Earth's interior with VLBI: … and the celestial frame?

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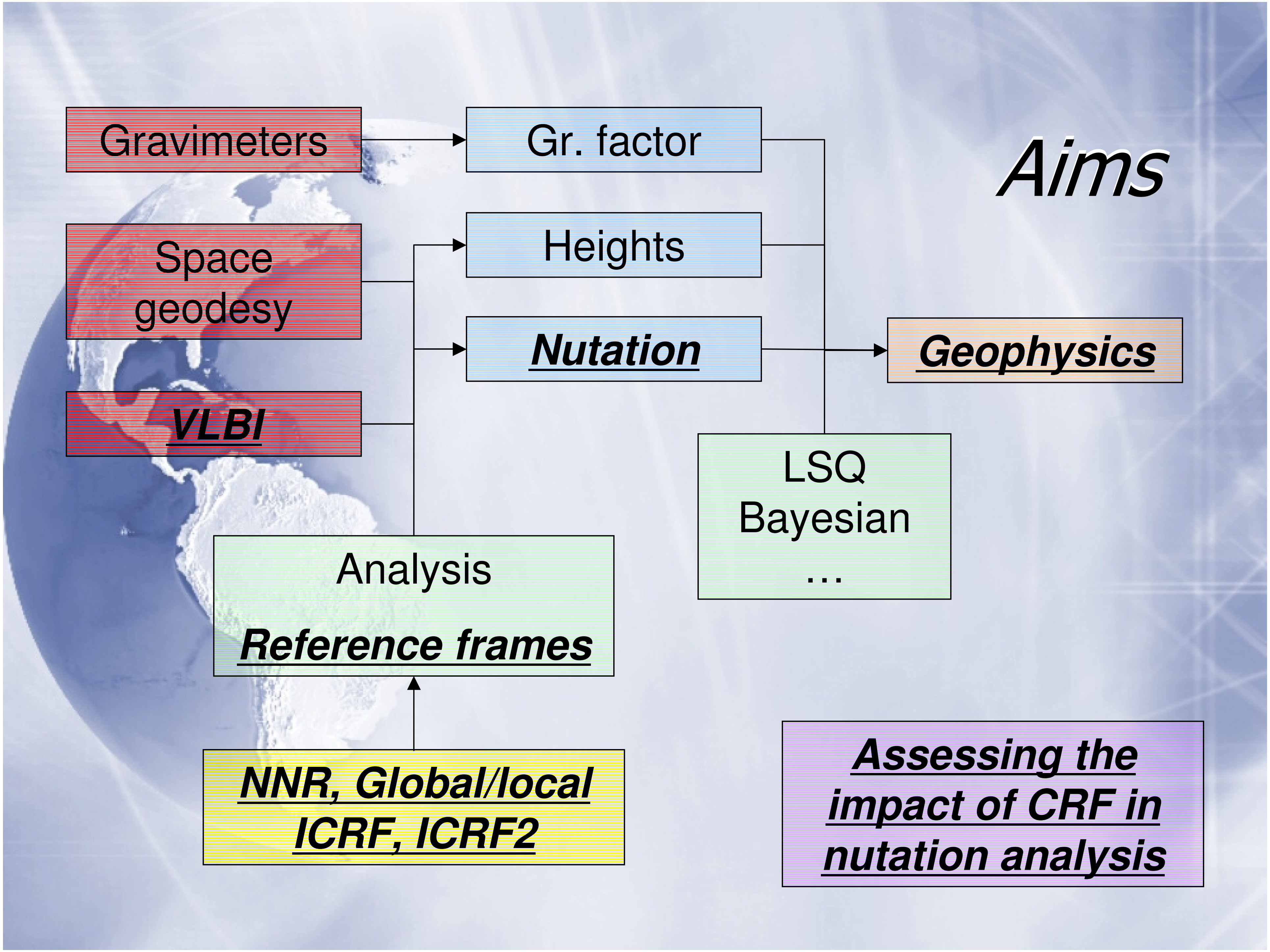
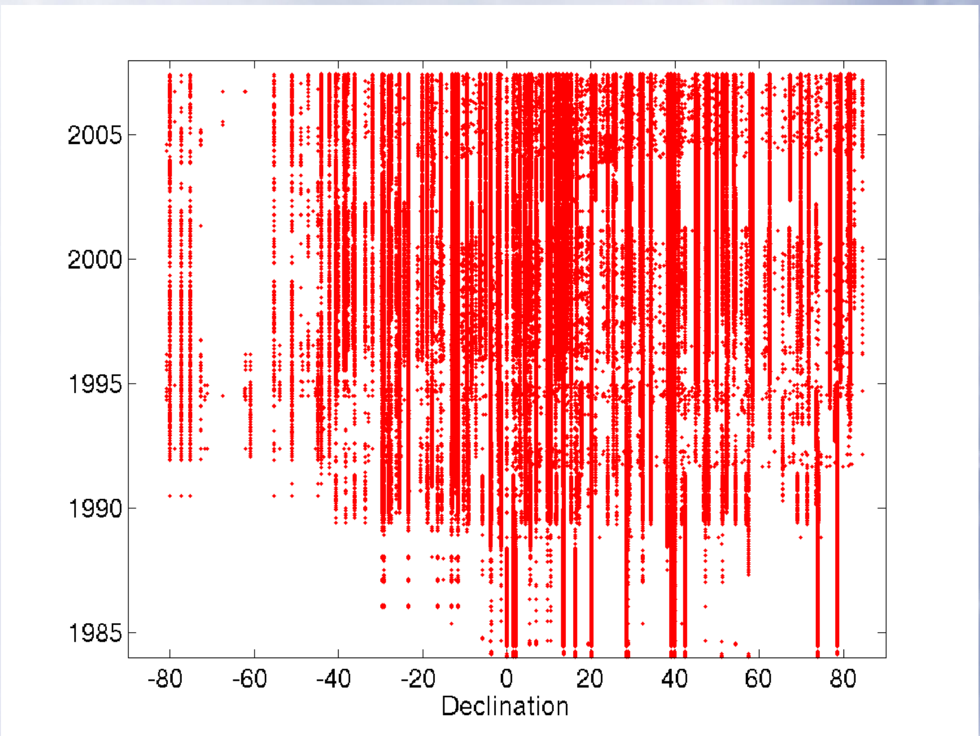

Aims
Gravimeters
Space geodesy
VLBI
Gr. factor
Heights
Nutation
Geophysics
LSQ
Bayesian
…
Analysis
Reference frames
NNR, Global/local
ICRF, ICRF2
Assessing the impact of CRF in nutation analysis

Observed sources

- The observational history is not uniform
- For global VLBI analysis, attention has to be paid to the underlying celestial reference frame
- Several strategies can be adopted: we propose to try some of them



Solution characteristics

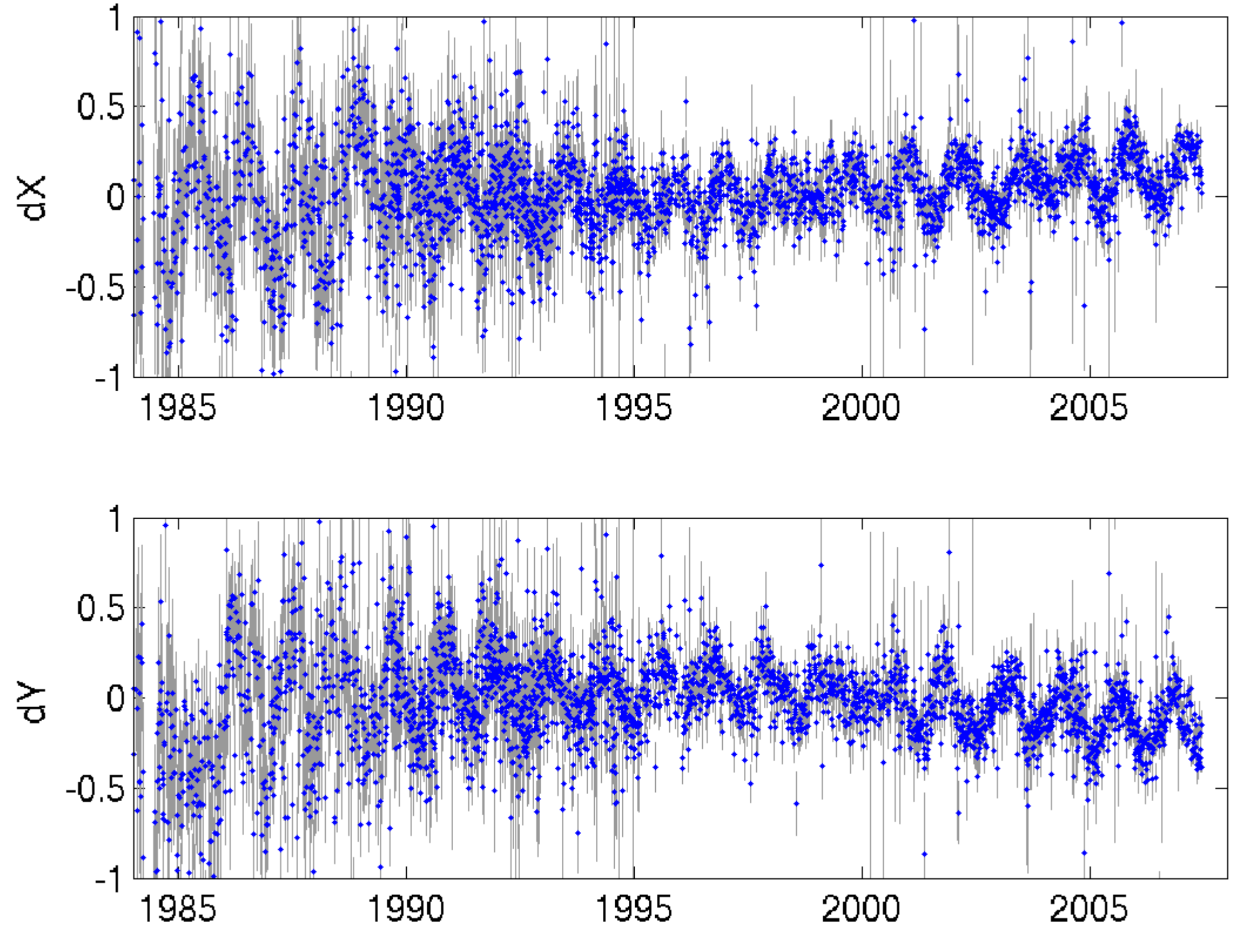
- Principle: several VLBI solutions
  - Identical…
  - … except for the handling of radio source positions
- 2995 sessions (~3.4 Mdelays) spanning 1984.0-2007.5
- Terrestrial frame
  - Most station coordinates as global
  - Some modeled by splines (e.g., Fairbanks)
  - NNR/T on 26 sites wrt VTRF 2005
- EOPs
  - PM, UT1, nutation, PM rates, LOD as local
  - IAU 2000 resolutions, including the NRO-based transfo
- Atmosphere
  - NMF
  - Zenith delay every 20 mn
  - Gradients every 6 hr
- Solve 2006.06.08

Solution characteristics

- Celestial frame
  - Elevation cut-off 6°
  - Split between global and local?
  - Subset for the NNR? ⇐ ICRF defining sources, 247 stable of Feissel-Vernier et al. (2006)… Please make your choice

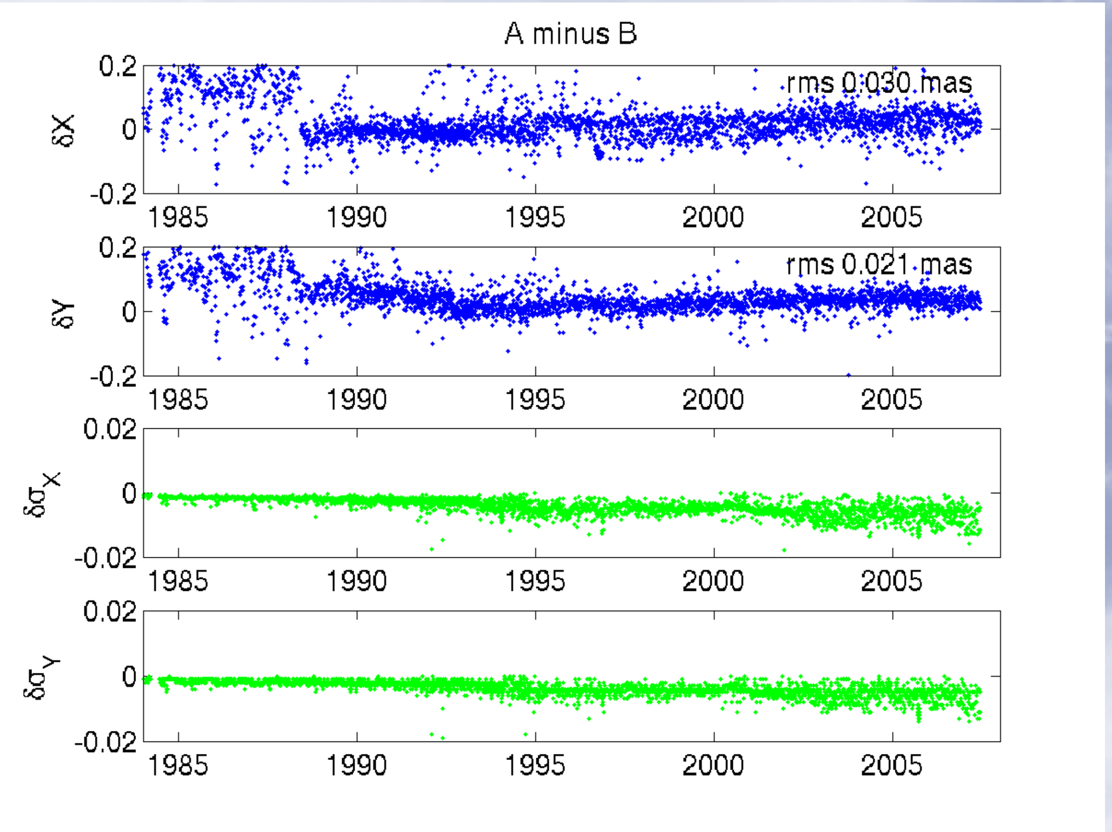
Name	Fixed	Global	Local	NNR	Postfit rms (ps)	Rms dX/dY (μas)
A: Fixed	816	0	0	-	24.0	165/167
B: Glo 212	0	816	0	ICRF 212	23.6	166/173
C: Glo 247	0	816	0	MFV 247	23.6	161/169
D: Loc 212	0	521	295 poorly observed	ICRF 212	23.6	162/170
E: Loc 247	0	521	295 poorly observed	MFV 247	23.6	161/169
F: Uns 212	0	653	163 unstable	ICRF 212	23.2	167/168
G: Uns 247	0	653	163 unstable	MFV 247	23.2	166/168

Nutation offsets at a glance



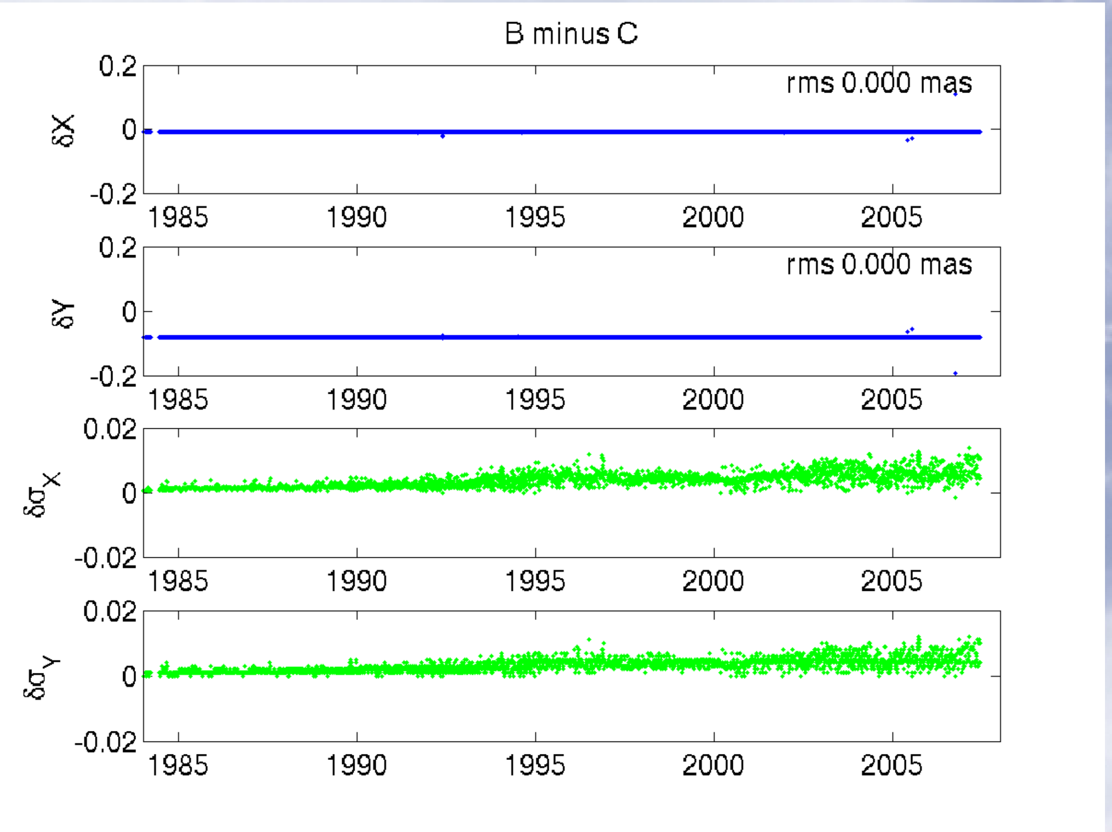
Differences between solutions

- Fixed - Glo 212



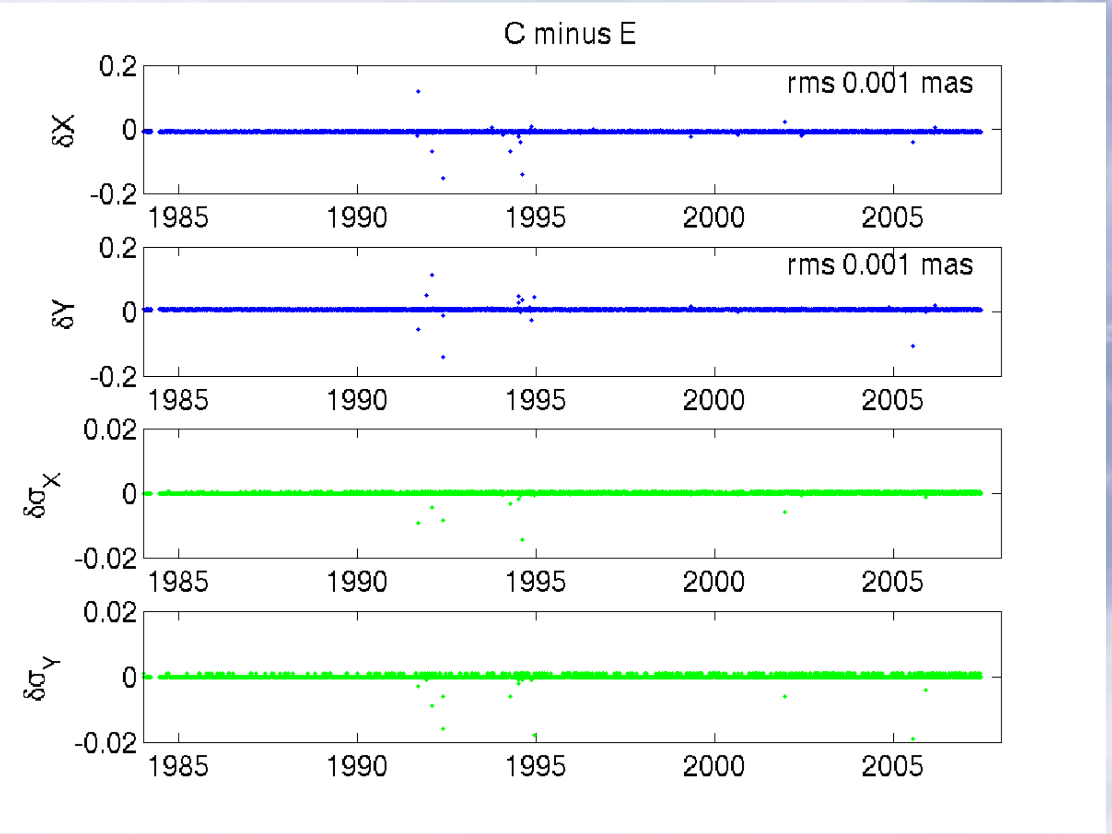
Differences between solutions

- Glo 212 - Glo 247



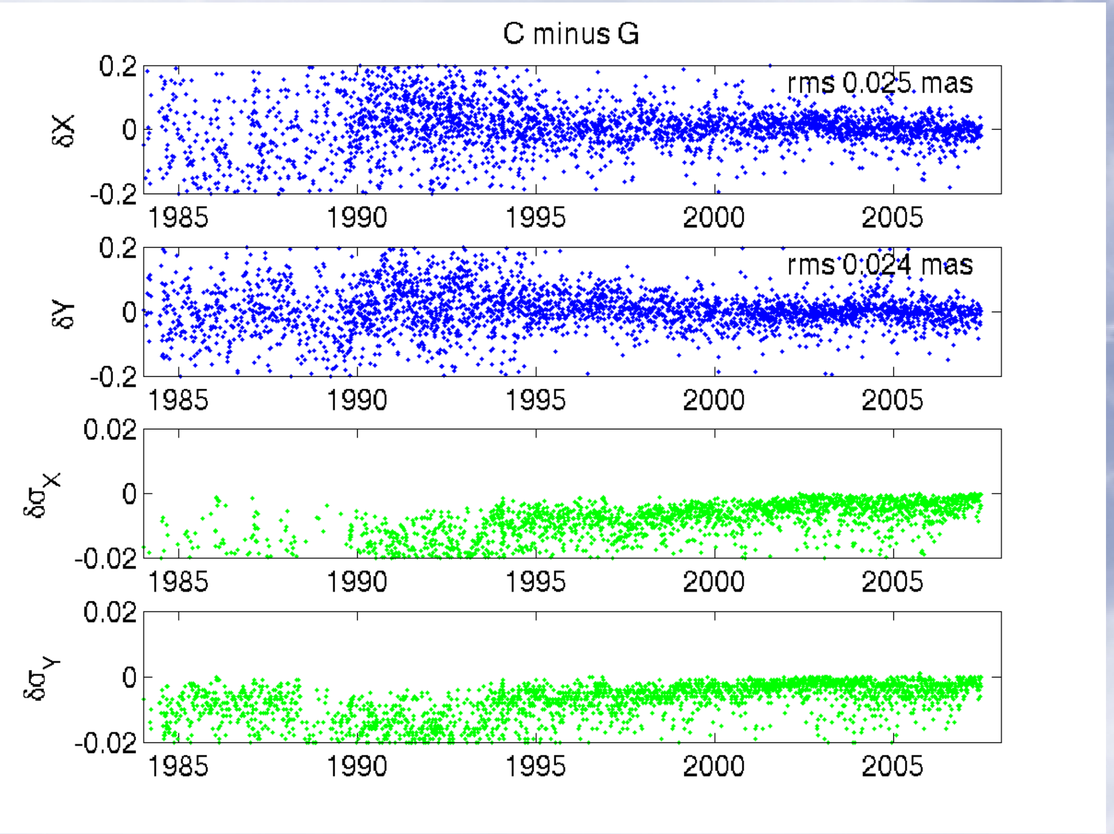
Differences between solutions

- Glo 247 - Loc 247



Differences between solutions

- Glo 247 - Uns 247



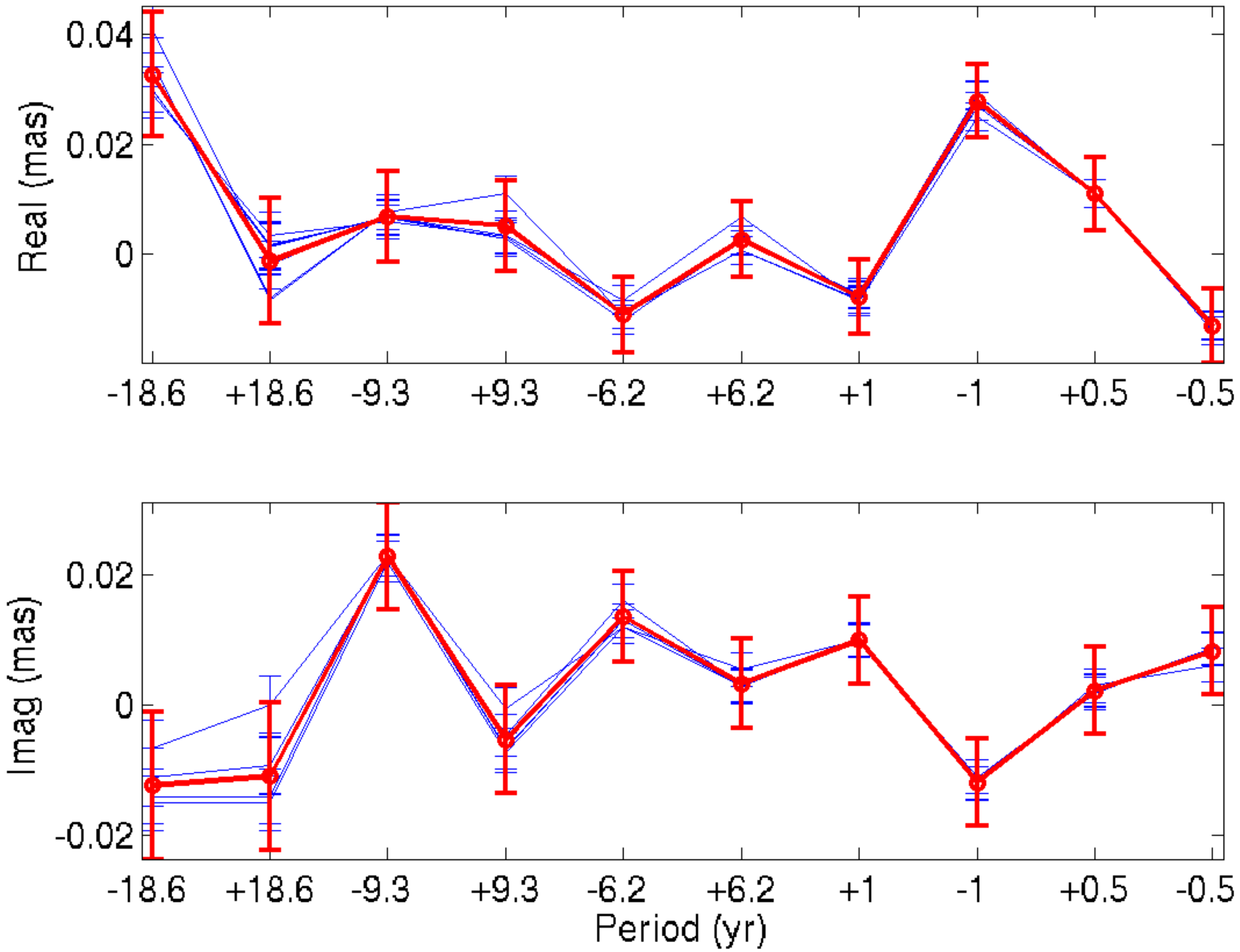
Forced nutations

- LSQ fit of

$$\tilde{\eta}(t) = \delta X(t) + \mathrm{i}\,\delta Y(t),$$
$$= (A^{\mathrm{Re}} + \mathrm{i}\,A^{\mathrm{Im}})\mathrm{e}^{\mathrm{i}\sigma t},$$

- Corrections for non linear terms
  - Erroneous values in MHB
  - Lambert & Mathews (2006)
  - Only affect the 18.6-yr at ~30 μas
- Pro and retro for 18.6-yr, 9.3-yr, 6.2-yr, annual, semi-, tri-, monthly, semi-, RFCN

Fit of forced nutations



Down to the Earth's interior

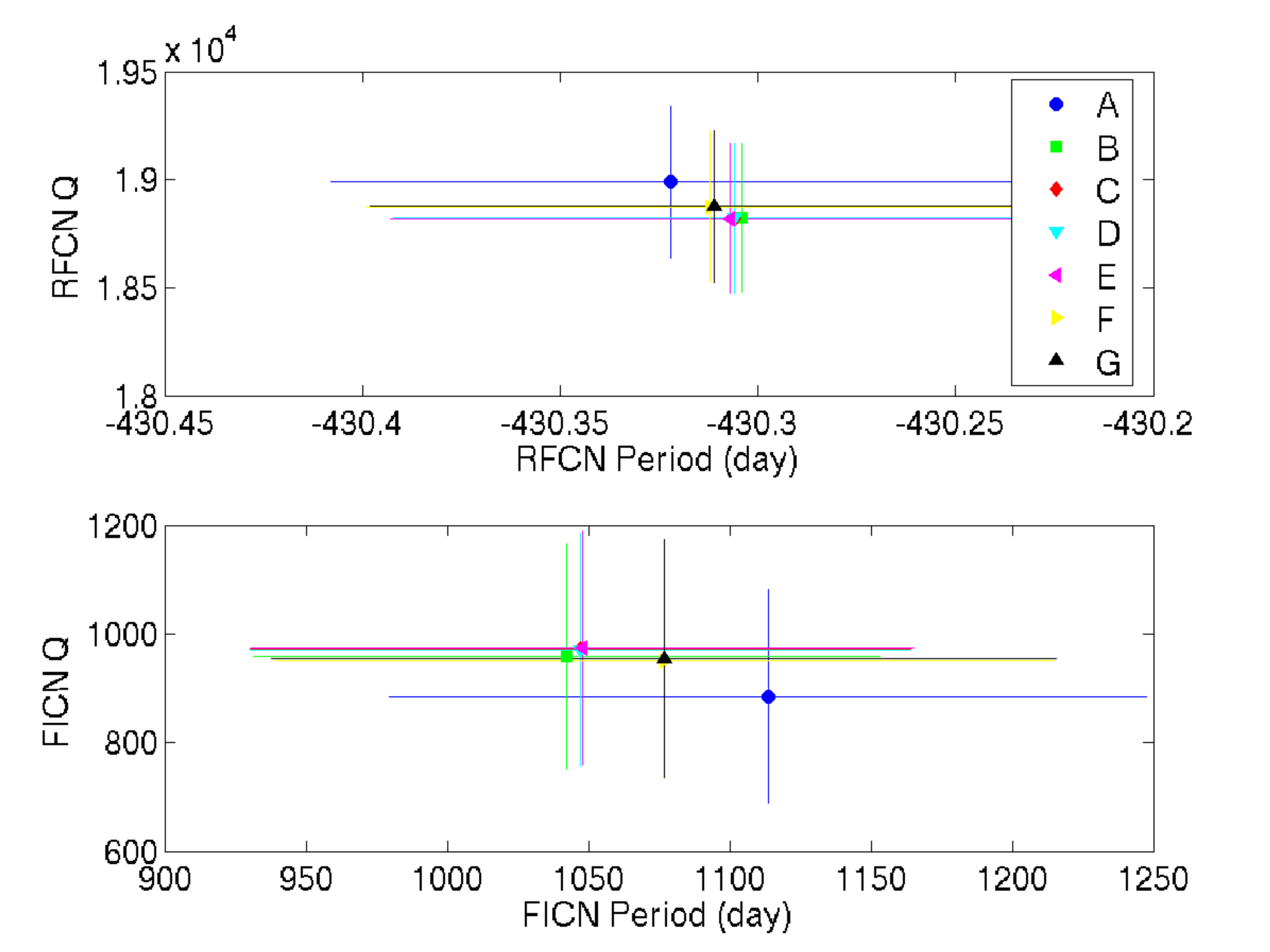
- Resonances associated w/ layers (mantle, core, inner core)
- Nutation frequency band: res. of outer and inner cores
- Resonance formula (Mathews et al. 2002)

$$\tilde{\eta}_{NR}(\sigma) = T(\sigma; e|e_R)\, \tilde{\eta}_R(\sigma),$$

$$T(\sigma; e|e_R) = \frac{e_R - \sigma}{e_R + 1} N_0 \left[1 + (1 + \sigma) \left(Q_0 + \sum_{\alpha=1}^{4} \frac{Q_\alpha}{\sigma - s_\alpha} \right) \right],$$

- Periods and damping of outer and inner cores

Outer and inner cores resonance periods and Q



Conclusion

- Positional instability of radio sources + VLBI analysis strategy can move the nutation amplitudes by ~30 μas for the 18.6-yr, ~20 μas for the annual
- Earth's interior
  - Outer core ΔP~0.05 day, ΔQ~1000
  - Inner core ΔP~100 days, ΔQ~300
- Caution in using the different VLBI data sets since done using various analysis strategies
- Which strategy for the best internal accuracy of nutations? (MacMillan & Ma 2007)