Mission complete for ESA's OPS-SAT flying laboratory

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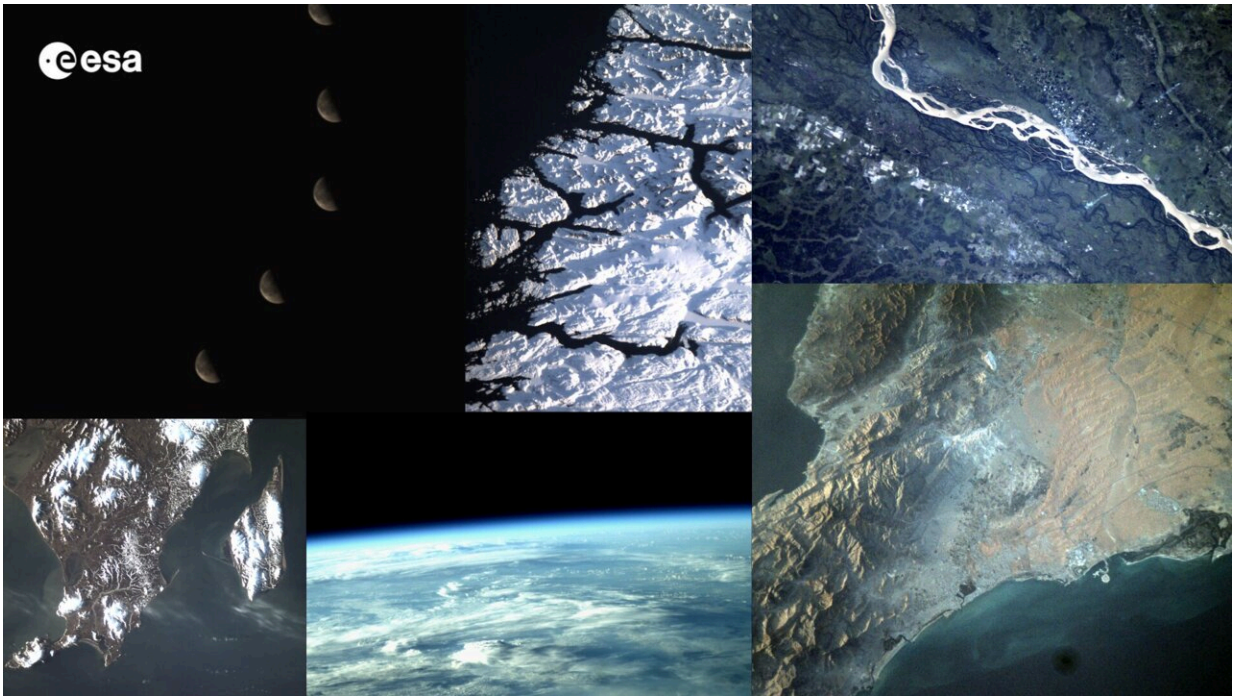

A collage of images taken by the camera onboard ESA's former OPS-SAT mission. Credit: European Space Agency

Launched on 18 December 2019, OPS-SAT was tasked with opening up the world of spacecraft operations to the widest possible audience. Its founding principle was to provide a fast, no-charge, non-bureaucratic experiment service for European and Canadian industry and academia.

It brought experimenters from companies, universities and public institutions across Europe and beyond into the heart of ESA's ESOC mission control center and helped them prove that their new ideas were up to the challenge of flying in orbit.

Flying ESA's most capable and flexible onboard computer, OPS-SAT showed us what future satellites will be capable of as they begin to carry more advanced equipment.

An in-orbit laboratory open to all

OPS-SAT was the first fully ESA-owned and operated CubeSat. A small, low-cost, innovative and open mission was unusual for ESA mission control, which typically flies Europe's largest and most complex spacecraft around Earth and across the solar system.

During OPS-SAT's four and a half years in orbit, the mission went from strength to strength, allowing 134 teams from 26 different countries to execute over 284 different experiments.

"Many experiments built on top of one another, and so the satellite became even more capable as time went on," says David Evans, OPS-SAT Space Lab Manager at ESA. "OPS-SAT was a research lab: Innovations and improvements made by one experiment could often be harnessed by others. If one team worked out a better way to operate the spacecraft's camera, the next could use that to improve their new artificial intelligence algorithm for image processing, for example."

OPS-SAT was the first satellite open to use by the public. It hosted experiments on AI and interplanetary internet and tested new software, some of which is now already in use by much larger missions. It was the first to conduct a stock market trade in orbit; the first to demonstrate that CubeSats can provide life-saving support during search and rescue

activities; the first to demonstrate an active cybersecurity attack in orbit, and much more.

In 2023, the mission received international recognition when the OPS-SAT team shared the SpaceOps Outstanding Achievement award with the team behind NASA JPL's Ingenuity Mars helicopter.

Running experiments to the very end

OPS-SAT was impacted by the recent unexpectedly strong increase in solar activity that began in early 2024. The resulting increase to the drag experienced by the satellite caused it to begin an early descent into the atmosphere.

Teams from ESA and the organizations running the final experiments on OPS-SAT fought hard to maintain communication with the spacecraft as increasing drag threatened to steal away control at any moment. They worked night and day to wrap up the mission's final activities, doing their very best to squeeze out the final drops of science and technology return.

The University of Oxford, U.K., the University of Stuttgart, Germany, and others successfully completed experiments in the mission's final few days, with Hellenic Aerospace Industry (HAI) completing the mission's final experiment just 24 hours before contact with the satellite was lost for good.

"As the satellite descended through the atmosphere, it became much harder to control. The OPS-SAT Mission Control Team and the teams from our experimenters all worked long hours to close out as many of the remaining experiments as possible before the end," says Evans.

"I was particularly happy to see us complete the experiment from

Protostar Labs. It involved the in-flight reconfiguration of the on-board Field Programmable Gate Arrays (FPGA), which is normally regarded as a high-risk procedure that can take months. However, they pulled it off within just a few days and with just 48 hours left on the mission clock!"

"It was also a perfect example of an OPS-SAT experiment. OPS-SAT is all about lowering barriers and providing access to space for new entities. Protostar Labs are a NewSpace company from Croatia—a nation with a young space industry—and are exactly the kind of team that OPS-SAT was developed to support."

As a CubeSat with a size and a mass comparable to a piece of aircraft carry-on luggage, there were no risks associated with OPS-SAT's atmospheric reentry and burn up. But the reentry itself offered a rare chance to gather valuable data.

We have very little information about what exactly happens to spacecraft as they fly through the lower levels of Earth's atmosphere. Understanding how a satellite behaves during its final moments is important for improving how we model and ensure the safety of atmospheric reentries.

With the support of the global radio amateur community, the OPS-SAT team was able to gather and process telemetry from receivers all around the world. These data are now being analyzed, but already promise to provide interesting new insights.

"During the final contact with the satellite as it flew over Australia, we were surprised to see very little internal heating. It must have gone from normal temperatures to burn up in the final few minutes. The impact on the satellite's attitude was more dramatic. As the drag increased, the satellite started spinning like a top about one axis but then re-stabilized

itself. How and why this happened is something we will have to look into."

The end is only the beginning

During the mission, as the number of experimenters increased, the team at ESOC began to spend the majority of their time providing what became the OPS-SAT Space Lab service, which included providing assistance to the experimenters, performing dry runs on the ground, and of course ensuring the safe execution of the experiments in space.

In addition to opening up the experience of ESA mission control to the wider world, OPS-SAT also opened mission control up to the agility, innovation and new ideas of university and industry teams. The concept proved so successful for all involved that "OPS-SAT" will now give its name to a family of future missions that have all agreed to follow the principles of the OPS-SAT Space Lab experiment service.

The OPS-SAT concept has been adopted by the ESA ARTES ScyLight Strategic Program Line for a mission dedicated to testing new optical and quantum communication technologies, called OPS-SAT VOLT. It was designed with in-flight experimentation in mind and 50% of the mission's time will be allocated to experiments coordinated by the OPS-SAT Space Lab. The UK Space Agency have invested 13 million euros in VOLT, and Craft Prospect will serve as the project's prime contractor.

Other proposed missions include OPS-SAT ORIOLE, a joint Hungarian-Estonian proposal to ARTES Scylight, and CYBERCUBE, a cybersecurity demonstration mission managed by the ESA Security Office, that will allow OPS-SAT Space Lab experimentation once the principal aims of the mission have been achieved.

The OPS-SAT Space Lab service will continue to provide an important

and mutually beneficial bridge between ESA, industry and universities across Europe and beyond, for many years to come.

Provided by European Space Agency

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