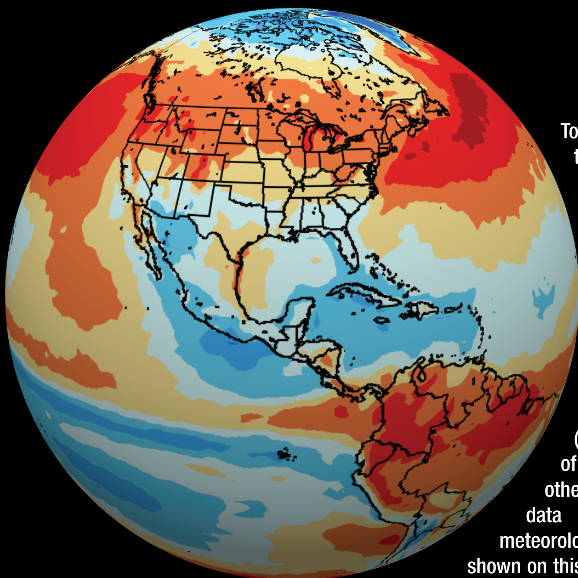
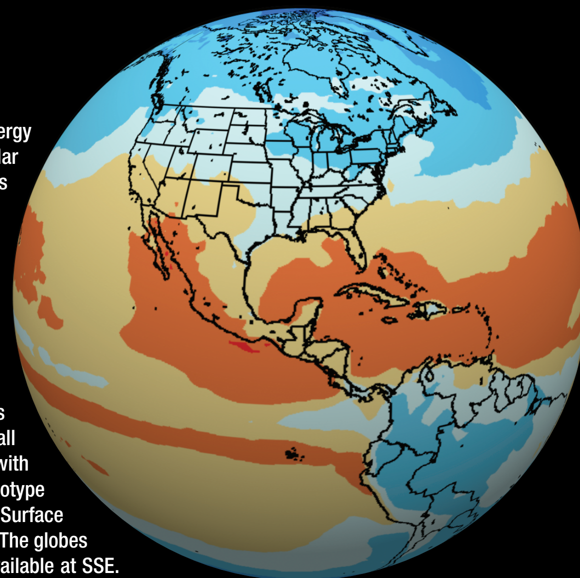
National Aeronautics and Space Administration

SCIENCE SERVING SOCIETY: ENERGY MANAGEMENT



To effectively use renewable energy technologies (RETs), such as solar and wind power systems, requires more comprehensive information than is traditionally provided in a weather report. NASA's Earth observing satellites, modeling, and data analysis systems are an important source of information for planning the best use of these RETs. The Prediction of Worldwide Energy Resources (POWER) project has combined all of these NASA resources together with other data sources, and created a prototype data information system called the Surface meteorology and Solar Energy (SSE) website. The globes shown on this page are examples of products available at SSE.



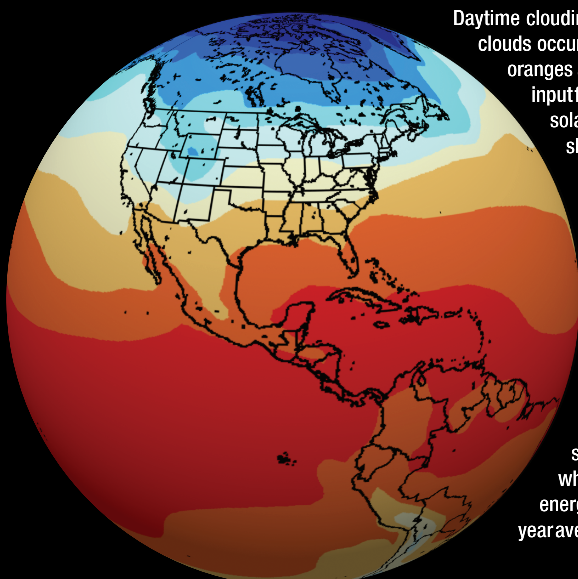
April Monthly Average Daylight Cloud Amount (%)

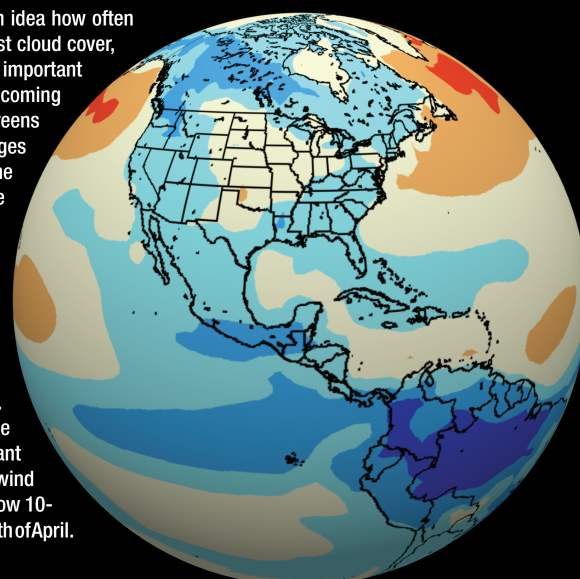
10 20 30 40 50 60 70 80 90

April Monthly Average Insolation (kW-hr/m²/day)

0.5 1.5 2.5 3.5 4.5 5.5 6.5 7.5

Daytime cloudiness (upper left) in percent gives an idea how often clouds occur. Blues and greens indicate the least cloud cover, oranges and reds the most. Cloud cover is an important input for calculations of total *insolation*—incoming solar energy (upper right), Blues and greens show the least insolation, oranges and reds indicate the greatest. The average temperature 2 m above the surface (lower left) is important for planning the most energy efficient location for heating and air conditioning systems and anticipating their demand on the power grid. Blues and greens show lower temperature, oranges and reds show higher. Average winds at 50 m above the surface (lower right) are important when assessing the potential for using wind energy in a given area. All four globes show 10-year average (1984-1993) values for the month of April.





April Monthly Average Air Temperature at 2 m (°C)

-15 -10 -5 0 5 10 15 20 25

April Monthly Wind Speed at 50 m (m/sec)

2 4 6 8 10 12 14

Using the unique vantage point of space, current and future NASA satellites are able to view the entire globe and can supplement existing surface measurement networks and data information products. Information designed for energy sector decision support systems will impact government and industrial organizations at all levels.

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Overview of the Program

At present, an array of Earth observing satellites are in orbit, and additional launches both by NASA and others will continue throughout the next decade. Our ability to observe our home planet from space has never been greater. Increasingly, studies of the Earth focus on understanding the Earth's land, atmosphere, oceans, and life as a whole integrated system rather than as individual independent elements. NASA is an important contributor in this systems approach to Earth science studies.

In addition to providing Earth observing capabilities, NASA forms strategic partnerships with other government, academic, private, and international organizations. Through these partnerships, NASA's Earth science observations and measurements are linked to practical applications. NASA data, information, and predictive models help NASA's partners, and nontraditional users of Earth science, make timely and accurate decisions regarding management of resources and development of policy. The agency's goal is to maximize the benefit of science and technology to stakeholders by smoothly flowing Earth science data and information from NASA satellites to society.

Energy Management

Our nation is critically dependent on stable and reliable sources of energy. Traditionally, most of this demand has been met by burning fossil fuels such as oil, coal, and natural gas. But such extensive use of these fuels impacts Earth's climate and environment, and so society is increasingly seeking alternative sources of fuel. Nuclear energy offers a cleaner alternative but there remain environmental concerns about the transport and disposal of nuclear waste. Other alternatives to fossil and nuclear fuels are now emerging, including *renewable energy technologies* that harvest solar energy and wind power, and biomass fuels derived from corn, sugar cane, switchgrass and other plant species. These alternative energy sources can help reduce mankind's dependence on fossil fuels, reduce greenhouse gas emissions, and, at the same time, may help to improve air quality.

For these alternative energy sources to achieve their fullest potential, however, planners require very detailed climatic data. A traditional weather report is no longer sufficient. In order to optimize the effectiveness of these renewable energy technologies and their integration into the power grid, planners need to precisely map incoming solar radiation, prevailing wind speed and direction, and temperature at the surface—see front. Not only must the information be accurate and timely, it must be collected on a global scale. To date, the energy sector has based their decisions on where to locate energy producing technology on historical climatic information. However, given rapid climatic and environmental changes experienced in a given region, historical information alone is no longer sufficient. Resource managers need to know how the conditions at a chosen location are changing with time. NASA and its partners at the Department of Energy (DOE), the DOEs National Renewable Energy Laboratory (NREL), the National Oceanic and Atmospheric Administration (NOAA), and U.S. Department of Agriculture (USDA), are working to provide this needed information.

A major component of the Earth Science Division in NASA's Science Mission Directorate is dedicated to understanding the Earth's energy and hydrological cycles on a global scale using remote sensing and modeling. NASA already has developed a unique Web-based climatological information system linked to a computer simulation used for energy management decision making (*eosweb.larc.nasa.gov/sse*). Over 10,000 individuals from government agencies, universities, and private sector industry use this system to meet data requirements for renewable energy projects (see front). The Clouds and the Earth's Radiant Energy System (CERES) sensors, on the Terra and Aqua satellites, provide input to this system. CERES scientists study major elements of Earth's water cycle (clouds) and energy balance. In addition to CERES, the Aqua mission carries an entire sensor package dedicated to studying the movements of water between the surface and atmosphere, while the Tropical Rainfall Measuring Mission (TRMM), measures precipitation throughout the tropics. The Global Precipitation Measurement (GPM) mission, a newly planned constellation of satellites provided by NASA and its international partners, will eventually succeed TRMM and contribute even more to our understanding of global precipitation patterns.

Better understanding of the role of clouds and aerosols in Earth's climate system has important implications for energy forecasting efforts. CloudSat collects a comprehensive inventory of clouds and provides information to help scientists study their impacts on climate in unprecedented detail, while Cloud-Aerosol Lidar Infrared Pathfinder Satellite Observations (CALIPSO) assists in studies of aerosols in the climate system. The National Polar-orbiting Operational Environmental Satellite System (NPOESS) and its precursor, the NPOESS Preparatory Project (NPP), both joint NASA, NOAA and Department of Defense collaborations, are also expected to contribute new information that will be useful for energy management . With all of its current and future missions, NASA is collecting data on important parameters for energy management over the entire globe. This information can supplement existing surface measurement networks and data information products, providing data where none are available.

But the story doesn't end with the collection of the data. As more data from increasingly sophisticated NASA missions become available, forecasting capabilities are expected to increase quite dramatically. Weather forecasts should eventually improve from today's fairly reliable 3–5 day forecasts to dependable 5–7 day forecasts. Seasonal predictions will also become increasingly accurate and useful for renewable energy production and distribution planning and enhancing energy efficiency through improved building design. These improvements will result in increased capability to plan for and respond to the ever-increasing energy demands of our society.

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