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Tree dynamic behavior with forestry activities and a category-5 tropical cyclone

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Climate change will alter the characteristics of tropical cyclones such as their intensity, trajectory, and frequency, which will lead to more forest damage not only in the current tropical cyclone affected regions but also in the regions where the trees are not acclimated to tropical cyclones. How can we reduce the increasing damage risk to forests due to these changes in tropical cyclones? Do forestry practices help to improve the resilience of forests to strong wind? In this paper, we present our 2-year observations of tree dynamic behavior in planted coniferous forests. This 2-year period included three forest management and weather related interventions to the forests: thinning, clear-cutting (creating a new-edge), and damage by a category-5 tropical cyclone.

In November 2017, we created two research plots in a research compartment consisting of genetically identical *Cryptomeria japonica* trees (full-siblings). One plot was a control, which did not receive any thinning following planting in 2005 (1.8 m between tree spacing; named as the P-100 plot); another was thinned with 50% tree removal in 2017 (3.6 m mean between tree spacing, named as the P-50 plot). We harvested the trees next to the P-50 plot (in the easterly direction), which created a new edge for the P-50 plot. To observe tree displacements, we attached two strain gauge transducers at the tree bases in the north and east directions, and one inertial measurement unit (IMU) sensor at the 6 m height on the tree stem. An ultrasonic anemometer was installed between the two plots and a 3-cup anemometer was installed outside the compartment.

In 2018, a category-5 tropical cyclone (super typhoon Trami) landed in Japan and damaged some of the trees in our plots. Interestingly, we found damaged trees only in the P-50 plot, which suggests that the forestry activities such as thinning might lead to changes in tree stability against strong wind. Our analysis confirmed that the tree and forest “stiffness” required to resist the

strong winds during tropical cyclones is highly dependent on how much support individual trees obtain from their neighbors.

We continued measuring the tree displacement in the P-100 plot after the damaging cyclone until November 2019. There was a new forest edge due to the absence of the P-50 plot and windbreak trees that had been cut down after the cyclone. Focusing on one subject tree in the P-100 plot, the frequencies of the first peak normalized power spectral density (*NPS*) stayed between 0.4 to 0.58 Hz before and during the tropical cyclone; however, the peak *NPS* became unclear in 2019 (after the cyclone and a new forest edge). The newly created edge seems to alter the manner of the tree sway, leading to more complex displacement, even though support from the neighbors remained the same throughout the 2-year period. This possibly represents an acclimation of the trees to their new wind environment.