

Rising clouds leave forests high and dry

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The base of clouds that form over the north-eastern states of the US have been getting ever higher over the past 30 years. It is a change that could severely disrupt forests in the Appalachian Mountains.

Rising cloud ceilings have been spotted before in other parts of the world. In 1999, scientists found that clouds in the Monteverde cloud forests of Costa Rica were not forming as far down the mountains as they once did.

This effect was initially attributed to rising sea temperatures in the Caribbean, caused by global warming, but in 2001 Robert Lawton of the University of Alabama in Huntsville reported that the main driving force behind the change was warmer, drier air moving up from the lowlands, which had been cleared of trees. The rising cloud ceiling has seriously damaged the cloud forest ecology, causing an alarming decline in populations of toads and frogs.

Now Andrew Richardson of Yale University in New Haven, Connecticut, and his colleagues have uncovered a similar trend in the temperate Appalachian ecosystem. The study was prompted by an intriguing observation by team member Thomas Siccama in the 1960s, when he regularly travelled through the mountains. "He noticed that in the fall, a lot of the time the clouds were at a level that coincided with the change from deciduous to coniferous forests," says Richardson.

Concerned about the effect of a rising cloud ceiling on this forest boundary, the researchers examined data from 24 airports located along the south-west to north-east axis of the Appalachians. Airports routinely measure the cloud ceiling because it is important to pilots.

Richardson's team found that in the 18 most northerly airports, the cloud ceiling has climbed an average of six metres per year since 1973. "Over 30 years, that's 180 metres, which is about six tree heights," says Richardson. "It is pretty stunning."

Scavenged water

With the cloud base moving up, many spruce and fir trees will not be able to scavenge water from the clouds. "That's got all sorts of implications for hydrology in the mountains," says Richardson. Normally, the scavenged water drips down to the forest floor, but if this supply began to run dry it would immediately affect moisture-loving animals such as toads and salamanders.

If the trend continued, broad-leafed deciduous trees such as sugar maple and yellow birch could move up the slope, visibly shifting the deciduous-coniferous boundary. The study is due to appear in a future issue of the *Journal of Climate*.

Roger Pielke, a climatologist at Colorado State University in Fort Collins and a member of Lawton's team, says that deforestation and urbanisation in the north-eastern US may be causing the cloud ceiling to rise, just as in Costa Rica, because both changes lead to warmer air that has to rise higher before it condenses.

Cleaner air, containing a lower level of particulates, may amplify this effect. Particulates normally act as condensation nuclei, encouraging clouds to form at lower altitudes.

Pielke cautions that because the research data comes from airports, it may be unduly influenced by the local effects of urbanisation. "But these are real trends," he says. "If they actually occurred in the



mountains, they would be of concern."

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