Exploring the Optimal Environmental Conditions for Life

Living Space

Humidity on Earth and on the ISS

Action Project
Backgrounder

Humidity on Earth

The three main states of matter are solid, liquid and gas.

Most of the air around you has water in it, but the water is invisible. So how do we know it is there? We can feel it! **Humidity** is a measurement of how much **water vapor** in the air. Water vapor is water in its gas state. Unlike the solid and liquid states of water, we cannot see water vapor. When you see clouds in the sky or steam coming out of a kettle, what you are seeing is liquid water and not water vapor.

Humidity is measured using a device called a **hygrometer** (*high-grow-meter*). The most common way that people measure humidity is called **relative humidity (RH)**. Relative humidity is the ratio of water vapor in the air to the maximum amount of water vapor that the air can hold at a specific temperature. The warmer the air, the more water vapor it can hold. Relative humidity measurements are given as a percentage (**%**). For example, if the air can potentially have 50 g of water vapour at a certain temperature, but it only actually has 25 g of water vapour, then the relative humidity is 25g/50g or 50%RH.

Water vapor plays a big role in the **water cycle**. Even in a clear, blue sky, there is still water vapor in the air. When water vapor in the air changes to liquid water, such as in a cloud, we call this **condensation**. When the clouds can no longer hold all of the liquid water, there is **precipitation**. The opposite of condensation is **evaporation**. Evaporation happens when water changes from a liquid back to a vapor. Heat is what makes evaporation happen, which is also why warmer air can hold more water vapor in it than cooler air.

Try this!
Wet a small patch on the back of your hand. Blow on that hand. Which part of the hand feels coolest?

People tend to be very sensitive to humidity. This is because as humans, we use sweating as a way to keep our bodies from overheating. When we sweat, water from the sweat evaporates from our skin. As it evaporates, the water transfers heat away from our skin, so our skin feels cooler.

When the relative humidity is high (over 50%), evaporation from our skin does not happen as much so we do not cool down very well. High humidity can also help things like dust mites, bacteria, viruses and mold (a type of fungus) to multiply and spread. This can make things worse for people with asthma, allergies or other breathing problems.

During the winter months, when the air is cooler, the relative humidity can go way down (under 30%). Relative humidity can get even lower indoors when heating systems come on. Very low relative humidity can lead to dry, itchy skin, lips and hair, scratchy throats and noses, and long-lasting colds and flu.

So, what is the optimal or 'best' range for relative humidity in a classroom? It depends on the season. In the winter months, the optimal relative humidity for an indoor environment is around 30%RH. For the spring and summer months, the optimal relative humidity for an indoor environment is between 30% and 50%RH.

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Humidity on the International Space Station

The International Space Station (ISS) is a closed environment. All of the water that is on board the ISS was originally brought up from Earth. Almost all of the humidity in the air of the ISS comes from the astronauts, either through respiration (breathing) or perspiration (sweating). Controlling the humidity on the ISS is important both to protect the astronauts' health and also to protect the equipment on board the ISS and the station itself.

Humidity on the ISS is measured and monitored by the Temperature and Humidity Control (THC) subsystem of the Environmental Control and Life Support System (ECLSS). Humidity on board the ISS is kept at around 60%. The THC makes sure that the air circulates throughout the station so that moisture does not build up anywhere. Humidity is controlled on board the ISS by the heat exchangers that are part of the Active Thermal Control System (ACTS) (see the Temperature on Earth and on the ISS Backgrounder). As air passes through the heat exchangers and is cooled, the water in the air condenses (changes from a gas to a liquid). The water is then collected so that it can be reused.

Recycling of water is very important on the ISS. Approximately 93% of astronauts' waste water (perspiration, respiration, and urine) is reprocessed to be usable water. This keeps the humidity on the station down and helps maintain the station's water supply.

If the relative humidity gets to 70% or higher, there can be problems for both the astronauts and the ISS. The biggest problem is that warm, humid conditions can lead to the growth of microorganisms like bacteria and fungi. These microorganisms can make astronauts sick if they breathe in the microorganisms. Microorganisms can also be bad for the station itself. Microorganisms can weaken the steel that makes up the structure of the ISS. They can also make glass hard to see through, make rubber seals brittle, and clog air and water filters.

Above: The Water Reclamation Subsystem for the International Space Station. (Photo by NASA)

High humidity can also lead to condensation inside the space station. Water on electronics could cause equipment to short-circuit and maybe start a fire. Russia's *Mir* Space Station, which astronauts lived on from 1986 to 2000, had a lot of problems with microorganisms and condensation as it got older. In 1998, astronauts found a floating globule of water the size of a grapefruit behind an access panel in one of *Mir*'s modules that was full of microorganisms. Over 140 different types of microorganisms were found to be living on *Mir* by the time it was decommissioned in 2000. Aside from the health hazards that high humidity and microorganisms on board *Mir* posed, astronauts on that station said that it smelled really bad, which didn't help their mental health!