Geophysical Research Abstracts, Vol. 9, 02033, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-02033

Geodesic and geophysical models for Deception Island (Antarctica)

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Abstract

Deception Island, located in the South Shetland Islands near to the Antarctic Peninsula, is one of the two active volcanic areas in the Antarctica. After its last eruptions in 1967, 1969 and 1970 which caused serious damage to the scientific stations there, the only research bases have been run by Spain and Argentina. So, scientific groups from these countries have been carrying out, since 1988, a vigilance of the volcanic and tectonic activities on the island by means of geodetic and geophysical techniques, in such a way that two important volcanic crisis were recorded in December and January, 1991, and in January and February, 1999. The purposes of these scientific activities are to obtain superficial deformation models of the caldera and to control the state of the volcano. The evaluation of this surface deformation is made by analyzing the horizontal and vertical deformation models obtained from GPS observations. Although the horizontal deformation models are totally described by these measurements, the lack of physical meaning of the ellipsoid heights makes necessary to establish a physical and mathematical reference frame, the geoid, in order to calculate the existing vertical deformations. Thanks to this surface, the orthometric height is calculated through the geoid undulation and the ellipsoid heights making possible to study the deformation of the island. Other remarkable application of the geoid to this area is to be able to carry out levelling measurements by means of GPS receivers, which would be an useful way of obtaining vertical deformation during a volcanic reactivation instead of using classical levelling methods. For this geoid computation, it has been necessary a complete set of data consisting of GPS observations, levelling data and gravimetric measurements. BERNESE v4.2GPS Software was used to obtain a relative position of the GPS network formed by twelve stations; the levelling network consists of fifty-

seven benchmarks divided into six independent levelling lines whereas the gravimetric data were collected during the 2002-2003 campaign from the different points of the geodetic net, the levelling points and other points to make the net denser. Moreover, all these data make possible obtain the free-air and Bouguer anomaly maps with a 2.63 gcm-3 Bouguer reduction and the teluroid. The combination of GPS measurements and high-precision levelling also yields information on the inclination of the geoid relative to the WGS84 ellipsoid (absolute deflections of the vertical) with good accuracy. Finally, the determination of this mean sea level surface which will be useful to fit the high degree geopotential models EGM96 and OSU91A in this area of the Antarctica. In fact, both models differs from the GPS/levelling geoid height an average of 28 cm and 15 cm respectively, what shows they fit properly in the area.