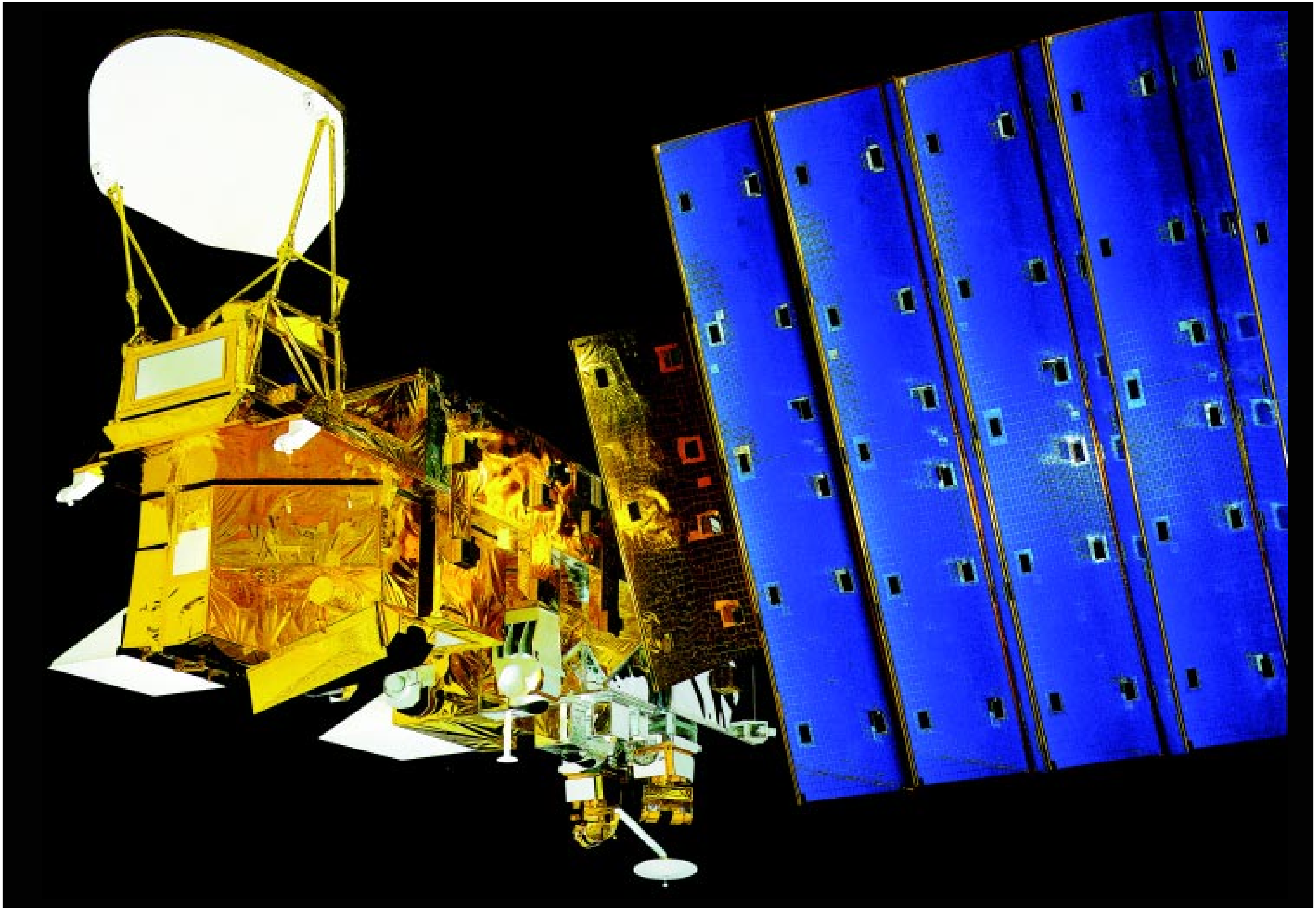
Aqua



National Aeronautics and
Space Administration

Goddard Space Flight Center

Aqua

Background

The Aqua mission builds on NASA's long history of studying the Earth and its atmosphere from the impressive perspective of space. NASA scientists and others have been doing such studies since the 1960s, and the efforts by now have matured to the point where many Earth science elements are being studied together as a global system. Earth System Science integrates several important scientific disciplines, including meteorology, atmospheric chemistry, oceanography, glaciology, hydrology, and biology. Amongst the aims are an integrated understanding of the Earth system at present, an improved understanding of the prominent changes the system has undergone in the past, and improved predictions regarding how the system is likely to change in the future. Satellites contribute toward these goals by enabling the collection of global data sets that would be impractical through any other available means.

Aqua Goals

The Aqua spacecraft, and more broadly the Earth Observing System (EOS) of which Aqua is a part, continues NASA's commitment to studying the Earth as a global system. Aqua will carry six state-of-the-art instruments to observe the Earth's oceans, atmosphere, land, ice and snow covers, and vegetation, providing high measurement accuracy, spatial detail, and temporal frequency. This comprehensive approach, provided by both Aqua and the earlier Terra satellite launched in December 1999, enables scientists to study interactions among the many elements of the Earth system.

Aqua, Latin for "water," is named for the large amount of information that the Aqua spacecraft will collect about the Earth's water cycle. In particular, the Aqua data will include information on water vapor and clouds in the atmosphere, precipitation from the atmosphere, soil wetness on the land, glacial ice on the land, sea ice in the oceans, snow cover on both land and sea ice, and surface waters throughout the world's oceans, bays, and lakes. Such information will help scientists to improve the quantification of the global water cycle and to examine such issues as whether or not the cycling of water might be accelerating.

In addition to information about the water cycle, Aqua will also provide information on many additional elements of the Earth system. For instance, Aqua will enable studies of the fluxes of radiation from the sun and from the Earth that combine to constitute the Earth's radiation balance. It will also enable studies of small particles in the atmosphere termed "aerosols" and such trace gases in the atmosphere as ozone, carbon monoxide, and methane. The trace gases each have a potential contribution to global warming, whereas the aerosols are more likely to have a cooling effect. Aqua will also provide observations on vegetation cover on the land, phytoplankton and dissolved organic matter in the oceans, and the temperatures of the air, land, and water. All of these measurements will have the potential to contribute to improved understanding of the changes occurring in the global climate and the role of the interactions among the various elements of the climate system.

One of the most exciting of the potential practical benefits likely to derive from the Aqua data is improved weather forecasting. Aqua will carry a sophisticated sounding system that will allow determination of atmospheric temperatures around the world to an accuracy of 1° Celsius in 1-kilometer-thick layers throughout the troposphere, the lowest portion of the atmosphere. The troposphere extends to an altitude of about 10-15 kilometers, depending on location, and contains most of the global cloud cover. The anticipated 1° Celsius accuracy far exceeds current accuracies from satellite observations and, in conjunction with the moisture profiles also obtainable from the Aqua sounding system, will offer the potential of improved weather forecasting. NASA is working with the U. S. National Oceanic and Atmospheric Administration and the European Centre for Medium-Range Weather Forecasts to facilitate the incorporation of the Aqua data in their weather forecasting efforts.

Mission Facts

Aqua is a joint project among the United States, Japan, and Brazil. The U.S. provided the spacecraft and the following four instruments: the Atmospheric Infrared Sounder (AIRS), the Clouds and the Earth's Radiant Energy System (CERES), the Moderate-Resolution Imaging Spectroradiometer (MODIS), and the Advanced Microwave Sounding Unit (AMSU). Japan's National Space Development Agency (NASDA) provided the Advanced Microwave Scanning Radiometer for EOS (AMSR-E); and Brazil's Instituto Nacional de Pesquisas Espaciais (INPE, the Brazilian Institute for Space Research) provided the Humidity Sounder for Brazil (HSB).

Overall management of the Aqua mission is located at NASA's Goddard Space Flight Center in Greenbelt, Maryland. Goddard also provided the MODIS and AMSU instruments, is managing the integration and testing of the spacecraft, will operate Aqua once launched, and will receive, process, and disseminate much of the science data through the EOS Data and Information System (EOSDIS). Goddard manages EOS for NASA's Earth Science Enterprise, headquartered in Washington, D.C. NASA's Jet Propulsion Laboratory, Pasadena, California, provided the AIRS instrument; and NASA's Langley Research Center, Hampton, Virginia, provided two CERES instruments, which will allow coincident measurements by one CERES scanning in lines perpendicular to the path of the satellite and by the other CERES scanning in lines at various angles with respect to the satellite's path. TRW constructed the Aqua spacecraft and is carrying out, at its facilities in Redondo Beach, California, the spacecraft's integration and testing.

Aqua is scheduled for launch in 2002 aboard a Delta 7920 launch vehicle from Vandenberg Air Force Base, California. NASA's Kennedy Space Center, Florida, is responsible for the launch operations, including the Delta launch vehicle and the pre-launch integrated processing facility, the former under a contract with the Boeing Company and the latter under a contract with Spaceport Systems International. The U.S. Air Force is responsible for all range-related matters.

During launch, Aqua will rise to an altitude of 680 kilometers, after which it will be boosted to its final orbital altitude of 705 kilometers (438 miles). The launched spacecraft will be positioned in a near-polar orbit around the Earth in synchronization with the Sun, with its path over the ground ascending across the equator at the same local time every day, approximately 1:30 p.m. Correspondingly, on the other side of its orbit, Aqua will descend across the equator at approximately 1:30 a.m. The early afternoon observation time contrasts with the 10:30-10:45 a.m. equatorial crossing time (descending in this case) of the EOS Terra satellite, launched in December 1999. The two daytime crossing times account for why the Terra and Aqua satellites were originally named "EOS AM" and "EOS PM," respectively. The combination of morning and afternoon observations will allow studies concerning the diurnal variability of many of the parameters discussed above.

More information on EOS and the science related to it can be found at the EOS Project Science Office website at *http://eospso.gsfc.nasa.gov* and at the Earth Observatory website at *http://earthobservatory.nasa.gov.* Further information on Aqua can be found at *http://aqua.nasa.gov* and at *http://aqua.gsfc.nasa.gov.*

FOR THE CLASSROOM

Conservation of Energy and Phase Change of Water

Adapted from the Institute for Global Environmental Strategies
http://www.strategies.org

INTRODUCTION

Water is the primary energy mover on Earth. Water's high specific heat allows it to transport energy (in the form of heat) in the Earth's atmosphere and oceans. Both liquid water and water vapor can transport energy over great distances, for instance through ocean currents and winds. In this exercise, we look at the energy absorbed by water needed to effect phase changes from ice to liquid water to water vapor.

MATERIALS

Bunsen burner; ring stand with wire screen; ring; 250 ml beaker; goggles; beaker tongs; pencil & paper; graph paper; thermometer; stopwatch; plastic stirrer; ice; water.

PROCEDURE

1. Attach the ring to the ring stand and place the Bunsen burner under the center of the ring. Adjust the ring so it's 3-5 cm above the top of the Bunsen burner and place the wire screen on top of the ring.
2. Put your goggles on. Take the Bunsen burner out from under the wire screen and light the burner when directed to do so by your instructor. Adjust the gas so that you have a small flame. Adjust the air holes until the flame is no longer yellow in color.
3. Put 150 ml of ice in the beaker and add 50 ml of water.
4. Using the plastic stirrer, stir the water and ice mixture. When it reaches the lowest temperature, record the temperature on the chart.
5. Using beaker tongs, place the beaker on the ring stand and start the stopwatch simultaneously. Begin recording the temperature every 30 seconds for at least 15 minutes. Continuously stir the ice/water mixture.
6. Note the time when the ice begins to melt, when all the ice is gone, and when the water begins to boil.
7. Graph the data, placing the temperature on the vertical axis and the time on the horizontal axis. Mark the points where the water was changing phase.

QUESTIONS

1. According to your graph, did the temperature change during the phase changes?
2. When was the temperature change most rapid? (Refer to the slope of your graph.) If the Bunsen burner output was constant, what can you infer about the absorption of energy by the water?
3. Which phase change required the most energy to achieve?
4. What can you infer about the release of energy by the water when it reverses the direction of phase change? (Vapor to liquid to solid.)

Image courtesy of TRW. Text by C. Parkinson, Aqua Project Scientist, Goddard Space Flight Center.

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