

# The MAVEN Mission: Climate Detective



## Mission Facts and Stats

Name: Mars Atmosphere and Volatile EvolutionN (MAVEN)

Launch: November 2013

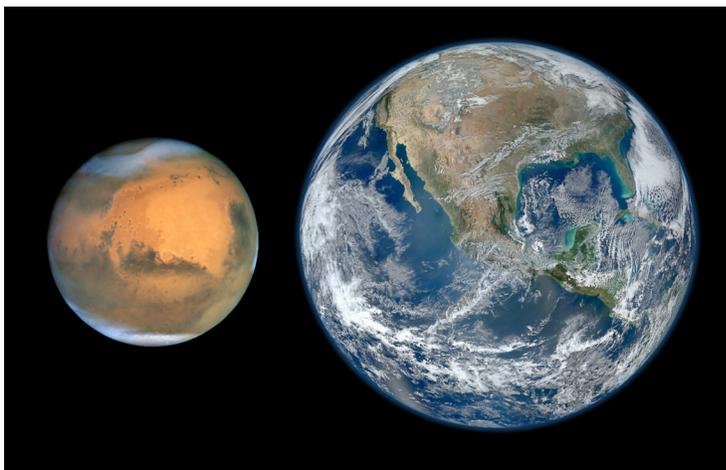
Arrival at Mars: September 22, 2014

Mission ends: April 2016

Image courtesy of NASA

## Why is Mars so Dry?

At some point in its early history, Mars had a warmer and wetter climate. Around four billion years ago, Mars and Earth both had flowing water, and it's pretty likely Mars had a similar climate to Earth's. To have liquid water on its surface, Mars must have had a thick atmosphere with a lot of greenhouse gases that kept it warm. On Earth, greenhouse gases in our air, like carbon dioxide and water vapor, keep us at a reasonable temperature. What happened to Mars? Where did all of the atmosphere and water go? Scientists aren't really sure, but they do have some guesses about where the atmosphere went. Sometime around 3.8 billion years ago, Mars started to change. To search for clues about Mars' lost atmosphere, scientists first compare what Earth and Mars were like 3.8 billion years ago. That way, they can spot what went wrong on Mars.



This is what Mars (left) and Earth (right) look like today. Now, they are very different places, but Mars and Earth were probably more similar in the past. Early in their history, Mars and Earth both had rivers and lakes. Today, only Earth has flowing water. The planets are shown sized to scale (but not for distance).

Images courtesy of NASA

## Let's Compare and Contrast Earth and Mars 3.8 Billion Years Ago

Earth	Mars
Volcanoes erupting ✓	Volcanoes erupting ✓
150 million kilometers (93 million miles) from the Sun	228 million kilometers (142 million miles) from the Sun
Greenhouse atmosphere ✓	Greenhouse atmosphere ✓
Frequent meteorite and comet impacts ✓	Frequent meteorite and comet impacts ✓
Magnetic Field	Magnetic field shut off (no magnetic field)
Gravity	Gravity (but about 1/3 of Earth's)

Items marked with a check were similar on both Earth and Mars 3.8 billion years ago.

The biggest differences are the distance from the Sun, the magnetic field, and gravity. Let's look at each one...

**Distance from the Sun:** The farther a planet is from the Sun, the colder it is, unless it has a lot of greenhouse gases in its atmosphere. Since Mars is farther from the Sun than Earth, it would have had even more greenhouse gases in its atmosphere than Earth to keep it warm. That just means beginning 3.8 billion years ago, Mars had a lot of atmosphere that got lost. Once it got cold enough, some of the atmosphere became permanently frozen—like water vapor freezes and forms snow on Earth—but most of it had escaped to space long before that ever happened.

**Magnetic Field:** The Earth acts like a gigantic magnet because the outer core is made of melted iron. The iron moves around as Earth spins, creating a global magnetic field. It's sort of like having a giant bar magnet inside of the Earth, and it's the reason we can use a compass—the dial in your compass lines up with Earth's global magnetic field telling you where north is located.

The Sun has an atmosphere, too, and it creates a wind called the "solar wind." This wind is made up of material from the Sun and it travels through the Solar System. Earth's global magnetic field acts like a protective bubble, blocking the material from impacting our Earth and atmosphere. Mars had a global magnetic field before about 4 billion years ago, but the interior cooled off and that made the magnetic field shut off. We still find areas of magnetized rocks in Mars' southern hemisphere today, but Mars doesn't have a global magnetic field anymore. The solar wind can impact Mars' surface and carry away some of the atmosphere. Would you be able to navigate with a compass on Mars?

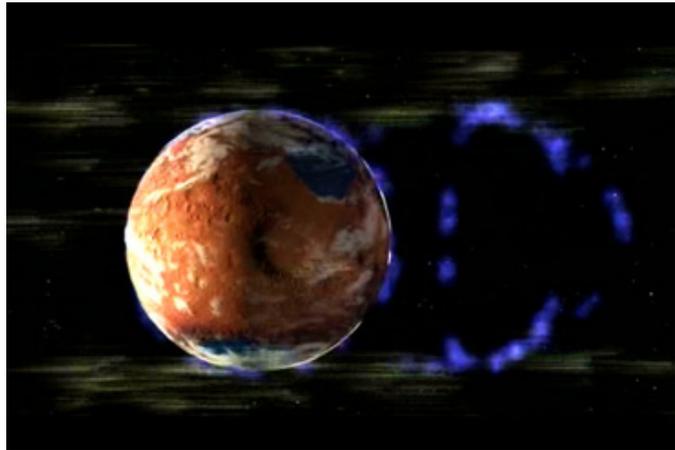
**Gravity:** Gravity holds things down, including our atmosphere. If there is less gravity, it's harder for a planet to hold on to its atmosphere. Mars probably had a lot of atmosphere—even more than Earth—but Mars doesn't have as much gravity. When a comet or meteorite hits a planet, it splashes into the atmosphere like a rock dropped into water. If you had a big splash from a big meteorite, some atmosphere could have escaped Mars' low gravity.

## So, What Happened to Mars' Atmosphere? The MAVEN Mission Searches for Clues

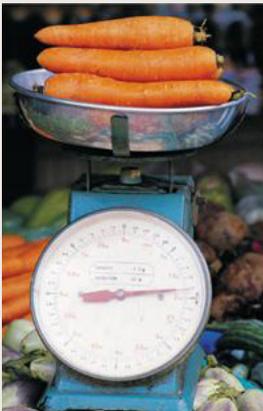
There are a lot of things about Mars that scientists don't know, so they send spacecraft to visit the planet. The MAVEN mission will visit Mars to gather clues about Mars' atmosphere. MAVEN has instruments that measure how much atmosphere Mars has, what's in the atmosphere (like carbon dioxide), and how much atmosphere is carried away by the solar wind today. By doing some careful math with a computer using clues from MAVEN, scientists can figure out how much of the atmosphere got carried away by the solar wind over time. Then they can trace out the entire history of Mars, like detectives solving a big crime case.

This image, created by an artist, shows the atmosphere being carried away by the solar wind. Scientists aren't sure how much of Mars' atmosphere actually got carried away over time. Instruments onboard MAVEN will make measurements to find out.

Image courtesy of NASA.



### What's an Instrument?



*An instrument is a tool used to collect information. Have you ever used a thermometer, scale, or ruler? These are scientific instruments used to take a measurement of temperature, weight, or length. Instruments of all kinds are used every day for many things. For example, scientists use instruments to collect measurements of wind speed, temperature, and the amount of water vapor in the air so we can get the weather report. Very often, those instruments are on satellites orbiting Earth in space!*

*MAVEN will have a set of instruments, called the Particles and Fields Package, to measure the solar wind speed and energy. Other instruments are called spectrometers (*spek-trom-i-ter*) and spectrographs (*spek-truh-graf*), which measure the gases in the atmosphere. Information about the solar wind and Martian atmosphere will help scientists solve the climate mystery!*



One of the instruments in the Particles and Fields Package. Image courtesy of NASA Goddard.