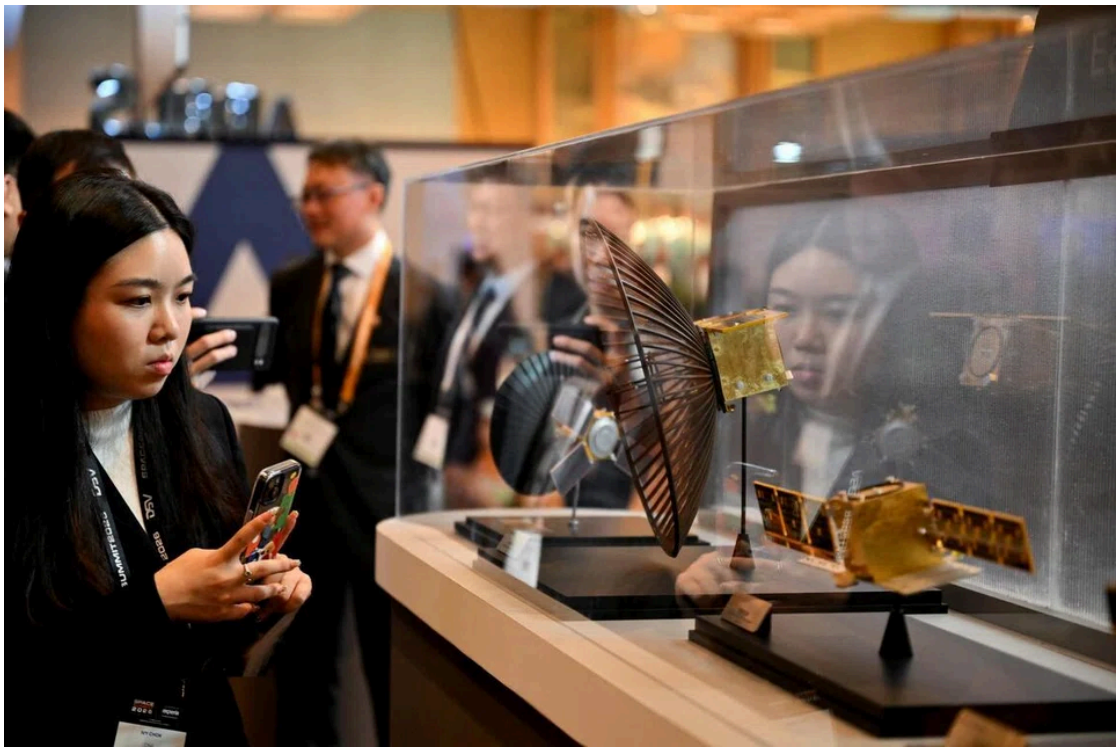
For subscribers

Singapore and space: Why the Equator gives the country a strategic edge

New space agency will sharpen Singapore's focus and coordinate its forays into space.



Satellite models on display at the ST Engineering booth at the Space Summit at Sands Expo and Convention Centre on Feb 2.
PHOTO: REUTERS

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Singapore is a tiny city state in the tropics, without a space port or rocket-building capabilities.

Yet it is placing renewed focus on space. The establishment of the National Space Agency of Singapore (NSAS), announced in

February, marks a pivotal moment in the country's ambitions for the cosmos.

One reason for this is to tap the geographical advantage Singapore gets from sitting almost exactly on the Equator. Climate change is hitting hardest in the tropics. Sea-level rise is among the highest, and extreme rainfall events are intensifying. The equatorial belt is one of the most climate-vulnerable regions on earth.

Singapore is not a new player in the space sector. It has more than 30 locally developed satellites placed in orbit. Domestic satellite engineering capability has steadily matured. Today, small satellites and earth observation systems are already being used to monitor, model and inform climate-related policy decisions in our region.

The key question is whether it can align geography, engineering and policy to create a sustained advantage.

The Equator as strategic advantage

Near-equatorial orbits offer high revisit rates. Satellites pass over the same region more frequently than those in mid-latitude systems. For fast-changing tropical environments, that frequency is critical.

High revisit rates improve flood nowcasting, rainfall estimation and tropical storm tracking. Passive microwave radiometers placed in near-equatorial orbits could significantly enhance weather prediction across South-east Asia, where persistent cloud cover limits optical sensing. More accurate forecasts translate into earlier warnings, better preparation and reduced disruption.

The applications extend further. Imaging satellites can verify carbon credits by monitoring forests and coastal ecosystems to confirm that they are genuinely absorbing carbon. They can strengthen maritime and air traffic management by tracking vessels and aircraft more efficiently. They can monitor crops to detect drought or flooding early, reinforcing food security. They

can also provide rapid damage assessments after earthquakes, floods or volcanic eruptions.

These functions support daily life and economic resilience, even if Singapore's satellites are invisible from earth. For instance, the VELOX-CI tropical climate satellite, built by Nanyang Technological University, Singapore and launched in 2015, showed that compact, cost-effective platforms can generate reliable operational data in orbit. The mission provided tropical weather data that helped refine climate models and validated small satellites as credible scientific tools.

Scientists from the Earth Observatory of Singapore have used such data to deepen understanding of regional atmospheric and climate processes, generating insights relevant to long-term infrastructure planning and urban development. This is accumulated operational experience that has direct benefits for Singapore and the region.

Learning from larger agencies

Larger space agencies provide useful benchmarks in coordination and scientific focus.

The Earth Science Division of the National Aeronautics and Space Administration has shown how science-led missions generate sustained societal and commercial benefits. Landsat has provided continuous earth imagery for more than 50 years, supporting agriculture, forestry and land-use planning worldwide. More recently, NASA's TROPICS mission deployed a constellation of CubeSats to improve tropical cyclone monitoring, demonstrating how smaller satellites can complement flagship missions.

In Europe, the European Space Agency's Copernicus programme unified member states around a coordinated constellation of Sentinel satellites. These provide open-access data supporting environmental monitoring, disaster management and commercial applications. The availability of open data has stimulated innovation across multiple industries.

On the commercial side, SpaceX's Starlink constellation shows how coordinated satellite networks can scale rapidly from concept to operational service. Broadband connectivity now reaches remote communities and polar research stations that previously lacked reliable access.

Singapore does not need similar scale. The relevant lesson lies in focus, coordination and sustained capability under a clear national direction.

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Building on local capability

Over the past three decades, Singapore has built domestic satellite engineering expertise quietly and steadily.

Locally developed small satellites have supported maritime surveillance and ship detection. Earth observation data has contributed to studies of carbon sinks and coastal ecosystems. Aviation and maritime analytics derived from satellite data supports route optimisation in one of the world's busiest transport corridors. Environmental monitoring and disaster response applications continue to expand.

International collaboration is also a key to success. NTU has worked with the Japan Aerospace Exploration Agency to test technologies on the International Space Station (ISS), including evaluating how advanced consumer electronics performs in space

environments. Such work explores cost-effective alternatives to traditional high-cost components.

Deep-tech start-ups such as Zero Error Systems have tested radiation-tolerant modules in space, reducing the weight and cost of electronics that would otherwise require heavy radiation shielding. These efforts reflect growing confidence in Singapore's ability to engineer reliable systems beyond earth.

Remote-imaging satellites can extend this impact by supporting disaster monitoring, guiding relief operations, tracking sea-level change and detecting volcanic eruptions that disrupt air traffic. NSAS can work with universities, for example, to deploy low-cost, yet high-impact missions that address real operational needs.

An advanced camera payload developed by NTU in collaboration with LightHaus Photonic is being prepared for deployment to the ISS. It will demonstrate strong optical imaging performance on a small satellite platform, showing how carefully designed payloads integrated through national programmes can elevate system-level capability.

The next frontier

As satellite constellations expand, operational complexity also rises. Collision avoidance, data-processing demands and solar activity are placing increasing pressure on ground infrastructure.

While artificial intelligence is already widely deployed and commonplace, the next frontier is AI in space.

Through a newly awarded Space Access Programme, NTU is developing and testing an AI module on a nanosatellite to process data directly in orbit. This "edge AI" approach enables satellites to extract useful insights before transmitting data to earth, reducing latency and delivering faster situational awareness.

Future applications can include earlier detection of illegal maritime activity, quicker identification of flood-prone zones and improved monitoring of rapidly developing tropical storms. The

path ahead is clear: Smaller satellites equipped with intelligent onboard processing are shaping the future of space systems. Sustained research and development are thus essential to support this transition and not just reliance on buying off-the-shelf components for AI.

In addition, Singapore needs to go beyond imaging into optical, hyperspectral and emerging sensor technologies. Advances in AI and edge computing can also enhance onboard processing and reduce dependence on ground infrastructure.

An open data policy will also further amplify impact, as shown in the US and Europe. Making satellite data accessible to researchers and entrepreneurs can stimulate innovation across sectors.

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Singapore to set up national space agency on April 1 to develop and run space capabilities

Why NSAS matters now

The Equator offers Singapore a structural advantage. Focused investment in intelligent small satellites, coordinated under NSAS, aligns science, engineering and policy towards clear national objectives.

A dedicated space agency can strengthen continuity across missions and build sustained capability rather than one-off projects. In an increasingly congested satellite space, relevance and speed will determine who remains influential.

Singapore's edge lies in precision engineering, applied science and geography. Anchoring space development in equatorial research and intelligent nanosatellite systems will help with climate

resilience, maritime security and food security. NSAS can provide coordinated direction.

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