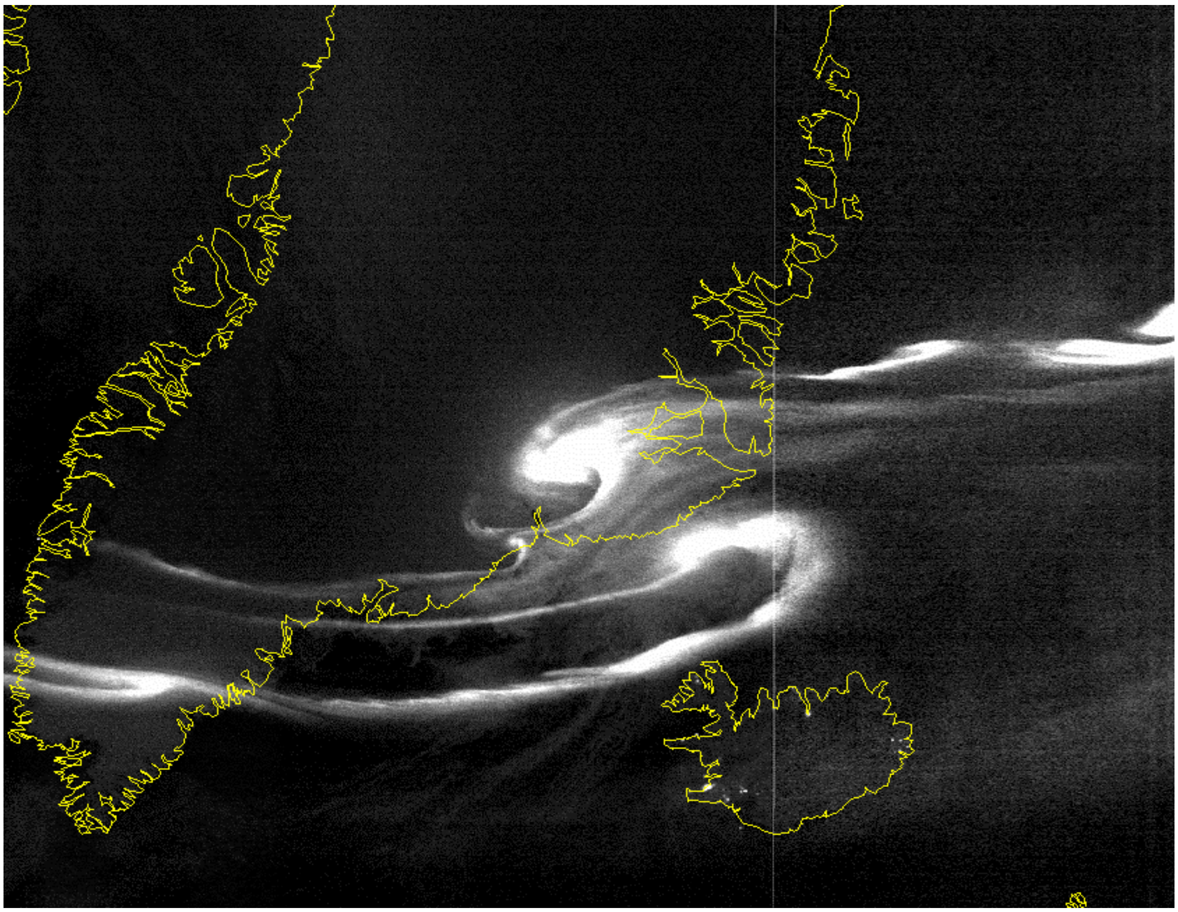
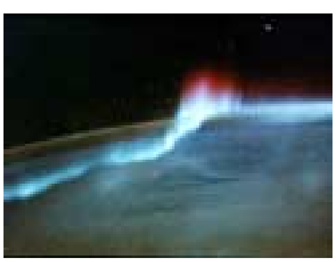
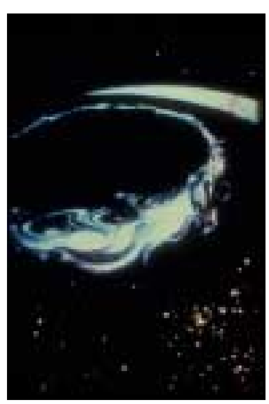
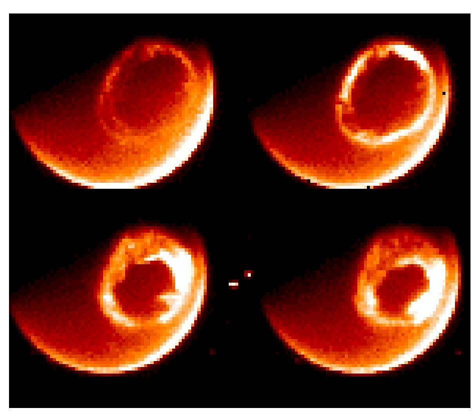
THE NORTHERN LIGHTS









A Grade 7-8 guide to understanding the Aurora Borealis through math, geometry and reading activities.

This series of activities will help students understand how the Northern Lights work, what causes them, and how to observe them.

Through a series of math and reading activities, students will learn:

- How aurora are described by scientists and by other students (Reading)
- The geographic locations of aurora based on satellite data (Geography)
- How aurora appear in the sky at different geographic latitudes (Geometry)
- The height of aurora above the ground (Geometry - parallax)
- How to predict when they will appear (Mathematics)
- What Norse Mythology had to say about aurora (symbolic code translation)

This booklet was created by the NASA, IMAGE satellite program's Education and Public Outreach Project.

Writers:
Dr. Sten Odenwald *(NASA/IMAGE)*
Ms. Susan Higley *(Cherry Hill School)*
Mr. Bill Pine *(Chaffey High School)*

Students:
Emily Clermont *(Holy Redeemer School)*
Denali Foldager *(Seward Elementary School)*
Sonta Hamilton *(Mt. Edgecumbe High School)*

For more classroom activities about aurora and space weather, visit the IMAGE website at:

http://image.gsfc.nasa.gov/poetry

The cover shows a view from the NPOESS satellite looking down at an aurora over Greenland. *(http://npoesslib.ipo.noaa.gov/S_sess.htm).* Viking rune inscription (http://www.commersen.se/vikingar/vardag/runor.html). The three smaller images at the bottom of the page are: (Left) an aurora borealis viewed from the Space Shuttle; (middle) portion of the auroral oval over North America viewed by the DMSP satellite showing city lights; (right) the auroral oval viewed over the Arctic region on July 15, 2000 by the IMAGE satellite.

Activity 7 Auroral Magnetism from the Ground

Introduction:

Solar storms can buffet the magnetic field of the Earth with clouds of charged particles and magnetic fields. Not only do these interactions affect the large-scale properties of the geomagnetic field, but their effects can also be easily detected on the ground. During the last 100 years, many 'magnetic observatories' have been commissioned around the world to monitor Earth's surface field conditions. These have been, historically, important for navigation by ships at sea. The data from these observatories can also be used to examine what happens when solar storms arrive at Earth.

Objectives:

By analyzing graphical data, students will become familiar with Earth's changing magnetic field through solar storm activity plots.

Procedure:

1) Plot the location of each magnetic observatory on a map of Canada. Label each station number next to the plotted point.

Materials:

5-station Data Sheet.
Calculator
Map of Canada

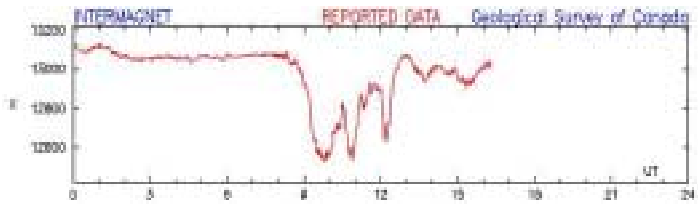
2) Analyze the magnetic intensity plot for each station and identify the largest difference in change in activity on the plot. The units of magnetic intensity are in nano-Teslas. One nanoTessla (nT) is equal to one billionth of a Tessla.

3) Find the absolute magnitude of the change for each station. Write the number below the location of the station on the map.

4) Discuss and work the following questions and procedures:

Where are the largest magnetic changes located for this event?
Draw a circle around the three stations with the largest magnetic changes.
Did the largest changes occur at the same time? Explain.
On the Data Sheet, organize the plots in order from the largest to the smallest change. Do you see any patterns?
Organize the magnetic intensity plots according to similar shapes. Are there any trends?

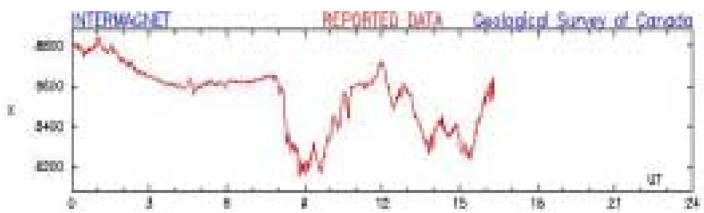
Student Data Sheet



Station 1: Meanook
(54.6 North , 113.3 West)

The largest range in 'X' is

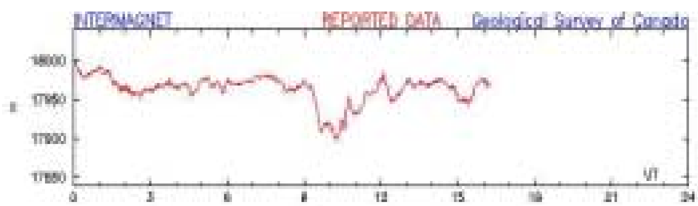
_______________ nano-Tesslas



Station 2: Fort Churchill
(58.8 North, 94.1 West)

The largest range in 'X' is

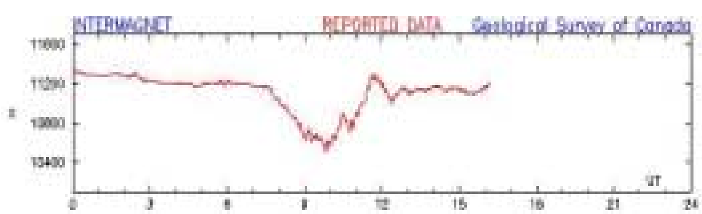
_______________ nano-Tesslas



Station 3: Victoria
(48.5 North, 123.4 West)

The largest range in 'X' is

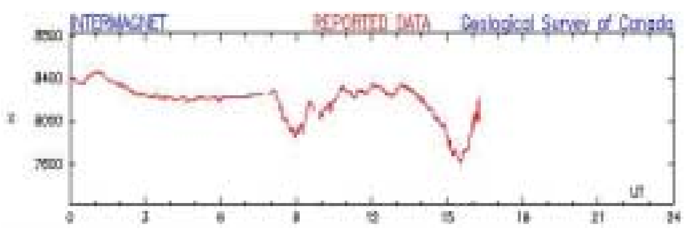
_______________ nano-Tesslas



Station 4: Poste-de-la-Baleine
(55.3 North, 77.8 West)

The largest range in 'X' is

_______________ nano-Tesslas



Station 5: Yellowknife
(62.4 North, 114.5 West)

The largest range in 'X' is

_______________ nano-Tesslas

The vertical axis is Earth's magnetic field strength measured in nano-Tesslas. The horizontal axis is the time in hours since midnight.

Teacher's Answer Key:

For each student, they will find the range of the variable 'X' plotted for each station during the three-hour period from 9:00 to 12:00 inclusive.

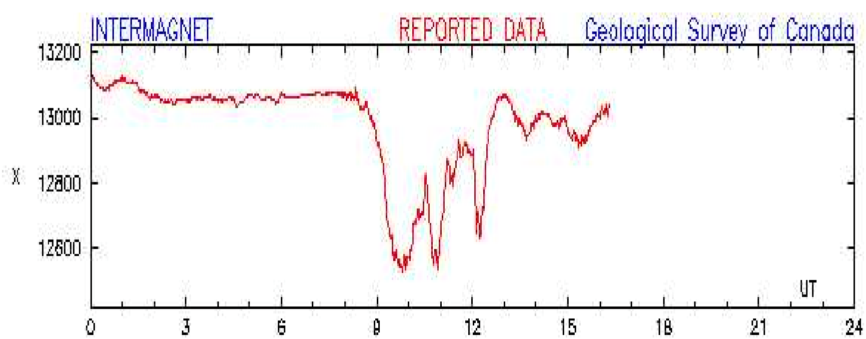
For example, the plot below is for Station 1 recorded on July 12, 2002 and the vertical tic marks occurs every 200 nano-Tesslas.

We can estimate that between 9:00 and 12:00 the magnetic field 'X' component varied from a minimum of 12500 nanoTesslas to a maximum of 12900 nanoTesslas.

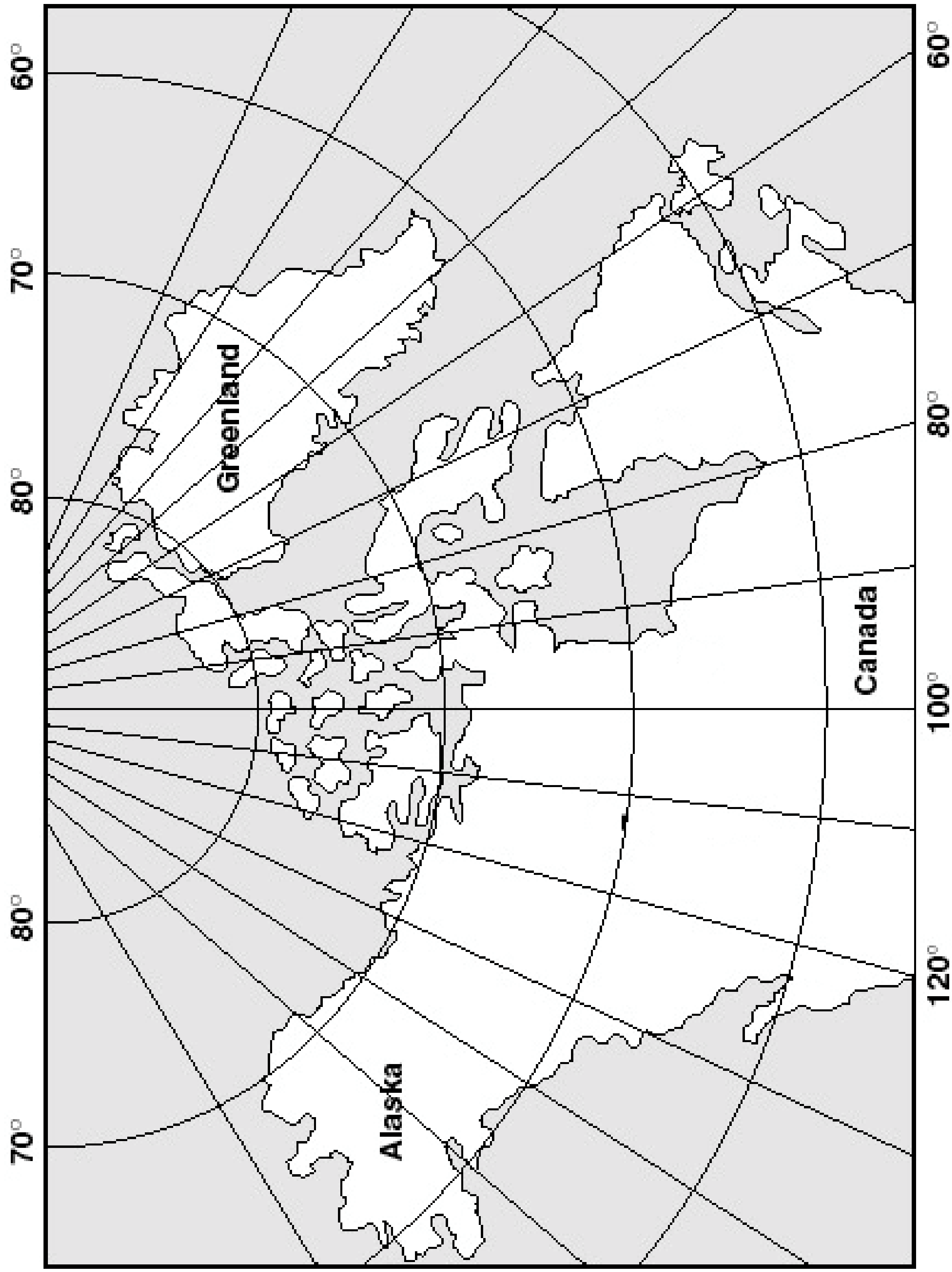
The range of the magnetic variation is 12900-12500 = 400 nanoTesslas for Station 1. Here are the answers for all five stations:

Station 1 =	12900 - 12500	= 400 nT
Station 2 =	8700 - 8200	= 500 nT
Station 3 =	17980 - 17900	= 80 nT
Station 4 =	11250 - 10600	= 650 nT
Station 5 =	8300 - 7900	= 400 nT

Students may obtain even more accurate estimates by measuring the scale on the vertical axis of each plot by using a millimeter ruler and determining the 'nanoTesslas per centimeter' constant and then interpolating the vertical axis.



For additional real-time plots from observatories in Canada, visit:
http://www.geolab.nrcan.gc.ca/geomag/e_digdat.html


Greenland
Canada
Alaska
60°
70°
80°
80°
70°
60°
80°
100°
120°

Useful Web Resources

Exploratorium "Auroras:Paintings in the Sky"
http://www.exploratorium.edu/learning_studio/auroras/

Archive of aurora photos by Jan Curtis:
http://www.geo.mtu.edu/weather/aurora/images/aurora/jan.curtis/

Archive of aurora photos by Dick Hutchinson:
http://www.ptialaska.net/~hutch/aurora.html

Space Weather Today:
http://www.spaceweather.com/

IMAGE real-time aurora images from space:
http://image.gsfc.nasa.gov/poetry/today/intro.html
http://www.sec.noaa.gov/IMAGE/
http://sprg.ssl.berkeley.edu/image/

NOAA Auroral Activity monitor:
http://www.sec.noaa.gov/pmap/index.html

CANOPUS real-time auroral monitor:
http://www.dan.sp-agency.ca/www/rtoval.htm#TOPOFPAGE

Current solar activity report:
http://www.dxlc.com/solar/

Alaska Science Aurora page for kids:
http://www.alaskascience.com/aurora.htm

Human Impacts of Space Weather:
http://image.gsfc.nasa.gov/poetry/weather01.html

Ask the Space Scientist:
http://image.gsfc.nasa.gov/poetry/ask/askmag.html

More classroom activities:
http://image.gsfc.nasa.gov/poetry/activities.html

The Northern Lights Essay Competition:
http://image.gsfc.nasa.gov/poetry/alaska/alaska.html