Status of the GRGS Analysis Center

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Abstract

Mid-july 2016, the whole system of IMCCE-GRGS in Paris Observatory severely crashed down, and a large part of analysis activities were affected for a while. As a consequence, the operational analyses and the contributions to the pilot projects from GRGS disappeared from the combination and the products delivered by the Analysis Steering Committee (ASC) of the ILRS. Two years later, thanks to the continuous support of the ILRS and from CNES and GRGS, the GRGS AC is operational again, and led by the authors.
We draw in this poster a quick assessment of the recovery of the GRGS Analysis Center, that is about to become again an official Analysis Center of the ILRS, once the new results are approved by the ASC. We take the opportunity to summarize the main updates of the new analysis scheme compared to the previous one, and we give here the headlines of the story that affected the french operational analyzes since two years. In particular, we show the results obtained with ITRF 2014 from Lageos-1 and Lageos-2 data sets acquired by the ILRS network, with a particular attention on the periode 2015-2018.
As GRGS results are also provided following the "VO-table format", this poster presents as well the astronomical so-called Virtual Observatory (VO), and gives some examples of Webservices hosted by GRGS website. We pay a particular attention on the capabilities suitable to extract and use time series of (i) Space Station Coordinates deduced from SLR, DORIS and GPS data sets, (ii) EOP deduced from SLR and VLBI data. We show how to use all these on-line tools through the web to: select charts to plot, display and edit the data (scale, appearance) ; download data, plots and graph statistics in several formats. The examples are based on some stations of interest with coordinates (latitudes, longitudes, altitudes) affected by several features such as earthquakes or technological evolutions.

1. Headlines of the GRGS ILRS (former/future) Analysis Center

History of the GRGS ILRS AC:

- 2000: GRGS/Toulouse (R.Biancale et al.) contributes to the AWG but not on a regular basis
- 2005: F.Deleflie gets a fix position as an astronomer
- 2005-2010: GRGS/(OCA) is a new official ILRS AC, using the Gins/MATLO s/w package.
- 2010: F.Deleflie leaves OCA and joins PO/IMCCE (GRGS/OP)
- 2012: the location of OCA/Grasse is closed, and F.Deleflie sets up of a new architecture for the GRGS AC on the IMCCE/OP IT : the Gins/locomotiv s/w package is now used
- 2015, june : GRGS contribution disappears from the ILRS combination for a couple of days, because of a catastrophic upgrade of the IMCCE IT
- 2015, autumn: the whole IMCCE IT is hackered, and some historical functionalities (internal, and of the website) are definitively lost,
- 2016, july, and then november : the whole IMCCE IT crashes down, and it is realized (wih horror) that no full back-up is available...
- summer-autumn 2017: a (partial) back-up is resumed:
  - thanks to a new executive team which puts the whole situation right again concerning all issues within IMCCE
  - a new IT manager
  - a new IT architecture, fully documented, and robust. Back-ups correctly parameterized
  - what was lost with the 2016 crash is partially recovered, as of December 2015: some scripts can be recovered, but other ones still need to be rewritten from scratch (independently from the Gins/locomotiv packahe that is correcly set up again)

Current status of the GRGS ILRS AC:

It appaears that some basic steps required much more time than originally expected to be fully operational again. Many steps of the analysis scheme are ready to be operational again, but some work was still required up to very recently to be able to be (robustly) operational again (i) on a weekly basis, (ii) on a daily basis, (iii) for the pilot projects, (iv) and the re-analysis projects over the whole period where SLR data are available, such as the new ITRF computations.

The team and the s/w package:

- Team: Florent Deleflie, D. Coulot, A. Pollet, F. Reinquin, A. Sammuneh, M. Gastineau (IT service)
- SLR Data analysis: A new dedicated storage and computation space of the IT IMCCE system: dedicated machines.
- GINS-17 / and LOCOMOTIV 2017 package correctly set up.
- Changes of paths within the operational scripts almosty completed
- A financial support for 2017-2018 by our scientific and administrative authorities. But the full results over 2017-2018 to be sent ASAP to the combination centers to de declared again as an official analysis center ASAP.

The projects:

- be back ASAP in the list of the official operational ACs of the ILRS
- ITRF2014 implementation; new format of the TRF in GINS, automatically upgraded (including eccentricity and data handling files) and robustly documented, new scripts for the generation of the SINEX
- By the end of the year: Parallelization of the operational scheme in IGN/LAREG.
- Taking part again of all the PPs of the ASC.

2. First new results of the GRGS ILRS (former/future) Analysis Center

The following figures show the results carried out on 5 years, over the period 2012.0-2017.0, for the two LAGEOS satellites. They show the rms on the weekly orbit arcs, the number of NPs kept in the orbit computation step, and the percentage of these kept NPs w.r.t. the total number acquired by the tracking network.
The results of two modes are shown:

- (i) full data set of NPs acquired by the tracking network, and computed using GINS 17.1 and ITRF2014.
- (ii) data sets simulated with GINS 15.2.2, ITRF2014, and with a level of noise considered as realistic: The NPs RMS level is estimated from the range bias values provided four times a year by T. Otsubo (downloaded from ILRS website) ; the mean range bias per station is computed four times a year from the weekly values provided by Appleby et al. (2016) and obtained from a single value obtained from the two Lageos, with removal of an annual signal estimated before estimating the mean value.

Figure 1: *LAGEOS-1: operational mode (i)*

Figure 2: *LAGEOS-1: simuation with realistic noise (ii)*

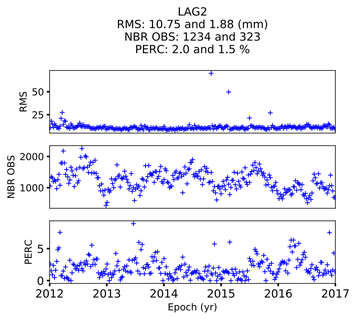

Figure 3: *LAGEOS-2: operational mode (i)*

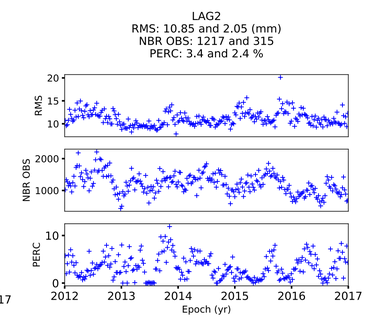

Figure 4: *LAGEOS-2: simuation with realistic noise (ii)*

3. Benefiting from a "Virtual Observatory"

Virtual Observatory (VO) is an ambitious international proposal to provide uniform, convenient access to disparate, geographically dispersed archives of astronomical data. The VO could be of interest for the geodetic community.

Astronomers using that Virtual Observatory are organized within an international association called the International Virtual Observatory Alliance (IVOA). As noted on the IVOA website, IVOA was formed in June 2002 with a mission to "facilitate the international coordination and collaboration necessary for the development and deployment of the tools, systems and organizational structures necessary to enable the international utilization of astronomical archives as an integrated and interoperating virtual observatory."

Figure 5: *IVOA logo*

Visit the IVOA Website !
http://www.ivoa.net/

- ⋆ Existing standards.
- ⋆ Existing self descriptive format based on these standards and XML: the VOTable.
- ⋆ Many tools already exist to manage, plot or analyze data supplied in VOTable format (described non-ambiguously). Convert ones own data in VO-Table format means benefiting of all existing tools.
- ⋆ Easy access to data by other scientific communities. Data that need to be distributed can be registered to a "registry". See for example http://esavo.esac.esa.int/registry/.
- ⋆ Successful project in Astronomy. The historical collaboration and close foundation between Astronomy and Geodesy encourages an adoption of VO standards by the geodetic community.

The VOTable Data Exchange Format

VOTable is a XML-based format for representing astronomical catalogues (properties of celestial objects: celestial coordinates, brightness etc.).

The VOTable has been defined in terms of XML in order to take advantage of computer-industry standards and to utilize standard software and tools.

Also, astronomical, as well as geodetic tables are rich in metadata, which in this context means annotation, interpretable by either computers or humans, both of the tables and the individual columns that they contain. **It is important that these metadata should be preserved with the table and the VOTable has features to permit this**. Adopting VOTable does not mean giving up of its own data format. VOTable may encapsulate existing files and simply supplies metadata to understand its content and facilitate data exchanges. VOTable is designed to describe a wide variety of physical parameters. However when it is itself not sufficient for an accurate description of complex data, it can be used conjointly with an external data model. An example of such model for reference system is the STC (Space-Time Coordinate Metadata for the Virtual Observatory) .

Figure 6: *Space Station Coordinates time series (Zimmerwald), provided through the VOTable format. Such files can easily and **automatically be built** thanks to dedicated tools from common ASCII files, such as "**stilts**" and "**TOPcat**".*

Following our recommendations, IVOA adopted standards relevant to the Earth orientation data (polar motion, UTI-UTC, nutation etc.) and to space geodesy, to exhaustively **describe in the VO all the products delivered by the ILRS** to a wide community.

4. GRGS web pages and VO Tools

What is available on the websites:

- GRGS AC Time series projected into a homogeneous reference frame
- ASCII and .vot files
- Status of the operational solutions, and reanalyses
  - Stations: SSCs, and biases
  - Additional informations:
    global transformation parameters: translations, rotations, scale
- IERS/ICRS-PC provides as well its products in VOTable format, including station coordinates and Earth Orientation Parameter time series.
- Comparison tools between different time series

GRGS on-line tools to visualize and compare station coordinates time series of DORIS, GPS, SLR and VLBI sites.

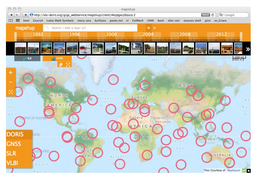

Figure 7: *Selection of the technique(s) and the station(s) through a dedicated page*

GRGS provides tools to browse station coordinates time series provided by the GRGS Analysis Centers. This service allows comparing time evolutions of coordinates for DORIS, GPS, SLR and VLBI sites. The time series are differences at observation epochs relative to a reference position (North, East and Up trended time series).
The tools proposed by this web service are:

- ⋆ a network viewer to select sites
- ⋆ a plot tool to display time series

Capabilities:

- ⋆ selecting charts to plot
- ⋆ displaying time series, editing data, changing plot appearance, specifying scaling
- ⋆ downloading data, plots and graph statistics in several formats
- ⋆ statistic tools for the calculation of mean, slope and weighted rms with respect to the slope (Weighted Relative Standard Deviation)
- ⋆ several series can be viewed and compared on the same graph
- ⋆ additional data can also be displayed, such as station or satellite events
- ⋆ the plot tools are based on the Highcharts/Highstock libraries.

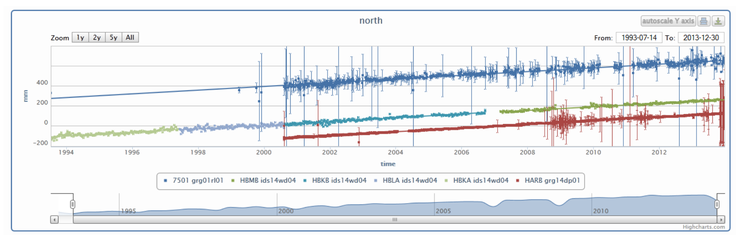

Figure 8: *Superimposition of SSC (North component) of the Hartebeesthoek station (SLR: 7501, coming from GRGS computation for ITRF2014), for various techniques*