Issues of a Rigorous Combination

Part 3: SINEX Combination Campaign

D. Angermann [1], D. Thaller [2], M. Rothacher [2]

[1] *Deutsches Geodätisches Forschungsinstitut, Munich, Germany*

[2] *Forschungseinrichtung Satellitengeodäsie, Munich, Germany*

Abstract: *This position paper briefly summarizes the present status regarding the combination of space techniques concentrating on a rigorous and consistent combination of ITRF, EOP and ICRF. Recommendations for improvements related to still existing deficiencies are presented. Further subjects include the intention, goal and set-up of the SINEX combination campaign, as well as a list of participants, a summary of the data pool and of the individual solution characteristics. Finally future steps, recommendations and action items are presented to stimulate discussions between the participating groups, which should be considered as a first step to achieve the ambitious goals of the SINEX combination campaign.*

1 Introduction and motivation

The space geodetic observation techniques (e.g. VLBI, SLR/LLR, GPS, DORIS) contribute in a different and unique way to the determination of geodetic parameters (e.g. site positions and velocities, EOPs, atmospheric parameters, gravity field coefficients) and each technique has its strengths and weaknesses concerning the determination of various parameters (e.g. Rothacher, 2000, Angermann, 2002a). The goal of the combination is to make an optimal use of the complementary properties of the different techniques. Besides this it has to be considered that the accuracy achieved today is mainly limited by technique-related and/or solution-related systematic effects (biases), which are often poorly characterized or quantified. This can lead to highly optimistic precision estimates that provide too optimistic accuracy expectations. Both, the different characteristics of the various space techniques for determining several parameters and the existing differences between space techniques observations (solutions) strongly require the development of rigorous integration and combination methods. This is of vital importance to exploit the full potential of the space techniques involved and to provide highly accurate and consistent results.

Currently the IERS products (e.g. ICRF, ITRF, EOPs) are computed (combined) separately by the responsible product centers. Consequently, they are not fully consistent, and not tolerable systematic biases between the different IERS products may exist. To overcome this problem it is necessary to develop suitable combination methods to generate consistent IERS products. To achieve this ambitious goal, the SINEX Combination Campaign was initiated by the IERS Analysis Coordinator. Objective of this campaign is to combine daily, weekly or monthly solutions from SINEX files of different techniques (VLBI, SLR, GPS and DORIS) with station coordinates and EOPs (and ICRF) and to assess systematic biases between the individual space techniques. Finally new combination strategies should be developed by the Combination Research centers (CRC) and other participating groups. The final goal is that these new combination methods should be implemented by the IERS product centers (PC) for the computation of the IERS products.

2 Present status of combination issues and deficiencies

Within IAG a large number of organizations and institutes significantly contribute to the integration and combination of space geodetic observations, such as the IERS, CSTG, and the Technique centres (IGS, ILRS, IVS and IDS). It would exceed the scope of this position paper to review the present status regarding all these different institutes/services and to cover the entire field of combination and integration issues. Therefore we concentrate on aspects that are relevant for the objectives of the SINEX combination campaign and we try to minimize duplications with other sessions of this IERS workshop.

At present, different IERS product centres are in charge (responsible) to generate the ITRF, ICRF and EOPs. A review of the status of combination issues, deficiencies, future recommendations, etc. related to these product centres are addressed in separate sessions of this IERS workshop. In this position paper we focus on some specific aspects that are important to fulfil the goals of this SINEX combination campaign.

Let us first summarize the present status of intra-technique combination aspects of the technique centres (services):

- IGS computes a large number of different combined products, such as satellite orbits, station and satellite clocks, station positions and velocities, troposphere, etc. (Weber and Springer, 2002) routinely on a weekly basis. NRCan combines sets of station coordinates, velocities, EOPs and apparent geocentre positions provided by the analysis centres, to produce the IGS official combined station position and EOP solutions (Ferland, 2002).
- The ILRS Analysis Working Group initiated since 1999 a series of pilot projects on "positioning + earth orientation" to compare and combine station positions and EOPs computed at different analysis centres. A call for participation "Positioning & Earth Orientation" for two different types of contributions will be released soon: (1) providing individual SLR solutions (2) for the quality control and combination of such individual solutions. Besides this, a pilot project on "benchmarking and orbits" has been initiated in June 2002, with the goal to benchmark the softwares that are in use by the various ILRS analysis groups (see http://ilrs.gsfc.nasa.gov).
- The IVS initiated a first pilot project aimed at the comparison and combination of EOP results (Nothnagel and Steinfort, 2002) and provides official combined EOP series (see http://miro.geod.uni-bonn.de/vlbi/IVS-AC). In a second pilot project, in addition to EOP results also atmospheric zenith path delays were submitted (Böhm et al. 2002).
- The creation of an IDS is initiated by the DORIS pilot project experiment (Tavernier, 2000).

In the following some shortcomings and deficiencies regarding the combination of the IERS products (ITRF, ICRF and EOPs) are outlined. Recommendations are presented to stimulate discussions within the IERS, and other relevant institutes / organizations.

(1) ITRF, ICRF and EOP consistency:

Currently ITRF, ICRF and EOPs are computed (combined) separately by different IERS product centres. Consequently, the results are not fully consistent, e.g. different ITRF realizations produce offsets and drifts in the EOP series (Rothacher, 2000).

Recommendation 1: *There is an urgent need to develop optimal methods (and software) for the combination of the relevant parameter types to derive fully consistent IERS products. This is the main task of the CRCs and the final goal of the SINEX Combination Campaign.*

(2) ICRF:

The ICRF is based on a single VLBI solution consisting of right ascension and declination coordinates in a barycentric inertial frame. The latest realization is the ICRF-Ext.1 (Ma et al. 1997).

Recommendation 2: *Other VLBI solutions (if possible computed with different softwares) should contribute to the realization of the ICRF. This should be coordinated by the IVS.*

(3) ITRF:

Conventionally the ITRF is realized by the adoption of a set of positions referred to a reference epoch and constant velocities for the ITRF network stations. The observed non-linear effects in position time series are in conflict with the assumption of constant velocities. This may produce errors and systematic effects in the individual solutions, which would also propagate into the TRF and degrade its accuracy. Hence a better monitoring of the TRF may require non-linear components in site positions.

Recommendation 3: *It is recommended to investigate non-linear site motions and to develop new concepts for combinations of TRF.*

(4) Systematic effects (biases) between solutions/techniques:

As an example for the current status we mention that the individual solutions submitted for ITRF2000 (http://lareg.ensg.ign.fr/ITRF/ITRF2000) reach differences of up to 5 cm for the origin and few parts per billion (ppb) for the scale (see http://lareg.ensg.ign.fr/ITRF/ITRF2000/T.gif and D.gif). Also differences up to a few centimetres for positions and up to one cm/yr for station velocities exist for some co-location sites with long time series (many years) of observations (Angermann et al. 2002b). The reported differences often exceed their r.m.s errors by a factor of 5-10 or even more, indicating that the individual solutions are significantly influenced by systematic errors.

Recommendation 4: *There is an urgent need to investigate these differences with regard to several aspects (e.g. modelling, parameterisation, software-related issues, analysis strategies, datum definition) and to identify the source of the existing inconsistencies. This requires a close cooperation between IERS PCs, analysis centres (ACs), CRCs, etc.*

(5) Combination methodology (level of combination):

One serious problem of the combination on the solution level is the reduction of a-priori datum constraints, which normally are included in the solutions. For some of the ITRF2000 input solutions these constraints could not be removed (for details see report of ITRS Combination centre at DGFI in IERS Annual Report, 2002). If one neglects these constraints, significant biases and systematic effects might be introduced into the combination results.

Recommendation 5: *It is recommended that unconstrained normal equations in addition to / or instead of solutions with variance-covariance matrices should be provided by the analysis centres and technique centres.*

(6) Co-location sites and local ties:

Currently, only six ITRF sites exist with collocations of VLBI, SLR, GPS and DORIS, and none of these is fully satisfactory regarding the data quality and/or the data time span for the various techniques. There are a number of VLBI and SLR stations that are not even collocated with a GPS receiver. In many cases, the intra-site vectors (local ties) are not well determined or dubious. The current situation regarding collocation sites and the accuracy and availability of the local ties is not satisfactory and can be considered as one limiting factor with regard to the consistency and long-term stability of reference systems, and urgently needs further improvements. The subcommission "International Space Geodetic Network (ISGN)" of CSTG chaired by Jim Long was formed to define best practice site criteria for all space geodetic sites, to designate a super set of multi-technique sites for intercomparisons and collocations, and to improve local survey ties between various techniques (Bosworth and Long, 2002).

Recommendation 6: *The current situation regarding co-location sites and local ties urgently needs to be improved. The CSTG subcommission ISGN should involve all the technique centres and representatives from potential agencies willing to contribute to this issue.*

(7) Intra-technique combinations:

IGS is the only Technique centre providing a single-technique combined solution with station positions and EOPs. At present there are no official combined intra-technique solutions from the ILRS, IVS, or IDS.

Recommendation 7: *ILRS, IVS and IDS should provide combined intra-technique solutions containing at least station positions and EOPs as parameters.*

3 The IERS SINEX Combination Campaign

a. Intention and goals of the campaign

The deficiencies in the actual combination processes for ITRF and EOP series mentioned above led to the initiation of a special campaign with the aim of developing new combination strategies with consistent ITRF and EOP (and ICRF) as result. The analysis centres of the different space geodetic techniques or other interested groups are asked to produce solutions with at least station coordinates and earth orientation parameters. If solutions of all space geodetic techniques (VLBI, GPS, SLR, DORIS) were available the existing systematic biases between these different techniques could be studied and tried to be solved. As preparation for the combination the individual solutions must be tested with regard to rank deficiencies of the normal equation, the ability of removing the constraints applied to the solution and reconstructing the solution. The experiences of these tests should result in a feedback to the analysis centres. Furthermore, recommendations about common standards of modelling and parameterisation in the technique solutions, derived from the combination experiences during this campaign should be compiled and given to the analysis centres. At the end of the campaign, combined solutions of high quality that can be used as the basis for consistent TRF and EOP series will be available. In the long term, the IERS SINEX Combination Campaign is a contribution for the replacement of the separate combinations of TRF and EOPs by a common and consistent combination process.

b. Set-up of the campaign

The IERS SINEX Combination Campaign is divided into two parts:

As a first step, solutions for each space geodetic technique have been and are generated by different analysis centres or other interested groups. These solutions must contain station coordinates and earth orientation parameters (at least x-pole, y-pole, UT1-UTC; if possible LOD, rates for x-pole and y-pole, and nutation parameters). The solutions themselves can be daily (as usual for VLBI), weekly (as usual for GPS; preferred time span for all solutions) or monthly (as usual for SLR), and should be delivered at least for the whole year of 1999. The SINEX (= Solution INdependent EXchange) format was chosen for delivering the individual solutions because it has many advantages:

- it is already in use for GPS, SLR, VLBI (and DORIS);
- a consistent format description for all techniques is now available, i.e. SINEX 2.00 (see ftp://alpha.fesg.tu-muenchen.de/iers/sinex/format/);
- statistical information, apriori information and constraints are included;
- the full variance-covariance information is available;
- the possibility of delivering free (reduced) normal equations is given, which avoids the problematical procedure of removing constraints.
- All series of individual solutions contributing to the campaign have been collected in a data pool.

The second step is dedicated to the combination of the SINEX solutions stemming from the first step. The IERS Combination Research centres and other interested groups should combine the terrestrial reference frame together with earth orientation parameters by using the strengths of one technique to compensate the deficiencies of another technique. The combination of more techniques must make use of the local tie information that is available in SINEX format as well.

The time table for the campaign looks as follows:

May 27, 2002: Call for participation (see IERS Message No.27)

June 15, 2002: Deadline for submitting proposals

August 15, 2002: Envisaged deadline for submission of SINEX series of step 1

August 23, 2002: First status report (see IERS Message No.31)

November 18-21, 2002: IERS Workshop in Munich
Presentation of first results; discussion of the experiences, encountered problems, etc.

April 6-11, 2003: EGS General Assembly in Nice
Presentation of final results; recommendations on strategies and standards for modelling, parameterisation, etc.

c. Participants

Table 1 summarizes the participating groups, the primary scientists and their contributions to the campaign. The proposals of all participants are collected on the web-site of the IERS SINEX Combination Campaign:

http://alpha.fesg.tu-muenchen.de/iers/sinex/sinex_campaign.html.

Altogether, eleven groups have sent a proposal: six groups are delivering SINEX series for the first step of the campaign, eight groups are participating in the combination step, and one group delivers solutions that are combined already at the observation level.

	Step 1	Step 2
AIUB (Urs Hugentobler)	*Weekly global GPS (2 versions)*	
ASI (Giuseppe Bianco)	*Monthly + weekly SLR*	*Combination*
BKG (Volkmar Thorandt, Gerald Engelhardt)	*Session VLBI*	
DGFI (Detlef Angermann)	*Session VLBI* *Monthly SLR* *Weekly regional GPS*	*Combination*
FESG (Markus Rothacher)		*Combination*
FFI (Per-Helge Andersen)	*VLBI / SLR (/ GPS) solution, combined on the observation level*	
GFZ (Shengyuan Zhu)		*Combination*
IGN (Zuheir Altamimi)		*Combination*
JCET (Erricos Pavlis)	*Monthly + weekly SLR*	*Combination*
NRCan (Remi Ferland)	*Weekly global GPS*	*Combination*
University of Newcastle-upon-Tyne (Konstantin Nurutdinov)		*Combination*

Table 1: Participating groups in the IERS SINEX Combination Campaign

d. Data pool

The data pool contains all files and information that is necessary for the combination step of the campaign and is accessible via the web-site of the IERS SINEX Combination Campaign:
http://alpha.fesg.tu-muenchen.de/iers/sinex/data_pool.html.
In detail, the data pool contains the following files:

1. All SINEX solution series stemming from the first step of the campaign, i.e.
   - 3 weekly global GPS solutions,
   - 1 weekly regional GPS solution,
   - 3 monthly SLR solutions,
   - 2 weekly SLR solutions (the solutions from ASI will be available at the end of November; the solutions from JCET will be available after the workshop),
   - 2 session (= daily) VLBI solutions (Attention: BKG files were resubmitted Nov. 6, 2002 !),
   - 1 combined (on observation level) VLBI / SLR solution.
2. Some solution series are available additionally and can be used in the combination step, but there is no official proposal from these groups:
   - session VLBI solutions from GSFC (2 series: from a recomputation and from an older computation),
   - weekly global GPS solutions of all seven IGS analysis centres for the whole year 1999, i.e. GPS weeks 991 - 1042 (the series from AIUB and NRCan that are officially contributing to the campaign stem from a recomputation, therefore they are not identical with these solutions),
   - monthly SLR solutions from the ILRS pilot project 'positioning and earth orientation' (altogether 11 analysis centres, but three of them are official participants of the IERS SINEX Combination Campaign, i.e. ASI, DGFI, JCET),
   - weekly DORIS solutions from IGN,
   - session VLBI solutions from IAA, but only with station coordinates.

3. The ITRF2000 SINEX files are available as one file per technique.
4. The local tie information that was used in the ITRF2000 combination is available in two forms: one SINEX file per site and a table with all local ties in text format.

e. Characteristics of individual solutions contained in the data pool

Comparing the individual solutions with respect to the parameters that are included in the solution, see table 2, it is clearly visible that there are some differences, especially regarding the earth orientation parameters. The station coordinates and the coordinates of the pole (x-pole, y-pole) are included in all global solutions, but the information about Universal Time is given in different ways (UT1-UTC or directly UT1), and the rates of the pole coordinates and LOD are missing in some solutions. The VLBI solutions are the only ones that contain nutation parameters, the GPS solution from NRCan contains geocentre coordinates, and the SLR solutions contain in addition some bias parameters (range and time biases). At the moment the ICRF is not yet included, because in both VLBI series that are directly contributing to the campaign (BKG and DGFI) the ICRF-Ext.1 was kept fix.

		Station coord.	**x-/y-pole**	**UT**	**Pole rates**	**LOD**	**Nutation**	**Additional parameters**
GPS	AIUB	***X***	***X***	*UT1-UTC*	***X***	***X***		
GPS	NRCan	***X***	***X***		***X***	***X***		*geocentre*
GPS	DGFI	***X***						
SLR Monthly	ASI	***X***	***X***	*UT1-UTC*				*Range bias*
SLR monthly	DGFI	***X***	***X***	*UT1-UTC*				*Range bias, Time bias*
SLR monthly	JCET	***X***	***X***	*UT1-UTC*	***X***	***X***		*Range bias*
SLR Weekly	ASI							
SLR weekly	JCET							
VLBI	BKG	***X***	***X***	*UT1*	***X***	***X***	***X***	
VLBI	DGFI	***X***	***X***	*UT1-UTC*			*Corrections to the model*	
VLBI+SLR	FFI							
VLBI	GSFC new	***X***	***X***	*UT1*	***X***	***X***	***X***	
VLBI	GSFC old	***X***	***X***	*UT1*		***X***	***X***	
GPS	IGS AC	***X***	***X***	*UT1-UTC*	***X***	***X***		
SLR	ILRS AC	***X***	***X***	*UT1-UTC*	***(X)***	***(X)***		*Biases*
VLBI	IAA	***X***						
DORIS	IGN	***X***	***X***	*UT1-UTC*	***X***	*LODR*		

Table 2: Parameters contained in the SINEX solutions available in the data pool

Regarding the variance-covariance information respectively the (reduced) normal equation contained in the SINEX files, all analysis groups deliver the variance-covariance information using the SOLUTION blocks MATRIX_ESTIMATE, MATRIX_APRIORI, APRIORI and ESTIMATE, but in some solutions the apriori information has been omitted. Only the VLBI solutions from BKG, DGFI and the recomputed GSFC solutions include normal equations in addition to the variance covariance information, but in two different formats: the DGFI solutions follow the SINEX 2.00 format description and use the SOLUTION/NORMAL_EQUATION blocks (MATRIX and VECTOR) whereas the BKG and the new GSFC solutions have their own format (named SINEX 2.10).

Differences between the individual solutions are also present in the constraints that are used for generating a solution: both inner constraints and loose constraints on the estimated parameters are used, and the size of the constraints differs as well. A summary of the information available about the constraints applied during the estimation process is given in table 3.

		TRF	x- / y-pole	UT	Nutation	Others
GPS	AIUB	*Rot: 0.0001rad* *Transl: 10m*		*first UT 0.0001rad*	-	*ERP continuity 0.01*
GPS	NRCan	*Rot: 0.003mas* *Origin: 0.1mm* *Scale: 0.02ppb*			-	
GPS	DGFI	*Coord: 1m*	-	-	-	
SLR Monthly	ASI	*Loose constraints on coordinates*	*Loose constraints on EOPs*		-	
SLR monthly	DGFI	*Coord: 1m*	*Pole 30mas*	*dUT 2ms*	-	
SLR monthly	JCET	*Coord: 1m*	*Equivalent to 1m on station positions*		-	
SLR Weekly	ASI				-	
SLR weekly	JCET				-	
VLBI	BKG	*Rot: 1m* *Transl: 1m*				
VLBI	DGFI	*Coord: 1m*	*Pole 30mas*	*dUT 2ms*	*30mas*	
VLBI +SLR	FFI	*Coord: 100m* *Vel: 1m/y*				*Orbits: 100m* *Radio sources: 100m*
VLBI	GSFC New	*Rot: 1m* *Transl: 1m*	*Pole 1mas* *Pole rate 1mas/d*	*UT1 1ms* *LOD 1ms/d*		
VLBI	GSFC Old	*Coord: 100m*	*Pole 100mas*	*UT1 1ms* *LOD 1ms/d*	*100mas*	
GPS	IGS AC	*Different for the analysis centres*			-	
SLR	ILRS AC	*Different for the analysis centres*			-	
VLBI	IAA	*One station fixed ?*	-	-	-	
DORIS	IGN	*Inner constraints ?*			-	

Table 3: Constraints applied for generating a solution

4 Future steps, recommendations and action items

It is obvious, that many of the objectives and ongoing activities of various IERS components, CSTG, the Technique centres (IGS, ILRS, IVS, IDS), and the individual ACs are closely related to each other. To achieve the ambitious future goals, it is important that there are close communication links with a good information exchange between the groups, and furthermore the activities of all contributing institutes and organizations need to be well-coordinated.

The major goal of the SINEX combination campaign is the development of methods (and tools) for a rigorous and consistent combination of ITRF, EOP (and ICRF), which then should replace the separate combinations by different IERS product centres. To achieve this ambitious goal a wide range of combination aspects has to be considered and the success will fundamentally depend on the cooperation of the groups involved and on well-coordinated activities. At the moment, it seems impossible to us to specify all future steps and tasks to be done in detail. The action items and deadlines specified below should stimulate discussions and should be considered as preliminary.

(1) CRC-Mail-Exploder:

An e-mail exploder "CRC Mail Forum" has been installed at the WebPages of the IERS Analysis Coordination at Technical University of Munich (http://alpha.fesg.tu-muenchen.de/iers) together with the IERS Central Bureau at BKG for the exchange of mails between CRCs and other interested persons.

Action Item 1:

All participants of the SINEX combination campaign should be members of this mail exploder to ensure an effective communication between different groups. Individuals that would like to be included in this exploder should send an e-mail to "lothhammer@iers.org". This mail exploder "crc_forum@iers.org" should be used for every communication concerning the SINEX combination campaign.

(2) Validation of individual SINEX Files:

The number of individual solutions for the different space techniques and their characteristics is very heterogeneous. In view of the goal of the SINEX combination campaign the available solutions have to be checked concerning various aspects, such as format and suitability for a rigorous combination.

a) Focus on a set of solutions as homogeneous as possible concerning time interval, parameterisation and modelling

b) Check SINEX format

c) Ensure that all constraints can be removed successfully

d) Perform rang defect analysis

e) Make sure that a correct solution can be produced

Available tools for checking SINEX-files:

- University of Newcastle (http://ucscgi2.ncl.ac.uk/~nkn3)
- DGFI: SINEX checker under development
- other tools ?

Who participates (NCL, DGFI, others) ?

Different groups for different techniques ?

Action Item 2:

Generate report for each individual solution regarding items a)-e), feedback to ACs

Deadline: ***15.01.2003***

Resubmission of corrected SINEX files by ACs (if necessary), Deadline: ASAP

(3) Form concerning modelling and parameterisation (see Annex I):

A form will be distributed to all ACs that are contributing to the SINEX campaign to be filled in and returned to the IERS Analysis Coordinator. These forms then will be archived together with the solutions in the SINEX data pool.

Action Item 3:

a) Preliminary version of this form exists and should be discussed during IERS Workshop

b) Distribution of form to ACs: IERS Analysis Coordinator, Deadline: ***30.11.2002***

c) All ACs return form to IERS Analysis Coordinator, Deadline: ***20.12.2002***

(4) Consistent modelling and parameterisation:

The SINEX series of the various techniques have to be as consistent as possible. Based on the forms common standards have to be defined and updated series complying with the standards should be produced by the ACs.

Action Item 4:

a) Define common standards, IERS Analysis Coordinator + others? Deadline: ***31.01.2003***

b) Submission of updated series by all ACs of the IERS SINEX Campaign, Deadline: ***28.02.2003***

(5) Scientific Studies / Combinations:

The outcome of the previous steps is essential to define future steps towards the final goal of the SINEX combination campaign in more detail. There is a wide spectrum of combination issues that have to be considered. Below some topics, which are important to study are outlined:

a) Local ties: Assess the quality of the local tie information and study the impact of local ties on the combination.

b) Study the weighting of solutions in the intra- and inter-technique case. Develop weighting methods, study variance component estimation, etc.

c) How to handle non-linear site motions (e.g. sites located in deformation zones)

d) Study datum definition issues for combined solutions

e) Study systematic biases between the techniques concerning:

- scale
- geocentre
- LOD (and nutation rates) from satellite techniques
- biases in time series of station coordinates (especially for collocation sites)
- biases in time series of EOPs
- consistency between TRF and EOPs
- impact of combination on the ICRF realization

Who: All combination centres of the IERS SINEX Campaign

+ other groups (e.g. CRCs, WG on ITRF Datum) ?

How should the work to be organized ?

- Definition of working packages ?
- Different groups for different tasks ?
- Relationship to the goals of other groups (e.g. CRCs, WG on ITRF datum) ?

Deadline: First results to be presented at the EGS-AGU-Meeting in Nice, Session G15 (April 2003)

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6 Annex

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|                   INTERNATIONAL EARTH ROTATION SERVICE                      |
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|                       Processing Strategy Summary                           |
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| Analysis Centre   |
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|-------------------------------------------------------------------------------
| Contact address   | Mail:
|                   |-----------------------------------------------------------
|                   | Phone:
|                   |-----------------------------------------------------------
|                   | Fax:
|                   |-----------------------------------------------------------
|                   | Email:
|-------------------------------------------------------------------------------
| Contact Person(s)|
|                   |
|-------------------------------------------------------------------------------
| Software Used     |
|                   |
|-------------------------------------------------------------------------------
| Public access to |
| products          |
|-------------------------------------------------------------------------------
| Preparation Date |
| of this file      |
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|                           SOLUTION DESCRIPTION                               |
|==============================================================================|
| Space geodetic    |
| technique         |
|------------------------------------------------------------------------------
| Time span of      |
| observations used|
|------------------------------------------------------------------------------
| Parameters        |
| included          |
|------------------------------------------------------------------------------
| Adjustment        |
| method            |
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TERRESTRIAL REFERENCE FRAME	
Apriori values	Station Coordinates:
	Station Velocities:
Datum definition	Definition of origin:
	Definition of orientation:
Reference stations used for datum definition	
Modeling station deformations	Tectonic plate motion:
	Solid earth tides:
	Pole tides:
	Ocean loading:
	Atmospheric loading:
	Others:
Estimation	Parameters:
	Length of interval:
	Reference epoch:
Geocentre	A priori model:
	Estimation:
Constraints	

EARTH ORIENTATION PARAMETERS	
Precession	Apriori model:
	Interpolation:
	Estimation:
Nutation	Apriori model:
	Interpolation:
	Estimation:
	Length of interval:

```
|                   | Reference epochs:
|-----------------------------------------------------------------------------
| Polar motion      | Apriori model:
|                   |---------------------------------------------------------
|                   | Interpolation:
|                   |---------------------------------------------------------
|                   | Polar motion rates:
|                   |---------------------------------------------------------
|                   | Estimation:
|                   |---------------------------------------------------------
|                   | Length of interval:
|                   |---------------------------------------------------------
|                   | Reference epochs:
|-----------------------------------------------------------------------------
| Universal time    | Apriori model:
|                   |---------------------------------------------------------
|                   | Interpolation:
|                   |---------------------------------------------------------
|                   | LOD:
|                   |---------------------------------------------------------
|                   | Estimation:
|                   |---------------------------------------------------------
|                   | Length of interval:
|                   |---------------------------------------------------------
|                   | Reference epochs:
|-----------------------------------------------------------------------------
| Subdaily EOPs     |
|                   |
|-----------------------------------------------------------------------------
| Constraints       |
|                   |
==============================================================================

------------------------------------------------------------------------------
|                          INERTIAL REFERENCE FRAME                          |
|============================================================================|
| Apriori values    |
|                   |
|-----------------------------------------------------------------------------
| Datum definition  |
|                   |
|-----------------------------------------------------------------------------
| Radio sources     |
| used for          |
| realization       |
|-----------------------------------------------------------------------------
| Estimation        |
|                   |
==============================================================================

------------------------------------------------------------------------------
|                   OTHER PARAMETERS (MODELING & ESTIMATION)                 |
|============================================================================|
| Orbits            |
|                   |
|-----------------------------------------------------------------------------
| Troposphere       | A priori model:
|                   |---------------------------------------------------------
|                   | Met data input:
```

	Estimation:
	Mapping function:
Ionosphere	
Clocks	
Gravity field	

MEASUREMENT MODELS	
Observables	Data weighting:
	Elevation cutoff:
	Sampling rate:
Biases	Range:
	Time:
	Tropospheric:
Relativity correction	
Time argument, relativity scale	
Satellite centre of mass correction	
Satellite phase centre calibration	

REFERENCES: