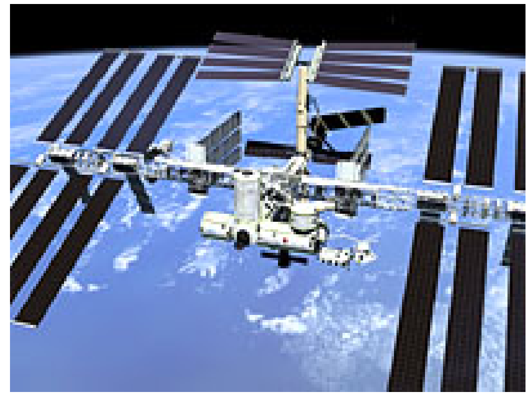
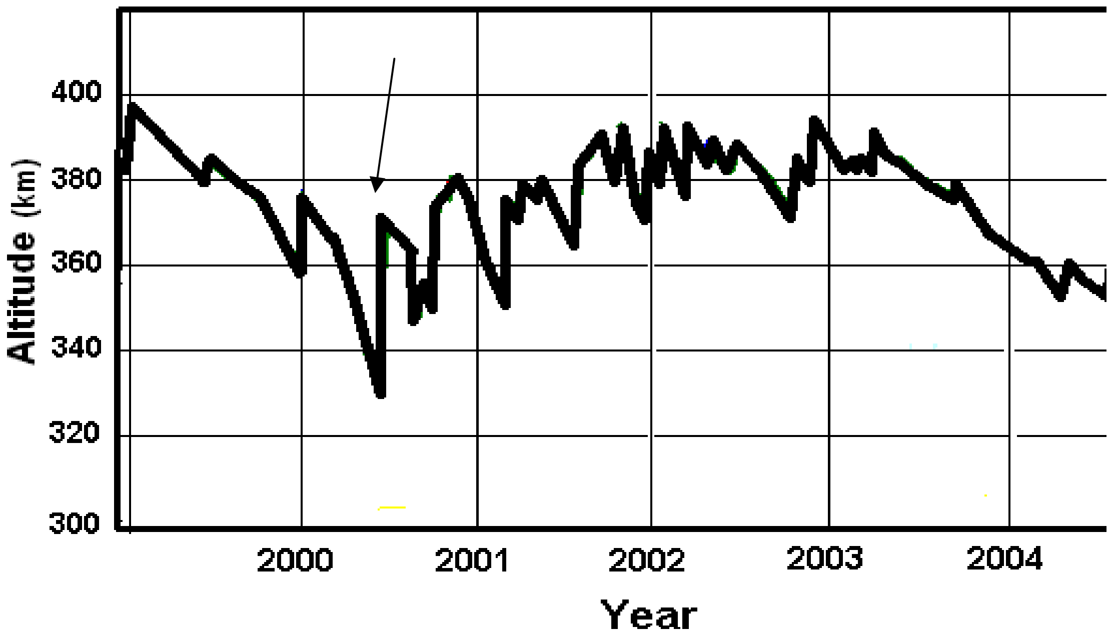
The first pieces of the International Space Station were launched in 1998, and the 'ISS' has been continuously occupied by a crew of 3 to 4 astronauts since 1999. At completion, it will have cost $100 billion, and will have a mass of 187 metric tons. It requires 110 kiloWatts to operate (equal to 55 average houses). One interesting thing about the ISS is that its orbit is constantly decaying because of aerodynamic drag with Earth's upper atmosphere. The figure below shows the altitude changes from 2000 to 2005.





The Space Shuttle and Russian Prognos vehicles periodically re-boost the ISS to higher altitudes. These appear as sudden changes in altitude from a low altitude to a higher one. One of these is identified with an arrow.

Question 1) How many other re-boosts can you identify in the graph?

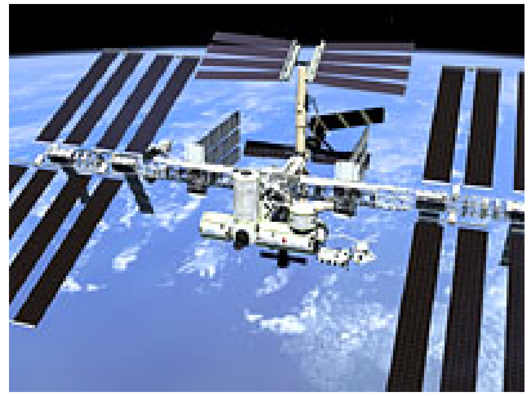
Question 2) What was the largest change in altitude by a re-boost?

Question 3) How fast was the altitude decreasing before the re-boost in 2000 and in 2004?

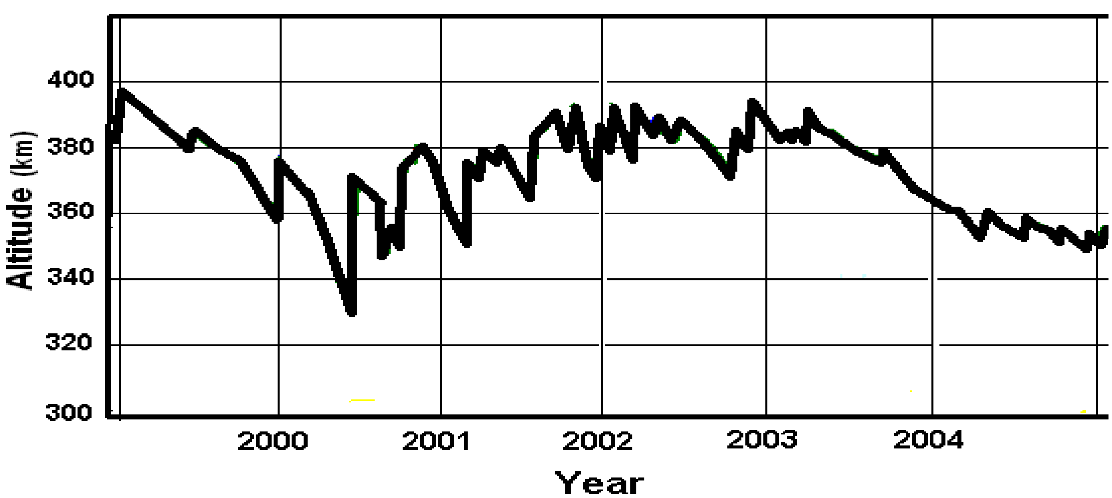
Question 4) Why do you think the orbit altitudes were changing faster near 2000 than 2004?

Question 5) From your answer to Question 3, how long would it take the ISS to burn-up at an altitude of 150 km if no re-boost had been performed?

The first pieces of the International Space Station were launched in 1998, and the 'ISS' has been continuously occupied by a crew of 3 to 4 astronauts since 1999. At completion, it will have cost $100 billion, and will have a mass of 187 metric tons. It requires 110 kiloWatts to operate (equal to 55 average houses). It is scheduled to be retired from service in 2010. One interesting thing about the ISS is that its orbit is constantly decaying because of aerodynamic drag with Earth's upper atmosphere.



The figure below shows its altitude from 1999 to 2005. The sharp vertical 'jags' near '2000' and '2000.5' are orbit re-boosts provided by the Space Shuttle to move the ISS to higher altitudes. In this activity, students will calculate the orbit decay rates from this figure, and investigate why the decay rate (slope) is higher at some times (i.e. 2000) than at other times (i.e. 2004). They will also be asked to predict how long it would take the ISS to re-enter the atmosphere without periodic orbit re-boosts.



Question 1) About 16, but you can check by visiting
Question 2) Around 2000.4 the change in altitude was about 40 km!
Question 3) In 2000 about 400 meters per day (0.4 km/day). In 2004 about 80 meters per day (0.08 km/day). Students should make measurements during each year in the plot.
Question 4) This is a good 'inquiry' problem. Solar activity heats upper atmosphere and causes increased drag. Compare the orbit decay rates for each year with the average sunspot numbers for each year.
Question 5) In 2000, it would reach an altitude of 150 km in about (330—150)/0.4 = 450 Days. In 2004 it would take (330-150)/0.08 = 2250 days. This is why there were more, and larger, orbit re-boosts in 1999-2001 than at other times.