Geophysical applications of radar altimeter data
– A case study of Drake Passage, Antarctica

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Summary: In this study, we investigated geophysical applications of Geosat altimeter data. Applications include determining geoid undulations and free-air gravity anomalies of the Drake Passage, Antarctica. We implemented new algorithms to enhance S/N ratio, and compared our results with the other global data sets and shipborne surveys to estimate the feasibility of our approach

Data and Methods

In March 1985, the US navy satellite Geosat was launched into an 800km altitude above sea level, nearly circular orbit with an inclination of 108°. It has 2 missions, GM(Geodetic Mission) and ERM(Exact Repeat Mission). We used GM data for this study. In addition, we used Sandwell's global free-air gravity anomalies and shipborne gravity measurement of R/V Onnuri, KORDI. Shipborne data were collected at the location of -58.5°W~-55.5°W longitude and -62°S~-59.95°S latitude. Its precision is 0.01mgal

We implemented co-linear track analysis to improve S/N ratio. We applied FFT to perform wavenumber correlation analysis on adjacent two tracks. After this, we obtained stable and highly correlated signals(geoid undulations).

Calculation of free-air gravity anomalies from geoid undulation is defined as below.

$$\Delta g = -\frac{\partial(N\gamma)}{\partial r} - \frac{2(N\gamma)}{R}$$

Where N, γ, *and* R denote geoid undulations, normal gravity from international gravity formula, and mean radius of the earth (6,371km), respectively. finally we used GMT(general mapping tool) modules SURFACE and GRDTRACK to compare our result with shipborne survey.

Key words: Geosat, satellite radar altimetry, Drake Passage, Antarctica

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Results and Discussions

1) We extracted geoid undulations and free-air gravity anomalies from radar altimeter data. Geoid undulation from this study and another studies has very high statistical correlation coefficient about 0.9 (Table 1.).

2) Altimetry-implied free-air gravity anomalies coincide with shipborne survey well. and used as reference data for adjusting shipborne surveys very effectively (Fig. 3, 4, and 5).

3) Altimetry-implied free-air gravity anomalies and shipborne gravity anomalies show good correlation with bathymetry

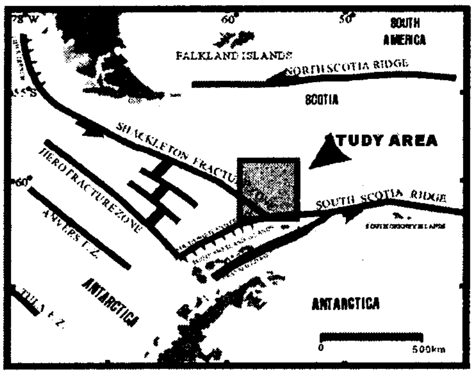

Fig. 1 Generalized tectonic features of Drake Passage (modified from Jeffers and Anderson, 1990).

	This study	Sandwell	OSU91A	EGM96
This study	1.0	0.899	0.908	0.907
Sandwell	0.899	1.0	0.987	0.986
OSU91A	0.908	0.987	1.0	0.993
EGM96	0.907	0.986	0.993	1.0

Table 1. Statistical comparison of geoid undulations.

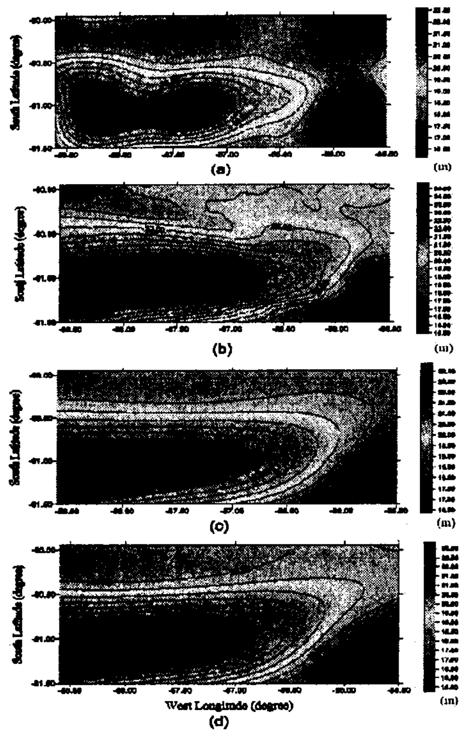

Fig. 2 Comparison of geoid undulations from (a) this study, (b) Sandwell's, (c) OSU91A, and (d) EGM96 model.

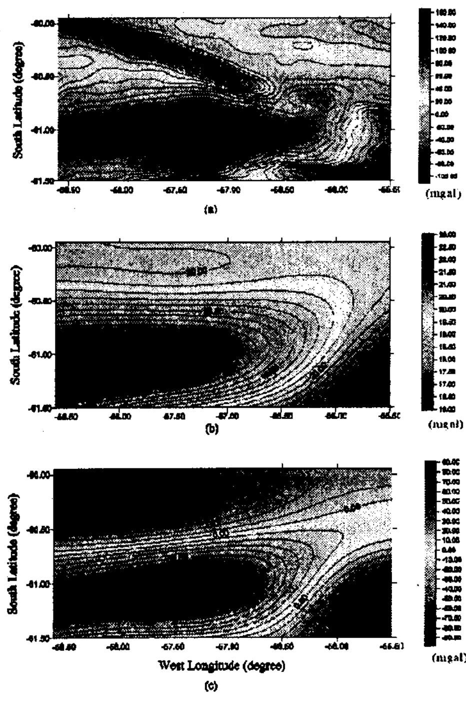

Fig. 3 Comparison of free-air gravity anomalies from (a) Sandwell's, (b) OSU91A, and (d) EGM96 model.

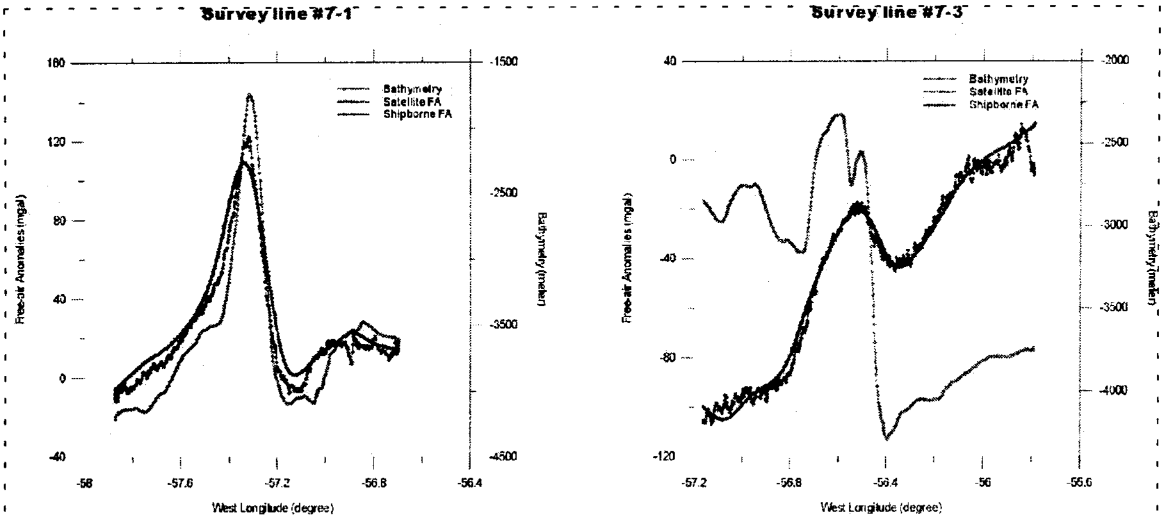

Fig.4 Profiles of bathymetry(green), satellite (red), and shipborne free-air gravity anomalies (blue) along survey line 7-1 and 7-3.

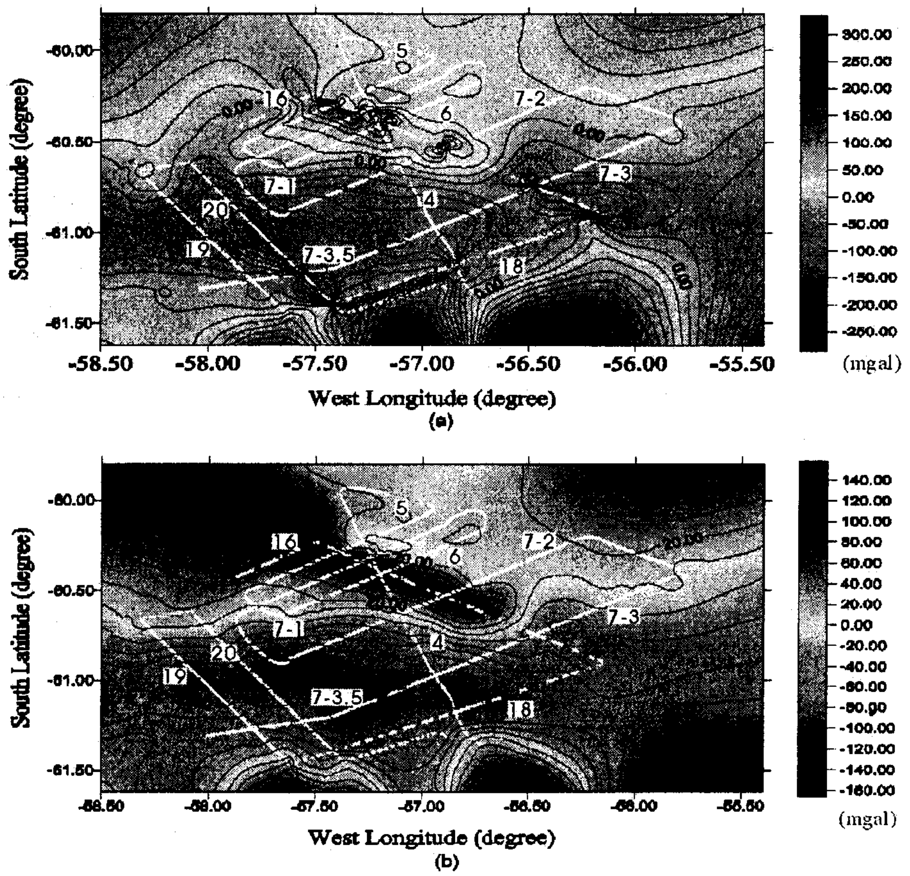

Fig.5 (a) Before and (b) after adjusted shipborne free-air gravity anomilies along survey lines.