New VLBI solutions at Analysis Center DGFI-TUM

M. Glomsda, Y. Kwak, M. Gerstl, D. Angermann, F. Seitz

Deutsches Geodätisches Forschungsinstitut (DGFI-TUM)
Technische Universität München

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Outline

- DGFI-TUM as IVS Analysis Center
- Features of the new contribution *dgf2018a*
- Assessment of solutions
- Outlook and summary

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DGFI-TUM as IVS Analysis Center

- DGFI-TUM is an operational IVS Analysis Center (AC) since November 2008.

- Daily SINEX products:
    - dgf2007a: with DGFI-branch of OCCAM (D-OCCAM).
    - dgf2008a: D-OCCAM.
    - dgf2009a: D-OCCAM, official contribution from January 2009 to March 2017.
    - dgf2017b: with proprietary software DOGS-RI, for validation.
    - dgf2018a: DOGS-RI, official contribution since February 2018.

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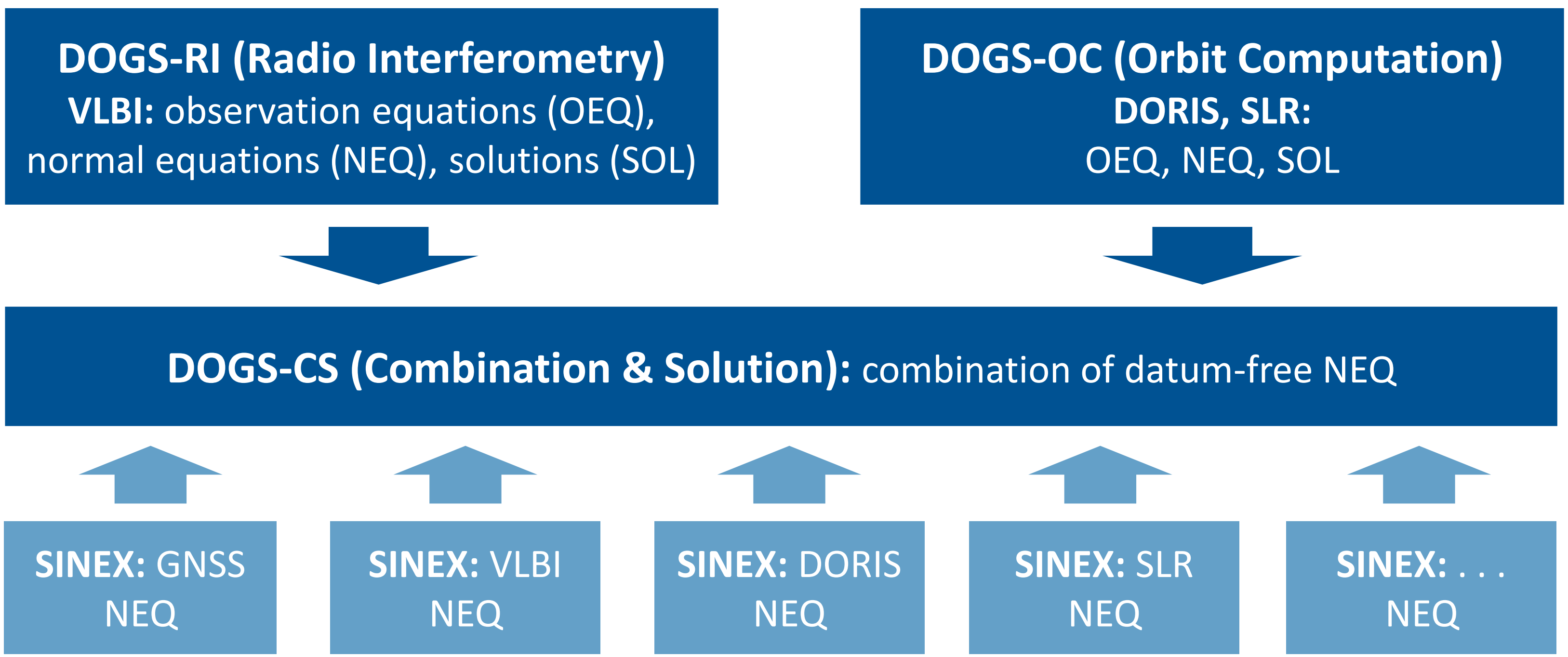
DOGS-RI: the new VLBI software at DGFI-TUM

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



DOGS-RI: workflow

INPUT

classic NGS (Mk3)
or
vgosDB
and
additional files:

observation data,
station data,
a-priori parameter values,
ephemerides,
…

LEAST-SQUARES MINIMIZATION

estimates corrections to:
- station coordinates
- source coordinates
- Earth orientation parameters (EOP)
- tropospheric parameters
- station clock parameters

optional constraints:
datum (NNT / NNR / NNS)
…

three step approach:
1) create / solve normal equation (NEQ)
2) determine observation outliers
3) create / solve new NEQ with reduced outlier weights

OUTPUT

SINEX format:
datum-free NEQ

DOGS-CS format:
datum-free NEQ

standalone format:
(constrained) NEQ
observation equations
solution equations

dgf2018a (DOGS-RI) vs. dgf2009a (D-OCCAM)

- In general, DOGS-RI has a greater set of available models, observation exclusion options and mathematical parametrizations than D-OCCAM.

	dgf2018a	dgf2009a
observation data format	NGS (Mk3)	NGS (Mk3)
precession / nutation	IAU 2006/2000A	IAU 2000A (MHB 2000)
nutation parameters	$\Delta X_{CIP}, \Delta Y_{CIP}$ (CIO based)	$\Delta\psi, \Delta\epsilon$ (equinox based)
a-priori station coord.	ITRF2014	VTRF2008
a-priori EOP	IERS 14 C04	IERS 08 C04
a-priori gradients	GSFC / TU Vienna	zero
IERS Conventions	2010	2003
atmosphere loading	Petrov & Boy (2003)	n/a
delay model	IERS 1996	IERS 1992

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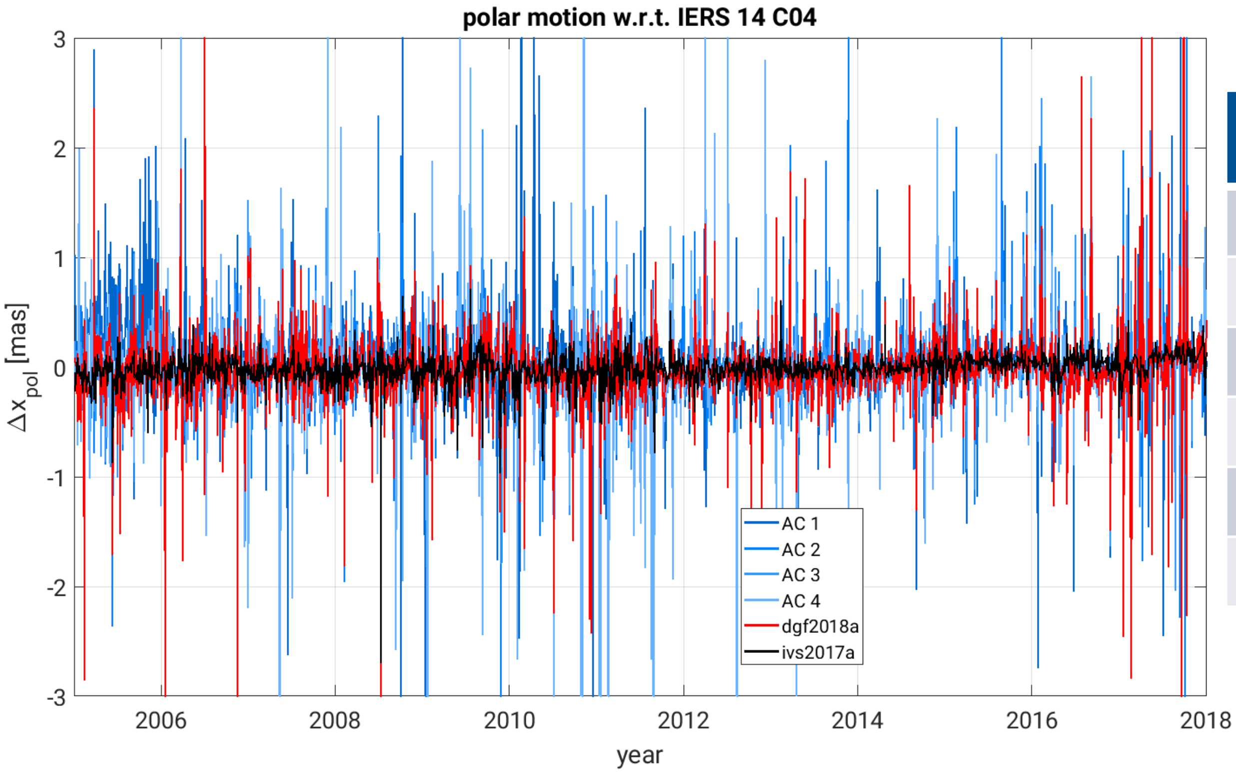
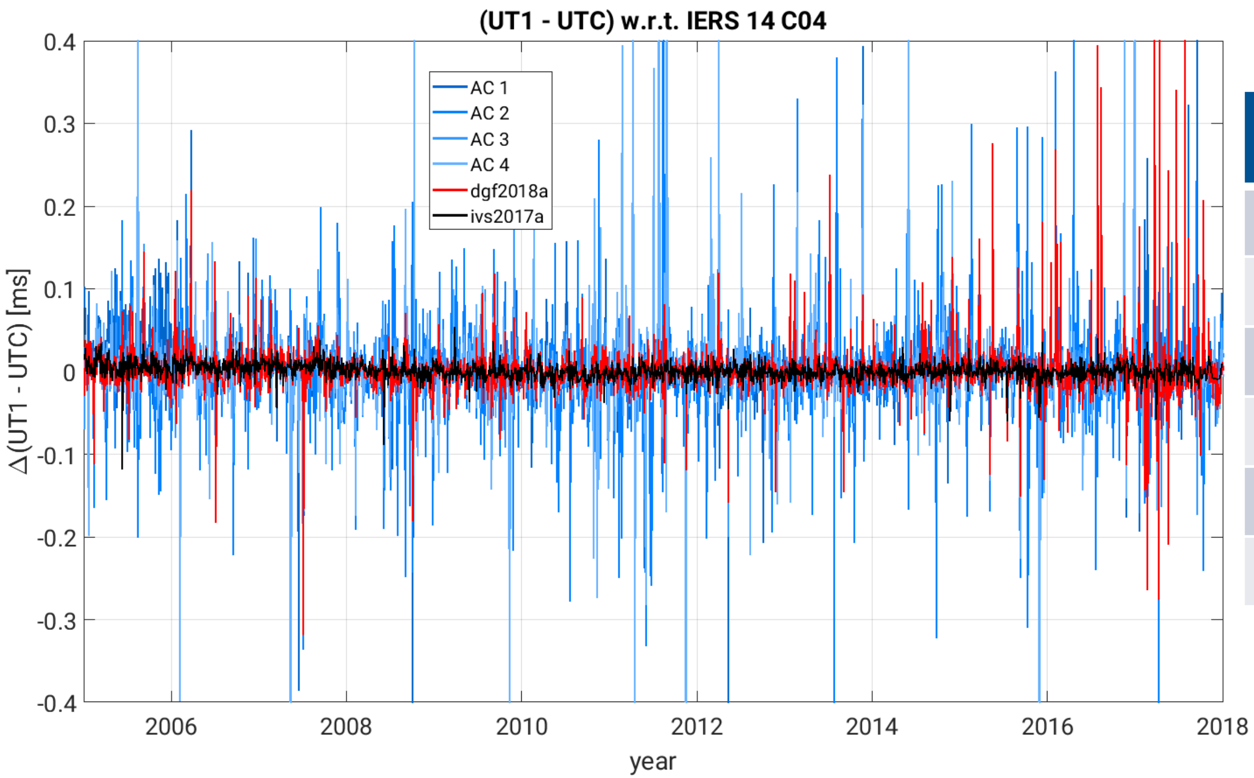
EOP: differences w.r.t. IERS 14 C04 (1)



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 estimated EOP values were taken directly from the AC's *daily-sinex* files. Outliers with $\Delta x_{pol} > 10\ mas$ have been removed.

EOP: differences w.r.t. IERS 14 C04 (2)



solution	WMEAN [ms]	WRMS [ms]
AC 1	0.00200	0.01540
AC 2	-0.00037	0.01853
AC 3	-0.00132	0.01479
AC 4	-0.00522	0.01641
dgf2018a	**-0.00226**	**0.01436**
ivs2017a	-0.00077	0.00965

- The estimated EOP values were taken directly from the AC‘s *daily-sinex* files. Outliers with $\Delta(UT1 - UTC) > 1\ ms$ have been removed.

Weighted mean for differences w.r.t. IERS 14 C04

EOP	AC1	AC2	AC3	AC4	dgf2018a	ivs2017a
x_{pol} [mas]	**0.05744**	0.00606	0.01231	-0.00873	-0.01940	**0.00299**
$\dot{x}_{pol}$ [mas/d]	0.02476	0.02584	0.02015	**0.01484**	**0.02833**	0.02602
y_{pol} [mas]	**0.25763**	-0.01996	-0.03460	-0.01763	**-0.00959**	-0.00984
$\dot{y}_{pol}$ [mas/d]	**0.01333**	-0.00026	**-0.00003**	0.01054	0.01322	0.00730
$DUT1$ [ms]	0.00200	**-0.00037**	-0.00132	**-0.00522**	-0.00226	-0.00077
LOD [ms/d]	**-0.00030**	-0.00100	-0.00106	**0.00200**	0.00123	-0.00135
ΔX_{CIP} [mas]	n/a	n/a	n/a	**0.02337**	0.01998	**0.00658**
ΔY_{CIP} [mas]	n/a	n/a	n/a	-0.00692	**-0.00470**	**-0.00757**

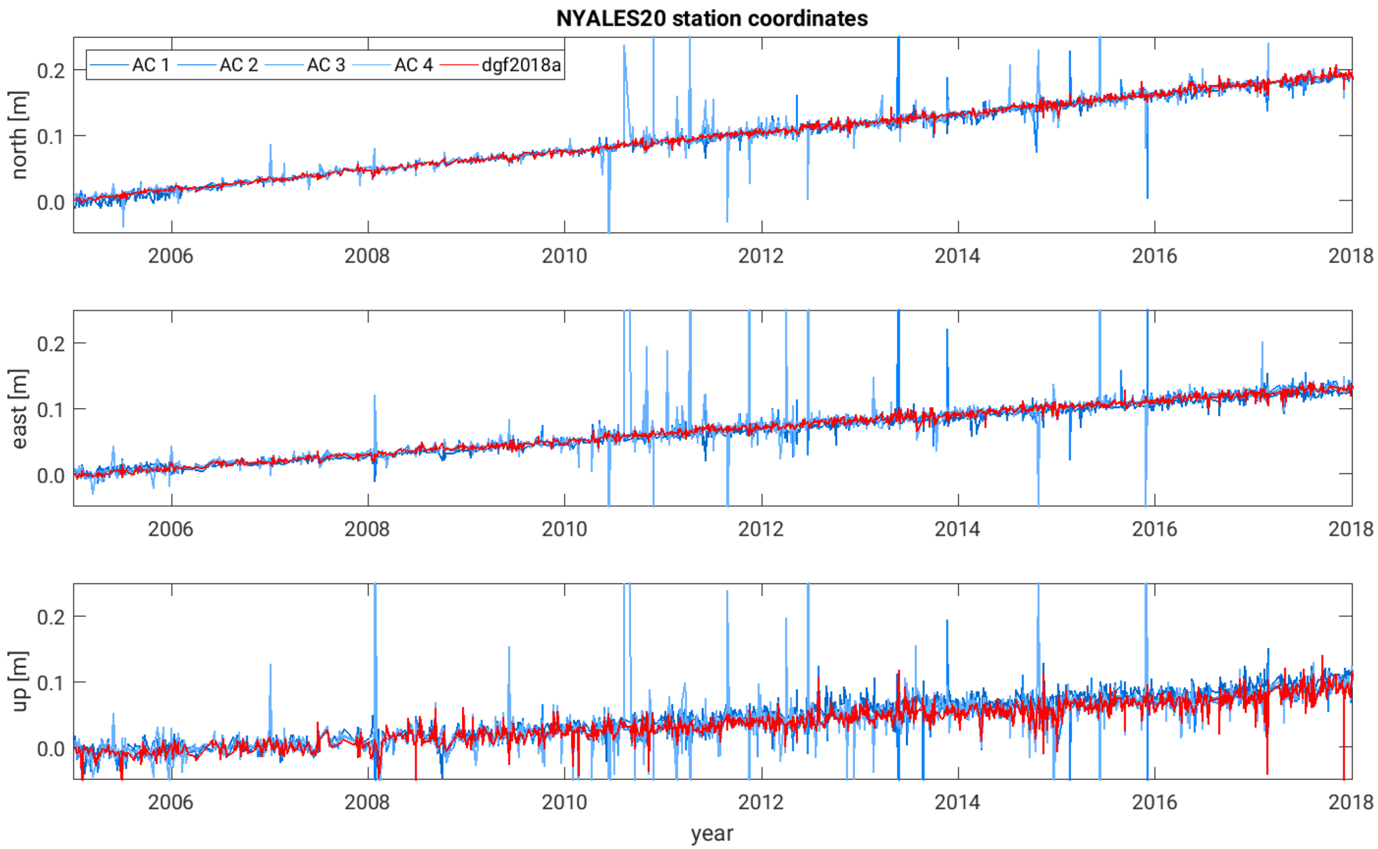
- For each EOP, *dgf2018a* has a WMEAN similar to those of the other ACs and the combined solution *ivs2017a* (n/a = different parameter provided).

WRMS for differences w.r.t. IERS 14 C04

EOP	AC1	AC2	AC3	AC4	dgf2018a	ivs2017a
x_{pol} [mas]	**0.16524**	0.15072	0.13215	0.15584	0.14788	**0.08005**
$\dot{x}_{pol}$ [mas/d]	0.29647	0.25791	0.27315	**0.31728**	0.29105	**0.23201**
y_{pol} [mas]	**0.19391**	0.16169	0.13461	0.17650	0.15703	**0.07625**
$\dot{y}_{pol}$ [mas/d]	0.28835	0.25398	0.26846	**0.32212**	0.29100	**0.23072**
$DUT1$ [ms]	0.01540	**0.01853**	0.01479	0.01641	0.01436	**0.00965**
LOD [ms/d]	**0.01937**	0.01727	0.01765	0.01858	0.01890	**0.01617**
ΔX_{CIP} [mas]	n/a	n/a	n/a	**0.16802**	0.13749	**0.03287**
ΔY_{CIP} [mas]	n/a	n/a	n/a	**0.15276**	0.13854	**0.03581**

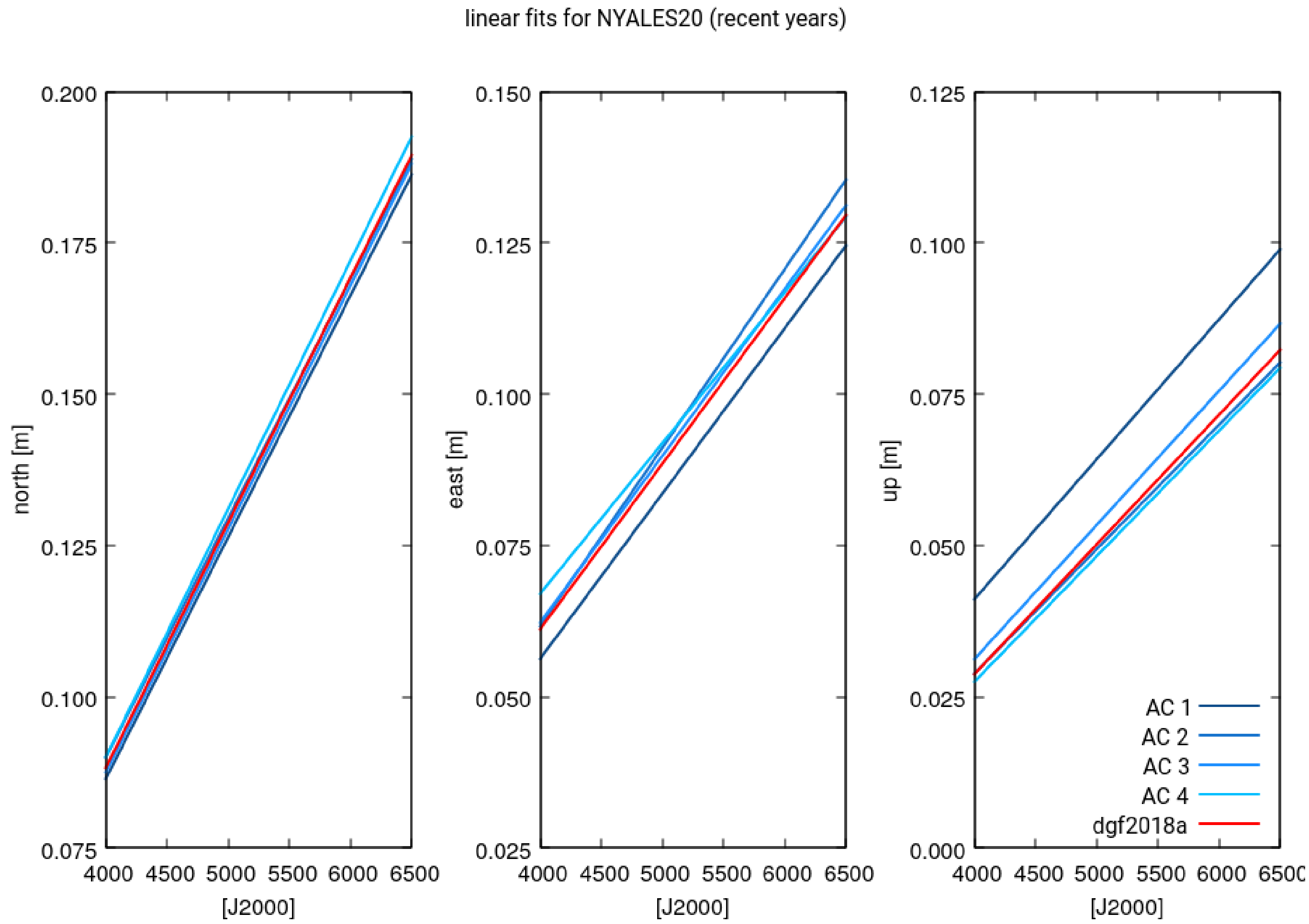
- For each EOP, *dgf2018a* has a WRMS within the range of the other ACs and the combined solution *ivs2017a* (n/a = different parameter provided).

Assessment of station coordinates: NYALES20 (1)



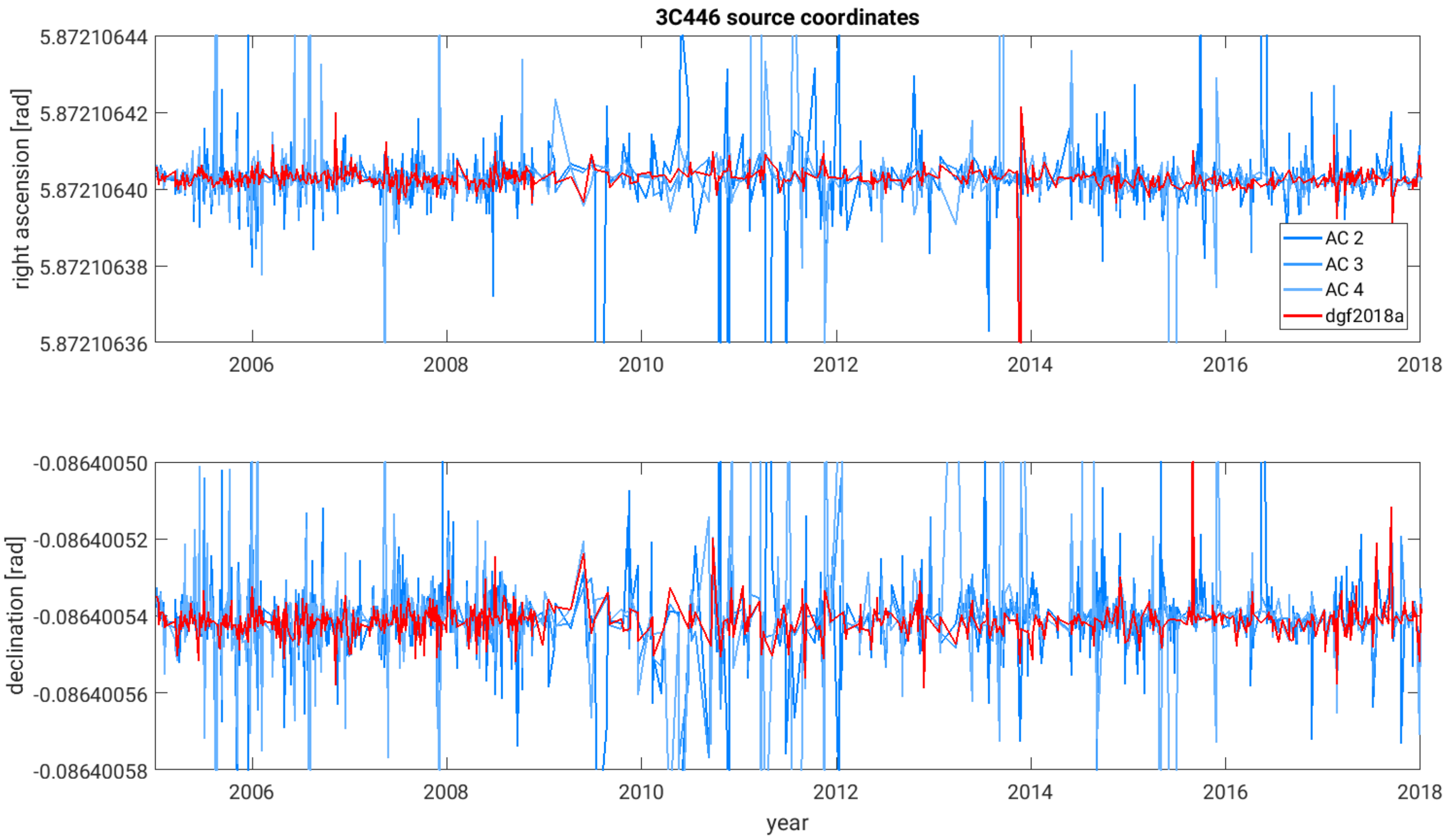
- Estimated cartesian station coordinates were taken directly from the *daily-sinex* files of the ACs and transformed into spherical coordinates.

Assessment of station coordinates: NYALES20 (2)



- Greatest variation for up-coordinate, *dgf2018a* is in line with most ACs.

Assessment of source coordinates: 3C446 (of ICRF2)



- The estimated source coordinates were taken directly from the *daily-sinex* files of the ACs. Again, *dgf2018a* provides matching parameters.

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NGS (Mk3) vs. vgosDB

- The vgosDB interface for DOGS-RI is basically working.
  However, there are some open issues.

- The conversion step between Mk3 DB and NGS file adds, for example:
  - formal error per baseline,
  - missing meteorological data.

- The corresponding routines are currently transferred to the vgosDB-DOGS-RI interface.

Summary

- *dgf2018a* is DGFI-TUM‘s latest IVS contribution.
- It is computed with our proprietary VLBI software DOGS-RI, which makes use of the current IERS Conventions 2010.
- The parameters estimated with DOGS-RI are in line with those of the other IVS Analysis Centers.
- *dgf2018a* is still calculated from the NGS (Mk3) data format. There will probably be a new contribution ID with the switch to vgosDB.

Thank you for your attention!

Are there any questions?