

To validate the results of the Earth Orientation Matrix Calculator, several tests have been performed. Firstly, several validation test cases are documented in the following reference (also listed at <http://ren.usno.navy.mil/refs/generalrefs.txt>):

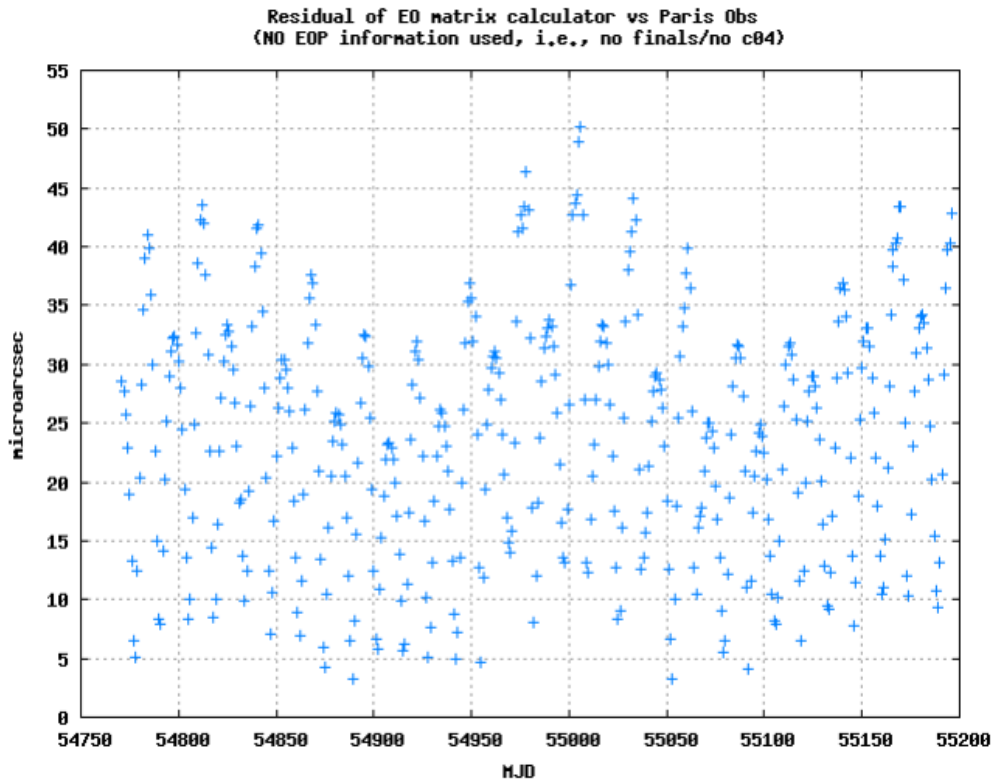
Barker, Lee; Dorsey, Art; Stamatakos, Nick; "Validation of IAU2000A/IAU2006 Frame Transformations Implementations", 33rd Annual AAS Guidance and Control Conference;  
AAS 10-054, February 6-10, 2010.

Lee Barker used the same algorithms as USNO, but made a completely independent computer code of the transformation matrix calculations. Results agreed to within 1 microarcsecond using at least 30 days of input test data from January 2009.

In addition to the above test cases, comparisons to the Paris Observatory based Earth Orientation calculator results have been made. (The Paris Observatory (PO) based calculator can be found at: <http://hpiers.obspm.fr/eop-pc/>). The output of each calculator is a direction cosine matrix (DCM), or optional quaternion in the case of the USNO calculator. The Euler rotation axis [1] relating the two direction cosine matrices is one kind of measure of the residual between the two. (It is the rotation angle about the euler rotation axis through which one can rotate the USNO DCM and obtain the PO DCM.)

Figure 1 below shows that when using no Earth Orientation Parameter (EOP) information, then the agreement with the Paris Observatory is quite good – the rms being about 26 microradians, 1 sigma. To obtain this result, several hundred random epochs during the year 2009 were chosen, and the USNO and PO transformation matrices were obtained and compared. Our colleague at the Paris Observatory suspects the differences to be due to the fact that PO is using software which has a different result for precession rate, and PO is planning on updating their software. Once these changes and other possible information is obtained, the comparison will be redone.

Figure 2 below shows the differences between the USNO and PO results for several random epochs over several years using EOP data. The PO calculator uses the c04 series and the USNO calculator uses the finals2000A.data results. Both use the CPOs and sub-diurnal and diurnal tidal models. (Note, at some date in the future, more results will be compared.)



**Figure 1:** Euler axis angle difference between USNO EO matrix calculator and Paris Observatory Result. No EOP (i.e., no polar motion, no UT1-UTC, and no celestial pole offsets used).

mean = 23.6219 microarcsec  
 std dev = 10.1585  
 rms = 25.7136  
 max = 50.1719  
 min = 3.21704

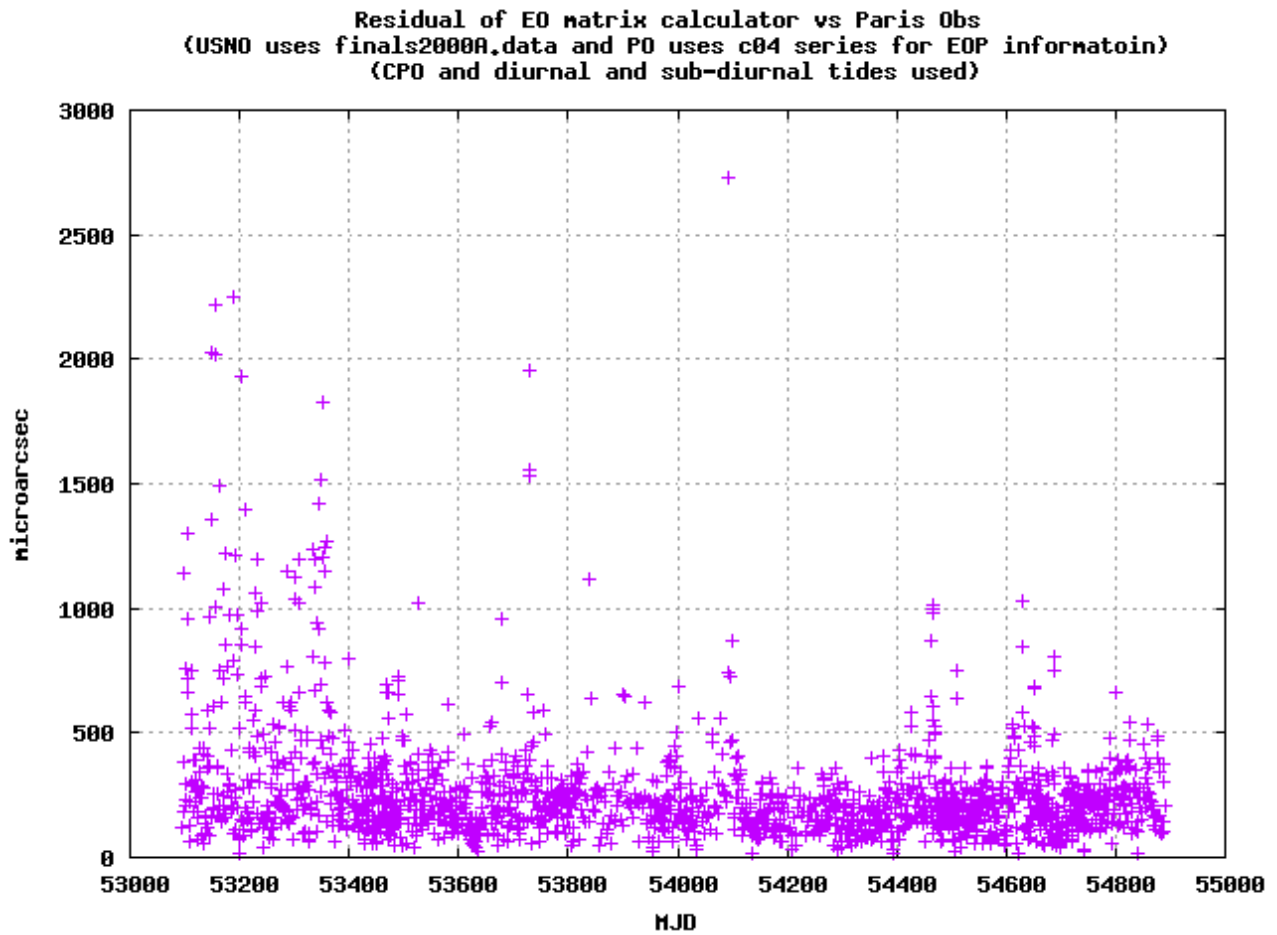


Figure 2: Euler axis angle difference between USNO and PO Earth Orientation matrix calculators. USNO uses finals2000A.data and PO uses the c04 series for EOP information. Both use diurnal and sub-diurnal tidal information. The range of dates begins in early 2004 and ends in early 2010.

mean	=	268.425	microarcsec
std dev	=	241.687	
rms	=	361.199	
max	=	2729.798	
min	=	15.579	

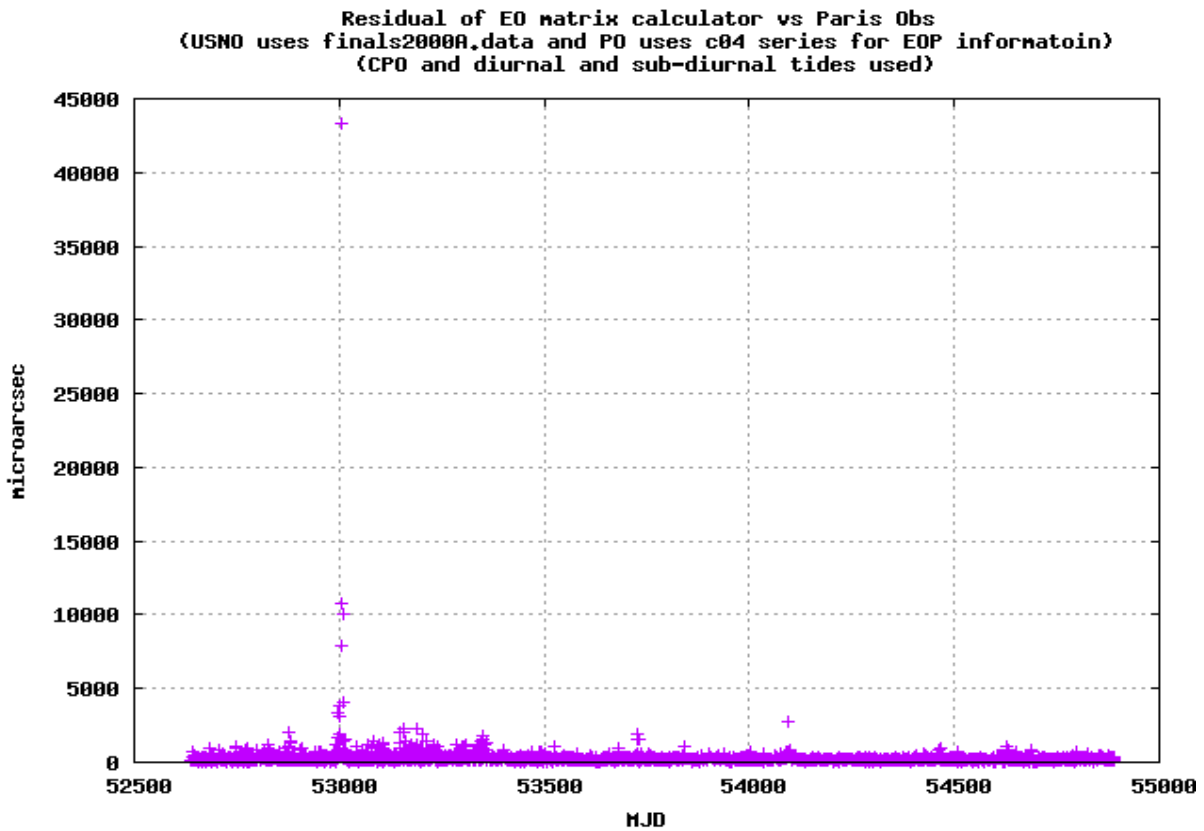


Figure 3: Euler axis angle difference between USNO and PO Earth Orientation matrix calculators. USNO uses finals2000A.data and PO uses the c04 series for EOP information. Both use diurnal and sub-diurnal tidal information. The range of dates begins in last 2002 and ends in early 2010. The anomalous peaks around MJD=53000 can be partly explained by differences in the finals2000A.data and C04 series at that time. However, investigation of the differences is on-going.

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