VIII. Decay Epoch of the "Tiangong-1" Spacecraft. January 30, 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 in November – December 2017 and in January 2018 [1–7].

1. The results for January 30, 2018

For 56 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 [8]. The results of the most recent updating (for ID 8) are presented below. Here the coordinates (in km) and velocities (in km/sec) are presented in the Topocentric Equatorial Coordinate System (as in TLEs).

21943.55228221 is the modified Julian date = January 29, 13^h 15^m 17.18^s

-3819.656631 - x
-5440.760284 - y
-0.547232 - z
4.6493367260 - Vx
-3.2755974384 - Vy
5.2616921748 - Vz
0.00289 - Sb (ballistic coefficient, m^2/kg).

Figure 1 presents the ballistic coefficient estimates, the values of the geomagnetic disturbance index (Kp) and the minimized criterion for all preceding time instants of orbital parameters updating after January 19, 2018.

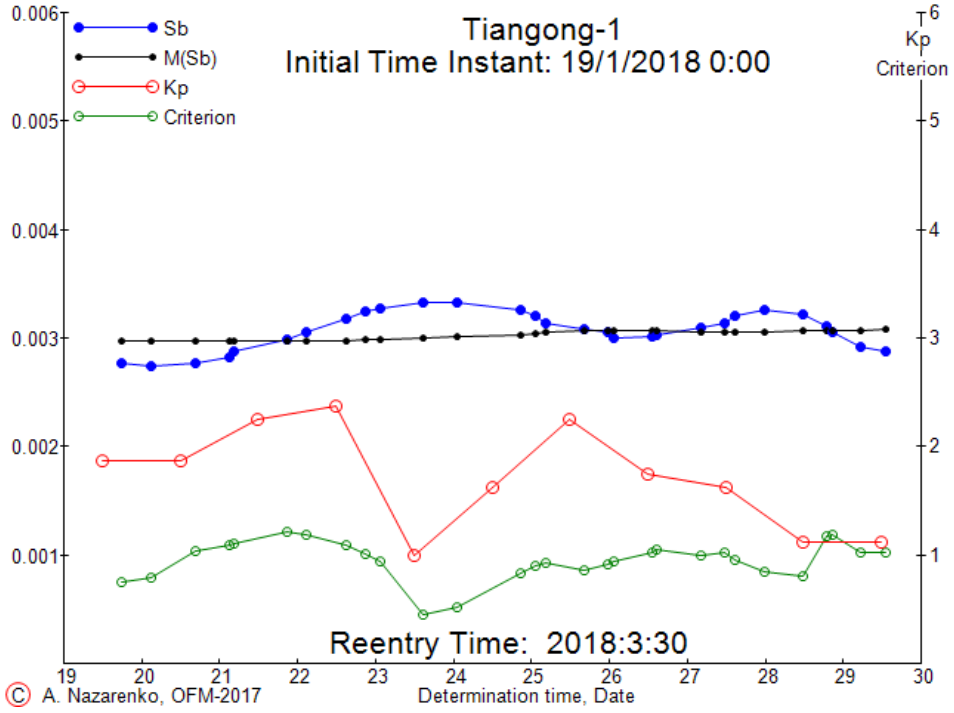


Figure 1. Values of ballistic coefficient, Kp and minimized criterion

The estimates of ballistic coefficient (Sb) have changed within the range from 0.00275 to 0.00333 m^2/kg, i.e. 1.2 times. The highest drag variations have been observed during January 22 (increase) and 28 (decrease), which reflects the Kp index variations in previous points in time. The black line marks the Sb estimates averaged over some preceding time interval (the sliding average). On the time interval after January 19 these estimates decreased by 3.7%.

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 0.46 to 1.21. Under perfect tuning of algorithm parameters, their average value should be close to 1. The averaged value of the criterion (0.95) is close to the ideal value.

The last smoothed ballistic coefficient value (0.00309 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 8) are shown in figure 2.

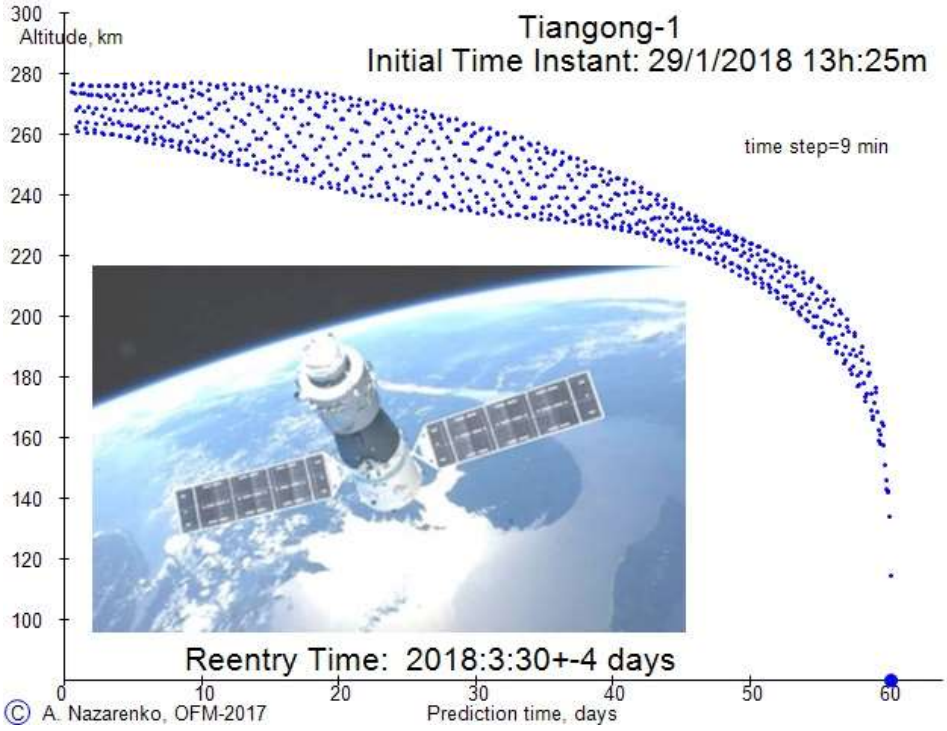


Figure 2. Change of the altitude on the prediction interval

Reentry Information.

Tianging-1 is predicted to reenter on March 30, 2018 ±4 days.

Figure 3 presents the results of all 76 preceding determinations of Tiangong-1 SC reentry time after January 01. The average value of reentry time is ≈ March 30. Deviations from the average value do not exceed 10% 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 was in line with the decrease of the average values of the Sb in this period by 15%.

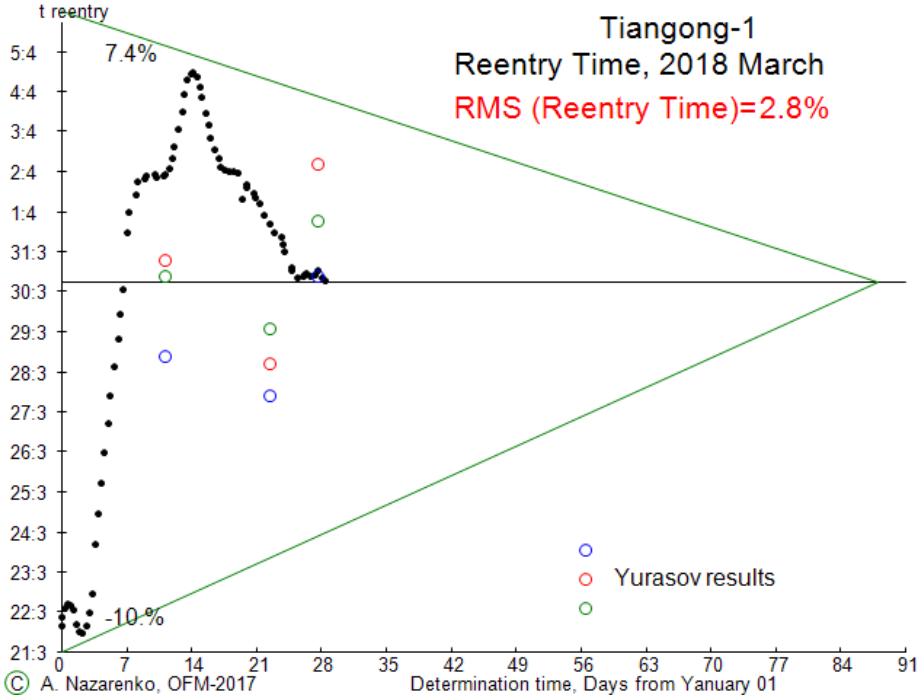


Figure 3. All determinations of Tiangong-1 SC reentry time in 2018

2. Recent publication of other authors

a) Tiangong-1 is predicted to reenter in late March 2018 ± 2 weeks.

This prediction was performed by The Aerospace Corporation on 2018 January 17.

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:

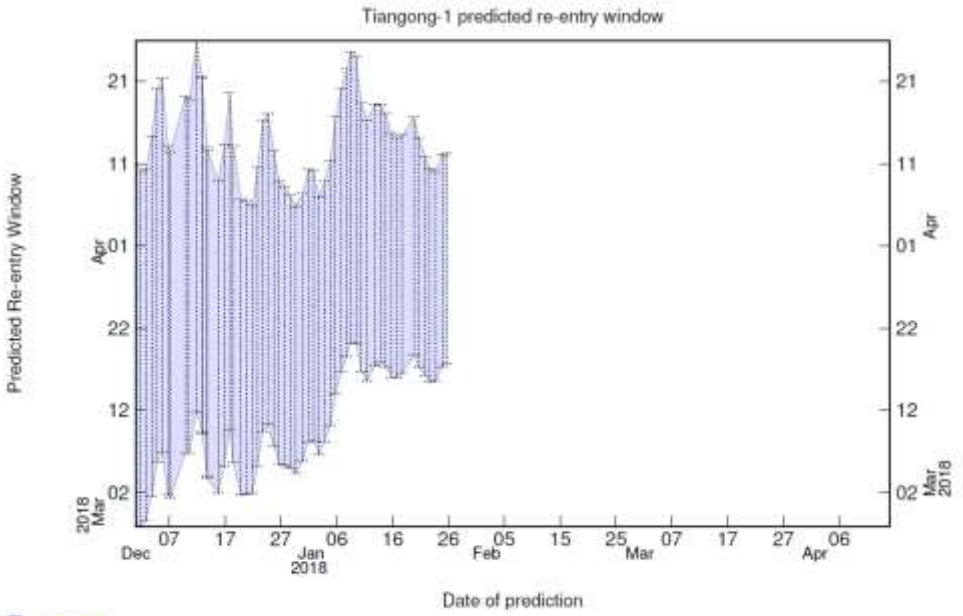
Initial data time	Results	Atmospheric model		
		GOST 1984	NRLMSIS	GOST 2004
November 9, 2017	t reentry	March **10** 02^h	March **9** 06^h	March **7** 00^h
	Sb, m^2/kg	0.00384	0.00386	0.00368
December 1, 2017	t reentry	March **12** 03^h	March **9** 18^h	March **11** 22^h
	Sb, m^2/kg	0.00361	0.00389	0.00360
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 27, 2018	t reentry	March **30** 09^h	April **02** 20^h	March **31** 04^h
	Sb, m^2/kg	0.00334	0.00334	0.00333

c) ESA

ESA - European Space Agency
26 января в 21:15 ·

Current #Tiangong1 reentry forecast updated by ESA's Space Debris Office: Not much change from last week! Estimated around 18 March to 12 April, but note this is highly variable. See http://blogs.esa.int/.../20.../01/12/tiangong-1-reentry-updates/

The current reentry uncertainty window is shown below



d) Space Track

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	2011-053A	PRC	2018-01-24 16:00:44	2018-03-12 0:00:00	LARGE	60day_msg	TLE	Prediction
37820	TIANGONG 1	2011-053A	PRC	2017-12-27 16:48:42	2018-02-22 0:00:00	LARGE	60day_msg	TLE	Prediction

References

1. A.I. Nazarenko. Decay Epoch of the "Tiangong-1" Spacecraft. November 1, 2017. Site satmotion.ru
2. A.I. Nazarenko. Decay Epoch of the "Tiangong-1" Spacecraft. November 15, 2017. Site satmotion.ru
3. A.I. Nazarenko. Decay Epoch of the "Tiangong-1" Spacecraft. December 1, 2017. Site satmotion.ru
4. A.I. Nazarenko. Decay Epoch of the "Tiangong-1" Spacecraft. December 10, 2017. Site satmotion.ru
5. A.I. Nazarenko. Decay Epoch of the "Tiangong-1" Spacecraft. December 20, 2017. Site satmotion.ru

6. A.I. Nazarenko. Decay Epoch of the "Tiangong-1" Spacecraft. December 30, 2017. Site satmotion.ru
7. A.I. Nazarenko. Decay Epoch of the "Tiangong-1" Spacecraft. January 15, 2018. Site satmotion.ru
8. http://www.space-track.org