III. Decay Epoch of the "Tiangong-1" Spacecraft November 30, 2017

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The materials described below are the continuation of the same text name posted on the website "satmotion.ru" for November 1 and 15, 2017 [1, 2].

The results of the November 30 2017

For 60 earlier points in time, updating the orbital parameters was made through the array of source measurements, which were as known TLE [3]. 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).

21883.142059- modified Julian day =November 30 03^h 24^m 33.90^s
-1733.340945   - x
-6454.494227   - y
0.290966   - z
5.4733719927 - Vx
-1.4667588867 - Vy
5.2427175854 - Vz
0.00341   - Sb ((ballistic coefficient, m^2/kg).

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

Values of ballistic coefficient (Sb) vary in the range from 0.00326 to 0.00424 m^2/kg, i.e. 1.3 times. These assessments play an important role, as used as initial data for calculating burn up SC in the atmosphere. The significant variation of estimates was observed in the time interval from November 22 to 24. Black line marked by the average assessment of Sb 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 between 0.31 to 2.14. Under perfect tuning algorithm parameters, their average value should be close to one.

Comparison of assessments of Sb with geomagnetic perturbation index shows that the above significant variation of braking is the consequence of geomagnetic storms on

November 21, which led to additional heating up of the atmosphere and the corresponding increase in its density. The last smoothed ballistic coefficient value (0.00372 m²/kg) was used as a constant value in the prediction of the SC motion until his entering the dense layers of the atmosphere.
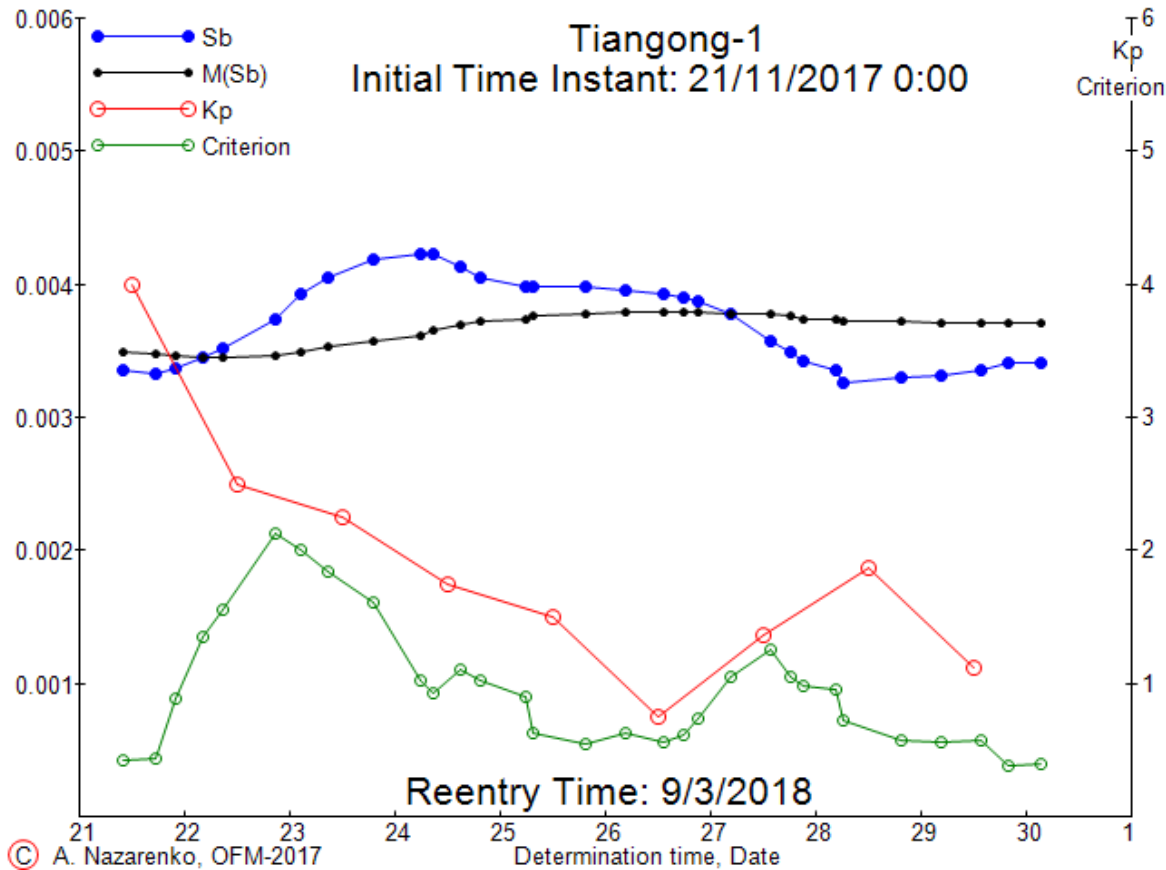

Figure 1. Values of ballistic coefficient, Kp and criterion

Criterion values (quadratic forms) are of important significance for checking the orbit determination. It is visible from figure that the maximum value are reached at instant of time when ballistic coefficient values are changes significant, i.e., at instant of significant unpredictable changes of atmospheric density. In these times the consistency of measurements with the computational motion model deteriorates, which leads to an increase in residuals. The criterion value, averaged according to figure data, equals 1.02, i.e. practically coincides with the perfect value.

The last smoothed ballistic coefficient value (0.00372 m²/kg) was used as a constant value in the prediction of the SC motion until his entering the dense layers of the atmosphere. Relevant results prediction for these initial data (ID 3) are shown in Figure 2. When this scatter plot is prepared, the time step of 100 minutes was used. That is why the figure has a peculiar appearance.
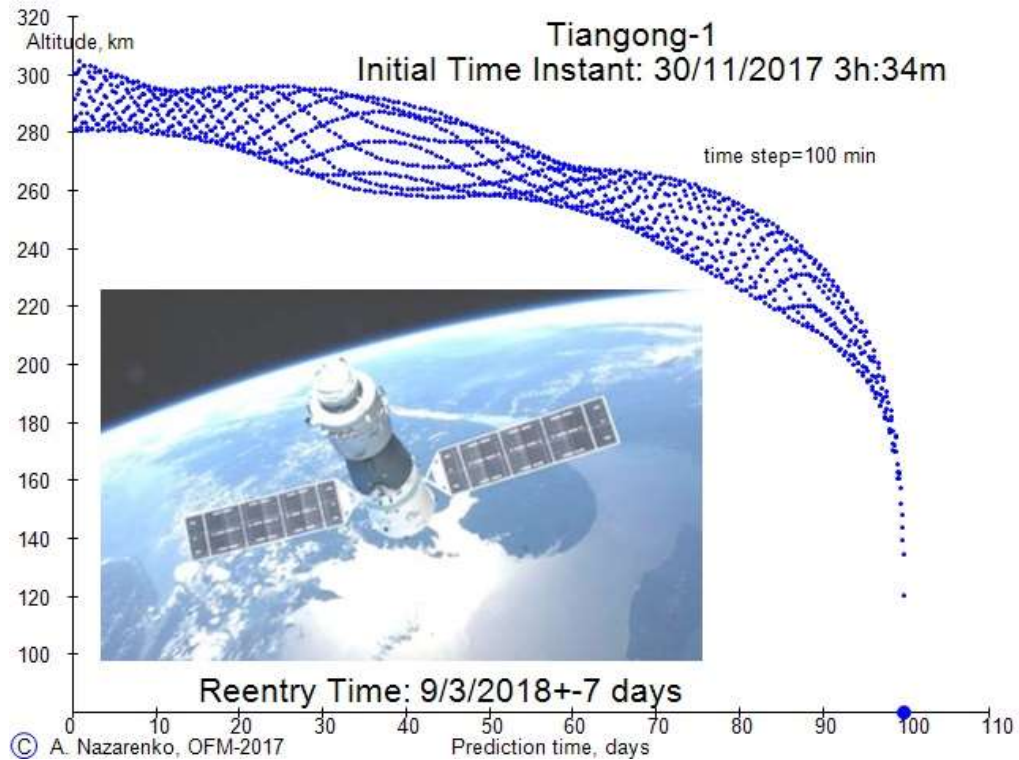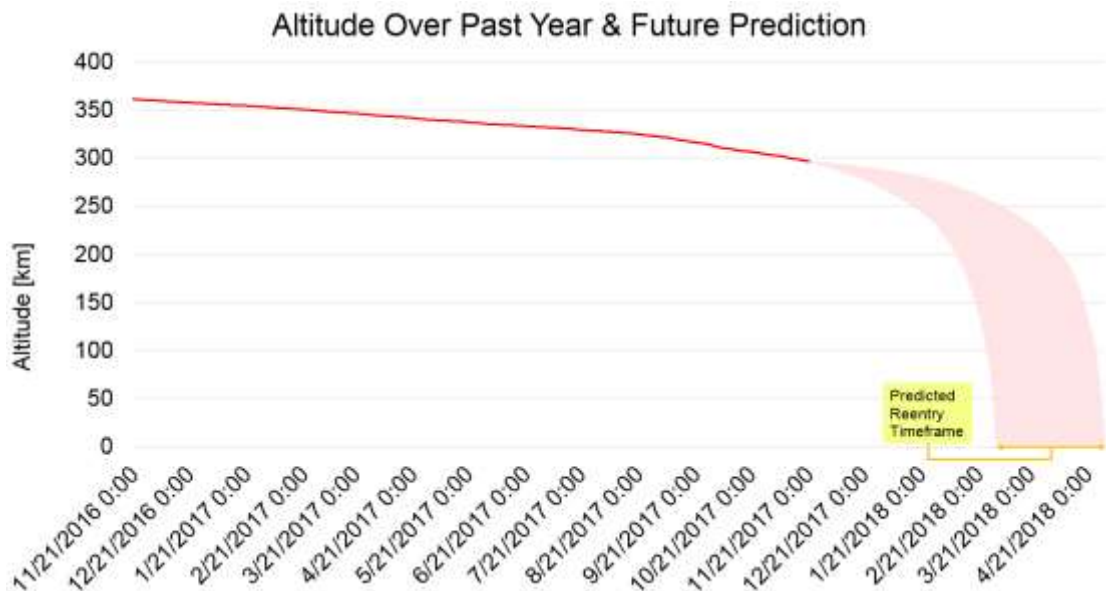
Figure 2. Altitude values as time goes on

Reentry Information.

Tianging-1 is predicted to reenter in 2018, March 09 ±7 days.

Recent publication

This prediction was performed by The Aerospace Corporation on 2017 November 21

Tiangong-1 is predicted to reenter in Март 21 2018 ± 1 month.

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