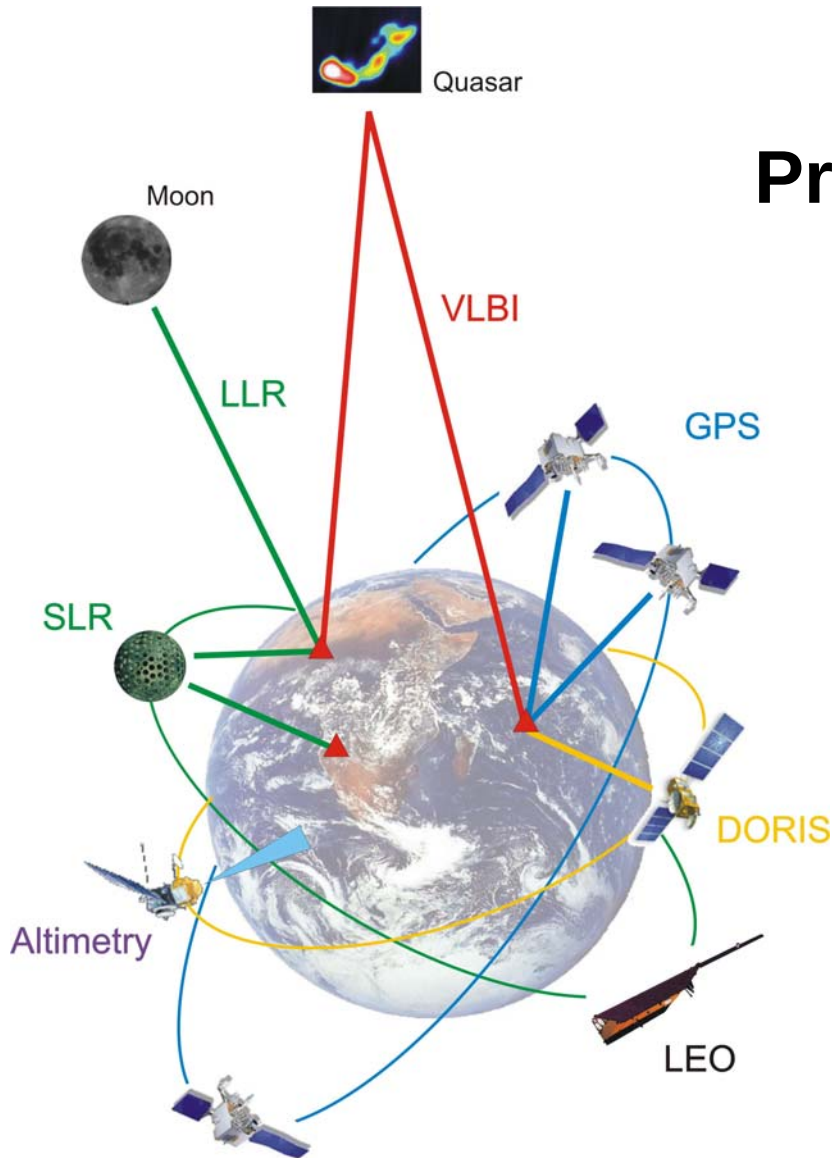




Product Generation and Future: IERS

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- **ITRF:** Generation from weekly (session) SINEX files, ITRF and ERPs together
- **ERPs:** Still based on individual ERP time series, consistency to ITRF cannot be realized
- **ICRF:** Based on one analysis center, no combination, no consistency with EOPs and ITRF
- **IERS Conventions:** IERS Workshop 2007 on Conventions
- **GGFs:** Few comparisons between products, no combination, many products not available operationally
- **CRCs:** Should be more involved in the rigorous inter-technique combination work
- **Gravity:** No connection to gravity, no vertical datum

Combined Products with Different Latency



Product Type	Main Parameters	Generation Cycle	Maximum Latency	Based on
Multi-Year	ITRF, EOPs, ICRF , static gravity field; time series of parameters (site coo. etc.)	Yearly	Maximum 1 year	Reprocessed high-accuracy time series from each technique
Weekly "Final"	EOPs , site coordinates, gravity field variations, ...	Weekly	3 weeks	Based on the "final" routine intra-technique combined products
Daily "Rapid"	EOPs, site coordinates, tropospheric delays , etc. = near real-time monitoring	Daily	1 day	VLBI Intensives and IGS Rapids and SLR/DORIS
Daily "Predicted"	EOPs , ...	Daily	1 day	Combined daily rapid IERS products



- **ITRF2005** was a really big step forward (consistency, quality, time series, ...)
- **Some open issues after ITRF2005:**
 - Treatment of non-linear station behavior and seasonal signals
 - Combination of UT1 from VLBI and LOD from satellite techniques
 - Different combination strategies by different combination centers (scale problem)
 - Improvements in local ties
 - Reduction of systematic effects (reprocessing necessary !)
 - Reprocessing of IGS solutions (homogeneity, discontinuities!)
 - Additional parameter types ?



- **Next version of IERS200x products:**

- Include GPS solutions from reprocessing efforts
- Common standards in modeling, parameterization, processing strategy to be used in the reprocessing by the individual analysis centers (ACs) across the techniques
 - Agreement on Standards / Modeling / Parameterization for the next generation of SINEX files (take into account IGS reprocessing options)
- As long time series of SINEX files as possible (ILRS back to 1984 ?)
- Not only reprocessing but also recombination (intra-technique) necessary
- Include quasar coordinates and nutation offsets from VLBI: combination of the three parameter types:

$$\text{IERS200x} = \text{TRF200x} + \text{EOP200x} + \text{CRF200x}$$

- Work on the combination of UT1 and LOD (VLBI and satellite techniques)
- Agree on common ERP parameterization and a priori values (subdaily resolution ?)

Example: GGOS-D Extended Parameterization



Technique	Coord	Pole	UT/ LOD	Nut.	Cnm/ Snm	Geo- Center	Trop. ZD	Trop. Grad.	Range Bias	Radio Source
VLBI (DGFI)	X	X	X	X			X	X		X
VLBI (IGGB)	X	X	X	X			X	X		X
GPS (Bernese)	X	X	X	X		X	X	X		
GPS (EPOS)	o	o	o			(o)	o	o		
SLR (DGFI)	X	X	X		X	(X)			X	
SLR (GFZ)	X	X	X		X	(X)			X	
LEO	X	o	o		X	(o)				
Altimetry	(X)	(o)	(o)		(X)	(X)				

- Extension of the parameterization (compared to international status)
- Higher temporal resolution: daily solutions, sub-daily ERPs (exc. SLR)
- X: realized; o: planned

2. Routine Weekly SINEX Generation: Status



- <http://iers1.bkg.bund.de/info/listFileCPP.php>
- All intra-technique solutions in time, available since March 2004

Technique	Institution	Continue Submiss. ?	ITRF2005 consist. ?	Param. Types ?	Shortest Delay ?
IGS	NRCan	Yes	Yes	Co, xp,yp,xpr,ypr, lod	10 (20)
ILRS	ASI	Yes	Yes	Co,xp,yp,xpr,ypr, lod	10 (15)
IVS	GIUB	Yes	Yes	Co,xp,yp,Ut1,xpr, ypr,lod,de,dp	8-14 (30)
IDS *	IGN	Yes	Yes	Co,xp,yp,xpr,ypr	30 (45)
Combined	GRGS	Yes	Yes	Co,xp,yp,de,dp rates	VLBI dep.

* Individual analysis center (Pascal Willis)

Inter-technique combination plans:

Technique	Institution	Intention to submit?	Strategy	Start
Inter-techn. Combination	OP/IGN	Yes	Not yet decided	Spring 2007
Inter-techn. Combination	ASI	Yes	In progress	Summer 2007
Inter-techn. Combination	DGFI	Yes	Weekly, reference frame ITRF2005	Summer 2007
Inter-techn. Combination	Who else ?			

3. Daily Rapid IERS EOP Product



Idea: Combination of VLBI Intensive Sessions (e-VLBI) with GPS rapid products to obtain highly precise rapid ERP solutions

IGS:

1. Generation of SINEX files by the ACs on a daily basis including station coordinates and EOPs (rapid product)
2. Generation of combined intra-technique SINEX files by the IGS AC on a daily basis

IVS:

1. Generation of daily SINEX files by the ACs for the VLBI Intensives (1hour) using e-VLBI
2. Generation of daily combined intra-technique SINEX files by the IVS AC

IERs:

1. Combination of the VLBI and GPS SINEX files (including local ties) to generate rapid daily ERPs

Daily Rapid Product: Parameter Space



Parameter space for the rapid IERS combination;
ideal complementarity of VLBI and GPS:

- GPS: Stable reference frame and polar motion
- VLBI: UT1
- SLR, DORIS: Geocenter ?

Parameter Type	VLBI	GPS/ GLON.	DORIS/ PRARE	SLR	
Nutation	X				Earth Rotation
Polar Motion	S	X	S	S	
UT1	X				
Length of Day (LOD)		S	S	S	
Coord.+Veloc.(ITRF)	S	X	S	S	ITRF
Geocenter		S	(X)	(X)	

X: Essential Contribution

S: Parameter Setup



Questions to the IGS and IVS ACs:

- Would you be ready to submit daily (VLBI: intensive sessions) SINEX files from your rapid solutions containing site coordinates and EOPs ?
- When could a routine submission of such rapid SINEX files start at your AC ?

Questions to the IGS and IVS Analysis Coordinators:

- What would be the effort needed to implement the generation of daily (VLBI: intensive sessions) SINEX files based on the rapid SINEX files from the individual AC SINEX files mentioned above ?
- When could a routine generation of such a daily combination start ?

Remark: A first test combination of VLBI intensives and GPS rapid solutions into a combined product (for polar motion and UT1) could be done based on only one IGS AC and one IVS AC ...

Remark: Near real-time monitoring of the global reference frame (earthquakes, dislocation of antennas, ...)

Goal: Rigorous Combination of troposphere zenith delays from GPS, VLBI, and DORIS

IGS, IVS, IDS:

- Generation of daily (session) SINEX files containing:
 - Site coordinates: daily resolution
 - Troposphere zenith delays (and gradients): 2-h and 1-day, piece-wise linear (?)
 - Polar motion and UT1-UTC and their rates: daily
- Implement the same troposphere modeling standards:
 - Use the same mapping function (e.g. GMF)
 - Use the same a priori troposphere model for the dry delay
- Problem: VLBI not observing from 00:00 to 24:00 UT

4. Predicted IERS Product

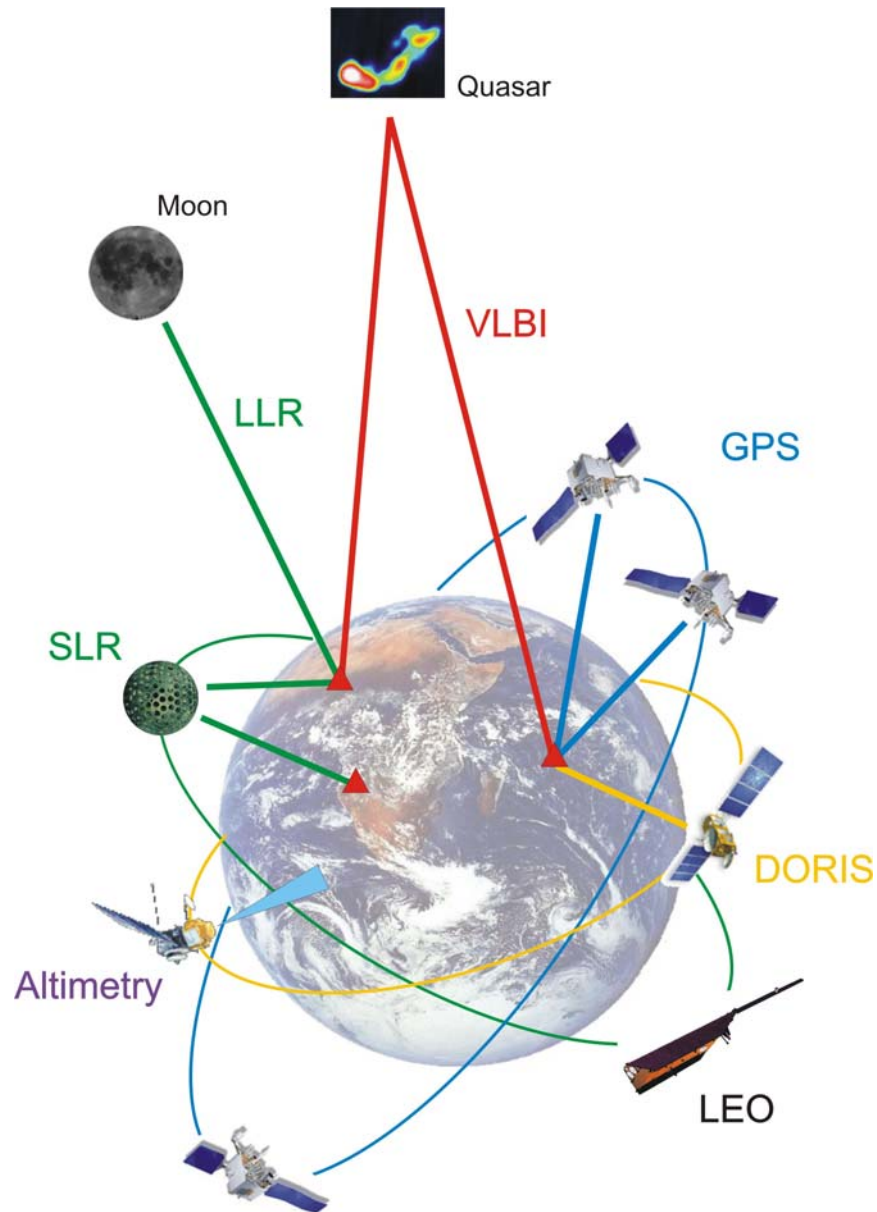


- **Predicted IERS Products:**
 - Daily predictions of EOPs
 - Based on combined IERS Rapid and Final Products
 - Using most recent prediction strategies (ERP prediction project)



Goal: Get a first, very simple meta data flow for the SINEX products of the IAG Services

- Define a simple meta data standard compatible with ISO
- Define necessary additional fields (block) in SINEX to contain all relevant meta data
- Encourage IAG Services to deliver the necessary meta data in the SINEX files
- Develop a procedure to generate XML meta data files from the SINEX files
- Develop a first simple database of meta data (portal) and meta data search tools etc.



**Thank you for
your attention !**



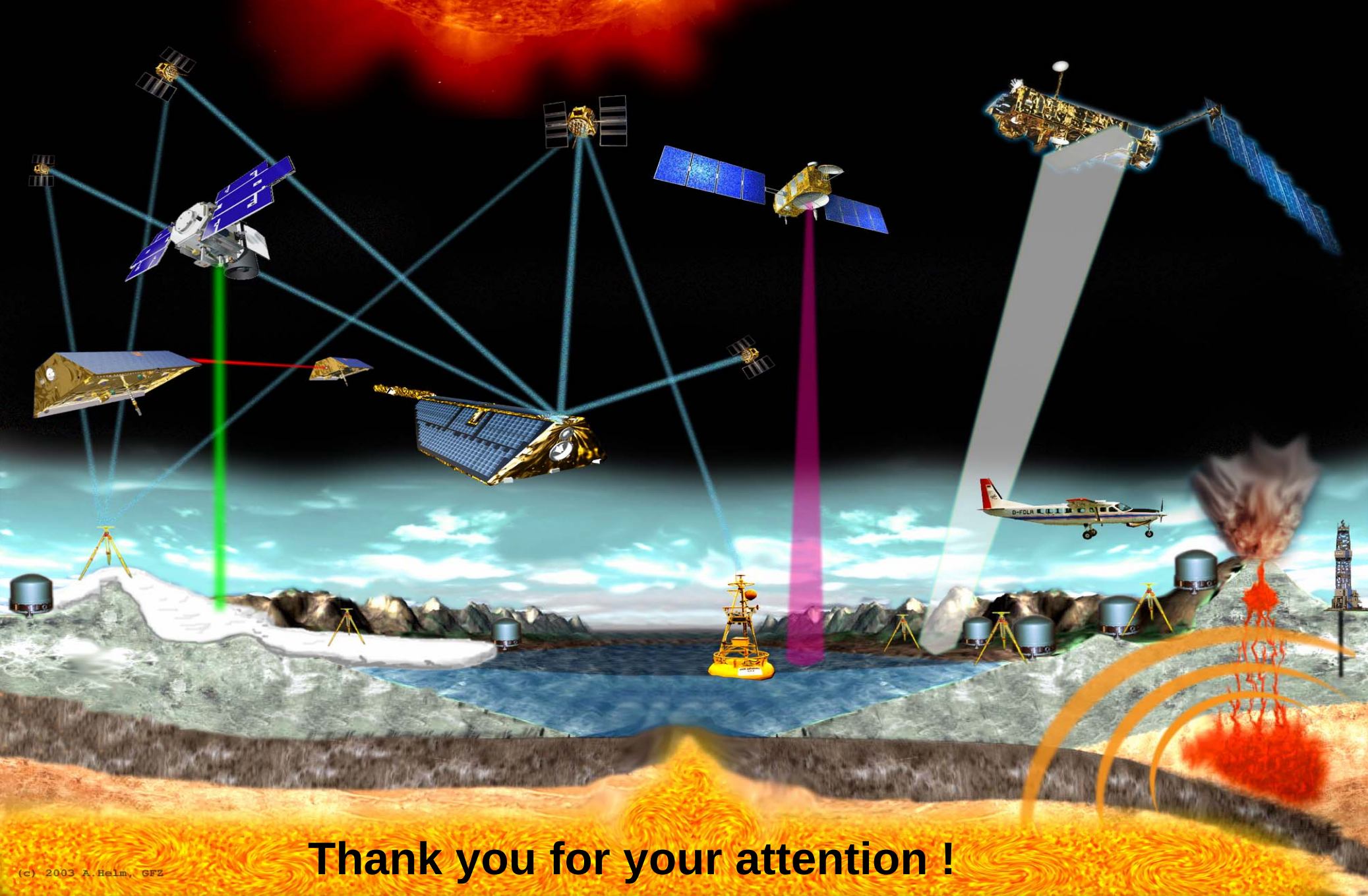
- **Proposal for next IERS200x:**

- Parameterization:**

- Include quasar coordinates and nutation offsets from VLBI
 - Include low-degree harmonics from SLR
 - Setup ERPs with $\frac{1}{2}$ -day resolution, piece-wise linear, offsets at 0:00, 12:00 and 24:00 UTC
 - Agree on common interpolation method for a priori ERPs
 - Include GPS solutions available from reprocessing efforts

- Modeling Standards:**

- Troposphere mapping function GMF
 - Ocean loading from FES2004
 - No atmospheric loading ???



Thank you for your attention !

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- Application of **unified/common standards** and **parameterizations** for all participating software packages
- **Enlargement of the parameter space** leading to the interesting combination of geometry, Earth rotation, gravity, and possibly sea level
- Inclusion of **SLR, VLBI, GPS, altimetry and LEOs**. Additional parameters are quasar coordinates, nutation offsets and rates, troposphere zenith delays and gradients, low-degree harmonics coefficients of the gravity field
- **Higher temporal resolution**, with not only weekly, but daily solutions and subdaily resolution of Earth rotation parameter
- **SINEX as the standard** for the exchange of all parameter types and solution types

GGOS-D: Generation of Homogeneous Time Series



Technique	Work Package	Institution	Software Package	Time Period
SLR	WP3200	DGFI	DOGS	1984-2005
SLR	WP3200	GFZ	EPOS	1984-2005
VLBI	WP3300	DGFI	OCCAM	1984-2005
VLBI	WP3300	GIUB/BKG	CALC/SOLVE	1984-2005
GPS	WP3400	GFZ	EPOS	1994-2005
GPS	WP3400	GFZ	Bernese V5.0	1994-2005
LEOs	WP3500	GFZ	EPOS	2000-2005
Altimetry	WP3600	DGFI	DGFI Software	1992-2005



2nd Iteration of SINEX Solution Generation:

- Higher-order ionospheric corrections (GPS)
- Absolute antenna phase center variations (GPS)
- New troposphere mapping functions (VMF1; using ECMWF data; GPS and VLBI)
- Hydrostatic a priori delay from ECMWF data (GPS and VLBI)
- IERS 2003 Standards and the same models for site motion (e.g. ocean loading, ...), troposphere, ...



2nd Iteration of SINEX Solution Generation:

- Site coordinates (piece-wise constant; 1-day)
- Troposphere zenith delays and gradients (piece-wise linear; 2-h and 1-day, resp.; same mapping functions; GPS and VLBI)
- Polar motion and UT1-UTC (piece-wise linear; 1-h)
- Nutation offsets and rates (1-day; VLBI and GPS, resp.)
- Low-degree harmonics coefficients of Earth's gravity field (piece-wise constant; 1-day; SLR, GPS, and LEOs; tests to include altimetry)
- Quasar coordinates (1-day; VLBI)

GGOS-D: Parameter Combination Space



Parameter Type		VLBI	GPS/ GLON.	DORIS/ PRARE	SLR	LLR	Alti- metry
ICRF	Quasar Coord. (ICRF)	X					
	Nutation	X	(X)		(X)	X	
	Polar Motion	X	X	X	X	X	
	UT1	X					
	Length of Day (LOD)		X	X	X	X	
ITRF	Coord.+Veloc.(ITRF)	X	X	X	X	X	(X)
	Geocenter		X	X	X		X
	Gravity Field		X	X	X	(X)	X
	Orbits		X	X	X	X	X
Atmosphere	LEO Orbits		X	X	X		X
	Troposphere	X	X	X			X
	Ionosphere	X	X	X			X
	Time/Freq.; Clocks	(X)	X		(X)		

Earth Rotation Gravity Field