

IX. Decay Epoch of the "Tiangong-1" Spacecraft. February 10, 2018

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The materials presented below represent a continuation of the text under the same name, posted on the “satmotion.ru” website from November 2017 to February 2018 [1–8].

1. The results for February 10, 2018

For 23 preceding time instants of attribution of measurements, the SC orbital parameters were updated over the array of initial measurements, which were presented by the well-known TLEs [9]. The results of the most recent updating (for ID 9) are presented below. Here the coordinates (in km) and velocities (in km/sec) are presented in the Topocentric Equatorial Coordinate System (as in TLEs).

21954.710044 is the modified Julian date = February 9, 17^h 02^m 27.80^s

-6380.745738 - x
 1804.877130 - y
 -0.068758 - z
 -1.5481276824 - V_x
 -5.4853742734 - V_y
 5.2724926808 - V_z
 0.00263 - S_b (ballistic coefficient, m²/kg).

Figure 1 presents the ballistic coefficient estimates, the values of the geomagnetic disturbance index (K_p) and the minimized criterion for all preceding time instants of orbital parameters updating after January 30, 2018.

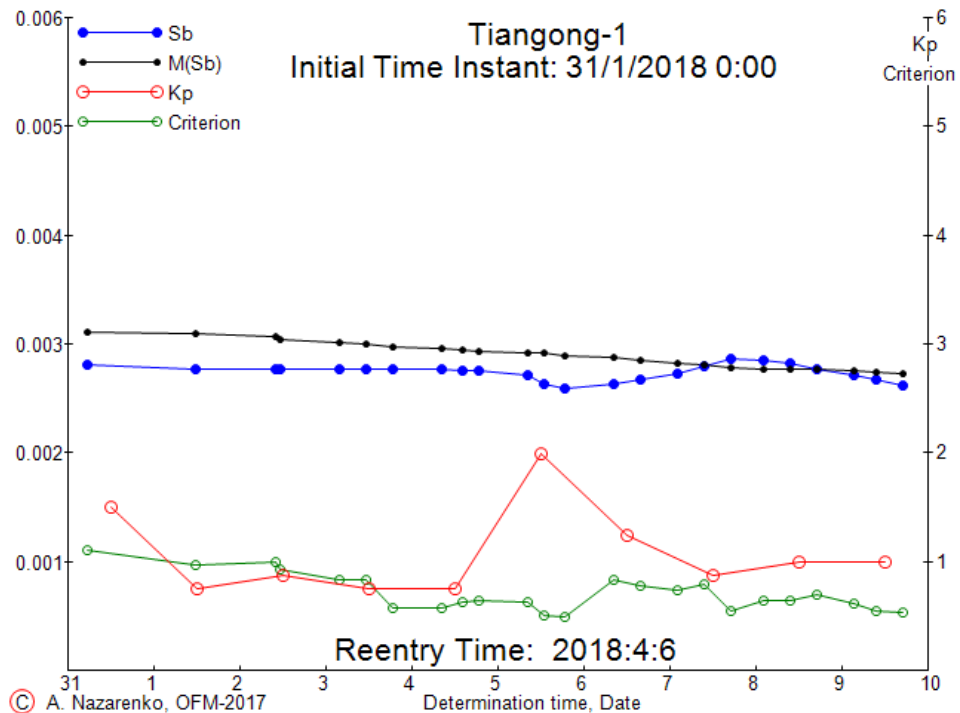


Figure 1. Values of ballistic coefficient, K_p and minimized criterion

The estimates of ballistic coefficient (S_b) have changed within the range from 0.00260 to 0.00287 m^2/kg , i.e. 1.1 times. The highest drag variations have been observed during February 7 (increase) and 9 (decrease), which reflects the K_p index variations in previous points in time. The black line marks the S_b estimates averaged over some preceding time interval (the sliding average). On the time interval after January 30 these estimates decreased by 14 %.

The values of a minimized criterion, presented in the figure, have a meaning of the ratio of residuals to the calculated RMS of errors, averaged over the time interval of measurements. These values depend on the magnitude of current residuals and vary from 0.49 to 1.11. Under perfect tuning of algorithm parameters, their average value should be close to 1. The average value of the criterion (0.81) was low, reflecting the low solar activity.

The last smoothed ballistic coefficient value (0.00274 m^2/kg) was used as a constant value in the prediction of SC motion until its entering the dense layers of the atmosphere. The relevant prediction results for the aforementioned initial data (ID 9) are shown in figure 2.

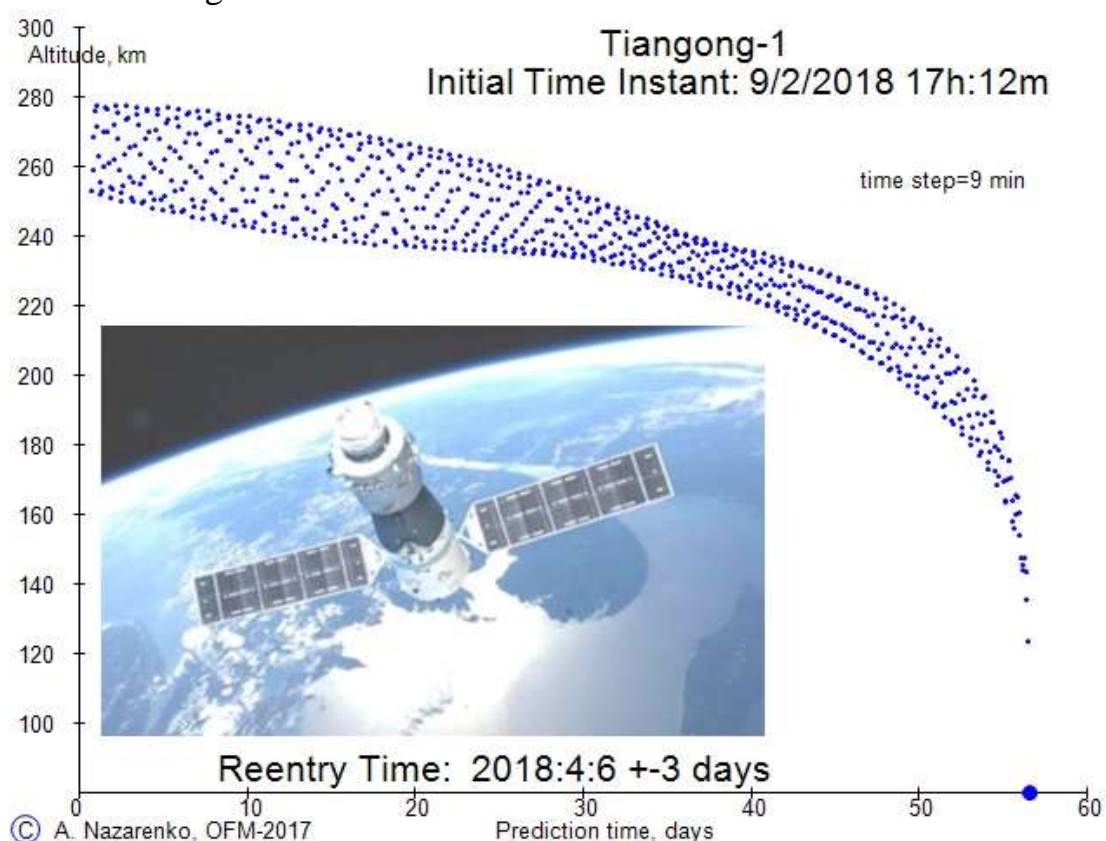


Figure 2. Change of the altitude on the prediction interval

Reentry Information.

Tiangong-1 is predicted to reenter on April 6, 2018 ± 3 days.

Figure 3 presents the results of all 100 preceding determinations of Tiangong-1 SC reentry time after January 01. The average value of reentry time is \approx March 31. Deviations from the average value do not exceed 11% of remaining lifetime. The

RMS of errors amounted **2.8%**, which is several times lower than the traditional estimates of errors. Removal of reentry time in early January and February was in line with the decrease of the average values of the Sb in 25% during this period.

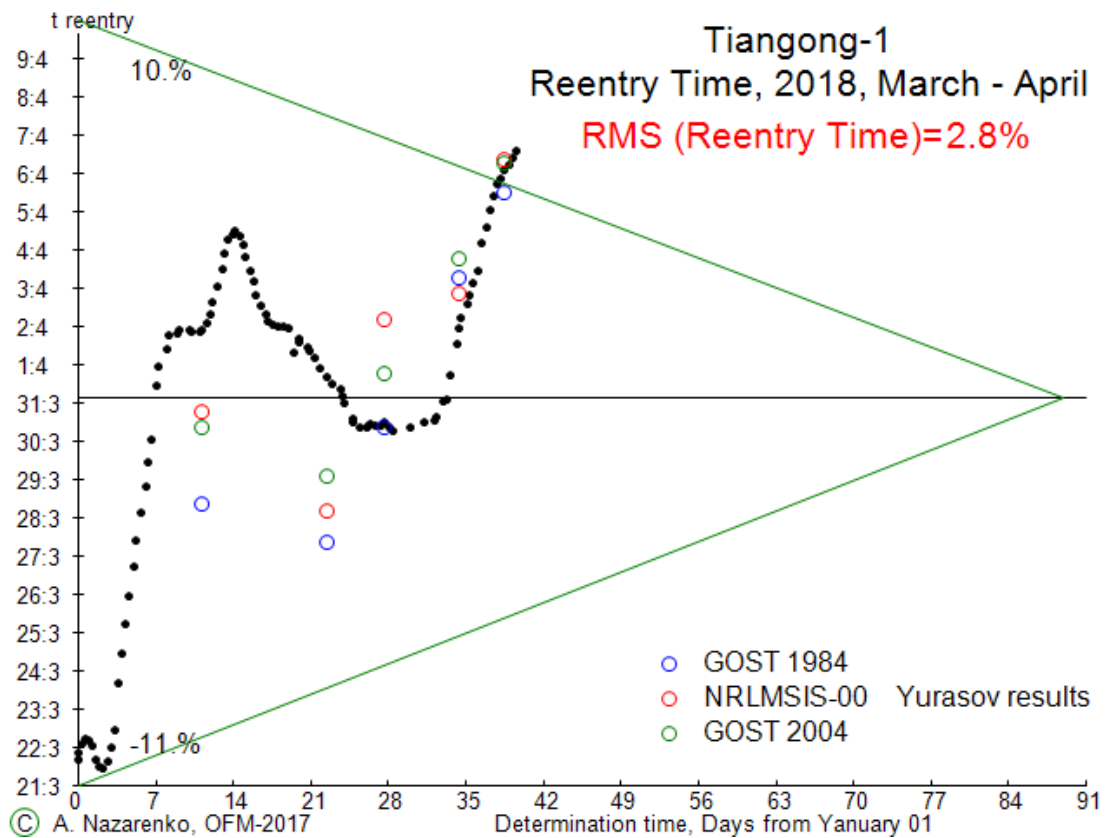


Figure 3. All determinations of Tiangong-1 SC reentry time in 2018

2. Recent publication of other authors

a) Aerospace Corporation

Reentry Information

Tiangong-1 is predicted to reenter in **late March 2018** \pm 2 weeks.

This prediction was performed by The Aerospace Corporation on 2018 January 30.

b) Space Track data

DECAY DATA:

Show 10 entries Search All Columns: 37820

NORAD CAT ID	SATNAME	INTLDES	COUNTRY	MSG_EPOCH	DECAY_EPOCH	RCS	SOURCE	TLE	Type
37820	TIANGONG 1	2011-063A	PRC	2018-01-31 17:25:58	2018-03-12 0:00:00	LARGE	60day_msg	TLE	Prediction
37820	TIANGONG 1	2011-063A	PRC	2018-01-24 16:00:44	2018-03-12 0:00:00	LARGE	60day_msg	TLE	Prediction
37820	TIANGONG 1	2011-063A	PRC	2017-12-27 16:48:42	2018-02-22 0:00:00	LARGE	60day_msg	TLE	Prediction

Showing 1 to 3 of 3 entries (filtered from 57,921 total entries)
 Country Legend RCS Legend

b) Data by V.S. Yurasov (private message).

The TLE processing results over the preceding week interval and the forecast of the SC motion until reentry:

Initial data time	Results	Atmospheric model		
		GOST 1984	NRLMSIS	GOST 2004
November 9, 2017	t reentry	March 10 02 ^h	March 9 06 ^h	March 7 00 ^h
	Sb, m ² /kg	0.00384	0.00386	0.00368
December 1, 2017	t reentry	March 12 03 ^h	March 9 18 ^h	March 11 22 ^h
	Sb, m ² /kg	0.00361	0.00389	0.00360
December 9, 2017	t reentry	March 14 00 ^h	March 16 12 ^h	March 18 06 ^h
	Sb, m ² /kg	0.00367	0.00373	0.00347
December 19, 2017	t reentry	March 19 14 ^h	March 21 03 ^h	March 17 14 ^h
	Sb, m ² /kg	0.00349	0.00361	0.00359
December 28, 2017	t reentry	March 19 20 ^h	March 20 18 ^h	March 20 15 ^h
	Sb, m ² /kg	0.00347	0.00369	0.00346
January 12, 2018	t reentry	March 28 10 ^h	March 30 22 ^h	March 30 10 ^h
	Sb, m ² /kg	0.00331	0.00341	0.00325
January 23, 2018	t reentry	March 28 09 ^h	March 28 22 ^h	March 29 22 ^h
	Sb, m ² /kg	0.00348	0.00342	0.00369
January 27, 2018	t reentry	March 30 04 ^h	April 02 20 ^h	March 31 04 ^h
	Sb, m ² /kg	0.00334	0.00334	0.00333
February 4 2018	t reentry	April 03 23 ^h	April 04 19 ^h	April 03 08 ^h
	Sb, m ² /kg	0.0032	0.0034	0.0032
February 8 2018	t reentry	April 05 12 ^h	April 06 8 ^h	April 06 07 ^h
	Sb, m ² /kg	0.0030	0.0032	0.0030

References

1. A.I. Nazarenko. Decay Epoch of the "Tiangong-1" Spacecraft. November 1, 2017.
2. A.I. Nazarenko. Decay Epoch of the "Tiangong-1" Spacecraft. November 15, 2017.
3. A.I. Nazarenko. Decay Epoch of the "Tiangong-1" Spacecraft. December 1, 2017.
4. A.I. Nazarenko. Decay Epoch of the "Tiangong-1" Spacecraft. December 10, 2017.
5. A.I. Nazarenko. Decay Epoch of the "Tiangong-1" Spacecraft. December 20, 2017.
6. A.I. Nazarenko. Decay Epoch of the "Tiangong-1" Spacecraft. December 30, 2017.
7. A.I. Nazarenko. Decay Epoch of the "Tiangong-1" Spacecraft. January 15, 2018.
8. A.I. Nazarenko. Decay Epoch of the "Tiangong-1" Spacecraft. January 30, 2018
9. <http://www.space-track.org>