STORM Team
Mission Day Instructions

Overview

Solar weather impacts the space station in much the same way as our weather impacts the earth. The difference is that solar weather can include X-Rays and protons from the sun. Solar proton events are dangerous and can cause great harm to the astronauts and damage the space station.

You will monitor X-Ray production, which provides an indicator of a possible Solar Proton Event.

X-Ray and proton data comes from the GOES-8 (Geostationary Orbiting Environmental Satellite-8). Your team is responsible for graphing the data and making calculations. Predict the strength of the storm as well as how long it might last. Make recommendations to the other teams to protect the space station and the crew.

Missions Day Materials

- One computer for real-time data
- Life Support Reference Guide
- Mission Day Materials (one per team member):
  - Mission Day Instructions
  - Storm Data Graphs and Instructions
  - Storm Data Tracking Tables
- Print and cut 7 copies of Blank Report Forms on colored paper to deliver to the Communications Team
- Rulers for plotting data on graphs
- Calculators

Your Task

By the time the mission starts, the Storm Team should be able to:

- Analyze real-time data, record it, graph it, and make calculations.
- Monitor solar activity, provide regular space weather reports and alert all teams and Mission Control of any noteworthy fluctuations.
- Use the STORM Team Reference Guide to understand X-Ray productions and SPEs and their potential impact on the space station as well as the earth.

Team Tasks

These tasks are listed in priority order. Next to each task, assign a team member. Depending on the size of your team, you may need to assign two tasks to one person.

_____ **Crisis Management:** Makes sure all data is analyzed every five minutes. Determines priority level, whether there are any concerns, and helps team decide on any recommendations.

_____ **Data Graphing:** Records real-time data on graphs and predicts which way the trend is moving. Uses ruler to make predictions. May be combined with Data Analysis tasks.

_____ **Data Analysis (X-Rays):** Records real-time data in Data Tracking Tables and conducts analyses. Completes Report Forms about every five minutes or as needed.

_____ **Data Analysis (Protons):** Records real-time data in Data Tracking Tables and conducts analyses. Completes Report Forms about every five minutes or as needed.

_____ **Crisis Management Helper/Data Runner:** Gathers report forms every five to six minutes. Prioritizes any urgent recommendations. Writes down all questions from Mission Control and responds with written notes given to the Comm Data Officer. This may be combined with Crises Management Tasks.

_____ **Data Recording:** Records real-time data from the computer. The data will be accessed and downloaded after the start of the mission. May be combined with other tasks.

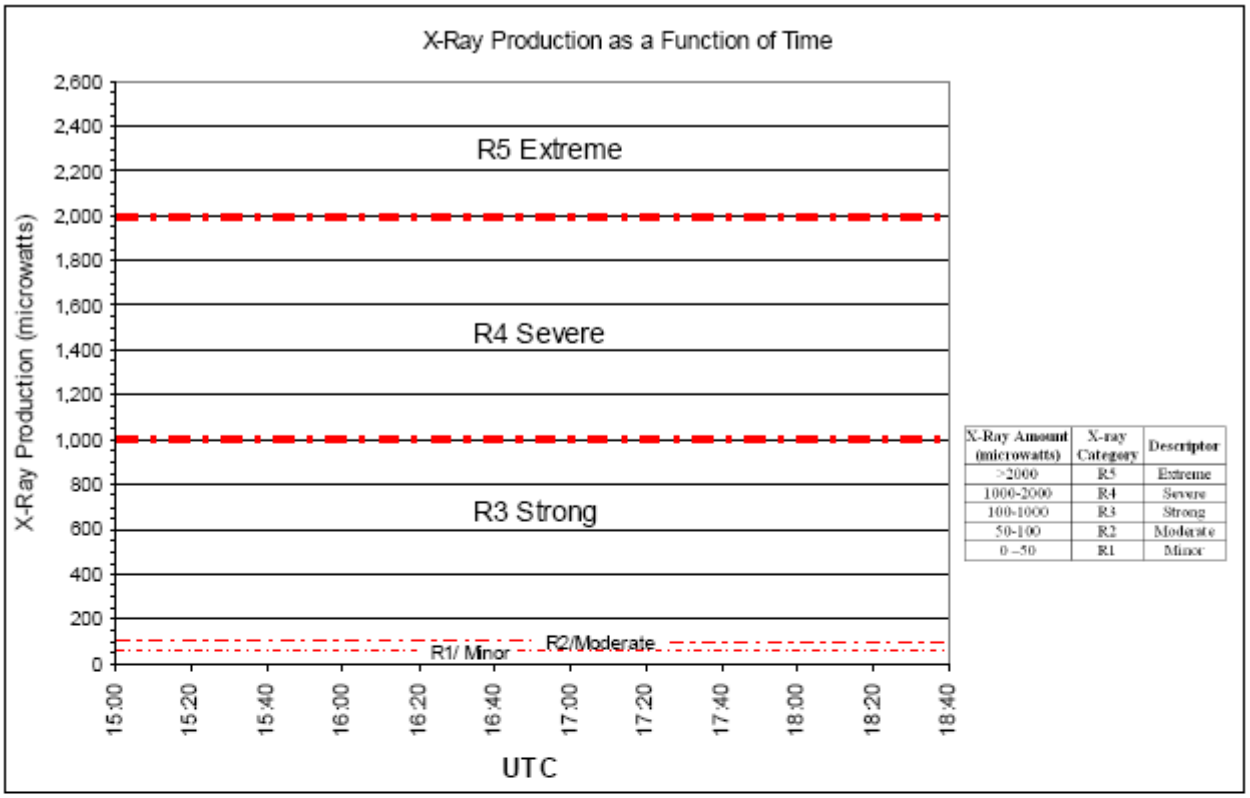
_____ **(optional) Research and Reference:** Reads and understands information provided in the Reference Guide to make recommendations to Mission Control. May be combined with other tasks above.

_____ **(optional) Reporter/Graphic Organizer:** Takes notes during the mission like a reporter from a newspaper. Writes down all the emergencies, options, choices, and successes. May want to use a "graphic organizer" like a white board or chalkboard posted on the wall that is visible to all teams.

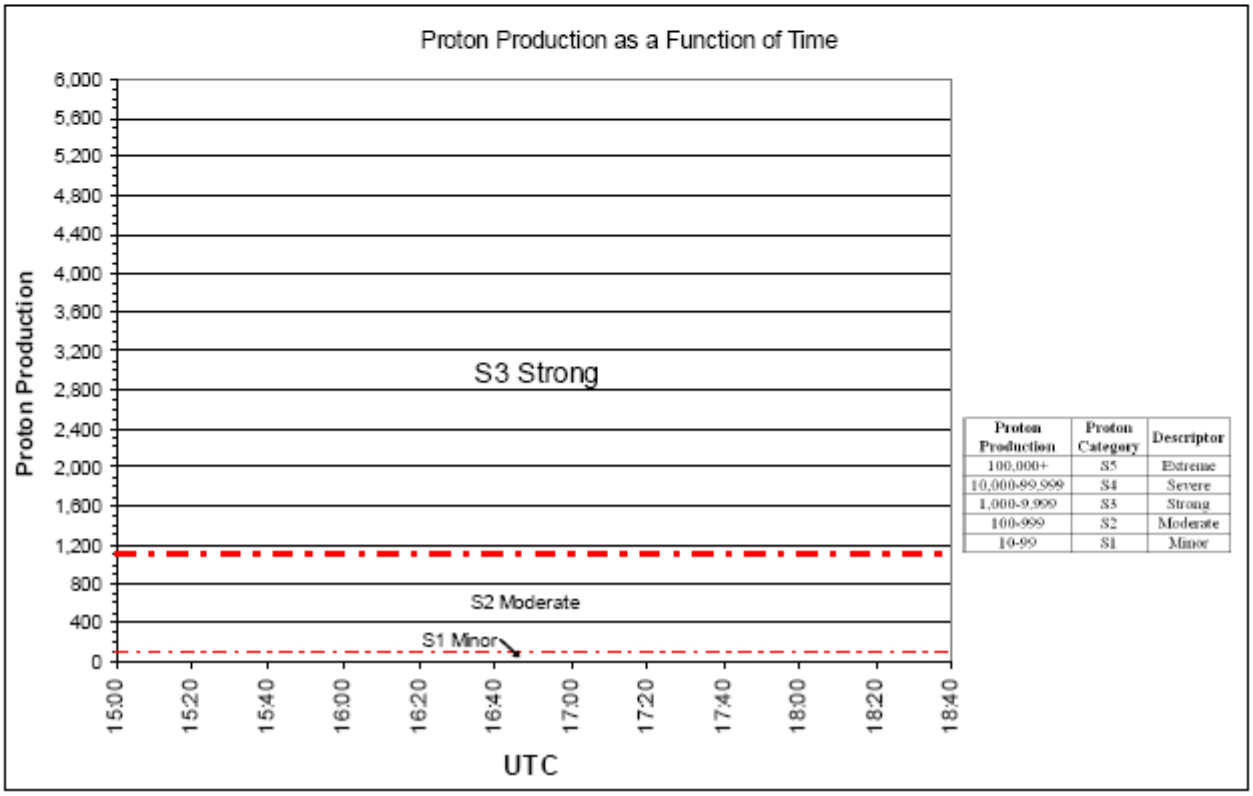
STORM Team
Graphs and Instructions

Instructions for Graphing the Data

The STORM Team will be responsible for creating two graphs. Use the data from **Column B** on each Data Tracking Table for the y-axis values and plot them along the x-axis according to the correct UTC time.



X-Ray Amount (microwatts)	X-ray Category	Descriptor
>2000	R5	Extreme
1000-2000	R4	Severe
100-1000	R3	Strong
50-100	R2	Moderate
0 –50	R1	Minor



Proton Production	Proton Category	Descriptor
100,000+	S5	Extreme
10,000-99,999	S4	Severe
1,000-9,999	S3	Strong
100-999	S2	Moderate
10-99	S1	Minor

STORM Team
Graphs and Instructions

You will receive real-time data about every five minutes from the GOES-8 Satellite in orbit between the Earth and the Sun. The data includes X-Ray and proton production from the sun. your team should be able to analyze this data quickly. **It is strongly recommended that you complete the practice worksheets and practice graphs before mission day.** Use the instructions below and the attached Data Tracking Table. Note: Since we are working with large numbers here, there is no need to use decimals – round to the **nearest whole number**.

First, find the two worksheets labeled STORM Team Data Tracking Table: (One is for X-Rays and the other for Protons)

Column	A	B (Graph this column)	C	D	E	F	G
Table Headings	UTC	X-Rays	Category	Change	Rate	Projected X-Ray Production in 1 Hour	Category
Units	24 Hour Clock	Amount of X-Rays	From R1 to R5	Amount of X-Rays	X-Rays/min	X-Ray Production	From R1 to R5
Calculations	From Data	From Data	See Reference Guide	B – Previous B	D / 20 min	(E x 60 min) + B	See Reference
Practice	15:00	9	R1·R2·R3·R4·R5	n/a	n/a	n/a	R1·R2·R3·R
	15:20	16	R1·R2·R3·R4·R5	7	0	37	R1·R2·R3·R
	15:40	46	R1·R2·R3·R4·R5	30	2	136	R1·R2·R3·R
	16:00	1250	R1·R2·R3·R4·R5	1204	60	4862	R1·R2·R3·R

Column A: Coordinated Universal Time (UTC)

UTC is a universal standard in which time is given on a 24-hour clock with no "am" or "pm." For example, on o'clock is 01:00. Four-twenty in the afternoon is 16:20. Eleven-fifteen at night is 23:15.

Column B: Real-Time Data

Record the real-time data in Column B. You will also need to plot this data on a graph.

With X-Rays, energy is measured in microwatts, which is 1/1000 of a watt. A nightlight is about 5 watts. With protons, the unit of measure is the number of protons hitting the measuring device on the satellite. Protons of an energy level exceeding 10 MeV (mega electron volts) are counted.

Column C: Category

Take the data from Column B and determine where that number falls in the ranges given in the Table 1 below.

Table 1

X-Ray Amount (microwatts)	X-Ray Category	Descriptor
0 – 50	R1	Minor
50 – 100	R2	Moderate
100 – 1000	R3	Strong
1000 – 2000	R4	Severe
>2000	R5	Extreme

Proton Production	Proton Production Category	Descriptor
10 – 99	S1	Minor
100 – 999	S2	Moderate
1000 - 9999	S3	Strong
10,000 – 99,999	S4	Severe
1000,000 +	S5	Extreme

Column D: Change

Calculate the change in X-Rays or protons since the last reading. Start with the current reading in Column B and subtract the previous reading from above.

Column E: Rate

Column E is for the rate of production per minute. It answers the question, "How many X-Rays or protons are being received each minute?" To calculate this number, use the number in Column D and divide by the number of minutes since the last reading.

Column F: Projection

X-Ray: For X-Rays, you are making a 1-hour projection. Use the rate you calculated in Column E and multiply it by 60 minutes, then add it to column B.

Proton: For Protons, you are making a 23-hour projection. Use the rate you calculated in Column F and multiply by 1440 minutes.

X-Ray:

You are making a 1-hour projection to determine if a CME or SPE will be forthcoming.

For example, if the hourly X-Ray production for UTC 16:40 is 14 microwatts per minute, then you would expect the rate to jump to 840 microwatts per minute one hour from now (14 * 60 = 840).

Proton:

You are making a 24-hour projection to determine how large the storm may grow and how long it may last.

For example, if the hourly proton production for UTC 16:45 is 0.12 protons per minute, then you would expect the rate to jump to 173 protons per minute 24 hours from now (0.12 * 1440 = 173).

Note: If your answer is a negative number, use Zero (because the sun cannot produce negative amounts of protons or x-rays). A zero in the Projected Production indicates that there is a current decrease in production that will go to zero in a 24 hour period if this rate of decrease continues.

You may want to refer to the tables given in the Space Weather Reference Guide about X-Ray and Solar Radiation Storm impacts on radio and navigation systems to decide if there are any effects to discuss with Mission Control.

STORM Team –
Data Tracking Table: X-Ray Production

Column	A	B (Graph this column)	C	D	E	F	G
Table Headings	UTC	X-Rays	Category	Change	Rate	Projected X-Ray Production in 1 Hour	Category
Units	24 Hour Clock	Amounts of X-Rays	From R1 to R5	Amount of X-Rays	X-Rays / min	X-Ray Production	From R1 to R5
Calculations	From Rate	From Data	See Reference Guide	B – Previous B	D / 20 min	(E * 60 min) + B	See Reference Guide
Examples and Practice	15:00	9	R1 · R2 · R3 · R4 · R5	n/a	n/a	n/a	R1 · R2 · R3 · R4 · R5
	15:20	16	R1 · R2 · R3 · R4 · R5	7	.35	37	R1 · R2 · R3 · R4 · R5
	15:40	46	R1 · R2 · R3 · R4 · R5	30	1.5	136	R1 · R2 · R3 · R4 · R5
	16:00	1250	R1 · R2 · R3 · R4 · R5	1204	60.2	4862	R1 · R2 · R3 · R4 · R5
	16:20	90	R1 · R2 · R3 · R4 · R5	-1160	-58	0	R1 · R2 · R3 · R4 · R5
	16:40	452	R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5
	17:00	892	R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5
	17:20	1029	R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5
	17:40	1876	R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5
	18:00	384	R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5
	18:20	236	R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5

Column	A	B (Graph this column)	C	D	E	F	G
Table Headings	UTC	X-Rays	Category	Change	Rate	Projected X-Ray Production in 1 Hour	Category
Units	24 Hour Clock	Amounts of X-Rays	From R1 to R5	Amount of X-Rays	X-Rays / min	X-Ray Production	From R1 to R5
Calculations	From Rate	From Data	See Reference Guide	B – Previous B	D / 20 min	(E * 60 min) + B	See Reference Guide
For the Mission	15:00		R1 · R2 · R3 · R4 · R5	n/a	n/a	n/a	R1 · R2 · R3 · R4 · R5
	15:20		R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5
	15:40		R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5
	16:00		R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5
	16:20		R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5
	16:40		R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5
	17:00		R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5
	17:20		R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5
	17:40		R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5
	18:00		R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5
	18:20		R1 · R2 · R3 · R4 · R5				R1 · R2 · R3 · R4 · R5

STORM Team –
Data Tracking Table: Proton Production

Column	A	B (Graph this column)	C	D	E	F	G
Table Headings	UTC	Protons	Category	Change	Rate	Projected 24 Hour Proton Production	Category
Units	24 Hour Clock	Amounts of Protons	From S1 to S5	Amount of Protons	Protons / min	Amount of Protons	From S1 to S5
Calculations	From Rate	From Data	See Reference Guide	B – Previous B	D / 20 min	(E * 1440 min) + B	See Reference Guide
Examples and Practice	15:00	45	S1 · S2 · S3 · S4 · S5	n/a	n/a	n/a	S1 · S2 · S3 · S4 · S5
	15:20	119	S1 · S2 · S3 · S4 · S5	74	3.7	5,447	S1 · S2 · S3 · S4 · S5
	15:40	1,310	S1 · S2 · S3 · S4 · S5	1,191	60	87,710	S1 · S2 · S3 · S4 · S5
	16:00	350	S1 · S2 · S3 · S4 · S5	-960	-48	0	S1 · S2 · S3 · S4 · S5
	16:20	765	S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5
	16:40	1,890	S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5
	17:00	3,410	S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5
	17:20	2,525	S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5
	17:40	4,100	S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5
	18:00	3,575	S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5
	18:20	780	S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5

Column	A	B (Graph this column)	C	D	E	F	G
Table Headings	UTC	Protons	Category	Change	Rate	Projected 24 Hour Proton Production	Category
Units	24 Hour Clock	Amounts of Protons	From S1 to S5	Amount of Protons	Protons / min	Amount of Protons	From S1 to S5
Calculations	From Rate	From Data	See Reference Guide	B – Previous B	D / 20 min	(E * 1440 min) + B	See Reference Guide
For the Mission	15:00		S1 · S2 · S3 · S4 · S5	n/a	n/a	n/a	S1 · S2 · S3 · S4 · S5
	15:20		S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5
	15:40		S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5
	16:00		S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5
	16:20		S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5
	16:40		S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5
	17:00		S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5
	17:20		S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5
	17:40		S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5
	18:00		S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5
	18:20		S1 · S2 · S3 · S4 · S5				S1 · S2 · S3 · S4 · S5