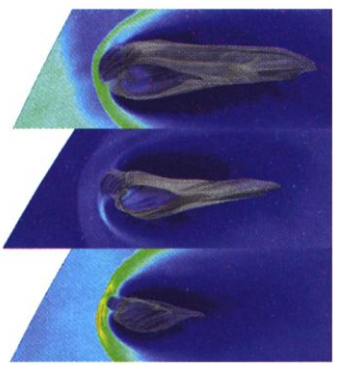
The Terrestrial Web

Earth is controlled by an integrated system of dynamic forces acting on all phases (gas, liquid, and solid) of the matter that makes up our terrestrial web. These forces and their phases are linked in an intricate, and in many ways unknown, pattern. Here we review some of the latest models and observations of five subsystems of Earth: the expansive plasma-dominated magnetosphere, the gaseous atmosphere, the fluid ocean, the solid convective mantle, and the fluid-to-solid core. The magnetosphere is dominated by Earth's magnetic field, which protects the planet from the solar wind while providing the connective conduit between the solar wind and the ionosphere, creating aurorae and geomagnetic storms. Lyon (p. 1987) reviews the recent observations of a substorm that provides an improved understanding of magnetic reconnection between the solar wind's magnetic field and Earth's magnetic field.

Coupled general circulation models (CGCMs) are one of the most promising approaches for understanding the complex interactions between the atmosphere and oceans. Grassl (p. 1991) reviews the current state of CGCMs, including the ways in which they are tested and evaluated, how they have improved our understanding of climate variability, how well we think we can predict climate, the extent and causes of modern climate variability, and how CGCMs can be improved.

El Niño and La Niña, the warm and cold phases of sea surface temperature in the equatorial Pacific Ocean, are the largest single sources of global interannual climate variability. How El Niño and La Niña have varied in the past; are varying now; and will vary in the future, perhaps in response to global warming, are questions with more than just academic importance. Fedorov and Philander (p. 1997) review what we have learned recently about why they occur and whether or not they may be changing as a consequence of changing climate. They suggest that understanding El Niño and La Niña must include a better knowledge of the background state of climate within which they exist.

In two News stories (pp. 1984 and 1986), Richard Kerr reports that climate shifts on longer time scales than El Niño's 2 to 7 years are drawing the attention of researchers. On the decadal scale of 10 to 20 years, there are persistent signs that an inconstant sun may subtly affect climate. And on multidecadal time scales of 40 to 80 years, a restless North Atlantic seems to be at work, alternately countering and enhancing humankind's alterations of climate.



PAGE 1987

Tackley (p. 2002) considers our current understanding of the convective pattern of the mantle, which comprises the bulk of the silicate Earth squeezed between the crust and the core. He tries to reconcile plate tectonics with mantle convection and discusses models that improve the integration of chemical mixing with convective flow. Finally, in the center of Earth, Buffett (p. 2007) explores the generation of the geodynamo by fluid motions in the outer liquid iron core, which produces the magnetic field. Models using different flow patterns are able to produce a self-sustained dipole field, and the challenge will be to determine which pattern represents Earth. Ultimately, the geodynamo drives the magnetic field, which dominates the magnetosphere. Finding the links within and between these subsystems remains a fundamental challenge for untangling the mysteries of the terrestrial web.

To provide additional depth, the staff of *Science* Online has put together a special Web supplement that includes a selection of previous *Science* articles related to the themes of the special issue, as well as links to other online resources. To explore it, see www.sciencemag.org/feature/data/earthdynamics/main.shl.

–LINDA ROWAN AND H. JESSE SMITH

CONTENTS

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