CNES-CLS Dynamical modelling of GPS orbits

and

SLR Residuals

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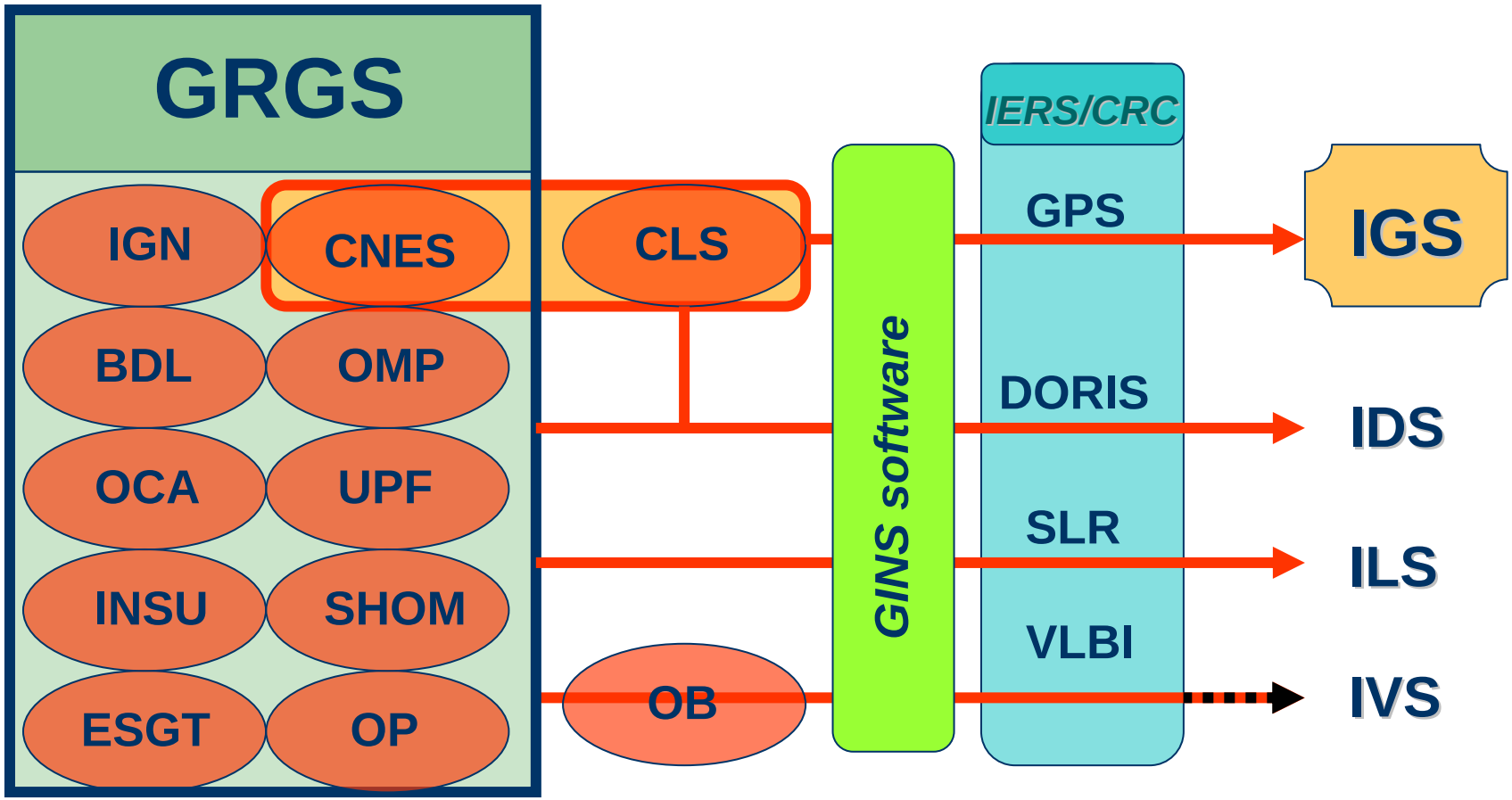
CNES-CLS IGS Analysis Center: igsac-cnes.cls.fr



- Submission & evaluation started July 2007
- joined officially IGS ACs week 1478

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Motivation of this study

Several months of evaluation of CNES-CLS products indicate that the main discrepancies are on orbit products :

- **around 3.5 – 4 cm WRMS3D vs IGS final orbits**
- **a systematic scale of around 1 ppb (~2.64 cm at GPS altitude) exhibits between CNES-CLS and IGS orbits**

Pole and station coordinate solutions are very comparable to any other AC.

We wanted to investigate the source of the scale vs IGS :

- dynamic parameters modeling (i.e. SRP parameterization)
- dynamic modeling (i.e. ALBEDO force model)

using SLR observations.

SLR tracking of SV35 and 36

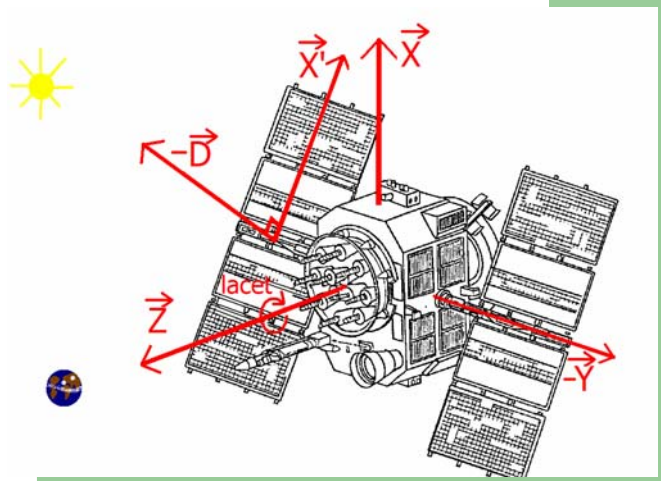
- **SLR residual analysis is supposed to give an independent evaluation of the precision and accuracy of the computed orbit**

  (up to a level of ~ 5 mm)
- **In the framework of GRGS team activities SLR data are routinely processed using the GINS software (ILS, EIGEN gravity field modeling,…)**

- **Questions :**
  - Origin of a systematic bias between SLR data and IGS and ACs orbits solutions ?
  - What is the impact on GPS orbits of considering or not ALBEDO forces in the orbit computation ?
  - Is the orbital precision derived from the statistical distribution of SLR residuals consistent with the expected value ?

Dynamical model and processing strategy

- **Full description available at : http://igscb.jpl.nasa.gov/igscb/center/analysis/grg.acn (see also Jim Ray's presentation in this session)**
- **Main significant differences:**
  - 48h Arc length ; 15mn data rate ; real ambiguities
  - Radiation pressure :
    - Solar direct + Earth albedo and IR flux
    - GINS Box and wing model (19 planar surfaces)
    - Nominal satellite attitude (no yaw steering model)
    - Empirical parameters (6+6 per arc) :
      - *1 scale/arc in factor of solar pressure*
      - *1 {Y}-bias/arc*
      - *1/rev. sin & cos in {X'} {D}*
    - Albedo and IR :
      - *Systematic ~ 5. 10^{-10} m/s/s mainly in {Z}*
      - *Flux from ECMWF 6h grids*
      - *Include overcast and umbra effects*



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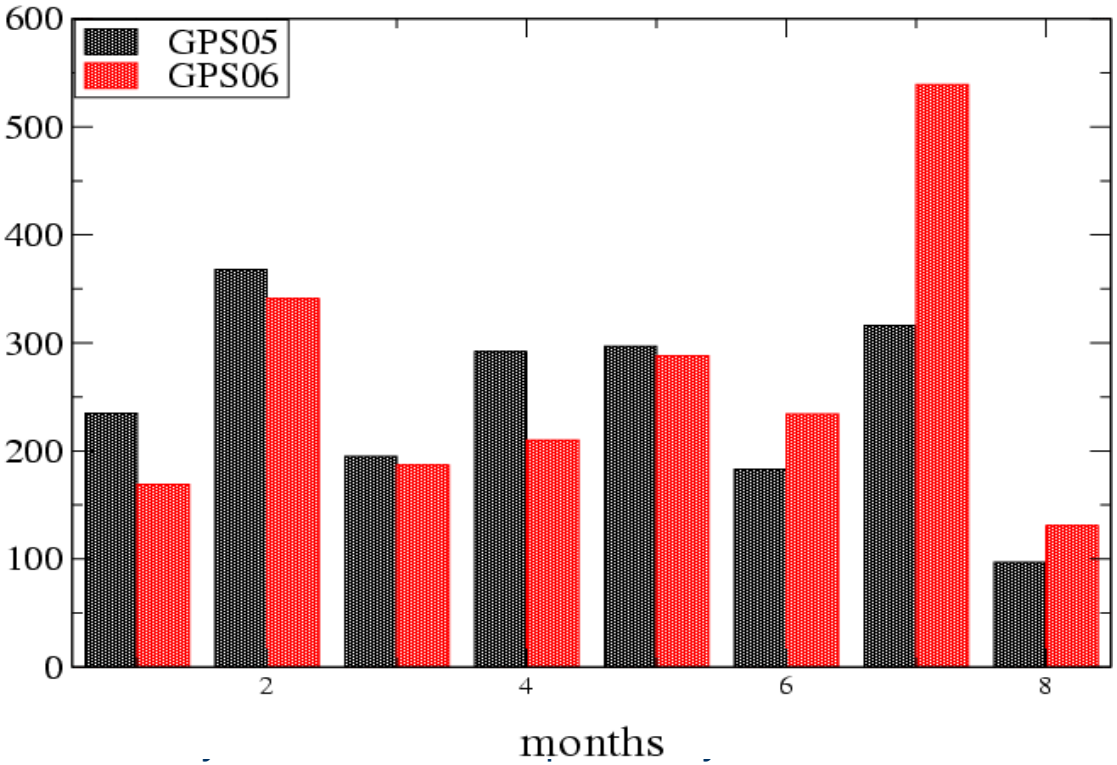
SLR data set and SLR processing strategy

- Data from 10 October 2007 to 10 may 2008 ; (2099/1983) valid normals points for GPS(35/36).
- Data weigthing : station quality factor
  + from LAGEOS residuals analysis
  + uncertainties from ITRF2005 coord.
- Fixed IGS or GRG orbits + one SLR bias per station



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SLR CoM offset

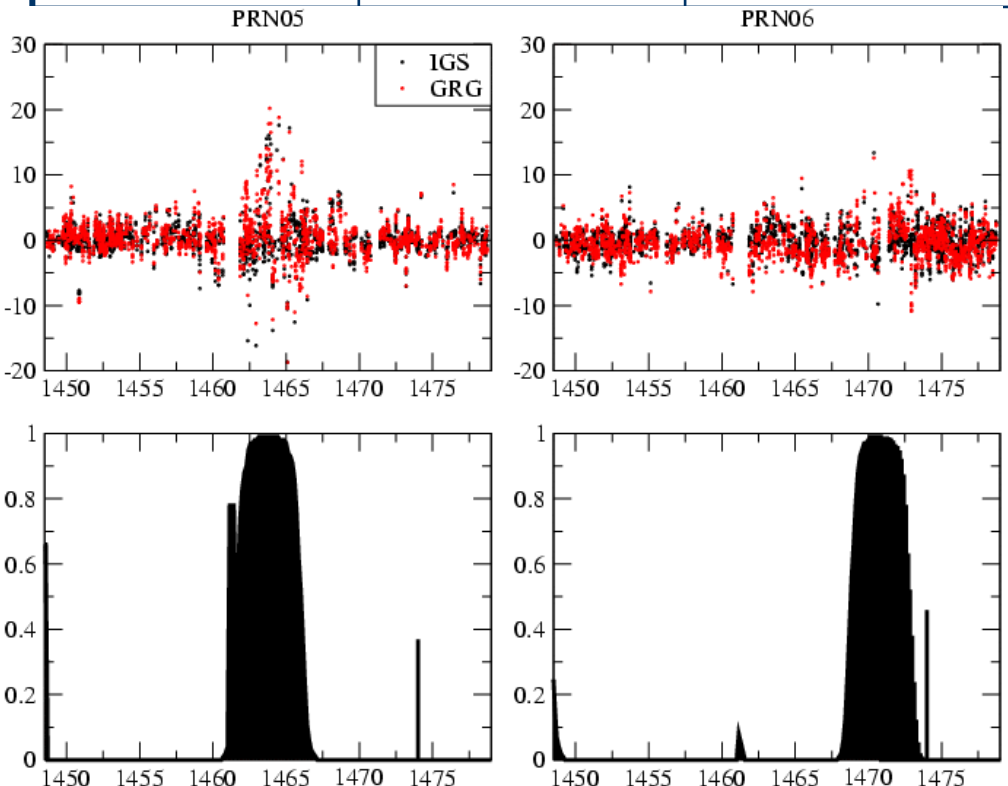
- **CoM offsets :**

  XY values : 862.6 mm / -524.5 mm

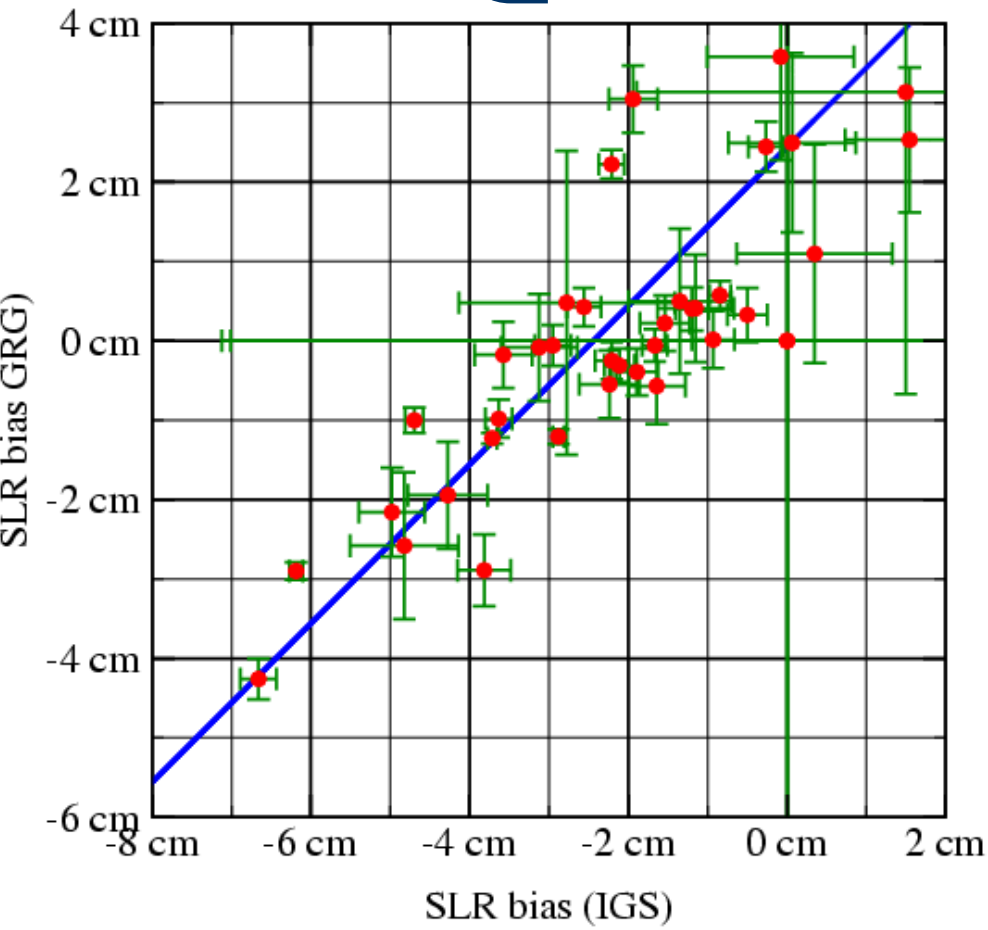
(values in millimeters)	GPS35	GPS36
ILRS Z axis (radial)(recomanded) (see also A. Davis & J. Trask, 08/2007).	669.5	671.7
Used Z axis (« old » values) used in this study.	658.4	658.4
Differences	11.1	13.3

Statistics on SLR residuals

(cm)	GPS35	GPS36	
GRG	2.88 (1983)	2.45 (2099)	Global
IGS	2.44 (1983)	1.98 (2099)	
GRG	1.72 (1516)	1.97 (1656)	Non-eclips periods
IGS	1.46 (1516)	1.77 (1656)	
GRG	4.65 (467)	3.65 (459)	Eclips periods
IGS	3.57 (467)	2.27 (459)	



SLR adjusted biases



⇒ **SLR bias differences :**

IGS=GRG -2.4 cm (0.91 ppb)

⇒ **GRG bias nearest from 0 cm (i.e. compatible with Laser Station calibration)**

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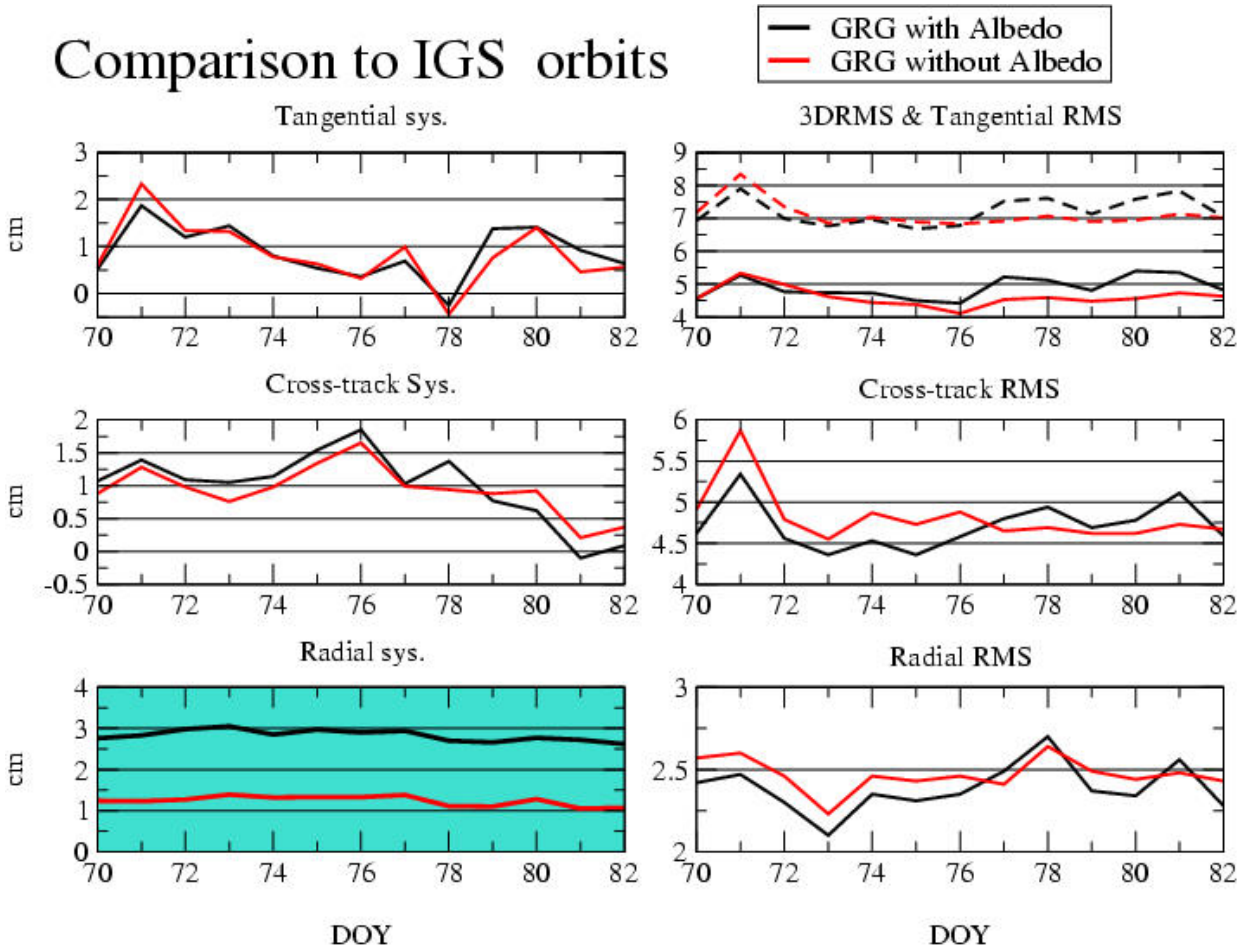
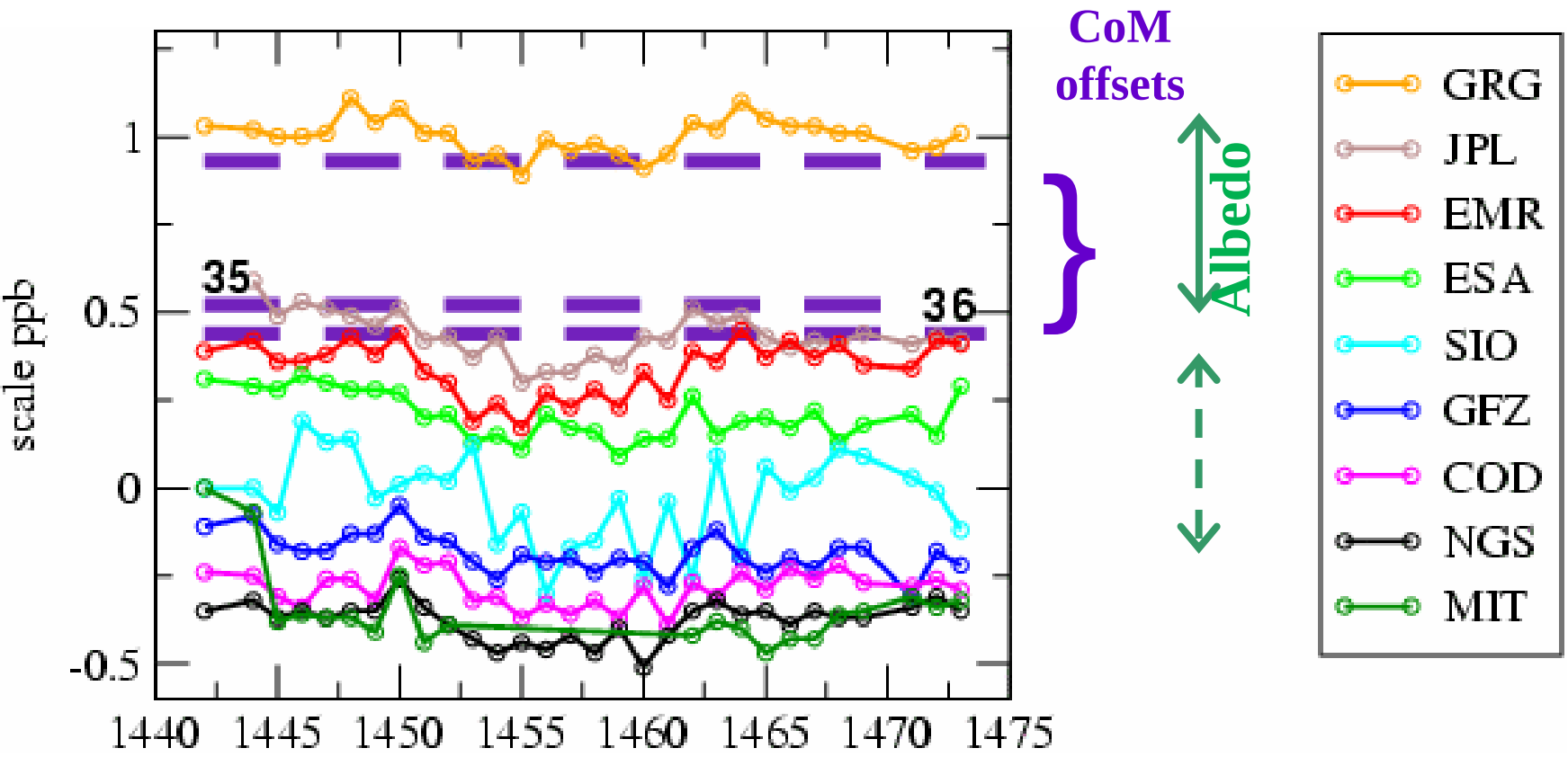
Dynamic impact of Albedo force.



➔1.6 cm (0.6 ppb) in syst. radial with nearly no change for other statistics.

All values together…



JPL ESA and GRG use an Albedo model in their orbit processing.

(Scales computed by G. Gendt & T. Nishan)

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CONCLUSIONS

- SLR bias still not compatible with IGS scale
- Discrepancies between ACs remain large (1 ppb)
- CNES-CLS orbit closer to « old » CoM offset value
- Albedo forces explain 0.6 ppb of the scale
  and maybe part of scale discrepancies between ACs.
- CNES-CLS scale is less than 0.5 ppb relatively to Laser data
- ACs with Albedo modeling (except EMR) are closer to current laser CoM offset value
- Radial error of CNES-CLS orbits increase SLR RMS by 2.5 mm

Orbits vs IGS Combined orbit:

TX = 2 +/- 1.5 mm ; TY = 0.3 +/- 1 mm ; TZ = -2 +/- 3 mm

RX = -17 +/- 35 uas ; RY = -75 +/- 65 uas ; RZ = 38 +/- 60 uas

Scale = 1 + /- 0.05 ppb ; WRMS3D : 3.2 +/- 0.35 cm

Stations vs IGS05 (bias + rms)

Nord = 0 +/- 2.5 mm ; Est = 0 +/- 1 mm ; Up = 0 +/- 6 mm

Pôle vs IGS solution (bias + rms)

Xp = 5 +/- 25 uas ; Yp = 43 +/- 30 uas ; LOD = -1.5 +/- 32 usec

Xprate = -56 +/- 90 uas/day ; Yprate = -6.5 +/- 90 uas /day

=> Main discrepancy concern orbits scale and WRMS.