3.7 IERS Working Groups

3.7.1 Working Group on Site Survey and Co-location

Report for 2008

The IERS Working Group on Site Survey and Co-location (*jointly with IAG Sub-Commission 1.2 – WG 2, SC1.2-WG2*) was established in February 2004. The major goals and objectives of the WG relate to:

Site Survey and Standards

- Develop, test, compare and set standards on site survey methods, including observational techniques, network design, classical adjustment, geometrical modelling and/or direct measurement techniques for invariant point determination, reference frame alignment, software implementation and SINEX generation. This will include the development of a standard document for undertaking site surveys;
- Preparation and coordination of a Pilot Project (PP) on site survey. The PP includes test campaigns to be used for the comparison of different approaches to local tie surveys addressing each of the technical elements;
- Develop standards for the documentation of site surveys, including survey report content and format;
- Suggest a pool of expertise to provide advice to survey teams, as required, on standards for site surveys.

Coordination

- Liaise with local and international survey teams undertaking site surveys at important co-location sites;
- Liaise with the technique combination groups to ensure WG site survey products meet user requirements;
- Coordinate as required and make recommendations to observatories as to survey scheduling and re-survey frequency;
- Develop and distribute software tools to the community to assist in the generation of site survey products, including SINEX generation software;
- Provide a forum to raise the profile of site survey as a critically important independent geodetic technique.

Site Survey Research

- Investigate new site survey methodologies, including observational techniques, observational modelling, invariant point definition, geometrical modelling and/or direct measurement techniques for invariant point determination, reference frame alignment and structural deformation analysis.

Meetings

A meeting was held in 2008, at the AGU2008 meeting in San Francisco, US, jointly with the GGOS Networks and communication working group. The meeting was well attended and presentations from a number of speakers illustrated current topics of interest. A particular emphasis was placed on attempting to establish a new methodology for monitoring co-location vectors in near real time. The current survey methodology is episodic and as such will not pick up variations to the co-location vector between surveys. The need to continually refine accuracies was also discussed. With the GGOS aim of refining the accuracy of the ITRF below the 1mm level it becomes imperative that component accuracies are well below that level of accuracy. Current local tie accuracies are at the 1–5mm level and as such need to be refined further. As usual the meeting also stressed the need to continue to develop the concept of Local Ties as a key component of the technique combinations and reference frame definition and to ensure all co-located sites have up to date tie information.

Other Activities

Geoscience Australia continues to undertake monitoring surveys at the Australian sites. A new calibration pier at Mt Stromlo has been constructed in an attempt to refine the accuracy of the Minico near real time IVP monitoring system. The IVP was showing an apparent seasonal motion through the Minico system. It is believed that the tallest of the four calibration piers was actually moving seasonally and this was biasing the IVP results at the 0.5mm level.

Plans are also being developed for local tie infrastructure at the Yarragadee site which will have a 12m VLBI telescope installed in 2009. A methodology for surveying the relationship between the VLBI dish, Moblas 5 system, Proposed NGSLR system and the variety of GNSS sites is being developed.

IGN is now undertaking routine local tie surveys at numerous sites and offers this service to observatory operators who are unable to complete their own surveys. Local surveys were carried out at Tahiti and Herstmonceux sites.

Change of Working Group Chair

In October 2008 the IERS DB asked Pierguido Sarti (IRA-INAF, Italy) to set up a new charter and to revise the list of the WG members in prevision of a transfer of the chairmanship of the WG. At the end of 2008 the WG chair was transferred from Gary Johnston (Geoscience Australia) to Pierguido Sarti (IRA-INAF, Italy).

Report for 2009

A new WG charter was prepared by the new WG chair Pierguido Sarti and submitted for approval to the IERS Directing Board meeting No. 48, held in Vienna on the 19th April 2009. The new charter was approved as follows.

Charter of the IERS Working Group on co-location and local ties – Jointly with IAG Sub-Commission 1.2

Introduction

Tie vectors are nowadays fundamental for the computation of global terrestrial reference frames: the combination of the individual techniques-specific reference frames relies on the accuracy of tie vectors as well as the number and distribution of co-location sites. In order to be useful, tie vectors must be provided with full variance covariance information and must be accurate to the 1 mm level. Variance covariance computation strictly attains to the data processing phase of the tie vector; it can be rather simply achieved and should be regarded as a mandatory task of any local tie. An accurate estimation of the tie vector is more difficult to obtain and many efforts must be taken during the whole local tie process. The accuracy of a tie vector is usually (and indirectly) assessed through a comparison with the space geodetic solutions in the combination phase: the residuals of the combination are analyzed and used to identify discrepancies between space geodetic and terrestrial measurements. If, on the one hand, these discrepancies simply highlight a disagreement for a specific co-location site, on the other hand, they are the starting point for a rigorous investigation on the wide variety of causes that might originate from technique specific problems. It should be noticed that the whole process is characterized by the unavoidable complication of reliably coupling measurements of different nature (space geodetic and terrestrial) related to different reference points (electronic and conventional points, respectively).

Local tie surveys are usually performed combining terrestrial measurements of angles, distances and height differences and aim at computing differential coordinates between space geodetic instruments expressed in a topocentric frame. In order to do so, terrestrial measurements are performed and combined according to a geometric model (whose complexity and flexibility can vary considerably) apt at realizing the *conventional* definition of the instrument's reference point. Regardless of the way the observations are acquired, processed and conditioned (all these aspects obviously impact the tie vector estimation) it should be noticed that it is impossible to directly observe the instrument's electronic reference point with terrestrial techniques (i.e. the antenna's phase centre for GPS, VLBI and DORIS and the photodetector for SLR). Furthermore, the tie vector is naturally expressed with respect to a topocentric frame and, in order to be useful, it must be accurately transformed into a global frame.

Space geodetic observations are acquired at the electronic reference point and are commonly referred to the conventional reference point by means of specific corrections and models that are assumed to properly realize the connection. Many factors may influence the stability of the electronic point and any inconsistency related to this very delicate connection phase obviously reflects on the combination's residuals. Addressing, investigating and understanding electronic point instabilities has been a major concern for the whole geodetic community and it is a mandatory task when tie vectors and space geodetic measurements are combined.

The WG on site surveys and co-locations aims at enhancing the cooperation between the groups involved in local tie surveys and their adjustment, the combination centres, the users of tie vectors and the space geodetic techniques services (i.e. IGS, ILRS, IVS and IDS), with the purpose of bringing together all necessary capabilities apt to improve present day situation.

Cooperation with GGOS activities and its branches should be sought and established.

Goals and Objectives

The WG should spread the knowledge related to local surveys and their adjustment among the national agencies in charge of co-location sites maintenance.

1. Site surveys standards:

a. Revise the local tie surveying activity developed so far. Identify open issues and promote research and discussion.

b. Set guidelines related to on-field operations.

c. Spread the know how among the community and the national agencies in charge of co-located sites maintenance.

2. Tie vector estimation:

a. Set guidelines on tie vectors computational standards and their transformation into global frame.

b. Provide local tie vectors with full variance-covariance information in SINEX format.

c. Develop a concrete action plan to improve local ties for future ITRF realizations.

3. Site surveys activities:

a. Promote local tie surveying wherever needed.

b. Remotely assist site surveying activities.

c. Provide computational support.

4. Coordination and research:

a. Liaise with technique combination centres.

b. Liaise with technique services.

c. Promote a joint effort aimed at focussing on the most recent combination residuals of the global frame for investigating local inconsistencies at co-location sites and identify actions to be taken to improve the performances of tie vectors within ITRF like combinations.

Working Group Members

The WG member list was prepared right after the approval of the charter and can also be found at the IERS WG web site <http://www.iers.org/WGSiteSurvey>.

Claudio Abbondanza (IRA-INAF, Italy, since 2011 JPL, USA)
Zuheir Altamimi (IGN, France)
Pippo Bianco (ASI, Italy)
Xavier Collilieux (IGN, France)
John Dawson (Geoscience Australia)
Bruno Garayt (IGN, France)
Rüdiger Haas (Chalmers, Sweden)
Maria Hennes (Univ. Karlsruhe, Germany)
Michael Lösler (Univ. Karlsruhe, since 2011 BKG, Germany)
Jim Long (Honeywell, USA)
Chuck Meertens (UNAVCO, USA)
Valerie Michel (IGN, France)
Axel Nothnagel (Univ. Bonn, Germany)
Mike Pearlman (Harvard-Smithsonian, USA)
Jean-Claude Poyard (IGN, France)
Jim Ray (NGS, USA)
Pierguido Sarti (IRA-INAF, Italy)
Jerome Saunier (IGN, France)
Ralf Schmid (TU Muenchen, Germany)
Manuela Seitz (DGFI, Germany)
Luca Vittuari (Uni. Bologna, Italy)
Alex Woods (Geoscience Australia)

Meetings

The first 2009 WG meeting took place during the AGU Fall Conference on Wednesday, December 16th, 2009 at Hotel Palomar in San Francisco (USA). The following items were discussed.

Site Survey Standards

Guidelines for surveyors: During the meeting the necessity of defining the guidelines regarding local tie practice has been pointed out several times. This would assure a minimum standard in tie vector measurements with the aim of estimating eccentricities to the highest precision achievable. Several methods nowadays exist and different groups claim to possess the know-how for optimal tie vector computation. Nowadays only a few tie vector surveying methods have been compared and proved to be consistent. As a matter of fact, tie vectors are submitted to ITRF Combination

Centres adopting a variety of non homogeneous methods which largely depend on the know-how of the local teams carrying out the local surveying operations. The issue must be discussed in the next Vienna meeting during EGU 2010 in order to agree on common surveying methods which may be routinely adopted as conventional IERS reference procedures for tie vector computation. Specific guidelines must be described, supplied and circulated in a document which should be used as quick reference manual. Operatively, the WG must identify a sub-group of WG members experts on tie surveying technical issues for the compilation of a reference manual.

Tie Vector Estimation

Software: Exchange of tie vector estimation software has to be promoted among the local tie groups and existing software must be made readily available. A validation phase must precede the former step and has to be supported.

Site Surveys activities

Critical co-location sites: ITRF2008 residuals will provide verification of critical co-locations in need of urgent actions such as re-measurements/re-computation of the tie vector. Specific action will be taken accordingly to support new local tie measurements or re-analyse data with existing software.

Coordination and Research

Who does what? The role of local agencies and their surveyors must be harmonised with IERS standards and combination requirements. Technique Services are crucial to endorse documentation eventually produced by this WG and must be actively involved in the finalisation of conventional IERS reference procedures related to tie vector estimation.

Output format: Software should allow to save and to output the full tie vector information (components and full variance-covariance matrix) in the native topocentric frame. Also, when available, information on local geoidal undulation should be provided. These aspects are crucial to align topocentric and local geodetic frames and to carry out a thorough investigation on combination residuals.
Alignment: Local to global frame tie vectors alignment remains an aspect which needs deep and further investigation.

Terminology: As research progresses, the lack of a univocal reference terminology on local tie issues is evident. Definitions are needed on specific procedures, items and quantities which relate to tie vector surveying, estimation and alignment. Particularly, the definition of space geodetic instrument reference point is ambiguous (e.g. stochastic, conventional, electronic). This part can be treated and included in the reference manual.

PCV & technique-dependent biases: As the knowledge of gravitational deformations of VLBI telescopes improves, a new lexicon on phenomena and quantities must be clearly set. PCV files similar to GPS might be needed in the future for VLBI in order to account for gravitational deformation of VLBI telescopes. This task can be fulfilled liaising with IVS and other services. Finally range biases in SLR and their signature in the misclosure between terrestrial and space geodetic results must be investigated in the near future. It is agreed that these corrections are responsibility of the technique services and cannot be relied upon tie surveying and computation procedures, i.e. the tie aims at connecting conventional-to-conventional reference points.

Survey activities

In August 2009 John M. Gipson (NVI Inc.) issued an invitation for a proof-of-concept demonstration involving a Robotic Total Station and a VLBI antenna at the Goddard Geophysical Observatory in Greenbelt, Maryland. The demonstration was carried out on Wednesday, September 23 at 2:00 and aimed at illustrating a 1 hour automated, straight-forward, fast, and, unassisted method for measuring the position of the VLBI/SLR conventional reference point.

Pierguido Sarti