ITRF2020 Update
Call for participation

Background

Starting with ITRF2005 and continuing with ITRF2008, ITRF2014 and ITRF2020, the International Terrestrial Reference Frame (ITRF) construction used time series of station positions and Earth Orientation Parameters (EOPs): weekly from DORIS and SLR, daily from GNSS and session-wise from VLBI. Time series are essential for the ITRF to account for not only station nonlinear motions and discontinuities but also to evaluate the stability over time of the physical frame parameters, namely the origin and the scale, which are critical for Earth science applications. The ITRF rigorous combination provides a self-consistent series of EOPs, including Polar Motion from VLBI and satellite techniques, and Universal Time and Length of Day from VLBI only.

The ITRF2020 marked considerable innovations compared with previous versions of the ITRF, by modeling nonlinear station motions (seasonal signals and Post-Seismic Deformation – PSD– for sites subject to major earthquakes), It also benefited from the improvement of the reprocessing efforts undertaken by the Technique Centers (TCs: International VLBI Service for Geodesy and Astrometry (IVS), International Laser Ranging Service (ILRS), International GNSS Service (IGS), International DORIS Service (IDS)).

A full open access article on ITRF2020 is now available (Altamimi et al. 2023; see reference at the end of this document), detailing the analysis strategy as well as the main geodetic and geophysical results.

For a number of reasons detailed below, the ITRS Center proposes to update the ITRF2020 at a regular yearly interval, by adding and accumulating extended time series, and therefore solicits the contribution of the four TCs. The ITRF2020 global combination has consisted by stacking / accumulating the four contributed technique time series all together. Therefore adding 3 years of time series for the first update, and yearly update for the following years, should be easy to handle.

ITRF2020 Update Motivation

The proposed regular (yearly) update of the ITRF2020 is motivated by the following reasons:

- Errors in ITRF station coordinates are more and more amplified as they are extrapolated after the end of the ITRF input data;
- ITRF stations subject to equipment changes or earthquakes posterior to the end of the ITRF input data cannot be used anymore as reference frame stations;
- For the above reasons, most of the TCs regularly update their own realizations of the ITRF. For the same reasons, we propose regular (yearly) updates of ITRF2020. This will increase its lifetime and may postpone the need for the next version of the ITRF.
- The ITRF long-term origin stability is evaluated to be at the level of or better than 5 mm and 0.5 mm/yr for its time evolution. For the first time of the ITRF history, the scale agreement between SLR and VLBI as result of ITRF2020 analysis is now at the level of 0.15 ppb (1 mm at the equator), with zero drift. We therefore do not expect significant changes for the origin and the scale by adding a few years of new data. Consequently, ITRF2020 updates will keep the same frame parameters of the ITRF2020 in origin, scale and orientation. This will accommodate and facilitate the life of a number of users, with no “datum” change in their applications;
- The ITRF2020 updates will provide the opportunity to monitor the stability of its origin and scale. (In particular: how does the VLBI scale drift evolves after 2021.0? Do the SLR and

VLBI scales stay in ~agreement? Does the SLR origin drift or not from the ITRF2020 origin after 2021.0?). This monitoring will be helpful in deciding when a new ITRF version is needed.

ITRF2020 Update Specifics

The analysis strategy of the ITRF2020 updates will follow the one used for the ITRF2020 generation (Altamimi et al. 2023).
As stated above, while we plan to preserve the frame and seasonal signal defining parameters in origin, scale, and orientation for the ITRF2020 updates, their stability and consistency with respect to the ITRF2020 initial parameters will be monitored and assessed.

ITRF2020 updates will be delivered to the users using the same file format as ITRF2020.

The proposed ITRF2020 update is planned for the beginning of 2024. For this first update, the ITRS Center solicits input from the IERS TCs who are requested to provide time series covering the period 2021.0 – 2024.0, to be delivered **by February 10, 2024.**

In their (re)processing efforts, the TCs are invited to adhere to the same models and strategy used in their contribution to the ITRF2020 and to follow, to the extent possible, model updates and effects that are listed in the appendix of this call for participation (CfP) and ITRF2020 CfP, as well as tidal load and other displacements for which models are given in the IERS Conventions, and its updates (http://iers-conventions.obspm.fr/ or http://maia.usno.navy.mil/conventions)
However, the TCs are free to use updated models that are judged to be superior, improved and more accurate than models used for the ITRF2020 contribution.

Time Series Contributions

Contributed time series (daily/weekly) solutions to be included in the ITRF2020 updates should be provided in SINEX format and comply with one of the following constraint categories:

- Solutions with removable constraints;
- Loosely constrained solutions (constraint level: $\sigma > 1$ m);
- Free singular normal equations.

The SINEX files must conform to the SINEX Version 2.02 format standard and should contain for one day — a session in the case of VLBI — or one week (Sunday to Saturday), station positions, a set of EOPs for each day (offsets and rates fitted over 24-hr intervals for polar motion, UT1 and LOD, where only VLBI provides UT1). Requested time series are daily solutions from GNSS, session-wise from VLBI, and weekly solutions from DORIS and SLR. IVS is highly encouraged to provide nutation offsets and quasar coordinates for future studies by the combination centers. If the SINEX files contain a variance-covariance matrix, all constraints applied to the solution should be given in the a priori variance-covariance matrix. If a non-tidal loading model is applied, then the contribution of the non-tidal loading corrections to the right-hand side of the normal equation should be provided in the SINEX files.

All solutions should conform to the IERS Conventions, including its updates.

Whenever departures from the recommendations of the IERS Conventions are used, it is requested that the effects of those deviations be documented, and discussed beforehand with the ITRS Center. Among the model updates and effects to be considered, as listed in the appendix, some specific model updates are strongly requested (an extract of the ITRF2020 CfP):

- The IVS is encouraged to consider modeling the gravitational deformation for as many antennas as possible, and possibly refining the modeling of the thermal expansion of the VLBI antennas, provided that no net artifactual scale offset/drift is introduced;
- Appropriate modeling of SLR station range biases is needed to improve SLR scale determination;
- The most up to date GNSS force models to minimize orbit mismodeling and its impact on station positions;
- Appropriate DORIS analysis strategy, and model updates, to minimize possible scale discrepancies between ACs.

Solicited solutions to be considered in the ITRF2020 updates are official single-technique combined time series from the Technique Centers.

A summary file describing the strategy adopted to generate the time series (a priori models but also combination strategy) should be submitted together with the SINEX files, as well as a recommended station position discontinuity file.

Local Surveys at Co-location Sites

The owners of co-location sites are solicited and highly encouraged to consider submitting new local tie results which were not used in the ITRF2020. The results of least squares adjustments of the survey observations should be provided to the ITRS Center in the form of SINEX format, with full variance-covariance information. It is desirable to receive new local tie SINEX files as early as possible, but before the start of the ITRF2020 update in February 2024. We strongly encourage local tie SINEX providers to submit with their SINEX files filled metadata forms that are available at https://itrf.ign.fr/en/local-ties/survey-metadata.

Reference:

Altamimi, Z., Rebischung, P., Collilieux, X., Métivier, L., Chanard, K. (2023) ITRF2020: an augmented reference frame refining the modeling of nonlinear station motions. J Geod 97(47). https://doi.org/10.1007/s00190-023-01738-w

Instructions

The Technique Centers intending to contribute their series of SINEX files should submit these series by February 10, 2024 at the latest. Earlier submissions are most welcome and are very much encouraged.

To submit a time series of SINEX files please send an e-mail to:

ITRS Center	itrf@ign.fr
and	
IERS Central Bureau	central_bureau@iers.org

The e-mail should contain the detailed instructions on where the solutions can be downloaded, their present naming convention, etc. The submitted SINEX files will be archived by the ITRS Center and in the IERS information and database system.

Tentative Schedule:

June 01, 2023	Dissemination of the Call for Participation
February 10, 2024	Deadline for solution submissions by Technique Centers. Earlier submissions are welcome.
May-June 2024	First and early results to be shared and discussed with the TCs.
Sep, 2024	Final ITRF2020 Update solution released by the ITRS Center.

Appendix (copied from ITRF2020 CfP)

Handling of technique systematic errors and needed model updates, in preparation for ITRF2020.

All Techniques:

- Implement linear mean pole model
- Develop and implement diurnal-subdiurnal tidal EOP models based on Desai-Sibois (2016) approach -- model fits to geodetic data will only redistribute technique systematic errors
- [except VLBI] Adopt post EGM2008 static gravity field based on ~all GRACE & GOCE data
- [except VLBI] Highest-fidelity time-variable gravity (TVG) model (degrees >1) using GRACE + SLR + geophysical fluid models for full space geodetic era, consistent with GRACE + GOCE standards
- [for GNSS mostly] New seasonally fitted TVG model (up to at least 3x3) derived from above
- If a loading model is applied [but preferably not], (1) ensure consistency with TVG model, (2) ensure the same loading model is used by all techniques and all ACs, and (3) provide contribution of loading corrections to the right-hand side of the normal equation in SINEX.
- Find cause of 13.63/13.66 d signal in GNSS time series & fix tide model responsible
- Derive and implement models for instrument/monument thermal 3D effects for all techniques; validate present VLBI model
- Collect metadata needed to implement instrument/monument thermal effect models
- IERS Conventions updates to document all the above
- Any other effects worth considering by any or all of the 4 techniques?

DORIS:

- Improve SRP modelling to reduce draconitics
- Minimize the SAA effect

GNSS:

- Research near-field signal multipath & develop methods to calibrate in-situ position biases at all reference frame stations
- Investigate methods to mitigate pervasive draconitic signals
- Improve radiation force modeling, especially associated with attitude changes during eclipse
- Try harder to minimize equipment- and local-induced position offsets

SLR:

- Add estimation/handling of station Range Biases (RB)
- Use updated CoM offsets
- Add estimation/handling of Time Biases (TB)
- Include applied RB & TB in SINEX file for next contribution to ITRF with their constraint information

VLBI:

- Validate Nothnagel model for VLBI thermal effects
- Structural gravitational deformation: Update software to apply models to as many antennas as possible
- Relativity: Evaluate extra terms (<~1 ps) in trial basis in calc/solve, and check with formulation of Soffel et al., 2016.
- Source Structure: Better/improved strategy

GGFC to provide:

- Individual and full loading models for all three contributions (atmosphere, ocean and hydrology) in both CF and CM frames for all sites of the ITRF2020
- Geocenter time series based on the total of global geophysical fluid