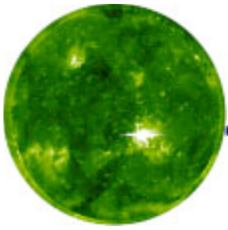


AM Radio Ionosphere Station

Middle School Grades

Lesson Summary
Students use an AM radio to monitor changes in the intensity of solar output

Prior Knowledge & Skills
Understanding of:
- The structure of the atmosphere
- Atomic structures including protons, electrons, ions

Ability to:
- Make and record observations for several days at dusk and dawn

AAAS Science Benchmarks
The Nature of Science
Scientific Inquiry
The Nature of Mathematics
Mathematics, Science, and Technology
The Nature of Technology
Technology and Science
The Physical Setting
Energy Transformations

NSES Science Standards
Science as Inquiry
Abilities to do Scientific Inquiry
Understandings of Scientific Inquiry
Physical Science
Transfer of Energy
Earth and Space Science
Earth in the Solar System
Science and Technology
Understandings about Science and Technology
History and Nature of Science
Science as a Human Endeavor

Mathematics Standards
Measurement
Statistics and Probability

Teaching Time: Long-term project

Materials
- AM radio with tuner knob and volume control knob
- Paper disk of diameter greater than volume knob
- ❖ *Data collection table*

Not included

Advanced Planning
Preparation Time: 20 minutes
1. Review lesson plan
2. Practice use of AM radio
3. Create data table
4. Identify period of solar activity via Internet sites

Editor's Note
Although difficult to implement in a formal classroom setting, this lesson provides interesting extra credit, project, or homework opportunities.

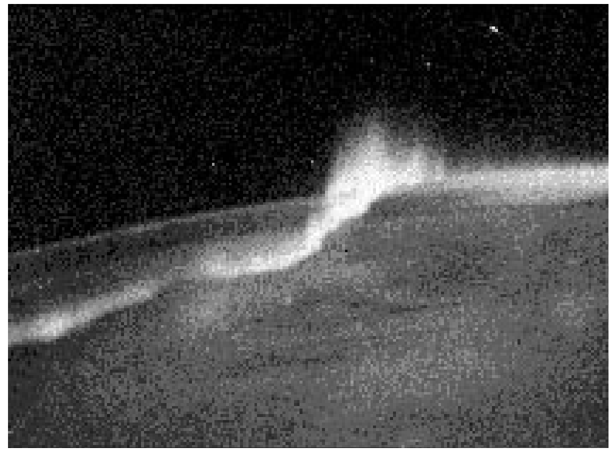
Solar Storms and You! Exploring the Aurora and the Ionosphere, pp/ 9-14, NASA EG-2000-03-002-GSFC
http://image.gsfc.nasa.gov/poetry/higley.html

LASP
LABORATORY FOR ATMOSPHERIC AND SPACE PHYSICS

Auroras and Ionosphere

Visible Auroral Emission Lines

Wavelength (Angstroms)	Altitude (kilometers)	Atom	Color
3914	1000	Nitrogen	Violet
4278	1000	Nitrogen	Violet
5577	90-150	Oxygen	Green
6300	150	Oxygen	Red
6364	150	Oxygen	Red
6563	120	Hydrogen	Red
6611	65-90	Nitrogen	Red
6696	65-90	Nitrogen	Red
6768	65-90	Nitrogen	Red
6861	65-90	Nitrogen	Red



Aurora have been observed for thousands of years and they are the most dramatic indications of solar activity. They are produced when flows of energetic charged particles collide with the upper atmosphere.

The brilliant colors from reds to purples indicate atoms of oxygen and nitrogen being stimulated by these collisions to give off specific wavelengths of light.

They are produced at altitudes from 65 kilometers to 1000 kilometers, under conditions where the atmosphere is a better vacuum than you would find inside a TV picture tube. Because of the specific way in which the light is produced, it is impossible for aurora to happen in the higher-density layers of the atmosphere below 50 kilometers. Despite the appearances to casual observers, the aurora never reaches the ground.

Auroral activity is most intense during times when solar activity is the highest and the Coronal Mass Ejections make their way to Earth to impact the magnetosphere. They can also be produced as various parts of the magnetosphere rearrange in the so-called **geotail** region, which extends millions of kilometers into space on the opposite 'night time' side of the earth from the sun.

The ionosphere is a narrow zone of charged particles in the earth's atmosphere. It was not discovered until radio communication was invented around the turn of the century. It has an average density of about 10 electrons per cubic centimeter, but can be 10 to 100 times as 'charged' during solar storms.

At low frequencies below 10 megaHertz, the ionosphere acts like a mirror and allows ground to ground signals to be 'bounced' long distances around the earth. At higher frequencies the ionosphere becomes transparent so that communication via ionosphere bounce becomes impossible. Instead, we must rely on satellite communication to relay signals from point to point on the earth.

The properties of the ionosphere change with the time of day, the season, and especially with the level of solar activity. In the latter case, solar flares can cause radio signal 'fade outs' which are well-known to amateur radio operators.

Teacher's Guide

AM Radio Ionosphere Station

Introduction

Above the earth's surface, a layer of charged particles has been used, since the turn of the century, to reflect radio waves for long distance communication. Radio waves, with frequencies less than about 10 megaHertz, are reflected by the ionosphere. They are used for military and civilian 'short wave' broadcasting. The properties of the ionosphere can change dramatically with daytime transmissions being noisier than night time ones. Solar flares also change the reflectivity of the ionosphere. This AM radio project will let students detect and study some of these changes.

Objective

Students will construct an Ionosphere Monitor by using an AM radio to track solar storms and other changes in ionosphere reflectivity.

Procedure

1) Break the class into equal groups and have one person in each group bring an AM radio to class.

2) Each group creates a graph of the AM band from 540 kiloHertz to 1700 kiloHertz marked every 50 kiloHertz or so over a 1-foot span.

3) Remove the volume control knob and place the paper disk over the shaft, then replace the knob. Tape the disk onto the radio and mark its edge with the numbers 0-10 counterclockwise.

4) Have the students slowly scan through the AM band and note the location of the station on the graph. Note its loudness by the number on the disk that makes the station hard to hear.

5) Identify the call letters and city of each station you find.

6) Have the groups compare their results to create a combined master plot of the AM band. Locate the most distant station you can hear and its distance in miles from your school.

7) Select a location in the band on the low end between stations. Note the kinds of 'noise' you hear in a journal log for that day. Lighting storms will sound like occasional pops and crackles. Electronic noise will sound like humming or buzzing.

8) Changes in the ionosphere near sunset or sunrise will be heard as a sudden change in the loudness of the background noise. New distant stations may suddenly become detectable. Note the time, the location on the plot, and the city or call letters. This will take some detective work.

Materials

—An AM radio with a tuner knob and a volume control knob.

—A paper disk with a hole punched in its center to fit over the volume control.

For more things to do, advanced students may want to visit:

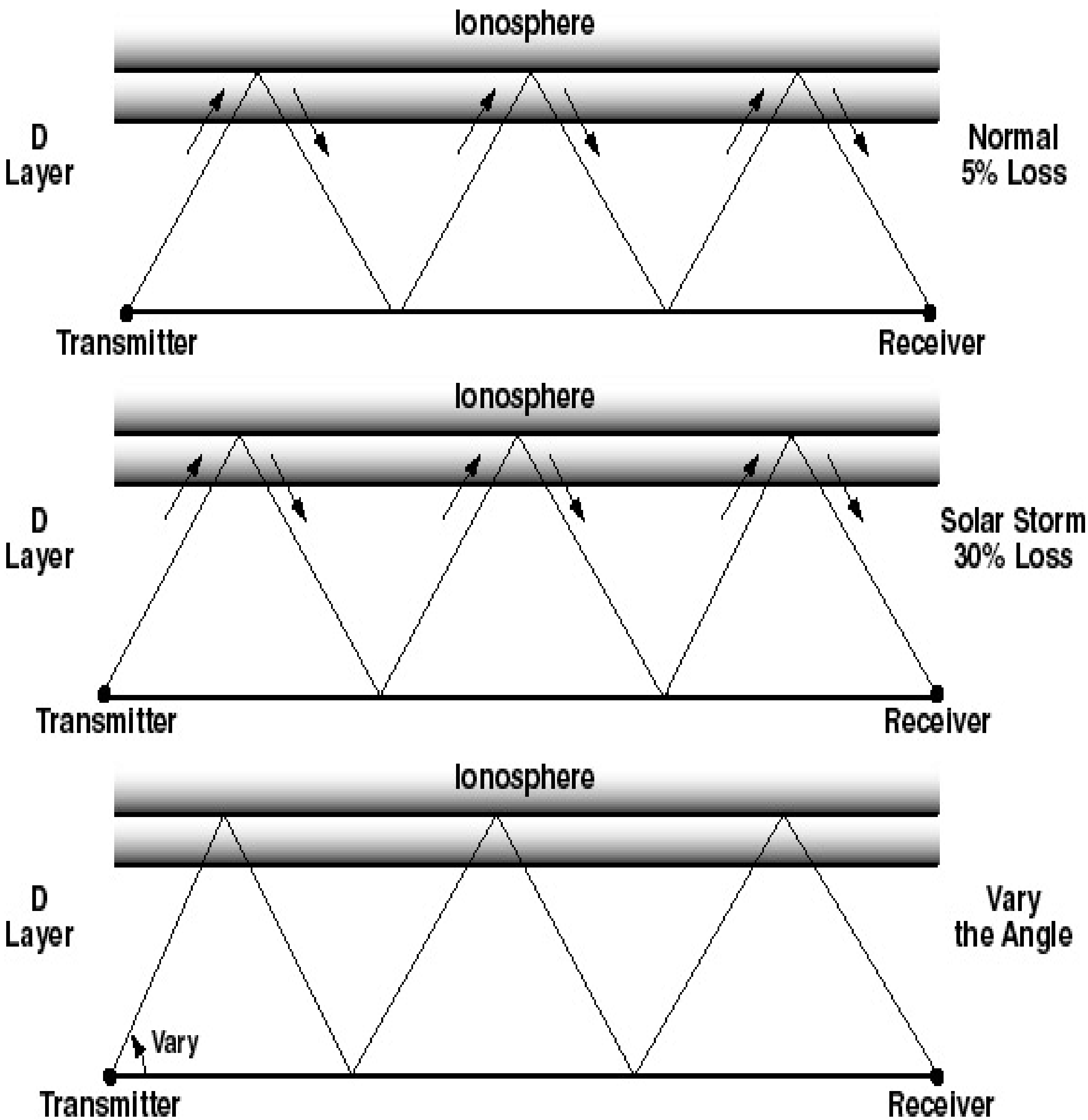
RadioJove at **http://radiojove.gsfc.nasa.gov**

INSPIRE at: **http://image.gsfc.nasa.gov/poetry/inspire**

Conclusion

Students will learn that a simple everyday device can let them listen-in to invisible changes in their environment caused by solar activity.

Name ____________________________ Date________________



Calculate the remaining signal strength for each bounce from the transmitter to the receiver. Determine the amount remaining at the receiver's location. Round the answers to the nearest whole number.