

VI. Decay Epoch of the "Tiangong-1" Spacecraft.

December 30, 2017

Andrey I. Nazarenko, Professor, retired

The materials described below are the continuation of the same text name posted on the website "satmotion.ru" for November 1, 15, as well as for December 1, 10 and 20 2017 [1 - 5].

The results of the December 30, 2017

For 60 earlier time points, updating the orbital parameters was made through the array of source measurements, which were as known TLE [6]. Following are the results of the most recent update (ID 6). Here the coordinates (km) and velocity (km/sec) are in Topocentric Equatorial Coordinate System (as in TLE).

21912.634719- modified Julian day = December =29, 15^h 13^m 59.72^s

2276.131512 - x

6249.911870 - y

0.195462 - z

-5.3508990349 - V_x

1.9325144072 - V_y

5.2636809347 - V_z

0.00349 - S_b (ballistic coefficient, m²/kg).

Figure 1 presents the assessment of ballistic coefficient, the index values of the geomagnetic perturbation (K_p) and criteria minimum for all previous time points of the orbital parameters updating after December 20.

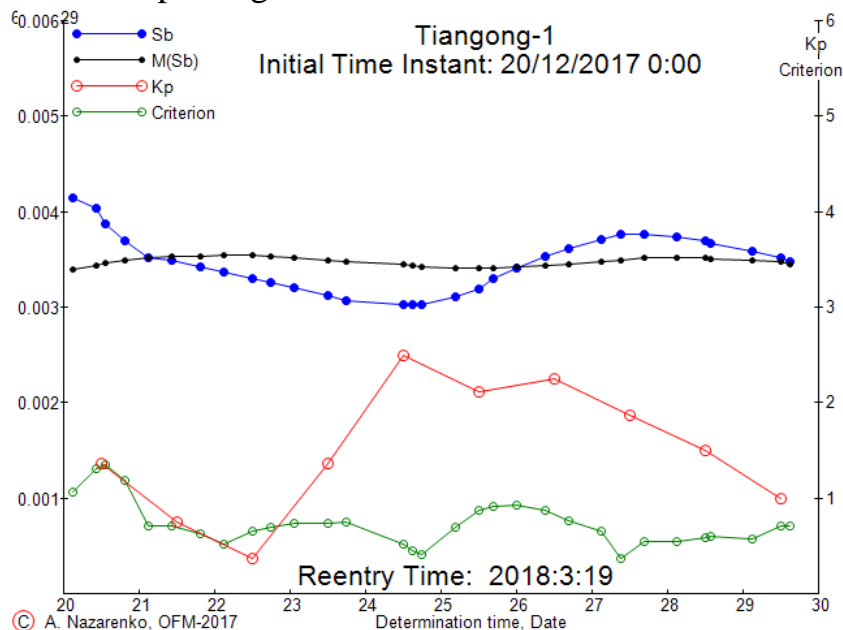


Figure 1. Values of ballistic coefficient, K_p and criterion

Values of ballistic coefficient (S_b) vary in the range from 0.00304 to 0.00415 m²/kg, i.e. 1.4 times. These assessments play an important role, as used as initial data for calculating burn up SC in the atmosphere. Substantial variations were observed in

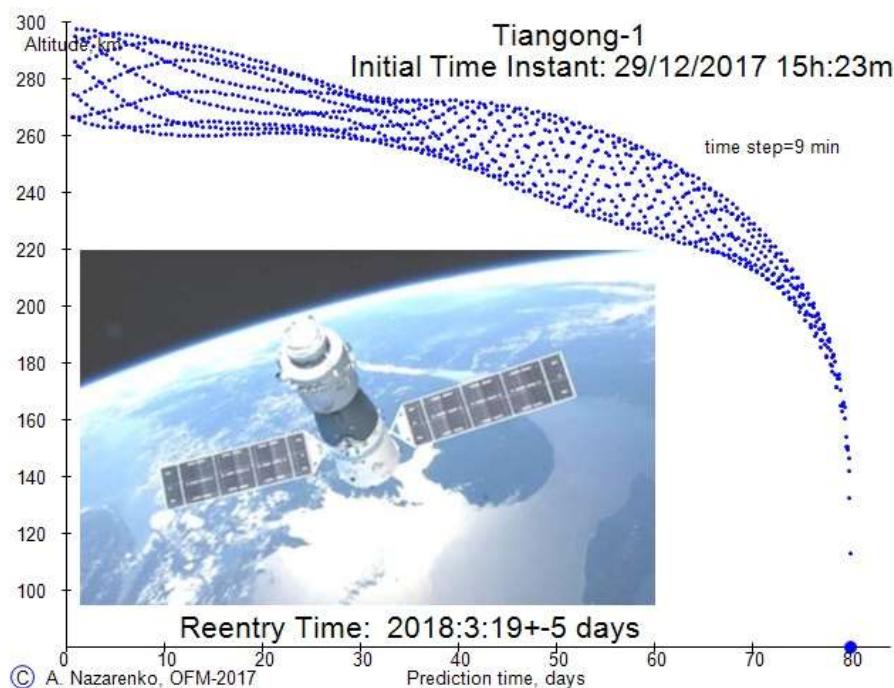
the time intervals December 20-21 (decrease) and 25-26 (increase). Black line marked by the average assessment of S_b at some previous time interval (moving average). They are used when generating initial data for prediction.

Shown in the figure criterion value have meaning the ratio of residuals to calculated RMS of errors, averaged on time interval of measurements. These values depend on the magnitude of the current residuals and vary from 0.37 to 1.35. Under perfect tuning algorithm parameters, their average value should be close to one. The average criterion value equal to 0.89 that acceptable manner consistent with an ideal value.

Comparison of S_b values with geomagnetic perturbation indexes shows that the above mentioned variation are the consequence of an extreme geomagnetic activity at December 17-18 and 21-22 that has led to a corresponding change in atmosphere density.

The last smoothed ballistic coefficient value ($0.00346 \text{ m}^2/\text{kg}$) was used as a constant value in the prediction of the SC motion until his entering the dense layers of the atmosphere. Feature smoothed estimates of S_b is their stability: on the considered time interval, deviation from the average did not exceed $\pm 3\%$.

Relevant prediction results by the above initial data (ID 6) are shown in figure 2.



Reentry Information.

Tiangong-1 is predicted to reenter in 2018, March 19 ± 5 days.

Figure 3 presents the results of all 89 earlier reentry time determination of SC Tiangong-1, based on techniques developed by the author. The average value of reentry time \approx March 17. Deviation from the mean does not exceed 8.5% remaining lifetime. RMS errors amounted to **2.7%**, which is several times smaller than traditional assessments of errors.

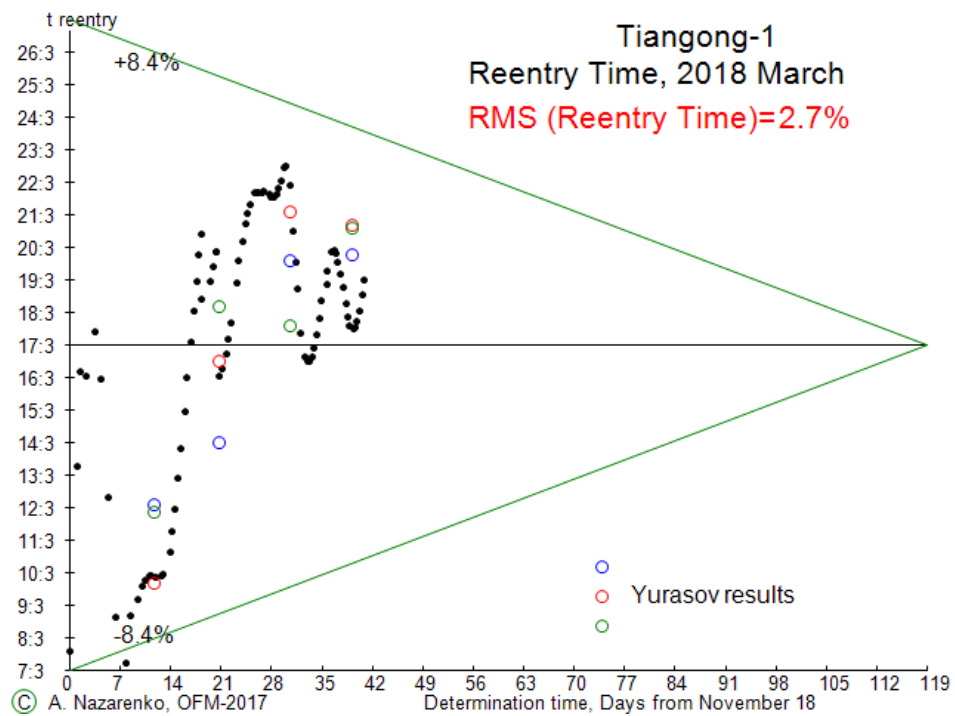
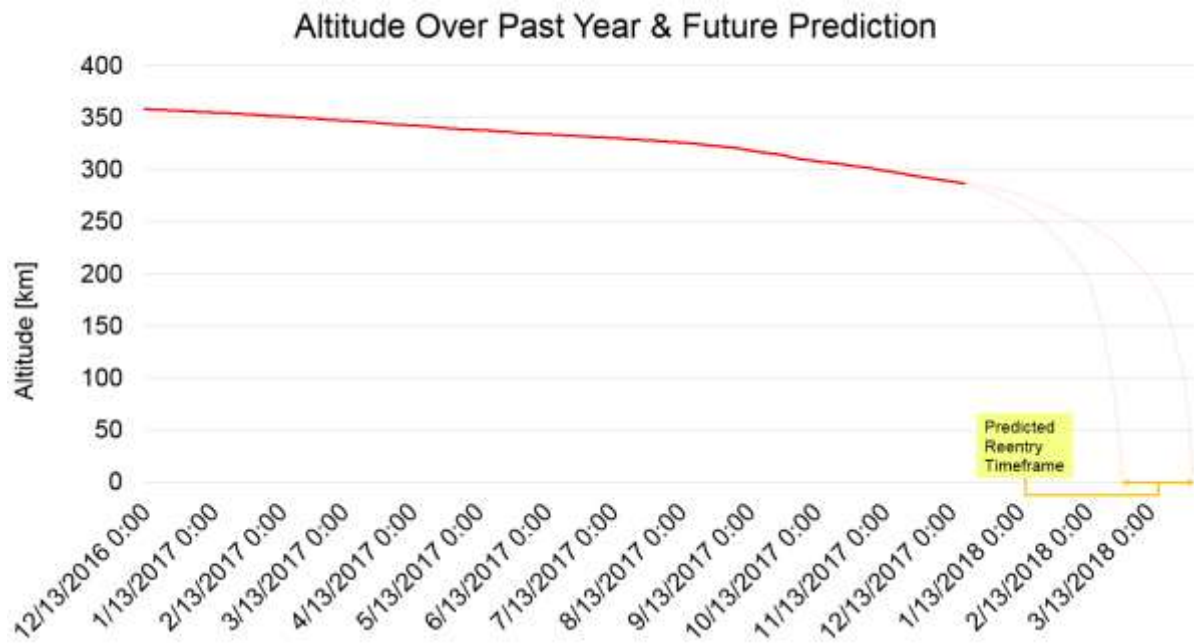


Figure 3. All determination of reentry time

Recent publication of other authors

a) Tiangong-1 Altitude Prediction. This prediction was performed by The Aerospace Corporation on 2017 December 19.



Tiangong-1 Altitude Prediction

Tiangong-1 is to reenter in mid-March 2018 ± 2 weeks

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

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

c) Site Satview.org



Forecast of Reentry Location

Update Wed 27-Dec-2017 22:11 UTC

The map above shows the location of the possible reentry of the space junk **TIANGONG 1 (37820U)** predicted by modeling of orbital evolution until the fragment or satellite reaches the altitude of nominal burst.

According to the forecast made by **Satview.org**, the object's reentry will occur in **Saturday, 24 Mar 2018 at 07:36 UTC**, above the coordinates shown on map.

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. <http://www.space-track.org>