship detection receiver, weather station, and an Iridium satellite modem. Wave gliders have demonstrated trans-oceanic range and long-term station keeping capabilities.
We present results from several deployments of a prototype system that demonstrate the feasibility of this concept. The system comprises ocean bottom package (OBP) and an ocean surface gateway (OSG). Acoustic communications connect the OBP instruments with OSG while communications between the gateway and land are provided by the Iridium satellite constellation. The most recent deployment of the OBP was off the edge of the Patton Escarpment some 300 km west of San Diego in 4000 m of water. The OSG was launched about 30 km west of San Diego harbor and programmed to navigate to the site of the ocean bottom package. Arriving after 161 hours, the OSG then commenced holding station at the site for the next 68 days. Speeds over-the-ground varied with wind, wave, and surface current conditions but averaged 0.5 m/s while winds varied between 0 m/s and 17 m/s and wave heights between 0.2 m and 5.9 m. Over this period the median total data latency was 260 s and the data loss less that 0.2% when the wave glider was within 1.5 km of the central point.
We have also tested a full-scale model of a towable ocean bottom package, which demonstrated that a wave glider could tow and navigate an autonomously deployable ocean bottom package.
Taken together, these tests have demonstrated that the concept is viable for long-term deployment as a high-seas seismographic station. The next generation will incorporate a towable OBP and a keel mounted rather than towed acoustic modem on the OSG. The longevity of the bottom package will be limited by its energy supply but at least two years is feasible while telemetering 1 sps data streams continuously plus an average of 1 hour /day of 40 sps data-on-demand. Biofouling is likely to be the limiting factor on the length of operation of a single OSG but a relief unit can be dispatched from a convenient port to take over operations.