National Aeronautics and Space Administration

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WATER RIPPLES ACROSS THE SOLAR SYSTEM AND BEYOND

The story of water connects each of us to processes that shape our universe. As NASA explores our solar system and beyond, water plays a crucial role in our search for habitable planets and life beyond Earth. We've found water in some pretty surprising places.

The hydrogen and oxygen in water are among the most abundant elements in the universe. Astronomers see the signature of water in giant molecular clouds, newborn planetary systems, and atmospheres of giant planets orbiting other stars.

In our solar system, water is abundant. NASA spacecraft have found it in comets, asteroids, dwarf planets, and even shadowed craters on Mercury and our Moon. The giant planets contain enormous quantities of water, while their moons and rings have substantial water ice.

Some of the most intriguing water worlds are icy moons with subsurface oceans, such as Jupiter's Ganymede, Europa, and Callisto, and Saturn's Enceladus and Titan. NASA's Hubble Space Telescope provided strong evidence of Ganymede's saltwater ocean, while the Cassini mission revealed Enceladus as an active world that vents its ocean into space.

Europa Clipper, NASA's first mission dedicated to exploring an ocean world, will soon study Jupiter's moon Europa up close. Like Enceladus, Europa is thought to have a subsurface ocean in contact with mineral-rich rock, potentially possessing the ingredients needed for life: liquid water, essential chemical elements, and energy sources. And that ocean has likely been around for most of the solar system's history.

While some parts of our solar system are drenched, others have lost significant water. On Mars, NASA rovers have discovered evidence of ancient rivers and hot springs. The Perseverance Rover has collected samples of water-altered rocks to return to Earth for detailed study. NASA scientists have been unraveling how Mars lost its water over time, finding it once had enough to form a vast ocean. Crucially, they've discovered that much of Mars' early atmosphere was stripped away by the solar wind – the stream of charged particles from the Sun – causing the planet to dry out.

The distribution of water across our solar system reveals much about its formation 4.5 billion years ago. A "frost line" near Jupiter's orbit divided the hot, dry inner solar system from the cold outer regions where water could condense into ice. Water was probably delivered to the inner planets, including Earth, by comets and water-bearing asteroids. NASA's study of these small bodies helps fill in our understanding of how the planets formed, and water is an important part of that story.

Jupiter, likely the first planet to form, holds clues about our system's origins in its water content. NASA's Juno mission has found Jupiter has more water in its deep atmosphere than expected, which is helping to refine our models of planetary formation.

Beyond our solar system, water is crucial in the search for habitable exoplanets – planets orbiting other stars. For example, the concept of a star's "habitable zone" is tied to the potential for liquid water. NASA's Kepler mission discovered thousands of planets in these zones, and scientists think many exoplanets could be covered by deep oceans. The TESS mission searches for Earth-sized exoplanets around nearby stars, and the James Webb Space Telescope will examine the atmospheres of many of those planets in detail, searching for signs of water and other interesting chemistry. As NASA continues to search, we're finding the night sky full of exoplanets, and it's likely some have seas crashing against their alien shores.

This is how the story of Earth's water connects to the larger story of our solar system and beyond. Every world orbiting our Sun got its water from the same source, and we think the watery processes that shaped our family of planets are echoed across the cosmos. Instead of ending up in your glass, the water you drink could easily have been part of a comet, an ocean moon, or an ancient river on Mars.

Through its exploration and discoveries, NASA illuminates how water links cosmic processes shaping our universe, from tiny moons to vast galaxies. In its own way, each glass of water tells a story spanning billions of years and countless worlds, and can remind us of our place in the cosmic sea.

https://science.nasa.gov/solar-system/ocean-worlds

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