II.ITRF2008 data analysis

II.1. Combination model

The CATREF combination model used for the ITRF combination is extensively described in previous publications and in particular Altamimi et al. (2002), Altamimi et al. (2007). For the ITRF2008 generation, we followed the same analysis strategy used for the ITRF2005 combination, described in Altamimi et al. (2007). We recall here that two steps are currently used for the ITRF construction: (1) stacking the individual time series to estimate a long-term solution per technique comprising station positions at a reference epoch, velocities and daily EOPs; and (2) combining the resulting long-term solutions of the four techniques together with the local ties in co-location sites. The main two equations of the combination model are given below for completeness. They involve a 14-parameter similarity transformation, station positions and velocities and EOPs and are written as:

$$\begin{cases} X_s^i &= X_c^i + (t_s^i - t_0)\dot{X}_c^i \\ &+ T_k + D_k X_c^i + R_k X_c^i \\ &+ (t_s^i - t_k)\left[\dot{T}_k + \dot{D}_k X_c^i + \dot{R}_k X_c^i\right] \\ \\ \dot{X}_s^i &= \dot{X}_c^i + \dot{T}_k + \dot{D}_k X_c^i + \dot{R}_k X_c^i \end{cases} \tag{II.1}$$

$$\begin{cases} x_s^p &= x_c^p + R2_k \\ y_s^p &= y_c^p + R1_k \\ UT_s &= UT_c - \frac{1}{f} R3_k \\ \dot{x}_s^p &= \dot{x}_c^p \\ \dot{y}_s^p &= \dot{y}_c^p \\ LOD_s &= LOD_c \end{cases} \tag{II.2}$$

where for each point i, X_s^i (at epoch t_s^i) and $\dot{X}_s^i$ are positions and velocities of technique solution s and X_c^i (at epoch t_0) and $\dot{X}_c^i$ are those of the combined solution c. For each individual frame k, as implicitly defined by solution s, D_k is the scale factor, T_k the translation vector and R_k the rotation matrix. The dotted parameters designate their derivatives with respect to time. The translation vector T_k is composed of three origin components, namely T_x, T_y, T_z, and the rotation matrix of three small rotation angles: R_x, R_y, R_z, following the three axes, respectively X, Y, Z. t_k is a conventionally selected epoch of the 7 transformation parameters. In addition to Eq. (II.1) involving station positions (and velocities), the EOPs are added by Eq. (II.2), making use of pole coordinates x_s^p, y_s^p and universal time UT_s as well as their daily rates $\dot{x}_s^p$, $\dot{y}_s^p$ and LOD_s. The link between the combined frame and the EOPs is ensured via the three rotation parameters appearing in the first three lines of Eq. (II.2).

The first line of Eq. (II.1) and the entire equation (II.2) are used to estimate long-term solutions for each technique, by accumulating (rigorously stacking) the individual technique time series of station positions and EOPs. In this process, the second line of equation (II.1) and the rates of the translation, scale and rotation parameters are not included, because station velocities are not available at the weekly (daily) basis. Moreover, a precise definition of the reference frame associated with the resulting long-term solution (comprising station positions at a reference epoch, station velocities and EOPs) has to be clearly specified. As transformation parameters are estimated between each weekly (or session-wise) frame and the long-term frame, it becomes necessary to define the long-term frame origin, scale, orientation and their time evolution, and therefore to complete the rank deficiency of the constructed normal equation. It is essential that the long-term solutions be representative of the mean origin and mean scale information of the space geodesy techniques. The particular type of minimal constraints introduced in Altamimi et al. (2007) have been designed for such purpose and are consequently

used here to preserve the long-term solution origin (for SLR and DORIS) and scale (for VLBI, SLR and DORIS). As the input GPS weekly frames have been explicitly expressed in the IGS05 (derived from ITRF2005, see IGSMail #5447), GPS long-term solution has been expressed with respect to ITRF2005 and was not used for the ITRF2008 origin and scale definition.

II.2. ITRF2008 frame definition

The second step of the ITRF2008 analysis consists in combining the long-term solutions of the four technique solutions together with local ties at co-location sites. The ITRF2008 is specified by the following frame parameters:

- Origin: The ITRF2008 origin is defined in such a way that there are null translation parameters at epoch 2005.0 and null translation rates with respect to the ILRS SLR time series.
- Scale: The scale of the ITRF2008 is defined in such a way that there are null scale factor at epoch 2005.0 and null scale rate with respect to the mean scale and scale rate of VLBI and SLR time series.
- Orientation: The ITRF2008 orientation is defined in such a way that there are null rotation parameters at epoch 2005.0 and null rotation rates between ITRF2008 and ITRF2005. These two conditions are applied over a set of 179 reference stations located at 131 sites as illustrated by Figure 2. The reference sites include 107 GPS, 27 VLBI, 15 SLR and 12 DORIS.

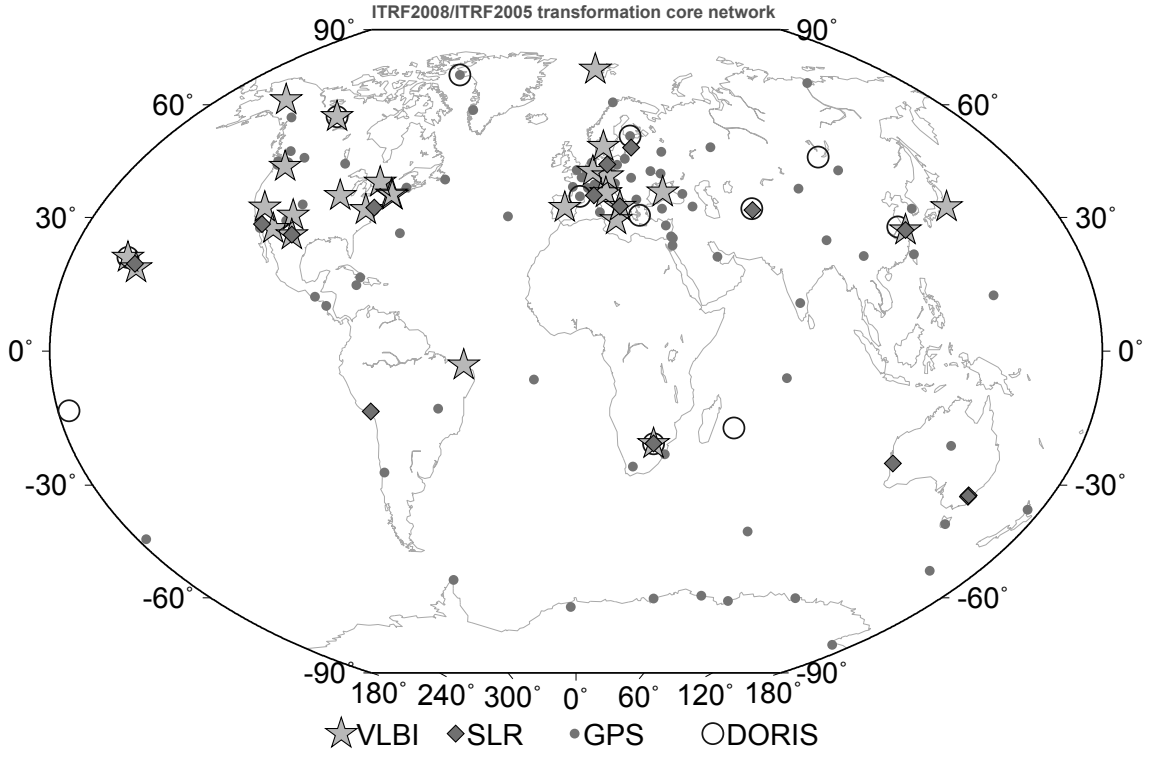

Figure 2. Location of the core sites used in the estimation of the 14 transformation parameters between ITRF2008 and ITRF2005 and their orientation alignment