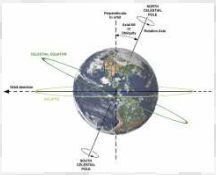

RS / PC

Recent Improvements in the IERS Rapid Service / Prediction Center Products

Nick Stamatakos
Brian Luzum
Beth Stetzler
Nathan Shumate
Merri Sue Carter

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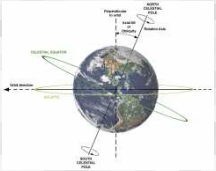
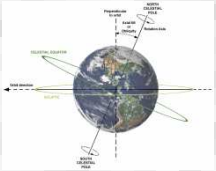


RS / PC

- IERS RS/PC Review
- UTAAM Processing Change
- Twice daily EOP solution
- IGS Ultra LOD
- EO Matrix Calculator

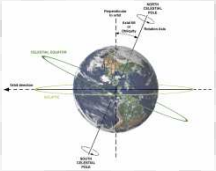
IERS RS/PC Review



RS / PC

- Produce daily and weekly EOP combination solutions
  - Daily EOPs produced after 1700 UTC
  - Weekly EOPs produced Thursday after 1700 UTC
  - Includes AAM, GPS, SLR, and VLBI data
  - Over 700 users by e-mail per week
  - Roughly 40000 ftp downloads per month
    - Most use the data for practical (non-research) purposes (85 to 90%)
    - Not all are technically skilled

UTAAM Processing Change Background:



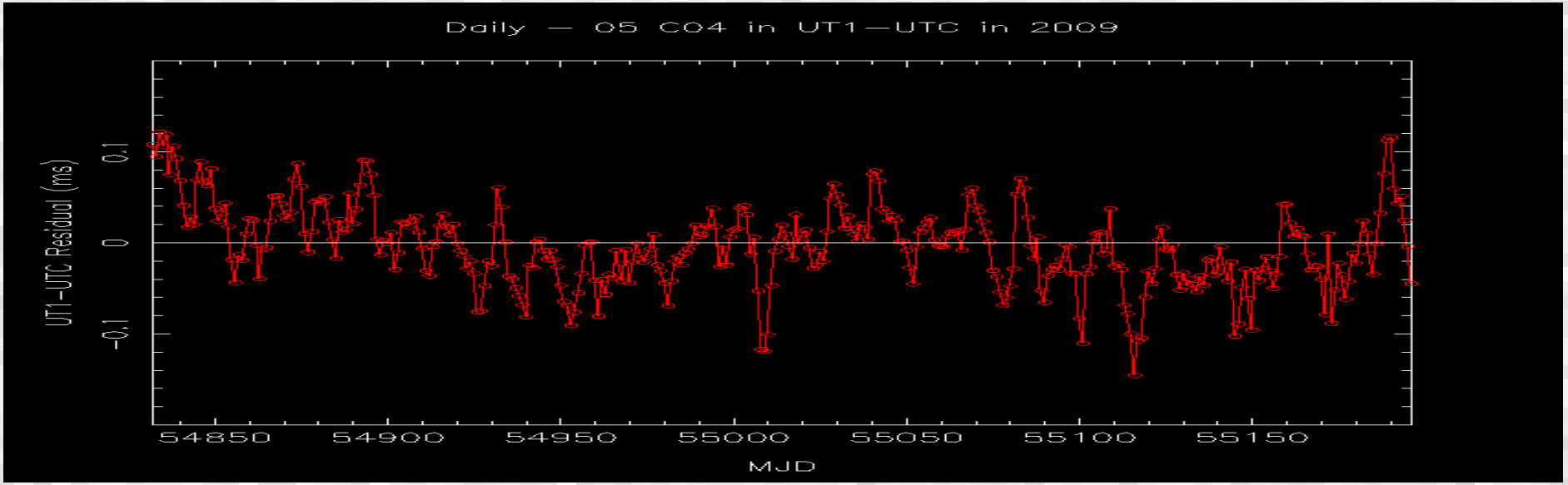
RS / PC

- One of our users of EOP data observed systematic errors in short term (<10 day) UT1-UTC predictions.
  - Similar to features studied at USNO previously.
- Salient features
  - Fortnightly (14-day) period
  - Annual period

UTAAM Processing Change Background:

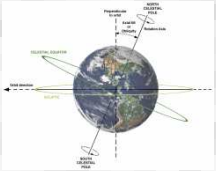
RS / PC

- Independent analysis run for Annual Reports showed similar features in the last day of combination.



- Predictions extended from last combination point.
  - Any error in combination solution will manifest itself as an increased prediction error.

UTAAM Processing Change Background:

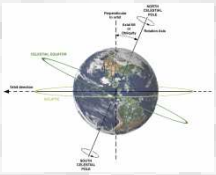


RS / PC

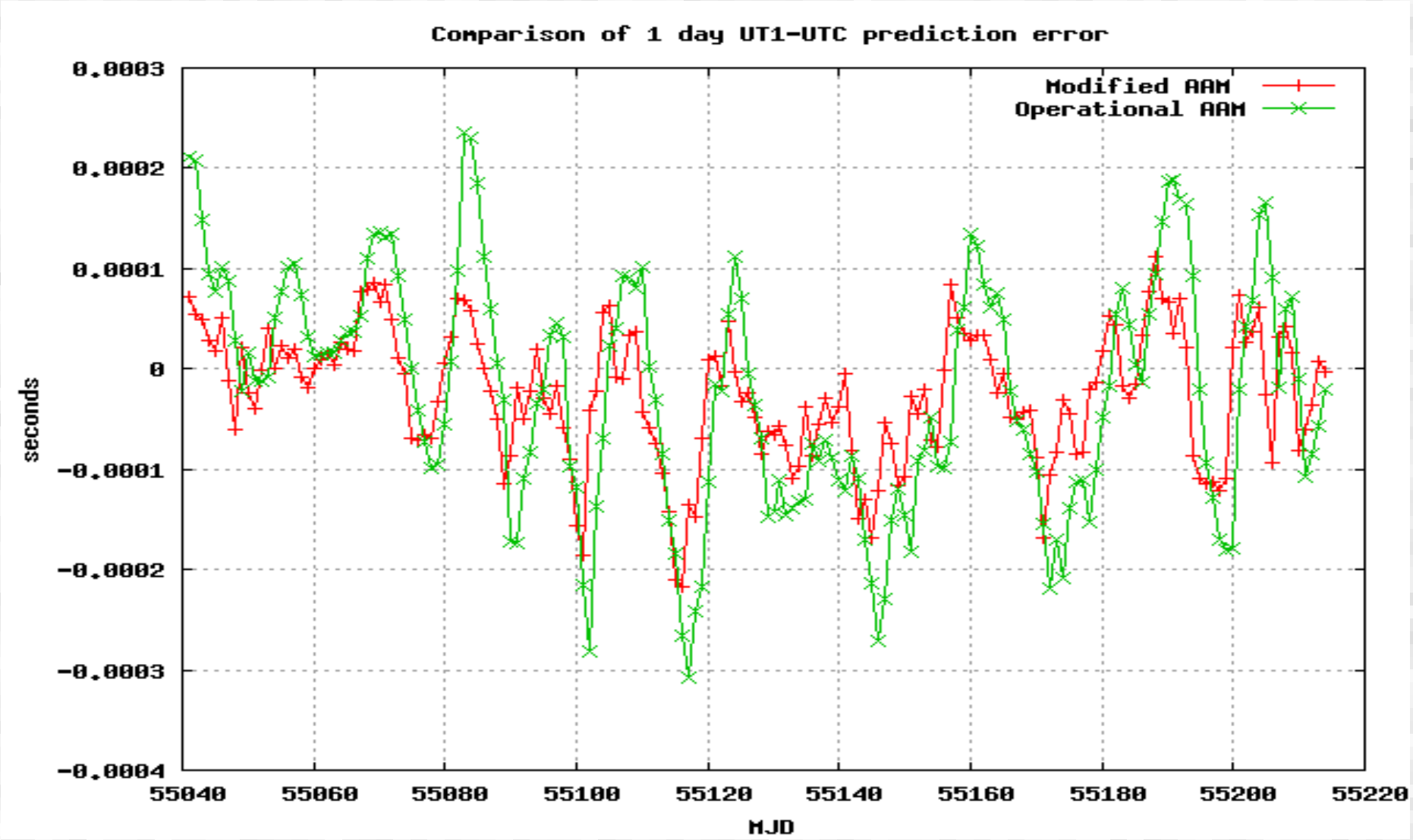
- Identified that the likely problem is the use of Atmospheric Angular Momentum (AAM) data in the combination.
  - AAM had been down-weighted, but still problematic.
  - Removing AAM from the combination only makes the solution better.

- Modified AAM code to run with no AAM in combination.
  - Only used in predictions

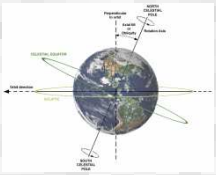
UTAAM Processing Change: Comparison of 1 day UT1-UTC Prediction Error



RS / PC

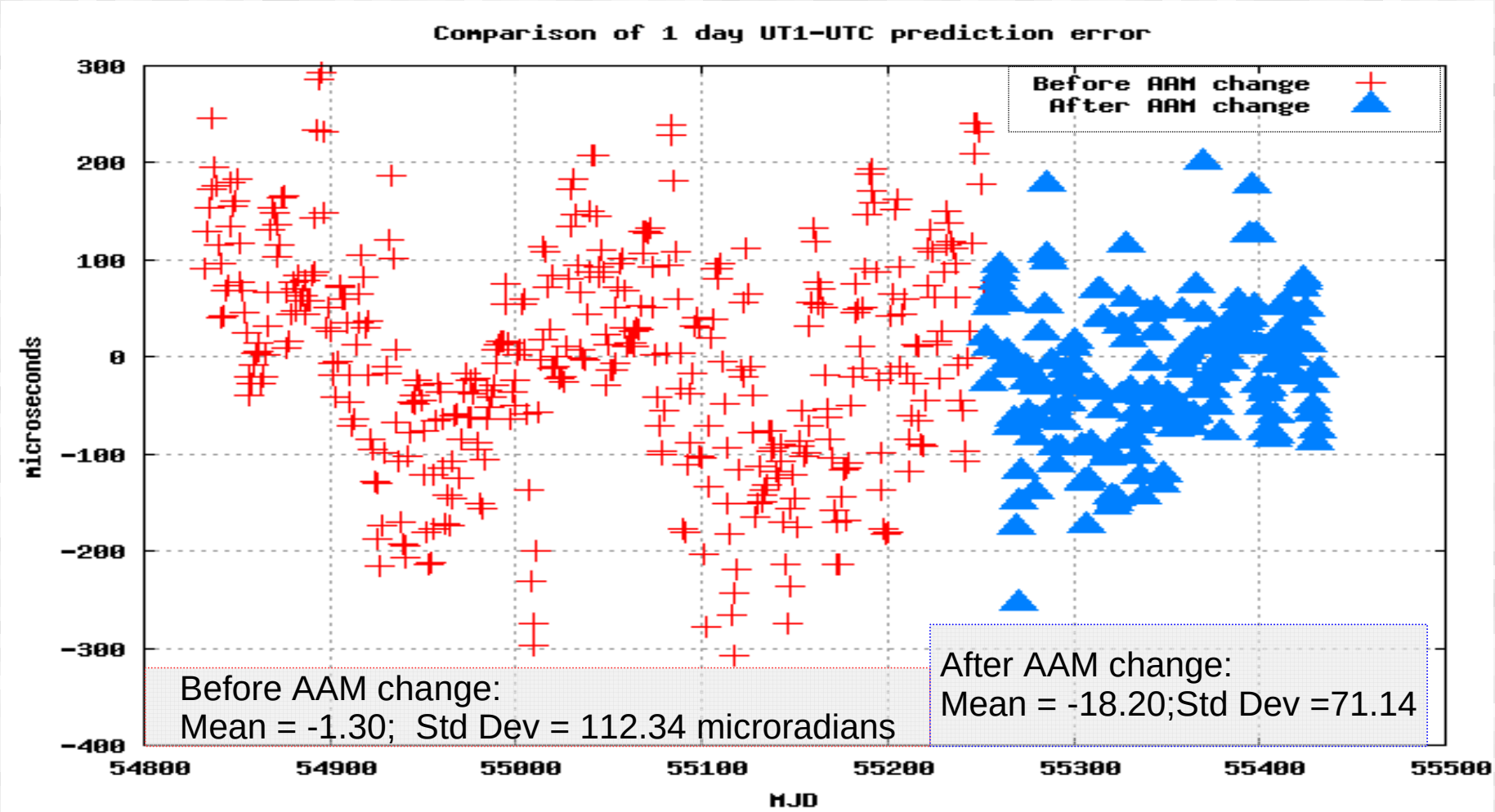


UTAAM Processing Change: Before and After Change to Operational Software

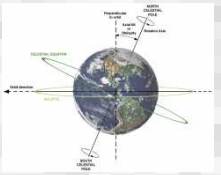


RS / PC

- 25-30% reduction in 1-day prediction errors, since March.



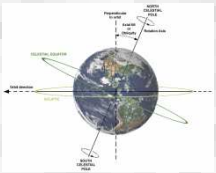
EOP Solution Multiple Times Per Day



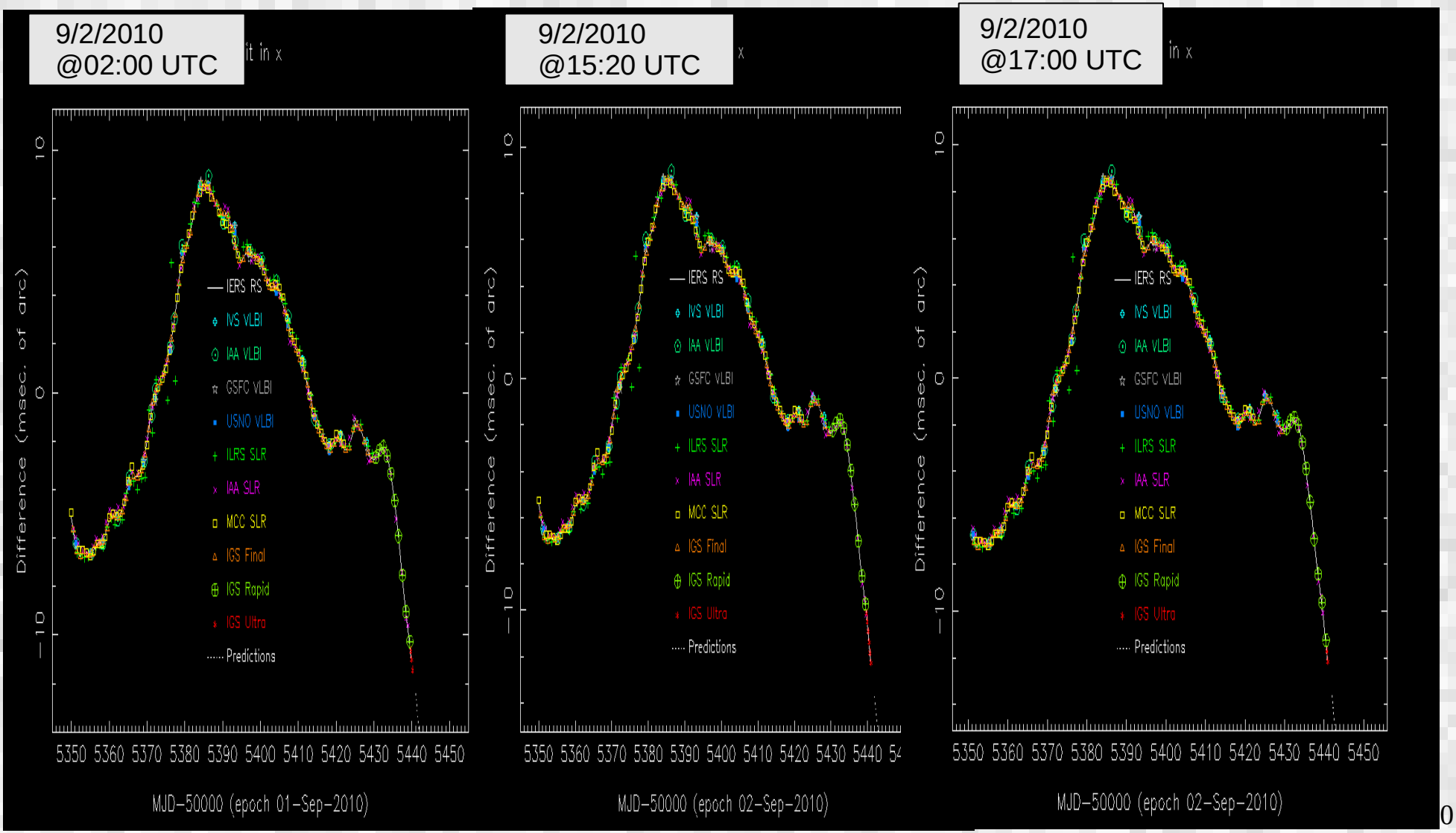
RS / PC

- IERS RS/PC has begun testing a Multiple Times Per Day Combination solution on a test computer.
- 2nd daily run occurs just before 04:00 UTC.
  - Additional manual runs can be made at most other times.
- Currently can accommodate updates to VLBI and IGS data.
  - Could be made to accommodate updates to SLR, UTGPS, and AAM also.
- So far, only updates to IGS Ultras have been available from the community.
  - Once Wettzell and Tsukuba antennas come back on-line, VLBI updates should be available.

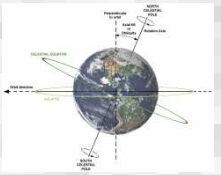
EOP Solution Multiple Times Per Day
Polar Motion X



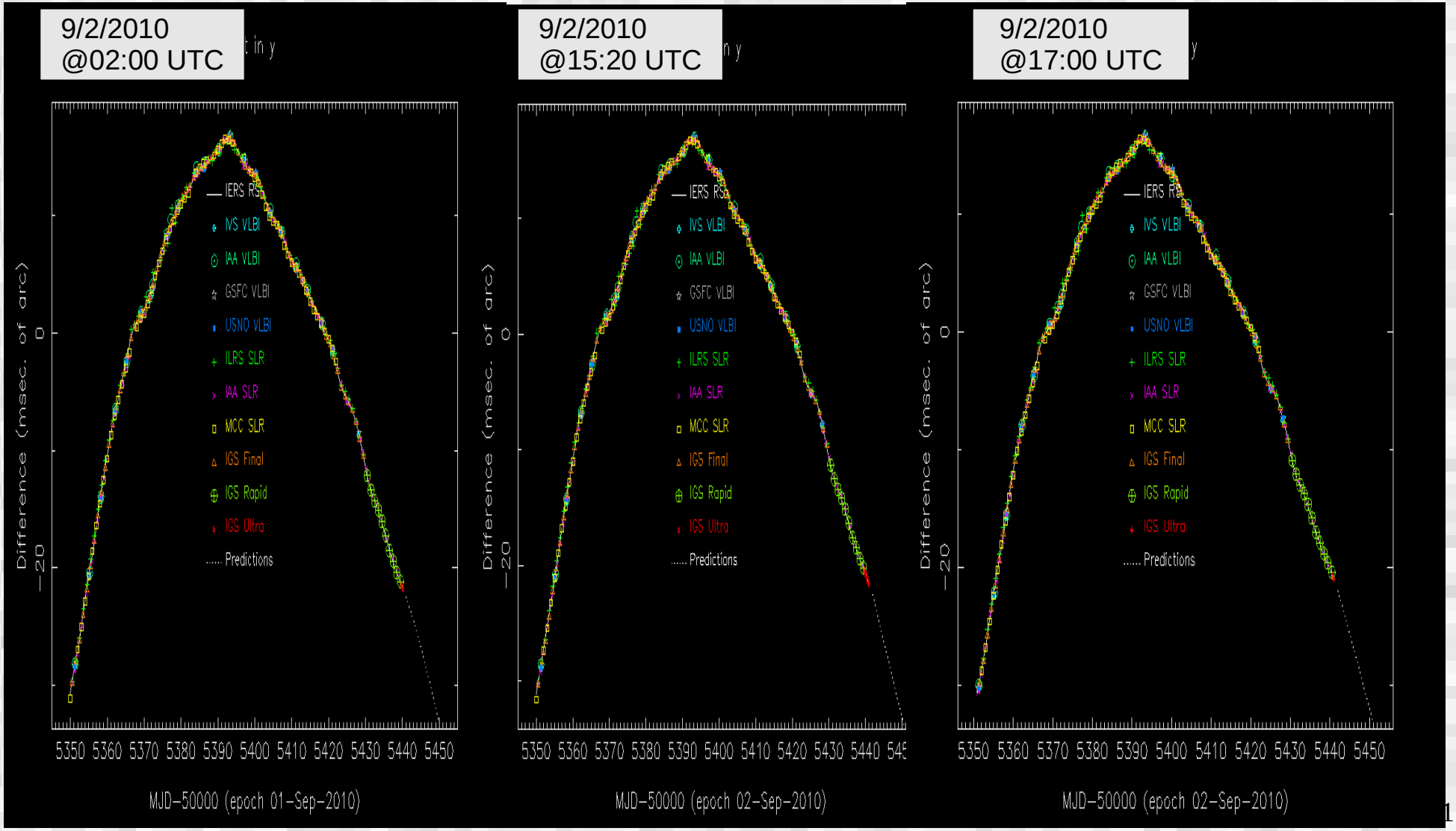
RS / PC



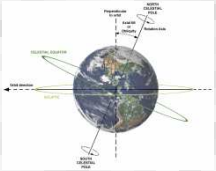
EOP Solution Multiple Times Per Day
Polar Motion Y



RS / PC



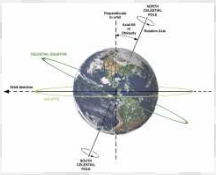
Use of IGS Ultra data in UT1-UTC Combination



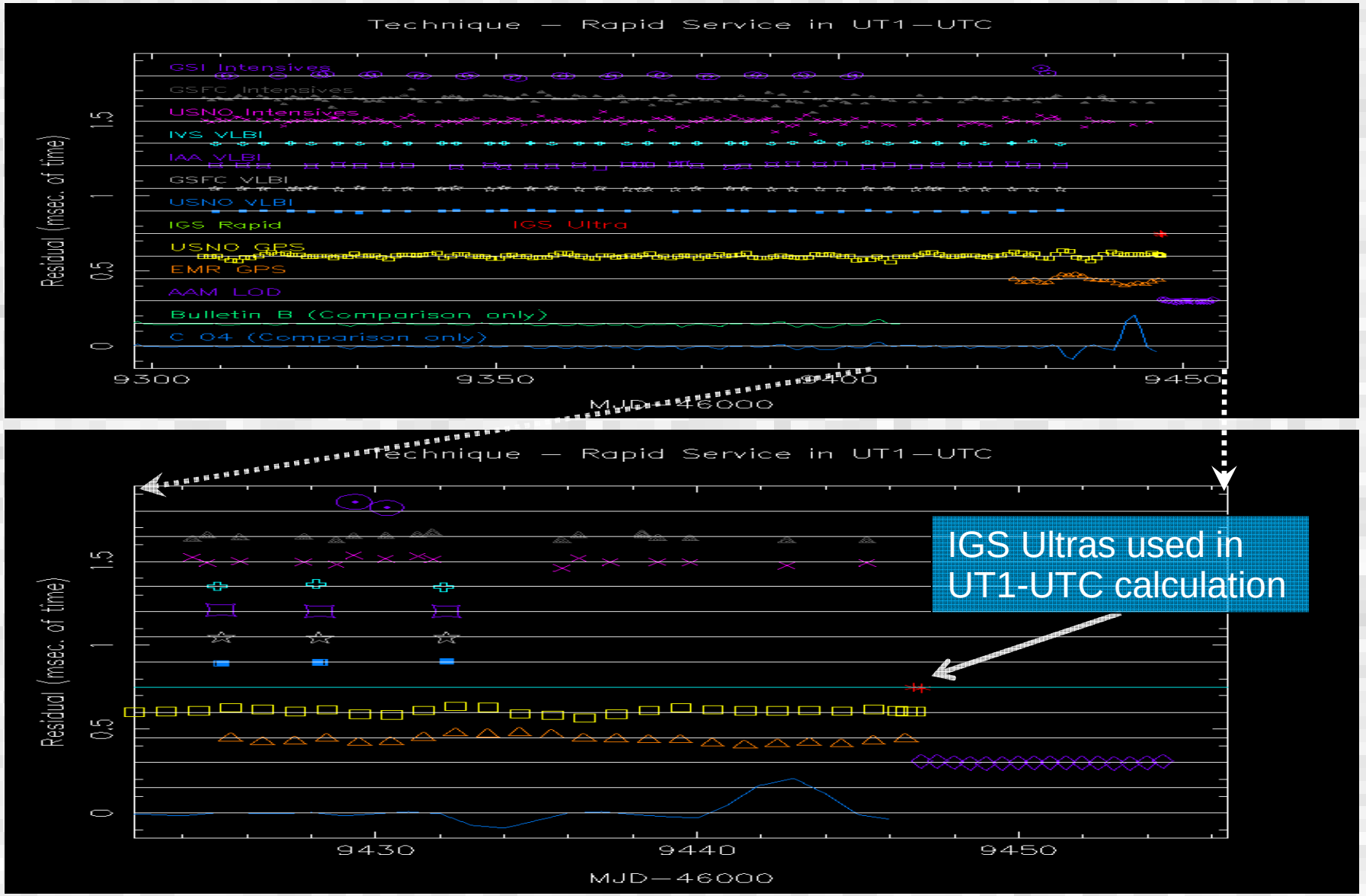
RS / PC

- We are adding code to use the IGS Ultras combination data in the UT1-UTC combination algorithm.
  - Additional useful UT1-UTC estimates beyond the last available VLBI intensive and UTGPS data.

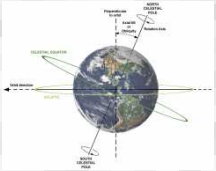
Use of IGS Ultra data in UT1-UTC Combination



RS / PC



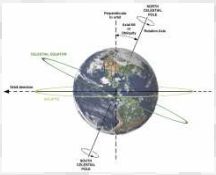
EO Matrix Calculator Background:



RS / PC

- A transformation matrix calculator has been added to the USNO EO Department server http://maia.usno.navy.mil (dedicated server may be coming soon)
- The IERS Conventions (2003) TN32 based validation code for computing the equinox-based to GCRS transformation
  - Written in FORTRAN
  - Relying heavily on code from http://tai.bipm.org/iers/conv2003/conv2003_c5.html and SOFA.
- Observable quantities are from a version of finals2000A.data or .daily
  - If necessary, the polar motion and UT1 observables are interpolated.
  - Long period tidal terms are removed and then, long period tidal, diurnal, and sub-diurnal tidal terms are added back into the observables.
- Adding sub-diurnal / diurnal tides and CPO's provide additional accuracy.
- Outputs include ITRF to GCRS and several intermediate quantities.

EO Matrix Calculator: User Interface



RS / PC

EARTH ORIENTATION MATRIX CALCULATOR

IERS Rapid Service Prediction Center (IERS RS/PC)

Earth Orientation Parameters Division, US Naval Observatory

	Year	Month	Day	Hour	Min	Secs
Enter a start date and time (UTC):						
Enter a stop date and time (UTC):						

Number of desired intervals

Choose any of these desired input variations:

Include Diurnal and Sub-Diurnal Tides:

Include Celestial Pole Offsets:

Enter the MJD on which the finals2000A.daily file was created: If no MJD is entered, then the most recent finals2000A.data file will be used:

Choose any of the desired intermediate matrix output quantities in addition to the default terrestrial to celestial transformation output:

Polar Motion: GMST: EE (Equation of the Equinoxes) Matrix:

Precession Matrix: Nutation Matrix: Combined Bias-Precession-Nutation Matrix:

Do you wish quaternion output instead of matrices for the above quantities:

Output containing eqn equinoxes-polar motion, polar motion, precession-nutation, ut1-utc offset and slope, and epoch:
Units: ut1-utc offset = seconds; slope = seconds/day; and epoch = UTC seconds from J2000UTC.

(Note: when this check box is chosen, results are unaffected by other check boxes selected above.)

Submit Query

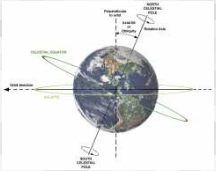
References Version # Acknowledgments Validation

What is the Earth Orientation Matrix?

Send questions or comments to ser7 at maia.usno.navy.mil.
(Please put 'EO Matrix Calculator' in part of Subject line.

Done

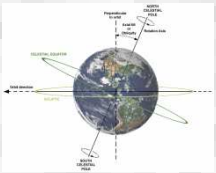
EO Matrix Calculator User-Interface:



RS / PC

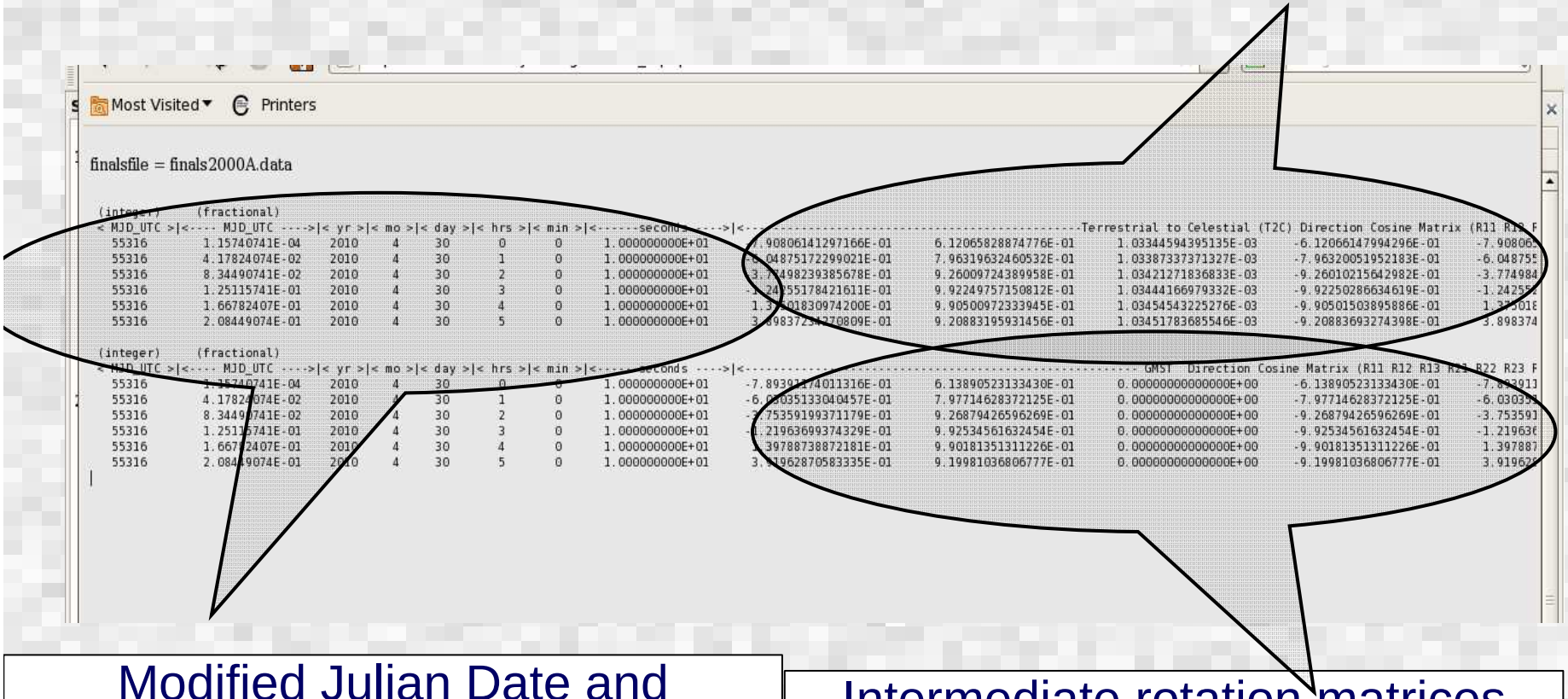
- User chooses dates and time intervals.
  - Code produces a file containing the ITRF to GCRS transformation and desired intermediate quantities.
  - Number of intervals currently limited to 100.
    - Special exceptions can be arranged.
    - Dedicated server will lift this restriction
- Standard output is the transformation matrix from terrestrial to celestial frames.
  - Optional quaternion/euler-parameter output.
- Intermediate options: polar motion, GMST, Equation of the Equinoxes, Precession, Nutation, and combined bias-precession-nutation matrices or quaternions.

EO Matrix Calculator Output:



RS / PC

Terrestrial to celestial (T2C) Rotation matrix



Most Visited ▾ Printers

finalsfile = finals2000A.data

(integer) (fractional)

MJD_UTC	MJD_UTC	yr	mo	day	hrs	min	seconds	Terrestrial to Celestial (T2C) Direction Cosine Matrix (R11 R12 R13 R21 R22 R23 R31 R32 R33)
55316	1.15740741E-04	2010	4	30	0	0	1.000000000E+01	7.908061412971 66E-01 6.12065828874776E-01 1.03344594395135E-03 -6.12066147994296E-01 -7.908065
55316	4.17824074E-02	2010	4	30	1	0	1.000000000E+01	6.048751722990 21E-01 7.96319632460532E-01 1.03387337371327E-03 -7.96320051952183E-01 -6.048755
55316	8.34490741E-02	2010	4	30	2	0	1.000000000E+01	3.774982393856 78E-01 9.26009724389958E-01 1.03421271836833E-03 -9.26010215642982E-01 -3.774984
55316	1.25115741E-01	2010	4	30	3	0	1.000000000E+01	-1.242551784216 11E-01 9.92249757150812E-01 1.03444166979332E-03 -9.92250286634619E-01 -1.242552
55316	1.66782407E-01	2010	4	30	4	0	1.000000000E+01	1.370018309742 00E-01 9.90500972333945E-01 1.03454543225276E-03 -9.90501503895886E-01 1.370018
55316	2.08449074E-01	2010	4	30	5	0	1.000000000E+01	3.898372347708 09E-01 9.20883195931456E-01 1.03451783685546E-03 -9.20883693274398E-01 3.898374

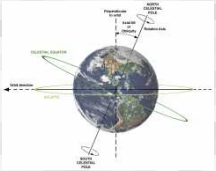
(integer) (fractional)

MJD_UTC	MJD_UTC	yr	mo	day	hrs	min	seconds	GMST Direction Cosine Matrix (R11 R12 R13 R21 R22 R23 R31 R32 R33)
55316	1.15740741E-04	2010	4	30	0	0	1.000000000E+01	-7.893917740113 16E-01 6.13890523133430E-01 0.00000000000000E+00 -6.13890523133430E-01 -7.893911
55316	4.17824074E-02	2010	4	30	1	0	1.000000000E+01	-6.030351330404 57E-01 7.97714628372125E-01 0.00000000000000E+00 -7.97714628372125E-01 -6.030356
55316	8.34490741E-02	2010	4	30	2	0	1.000000000E+01	-3.753591993711 79E-01 9.26879426596269E-01 0.00000000000000E+00 -9.26879426596269E-01 -3.753593
55316	1.25115741E-01	2010	4	30	3	0	1.000000000E+01	-1.219636993743 29E-01 9.92534561632454E-01 0.00000000000000E+00 -9.92534561632454E-01 -1.219636
55316	1.66782407E-01	2010	4	30	4	0	1.000000000E+01	1.397887387281 81E-01 9.90181351311226E-01 0.00000000000000E+00 -9.90181351311226E-01 1.397887
55316	2.08449074E-01	2010	4	30	5	0	1.000000000E+01	3.919627058333 35E-01 9.19981036806777E-01 0.00000000000000E+00 -9.19981036806777E-01 3.919627

Modified Julian Date and YMDHMS epochs.

Intermediate rotation matrices Are below the T2C matrix

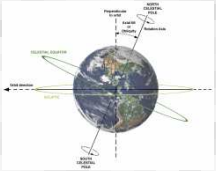
EOP Improvements
Future Work:



RS / PC

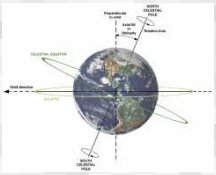
- 2x-day daily EOP solution evaluated in 2010 and then operational in early 2011.
  - Test results can be made available upon request
  - Eventually, Nxdaily will be made to re-evaluate new EOP solution any time a new input data series is detected.
- Celestial Pole Offsets will be with respect to P03 series.
- Use of IGS Ultra data in UT1-UTC Combination will be evaluated.

BACKUP SLIDES



RS / PC

UTAAM Processing Change: Analysis of 1 day UT1-UTC Prediction Error



RS / PC