EOS

Earth & Space Science News

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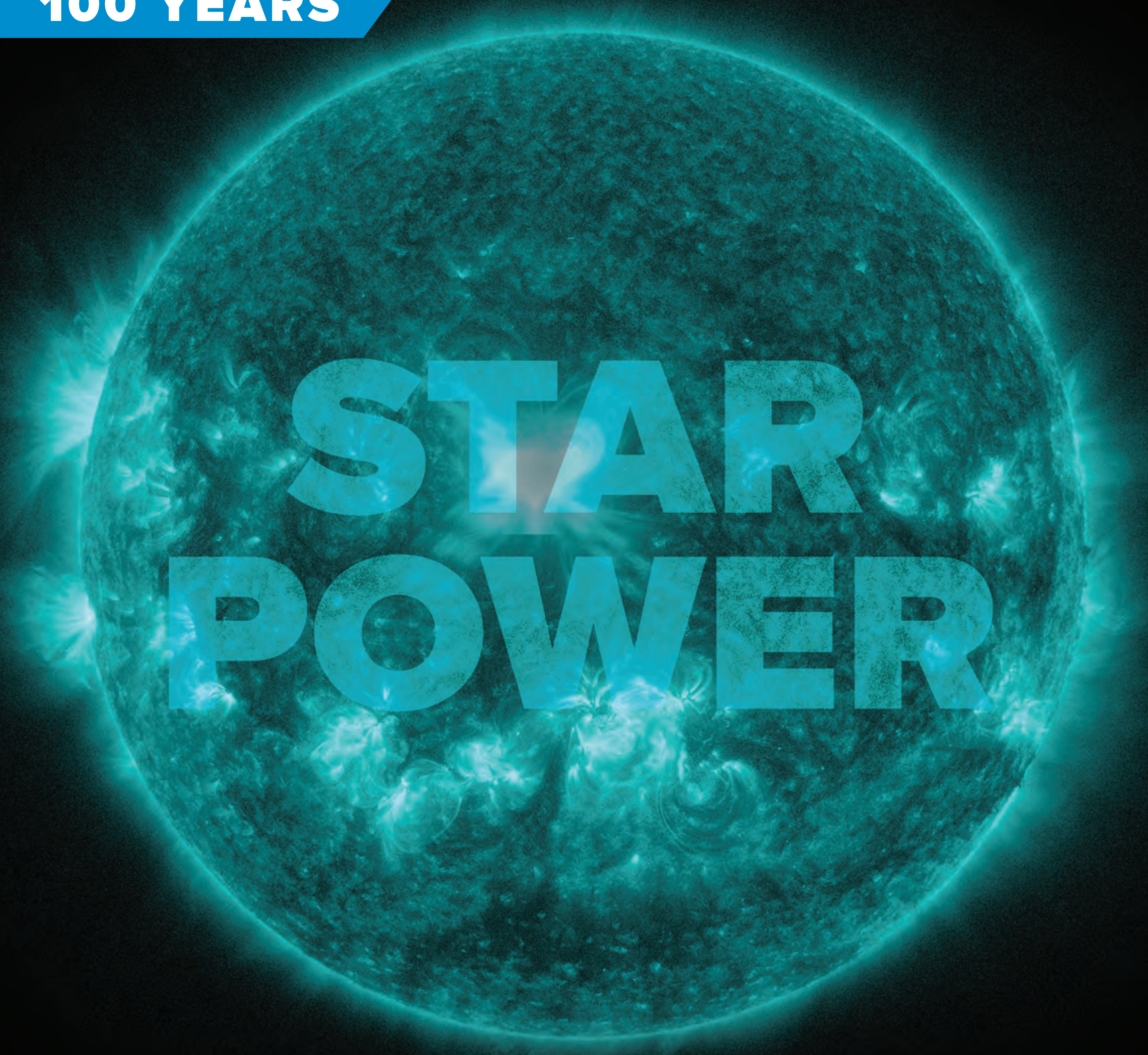
100 YEARS

Our Water Cycle Diagrams Are Missing Something: Us

Rivers of Antibiotics

Magnetic Map Gaps



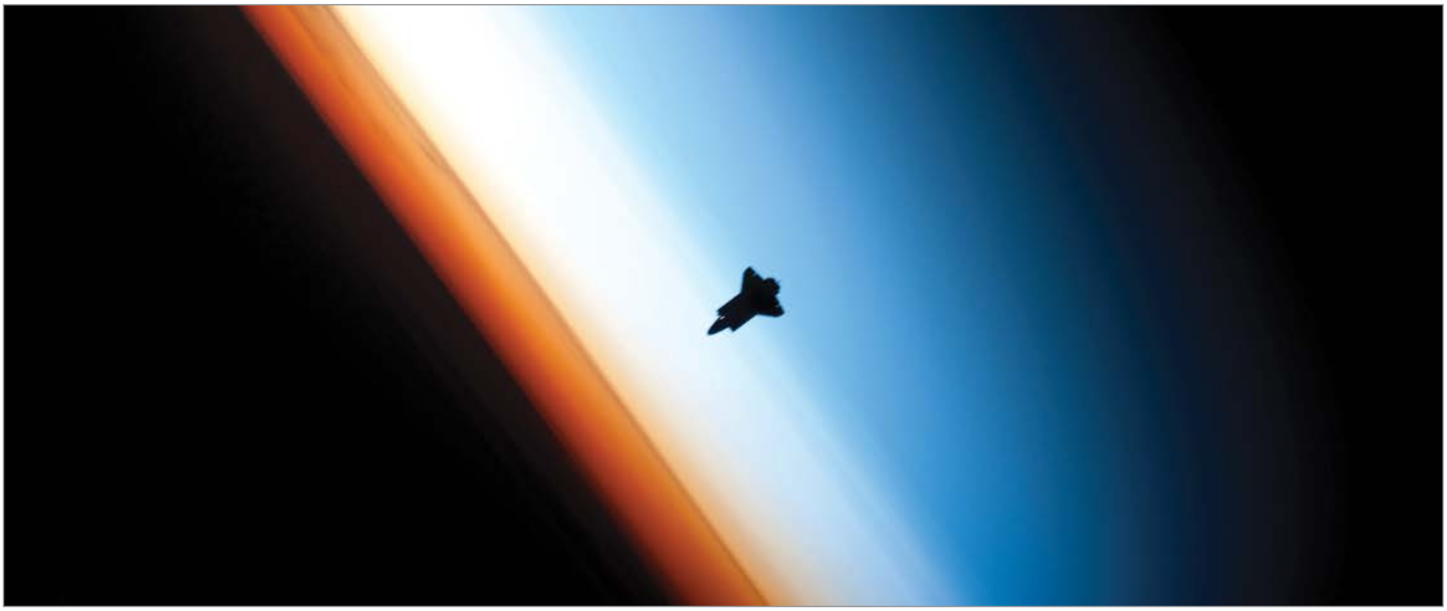
AGU 100

ADVANCING EARTH AND SPACE SCIENCE

RESEARCH SPOTLIGHT

EOS CENTENNIAL COLLECTION

The Thermosphere Responds to a Weaker Than Normal Solar Cycle



Space shuttle Endeavour *orbits in the thermosphere in 2010 while en route to the International Space Station. The orange layer is the troposphere, the lowest part of the atmosphere; the whitish layer is the stratosphere; and the blue layer is the mesosphere. Credit: NASA*

The Sun undergoes a magnetic metamorphosis approximately every 11 years, when the celestial body flips its magnetic poles: North becomes south, and south becomes north. The Sun is currently in solar cycle 24, which began in June 2009. No cycle is the same. The length can vary from 9 to nearly 14 years, and the degree of solar activity fluctuates as well. Within each solar cycle, the frequency of sunspots and flares ebbs and flows in response to the changing magnetic field around the star.

The thermosphere, one of the outer layers of Earth's atmosphere, is particularly sensitive to variations in solar activity. The thermosphere forms about 100 kilometers (62 miles) above our heads and extends for several hundred kilometers above that. It absorbs much of the X-ray and ultraviolet radiation from the Sun. During periods of high solar activity, X-ray and ultraviolet radiation from the Sun increases, and the thermosphere swells as it sops up this increase in energy from the Sun. As the Sun approaches solar minimum, the thermosphere cools and shrinks as the intensity of the X-ray and ultraviolet radiation decreases. Because the International Space Station and many satellites orbit through this layer, changes in thermospheric boundaries and densities can affect their operation and the maintenance of their orbits.

The cooling near solar minimum is natural and specific to the thermosphere. The cooling thermosphere does not affect the troposphere, the layer of the atmosphere closest to Earth's surface. The temperatures we experience on the ground do not get colder because of this solar cycle. Climate researchers at NASA and elsewhere continue to see a warming trend in the troposphere. These two effects are ongoing but unrelated.

Nitric oxide and carbon dioxide play important roles in cooling the thermosphere. These molecules are able to radiate energy at infrared wavelengths and thus moderate the effects of energy inputs to the thermosphere. In particular, nitric oxide acts as a thermostat and, in concert with carbon dioxide, can significantly influence the temperature of the atmosphere, especially during periods when the thermosphere is disturbed during geomagnetic storms. The Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) instrument on NASA's Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED) satellite was launched in 2002 and has been observing the infrared radiation from these molecules ever since.

Here *Mlynczak et al.* looked at the past 16 years of SABER data to quantify how much energy nitric oxide and carbon dioxide discharged from the thermosphere over the past two solar cycles. The period covers most of solar cycle 23 and all of solar cycle 24 to date.

The authors found that the infrared power emitted by the two molecules during solar cycle 24 is substantially lower than the emissions during solar cycle 23. In fact, the radiated energy from nitric oxide and carbon dioxide are only 50% and 73%, respectively, of the average emission of the five prior cycles dating back to 1954. The low rates of radiation are likely tied to the relative weakness of solar cycle 24. To equal the average infrared radiation released from within the thermosphere over the past five cycles, the current solar cycle would need to span an additional 1,690 days. At that projected length, it would make the current cycle a full year longer than its predecessor and one of the longest in the historical record.

The study offers insightful information on the thermal state of Earth's atmosphere above 100 kilometers. The Sun's influence on the thermosphere is a growing topic of research, and this study provides crucial quantitative context for future work. (*Geophysical Research Letters,* https://doi.org/10.1029/2018GL080389, 2018) **—Aaron Sidder, Freelance Writer**