Federal Agency for
Cartography and Geodesy

GGOS and the Importance of the Combination of Space Techniques

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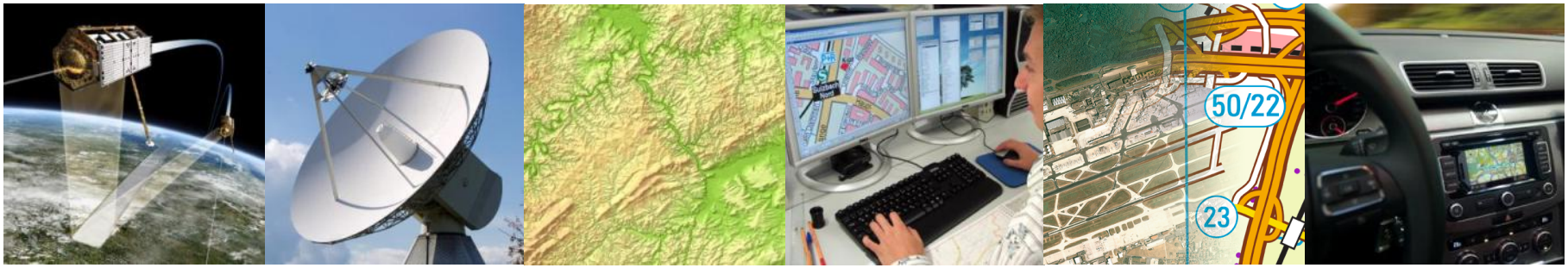


Content

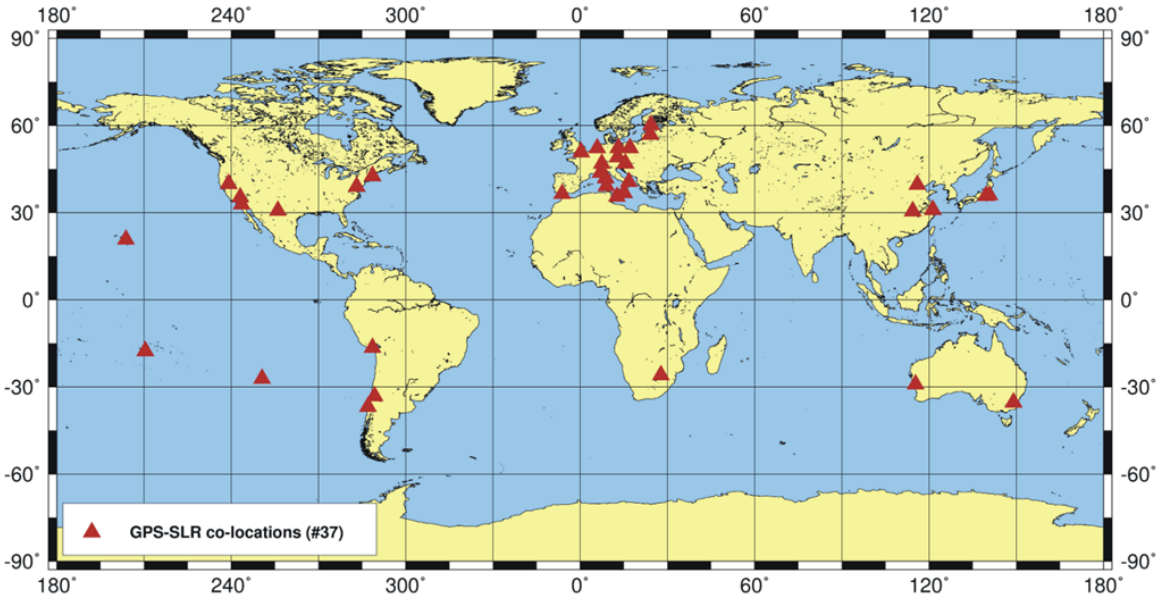
- Combination of space-geodetic techniques
- Combination examples
- Role of GGOS
- Conclusions

Combination: State of the Art
Current ITRF approach

- **Station co-locations** are the major connection between space-geodetic techniques
- Connection mainly via GNSS

BUT:

- Only few co-locations
- Insufficient global distribution
- Discrepancies with local ties



from DTRF2008 (Seitz et al.)

Combined parameters: Current ITRF approach

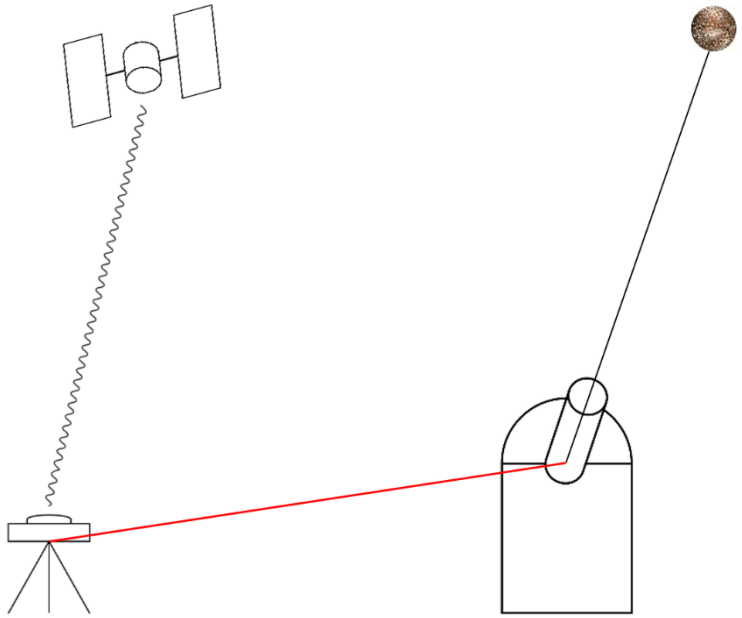
	VLBI	GNSS	SLR	DORIS
Quasar coordinates	X			
Station positions	X	X	X	X
Satellite orbits: GNSS		X	X	
Satellite orbits: spherical sat.			X	
Satellite orbits: LEO		X	X	X
Nutation	X	(x)		
UT1-UTC, LOD	X	lod	lod	lod
Polar motion	X	X	X	X
Geocenter		(X)	X	X
Low-degree gravity field		(x)	X	(x)
Troposphere	X	X		X

Combined parameters: Further possibilities

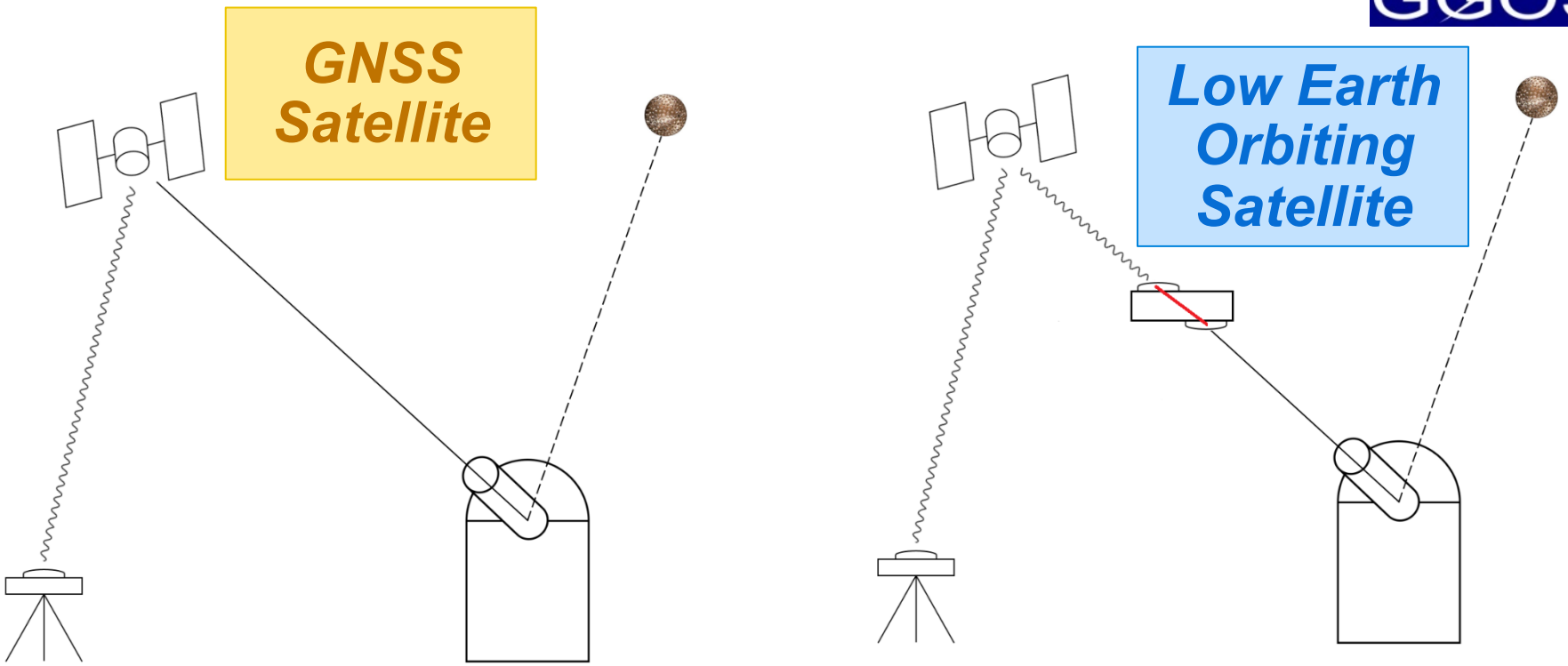
	VLBI	GNSS	SLR	DORIS
Quasar coordinates	X			
Station positions	X	X	X	X
Satellite orbits: GNSS		X	X	
Satellite orbits: spherical sat.			X	
Satellite orbits: LEO		X	X	X
Nutation	X	(x)		
UT1-UTC, LOD	X	lod	lod	lod
Polar motion	X	X	X	X
Geocenter		(X)	X	X
Low-degree gravity field		(x)	X	(x)
Troposphere	X	X		X

Station co-locations

- All instruments have to be located at one site together
- „Local Ties“ are necessary as additional information
- Independent of the satellites tracked by each instrument



Satellite co-locations GNSS-SLR



In both cases: Vectors of „Space Tie“ are needed

Center-of-Mass -> microwave GNSS antenna

Center-of-Mass -> Laser retro-reflector array

General aspects of the combination

- Observational point of view:

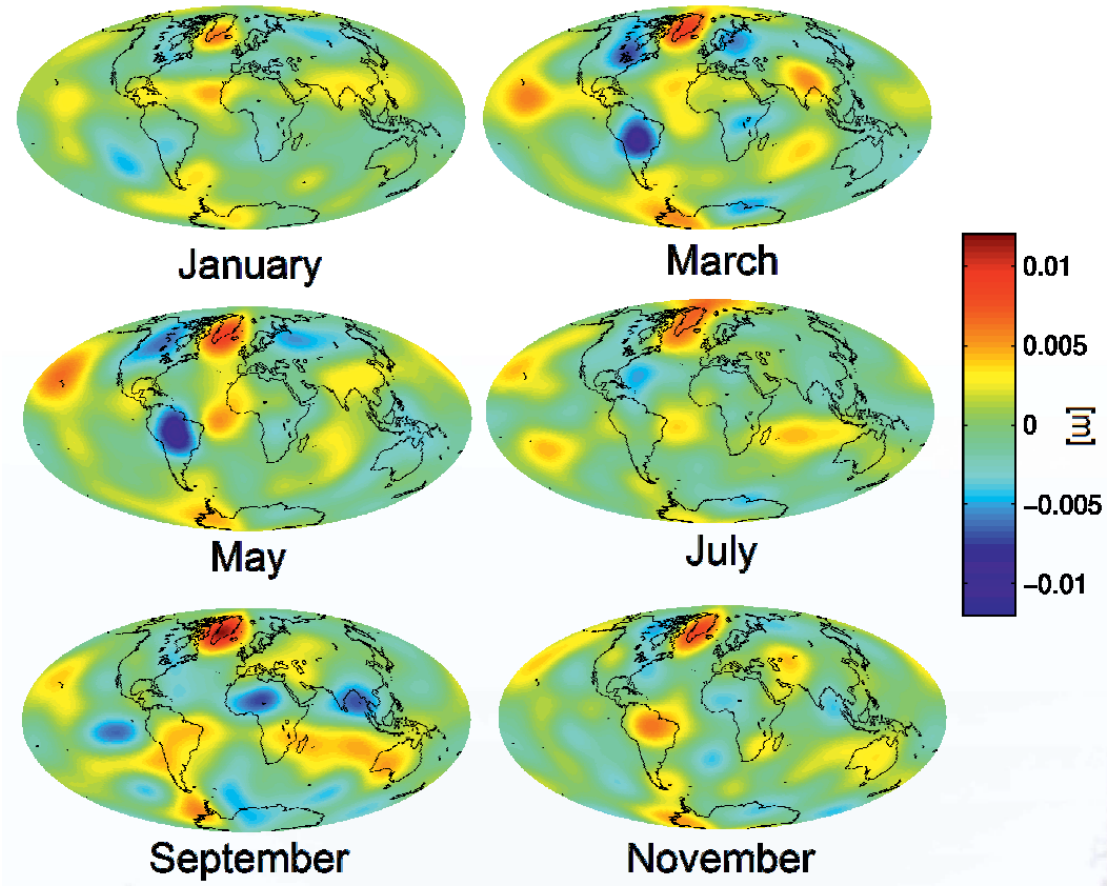
  usable infrastructure with technique ties
- Mathematical point of view:

  need for identical or mutually transformable parameters
- Standardizational point of view:

  unique constants, backfround models, etc.
- Organizational point of view:

  dedicated structures, workflows, ressources

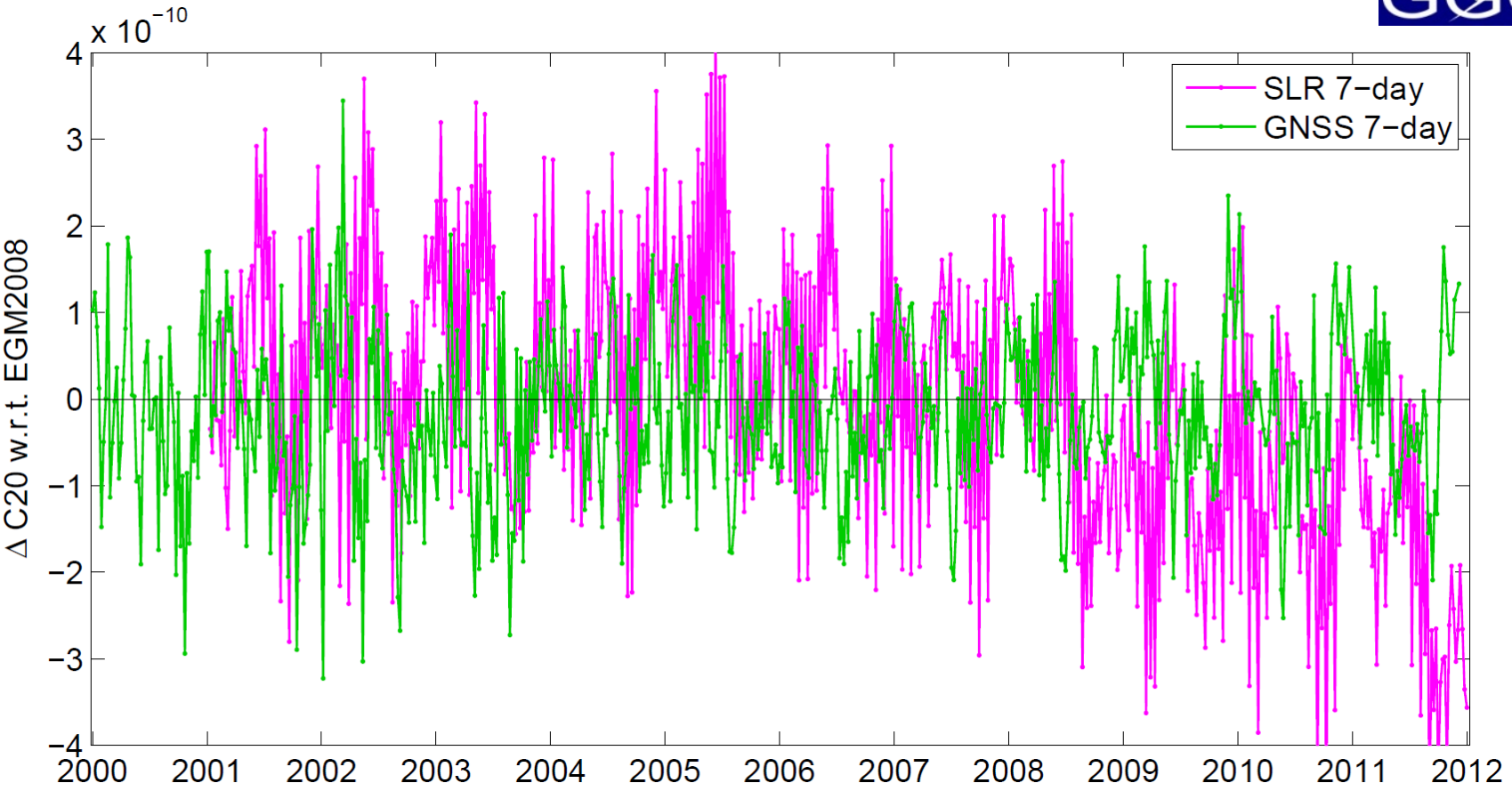
Gravity: Contribution of SLR



- Mean monthly gravity field variations (w.r.t. EGM2008)
- up to degree/order 10
- 9 spherical satellites: LAGEOS-1/2, Starlette, Stella, AJISAI, Beacon-C, Blits, Larets, LARES

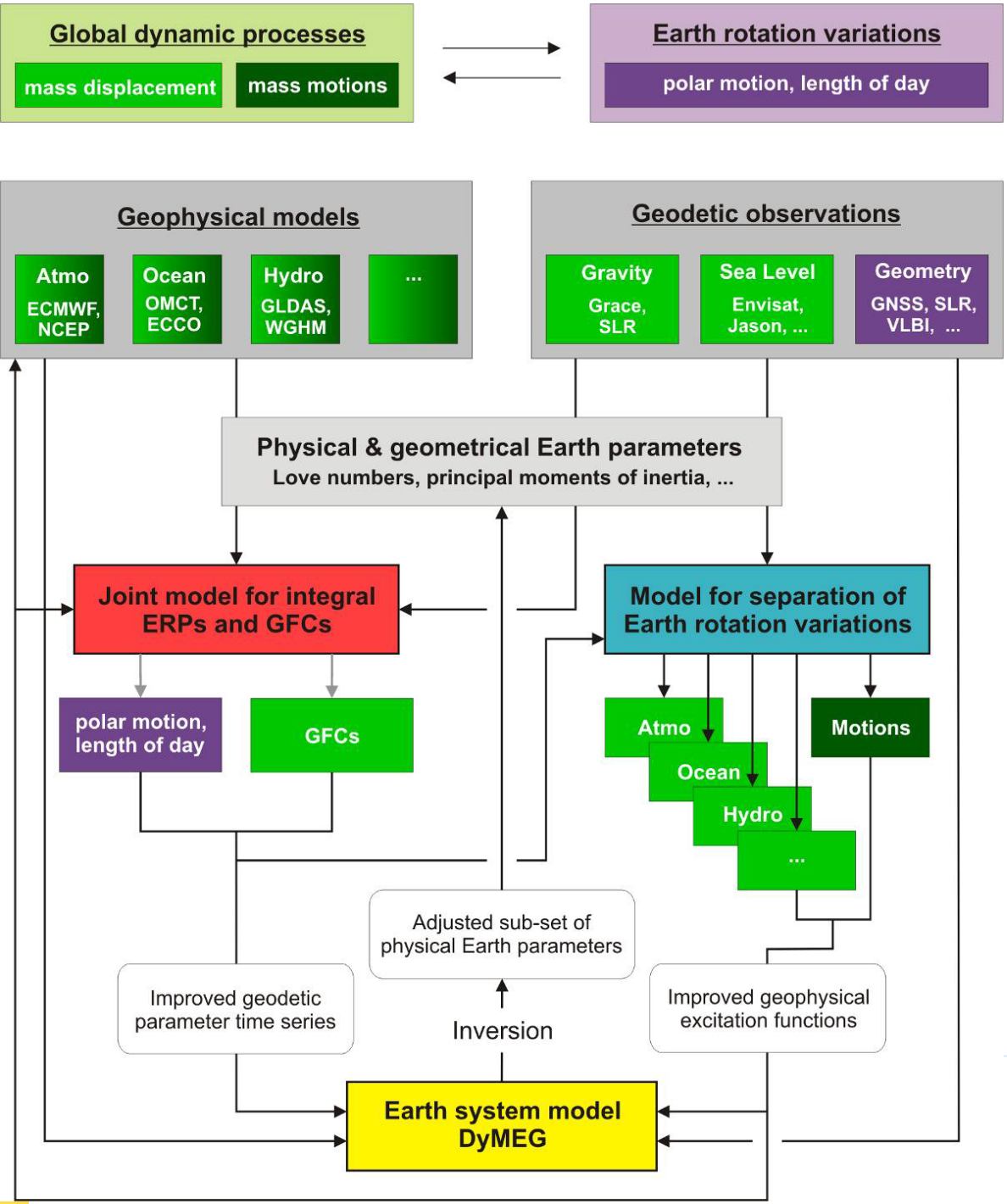
from Sosnica et al., 2014:
„Earth Rotation and Gravity Field Parameters from Satellite Laser Ranging".
Poster presentation at the ILRS Workshop 2014, Annapolis

Gravity: SLR and GNSS



from Thaller et al., 2013:
„Earth Rotation Parameters from Satellite Techniques“. Presented at the EGU General Assembly 2013, Vienna

ERP + GFC + Geophysical models



German DFG Research Unit FOR 584: „Earth Rotation and Global Dynamic Processes“ (Lead: J. Müller)

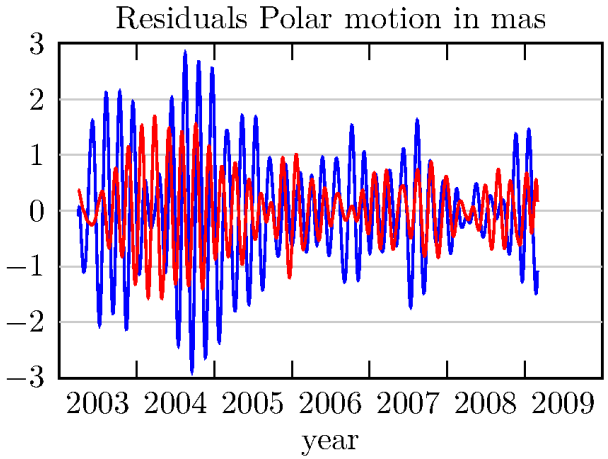
Here: Joint project together with DGFI and TU Munich

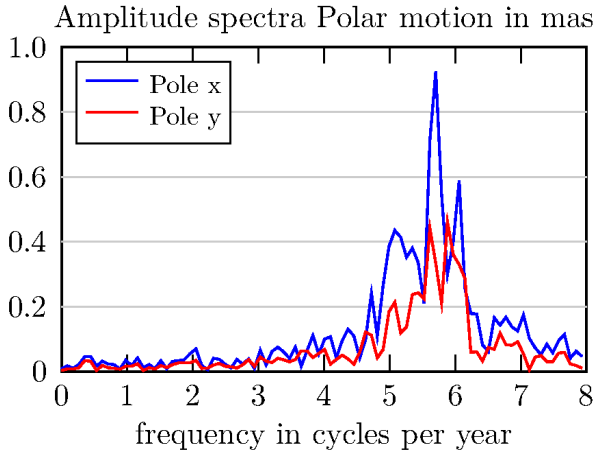
Integration of ERP + gravity variations + data from geophysical models

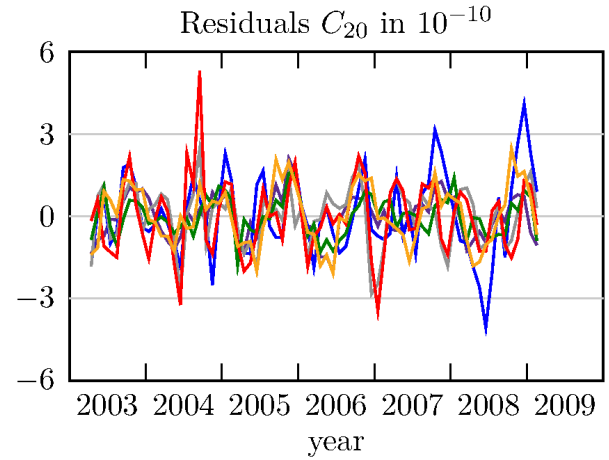
Standards and conventions!

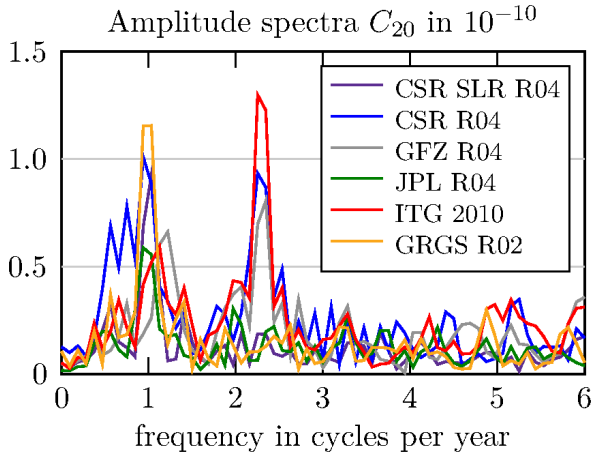
Metadata!

Results: ERP + GFC + Geophysical models









from A. Heiker (2013): Mutual validation of Earth orientation parameters, geophysical excitation functions, and second degree gravity field coefficients.

Role of GGOS: Motivation

Role of GGOS: Terms of Reference

The vision of GGOS is

"*Advancing our understanding of the dynamic Earth system by quantifying our planet's changes in space and time.*"

The mission of GGOS is

to p… …d
cha…

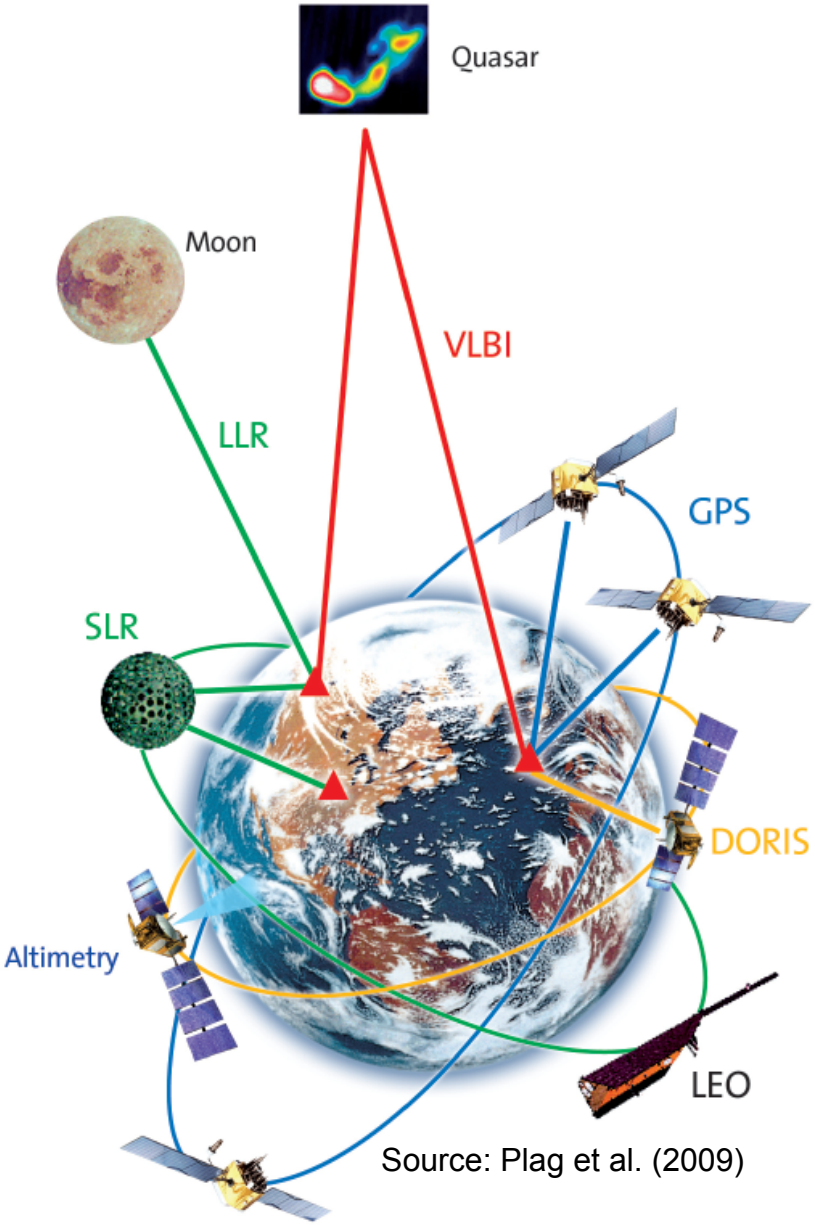
to p…
bac…
cha… …
applications.

GGOS strongly relies on the comprehensive combination of space-geodetic techniques …

… but this does not complete the job !

to benefit science and society by providing the foundation upon which advances in Earth and planetary system science and applications are built.

GGOS: Observation Architecture



Source: Plag et al. (2009)

Five major levels of instrumentation and objects to be observed

Level 1: terrestrial geodetic infrastructure;

Level 2: LEO satellite missions;

Level 3: GNSS and Lageos-type SLR satellites;

Level 4: planetary missions and geodetic infrastructure on Moon and planets;

Level 5: extragalactic objects.

Consistent spatial referencing as immanent condition / contribution

GGOS: Present state and next steps

- Strategic plan adopted in April 2014 ⇨ Strategic focus areas
  - Geodetic information and expertise
  - Global geodetic infrastructure
  - Services, standards and support
  - Communication, education and outreach

  ⇨ Implementation plans
- Structural enhancement of the GGOS organization (BNO, BSP, CO) ⇨ Implementation plans
- High-level GGOS Plenary Talk at IAG Scientific Assembly 2013
- Participation in GEO, CEOS, UN GGIM

Conclusions

- Thorough combination of space techniques (and others) is the feasible key to further relevant applications of Geodesy for science and society
- Ongoing activities
  - IAG: Services, GGOS ⇔ Scientific Community together with National Agencies ⇔ National Level / Regional Level
  - Establishment and maintenance of geodetic observatories – meeting GGOS requirements
  - Further development and adoption of standards and metadata
  - Scientific work as well as R&D work
- Needs
  - *Official* High-Tech Infrastructure with better global coverage
  - *Strategic* Partnerships (NMAs, Space Agencies, ...)
  - *Coordinated* Policies
  - *Sustainable* Funding

Inter-governmental coordination and support ⇨ UN GGIM !!!

Thank you for your kind attention!

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