

# RESEARCH SPOTLIGHT

Highlighting exciting new research from AGU journals

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## Coastal turbulence is highly heterogeneous

When fresh river water first flows into the salty coastal ocean, the two types of water remain highly stratified. However, the difference in velocity between the river and ocean waters can cause turbulence—chaotic motion that breaks through density barriers and promotes mixing. Understanding the role of turbulence in driving coastal water properties—from temperature to salinity to nutrient load distributions—requires a more complete understanding of the physics of coastal turbulence.

Previously, researchers had used two different techniques to analyze coastal turbulence: small-scale microstructure analysis, which measures individual turbulent vortices that can sometimes be as small as a few centimeters, and control volume measurement, which estimates mean turbulent properties over tens or hundreds of meters. These techniques, however, disagreed in their observations.

Rather than assuming that one of the techniques is necessarily flawed, researchers proposed that the discrepancy could arise if turbulence is highly heterogeneous. If tur-

bulent motion is not evenly distributed throughout the water, then the point-measure microstructure approach would give a different result than the broader control volume approach.

Adding a third observational technique to the mix, a point-measure technique known as turbulent overturn analysis, *MacDonald et al.* studied coastal turbulence in the outflow of the Merrimack River into the Gulf of Maine as part of the Merrimack River Mixing and Divergence Experiment (MeRMADE) project. The additional technique offered a way to bridge from the small-scale microstructure analysis to the larger-scale volume control measurements. Their observations showed that coastal turbulence is highly heterogeneous, with overturning motion in 10% of the water volume accounting for roughly 95% of the total mixing. (*Journal of Geophysical Research-Oceans*, doi:10.1002/2013JC008891, 2013) —CS

## Curiosity rover finds evidence of Martian atmospheric loss

Researchers think that roughly 4 billion years ago, the atmosphere of Mars started to wither away, blasted into space by the solar wind and other forces.

This atmospheric loss transformed Mars from a warmer and wetter planet to its current cold, arid state. As time progressed, Mars lost at least half but probably as much as 95% of its atmosphere.

This hypothesis of the red planet's atmosphere fading over time by loss to space has gathered new support from measurements made by NASA's Curiosity rover. Using the rover's quadrupole mass spectrometer, one part of the Sample Analysis at Mars (SAM) instrument suite, *Atreya et al.* determined the argon isotope



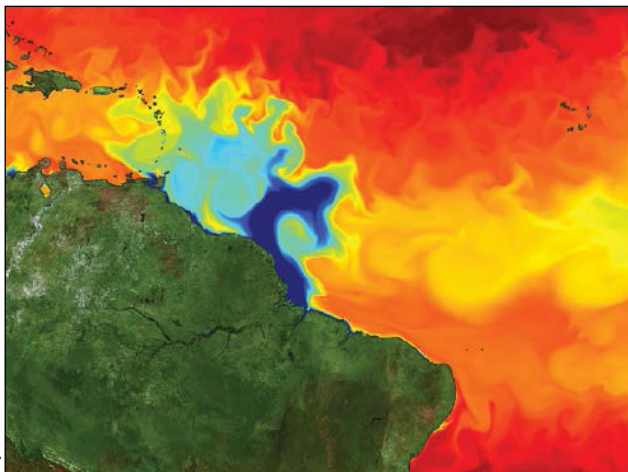
MSL/SAM Project. NASA GSFC/JPL

Scientists load the Sample Analysis at Mars (SAM) instrument suite into its qualification and calibration chamber before the launch of the Curiosity rover.

ratio in the modern Martian atmosphere. The authors found that the ratio of argon-36 to argon-38 is biased toward the heavier isotope, a trend consistent with measurements of isotopes in other atmospheric gases. The observations, they suggest, provide proof of Mars's history of atmospheric loss to space.

Gases in the Martian upper atmosphere become stratified by mass, with heavier isotopes occupying lower atmospheric levels than lighter ones. As the solar wind strips the particles from the upper layers of the planet's thinning atmosphere, heavy isotopes increase in relative abundance, and over time, the well-mixed atmosphere slowly becomes enriched in heavy isotopes. As a nonreactive noble gas, the sources and sinks of argon are much easier to trace than those of other atmospheric constituents, such as carbon, oxygen, and nitrogen. The team found a ratio of 4.2 for the concentration of argon-36 to argon-38, skewed compared to a ratio of roughly 5.4 found in a wide variety of other objects in the solar system, which is a clear signature of the loss of atmosphere from Mars in the past 4 billion years. (*Geophysical Research Letters*, doi:10.1002/2013GL057763, 2013) —CS

—COLIN SCHULTZ, Writer



MyOcean

Fresh river water from the Amazon (cool colors) pushes into the saltier Atlantic Ocean (warm colors).