**A Factor of 2-4 Improvement in Marine Gravity From CryoSat, Envisat, and Jason-1 Data**

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Marine gravity anomalies derived from satellite radar altimetry provide an important tool for assessment of sedimentary basin structure on remote continental margins. A wealth of new marine gravity data are being collected by three satellite altimeters CryoSat, Envisat, and Jason-1. With careful processing of the data, in combination with data from past Geosat and ERS-1/GM altimeter missions, we are in the process of improving the accuracy of the global marine gravity field by at least a factor of two and in some areas such as the Arctic, a factor of four. This work is funded by ConocoPhillips (COP), The National Science Foundation (NSF), and the Office of Naval Research (ONR). During this visit to COP in June 2012, we will deliver a new preliminary global gravity grid having an accuracy of better than 2 mGal in the Gulf of Mexico and somewhat lower accuracy in Arctic areas where there is seasonal ice coverage. COP has access to these products 6 to 9 months prior to their publication. We encourage a blind assessment of the accuracy of these data using proprietary shipboard data available at COP and welcome feedback on regions of the world to focus our analyses.

The accuracy of the global marine gravity field depends primarily on two factors - spatial track density and altimeter range precision. Current models, having accuracies of 3-5 milligals (e.g., S&S V18, DNSC08, GETECH), are based on the non-repeat data collected by Geosat (US Navy - 18 mo.) and ERS-1 (ESA - 12 mo.), which use altimeter technology from the 70’s and 80’s, respectively. The next major advance in mapping the marine gravity will come from new satellite altimeter measurements having dramatically improved spatial track density combined with improved range precision.

*Track Density*

Recently three new non-repeat altimeter data sets are becoming available. (1) CryoSat has been collecting data over the world’s oceans for the past 2 years and should continue to operate for another 5 years. While its main mission is to map the changing topography of the ice sheets it is also revolutionizing our understanding of marine gravity. We are part of the calibration and validation team at the European Space Agency to assess the quality of these data as noted in their recent press release <http://www.esa.int/SPECIALS/Cryosat/SEM037ZWD2H_0.html> . (2) In October 2010, the Envisat radar altimeter was placed in a new partly drifting phase orbit to conserve fuel. Although the spacecraft failed in April 2012, it was able to collect 1.5 years of data along this new ground track. (3) In April of 2012, the Jason-1 radar altimeter was maneuvered from its 10-day repeat track to a new 406 day repeat track to begin its new geodetic mission phase. We are currently constructing retracking software to process Jason-1 data.

*Range Precision*

The largest error source in the construction of marine gravity models from satellite altimetry is due to errors in picking the arrival time of the return radar echo. We have developed a new approach to retracking altimeter waveforms by assuming that rise-time parameter, which represents the roughness of the ocean surface from ocean swell (SWH), varies smoothly along the satellite ground track. The results of the 20 Hz range precision for all the non-repeat altimeters are provided in the Table below. Note the improved range precision of the newer altimeters on Envisat and CryoSat with respect to the older altimeters on Geosat and ERS-1. These improvements in range precision combined with the increased track density will result in dramatic improvements in the accuracy of the marine gravity field.

*Table - Altimeter Noise (mm)*

|  |  |  |
| --- | --- | --- |
| Altimeter | 2 m SWH | 6 m SWH |
| Geosat | 57.0 | 105.4 |
| ERS-1 | 61.8 | 111.8 |
| CryoSat | 42.7 | 71.7 |
| Envisat | 51.8 | 88.6 |
| Jason-1 | TBD | TBD |

Standard deviation of retracked 20 Hz height estimates for two significant wave heights (SWH). The data are from a region of the North Atlantic with relatively high sea state. The values represent the median of thousands of estimates over a 0.4 m range of SWH.