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

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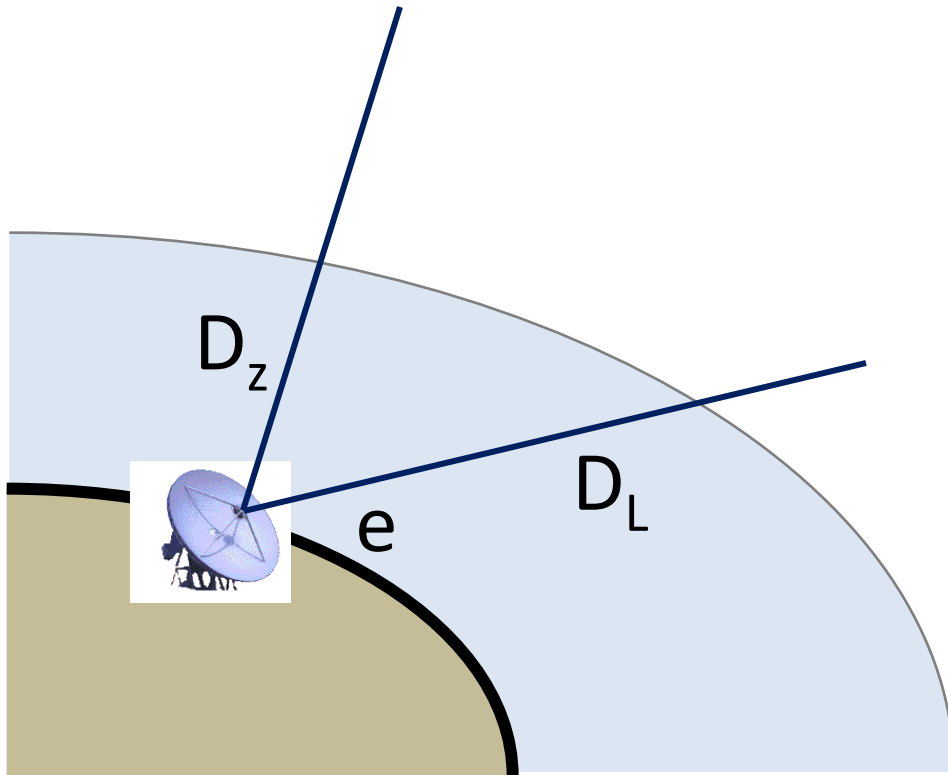(5) Institut für Astronomische und Physikalische Geodäsie, Technische Universität München, Germany

The aims of our study are

- Quantify agreement of troposphere estimates from DORIS with those from other techniques.

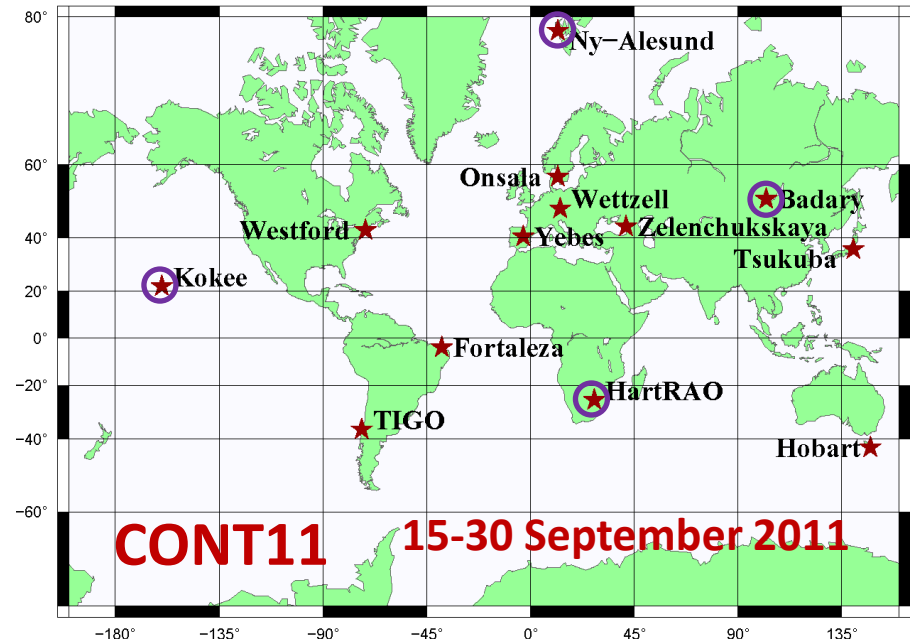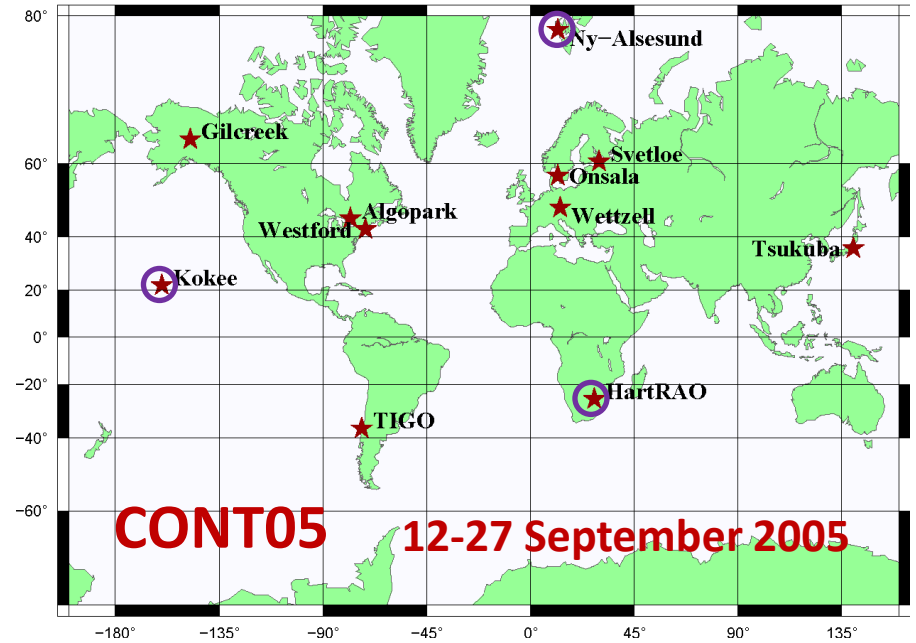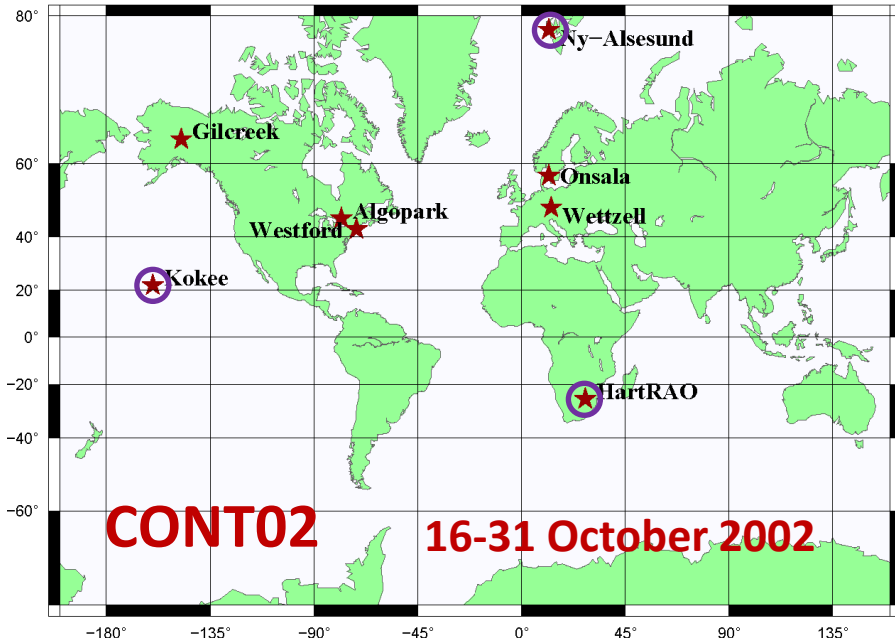- Figure out site- and season-specific irregularities.

Troposphere delays

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

+ gradients

D_z

D_L

e

CONT Sessions

CONT02 — 16-31 October 2002
Stations: Ny-Alesund, Gilcreek, Onsala, Westford, Algopark, Wettzell, Kokee, HartRAO

CONT05 — 12-27 September 2005
Stations: Ny-Alesund, Gilcreek, Svetloe, Onsala, Westford, Algopark, Wettzell, Tsukuba, Kokee, TIGO, HartRAO

CONT08 — 12-27 August 2008
Stations: Ny-Alesund, Svetloe, Onsala, Wettzell, Medicina, Westford, Zelenchukskaya, Tsukuba, Kokee, TIGO, HartRAO

CONT11 — 15-30 September 2011
Stations: Ny-Alesund, Onsala, Wettzell, Badary, Yebes, Zelenchukskaya, Tsukuba, Westford, Kokee, Fortaleza, TIGO, HartRAO, Hobart

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 (GNSS)

- **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)
GNSS-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)

REFERENCE HEIGHT
(87.79 m)

VLBI antenna
reference point

Atmosphere

Δh = 34.73 m

DORIS, SPJB
height (53.06 m)

Earth
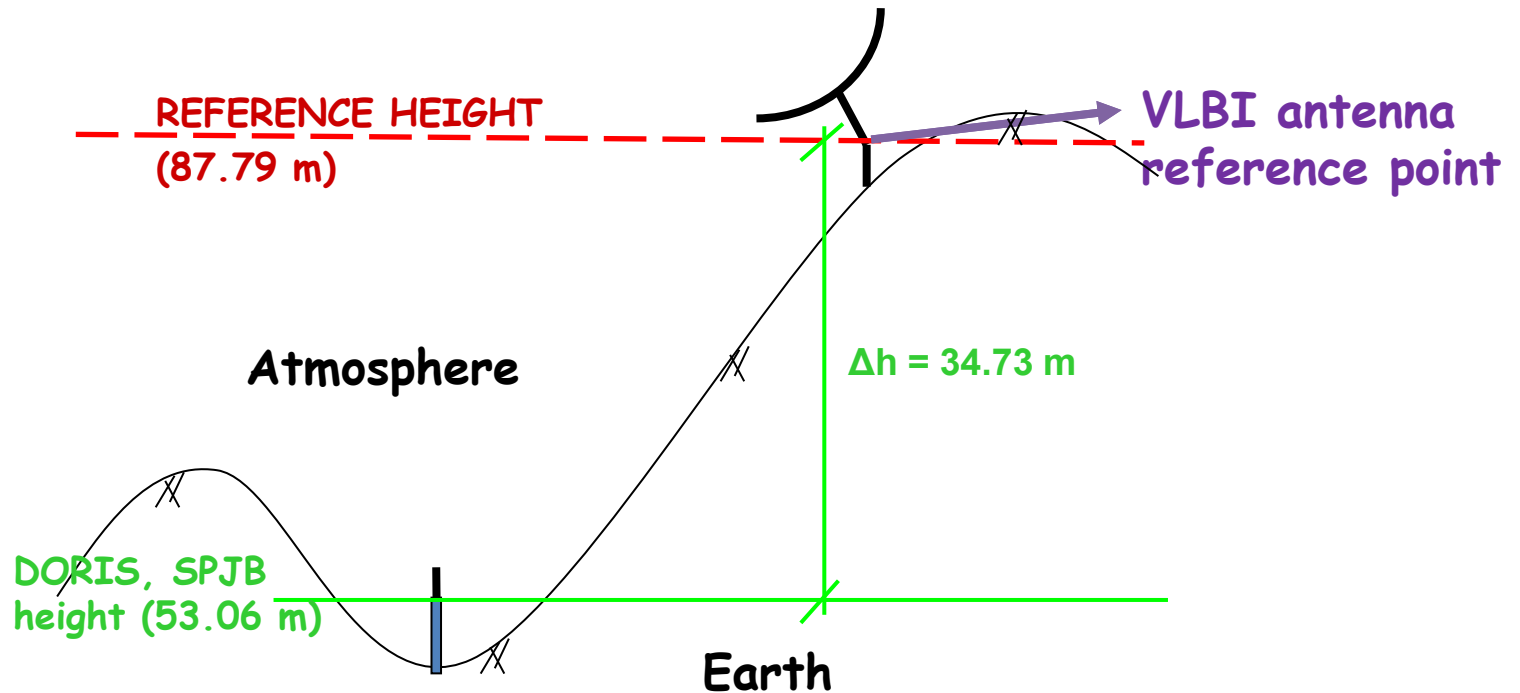
Troposphere ties calculated based on 6-hourly ECMWF!

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

between VLBI and DORIS common epochs
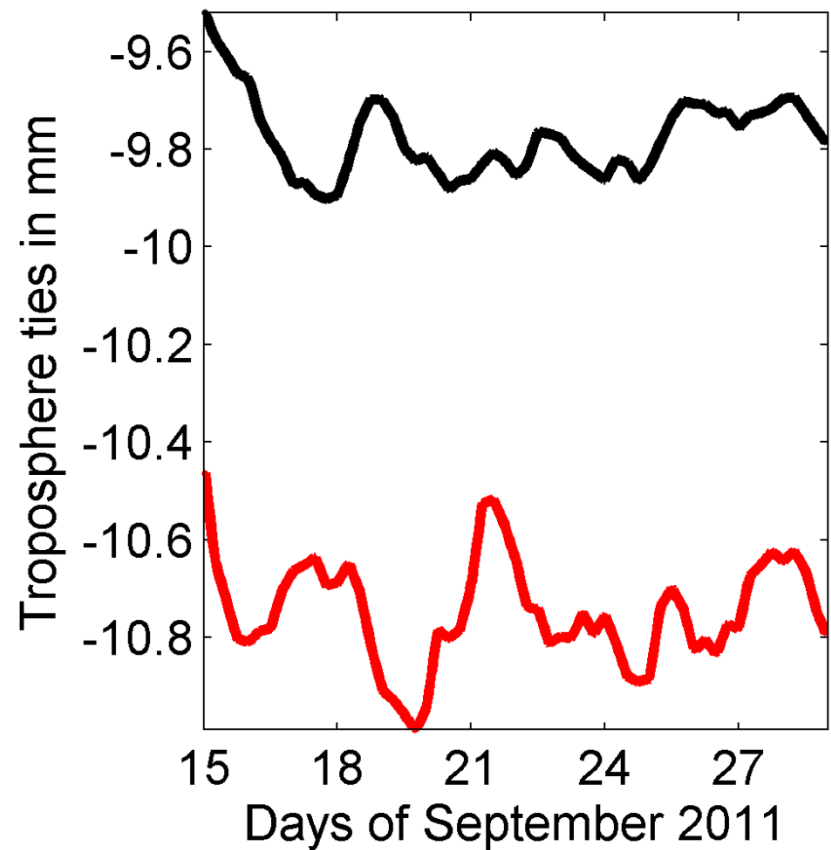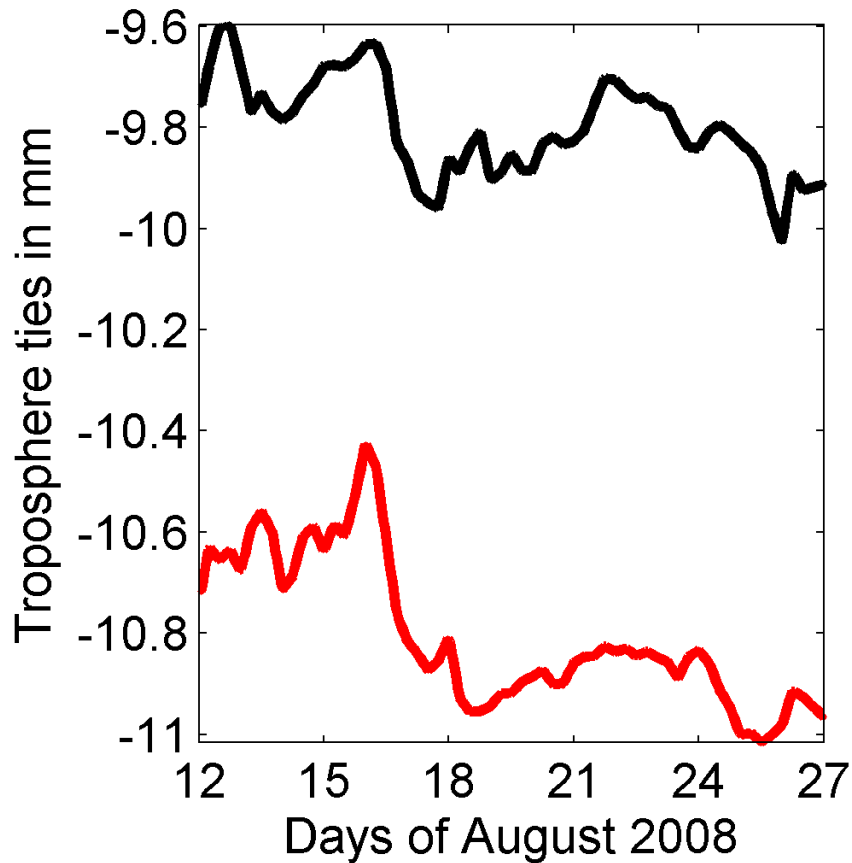
Total (in red) and hydrostatic (in black) troposphere ties at Hartebeesthoek (Δh=144 m)

between VLBI and DORIS common epochs
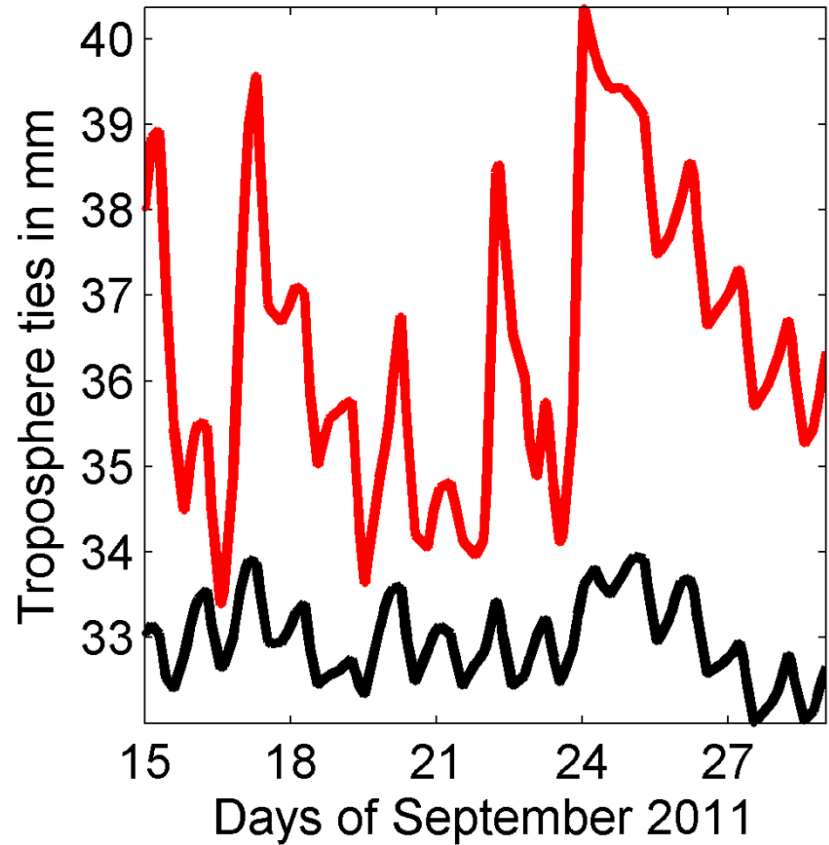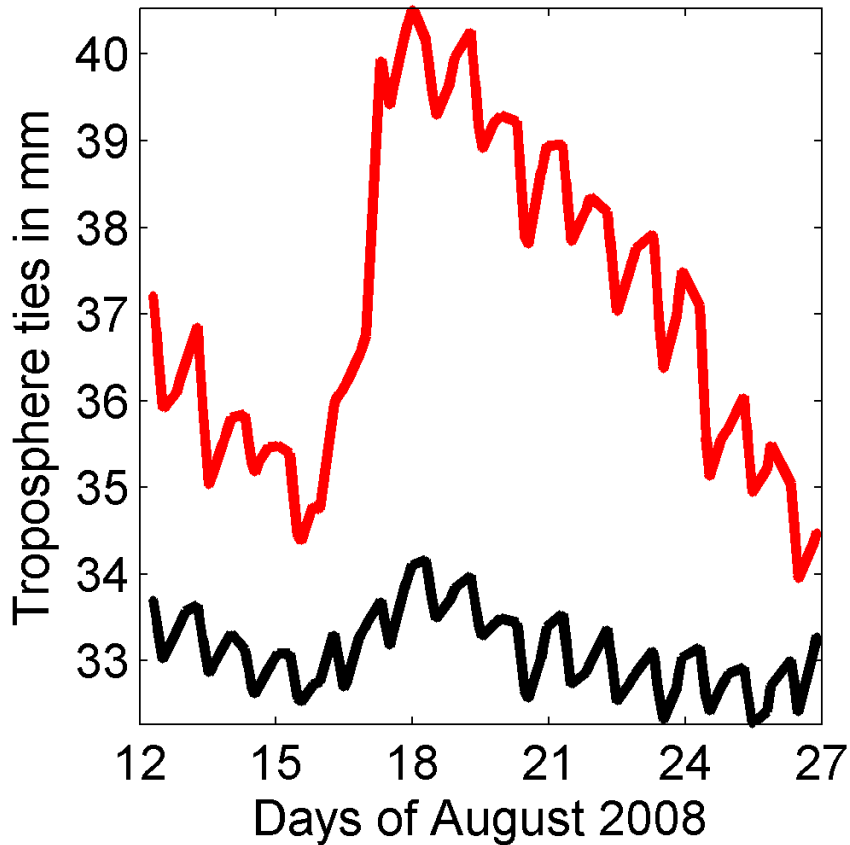
Troposphere ZTD of the co-located site Hartebeesthoek during CONT02
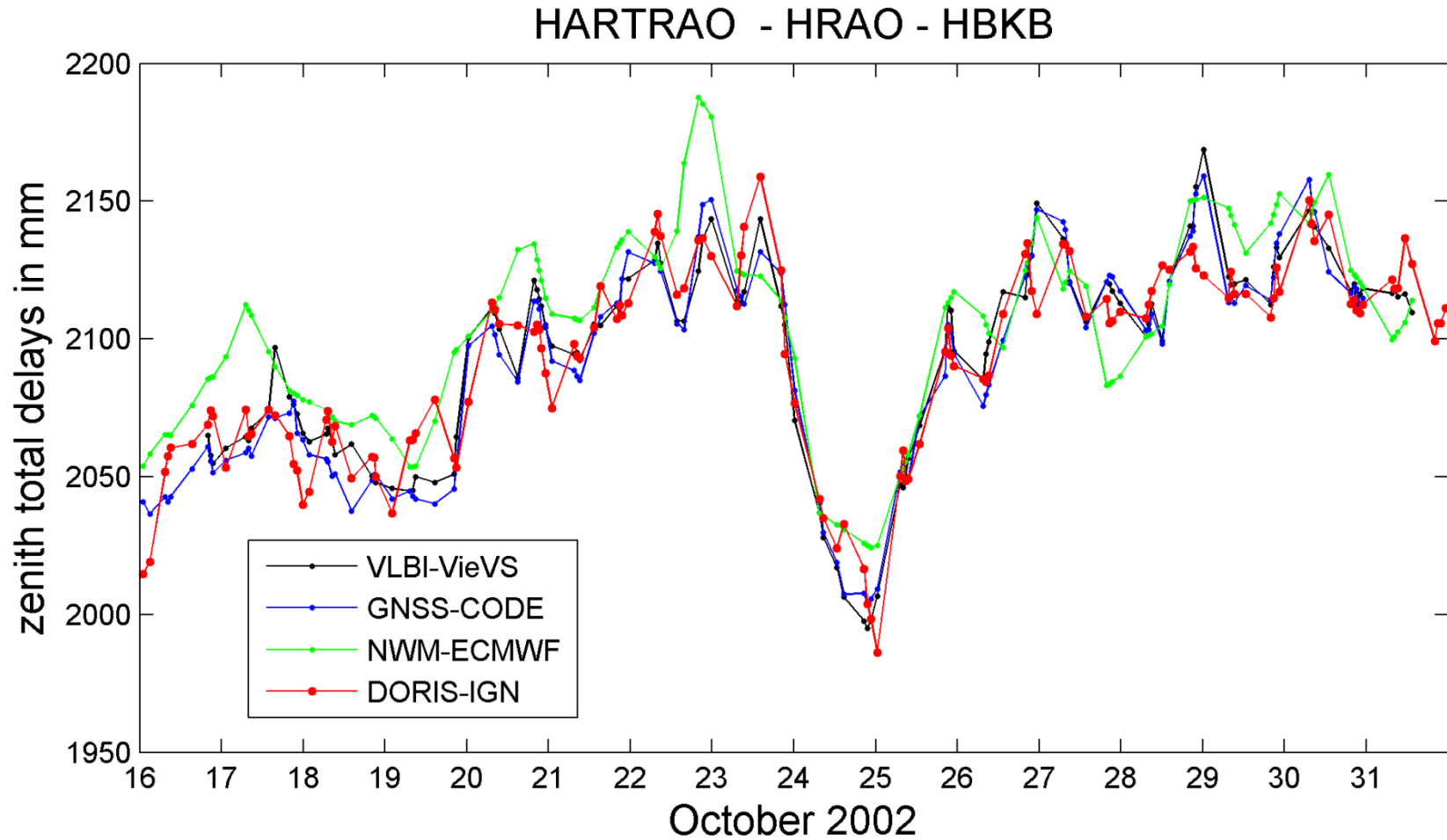
HARTRAO - HRAO - HBKB

Troposphere ZTD of the co-located site Hartebeesthoek during CONT05

HARTRAO - HRAO - HBKB

Troposphere ZTD of the co-located site Hartebeesthoek during CONT08
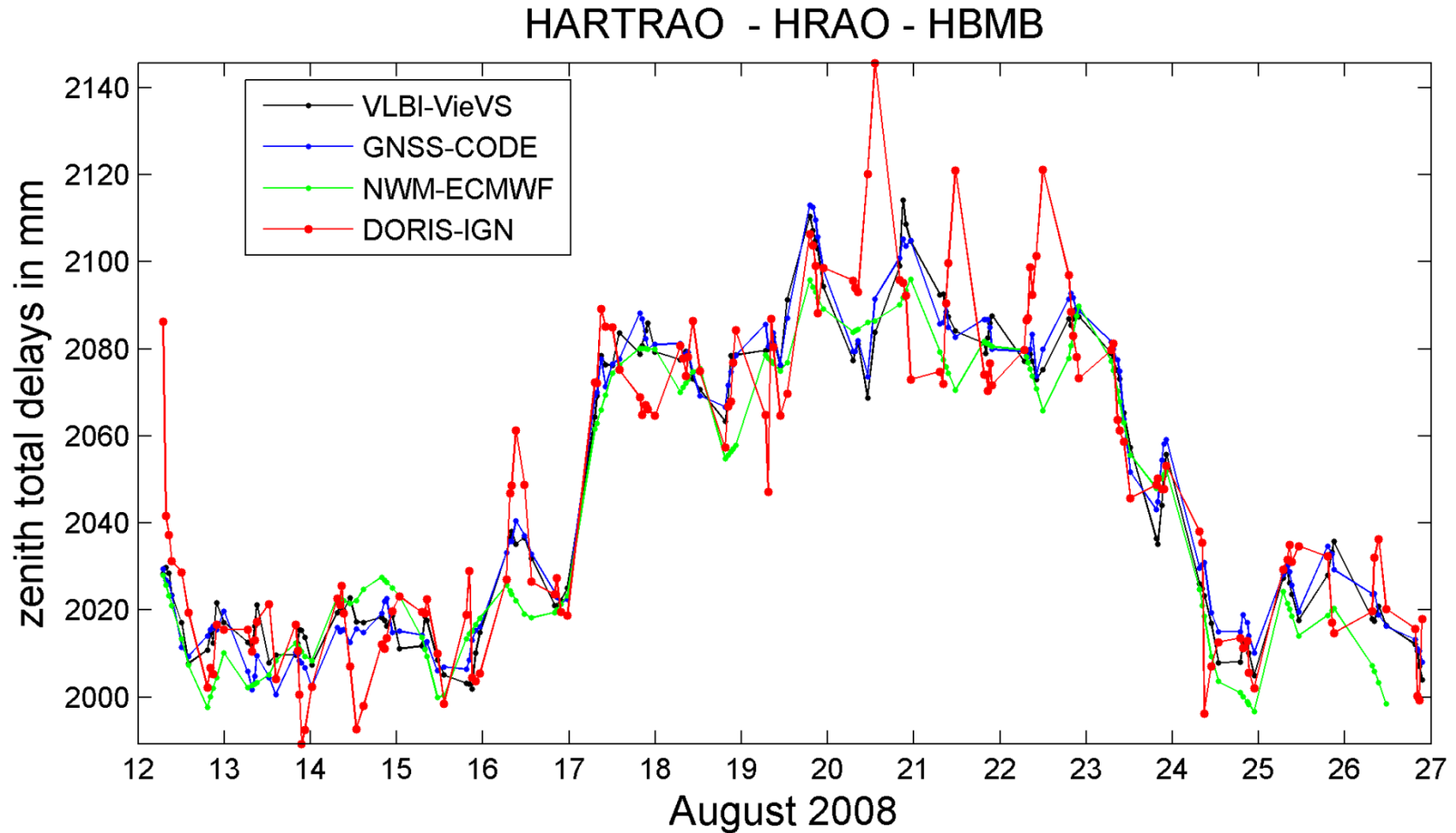
HARTRAO - HRAO - HBMB

Troposphere ZTD of the co-located site Hartebeesthoek during CONT11

HARTRAO - HRAO - HBMB

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

KOKEE - KOKB - KOKA

Troposphere ZTD of the co-located site
Kokee during CONT05

Troposphere ZTD of the co-located site Kokee during CONT08
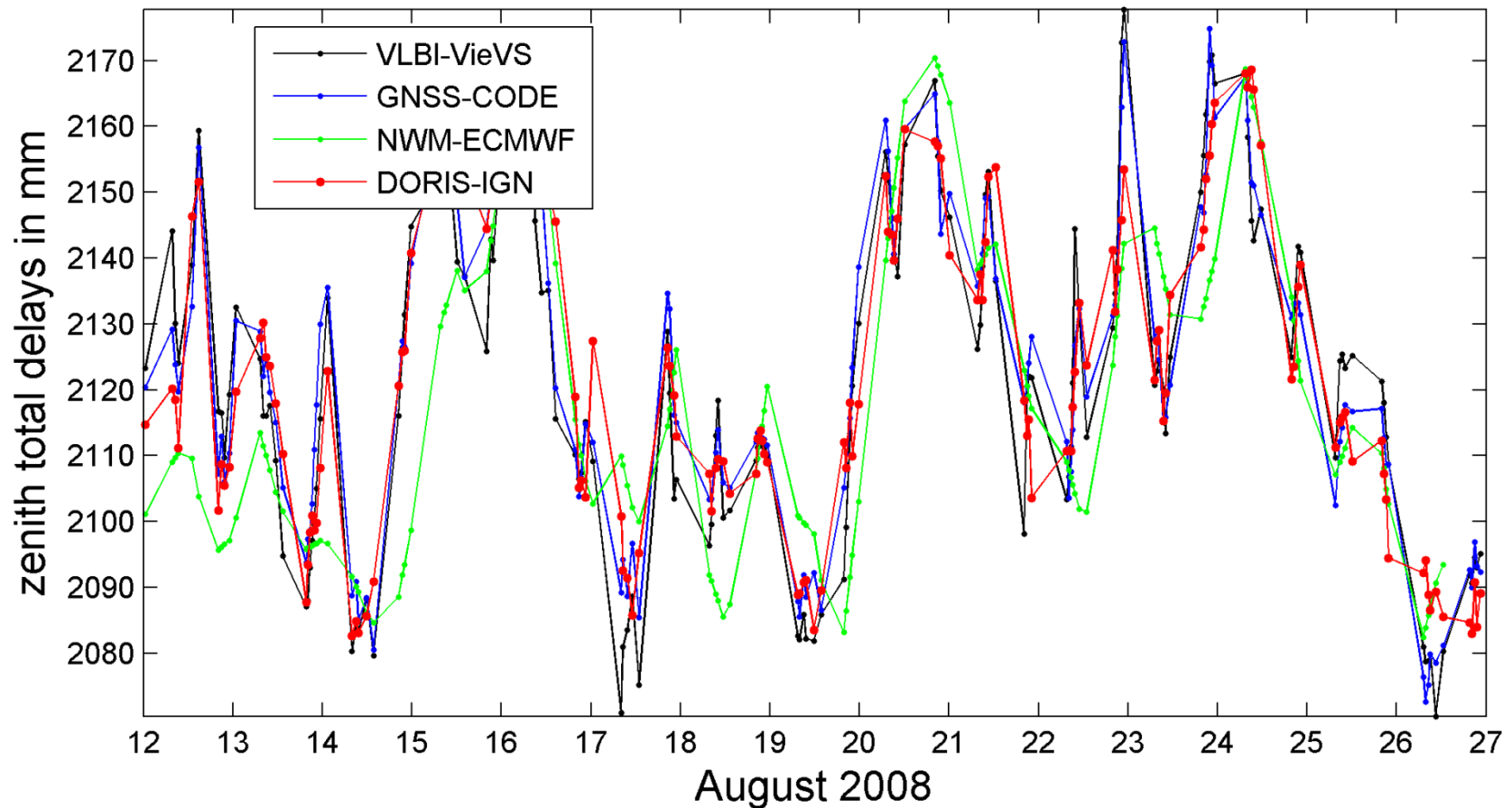
Troposphere ZTD of the co-located site Kokee during CONT11

KOKEE - KOKB - KOLB
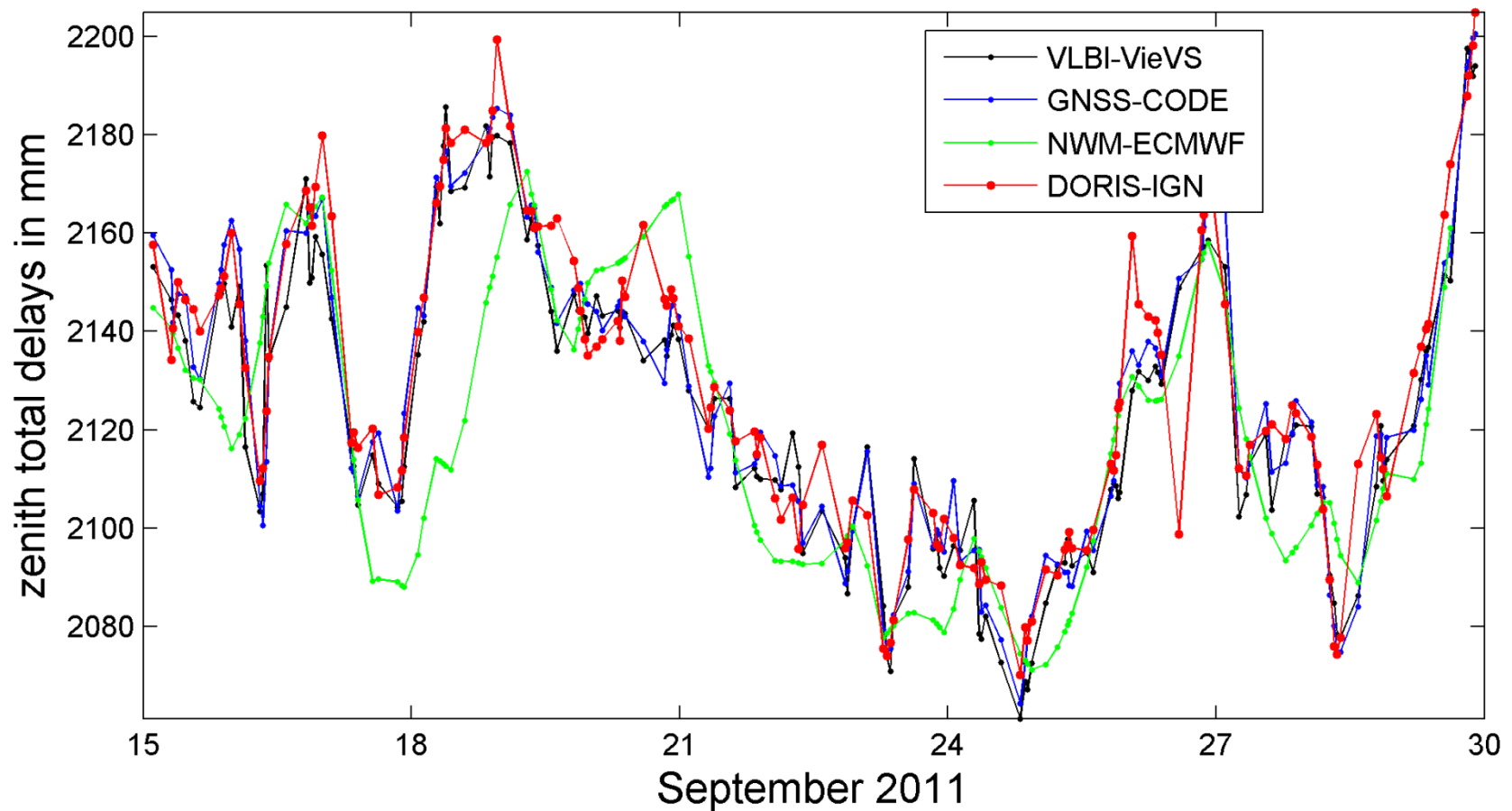
Troposphere ZTD of the co-located site Ny-Ålesund during CONT02
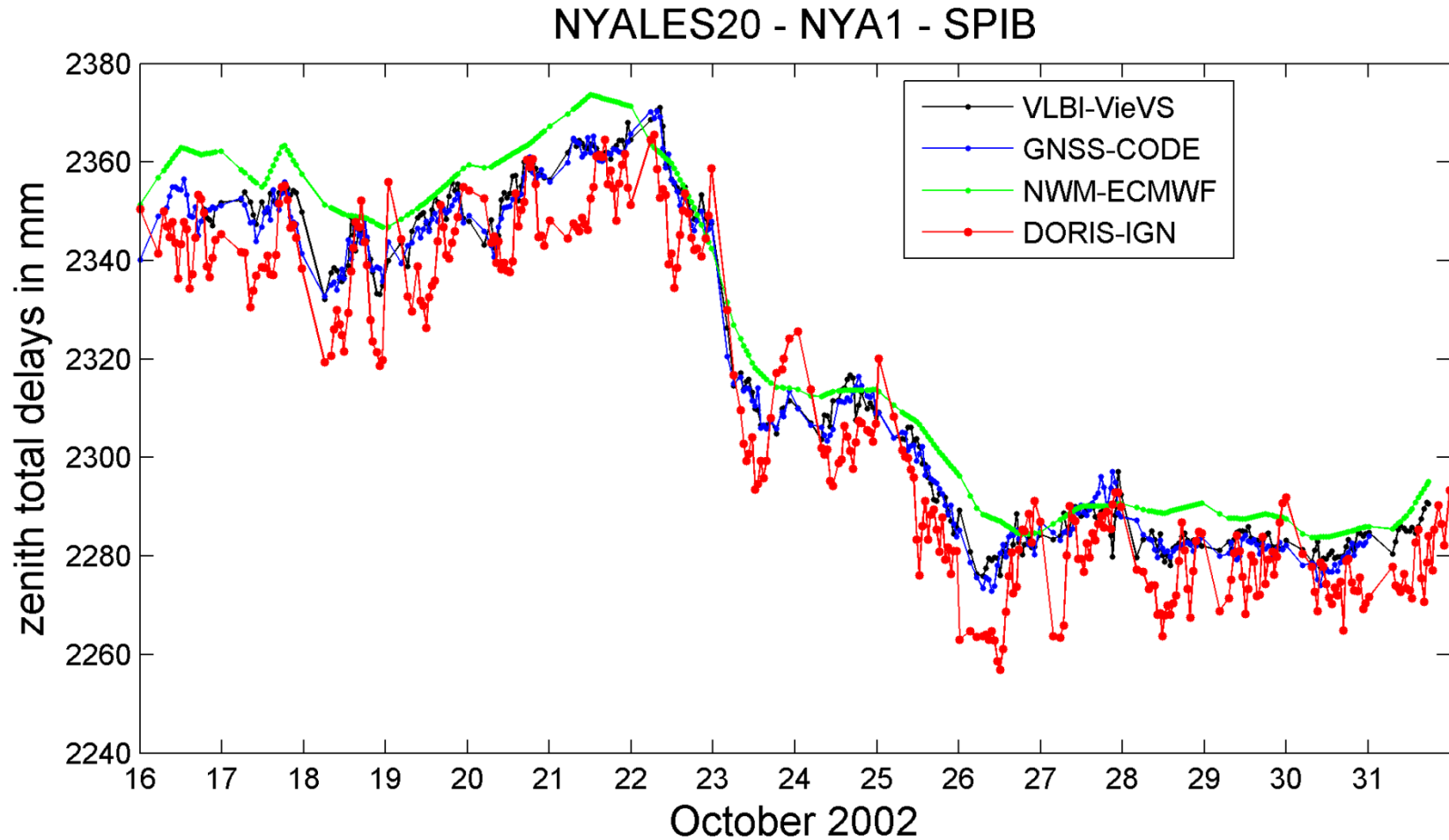
NYALES20 - NYA1 - SPIB

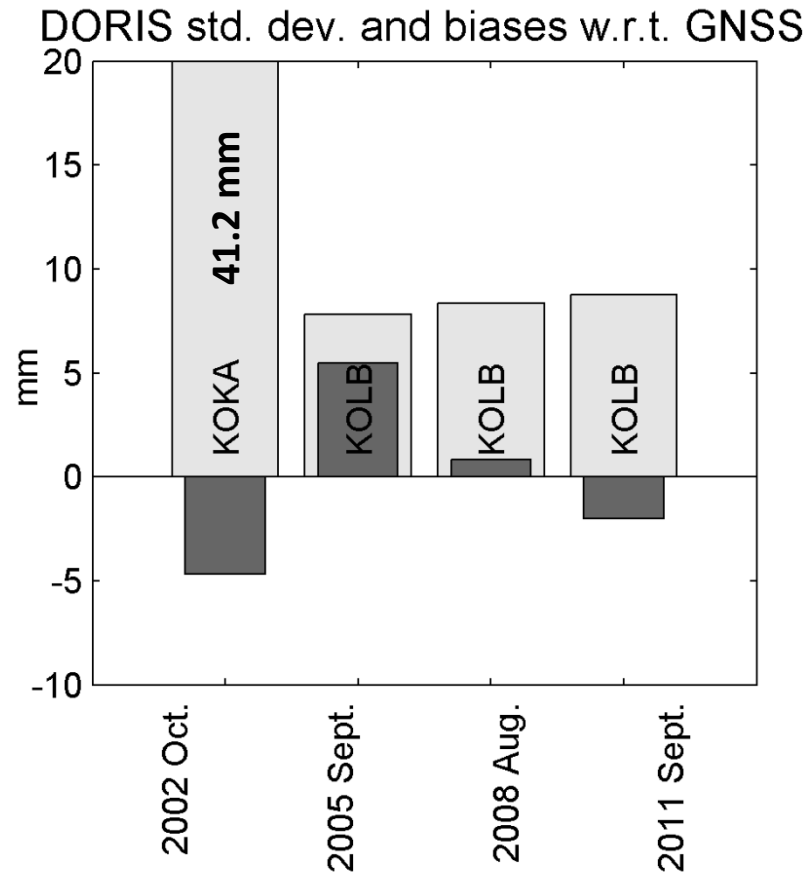# Troposphere ZTD of the co-located site Ny-Ålesund during CONT05
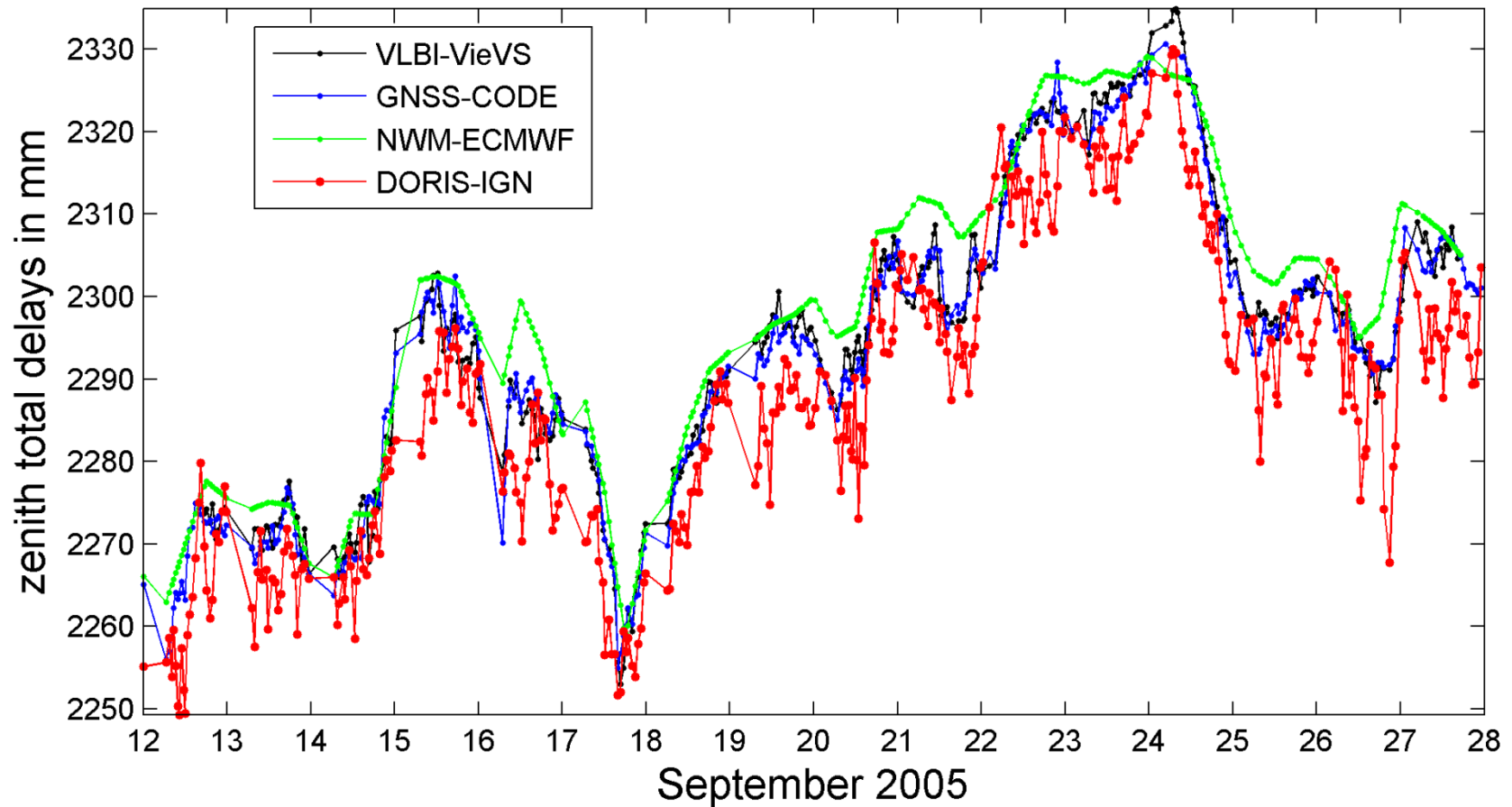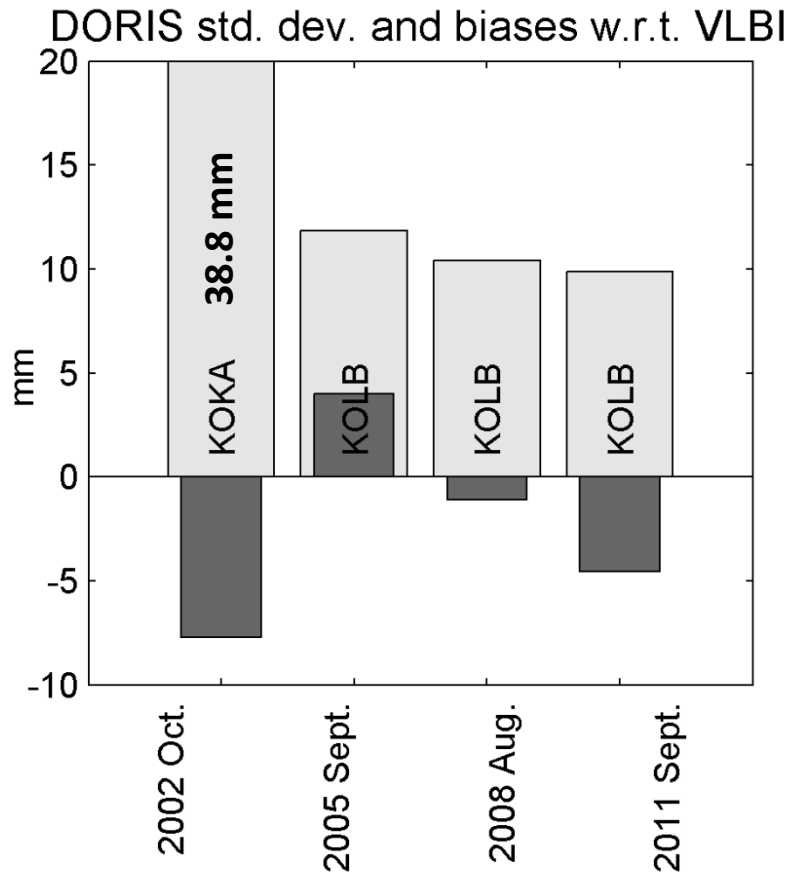
Troposphere ZTD of the co-located site Ny-Ålesund during CONT08

NYALES20 - NYA1 - SPJB
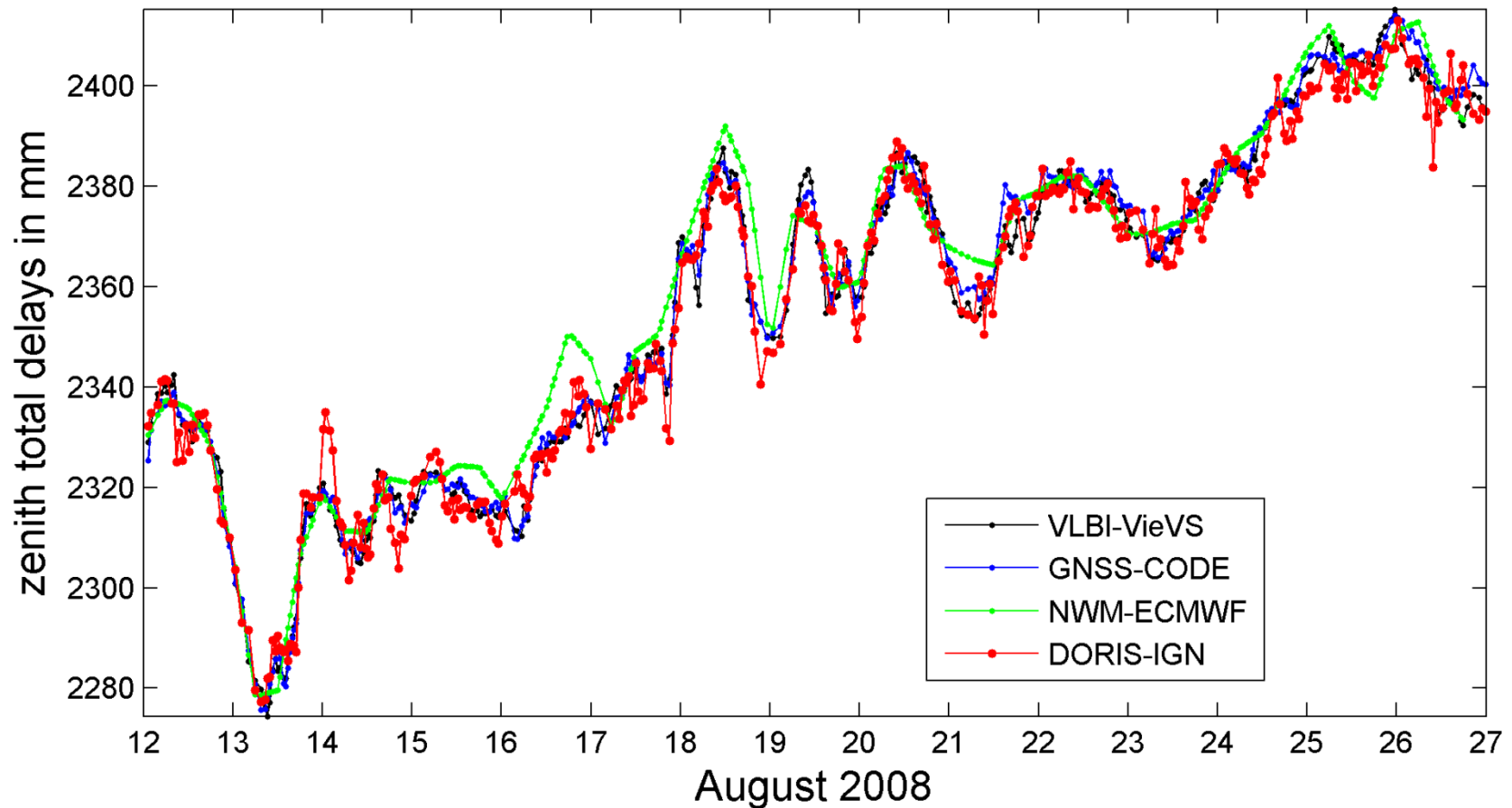
Troposphere ZTD of the co-located site Ny-Ålesund during CONT11
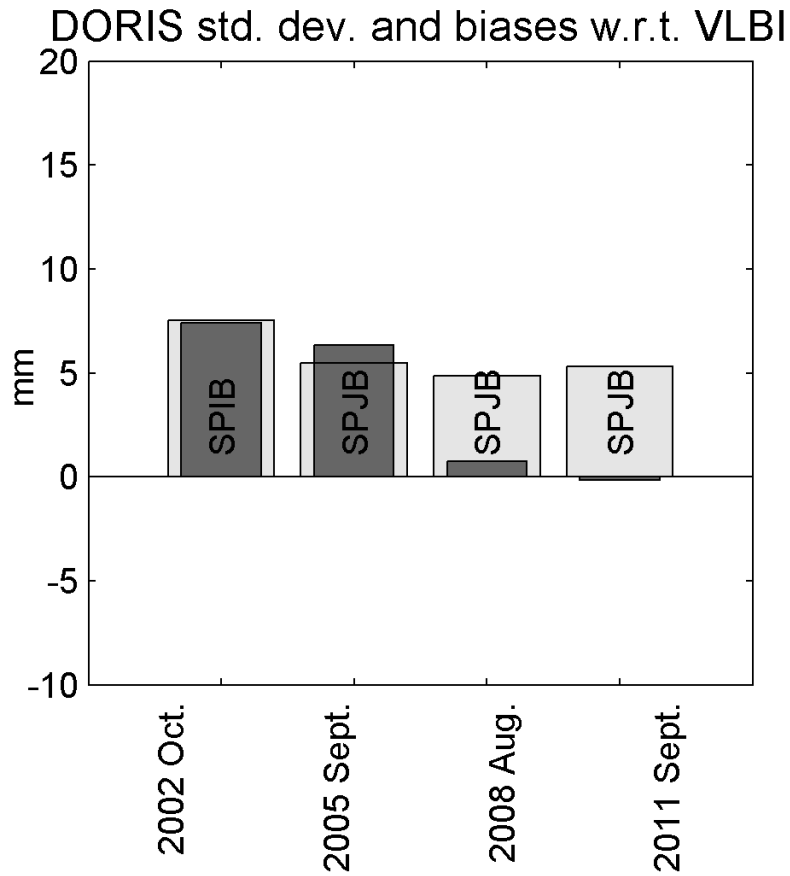

NYALES20 - NYA1 - SPJB
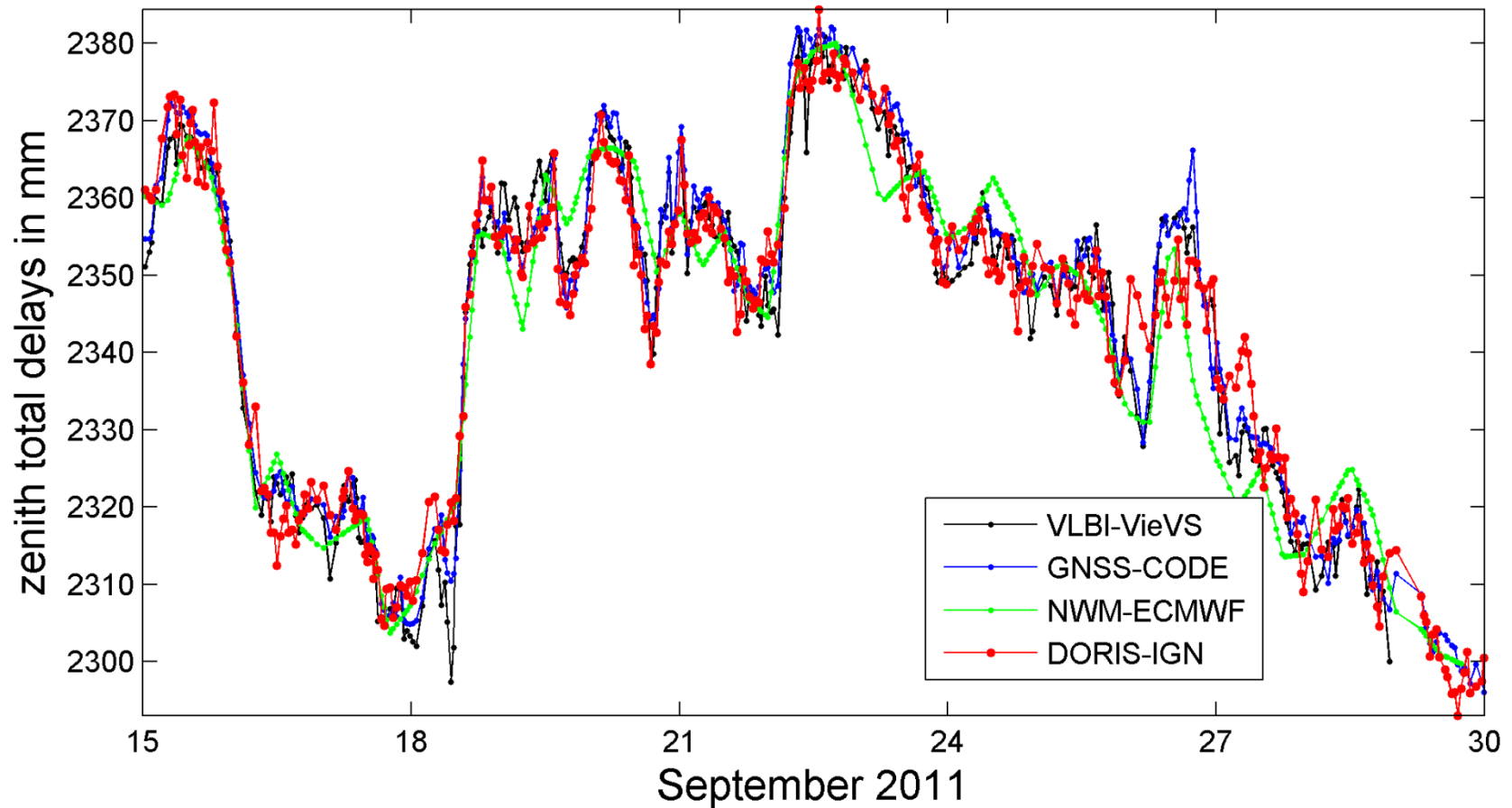
Hartebeesthoek ZTD std. dev. and biases w.r.t. VLBI and GNSS
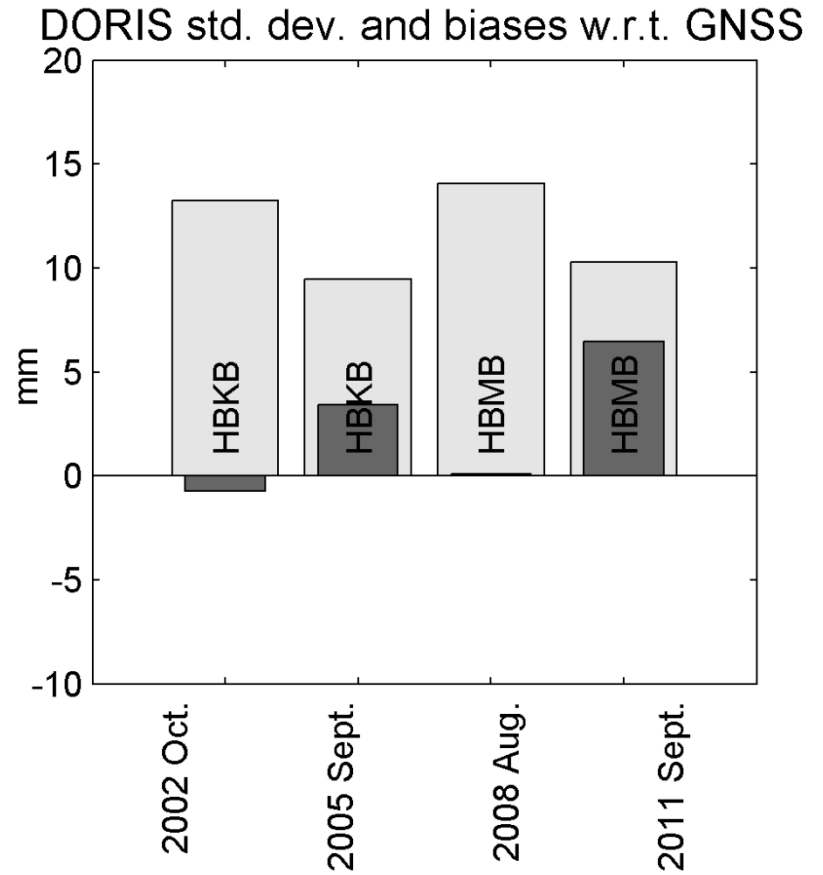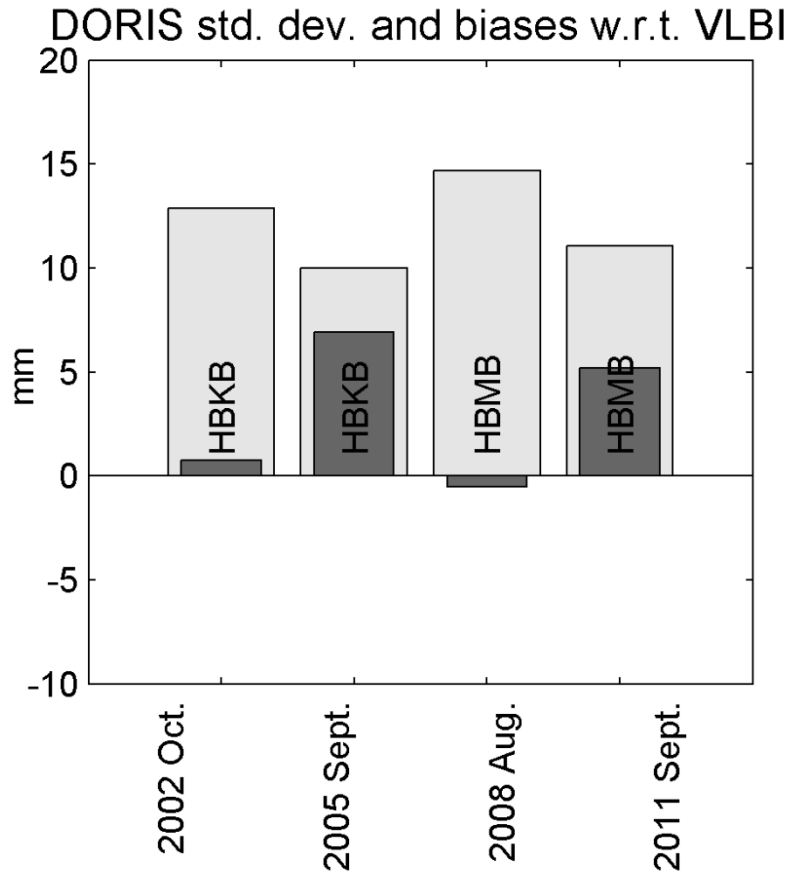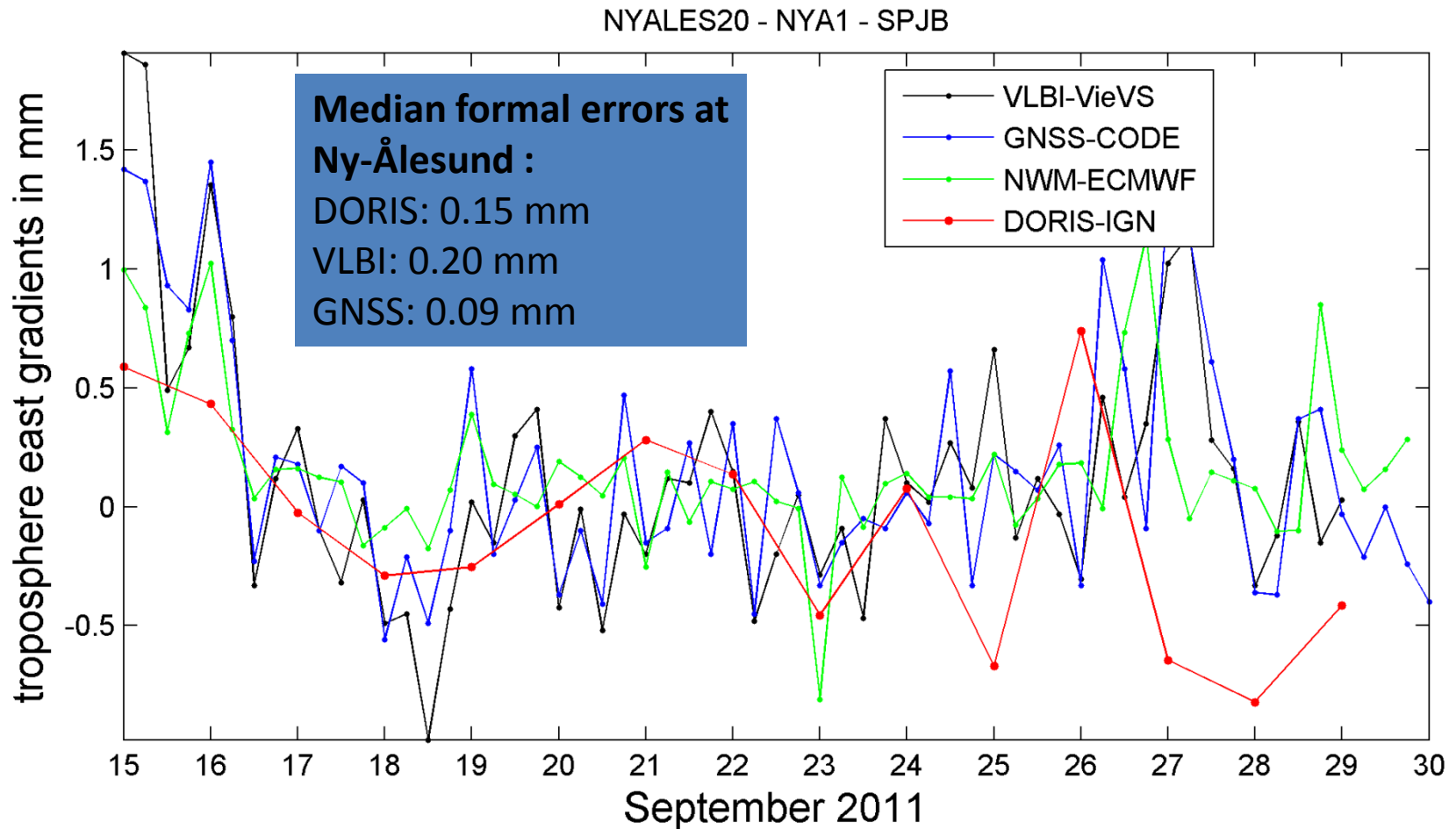
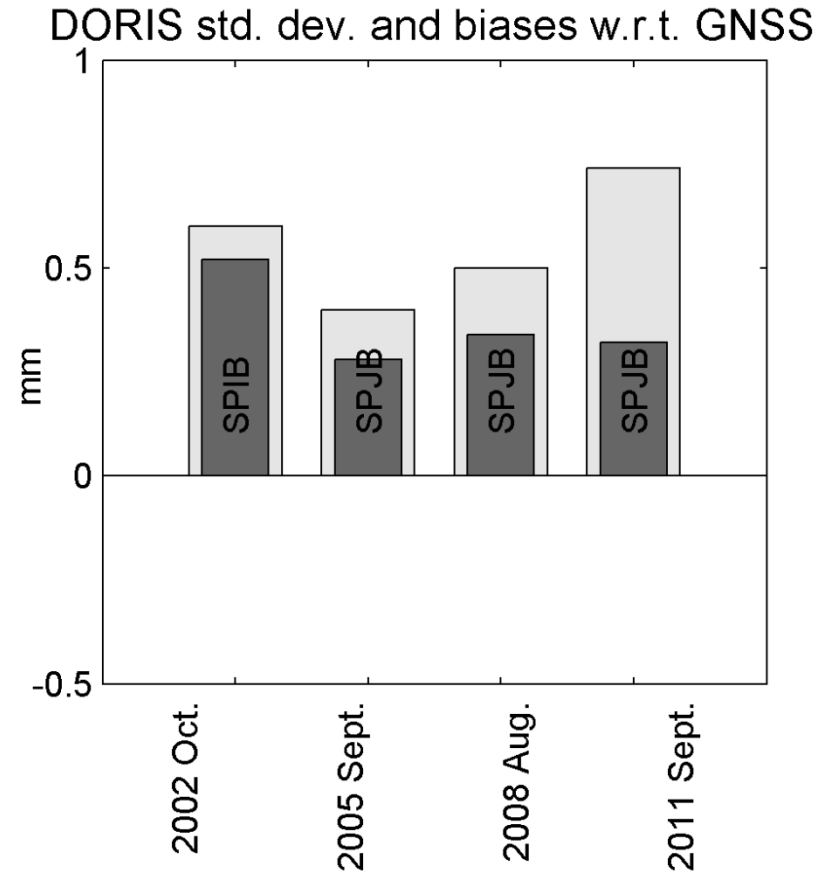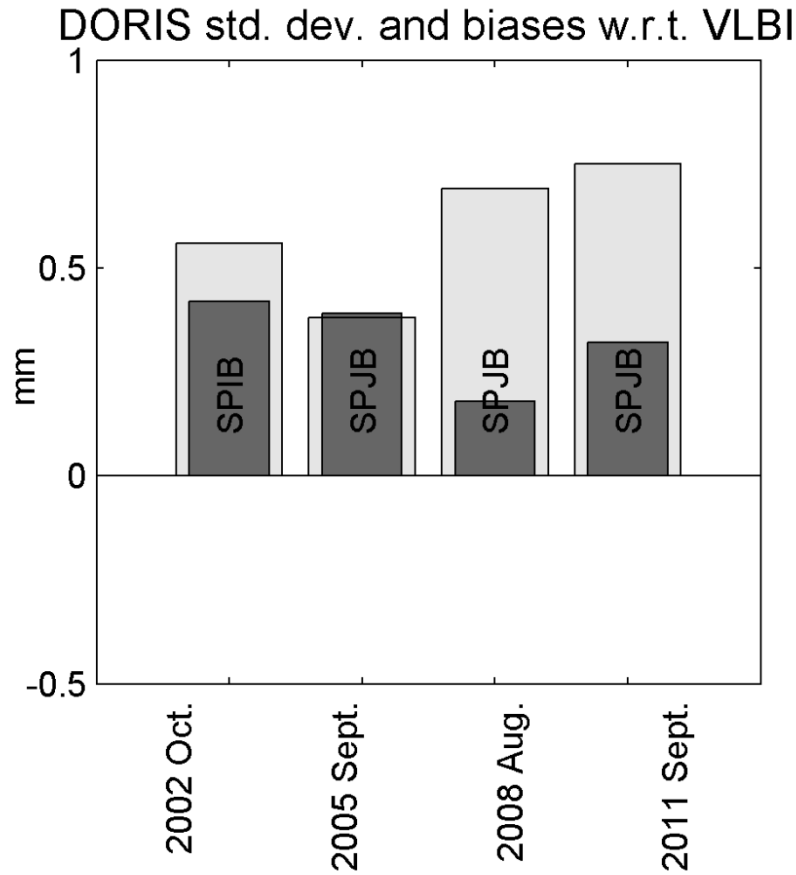# Kokee ZTD std. dev. and biases w.r.t. VLBI and GNSS

Ny-Ålesund ZTD std. dev. and biases
w.r.t. VLBI and GNSS
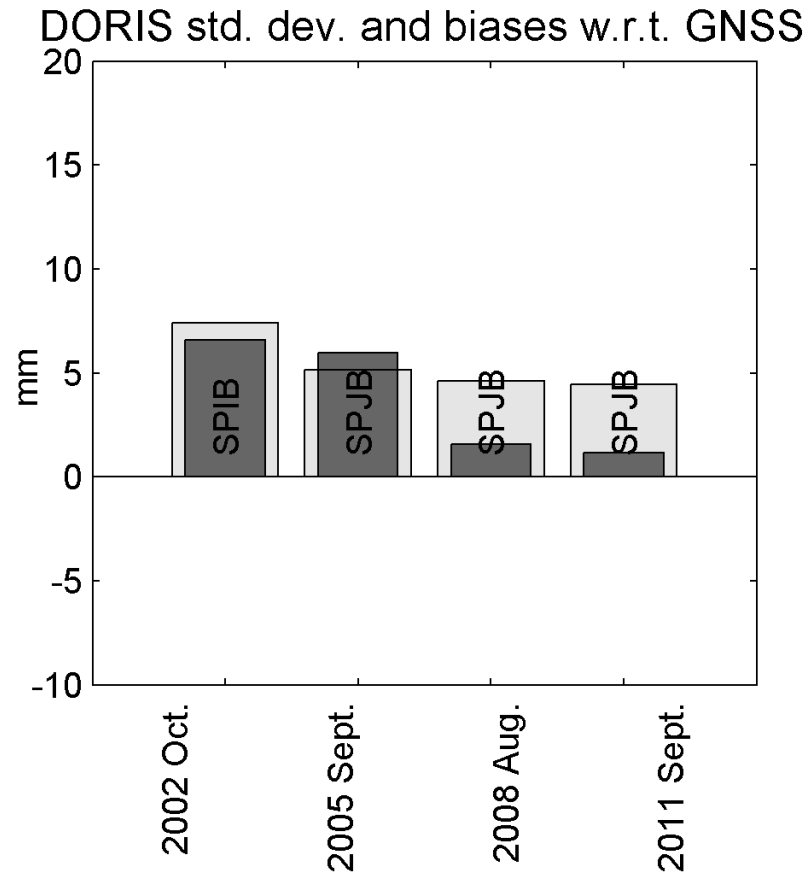
Troposphere east gradients of the co-located site Ny-Ålesund during CONT11

NYALES20 - NYA1 - SPJB

Median formal errors at Ny-Ålesund :
DORIS: 0.15 mm
VLBI: 0.20 mm
GNSS: 0.09 mm

Legend:
- VLBI-VieVS
- GNSS-CODE
- NWM-ECMWF
- DORIS-IGN

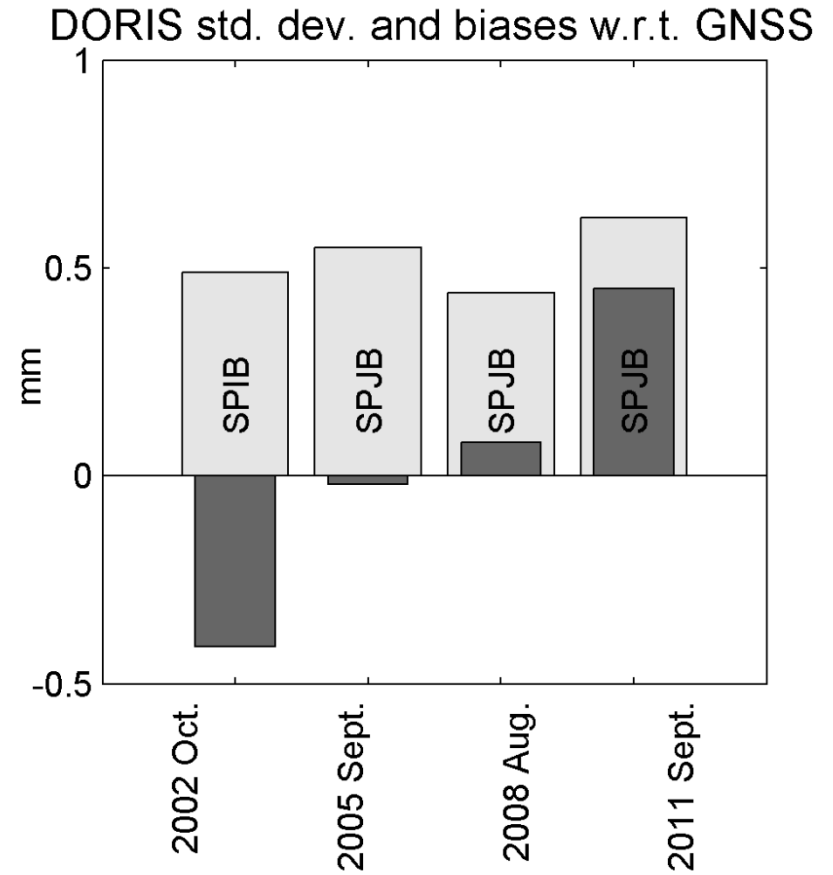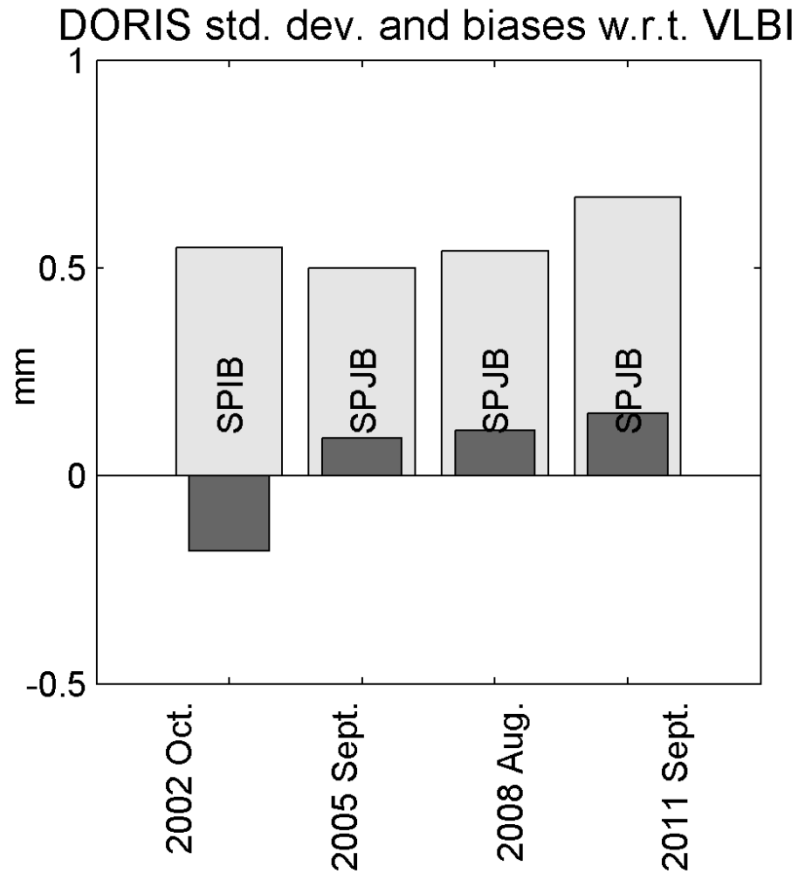y-axis: troposphere east gradients in mm
x-axis: September 2011

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

NYALES20 - NYA1 - SPJB

Median formal errors at Ny-Ålesund :
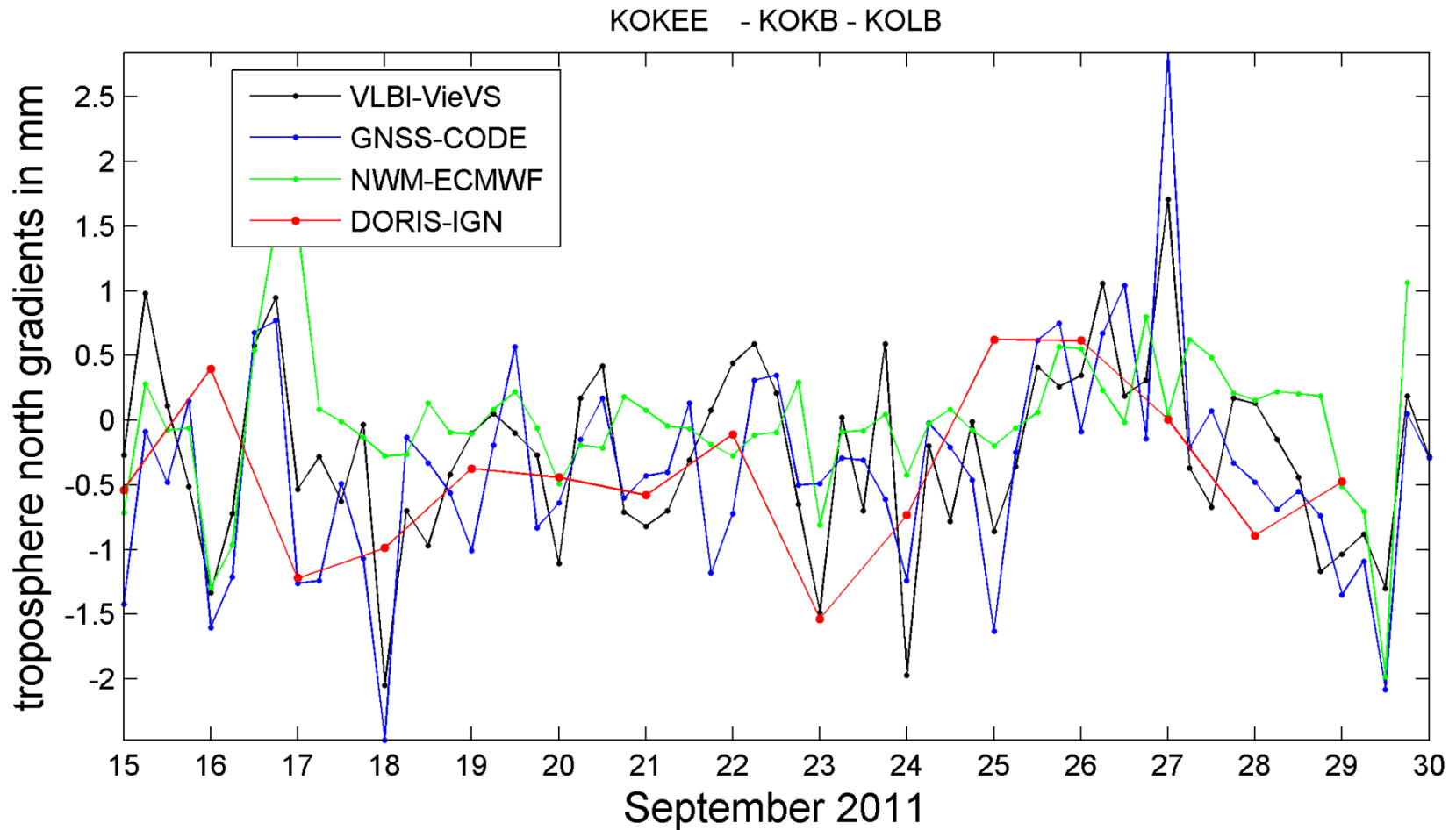DORIS: 0.13 mm
VLBI: 0.23 mm
GNSS: 0.09 mm0
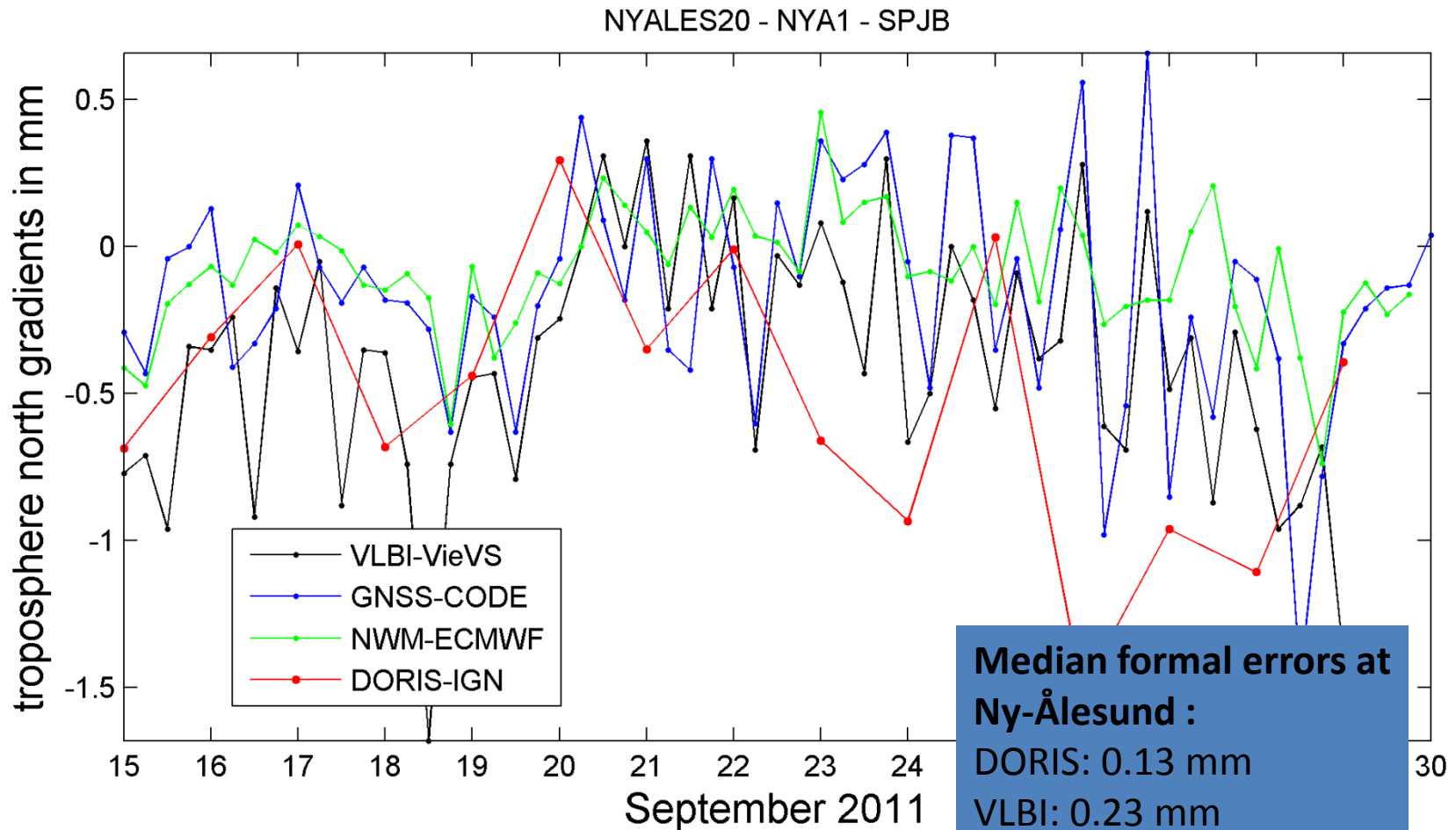
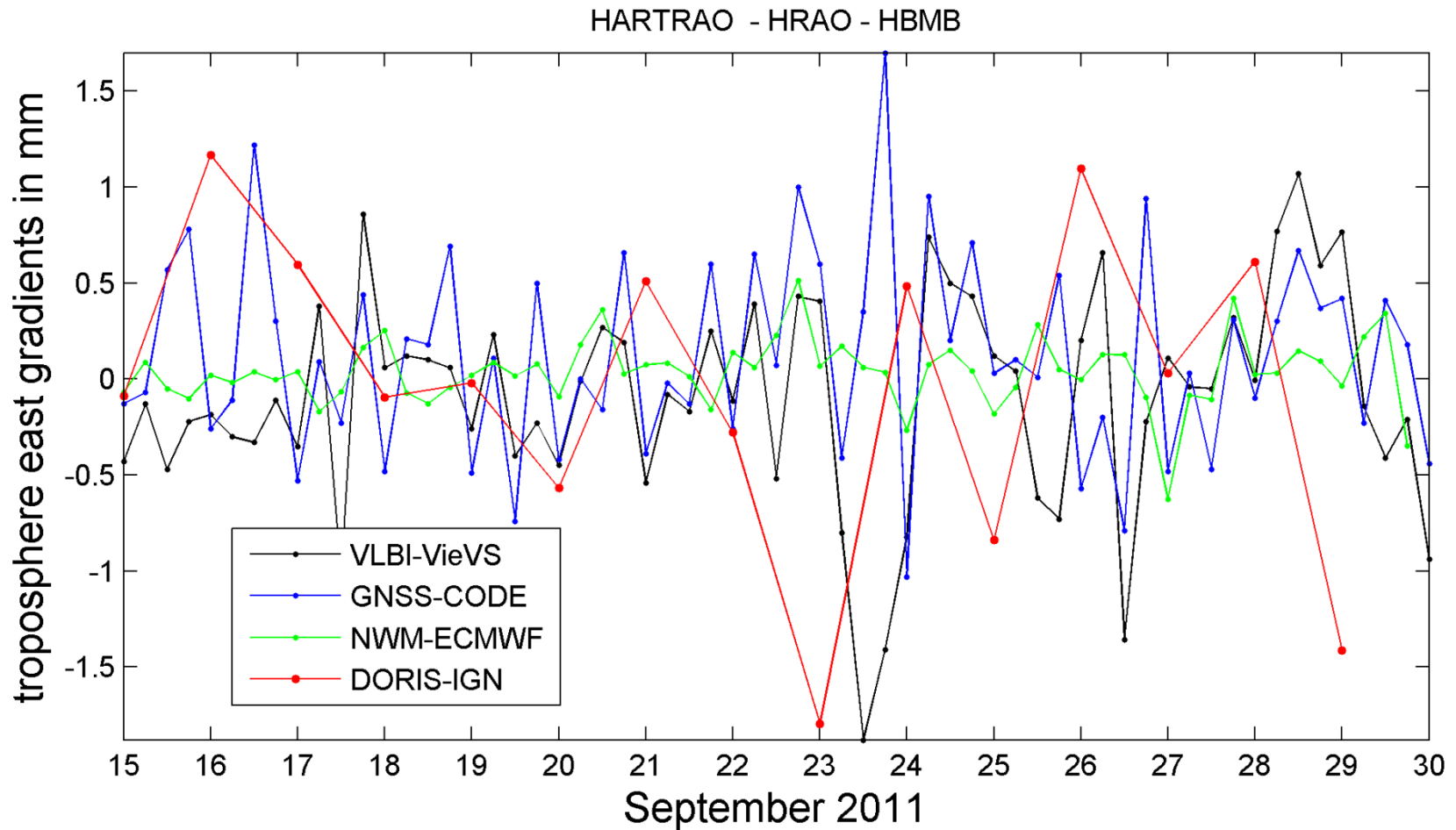# Ny-Ålesund north gradients std. dev. and biases w.r.t. VLBI and GNSS
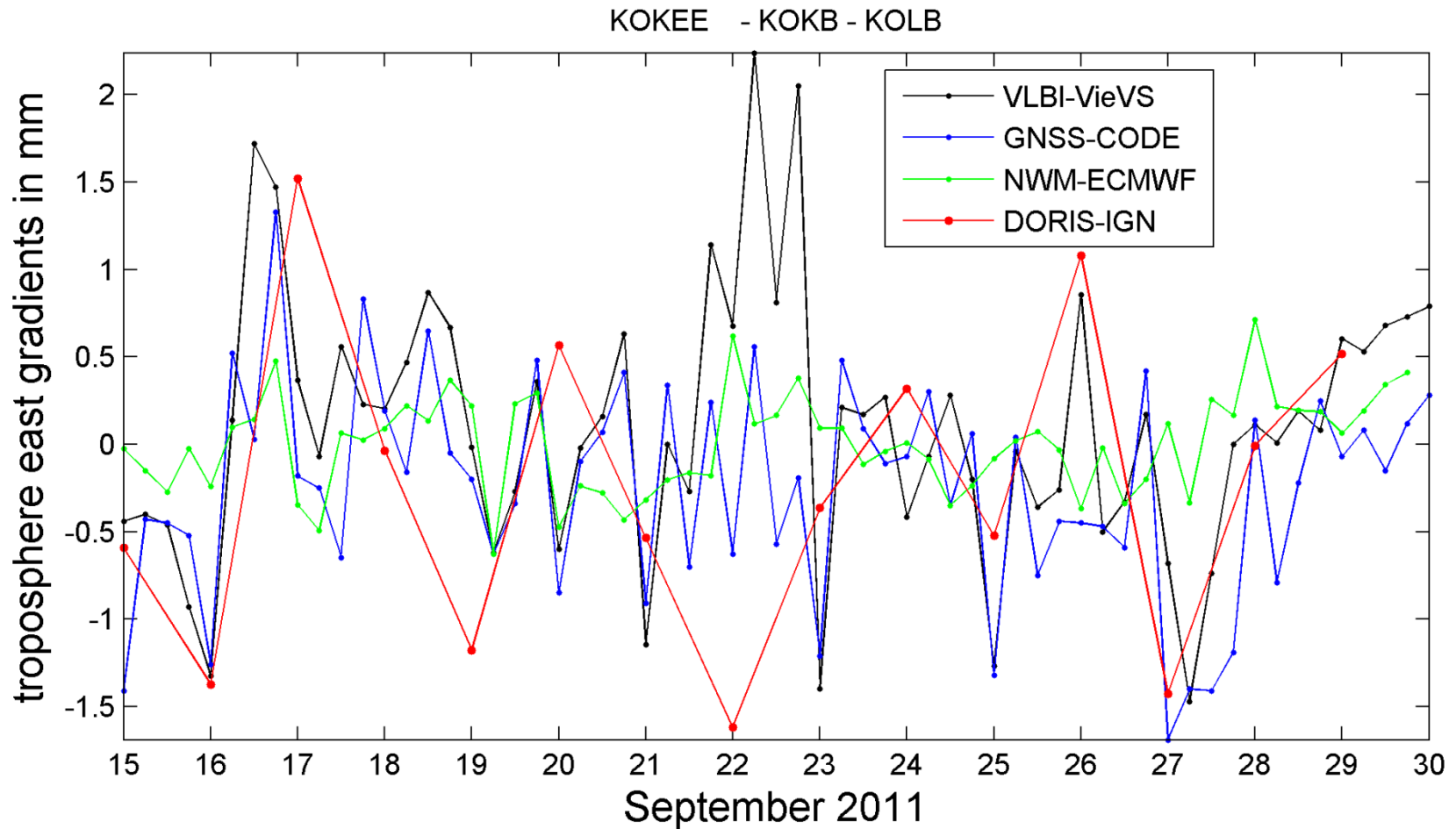
Troposphere east gradients of the co-located site Kokee during CONT11

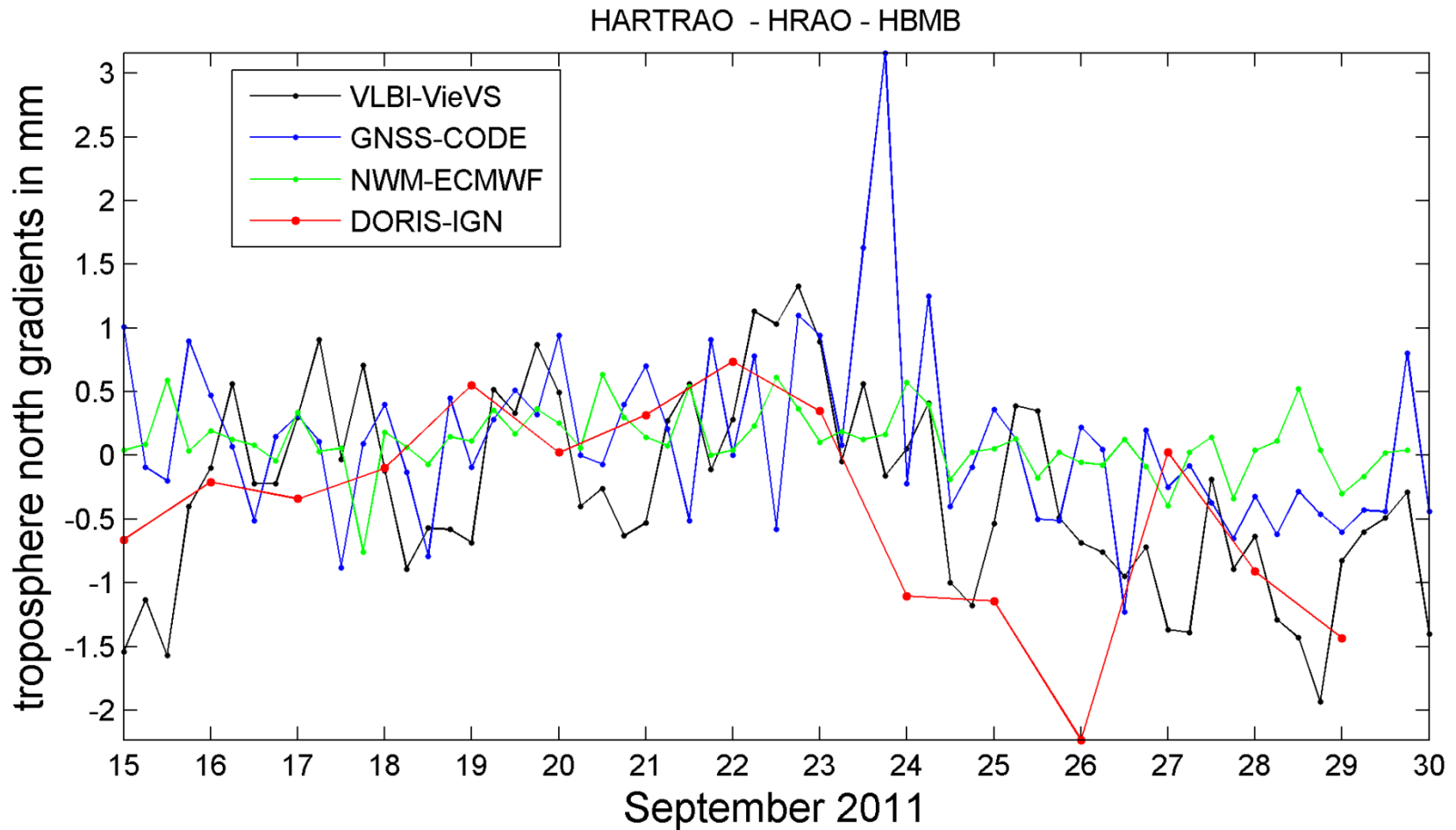# Troposphere north gradients of the co-located site Kokee during CONT11

KOKEE   - KOKB - KOLB

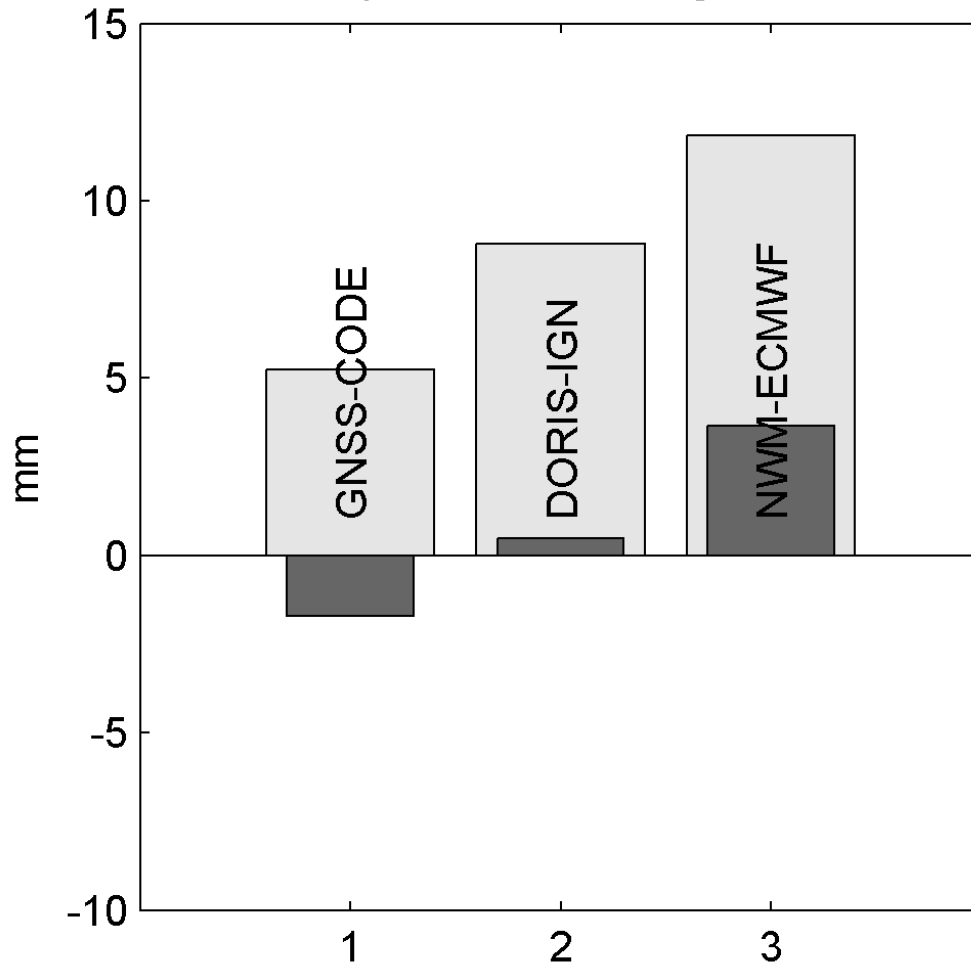# Troposphere east gradients of the co-located site Hartebeesthoek during CONT11

HARTRAO - HRAO - HBMB

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

HARTRAO - HRAO - HBMB

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

Technique-VLBI during CONT11

Total number of common epochs with VLBI during CONT11

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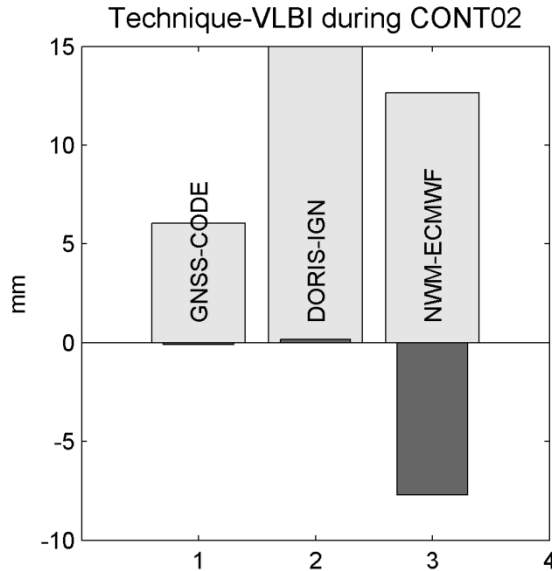DORIS: 917 (BADB)
ECMWF: 906 (BADARY)

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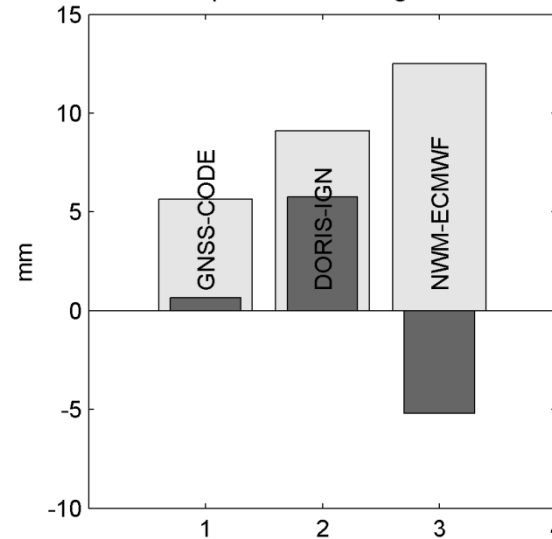

CONT02

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

Number of common epochs with VLBI during CONT05

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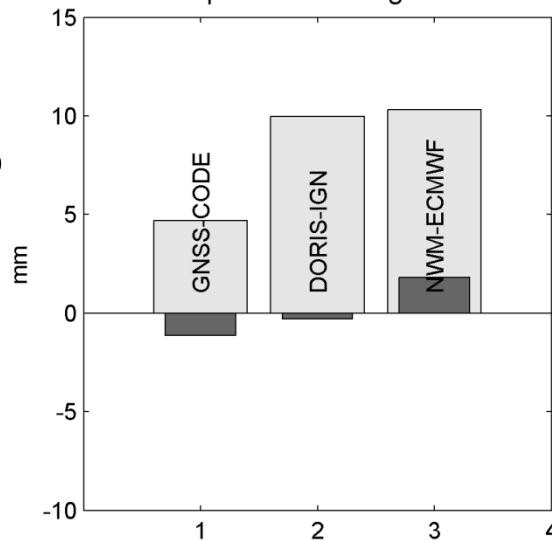SPJB : 350
total: 475

CONT08

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

CONT11

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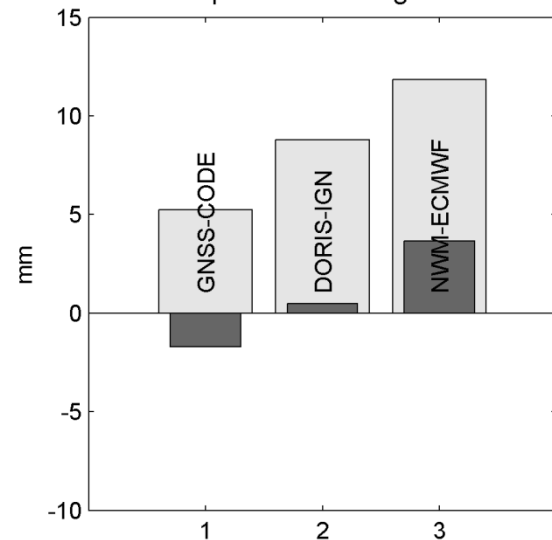
Conclusions

- 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.