DORIS DAYS 2021

November 16,17 and 18

Geodetic requirements

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Session 3 – Presentation 9

Network contribution to Geodesy

- International Terrestrial Reference Frame (ITRF)
  - Even distribution of the stations
  - Co-location with other space geodetic techniques (GNSS, SLR, VLBI)
- Global Geodetic Observing System (GGOS)
  - Striving for mm data quality
  - Participating to the GGOS Core Sites development
- Local scientific research activities
  - Sea-level monitoring
  - Crustal deformation monitoring
  - Local reference frame improvement

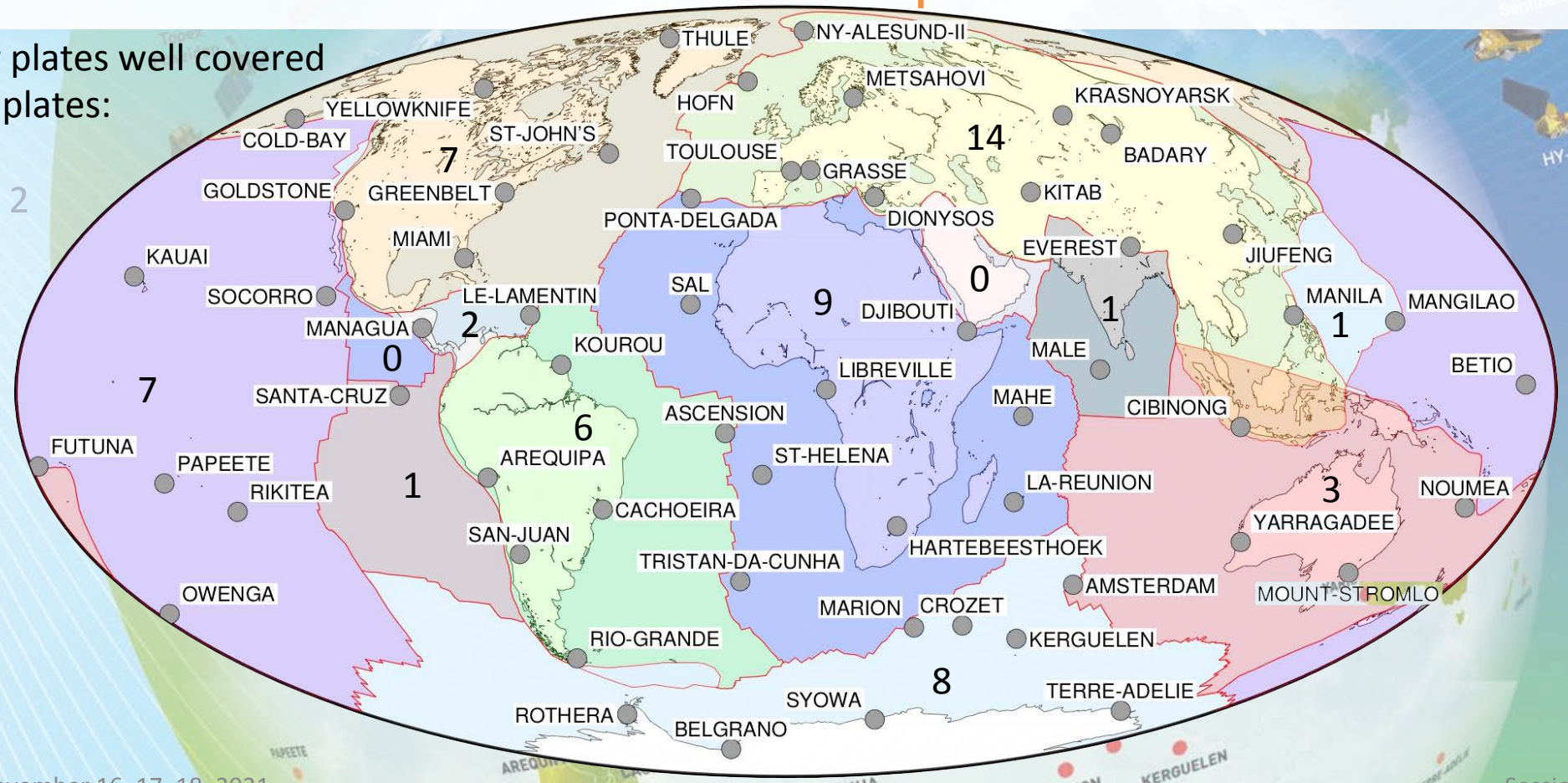
Network geodetic requirements

1. Distribution
   - Geometry
   - Tectonic plates coverage
2. Co-location
   - Multiplication of the number of co-located sites
   - Maximum distance between instruments
3. Stability
   - Short-term and long-term stability of the antenna monument
   - Standard monuments
4. Antenna Installation
   - Antenna verticality
   - Precise determination of the antenna reference point position
5. Local tie survey
   - Connecting all reference points at co-located sites through terrestrial measurements

1. Distribution

- Continual improvement of the distribution with new sites
- At least 2 stations on each tectonic plate

All primary plates well covered
Secondary plates:
Arabian: 0
Caribbean: 2
Cocos: 0
Filipino: 1
Indian: 1
Nazca: 1



2. Co-location (1/2)

- Definition
  - All instruments are part of core networks of global observing system: IDS, IGS, ILRS, IVS, GLOSS, PSMSL.
  - The spacing between instruments must meet the definition of a geodetic site: unique site identifier (DOMES* number)
  - All reference points can be linked by high precision local tie surveys: distance = ideally a couple hundred meters, in any case < 1km
- Purposes
  - ITRF is based on the data combination of the 4 space geodesy techniques
  - Co-location sites are necessary for ITRF combination: terrestrial measurements (tie vectors) allow to connect the independent reference frames
  - Co-location with tide gauges allows monitoring of sea level variations

DOMES: Directory of MERIT sites (assigned by ITRS Product Center: IGN)*

***MERIT: Monitoring of Earth Rotation and Intercomparison of Techniques*

2. Co-location (2/2)

- Constraints
  - DORIS / VLBI compatibility => *see T. Klügel (BKG) presentation 11 session 3*
  - Regular local tie surveys
  - Necessary technical skills and equipment => *see D. Pesce (IGN) presentation 10*
- Permanent goals
  - Multiplying co-locations throughout the network development => *see session 1*
  - Achieving the best possible accuracy in the tie vectors (TVs) determining
  - Make available DORIS TVs at co-located sites

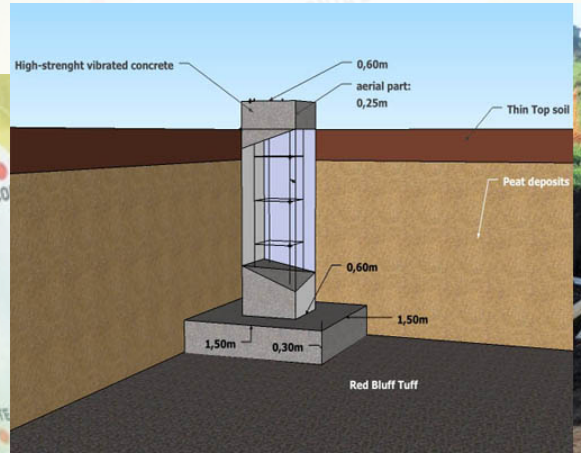
    ⇒ *File available on ftp://doris.ign.fr/pub/doris/cb_mirror/stations/**DORIS_ext_ties.txt** or CDDIS*

    : Tie vectors with instruments identification, co-location dates, site survey date and precision

3. Stability (1/2)

Minimizing noise and systematic errors in the station position time series

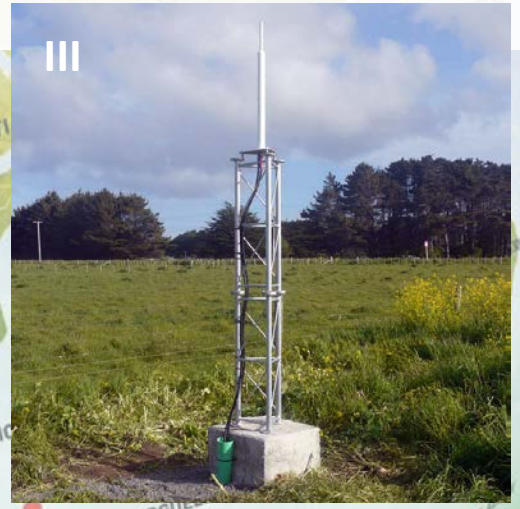
- Long-term life and stability of the stations
  - Very few relocations or changes of sites to have long position time series
- Ground stability
  - Avoid locations with landslides, drought-affected areas, soft soils…
- Long-term stability of the antenna monument
  - Monuments must be firmly coupled with the substrate
  - Properly size the monument foundations according to the soil structure
- Stability of the antenna support in the short term
  - Minimizing thermal or elastic distortion due to weather conditions



3. Stability (2/2)

Avoiding any uncontrolled displacement of the antenna reference point

- **Standard monuments**
  - Type I: short steel tower installed on load- bearing wall
  - Type II: small stainless steel tripod installed on concrete pillar
  - Type III: very rigid 2 m high steel tower on concrete pad
- **Assessment of metallic structures stability**
  - Elastic deformations < 1 mm when undergoing extreme climatic conditions
  - *Further details: Saunier, J., 2016. Assessment of the DORIS network monumentation. Adv. Space Res. 58 (12), 2725–2741. http://dx.doi.org/10.1016/j.asr.2016.02.026.*

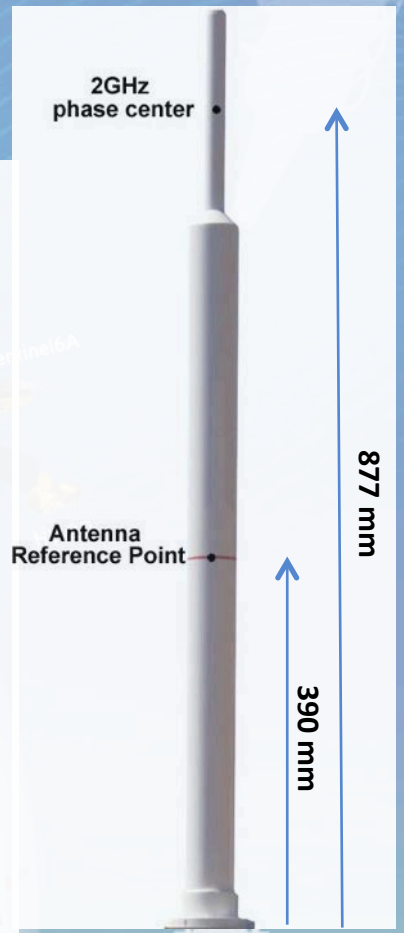


4. Antenna installation

- Antenna Reference Point (ARP)
  - Roughly indicated with a red painted ring
  - ARP = located on the antenna axis 390 mm above the antenna base
  - Physical point on the antenna to which the station coordinates are assigned
- Actual Measurement Point (AMP)
  - 2GHz phase center: located on the antenna axis, 877 mm from the antenna base
- DORIS Mark
  - Witness mark underneath the antenna

⇒ **EX. F_178: Verticality of the antenna must be better than 0.5 for 1000**

⇒ **EX. F_100: tie vector determination between successive antenna positions**

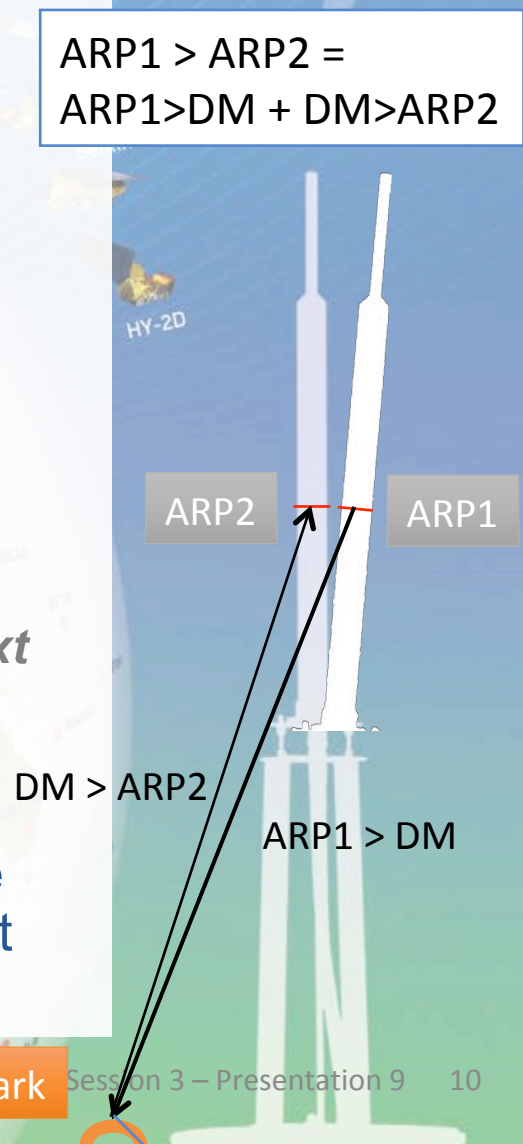


DORIS Mark

5. Local tie survey (1/2)

- Initial coordinates determination
  - The ARP coordinates are derived from tie vectors with available known points in the vicinity: IERS stations or markers
  - Input for the DPOD (set of coordinates and velocities of all the DORIS tracking stations for Precise Orbit Determination) => *see F. Lemoine (NASA) presentation 1 session 2*
- Successive antenna locations on the same site
  - Systematic local tie surveys in order not to disrupt position time series
  - Tie vector between the former and the new ARP position

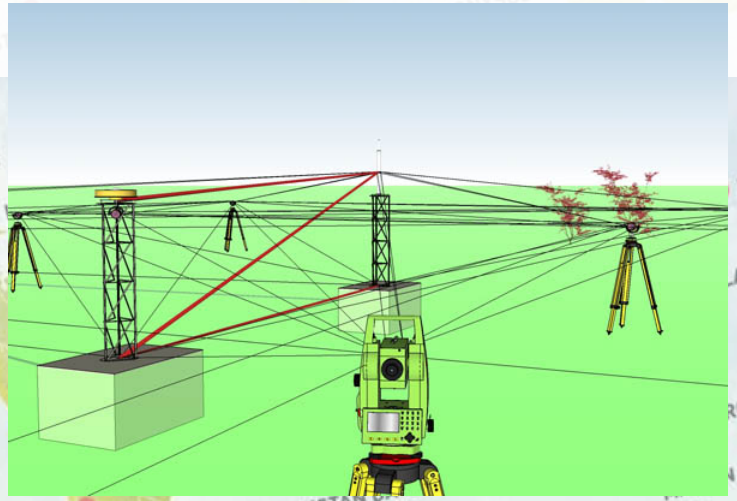
  ⇒ *File available on ftp://doris.ign.fr/pub/doris/cb_mirror/stations/**DORIS_int_ties.txt** or CDDIS*
- Antenna replacement
  - Local tie survey as much as possible in order to check the stability of the antenna monument and correct possible manufacturing defect (imperfect reproducibility between antennas)



5. Local tie survey (2/2)

- Site survey at co-located sites
  - Relative position between reference points of space geodetic instruments
  - Determined by standard surveying methods using topometry, leveling and GNSS observations
  - Achieving the best possible accuracy in the tie vectors determining
  - Tie vectors current accuracy: 1 to 4 mm
  - Carrying out as far as possible periodic local tie survey to better contribute to ITRF
  - Involvement in the IERS WG “Site surveys and co-location”:

    https://www.iers.org/IERS/EN/Organization/WorkingGroups/SiteSurvey/sitesurvey.html



Key points

- The contribution to geodesy is taken into account in the site selection
- Co-location is a permanent objective for the DORIS network
- Stability of the antenna monument is a key requirement to minimize velocities uncertainty and noise in the position data
- The antenna installation requires systematic site survey in order to adjust its verticality and ensure good quality position data
- Local tie surveys allow continuity in the position time series and contribution to new ITRF solutions