

Bursting the clouds for better communication

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Laser that heats the air over 1,500 degrees Celsius and produces a shock wave to

expel sideways the suspended water droplets that make up the cloud. Credit: UNIGE, Xavier Ravinet

We live in an age of long-range information transmitted either by underground optical fibre or by radio satellites. But the throughput today is so great that radio frequency is no longer enough in itself. Research is turning toward the use of lasers which, although technically complex, have several advantages, especially when it comes to security. However, this new technology, currently in the testing phase, faces a major problem: clouds. Due to their density, clouds stop the laser beams and scramble the transfer of information. Researchers at the University of Geneva (UNIGE), Switzerland, have devised an ultra-hot laser that creates a temporary hole in the cloud, which lets the laser beam containing the information pass through. They have published their results in the journal *Optica*.

Although satellite radio communication is powerful, it can no longer keep up with the daily demand for the flow of [information](#). Its long wavelengths limit the amount of information transmitted, while the frequency bands available are scarce and increasingly expensive. Furthermore, the ease with which radio frequencies can be captured poses ever more acute security problems, which is why research is turning to lasers. "It's a new technology that is full of promise," says Jean-Pierre Wolf, professor in the Physics Section at UNIGE's Faculty of Science. "The very short wavelengths can carry 10,000 times more items of information than [radio frequency](#), and there aren't any limits to the number of channels. Lasers can also be used to target a single person, meaning it's a highly secure form of communication."

But there is a problem: the [laser beams](#) cannot penetrate [clouds](#) and fog. So if the weather is bad, it is impossible to transmit information using

lasers.

A cloud-piercing laser

To counter this difficulty, researchers are building ground stations in various parts of the world capable of receiving [laser](#) signals. The idea is to choose the station targeted by the satellite according to the weather. Although this solution is already operational, it is still dependent on weather conditions. It also creates certain problems regarding the settings on the satellite, which have to be processed upstream of the communication, without any assurance that there will not be any cloud cover at the appointed time.

"We want to get around the problem by making a hole directly through the clouds so that the laser beam can pass through," explains Professor Wolf. His team has developed a laser that heats the air over 1,500 degrees Celsius and produces a shock wave to expel the suspended water droplets sideways. This creates a hole a few centimetres wide over the entire thickness of the cloud. The discovery of these ultra-powerful lasers has just been awarded the 2018 Nobel Prize for Physics. "All you then need to do is keep the [laser beam](#) on the cloud and send the laser that contains the information at the same time," says Guillaume Schimmel, a researcher in the team led by Wolf. "It then slips into the hole through the cloud and allows the data to be transferred."

This "laser cleaner" is currently being tested on artificial clouds that are 50 cm thick but that contain 10,000 times more water per cm^3 than a natural cloud—and it works, even if the cloud is moving. "Our experiments mean we can test an opacity that is similar to natural clouds. Now, it's going to be about doing it on thicker clouds up to one kilometre thick," says Wolf.

"It's also about testing different types of clouds in terms of their density

and altitude," adds Schimmel.

This [new technology](#) represents an important step toward the commercial use of satellite laser communication. "We're talking about possible global implementation by 2025, and our idea is to be ready and to allow countries that are overcast to have this technology," says Professor Wolf.

More information: Guillaume Schimmel et al, Free space laser telecommunication through fog, *Optica* (2018). [DOI: 10.1364/optica.5.001338](#)

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