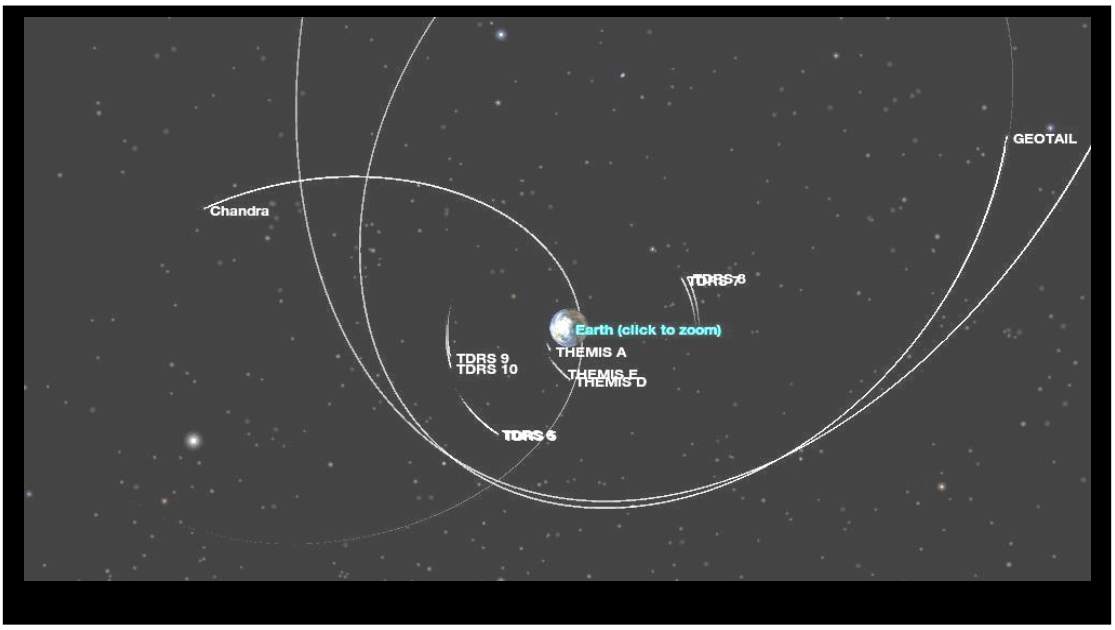
Eye Spy – RBSP Spacecraft Explores the van Allen Belts



Get the Data

Visit EOSS **http://1.usa.gov/LX1JjY** to recreate the scene above. Recommended operating system: MS Vista or later; Browser: MS Internet Explorer 8 or later.

Step 1 – Click on the 'Visual Controls' tab and make sure that the following items are selected with a 'white spot': spacecraft, planets, labels, orbit lines, trails and metric.

Step 2 - Activate the Distance Measuring tool and measure the distance between each satellite and Earth.

Answering Questions

When studying events taking place in space near Earth, physicists often measure distances in terms of the radius of Earth, which is 1.0 Re = 6378 kilometers. In these units of measure, R = 2.0 Re means a distance of 2.0 x 6378 or 12,756 kilometers.

Problem 1 – The van Allen Radiation Belts extend from about R=1.0 Re to R=5.0 Re from the surface of Earth. How many kilometers from the center of Earth do the radiation belts extend?

Problem 2 – The strength of Earth's magnetic field in space is given by the function B(R) = $70000/R^3$ where R is the distance to the center of Earth in units of Re, and B is the strength in nanoTeslas (a unit of magnetism). What is the strength, B, at A) Earth's surface? B) At the middle of the van Allen Belts at R = 2.0?

Math Challenge

Using EOSS, measure the distance, D, in kilometers to the five satellites given in the table below, and complete the table if R = 1 + (D/6378) and B = $70000/R^3$.

Satellite	Distance (km)	R	B
GEOTAIL			
Chandra			
Themis D			
TDRS-7			
RBSP			

Answer Key

Problem 1 – The van Allen Radiation Belts extend from about R=1.0 Re to R=5.0 Re from the surface of Earth. How many kilometers from the center of Earth do the radiation belts extend?

Answer: D = 6378 x R, so for R=1.0, **D = 6378 km**, and for R = 5.0, D = 5.0 x 6378 so **D = 31,890 km**.

Problem 2 – The strength of Earth's magnetic field in space is given by the function $B(R) = 70000/R^3$ where R is the distance to the center of Earth in units of Re, and B is the strength in nanoTeslas (a unit of magnetism). What is the strength, B, at A) Earth's surface? B) At the middle of the van Allen Belts at R = 2.0?

Answer: A) Earth's surface is located at R = 1.0 Re from the center of Earth, so

$B(1) = 70000/(1)^3$

= **70000 nano Tesslas**.

B) R = 2.0, so $B(2) = 70000/(2)^3$ and so B(2) = **8750 nano Tesslas**.

Challenge Problem: Using EOSS, measure the distance, D, in kilometers to the five satellites given in the table below, and to the nearest tenth, complete the table if

R (D) = 1 + (D/6378) in units of Re and

$B(R) = 70000/R^3$ in units of nanoTesslas (nT)

Answer: For the EOSS scene at http://1.usa.gov/OPRP4r, the distances in red were measured using the Distance Tool:

Note: The RBSP satellites will be operating in a region of Earth's magnetic field where the field is about 1/8 the strength of Earth's field at the surface of Earth.

Satellite	Distance	R	B
GEOTAIL	117,109	19.4	9.6 nT
Chandra	90,294	16.2	16.5 nT
Themis D	39,900	7.3	180.0 nT
TDRS-7	22,294	4.5	768.2 nT
RBSP	TBD		