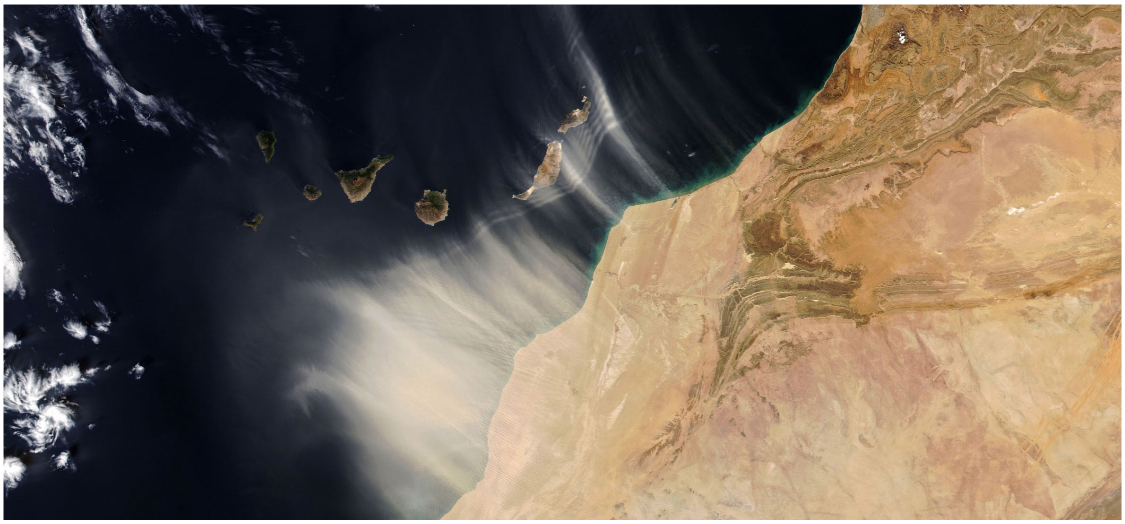
National Aeronautics and Space Administration

Earth Surface Mineral Dust Source Investigation (EMIT)



NASA's EMIT mission studies the composition of surface minerals in Earth's arid regions, helping climate researchers better understand how dust affects climate when it is blown into the atmosphere.

The effects of airborne dust go beyond congesting noses, irritating lungs, and covering windshields with a gritty film. Research has shown that dust can fertilize rainforests and algae blooms while also affecting the rate at which snow melts, and there is more to learn about how dust might affect climate and weather. NASA's Earth Surface Mineral Dust Source Investigation (EMIT) mission aims to advance climate researchers' understanding of those effects.

From its vantage point aboard the International Space Station (ISS), EMIT collects data on the color and composition of the surface of Earth's dry, dusty, windswept regions, which produce mineral dust that can be blown into the atmosphere, traveling thousands of miles with the wind. Darker-color dust tends to absorb more energy from the Sun, heating the surrounding air, while lighter-color dust tends to reflect solar energy back to space, cooling the air around it.

Managed by NASA's Jet Propulsion Laboratory (JPL), EMIT is providing significantly more detail than previously available about the composition and color of surface minerals in the regions of the planet that produce the most dust. Researchers will use this information to refine climate models, which currently can account for the temperature effects of atmospheric dust but rely on assumptions about the dust's color.

EMIT targets 10 key dust-source minerals, each of which responds to light and heat differently. Understanding which substances are prevalent in specific regions will close our current knowledge gap and help researchers to better understand whether dust moving through the atmosphere has overall heating or cooling effects on global and regional scales, and if so, how large these effects are. Heating and cooling can influence the temperature of the atmosphere, which, in turn, can affect where and when precipitation occurs. The EMIT data is filling a key gap in researchers' understanding the role of dust in Earth's climate system.

EMIT launched July 14, 2022, aboard the 25th SpaceX Commercial Resupply Services mission (CRS-25). It was installed on the underside of the space station on ExPRESS Logistics Carrier 1 (ELC1), and is expected to remain on the space station for more than 12 months.

Science Goals and Objectives of EMIT

1. To acquire remote-sensing measurements of the abundance of surface minerals — namely, hematite, goethite, illite, vermiculite, calcite, dolomite, montmorillonite, kaolinite, chlorite, and gypsum — in arid regions between 50-degree south and north latitudes in Africa, Asia, North America, South America, and Australia

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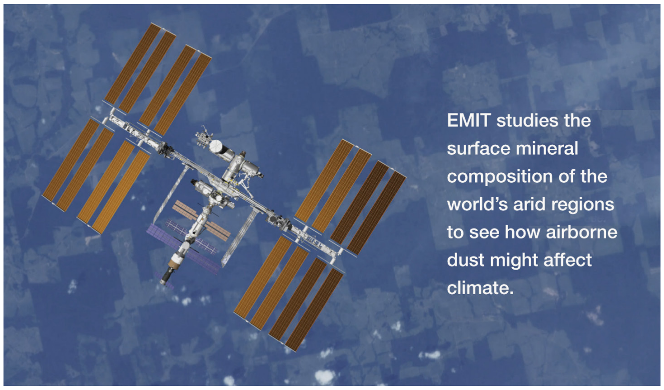
2. To deliver an improved assessment of the heating and cooling effects of mineral dust in Earth's atmosphere
3. To improve predictions of how future climate scenarios might change the amount and type of mineral dust emitted into Earth's atmosphere


EMIT studies the surface mineral composition of the world's arid regions to see how airborne dust might affect climate.

The Science of Dust

Millions of tons of dust from Earth's most arid, sparsely vegetated regions are swept up by wind and blown around the globe every year. Dust varies in composition, typically sharing the same mineral and chemical makeup as the rocks and dirt in the places it originates. Depending on that composition, it has different colors: Iron-rich dust is typically dark red and tends to absorb more energy, while clay-rich dust is pale yellow or white and tends to be more reflective. The effect of this phenomenon on atmospheric temperatures is called radiative forcing.

There's a lack of data on which varieties of dust predominate in the planet's most dusty regions. Most of the sampling stations around the world that provide dust data are in agricultural areas, where the data collected has direct applications for farming. Dust-producing regions —deserts mostly — don't support agriculture, so sampling there is infrequent.

Much of researchers' knowledge of dust characteristics comes from fewer than 5,000 analyzed mineral samples, so researchers must make assumptions about dust composition in their models; often dust is modeled as yellow, the average color of all dust on Earth. As a result, there is significant uncertainty in climate models as to whether, for example, dust has a net cooling or warming effect on the planet.

By more precisely accounting for the color and composition of dust in climate models, researchers hope to understand the effect dust has on the regional and overall temperature of the planet.

The Science Instrument

From the outside, EMIT is a metal box about the size of a minifridge, with an oblong opening on one side that faces Earthward from the space station. Reflected sunlight enters through the opening into the instrument's telescope, where two highly polished, silver-coated mirrors direct the light into a state-of-the-art imaging spectrometer, which analyzes light reflected off distant objects to determine what they are made of, down to the molecule.

In the spectrometer, light passes through a calcium fluoride lens called a Dyson block. The lens focuses the light onto a specially shaped reflection grating whose microscopic grooves divide the light rays into hundreds of distinct colors and direct them to a detector array.

The detector array has 1,280 columns aligned with the flight direction of the space station. With 480 light-sensing elements, each column is effectively its own spectrometer that records visible to short wavelength infrared (VSWIR) light as the instrument orbits over arid dust-source zones.

Over the course of its mission, EMIT will collect more than 1 billion usable measurements — each a snapshot of the color and composition of a roughly 200-foot-by-200-foot (60-meter-by-60-meter) patch on the surface, an area about the size of a soccer field.

Project Team

EMIT is a principal investigator-led competed mission selected under the Earth Venture Instrument solicitation by the NASA Earth Science Division. EMIT's principal investigator is Robert O. Green of JPL; the deputy principal investigator is Natalie Mahowald of Cornell University in Ithaca, New York. The project manager is Charlene Ung of JPL.

Mission Partners

EMIT was developed at JPL, which is managed for NASA by Caltech in Pasadena, California.

SpaceX transported the instrument to the space station aboard CRS-25.

The Aerospace Corp. supported thermal design; Alpha Data Inc. developed key elements of the onboard digital processing subsystem; Arizona Optical Systems developed elements of the telescope; Mercury Systems Inc. developed the solid-state data recorder; Northrop Grumman Space Systems constructed the Heat Rejection System; Optimax produced the calcium fluoride Dyson lens; Sierra Lobo was responsible for mechanical design and development; Southwest Research Institute was responsible for key electronics fabrication and delivery; Teledyne Imaging Sensors developed the detector array; Thales Cryogenics developed the cryocooler; Viavi Solutions Inc. provided the order-sorting filter.

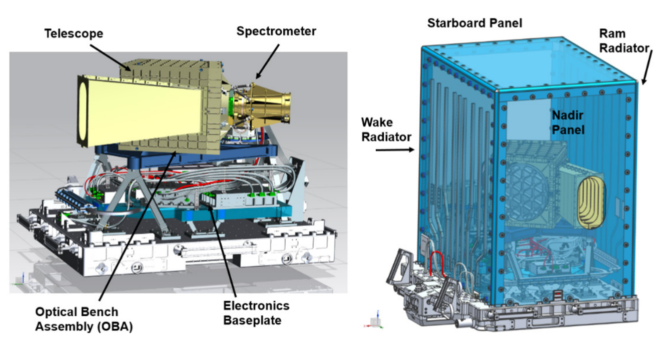


Diagram of the EMIT instrument that was installed on the International Space Station on July 24, 2022.