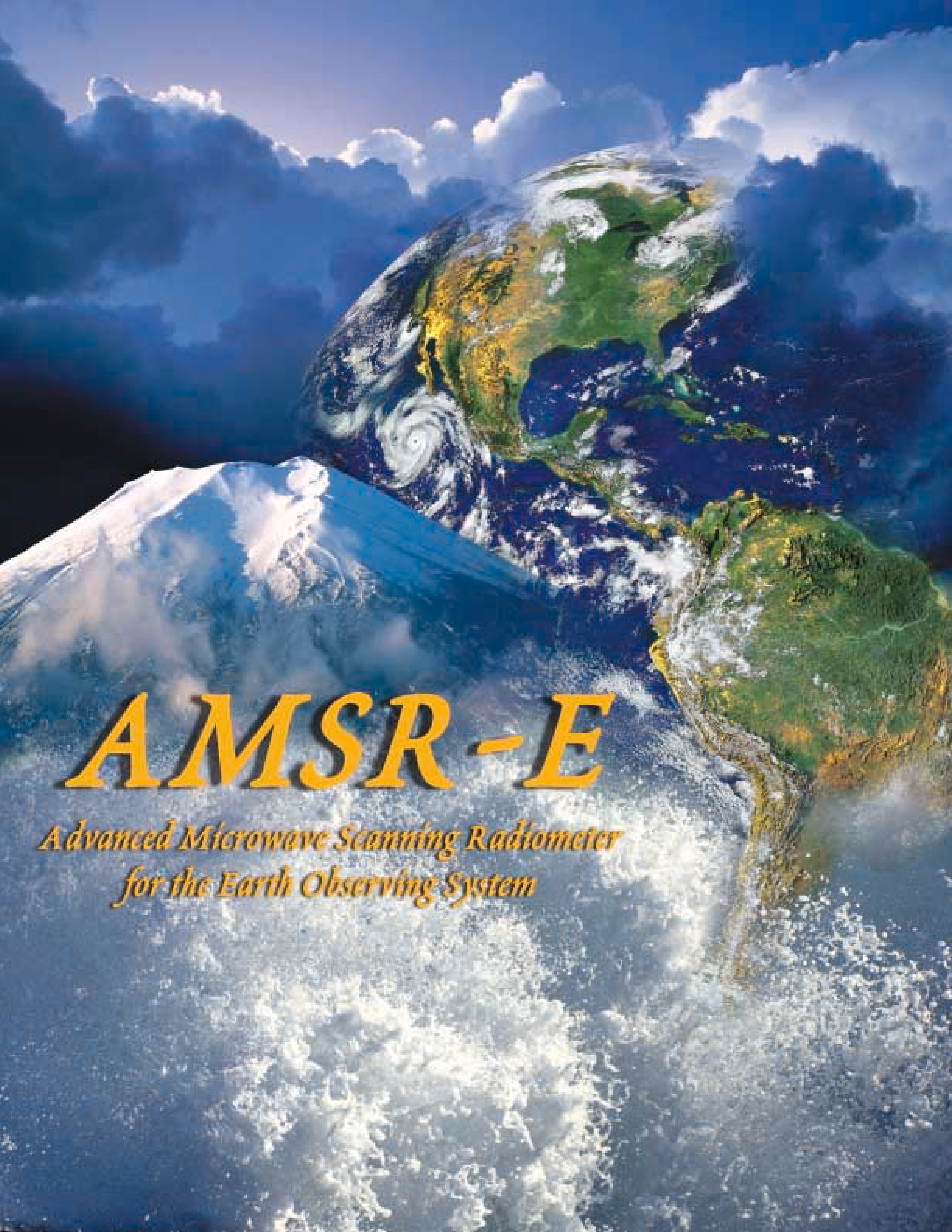
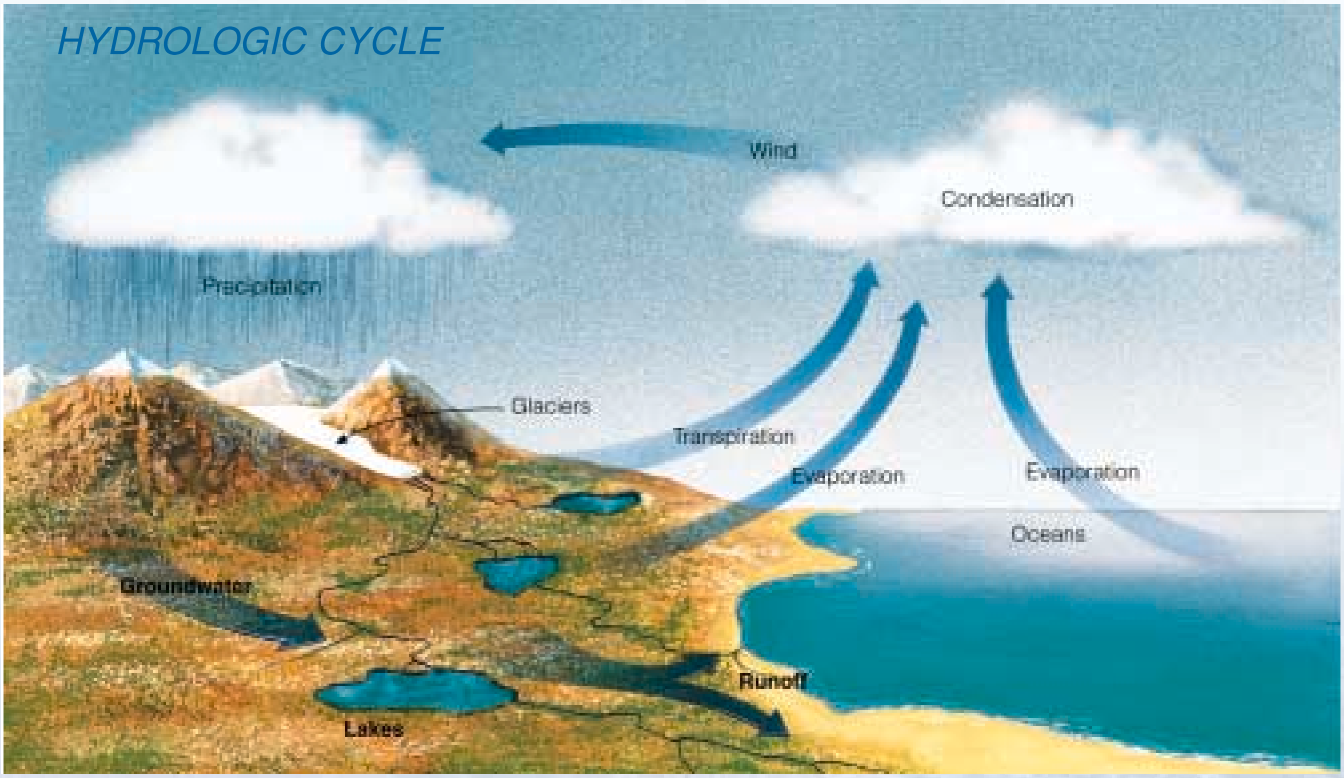


AMSR-E

Advanced Microwave Scanning Radiometer for the Earth Observing System

AMSR-E: Monitoring the Global Water Cycle

. . . Almost all of the water that is evaporated eventually returns to the Earth's surface as precipitation.



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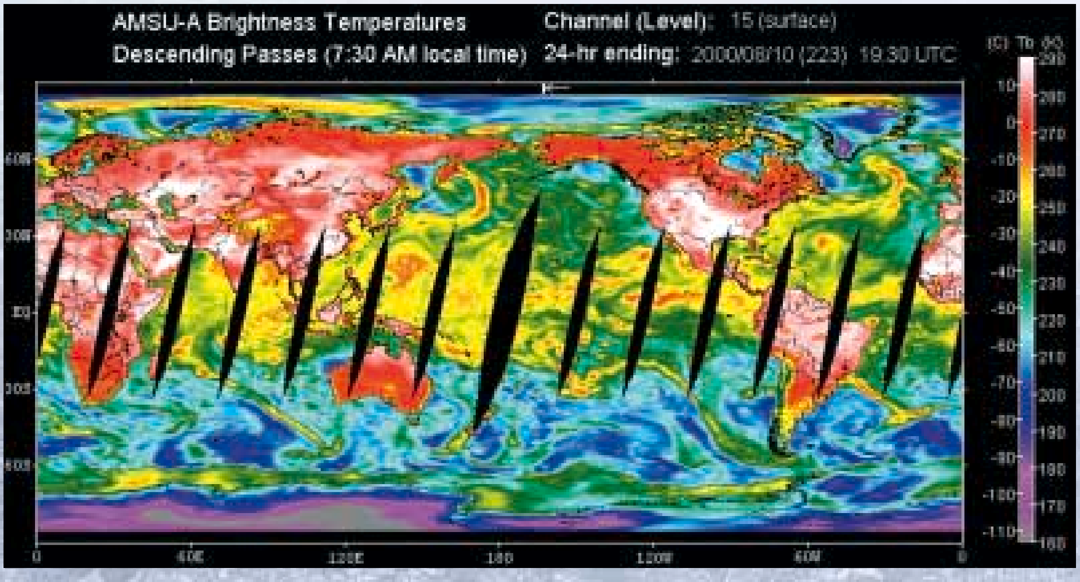
The Advanced Microwave Scanning Radiometer for the Earth Observing System (EOS) program, abbreviated AMSR-E, is a part of the EOS Aqua mission, scheduled for launch in 2001. AMSR-E will monitor various water processes that exert a strong influence on climate and weather. The variables to be measured include precipitation, oceanic water vapor, cloud water, near-surface wind speed, sea surface temperature, soil moisture, snow cover, and sea ice parameters (Table 1).

Table 1. Standard Products from AMSR-E

PARAMETER	ACCURACY	SPATIAL RESOLUTION	INVESTIGATORS
Brightness Temperature (Tb)	0.2° - 0.7°C	5-56 km	NASDA (Level 1B); F. Wentz (RSS, Level 2A)
Oceanic Surface Wind Speed	1.0 m/s	24 & 38 km	F. Wentz (RSS)
Oceanic Integrated Water Vapor	1.0 mm	24 km	F. Wentz (RSS)
Oceanic Cloud Liquid Water	0.02 mm	12 km	F. Wentz (RSS)
Sea Surface Temperature (SST)	0.5°C & 0.7°C	38 & 56 km	F. Wentz (RSS)
Global Rainfall	Over ocean: 1 mm/hr or 20%, whichever is greater Over land: 2 mm/hr or 40%, whichever is greater	5 km	C. Kummerow (CSU) R. Ferraro (NOAA/NESDIS) T. Wilheit (TAMU)
Rain Type (convection fraction)	N/A	5 km	C. Kummerow (CSU)
Surface Soil Moisture	0.06 g/cm^3 where vegetation is less than 1.5 kg/m^2	25 km (equal area Earth grid)	E. Njoku (JPL)
Snow Water Equivalent	10 mm or 20%	25 km (equal area Earth grid)	A. Chang (NASA/GSFC)
Sea Ice Concentration	<5%	12.5, 25 km (equal area Earth grid)	D. Cavalieri (NASA/GSFC) J. Comiso (NASA/GSFC)
Snow Depth Over Sea Ice	<5 cm	12.5 km (equal area Earth grid)	D. Cavalieri (NASA/GSFC) J. Comiso (NASA/GSFC)
Sea Ice Temperature	<4°C	25 km (equal area Earth grid)	D. Cavalieri (NASA/GSFC) J. Comiso (NASA/GSFC)

NASDA National Space Development Agency of Japan
RSS Remote Sensing System
CSU Colorado State University
NOAA/NESDIS National Oceanic and Atmospheric Administration/National Environmental Satellite, Data, and Information Service
TAMU Texas A&M University
NASA/GSFC NASA Goddard Space Flight Center
JPL Jet Propulsion Laboratory

All of these measurements are critical to understanding the Earth's climate. Water vapor is the Earth's primary greenhouse gas, helping to keep the Earth habitable. The evaporation of water from the surface carries away excess heat, preventing unbearably hot temperatures in most regions. Almost all of the water that is evaporated eventually returns to the Earth's surface as precipitation. In the process of precipitation formation, heat that was absorbed during evaporation is released to the atmosphere. This



Advanced Microwave Sounding Unit-A 89 GHz image for August 11, 2000 from the NOAA-15 satellite. The 89 GHz channel will also be included in the AMSR-E instrument, and provides information on atmospheric water vapor, clouds, precipitation, sea ice, and land surface temperature.

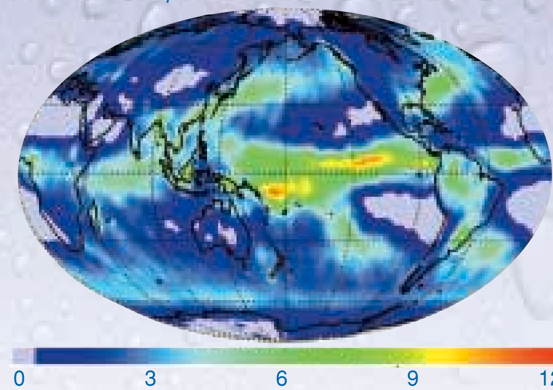
process provides over half of the energy needed for the global atmospheric circulation and is the prime mechanism for transferring the effects of local climate anomalies such as El Niño to a global scale. Wind speed at the ocean surface has a large influence on evaporation and the organization of sea surface temperature patterns. Sea surface temperature changes, in turn, greatly influence the atmospheric circulation, such as during El Niño. Cloud water reflects sunlight back out to space, cooling the Earth.

Soil moisture is a key state variable in land surface hydrology. It controls the proportion of rainfall that percolates, runs off, or evaporates from land.

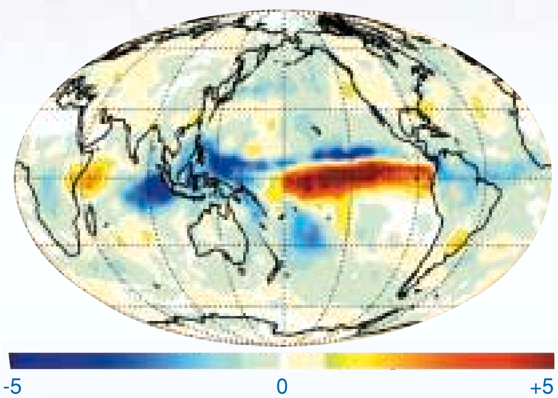
Soil moisture also enables photosynthesis in plants that use solar energy to convert carbon dioxide and water into the oxygen and food necessary for animal life on Earth.

Sea ice reflects sunlight away from the Earth, but it also helps the ocean to retain thermal energy by restricting evaporation and other heat transfers from the ocean surface. Snow cover over sea ice further restricts heat loss from the ocean. Similarly, snow cover over land reduces the amount of sunlight absorbed by the Earth, while also limiting the flow of heat from the ground to the atmosphere. Snow cover is also an important part of the land hydrology and provides a yearly replenishment of water resources in many regions.

ENSO Global Precipitation
(Based on observations from multiple satellites)
April 97 to March 98 Rainfall



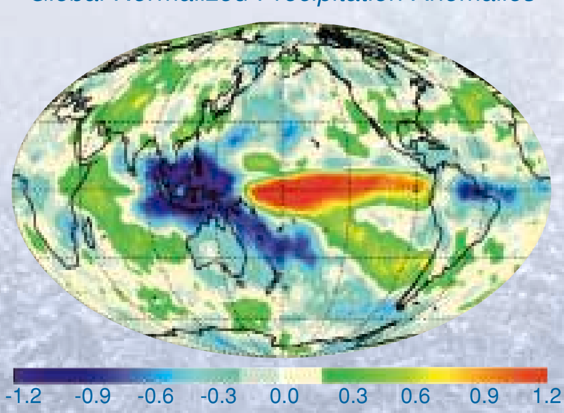
Rainfall Anomalies



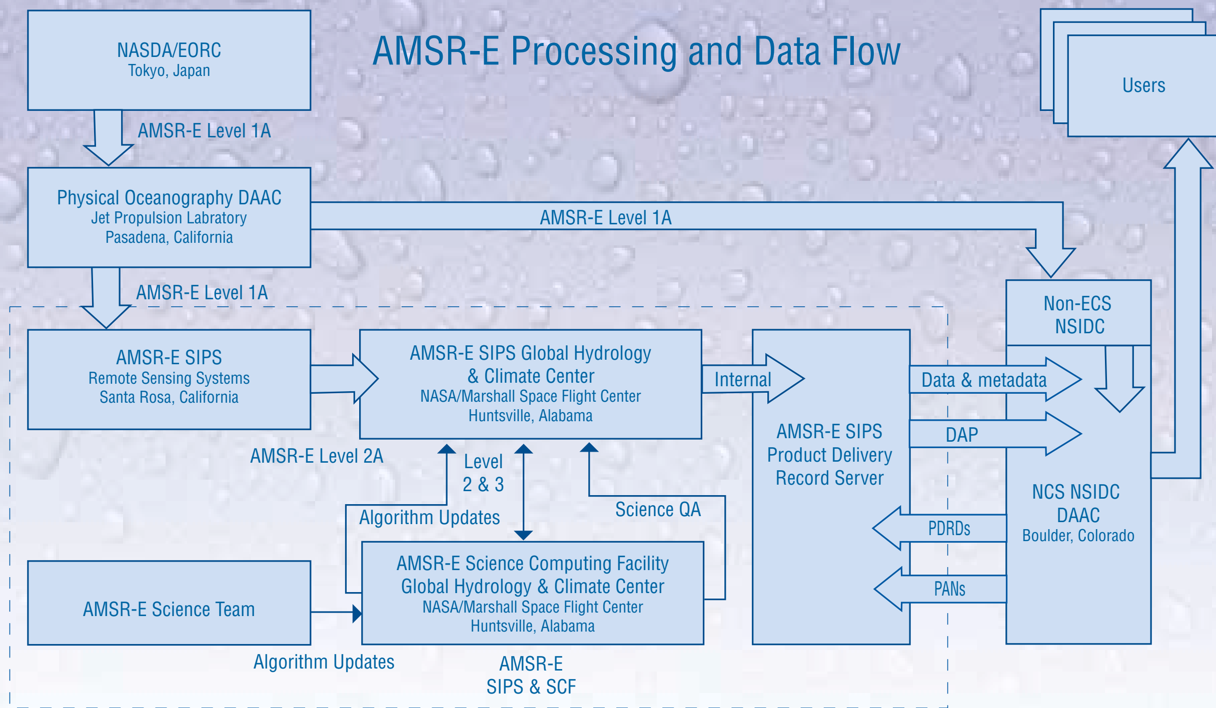
Global Precipitation Climatology Project (GPCP)

▲ Rainfall (top panel) and anomalies from the 1979-98 climatology (bottom panel) during the El Niño year: April 1997 to March 1998. The El Niño phenomenon is characterized by increased rainfall over the central Pacific and a drying of the East Indies, as well as climate changes on a global scale.

El Niño minus La Niña composites of Global Normalized Precipitation Anomalies



◄ Differences of precipitation anomalies (normalized by monthly standard deviations to show variability in low rain areas) during the period January 1979 to June 1999. This analysis shows rainfall differences between El Niño months and La Niña months and emphasizes the global pattern of wet and dry areas.

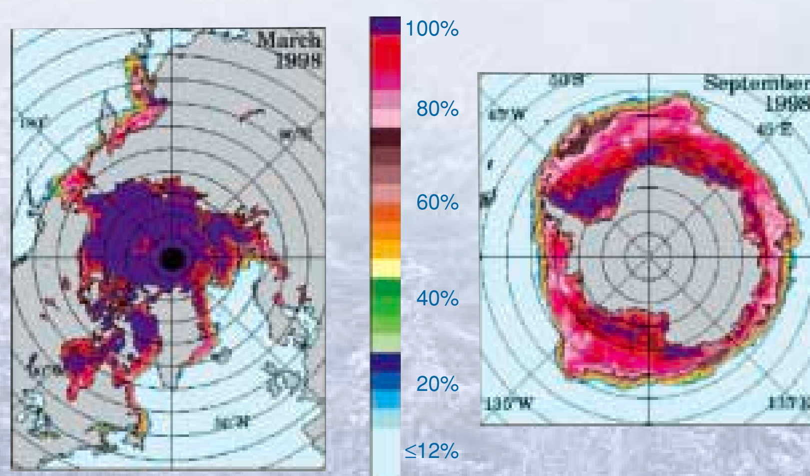


DAAC	Distributed Active Archive Center	EORC	Earth Observations Resource Center	PDRDs	Product Delivery Record Discrepancy
DAP	Data Algorithm Package	NSIDC	National Snow and Ice Data Center	SIPS	Science Investigator-led Processing System
ECS	EOSDIS Core System	PANs	Product Acceptance Notifications	SCF	Scientific Computing Facility

Climate Change Research

How clouds, water vapor, precipitation, sea ice, soil moisture, and snow cover respond to increasing atmospheric levels of greenhouse gases is still unclear, and they all have the potential to either enhance or suppress global warming. The same can be said for their influence on natural climate fluctuations. The data that AMSR-E provides will be utilized by climate researchers to develop a better understanding of climate change. The AMSR-E data will also be utilized with data from other sensors on the Aqua spacecraft to gain a more complete picture of these processes. In order to sustain a long-term dataset for climate monitoring, the AMSR-E products will be intercalibrated with similar products from previous spacecraft missions, where they exist, to allow long-term monitoring of climate. Currently, the Special Sensor Microwave/Imager (SSM/I) flying on Department of Defense weather satellites is the primary heritage instrument of AMSR-E. AMSR-E will extend and enhance the SSM/I data record, begun in 1987, and the earlier Nimbus 7 Scanning Multichannel Microwave Radiometer (SMMR) data record, begun in 1978, to allow studies of decadal-scale climate change.

Northern and Southern Hemisphere Winter Sea Ice Coverages Derived From Satellite Passive–Microwave Data



The values mapped are sea ice concentrations (percent areal coverages of ice) (NASA/GSFC)

Predictions of Climate and Weather

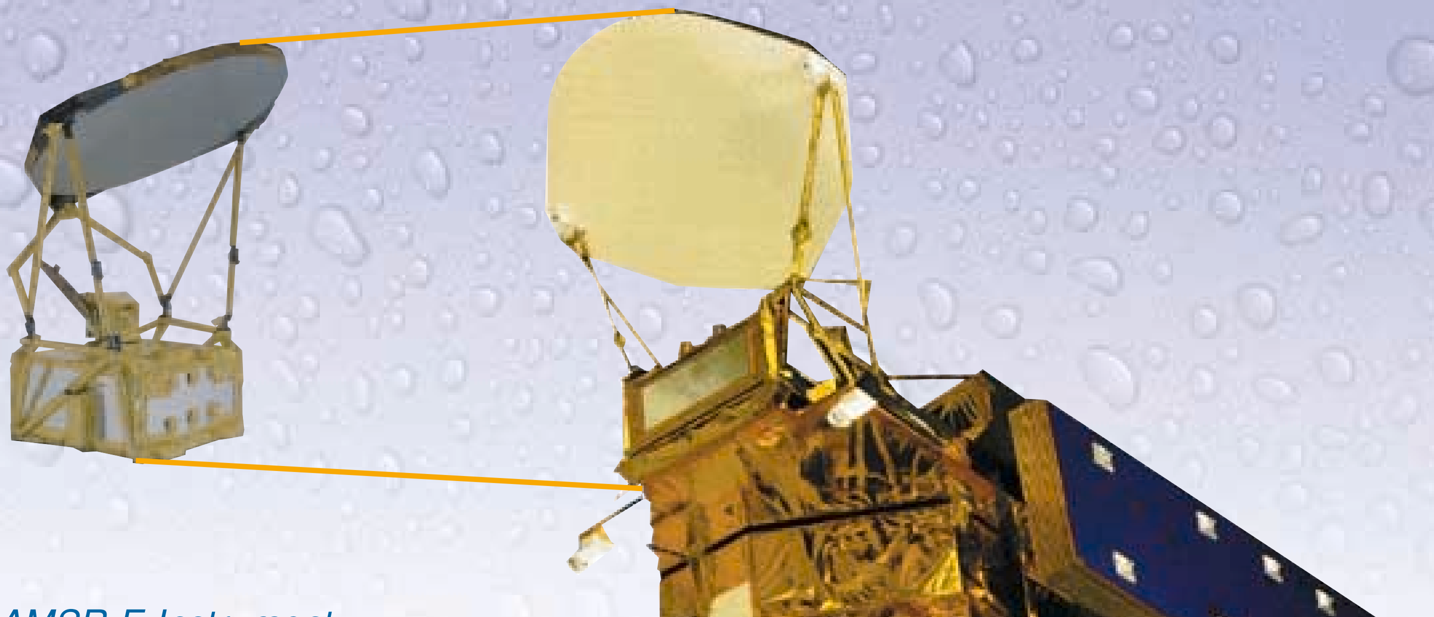
A better understanding of climate processes resulting from analysis of AMSR-E data will be utilized by researchers to develop and improve computer models of the climate system. These models are the mechanism ultimately used for predictions of climate change, whether it be El Niño, La Niña, or global warming. Climate models have shown increasing skill at the prediction of the onset of El Niño from one year to the next. Improvements in the water-related processes in models will increase our confidence in their predictions of global warming and the regional weather changes expected to accompany warming. Some weather forecast models will likely ingest the AMSR-E data in near-real time to help improve daily weather predictions. For example, wintertime tropical moisture surges into the United States, which have a controlling influence on rainfall and snowfall, can be monitored through the AMSR-E data.

Science Teams

There are two science teams involved in the production of products from AMSR-E. The U.S. AMSR-E Science Team works to develop methods (algorithms) to convert the raw satellite measurements into the products listed in Table 1. The U.S. Team has a Japanese counterpart, the NASDA (National Space Development Agency of Japan) AMSR Science Team, that has similar goals. Members from each team constitute a Joint AMSR Team that works together to share findings and unify procedures for analysis of the AMSR-E data. Both teams are also involved in field campaigns to help validate the products after launch of the Aqua spacecraft. The science teams are responsible for the routine processing and archival of those products for use by the science community.

Sea ice in the Bering Sea. Courtesy of Claire Parkinson, NASA/GSFC

Lake ice sampling in Saskatchewan, Canada. Courtesy of Dorothy Hall, NASA/GSFC



AMSR-E Instrument

The AMSR-E is a conically scanning passive microwave radiometer sensing microwave radiation at 12 channels and 6 frequencies ranging from 6.9 to 89 GHz (gigahertz). It is built by Mitsubishi Electric Company with NASDA funding. Horizontally and vertically polarized radiation are measured separately at each frequency. The AMSR-E utilizes an offset parabolic reflector 1.6 meters in diameter to focus the radiation into an array of feedhorns that feed the radiation to detectors. During scanning, the instrument spins at 40 revolutions per minute (rpm), covering a swath 1445 km wide on the Earth from an altitude of 705 km. Instrument specifications are contained in Table 2.

Table 2. AMSR-E Characteristics from the 705 km Orbital Altitude of the EOS Aqua Platform.

Center Frequencies (GHz)	6.925	10.65	18.7	23.8	36.5	89.0
Bandwidth (MHz)	350	100	200	400	1000	3000
Sensitivity (K)	0.3	0.6	0.6	0.6	0.6	1.1
IFOV (km x km)	74 x 43	51 x 30	27 x 16	31 x 18	14 x 8	6 x 4
Sampling Interval (km x km)	10 x 10	10 x 10	10 x 10	10 x 10	10 x 10	5 x 5
Integration Time (msec)	2.6	2.6	2.6	2.6	2.6	1.3
Main Beam Efficiency (%)	95.3	95.0	96.3	96.4	95.3	96.0
Beamwidth (half-power, degrees)	2.2	1.4	0.8	0.9	0.4	0.18

Education and Outreach

The AMSR-E Science team will tap into the existing international GLOBE program. Students' observations will be compared with the satellite-derived atmospheric parameters, as part of the AMSR-E validation program. Feedback will be provided to the students on how their observations compare to the Aqua AMSR-E retrieved data. As part of our educational outreach, our scientists will participate with the GLOBE students and teachers in Web chats and respond to questions that students FAX or mail. It is our goal to reach and educate as many students as possible and, through them, reach the general public.

NASA/GSFC/NOAA/USGS

For further information on the AMSR-E instrument and data products see the AMSR-E website at www.ghcc.msfc.nasa.gov/AMSR, or contact:

Roy W. Spencer
SD 60
320 Sparkman Drive
Hunstville, AL 35805

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"Man masters nature
not by force,
but by understanding"

Jacob Bronowski, 1956

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