Intercomparing EOPs from ITRF2008, DTRF2008, and JTRF2008

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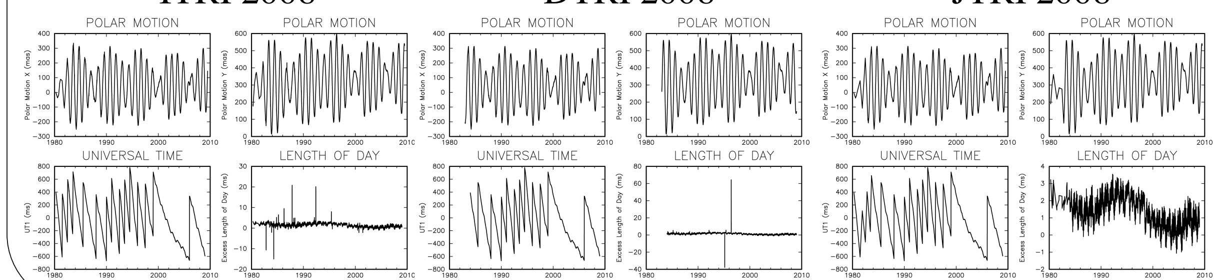
Abstract. ITRF2005 from IGN and DTRF2005 from DGFI were the first terrestrial reference frames (TRFs) to be realized using time series of both space-geodetic station positions and Earth orientation parameters. While the IGN approach is based on the combination of technique solutions, the principle of the method applied at DGFI is the combination of normal equation systems. Using time series of station positions leads to a robust frame determination by, in principle, allowing non-linear and discontinuous station motions to be corrected prior to frame determination. Using Earth orientation parameters helps tie the technique-specific frames together and yields a combined EOP series that is automatically consistent with the combined reference frame. By comparing the resulting ITRF2005 combined EOP series to other available combined EOP series and to global geophysical fluid models, it has been previously shown that the ITRF2005 EOP series is at least as accurate, and probably more accurate, than other available EOP series (Gross, 2006).

A Kalman filter-based approach to determining combined TRFs has been recently developed at JPL. The resulting software package, KALREF (KALman filter for REFerence frame determination), has been used to determine JTRF2008, an ITRF2008-like terrestrial reference frame from measurements of both time-dependent station positions and Earth orientation parameters. The JTRF2008 frame parameters have been shown previously to compare favorably with the ITRF2008 frame parameters. Here, the EOP series from JTRF2008 is compared to those from ITRF2008 (Altamimi et al., 2011) and DTRF2008 (Seitz et al., 2012) as well as to the IGS Final combined EOP series. The results of these comparisons are presented below.

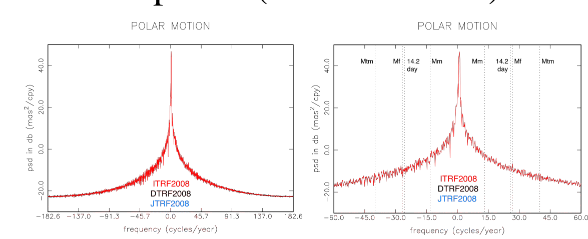
In summary, all three EOP solutions are in excellent agreement with each other with the differences between them, which are at least 20 db less than the signal, being attributable to differences in data editing, data weighting, and application of the no net rotation (NNR) condition. In particular, the GNSS data in DTRF2008 are weighted less than they are in either ITRF2008 or JTRF2008. This can explain why the ITRF2008 and JTRF2008 polar motion series agree better with the IGS Final combined series than does the DTRF2008 series. Since ITRF2008 and JTRF2008 applied the same weights to the GNSS series, this can also explain why the ITRF2008 and JTRF2008 polar motion series agree better with each other than they do with DTRF2008. For LOD, DTRF2008 used data from GNSS and VLBI but ITRF2008 and JTRF2008 used LOD data from only VLBI. This can explain why the DTRF2008 LOD series agrees quite well with the IGS Final combined series during 2002.3–2009.0 and why it has less outliers during this time than do the ITRF2008 and JTRF2008 series.

ITRF2008, DTRF2008, and JTRF2008 EOPs

ITRF2008 DTRF2008 JTRF2008



Spectra (2002.3-2009.0)

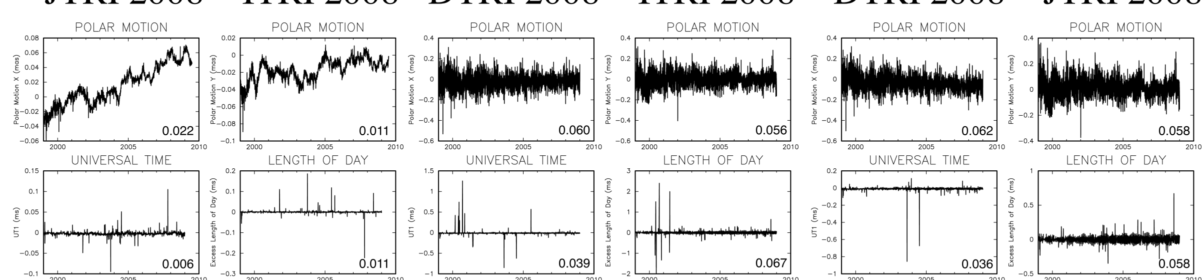


Numerous outliers exist in the ITRF2008, DTRF2008 and JTRF2008 EOPs, especially before 1997 when the GNSS series used in these TRFs began. There are fewer outliers in the JTRF2008 EOP series than in the ITRF2008 or DTRF2008 series, probably because of differences in the procedures used to edit the input data.

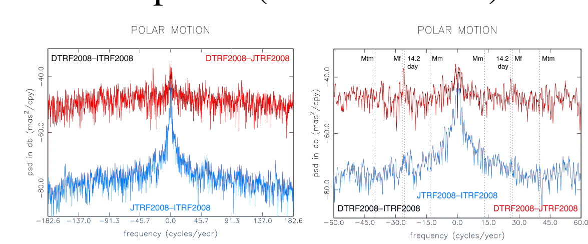
Spectra of the ITRF2008, DTRF2008, and JTRF2008 polar motion values are very similar to each other. They all show a small spectral peak at the prograde fortnightly tidal frequency (+26.7 cpy), but not at the retrograde fortnightly tidal frequency (–26.7 cpy).

Comparison With Each Other

JTRF2008 – ITRF2008 DTRF2008 – ITRF2008 DTRF2008 – JTRF2008



Spectra (2002.3-2009.0)



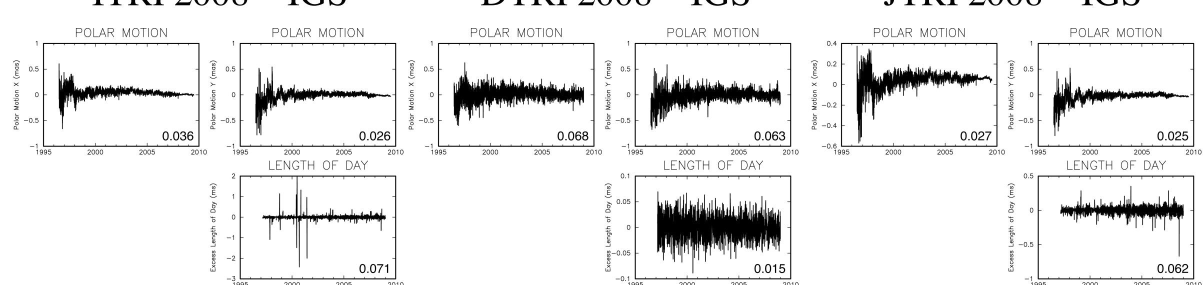
The standard deviation of the difference of the JTRF2008 and ITRF2008 EOP series during 2002.3 to 2009.0 are quite small, being only (0.022, 0.011) mas for (PMX, PMY) and (0.006, 0.011) ms for (UT1, LOD). Thus the JTRF2008 and ITRF2008 EOP series agree quite well with each other. However, a drift of about 0.01 mas/yr appears in the difference of the PMX values, with a smaller drift evident in the difference of the PMY values, probably caused by differences in the application of the NNR condition.

The standard deviation of the difference of the DTRF2008 and either the ITRF2008 or JTRF2008 polar motion series are much larger, indicating that the ITRF2008 and JTRF2008 polar motion series agree much better with each other than they do with the DTRF2008 polar motion series. This is likely due to differences in the weights assigned to the input data sets. The same relative weights were used in ITRF2008 and JTRF2008 but not in DTRF2008. The standard deviations of the UT1 and LOD series are affected by the presence of outliers, making them useless as a diagnostic.

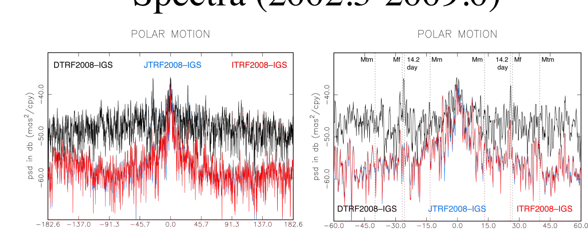
Spectra of the difference of the polar motion series show that the greatest difference between the ITRF2008 and JTRF2008 series occurs at low frequencies.

Comparison With IGS Final Combined EOPs

ITRF2008 – IGS DTRF2008 – IGS JTRF2008 – IGS



Spectra (2002.3-2009.0)



In general, the JTRF2008 polar motion series agrees slightly better with the IGS Final combined polar motion series (igs00p03) than does the ITRF2008 series, as evidenced by slightly smaller values of the standard deviation of the difference with the IGS Final combined polar motion series during 2002.3 to 2009.0. However, this slightly better agreement is probably not significant.

For LOD, DTRF2008 used LOD data from GNSS and VLBI but ITRF2008 and JTRF2008 used LOD data from only VLBI. This can explain why the DTRF2008 LOD series agrees quite well with the IGS Final combined series and why it has less outliers during 2002.3–2009.0 than do the ITRF2008 and JTRF2008 series.

Spectra of the difference of either the JTRF2008 or ITRF2008 polar motion series with the IGS Final combined series show that the greatest difference between them occurs at low frequencies. The spectrum of the difference of the DTRF2008 with the IGS polar motion series shows much greater power, again showing that the DTRF2008 polar motion series does not agree as well with the IGS series as do either the ITRF2008 or JTRF2008 series, most likely because the input GNSS data were weighted less in DTRF2008 than they were in ITRF2008 or JTRF2008.