Presence of atomic oxygen confirmed on both day and night sides of Venus

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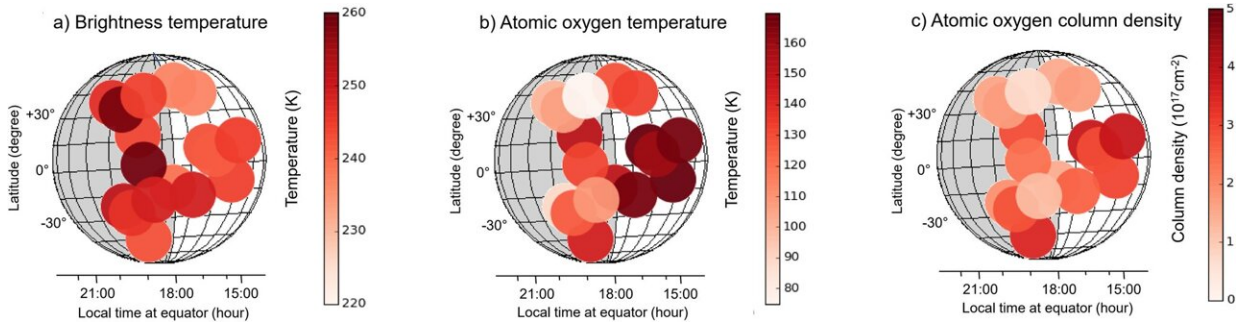

Maps of temperature and atomic oxygen. a brightness temperature, b atomic oxygen temperature, and c atomic oxygen column density of Venus. The light gray area of Venus marks the nightside. The evening terminator is the border between the white (daytime) and the gray (nighttime) area. The LT refers to the equator. The size of the circles corresponds to the FWHM of the telescope beam. Credit: *Nature Communications* (2023). DOI: 10.1038/s41467-023-42389-x

A multi-institutional team of astrophysicists from Germany has made the first direct observation of oxygen atoms in the day side atmosphere of Venus. In their project, reported in the journal *Nature Communications*, the group studied data from the Stratospheric Observatory for Infrared Astronomy, (SOFIA), the airplane-based reflecting telescope, to learn more about elements and molecules in Venus's atmosphere.

Planetary scientists have long suspected that the atomic form of oxygen exists in Venus' atmosphere on both the day and night sides. While high levels of carbon monoxide and carbon dioxide have been measured in the planet's atmosphere, finding evidence of oxygen in its elemental form has proven more challenging due to its reactivity—it tends to bind quickly to other elements it encounters.

Prior researchers have observed the presence of atomic oxygen in the atmosphere on the dark side of Venus, where it emits a faint glow. But until now, it not been observed on the sunny side. In this new effort, the research team focused on 17 points in the Venusian atmosphere buried in data from SOFIA observations. They found evidence of atomic oxygen in all of them, marking the first time oxygen in its atomic form has been observed on the sunny side of Venus.

The researchers suggest that the oxygen comes about due to energy from the sun breaking apart carbon monoxide and carbon dioxide molecules. They further suggest that these atoms make their way to the dark side of the planet courtesy of the strong winds in the Venusian atmosphere. Once there, they likely combine into molecular oxygen and react with other elements as well.

The research team also suggests that atomic oxygen in Venus's atmosphere likely has a cooling effect on the planet—when single oxygen atoms collide with other molecules, such as carbon dioxide, energy is transferred to the molecule, which is then radiated away. The result is a cooling of the upper layers of the Venusian atmosphere.

More information: Heinz-Wilhelm Hübers et al, Direct detection of atomic oxygen on the dayside and nightside of Venus, *Nature Communications* (2023). DOI: 10.1038/s41467-023-42389-x