

Benchmarking Results (Phase II) and Status

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Phase II Solution Requirements

- Provide four orbital solutions adhering to strict modeling requirements in the benchmark plan
 - (A) Nominal Model integration
 - (B) Iteration of (A) for state vector and constant along-track accelerations, (Fixed EOP and Station Coordinates)
 - (C) Final Orbit Standard Version (as in (B) but adjusting EOP and Station Coordinates also)
 - (D) Final Orbit Optimal Version using analysis center dependent modeling (***) FULLY DESCRIBED (***)
- Solution D was optional

Phase II Solution Requirements

- Provide the following files with each solution:
 - A) Orbital parameters, station residuals and data corrections
 - B) Orbital parameters, station residuals and data corrections
 - C) Orbital parameters, station residuals and data corrections, and SINEX file with estimated station coordinates and EOP
 - D) Orbital parameters, station residuals and data corrections, and SINEX file with estimated station coordinates and EOP

Benchmark Evaluation Categories

- Orbit C would be used for the *'official'* test (i.e. no pass/fail for orbits A,B and D)
- **Note: Orbit C is not the BEST orbit, but if we use the same models, then we should get the same results.**
- Categories
 - Orbital Parameters (Radial, Cross, Along)
 - Range Corrections (tropospheric, relativity, CoM)
 - Residuals
 - Station Coordinates
 - EOP
- Pass/Fail Criteria (per Category) are to be developed

Benchmark Metrics

- Orbital parameters
 - Compare each component (i.e. radial, cross-track, along track) from each solution
 - RMS Difference
 - Mean Difference
 - No obvious systematics

Benchmark Metrics

- Range Corrections
 - CoM
 - Perfect Agreement (0mm)
 - May need to retest if the Signal Processing WG can provide site specific LAGEOS CoM corrections
 - Relativity Correction
 - RMS Difference
 - Mean Difference
 - No obvious systematics (e.g. no correlation with range)
 - Tropospheric Correction
 - RMS Difference
 - Mean Difference
 - No obvious systematics (e.g. no correlation with range)

Benchmark Metrics

- Residuals
 - RMS Difference
 - Mean Difference
 - No obvious systematics (e.g. discontinuities, temporal drifts)

Benchmark Metrics

- Station Coordinates

Each station position from each solution will be compared to ITRF2000 (i.e. the a priori condition).

- Site X Positions

- RMS agreement

- Site Y Positions

- RMS agreement

- Site Z Positions

- RMS agreement

- Site Heights

- Height agreement per site

Benchmark Metrics

- Earth Orientation Parameters (EOP)

All EOP solutions will be compared to C04.

- For X Pole, Y Pole and LOD
 - RMS Agreement
- UT1 (no pass/fail criteria)

Benchmark Phase II Solutions

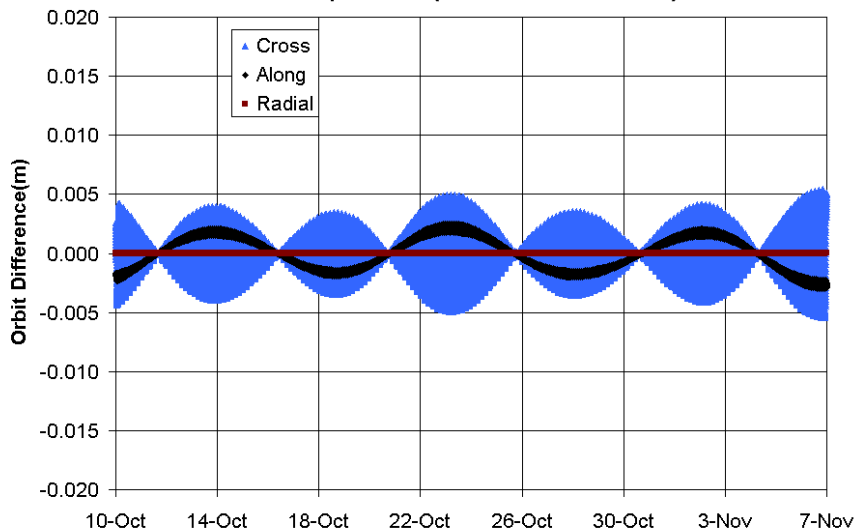
Analysis Center	Solution				Comments
	"A"	"B"	"C"	"D"	
ASI	V14	V14	V14	V14	
DGFI				V10	Developing required models
GEOS	V10	V10	V10	V10	
GFZ	V10	V10	V10	V10	
IAAK	V11	V11	V11		Developing required models
JCET	V11	V11	V12	V12	V11 had tight EOP constraints
NERC			V11		Developing tidal loading model

Benchmark Results (Orbit Parameters)

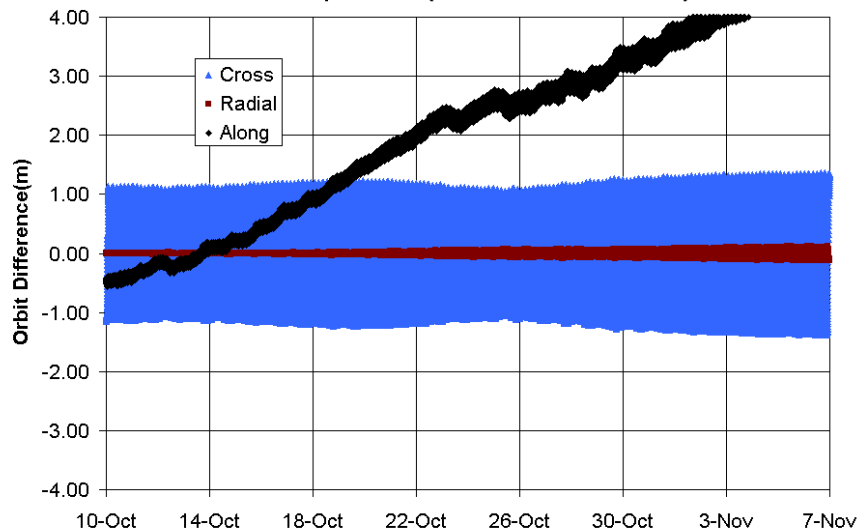
Note: All solutions compared to JCET.

Orbit 'A' Comparisons

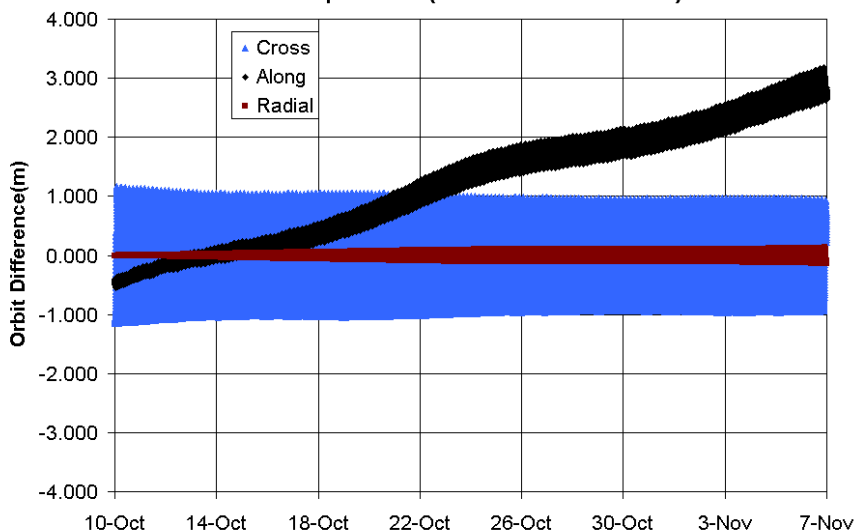
Orbit "A" Comparisons (JCET V11 vs ASI V14)



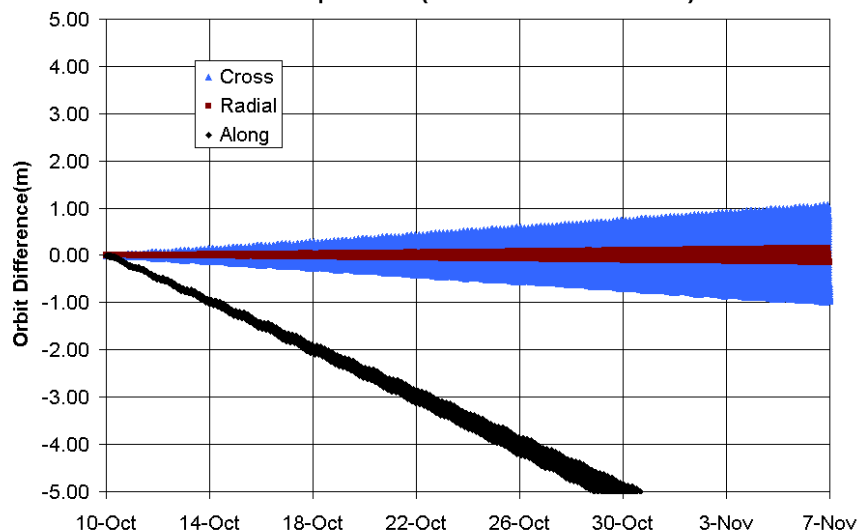
Orbit "A" Comparisons (JCET V11 vs IAAK V11)



Orbit "A" Comparisons (JCET V11 vs GFZ V10)

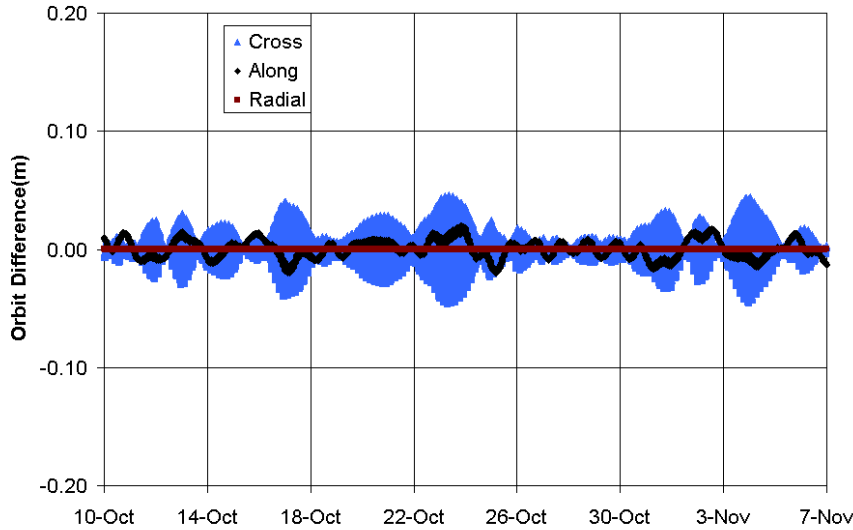


Orbit "A" Comparisons (JCET V11 vs GEOS V10)

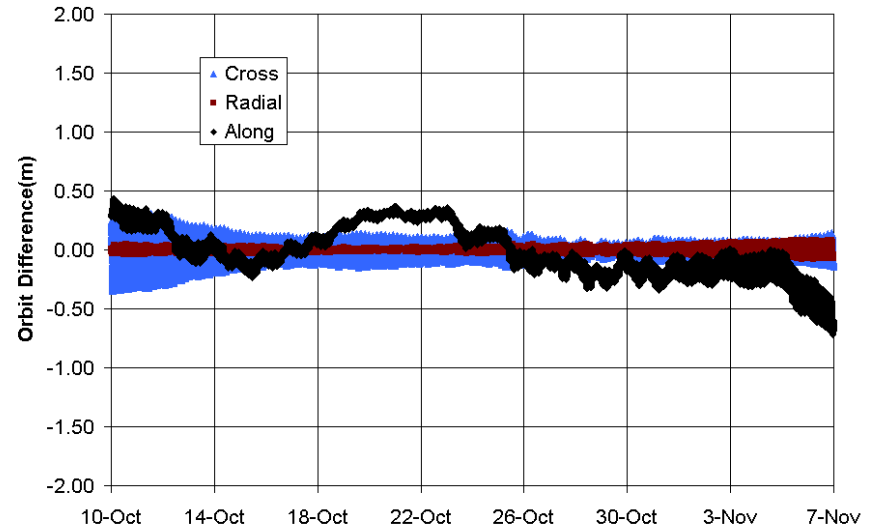


Orbit 'B' Comparisons

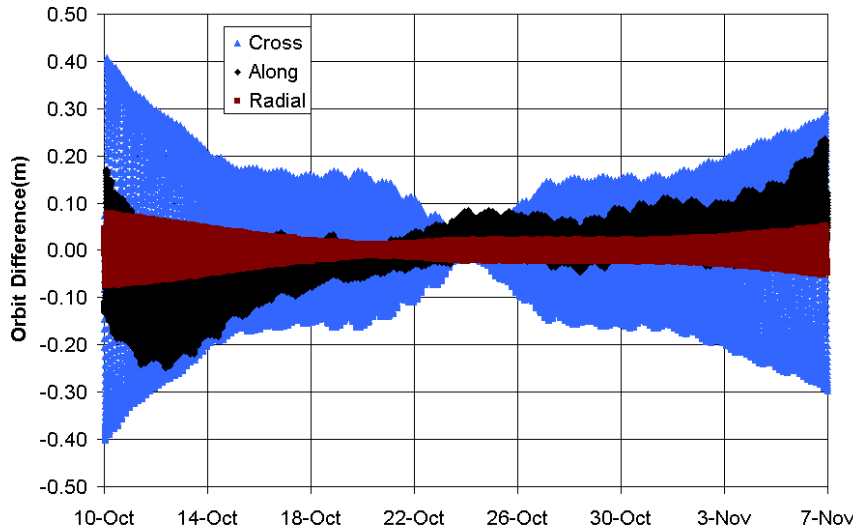
Orbit "B" Comparisons (JCET V11 vs ASI V14)



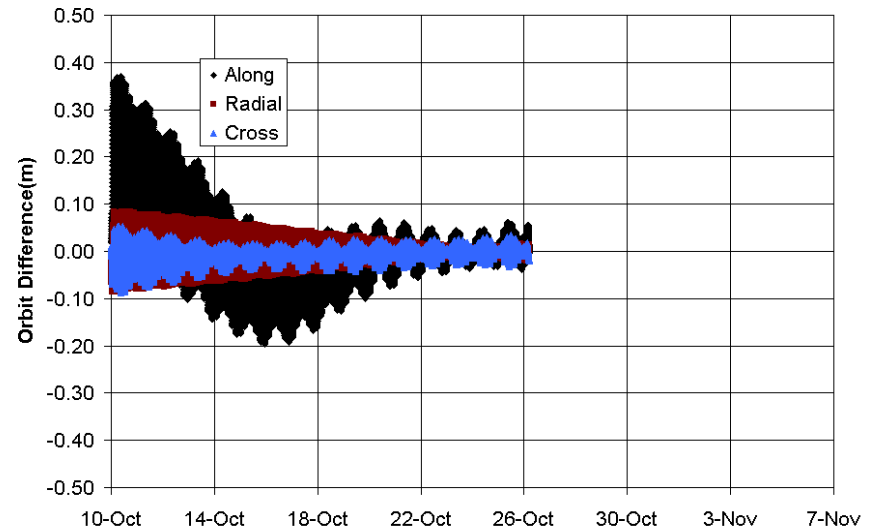
Orbit "B" Comparisons (JCET V11 vs IAAK V11)



Orbit "B" Comparisons (JCET V11 vs GFZ V10)

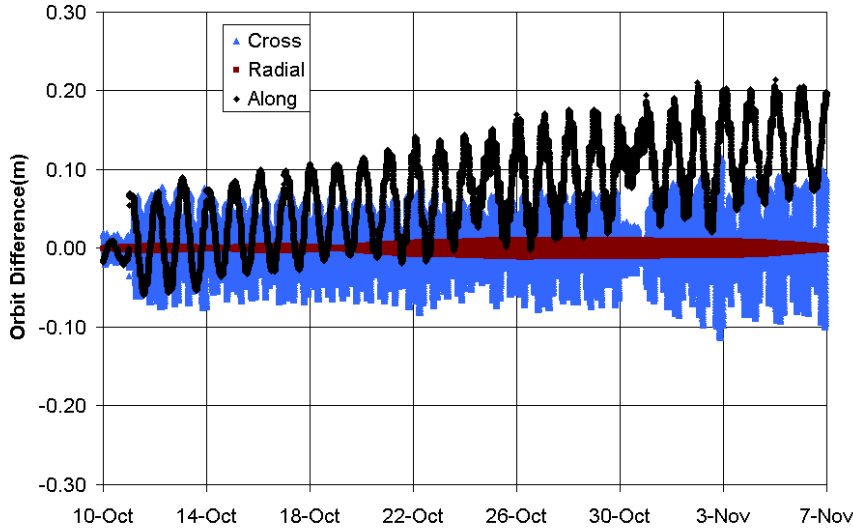


Orbit "B" Comparisons (JCET V11 vs GEOS V10)

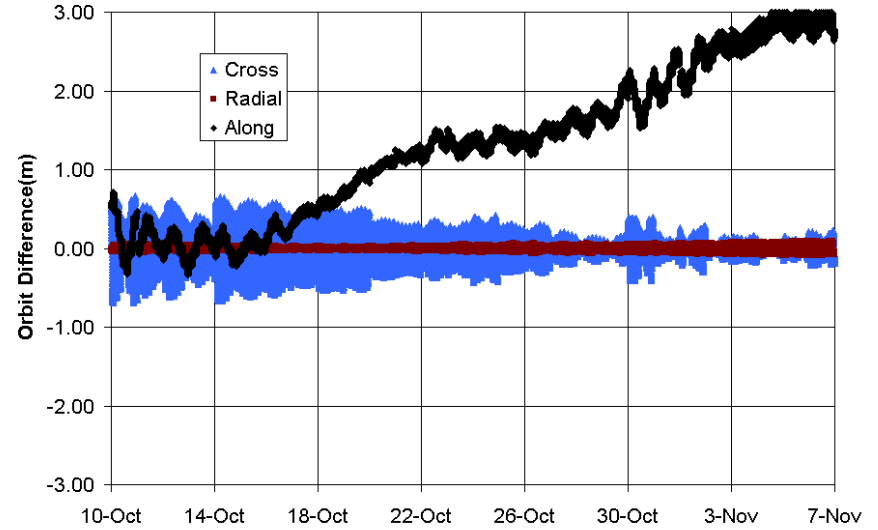


Orbit 'C' Comparisons

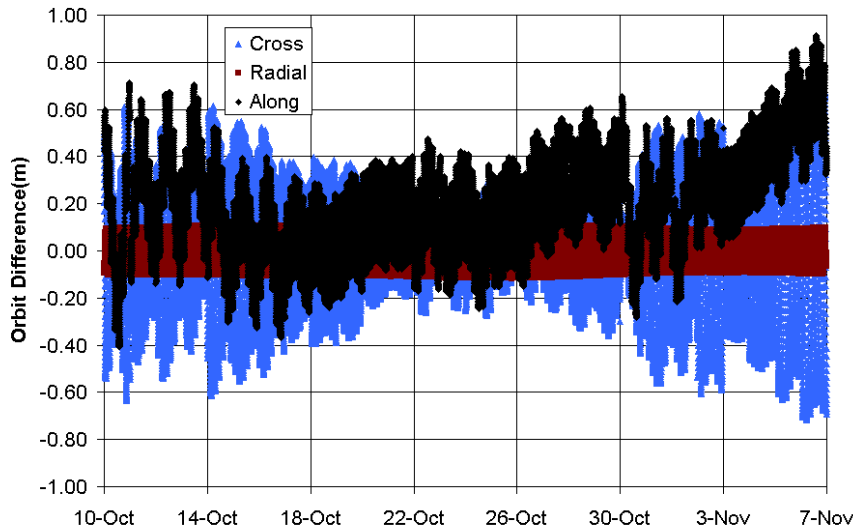
Orbit "C" Comparisons (JCET V12 vs ASI V14)



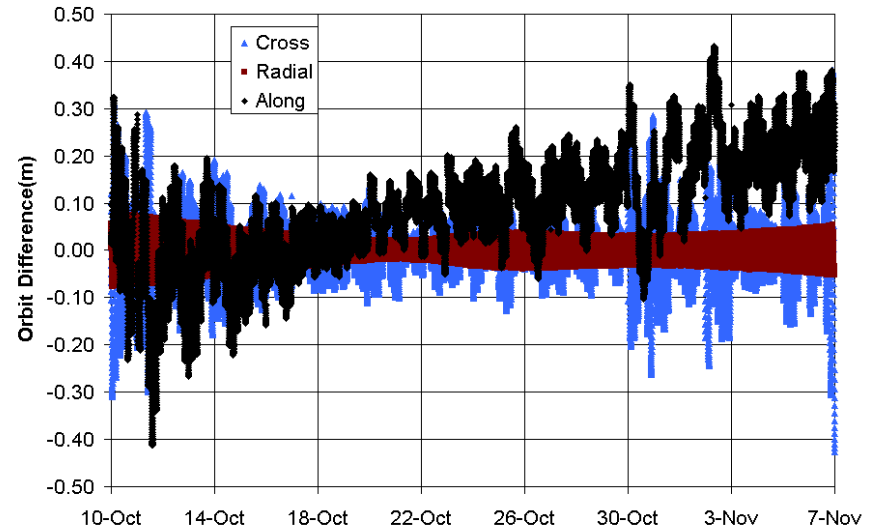
Orbit "C" Comparisons (JCET V12 vs IAAK V11)



Orbit "C" Comparisons (JCET V12 vs NERC V11)

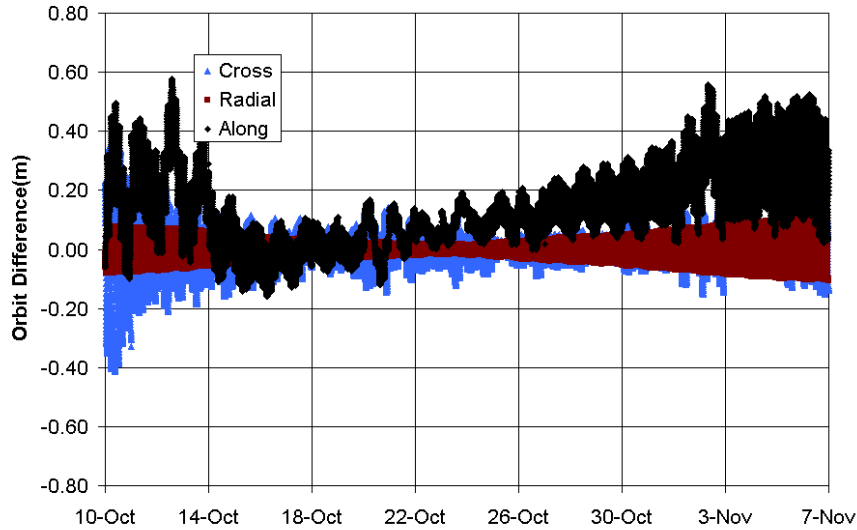


Orbit "C" Comparisons (JCET V12 vs GFZ V10)



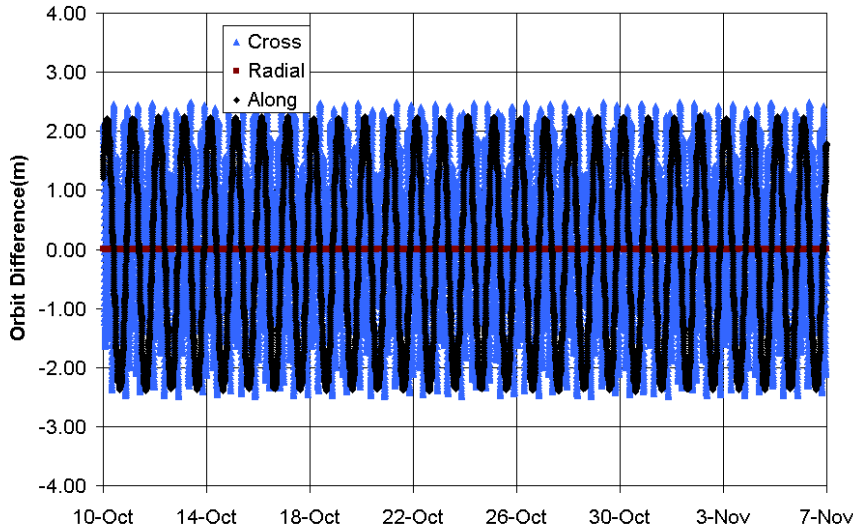
Orbit 'C' Comparisons

Orbit "C" Comparisons (JCET V12 vs GEOS V10)

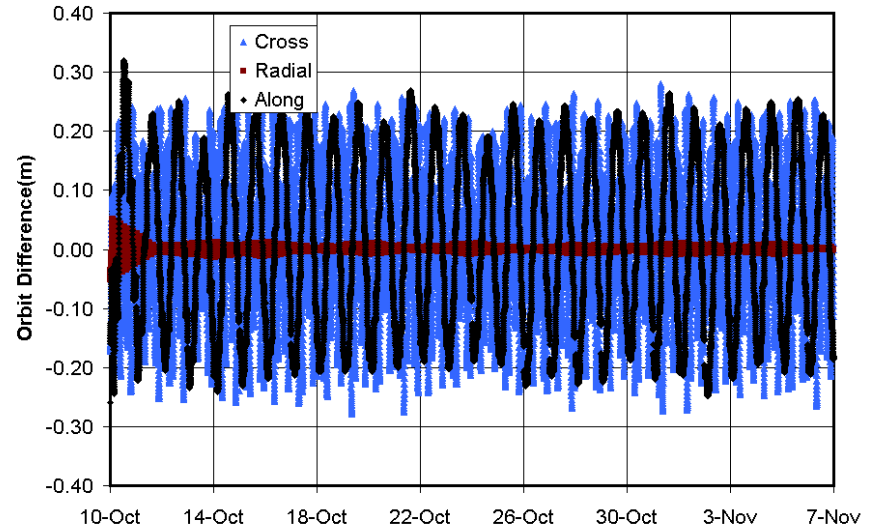


Orbit 'D' Comparisons

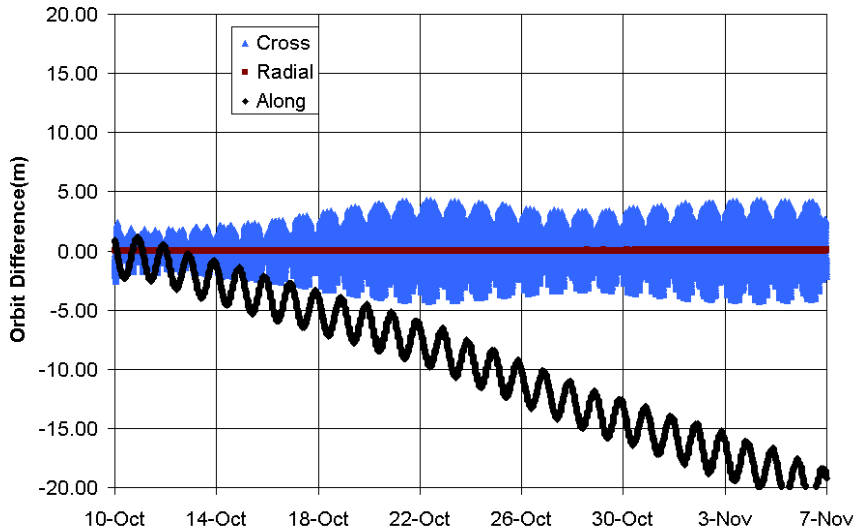
Orbit "D" Comparisons (JCET V12 vs ASI V14)



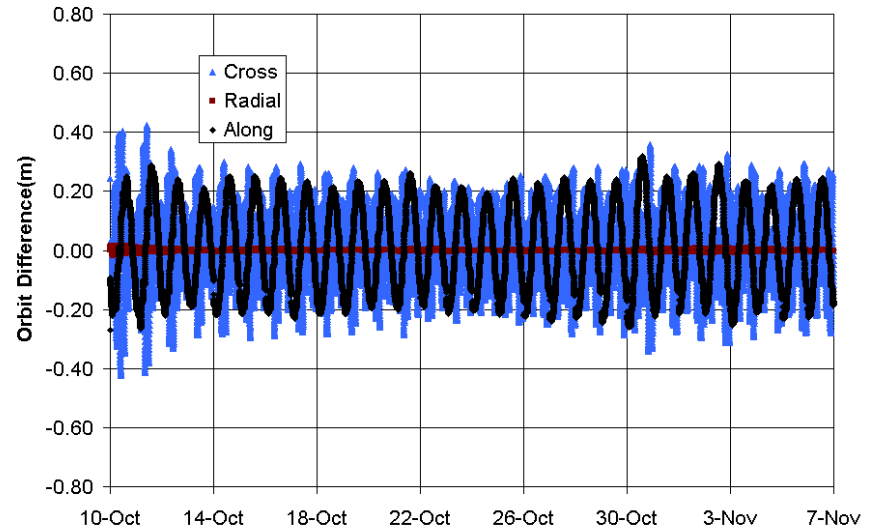
Orbit "D" Comparisons (JCET V12 vs GFZ V10)



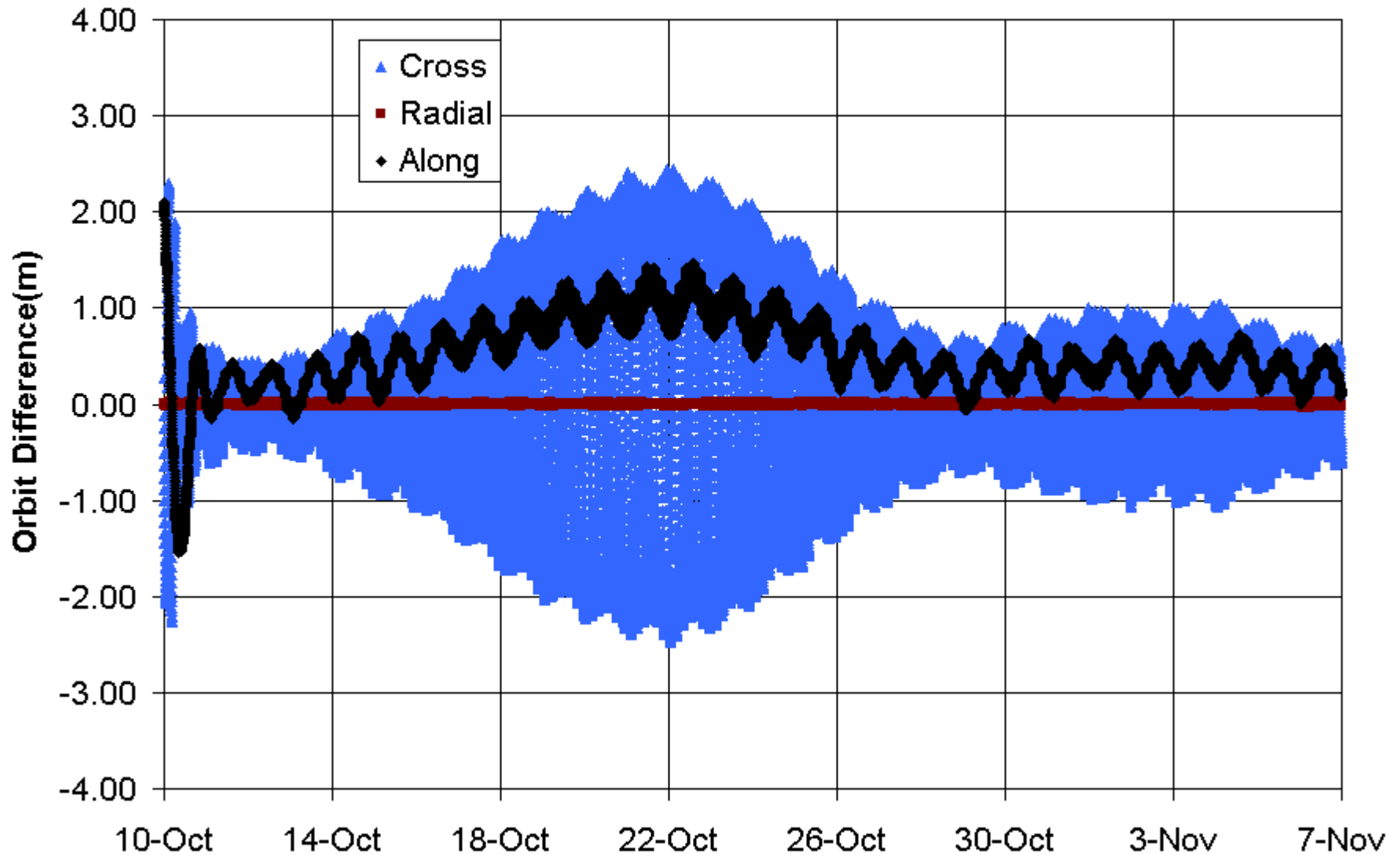
Orbit "D" Comparisons (JCET V12 vs DGFI V10)



Orbit "D" Comparisons (JCET V12 vs GEOS V10)



Orbit "D" Comparisons (JCET V12 vs DGFI V11)



Range Corrections (Tropospheric, Relativity, CoM)

Note: All solutions compared to ASI.

Range Correction Differences

Relativity

Category	DGFI-ASI	GEOS-ASI	GFZ-ASI	IAAK-ASI	JCET-ASI	NERC-ASI
Mean(m)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
RMS(m)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Min(m)	0.0000	-0.0001	0.0000	-0.0001	-0.0001	-0.0001
Max(m)	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001

LAGEOS Center of Mass

Category	DGFI-ASI	GEOS-ASI	GFZ-ASI	IAAK-ASI	JCET-ASI	NERC-ASI
Mean(m)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
RMS(m)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Min(m)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Max(m)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Troposphere

Category	DGFI-ASI	GEOS-ASI	GFZ-ASI	IAAK-ASI	JCET-ASI	NERC-ASI
Mean(m)	0.0000	-0.0017	0.0000	0.0000	0.0000	0.0000
RMS(m)	0.0001	0.0013	0.0001	0.0001	0.0003	0.0000
Min(m)	-0.0004	-0.0068	-0.0004	-0.0004	-0.0006	-0.0001
Max(m)	0.0002	0.0005	0.0002	0.0003	0.0006	0.0001

Analysis Center	Number of Residuals
ASI	4711
DGFI	4710
GEOS	4711
GFZ	4710
IAAK	4711
JCET	4710
NERC	4710
DGFI, GFZ, JCET & NERC missing the last point	

Residuals

(RMS, Mean)

Residual Comparisons

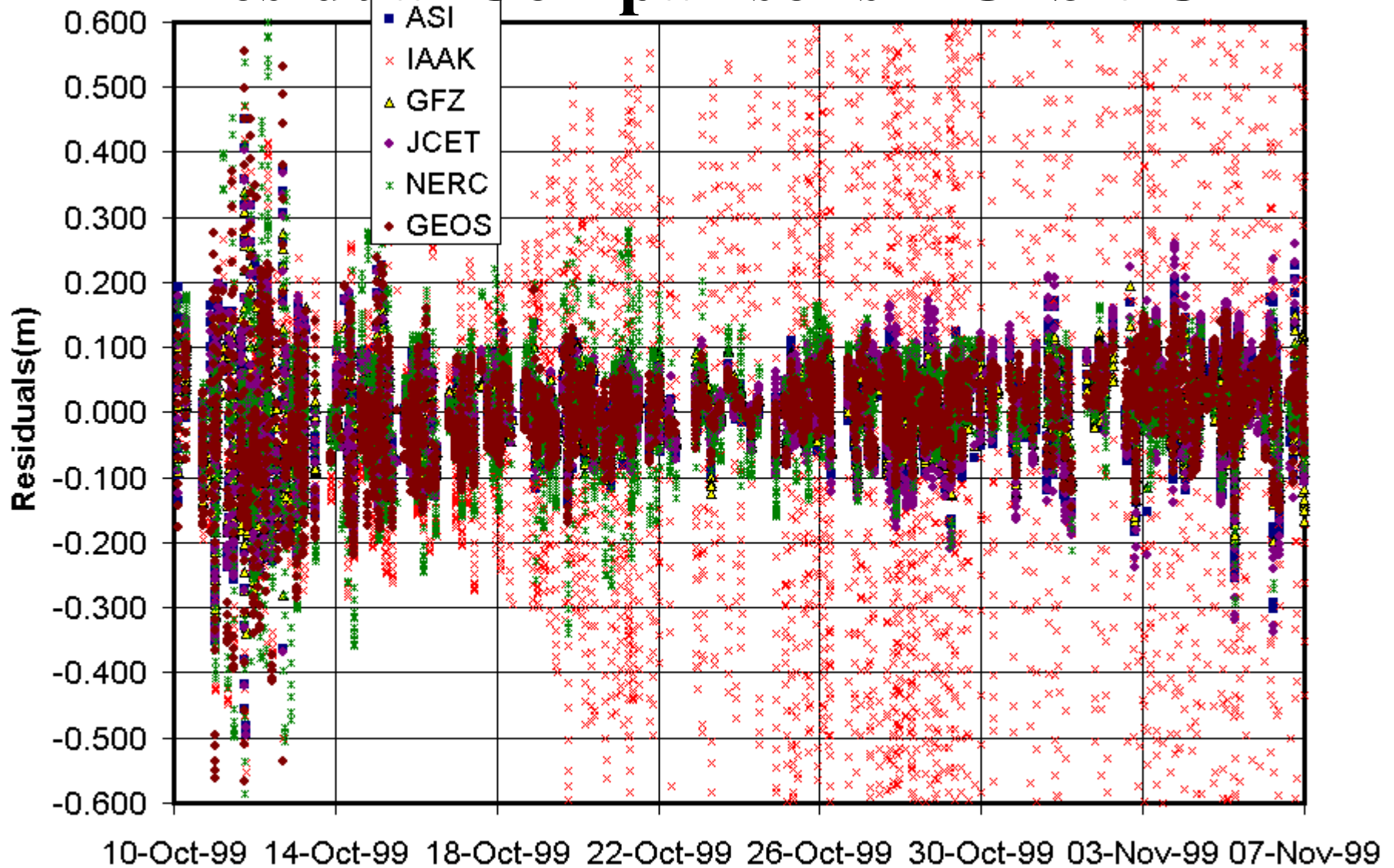
Residuals Orbit A							
Category	ASI	DGFI	GEOS	GFZ	IAAK	JCET	NERC
Mean(m)	0.1040		0.1999	0.1565	0.1524	0.1038	
RMS(m)	0.9584		1.9263	0.7273	0.6199	0.9584	
Min(m)	-4.2314		-7.7860	-3.1474	-2.2864	-4.2309	
Max(m)	4.4733		7.9870	3.3340	2.6178	4.4724	

Residuals Orbit B							
Category	ASI	DGFI	GEOS	GFZ	IAAK	JCET	NERC
Mean(m)	-0.0009		-0.0043	-0.0024	-0.0064	-0.0010	
RMS(m)	0.0954		0.0993	0.1001	0.1130	0.0955	
Min(m)	-0.4522		-0.4970	-0.4476	-0.5568	-0.4524	
Max(m)	0.3669		0.4610	0.3723	0.4518	0.3696	

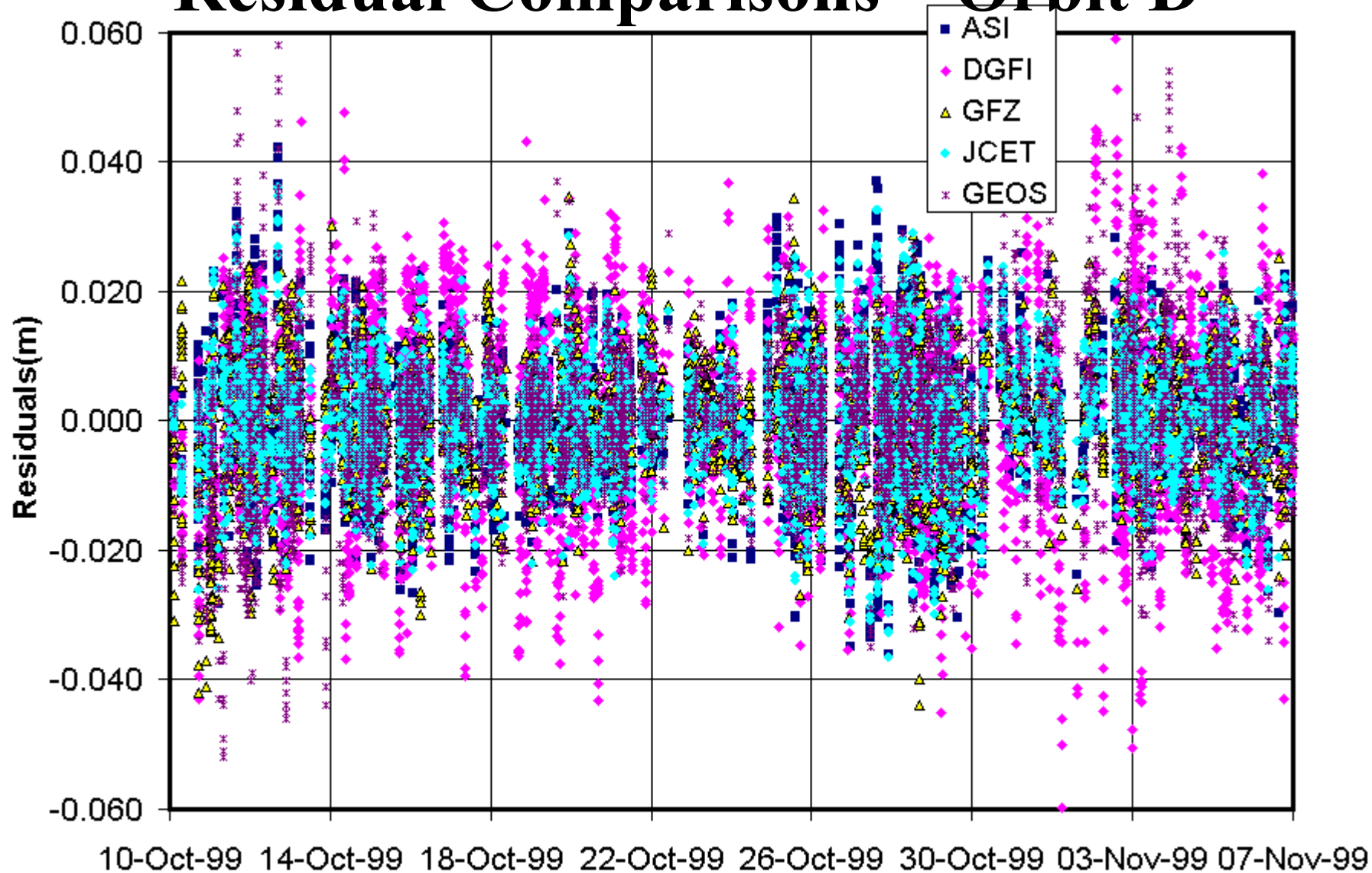
Residuals Orbit C							
Category	ASI	DGFI	GEOS	GFZ	IAAK	JCET	NERC
Mean(m)	0.0014		-0.0019	0.0010	-0.0263	0.0023	0.0013
RMS(m)	0.0777		0.0856	0.0658	0.3834	0.0814	0.1069
Min(m)	-0.4943		-0.6300	-0.3399	-1.2979	-0.4961	-0.6822
Max(m)	0.4516		0.6070	0.3388	1.2832	0.4504	0.6017

Residuals Orbit D							
Category	ASI	DGFI	GEOS	GFZ	IAAK	JCET	NERC
Mean(m)	0.0002	0.0000	0.0003	-0.0001		-0.0001	
RMS(m)	0.0095	0.0141	0.0115	0.0091		0.0087	
Min(m)	-0.0360	-0.0598	-0.0520	-0.0439		-0.0366	
Max(m)	0.0423	0.0592	0.0670	0.0347		0.0361	

Residual Comparisons – Orbit C

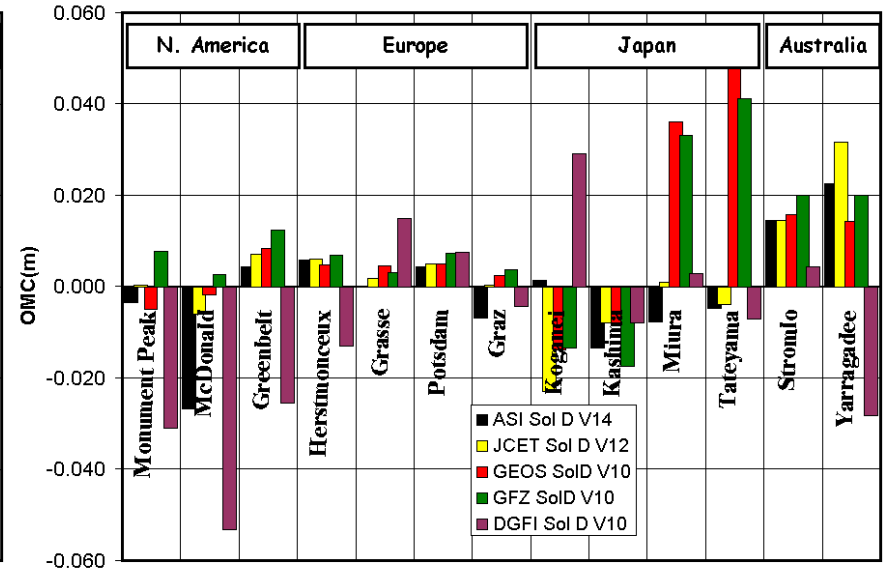
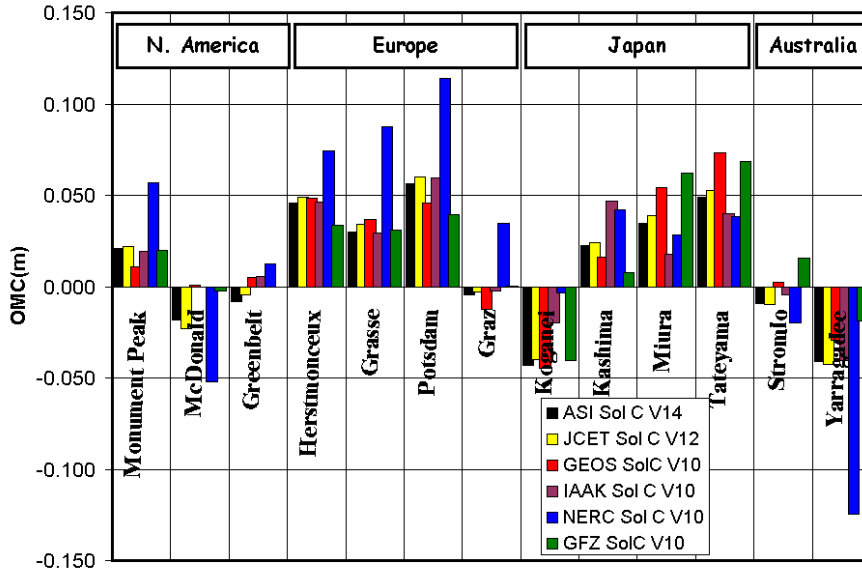


Residual Comparisons – Orbit D

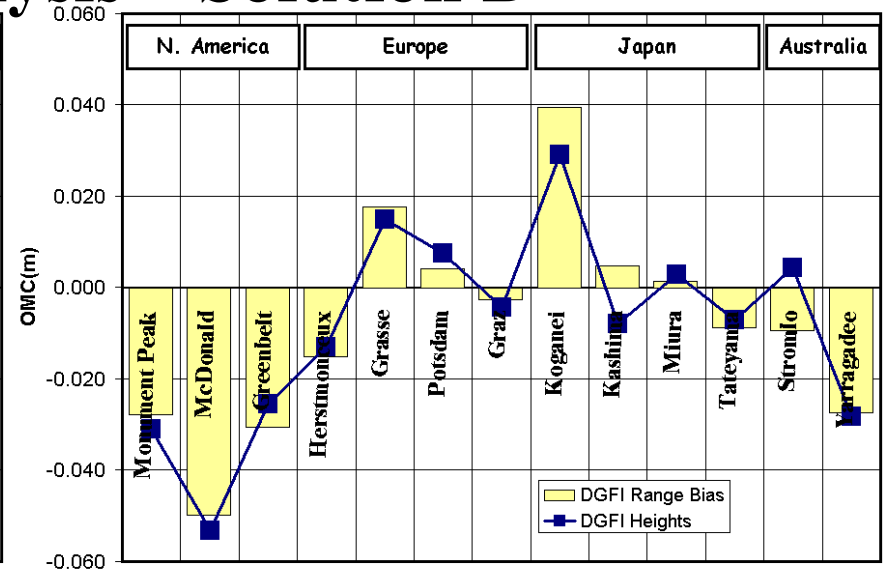
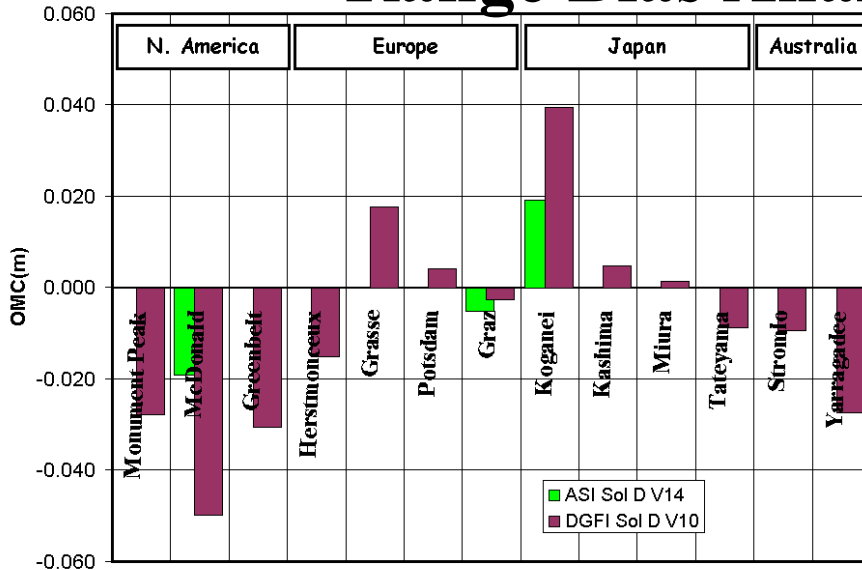


Station Position (X, Y, Z, Heights)

Station Heights

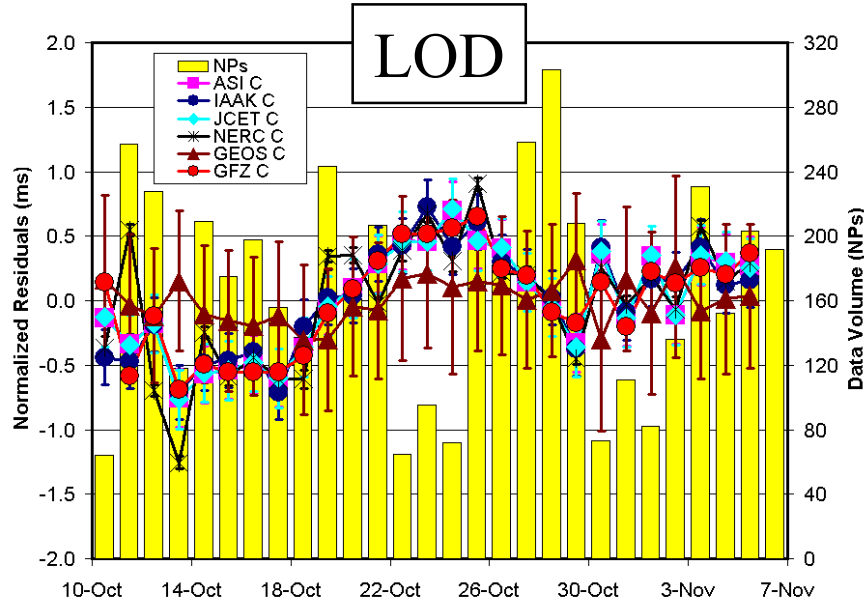
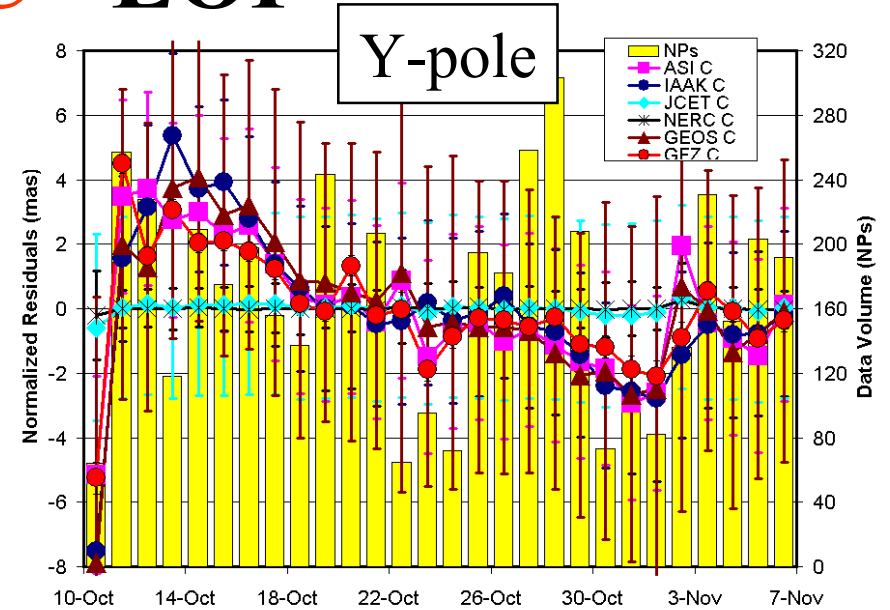
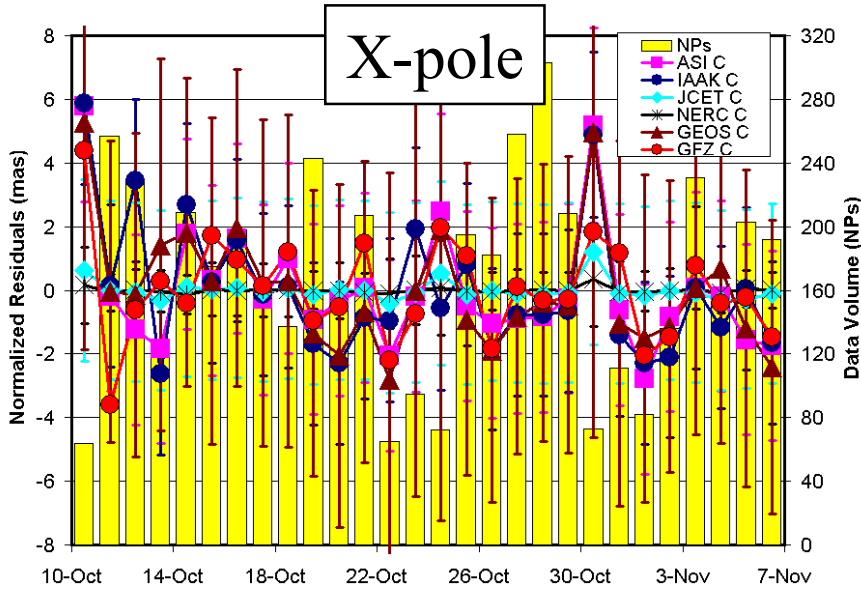


Range Bias Analysis – Solution D

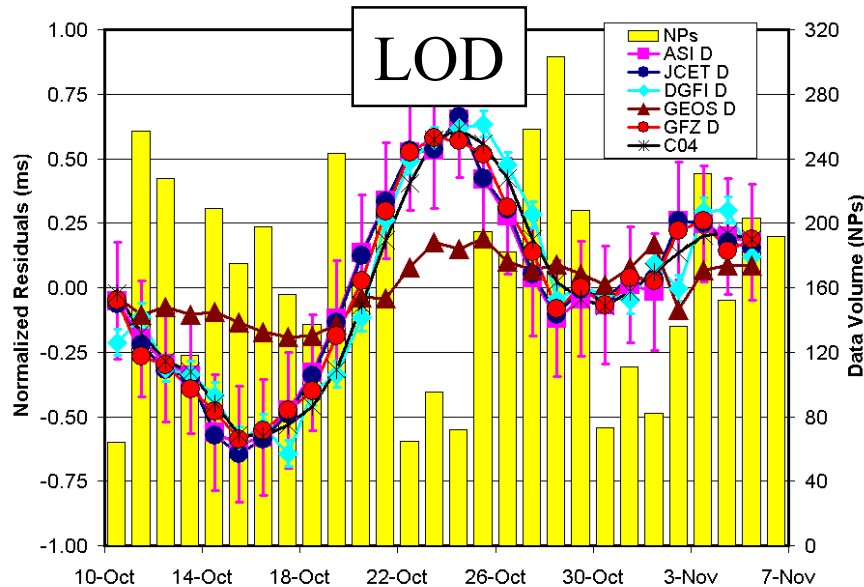
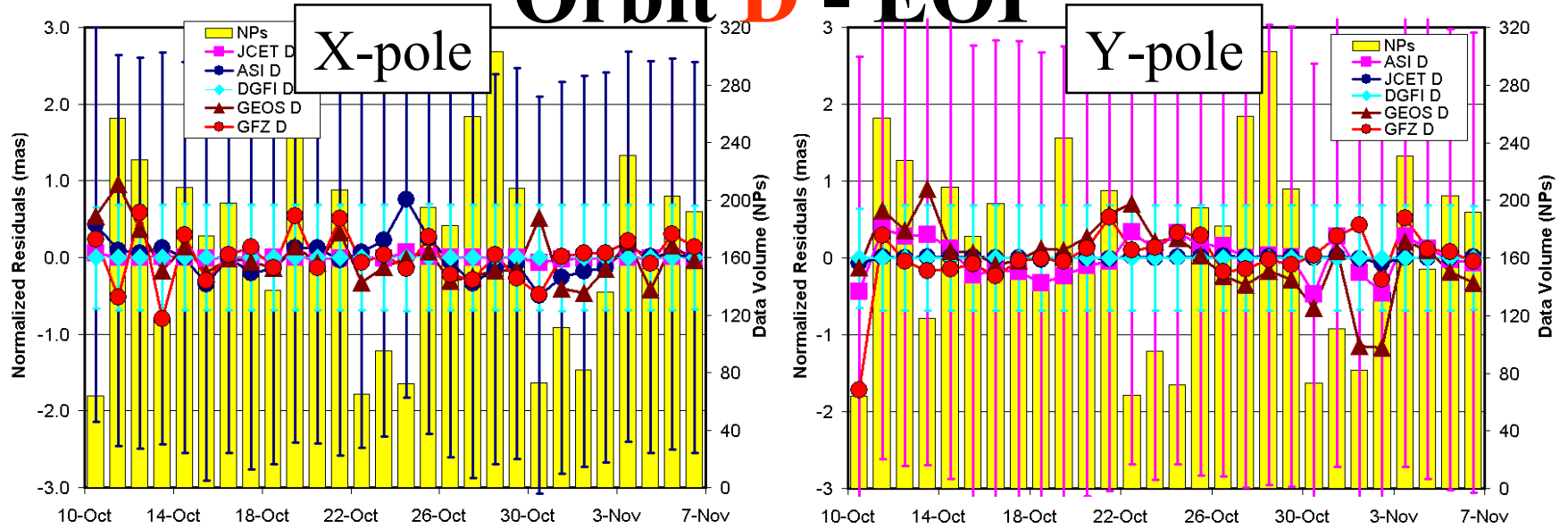


EOP Comparisons (X-Pole, Y-Pole, LOD, UT1)

Orbit C - EOP



Orbit D - EOP



**How can we minimize this
differences?**