Change of CO_2 flux during an early secondary succession after severe forest disturbance

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Forest ecosystems are expected as a major sink of atmospheric carbon dioxide (CO_2), whereas their ability to absorb CO_2 is severely perturbed by disturbances, such as deforestation, fires, windthrow etc. Many studies which adopted the chrono-sequence approach reported that such severe disturbances often changed forest to be a CO_2 source. However, there are few studies that directly measure CO_2 flux for a long term (more than 10 years) above a disturbed forest site during an early stage of secondary succession after severe disturbance.A flux site of a larch plantation in Tomakomai, Hokkaido, Japan was struck by a typhoon in September 2004. Because of wind storm, about 90% of trees fell down. The fallen trees were removed by heavy machinery from the site, through which the soil surface and understory species were also disturbed. After the operations of timber transport, secondary succession progressed naturally in the ex-forest site. We recommenced flux measurement in August 2005. CO_2 flux has been measured by the eddy covariance technique with an open-path CO_2 / H_2O analyzer (LI7500, Licor) during a snow-free period from mid-April to mid-November. Cumulative net ecosystem CO_2 exchange (NEE) during the snow-free period was positive every year until 2015, whereas it showed a negative relationship, which indicates that the CO_2 source strength of the ecosystem decreased. This negative relationship was caused by the increase of gross primary production (GPP) or ecosystem photosynthesis, which corresponded to vegetation recovery through secondary succession.

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