On a possible contribution of VLBI to geocenter realization via satellites assessed by simulations

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1 Motivation

Motivation

Currently *DORIS*, *GNSS*, *SLR* and *VLBI* are combined applying **local ties** to construct global terrestrial reference frames

Achieved accuracy of the ITRF 2014

Origin

Accuracy:	3 mm
Stability:	0.2 mm/yr

Scale

Accuracy:	1.37 ppb
Stability:	0.02 ppb/yr

(Altamimi et al. 2016)

Requirements to a TRF on GGOS

Origin

Accuracy:	1 mm
Stability:	0.1 mm/yr

Scale

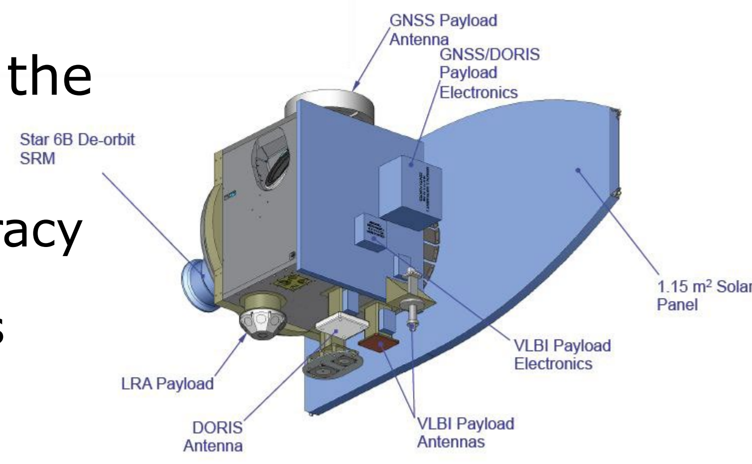
Accuracy:	0.10 ppb
Stability:	0.01 ppb/yr

(Gross et al. 2009)

GGOS-SIM2

DFG Project at GFZ and TU Berlin with the targets:

- Investigation of the global TRF accuracy
- Co-location in space using space ties



Focus of this study:

Geocenter estimates from **VLBI observations to satellites** - *a simulation study*

Geocenter motion: translation motion of the center of network (CN) relative to Earth's center of mass (CM)

GFZ Helmholtz Centre POTSDAM

TU berlin

DFG Deutsche Forschungsgemeinschaft German Research Foundation

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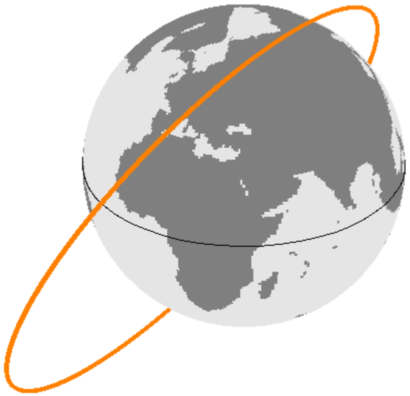
Strategy

Data

Orbit integration

	Perigee [km]	Apogee [km]	Inclination [°]	Eccentricity
LEO Sat.	762	7472	63.4	0.32



Network configuration

- **Network A :** 14 Stations, weakly distributed observation network, V = 0.21 Mm^3
- **Network B :** 15 Stations, globally well distributed observation network, V = 0.56 Mm^3

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Data

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Data

Geophysical loading models

Non-tidal atmospheric, oceanic and hydrological loadings:

- have been consistently derived,
- conserve the global mass, and
- have been successfully tested in GNSS and VLBI data analysis (e.g., Männel et al. 2019)

Products generated by the Earth-System-Modeling group GFZ (ESMGFZ) (Dill and Dobslaw 2013)
(https://isdc.gfz-potsdam.de/esmdata/loading/)

Scheduling

- Daily sessions
- Time span: January 2008 – December 2009
- Observation time: 1 min
- Only spacecraft observations

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- Different geophysical models + white noise
- 10 different scenarios (5 geophysical models × 2 station networks)

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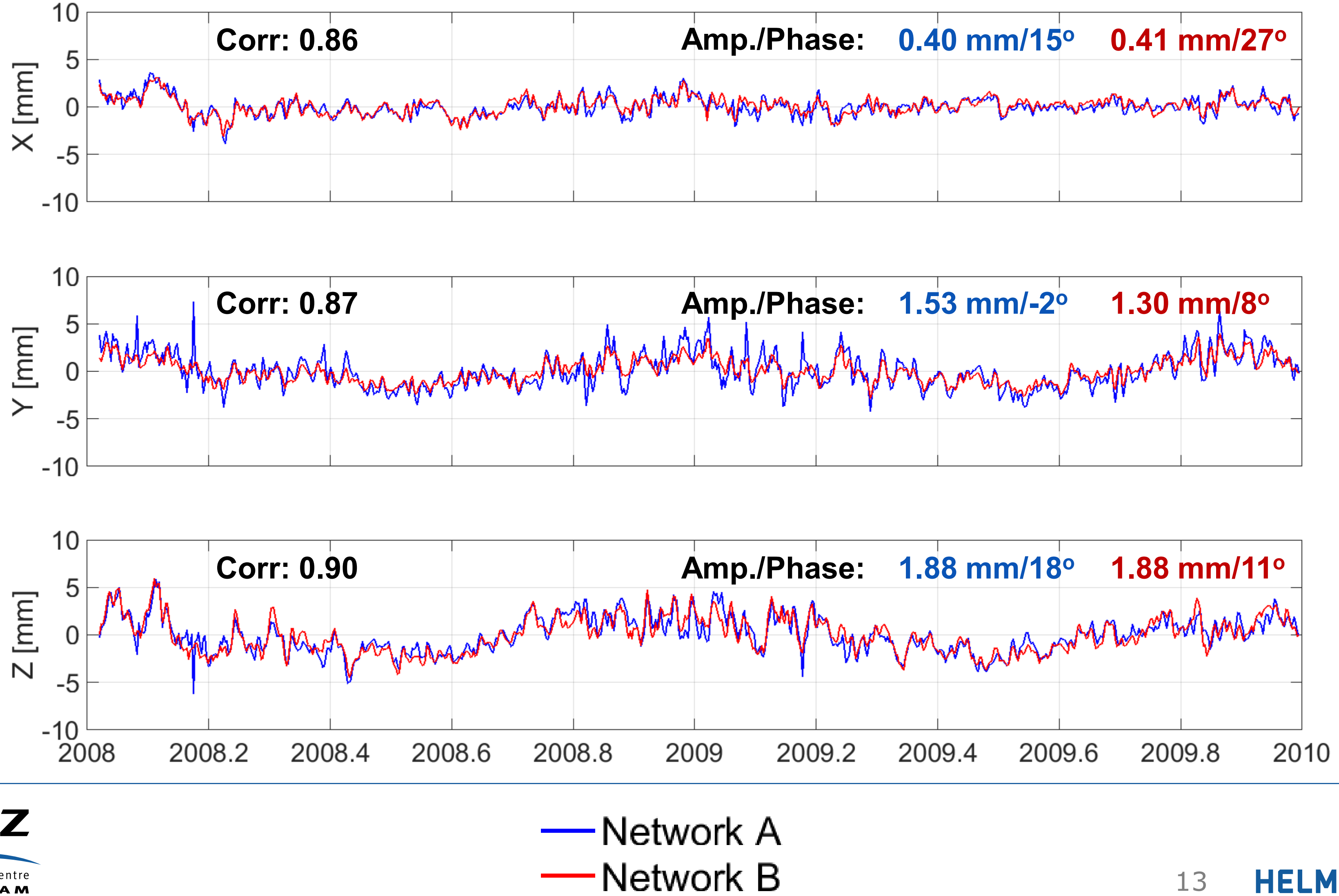
Estimation

- Station coordinates, troposphere, clock, **geocenter coordinates**

3 Results

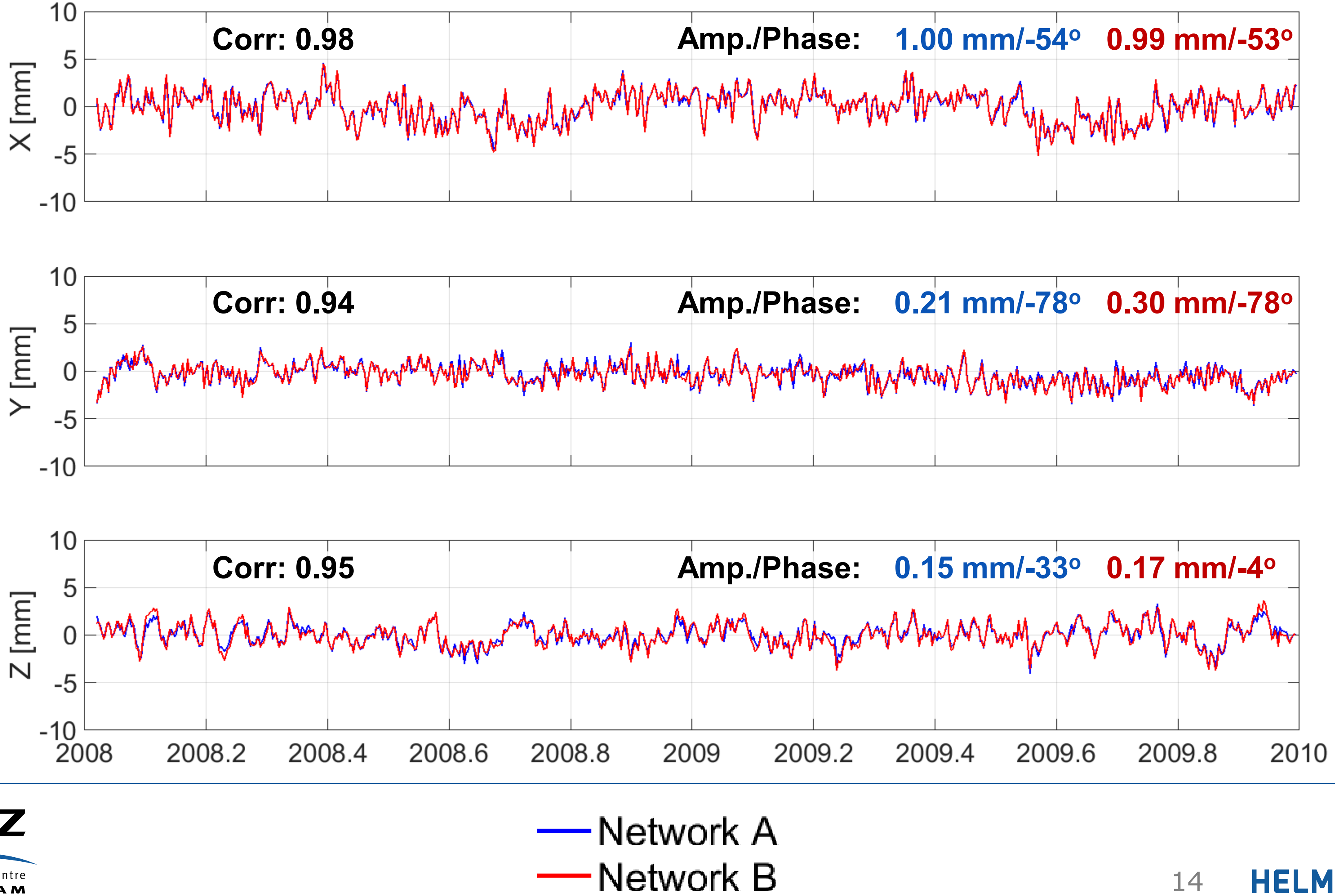
Non-tidal atmospheric loading

- Difference between two networks – 4.3 mm in Y component



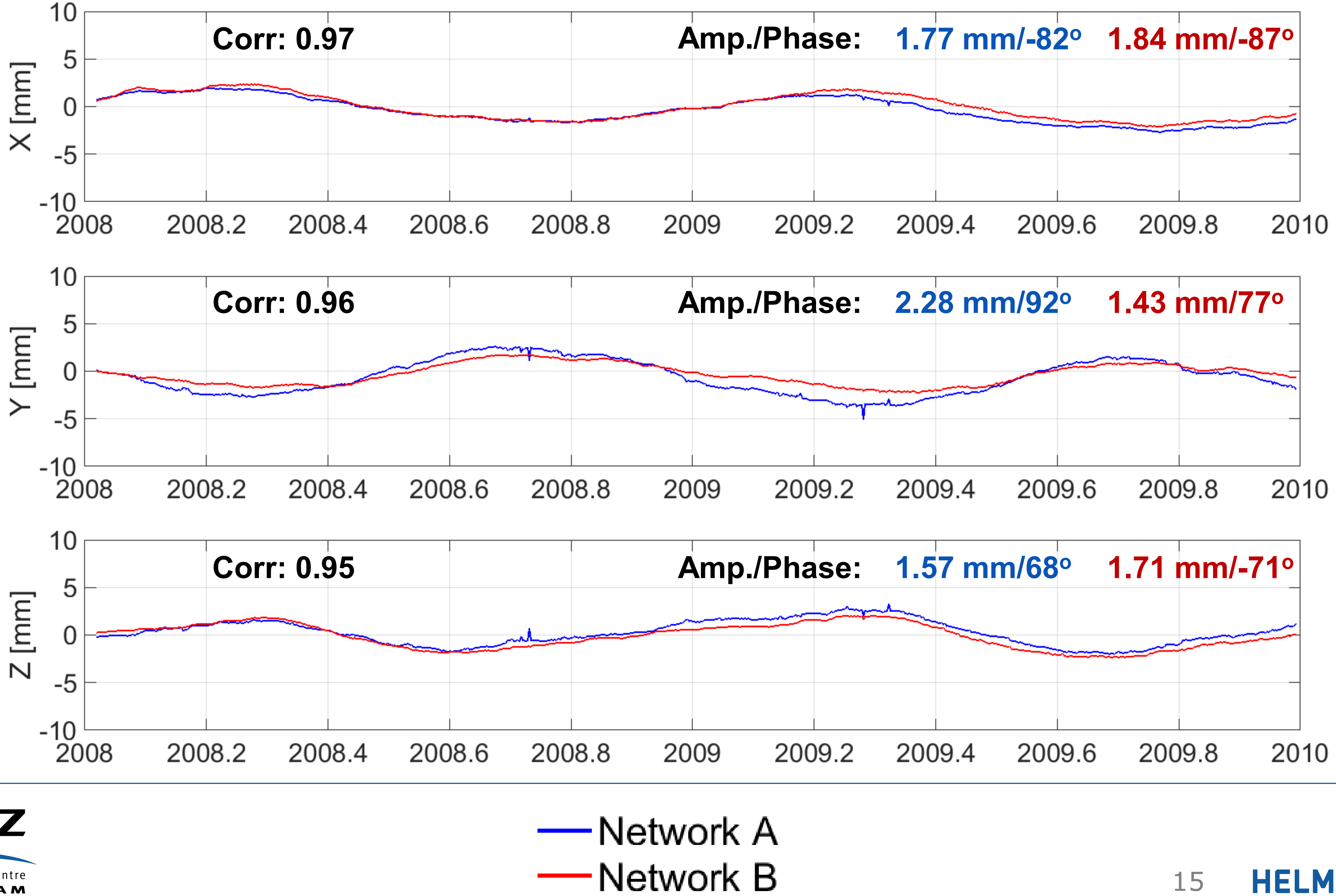
Non-tidal oceanic loading

- Difference between two networks < 1.5 mm for all components



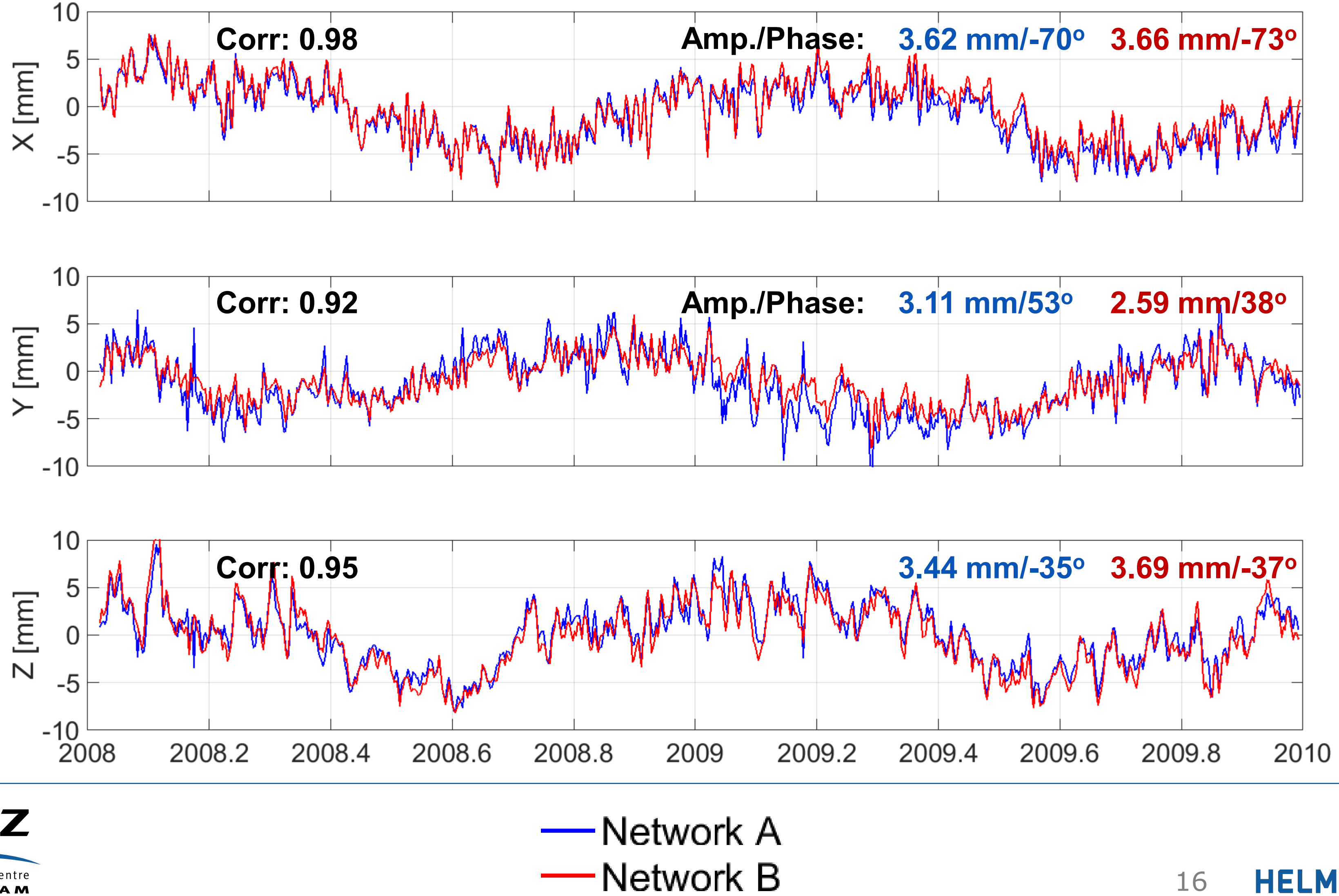
Hydrological loading

- Difference between two networks – 1.5 mm in Y component



Total non-tidal loadings

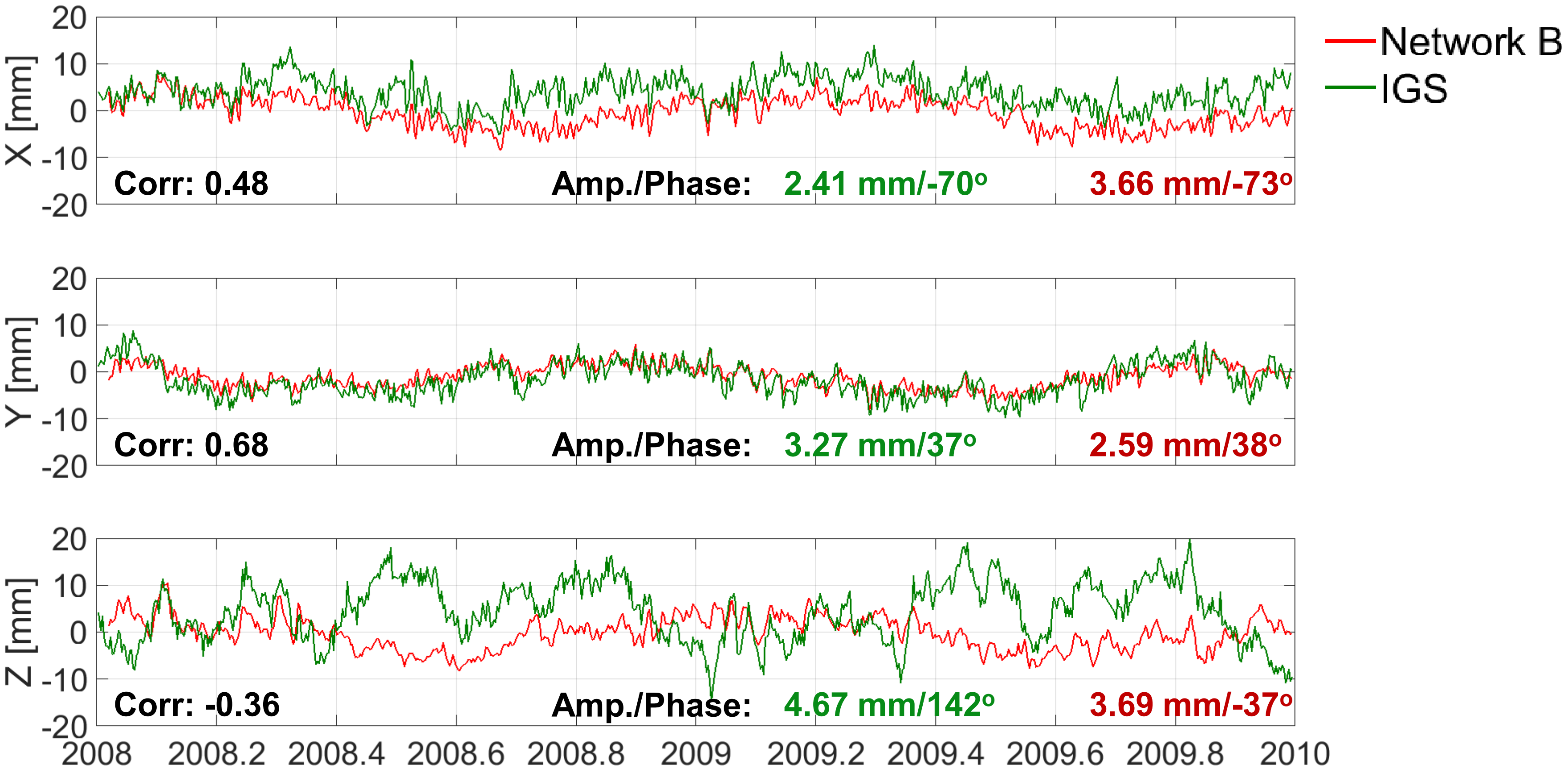
- Difference between two networks – up to 5.5 mm



4 Comparison

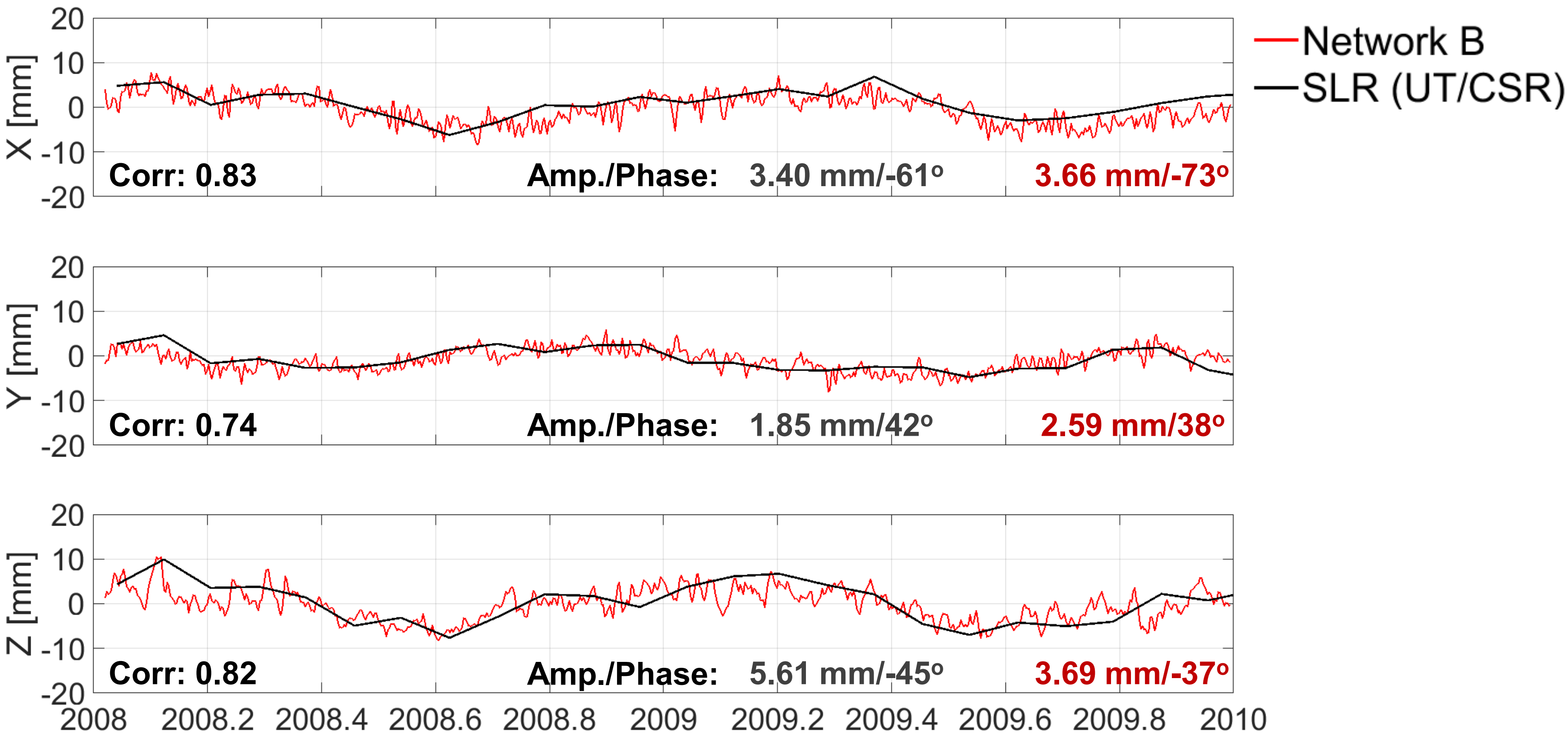
Simulation vs. IGS

Geocenter coordinates from the IGS contribution to ITRF2014
(Rebischung et al. 2016)



Simulation vs. SLR

UT/CSR monthly geocenter estimates from the analysis of SLR observations (Cheng et al. 2013)



5 Conclusion

Conclusion

- VLBI's capability to determine geocenter explored via simulations to LEO satellite, utilizing non-tidal loading models
  - VLBI to LEO satellite observations have been scheduled and simulated for two different station networks
  - Station network affects geocenter estimation up to 5 mm
  - Effects of the geophysical loading models:
    - Non-tidal atmospheric loading : to Y and Z components
    - Non-tidal oceanic loading : to X component
    - Hydrological loading : to all components
  - Total impact of the loadings can reach up to 12 mm
- Good agreement with real data:
  - SLR (UT/CSR) : in all components
  - GNSS (IGS combined) : in X and Y components

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Thanks for your attention!

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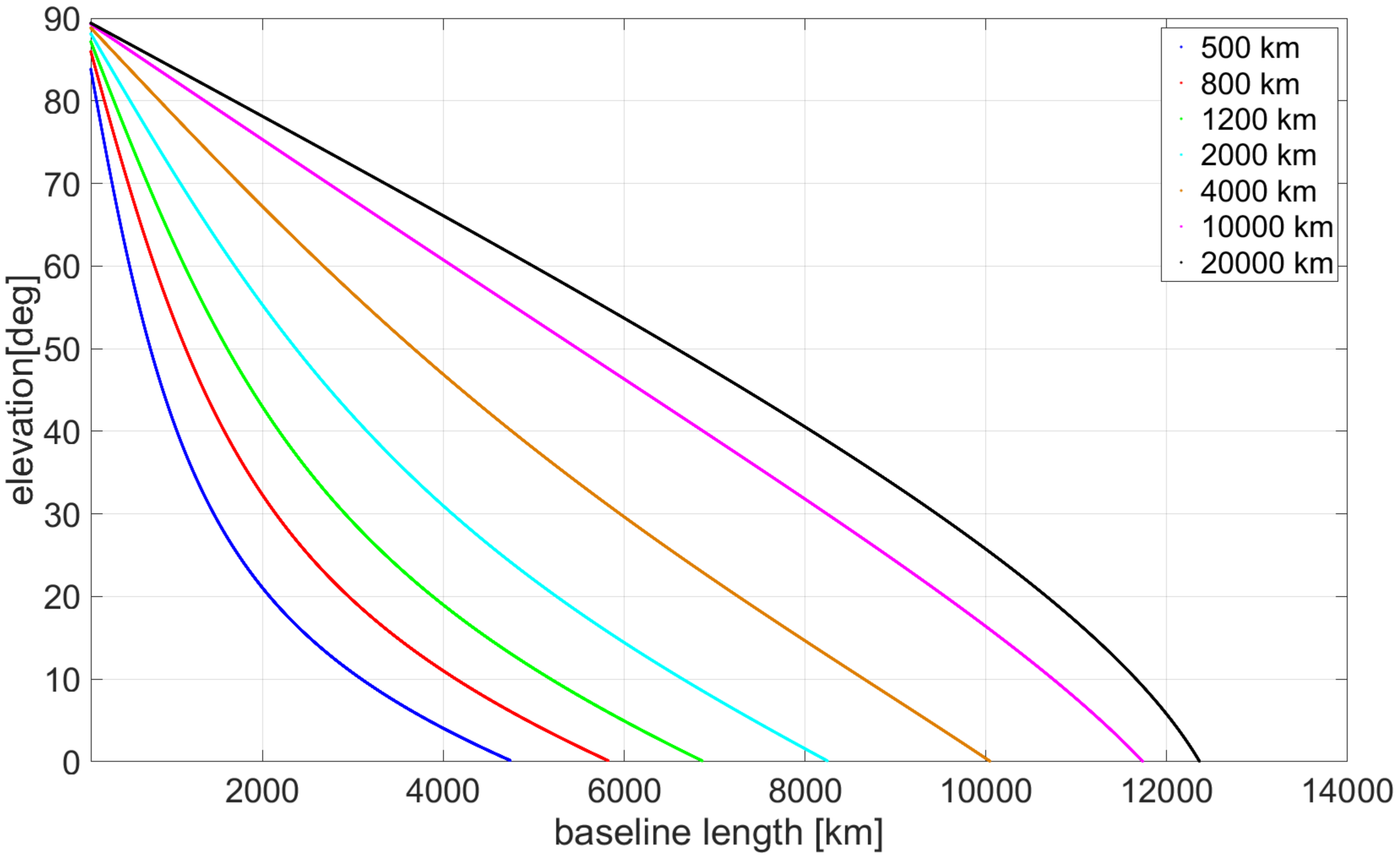
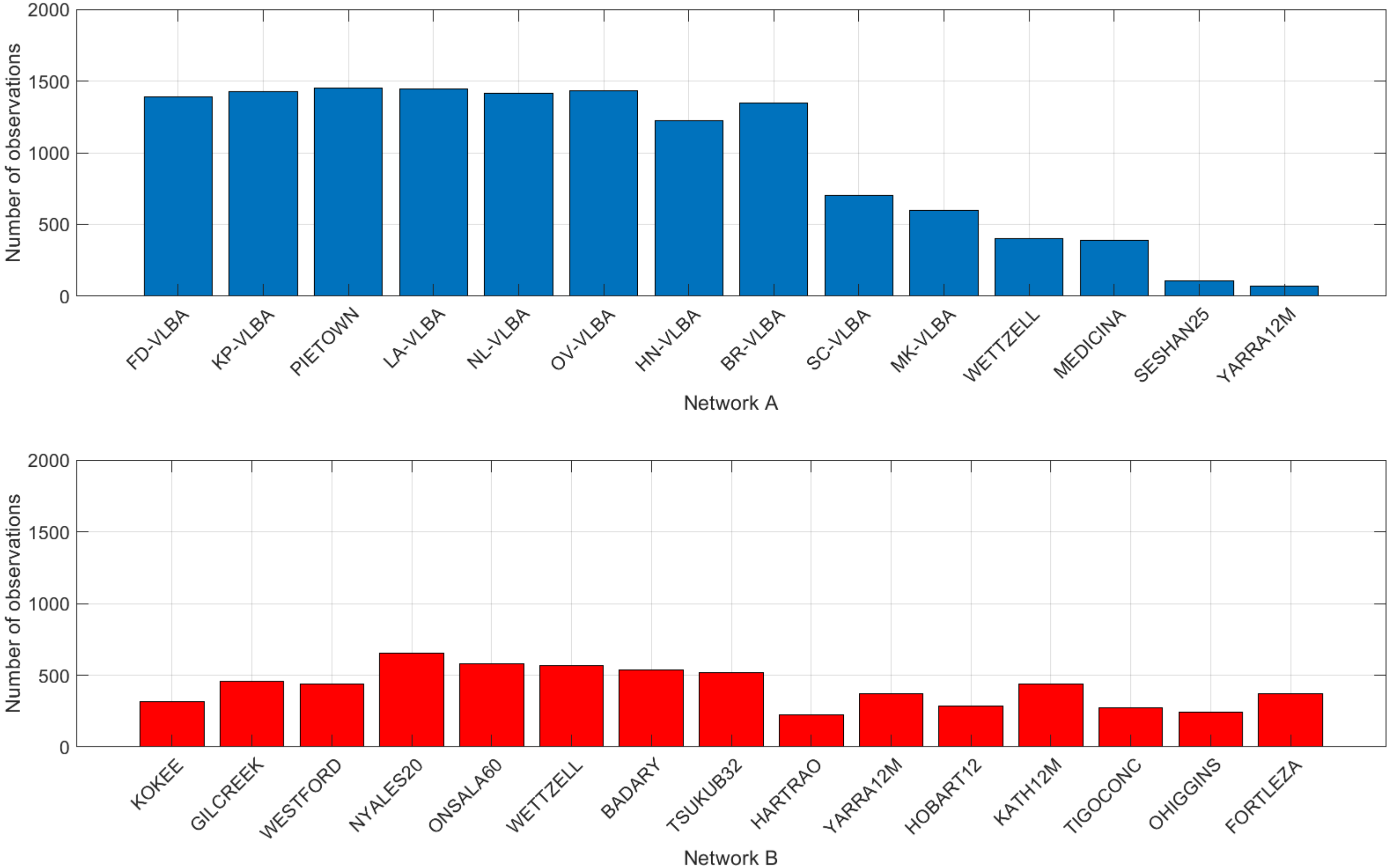
Backup

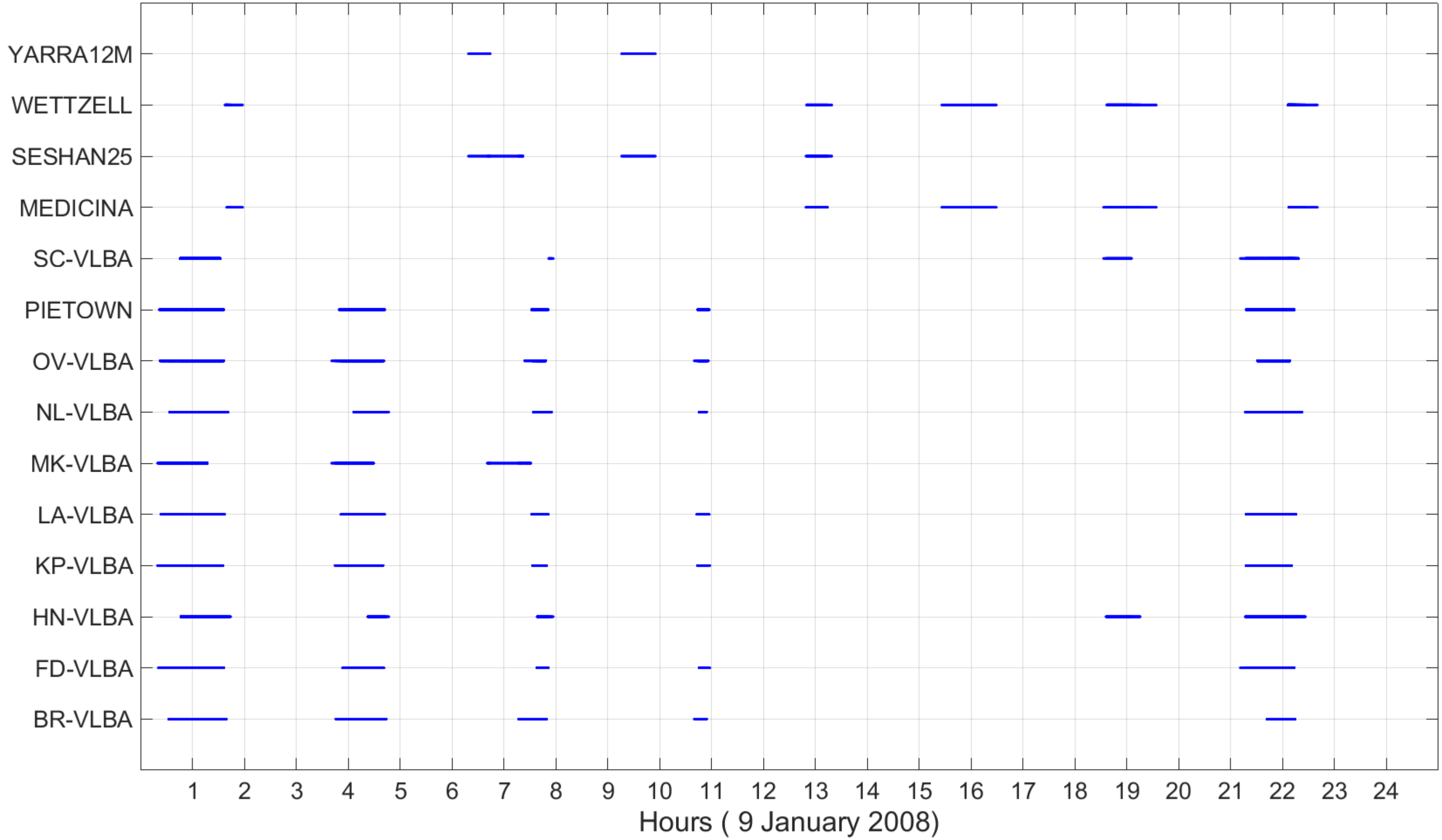
Common visibility of satellite



Number of observations



Satellite observations of Network A



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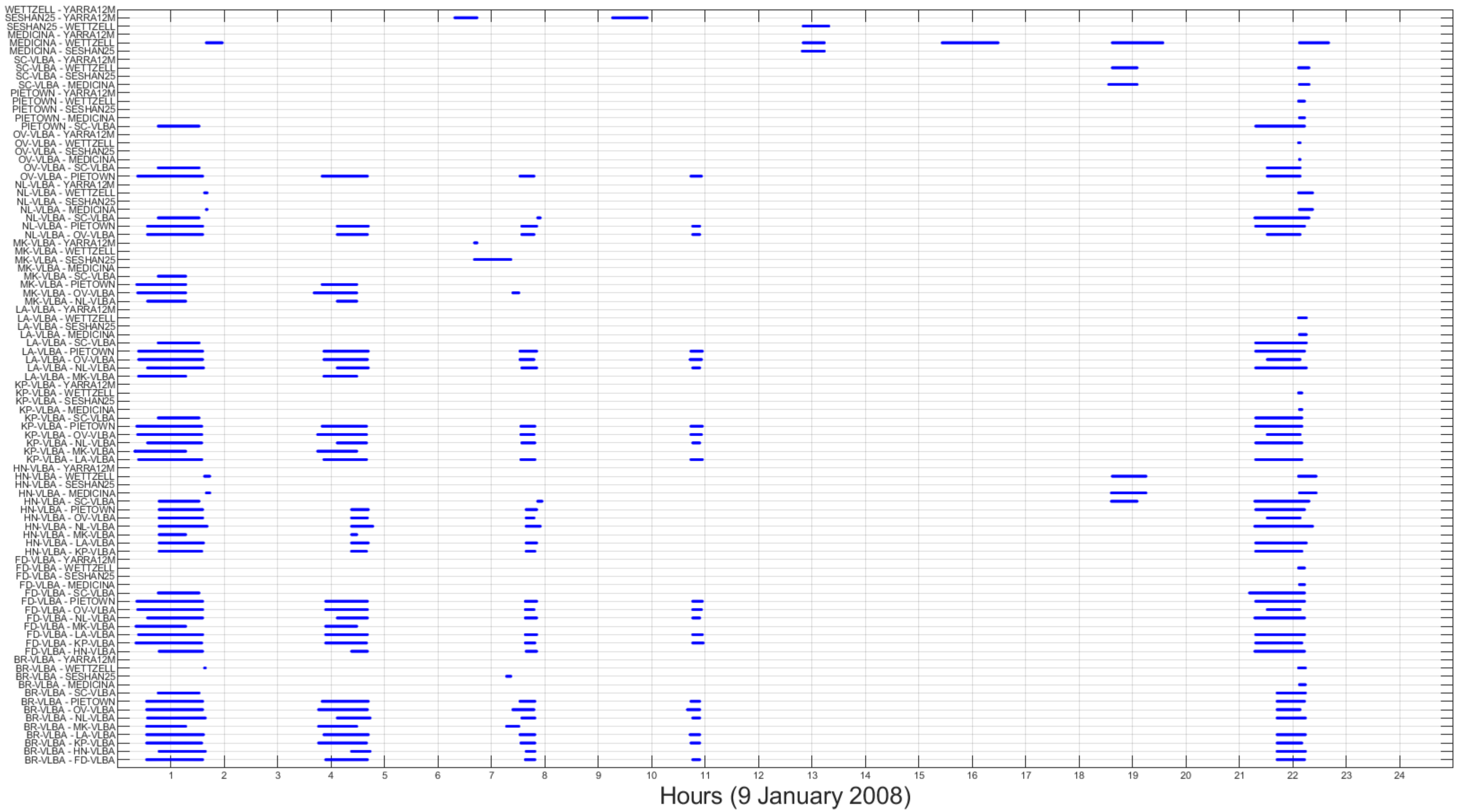
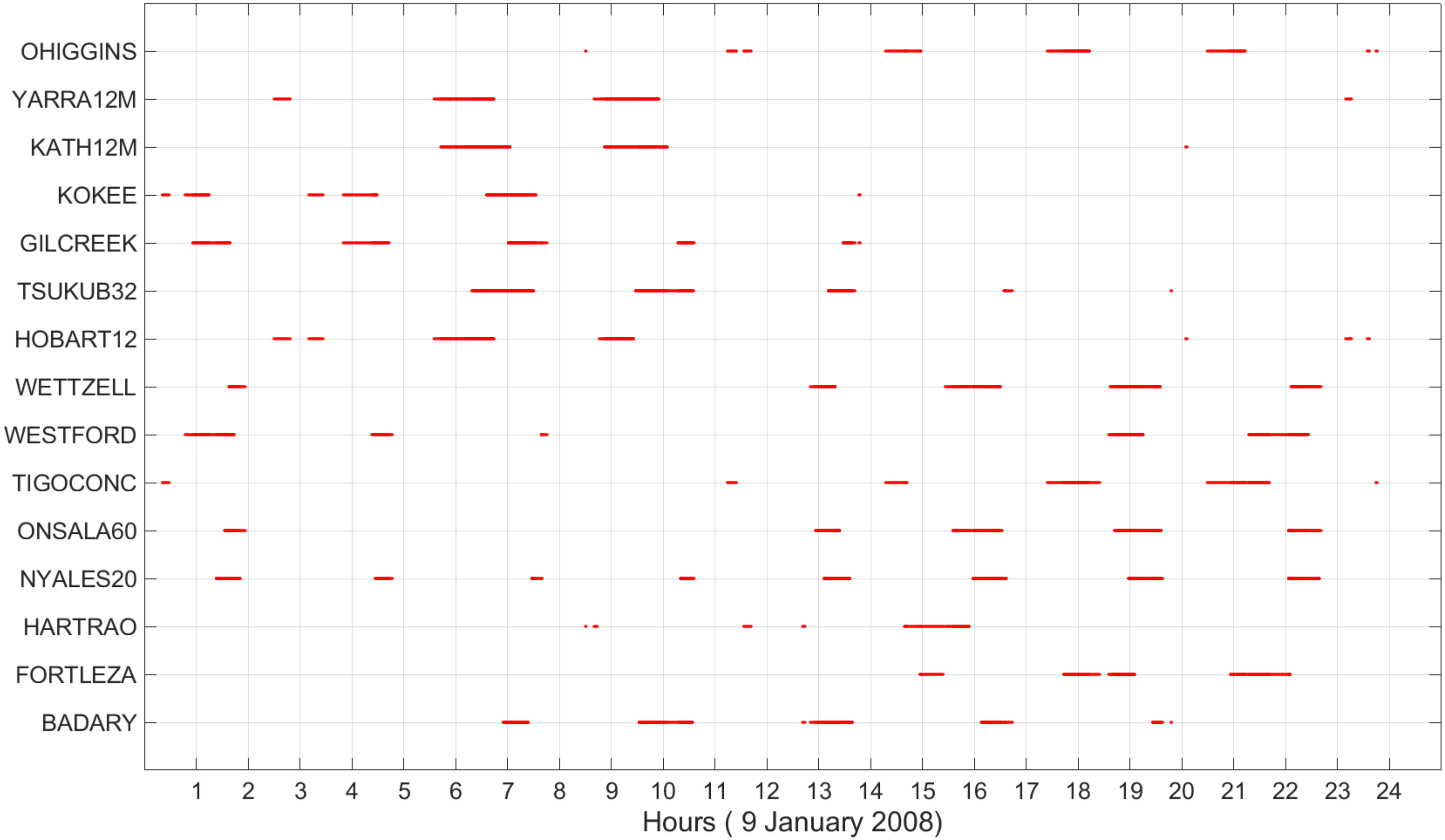
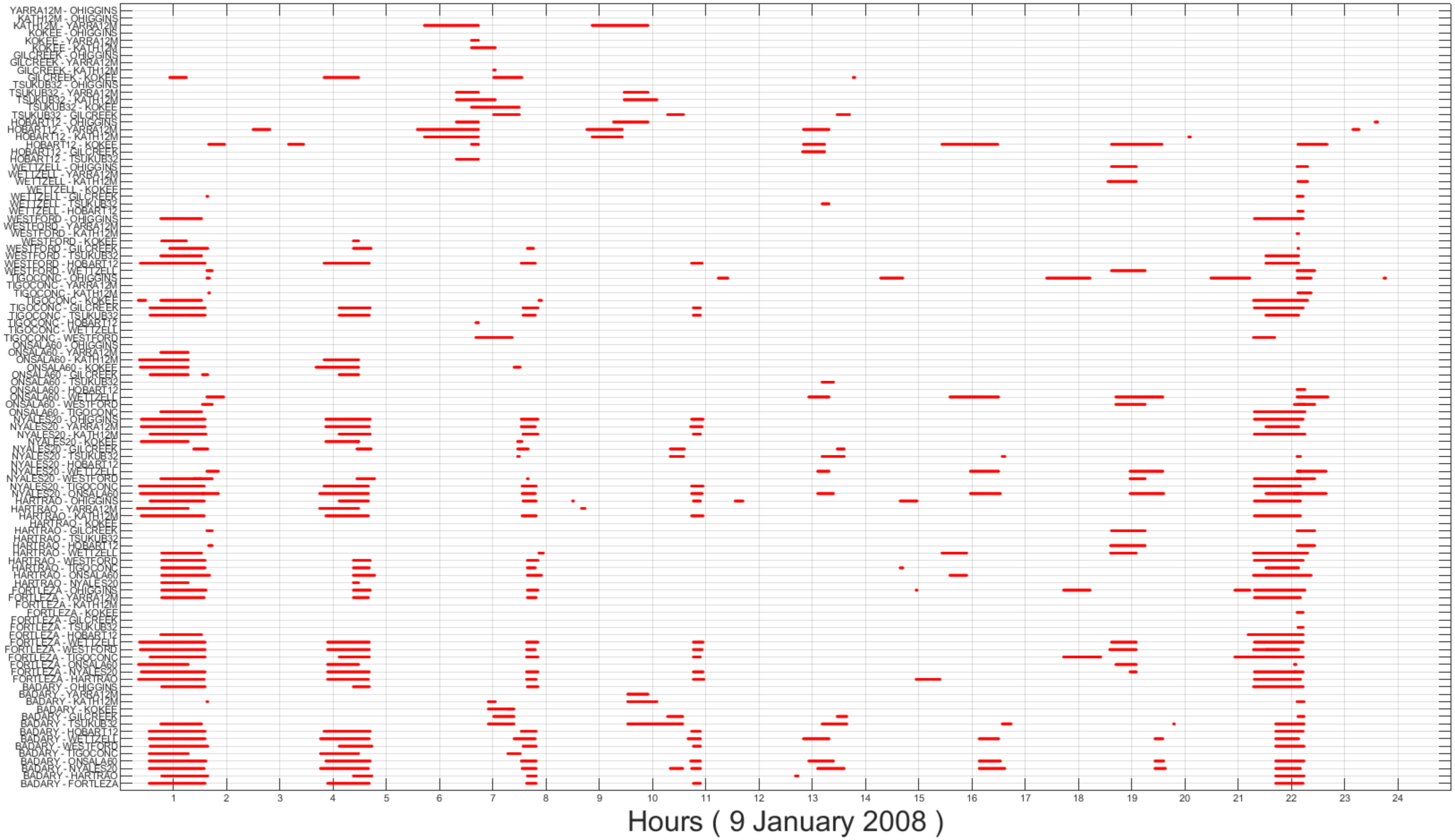


Satellite observations of Network B



Satellite observations of Network B



Sea level loading

- Calculated from daily barystatic sea-level variations