Science and Technology Facilities Council

STFC Cloud delves into dark energy

Scientists at the Royal Observatory Edinburgh (ROE) are using the Science and Technology Facilities Council (STFC) Cloud for the Euclid space mission. Euclid, which is a European Space Agency (ESA) mission, aims to explore why the expansion of the Universe is accelerating, and the source responsible; dark energy.

STFC Cloud

STFC is a world-leading multi-disciplinary science organisation, with the goal to deliver economic, societal, scientific and international benefits to the UK and worldwide. The STFC Cloud is a dedicated cloud infrastructure which provides access to compute resources for users across STFC and partner organisations. Developed and managed by the Scientific Computing Department (SCD), it's designed to be flexible, allowing many different uses. The STFC Cloud aims to enable users to perform complex data analysis as and when required, without the overheads of running their own computing infrastructure.

Euclid and the STFC Cloud

The Euclid software pipeline requires a High Performance Computing (HPC) environment, a system that connects users' applications and supercomputers from multiple institutions, to run effectively. It also needs a Digital Rights Management server, which sets access control technologies to restrict the use of copyrighted works. Additionally, it needs a job-scheduling system so the STFC Cloud has been used to build a federated cluster – a huge network of servers all working in parallel with each other. This virtual cluster operates like a traditional HPC cluster, and meets the functional requirements for Euclid data processing.

Expansion of the Universe

The space between galaxies is getting bigger, stretching, like dough rising in the oven, and it's doing so more rapidly every second. The mysterious force thought to be causing this, dark energy, makes up around 70% of the energy content of the Universe today. The remainder is 25% dark matter, and only 5% ordinary matter – which makes up everything we can see in the Universe, from the smallest of atoms, to the largest of distant galaxies.

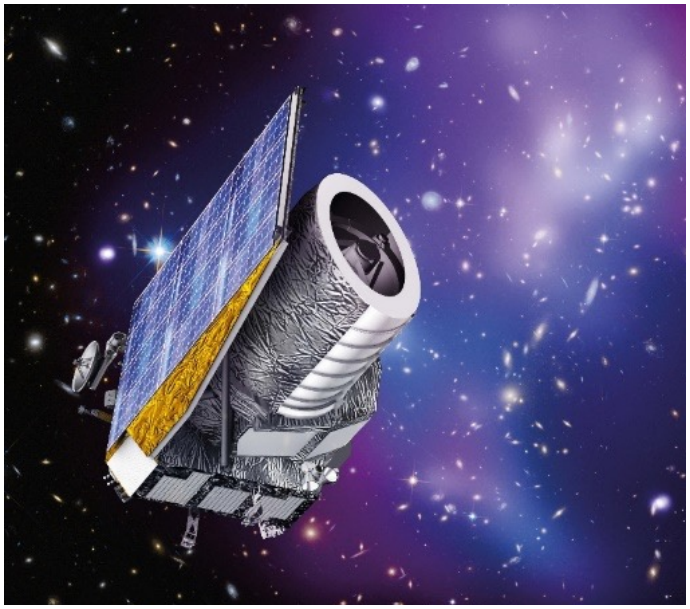

Image credit: ESA

"The main benefit of using the STFC Cloud is accessing significant computing power in a flexible format. This allows us to expand and contract our virtual cluster as needed, as well as deploying different worker node configurations for specific tasks on the fly.

"The STFC Cloud services also make administration easier, allowing us to manage the deployment of our operating environment without the intervention of system administrators."

Mark Holliman, ROE, Euclid mission

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Euclid

Euclid is an ESA astronomy and astrophysics space mission, expecting to launch in 2022. The programme is aimed at understanding why the expansion of the Universe is accelerating, as well as the nature of dark energy, the source responsible for this acceleration.

The Euclid satellite telescope will observe three extremely dark patches of the sky, the Euclid Deep Fields – one located in the northern hemisphere, and two in the southern hemisphere. The Deep Fields will be the subject of the mission's deepest observations, imaging billions of galaxies, and exploring faint and rare objects in our Universe. The largest fraction of the mission's observations is the Wide Survey, which will cover 15,000 degrees outside the Milky Way, more than one third of the entire sky.

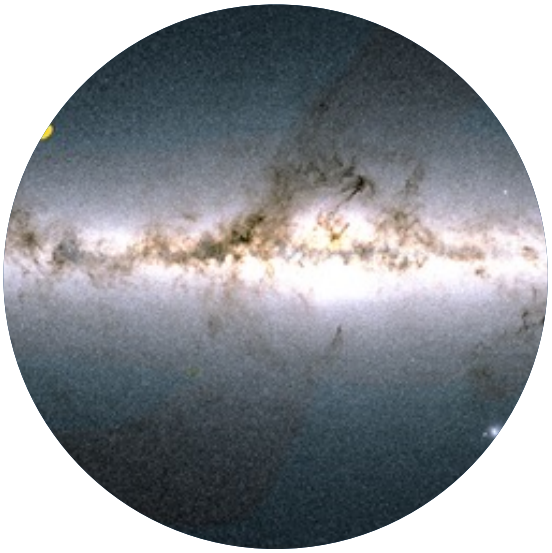

Image credit: Euclid Deep Fields (ESA /Gaia/DPAC)

The observations will enable scientists to investigate two cosmological phenomena: the evolution of how galaxies have clustered together over the past 10 billion years, and the distortion of galaxy images, an effect called gravitational lensing. These two phenomena address the mission's key science goal: delving into the history of the Universe's expansion and characterising the acceleration of this expansion during the last few billion years.

Euclid is using the STFC Cloud for software development tests and simulations. One of these is a sensitivity test simulation, which measures the accuracy of the weak gravitational lensing algorithms. Another is to test the ability of the STFC Cloud for receiving large bursts of data processing, which is likely to occur over the course of the mission.

The images will be analysed by a complex software pipeline, run through the STFC Cloud, to derive science-ready data products for the astronomical community. The UK research team will process some of the hundreds of thousands of images and several tens of Petabytes of data.

The imprints of dark energy will be tracked by using two complementary cosmological probes; Weak Gravitational Lensing and Galaxy Clustering. About ten billion sources will be observed by Euclid, out of which more than one billion will be used for weak lensing and several tens of million galaxy redshifts will be also measured and used for galaxy clustering.

"We would not have been able to carry out our simulations as easily without the STFC Cloud. Ultimately, the entire astronomical research community will benefit as these data products become public."

Mark Holliman, ROE, Euclid mission

Image credit: Euclid Deep Field predicted view (Euclid Consortium)

Contact us:

cloud-support@stfc.ac.uk

www.scd.stfc.ac.uk