

## 3.6.2 Combination Research Centres

### 3.6.2.1 Agenzia Spaziale Italiana (ASI) – Centro di Geodesia Spaziale

**Introduction** The Italian Space Agency's (ASI) Space Geodesy Center (CGS), located near Matera, Italy, is a Fundamental Geodetic Station, hosting three permanent Space Geodetic systems (SLR since 1983, VLBI since 1990, GPS since 1995) providing raw observational data, acquired, screened and archived continuously and then forwarded to the IERS Technique Centres (ILRS, IVS, IGS). Since several years, in addition to the single-technique data analysis products provided to ILRS, IVS, IGS, IERS as Analysis Center (AC), ASI-CGS consolidated its role of Combination Center (IERS CRC, ILRS CC).

**Combination research activity and products** In 2007, the ASI-CGS combination activities, within the ILRS frame, have been focussed on the continuous production of the ILRS official combined weekly solution and its further analysis to prepare the new long term contribution to the ITRF, as well as on the preparation of the experimental combined ILRS orbital products. Moreover, other combination products and value-added geophysical products based on combined geodetic products have been realized, such as the Mediterranean area combined solution and the derivation of excitation functions from the estimated EOP's.

#### 1. ILRS combined SSC/EOP weekly solution

Every Wednesday ASI-CGS issues the weekly ILRS official solution (ILRSA) derived from the combination of individual contributing SLR solutions based on the observations to Lageos 1-2 and Etalon 1-2 satellites, providing them to the users via the CDDIS and EDC archives, and hereto IERS. The combination methodology relies on the direct combination of loose constrained solutions, described in previous IERS reports. In 2007, two more AC's joined the operational weekly production (namely GA, Australia and GRGS, France), raising to eight the number of official ILRS contributing ACs. The ILRSA solutions contain:

1. Weekly coordinates of the worldwide SLR tracking network
2. Daily EOP's (xpole, ypole, LOD), ITRF2000-framed for IERS Bulletin B, ITRF2005-framed since November 2007

The transition to the new ITRF2005 was performed in November 2007 and its impact on the individual and combined solutions has been evaluated on a 2-year long time series (Jan 2006 – Oct 2007), as plotted below. Besides the expected stability for the Core Sites, a significant improvement is reflected also on the non-Core Sites, whose average differences (3d WRMS) with respect to ITRF2005 is limited by 20 cm in the case of the ILRS combined solutions, even if the apparent rising trend proves the need of frequently updating the ITRF.

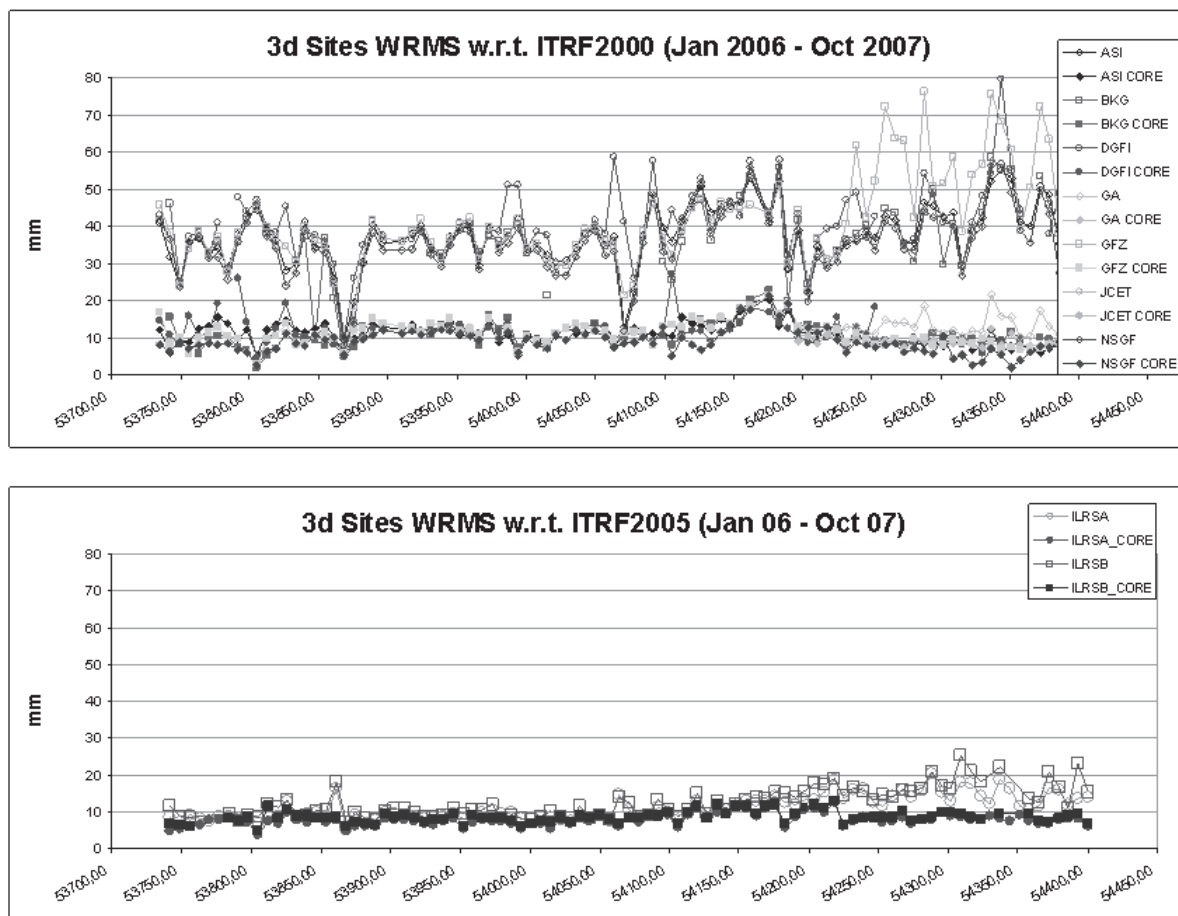


Fig. 1: ILRSA SSC differences w.r.t. ITRF2000 and w.r.t. ITRF2005 (2006–2007)

To prepare the new ILRS contribution to ITRF on a longer data span covering the majority of SLR tracking history, a critical analysis has been started in 2007 on the already submitted SSC time series from the contributing AC's, and guidelines to all AC's in order to properly analyze the older data set have been set up.

## 2. ILRS combined orbital weekly solution

An experimental ILRS combined orbital product has been under study since September 2007: in principle, it consists in a combined set of state vectors (SV's) for Lageos 1-2, Etalon 1-2 satellites, aligned to the EOP/SSC weekly product.

The ILRS AC's are requested to provide their orbital solutions in the form of SP3-formatted files, in the same ECEF in which they provide their 'loose' SSC/EOP solutions, with SV's every 2 minutes (Lageos) and every 15 minutes (Etalon), covering the whole week, while the ILRS CC's are requested to develop a combination procedure to provide an optimal ILRS combined product. The ASI-CGS combination procedure is under design; basically, it will include an homogeneous transformation of the SP3 files to the ITRF of reference, by using the Helmert parameters estimated in the SSC/EOP

combination and reported in the weekly summary report, and a weighted average of the state vectors, based on a unique weekly weight for each AC solution reflecting the agreement of each solution to the reference ITRF (3d WRMS of SSC residuals).

The initial study phase started with the analysis of the available SP3 test files from the ILRS AC's (in 2007, ASI and DGFI only); comparison tests showed, as an initial result, a 5-cm level position agreement in the Lageos 1 orbit after the proper similarity transformation.

Table 1: ILRSA EOP differences w.r.t. IERS C04 for 2006

| SAT             | X<br>mean<br>std | Y<br>mean<br>std | Z<br>mean<br>std | VX<br>mean<br>std | VY<br>mean<br>std | VZ<br>mean<br>std |
|-----------------|------------------|------------------|------------------|-------------------|-------------------|-------------------|
| <b>LAGEOS 1</b> | <b>m</b>         | <b>m</b>         | <b>m</b>         | <b>mm/s</b>       | <b>mm/s</b>       | <b>mm/s</b>       |
| <b>6 days</b>   | 0,001            | 0,004            | -0,010           | -0,001            | 0,001             | 0,001             |
|                 | 0,053            | 0,060            | 0,055            | 0,062             | 0,061             | 0,034             |
| <b>1 day</b>    | -0,003           | 0,006            | -0,012           | 0,001             | 0,001             | -0,001            |
|                 | 0,035            | 0,037            | 0,044            | 0,058             | 0,054             | 0,026             |

### 3. The ASIMed solution

Twice a year, ASI-CGS produces a combined velocity solution for the Mediterranean area using its original single-technique velocity solutions (SLR, VLBI and GPS) that cover the whole data span acquired by the three co-located systems from the beginning of acquisitions in Matera. The ASIMed solution ([http://geodaf.mt.asi.it/html\\_old/ASImed/ASImed\\_06.html](http://geodaf.mt.asi.it/html_old/ASImed/ASImed_06.html)) gives a detailed picture of the residual velocity field in the area, profiting of the dense permanent GPS coverage. The semiannual updating profits of the improvements in the velocity field information as geodetic sites become stable in terms of their data acquisition history.

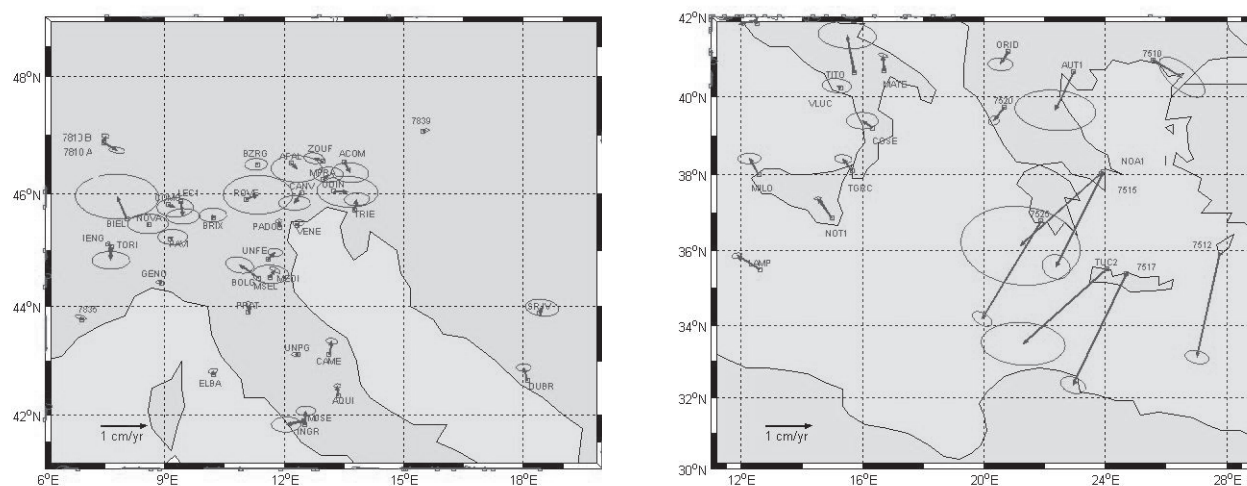


Fig. 3: Italian residual velocity field from ASIMed2007\_ver2.0

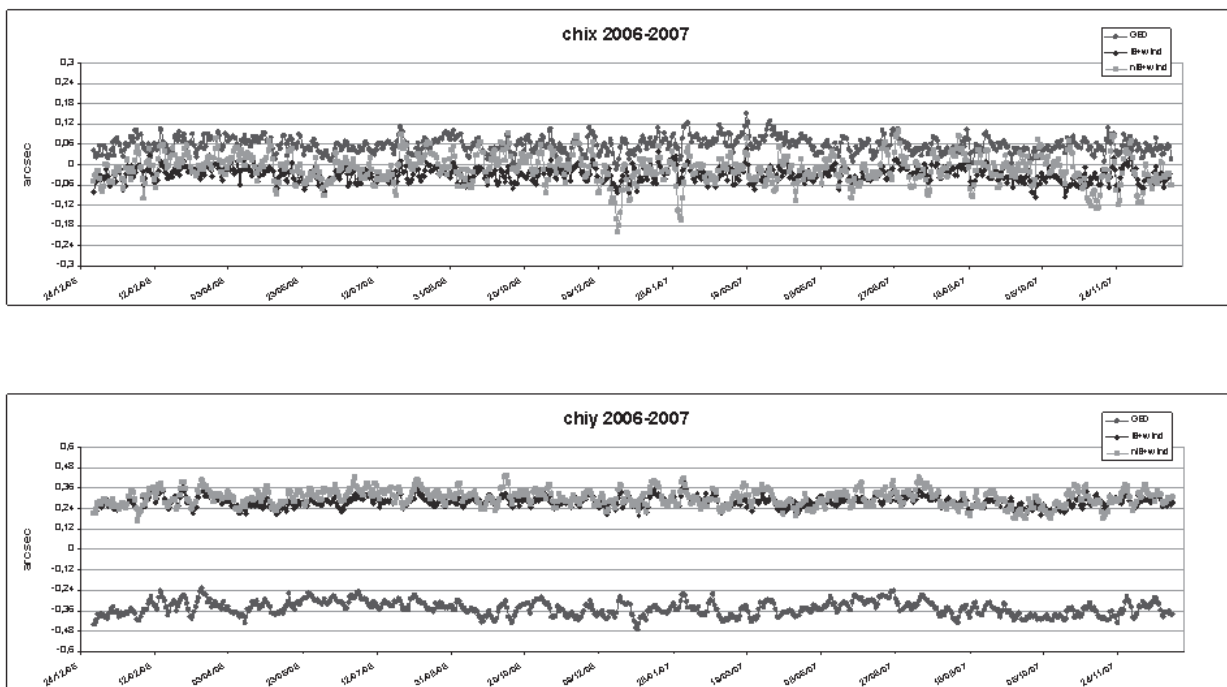


Fig. 3: x-y Excitation Functions 2006 – 2007 from ASI, SBA values

#### 4. The EOP excitation functions

ASI-CGS continued the pre-operational production and the testing/validation phase for the geodetic excitation functions from its own estimation of EOP values (at present SLR only; the current use of CGS VLBI and GPS EOP is also under testing) to make them available on the ASI geodetic web site (<<http://geodaf.mt.asi.it>>): the daily geodetic excitation functions are produced every Tuesday along with the operational weekly SLR solution, staked and compared whenever possible with the atmospheric excitation functions from the IERS SBA, under the IB and non-IB assumption, including the “wind” term.

The atmospheric and geodetic excitation functions show clear similarities, not considering the expected systematic differences, as in the plots above, relevant to the x and y components. An even clearer and quantifiable correlation is shown in the z component: the linear dependence between the atmospheric and geodetic values is evident ( $R^2 > 0.94$  over two years of values) as it is shown in the following plots (a systematic bias has been removed from the atmospheric values). The product is expected to be published on the GeoDAF web site during 2008.

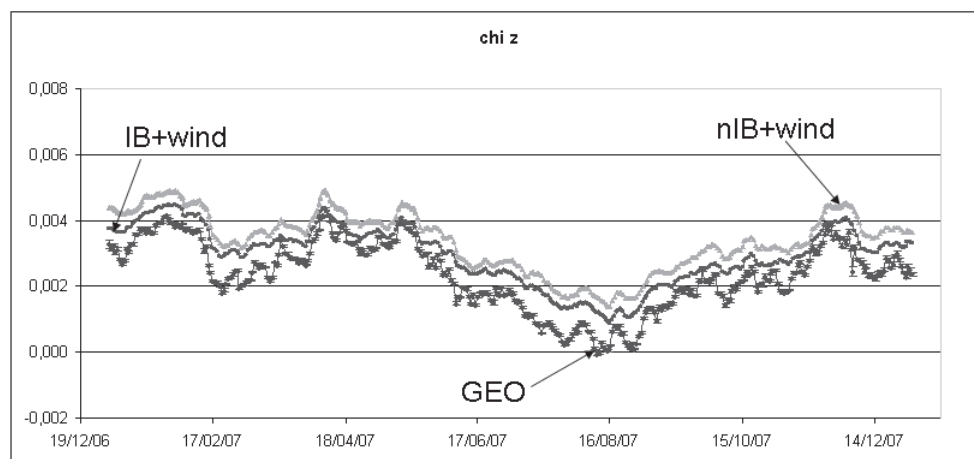


Fig. 4: *z* Excitation Functions 2006 from ASI, SBA values

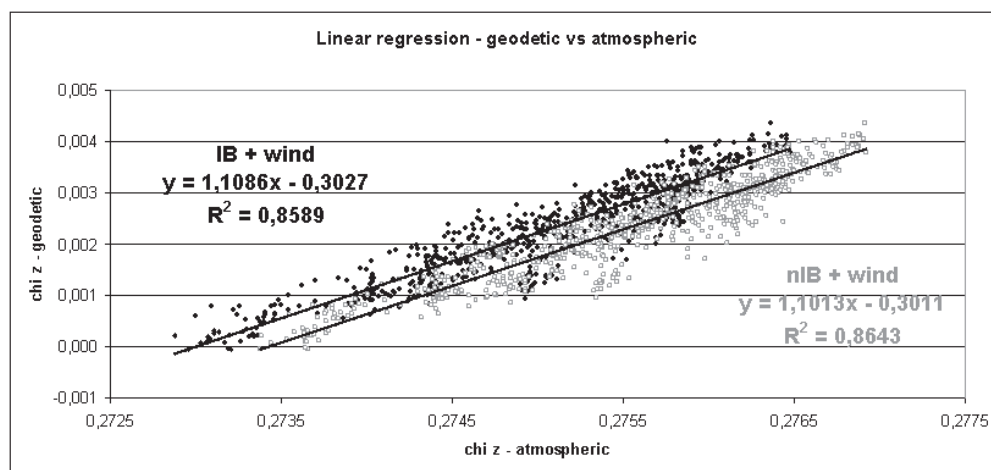


Fig. 5: Linear regression of *z* Excitation Functions 2006–2007 from ASI, SBA values

Giuseppe Bianco, Vincenza Luceri, Cecilia Sciarretta