Citizen Science for the 2017 Eclipse with NASA/MSFC, the U.S. Space and Rocket Center, Austin Peay State University, and the University of Alabama in Huntsville

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The Great American Solar Eclipse
August 21, 2017

National Aeronautics and
Space Administration

NASA

What is a Solar Eclipse?

A solar eclipse happens when the Moon, as it orbits Earth, fully or partially blocks the light of the Sun, thus **casting its shadow on Earth**.

Observers within the *path of totality* can expect to see something like the image below. Observers outside the path of totality will see the Sun partially eclipsed as a crescent Sun (with safe filters).

Maximum Eclipse

| Time	Location
10:17am PDT	Lincoln Beach, OR
	Depoe Bay, OR
11:26am MDT	Lime, ID
1:19pm CDT	Valley View, MO
	Bloomsdale, MO
1:26pm CDT	Hopkinsville, KY
1:28pm CDT	Calistia, TN
2:47pm EDT	Bethera, SC

After the 2017 solar eclipse, the next total solar eclipse visible over the continental United States will be on April 8, 2024.

The last total solar eclipse to cover this much of the country was on June 8, 1918.

If the Sun is scaled to about 10 cm (3.9 in), Earth would be about 10 meters away (33 feet).

©1999 by F. Espenak, MrEclipse.com

Solar Eclipse
Sun • Umbra • Penumbra • Moon • Earth • Not to scale
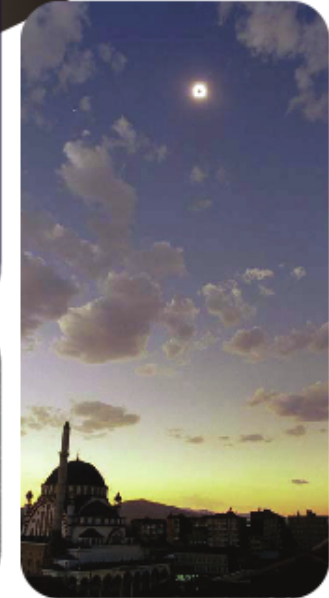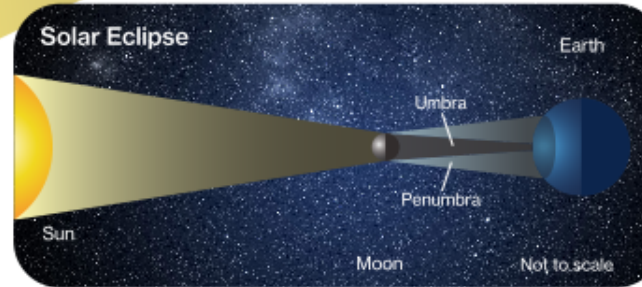
©1999, Photos by F. Espenak used with permission. MrEclipse.com.

The predicted path of the August 21, 2017 solar eclipse

Duration of Greatest Eclipse:
2 min 40 sec
(18:25 UT=13:25 CDT or 1:25 p.m. CDT)

Location of Greatest Eclipse:
36 deg 58 min N; 87 deg 40 min W
(between Princeton, KY and Hopkinsville, KY)

Path Width: approximately 115 km

Eclipse predictions by Fred Espenak, GSFC, NASA Emeritus

Path of Totality

Greatest Eclipse

The NASA image above shows the Moon's **umbral shadow** as seen from the International Space Station during the total solar eclipse on 29 March 2006.

http://mail.colonial.net/~hkalter/index.html

Never look directly at the Sun unless you have filters that you know are safe.

For more information: http://eclipse/gsfc.nasa.gov/SEhelp/safety.html
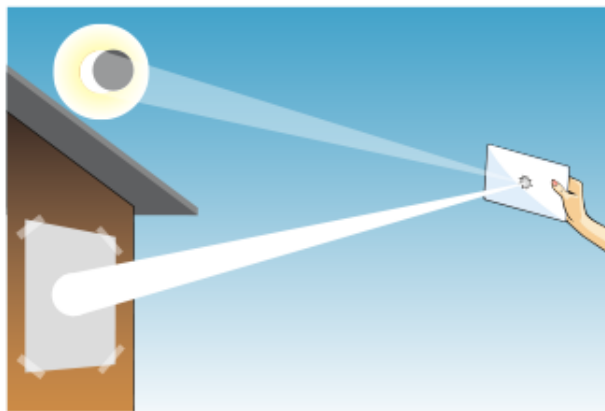For more information about solar eclipses: http://eclipse.gsfc.nasa.gov/solar.html
http://eclipsewise.com/solar
http://eclipse2017.org/

www.nasa.gov

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FL–2016–06–52–MSFC G–157953

Safely Observing the Sun

WARNING: Never look directly at the Sun without proper eye protection. **You can *seriously* injury your eyes.**

Mirror in an Envelope

Slide a mirror into an envelope with a ragged holde cut into the front. Point the mirror toward the Sun so that an image is reflected onto a screen at least 5 meters (about 15 feet) away. The longer the distance, the larger the image.

Do not look at the mirror, *only* at the screen.

Strange Shadows!

Sunlight through trees produces projected crescents during partial phases.

Photograph (below) Copyright © Elisa J. Israel

Go Stick Your Head in a Box

You can make this simple "eclipse telescope" with some cardboard, paper, tape, and foil.

The longer the distance from the pinhole to screen, the larger the image of the Sun will be

White paper screen taped to inside end of box

Sunlight

Aluminum foil with pinhole

Small image of partially eclipsed Sun

Local Area Eclipse Details

Location	% Covered	Start (CDT)	Max (CDT)	End (CDT)
Nashville, TN	100.0%	11:58AM	1:28PM	2:54PM
Totality begins 1:27PM • Totality ends 1:29PM				
Brentwood, TN	100.0%	11:58AM	1:28PM	2:54PM
Totality begins 1:28PM • Totality ends 1:29PM				
Franklin, TN	99.9	11:58AM	1:28PM	2:54PM
Fayetteville, TN	98.2	11:59	1:30	2:56
Ardmore, AL/TN	97.3	11:59	1:29	2:55
Florence, AL	95.9	11:57	1:28	2:54
Athens, AL	96.7	11:59	1:29	2:56
Decatur, AL	96.1	11:59	1:30	2:56
Hartselle, AL	95.8	11:59	1:30	2:56
Madison, AL	96.7	11:59	1:30	2:56
USSRC	96.8	11:59	1:30	2:56
Huntsville, AL	97.0	11:59	1:30	2:56
VBAS	97.1	12:00PM	1:30	2:56
Arab, AL	96.0	12:00	1:31	2:57
Gurley, AL	97.1	12:00	1:31	2:57
Guntersville, AL	96.4	12:01	1:31	2:57
Scottsboro, AL	97.4	12:01	1:31	2:57
Bridgeport, AL	98.6	12:01	1:32	2:57

JAVA Script Solar Eclipse Explorer
http://eclipse.gsfc.nasa.gov/JSEX/JSEX-NA.html

Sun Funnel

Make this device for your telescope with simple instructions at: www.astrosociety.org/tov/Build_a_Sun_Funnel.pdf

Cool in the Shades

Visit the Von Braun Astronomical Society (or your local astronomical society) and pick up a pair of these special Eclipse Sunglasses!

www.vbas.org

The Great American Eclipse
August 2, 2017

VBAS
Von Braun
Astronomical
Society

All images used with permission.

Proposed Science for Eclipse 2017

- Impact of rapid reduction in solar irradiance on the formation of clouds

- Impact of rapid reduction in solar irradiance on ionospheric propagation

- Better characterize the lower layer of the ionosphere

- Better understand the inner corona and how it is affected by the solar photospheric magnetic field

- Observe domestic cattle to determine if rapid changes in solar illumination at an odd time of day affect rumination or other behaviors

Atmospheric Response and Cloud Formation

Physical Processes: Solar radiation reduced
Atmospheric boundary layer responds   --   turbulent unstable to
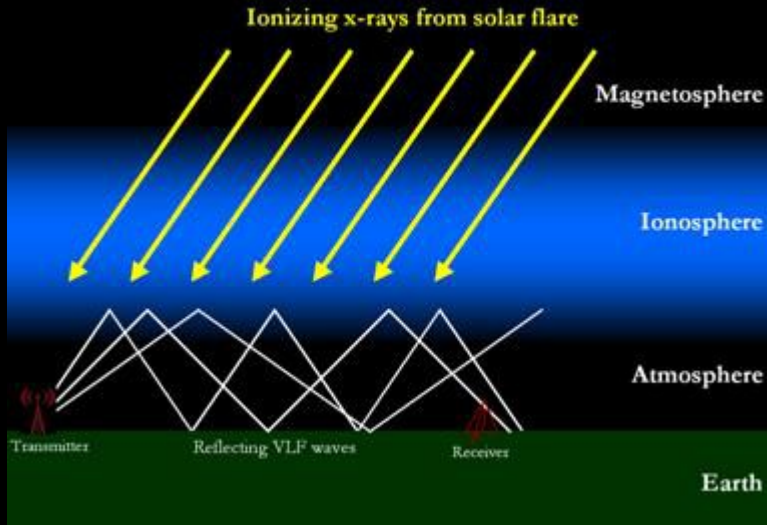less turbulent stable

Will low-level cumulus clouds dissipate?
What is the mesoscale response of pre-existing convergence lines?
What is the cloud depth and coverage?

Balloons: 1 per hour beginning at 6-7 a.m. CDT, to heights of 12-15 km above ground
Radiosonde data: Temperature, humidity, wind

MIPS: Mobile Integrated Profiling System

915 MHz wind profiler

CL51 ceilometer
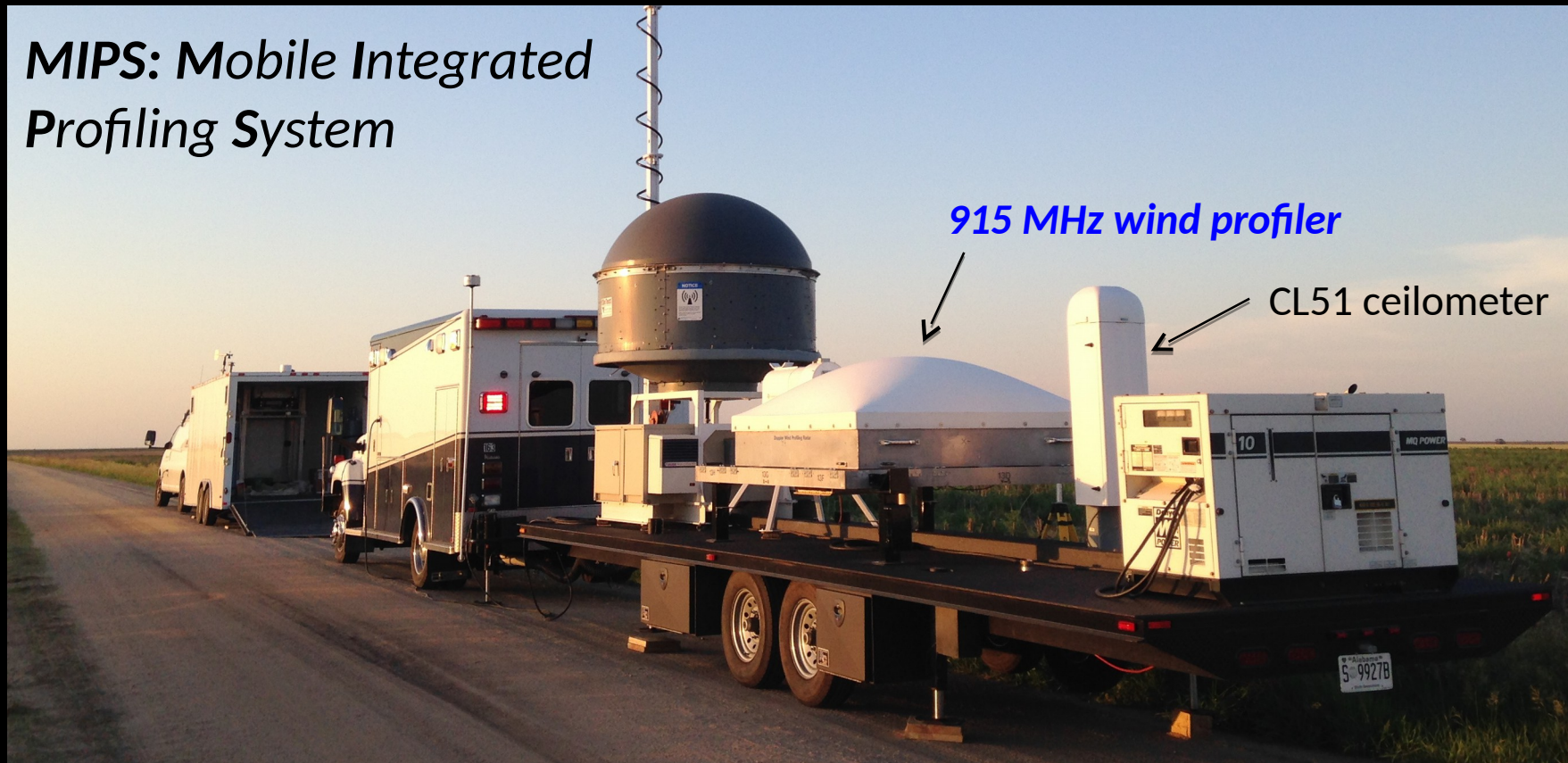
Impact of Reduced Solar Irradiance on the Ionosphere

Character of the lower ionosphere not well understood

Ionizing x-rays from solar flare

Magnetosphere

Ionosphere

Atmosphere

Transmitter   Reflecting VLF waves   Receiver
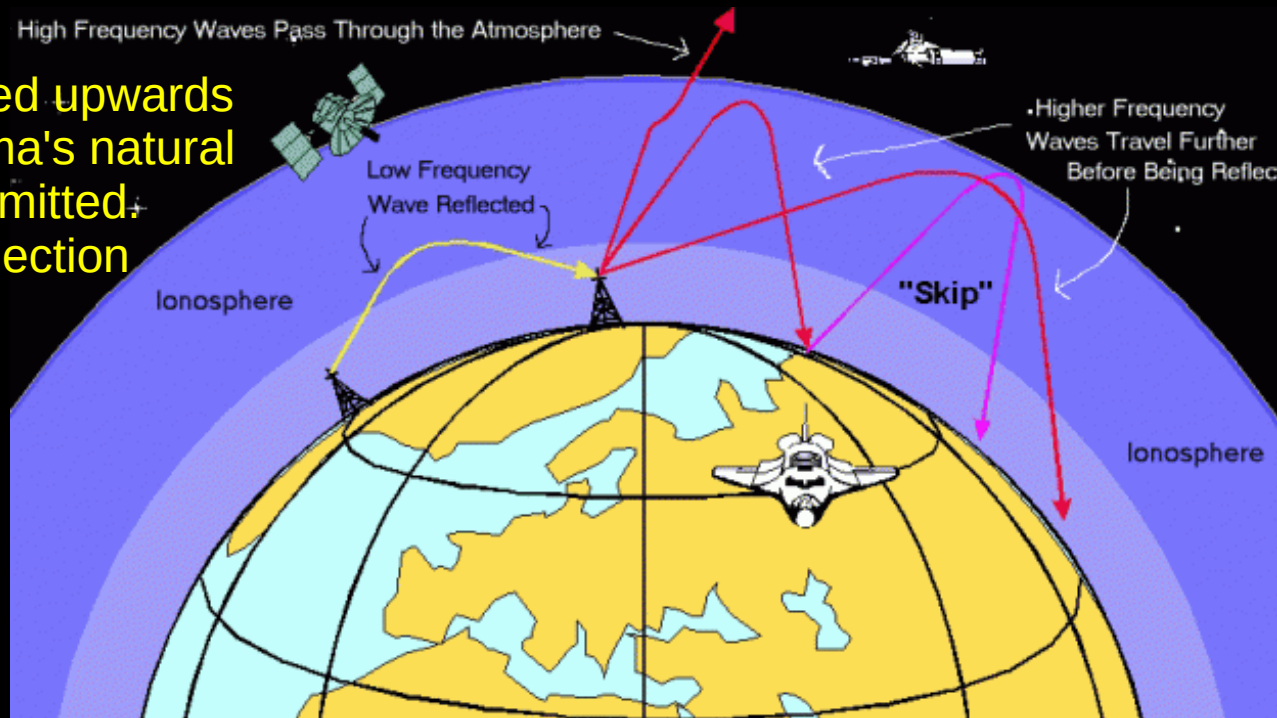
Earth

Physical Processes:

Solar radiation reduced

Ionosphere responds--ions recombine

How quickly does the ionosphere recover?

Measurements: Radio signal transmitted upwards
A layer of electrons reflect, when plasma's natural
oscillation frequency equals that transmitted.
Time-of-flight measured->Height of reflection
Plasma density
proportional
to frequency ->   Plasma Density
                    as function of altitude

Balloon Measurements will also be
made

High Frequency Waves Pass Through the Atmosphere

·Higher Frequency
Waves Travel Further
Before Being Reflec

Low Frequency
Wave Reflected

"Skip"

Ionosphere

Ionosphere

Reverse Beacon Network (RBN)

The RBN: an array of passive receivers that record radio links of amateur (ham) operators (Frissell et al., 2014)

Ionosphere's D layer absorbs HF radio waves, 3 MHz -30 MHz
Reduced solar irradiation decreases ionization in D layer.
Radio communication can be enhanced (go over longer distances)

http://reversebeacon.net

- Existing 100+ amateur sites yield near-real-time propagation information
- Expedition site enhances eclipse diagnostics of ionospheric response and recovery
- Project leverages extensive world-wide database for the study of pre-, during-, and post-eclipse ionospheric conditions
- Day-Night terminator ionospheric changes can be compared with ionospheric changes as a result of the eclipse

Studying the Inner Corona of the Sun

Credit:
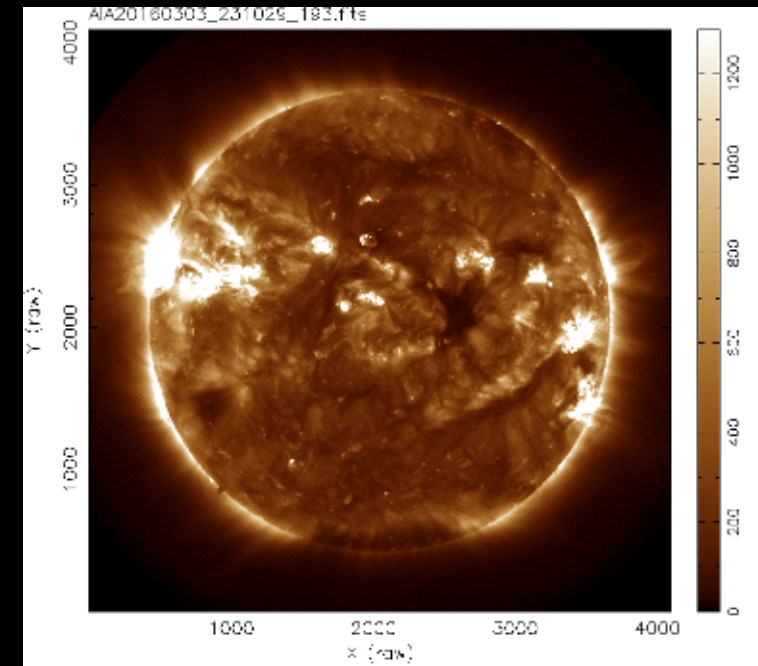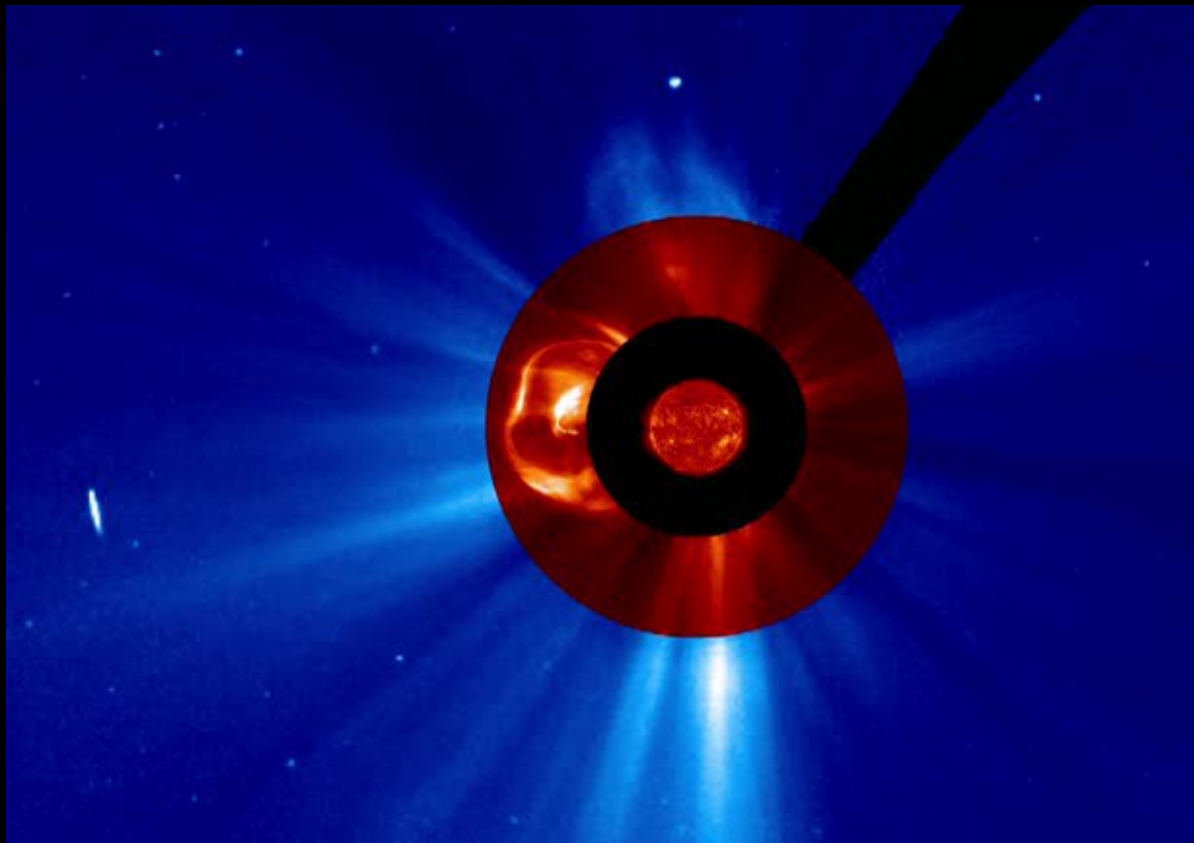S. Habbal, M. Druckmüller
and P. Aniol
Total eclipse image taken Mar. 20, 2015 at Svalbard, Norway.

Track prominences and CMEs (if one occurs) from inner corona to outer

Explore how active regions affect the corona

Balloon-borne imaging will be done in addition to ground-based.

Domestic Cattle (Bos taurus) Grazing, Ruminating, and Behavioral Responses to a Total Solar Eclipse in Montgomery County, TN

Lactating dairy cows previously found to be affected by eclipse (Aug. 1999): decreased grazing behavior and drop in rumination time (Rutter et al., 2002)

Project will study beef cattle using: weather data and solar irradiation changes
GPS monitoring of cow movement
direct observations of cow movement
grazing monitors for rumination measurements

U.S. Space and Rocket Center

- Since 1970, ~16 million people have toured
- Programs include Space Camp, Space Academy, Aviation Challenge, and Robotics Camp
- Special Request Camps for groups such as the INSPIRE Project
- In 2015, > 250,000 visitors
- Museum holds Saturn V rocket, Apollo 16 Command Module, Apollo 12 moon rock
- FY 2016:

32,054	Campers
26, 749	Children
548	Educators
1,416	Family Programs
3,341	Adult Space Camp

INSPIRE INTERACTIVE NASA SPACE PHYSICS IONOSPHERE RADIO EXPERIMENTS
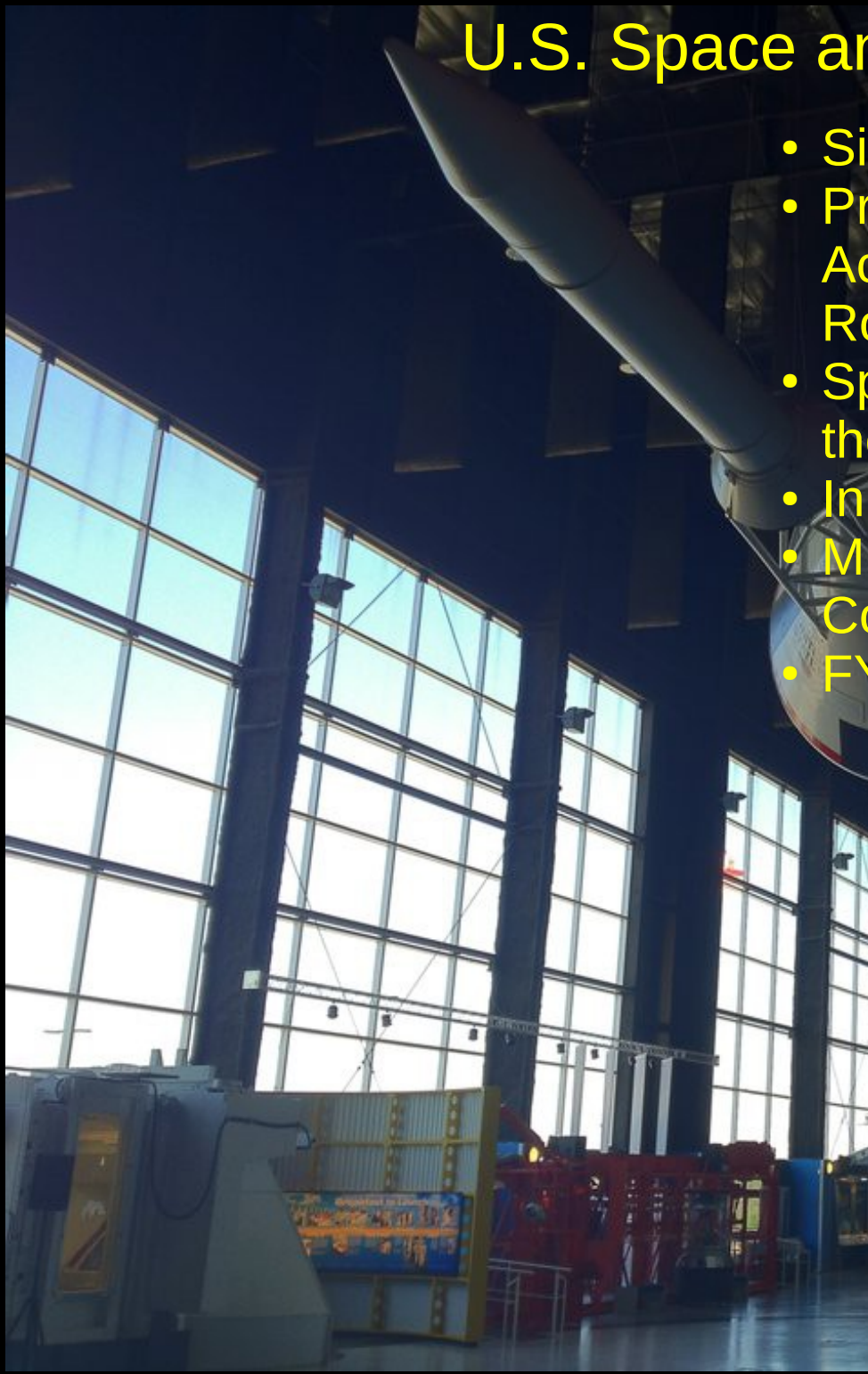
INSPIRE Project's Annual Space Academy for Educators & Students Full Scholarship Programs -- D.C. Area

Established 2008
~ 90+ Competitive Scholarship Awards
2015-16 School Year

Wav files!

Proposed Activities for Total Solar Eclipse 2017 Involving Advanced Space Academy Kids

1. RadioJove

2. INSPIRE

3. Reverse Beacon

4. Balloon Experiments -- meteorological and other

5. Weather Observations

6. Animal/Plant Observations

Science Co-Is

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Summary

Science Experiments will be done in conjunction with the August 21, 2017 eclipse to investigate:

-- Cloud formation/dissipation due to solar irradiance changes
-- Ionospheric properties (e.g. density)
-- Ionospheric propagation of radio in the 3 MHz - 30 MHz range
-- Solar prominences, the inner solar corona, and coronal mass ejections (if we are lucky)
-- Behavioral responses of beef cattle

Students from the U.S. Space and Rocket Center will participate in experiments, as Citizen Scientists and/or as technical assistants. In addition to helping with the above on eclipse day, technical assistants may also collect data for Radio Jove and INSPIRE.