

Decay Epoch of the "Tiangong-1" Spacecraft

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1. Published data about the spacecraft and its expected decay epoch

Tiangong-1 "(literally:" Heavenly Palace-1 ") is the first Chinese spacecraft orbital class the station, created on draft 921-2, referred to as the target module and is designed for testing technologies for spacecraft rendezvous and docking. "Tiangong-1 became the first not Soviet and not American freely flying manned orbital station, a smaller but similar in function to the Soviet orbital stations of the first generation Salyut and Almaz.

On 21 March 2016, after a lifespan extended by two years, the Space Engineering Office announced that Tiangong-1 had officially ended its service. They went on to state that the [telemetry](#) link with Tiangong-1 had been lost. In September, after conceding they had lost control over the station, officials announced that the station would [re-enter](#) and burn up in the atmosphere late in 2017. It is currently expected to deorbit some time between early January and late February 2018.

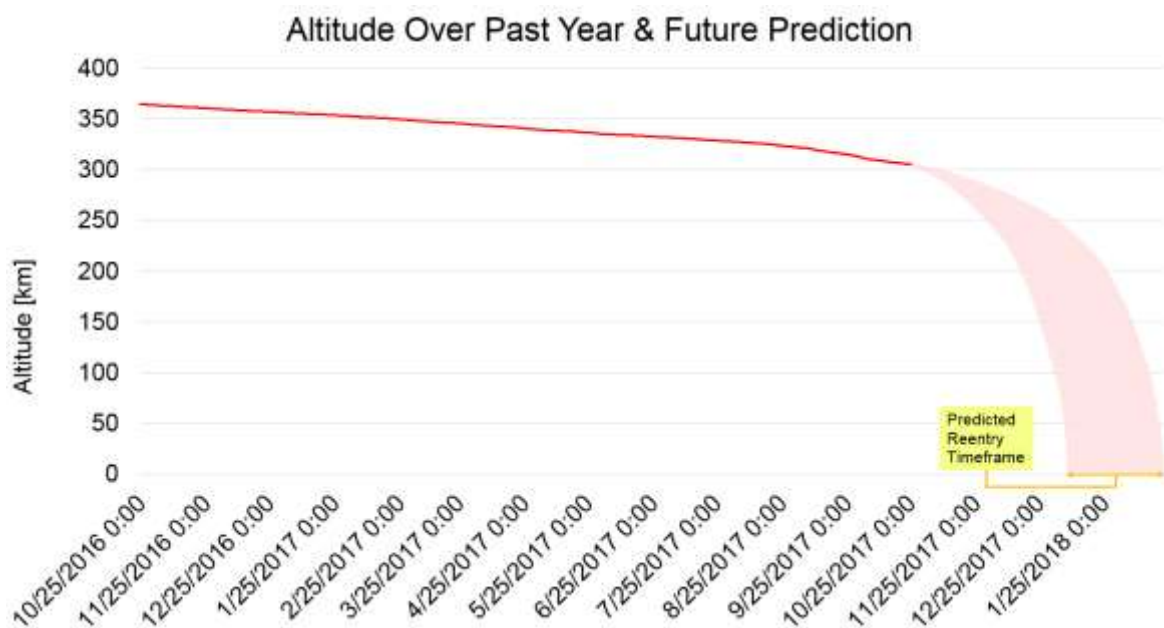
Data for May 19, 2017.

According to a note verbale from the Permanent Mission of China to the United Nations (Vienna), Tiangong-1's average orbital altitude is 349 kilometres, decaying at a daily rate of approximately 160 metres. Its re-entry into the Earth's atmosphere is expected to occur between October 2017 and April 2018.

The Aerospace Corp.'s Center for Orbital and Reentry Debris Studies (CORDS)

Reentry Information, October 31.

Tiangong-1 is predicted to reenter in **late January 2018±1 month.**



Explanation

In circumstances where prior to the SC reentry remains for several months, the above data on publications are typical [1]. Namely, all ratings are episodic and approximate. On the site SpaceTrak estimates expected reentry of non-existent. Most professional is above Aerospace Corp data. Experts realize that currently, localize the place of incidence is impossible. Therefore, all stakeholders until activity. Vanity will begin when less than a month remains before the re-entry.

The author decided to prepare the following material for a number of reasons:

- Inter-Agency Space Debris Coordination Committee organizes re-entry Prediction Campaigns involving representatives of different space agencies. In 2018, this campaign is scheduled for "Tiangong-1".
- On 28 February-March 2, 2018, the International Workshop on Space Debris (ESA/ESOC, Darmstadt, Germany) is planned.
- The activities referred to above are a very appropriate place to show case the possibilities to increase the accuracy of the solution of the problem through the using the Optimal Filtration of Measurements (OFM) method, developed by author.
- Early analysis of the evolution of the orbit and its forecast allow accumulate representative statistics and thus improve the reliability of the analytical results.

2. The results of the November 1, 2017

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

21852.827638 - modified Julian day = October 30, 19^h 51^m 47.92^s

689.640944 - x

6634.447513 - y

0.174153 - z

-5.6511322414 - V_x

0.5899191332 - V_y

5.2571702871 - V_z

0.00290 - S_b (ballistic coefficient, m²/kg).

Figure 1 presents the assessment of ballistic coefficient and subscript geomagnetic perturbation (K_p) for all points in time updating the orbital parameters.

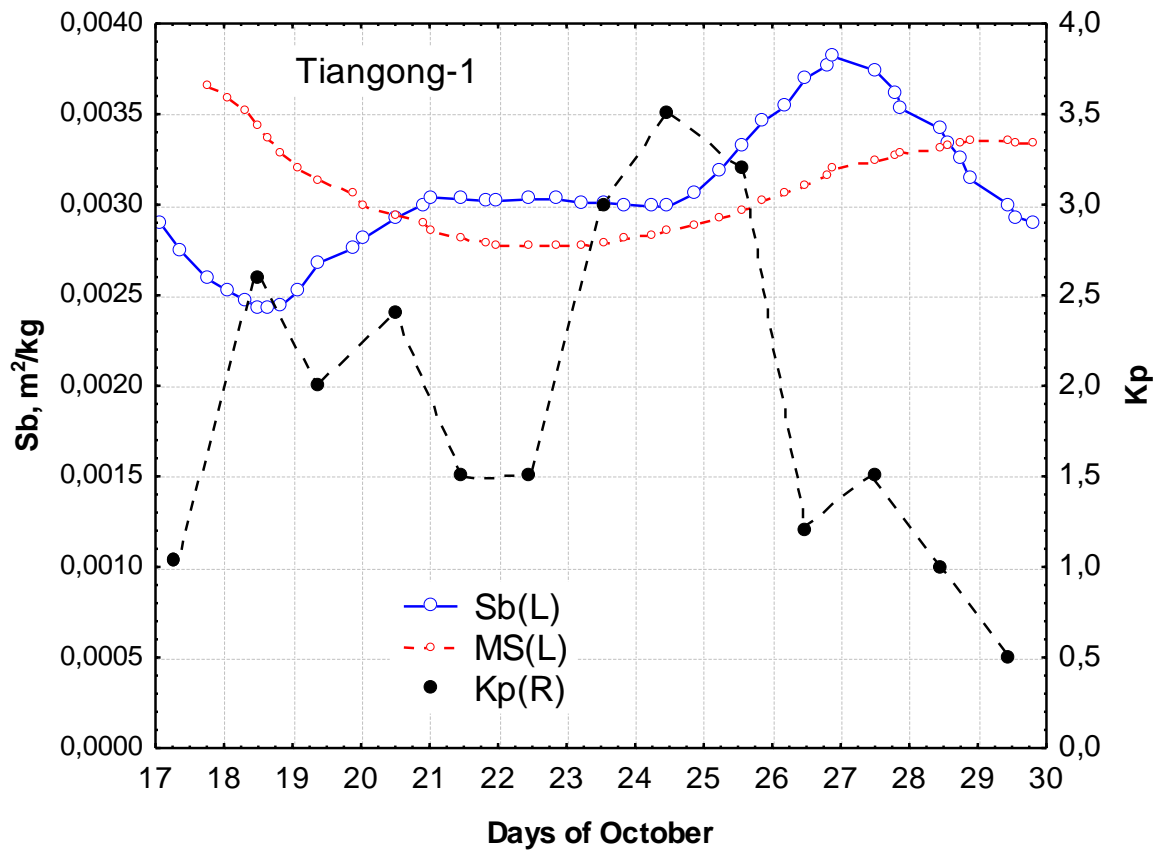


Figure 1. Sb and Kp values

Values of ballistic coefficient (Sb) vary in the range from 0.0024 to 0.0038 m²/kg, i.e. 1.6 times. These assessments play an important role, as used as initial data for calculating burn up SC in the atmosphere. The most powerful variation of inhibition was observed in the time interval from October 26 to 29. Red dotted line marked by the average assessment of Sb at some previous time interval (moving average). They are used when generating initial data for prediction.

Comparison of assessments of Sb with geomagnetic perturbation index shows that the above strong variation of braking are the consequence of geomagnetic storms on October 24-26, which led to additional heating up of the atmosphere and the corresponding increase in its density.

The last smoothed ballistic coefficient value (0.00334 m²/kg) was used as a constant value in the prediction of the SC motion until his entering the dense layers of the atmosphere. The relevant results of the forecast are presented in Figure 2.

When this scatter plot is prepared, the time step of 10 minutes was used. That is why the figure has a peculiar appearance.

Reentry Information.

Tiangong-1 is predicted to reenter in 2018, March 12 ±13 days.

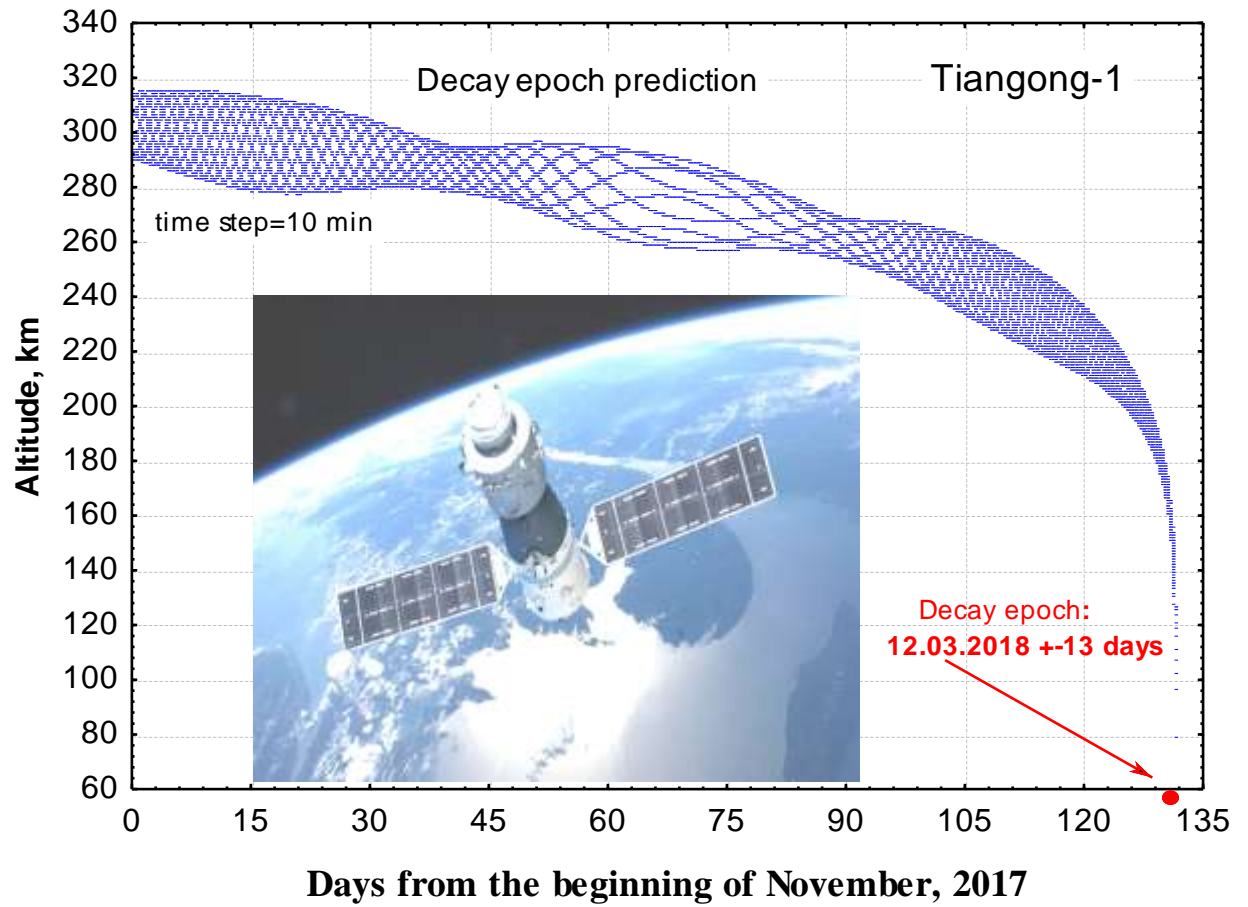


Figure 2. Altitude values as time goes on

References

1. A.I. Nazarenko. Reentering spacecraft Molniya 1-44. Comments. Site "satmotion.ru".

2017, November 1