PARTICIPATION OF LEGOS-GRGS AND CLS AS AN ANALYSIS CENTER IN THE FUTURE IDS

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RÉSUMÉ – Le LEGOS-GRGS et CLS procédent au traitement des données DORIS depuis le lancement de Spot-2 en 1990 qui embarque à son bord le premier instrument DORIS. Ces deux entités analysent les données fournies par le système pour des objectifs scientifiques dans le domaine de la géodésie, de la géophysique et de l'océanographie spatiales. Le LEGOS-GRGS qui est Centre d'Analyse de l'IERS depuis 1994, souhaite naturellement poursuivre cette activité dans le cadre de l'expérience pilote préparatoire à la mise en place du Service International DORIS. Elle s'associe pour cela à CLS qui a en charge l'exploitation opérationnelle du système. Ce papier présente la procédure de traitement des données et les produits générés par le logiciel GINS/DYNAMO.

ABSTRACT - LEGOS-GRGS and CLS have been involved in DORIS data processing since the launch of Spot-2 in 1990, the first satellite with DORIS onboard. LEGOS-GRGS and CLS are in charge of the scientific analysis of DORIS data in the field of geodesy, geophysics and space oceanography. LEGOS-GRGS being a DORIS Analysis Center for IERS since 1994, will naturally carry on this activity in the frame of the Pilot Project on "International DORIS Service" (IDS) with the support of CLS which has a strong experience as a system operator. This paper presents the data processing procedure and the products generated with the GINS/DYNAMO software.

1. INTRODUCTION

LEGOS-GRGS (Laboratoire d'Etudes en Géophysique et Océanographie Spatiale – Groupe de Recherche en Géodésie Spatiale) has been regularly analysing DORIS data since early 1990 for scientific purposes. It performs location of the stations of the permanent network to measure large scale tectonic motions [*Crétaux et al.*,1998], vertical crustal motions [*Soudarin et al.*, 1999], [*Cazenave et al.*, 1999], [*Mangiarotti et al.*, 2000], geocenter variations [*Bouillé et al.*, 1999] …
As a DORIS Analysis Center for the International Earth Rotation Service (IERS) since 1994, LEGOS-GRGS has submitted several positions and velocities solutions contributing to the

realizations of the International Terrestrial Reference System : ITRF94, ITRF96, ITRF97, and the forthcoming ITRF2000. It was also done for earth orientation parameters (EOP).

CLS (Collecte Localisation Satellite) is responsible, on behalf of the French space agency CNES, for the day-to-day operation of the DORIS instruments in service on SPOT 2, SPOT 4 and TOPEX/POSEIDON. This includes:
- generating and uplinking commands to the satellites
- receiving and processing the data.

CLS also monitors all elements of the DORIS system, such as the station network and the DIODE navigator. It generates and distributes location and orbit determination data within 48 hours.

Both entities intent to participate tightly to the IDS start-up, and propose their contribution as an Analysis Center. In that aim, they join their effort to regularly process the DORIS data and provide products required by the IDS.

2. DATA PROCESSING

Processing of the DORIS data is performed using the GINS/DYNAMO software developed at GRGS for precise orbit computation. The method of analysis is a dynamical one which consists of computing the satellite's orbit, beacon positions and velocities, and Earth orientation parameters, in a single inversion, together with a number of selected parameters required to improve the acceleration model and corrections to the measurements. The acceleration model includes geopotential, lunisolar, and planetary accelerations, atmospheric drag, solid Earth and ocean tides, direct and Earth reflected radiation pressure, and relativistic acceleration. For the wet tropospheric and the ionospheric corrections, the CNET1 model [*Berrada-Baby et al*., 1987] and dual-frequency measurements were used, respectively. Corrections due to Earth tide and ocean tide loading were applied to the a priori coordinates of the stations.

Orbit computation is performed on a daily basis for SPOT-2, SPOT-3 and SPOT-4, and on 3-day arcs for TOPEX/Poseidon. This choice is based on orbital considerations. The SPOT satellites at 830 km altitude have their orbit more precisely determined using daily arcs because of atmospheric drag. For TOPEX/Poseidon at a higher altitude (1330 km), tests have shown that the optimal arc length is about 3-day, a value which improves polar motion determination. For each basic orbital arc, normal equations for station positions and velocities and EOP are constructed. The orbital parameters are then backsubstituted, and the normal equations are accumulated over a monthly or multiyear basis. Inversions of the normal equations are then performed and solutions (positions and velocities of the DORIS beacons) derived. Velocities are solved in the multiyear inversion.

Along the years, various evolutions have been brought to the computation strategy which allowed improvement of orbit determination, positioning performances, and pole position estimates. The main recent evolutions are the use of :

- atmospheric density model DTM94,
- gravitationnal effect on the orbit and loading effect on the station due to the atmospheric pressure,

- laser data on TOPEX/POSEIDON.

Moreover, evolutions have been brought to the software which offers the possibilty to estimate parameters relating to the monthly variation of the geocenter.
For the processing of the 1999's data, we used in addition the new geopotential model GRIM5 [*Biancale*, 2000] with its associated ocean tide model and a revised positions and velocities set. For the DORIS stations, initial coordinates and velocities are taken from the most recent solution based on the analysis of the SPOT2, SPOT3, SPOT4 and TOPEX/POSEIDON over 1993-1998. For the laser stations, they were derived from the reference system solution determined simultaneously with the GRIM5 gravity field.
All these strategy evolutions added to software improvements have led to a significant gain of the performances and, in that way, we plan to apply the last modelisation to the analysis of the whole data over 1993-1998.

3. PRODUCTS

The products generated with the GINS/DYNAMO software are as following:

- precise ephemerides of all satellites having DORIS onboard;
- earth orientation parameters;
- station network coordinates and velocities;
- geocenter coordinates and low-degree harmonics of the Earth's gravity field;
- environmental data.

Coordinate sets are determined on monthly and multi-year basis for each satellite and for a combination of all the satellite. Weekly solutions could be also performed. Station velocity determinations are based on the whole data (multi-satellite and multi-year solution). Through the laser tracking data on Topex-Poseidon, positions and velocities of the SLR stations can be estimated simultaneously with those of the DORIS beacons. Position and velocity solutions can be provided in a SINEX format.
Daily values of the earth orientation parameters are given from the data of all the satellites.
Environmental data are correction factors adjusted on each orbital arc (drag, solar pressure, frequency bias, tropospheric bias...)

The basic products may be completed at some specific occasions; for example analysis of ionospheric corrections during a strong solar activity period or calculations for geophysical investigations on a DORIS temporary site (see Vincent et al. 2000).

4. CONCLUSION

With the support of CLS, LEGOS-GRGS will be capable of computing and delivering these products regularly, without interruption and with the IDS required time lag. Developments are being done to get the processing more operationnal, from the data and environmental input acquisition to the computing validation.

A web site is currently being developped to provide information relative to the products performed by the Analysis Center. It will provide various graphic outputs such as position time series, plots and statistics of the estimated coefficients (coefficient drag, solar radiation, frequency bias, tropospheric bias...). It will also include informations on the day-to-day system operations from the DORIS Control and Processing Center (daily reports, lists of events, data calendar, meteorological data...), and informations about the modelisation and processing.

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