Multi Technique Comparison of Jason-1 Orbits

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Objectives of IGS Jason-1 orbit campaign

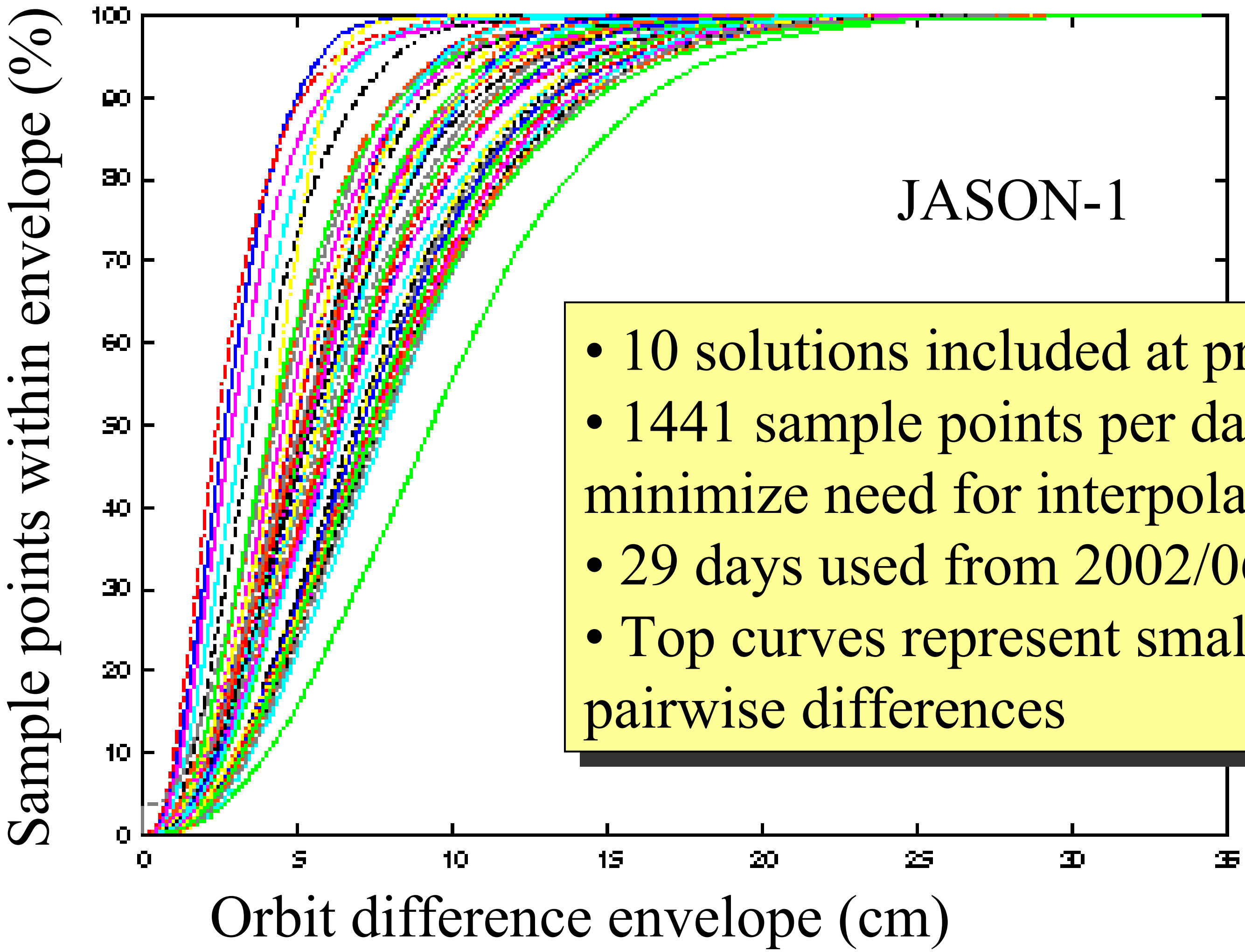
- Carefully check for biases between reference systems of SLR, DORIS, GPS and possible altimetry.
- Assess absolute orbit accuracies that can be achieved by different tracking data sets.
- Provide reliable set of reference orbits.
- Assist the IGS LEO groups and others in establishing JASON data processing.

Orbit comparisons

- RMS difference between two independent solutions gives upper limit orbit precision.
- Three types of comparisons:

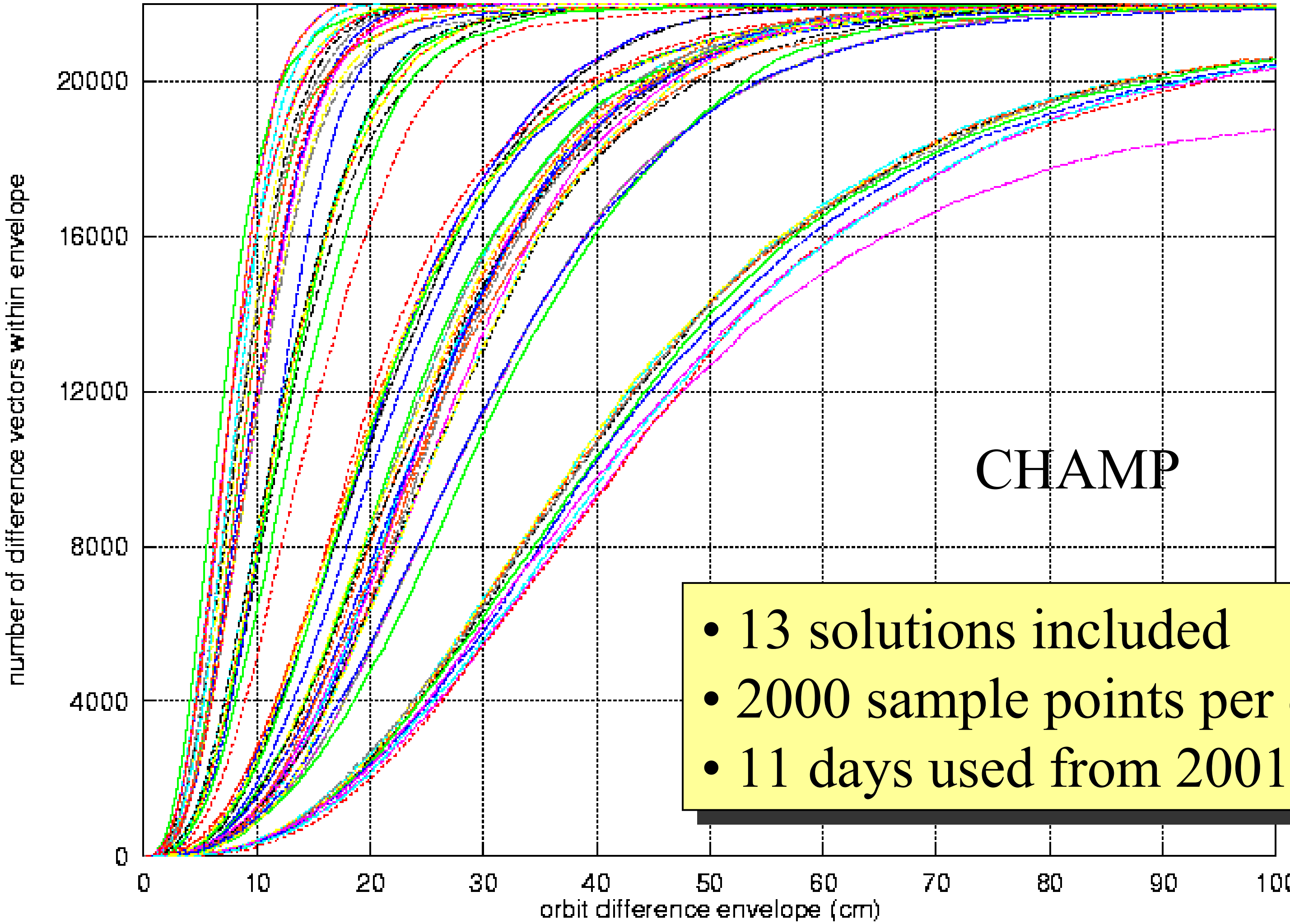
1. Two full solution arcs.
2. Overlap comparison between consecutive arcs of single solutions.
3. Same as 2 but different solutions .

Pairwise orbit comparisons – example (1)



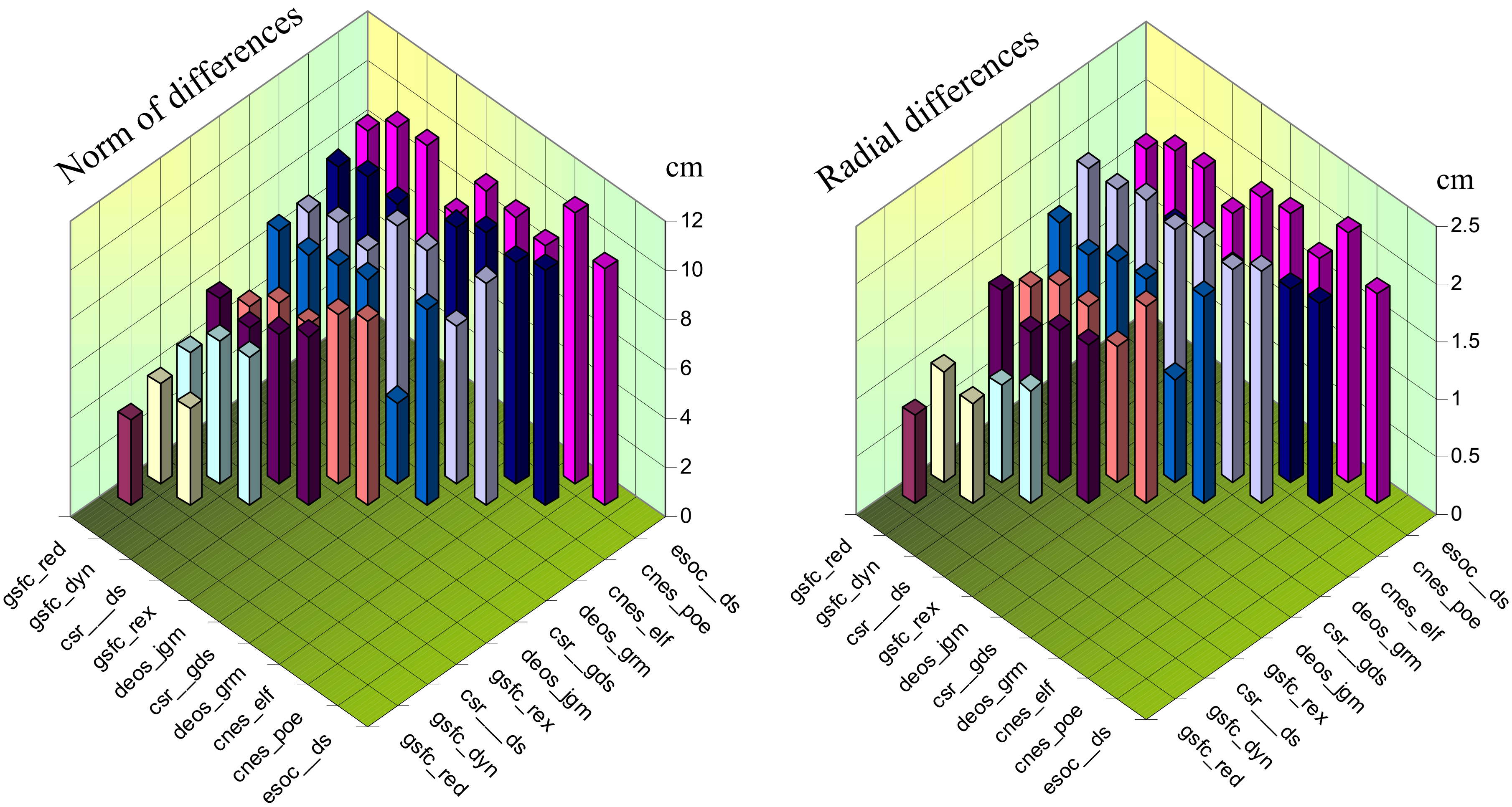
- 10 solutions included at present
- 1441 sample points per day to minimize need for interpolation
- 29 days used from 2002/06/03
- Top curves represent small pairwise differences

Pairwise orbit comparisons – example (2)



- 13 solutions included
- 2000 sample points per day
- 11 days used from 2001/05/20

Pairwise orbit comparisons – example (3)



Tracking data analysis (1)

Orbit comparison gives upper limit to orbit error, tracking data sets lower limit.

For Jason, residuals for nine observation types could be considered:

- SLR, DORIS, GPS (PR/Ph/SD/DD), Altimeter (height, SXO, DXO)
- XO analysis presently not available at ESOC
- SLR best data set for verification purposes

Tracking data analysis (2)

SLR analysis for JASON campaign:

- Orbit fixed to input solutions
- Exactly the same data set used in all cases(*)
- Station coordinates: ITRF2000
- Earth orientation: IERS 96
- Spacecraft attitude: quaternions
- *CSR GPS solution has a two day data gap

Tracking data analysis (3)

4559 SLR observations used, RMS & mean in cm

centre	data	remark	RMS	mean
CSR	doris, slr, gps		1.817	0.216
GSFC	doris, slr	dynamic	2.014	0.105
CSR	doris, slr		2.061	0.110
GSFC	doris, slr	reduced dynamic	2.064	0.040
ESOC	doris, slr		2.346	0.180
GSFC	doris, slr, sxo	reduced dynamic	2.498	0.068
DEOS	doris, slr	grim5	2.688	0.231
DEOS	doris, slr	jgm3	2.724	0.362
CNES	doris, slr	poe	2.768	-0.099
CNES	doris, slr		2.968	-0.335
CNES	doris, slr, gps		3.206	-0.128

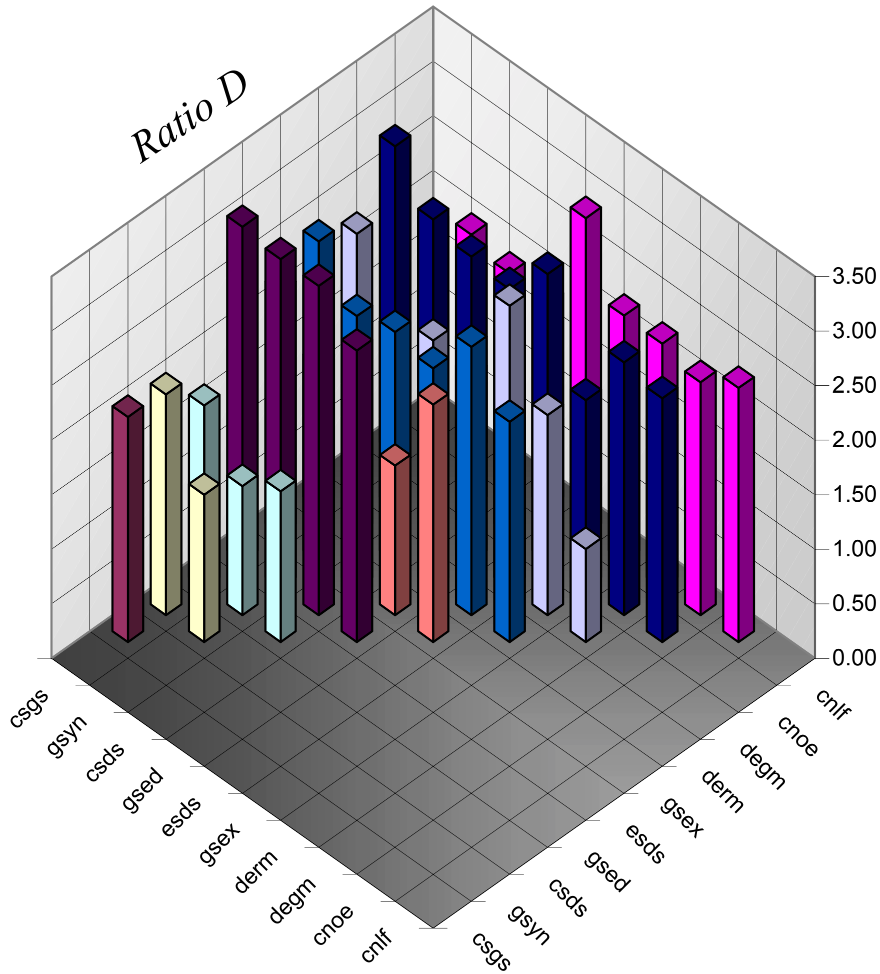
Absolute precision estimate (1)

- Pairwise orbit difference ***RMS*** can be interpreted as pairwise orbit error,

$$RMS_{AB} = \sqrt{RMS_A^2 + RMS_B^2}$$

- Similar pairwise ***rms*** can be constructed for SLR residuals
- If D = ***RMS / rms*** between pairwise values is constant, individual orbit errors follow from $\mathrm{RMS}_\mathrm{A} = \mathrm{D} * \mathrm{rms}_\mathrm{A}$

Absolute precision estimate (2)



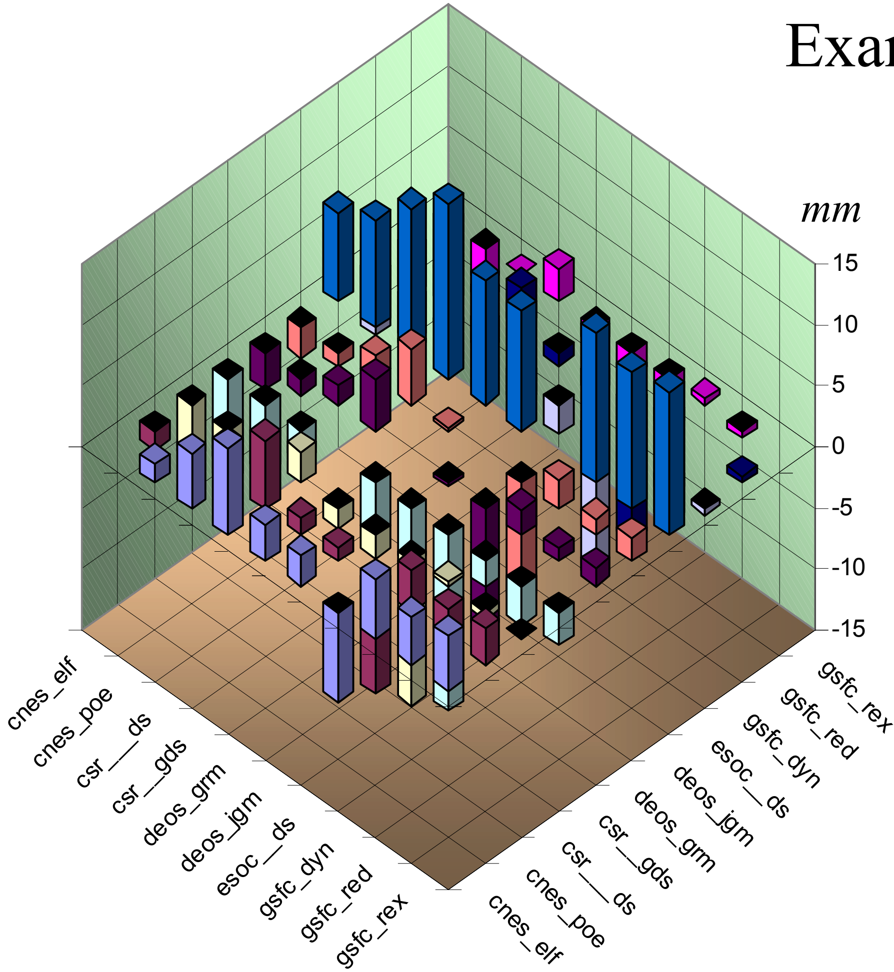
- Some dependencies can be noticed
- Mean value of D : 2.10
- Sigma for D is high: 0.48 (23%)
- ESOC solution not independent from current SLR analysis

cm	1-way SLR	orbit error	sigma
csgs	1.82	3.82	0.88
gsyn	2.01	4.23	0.97
csds	2.06	4.33	0.99
gsed	2.06	4.34	1.00
esds	2.35	4.93	1.13
gsex	2.50	5.25	1.21
derm	2.69	5.65	1.30
degm	2.72	5.72	1.31
cnoe	2.77	5.82	1.34
cnlf	2.97	6.24	1.43

Collocation of reference frames (1)

- POD solutions based on different data sets (SLR, DORIS, GPS, Altimetry) may reflect reference frame offsets
- 7-parameter transforms are estimated between all compared solution pairs
- Statistics over these results can indicate reference frame deficiencies in individual solutions, in particular Z-bias

Collocation of reference frames (2)



Example for Z-axis translation

solution	***mean offset***
cnes_elf	2.456
cnes_poe	0.952
csr___ds	-2.052
csr__gds	-4.651
deos_grm	-0.429
deos_jgm	-0.108
esoc__ds	9.738
gsfc_dyn	-2.496
gsfc_red	1.352
gsfc_rex	-0.388

Summary

- Current results for JASON are preliminary, most IGS groups have only worked on JASON data since October 2002
- Initial results are encouraging
- Number of contributions is expected to grow considerably, up to ~30 solutions
- See nng.esoc.esa.de/gps/igsleo.html for latest results and contributions