National Aeronautics and Space Administration

Aquarius/SAC-D

Understanding the Interaction Between Ocean Circulation, the Water Cycle, and Climate by **Measuring Ocean Salinity**

www.nasa.gov

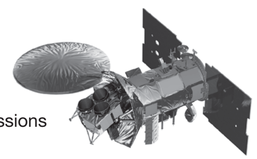
CONAE
COMISION NACIONAL DE ACTIVIDADES ESPACIALES

24” x 20”

Aquarius Highlights

Aquarius/SAC-D will measure ocean salinity from satellite in order to study the climate interactions between the ocean circulation and changes in the global water cycle.

The Goals of Aquarius
- Provide pioneering sea surface salinity (SSS) observations of the global ice-free ocean
- Deliver 150-kilometer resolution SSS maps over a 3-year mission lifetime
- Provide monthly global maps of SSS with an accuracy of 0.2 PSS. Salinity is measured on the Practical Salinity Scale (PSS), closely equivalent to grams of salt per kilogram of seawater. The accuracy of Aquarius's monthly average salinity measurement will be about a "pinch" (i.e., 1/8 of a teaspoon) of salt in one gallon of water.



Benefits from Aquarius
- Discovery
- Exploration
- Climate prediction
- El Niño forecasts
- Global water budget
- PATHFINDER: Proof-of-concept for future missions

Discovery/Exploration
- Almost all of the information on ocean salinity has been collected by ships and has been largely confined to shipping routes. Most of the southern hemisphere has not been sampled by ships at all.
- Aquarius will measure the entirety of the ocean surface every seven days for three years.
- Aquarius will record more SSS data in its first few months than has been measured since the dawn of oceanography 125 years ago. (US Ocean Action Plan, 2005)

Aquarius Science Addresses NASA's Research Strategy in These Important Areas
- Earth System Variability and Trends: How are global precipitation, evaporation, and the cycling of water changing?
- Earth System Responses and Feedback Processes: How can climate variations induce changes in the global ocean circulation?

Aquarius/SAC-D Synergy
- The SAC-D Platform, built by the Space Agency of Argentina (Comisión Nacional de Actividades Espaciales, CONAE), will accommodate the primary Aquarius SSS instrument plus several Argentinian SAC-D instruments and instruments from the French Space Agency (Centre National d'Etudes Spatiales) and Italian Space Agency (Agenzia Spaziale Italiana).

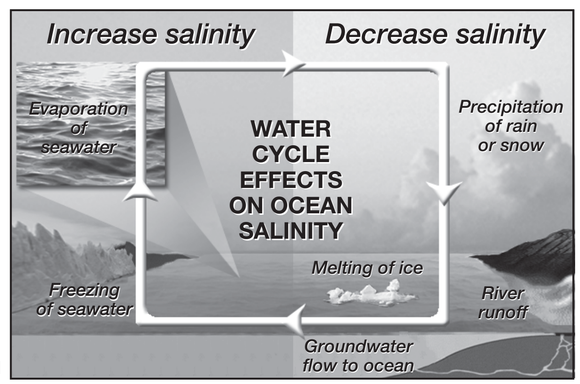
Two SAC-D Science Instruments Directly Complement Aquarius SSS Measurements
- CONAE Microwave Radiometer: Wind, rain, cloud water, sea-ice detection
- CONAE New Infrared Scanner Technology: Sea Surface Temperature

aquarius.nasa.gov

Salinity & the Global Water Cycle

The water molecule, H_2O, exists as a gas (steam), liquid (water), and solid (ice) within the relatively small range of air temperatures and pressures found at Earth's surface. Ancient Greeks, including Homer and Plato, knew that water continually circulates from the ocean to the atmosphere to the land and back again to the ocean. Today's scientists know that Earth's "water cycle" is dominated by exchanges between the ocean and atmosphere. In fact, about 86% of global evaporation and 78% of global precipitation occur over the ocean.

Sea Surface Salinity (SSS) is a key tracer for understanding the fresh water cycle in the ocean. This is because some parts of the water cycle increase salinity, and parts decrease it (see diagram, right):



Global SSS patterns are governed by geographic differences in the "ocean water budget." Like on continents, some latitudes of the ocean are "rainy" whereas others are arid and "desert-like."

In general:
- Lowest SSS occurs at latitudes dominated by precipitation: Equatorial regions, 40–50 degrees North and South latitude, and near coasts.
- Highest SSS occurs at latitudes dominated by high evaporation: At ocean centers, in enclosed seas, and between 25–30 degrees North and South latitude.

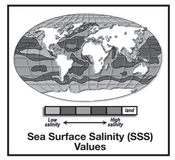
Ocean currents can also modify SSS patterns by transporting surface waters—and their SSS "signature"—across latitude belts. The Gulf Stream for example, transports warm, high salinity water from the tropics to Europe along the Atlantic Ocean's western boundary.

CONAE • GSFC • JPL

Grains of (Salt) Wisdom—Knowing Your Salt

*The word "**salary**" comes from the ancient Roman custom of paying soldiers money to buy salt.*

You May Know These Facts...	But Do You Know These?
• Oceans are salty 	• Until recently, salinity had NEVER been measured over 24% of the ocean's surface
• On land, the availability of salt varies (e.g., salt flats have high concentrations of salt)	• Ocean salinity patterns vary over time and space
• Salinity affects water density (e.g., the Dead Sea's high salinity makes it easier for people to float)	• The North Atlantic is a key area for sinking of dense, cold, high-salinity water masses that drive the "thermohaline circulation"
• Salt affects water's freezing point (e.g., roads are salted as a de-icing mechanism)	• Thermohaline circulation accounts for much of the oceanic heat transport that regulates climate
• Icebergs form in polar regions and are made of fresh water	
• Climate warming could cause polar ice to melt, sea level to rise, etc.	• Studies show that past climate shifts are linked to significant changes in the strength of thermohaline circulation
• El Niño and La Niña influence weather patterns; both are related to ocean temperature	• El Niño and La Niña are both influenced by ocean salinity
• Hurricanes can devastate coastal cities with heavy downpours and flooding	• Hurricanes can dump hundreds of trillions of gallons of freshwater on the ocean surface



Sea Surface Salinity (SSS) Values

http://aquarius.nasa.gov/education.html

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"Hands On" Activities & Online Data Tools

"Hands On" Activities for Physical Sciences: **http://aquarius.nasa.gov/education-classroom.html**

Elementary Grade Levels
- Properties of Objects and Materials
  - ***Potato Float***—Understand how the same object can both sink and float, depending on its density relative to a fluid
  - ***Liquid Rainbow***—Use analytical thinking by devising schemes to stack solutions of different densities
  - ***The Water Cycle - Now You See It, Now You Don't***—Learn about the relationship between temperature and condensation
  - ***Evaporation Investigation***—Observe and understand the process of evaporation

Middle Grade Levels
- Properties and Changes of Properties in Matter
  - ***Can Seawater Freeze?***—Freeze liquids of varying salinity & learn how it relates to the buoyancy of sea ice and icebergs
  - ***Properties of Fresh & Seawater***—Conduct experiments on the boiling point, freezing point, and heat capacity of fresh water and seawater
- Transfer of energy
  - ***Density: Seawater Mixing & Sinking***—Use temperature-salinity diagrams to understand the importance of seawater density studies

High School Grade Levels
- Structure of Atoms
  - ***Electrolysis of Salt Water***—Conduct an experiment to see that water can be split into its constituent ions through the process of electrolysis
- Structure and Properties of Matter
  - ***The Nature of Salt***—Research the structure of salt to understand the difference between molecular compounds and ionic compounds

Salt Crystals Magnified 100x

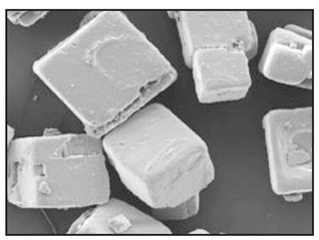

Image from California State Univ., Hayward

Online Data Tools: **http://aquarius.nasa.gov/education-datatools.html**

Analyzing sea surface salinity data patterns over time provides insight into variations in Earth's water cycle. This is because salinity patterns are governed by geographic differences in the global "water budget." Like on continents, some areas of the ocean are rainy whereas others are arid and "desert-like." Use Aquarius online data tools to learn more about the factors that influence salinity patterns, including air temperature, sea surface temperature, evaporation, and precipitation.

Aquarius/SAC-D is a space mission developed by NASA and the Space Agency of Argentina (Comisión Nacional de Actividades Espaciales, CONAE).

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24" x 20"