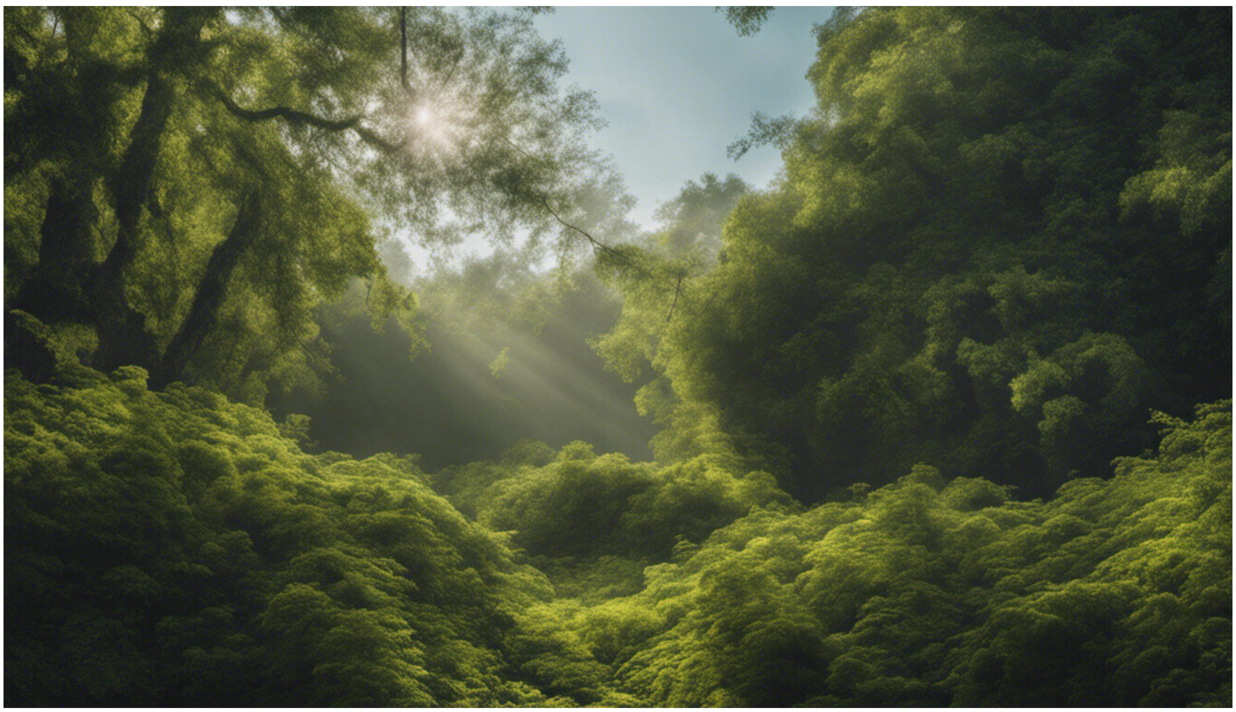
The interaction between vegetation and clouds

March 13 2014



Credit: AI-generated image (disclaimer)

Jordi Vila and colleagues just published an article in *Geophysical Research Letters* on interactions between plant evapotranspiration, controlled by photosynthesis, and moist thermals responsible for the formation of shallow cumulus clouds. "As far as we know, this is the first time that we have explicit simulations of fair weather clouds coupled to a dynamic vegetation model," Jordi says.

Jordi Vilà, Huug Ouwersloot and Cor Jacobs (Meteorology and Air Quality chair group, and Alterra) conducted their research on the interaction between plants and clouds together with Dennis Baldocchi (University of California, Berkeley). Jordi Vila: "In our research, we explicitly simulate the effect of cloud shading on evaporation via its links to photosynthesis and the stomatal adjustment time to changing light conditions. We then assess how this effect influences the cloud characteristics over different kinds of vegetation. For example, we further investigate the influence of shading in a region covered by maize, which is a C4 plant (see note below), compared to C3 grasses. We found that maize favours the formation of clouds compared to the grasses for typical Dutch summer weather conditions."

These computational expensive numerical experiments captured the relevant processes for the interactions between vegetation and atmosphere, which are characterized by temporal scales ranging from seconds to hours. Turbulent thermals transporting moisture in the atmospheric convective boundary layer control the dynamics associated to fair weather clouds. Over land that is mainly covered by vegetation, these thermals strongly depend on the partitioning of the available energy into the fluxes of heat and evaporation. Photosynthesis affects this partitioning due to the intimate link between CO2 uptake and the water loss of the plants. In consequence, these surface processes play a key role in the transition between clear to cloudy boundary layers, and the further development of deep convection that may ultimately lead to precipitation.

The findings of this research are based on a series of systematic numerical experiments at fine spatial and temporal scales using large-eddy simulations (see note below), that are explicitly coupled to a plant-physiology model. Jordi Vila: "We found that the shading by shallow cumulus clouds leads to strong spatial variability in photosynthesis and the surface energy balance. This in turn results in fair weather clouds characterized by less extreme and less fluctuating values of the cloud liquid water content. The larger water-use efficiency of C4 plants, like maize, leads to two opposite effects that influence fair weather clouds: more vigorous and deeper thermals due to the larger surface buoyancy flux (positive effect) that are characterized by less moisture content (negative effect). Our numerical simulations show that under atmospheric conditions typical for mid-latitude summers and well-watered vegetation, fair weather clouds are more abundant and deeper over maize than over C3 grassland.

More information: Vilà-Guerau de Arellano, J., H. G. Ouwersloot, D. Baldocchi, and C. M. J. Jacobs (2014), "Shallow cumulus rooted in photosynthesis," *Geophys. Res. Lett.*, 41, DOI: 10.1002/2014GL059279.

Provided by Wageningen University