

RMAE 8th Grade Science Students use their Real-Time Data to Predict the Uncontrolled Re-entry of the Chinese Space Station Tiangong-1

As the 8th-Grade students were looking forward to Spring Break, they were also looking forward to the uncontrolled re-entry of the Tiangong-1 (aka Heavenly Palace) Chinese Space Station. Early estimates of the re-entry had it coming down as early as fall of 2017.

Tiangong-1 was launched in 2011 and was destined to be at least as large as the International Space Station (ISS) upon completion. However, the orbit began to decay early on and by March 2016 the space station had stopped functioning. Mr. Bryant began tracking it in July 2016 when it was at an altitude of about 369 kilometers (229 miles) and traveling at a speed of 7.69 km/s (4.78 mi/s). At that time, the satellite's orbital period was 93 minutes. By comparison, the ISS orbits at an average altitude of 409 km, traveling at a speed of 7.66 km/s, with an orbital period of 93 minutes.

During March 2018, the RMAE 8th-Grade Science students just happened to be studying forces (think Newton's Laws of Motion) as they apply to rockets and satellites. It seemed like a great opportunity to collect some real-time data and produce our own predictions as to when Tiangong-1 would meet its fiery demise. The students tracked the satellite as it crossed the equator traveling from north to south on its elliptical orbit in order to have a consistent datum for altitude measurements. The equatorial crossing tended to be the low point of the decaying elliptical orbit. At least one north-to-south equatorial crossing was recorded on most days during March 2018. The data recorded during these equatorial crossings included: date, time, latitude, altitude (in both kilometers and miles), speed (in both kilometers/second and miles/second), and orbital period.

At 7:54 am on Thursday, March 22, 2018 (during 8th Grade Science class) the altitude was down to 228.29 km with a speed of 7.77 km/s and an orbital period of 89 minutes. The students used the accumulated date, time, and altitude data to produce graphs of the satellite's orbital motion during March 2018. The students used their graphs to project the date the satellite would drop to about 100 kilometers (km). This is the location of the Karman line, or roughly the boundary between where Earth's atmosphere ends and space begins. At this point, the drag (fluid friction) created by the atmosphere would cause the orbit to decay rapidly.

As it turned out, the school-bus-size (10.4 meter) Chinese Space Station re-entered April 2, 2018 @ 00:16 UTC (April 1, 6:16 pm local time). Any surviving fragments of the 8,506 kilogram (18,752 lb.) satellite landed in the Pacific Ocean northwest of Tahiti. **Congratulations to Anna Laczak and Ellie White** for successfully (and independently) predicting the correct date of re-entry, based on data they graphed on March 22, 2018. Students were encouraged to suggest a prize if they won. Anna wishes to be surprised, while Ellie requested an acre of the Moon. Look out NASA, two new recruits are headed your way!