# FactSheet

National Aeronautics and
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# GIFTS: A New Way to Observe Weather and the Changing Atmosphere

Weather forecasts give us a "best guess" of storm formation and movement. Storms are complex and have changing atmospheric variables such as temperature, wind, and moisture. The key to weather prediction lies in accurately measuring these variables and feeding the data into numerical models that can predict changes in the atmosphere.

Considering the difficulties of forecasting atmospheric variables, it is not surprising that predictions sometimes differ from what actually occurs. Accurate predictions are valuable; ones that go astray can be costly in terms of property loss and, sometimes, human life.

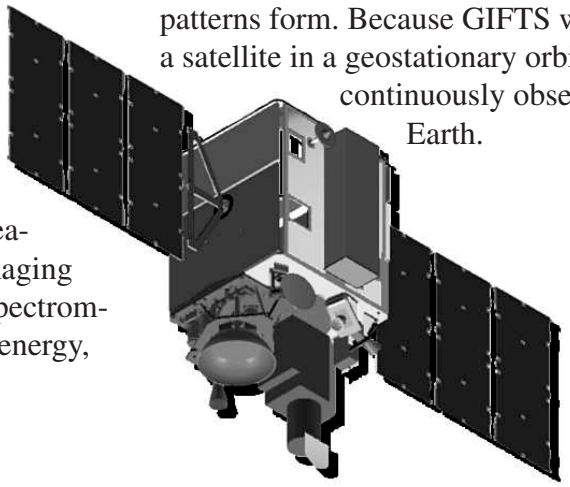
Soon, new measurements made by remote sensing instruments using advanced technologies should radically improve weather and climate predictions. Remote sensing is the science of detecting and measuring phenomena without coming into contact with it.

NASA Langley Research Center (LaRC) has teamed with the University of Wisconsin-Madison, the Space Dynamics Laboratory (SDL) of Utah State University, and the National Oceanographic and Atmospheric Administration (NOAA) to develop a new measurement concept known as Geostationary Imaging Fourier Transform Spectrometer (GIFTS). (Spectrometers look at different wavelengths of radiant energy, or the spectrum, to make measurements.)

Upon completion of a successful GIFTS mission, highly detailed information about temperature, water vapor (water in its gaseous state), and winds will be available to aid in the observation and prediction of severe weather conditions and to extend the range of global weather forecasts. This new capability will also allow scientists to monitor and predict the path of undesirable chemical pollutants (e.g., carbon monoxide and ozone) that affect air quality.

## What is GIFTS?

GIFTS, led by LaRC, is an innovative, economical approach for continuous observation of Earth's surface and atmosphere from geostationary orbit (22,000 miles above the Earth). Current observation instruments are mounted on airborne platforms and low Earth orbiting satellites. These satellites pass close to Earth and can see only a small region at a time. They cannot monitor a region long enough to see weather patterns form. Because GIFTS will be mounted on a satellite in a geostationary orbit, it will be able to continuously observe large areas of the Earth.



**GIFTS instrument on a satellite.**

GIFTS uses an advanced instrument called an Imaging Fourier Transform Spectrometer to observe atmospheric temperature, water vapor content and distribution, and the concentration of certain other atmospheric gases present at a given altitude over time. By noting changes in temperature, water vapor, and gases that modulate energy in different spectral bands (regions or intervals of the electromagnetic spectrum), scientists will get a very accurate picture of what is happening and what weather is likely to develop in the atmosphere.

Producing an image of the atmosphere that can be examined at many altitudes is a key advantage of the Imaging Fourier Transform Spectrometer. For example, if a scientist wants to see the amount of water vapor in a given area, the instrument's data can be used to analyze only the water vapor, to the exclusion of all other variables.

**This series of images illustrates how GIFTS "selects" a particular atmospheric variable at a certain "depth." In this case, it is the CO2 in the man's breath.**

## GIFTS' Place in NASA's New Millennium Program

GIFTS is part of the NASA New Millennium Program (NMP). NMP was created to identify, develop, and space-test breakthrough measurement techniques and technologies that will enable new capabilities or significantly lower costs of existing capabilities for science missions in the 21st century.

The GIFTS mission, scheduled for launch in 2004, is the first step toward incorporating technological breakthroughs into the next generation of operational weather observing systems.

GIFTS will include advanced technologies in imaging spectrometry, active cooling, fast data processing, pointing and control, radiation protection, and lightweight materials.

Testing and validation of the technological breakthroughs need to be conducted in space. The space demonstration will use GIFTS' new techniques to gather water vapor, temperature, and cloud data. At the same time, measurements will be taken on the ground and from aircraft (for comparison) to confirm the accuracy of GIFTS measurements.

## A Key to Improved Weather Predictions

Water vapor absorbs energy emitted from Earth. Water vapor reaches the atmosphere through the evaporation of ocean and lake water. Clouds form when water vapor is cooled by being lifted or by being forced upward as the air flows across higher terrain. Water vapor and clouds have a very strong influence on Earth's climate system. When water vapor transforms to a cloud, energy is produced that fuels severe weather such as tornadoes and hurricanes.

GIFTS key advancement will be its ability to track the three-dimensional (3-D) movement of water vapor through the atmosphere.

## Atmospheric Winds: The Power of Severe Storms

GIFTS will provide hourly updates of wind movement and water vapor within selected vertical layers of Earth's atmosphere. These updates will prove extremely valuable to meteorologists analyzing severe weather systems, particularly the development and movement of intense weather. A similar water vapor tracing approach is used now with current weather satellites, but it only provides winds in a single vertical layer high in the atmosphere.

## Atmospheric Chemistry: The Beaker in the Sky

GIFTS will also measure the transport of pollutant gases such as those discharged during volcanic eruptions, forest fires, and industrial emissions. Following the emissions trail has become a high international environmental priority and provides another important application of GIFTS' technology.

## How Will GIFTS Improve Weather Forecasts?

The NOAA National Weather Service can achieve improvements in weather and climate observation, analysis, and prediction by using GIFTS' high resolution atmospheric and wind data. NOAA is committed to evaluating GIFTS' temperature, moisture, and tracer wind profile products to assess their operational benefits.

## How Will GIFTS Benefit the Airline Industry?

GIFTS is especially interesting to the airline industry because its technology will enhance forecasts, making it easier to track potential weather hazards that threaten flight safety. Better wind data should also help lower aircraft fuel consumption through improved flight route management.

American Airlines will help test GIFTS products for airline operations. NASA's Aviation Safety Program, a project created to reduce the threat of weather-related aviation accidents, will also benefit from GIFTS technology. Led by LaRC, the program develops and supports products for use by government and industry pilots, dispatchers, airline meteorologists, and air traffic controllers.

## Summary

GIFTS will provide accurate measurements of atmospheric water vapor distribution and its transport. The lack of information about the distribution of water vapor in the atmosphere limits the ability of weather and climate models to predict the future state of the atmosphere. The accuracy and reliability of climate models will be greatly improved as current problems in resolving the global water vapor distribution and variability are solved by the implementation of GIFTS technology.

The information, temperature, water vapor, clouds, and pollutant gases then will be fed into numerical models used for weather prediction. With GIFTS data, short-term severe weather forecasts should be greatly improved. Also, GIFTS should enable improved accuracy of current three-day weather forecasts and extend the duration of accurate weather forecasts to five days by the end of the decade.

## Related Information and References

NASA's total mission cost, including launch, is expected to be approximately $105 million.

For more detailed information about GIFTS, see **http://danspc.larc.nasa.gov/GIFTS**.

Information regarding NASA's Earth Science Enterprise is available at **http://www.earth.nasa.gov.**

See **http://nmp.jpl.nasa.gov** for more information on NASA's New Millennium program.

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