Combination at the Observation Level

IERS Working Group

Status, results, challenges of the Combination at the Observation Level WG (COL)

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Background history

2000 – PhD work on combination at the observation level (Ph. Yaya/GRGS)

2002 – creation of the IERS Combination Research Centres (11 CRCs)

2004 – IERS proposal of Combination Pilot Project (CPP)

2005 – routine combination processing within GRGS

2008 – proposal for creating a WG on Combination at observation level

2009 (21-22 October) – kick-off meeting of the COL-WG / Warsaw

2010 (3 June) – intermediate meeting / Vienna

2010 (9-10 December) – 2nd COL meeting / Munich

2011 (5 April) – intermediate meeting / Vienna

2011 (21-22 November) – 3rd COL meeting / Paris

COL objectives

COL-WG major tasks will be **to study methods and advantages of combining techniques at the observation level**, searching for an optimal strategy to solve for geodetic parameters.

Demonstration is based on **weekly combined SINEX files** (containing unconstrained **normal equations** of station coordinates, Earth rotation parameters, nutation parameters and eventually quasar coordinates) from all space geodetic techniques together (SLR/LLR, GNSS, VLBI, DORIS).

Combination at the observation level is equivalent to the normal equation level under the condition that **all common parameters must be combined together** (inclusive tropospheric parameters for instance).

Roadmap of COL (from the charter)

1) review the approach of the various groups
and their capability to process two or more techniques.

2) elaborating benchmarks
to intercompare results between groups from the same data set.

3) insuring SINEX compatibility
between techniques and with the international technique services and IERS.

4) establishing common processing standards
for all techniques in order to guarantee homogeneity and consistency.

5) optimizing and unifying parameterization
for instance for tropospheric parameters in order to minimize globally the degree of freedom of the whole inverse system and to reach consistency.

6) studying the appropriate weighting between techniques
and the use of local ties or identical satellites tracked by several techniques.

7) studying stabilization methods
and looking for high temporal resolution of parameters.

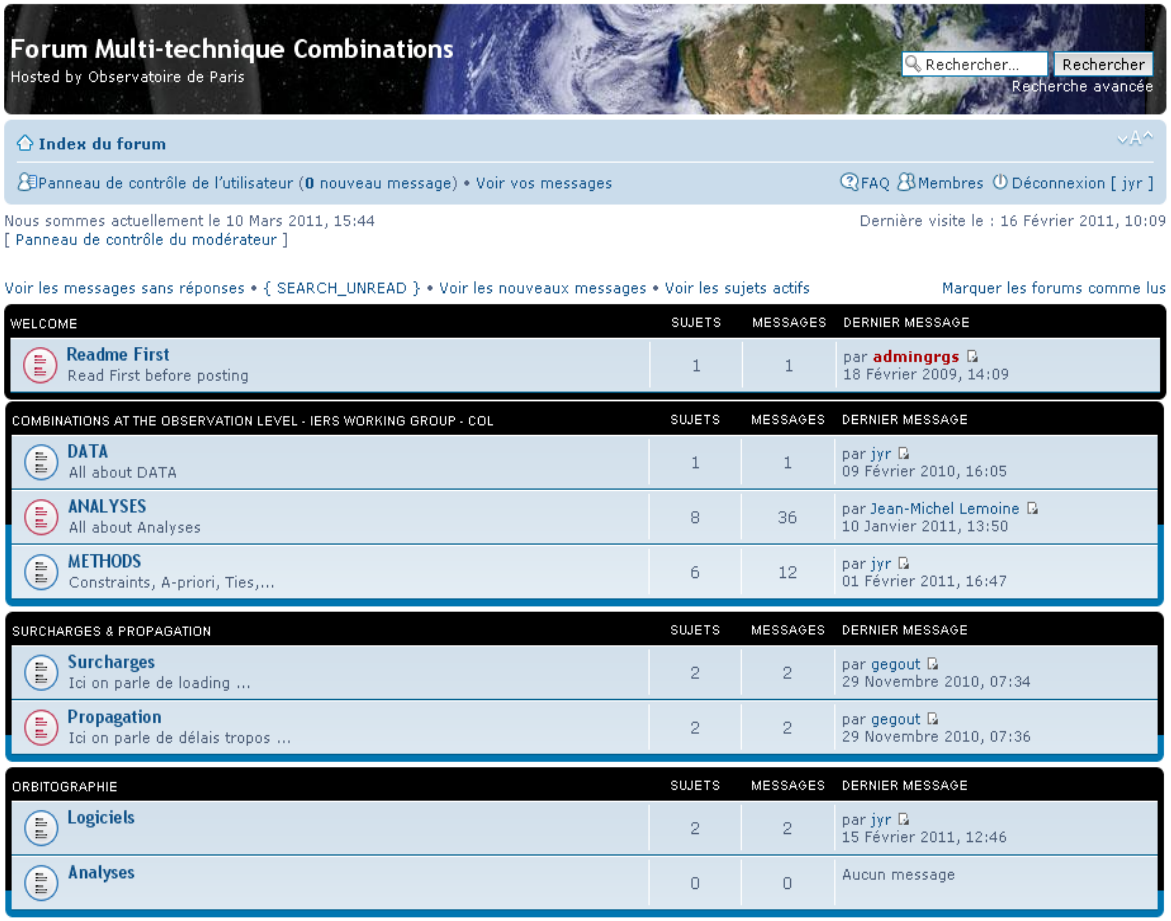
8) evaluating and comparing results
to search for compatibility between groups.

9) organizing routine operations
for a new TRF realization, either in the framework of the next ITRF or as ITRF assessment.

COL-WG Participants and software packages

Analysis Centres	Techniques	Software
AIUB/BKG	SLR, GNSS	Bernese 5.1
DGFI	SLR	DOGS 5.0
	VLBI	OCCAM 6.1 LSM + DOGS 5.0
ESOC	SLR+GNSS, +DORIS	NAPEOS
GFZ	SLR+GNSS	EPOSOC 06.61
GRGS	SLR,GNSS,VLBI,DORIS	GINS / DYNAMO
ASI	SLR	GEODYN/SOLVE
TUW	VLBI	VieVS
GSFC	SLR,GNSS,VLBI,DORIS	GEODYN/SOLVE
Combination Centres		
DGFI		DOGS-CS
GRGS		DYNAMO

Forum news at: http://grgs.obspm.fr/forum/



delivery of SINEX through the ftp server ftp://hpiers.obspm.fr/iers/eop/grgs/

First actions of the COL-WG (2010)

To intercompare results of different software packages:

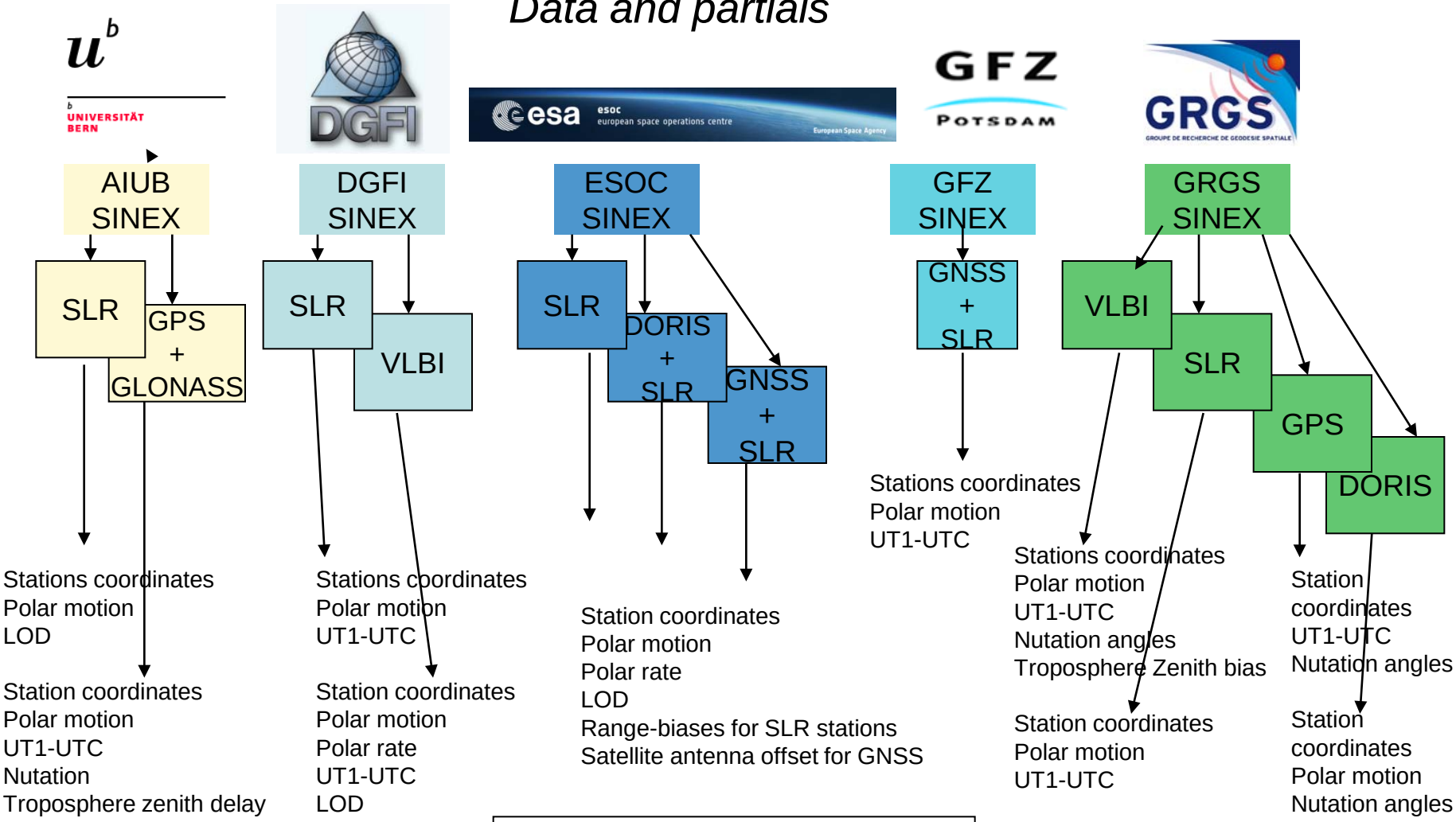
- **Defining benchmarks:** the period chosen for establishing benchmarks is **from August 10 to August 30, 2008**. It includes the intensive **CONT08 VLBI period** (from 12 to 26/08/08). Combined SINEX should be delivered per week, separated per technique.

- **Reviewing the approach of the various groups:** models, standards, methods, parameterization and defining homogeneous processing between groups

- **Defining parameters:** the non reduced parameter sets should include EOP (piece-wise linear pole, UT1 and nutation parameters per day), station coordinates (per week), troposphere zenith delay ZTD (per hour). In order to reduce the size of SINEX files, troposphere parameters of non colocated GPS stations should be previously reduced.

Analysis Centers participating (in 2010)

Data and partials



SLR: Lageos 1/2

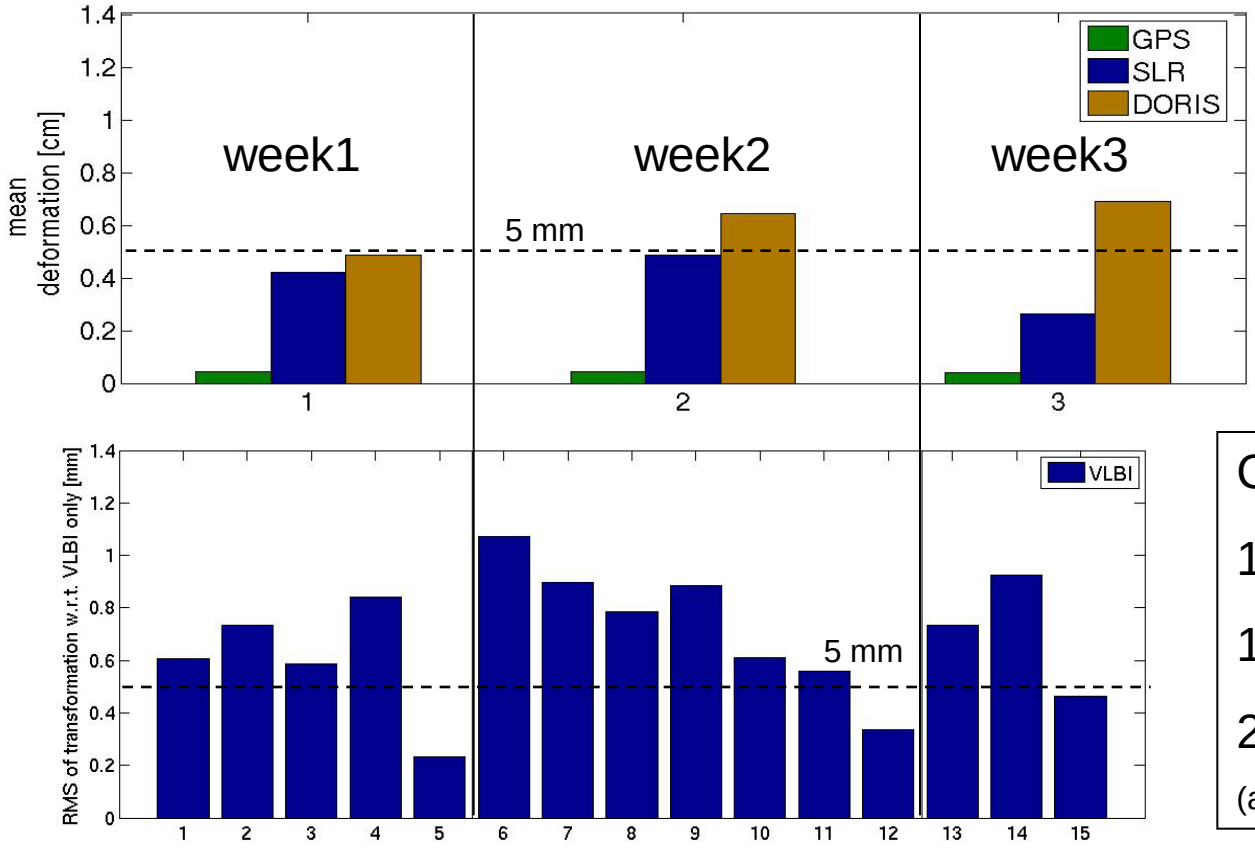
DORIS: SPOT-2/4/5, Envisat, Jason 2

GNSS: GPS & GLONASS

Deformation of the network due to combination

Comparison to single technique solutions

[cm]



Co-locations:

12 GPS-VLBI

17 GPS-SLR

25 GPS-DORIS

(applied when < 25mm)

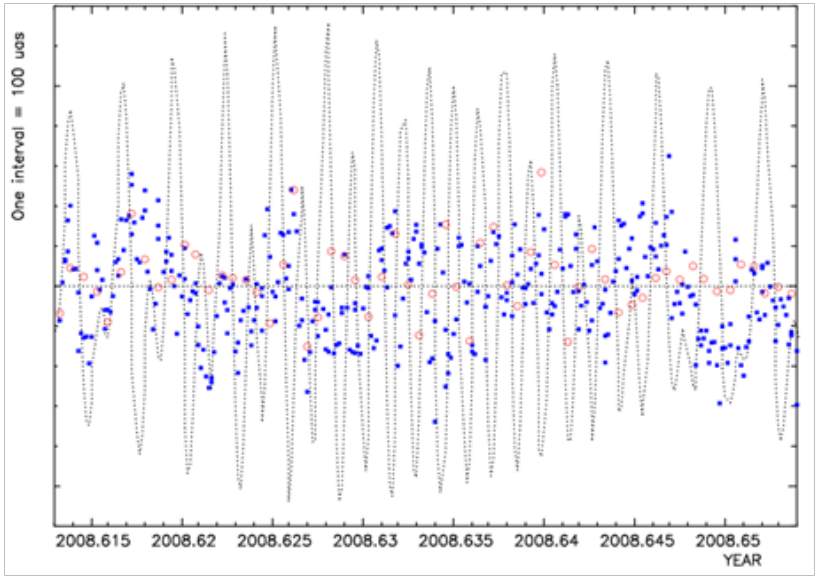
Conservation of datum:

Origin: SLR (< 3mm)

Scale: SLR (< 1mm) + VLBI (~0)

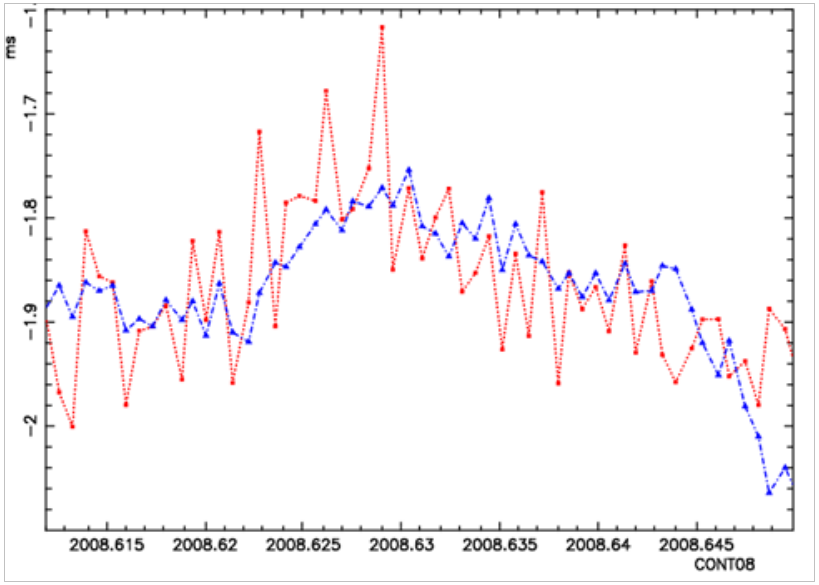
Orientation: NNR

High frequency EOP results at OP/GRGS



X-Pole sub-diurnal residuals to the IERS-Convention 2010 model over CONT08. GRGS combined (red), OP-VLBI (blue) and the complete diurnal/sub-diurnal model in dash lines.

They likely show the inaccuracy of the oceanic model at the level of 20-30 uas. According to de Viron et al. some part of the variations can be attributed to non-tidal fluctuations in water height and currents partly caused by atmospheric wind and pressure variations.



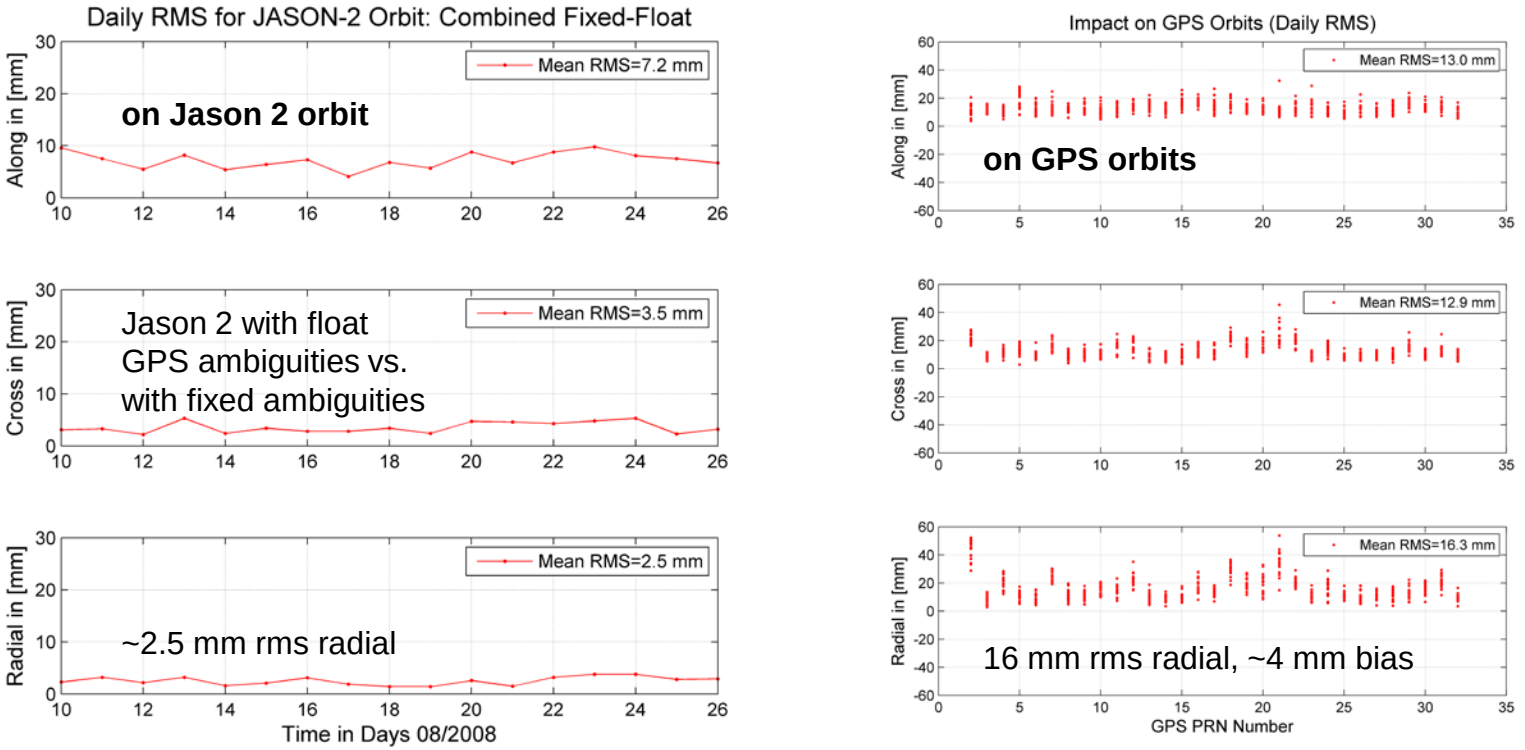
Length of Day derived from the 6-hour UT1 VLBI+GPS combination (red) compared to the atmospheric-based LOD (blue) derived from NCEP observations.

High-frequency variations that appear can be attributed in part to inaccuracy in the oceanic model and to noise at some level. Partly, they can be attributed to the atmosphere, which bring variations of the order of 30 to 40 µs.

Impact of including Jason 2 in GPS orbit and clock determination process in determining the TRF

According to an ESOC/ESA study (D Svehla & al.):

- Jason 2 is an ideal LEO satellite for the Combination GPS-SLR-DORIS. It is like an orbiting station connecting all GPS satellites in only 90 min.
- Adding Jason 2 data has similar effect as ambiguity resolution in the global network. Fast changing geometry decorrelates the system.



Impact of Jason 2 + GPS combined processing over the CONT08 period

Summary

The COL-WG wants to be a forum for:

- bringing together the expertise of groups able to process and to combine several space techniques (SLR/LLR, GNSS, VLBI, DORIS)

- evaluating software homogeneity (models, standards, parameterization, weighting…) for multi-technique processing

- defining some common parameterization wrt all techniques: EOP (x-hourly sampling), nutation (model) parameters, stations, quasars, troposphere parameters…

- discussing and testing combination strategies of different techniques involving ground and space ties (Jason 2 and GRACE-A/B, GPS-35/36)

Next COL workshop on November 21-22 at the Paris Observatory