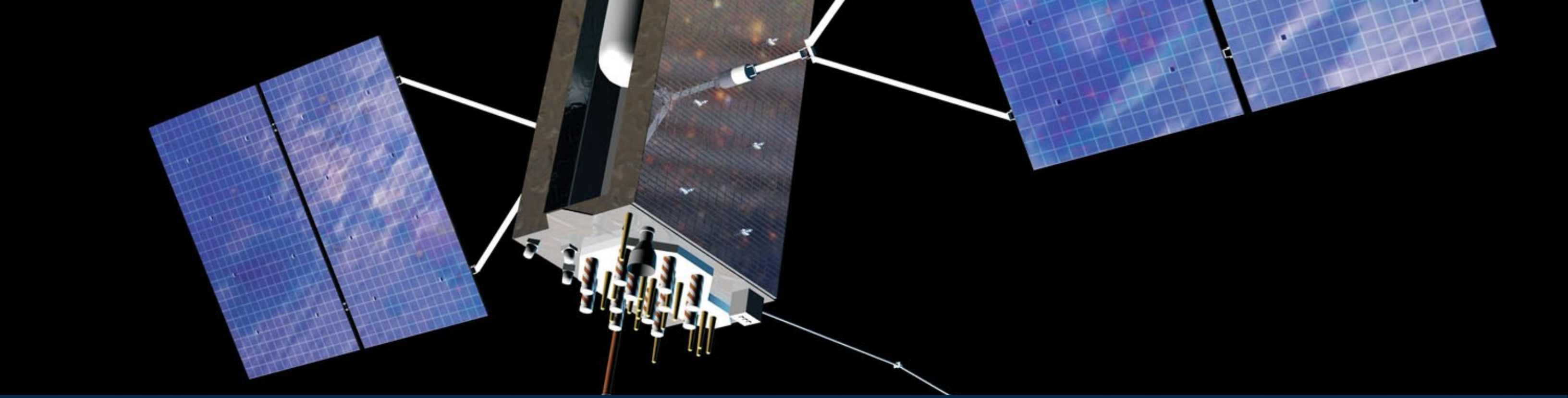

NGA GNSS Division Earth Orientation

The National Geospatial-Intelligence Agency provides Earth Orientation Parameter Prediction (EOPP) coefficients and predictions daily. Using NGA's EOPP coefficients allows a user to generate Polar X, Polar Y, and UT1-UTC (dUT) predictions for any number of days in the future through the summation equations given below. The coefficients are recomputed every day and labeled to go into effect on the following day. Currently the NGA GNSS Division is utilizing the IERS Technical Note 36/IERS Conventions (2010) (TN36) which is covered in TN36/Chapter 8. The NGA EOPP restores the full 62 Gross zonal tide model along with the Oceans diurnal/semidiurnal model.

The coefficients are computed daily by using updated Polar x, Polar y, and UT1-UTC(dUT) values from the International Earth Rotation and Reference Systems Service (IERS) at the United State Naval Observatory. These updated values are fit to the math models below. NGA removes a 62-term Gross zonal tide model(TN36) from the UT1-UTC data prior to computing the coefficients. The resulting coefficients, constants, and variables used in the math models are output in a five line format file specified in the following pages and in the Space Force ICD-211. By simply substituting the output values back into the math model it is possible to get parameter predictions for any day in the future. One must only know the Modified Julian Day (MJD) of your day of interest. However, with days too great in the future there will be reduced accuracy. Historical prediction files are also provided online by NGA, and USNO provides updated values daily.

The following equations are the math models used in x_p, y_p, and dUT coefficient generation:

$$x_p(t) = A + B(t - t_a) + \sum_{j=1}^{2} C_j \sin\left\{\frac{2\pi(t - t_a)}{P_j}\right\} + D_j cos\left\{\frac{2\pi(t - t_a)}{P_j}\right\}$$

$$y_p(t) = E + F(t - t_a) + \sum_{k=1}^{2} G_k \sin\left\{\frac{2\pi(t - t_a)}{Q_k}\right\} + H_k cos\left\{\frac{2\pi(t - t_a)}{Q_k}\right\}$$

$$UT1 - UTC(t) = I + J(t - t_b) + \sum_{m=1}^{4} K_m \sin\left\{\frac{2\pi(t - t_b)}{R_m}\right\} + L_m cos\left\{\frac{2\pi(t - t_b)}{R_m}\right\}$$

NGA analysis shows that the weekly RMS difference between NGA predictions and final IERS values is under 0.003 arcsec (10 cm. at the equator) for Polar X and Y and under 0.8 msec for UT1-UTC. The accuracy of NGA's EOPP coefficients and model degrades with time. Always use the most recent set of NGA coefficients. The EOP predictions calculated from NGA coefficients and equations may not necessarily reproduce the NGA predicted EOP values. This is primarily due to differences in machine precision and the restoration of zonal and diurnal solid Earth tides.

Date last modified: April 21, 2026

Approved for public release, 17-805.

1) NGA EOPP BULLETIN DOES NOT CONTAIN APPROXIMATE ZONAL TIDES.
The use of the 62-term Gross zonal tide model eliminates the need for approximate zonal tide coefficients. Thus, the zonal tide coefficients K_1, K_2, L_1, and L_2 are set to 0. The corresponding lunar and semi-lunar periods, R_1 and R_2, are set to 500.

2) TOTAL RESTORATION TO THE POLAR X, POLAR Y, AND UT1-UTC PREDICTIONS.
The 62-term Gross zonal tide model, representing periods from 5.64 days to~18.6 years, is added back to the UT1-UTC value as calculated above. Similarly, the diurnal/semi-diurnal ocean tide model is added to the Polar X, Polar Y, and UT1-UTC. This method gives the best accuracy of all three components when compared to the IERS Finals. The Space Force GPS Master Control Station uses these coefficients and predictions in their process.

Solid Earth Tide Phases

Quantity	Period (days)	EOPP Model Parameters
Annual	365.25	P_1, Q_1, and R_3
Chandler cycle	435	P_2 and Q_2
Lunar	500.0 (no longer used)	R_1
Semilunar	500.0 (no longer used)	R_2
Semiannual	182.625	R_4

Seasonal Variation Coefficients (assumed constant)

EOPP Model Parameter	Coefficient (sec)
K_3	-0.022
K_4	0.006
L_3	0.012
L_4	-0.007

These constants were computed by I. I. Mueller in the 1960's (Moritz, H. and I.I. Mueller, Earth Rotation: Theory and Observations, 1987, Ungar, New York).

Sample EOPP 5-Line Products

```
57134.00   .096535   .000000   .079560  -.001056  -.094888   .011426365.25
 435.00   .360340   .000000   .110327  -.043663   .056139   .001909365.25435.00
  57387.00   .037772  -.001042   .000000   .000000  -.022000   .006000
   .000000   .000000   .012000  -.007000 500.0000 500.0000 365.2500 182.6250
  36 6166 57553  57552 00000   -1.041778
            57553     .11412908     .49412727    -.20154468
            57554     .11622101     .49396709    -.20219709
            57555     .11832966     .49378092    -.20277489
            57556     .12045747     .49355565    -.20326385
            57557     .12260569     .49327790    -.20365996
            57558     .12477375     .49293417    -.20397038
```

EOPP 5-Line Output Format

Var.	Col. Start	Field Width	Req. Prec.	Value
Line	1			
t_a	1	10	8	MJD(UTC) of the Polar X-Y model of the first day of input data
A	11	10	9	Polar X offset (arcsec)
B	21	10	9	Polar X linear drift (arcsec/day), nominally ".000000"
C_1	31	10	9	Polar X sine coefficient of the annual period (arcsec)
C_2	41	10	9	Polar X sine coefficient of the Chandler period (arcsec)
D_1	51	10	9	Polar X cosine coefficient of the annual period (arcsec)
D_2	61	10	9	Polar X cosine coefficient of the Chandler period (arcsec)
P_1	71	6	6	Annual Period (days), nominally "365.25"
Line	2			
P_2	1	6	6	Chandler Period (days), nominally "435.00"
E	7	10	9	Polar Y offset (arcsec)
F	17	10	9	Polar Y linear drift (arcsec/day), nominally ".000000"
G_1	27	10	9	Polar Y sine coefficient of the annual period (arcsec)
G_2	37	10	9	Polar Y sine coefficient of the Chandler period (arcsec)
H_1	47	10	9	Polar Y cosine coefficient of the annual period (arcsec)
H_2	57	10	9	Polar Y cosine coefficient of the Chandler period (arcsec)
Q_1	67	6	6	Annual Period (days), nominally "365.25"
Q_2	73	6	6	Chandler Period (days), nominally "435.00"
Line	3			
t_b	1	10	8	MJD(UTC) of day before Jan 1 of current/following year
I	11	10	9	UT1-UTC offset (sec)
J	21	10	9	UT1-UTC linear drift (sec/day)
K_1	31	10	9	dUT zonal tide approx. coefficient of lunar cycle (sec), nominally 0
K_2	41	10	9	dUT zonal tide approx. coefficient of semilunar cycle (sec), nominally 0
K_3	51	10	9	dUT seasonal coeff. of the annual period (sec), nominally "-.022000"
K_4	61	10	9	dUT seasonal coeff. of the semiannual period (sec), nominally ".006000"
Line	4			
L_1	1	10	9	dUT zonal tide approx. coefficient of lunar cycle (sec), nominally 0
L_2	11	10	9	dUT zonal tide approx. coefficient of semilunar cycle (sec), nominally 0
L_3	21	10	9	dUT seasonal coeff. of the annual period (sec), nominally ".012000"
L_4	31	10	9	dUT seasonal coeff. of the semiannual period (sec), nominally "-.007000"
R_1	41	9	8	Lunar tidal period (days), nominally "500.0000"
R_2	50	9	8	Semilunar tidal period (days), nominally "500.0000"

EOPP 5-Line Output Format (cont'd)

Var.	Col. Star t	Field Width	Req. Prec.	Value
Line	4			
R_3	R_3	9	8	Annual period (days), nominally "365.25"
R_4	R_4	9	8	Semiannual period (days), nominally "182.6250"
Line	5			
	1	4	int	TAI-UTC: Number of total leap seconds (sec)
	5	5	int	NGA identifying bulletin Number (unitless)
	10	6	int	Effectivity date in MJD (days)
	17	7	int	Generation date in MJD (days)
	24	6	int	Time of effectivity, nominally "00000" for midnight
rJ	30	12	9	Rescaled dUT linear drift (msec/day), see variable J
Line	6-12			
		22	int	Prediction date in MJD for following prediction values (days)
X_p		14	9	Polar X motion (arcsec)
Y_p		14	9	Polar Y motion (arcsec)
dUT		14	9	UT1-UTC (sec)

Before June 14th, 2016, NGA GNSS Division used the Tech Note 21 conventions which restored a 41-term Yoder zonal tide model with periods from 5.64 days to 34.85 days. This was accomplished by using the un-used UT1-UTC coefficients and fitting the two dominant periods, 27.56 days (lunar cycle, R_1) and 13.66 days (semi-lunar cycle, R_2), of the zonal tides. Zonal tide approximation for TN21 utilized the unused UT1-UTC coefficients, K_1, K_2, L_1, and L_2 (all formerly set = 0.000000), as specified in the NGA bulletin in the web file named 'EOPP####.TXT'. The web tabular file named 'USAF####.DAT' had the 41-term Yoder zonal tide model applied to the UT1-UTC predictions and the Ray diurnals/sub-diurnals model applied to the polar X, polar Y, and UT1-UTC. This second method of restorations was used by the Air Force GPS Master Control Station .