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DORIS as a potential part of a Global Geodetic Observing System

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Abstract

We have processed all available DORIS data from all available satellites, except Jason-1 over the past 10 years (from January 1993 to April 2003). Weekly solutions have been produced for stations positions coordinates, geocenter motion and scale factor stability. We present here accuracy presently achievable for all types of potential geodetic products. Typically weekly stations positions can be derived with a repeatability of 1.0–1.5 cm using data from 5 satellites simultaneously, showing the significant improvement in precision that has been gained recently using the additional new DORIS satellites. As an example, we show how such new results can detect displacement from large magnitude earthquakes, such as the 2003 Denali fault earthquake in Alaska. Displacements of −5 cm in latitude and +2 cm in longitude were easily detected using the DORIS data and are confirmed by recent GPS determination. The terrestrial reference frame was also well be monitored with DORIS during this 10-year period. Other geodetic products, such as tropospheric corrections for atmospheric studies are also analyzed. Finally, we discuss here the possible advantages and weaknesses of the DORIS system as additional geodetic tool, in conjunction with the already existing GPS, VLBI and SLR services, to participate in an Global Geodetic Observing System (GGOS).

Keywords: Geodesy; DORIS; Terrestrial reference frame; Earthquake; Denali fault; Fairbanks; Troposphere

1. Introduction

For more than 10 years, DORIS has been successfully used for precise orbit determination (POD) (Jayles et al., 2002) but also for geodetic and geophysical applications, such as stations velocities determinations (Soudarin and Cazenave, 1993; Cazenave et al., 1994; Crétaux et al., 1998; Soudarin et al., 1999) or monitoring of the geocenter motion (Bouille et al., 2000). More recently, three new DORIS satellites have been launched: Jason-1 on December 7, 2001; ENVISAT on March 1, 2002 and SPOT-5 on May 4, 2002. This doubled the number of available DORIS satellites, as SPOT-2, SPOT-4 and TOPEX/Poseidon still continued to operate on a continuous basis. Furthermore, these three satellites are equipped with a new type of DORIS allowing a better signal-to-noise-ratio and allowing them to observe two ground stations simultaneously using its newly developed dual-channel receiver (Tavernier et al., 2003). The goal of this paper is to investigate how this additional number of more precise DORIS data improve the current

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geodetic results. We have then investigated how useful DORIS could be as a possible part of a more general Global Geodetic Observing System (GGOS) that is currently being established (Beutler et al., 2002; Rummel et al., 2002) using the already existing geodetic services, such as the IGS for GPS (Beutler et al., 1999), the IVS for VLBI (Schlueter et al., 2002) and the ILRS for laser ranging (Pearlmann et al., 2002).

2. The DORIS permanent tracking network

Since the very beginning of the DORIS system (Dorrer et al., 1991), the DORIS network has been considered as an important factor of success of the system. It ensures an almost continuous visibility of the Low Earth Orbiting (LEO) satellites at different altitudes: 87% for ENVISAT (800 km), 88% for SPOTs (830 km) and 98% for TOPEX/Poseidon and Jason (1330 km), for elevation above 12°. This is a very positive aspect of the DORIS system and one of the reason why it has been selected for precise orbit determination of several altimetric missions, such as TOPEX/Poseidon, Jason-1 and ENVISAT for which a 1-cm radial accuracy is now clearly the goal (Haines et al., 2003, 2004; Luthcke et al., 2003).

The Institut Géographique National takes care of the installation and of the maintenance of this network (Fagard, 2004). Key elements in the selection of DORIS sites are the geographical distribution and the geodetic collocations with other techniques (SLR, VLBI, GPS, GLONASS, tide gauges, or absolute gravimeters). Fig. 1 displays the exact location of the DORIS tracking stations as well as an indication on the total observation data span.

This tracking network of 56 stations has been extremely stable with time. Out of the total 68 stations, 39 stations have observed 10 years or more, 11 stations have observed between 5 and 10 years and only 18 stations have observed less than 5 years usually during campaigns. Furthermore, the equipment itself is very stable: there are only two types of antennas and the instruments changes are very rare (Tavernier et al., 2002).

The DORIS permanent tracking network is then totally suited for any long-term investigation for geodesy, geophysics or atmospheric sciences.

3. DORIS weekly solutions

We have processed all available DORIS data at CDDIS, from January 1993 to April 2003 using the Gipsy/Oasis II (GOA) software developed at the Jet Propulsion Laboratory (Willis, 1996). We have processed these 10 years of data

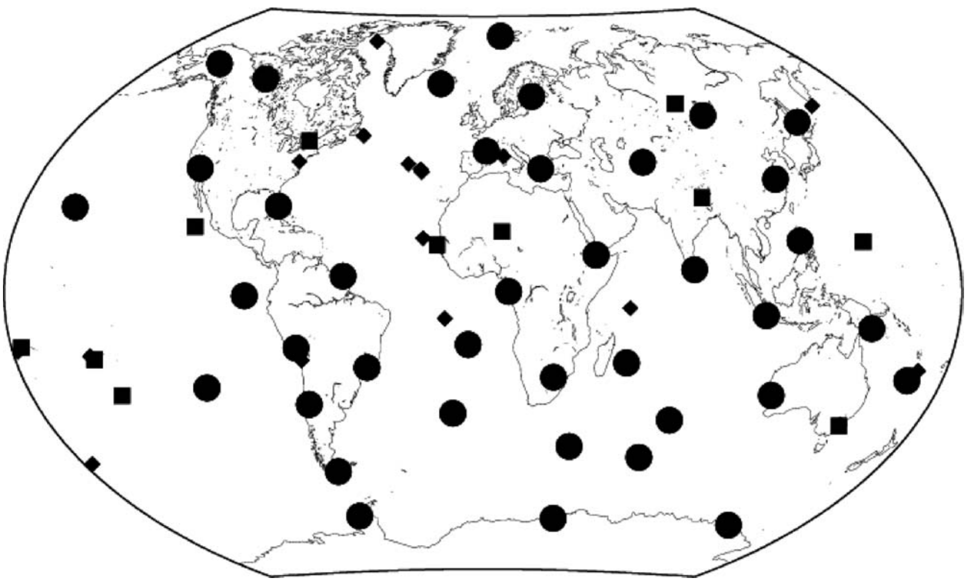

Fig. 1. Permanent observation of the DORIS network. From January 1993 to April 2003. Stations with more than 10 years of observations are represented with large dots (39). Stations with more than 5 years but less than 10 years of observations are represented with squares (11). Stations with less than 5 years of observations are represented with diamonds (18).