
Combination of Earth Orientation Parameters

*Daniela Thaller¹⁾, Manuela Krügel²⁾, Volker Tesmer²⁾,
Markus Rothacher³⁾, Ralf Schmid¹⁾, Detlef Angermann²⁾*

¹⁾ FESG, TU München

²⁾ DGFI, München

³⁾ GFZ, Potsdam

IERS Workshop on Combination, GFZ, Potsdam, October 10-11, 2005

Outline

- Data Description: 2 weeks (CONT02)
- Combination of UT1 and LOD:
VLBI, GPS and SLR
- Combination of nutation offsets and rates:
VLBI, GPS and SLR
- Correlations between subdaily polar motion and nutation:
Based on simulated GPS observations
- Conclusions

Data Description: CONT02

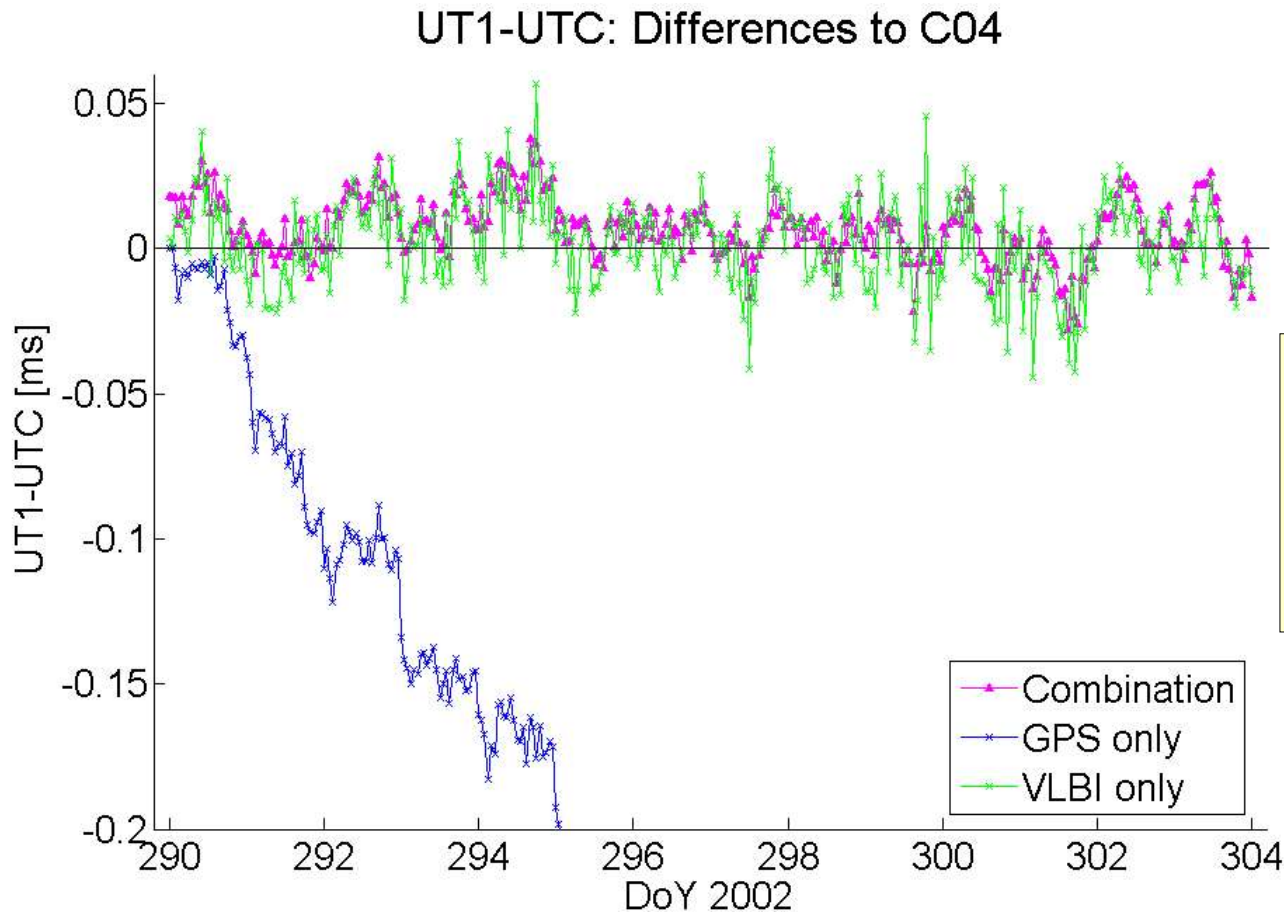
14 days of continuous VLBI observations: *October 16-30, 2002*

- Single-Technique Solutions:***
- 8 VLBI stations (OCCAM)
 - 153 GPS stations (Bernese)
 - 23 SLR stations (Bernese)

Using identical models and parameterization for all techniques!

- Estimated Parameters:***
- *Station coordinates*
 - ***Pole, UT***: Hourly, piece-wise linear
 - ***Nutation***: Linear over 14 days
 - *Troposphere*: Hourly ZD + daily gradients

Motivation



RMS UT1-UTC:

Combination: 0.011 ms

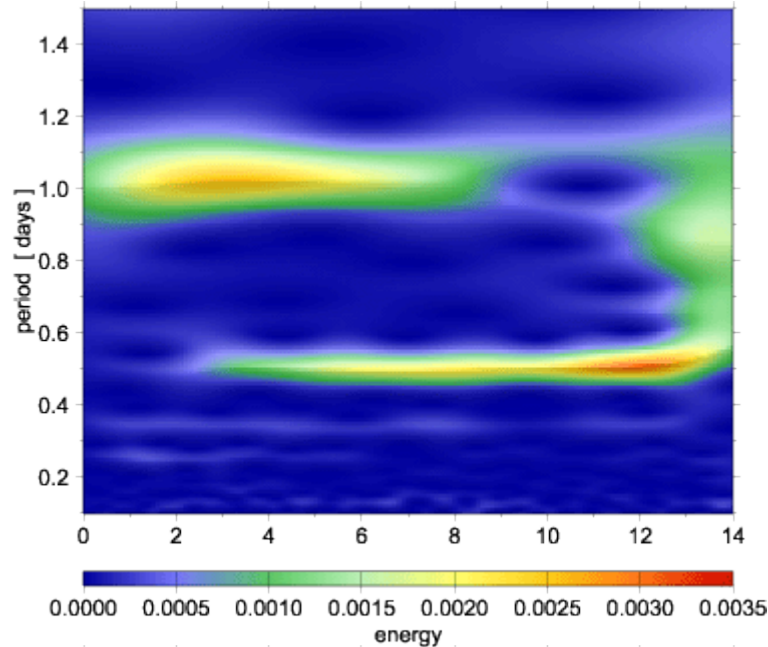
GPS: (0.182 ms)

VLBI: 0.015 ms

Successful combination without special handling of LOD!

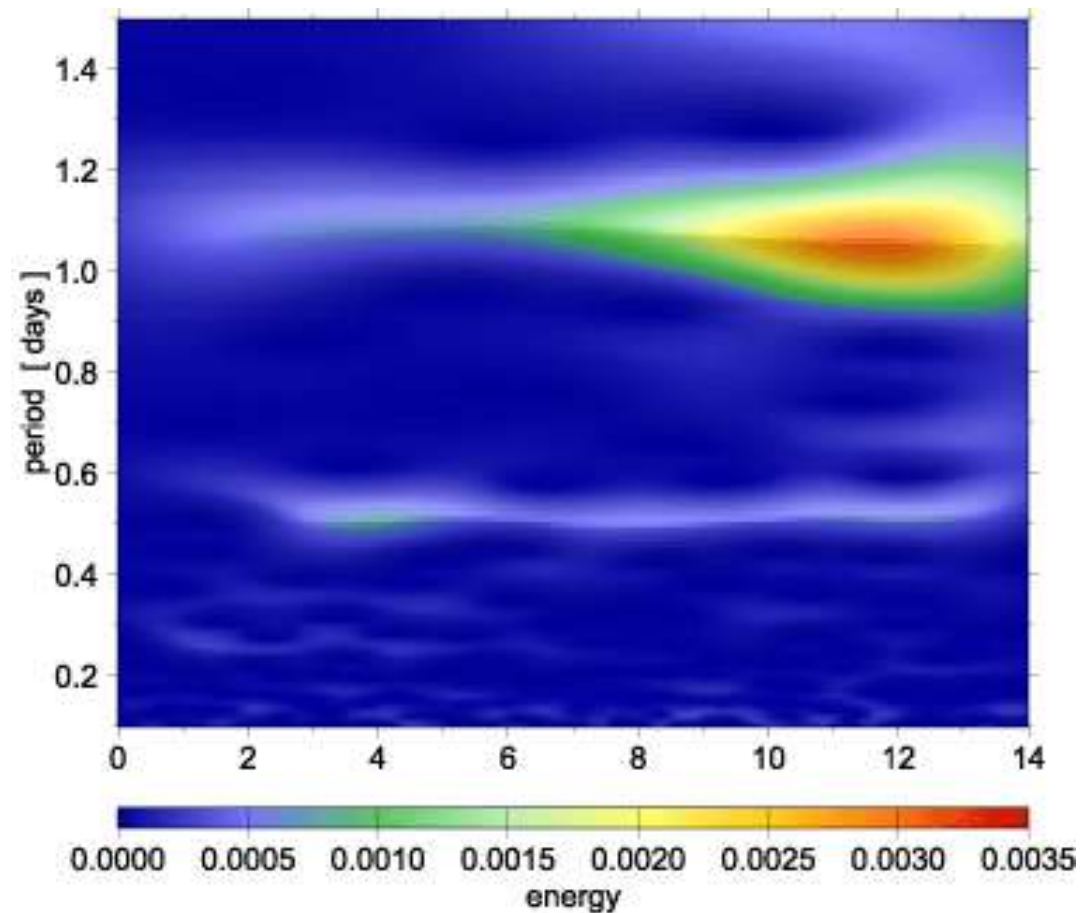
UT Wavelet Analysis (1): High Frequencies

GPS

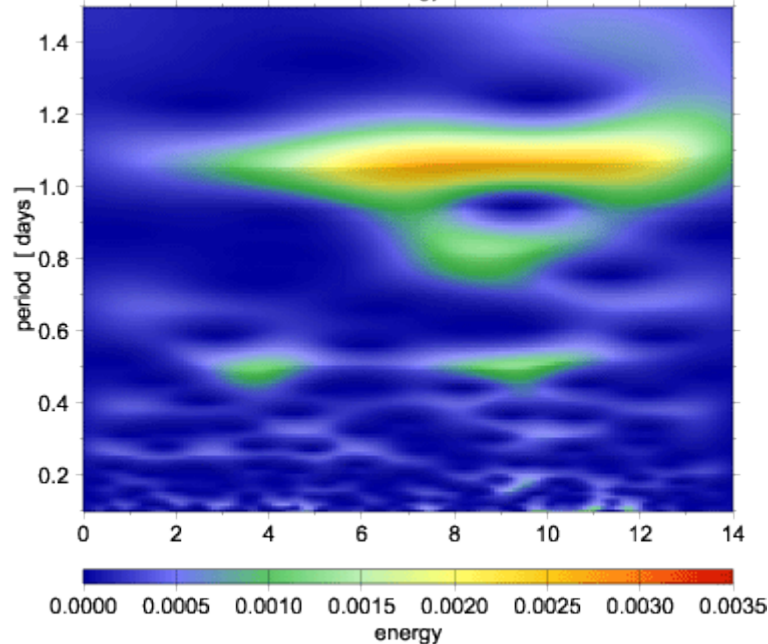


*Thanks to Michael Schmidt (DGFI)
for the wavelet analyses!*

Combination

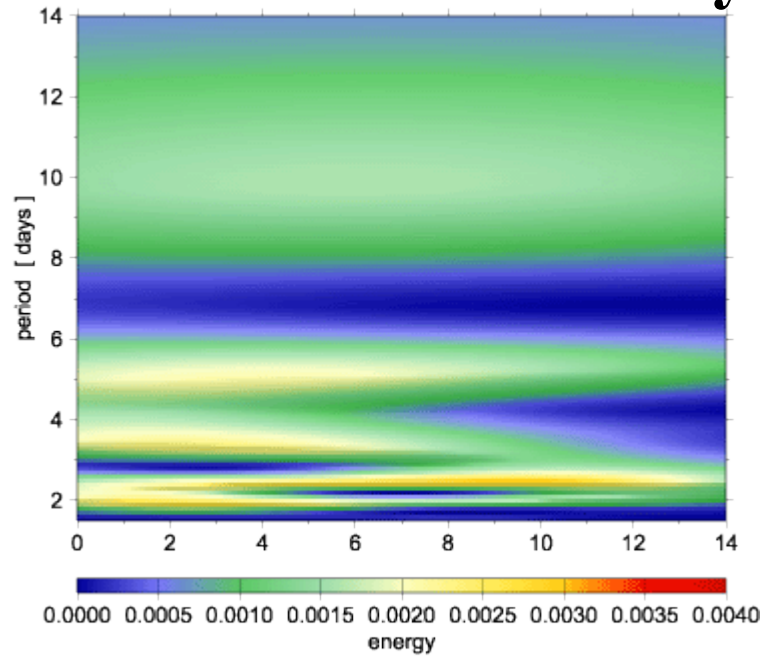


VLBI

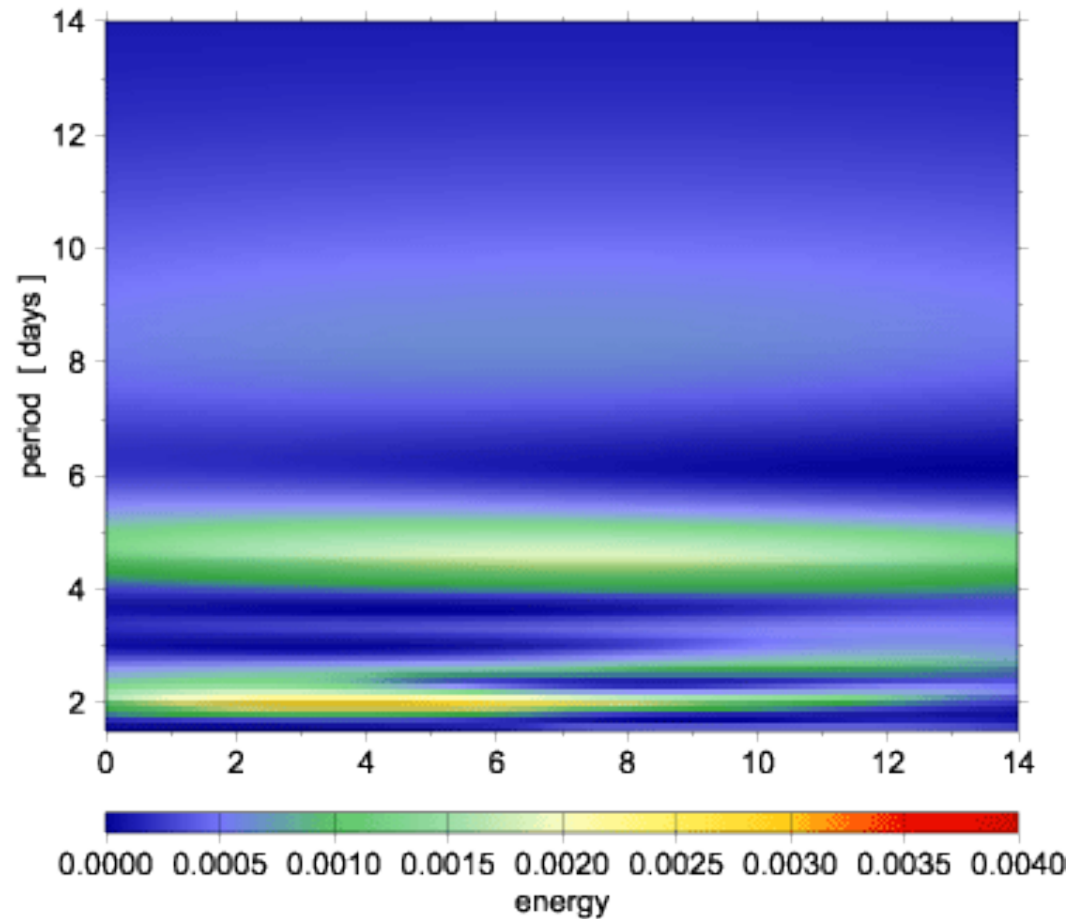


UT Wavelet Analysis (2): Low Frequencies

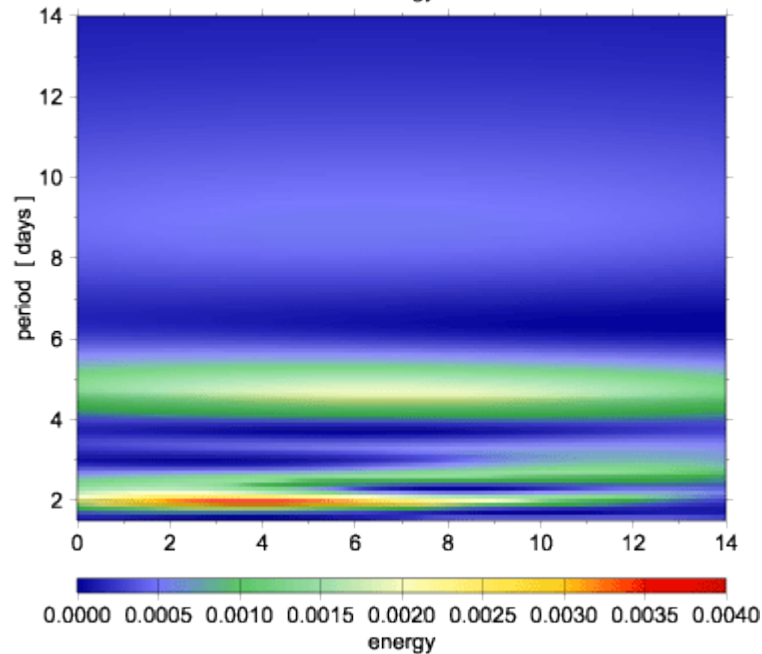
GPS



Combination

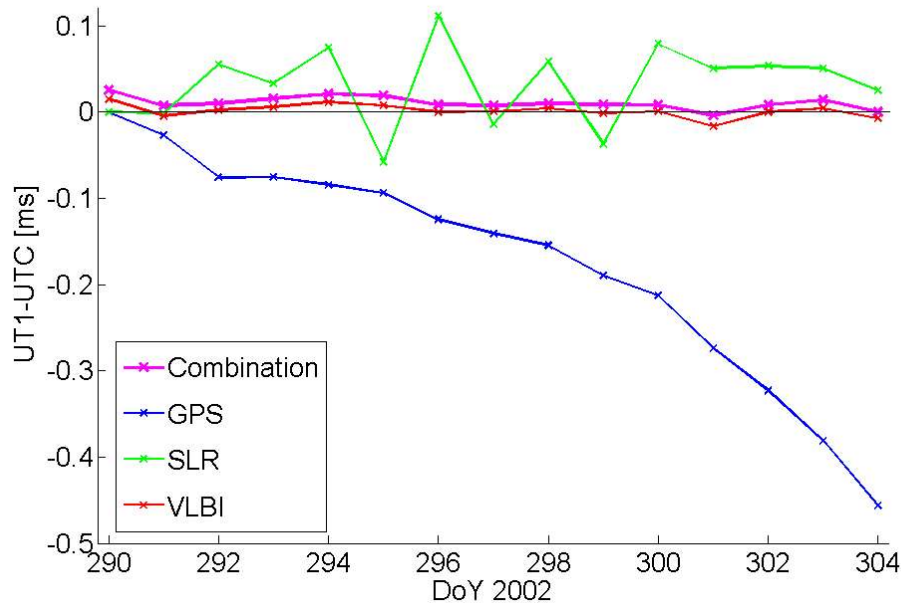


VLBI



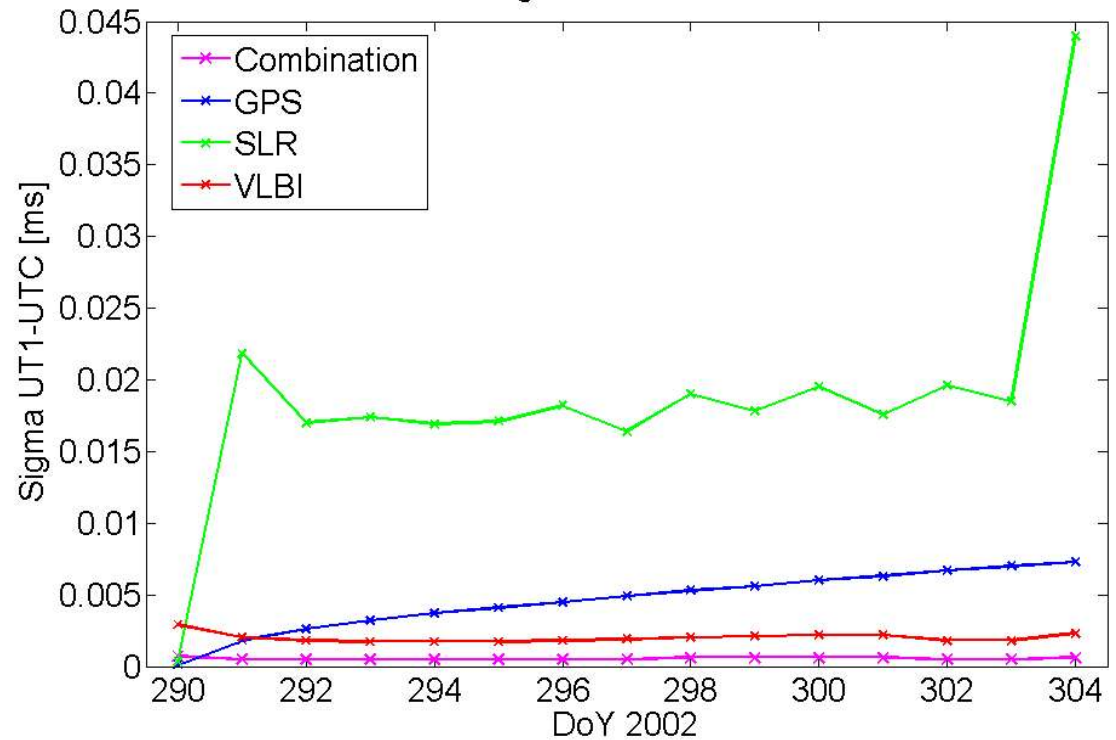
UT: Standard Deviation

UT1-UTC: Differences to C04



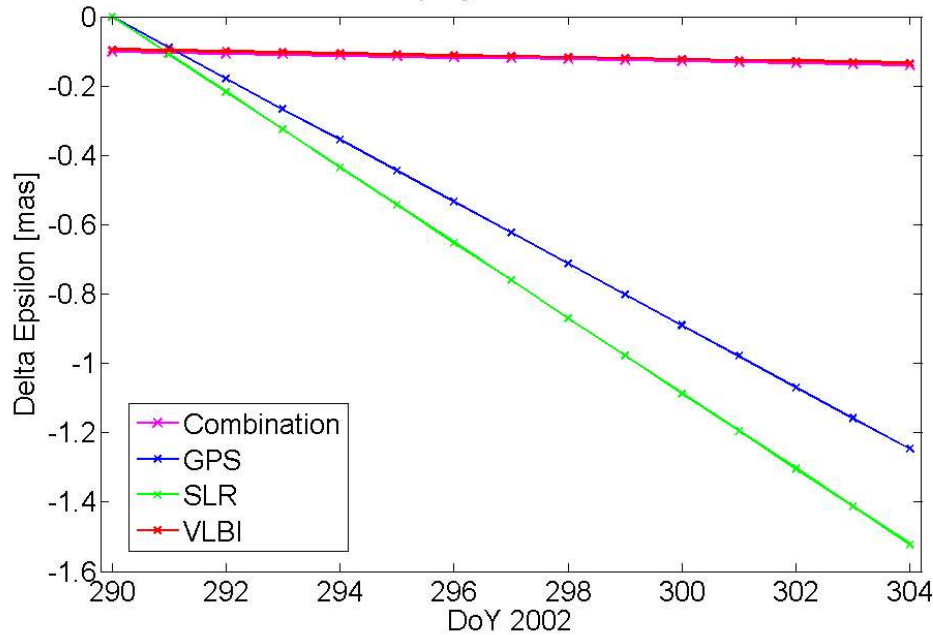
Combination is successful due to rapidly increasing formal errors of GPS/SLR estimates

Sigma of UT1-UTC



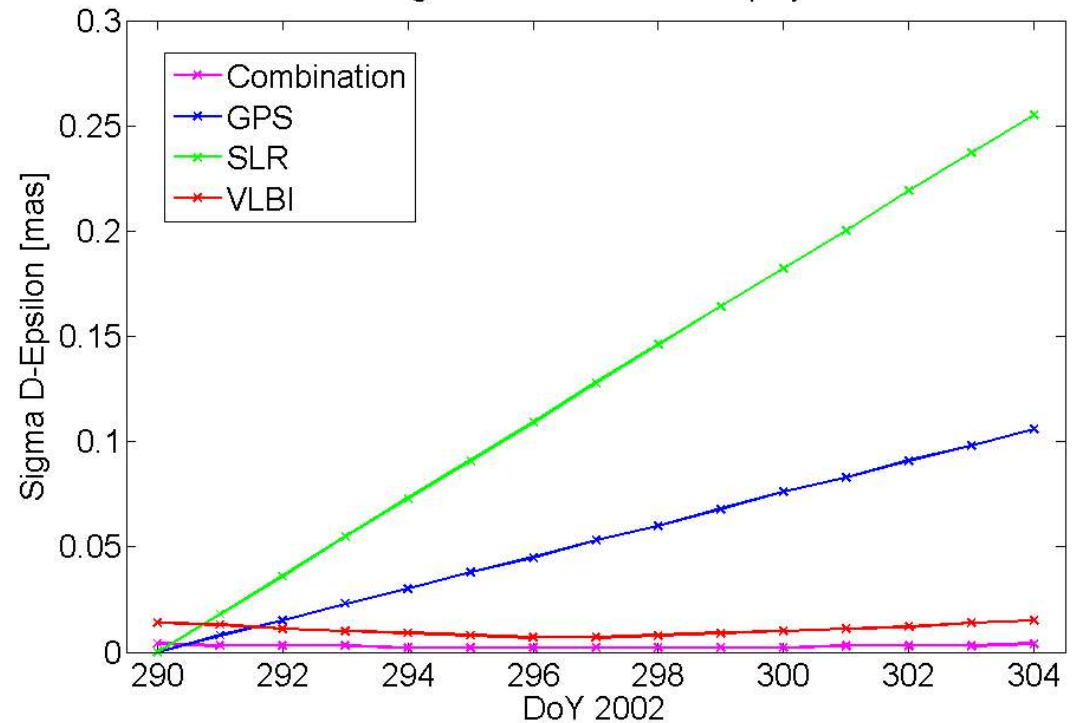
Combination of Nutation

Nutation in Obliquity: Differences to IAU2000



Combination is successful due to rapidly increasing formal errors of GPS/SLR estimates

Sigma of Nutation in Obliquity



Correlations: Subdaily Polar Motion and Nutation

Retrograde diurnal polar motion $\hat{=}$ Nutation **offset**

- Estimating **subdaily polar motion** + **nutation** simultaneously causes problems
- Retrograde diurnal terms in polar motion are **blocked** (amplitudes constrained to zero)
- **BUT**: Signals with other periods are affected as well; depending on the length of the data set:

$$\Delta T \geq \frac{T_0^2}{T_s + T_0}$$

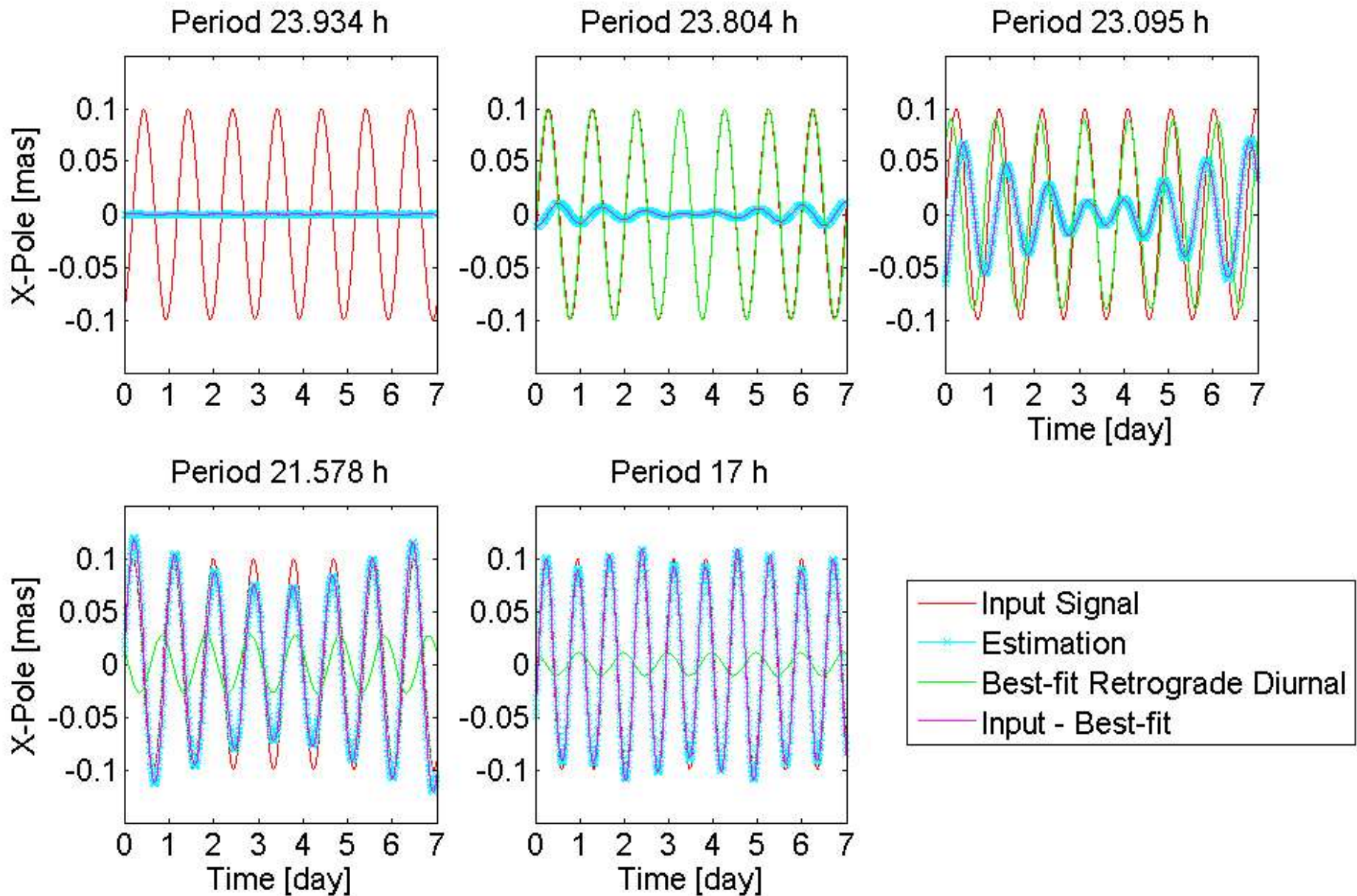
T_s = Length of data set

T_0 = Period of reference signal
(= 23.934 h)

ΔT = Difference in period necessary
for a full decorrelation of the signals

T_s	ΔT	$T_0 - \Delta T$
1 d	11.9505 h	11.9835 h
7 d	2.9845 h	20.9495 h
14 d	1.5915 h	22.3425 h
365 d	3.91 min	23.8688 h

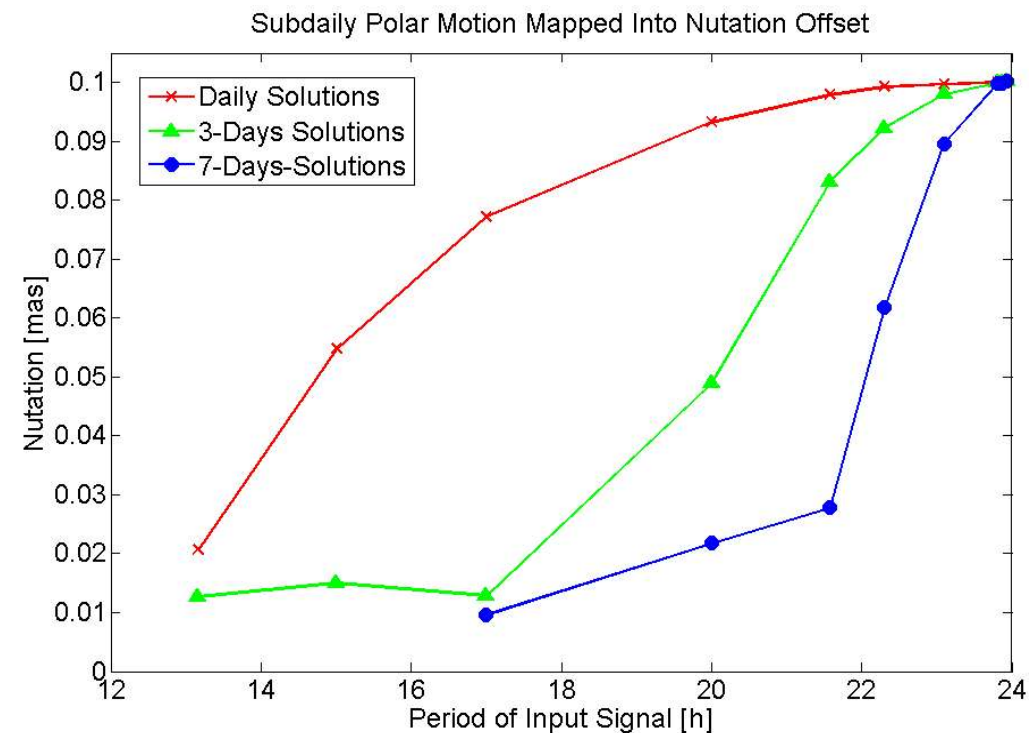
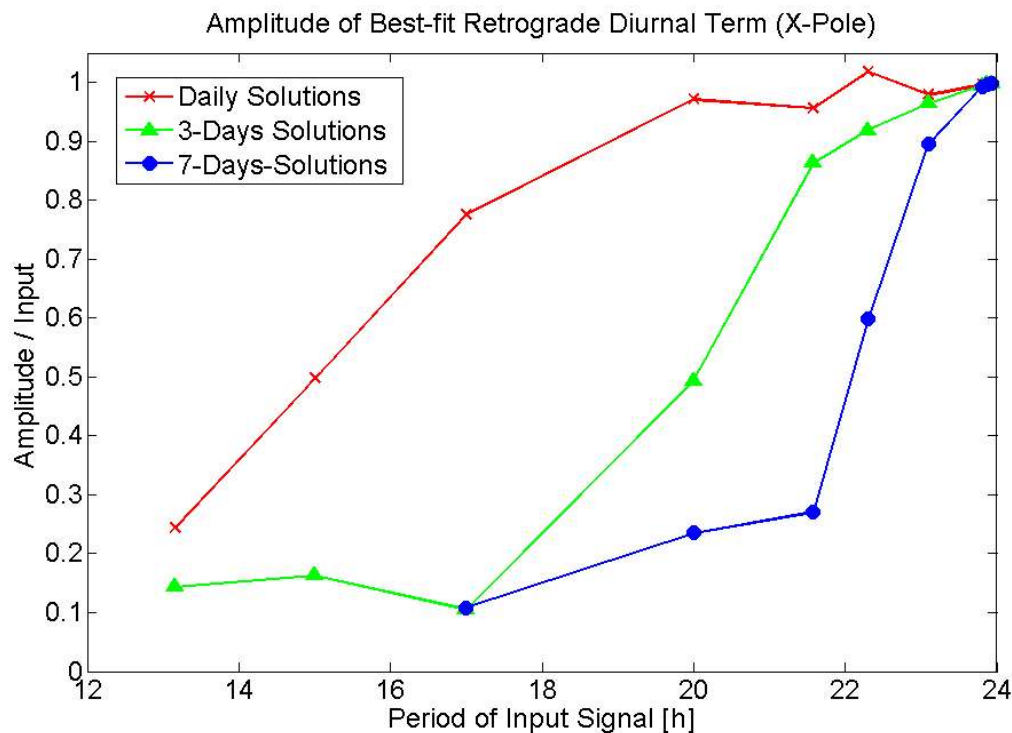
Correlations: Simulation for a 7-Day Solution



Correlations: Subdaily Polar Motion and Nutation

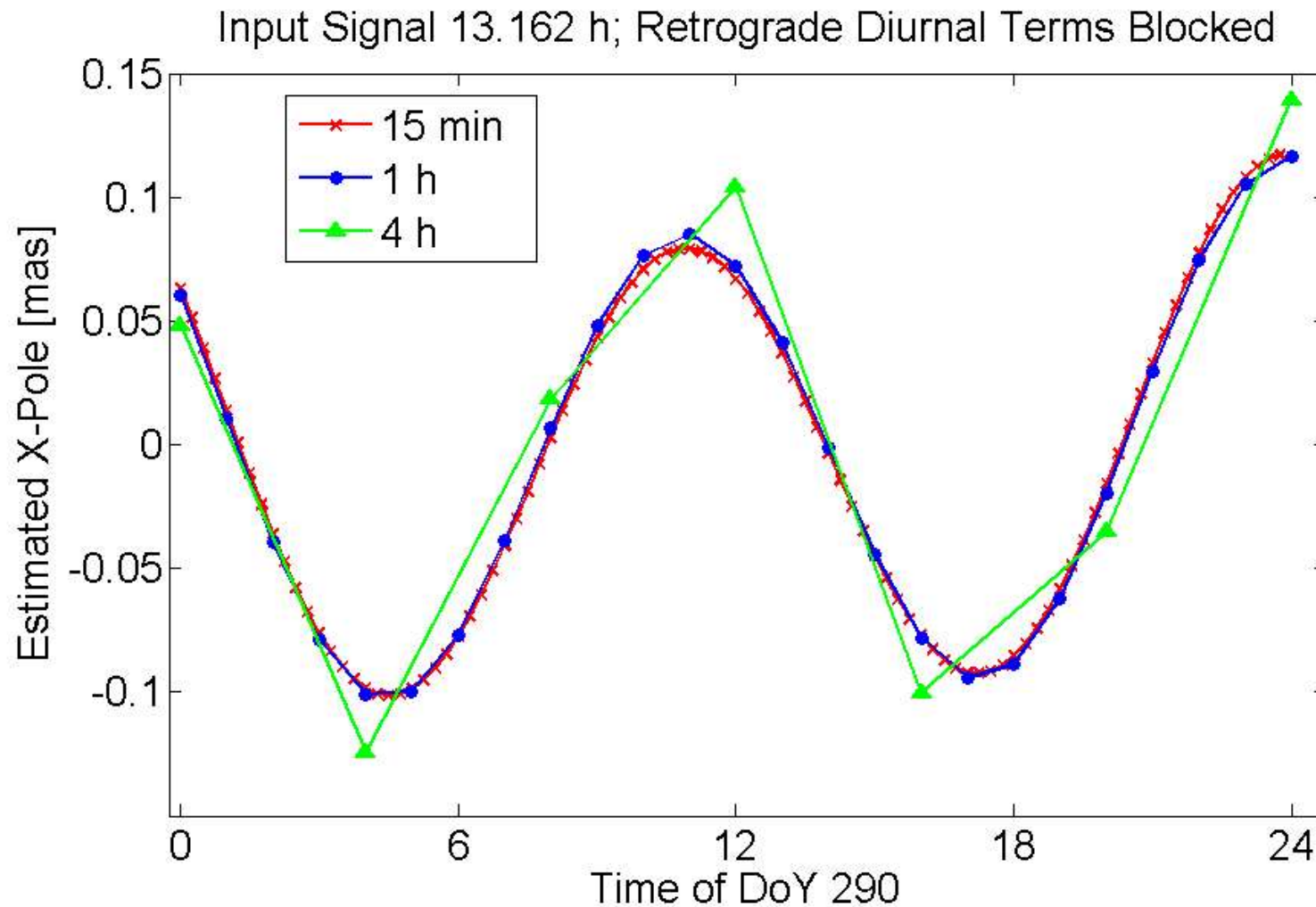
Amplitude of the 'best-fit'
retrograde diurnal polar motion
(w.r.t. the amplitude of the signal
introduced additionally: 0.1 mas)

Nutation offset estimated after
introducing an additional
subdaily polar motion term



Correlations: Temporal Resolution

Temporal resolution has no influence on the constraint



Conclusions

Combination of UT1/LOD from VLBI and satellite techniques:

- LOD from satellite techniques does not disturb VLBI-derived UT1
- GPS (/SLR) delivers high frequencies of good quality
- Pre-condition: Satellite orbits have to be free!
- No principle difference between a combination of UT1+LOD and nutation offsets+rates

Simultaneous estimation of subdaily polar motion and nutation:

- The blocking of retrograde diurnal polar motion is a convenient tool
- Length of data set has to be considered
- Nutation rates have not been studied yet
- Additional correlation for satellite techniques: Rotation of all orbital planes