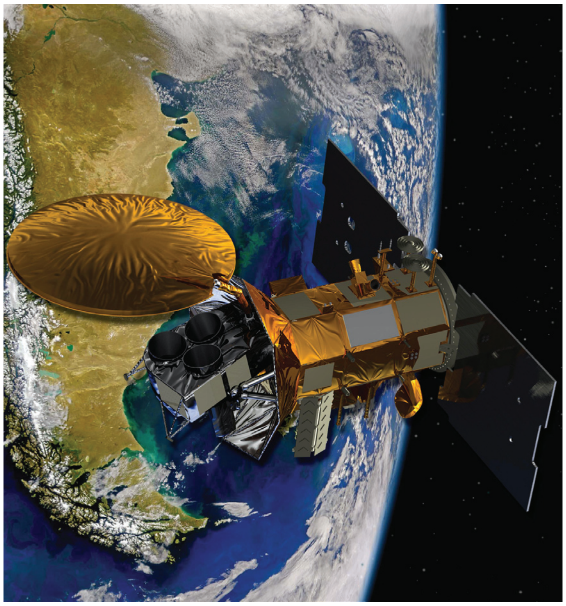
NASA facts

# Aquarius/SAC-D



Salt. Most people view it first and foremost as the most common condiment. It comes in many forms, including the one we typically eat — sodium chloride — and has thousands of uses, from preserving food to manufacturing pharmaceuticals.

But salt actually plays much larger roles, both in our lives and in how the Earth system functions. It's essential to animal life — our bodies need it for respiration and digestion. And just as salt flows through our veins, it also flows through Earth's ocean, the lifeblood of Earth's climate system. The ocean is roughly 3.5 percent salt, about 86 percent of which is sodium chloride. The concentration of dissolved salts in the ocean is referred to as salinity, and it varies across the globe and over time.

Just as too much or too little salt in our diets affects our health, so too do high and low salinity have profound effects on how the ocean circulates, how freshwater cycles around Earth and how our climate works. The concentration of salt on the ocean surface — the part of the ocean that actively exchanges water and heat with Earth's atmosphere — is a critical driver of ocean processes and climate variability.

The global measurement of ocean surface salinity over time provides a clear way to understand these relationships. By tracking changes in ocean surface salinity, we can directly monitor variations in Earth's water cycle: land runoff, sea ice freezing and melting, and evaporation and precipitation over the ocean.

Yet despite the key role salinity plays in climate, measurements of ocean surface salinity have, until quite recently, been limited to sparse data collected from ships, buoys and a small number of airborne science campaigns. Ocean surface salinity is one of the missing variables in satellite studies of Earth.

**Mission Overview**

To better understand the regional and global processes that link variations in ocean salinity to climatic changes in the global water cycle and how these variations influence ocean circulation and climate, NASA will launch the Aquarius/SAC-D mission in June 2011. Aquarius, the NASA-built primary instrument aboard the international Aquarius/Satélite de Aplicaciones Científicas (SAC)-D observatory, will make NASA's first space-based global observations of ocean surface salinity, providing a key new measurement that will greatly expand on limited past direct measurements of ocean salinity. Aquarius/SAC-D is a collaboration between NASA and Argentina's space agency, Comisión Nacional de Actividades Espaciales (CONAE), with participation by Brazil, Canada, France and Italy.

During Aquarius' three-year lifetime, this experimental NASA Earth System Science Pathfinder mission will make monthly maps of global changes in ocean surface salinity with a resolution of 93 miles (150 kilometers), showing how salinity changes from month to month, season to season and year to year. Scientists will combine Aquarius data with in-water measurements of salinity to generate routine maps of ocean salinity distribution.

Because ocean surface salinity varies from place to place and over time, scientists can use it to trace the ocean's role in Earth's water cycle. For example, about 86 percent of global evaporation and 78 percent of global precipitation occur over the ocean. By measuring changes in ocean surface salinity caused by these processes, as well as changes caused by melting ice and river runoff, Aquarius will provide important new information about how Earth's freshwater moves between the ocean and atmosphere and around the globe.

Aquarius will also help scientists track ocean currents and better understand ocean circulation. Salinity, together with temperature, determines how dense and buoyant seawater is. This, in turn, drives how ocean waters are layered and mixed. Salinity has a major effect on the flow of deep ocean currents that move heat from the tropics to the poles and affect global climate.

Studies from Aquarius will improve computer models used to forecast future climate conditions, including short-term climate events like El Niño and La Niña.

When combined with data from other sensors that measure sea level, ocean color, temperature, winds, rainfall and evaporation, Aquarius' continuous, global salinity data will provide a clearer picture of how the ocean works, how it is linked to climate and how it may respond to climate change. Its measurements will provide a baseline from which to detect future changes in salinity as our climate changes. Aquarius will also serve as a pathfinder to demonstrate the technology and scientific rationale for future long-term satellite missions to monitor ocean surface salinity. Later in the mission, Aquarius data will be inter-calibrated and combined with complementary data from the European Soil Moisture and Ocean Salinity satellite.

**Aquarius/SAC-D Instruments Overview**

Aquarius will measure ocean surface salinity by sensing microwave emissions from the water's surface with three passive microwave instruments called radiometers. The strength of the thermal signal emitted from the ocean surface depends on both the salinity of the ocean water and its temperature. When other environmental factors are equal, these emissions indicate how salty the surface water is. A microwave radar instrument called a scatterometer will measure ocean waves that affect the precision of the salinity measurement.

Because salinity levels in the open ocean vary by only about five parts per thousand, Aquarius employs new technologies to detect changes in salinity as small as about two parts in 10,000, equivalent to about one-eighth of a teaspoon of salt in a gallon of water. The microwave radiometers developed for Aquarius are the most accurate ever developed for Earth remote sensing at the protected microwave frequency used on Aquarius.

The three Aquarius radiometers are aligned with an 8.2-foot-(2.5-meter)-diameter antenna reflector to generate three fixed beams at different angles relative to the ocean surface. The beams form three "footprints" on the ocean surface aligned across a 242-mile (390-kilometer)-wide swath. This provides for complete global coverage every seven days and produces enough samples in a month to achieve the mission's salinity accuracy requirements.

The Aquarius/SAC-D observatory also includes seven other science instruments and technology packages built by CONAE, the French Space Agency (Centre National d'Etudes Spatiales, or CNES), Italian Space Agency (Agenzia Spaziale Italiana, or ASI) and Canadian Space Agency, or CSA. These are:

- A Microwave Radiometer, built by CONAE, which will measure rain, wind, sea ice and water vapor.
- A New Infrared Scanner Technology camera, built by CONAE in collaboration with the Canadian Space Agency, which will detect forest fires on land and map sea surface temperatures.
- A High Sensitivity Camera, built by CONAE, which will acquire nighttime images of urban lighting and fires and aurora events.
- A Data Collection System, built by CONAE, which will be used to relay environmental data from ground stations.
- The Radio Occultation Sounder for Atmosphere, built by Agenzia Spaziale Italiana, which will measure atmospheric temperature and humidity using a technique known as GPS occultation.
- The Cosmic Radiation Effects and Orbital Debris and Micrometeoroids Detector, or CARMEN (for CARacterisation et Modelisation de l'ENvironnement), built by CNES, which consists of an instrument called ICARE that will measure the effects of cosmic radiation on electronics; and three detectors that will measure the distribution of microparticles and debris in space.
- A Technology Demonstration Package, provided by CONAE, which is a prototype of sensors planned for use on future CONAE spacecraft.

**Launch and Orbit**

Aquarius/SAC-D will be launched on a United Launch Alliance Delta II rocket from Vandenberg Air Force Base, Calif. The observatory will fly in a 408-mile-high (657 kilometer), sun-synchronous, near-polar orbit, completing one orbit every 98 minutes and mapping the global open ocean once every seven days.

**Partners**

The Aquarius instrument was jointly built by NASA's Jet Propulsion Laboratory, Pasadena, Calif., and NASA's Goddard Space Flight Center, Greenbelt, Md. NASA's Launch Services Program at the agency's Kennedy Space Center in Florida provides launch management. JPL will manage Aquarius through the mission's commissioning phase and will archive mission data. Goddard will manage the mission's operations phase and process Aquarius science data. CONAE is providing the SAC-D observatory, an optical camera, a thermal camera in collaboration with Canada, a microwave radiometer, sensors developed by various Argentine institutions and the mission operations center in Argentina. France and Italy are also contributing instruments.

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