Scientists discover how forest fires influence rain cloud formation in the Amazon

October 27 2021, by Thais Szegö

Particles released into the atmosphere by fire modify the water droplet freezing process and can affect precipitation, according to a paper in *Communications Earth & Environment*. Credit: Agência Brasil

A Brazilian study published in the journal *Communications Earth & Environment* shows how wildfires and forest burning for agriculture influence rain cloud formation in the Amazon. According to the authors, aerosols (tiny solid particles and liquid droplets emitted into the atmosphere by fire) hinder the freezing of cloud droplets when the atmosphere is humidified, but can also promote freezing when the atmosphere is dry. This alters the natural functioning of clouds and their

typical height, and may also affect precipitation and the amount of sunlight reaching the ground.

To arrive at this conclusion, the scientists used a large dataset collected over a 15-year period, from 2000 to 2014, involving satellite imagery from the United States National Oceanic and Atmospheric Administration (NOAA), measurements of atmospheric aerosols from fires made by NASA's Aerosol Robotic Network (AERONET), and reanalysis data from the European Center for Medium-Range Weather Forecasts (ECMWF). Reanalysis data provides the most complete picture currently possible of past weather and climate, blending observations and past forecasts rerun with modern forecasting models, according to ECMWF.

The satellite images and reanalysis data covered the entire Amazon region. The aerosol data referred to five locations in southern Amazonia: Alta Floresta and Cuiabá in Mato Grosso state; Rio Branco in Acre state; and Ji-Paraná and Ouro Preto do Oeste in Rondônia state.

The purpose of the investigation was to perform an observational study of the temperature at which droplets freeze in convective clouds, which form vertically and can reach heights exceeding 10 km, in order to identify the key drivers of the phenomenon. The presence of ice in clouds is important since it influences the formation of rain and the average time clouds remain in the atmosphere. "The longer clouds last on average, the more solar radiation is reflected back into space, contributing to the cooling of the planet," said Alexandre Correia, a professor in the Department of Applied Physics at the University of São Paulo's Institute of Physics (IF-USP) and first author of the article.

The study was supported by FAPESP. The co-authors were Elisa Sena (Federal University of São Paulo), Maria A. F. Silva Dias (Institute of Astronomy, Geophysics and Atmospheric Sciences, IAG-USP), and Ilan

Koren (Weizmann Institute of Science, Israel).

The findings show that freezing, which in this case occurs not at 0 °C, as it does in our day-to-day lives, but at about -10 °C, depends mainly on a combination of three factors: Atmospheric humidification, solar radiation, and aerosols. In southern Amazonia's rainy season (roughly December-April), the atmosphere is extremely clear and the origin of the particles in the aerosols is natural. They come from condensation of gases emitted by the forest, and from wind abrasion of soil and vegetation. They typically contain pollen, microorganisms and sea salt, among other kinds of particles. In the burning season, which occurs annually in August-October, large-scale fires emit a huge amount of smoke, which spreads throughout the region and is blown by the wind to other regions. "They produce much worse pollution than urban activities in the city of São Paulo, for example," Correia said.

The study is a contribution to the knowledge of the behavior of clouds in the Amazon and can be enriched by further research. "The influence of clouds on the climate is very important. This is the most complex topic in climate models that set out to forecast what will happen with regard to this theme in the future, so any improvement in knowledge of how clouds function is a major contribution to the advancement of climate science," he stressed.

More information: Alexandre L. Correia et al, Preconditioning, aerosols, and radiation control the temperature of glaciation in Amazonian clouds, *Communications Earth & Environment* (2021). DOI: 10.1038/s43247-021-00250-3

Provided by FAPESP