HyMS technology is set to reinvent how the world approaches weather forecasting

Global weather forecasting from space has taken a significant step forward with the launch of Spire Global's Hyperspectral Microwave Sounder (HyMS).

Developed in collaboration with the UK Science and Technology Facilities Council's RAL Space, STAR-Dundee Ltd, and JCR Systems Ltd, the highly compact hyperspectral microwave sounder captures detailed internal views of the Earth's atmosphere, measuring important atmospheric variables including temperature, humidity, and precipitation.

The HyMS sensor has been fully integrated into Spire 16U satellites, and nine satellites were launched aboard SpaceX's Falcon 9 Twilight mission in January 2026 to form an observation constellation.

Combined with Spire's established radio occultation (RO) data, HyMS will set new benchmarks for weather forecasting accuracy and deliver an unprecedented update rate for monitoring rapidly evolving weather events. Paired with advanced AI forecasting algorithms, it will improve forecast precision and extend predictive capabilities further into the future.

Spire is the first company to provide hyperspectral microwave weather data across critical temperature and water vapour bands in a satellite. This revolutionary technology will help forecasters better understand how weather systems form and evolve in real time and provide vital global weather nowcasting for a range of sectors, including energy, agriculture, shipping, finance and government.

The importance of HyMS

The weather has a huge impact on global operations from flight safety and maritime routing to energy markets and agricultural output.

Even after decades of investment, accurate, timely forecasting remains one of the world's most persistent challenges. As climate volatility increases, forecasting complexity does too and legacy forecasting models and sparse observational inputs are not sufficient for today's needs. Forecasting's future lies in space-based Earth observation systems, particularly those delivering high-resolution atmospheric profiling from Low Earth Orbit (LEO). Among the most impactful technologies enabling this shift are RO and microwave sounding (MS), and Spire is a global leader in both.

In recent years, with support from organisations like the Centre for Earth Observation (CEOI), Spire has expanded its capabilities in this area with HyMS – a next-generation class of sensors designed to provide deeper, higher-resolution atmospheric insights from orbit.

Visible and infrared sensors are severely limited in their ability to collect meteorological data from LEO when faced with the likes of dense cloud cover or heavy rainfall, but microwave sensors can seamlessly collect data in such conditions. Out of all weather data, they consistently rank the highest impact observations in terms of weather forecast accuracy. Despite their significance, they have been limited in the number of sensing channels they observe. HyMS significantly advances this critical remote sensing technique by collecting data across numerous frequency bands in the microwave spectrum. Spire's hyperspectral sensor samples at fine (narrow) resolution across a broad continuous bandwidth (>16 GHz instantaneously) versus traditional microwave sensors, which sample only select parts of the atmospheric spectrum.

The data collected with HyMS enhances the vertical resolution of atmospheric soundings, enables greater accuracy of temperature and water vapour, and provides greater

This image shows the precise integration of HyMS sounder payloads into Spire satellites, transforming advanced hyperspectral technology into operational, space-based observations that power next-generation weather forecasting.

information about hydrometeors such as rain, snow and ice cloud.
This ground-breaking technology also ensures the resilience of critical meteorological observations against the growing threat of radio frequency interference (RFI) from 5G and future 6G phone networks and telecom service satellites that are moving to higher microwave frequencies next to critical bands. Weather satellites study variables which influence our weather and are critical to our ability to make forecasts, such as rain, snow, water vapour, cloud cover and ice content. However, some 5G networks transmit near a frequency similar to that emitted by water vapour and produce a signal that looks very like the presence of water vapour in the atmosphere which compromises our ability to make accurate forecasts. HyMS tackles this problem through its high-resolution sampling and signal processing methods which detect and filter out unwanted signals from outside sources.
HyMS is also ultra-compact and fits neatly on a 16U Nanosatellite platform. Spire's small satellite constellation of HyMS will enhance our ability to observe the same spot on Earth at faster revisit rates and support the growing need for real-time weather monitoring and forecasting for a range of industries.
For example, HyMS' enhanced solar and wind forecasts will support the energy sector with grid management and its renewable energy production ambitions as experts will know when it is most effective to switch between gas turbines and wind energy.
HyMS will also provide farmers with greater information about weather conditions, allowing them to plant, apply pesticides and fertilisers, and harvest at optimal times and as a result improve crop yields. Advanced notice of extreme weather events, like droughts, floods, heatwaves and storms, will also enable farmers to prevent crop damage by taking measures such as preparing additional drainage systems and avoiding fertiliser applications before heavy rain.

"Spire is the first company to provide hyperspectral microwave data across critical temperature and water vapour bands in a satellite. We're the forerunner on this – even compared to the US and Europe."

Manju Henry
Technical Director, Microwave Technologies at Spire Global Inc

How the CEOI grant helped

CEOI has provided £850,000 to help develop HyMS since 2018. CEOI initially provided around £250,000 to support the HyMS technology development and the creation of a laboratory prototype. This work was completed in collaboration with several UK organisations, including RAL Space, STAR-Dundee Ltd, JCR Systems Ltd and the Met Office. CEOI provided a further £600,000 to support an airborne demonstration of HyMS. In August 2021, a successful airborne engineering trial took place which proved the instrument's flight worthiness. This trial was followed by further airborne measurement campaigns to acquire atmospheric data, the most recent of which took place in July 2025. The success of the airborne trial, supported by CEOI, led to HyMS receiving funding from the UK Space Agency National Space Innovation Programme (NSIP) in 2021-22. This funding enabled the development of the HyMS ultra-compact space borne sensor – about 50 times smaller in footprint than the original airborne sensor – which can be deployed in a constellation of small satellites.
HyMS received a $4 million contract from the US National Oceanographic and Oceanic Administration (NOAA) in September 2022 to fund Spire's in-orbit demonstration of the HyMS-enabled 16U nanosatellites and enhance the value and accuracy of NOAA's Numerical Weather Predictions. In September 2023, Spire was awarded a $4.6 million NASA contract, on behalf of NOAA, to participate in NOAA's Sounder for Microwave-Based Applications (SMBA) Phase-A study.

"We're excited to see HyMS reach orbit and begin delivering new levels of atmospheric insight for the global forecasting community."

Mohammed Belal
Programme Director
Microwave Technologies at Spire Global Inc

In the words of Mohammed Belal

Programme Director, Microwave Technologies at Spire Global Inc

"If you removed microwave sounders from weather forecasting you would have the biggest reduction in forecast accuracy because they can measure within and through the cloud layer. However, despite their significance this technology has been hindered for a long time because it typically flies on very large platforms that cost tens of billions of pounds and take about 20 years from start to launch and operation. As a result, people tend to put very conservative technology on them – you don't rock the boat if you're spending that much money.

At Spire we're trying to buck the curve. We're using the new space small satellites' capability so we can work with commercial launch providers to quickly launch more satellites into orbit that don't cost tens of billions of pounds. Having larger constellations of satellites increases the number of times the same spot on Earth gets observed and improves coverage.

We're innovating and deploying new technology, and this is in part thanks to CEOI's support. CEOI's funding helped us to push towards new boundaries of microwave capability with HyMS. Typically, state-of-the-art sounders will have 24 frequency bands but we have thousands and that means you can better sample the spectrum. As a result, you get more information content from the atmosphere, greater accuracy and you can improve the vertical resolution."

Spire recognises the urgent need for more accurate, timely weather data. That's why the company is pioneering the integration of Hyperspectral Microwave Sounding (HyMS) technology into its satellite constellation, aiming to support critical industries with deeper atmospheric insights and better forecasts.

At a glance

- Approximately **£850,000** provided by CEOI for the development of HyMS
- HyMS is **ultra-compact** and fits on a 16U Nanosatellite platform
- Spire's **hyperspectral sensor** samples at fine (narrow) resolution across a broad continuous bandwidth (>16 GHz instantaneously)
- HyMS sensors offer the ability to detect Radio Frequency sources from the emerging threat of 5G, future 6G, and telecom service satellites that are moving to **higher microwave frequencies** adjacent to critical bands
- A small satellite constellation of HyMS will improve our ability to observe the same spot on Earth at **faster revisit rates**
- After Spire licensed HyMS in 2022, it opened a **new office** in Harwell, Oxfordshire
- **Five full-time members of staff**, supported by **five contractors**, work on HyMS
- Spire works with **several UK-based companies** and consultants on HyMS

Spire's Hyperspectral Microwave Sounder, HyMS, is built to capture detailed internal views of Earth's atmosphere, measuring important atmospheric variables including temperature, humidity, and precipitation.