Session 5

Gravity

05-01

Preliminary Results of the Absolute Gravity and Superconducting Gravity Observation in China for APSG

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ABSTRACT

The observation of gravity change and is study are the component part of APSG project, which can be used for: 1) testing the vertical crustal movement in active tectonic areas, e.g.. Hingham-Tibet region; 2) monitoring the gravity field changes related to the earthquake; 3) combining with GPS and tide gauge data to separate sea level changes and vertical crustal movement; 4) establishing the absolute datum of relative gravity network.

The repeated absolute gravity measurement is an important means for checking the gravity changes. This paper reports the results of absolute gravity measurements at 20 new stations and repeated observations at 13 old ones in recent years in China, and the accuracy and reliability in field campaign for new FG5 meter, in the meantime, the effect of atmospheric pressure and rainfall on the results is discussed. After the analysis to the results of 13 repeated observation stations, it is indicated that no significant discrepancies appears in comparison with the former determinations given by JILAG-3, JILAG-5 and FG5 meters at most stations. But we found out that 1) the gravity decreases about 2-3 μ gal at Lhasa station due to the uplift of Qinghai-Tibet plateau, which is consistent with the results obtained from the relative gravity measurements between Lhasa and Chengdu in the past ten years, 2) 15 μ gal gravity variations at Lijiang station before and after the 1996 Lijiang earthquake (Ms=7.0), this change is also verified by the measurements of Lijiang relative gravity network. To interpret the gravity changes before and after earthquake, the expected gravity changes caused by co-seismic dislocation of this event was calculated.

Superconducting gravimeter at Wuhan has participated in the work of GGP plan (1997-2003). Because of the upgrading of our SG meter and improvement of station condition, observation noise decreases greatly. Besides the determination of NDFW period, SG data at Wuhan is also used to the test of examining Slichter core mode (Smylie et al. 1999), and the attempt of separating the mass variation inside of sea level changes.

05-02

The CHAMP Geopotential Mission and First Preliminary Results

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ABSTRACT

The German geopotential and atmosphere sounding mission CHAMP was successfully launched on July 15, 2000 from the Russian cosmodrome Plesetsk into a 455 km altitude, near polar orbit. After an initial attitude stabilization, instrument switch-on and overall system technical commissioning phase, the satellite is flying stable in nominal attitude and is producing almost continuously science and housekeeping data since July 28, 2000. Data from the NASA-provided GPS Blackjack receiver, the CNES-provided STAR accelerometer, the laser retroreflector, the scalar- and vector-magnetometers, the star sensor package and the AFRL-provided Digital Ion Drift Meter are being analysed in detail by the CHAMP Project Team by a combined processing to determine adaptation coefficients and calibration parameters, to verify the performance and precision of the instruments and to establish and test the most appropriate and efficient pre- and post-processing procedures. The presentation will give latest results on the CHAMP overall system status, will describe the activities and achievements obtained in the course of the just finalized Commissioning Phase and will provide details and plans for the next future in using CHAMP data for various applications.

05-03

Secular Variations in the Earth's Gravity Field and Its Geoscience Application

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ABSTRACT

The secular variations in the lower degree and order ($n < 9$, $m < 6$) coefficients of the Earth's gravity field were determined by analyzing satellite laser ranging (SLR) and DORIS observations from multiple satellites spanning an interval of over 25 years. The readjustment of the Earth to glaciation, including, the postglacial rebound, and the mass balance of the glacial and polar ice sheets are the primary effects which cause the observed secular changes in the Earth's gravity field. Thus, the secular variations in the Earth's gravity field derived from long-term satellite laser ranging (SLR) data are especially important for the study of the mantle viscosity contrast effecting the postglacial rebound and mass balance of polar ice sheets. The odd degree Jn dot, in particular, J3 and J5 rates, are capable of distinguishing the total mass change in Antarctica and Greenland in a forward solution. The observed signature of J3 rate suggests that the ICE-3G model for the distribution and melting history for ice sheets since the Last Glacial Maximum (LGM) may over estimate of the present mass balance of polar ICE sheets. A forward solution from satellite results indicate that the contribution to sea level changes could be approximately 0.8 and 0.2 mm/year from the Antarctica and Greenland, respectively, based on the earlier ice model: ICE1A. Acknowledgments: This research was supported by the National Aeronautics and Space Administration under grants NAG5-9989 and NGA5-5710.

05-04

Mantle Tidal Shielding

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ABSTRACT

Magnetic torques exerted on the highly conductive inner core have shown the tendency to move the inner core off its alignment with the figure axes of the mantle, resulting in the inner core differential rotation and relative polar motion. As a result of these relative motions, a tidal force (gravity) is created in the mantle from the core. The gravity signal on the surface due to the relative motions of the inner core is modified by the deformation of the mantle. The mantle and the core in this internal tidal problem are mechanically decoupled in the sense that the thermally and compositionally driven geodynamo in the outer core is mostly independent from the mantle deformation. An appropriate approach to this problem is to treat the mantle as an elastic shell passively deformed due to the pressure variation at the CMB and the tidal force from the core as well. We define the tidal Love numbers based on the surface gravitational potential of the core, similar to the conventional tidal Love numbers. These new Love numbers crucially depend upon the pressure variations at the CMB. We demonstrate by direct calculations that the vertical and gravity Love numbers remain negative for a wide range of CMB pressure variations. In particular, the degree 2 gravity Love number can reach the value of -1 at a substantial pressure drop, meaning that the surface gravity signal due to the relative motion of the inner core is completely canceled by the deformed mantle. In order to obtain a dynamically consistent model of this mantle "shielding", we apply a pressure distribution at the CMB from the self-consistent, fully nonlinear dynamo model of Kuang and Bloxham (1997). We then evaluate the tidal Love numbers based on the PREM elastic Earth together with the pressure variations. We conclude by discussing the detectability of the relative motion of the inner core through the time variation of satellite gravity.

05-05

The Regularization Methods of Recovering the Geopotential Model of From Satellite to Satellite Tracking Data

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ABSTRACT

This paper discusses three regularization methods of recovering the geopotentoal model from satellite to satellite tracking data. The first is the common used Tikhonov regularization method, the second is the regularization method constraint to Kaula' s rule and the third is a multi-parameter regularization methods. The regularization parameter is computed based on the criteria of minimizing the mean square error, which needs to know the prior value of the parameters to be estimated. The simulated computation of recovering the geopotential coefficients up to degree and order 54 has been done with the simulated ephemerides of CHAMP. And the results show that the first method hardly improve the accuracy, but the second method can significantly improve the accuracy of the recovered coefficients and the third method is more sensitive to the prior values of the parameters to be estimated.

05-06

High Resolution Bathymetry of China Seas and Their Surroundings

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ABSTRACT

The digital bathymetric map and model is the important basic data for the study of oceanography, marine geology, marine geophysics and ocean biology. The construction of the conventional bathymetric model mainly used the procedures and techniques of single-beam echo sounders, that only provide the sparse ocean depth data. Since 1980s, the multi-beam swath mapping techniques have been come into use on some ship for the high resolution and accuracy bathmetry. However, the enough data for mapping and constructing the high resolution bathymetry have not yet obtained. Currently, the popular bathymetry mode used in the Geodesy, marine geology and marine geophysics field is ETOPO5,what is built by the single-beam echo sounders, and only shows the medium and long wave characteristics of bathymetry. In recent 10 years, with the advent of satellite altimetric technique, a lot of high accuracy and resolution altimeter data have been obtained. The reversion of high resolution bathymetry from altimeter-derived gravity anomalies becomes possible, and it provides a new means and technique for constructing the bathymetric model. Since 1980s, this study have been attracted great attention. Up to now, the high resolution bathymetry over open seas have be obtained from multi altimeter-derived gravity anomalies.

Based on the oceanic lithospheric flexure and the worldwide bathymetric data ETOPO5, the high resolution Bathymetry of the China seas and their surroundings is computed from altimeter derived gravity anomalies. The new bathymetry obtained by this study is higher resolution and accuracy than the widely used ETOPO5 data, meanwhile it show clearly the seafloor, the tectonic characteristics and the geodynamical processes in China seas.