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## The Chill of Solar Minimum

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**Sept. 27, 2018:** The sun is entering one of the deepest Solar Minima of the Space Age. Sunspots have been absent for most of 2018, and the sun's ultraviolet output has sharply dropped. New research shows that Earth's upper atmosphere is responding.

"We see a cooling trend," says Martin Mlynczak of NASA's Langley Research Center. "High above Earth's surface, near the edge of space, our atmosphere is losing heat energy. If current trends continue, it could soon set a Space Age record for cold."



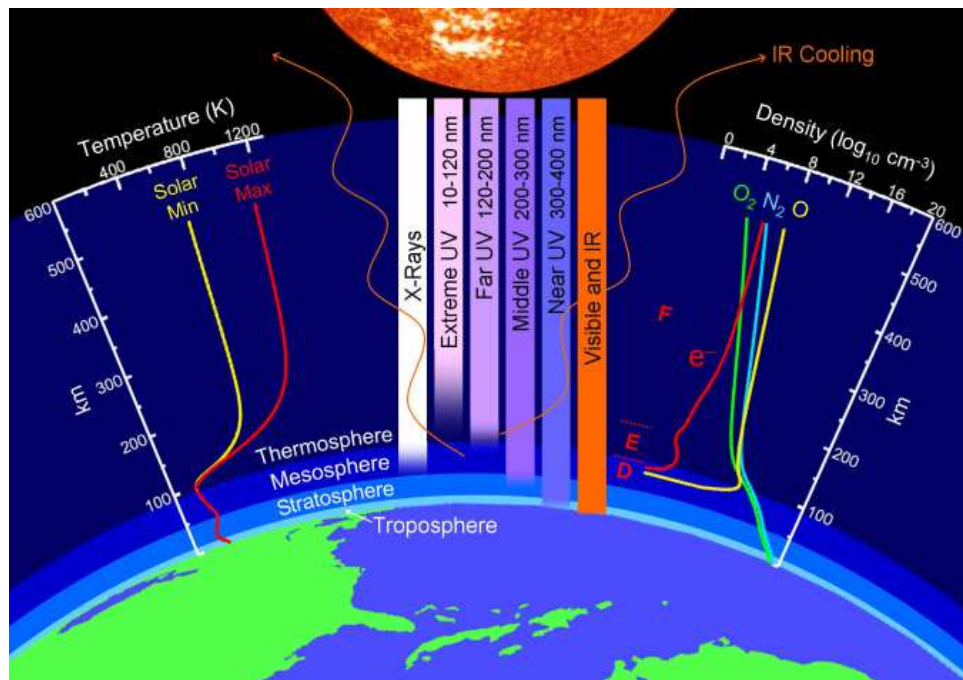
Above: The TIMED satellite monitoring the temperature of the upper atmosphere

These results come from the SABER instrument onboard NASA's TIMED satellite. SABER monitors infrared emissions from carbon dioxide (CO<sub>2</sub>) and nitric oxide (NO), two substances that play a key

role in the energy balance of air 100 to 300 kilometers above our planet's surface. By measuring the infrared glow of these molecules, SABER can assess the thermal state of gas at the very top of the atmosphere—a layer researchers call “the thermosphere.”

“The thermosphere always cools off during Solar Minimum. It's one of the most important ways the solar cycle affects our planet,” explains Mlynczak, who is the associate principal investigator for SABER.

When the thermosphere cools, it shrinks, literally decreasing the radius of Earth's atmosphere. This shrinkage decreases aerodynamic drag on satellites in low-Earth orbit, extending their lifetimes. That's the good news. The bad news is, it also delays the natural decay of space junk, resulting in a more cluttered environment around Earth.



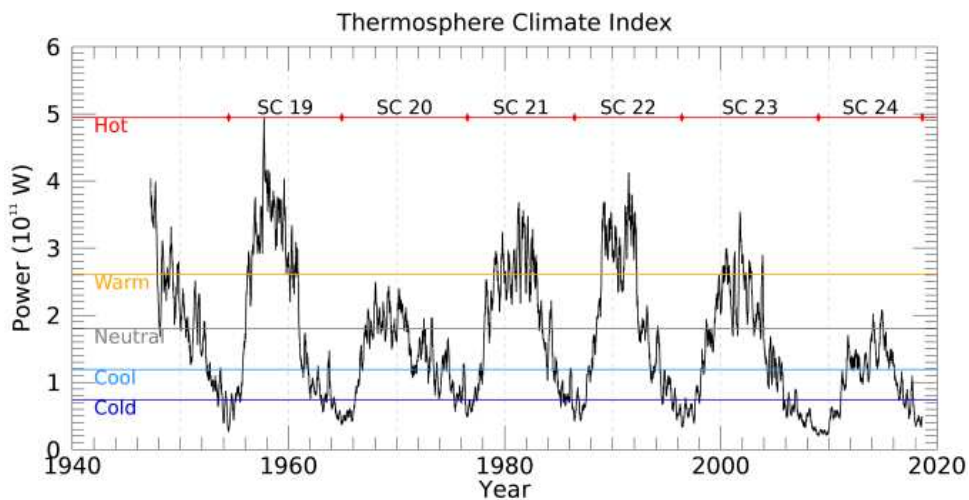
Above: Layers of the atmosphere. Credit: NASA

To help keep track of what's happening in the thermosphere, Mlynczak and colleagues recently introduced the “Thermosphere Climate Index” (TCI)—a number expressed in Watts that tells how much heat NO molecules are dumping into space. During Solar Maximum, TCI is high (“Hot”); during Solar Minimum, it is low (“Cold”).

“Right now, it is very low indeed,” says Mlynczak. “SABER is currently measuring 33 billion Watts of infrared power from NO. That's 10 times smaller than we see during more active phases of the solar cycle.”

Although SABER has been in orbit for only 17 years, Mlynczak and colleagues recently calculated TCI going all the way back to the

1940s. “SABER taught us to do this by revealing how TCI depends on other variables such as geomagnetic activity and the sun’s UV output—things that have been measured for decades,” he explains.



Above: An historical record of the Thermosphere Climate Index. Mlynczak and colleagues recently published a paper on the TCI showing that the state of the thermosphere can be discussed using a set of five plain language terms: Cold, Cool, Neutral, Warm, and Hot.

As 2018 comes to an end, the Thermosphere Climate Index is on the verge of setting a Space Age record for Cold. “We’re not there quite yet,” says Mlynczak, “but it could happen in a matter of months.”

“We are especially pleased that SABER is gathering information so important for tracking the effect of the Sun on our atmosphere,” says James Russell, SABER’s Principal Investigator at Hampton University. “A more than 16-year record of long-term changes in the thermal condition of the atmosphere more than 70 miles above the surface is something we did not expect for an instrument designed to last only 3-years in-orbit.”

Soon, the Thermosphere Climate Index will be added to Spaceweather.com as a regular data feed, so our readers can monitor the state of the upper atmosphere just as researchers do. [Stay tuned for updates \(http://spaceweather.com/services\)](http://spaceweather.com/services).

## References:

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Solar Cycle, thermosphere