# JUMPING JIVE - WP7
# Astrometry and geodesy

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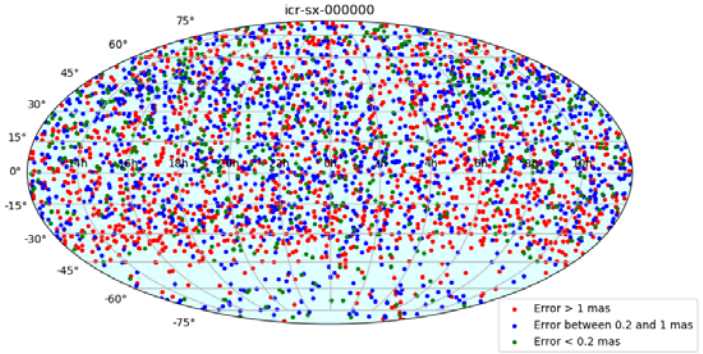
# Outline

- Will cover three fields
  - Astrometry (global, i.e. celestial reference frames)
  - The Earth's rotation
  - Geodesy (i.e terrestrial reference frames)

- For each field, attempt to address
  - Where we are
  - Where we are going
  - Potential role of the EVN

# Celestial frames: background

- ICRF2 (International Celestial Reference Frame, 2nd realization)
  - Includes 3414 extragalactic sources
  - 295 « defining » sources
  - Noise floor of 60 µas
  - Built in 2009, hence outdated

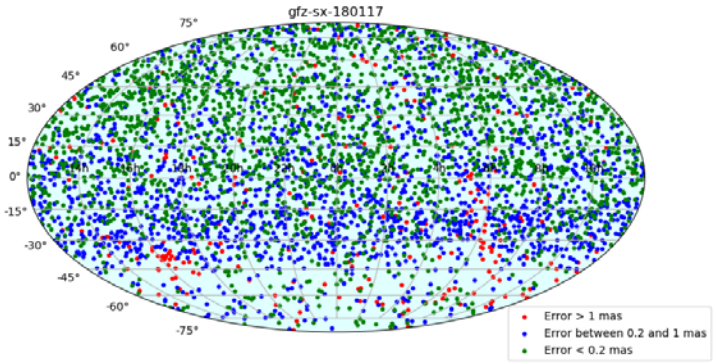



Credit: S. Lambert and F. Arias / ICRF3 Working Group

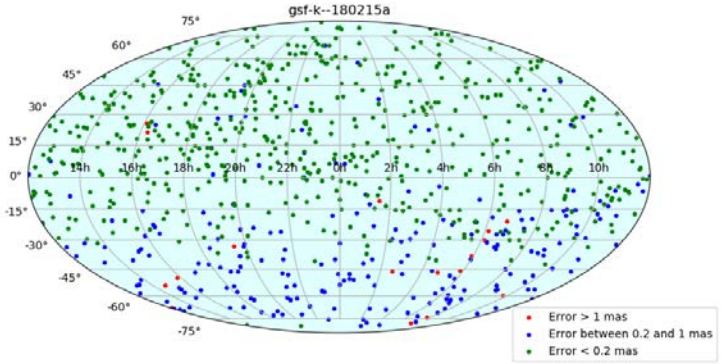
- ICRF3 (3rd realization)
  - Is currently built by a Working Group of the IAU, chaired by P. Charlot
  - Will use state-of-the-art astronomical and geophysical modeling
  - Twice as many observations compared to ICRF2

# Celestial frames: current status

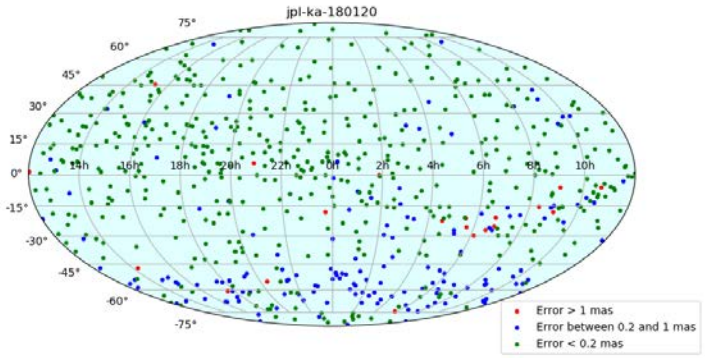
S/X band



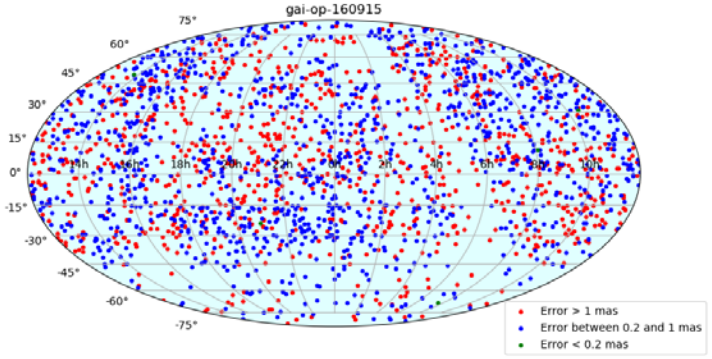

K band




X/Ka band



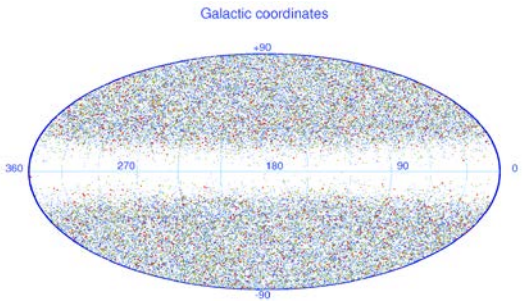

Gaia DR1 (optical)




Credit: S. Lambert and F. Arias / ICRF3 Working Group

# Celestial frames: short term

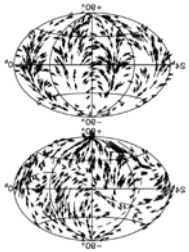
- Release of ICRF3
  - Must be finalized by summer 2018
  - To be presented at IAU General Assembly 2018 for adoption as the new IAU fundamental celestial reference frame (in replacement of ICRF2)
  - Should be a multi-frequency frame (including positions at S/X, K and X/Ka bands)
- Release of Gaia DR2 (optical)
  - On 25 April 2018
  - Will comprise > 500 000 quasars
  - Position accuracy comparable to ICRF3




Credit: Slezak and Mignard (2008)

# Celestial frames: the future

- Areas of work (beyond ICRF3)
  - Improving the density of sources in the far South
  - Improving the North-South geometry
  - Continue to develop the frame at the higher frequencies (K and X/Ka bands)
  - Align at best the VLBI and Gaia frames
- Science (excluding « practical » applications)
  - Comparison of the location of the radio and optical emission for any source in the sky (extragalactic of Galactic) at sub-mas level
  - Detection of core shifts in AGN by comparison of the S/X, K and X/Ka band VLBI positions
  - Measurement of galactocentric acceleration
  - Upper limit (or detection) of gravitational wave background (through proper motions of quasars)
  - …



Credit: Gwinn et al. (1997)

# Celestial frames: role of the EVN

## *Jointly with the AVN (African VLBI Network)*

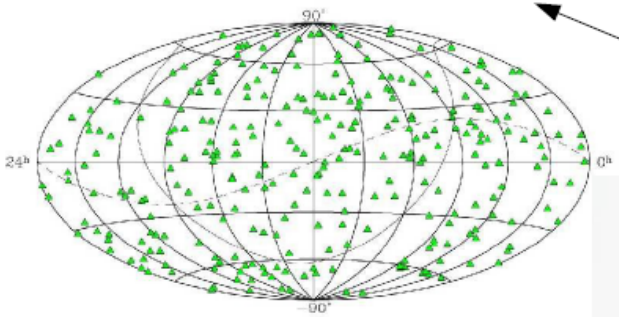
- Strengthen the North-South geometry and contribute to improving position accuracy at mid-southern declinations
- Densify the K band frame by taking advantage of the high sensitivity of the network

## *Jointly with the AVN and SKA1*

- Densify massively the radio frame
- Build the radio counterpart of the Gaia optical frame…

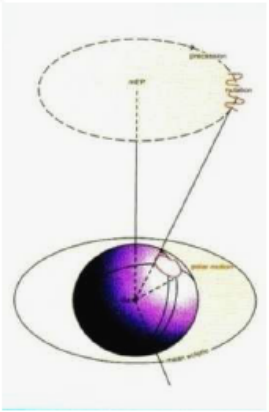
# Moving to Earth rotation and geodesy…

ICRF



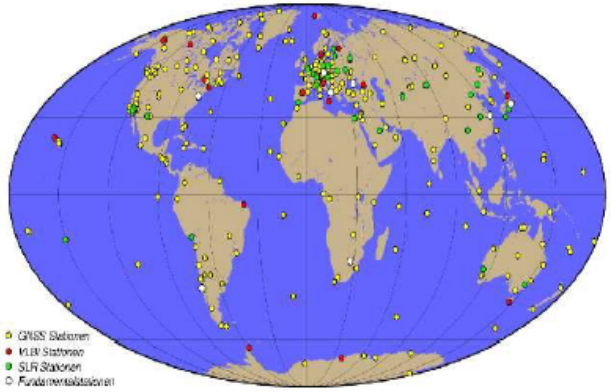
quasar positions

EOP



precession
nutation
polar motion
UT1-UTC

ITRF



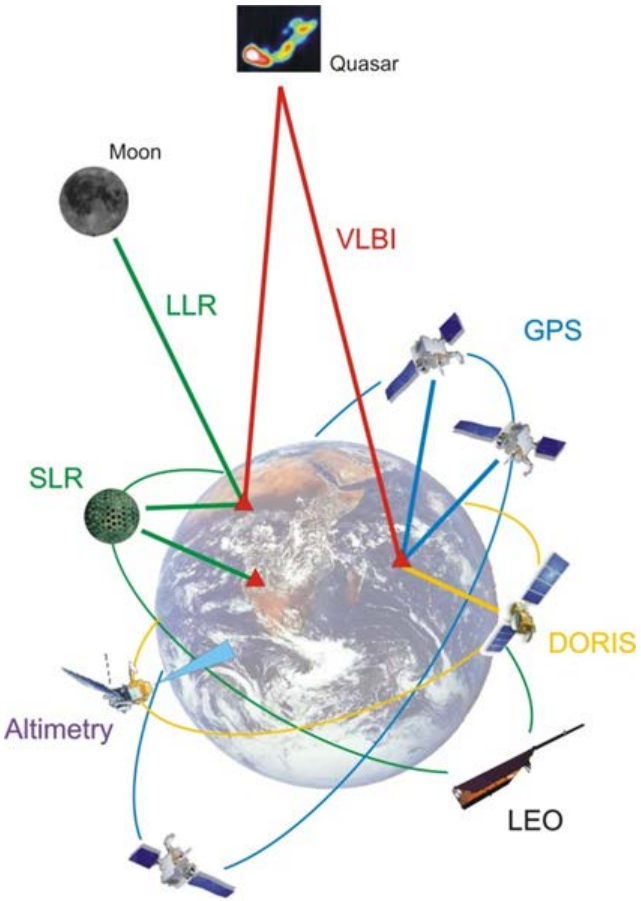
ref. point positions and velocities
time series
baselines

VLBI is the only geodetic space technique which provides:
ICRF, ITRF and the full set of Earth orientation parameters (EOP).

Credit: H. Hase

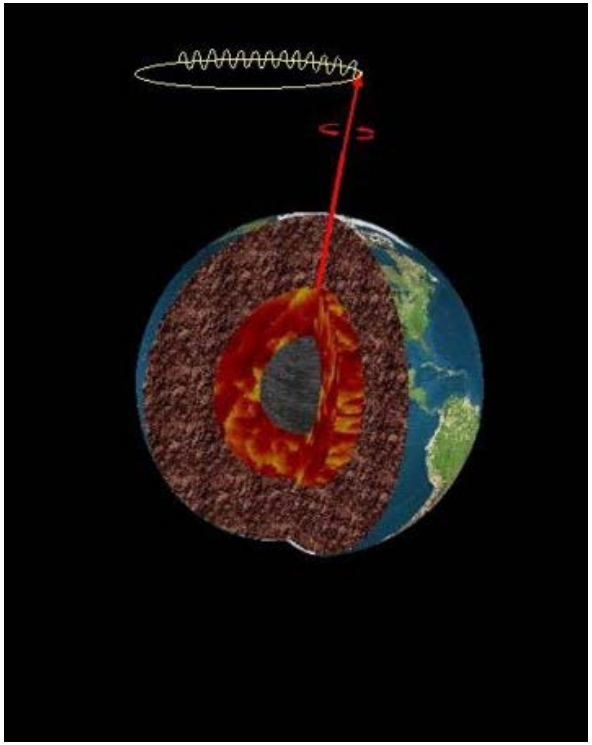
# The geodetic space techniques

- Geodetic space techniques (VLBI, GPS,Galileo, SLR, LLR, DORIS,…) are used to:
  - Monitor the Earth's orientation
  - Establish the terrestrial reference frame (e.g. ITRF2014)
- VLBI is unique for determining:
  - UT1-UTC
  - Precession and nutation
- Note: superconducting gravimeters are becoming competitive for
  - measuring nutation



# Nutation: key challenges

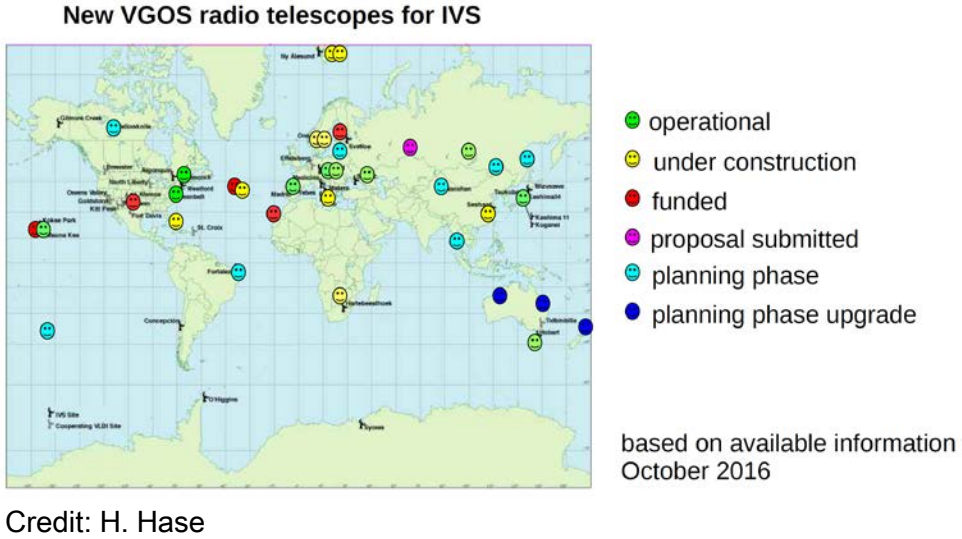
- Detection of the solid inner core
  - Through monitoring of the VLBI nutation with the highest accuracy
  - Independent from seismic data
- Understanding the origin/variability of the FCN (free core nutation)
  - Requires regular, long-term VLBI monitoring
  - Progress in global circulation models
  - Progress in the theory of the Earth's rotation
- Question: does the nutation annual term vary?



*Nutation allows one to learn about the Earth's interior*

# The Earth's rotation: role of EVN

- Requires regular, permanent monitoring with VLBI
- Is to be done by the future VGOS network of the IVS (with some VGOS stations at EVN sites)



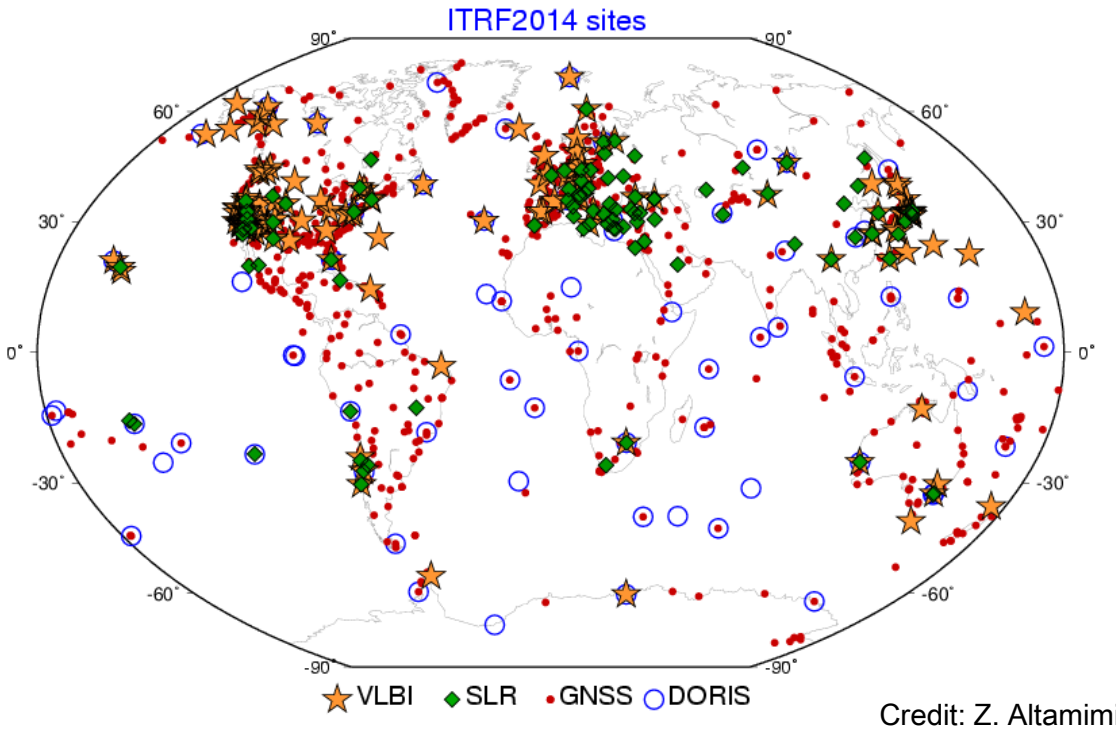

Credit: H. Hase

- Not sure the EVN has a role to play here (but help with correlating VGOS data may be needed…)

# Terrestrial reference frames

## International Terrestrial Reference Frame

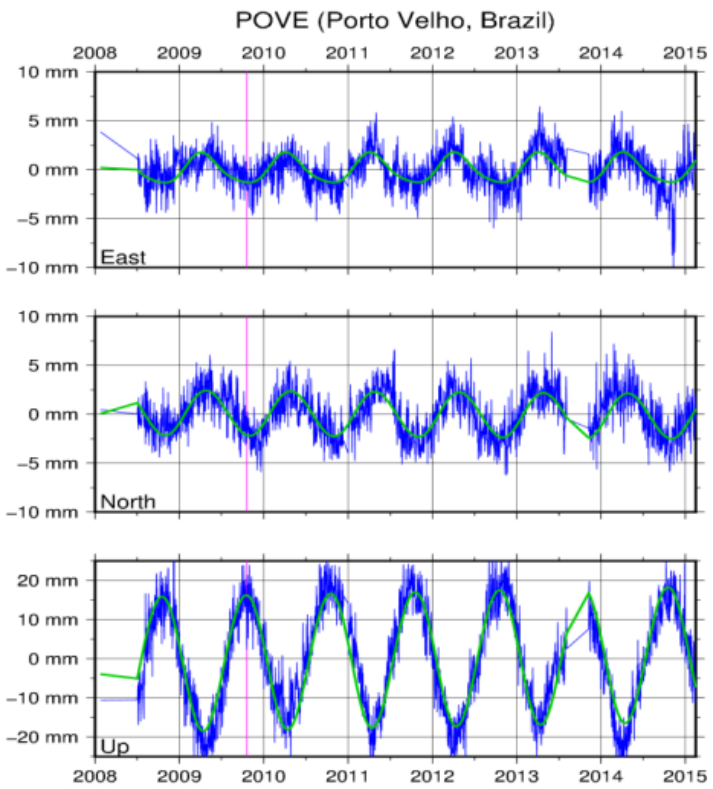
### Current version: ITRF 2014




Credit: Z. Altamimi

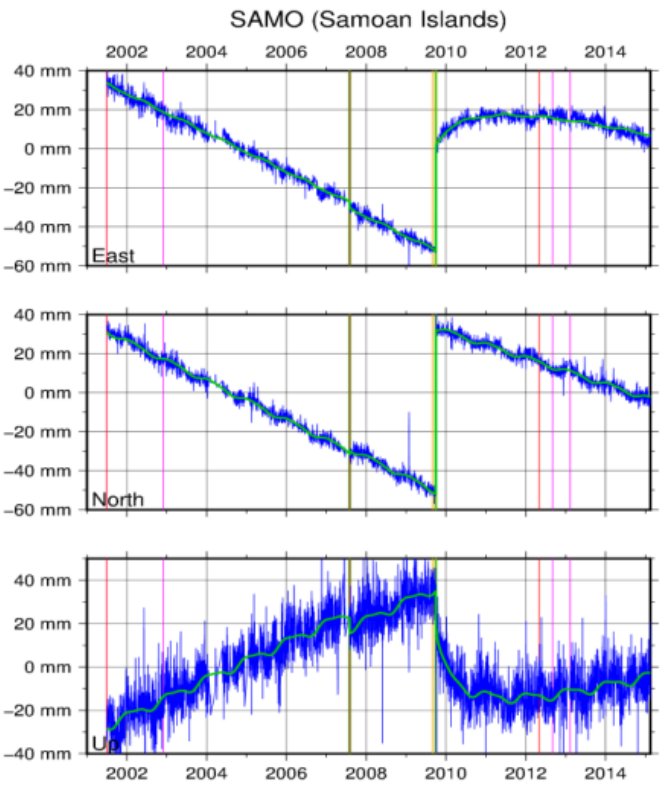
# ITRF2014: new features

## Seasonal signals




Credit: Z. Altamimi

## Post-seismic deformations




Credit: Z. Altamimi

# ITRF: impact of VLBI

- Current VLBI observing not designed for terrestrial frame work: sparse network, sparse sessions
  - Situation may be different for VGOS (continuous observing)
- VLBI contributes to defining the ITRF scale
  - Together with SLR
  - Unsolved issue: disagreement between VLBI and SLR scale (1.37 +/- 0.10 ppb)
- Have not yet really thought about the possible role of EVN in this context…