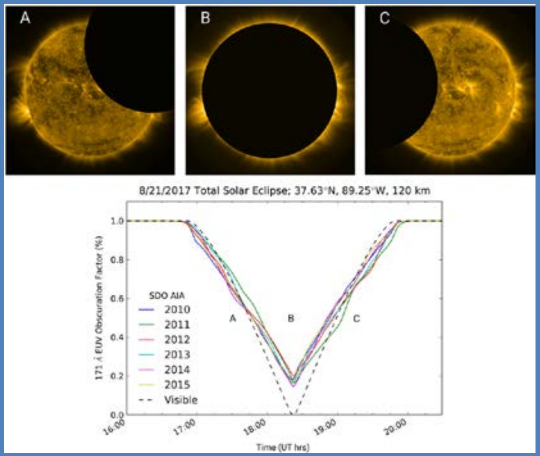
Blocked from the Sun's Rays: Predicting how the 2017 Total Solar Eclipse may affect Earth's Ionosphere and Plasmasphere

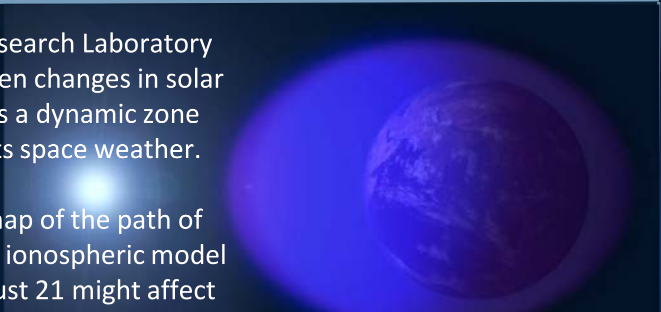
The primary source of energy to the Earth is radiant energy from the sun. This radiant energy per unit area is measured and reported as solar irradiance. The most energetic part of the solar spectrum varies considerably with solar activity, and creates a dynamic, electrically charged layer of the atmosphere, called the ionosphere. Although the sun's production of photoelectric light never stops, during a solar eclipse, the moon blocks the sun's rays from reaching Earth in specific places causing solar irradiance in these areas to rapidly and significantly dim.



Simulated occultation of the sun at times corresponding to the upcoming 2017 solar eclipse: (A) 17:30 UT, (B) 18:22 UT, and (C) 19:15 UT. Using various years of SDO observations at 171 Å (at 37.63° N, 270.75° E, 125 km), eclipses were simulated. The figure shows the resulting time histories of normalized obscuration factors. Credit: NRL, Huba and Drob 2017

Scientists J. D. Huba and D. Drob with the Naval Research Laboratory recently published a paper on how the eclipse-driven changes in solar irradiance affect the ionosphere. The ionosphere is a dynamic zone high in our atmosphere where Earth weather meets space weather.

Using NASA Heliophysics SDO mission data and a map of the path of totality for the 2017 total solar eclipse, they ran an ionospheric model to test hypotheses on how solar irradiance on August 21 might affect Earth's ionosphere and plasmasphere.



Artist's visualization of the pulsating ionosphere. Credit: NASA GSFC SVS/G. Duberstein

The team ran two models simulating total electron content (TEC) and electron density in the F region located 150-350km in altitude in Earth's atmosphere. One model included a solar eclipse "mask" that blocked solar radiation from reaching Earth along the path of totality. The second model was run without a mask as the control simulating normal solar irradiance conditions at Earth.

In the vicinity of the path of totality during the eclipse simulation, the TEC decreases by ~35%, while electron density in the F region decreases by ~50%, relative to the control. In the plasmasphere, the layer above the ionosphere in altitude, electron temperature decreases roughly by 15% or ~800 K. These results are consistent with observations made of an annular eclipse made at Millstone Hill in Massachusetts in 1984.

Models like the one used in this study help scientists better predict how Earth responds to a dynamic event, like an eclipse or a geomagnetic storm.

Many scientists and researchers are taking advantage of the experiments made possible during the 2017 total solar eclipse. NASA Heliophysics is supporting eleven scientific investigations including one led by Virginia Tech that will provide data on how the ionosphere changes in response to sunlight. Another project, managed through the University of Montana, involves the launch of over 50 high-altitude balloons equipped with cameras and instruments to live-stream video and provide imagery and meteorological observations of the entire eclipse event from near-Earth space. One of the citizen science-based projects, Citizen CATE, will be deploying 60 identical telescopes with digital cameras along the path of totality to take images of the solar corona which will be stitched together to reveal coronal dynamics over a 90-minute period.

Read about other great eclipse investigations, events and activities on NASA 2017 total solar eclipse website: https://eclipse2017.nasa.gov/