



**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

Gateway to the Earth

Thoughts on Challenges facing SLR: SLR analysis, Geodesy and measurement bias

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Scope

To focus on the primary geodetic aspects of SLR:

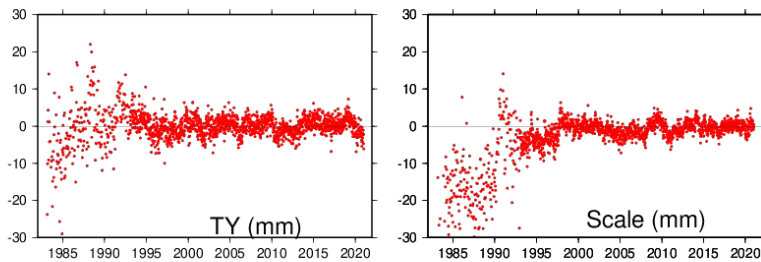
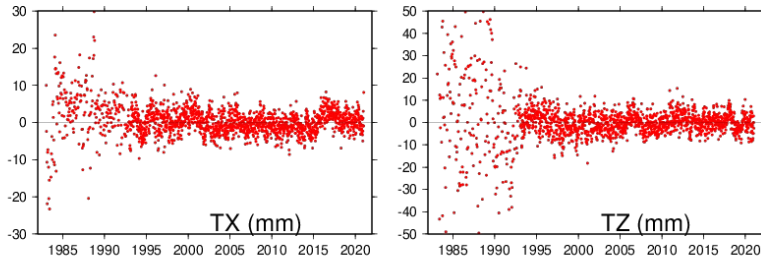
- Major contribution to realisation of the ITRF
 - **Accurate** data absolutely critical in this effort
- Determination of long-wavelength gravity field terms
 - In conjunction with dedicated missions
- Which satellites and best observing strategy:
 - Primarily the LAGEOS, LARES-2 and Etalons
- 'Threats' from the other techniques?
 - Geocentre from DORIS, GNSS?

Reference frame

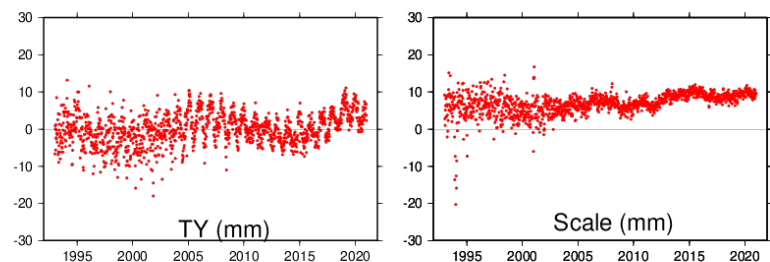
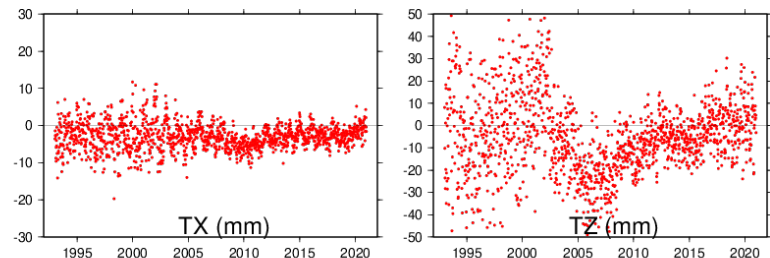
- All four Techniques are working toward achieving the common GGOS goal of realising a TRF:
 - with accuracy 1mm, and stability 0.1mm yr^{-1}
- The laser ranging technique is capable **uniquely** to determine the origin of the TRF (CoM of Earth sys)
- and, with VLBI, the scale of the TRF;
 - But, let's not be complacent:

From published ITRF2020 results

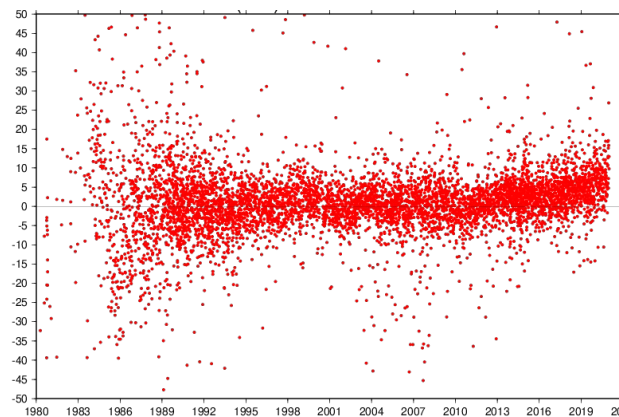
<https://itrf.ign.fr/en/solutions/itrf2020>



SLR



DORIS



VLBI Scale

accuracy

- Intrinsically the SLR technique is capable of 1mm range *accuracy*;
- In practice this is a hard aim, but not impossible
- Key is to detect and mitigate long-term, entrenched systematics, station by station
 - As well as detecting transitory ‘glitches’
- All stations were and are found to have *some* systematic bias *
 - From a few mm to a cm or more;
 - Target-board survey error; ToF hardware error; variable return rates, etc.

* J Geod, 2016

ITRF2020 strategy

- Great deal of work done by the CCs using AC's 'SSEM' solutions that solved for RB **and** ref frame
 - Average RBs found empirically per station at variable time intervals;
 - Used to populate 'data handling file'
 - ACs re-run solutions *using* averaged RB
 - i.e., a two-stage process needed for ITRF2020
 - Mostly, RB is not solved-for during this 2nd stage

Impact on ongoing observing practices

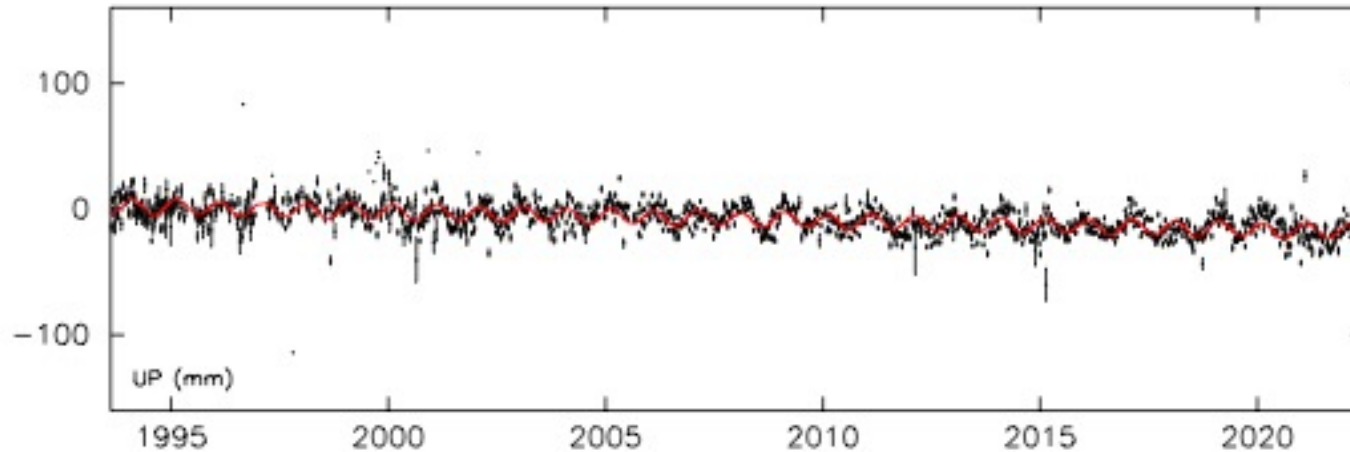
- Most important is that any bias remains *fixed*
 - i.e., hardware/practices not **often** 'tuned'
 - A fixed bias will be determined during analysis
- Essential that site logs are modified to follow changes
 - Particularly important in order to inform CoM updates
 - Rodriguez, 2019, JoG

Impact on ongoing observing practices

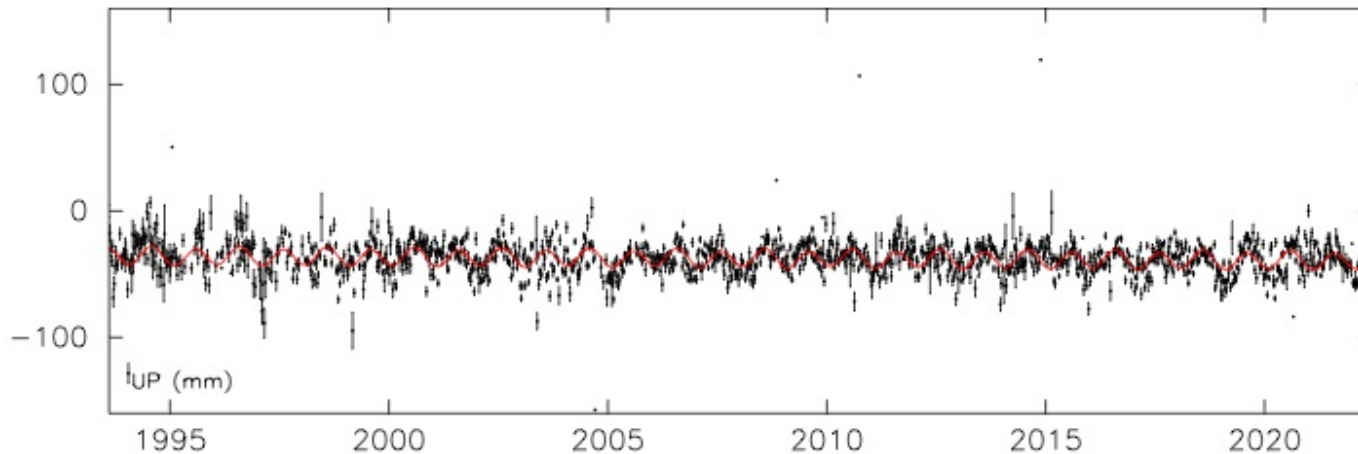
- Given the need (mostly) for RB to be solved together with the reference frame:
- Lots of data!
 - Very useful to get low elevation parts of passes:
 - This greatly helps the separation of height & RB
- -Track LAGEOS & LARES-2 to **as low an elevation as your system normally permits.**
- Resist quitting at low elev. to get another sat!

Heights of two stations with RB solved each 7-day arc

Height velocity stabilities at 0.1mm/y



7090



7840

thoughts

- Many new demands on LR telescope time
- Important to remember to support the realization of the reference frame
 - Good number of LAGEOS, LARES-2, Etalon NPs
 - Used also for J2, J3 to constrain e.g., GRACE-FO fields
- Document and publicise system/practice changes
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