TOWARDS THE 1-CM ORBIT GOAL

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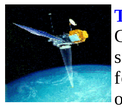


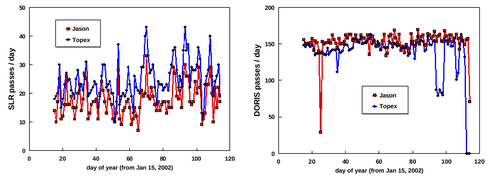
TOPEX/POSEIDON (T/P) orbits produced at GSFC with a 2-3 cm radial accuracy, have become a standard for other altimeter satellites, and are useful for evaluating orbit improvement strategies. T/P orbits are based on SLR and DORIS tracking.

Jason-1 was injected into the T/P orbit, flying just 72 seconds ahead of T/P for verification. The Mission objective is T/P level accuracy, and goal is to reach 1-cm orbits. SLR, DORIS, and GPS tracking are available.

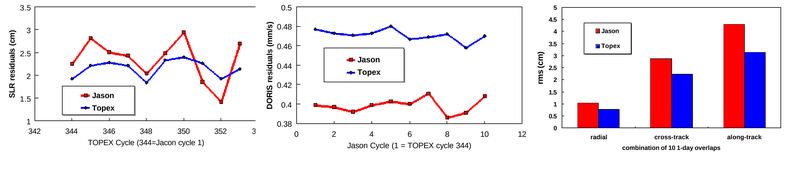
Jason and T/P POD

- **Intercomparison orbits are based on T/P standards and ITRF2000**
- **Initial tests show Jason SLR+DORIS orbits are close to T/P accuracy even before tuning**
- **DORIS data contributes more to Jason POD**
- **Jason SLR measurement modeling and data weighting needs further study**
- **Our Preliminary GPS-only Jason POD solutions show very good agreement with SLR+DORIS solutions (1.38 cm RMS for Cycle 9)**

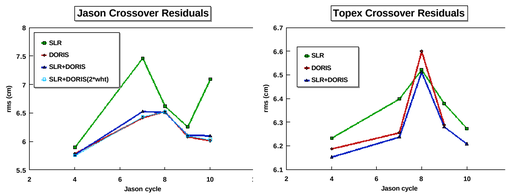
Jason shows weaker SLR, but stronger DORIS tracking

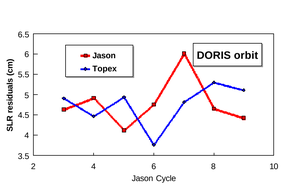


Example Jason and T/P SLR+DORIS POD Performance

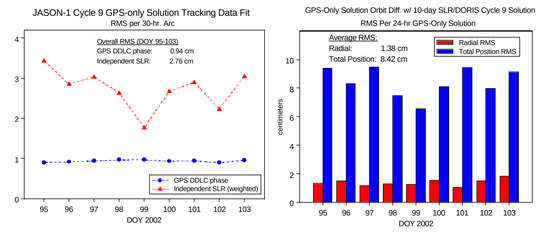


Altimeter crossover and SLR residuals offer an independent measure of orbit accuracy

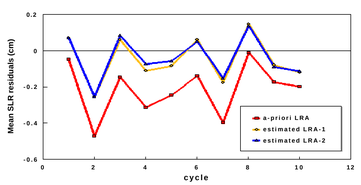




Example Jason POD based on GPS Tracking data analysis



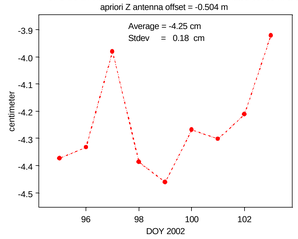
SLR analysis shows Jason LRA offset and possibly Center of Mass can be corrected



LRA offset estimated using cycles 1-6 SLR data

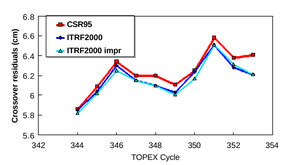
description	spacecraft body-fixed coordinates (cm)			SLR residuals (cm) over cycles 1-6		SLR residuals (cm) over cycles 7-10 (independent data)	
	X	Y	Z	Mean	RMS	Mean	RMS
a-priori CoM	94.2	0.0	0.00				
a-priori LRA	117.1	59.8	68.28	-0.227	2.455	-0.173	2.327
estimated LRA-1	115.1	59.8	68.76	-0.041	2.357	-0.038	2.293
formal sigma	0.17	0.17	0.10				
recomputed CoM-1	96.2	0.0	0.00				
estimated LRA-2	116.6	59.8	68.84	-0.028	2.348	-0.037	2.293

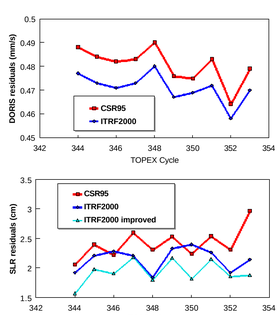
Analysis shows Jason GPS antenna phase center offset must be corrected

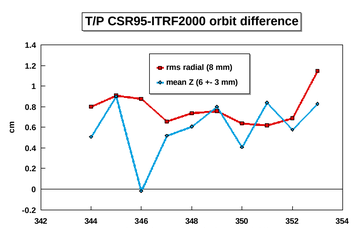


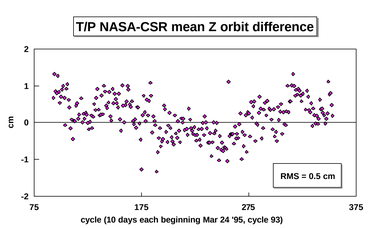
ITRF2000

ITRF2000 promises an improvement over the current PODPS CSR95 SLR and DORIS station reference. The small orbit Z-shift is close to the expected POD centering accuracy but may need further study. Improvements to a small number of ITRF2000 stations further improve POD and may warrant additional study



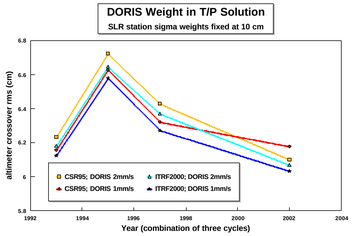






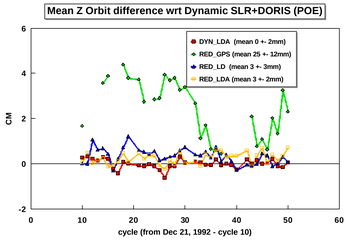
Orbit Improvement

- **Increasing DORIS weight improves SLR+DORIS POD**
- **ITRF2000 offers an improvement over the CSR95 station positions**
- **T/P SLR+DORIS reduced-dynamic POD solutions appear more accurate than GPS solutions (from JPL)**
- **T/P SLR+DORIS+Crossover reduced-dynamic orbits appear to be better than 2-cm accuracy**
- **Simulations indicate 1-cm orbits can be achieved with sufficiently precise and dense tracking**



38 TOPEX cycles spanning Dec '92 - Jan '94

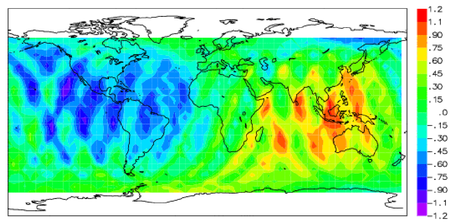
Solution Strategy (using pgs7727, ITRF2000)		Number cycles	RMS DORIS (mm/sec)	RMS SLR (cm)	RMS Crossover (cm)	Collinear Altimeter Analysis (adjacent cycle difference (cm))			
Name	Description					Mean	Standard Deviation	RSS wrt DYN_LD	Orbit Error estimate
DYN_LD	Dynamic SLR+DORIS	38	0.552	3.40	6.24	0.014	8.454	-----	2.5
DYN_LDA	Dynamic SLR+DORIS+Crossover	38	0.553	3.51	6.18	0.011	8.361	1.25	2.2
RED_GPS	Reduced-Dynamic GPS (from JPL)	29	-----	-----	-----	0.178	8.428	0.66	2.4
RED_LD	Reduced-Dynamic SLR+DORIS	38	0.551	3.61	6.20	0.020	8.407	0.89	2.3
RED_LDA [1]	Reduced-Dynamic SLR+DORIS+Crossover	38	0.551	3.03	5.88	0.019	8.263	1.79	1.7



Overlap Arc Test of Orbit Consistency
20 TOPEX cycles spanning Dec '92-July '93; 5.6 day arcs with 1 day overlap

Solution Strategy		RMS DORIS (mm/sec)	RMS SLR (cm)	RMS Crossover (cm)	RMS orbit overlap difference (cm)		
Name	Description				radial	cross-track	along-track
DYN_LD	Dynamic SLR+DORIS	.547	3.73	5.97	1.04	2.51	4.00
DYN_LDA	Dynamic SLR+DORIS+Crossover	.547	3.80	5.84	0.80	2.69	3.49
RED_LD	Reduced-Dynamic SLR+DORIS	.546	3.95	5.88	0.60	1.92	2.90
RED_LDA	Reduced-Dynamic SLR+DORIS+Crossover	.544	3.50	5.65	0.82	1.68	2.90

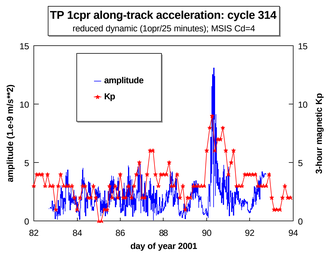
Radial Orbit Difference (cm)
RED_LDA - DYN_LD



Reduced-Dynamic strategy

The reduced-dynamic strategy calls for the constrained adjustment of a time series of empirical accelerations, and is only possible with sufficiently precise and dense tracking. **GPS**, **DORIS** and **altimeter crossover** data offer such density.

The example indicates recovered accelerations represent actual mis-modeled forces



Simulations indicate 1-cm orbits can be achieved if sufficiently precise and dense tracking data are available

Satellite / POD solutions Anticipated Force Model Error (Gravity model improvement)		Orbit Error RMS (cm) radial	cross track	along track
TOPEX	SLR	2.9	5.5	8.2
	GPS	2.0	3.7	6.0
	GPS+SLR	1.8	4.5	5.4
	Perfect Tracking	0.4	0.8	0.2
JASON	SLR	5.0	5.6	18.0
	GPS	2.1	3.6	6.1
	GPS+SLR	1.8	4.9	5.4
	Perfect Tracking	0.6	0.9	0.3