Bias discovered in measuring Earth's vegetation

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Background: Satellite data on the greenness of Earth's vegetation informs our understanding of pressing societal issues, from crop production to climate change. A team of researchers working with ARC scientists noticed a puzzling pattern in satellite-derived vegetation greenness, a proxy for the amount of leaves in an area and for vegetation productivity. The issue became clear when vegetation greenness measurements retrieved from satellites over the US Corn Belt were higher than the same measurements over the Amazon rainforest, despite the rainforest having a greater amount of leaf area (**Fig. 1**). Researchers hypothesized that the shadows cast by complex canopies might contribute to this paradoxical phenomenon and tested it by examining how light interacts with the vegetation canopy.

Main Findings: Researchers found that macroscale shadows cast by complex forest structures result in lower greenness measures compared with those cast by structurally simple and homogeneous crops. The shadow-induced measurement bias occurs because most Earth-observing instruments on satellites (e.g., MODIS, VIIRS) do not view the Earth in the solar direction and thus view shadows. Shadows influence the interpretation of vegetation indices (VI) and solar-induced chlorophyll fluorescence (SIF) as measures of global vegetation changes (**Fig. 2**).

Impact:. Misinterpretations of Earth's vegetation could lead to heightened uncertainty in climate models, misguided agricultural policies, and ineffective conservation efforts. This study uncovered a bias in global vegetation measurements that, when corrected, enables improved interpretations of remotely sensed VIs and SIF.

Article: Zeng, Y., Hao, D., **Park, T.** …, **Nemani, R.**, et al. 2023. Structural complexity biases vegetation greenness measures. *Nature Ecology & Evolution*, *7*(11), pp.1790-1798., https://doi.org/10.1038/s41559-023-02187-6

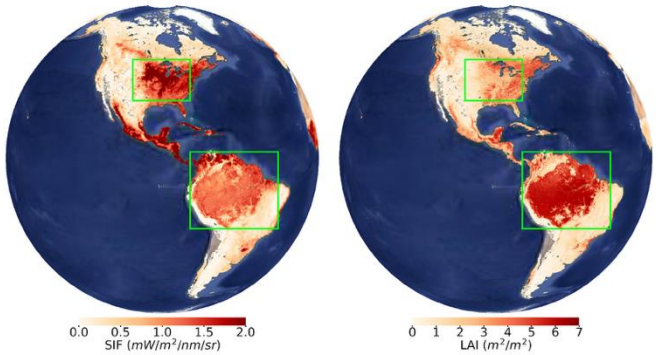

Fig 1. Spatial pattern of solar-induced chlorophyll fluorescence (SIF, Left) and leaf area index (LAI, Right). SIF is an innovative measurement that serves as a proxy for plant photosynthetic activity. LAI is the green leaf area of a canopy or plant community per unit ground area.

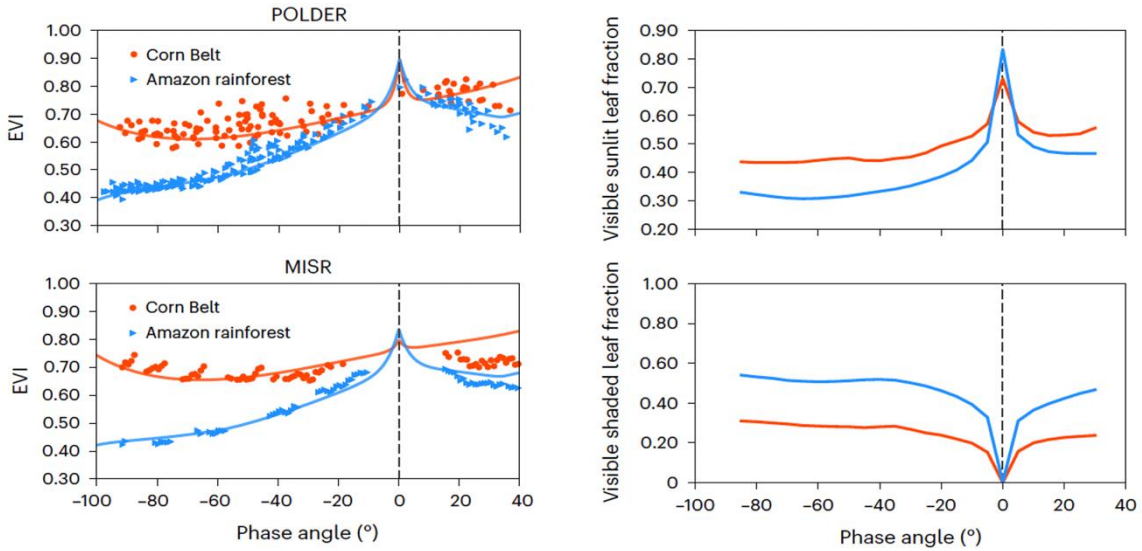

Fig 2. Simulated satellite observations with MISR and POLDER sensors demonstrate biases. A phase angle of 0 means the sun is behind the satellite (the hot spot direction), where the satellite doesn't perceive any canopy-casted shadows. However, as the phase angle increases (either + or –), the satellite begins to detect shadows. Consequently, the enhanced vegetation indices (EVI) in the Corn Belt become larger than those in the Amazon rainforest.