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VIENNA UNIVERSITY OF TECHNOLOGY
DEPARTMENT OF GEODESY
AND GEOINFORMATION

The ICRF-3: Status, Plans, and Progress on the Next Generation Celestial Reference Frame

J. Böhm and the **IAU WG on the ICRF-3**

ICRF-3 WG: C. Jacobs (Chair), F. Arias, D. Boboltz, J. Böhm, S. Bolotin, G. Bourda, P. Charlot, A. de Witt, A. Fey, R. Gaume, D. Gordon, R. Heinkelmann, S. Lambert, C. Ma, A. Nothnagel, Z. Malkin, M. Seitz, E. Skurikhina, J. Souchay, O. Titov

International Celestial Reference Frame ICRF

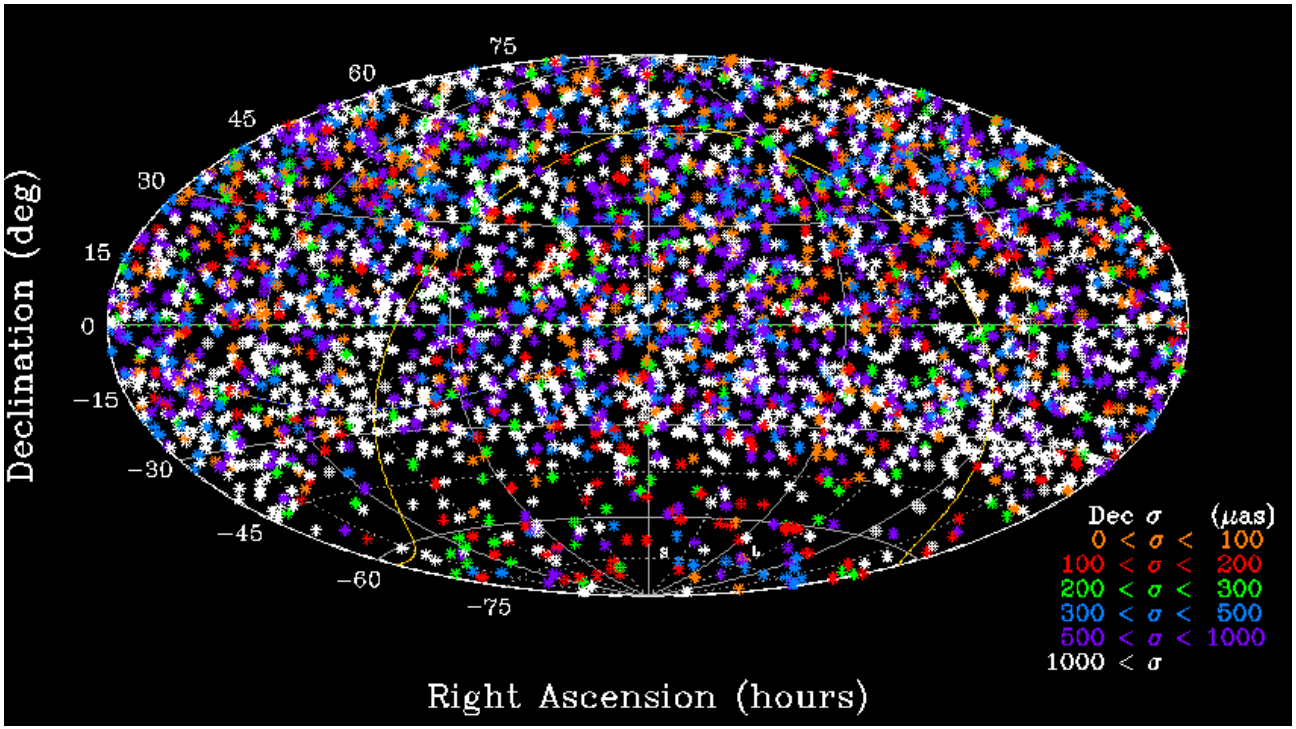
- International Astronomical Union is the governing body for the Celestial Reference Frame
  - ICRF-1 accepted as fundamental CRF 01 Jan 1998
  - ICRF-2 accepted as fundamental CRF 01 Jan 2010, previously endorsed by IERS and IVS DBs
- First discussions on ICRF-3 at XXVIII General Assembly of the IAU in Beijing in 2012
- Plan: ICRF-3 acceptance at the IAU GA 2018

Overview of ICRF-2

- S/X data (2.3 / 8.4 GHz) for 3414 sources
  - 6.5 million group delays from 1979 to 2009
- NNR relative to ICRF-1 (138 defining sources)
- NNR/NNT relative to VTRF2008 (27 stations)
- Produced from a single monolithic fit
  - verified with solutions from various groups using independent software packages

Overview of ICRF-2

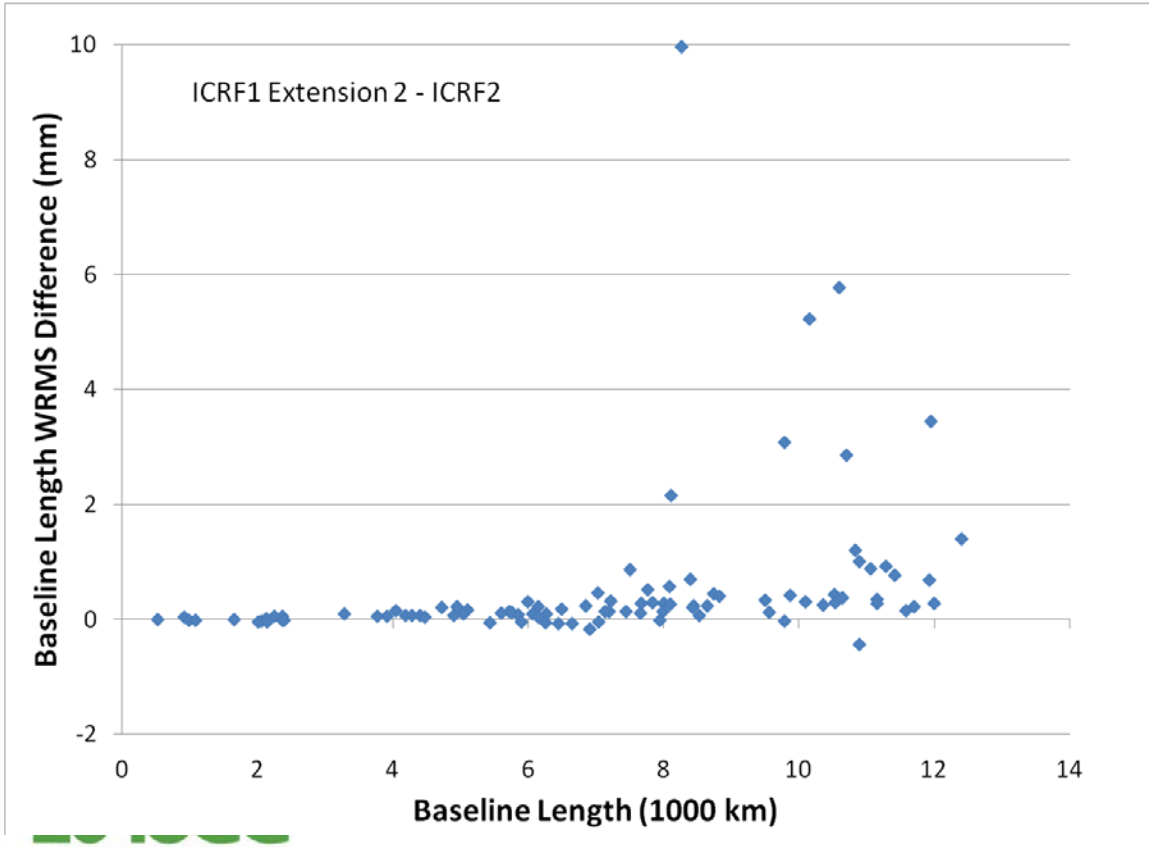
- Ma et al. 2009 (IERS Technical Note)
- 2200 are single session survey sources (VLBA)



credit: C. Jacobs

Geodetic Impact by the Switch from ICRF-1 to ICRF-2

- Improvements for baselines including southern stations: ICRF-1-Ext2 – ICRF-2



Courtesy D. MacMillan, GSFC

Geodetic Impact by the Switch from ICRF-1 to ICRF-2

- EOP differences w.r.t. IGS

Courtesy D. MacMillan, GSFC

EOP	ICRF-1 Ext. 2 fixed		ICRF-2 fixed	
	WRMS	Chi²/dof	WRMS	Chi²/dof
x-pole (μas)	123.4	3.3	113.5	2.8
y-pole (μas)	113.3	3.1	109.6	2.9
x-pole rate (μas/d)	318.9	2.1	305.0	1.9
y-pole rate (μa/ds)	315.1	2.1	302.7	1.9
LOD (μs/d)	19.6	3.7	18.9	3.4

All EOP improved with ICRF-2

Geodetic Impact by the Switch from ICRF-2 to "ICRF-3"

- Average source position uncertainty

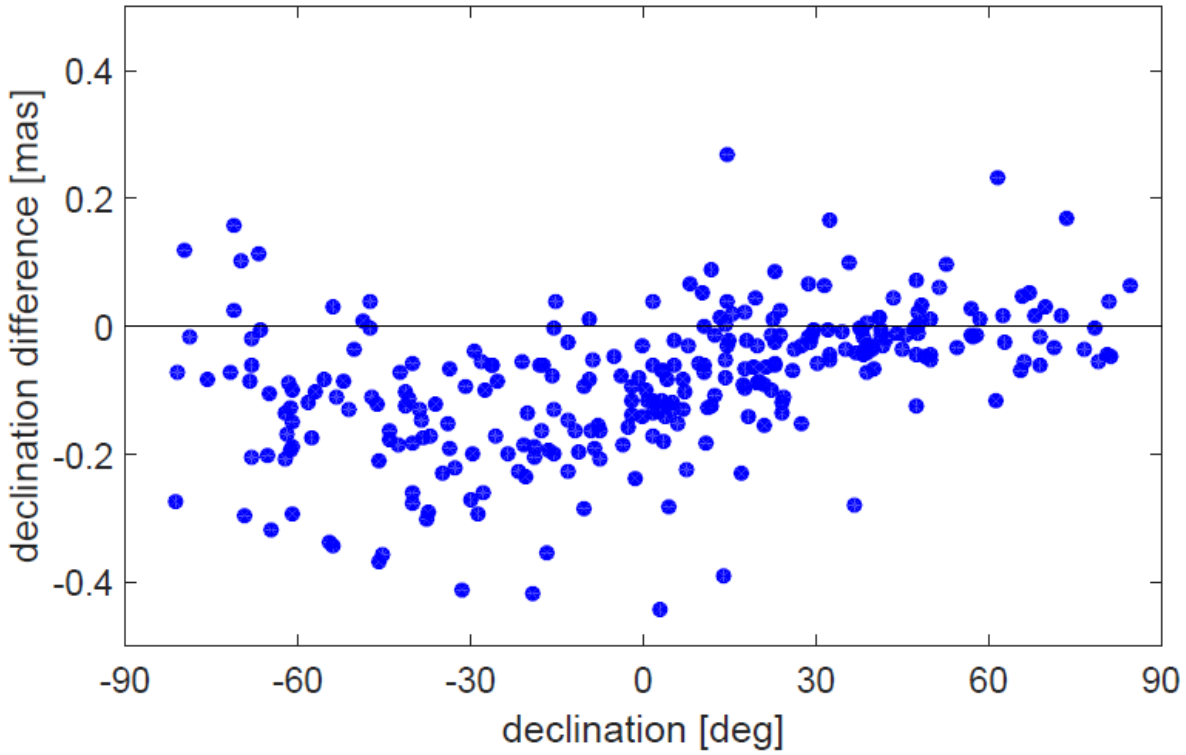
Courtesy D. MacMillan, GSFC

	Right Ascension wrms (μas)	Declination wrms (μas)	Number of Sources
ICRF2 (1980-2009)	52	62	794
ICRF3 (test) (1980-2014)	32	43	883

Geodetic Impact by the Switch from ICRF-2 to "ICRF-3"

- Declination bias

Courtesy D. Mayer, TU Wien

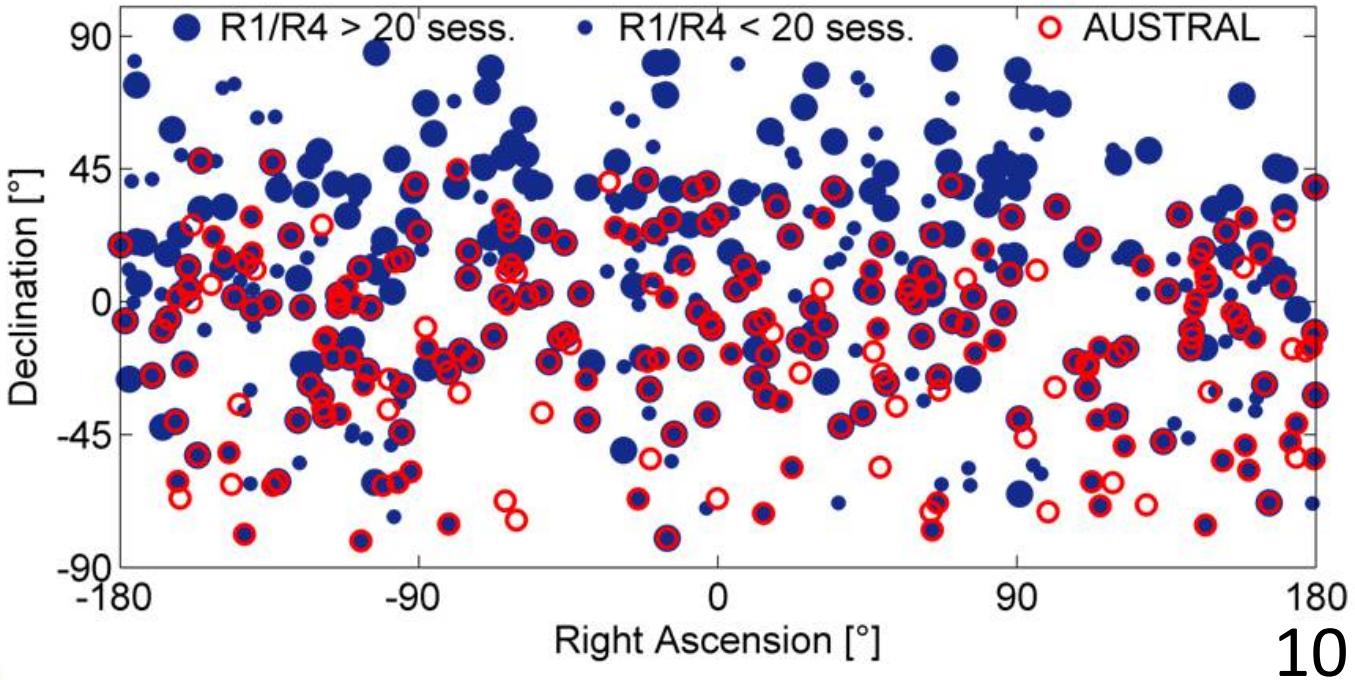


Deficiencies of ICRF-2

- VLBA Calibrator Survey (VCS) is most (2/3) of ICRF-2 but positions are 5 times worse than rest of ICRF-2
- ICRF-2 is weak in the south, especially below –40 deg declination

S/X-band Observations for Southern Sky Improvements

- Plan (Titov et al., 2013) to observe strong (>400 mJy) sources using the small, fast stations of the southern CRF network at S/X-bands



Mayer et al. 2015

S/X-band Observations for Southern Sky Improvements

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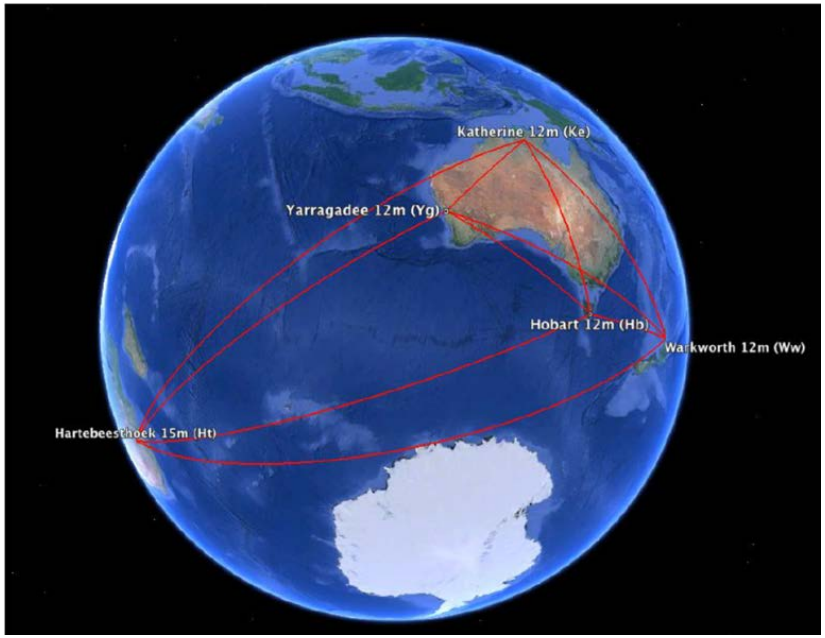
Hopefully more observations again in the future

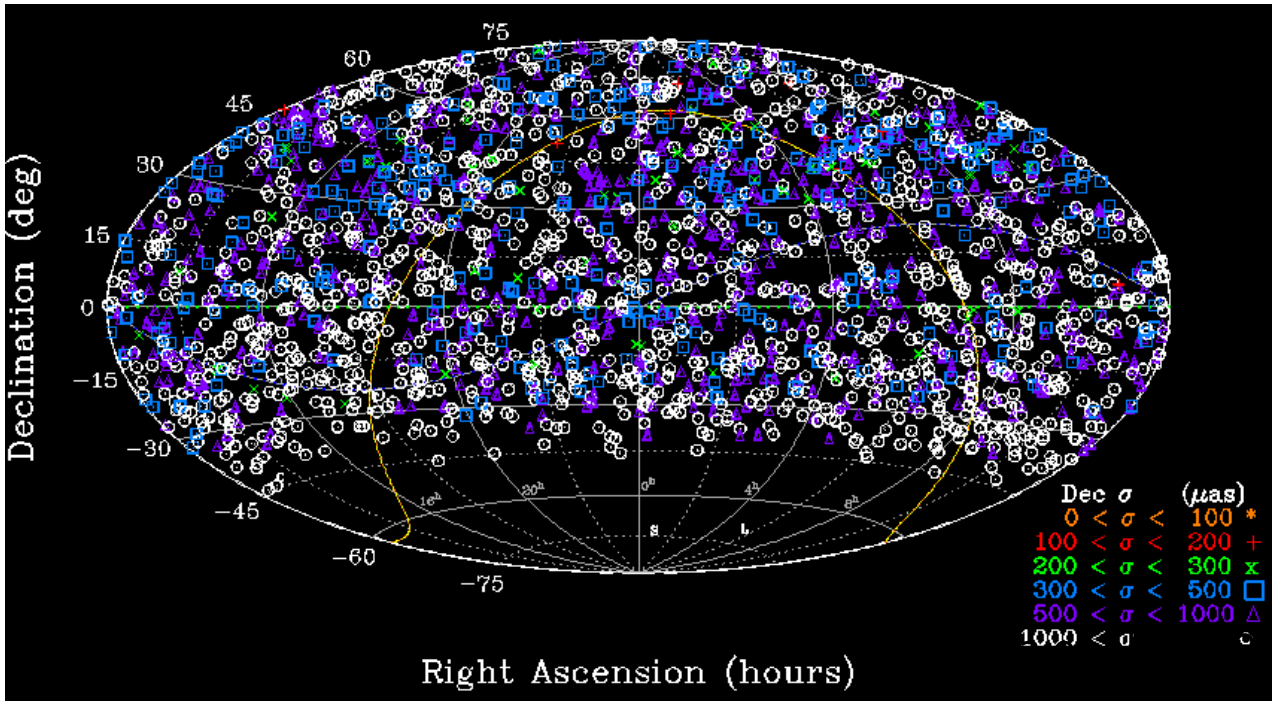


S/X-band Observations for Southern Sky Improvements

- Observe 100-200 weaker sources with large telescopes: Parkes, DSS45, Hobart26, HartRAO
  - Goal 20 scans per source, 100-150 μas precision

S/X Survey Sources (VCS)

- Re-observe VCS sources with VLBA
  - VCS-II sessions organized by D. Gordon (PI)

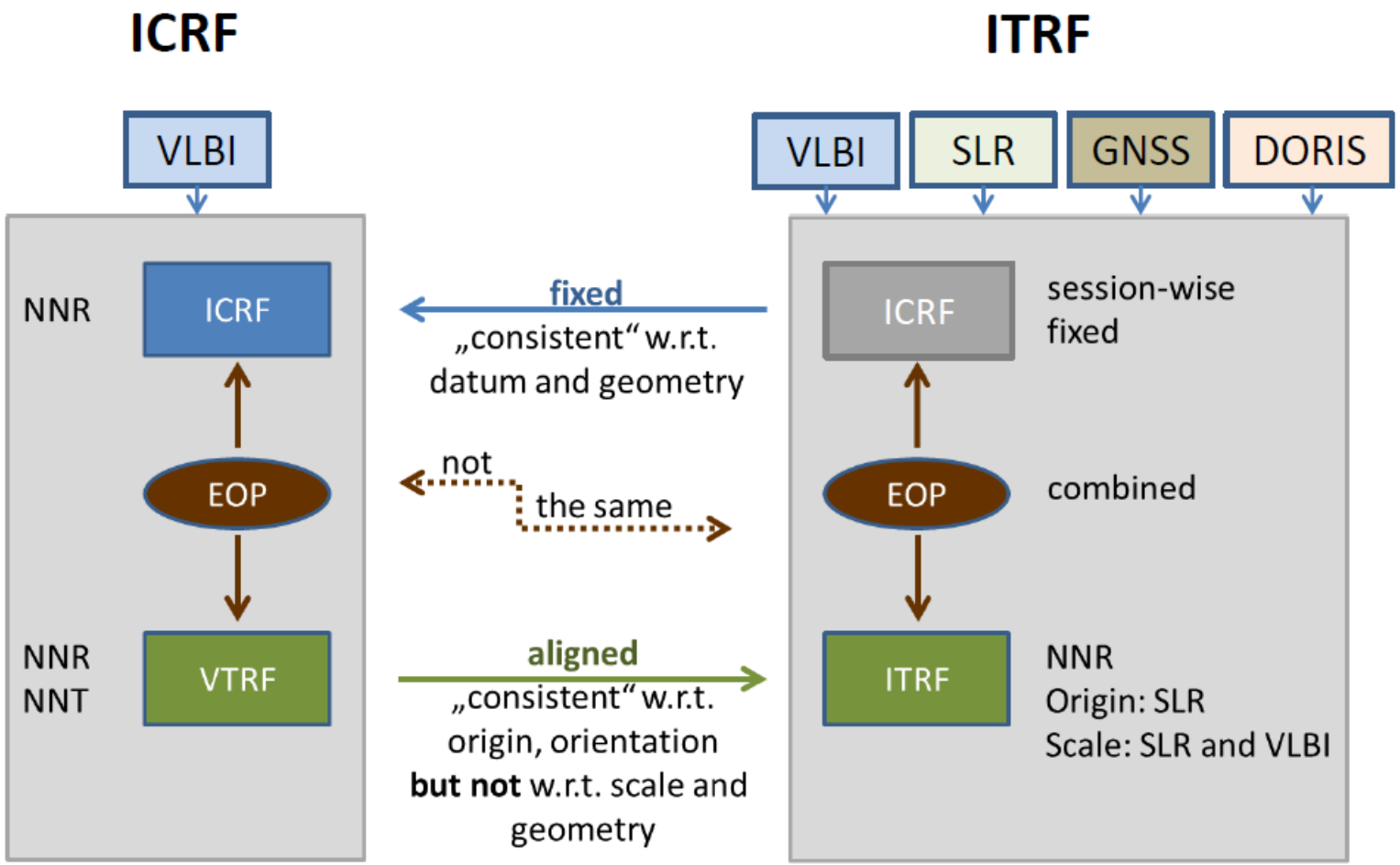


credit: C. Jacobs

IUGG Resolution 3 (2011)

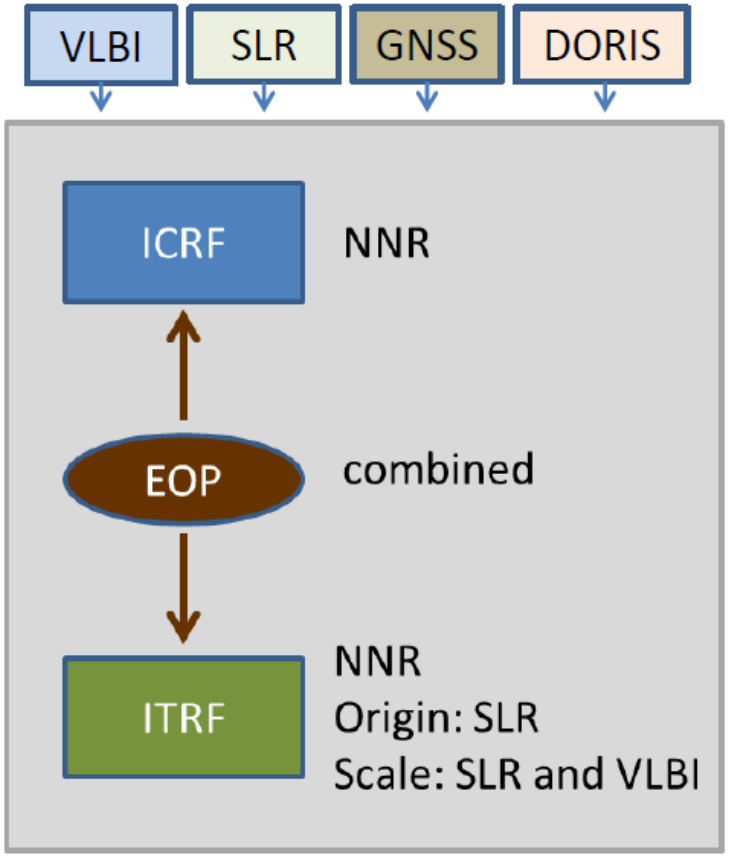
- *"... highest consistency between the ICRF, the ITRF, and the EOP as observed and realized by the IAG and its components such as the IERS should be the primary goal in all future realizations of the ICRS"*

Current Situation



from Seitz et al. 2012

Consistent Realization



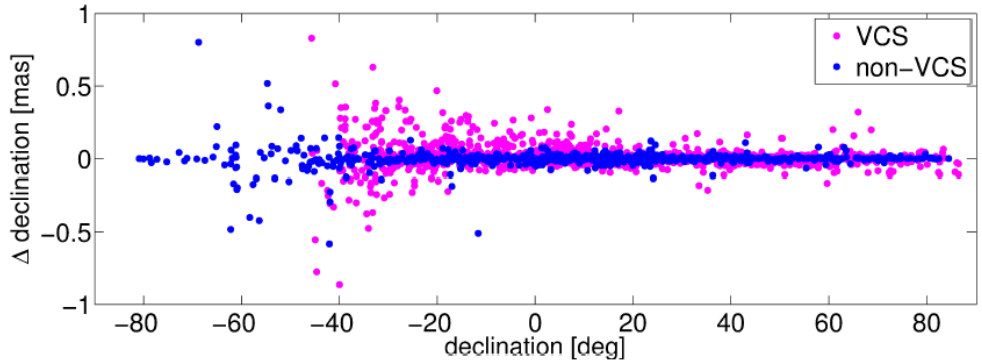
from Seitz et al. 2012

What is expected?

- Consistency between all parameters
- Improvement of EOP time series
- Effects on CRF
  - due to combination of EOP
  - due to combination of station coordinates

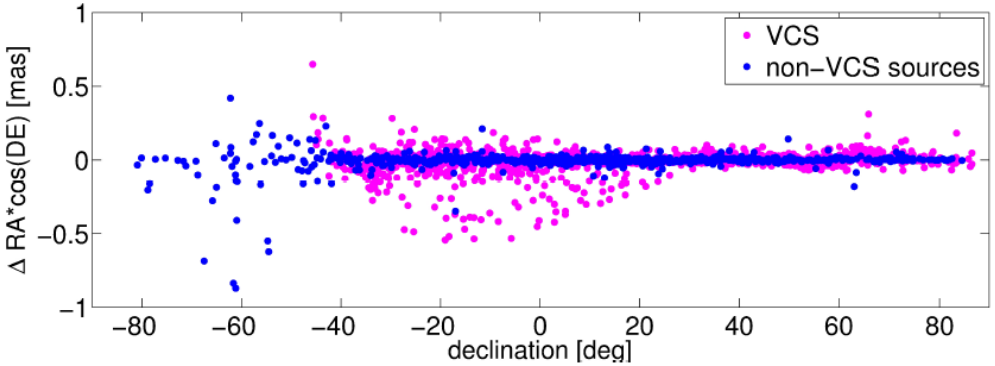
Effect of EOP Combination on CRF

- Declination w.r.t. VLBI-only



from Seitz et al. 2012

- Right ascension w.r.t. VLBI-only

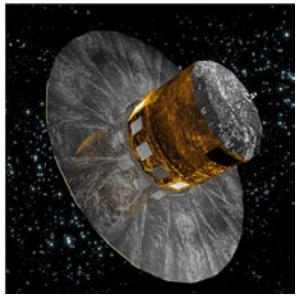


Effect of EOP Combination on CRF

- 100 (out of 2200) VCS sources are stronger affected by the combination
  - for non-VCS sources the effect is negligible
- Combination of LOD
  - has large impact on source positions
- Combination of the pole
  - has large influence on the standard deviation of the source positions

See next presentation by Hana Krásná

Summary of ICRF-3 goals



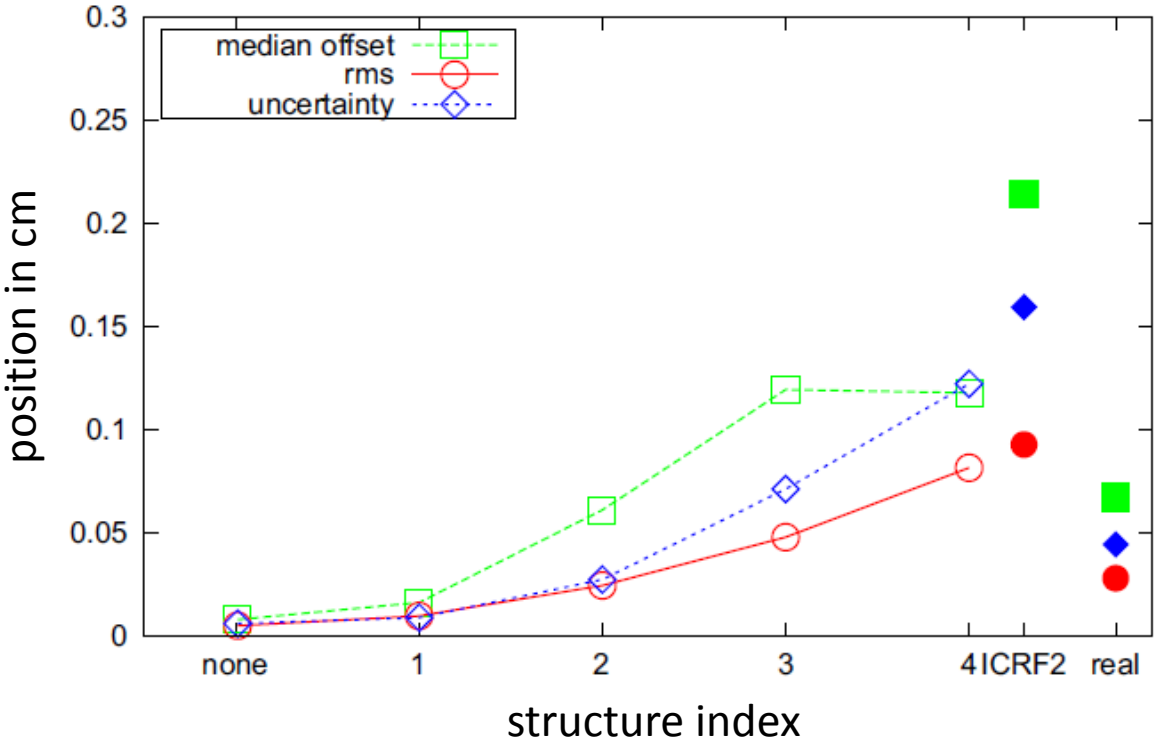
www.esa.int

- Improve VCS positions
- Improve southern observations
- Improve high frequency frames
  - High frequency frames have more point-like sources but fewer sources at present
  - High frequency CRFs are weak in the south and agree at 100 to 500 μas level with ICRF-2
- Complete ICRF-3 by 2018 for alignment w. Gaia

THANKS FOR YOUR ATTENTION

Source Structure Effects

- CONT11 simulation by Shabala et al. (2015)



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