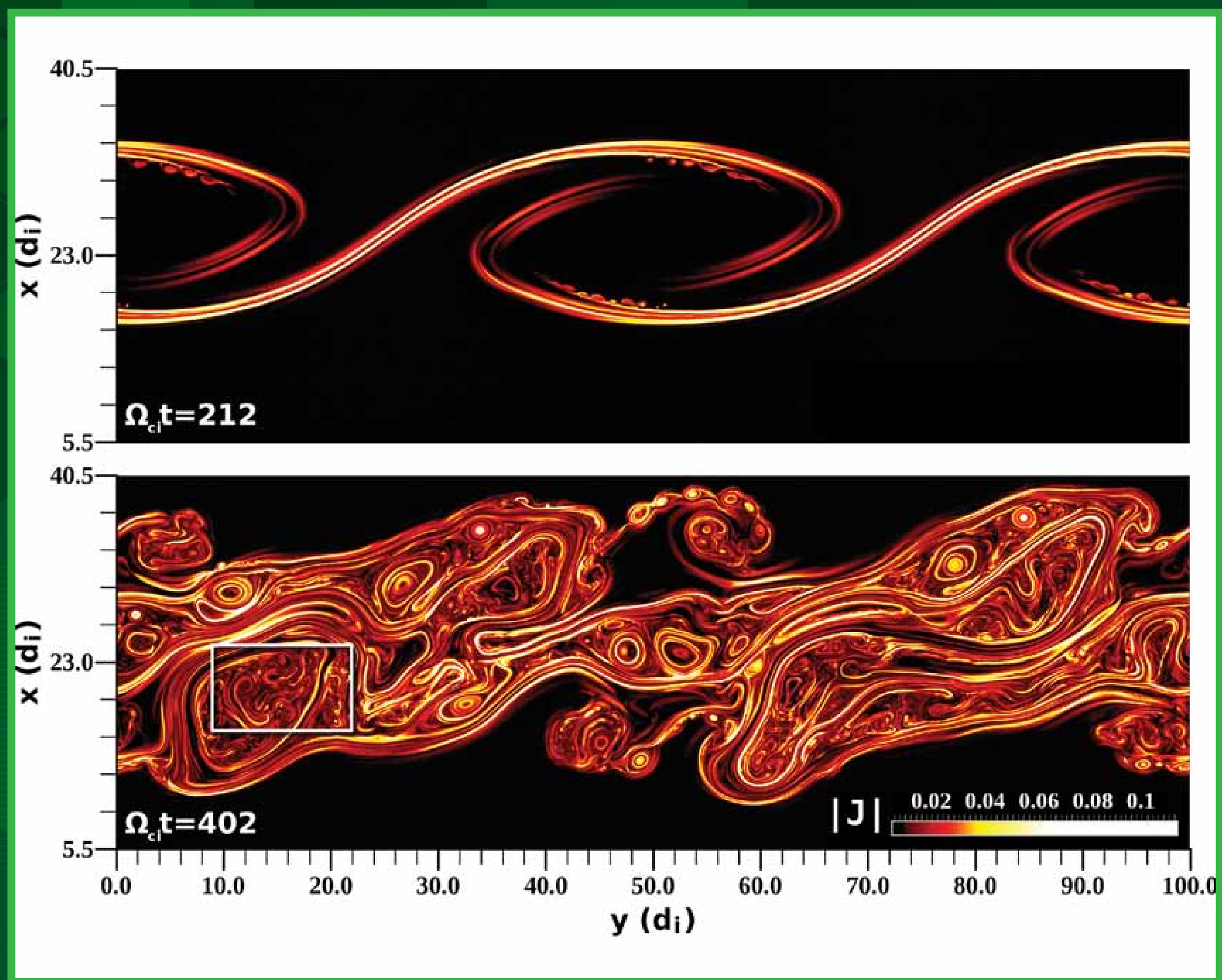
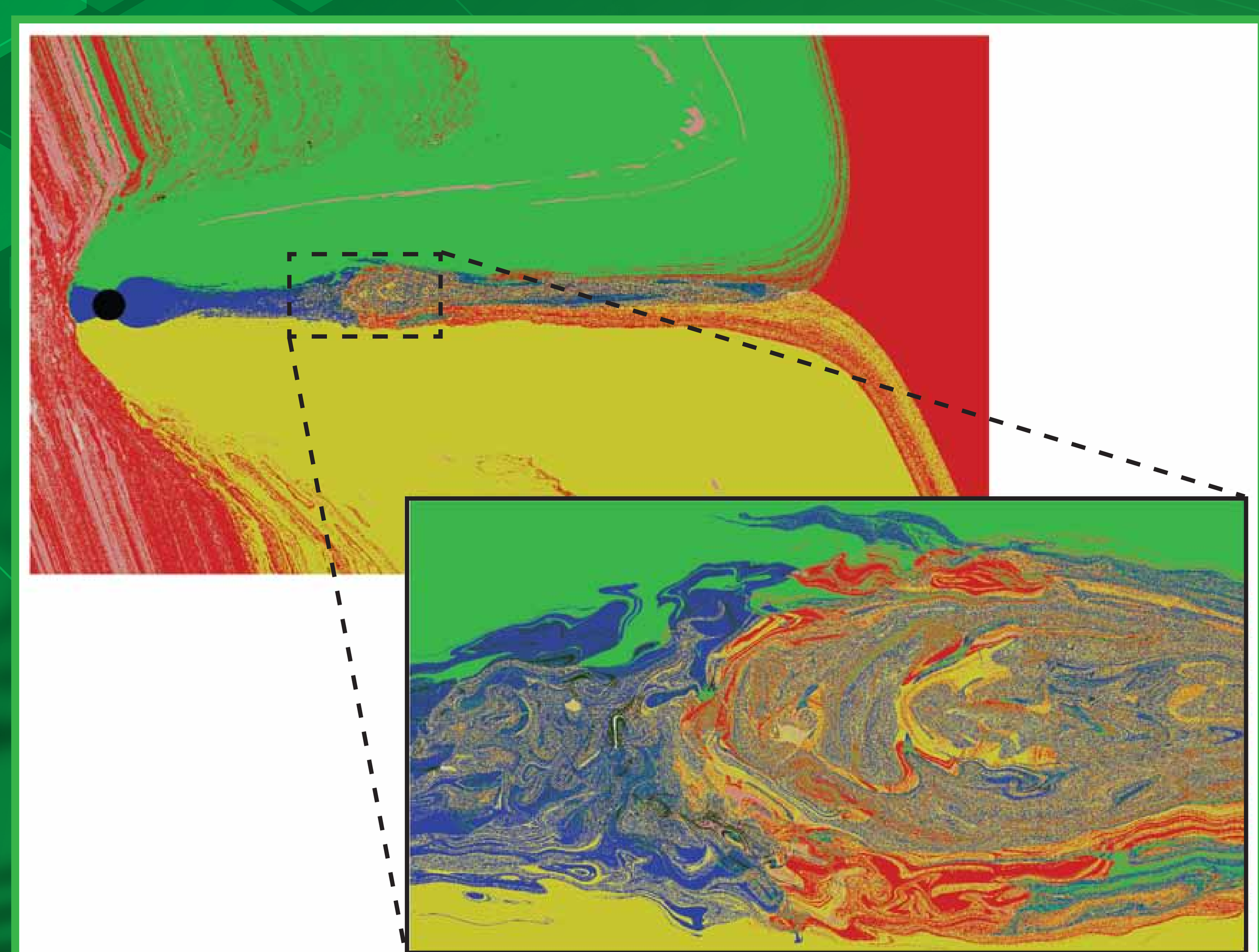
Causes and Consequences of Turbulence in the Earth's Protective Shield



Formation of turbulence driven by the presence of velocity shear. This turbulence gives rise to structures at the smallest, electron-level scales, and mixes solar wind plasma and fields with those in the Earth's magnetosphere. *Homa Karimabadi, University of California, San Diego; Burlen Loring, Lawrence Berkeley National Laboratory*



3D global hybrid simulation of the Earth's magnetosphere. The magnetic field from the solar wind is colored in red. The regions with mixed colors indicate areas where the magnetic field from the solar wind has entered and mixed with the magnetic field of the Earth. These turbulent regions amplify the adverse effects of space weather on Earth and its technological systems. *Homa Karimabadi, University of California, San Diego; Burlen Loring, Lawrence Berkeley National Laboratory*

The solar wind blows continuously from the outer atmosphere of the Sun at speeds as high as 900 kilometers per second and at a temperature of 1 million degrees Celsius, engulfing the Earth and other planets, and extending to over 10 billion miles. The Earth's dipole magnetic field creates a protective shield, called the magnetosphere, which insulates us from most of the Sun's effects. Without this field, life on Earth would not be possible. However, the shielding is not perfect, allowing the solar wind to penetrate the Earth's magnetosphere.

Spacecraft observations reveal that many regions in the magnetosphere exhibit turbulence, which can enhance mixing—thereby amplifying the effects of space weather on the Earth. In this project, we have:

- Run simulations that for the first time enable us to follow the development of this turbulence and its consequences
- Discovered mechanisms for the generation of the turbulence
- Confirmed several predictions through comparison with spacecraft observations
- Provided input to the design and planning of NASA's upcoming Magnetospheric Multiscale Mission

Petascale, kinetic simulations on massively parallel systems such as Pleiades have enabled us to leapfrog existing state-of-the-art magnetospheric models. These simulations have been crucial to our breakthrough studies and are enabling closure on critical issues in magnetospheric physics

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