3.6.1 ITRS Combination Centres

3.6.1.2 Institut Géographique National (IGN)

The IGN ITRS Combination Centre concentrated its activity during the year 2006 on the production of the ITRF2005.

For the first time, the ITRF2005 benefited from the contribution of the two other ITRF combination centres, namely Deutsches Geodätisches Forschungsinstitut (DGFI) and Natural Resources Canada (NRCan). Comparisons between intra and inter-technique combinations of the three ITRF combination centres were undertaken that allow improving the final ITRF2005 reliability.

Contrary to previous ITRF versions, the ITRF2005 integrates time series of station positions and daily Earth Orientation Parameters (EOPs). The time series solutions are now provided in a weekly basis by the Services of the International Association of Geodesy (IAG): International services of satellite techniques (IGS, ILRS, IDS) and in a daily (VLBI session-wise) basis by the IVS. Reasons for which it was decided to use time series of station positions and EOP as input to ITRF2005 include:

- Monitoring of non-linear station motions and all kinds of discontinuities in the time series: Earthquake related ruptures, site instability, seasonal loading effects, etc.;
- Examining the temporal behaviour of the frame physical parameters, namely the origin and the scale;
- Rigorously and consistently including EOPs in the combination and ensuring their alignment to the combined frame.

One set of times series per space geodesy technique was considered as input to the ITRF2005 combination. These solutions are the official time series provided by the international services of the 4 techniques, known as Technique Centres (TC) by the IERS. Note that these official TCs’ solutions result from a combination at the weekly (daily) basis of the corresponding individual solutions provided by the Analysis Centres (AC) participating to the activities of each TC. Official time series were submitted to the ITRF2005 by the International VLBI Service (IVS), the International Laser Ranging Service (ILRS), and the International GNSS Service (IGS). At the time of the ITRF2005 release, official weekly combined solutions from the International DORIS Service (IDS) were not available, so that individual solutions were submitted by two DORIS analysis centres, namely Institut Géographique National (IGN) in cooperation with Jet Propulsion Laboratory, and the Laboratoire d’Etudes en Géophysique et Océanographie Spatiale (LEGOS) in cooperation with Collecte Localisation Satellites (CLS), designated hereafter by (LCA). A specific analysis of DORIS solutions submitted to the ITRF2005 was performed prior to the ITRF2005 release. Table 1
Table 1: Summary of Submitted Solutions to ITRF2005

<table>
<thead>
<tr>
<th>TC – AC</th>
<th>Time span</th>
<th>Type of constraints/solution</th>
<th>EOPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>IVS</td>
<td>1980.0-2006.0</td>
<td>Normal Equation</td>
<td>Polar Motion, rates, UT1, LOD</td>
</tr>
<tr>
<td>ILRS</td>
<td>1992.9-2005.9</td>
<td>Loose; variance-covariance</td>
<td>Polar Motion, LOD</td>
</tr>
<tr>
<td>IGS</td>
<td>1996.0-2006.0</td>
<td>Minimum; variance-covariance</td>
<td>Polar Motion, rates, LOD</td>
</tr>
<tr>
<td>IDS - IGN-JPL</td>
<td>1993.0-2006.0</td>
<td>Loose; variance-covariance</td>
<td>Polar Motion, rates, LOD</td>
</tr>
<tr>
<td>IDS - LCA</td>
<td>1993.0-2005.8</td>
<td>Loose; variance-covariance</td>
<td>Polar Motion, rates, LOD</td>
</tr>
</tbody>
</table>

summarizes the submitted solutions to ITRF2005, specifying the data-span, their type, the originally applied constraints and the nature of the included EOPs. Table 2 lists all the Analysis and Combination Centres for each one of the 4 techniques which contributed to the time series submitted to the ITRF2005.

The ITRF2005 is composed of 608 stations located at 338 sites as illustrated in Figure 1, with an imbalanced distribution between the northern hemisphere (268 sites) and the southern hemisphere (70 sites).

As illustrated by Figure 1, there are in total 84 co-location sites for which local ties are available for the ITRF2005 combination. They are distributed as follows: 52 sites with two techniques, 26 with 3 techniques and 6 sites with 4 techniques. There are about 10 co-location sites where local ties are not available. Note also that, unfortunately, not all these co-located instruments are currently operating. For instance, among the 6 sites having 4 techniques, only two of them are currently operating: Hartebeesthoek, South Africa and Greenbelt, MD, USA.

Fig. 1: ITRF2005 Sites with Co-located Techniques
The usual procedure adopted for the ITRF combination is to use the local ties as independent measurements with proper weighting. For the ITRF2005, about 45% of the available local ties are provided in SINEX files with full variance-covariance information as well as the measurement epochs: all sites in Australia; three sites in Italy: Medicina, Noto and Matera; Wettzell and Concepcion; and all the DORIS co-location sites were re-adjusted by the ITRS Centre in order to generate full SINEX files. The other 55% of the available local tie vectors were converted to SINEX format, following the procedure described in the ITRF article and technical notes. All the local tie SINEX files used in the ITRF2005 combination are available at <http://itrf.ensg.ign.fr/local_surveys.php>. The local tie...
SINEX files were introduced in the ITRF2005 combination as independent solutions, in the same way as the long-term space geodesy solutions. Empirical variance factor estimation for each one of the individual local tie solutions (SINEX files) is operated following the procedure described in (Altamimi et al., 2002). The global combination is iterated as necessary and new variance factors are estimated at each run and in such a way that any position component should not exhibit a residual exceeding a certain chosen threshold. For the ITRF2005 solution it was decided to avoid having a position or velocity normalized residual (raw residual divided by its observation a priori error) exceeding a threshold of 4. Note that in each iteration, new individual variance factors are estimated which are then used to re-scale the individual matrices for the next iteration. A list of local tie vectors, together with their uncertainties as extracted from the re-scaled SINEX files, is also available at the same place as the SINEX files as mentioned above. In addition, all the post-fit residuals of the ITRF2005 combination are available at <ftp://igs.ensg.ign.fr/pub/igs/itrf2005/>. These residuals reflect, site by site, the level of agreement between the local ties and space geodesy estimates. There are some important co-located sites where we observe discrepancies larger than or equal to 1 cm, between local ties and space geodesy estimates. These discrepancies mean that either local ties or space geodesy estimates (or both) are imprecise or in error. Example of such sites are: GPS/VLBI: Westford, USA and Fortaleza, Brazil; GPS/SLR: Zimmerwald, Switzerland and Herstmonceux, UK. In order to preserve the implied co-locations in the combination, the local ties having normalized residuals exceeding the threshold of 4 were down-weighted rather than rejected, through the usage of appropriate variance factor as mentioned above.

**ITRF2005 Main Results**

In addition to the usual ITRF products (station positions and velocities), other important ITRF2005 results are also available to the users, namely:

- Full ITRF2005 and per technique SINEX files containing station positions, velocities and EOPs with complete variance-covariance matrices;
- Time series of station position residuals as results from the stacking of the individual time series of the 4 techniques;
- Geocentre time series from SLR and DORIS. There is no useful geocentre motion information from GPS/IGS, the submitted weekly solutions being aligned to ITRF2000;
- Full time series of EOPs consistent with the ITRF2005.

Reference


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