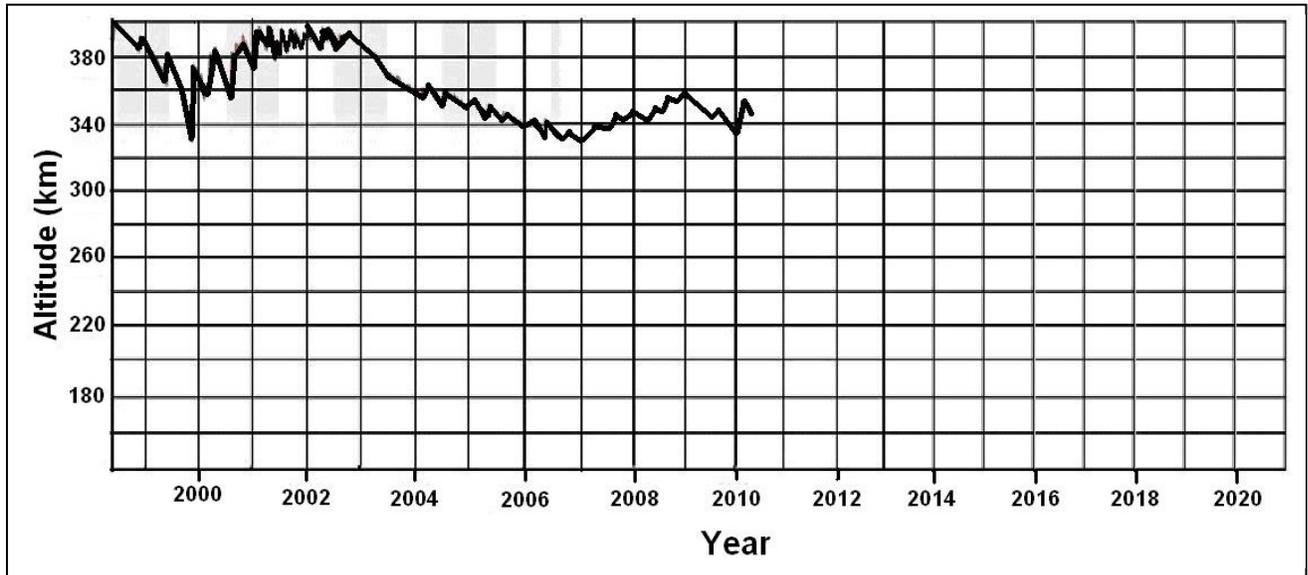


At the present time, the International Space Station is losing about 300 feet (90 meters) of altitude every day. Its current altitude is about 345 km after a 7.0-km re-boost by the Automated Transfer Vehicle, Jules Vern spacecraft on June 20, 2008. The graph below shows the ISS altitude since 1999.



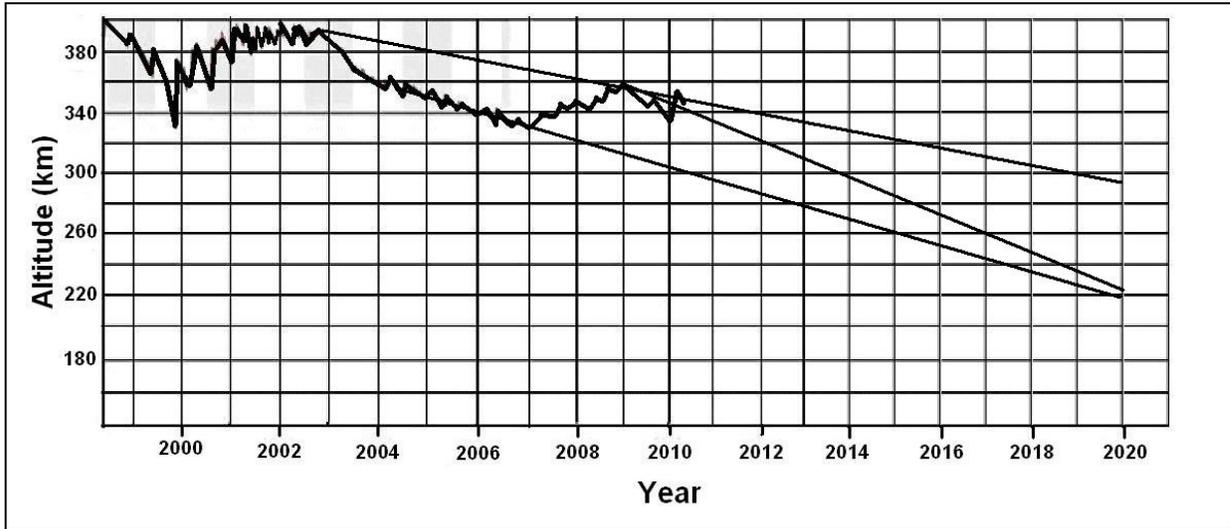
The drag of Earth's atmosphere causes the ISS altitude to decrease each day, and this is accelerated during sunspot maximum (between 2000-2001) when the dense atmosphere extends to a much higher altitude. At altitudes below about 200 km, spacecraft orbits decay and burn up within a week.

**Problem 1** - From the present trends, what do you expect the altitude of the ISS to be between 2010 until its retirement year around 2020?

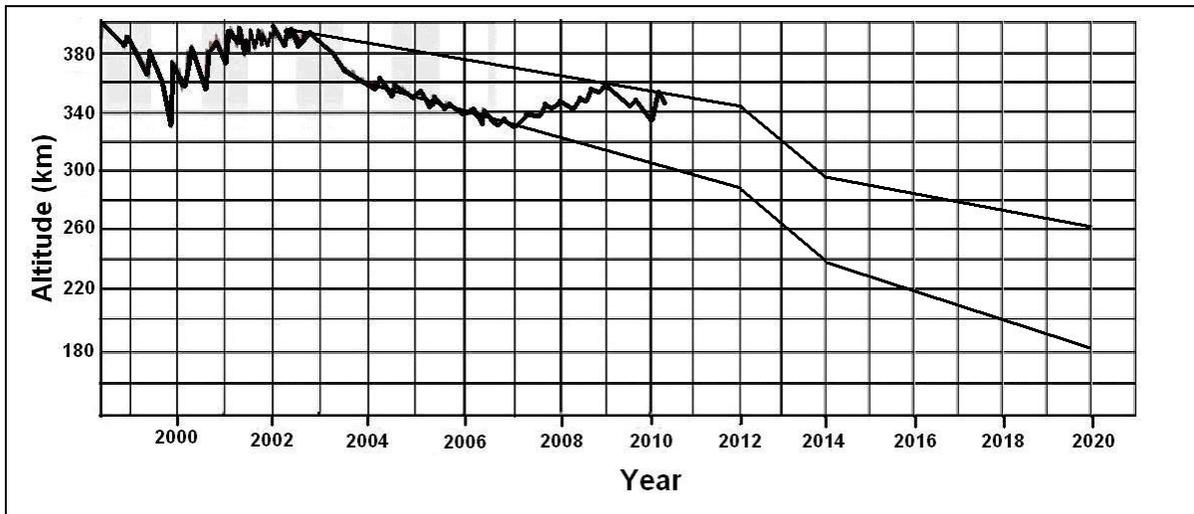
**Problem 2** - Sunspot maximum will occur between 2012-2014, and we might expect a 50-km decline in altitude during this period if the solar activity weaker than the peak in 2000, which is currently forecasted. Including this effect, what might be the altitude of the ISS in 2020? Is the ISS in danger of atmospheric burn-up?

**Problem 3** - What are the uncertainties in predicting ISS re-entry, and what strategy would you use if you were the Program Manager for the ISS?

**Problem 1 – Answer:** The graph below shows several plausible linear trends depending on which features you use as a model for the slope. The predicted altitude would be between 220 and 300 km .



**Problem 2 -** The graph below shows, for example, two forecasts that follow the extremes of the general decline trend, but then assume all of the altitude loss occurred between 2012-2014 at 50 km. Note that the range of altitudes in the graph in either case is 180-260 km. This places the ISS in danger of burn-up before its retirement year in 2014.



**Problem 3 -** The largest uncertainty is the strength of the next solar activity (sunspot) cycle. If it is stronger than the previous maximum between 2000-2001, the ISS altitude losses will be even larger in 2012-2014, and the ISS will be in extreme danger of re-entry before 2020.

The period after 2010, when the US loses access to space travel and has to rely on Russian low-capacity shuttles, will be a critical time for the ISS, and an intensely worrisome one for ISS managers.