Abrupt seasonal transitions in land carbon uptake in 2015

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Résumé

The year 2015 saw global annual mean concentration surpassing 400 ppm for the first time at the Mauna Loa station since 1959, with an annual atmospheric CO2 growth rate (AGR) reaching a record high value of 2.94±0.09 ppm. Paradoxically, it was also the greenest year since 2000. Not only was vegetation greenness higher on average than in previous years, but also the fraction of land area with record-high NDVI values across the globe was twice larger in 2015 than in other years. After removing a linear long-term trend during 1979-2015, the positive AGR anomaly in 2015 is 1.56 PgC y-1 and reflects a loss of terrestrial sink of 1.22 PgC, that is the fifth lowest land sink observed over 1979-2015. To reconcile the seemingly paradoxical observations of a weaker terrestrial sink during a high greening, we examined the temporal pattern and magnitude of CO2 fluxes using two atmospheric inversions assimilating atmospheric CO2 records from the surface in-situ network. Inversion results reveal that the year 2015 had a higher than usual seasonal land carbon uptake in the second and third trimester (April-June & July-September) in northern boreal and temperate regions, consistent with the strong greening anomaly and with warmer spring and summer temperature conditions. This higher spring and summer uptake was followed by a large source of CO2 in autumn (October-December), suggesting a coupling between early season uptake and late season release of CO2 in northern ecosystems, i.e. the respiration of a large fraction of labile carbon formed during the previous growing season. For the tropics and southern hemisphere, here we provide evidence for a strong and abrupt transition toward a large carbon source for the last trimester of 2015, concomitant with the peak of El Nino development. This abrupt transition of terrestrial tropical CO2 fluxes between two consecutive seasons is the largest ever found in the inversion records since c.a. 1980. But, the sparse number of atmospheric stations in the 1980s and 1990s may have diminished the ability of inversions to detect other strong transitions, during some of the previous El Niño and La Niña events. The abrupt transitions in CO2 fluxes diagnosed in this study form an interesting test bed for evaluating ecosystem models and gaining understanding of their controlling processes.

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