Summary of the Marine Geodesy, Gravity and Bathymetry Session

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There is a growing interest in the recovery of high-resolution gravity and bathymetry from non-repeat or swath altimetry. Multi-disciplinary results and applications of satellite-derived gravity were presented in two sessions: fifteen posters were presented on Tuesday March 14, followed by 6 oral presentations on Wednesday March 15. In addition, an informal discussion of plans for a new geodetic altimeter mission was convened in the evening of Wednesday March 15.

Geodesy

After years of slow progress, the field of global geodesy is providing exciting results from three new missions, *CHAMP* (2000), *GRACE* (2002), and *GOCE* (late 2006?). Papers in this session were focussed on the static part of the gravity field. The new EIGEN04 gravity model derived from these missions and terrestrial gravity data eliminates much of the meridional striping seen in earlier *GRACE*-dominated gravity models. Subtraction of this new model from an altimeter-derived sea surface reveals the dynamic ocean topography; the resolution is nearly sufficient to resolve the western boundary currents. These new models are an improvement over the EGM96 combined model and thus will provide an improved reference for higher-resolution marine gravity models derived from altimetry. The new global-scale geoid models also serve as a global vertical reference system. The community is preparing for the *GOCE* mission which will provide improved spatial resolution (~100 km) with respect *CHAMP* and *GRACE* suffieientto fully resolve western boundary currents, such as the Gulf Stream.

Marine Gravity

Although no new non-repeat orbit radar altimeter data have become available since ERS-1 geodetic phase in 1994-1995, several papers showed a nearly 40% improvement in gravity field accuracy due to retracking the raw altimeter waveforms, while other papers presented additional gains from careful blends of heterogeneous data. Comparisons with ship-gravity in the deep ocean shows the accuracy is now 3-5 mGal and the shortest ½ wavelength resolved is approaching the altimeter track spacing of 8 km from ERS-1. Local and regional geoids from blended solutions having errors approaching 2-3 cm were also presented. The Cryosat launch failure was a major setback for the marine gravity and geophysics communities because it would have provided a new global altimeter data set with dense track spacing but, more important, would have demonstrated the technology for the next generation of marine gravity measurements from altimetry. The participants are delighted that ESA will rebuild the mission. The laser altimeter aboard the Icesat satellite has provided new gravity information in those parts of the Arctic Ocean where permanent sea ice closely conforms to the shape of the geoid. Further improvements in the accuracy and resolution of marine gravity would provide important contributions in both scientific and practical studies such as locating 50,000 uncharted seamounts in the deep oceans or exploring the offshore sedimentary basins for oil. Other applications include: mapping the details of plate tectonic fabric, planning shipboard surveys in remote areas, and improved inertial navigation of aircraft and ships.

Bathymetry

Ocean bathymetry is best measured by multibeam sonars aboard ships but only a small fraction of the global ocean basins have been surveyed and it is estimated that it will take 125 ship-years to survey the deep oceans. Several papers discussed the prediction of seafloor topography in the 20 to 160 km wavelength band using the new altimeter derived gravity models. The remaining problems are calibrating the gravity to topography ratio in areas of thick sediment cover and downward continuation of the gravity field without amplifying the noise at shortest wavelengths. The need for improved global bathymetry is critical since it is foundational data for many fields including: tsunami propagation/hazard models, hydrodynamic tide models/tidal friction, ocean circulation models, models of seafloor tectonics, identification of linear volcanic chains, defining the 2500 m isobath for the law of the sea, and fisheries management.

Planning for a New Mission

Several papers discussed the needs and opportunities for a new non-repeat satellite altimeter mission. It was demonstrated that a non-repeat orbit altimeter can also contribute to the resolution of mesoscale eddies although the degree of this contribution is unknown because the 100-km scale errors in the mean sea surface are not well characterized. We held an open evening session to discuss European and US plans for the next generation of altimeters for gravity field recovery. Smith, Sandwell and other US investigators will continue to promote a new mission in the US through the National Research Council and NASA. European colleagues propose to form a similar study groups to

investigate the opportunities at CNES and ESA for an altimeter gravity mission. Louis Geli, Ole Anderson, Marie-Francoise Lalancette, Jean-Yves Royer, and Marcia Maia are leading this effort. The CNES AltiKa instrument may be a low-cost and ready-to-hand solution, and swath imaging systems could also be studied.