IDS workshop, Venice, Italy, 25-26 September 2012

Tropospheric parameters from DORIS in comparison to other techniques during CONT campaigns

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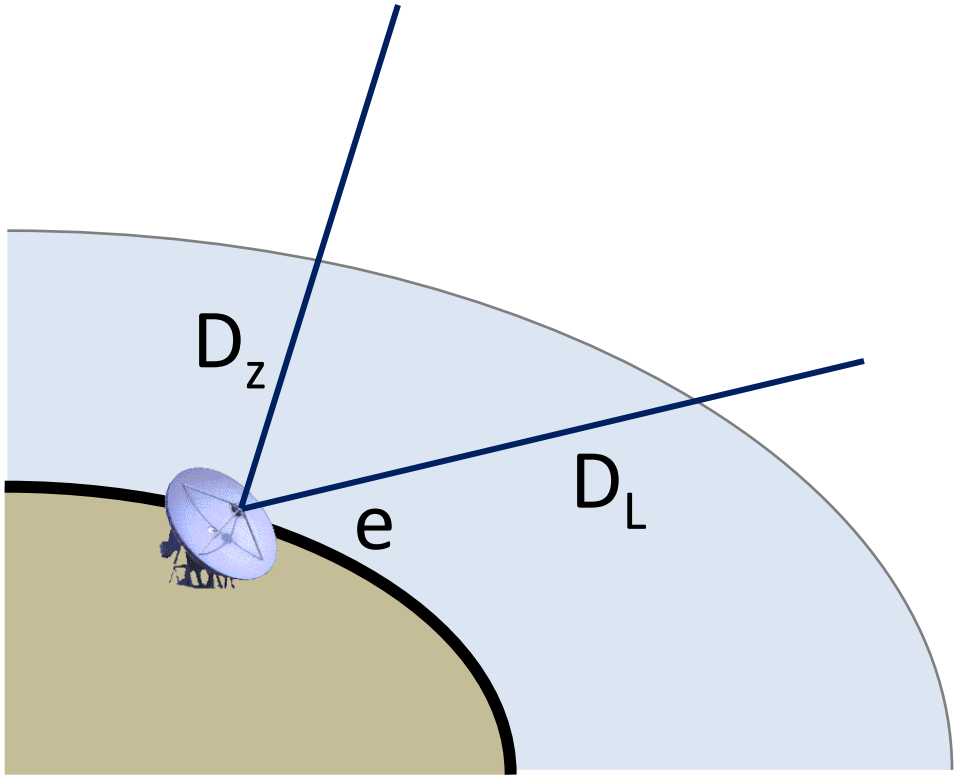
The aims of our study are

- Quantify agreement of troposphere estimates from DORIS with those from other techniques.
- Figure out site- and season-specific irregularities.

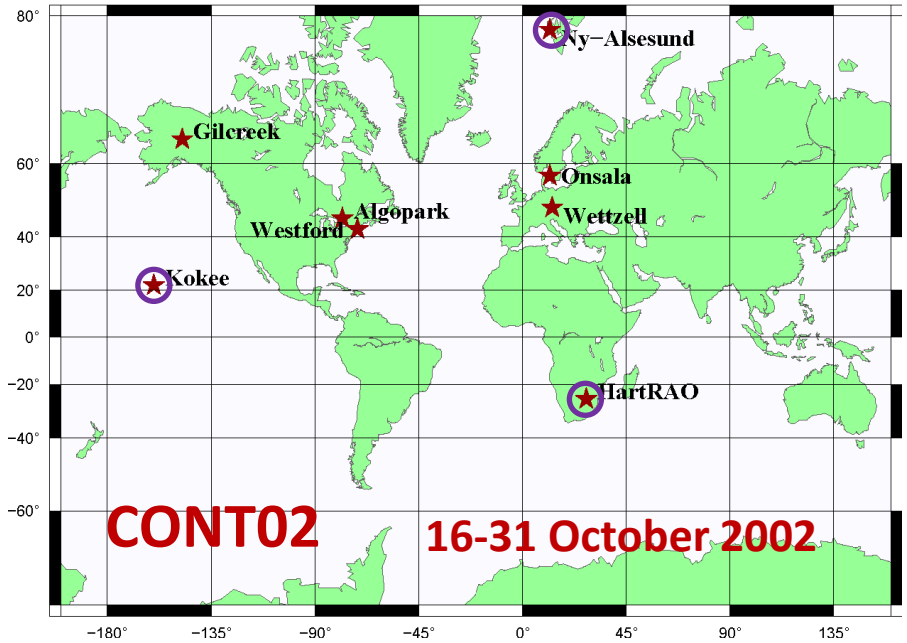
Troposphere delays

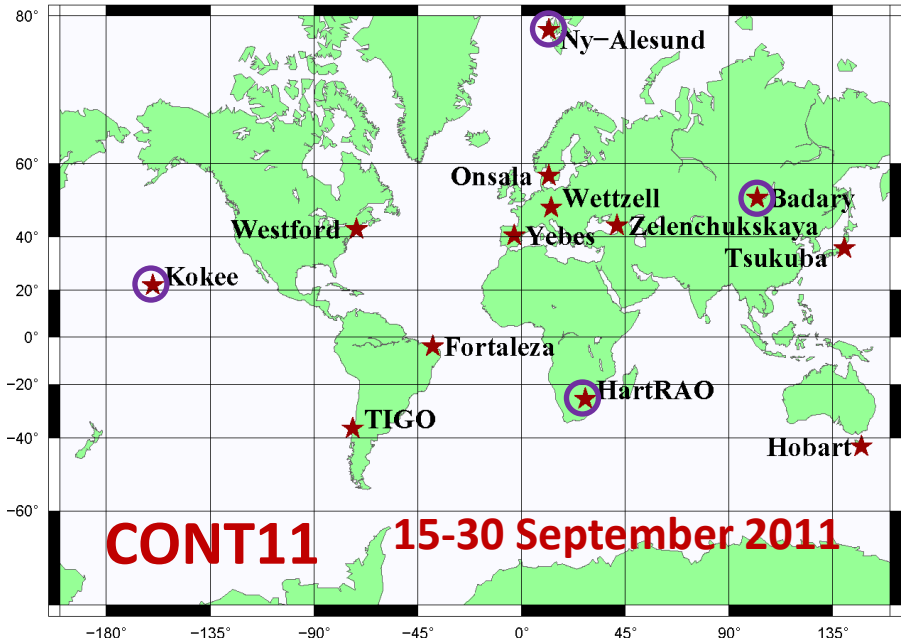
$$D_L(e) = D_z \cdot m(e) = D_{zh} \cdot m_h(e) + D_{zw} \cdot m_w(e)$$



+ gradients

CONT Sessions





Very Long Baseline Interferometry (VLBI)

- **Vienna VLBI Software (VieVS):**

- VieVS Software.
- Fixed to ICRF2.
- NNT/NNR on ITRF2008.
- A priori ZHD from surface pressure.
- No a priori gradients.
- VMF1, 5° - no elevation-dependent weighting.
- Gradient MF: Chen and Herring, 1997.
- Relative constraints for ZTD are 1.6 cm after 1 hour.
- Relative constraints for gradients are 0.12 mm after 6 hours.
- 1 hour interval for ZTD, and 6 hours for gradients.

Global Positioning System (GPS)

- **Center for Orbit Determination in Europe (CODE)**

- Bernese GPS software.
- NNR on IGS08.
- VMF1, 3° + elevation-dependent weighting.
- No constraints for zenith delays and gradients.
- 1 hour interval for ZTD and 6 hours for gradients.

Doppler Orbitography and Radio Positioning Integrated by Satellite (DORIS)

- **Institut Géographique National (IGN)**

- Software is GIPSY/Oasis.
- TRF is fixed to ign09d02.
- VMF1, 5°.
- DORIS reset at no regular interval.
- It is reset at start of pass and only if the previous reset is 20 minutes before or earlier.
- Co-located sites are Ny-Ålesund (SPIB, SPJB), Kokee Park (KOKA, KOLB), Hartebeesthoek (HBKB, HBMB), Badary (BADB).

Doppler Orbitography and Radio Positioning Integrated by Satellite (DORIS)

	CONT02	CONT05	CONT08	CONT11
envisat	✓	✓	✓	✓
spot2	✓	✓	✓	✓
spot4	✓	✓	✓	✓
spot5	✓	✓	✓	✓
topex	✓	-	-	-
cryosat2	-	-	-	✓
jason2	-	-	✓	✓

Numerical Weather Model (NWM)

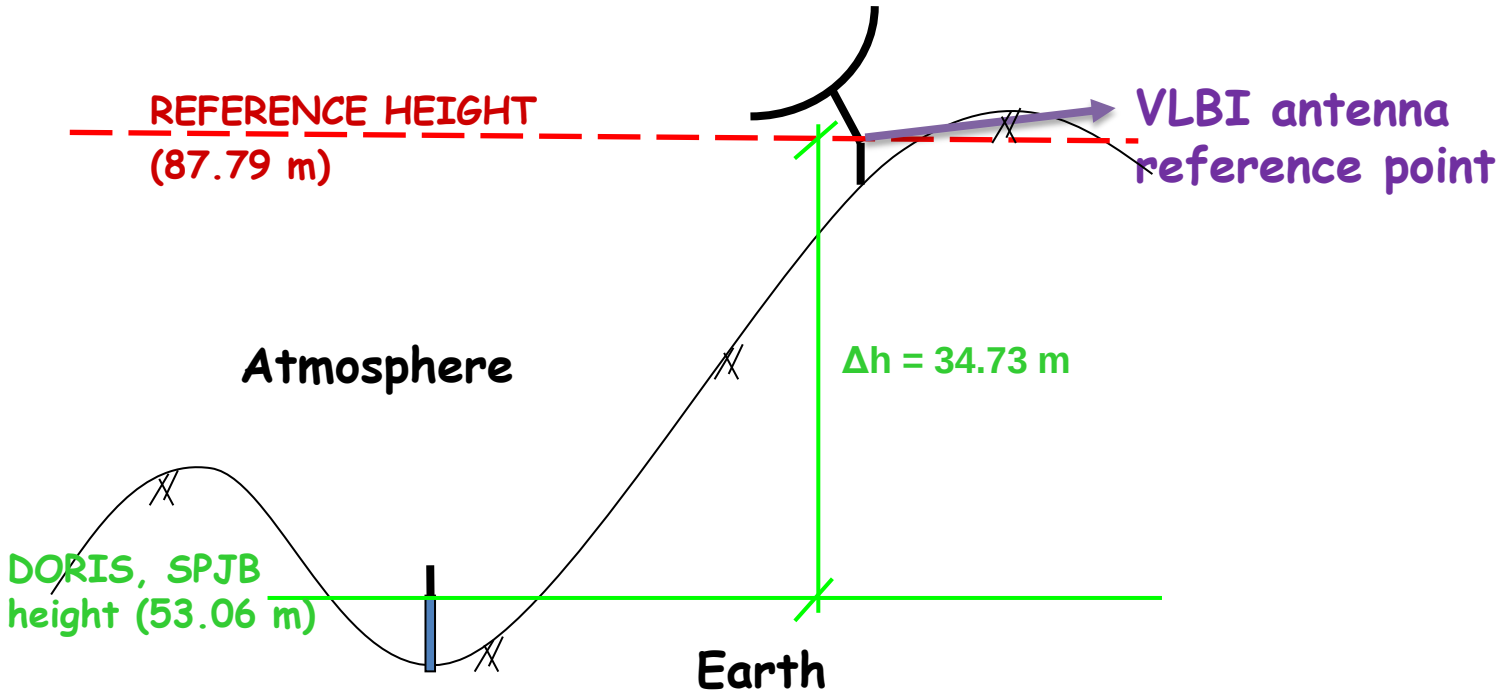
- **European Centre for Medium-Range Weather Forecasts (ECMWF).**

NWM	The regions for which the models provide data	Spatial resolution	Time Resolution (hours)	Number of levels at each profile	Troposphere gradients estimated ?
ECMWF	Global	0.25°	6	21	YES

Summary of the data used for the comparisons

Technique	Zenith wet/total delay	Estimation interval of zenith delay	Estimation interval of gradients
VLBI-VieVS	ZWD, ZTD	1 hour	6 hours (total gradients)
DORIS-IGN	ZTD	per satellite pass	1 day (total gradients)
GPS-CODE	ZWD, ZTD	1 hour	6 hours (total gradients)
ECMWF	ZWD, ZTD	6 hours	6 hours (total gradients)

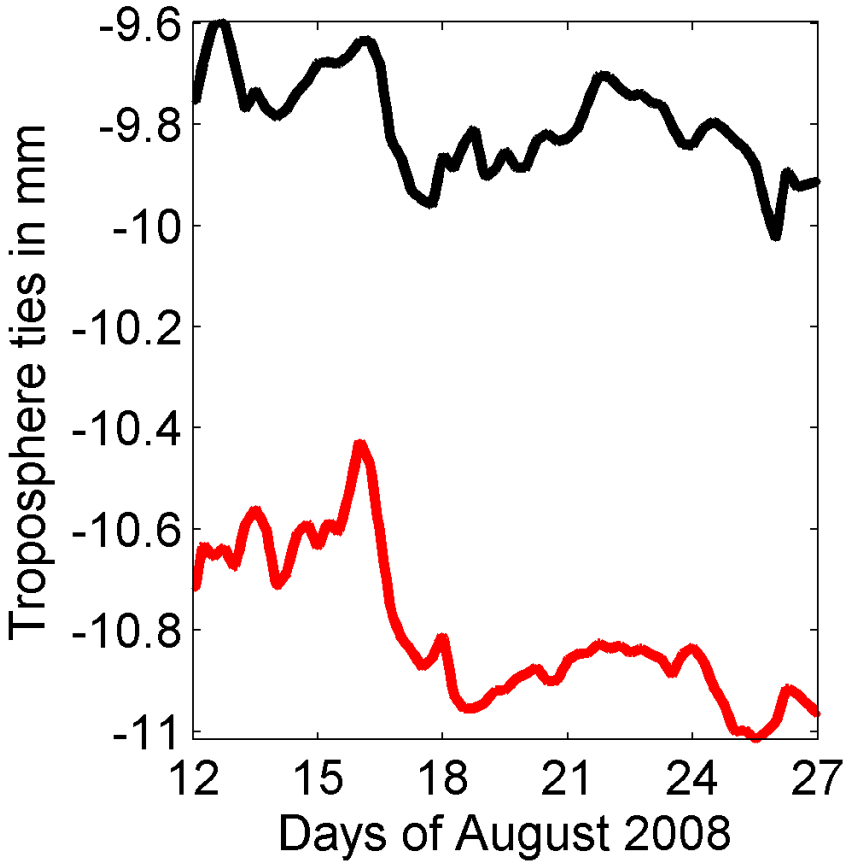
Ny-Ålesund co-located site (Vertical troposphere between antennas)

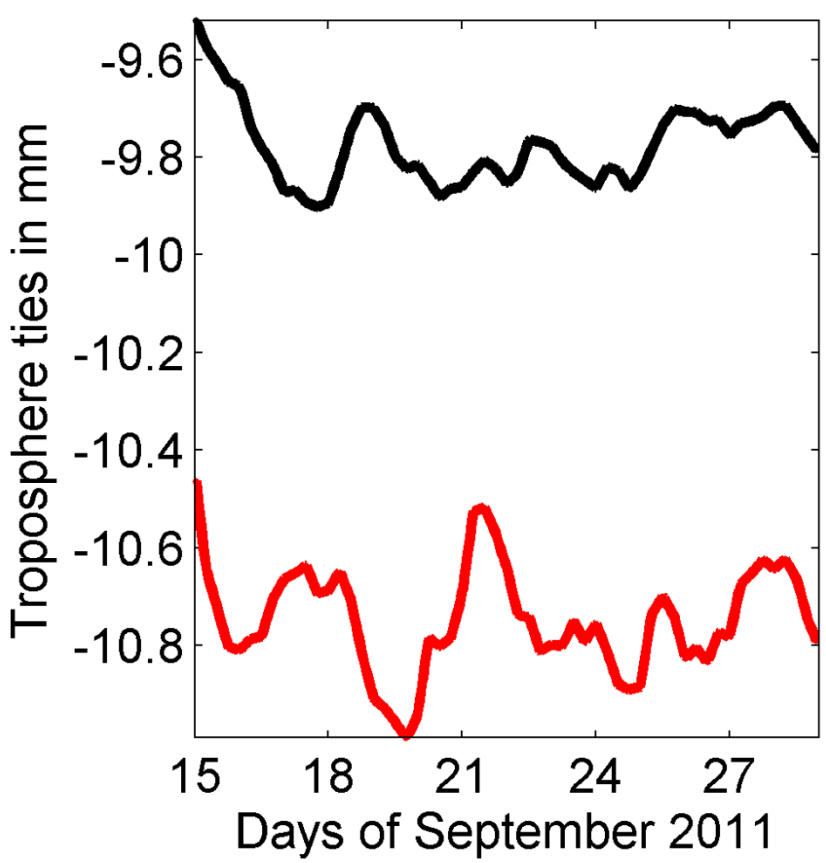


Troposphere ties calculated based on 6-hourly ECMWF!

Total (in red) and hydrostatic (in black) troposphere ties at Ny-Ålesund (Δh=35 m)

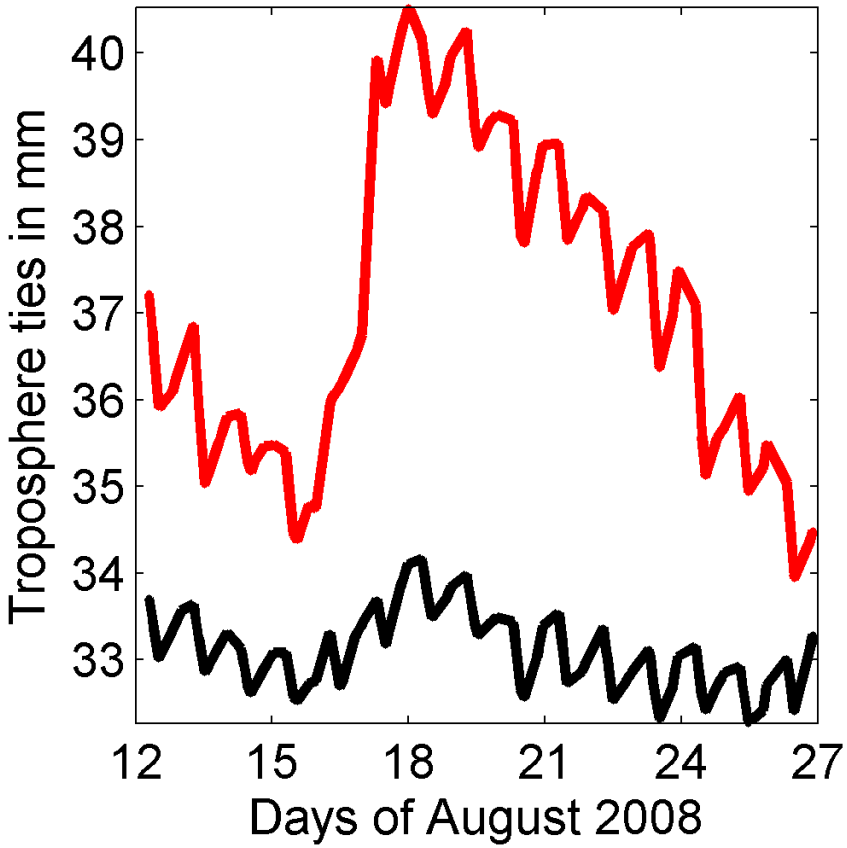
between VLBI and DORIS common epochs

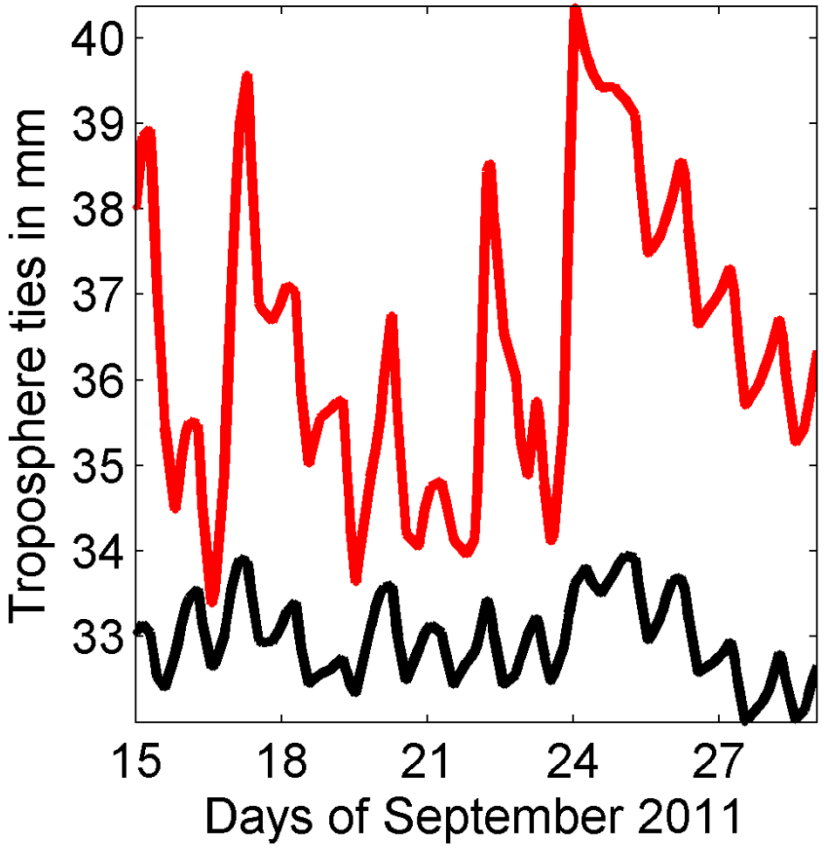




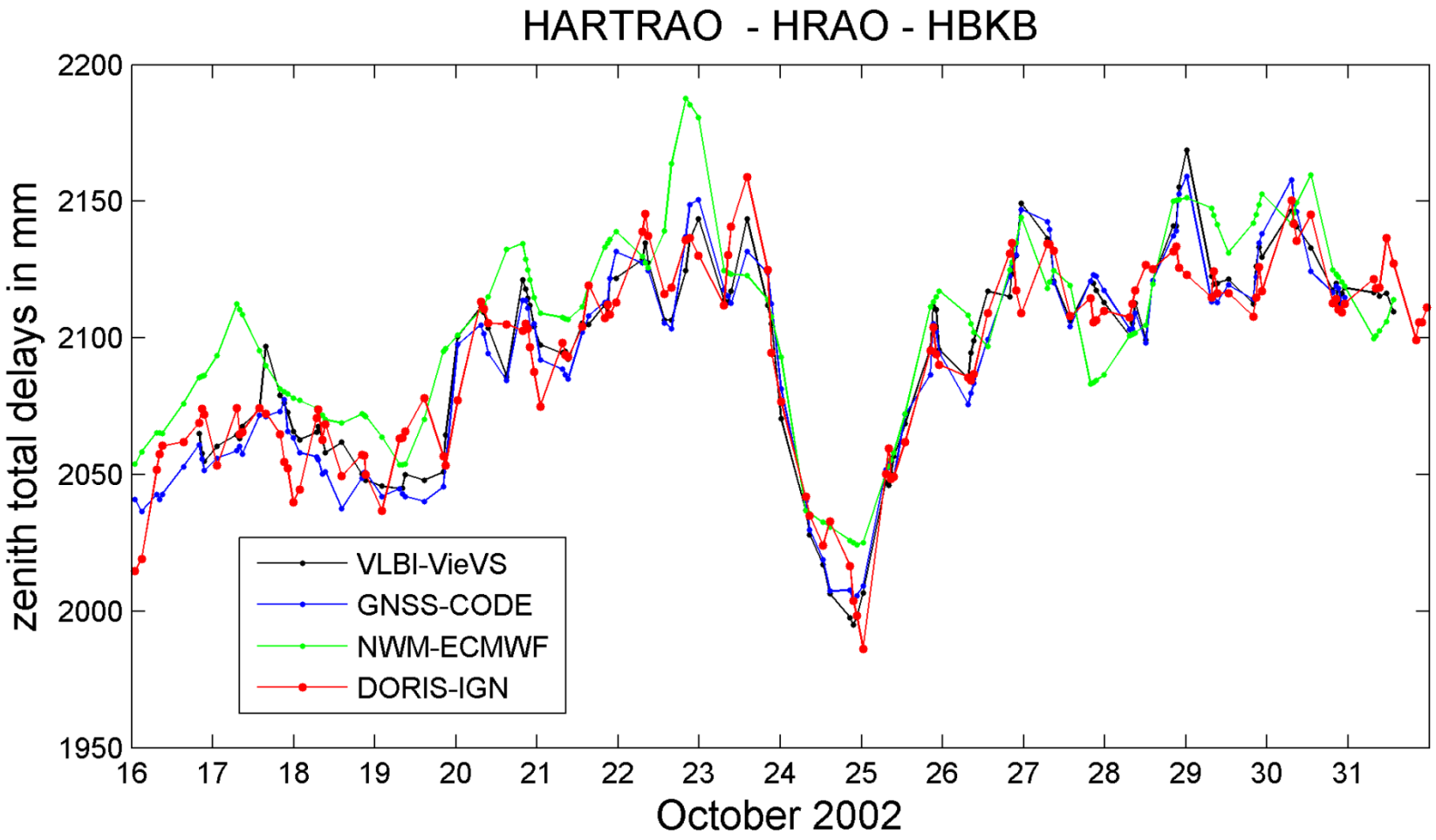
Total (in red) and hydrostatic (in black) troposphere ties at Hartebeesthoek (Δh=144 m)

between VLBI and DORIS common epochs

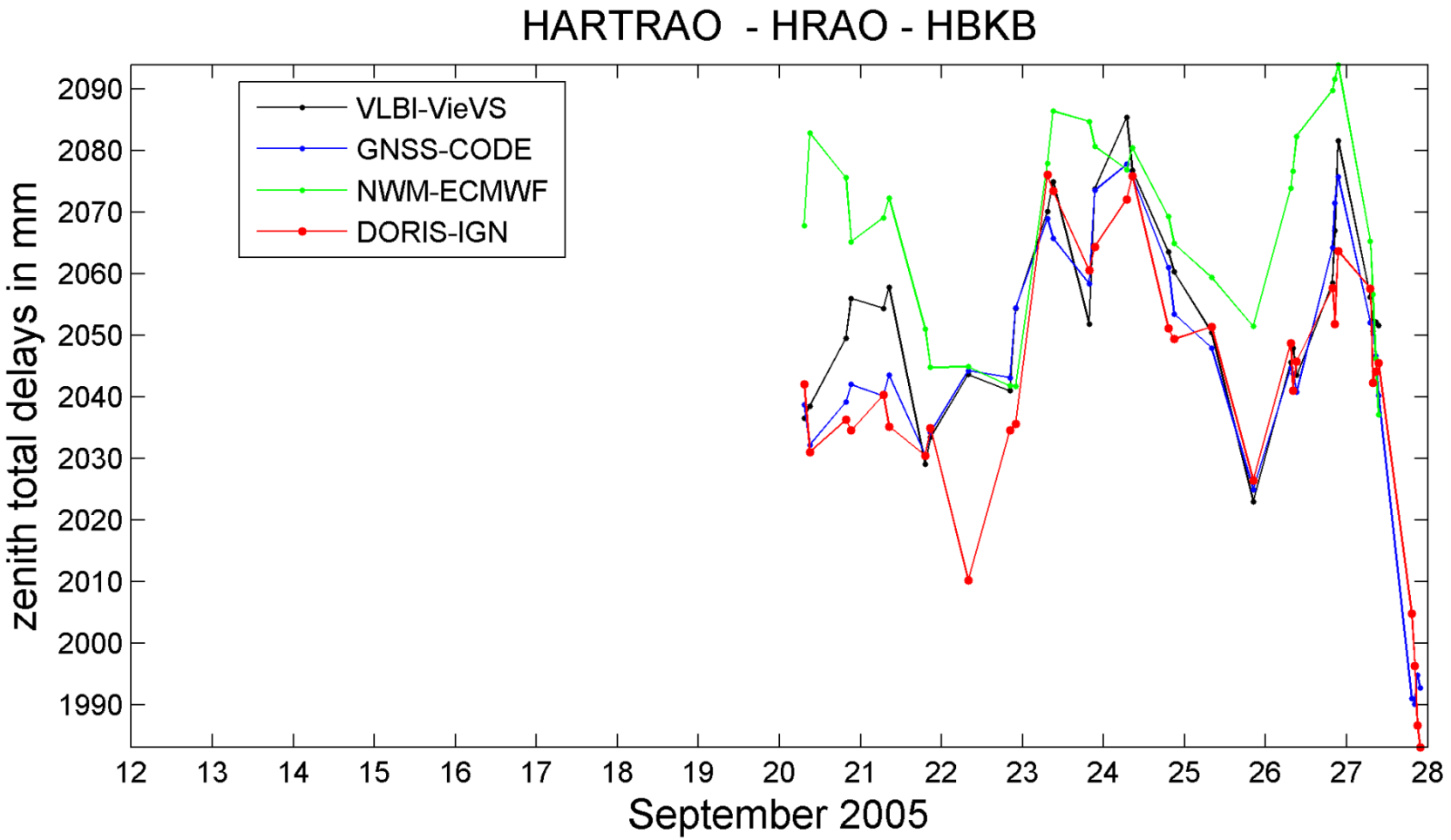




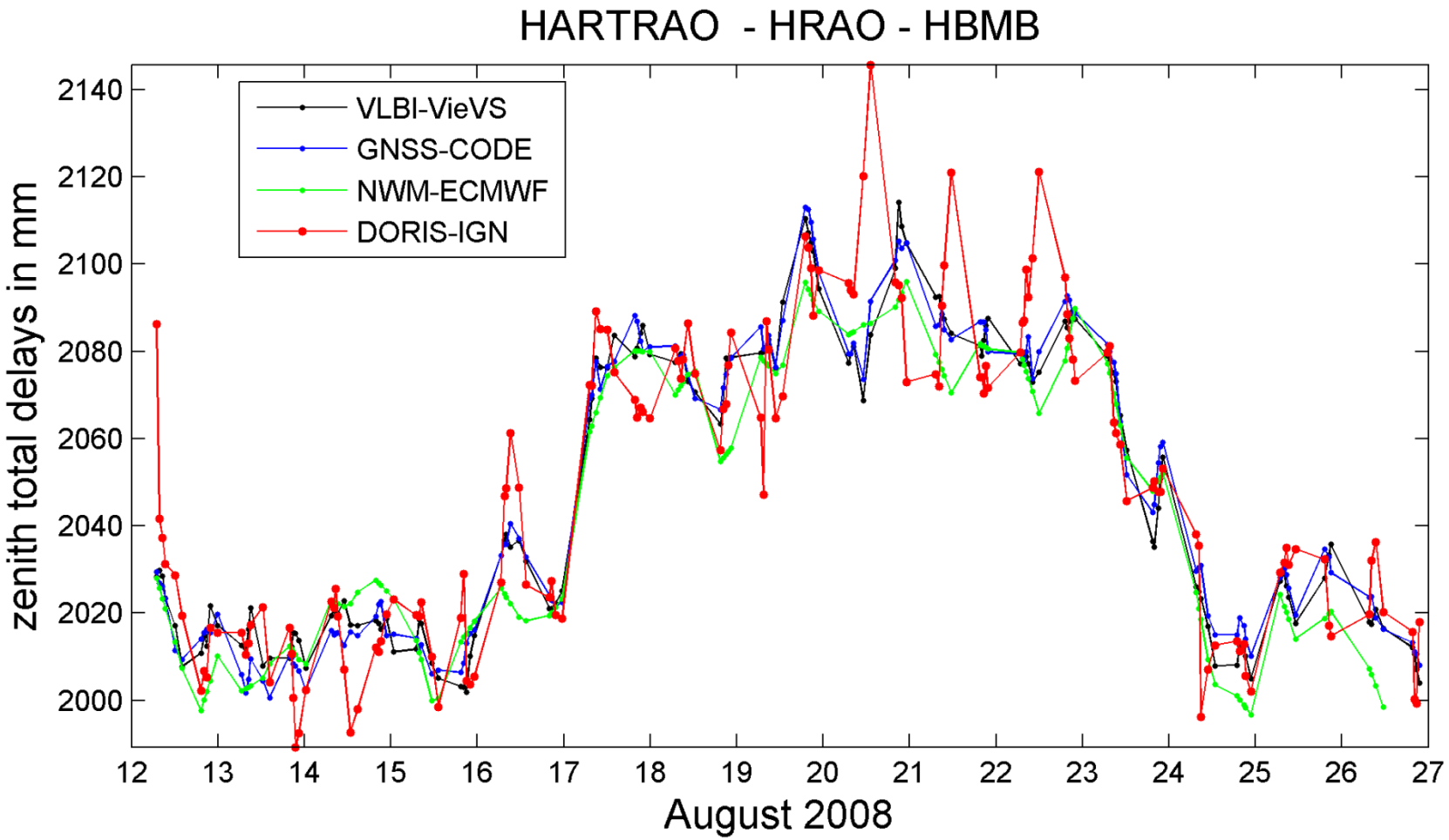
Troposphere ZTD of the co-located site Hartebeesthoek during CONT02



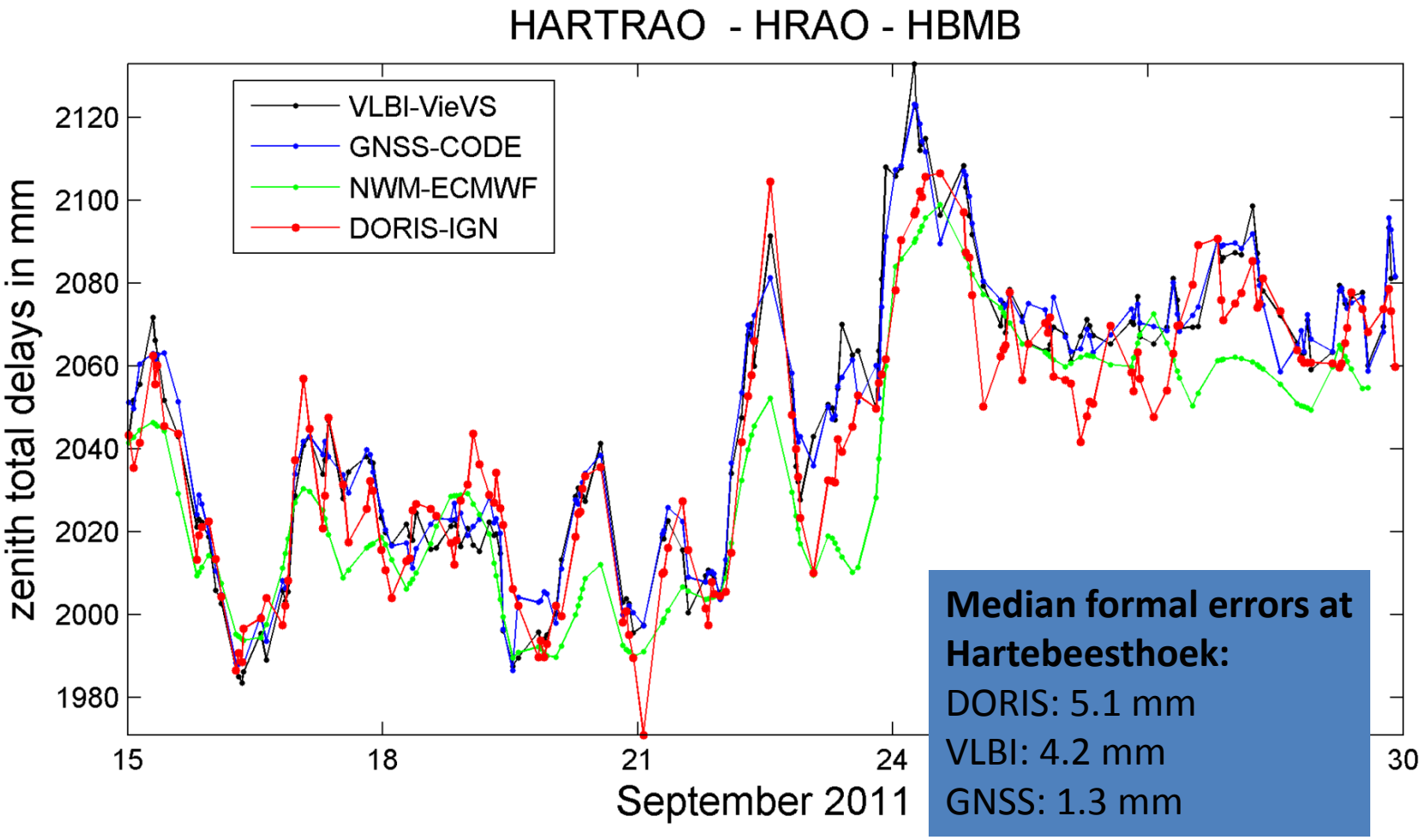
Troposphere ZTD of the co-located site Hartebeesthoek during CONT05



Troposphere ZTD of the co-located site Hartebeesthoek during CONT08

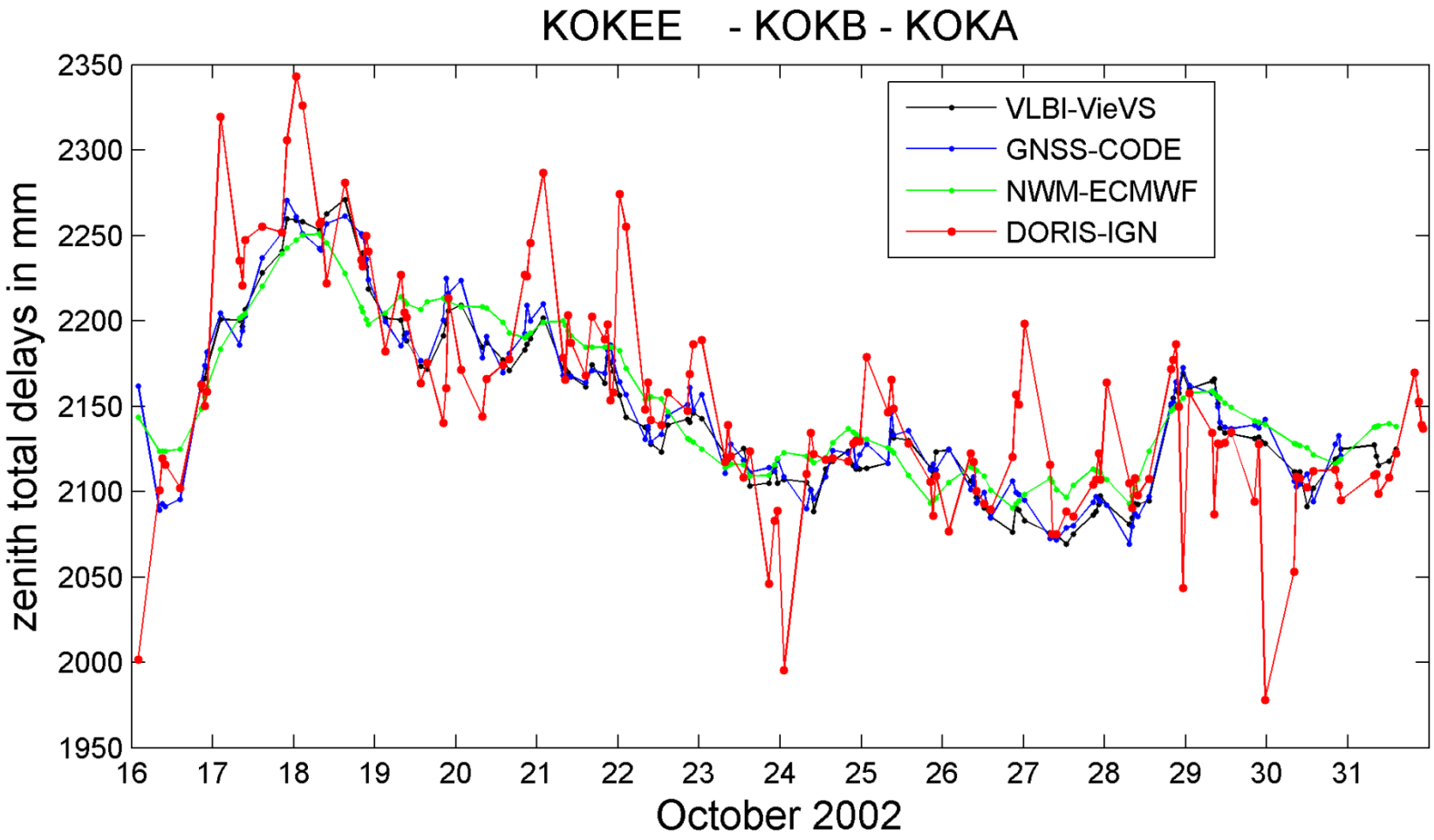


Troposphere ZTD of the co-located site Hartebeesthoek during CONT11

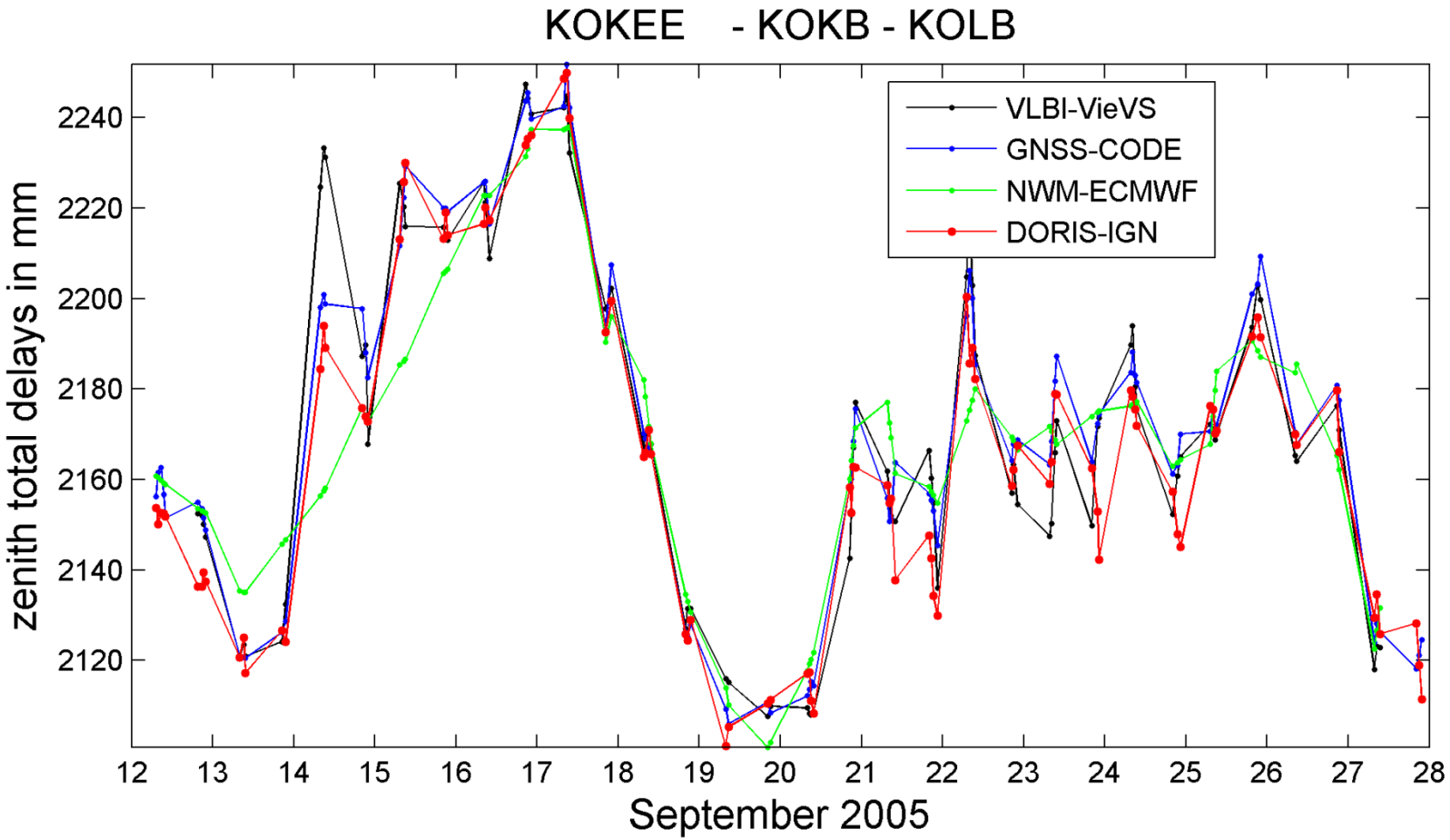


Median formal errors at Hartebeesthoek:
DORIS: 5.1 mm
VLBI: 4.2 mm
GNSS: 1.3 mm

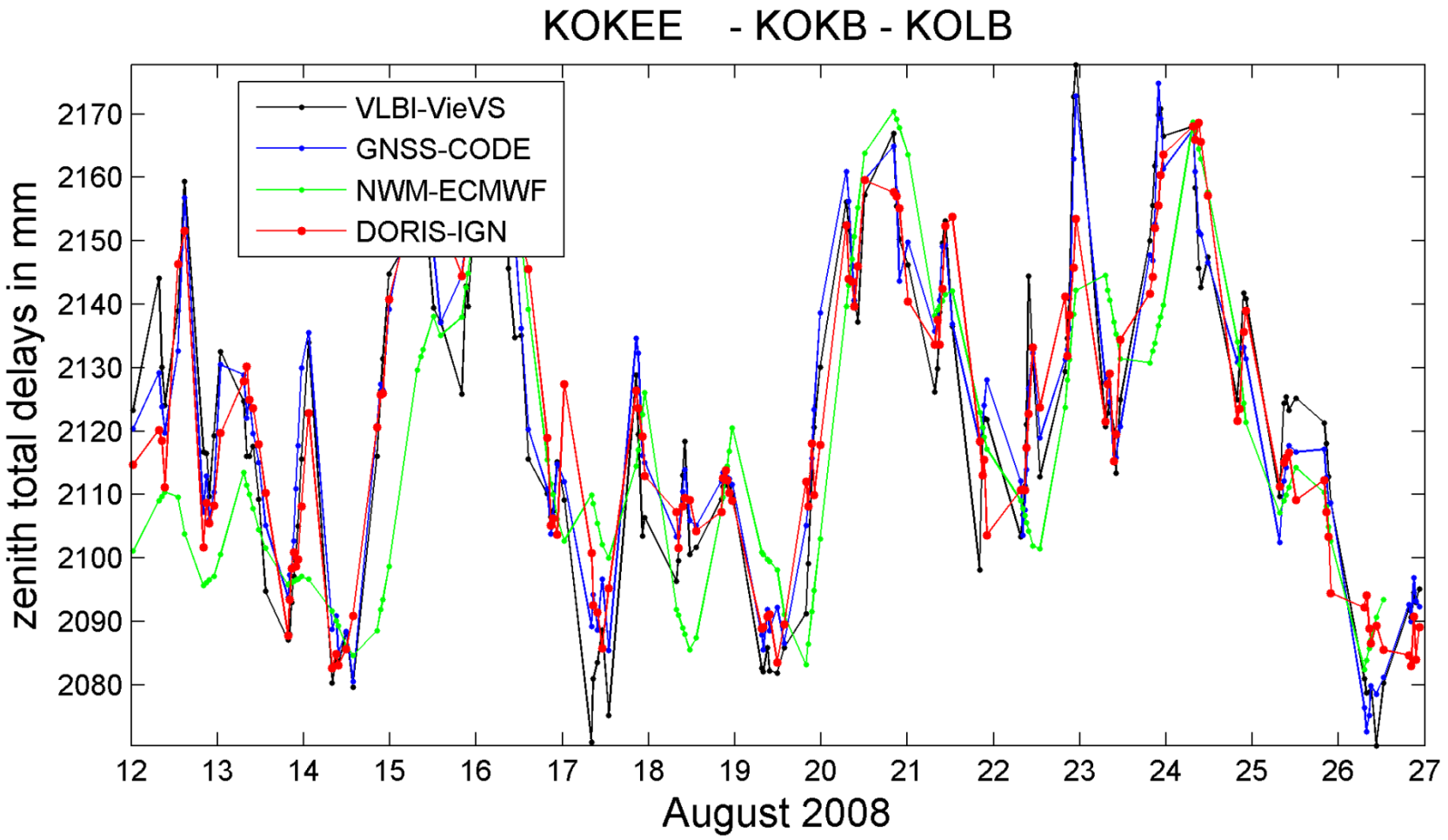
Troposphere ZTD of the co-located site Kokee during CONT02



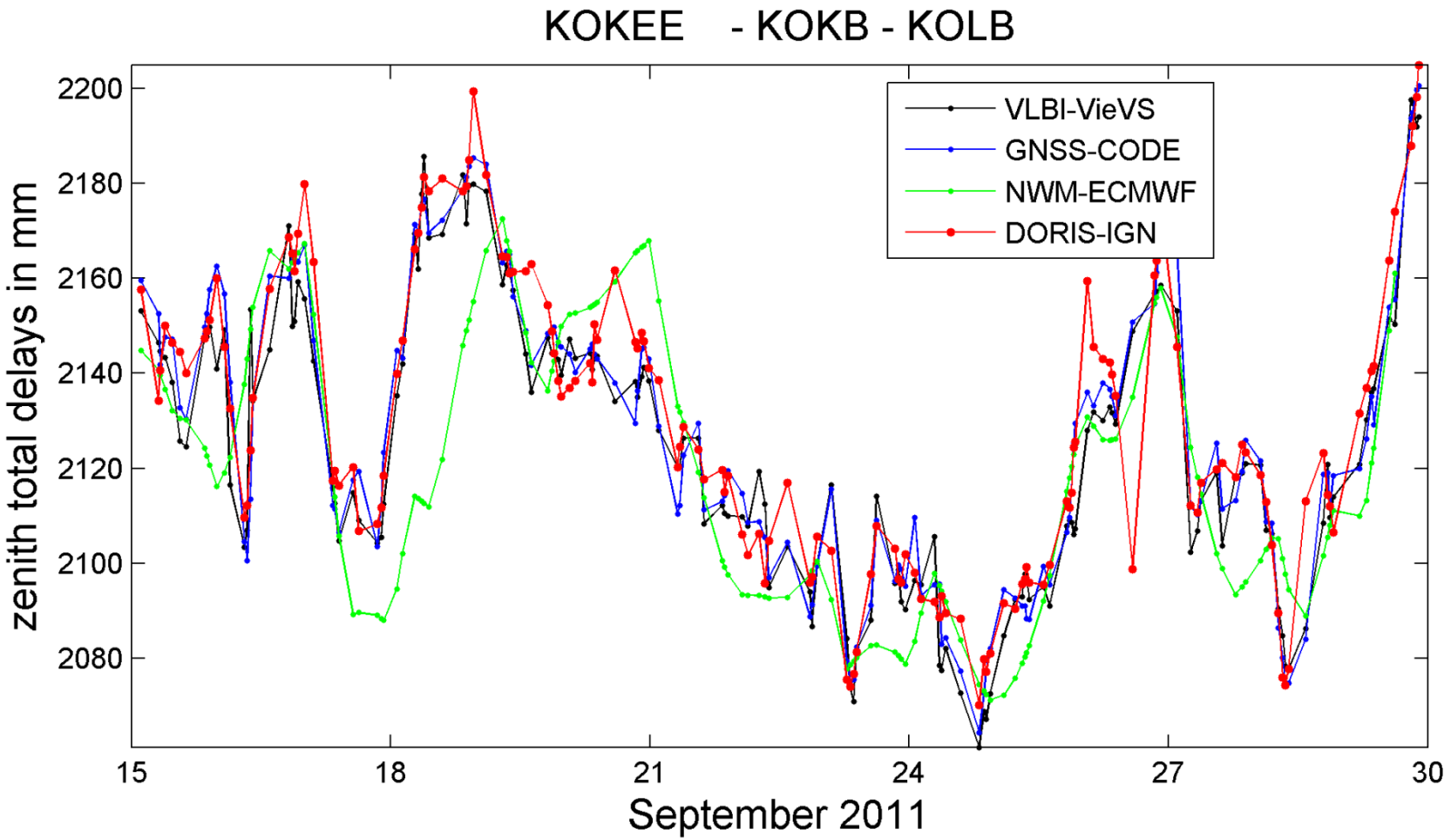
Troposphere ZTD of the co-located site Kokee during CONT05



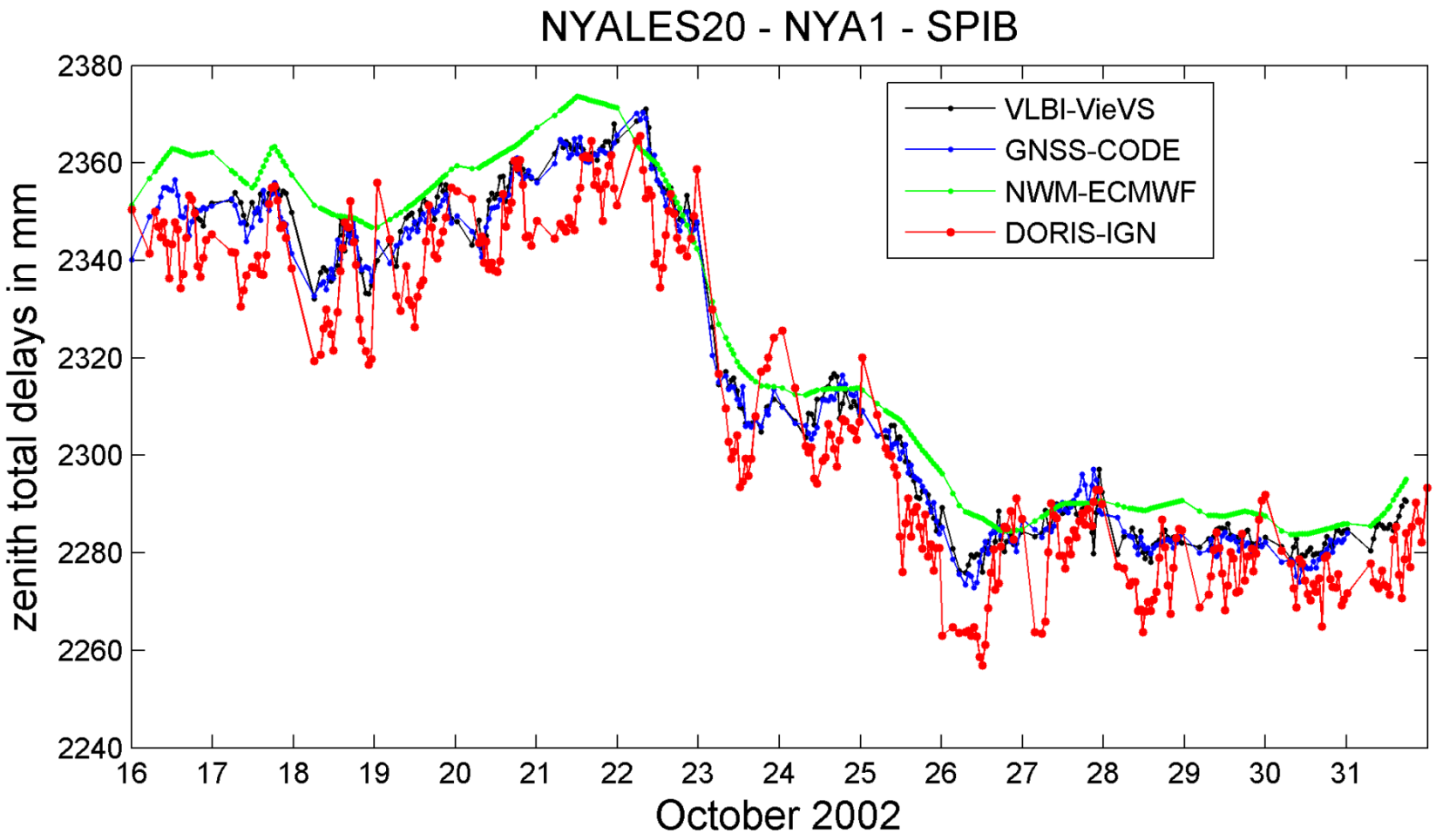
Troposphere ZTD of the co-located site Kokee during CONT08



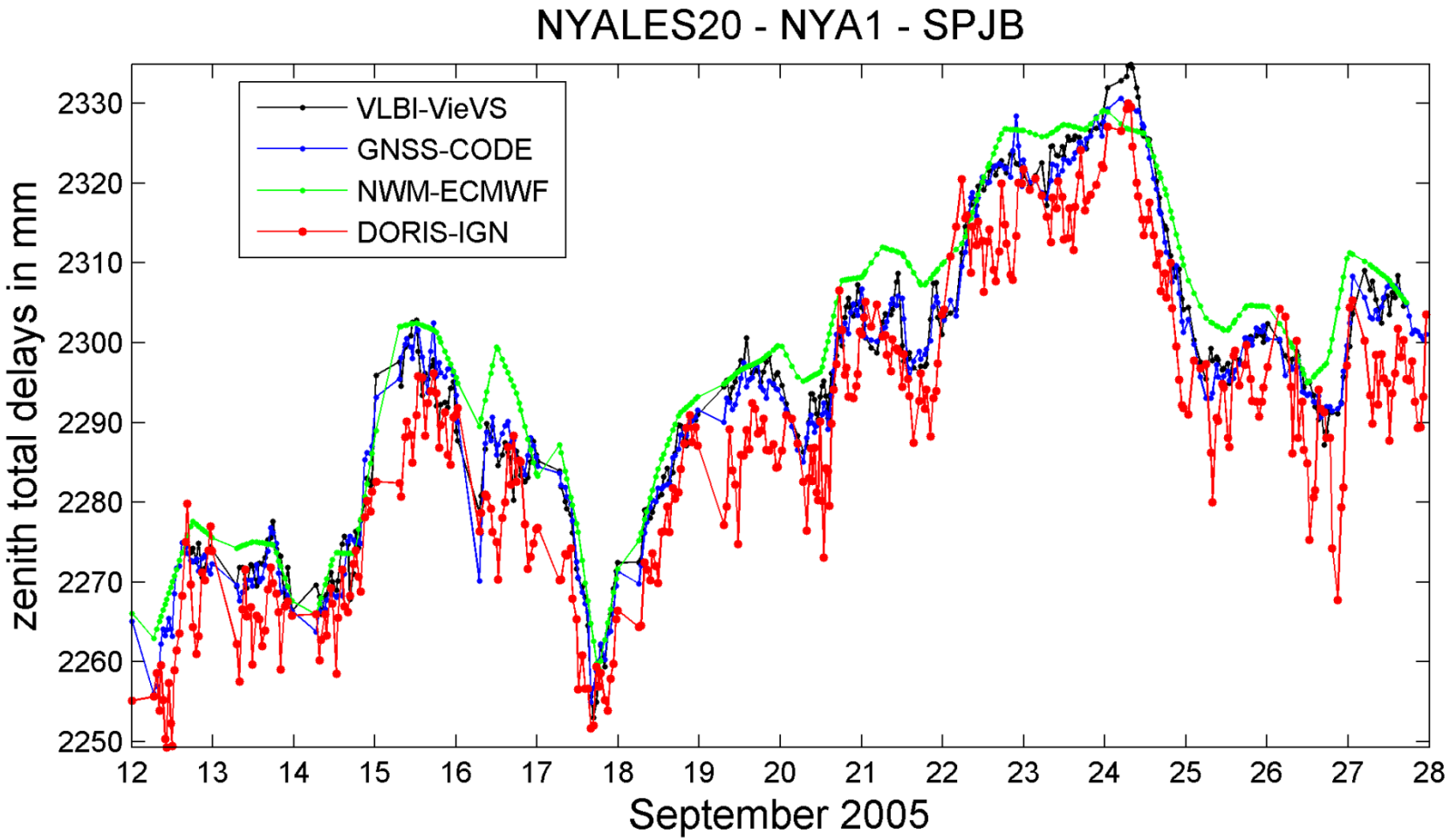
Troposphere ZTD of the co-located site Kokee during CONT11



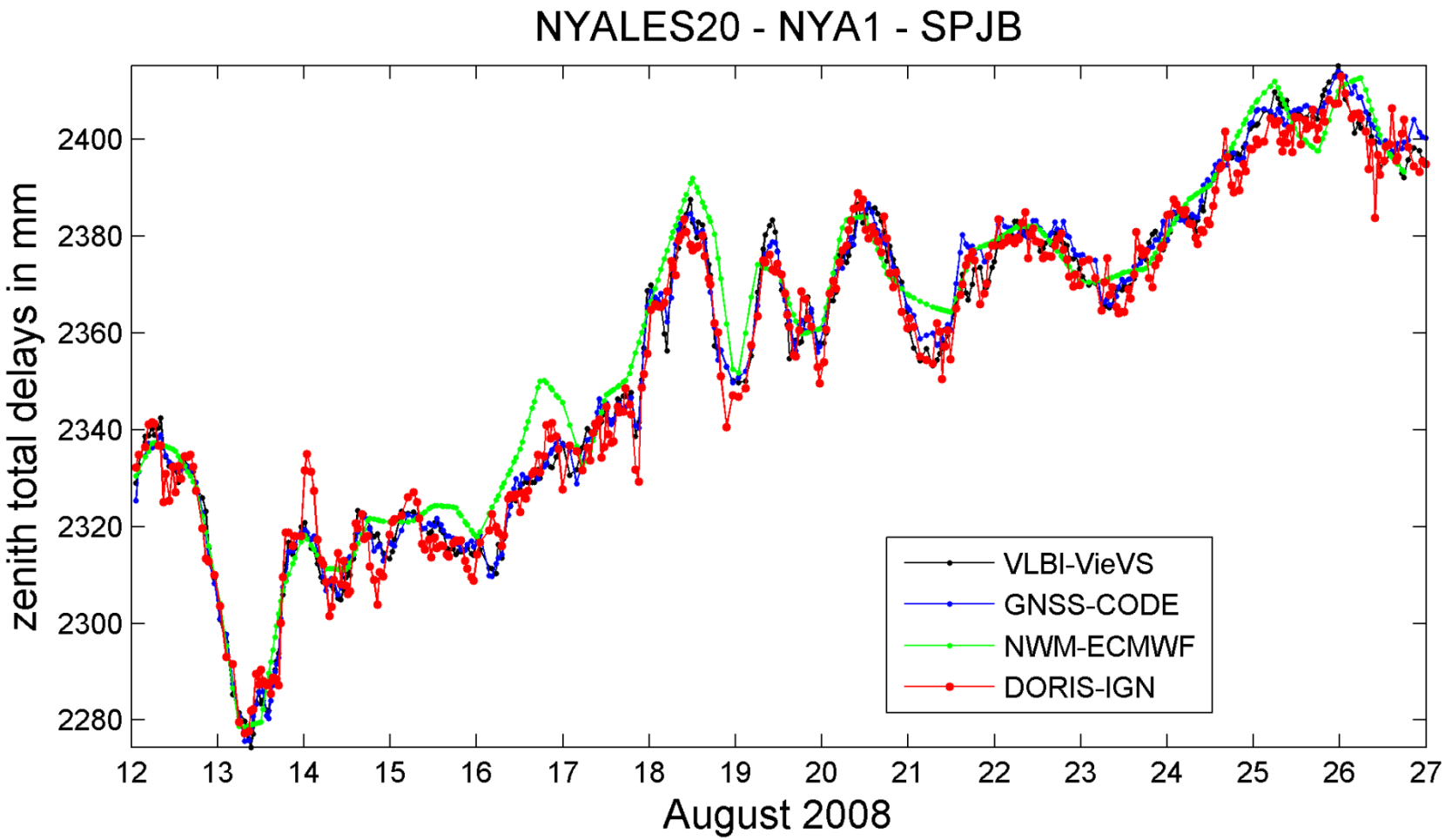
Troposphere ZTD of the co-located site Ny-Ålesund during CONT02



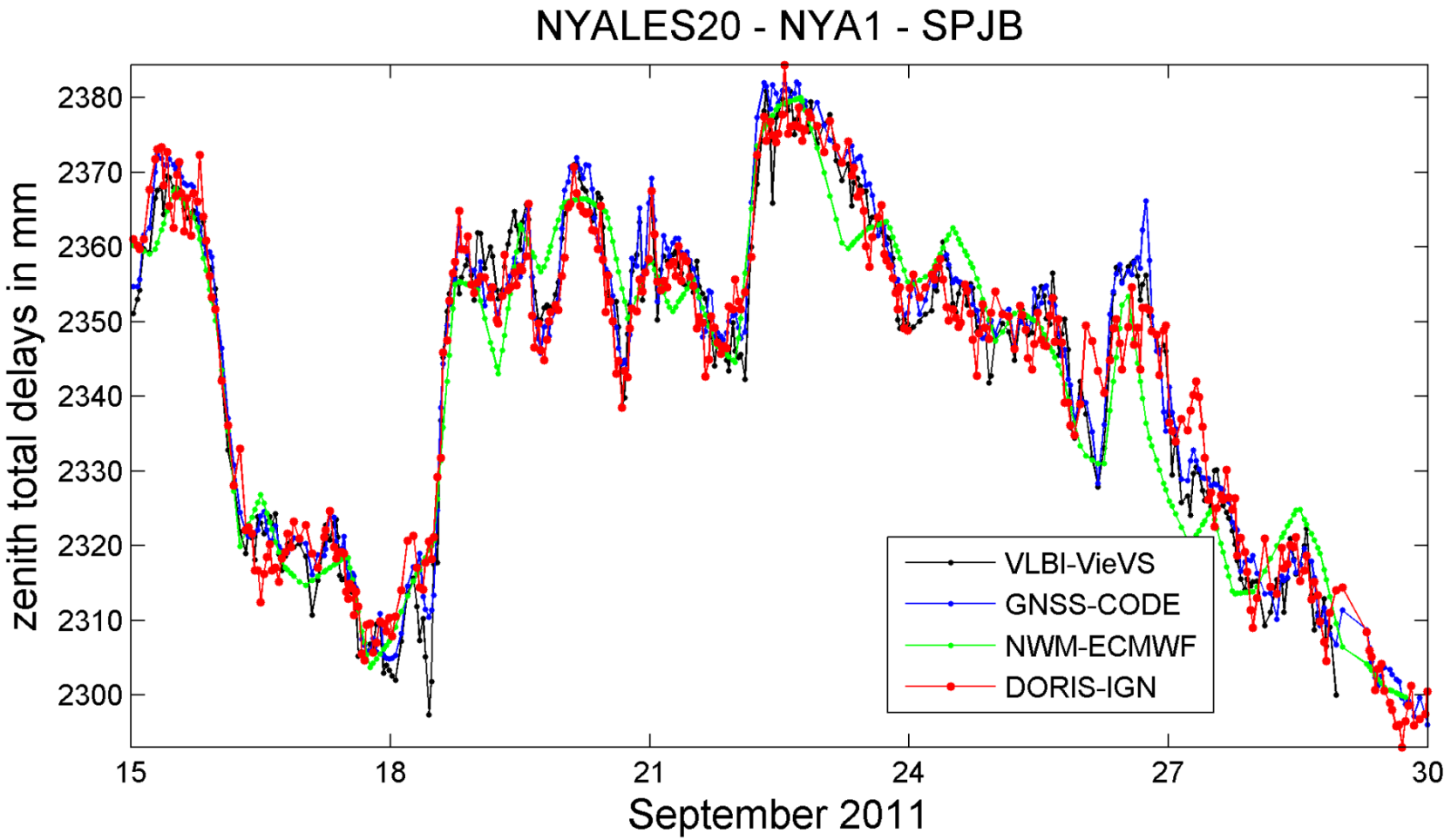
Troposphere ZTD of the co-located site Ny-Ålesund during CONT05



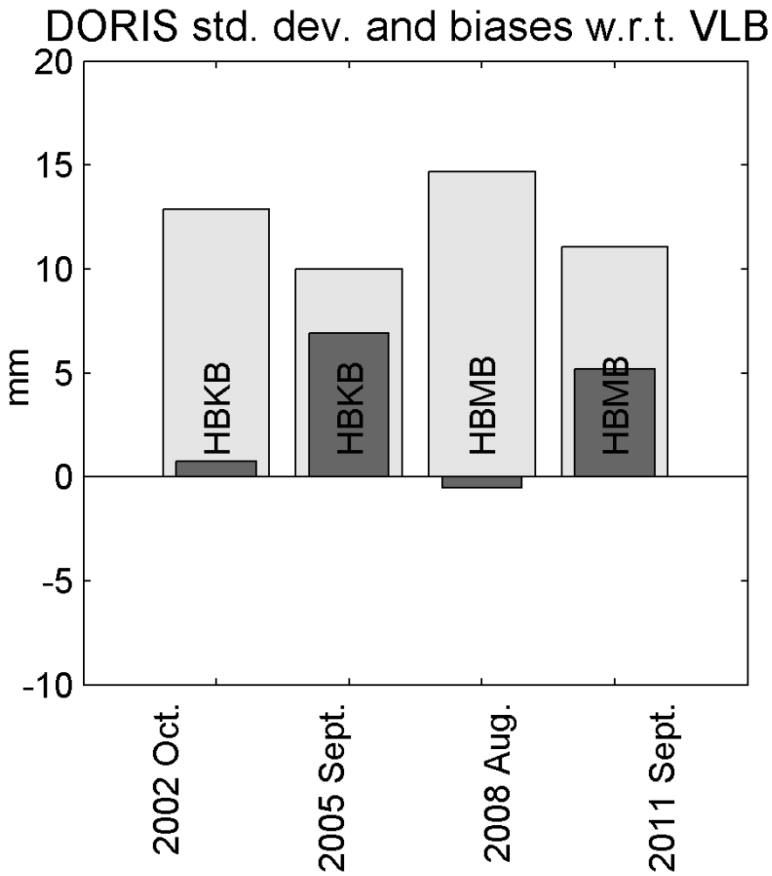
Troposphere ZTD of the co-located site Ny-Ålesund during CONT08

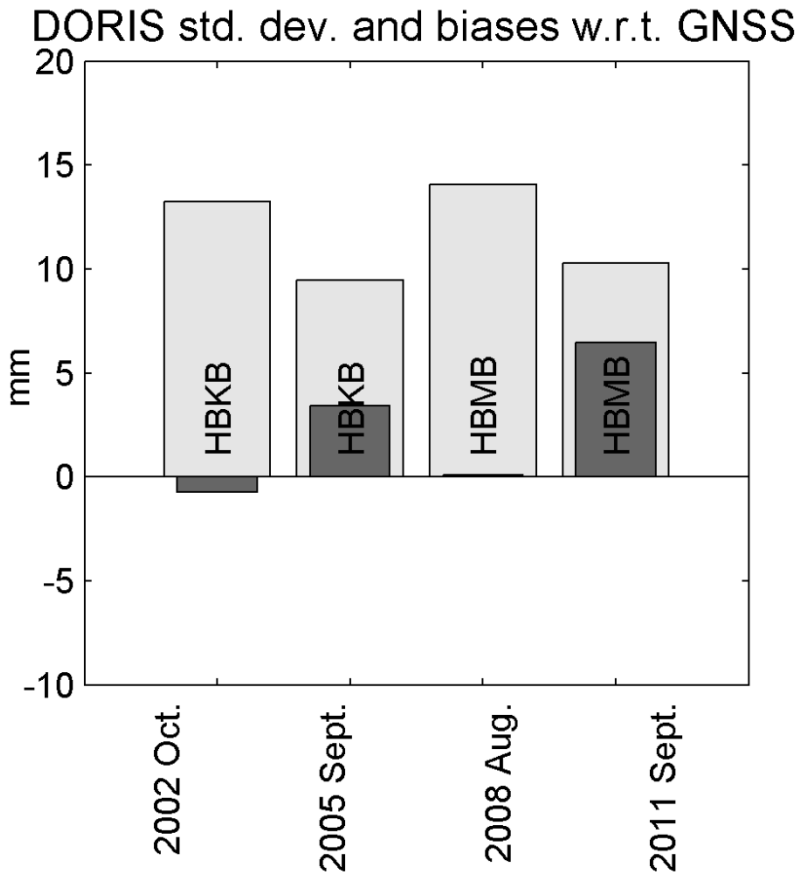


Troposphere ZTD of the co-located site Ny-Ålesund during CONT11

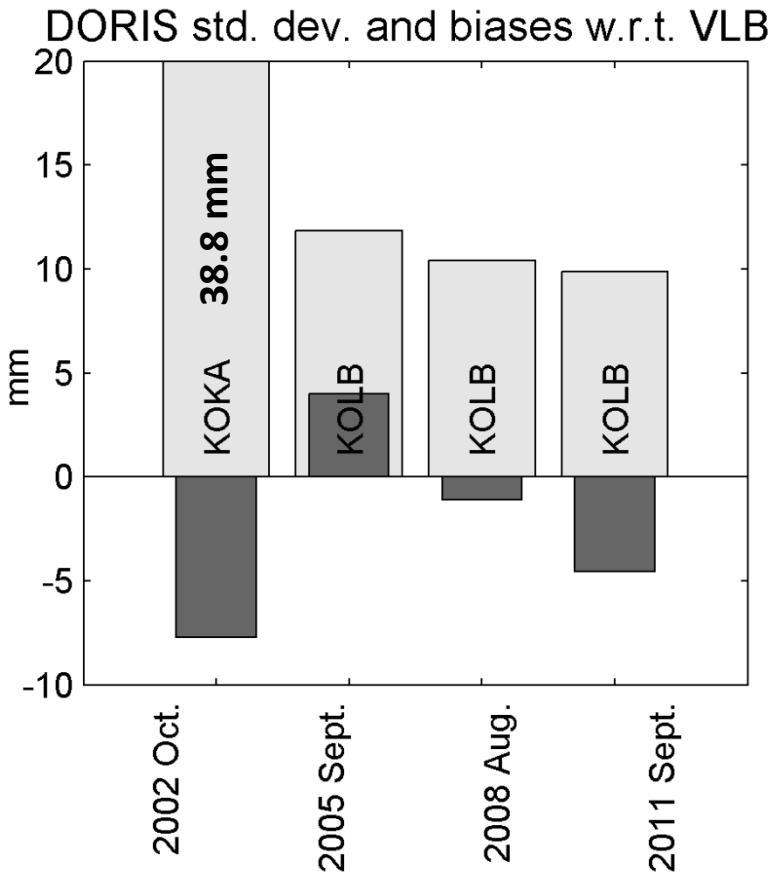


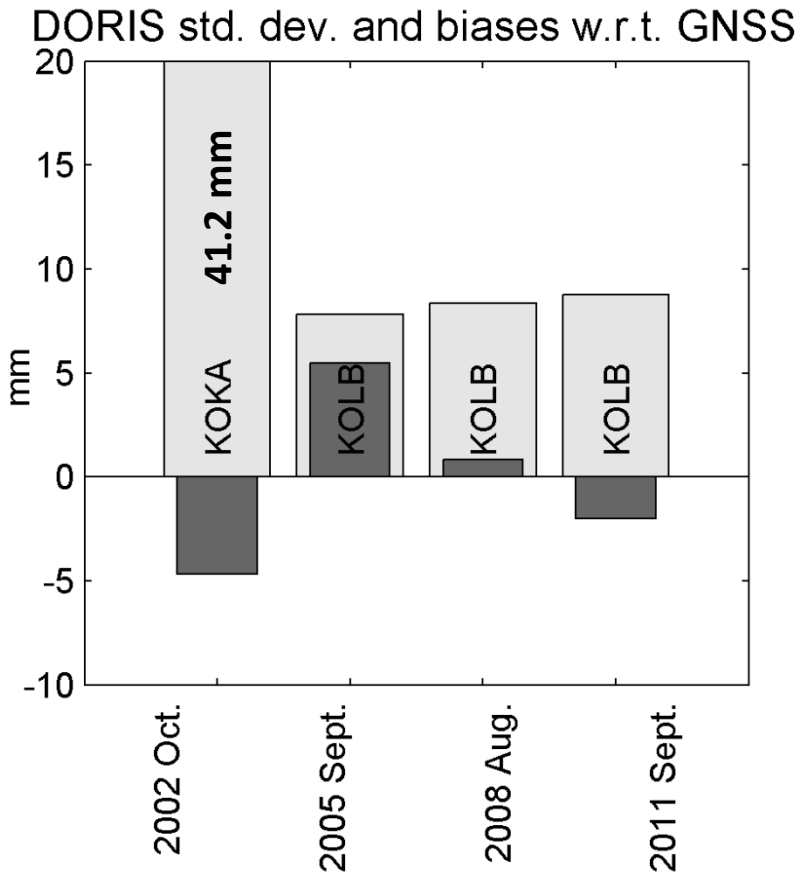
Hartebeesthoek ZTD std. dev. and biases w.r.t. VLBI and GNSS



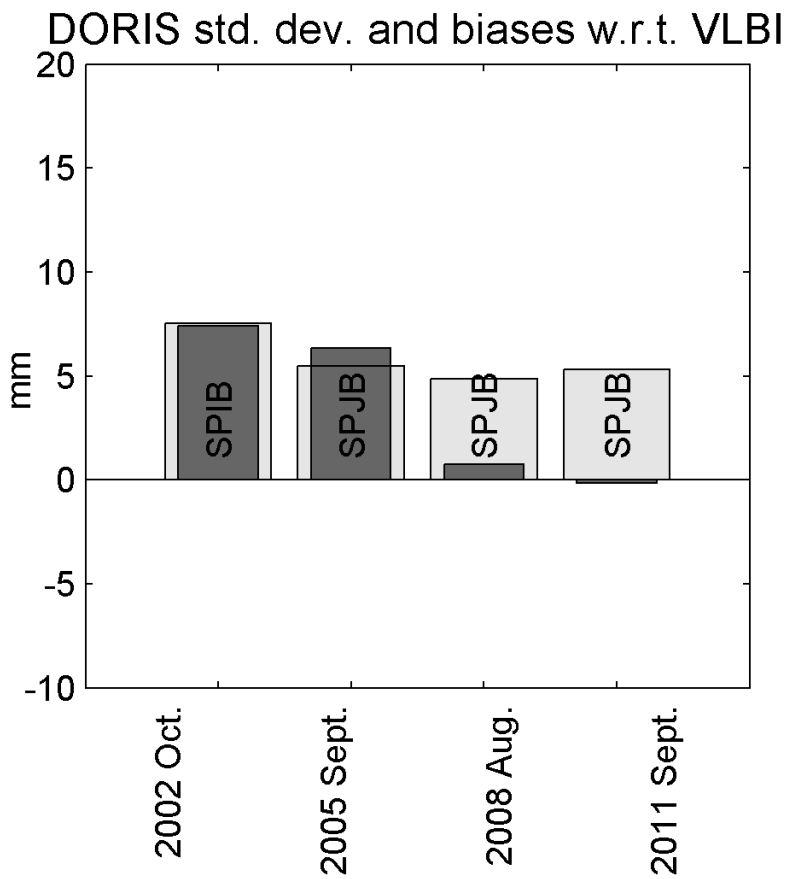


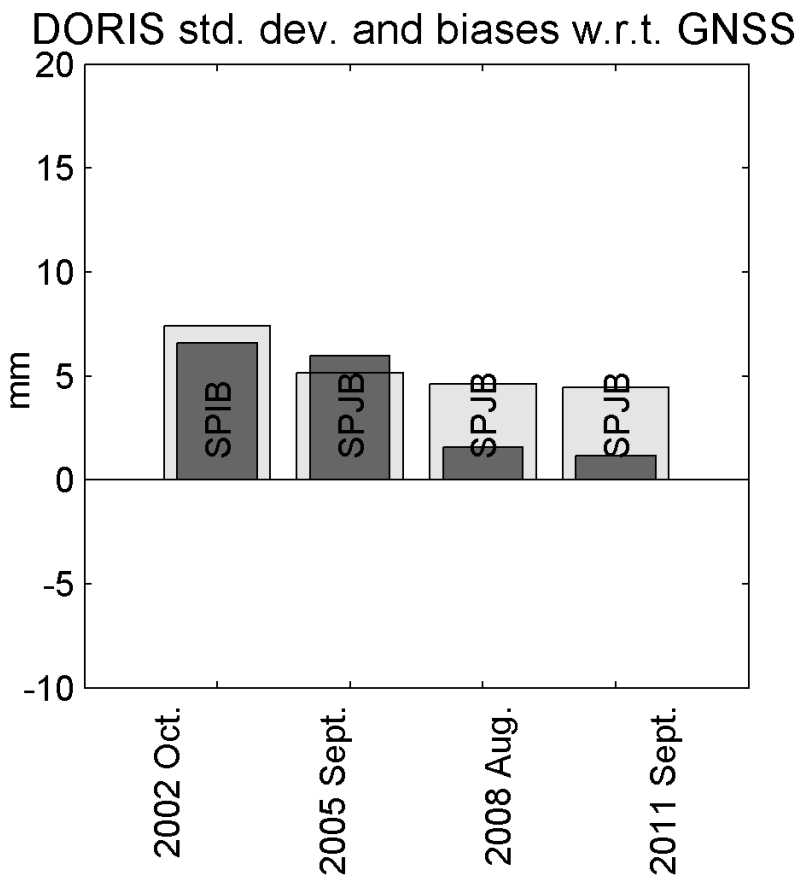
Kokee ZTD std. dev. and biases w.r.t. VLBI and GNSS



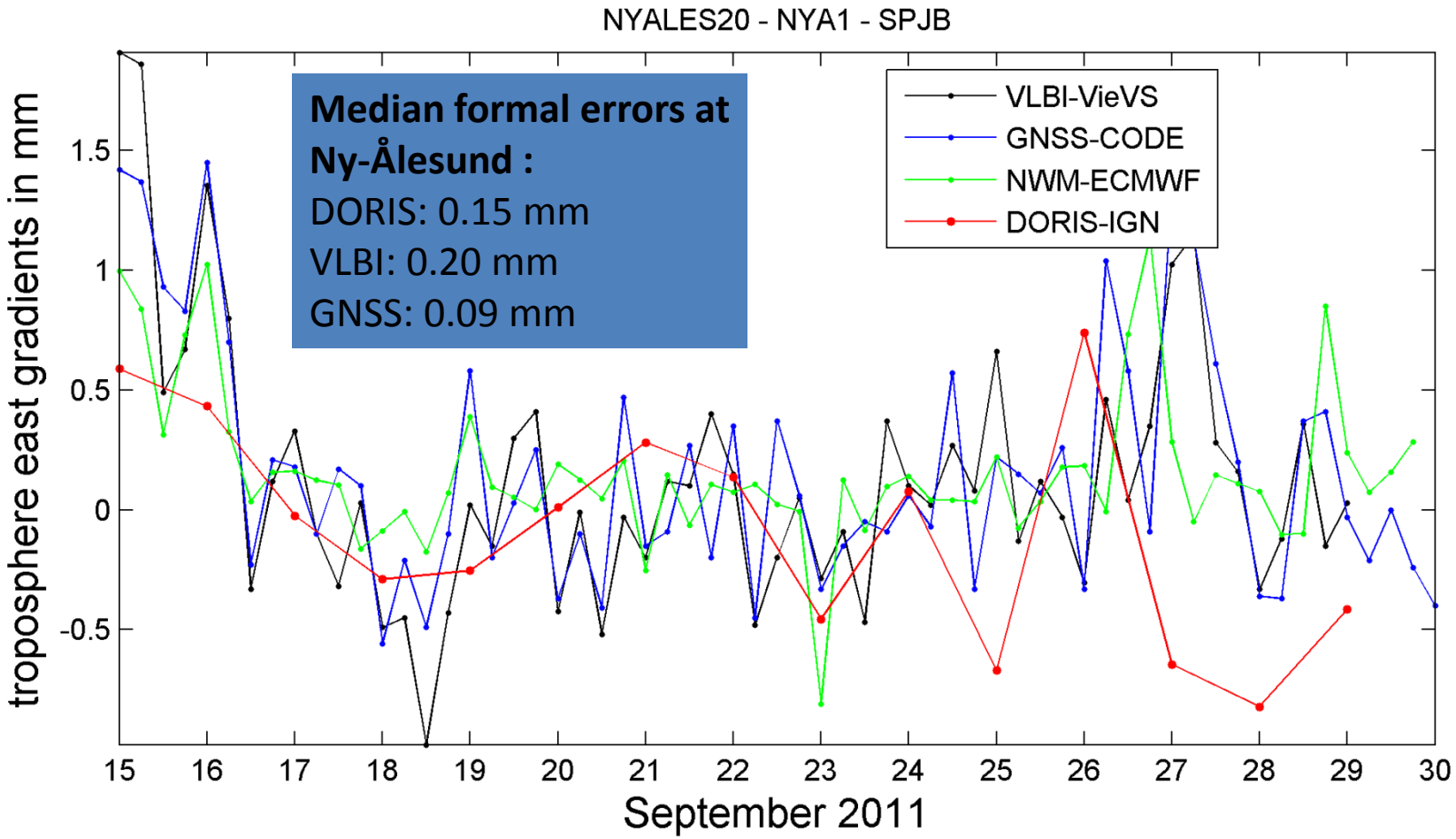


Ny-Ålesund ZTD std. dev. and biases w.r.t. VLBI and GNSS

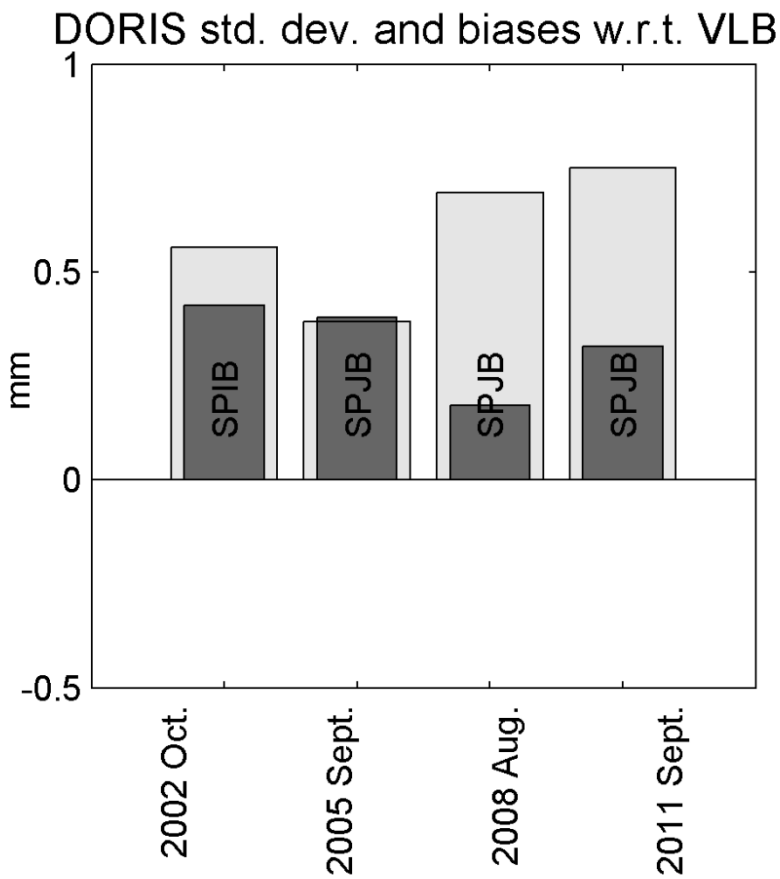


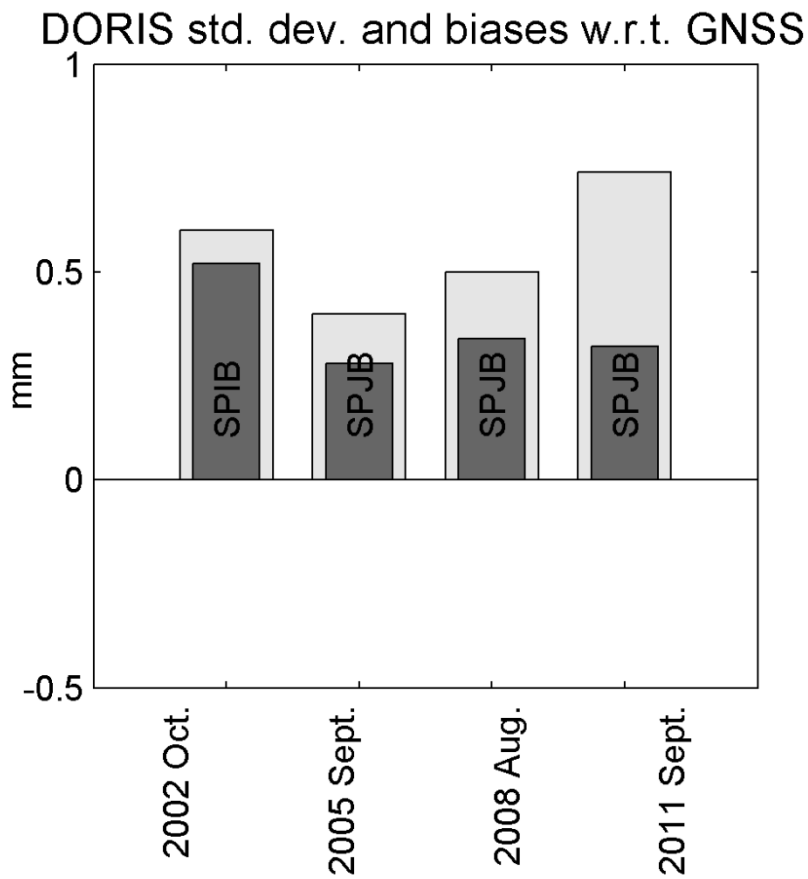


Troposphere east gradients of the co-located site Ny-Ålesund during CONT11

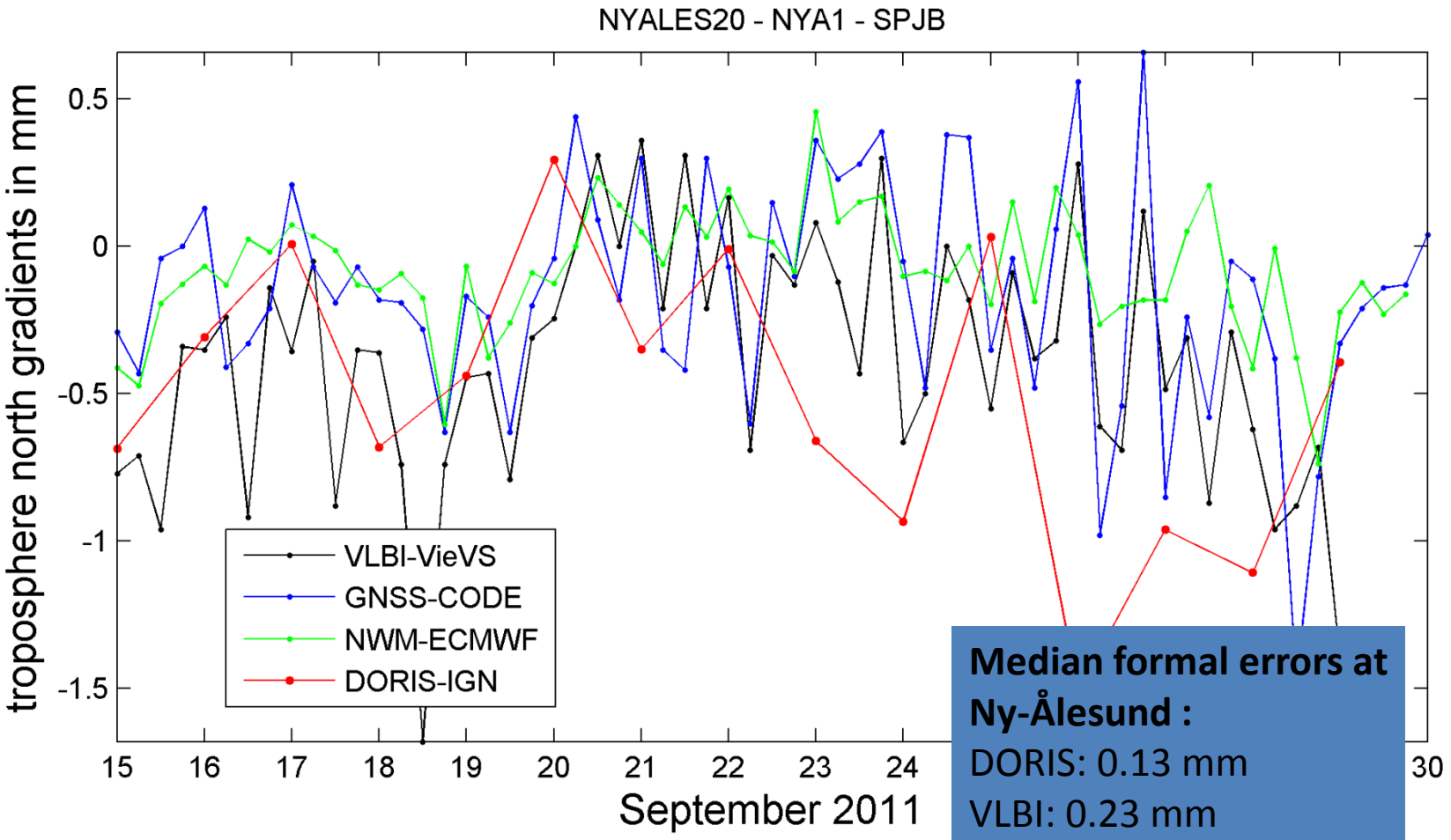


Ny-Ålesund east gradients std. dev. and biases w.r.t. VLBI and GNSS





Troposphere north gradients of the co-located site Ny-Ålesund during CONT11



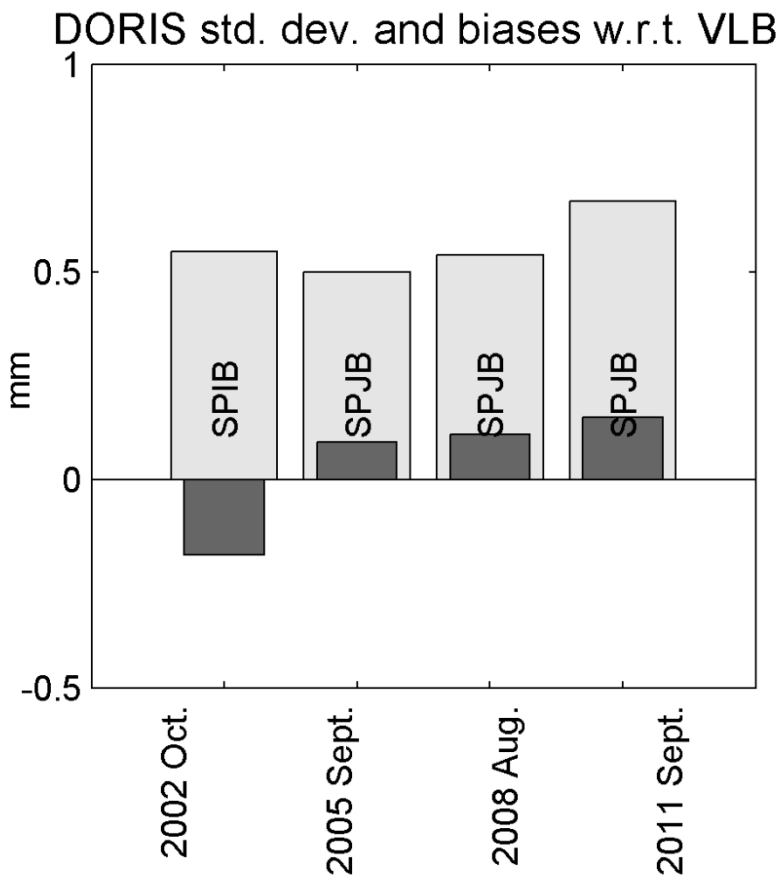
Median formal errors at Ny-Ålesund :

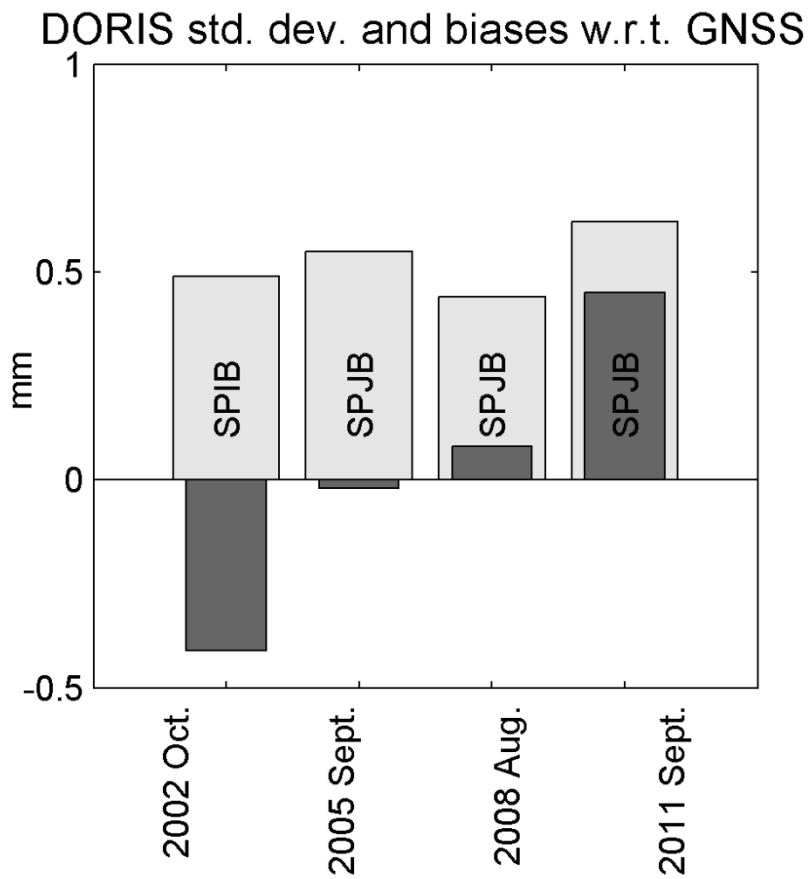
DORIS: 0.13 mm

VLBI: 0.23 mm

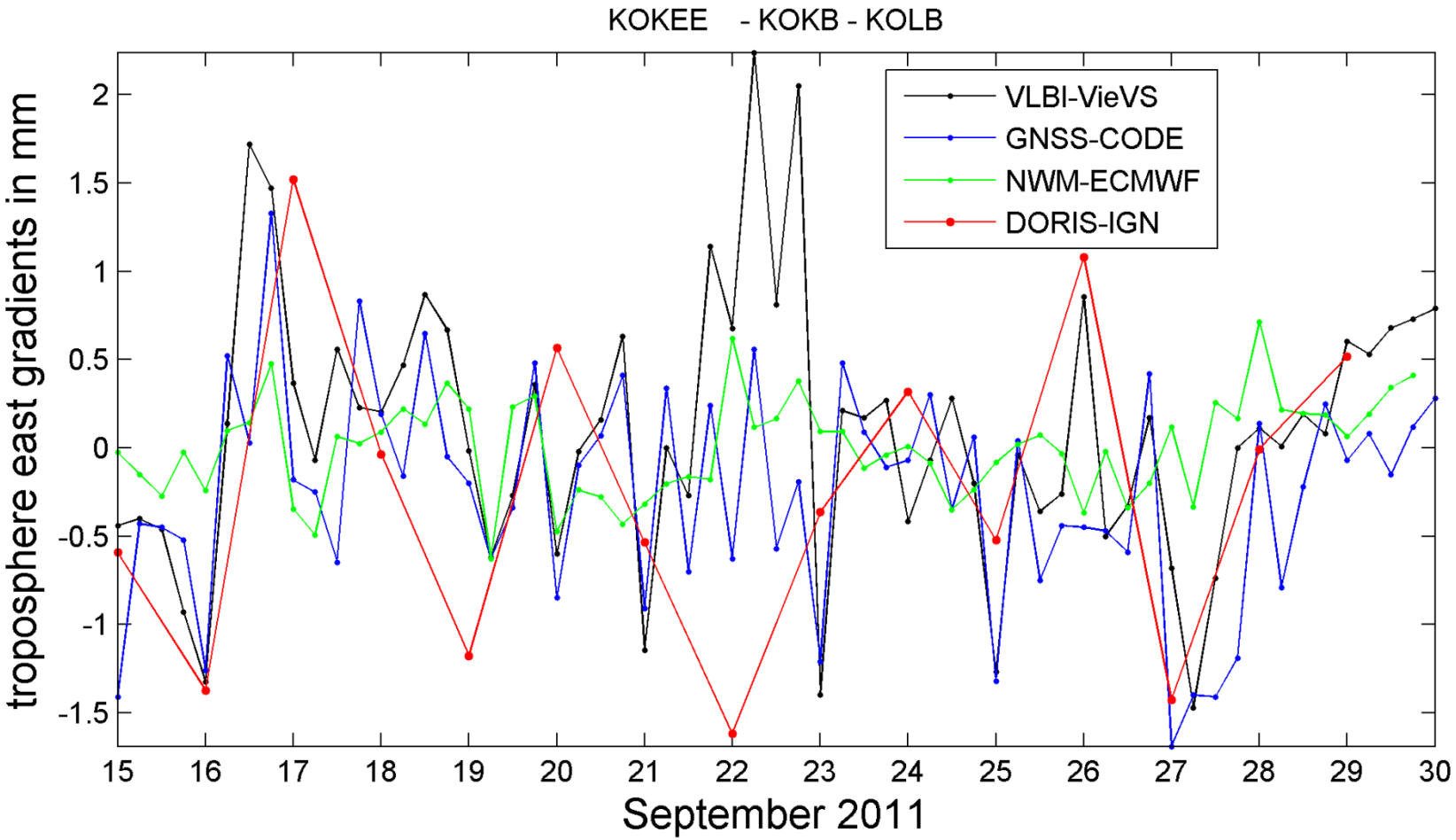
GNSS: 0.09 mm0

Ny-Ålesund north gradients std. dev. and biases w.r.t. VLBI and GNSS

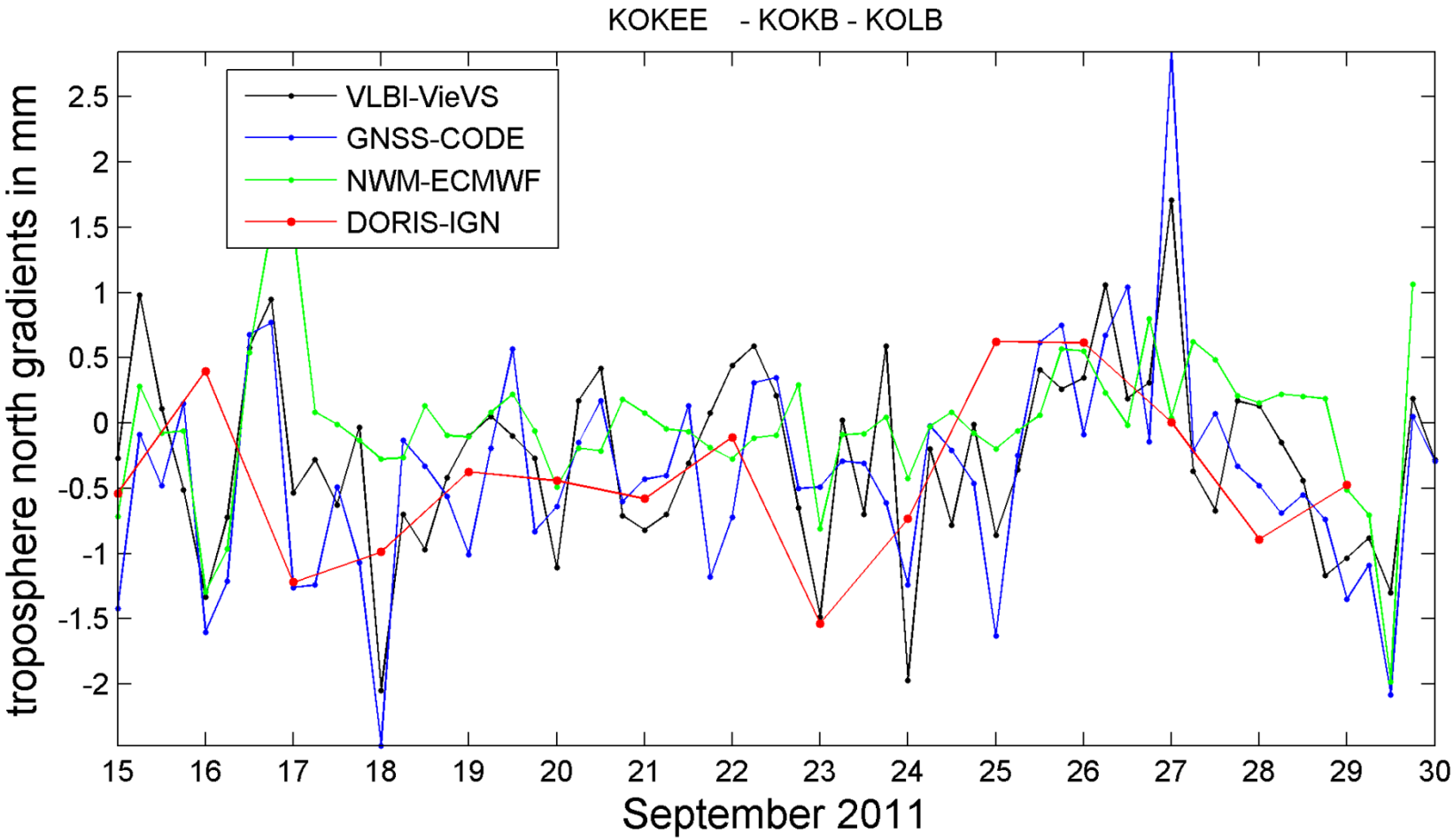




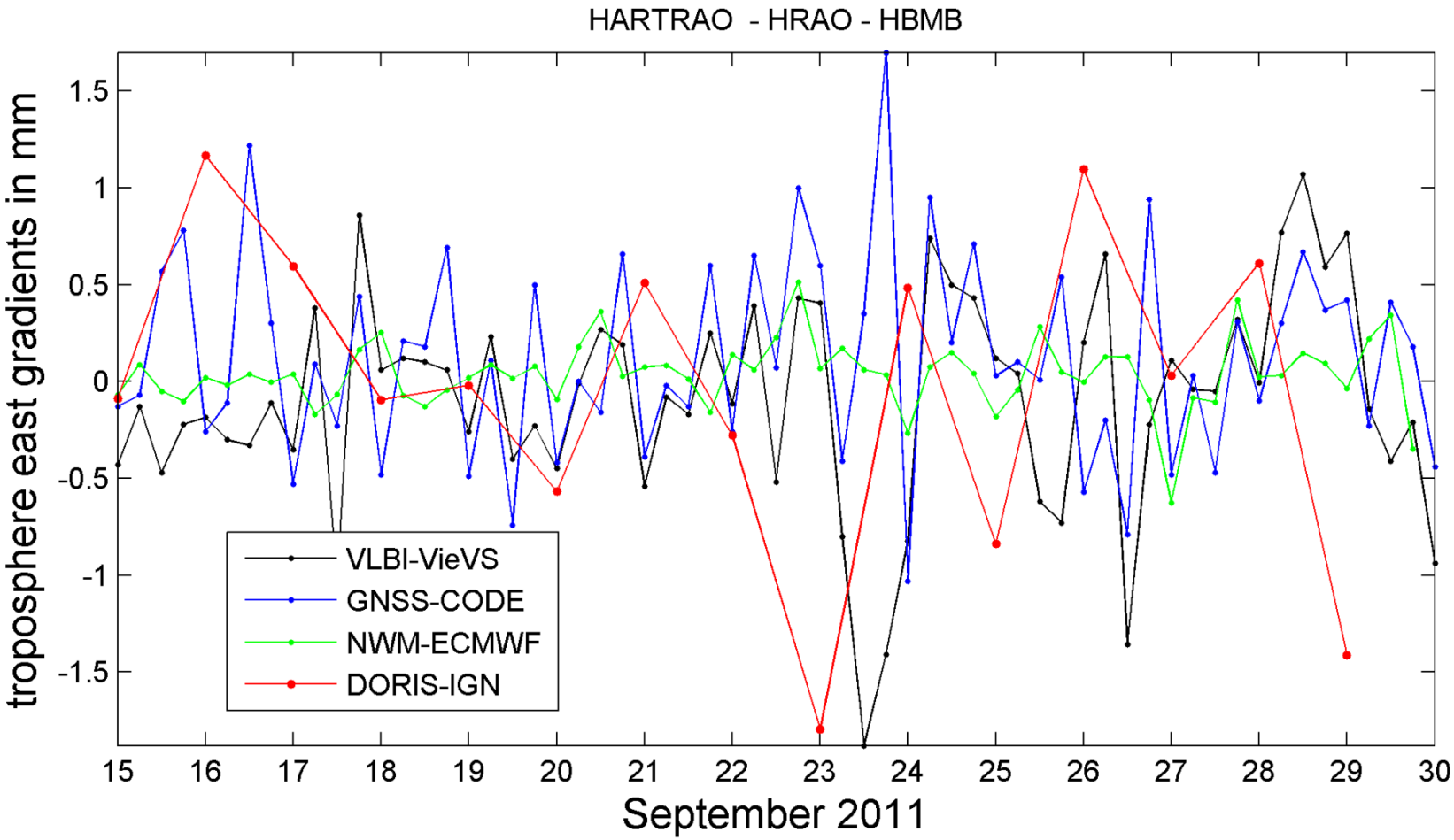
Troposphere east gradients of the co-located site Kokee during CONT11



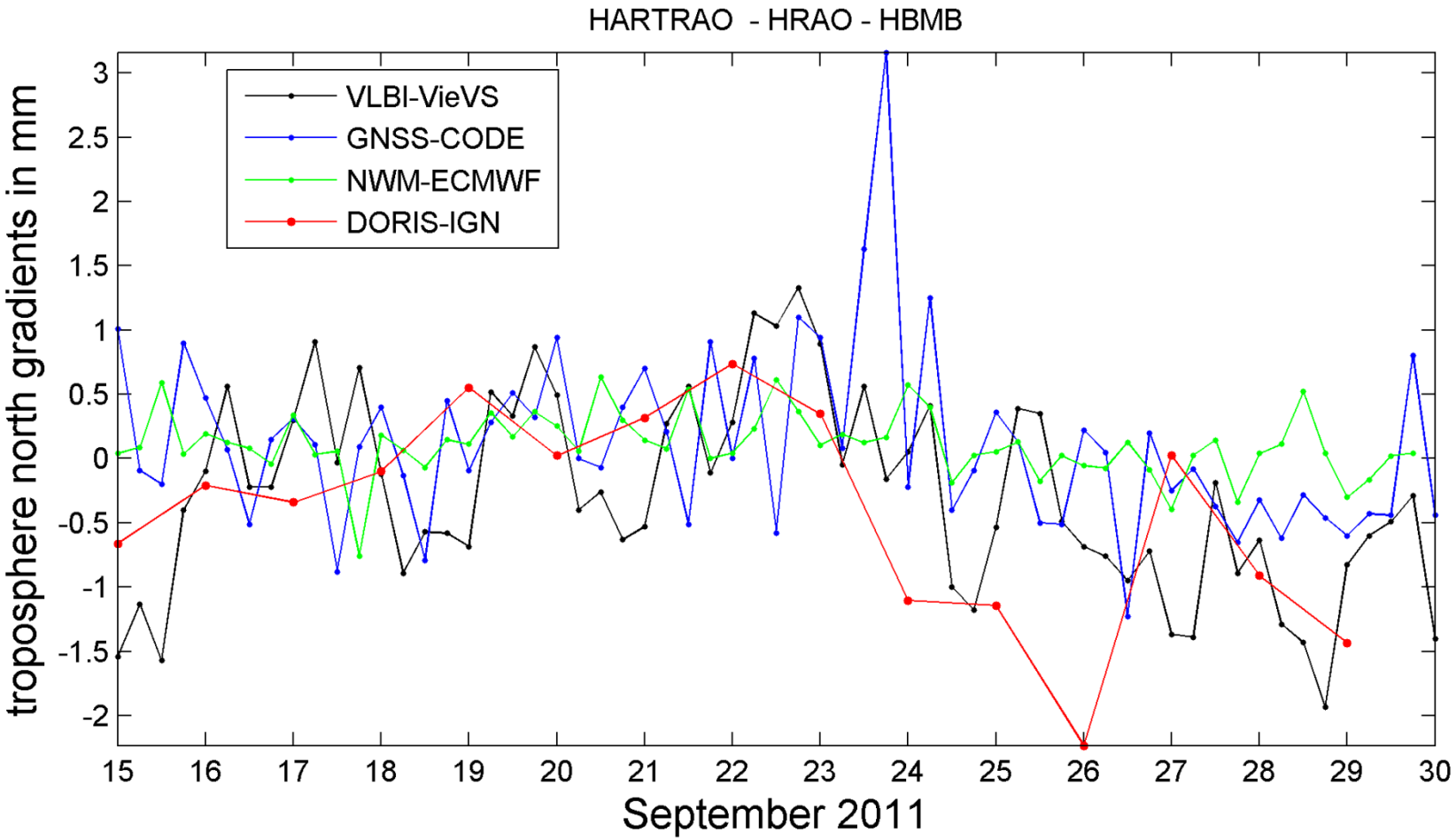
Troposphere north gradients of the co-located site Kokee during CONT11



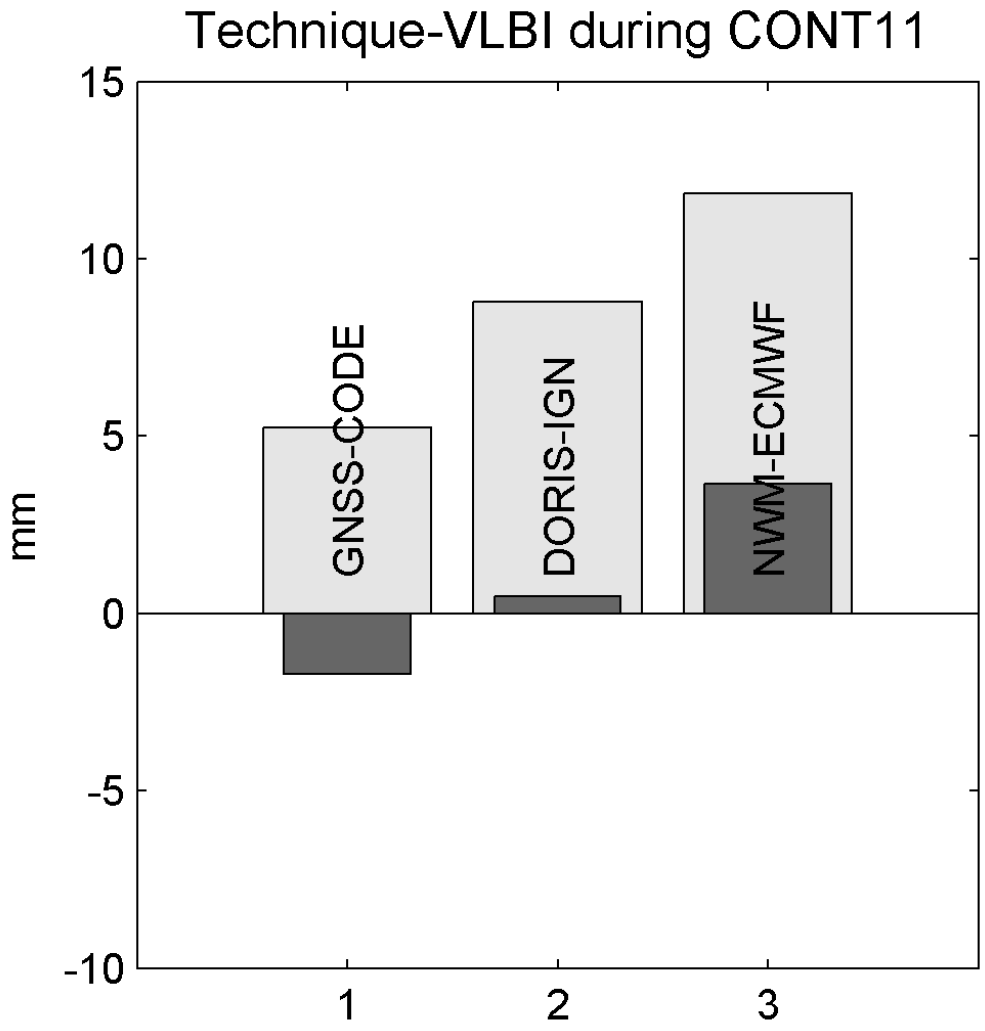
Troposphere east gradients of the co-located site Hartebeesthoek during CONT11



Troposphere north gradients of the co-located site Hartebeesthoek during CONT11



ZTD mean std. dev. and biases w.r.t. VLBI during CONT11



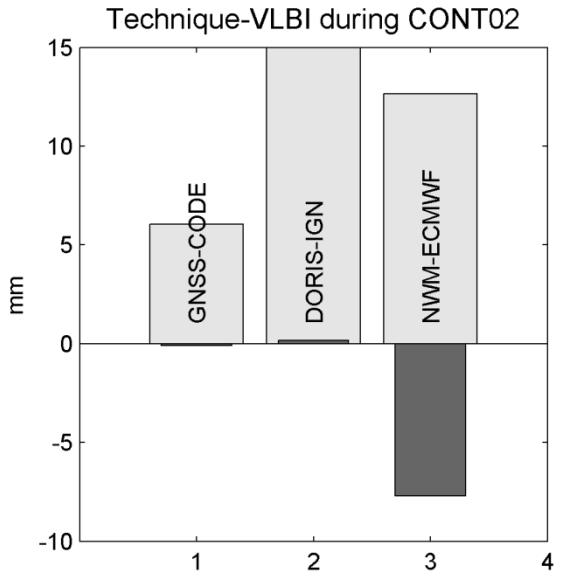
Total number of common epochs with VLBI during CONT11

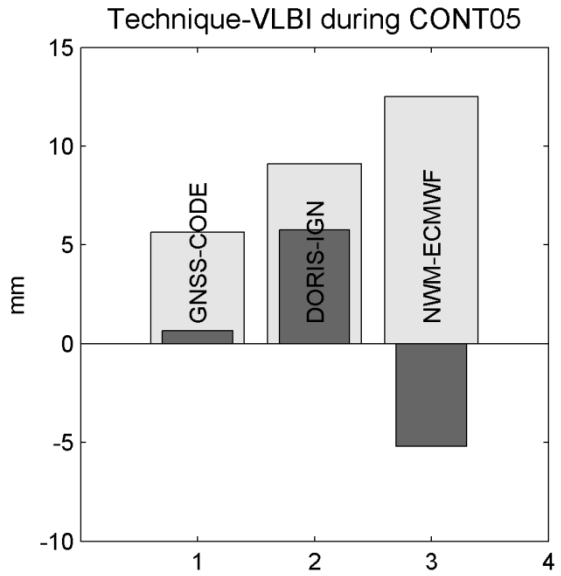
GNSS: 694 (No BADARY)
DORIS: 917 (BADB)
ECMWF: 906 (BADARY)

ZTD mean std. dev. and biases w.r.t. VLBI during CONT02, 05, 08, and 11

CONT02

HBKB : 128
KOKA : 138
SPIB : 316
total: 582



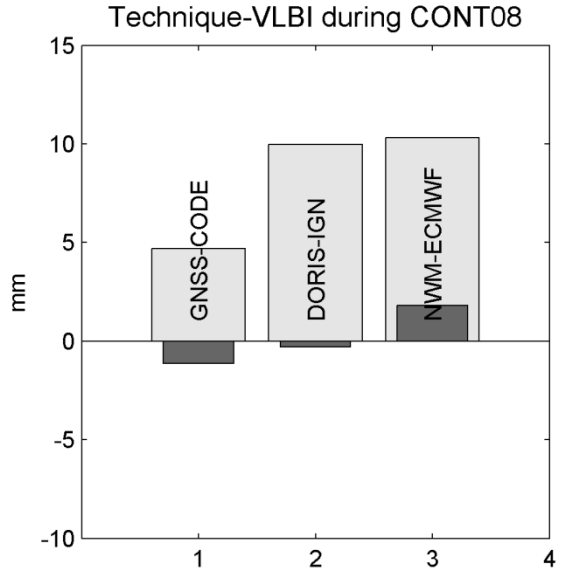


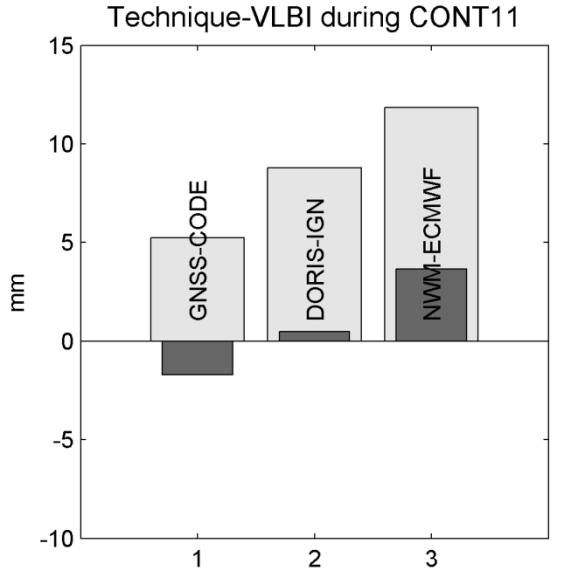
Number of common epochs with VLBI during CONT05

HBKB : 31
KOLB : 94
SPJB : 350
total: 475

CONT08

HBMB : 156
KOLB : 159
SPJB : 390
total: 705





CONT11

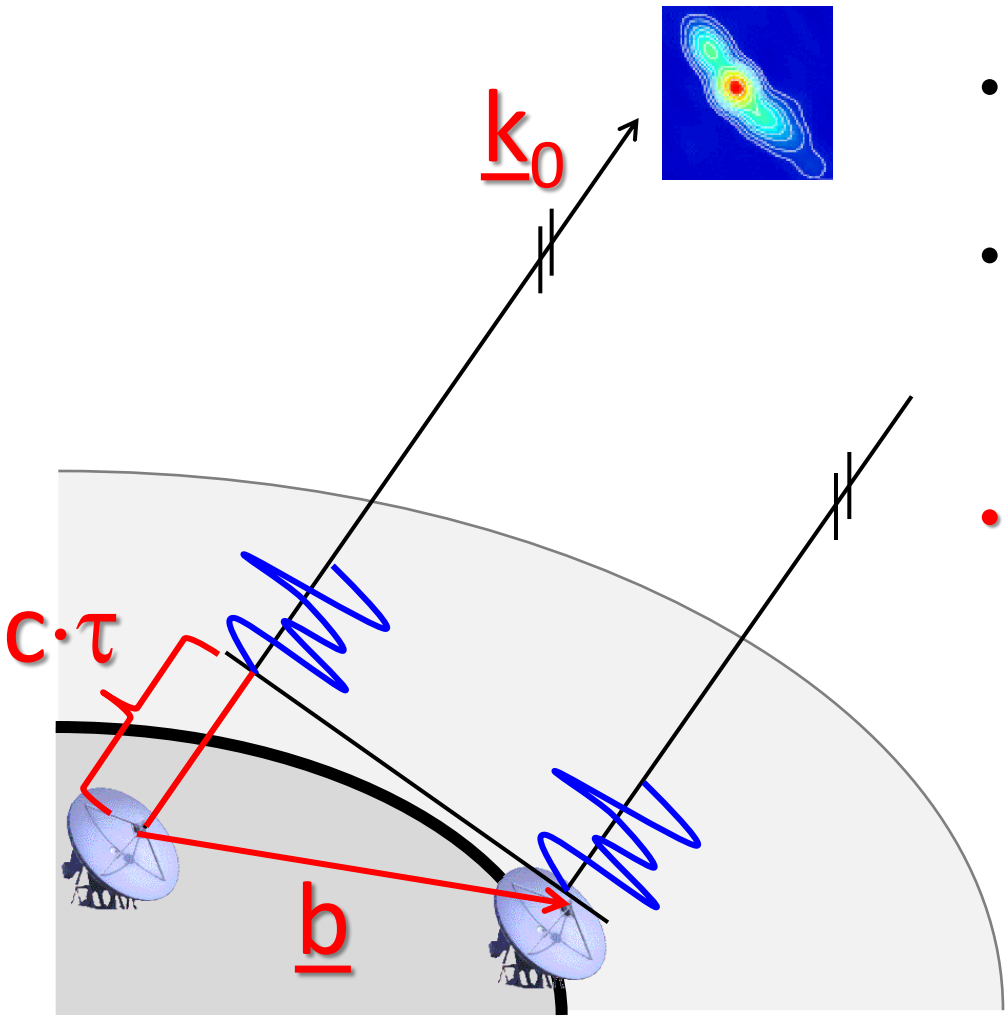
HBMB : 175
KOLB : 162
BADB : 223
SPJB : 357
total: 917

Conclusions

- Standard deviations of troposphere zenith delays between 5 mm (SPJB) and 10 mm w.r.t. GNSS and VLBI.
- No clear improvement over time (except CONT02).
- No season-dependency of standard deviations.
- Small correlation of DORIS gradients with those from GNSS and VLBI.

Thanks for your attention.

Very Long Baseline Interferometry

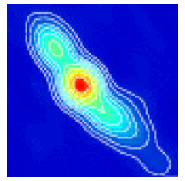


- Group delay τ determined by correlator
- Ionospheric corrections by S- and X-band observations

- $c\cdot\tau = -\underline{b}\cdot\mathrm{WSNP}\cdot\underline{k}_0$

Earth orientation parameters (EOP)

Troposphere delays



$$D_L = 10^{-6}\left[\int_S N(s)ds\right] + [S - G]$$

Pressure, temperature, and humidity from numerical weather models