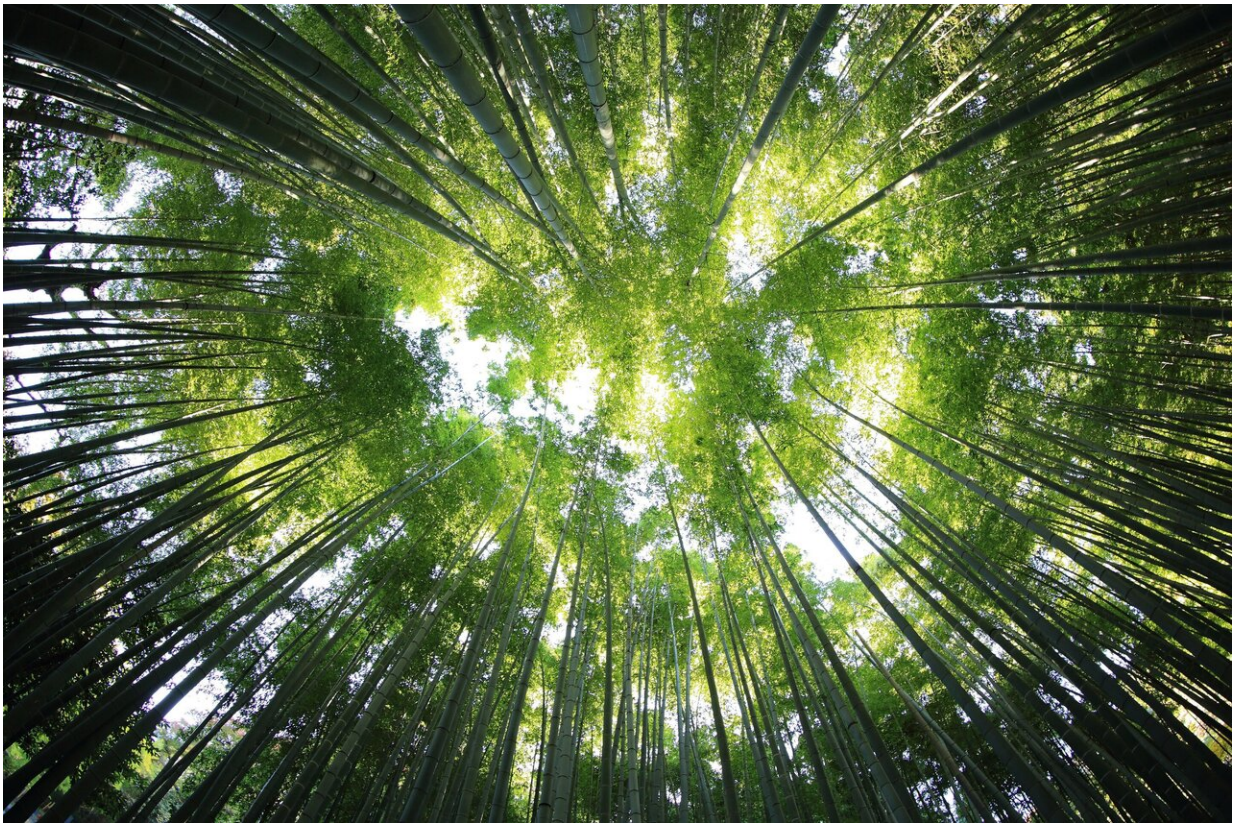
Local mountain climate is affected by leaf area ratio in surrounding forests

September 6 2022



Credit: Unsplash/CC0 Public Domain

The changing seasons tell us much about the workings of nature. Now, a research group from Japan has discovered that the seasonal changes of tree leaf growth and shedding can have a big influence on climate even

on small, local scales.

Forests act as intermediaries between the atmosphere and land, reducing surface wind speeds and controlling surface heat budgets, as well as indirectly affecting cloud formation and the energy-water cycle. The forest canopy protects the forest floor from sunlight and reduces diurnal variations in surface air temperature. These effects may alter not only forest ecology, but also the surrounding microclimate. For mountain forests, the effects of global climate change on phenology (periodic biological events, e.g., flowering, in relation to climatic conditions) have been shown, such as an extended growing season for deciduous forests. Changes in forest phenology could also alter local circulation and heat budgets of the low-level atmosphere in surrounding environments.

"However, previous studies have not fully considered the contribution of mountain forests to the nocturnal local climate in downstream areas," says senior author of the study, Professor Kenichi Ueno. "This is what we set out to investigate."

Specifically, the researchers sought to clarify the effects of leaf expansion (the stage in deciduous plant phenology where leaves expand from buds to mature leaves) on nocturnal temperature inversion (NTI) in mountain basins. NTI is a key factor that characterizes the local climate in mountainous areas, and much of the mountain slopes in central Japan are covered by deciduous forests.

The research team conducted a three-year study of leaf area index (LAI) at a mixed-forest mountain slope site in a small basin. They observed sudden shifts in the development of the nighttime cold-air pool over the basin that were related to leaf expansion and leaf fall. Specifically, they found weakening of the NTI related to leaf expansion, and strengthening after leaf fall. On the basis of these relationships, the researchers concluded that changes in LAI influenced seasonal changes in the

development of the nighttime cold-air pool.

"Our results indicated that changeability in daytime forest heat storage can offset nighttime radiative cooling from the forest canopy," says Professor Ueno. "In short, our research has revealed that the cycle of tree leaf growth and leaf shedding in mountain forests has an observable effect on the local climate."

The results of this study will be applicable to research on the effects of mountain forest processes on nearby areas, such as downwind locations in which human activities are focused, which has important implications for how agricultural areas are designed, and on long-term mountain meteorological records. Future studies are expected to assess the effects of forest phenology of mountain areas on inland nocturnal climates.

More information: Kenji Kusunoki et al, Development of a Nocturnal Temperature Inversion in a Small Basin Associated with Leaf Area Ratio Changes on the Mountain Slopes in Central Japan, *Journal of the Meteorological Society of Japan. Ser. II* (2022). DOI: 10.2151/jmsj.2022-047

Provided by University of Tsukuba