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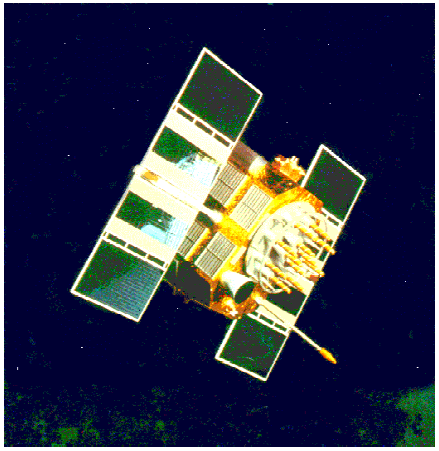
Combined Solutions GPS+LEO

GPS



by

Rolf König
Christoph Reigber
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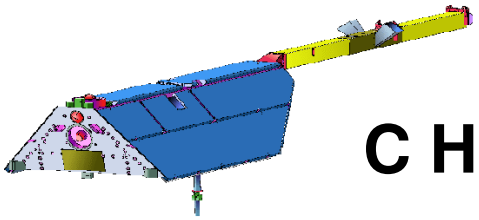
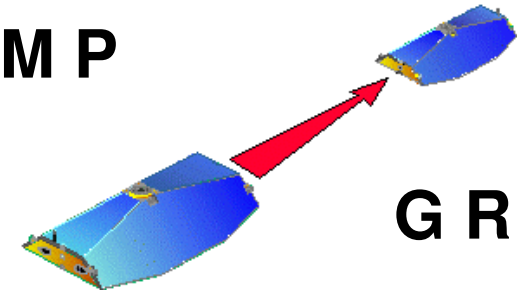
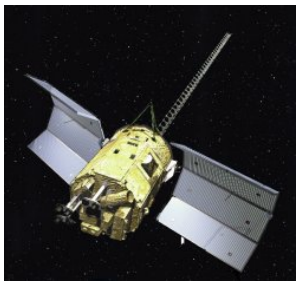


CHAMP



GRACE



SAC-C

10 Years IGS, Workshop & Symposium
Berne, Switzerland, March 1-5, 2004

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Integrated POD

- Ground-based and space-borne GPS observations
- Non-GPS observations: SLR, low-low K-band

Benefits

- Better ephemerides
- Better low degree Earth parameters

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LEO Ephemerides

Observation	CHAMP Orbital Fit			
	2-step RMS (cm)	n	Integrated RMS (cm)	n
Code	74.36	88060	72.42	88059
Phase	2.58	88060	0.73	88059
SLR	5.33	474	4.39	474

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LEO Ephemerides, II

Observation	GRACE Orbital Fit			
	2-step RMS (cm)	n	Integrated RMS (cm)	n
Code	52.73	187753	48.29	188213
Phase	1.24	187753	0.62	188213
SLR	5.53	506	4.12	506
K-range	1.26	75754	0.82	75754

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LEO Ephemerides, III

Observation	SAC-C Orbital Fit			
	2-step RMS (cm)	n	Integrated RMS (cm)	n
Code	123.66	77907	122.12	77906
Phase	2.90	77907	1.41	77906

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Adding more LEOs to the Integrated POD

Observation	Orbital Fit (in green either LEO mission alone)			
	CHAMP		**GRACE**	
	RMS (cm)	n	RMS (cm)	n
Code	72.42/72.45	88061	48.29/48.26	188213
Phase	0.73/0.73	88061	0.62/0.62	188213
SLR	4.39/4.66	474	4.12/4.27	506
K-range			0.82/0.83	75754

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Adding more LEOs to the Integrated POD

Obs.	Orbital Fit (in green either LEO alone)		
	CHAMP	**GRACE**	**SAC-C**
	RMS (cm)	RMS (cm)	RMS (cm)
Code	72.42/72.45	48.29/48.29	122.12/122.10
Phase	0.73/0.74	0.62/0.63	1.41/1.42
SLR	4.39/4.74	4.12/4.04	
K-range		0.82/0.85	

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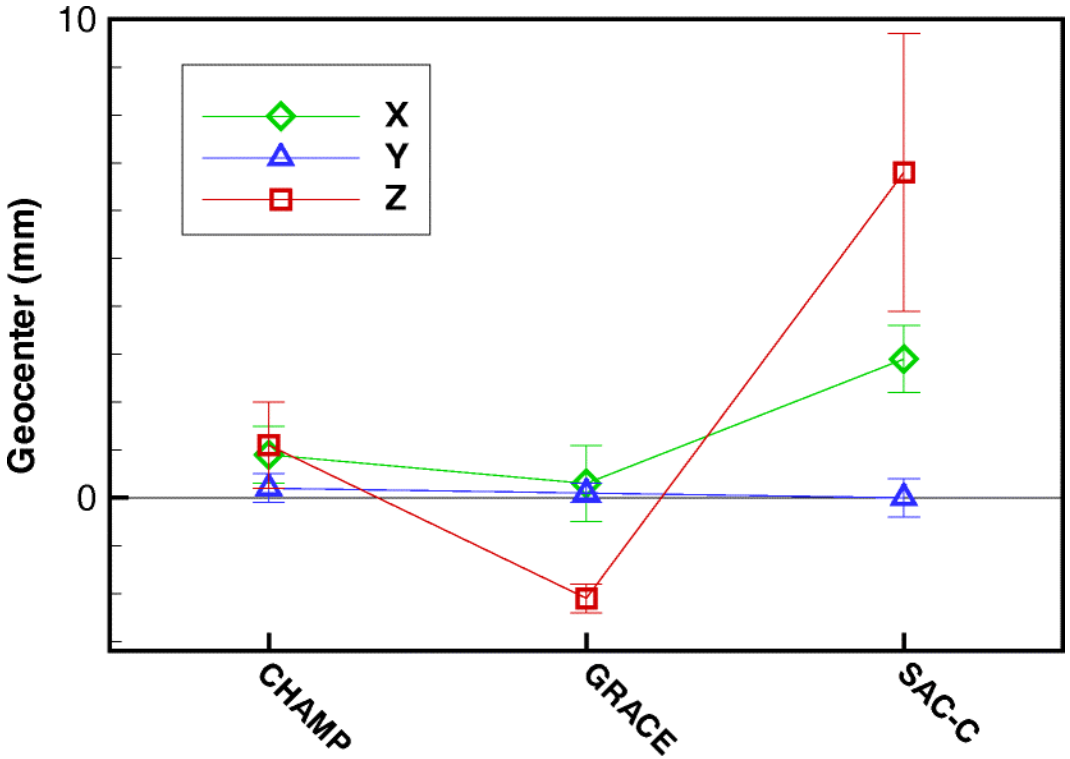
Geocenter: C(1,0), C(1,1), S(1,1)



	Mean Standard Dev. (mm)		
	X	Y	Z
Integ.	0.7	0.3	1.4
2-step	4.0	2.2	3.4

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Computation Times

	CPU Elapsed (h)		Observations		Unknowns	
n LEO	2-step	Integ.	2-step	Integ.	2-step	Integ.
1	0.8	6.8	30,000	1,160,000	1,000	5,700
2	1.7	8.9	60,000	1,190,000	1,400	6,200
3		12.3		1,220,000		7,200
4		15.3		1,250,000		8,000

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Conclusions

- The integrated dynamic POD of GPS and LEOs provides
  - more accurate and reliable sender ephemerides
  - more accurate and reliable LEO ephemerides
  - more accurate and reliable low degree Earth parameters
- Additional LEOs in the integrated case
  - effect on sender ephemerides not visible
  - seem not to provide better LEO ephemerides
  - effect on low degree Earth parameters not yet analyzed
- Geocenter
  - different efficiencies by different LEOs
  - longer analysis period needed