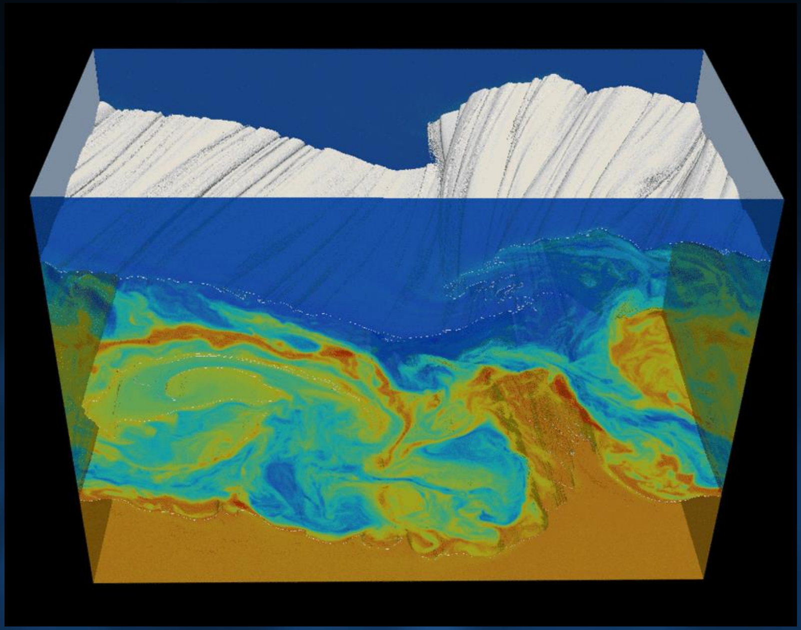
Plasma Space Tornadoes

The magnetosphere deflects most of the high-energy charged particles that come from the Sun, as well as from beyond our solar system – but some sneak through and get fed into the plasma circulatory system thousands of miles above Earth's surface. NASA's MMS (Magnetospheric Multiscale) mission is at the forefront of figuring out why: New results show that tornado-like swirls of space plasma create a boundary tumultuous enough to let particles slip into near Earth space.

Just inside the magnetosphere, the density of the space plasma is much lower than the plasma outside, where the solar wind prevails. The boundary, called the magnetopause, becomes unstable when the two different density regions move at different rates. Giant Kelvin Helmholtz waves form along the edge – looking like crashing ocean waves. The once-smooth boundary becomes tangled and squeezed, forming plasma tornadoes, which act as portholes for the transportation of charged particles from the solar wind into the magnetosphere.



MMS has spotted Kelvin Helmholtz waves at the magnetosphere's boundary, which can allow particles from the solar wind to enter Earth's magnetosphere.

Using large-scale computer simulations of this mixing, performed at the Oak Ridge National Laboratory in Oak Ridge, Tennessee, on the Titan supercomputer, and comparing them to observations MMS took while passing through such a region in space, scientists were able to show that the tornadoes were extremely efficient at transporting charged particles — much more so than previously thought. The comparisons between the simulations and observations allowed the scientists to measure the exact dimensions of the tornadoes. They found these tornadoes to be both large and small — ones reaching 9,300 miles spawned smaller tornadoes 60 to 90 miles wide and over 125 miles long.