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## The Qinghai-Tibet Plateau may have already shifted to carbon source: Evidence from OCO-2 satellite XCO<sub>2</sub> observations

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As one of the most sensitive regions to climate change on the Earth's surface, the Qinghai-Tibet Plateau is experiencing lasting warming, which has been evidenced to enhance surface carbon uptake but also could lead to carbon emission due to accelerated permafrost degradation and ecosystem respiration. Due to the difficulties of limited observations and imperfect modeling techniques, whether the Qinghai-Tibet Plateau is a carbon sink or source has been an ongoing debate. The recent satellite XCO<sub>2</sub> Observations could provide some useful constraints on the carbon budget in this region. Here, based on the recent OCO-2 XCO<sub>2</sub> observations and the inversion results from the OCO-2 v10 MIP, we estimated the net biome carbon fluxes for the Qinghai-Tibet Plateau. Our results suggest that this region has become a carbon source (around -0.10 PgC/year) already, which is supported by an upscaling estimate with intensified eddy covariance flux measurements over China. Meanwhile, we found this carbon source signal is not detected by either in-situ CO<sub>2</sub> inversions or terrestrial biosphere model simulations. Currently, although some studies based on flux measurements report this region is a carbon sink and even keeps increasing recently, many others hold opposite viewpoints about it. Our result provides an important piece of evidence supporting that the Qinghai-Tibet Plateau becomes a carbon source, albeit additional evidence is needed, especially from in-situ CO<sub>2</sub> observations and aerial CO<sub>2</sub> observations (e.g., by aircraft, unmanned aerial vehicle, and AirCore). In principle, atmospheric CO<sub>2</sub> measurements could provide a more complete picture of the carbon budget in this region compared to discrete and limited eddy flux measurements. In the future, enhanced in-situ and aerial CO<sub>2</sub> observations are expected to disentangle the puzzle of this carbon budget issue in this region.