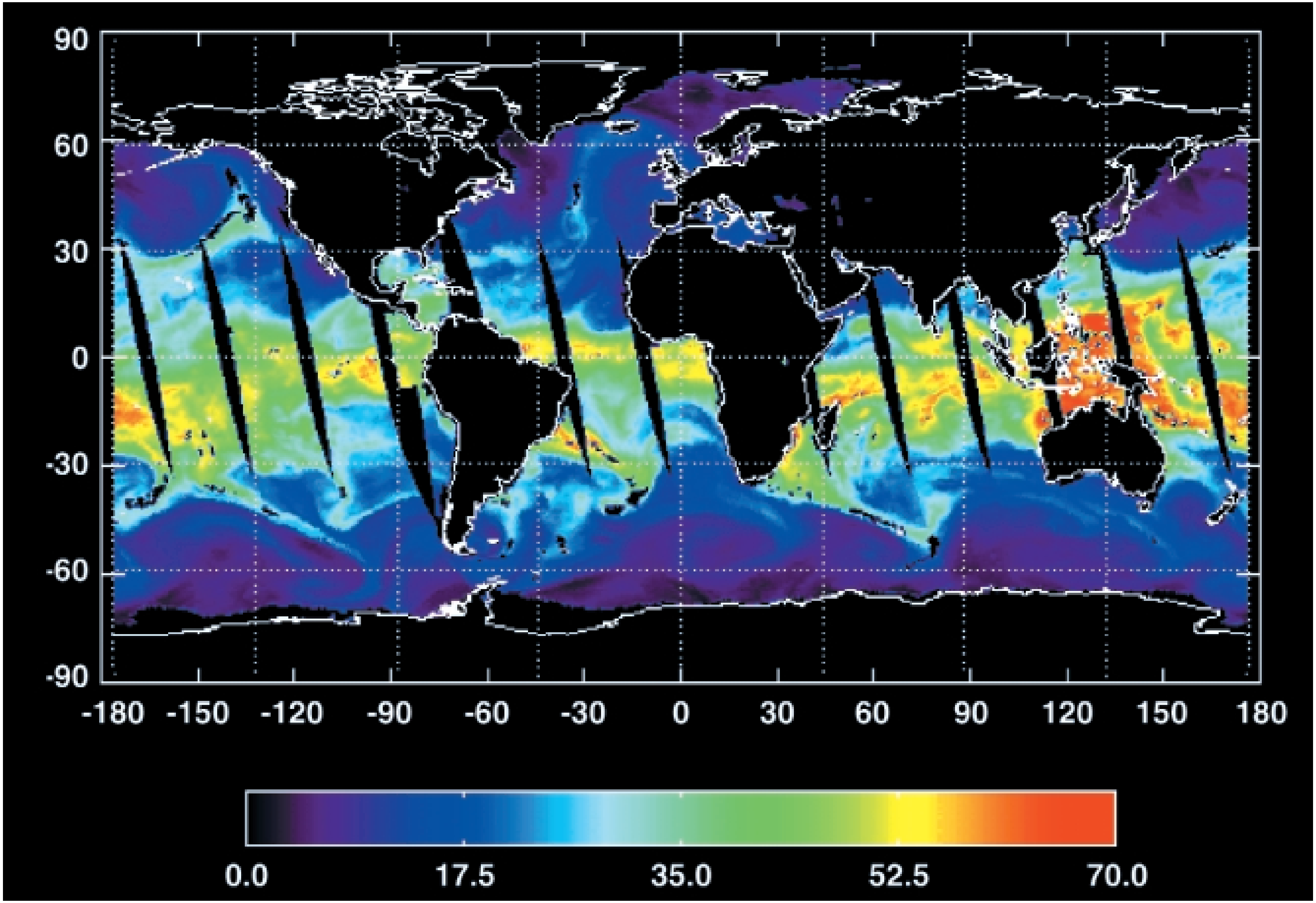
National Aeronautics and Space Administration
Goddard Space Flight Center

TOTAL PRECIPITABLE WATER

National Oceanic and Atmospheric Administration



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Scene radiance data obtained from the Advanced Microwave Sounding Unit (AMSU)-A instrument is used along with data obtained from the High Resolution Infrared Radiation Sounder/3 (HIRS) to produce a new suite of microwave-based surface and hydrological products, including global atmospheric temperature profiles from the Earth's surface to the upper stratosphere, about 48 kilometers or 29.8 miles and humidity profiles to about 12 kilometers (7.5 miles). Among these products are total precipitable water (water vapor), cloud liquid water, rain rate, snow cover, and sea ice concentration, which are generated under all weather conditions and where traditional visible and infrared instruments have decreased capability. These products are useful in studying the Earth's hydrological cycle – the process by which precipitation falls, eventually turns into vapor, and then returns to the atmosphere. The AMSU-B is designed to allow the calculation of vertical water vapor profiles from the Earth's surface to about a 200-millibar pressure altitude (12 kilometers or 7.5 miles).

The AMSU-A and -B, which fly on all NOAA polar-orbiting satellites, continuously scan the Earth's surface and the atmosphere, measuring naturally emitted microwave signals radiated by the Earth's surface and atmosphere. The microwave energy measured by the AMSU-A is at 15 channels, which range from 23 gigahertz (GHz) to 89 GHz. The AMSU-B measures microwave energy at five channels from 89 GHz to 183 GHz. This array of energy responds to changes in the Earth's surface and atmospheric conditions and allows for the generation of surface and hydrological data products. The information from the AMSU instruments is used in a wide variety of meteorological applications including monitoring global rainfall patterns, studying hurricane intensity and track, and in weather forecast models.

Shown is an image of the total precipitable water field (water vapor in the atmosphere) derived from NOAA-15's AMSU-A on March 3, 2000, with values ranging up to 70 millimeters (2.8 inches), as represented by the scale at the bottom of the image. These values indicate the depth of moisture in the atmosphere if it was condensed from a gas to its liquid state. Note how the moistest air is located in the tropical regions of the Earth. The black diagonal lines in the image represent the areas outside the instrument's scan width, which is approximately 2300 kilometers (1426 miles). Each part of the image between the black lines shows a composite that was obtained from the 23.8-GHz and 31.4-GHz channels on the AMSU during various orbits around the Earth. The land masses in this image appear black because the total amount of water vapor can be reliably obtained only over ocean surfaces. Over land, other channels can be used to obtain upper atmospheric water vapor, rain rate, and snow cover data.

Since the 1960s, NASA and NOAA have been actively engaged in a cooperative program to develop and launch the NOAA Polar Operational Environmental Satellites (POES). NASA's Goddard Space Flight Center in Greenbelt, Maryland, is responsible for the construction, integration, and verification testing of the spacecraft, instruments, and unique ground equipment. The U.S. Air Force provides the Titan II launch vehicle. NASA checks out the satellite on-orbit performance to assure it meets its requirements. NASA turns operational control of the spacecraft over to NOAA after a comprehensive subsystem checkout.

These spacecraft monitor the entire Earth, providing atmospheric measurements of temperature, humidity, ozone and cloud images as they track weather patterns that affect the global weather and climate. The satellites send millions of global measurements daily to NOAA's Command and Data Acquisition stations in Fairbanks, Alaska, and Wallops Island, Virginia, and to its data processing center in Suitland, Maryland, adding valuable information to forecasting models, especially for ocean areas, where conventional ground-based data are lacking.

Currently, NOAA has two operational polar orbiters: NOAA-16, launched in September 2000, into a 2:00 p.m. local solar time orbit and NOAA-15, launched in May 1998, into a 7:30 a.m. local solar time orbit. NOAA-M will replace NOAA-15 in a 10:00 a.m. local solar time orbit. The new 10:00 a.m. orbit will allow NOAA-M to carry the same instruments as the 2:00 p.m. satellite (both cross the equator two hours away from noon), and allows for the generation of the same product suite from each orbit.

NOAA-M is scheduled to be launched in the summer of 2002 will be renamed NOAA-17 after achieving orbit. The satellites receive a letter designation while under construction on the ground and are then renamed with a numerical designation after launch. This is done because the satellites are built in alphabetical order but are not necessarily launched in this same order. Therefore, to avoid confusion, they are numbered upon reaching orbit.

More information on the POES program can be found on the Internet at http://poes.gsfc.nasa.gov and at http://www.osd.noaa.gov/POES/index.htm.

For the Classroom

One of the most vital tools scientists use to study the atmosphere is remote sensing. In this "long distance seeing" that will be performed by NOAA-M, researchers will use infrared, microwave, and visible spectral data to trace weather patterns and to image cloud cover. To be effective and provide the most accurate results, remote sensing must be performed over a long period of time. NOAA-M will collect data for at least two years and probably longer.

Why must these investigations be so comprehensive and continue for a long period of time? Try this investigation to find out.

Materials Needed:

Notebooks, pencils, paper, graph paper, if available, an instant camera or video camera, with film or videotape

Procedure:

Count the number of students at a central location in your school cafeteria or gym for a 1-minute period several times a day. You can do this by taking a photograph of the cafeteria or gym or by stationing yourself there and counting the number of students that you see. Draw a graph with the times shown on the horizontal axis and the numbers of students on the vertical axis.

Questions:

1. Is there a noticeable difference in numbers of students at various times?
2. Could you make accurate statements about how many students use the cafeteria or gym by looking at the results of only a single observation?
3. What does this tell you about the need for long-term observations from space?

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