Earth rotation parameters from satellite techniques

D. Thaller[1,2], G. Beutler[1], A. Jäggi[1], M. Meindl[1,3],

R. Dach[1], K. Sosnica[1], C. Baumann[1]

(1) AIUB, University of Bern, Switzerland

(2) now at: BKG, Frankfurt / Main, Germany

(3) now at: ETH Zurich, Switzerland

EGU General Assembly 2013, Vienna, Austria

Overview

- Sub-daily Earth rotation:
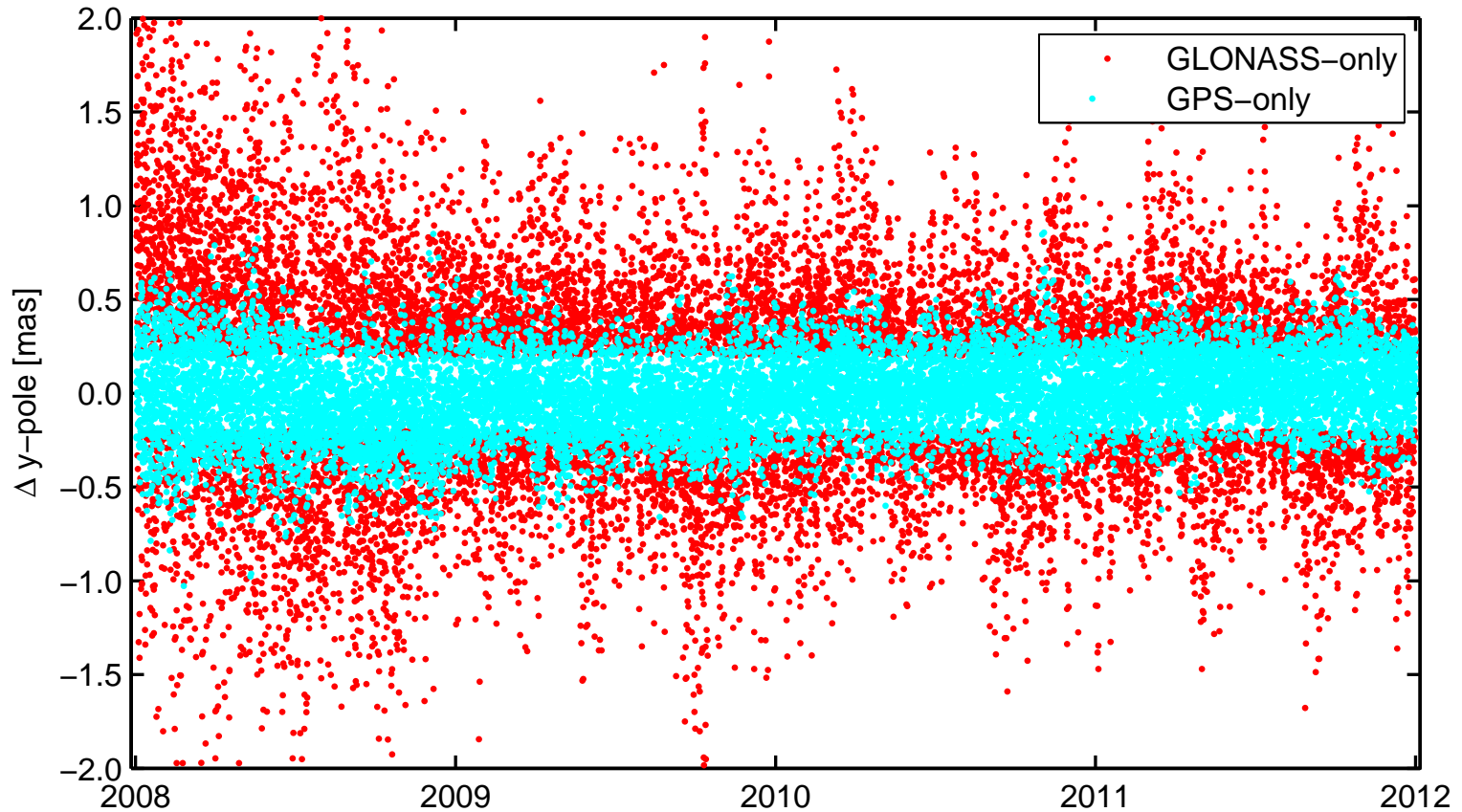 - GPS, GLONASS and SLR
  - Time-series (up to 1-hour resolution)

- Impact of gravity field variations on ERPs:
  - Estimation of low-degree gravity field coefficients together with ERPs
  - GNSS and SLR solutions

ETH   Bundesamt für Kartographie und Geodäsie   **AIUB**

Sub–daily ERPs

Comparison of different satellite systems:

- **GPS–only:**
  - 2008 – 2011
  - Daily solutions
  - 1.5 hour temporal resolution

- **GLONASS–only:**
  - Settings / network identical to GPS–only solution

- **LAGEOS–only:**
  - 2001 – 2011
  - Weekly solutions
  - Testing different temporal resolutions (1 h, 2 h, 3 h)
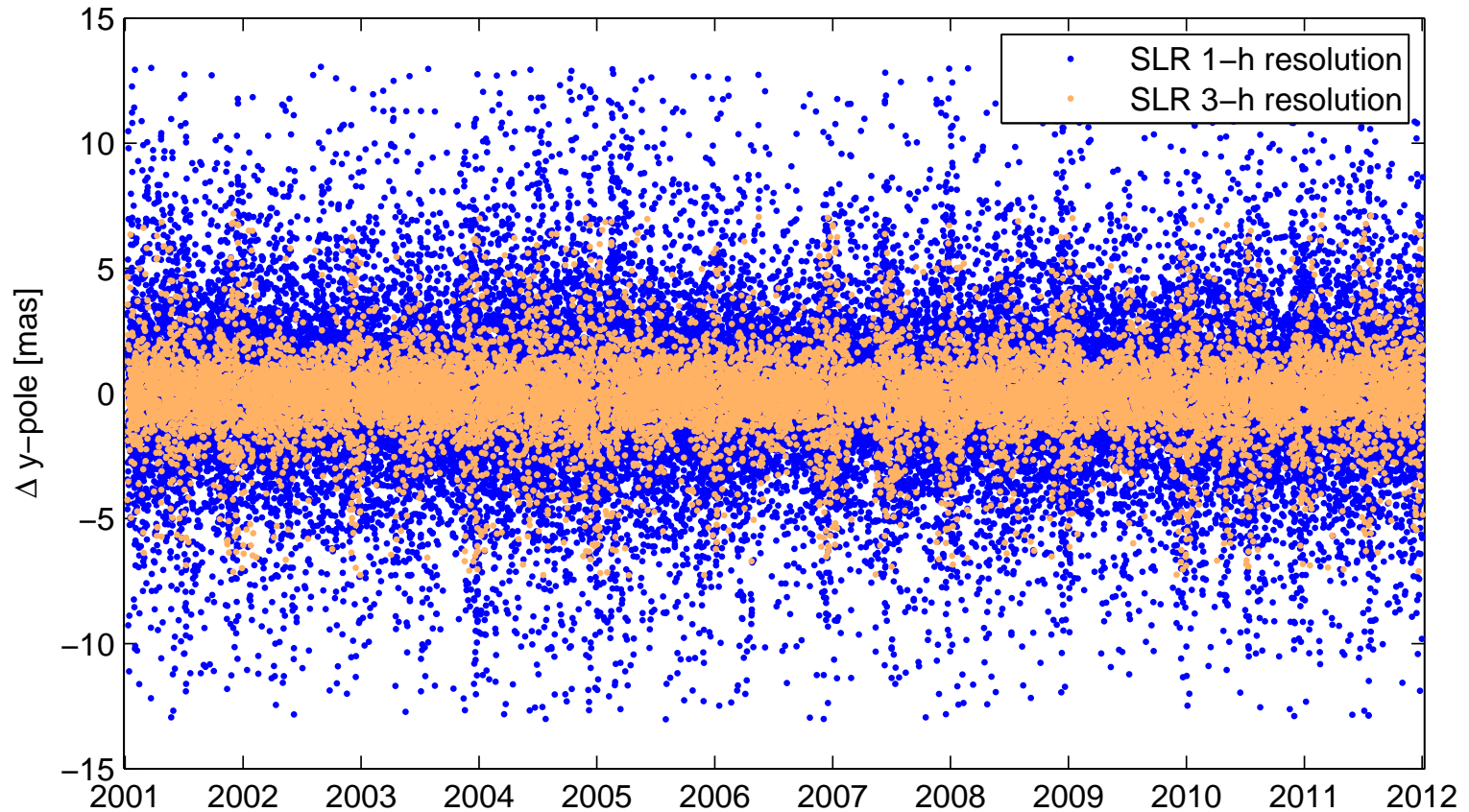
Sub–daily ERPs: Time series PM

GLONASS: WRMS = 372.6 μas

GPS: WRMS = 162.2 μas

=> PM based on GLONASS is clearly noisier than PM based on GPS

ETH   Bundesamt für Kartographie und Geodäsie   AIUB
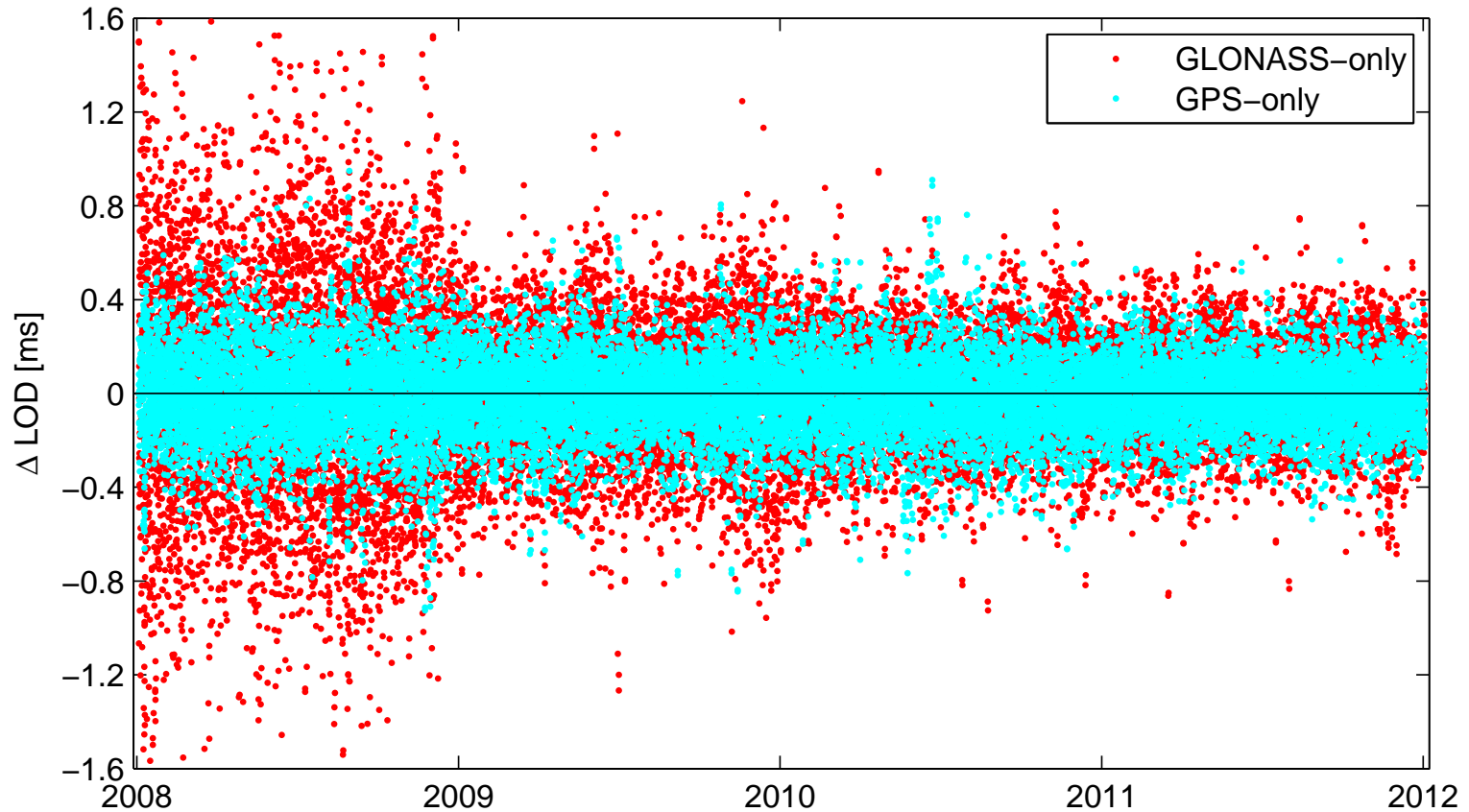
Sub–daily ERPs: Time series PM

SLR 1–h: WRMS = 1648.6 μas

SLR 2–h: WRMS = 1213.1 μas (not shown)

SLR 3–h: WRMS = 1050.7 μas

=> 1-hour resolution might be too high for SLR
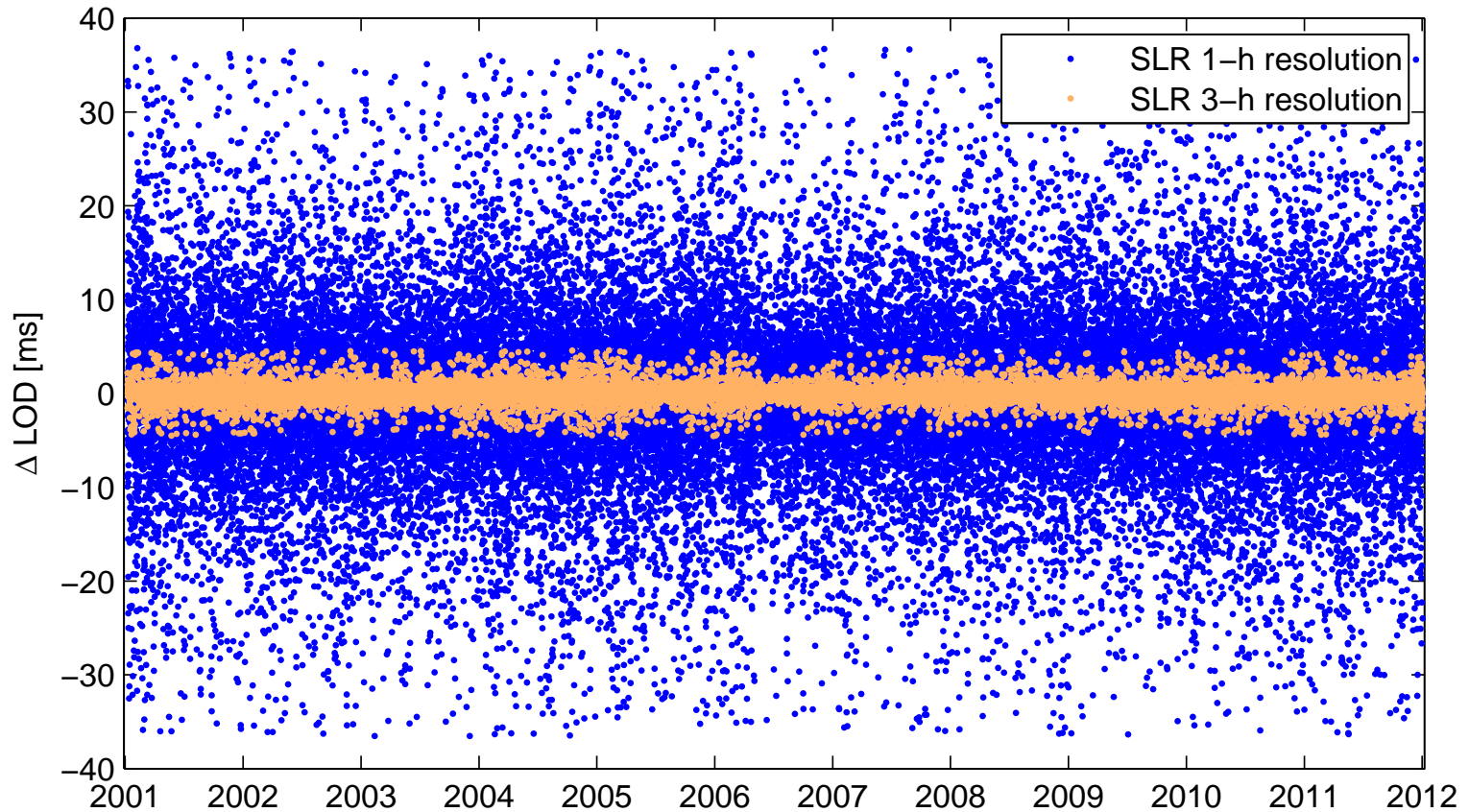
Sub–daily ERPs: Time series LOD

GLONASS: WRMS = 229.5 μs

GPS:　　　　WRMS = 161.9 μs

=> GLONASS has similar quality as GPS if full satellite constellation is available
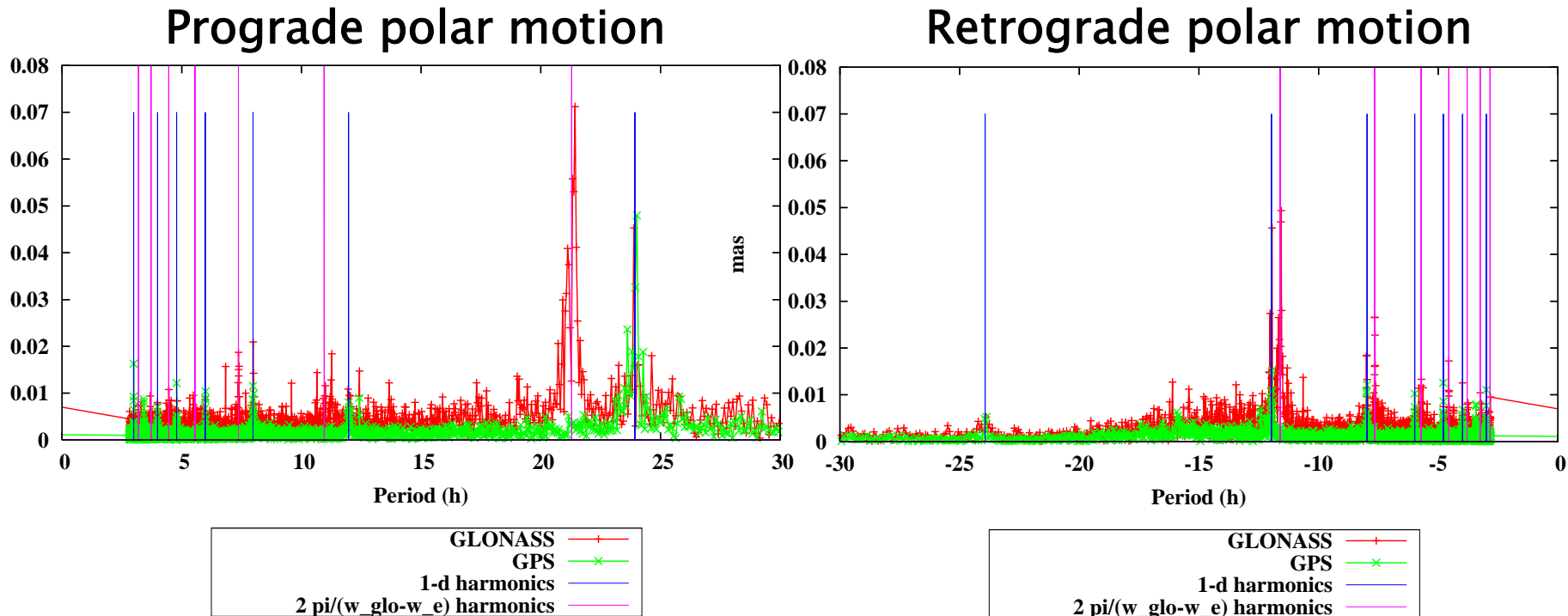
Sub–daily ERPs: Time series LOD

SLR 1–h: WRMS = 4380.0 μs

SLR 2–h: WRMS = 1171.3 μs
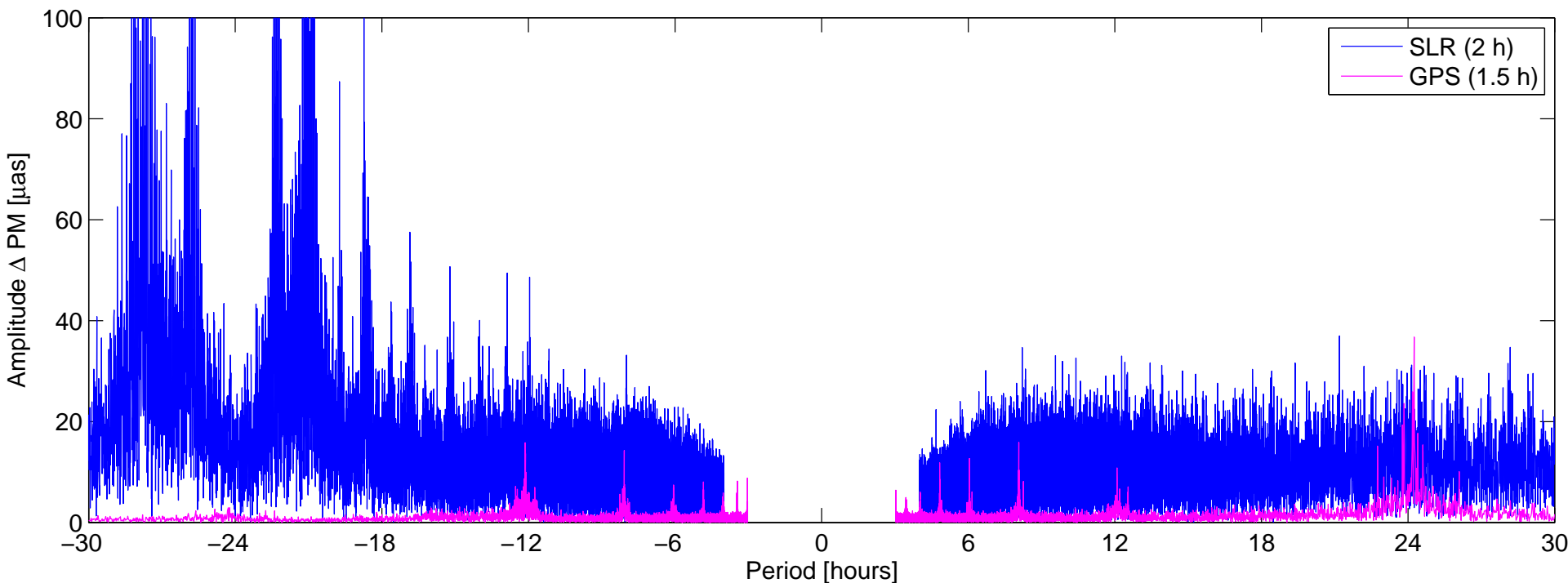
SLR 3–h: WRMS = 552.1 μs

=> The temporal resolution has a bigger impact on LOD than on PM

Sub–daily ERPs: Spectra of PM time–series

Prograde polar motion

Retrograde polar motion

- **GPS**: many orbital artefacts

    = harmonics of a **diurnal period**

- **GLONASS**: many orbital artefacts

    = harmonics of **linear combination** of the **Earth's** and the **satellites' revolution periods**

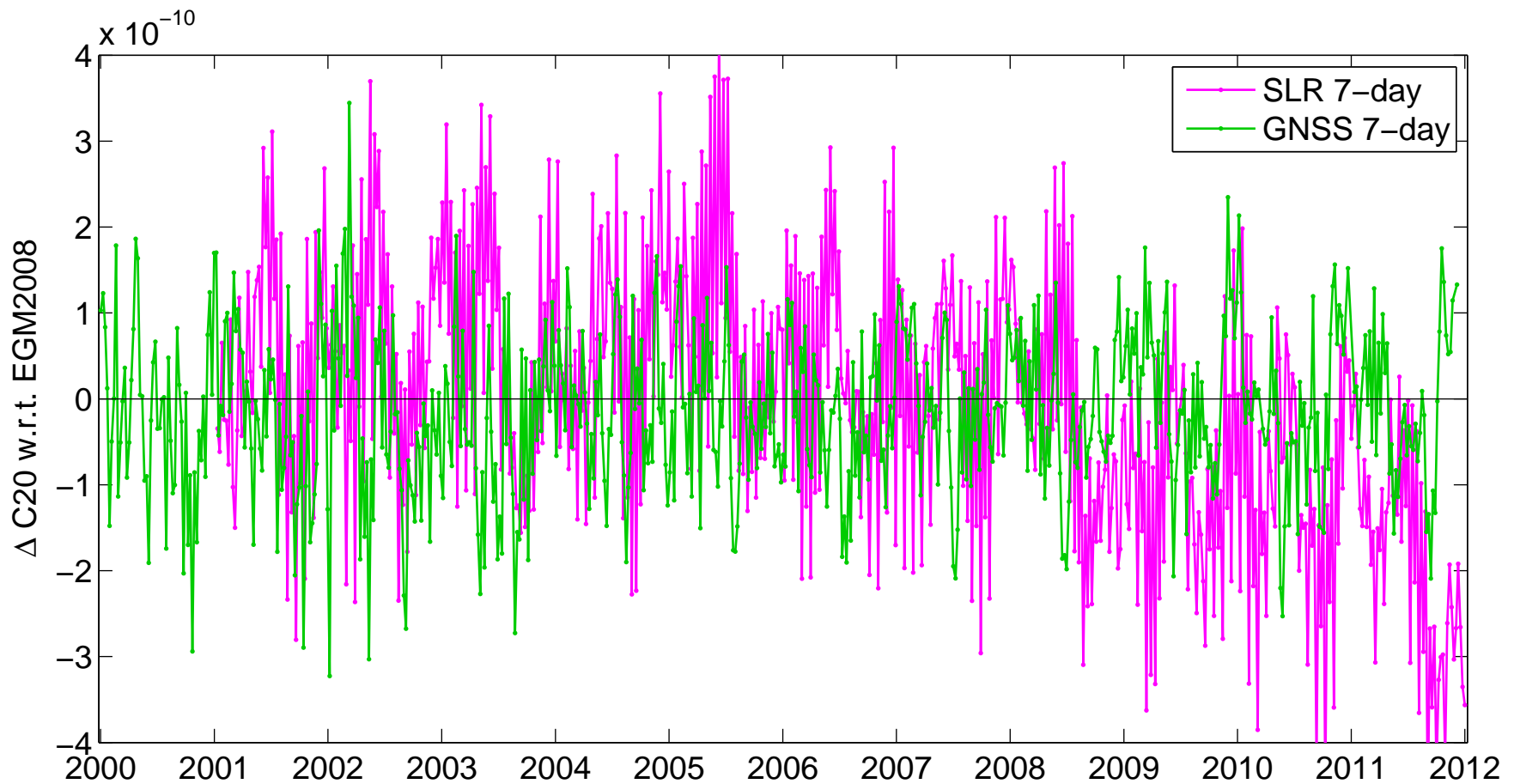# Sub-daily ERPs: Spectra of PM time-series

SLR–LAGEOS:

- Many artefacts in retrograde PM: linear combinations of Earth's and satellites' revolution periods (3.75 h)
- Prograde PM does not have artefacts (but much larger noise level than GNSS)

Impact of low-degree gravity

➤ **2 types of solution series** are computed:

- **No** gravity field coefficients estimated

  (= «Standard» solution)

- **C20 estimated**

➤ GNSS: weekly solutions, 2000 – 2011
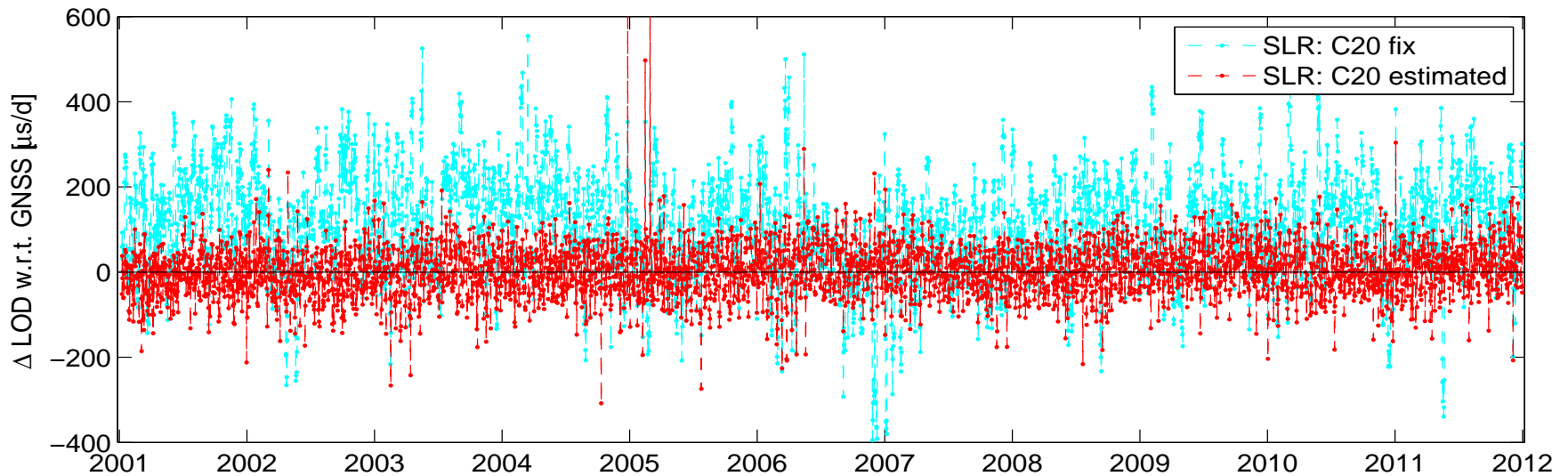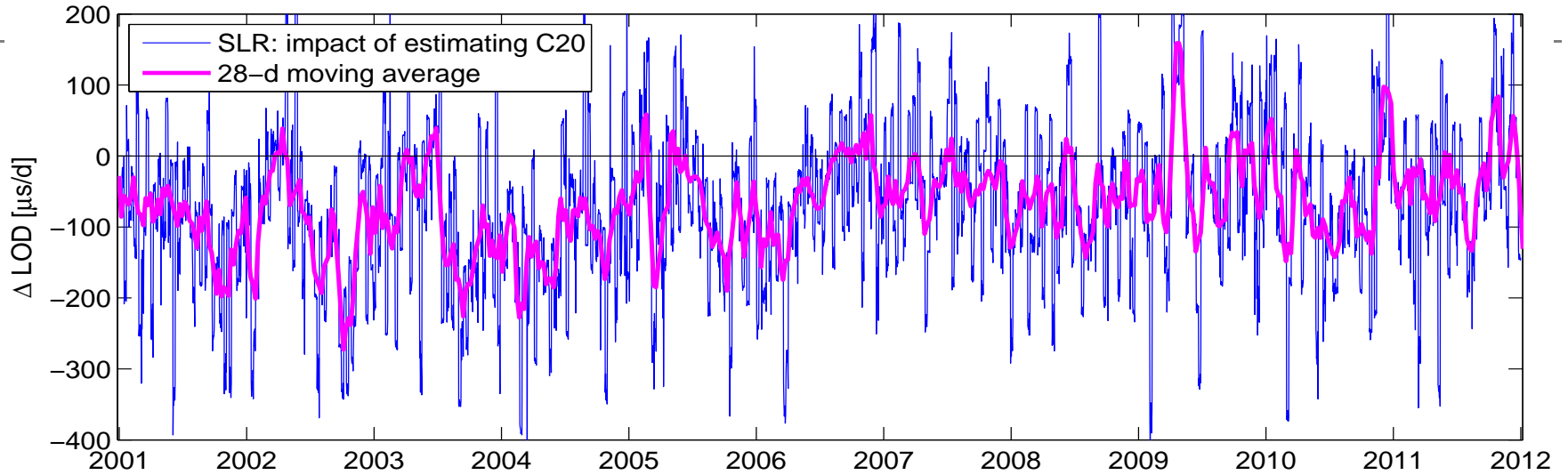
➤ SLR: weekly solutions, 2001 – 2011

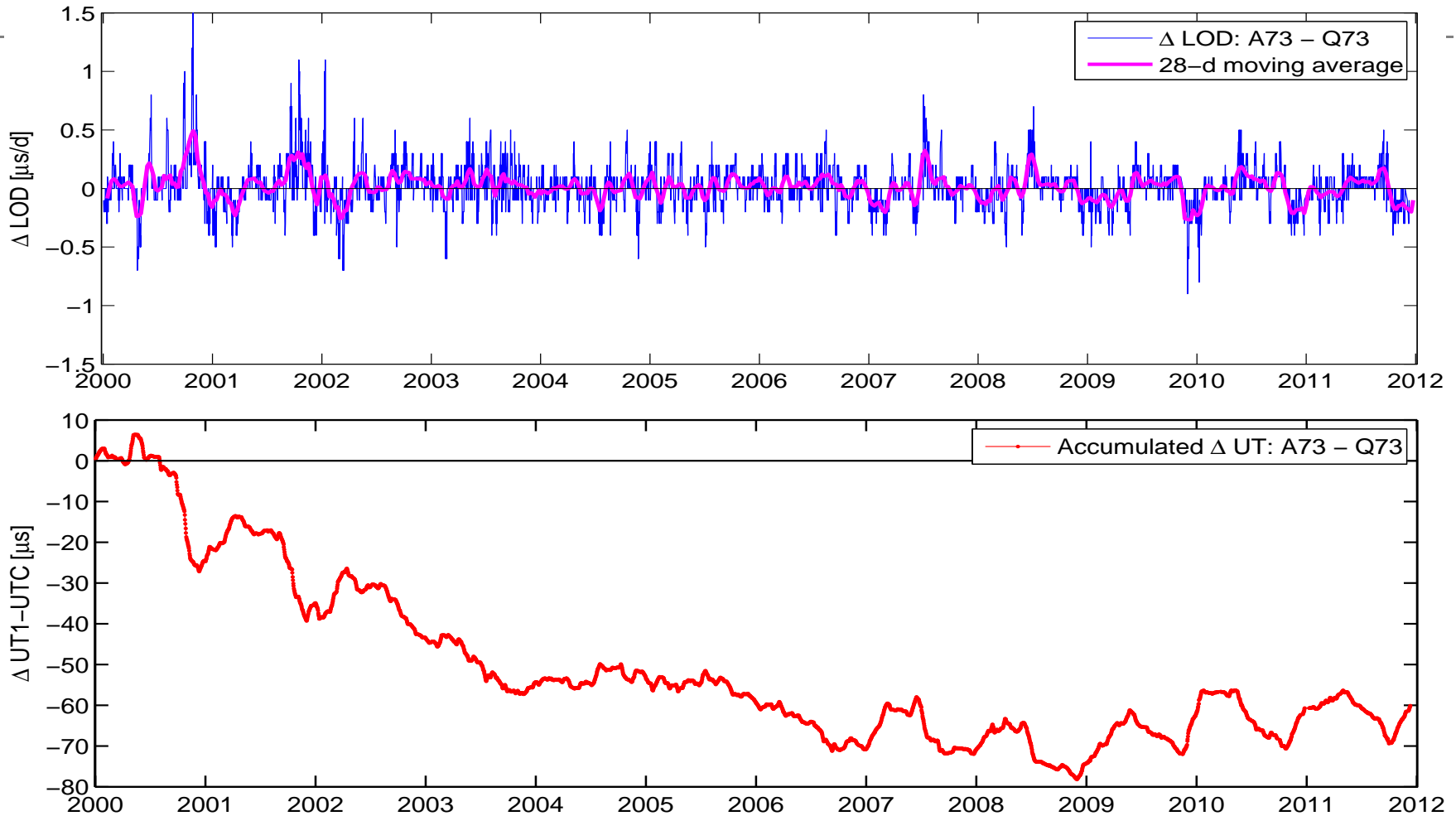# Impact of low-degree gravity: C20

Variations are not negligible

Formal errors: ~1.e-12

Impact of low–degree gravity: SLR

LOD is shifted if C20 is not estimated: ~ 74 µs

Impact of low–degree gravity: GNSS

Impact of estimating C20 on UT1–UTC / LOD seems to be small

BUT: Accumulated effect is not negligible

Conclusions

- **Sub-daily ERPs:**

  - Orbit-related artefacts in all satellite techniques

  - SLR capability is surprisingly good (considering the small amount of data)

  - 1-h resolution is too high for SLR, but 2-h resolution seems feasible

- **Impact of low-degree coefficients of the Earth's gravity field:**

  - Impact of C20 was studied

  - SLR: LOD is shifted by ~**74 μs**

  - GNSS: Accumulated effect reaches ~**70 μs** after few years

  - Consequence: C20 should be estimated together with ERPs

ETH   Bundesamt für Kartographie und Geodäsie   AIUB