

# Solar Storms and Satellites

Grades 6 – 10

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## **Objective**

1. Students will be able to explain the effect of solar activity on satellites in the upper atmosphere.
2. Students will be able to conclude that the sun goes through an 11 year cycle of activity.
3. Students will be able to draw conclusions about data.
4. Students will be able to calculate the probability of an uncertain situation and express it as a percentage.

## **AAAS Standards**

### **Science**

- Grades 6 – 8, Energy Transformations: Energy appears in different forms. Energy can be transferred through materials by the collision of atoms or across space by radiation.
- Grades 9 – 12, Energy Transformations: Whenever the amount of energy in one place or form diminishes, the amount in other places or forms increases by the same amount.
- Grades 6 – 8, The Universe: The sun is a medium sized star located near the edge of a disk shaped galaxy of stars.
- Grades 9 – 12, Systems: Understanding how things work and designing solutions to problems of almost any kind can be facilitated by systems analysis.

### **Math**

- Grades 6 – 8, Uncertainty: By the end of 8<sup>th</sup> grade students should know how probability is estimated depending on what is known about the situation. Probabilities are ratios that can be expressed as fractions, percentages, or odds.

## **Materials**

- Worksheets
- Data tables
- Graphing paper or calculator
- Optional: Graph overheads and pens.

Reproducible for educational purposes only.

NASA Solar Dynamics Observatory 2008

<http://sdo.gsfc.nasa.gov/epo/educators/resources.php>

## **Background**

### **New Communication Satellite to be Launched by US Government**

The US government wants to launch a new, state of the art, communications satellite to guide aircraft on flight paths over the North Pole. North pole routes are the fastest way to get from north America to Asia, but they rely on being in contact with the ground at all times for safety reasons.

Communication satellites orbit at an altitude of 50 – 500 km above the earth’s surface. There are an average of 270 of them in Low Earth Orbit each year. At that altitude they are exposed to solar wind, or charged particles emitted by the sun. These particles charge earth’s ionosphere and create the aurora borealis. When the sun is most active, energy released from the sun can also cause significant damage to electrical systems on satellites, along with creating more friction on the satellite as it moves through the upper atmosphere.

As a NASA employee, you have been asked to analyze the risk of placing a communication satellite in orbit above the earth. When is the sun most active, how do we know this, and are satellites really in more danger? Due to the high cost of development the US government is counting on you to base your recommendation on data and research. Use the form provided to submit your recommendation. All recommendations must be accompanied by data analysis as well.

## **Content**

**Predict:** (Engagement and assessing prior knowledge)

Hand out memos to teams and go over assignment.

Review: Solar wind, CME, and Sunspot.

**Method:** (Body of the lesson)

Hand out recommendation forms and give students these steps:

**The Question:** What does the government want you to do? Restate the problem in your own words.

**Research:** Have students create a list of questions they will need to answer in order to solve the problem. Do this prior to handing out data tables showing the number of sunspots and satellites re-entering the atmosphere per year.

**Recommendation:** Write your group’s recommendation based on three (or more) pieces of evidence – research or data.

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**Conclusion:** Conclude the proposal by restating your recommendation and thanking them for choosing your team.

**Tips for evidence:**

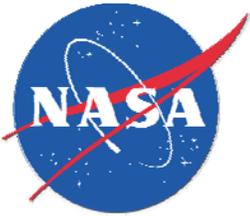
- Does solar activity correlate with satellite re-entry?
- Does it matter how you lay out the data?
- Does scale affect how you interpret at your graphs?
- How often does solar activity increase?
- How do we know this?
- What other types of data might be useful to make this decision and how can we find them?

**Live-It:** (Assessment questions)

The assessment is the final recommendations. They can be submitted for grading or given orally in front of the class.

**Resources**

- NASA created a layer for Google Earth that shows a real-time image of the total electron count in the ionosphere.
  - [http://www.gearthblog.com/blog/archives/2008/05/nasa\\_time\\_animation\\_of\\_ionosphere\\_f.html](http://www.gearthblog.com/blog/archives/2008/05/nasa_time_animation_of_ionosphere_f.html) (Accessed July 2008)
- Sunspot numbers per month since 1749
  - [http://solarscience.msfc.nasa.gov/greenwch/spot\\_num.txt](http://solarscience.msfc.nasa.gov/greenwch/spot_num.txt) (Accessed July 2008)



# Communications Satellite Launch Recommendation

**NASA Group Members:**

**Period:** \_\_\_\_\_

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## The Problem

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## Our Recommendation

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## Evidence

1. \_\_\_\_\_

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2. \_\_\_\_\_

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3. \_\_\_\_\_

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## Conclusion

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# Memo

**From:** NORAD/FAA

**To:** NASA Solar Scientists

**RE:** New Communication Satellite to be Launched by US Government

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CC: SDO Scientists

