TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Challenges and perspectives for CRF and TRF determination

J. Böhm, Z. Malkin, S. Lambert, C. Ma

with contributions by H. Spicakova, L. Plank, and H. Schuh

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www.oan.es/gm2012/
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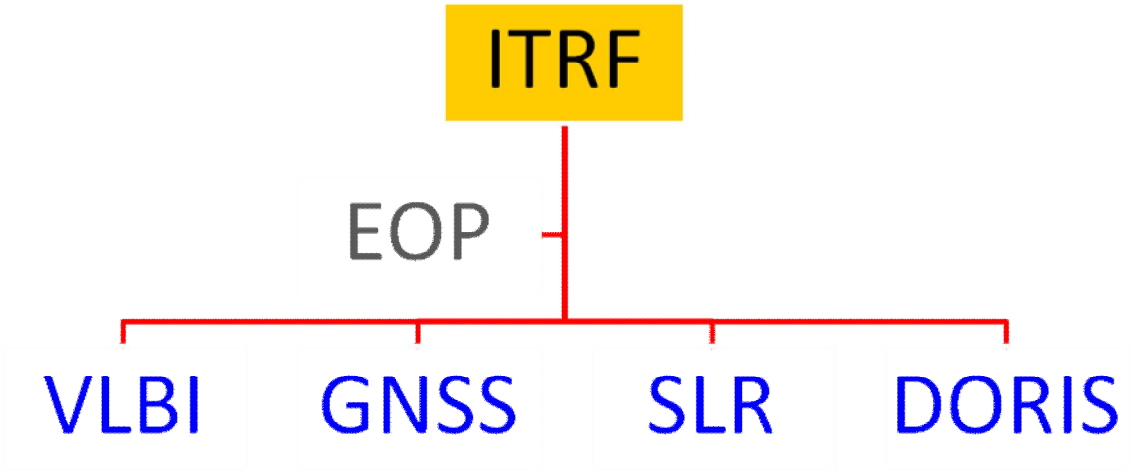
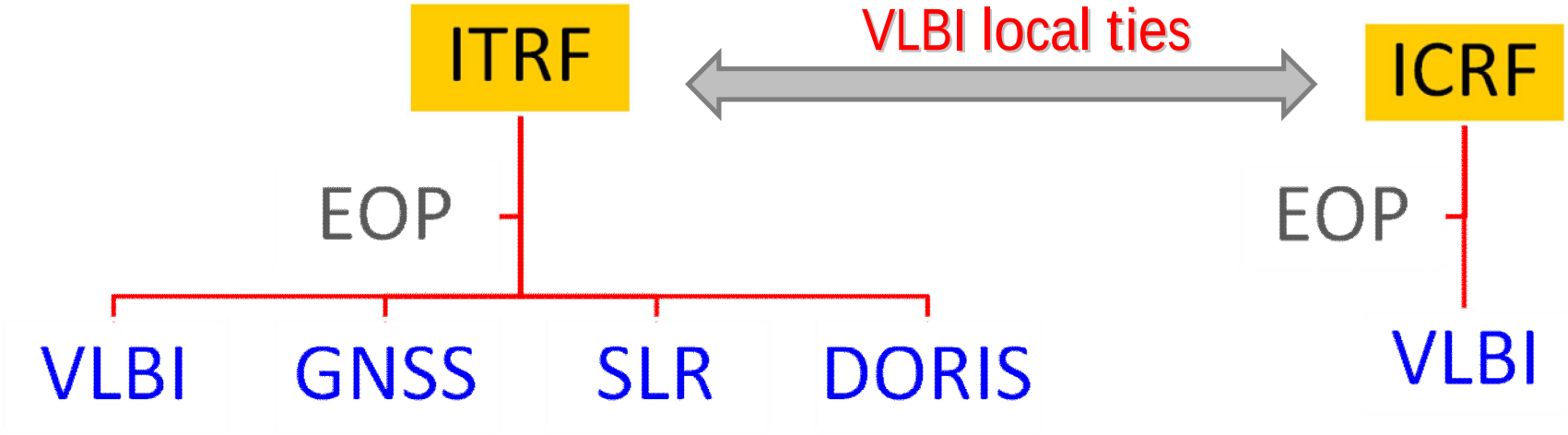
Consistency TRF – EOP – CRF

- ITRF2008 from VLBI/GNSS/SLR/DORIS normal equations



Consistency TRF – EOP – CRF

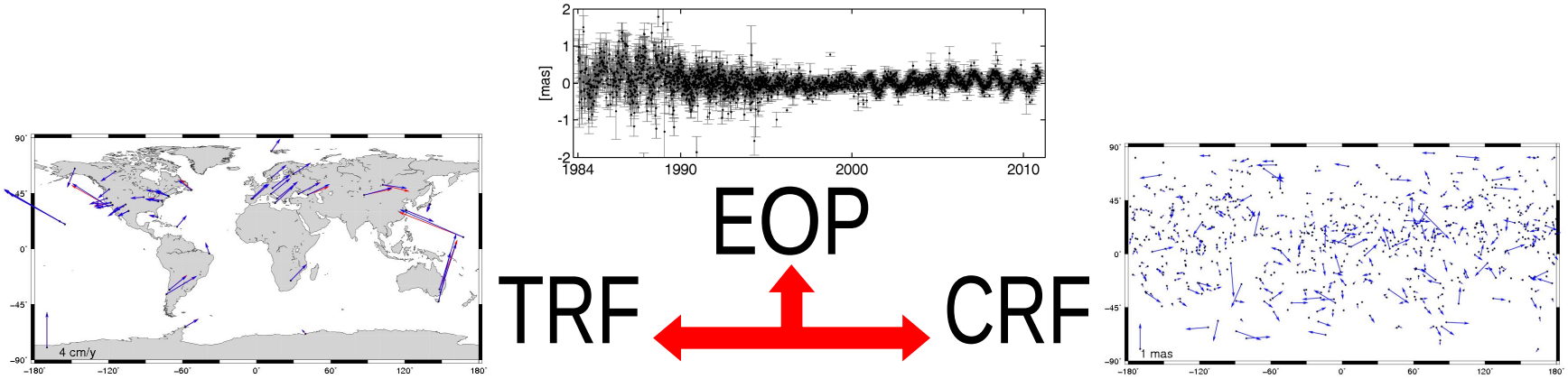
- ITRF2008 from VLBI/GNSS/SLR/DORIS normal equations
- ICRF2 from global VLBI solution



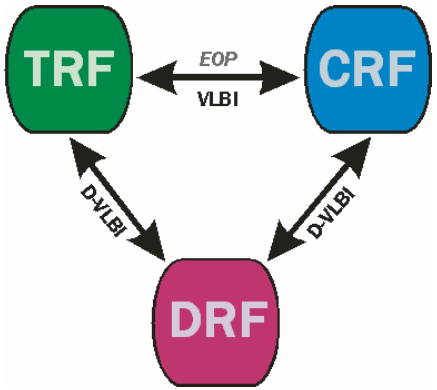
Consistency TRF – EOP – CRF

- This situation causes a complicated mutual impact of ITRF and ICRF which should be carefully investigated
  - to improve the accuracy of both, ICRF and ITRF,
  - and the consistency between them.

Consistency TRF – EOP – CRF



- Many groups working on that topic
  - DFG Forschergruppe on Reference Systems
  - IAG SC 1.4
  - see other presentations

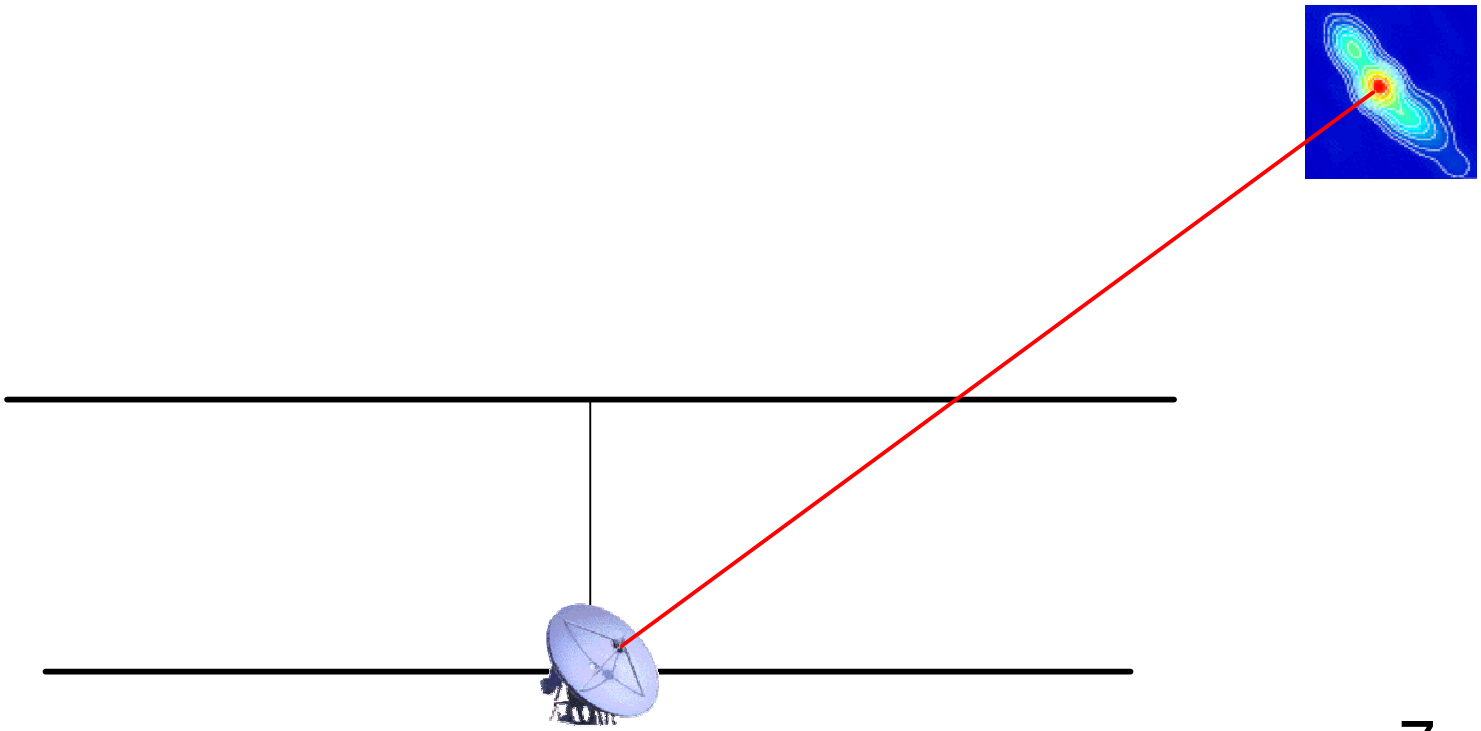


Interaction of Celestial and Terrestrial Reference Frames

- **IAG SC 1.4** (2011-2015) (Chair: J. Böhm)
- WG 1: Geophysical and Astronomical Effects and the Consistent Determination of CRF and TRF (Chair: Z. Malkin)
- WG 2: Co-location on Earth and in Space for the Determination of the CRF (Chair: S. Lambert)
- WG 3: Maintenance of CRF and the link to the new GAIA frame (Chair: C. Ma)

Geophysical and Astronomical Effects

- Insufficient models
  - Tropospheric delays, in particular gradients
  - ...



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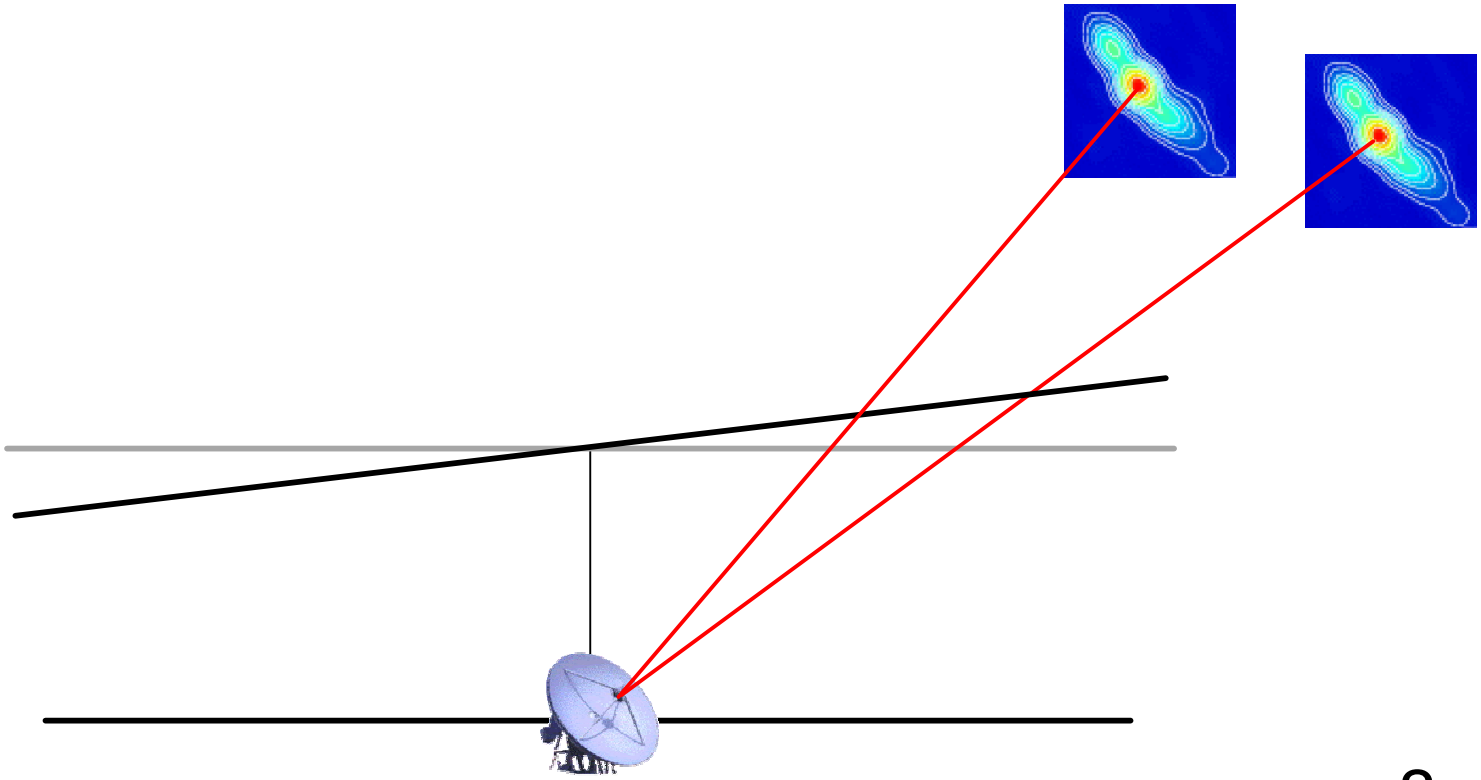
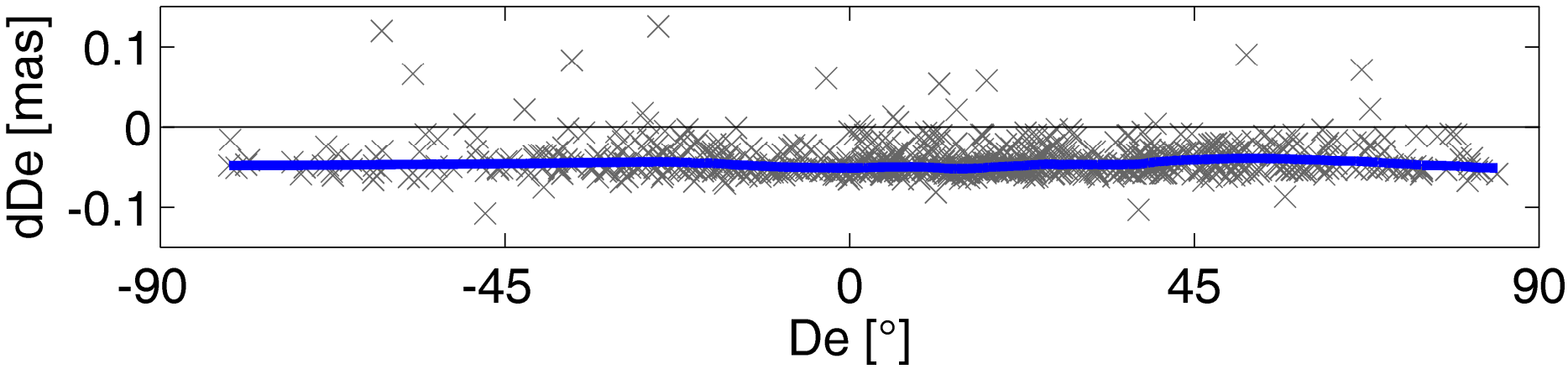


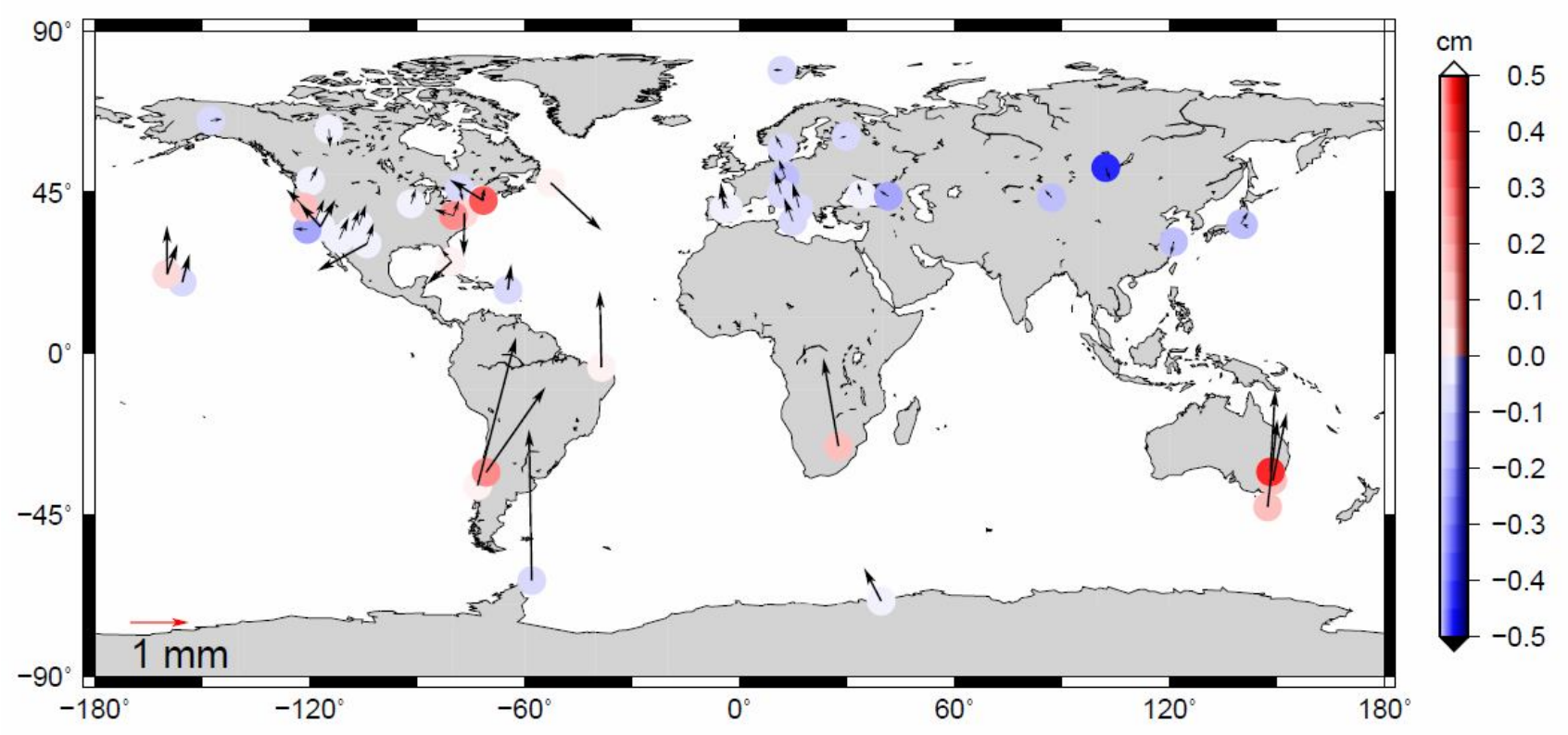
Constraints on Gradients

- 6 h piecewise linear offsets as gradients
- 0.5 mm relative and 1 mm absolute constraints
- Zero vs. DAO a priori gradients



mean bias in declination ≈40 μas

Constraints on Gradients



TRF changes at J2000.0
(Spicakova et al., 2012)

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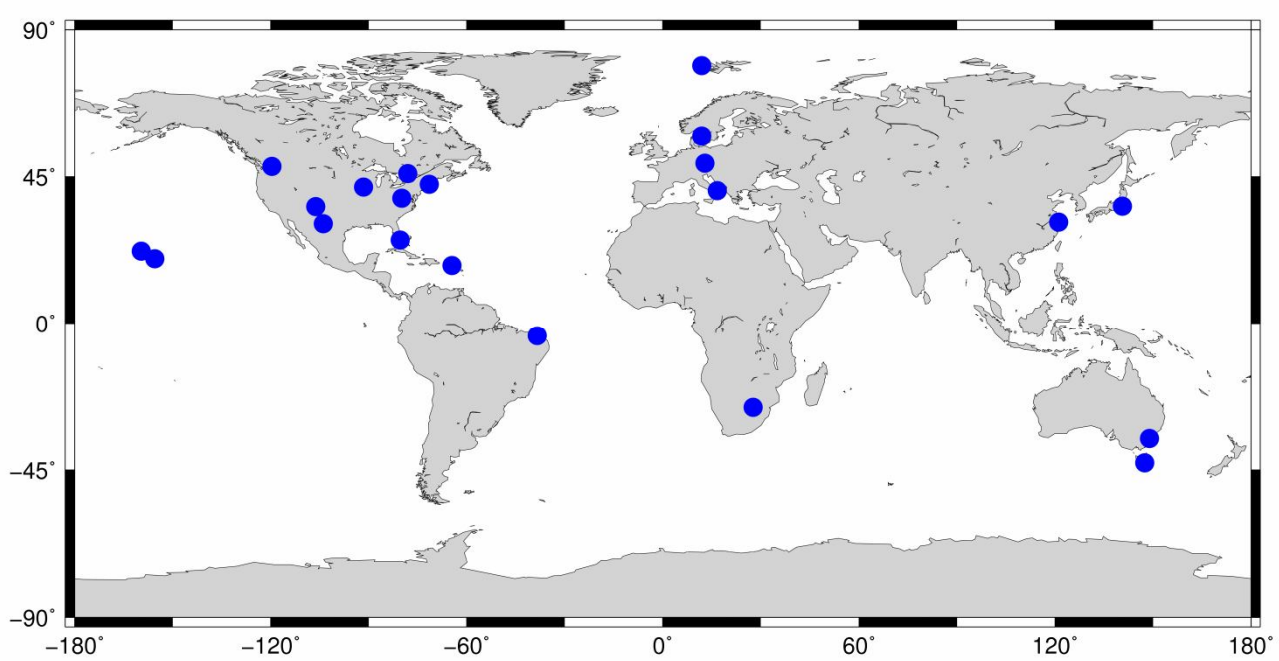
Geophysical and Astronomical Effects

- Insufficient models
- Terrestrial reference frame
  - Poor geometry in the southern hemisphere
  - Modeling of non-linear station motions
  - Dependence on ITRF datum
  - Choice of datum stations for NNR/NNT

Selection of Datum Stations

- 6 instead of 22 datum stations



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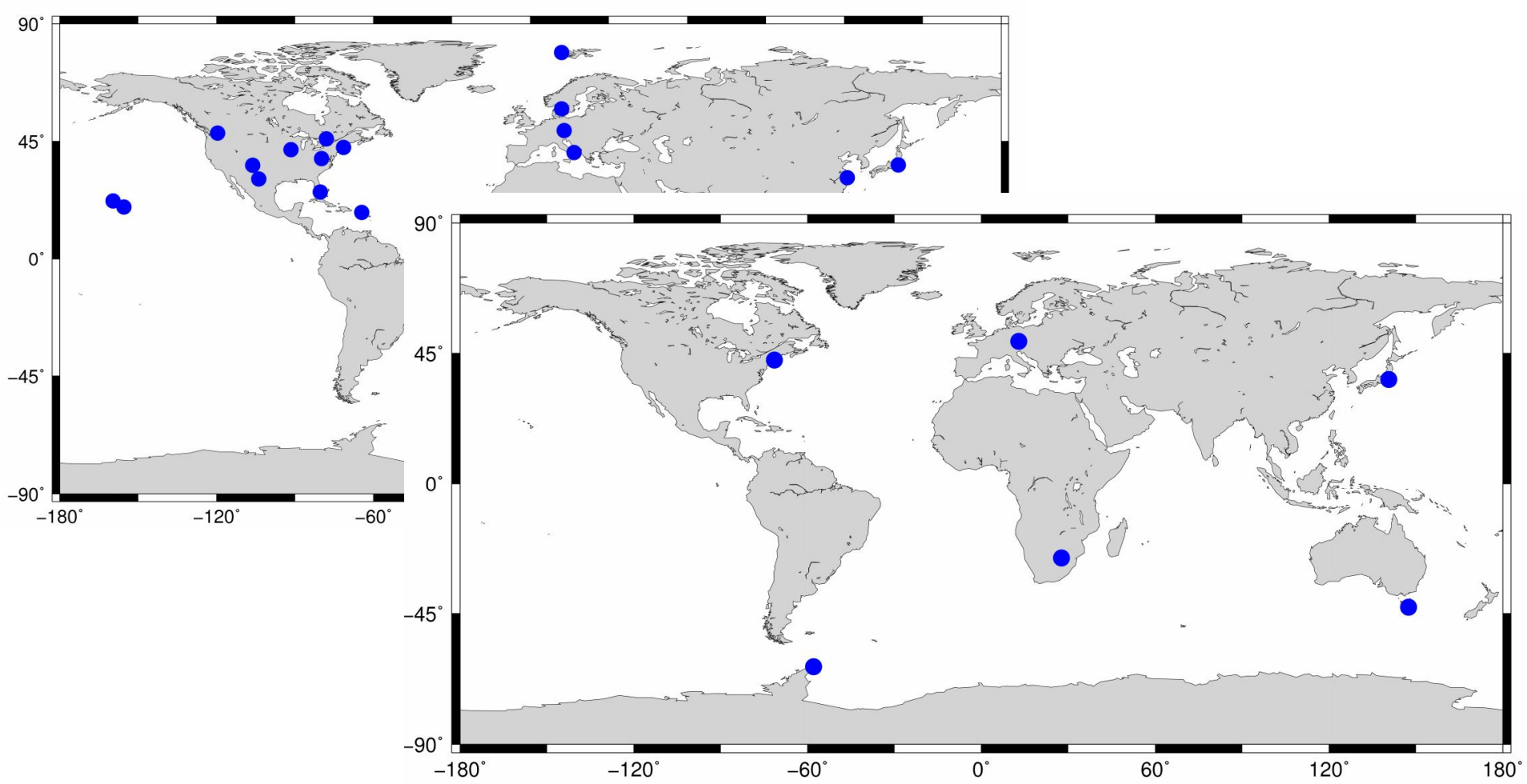

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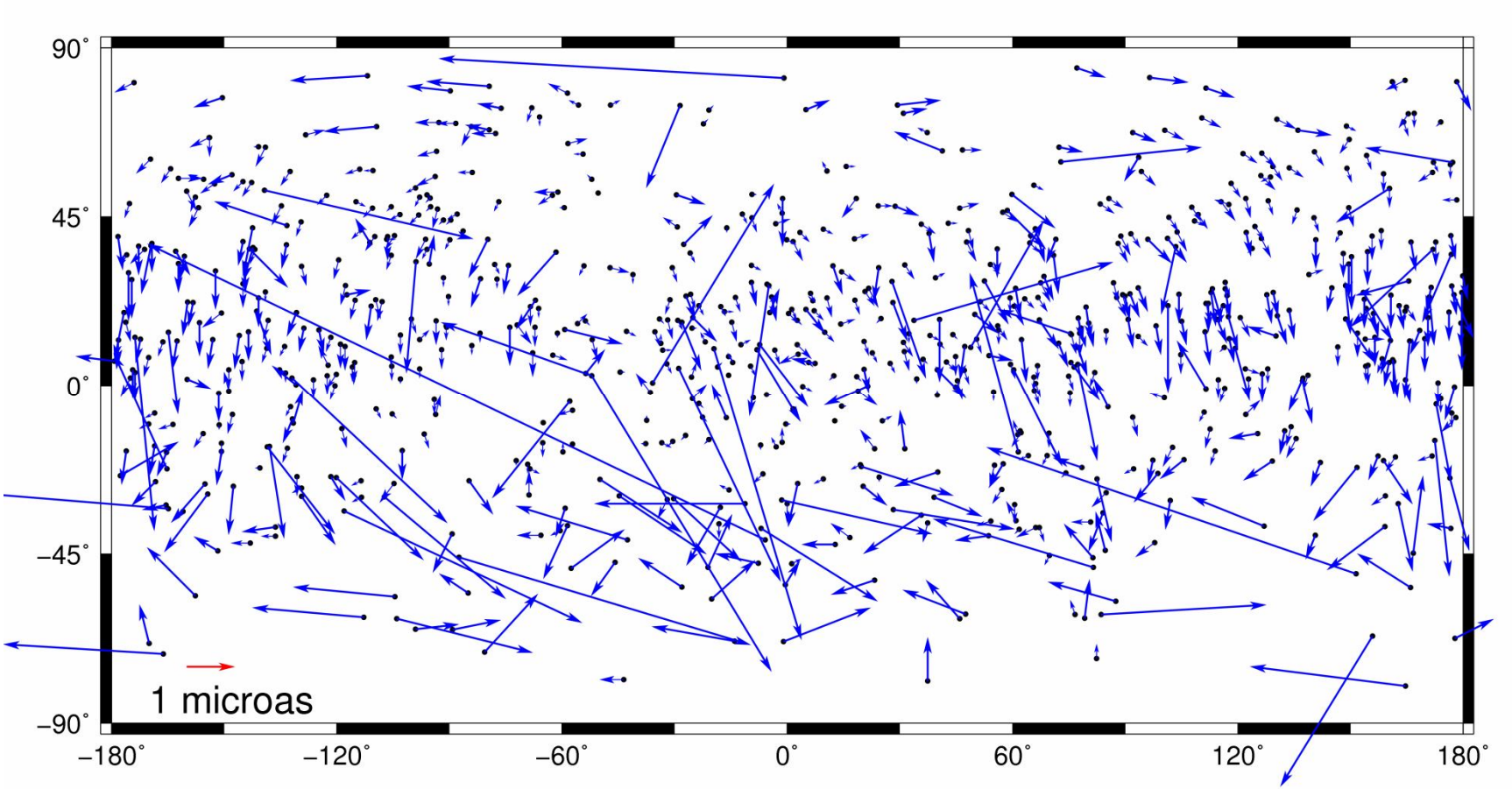
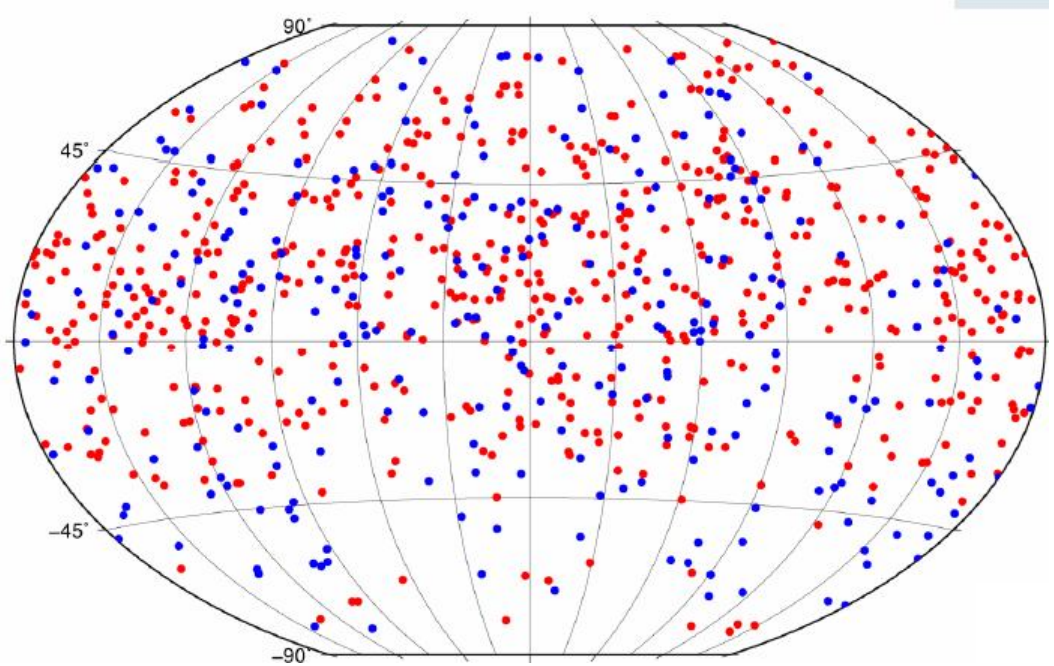


Geophysical and Astronomical Effects

- Insufficient models
- Terrestrial reference frame
- Celestial reference frame
  - Uneven distribution of sources over sky



Geophysical and Astronomical Effects

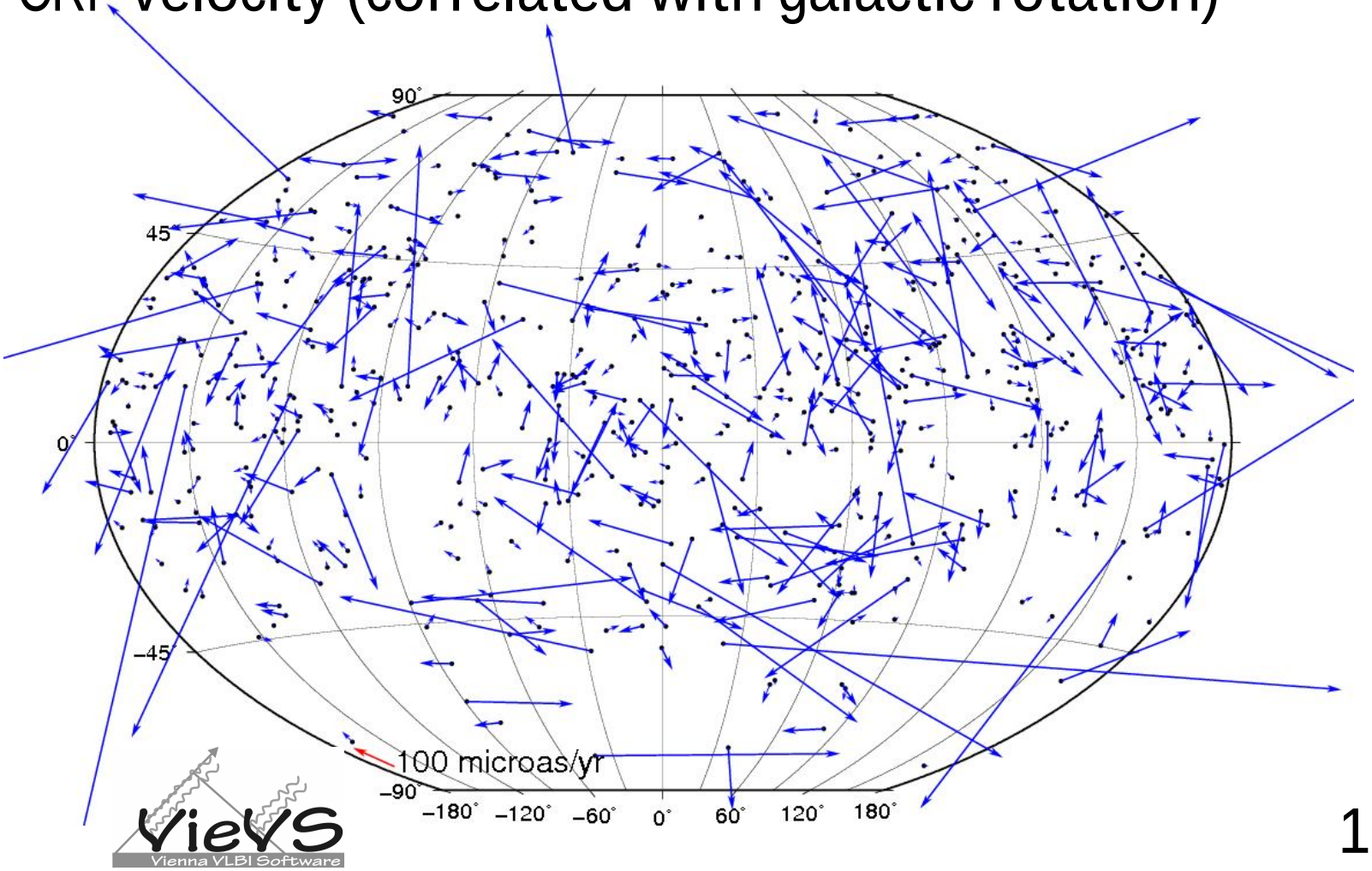
- Insufficient models
- Terrestrial reference frame
- Celestial reference frame
  - Uneven distribution of sources over sky
  - Impact on Earth rotation (presentation by Nilsson)

Geophysical and Astronomical Effects

- Insufficient models
- Terrestrial reference frame
- Celestial reference frame
- Astronomical effects
  - Apparent source motions
  - Source structure effects / wavelength dependency
  - Galactic rotation

Geophysical and Astronomical Effects

- CRF velocity (correlated with galactic rotation)



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Co-location on Earth and in Space

- ITRF2008 is determined by a VLBI/GNSS/SLR/DORIS combination (intra-, then inter-technique)
- ICRF2 is VLBI-only solution (once AC)
- Next ICRF should be estimated together with ITRF
  - Connection via local ties
  - see presentation by M. Seitz

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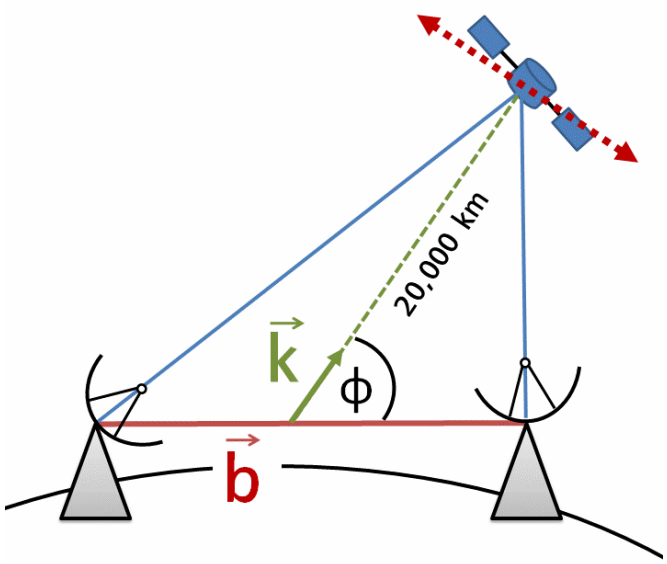
- more possibilities
  - Troposphere ties

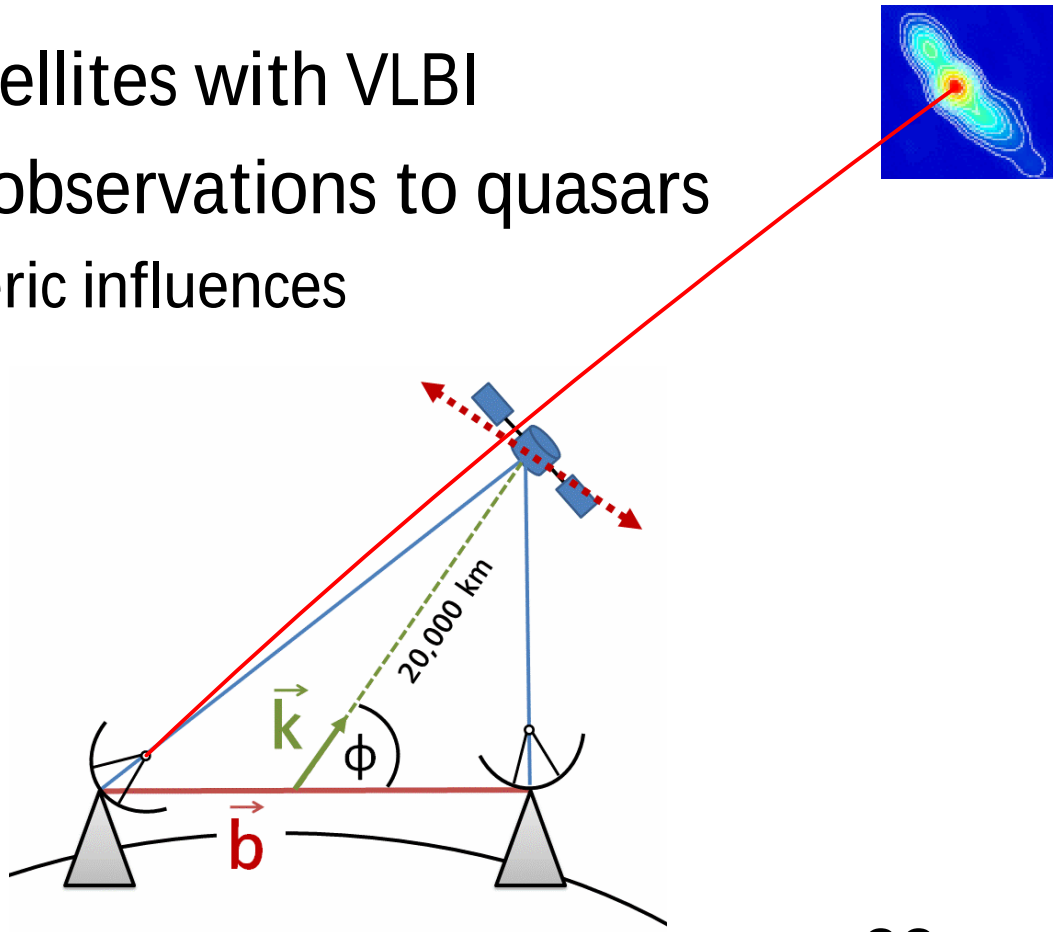
Co-location on Earth and in Space

- Space ties
  - Observing GNSS satellites with VLBI (Tornatore and Haas)



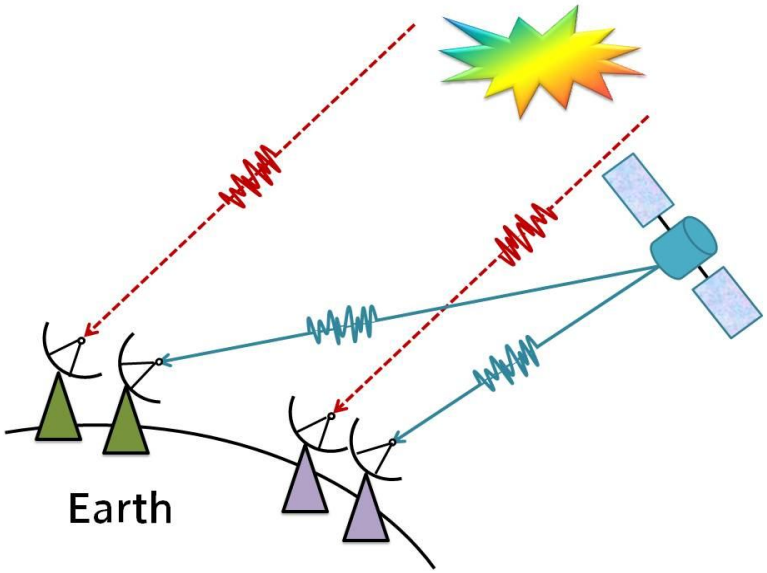
Co-location on Earth and in Space

- Space ties
  - Observing GNSS satellites with VLBI
  - Adding differential observations to quasars
    - mitigates atmospheric influences



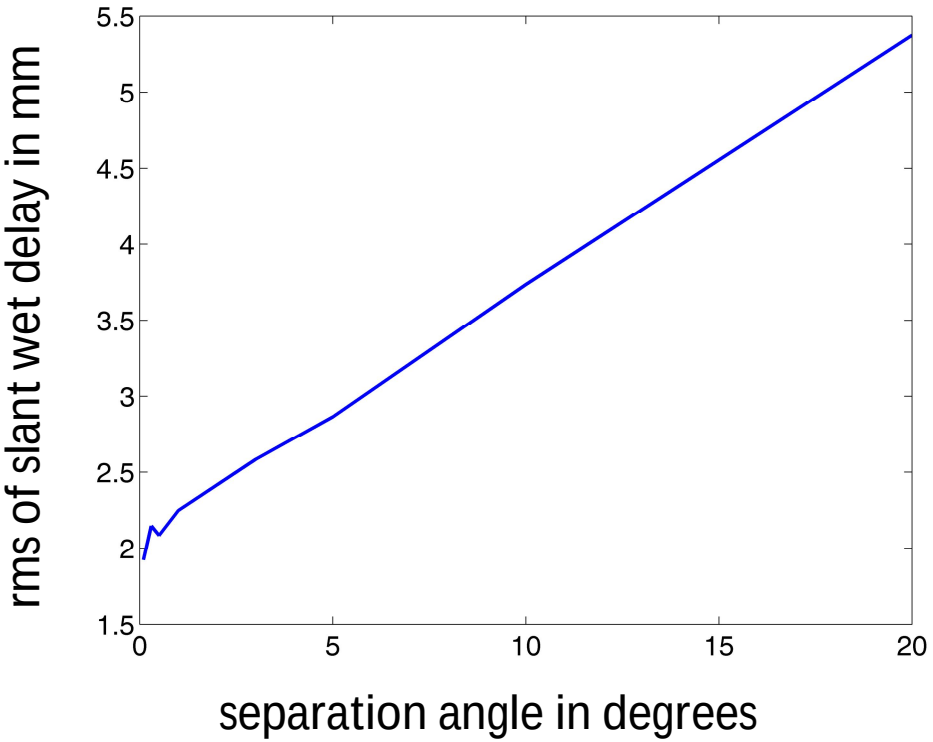
Co-location on Earth and in Space

- Space ties
  - Observing GNSS satellites with VLBI
  - Adding differential observations to quasars
  - Or even mixing both with twin telescopes



Co-location on Earth and in Space

- Effect on slant wet delay at 30° elevation
  - when alternately observing source and satellite every 15 seconds (turbulent atmosphere)

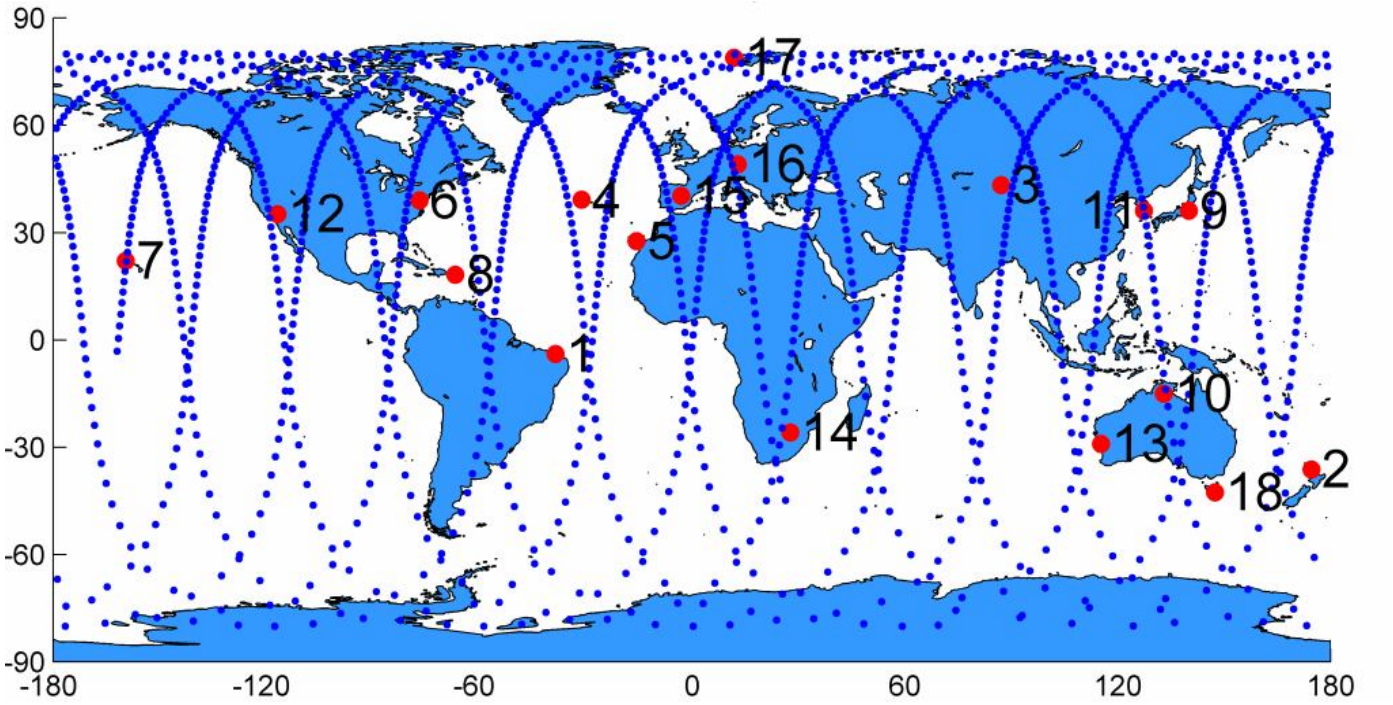


Co-location on Earth and in Space

- Space ties
  - Observing GNSS satellites with VLBI
  - Adding differential observations to quasars
  - Or even mixing both with twin telescopes
  - GRASP like satellites

Co-location on Earth and in Space

- GRASP (Geodetic Reference Antenna in Space)
- E.g., h = 1350 km, i = 99.9°, e = 0.0334



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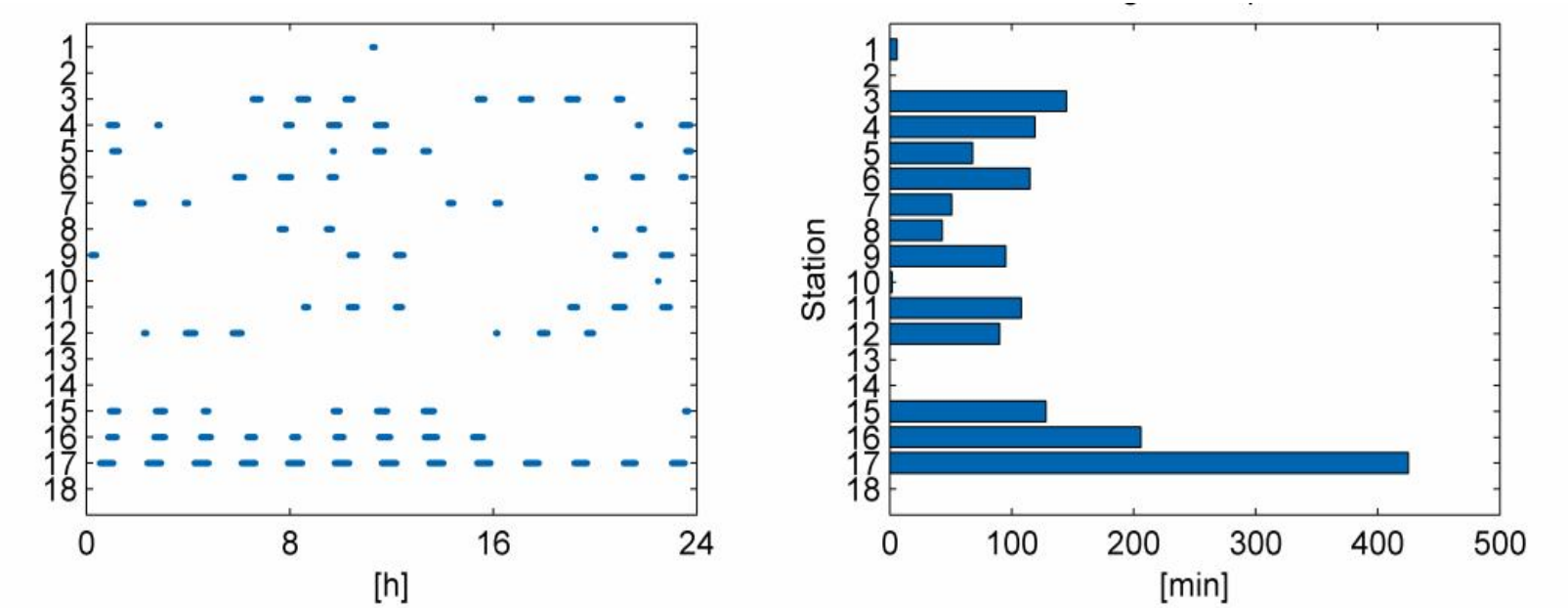
Visibility



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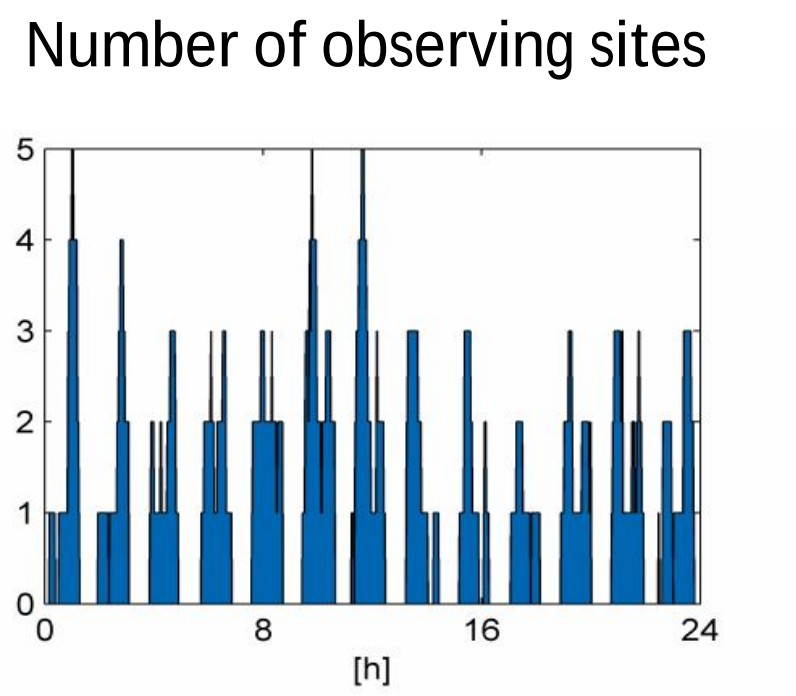

Maintenance of CRF and the link to the new GAIA frame

- GAIA mission scheduled for launch in 2013
- Optical realization of the CRF with similar precision
- At least an order of magnitude more objects
- For geodetic use the CRF realization must be accessible from the ground
- Search for optical/radio counterparts

Conclusions and Outlook

- A combined ITRF/ICRF/EOP solution from VLBI, GNSS, SLR, and DORIS should be striven for.
- Additionally, systematic errors need to be mitigated, not only by improved models but also by better observing strategies.
- VLBI2010 will open new possibilities.
- Space ties will greatly enhance the consistency between TRF and CRF.

Thanks for your attention!

D-VLBI
Integrated VLBI