TUM

VLBI Analysis with DOGS-RI at DGFI-TUM

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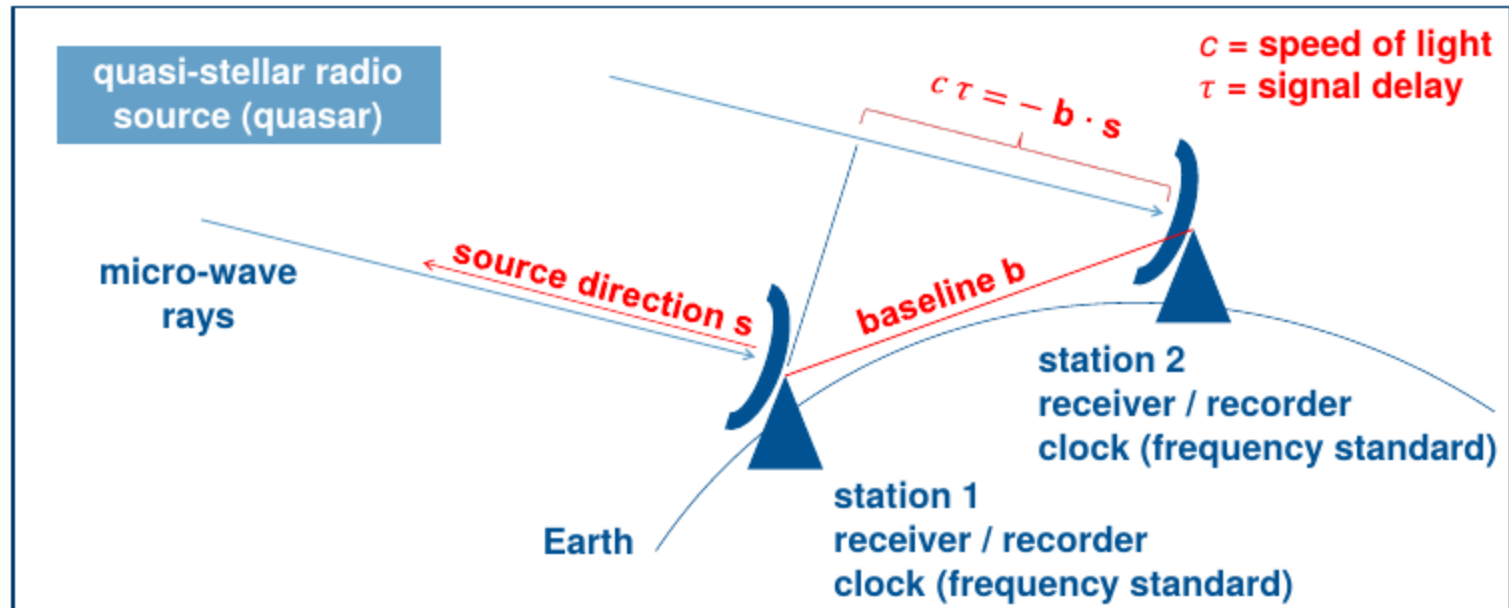Frankfurt a.M., Germany, October 16-18, 2018

Outline

- Introduction (VLBI, DGFI-TUM)

- VLBI analysis software DOGS-RI

- Comparison of solutions

- Impact of distinct geophysical models

- Summary

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Introduction:
Very Long Baseline Interferometry (VLBI)

- Estimation of geodetic parameters from simultaneous observations of extragalactic radio sources by multiple telescopes.

Introduction:
Very Long Baseline Interferometry (VLBI)

- With the theoretical delay model, we can estimate (among others):

  - the Terrestrial Reference Frame (station coordinates and velocities)

  - the Celestial Reference Frame (source coordinates)

  - the complete set of Earth Orientation Parameters (EOP)

- Global coordination of VLBI experiments, distinct member institutes and data transfer is provided by the International VLBI Service for Geodesy and Astrometry (IVS).

- VLBI experiments (mostly 1h or 24h sessions) are conducted several times a week.
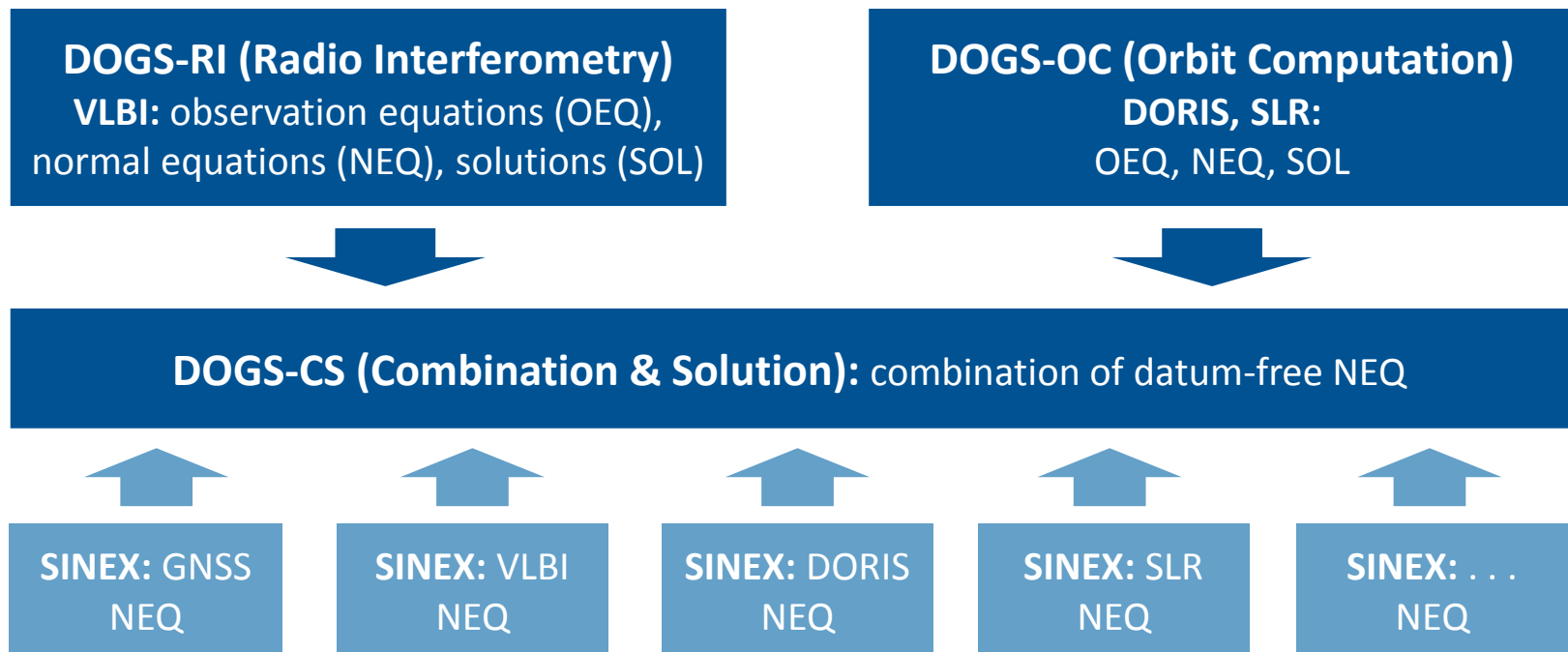
Introduction:
VLBI at DGFI-TUM

- The Deutsches Geodätisches Forschungsinstitut at Technische Universität München (DGFI-TUM) is a fully operational IVS Analysis Center.

- In this respect, we have to regularly provide station and source coordinates and EOP as estimated from the various VLBI experiments to the IVS (in terms of normal equations of the Gauss-Markov model).

- We have developed a proprietary VLBI analysis software called DOGS-RI (DGFI Orbit and Geodetic parameter estimation Software, Radio Interferometry component).

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DOGS-RI: the VLBI analysis tool at DGFI-TUM

- DOGS-RI is part of the DGFI Orbit and Geodetic parameter estimation Software (DOGS) package written in Fortran:

DOGS-RI (Radio Interferometry)
VLBI: observation equations (OEQ), normal equations (NEQ), solutions (SOL)

DOGS-OC (Orbit Computation)
DORIS, SLR:
OEQ, NEQ, SOL

DOGS-CS (Combination & Solution): combination of datum-free NEQ

SINEX: GNSS
NEQ

SINEX: VLBI
NEQ

SINEX: DORIS
NEQ

SINEX: SLR
NEQ

SINEX: . . .
NEQ

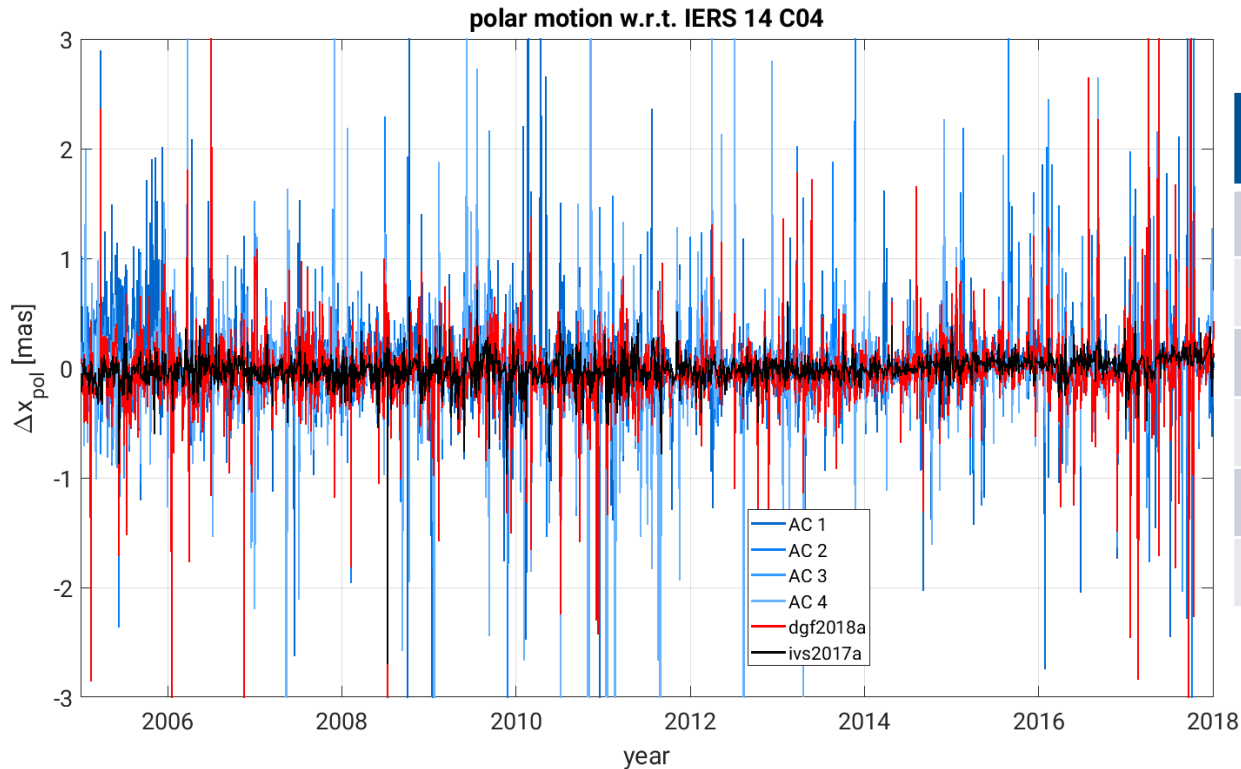# DOGS-RI: the VLBI analysis tool at DGFI-TUM

- Extensive set of mathematical and geophysical models (IERS 2010 Conv.)
- 2-step least-squares minimization.

sample component	default model	other models
observation data format	vgosDB	NGS (Mk3)
precession / nutation	IAU 2006/2000A ΔX_{CIP}, ΔY_{CIP} (CIO based)	IAU 2006/2000A $\Delta \psi$, $\Delta \varepsilon$ (equinox based), SOFA
a-priori station coordinates	ITRF2014	DTRF2014, JTRF2014, VTRF2008
a-priori source coordinates	ICRF2	to come: ICRF3
a-priori EOP	IERS 14 C04	IERS 08 C04
troposphere model	Marini / Saastamoinen; VMF1	Simpl. Marini; NMF, GMF, VMF3
ocean tide corrections of ERP	Eanes (2000)	Ray (1994)
delay model	IERS 2010 (= IERS 1996)	IAU 1997 (Klioner)

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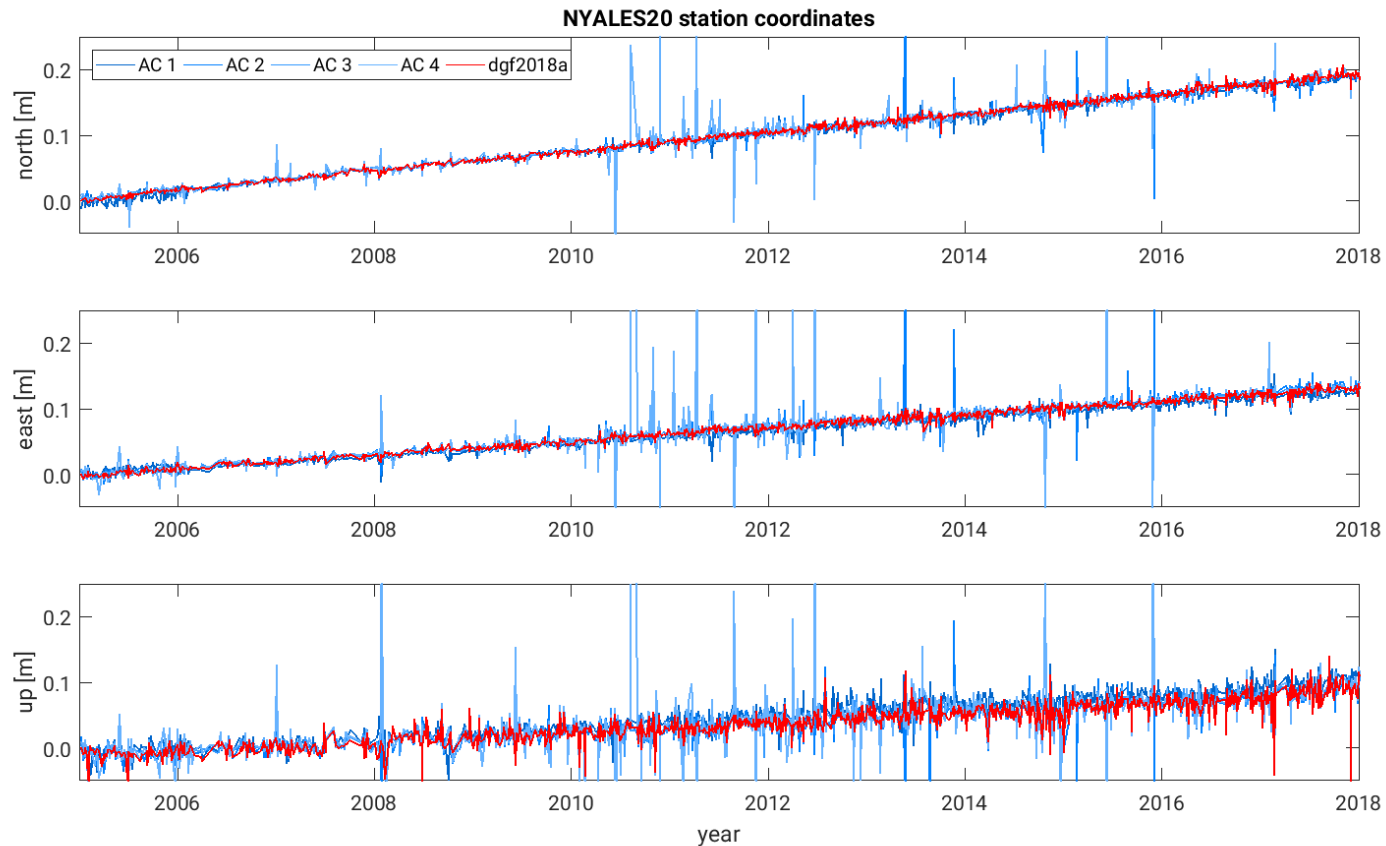- Impact of distinct geophysical models

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EOP: differences w.r.t. IERS 14 C04

polar motion w.r.t. IERS 14 C04

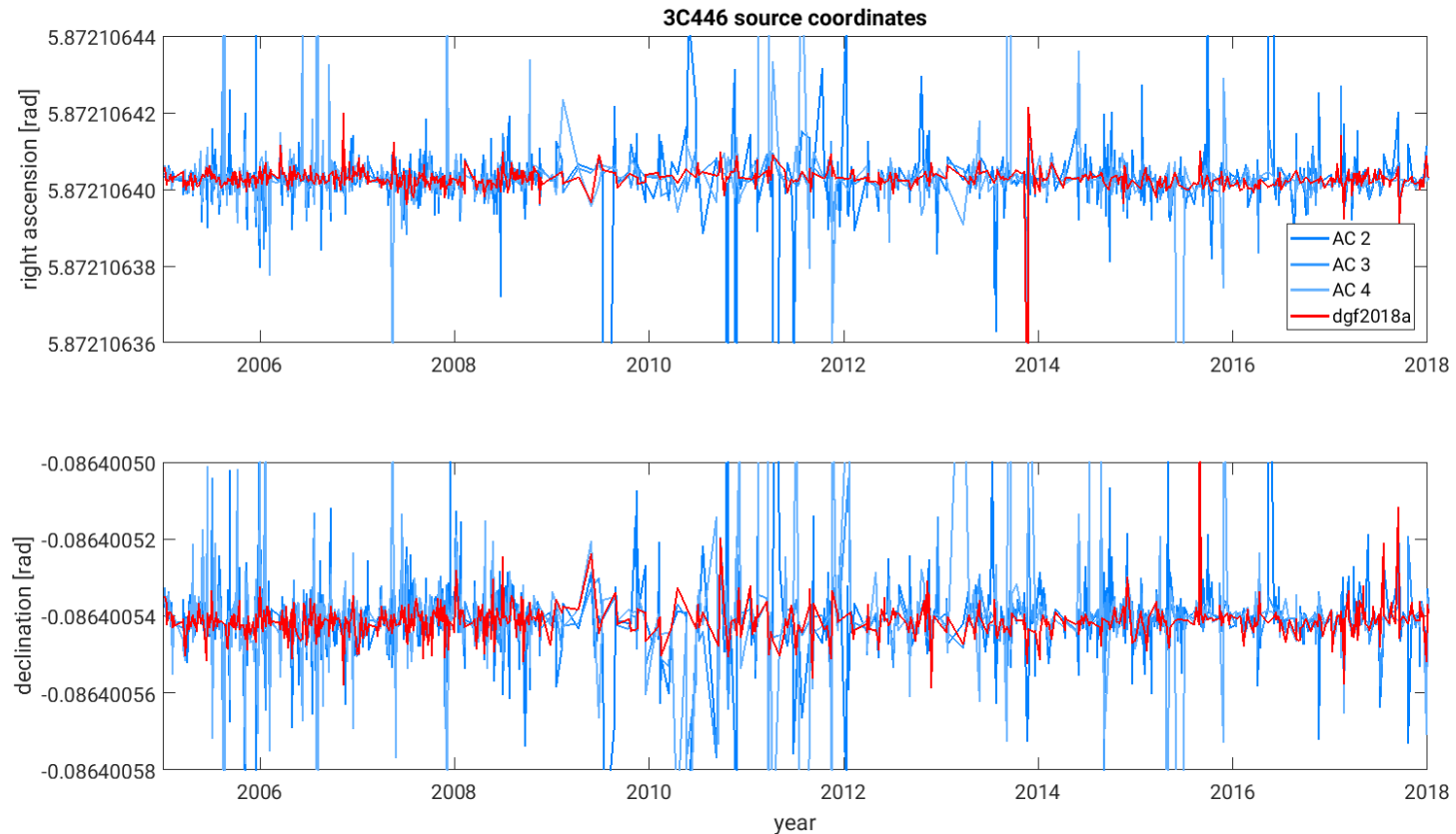| solution	WMEAN [mas]	WRMS [mas]
AC 1	0.05744	0.16524
AC 2	0.00606	0.15072
AC 3	0.01231	0.13215
AC 4	-0.00873	0.15584
dgf2018a	**-0.01940**	**0.14788**
ivs2017a	0.00299	0.08005

- The EOP as estimated by DOGS-RI (solution dgf2018a) agree well with those of the other Analysis Centers and the combined solution (ivs2017a).

Station coordinates: Ny Alesund (NYALES20)

NYALES20 station coordinates

- The station coordinates as estimated by DOGS-RI (solution dgf2018a) agree well with those of the other Analysis Centers.

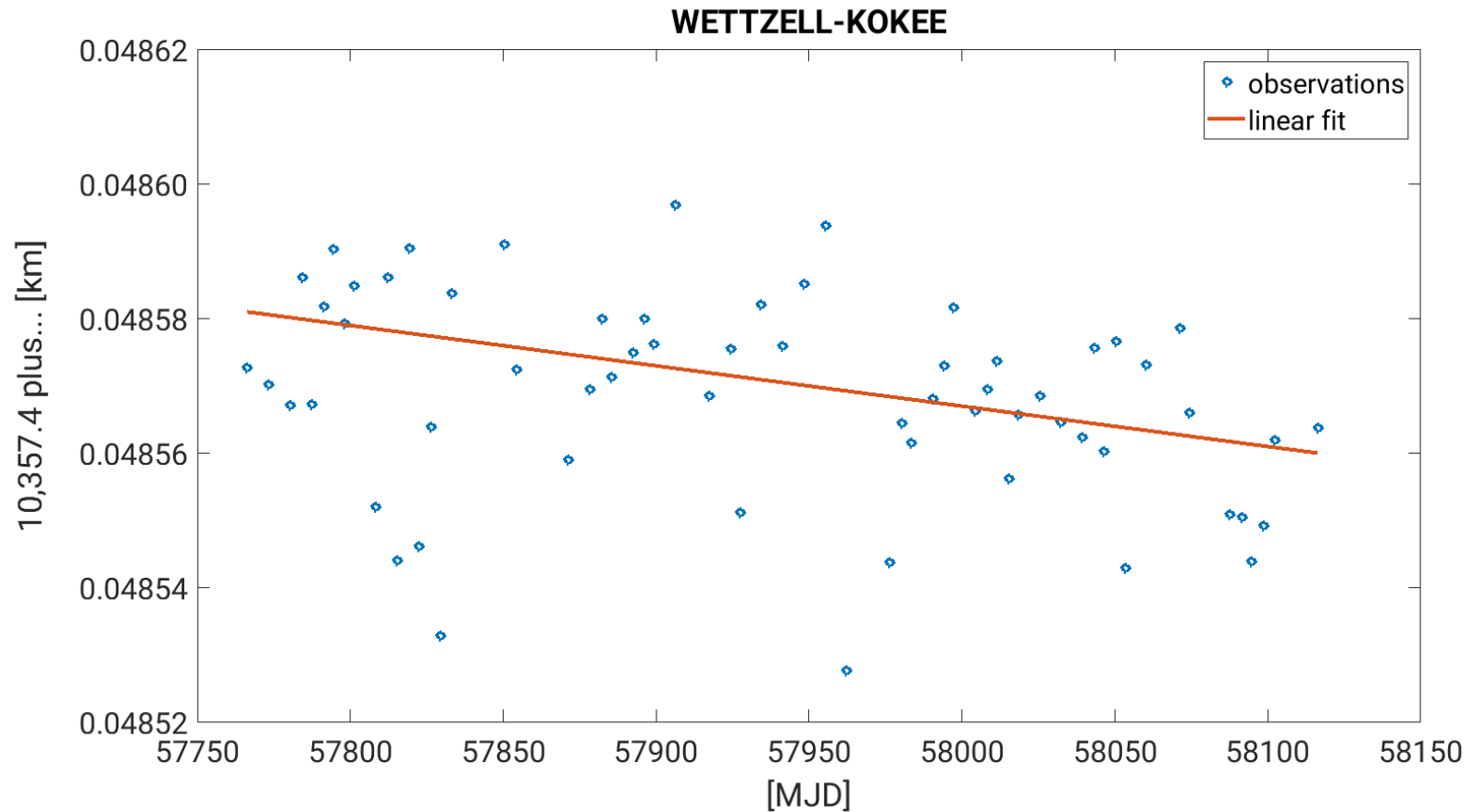# Source coordinates: 3C446

3C446 source coordinates

- The source coordinates as estimated by DOGS-RI (solution dgf2018a) agree well with those of the other Analysis Centers.
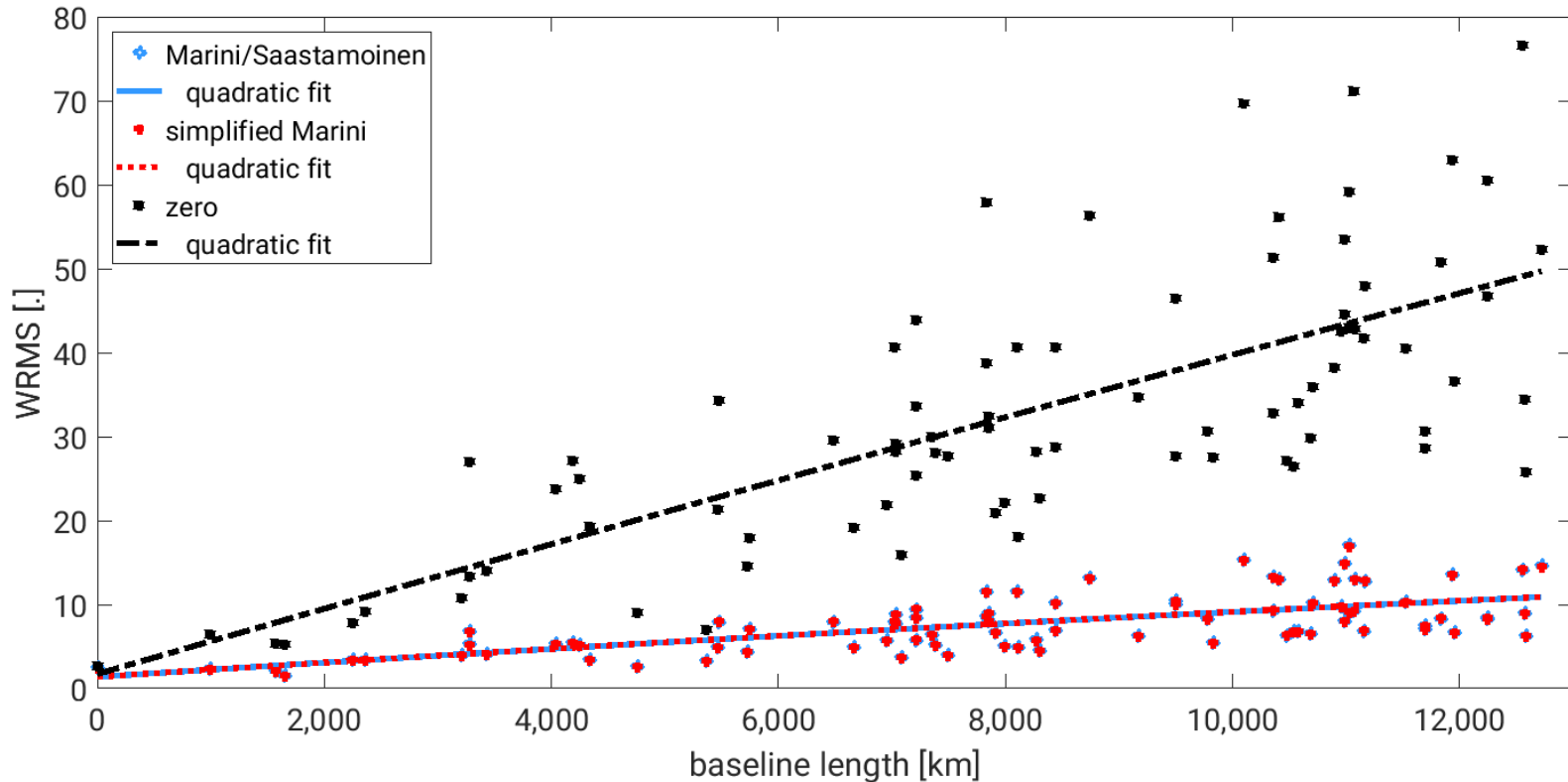
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Measuring the quality of VLBI results:
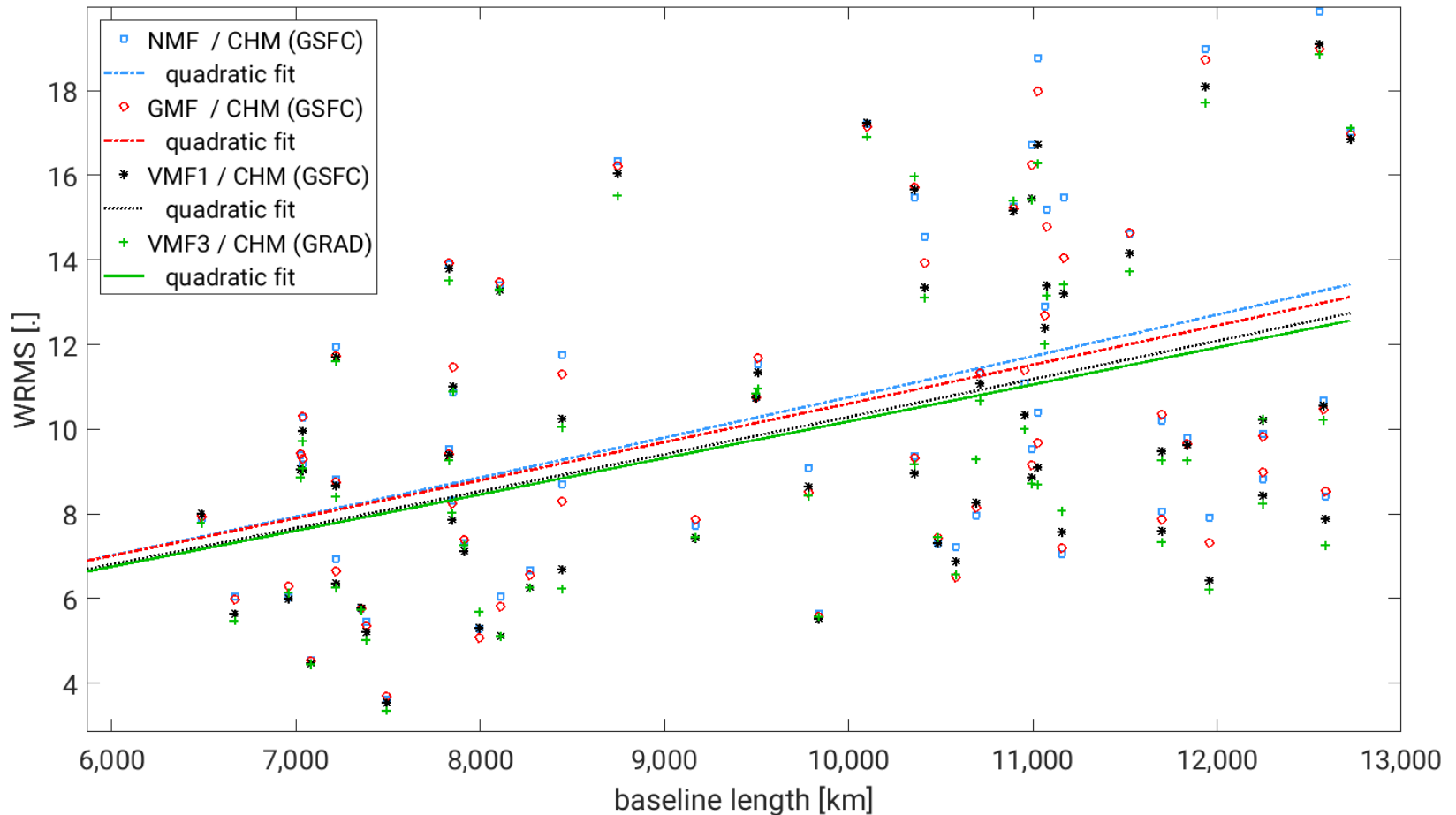# Baseline Length Repeatabilities (BLR)

- Repeatability = WRMS of deviations from linear fit per estimated baseline.

Different models for the hydrostatic zenith delay

- The hydrostatic zenith delay is usually not an estimated parameter, as it can be modelled well with the simplified Marini approach already.

Different models for tropospheric mapping functions and a-priori wet gradient delays

- The Vienna Mapping Functions are an improvement of previous models.

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Summary

- DGFI-TUM is an operational IVS Analysis Center.

- Its proprietary VLBI software DOGS-RI contains a multitude of mathematical and geophysical models for comparing their impact on the estimated parameters.

- DOGS-RI has been successfully validated against other VLBI software packages and is hence used for official IVS contribution.

Thank you for your attention!

Are there any questions?