ECHOES

"If people knew that they were threatening the environment by eating more meat, they might think twice before ordering a burger."

—GERI BREWSTER, nutritionist at Northern Westchester Hospital in New York on how eating less meat could help slow global warming by reducing livestock and the methane flatulence they produce. In a special energy and health series of the medical journal, *The Lancet*, experts said people should eat fewer steaks and hamburgers and reduce global red meat consumption by 10% to have an effect. (SOURCE: The Associated Press)

by the U.S. Navy and NASA, was built in 1986. It began operating in the U.S. Virgin Islands before being redeployed off Key Largo in 1993. It is a 9-ft-diameter tube, 43 ft long, resembling a school bus in size and color, sitting beneath 60 ft of water. The facility has bunk beds and showers; a microwave, refrigerator, and sink; and the computer and diving equipment needed to research reefs and collect, assemble, and relay data.

Food, computers, and other equipment are sent down using pots that can handle two and a half times normal atmospheric pressure below the ocean's surface. The station lets researchers dive for 9 hours a day and return to the habitat without standard scuba diving requirements of surfacing and decompressing. After the expedition, the aquanauts must decompress for 17 hours to avoid the "bends."

This was the first time live classes were conducted from Aquarius Reef Base. A school in Florida and another in Michigan received direct interactive feeds, as did the University of North Carolina-Chapel Hill and UNC's Institute of Marine Science in Morehead City. Other classes could follow the team online at www.oceanslive.org. (SOURCE: NOAA)

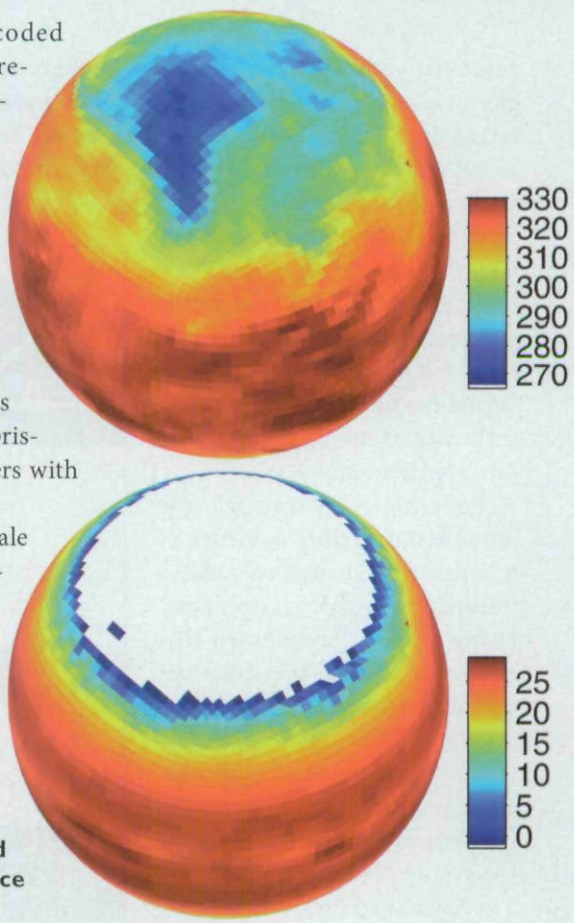
PAPERS OF NOTE

MEAN CLIMATE AND VARIABILITY OF AN IDEALIZED 'AQUA-PLANET'

It is very difficult to identify controlling mechanisms behind climate and climate variability because there is a myriad of drivers acting on a vast range of time scales that, due to nonlinearities and feedbacks, do not superpose. As a result, it is all but impossible to carry out "what if" experiments even with observations. Moreover, climate models have to represent key processes parametrically and are used almost exclusively in "simulation and projection" mode rather than for asking mechanistic questions.

In an attempt to exploit in a different way the information and knowledge encoded in climate models, researchers at the Massachusetts Institute of Technology have recently begun to use them to explore the climate of highly idealized worlds in which, for example, there is no land, or the land distribution is highly idealized comprising meridional barriers with and without gaps.

Millennial time-scale simulations of a coupled atmosphere–ocean–ice system in the absence of land and driven by mod-



Atmospheric temperature at 500 mb (K, top) and sea surface temperature and ice distribution (°C, bottom) in an equilibrium state after 3000 yr of integration of a coupled atmosphere–ocean–ice model on an "aqua-planet." Sea ice extends down to 55° latitude in each hemisphere.

ern-day orbital and CO_2 forcing yield a climate on this so-called "aqua-planet" in which ice caps reach down to 55° latitude and both the atmosphere and ocean comprise eastward- and westward-flowing zonal jets whose structure is set by their respective baroclinic instabilities. Despite the zonality of the ocean, it is remarkably efficient at transporting heat meridionally through Ekman transport and eddy-driven subduction. Indeed the partition of heat transport between atmosphere and ocean is much the same as the present climate, with the ocean dominating in the tropics and the atmosphere in the middle-to-high latitudes.

Variability of the system is dominated by the coupling of annular modes in the atmosphere and ocean. Stochastic variability inherent to the atmospheric jets drives variability in the ocean. Zonal flows in the ocean exhibit decadal variability which, remarkably, feeds back to the atmosphere, coloring the spectrum of annular variability. A simple stochastic model can capture the essence of this process.

We are presently studying, in an aqua-planet framework, the role of geometry in constraining ocean pathways and the ability of the ocean to transport heat poleward; the possibility of the coupled system exhibiting multiple equilibria; snowball earth scenarios; and coupling in biogeochemical cycles. Our goal is to improve our understanding of the interaction between the atmosphere and ocean in setting the climate of our own planet.—John Marshall (Massachusetts Institute of Technology), D. Ferreira, J.-M. Campin, and D. Enderton. *"Mean Climate and Variability of the Atmosphere and Ocean on an Aqua-Planet," in the December* Journal of the Atmospheric Sciences.

CLIMATE GAMES

The popular series of "Sim" computer games, known for their realistic reproduction of real-life events, are now incorporating the effects of greenhouse-gas emissions into their newest game, SimCity Societies, released in November. In the game, players build a society by placing roads, buildings, power sources, etc., onto a grid. The society then grows based upon various developmental choices of the players. Those choices include the societies' power sources, which range from cheaper options that emit high levels of carbon dioxide to more expensive, but more environmentally friendly, options such as wind farms and solar power. The game monitors the carbon released into the atmosphere as well as threat levels for natural disasters such as droughts and heat waves. "With SimCity Societies, we have the opportunity not only to demonstrate some of the causes and effects of global warming, but also to educate players how seemingly small choices can have a big global impact," notes Steve Seabolt of Electronic Arts, which released the game. (Source: Electronic Arts Inc.)

Vertical Precipitation Structures of Cyclones Crossing the Cascades

On 23 March 1806, as the Lewis and Clark expedition was breaking camp after spending the winter on the Oregon coast, Lewis complained about "rain which has fallen almost constantly since . . . November last." This thought was perhaps the first ever recorded about the seemingly continual barrage of winter rainstorms passing over the Pacific Northwest. With the region's primary annual precipitation falling from Pacific storms, their evolution into the mountainous western United States has been the focus of a long history of mesoscale studies and field projects. Our research provides a recent look at the precipitation structure in these storms from an observational perspective.

We describe radar-observed structures characterizing sectors of extratropical cyclones as they move over the Oregon Cascade Mountains from the Pacific. "Early," "middle," and "late" cyclone sectors are associated with warm advection, warm-to-cold advection transition, and cold, unstable air behind cold and/or occluded fronts, respectively. Previous studies have documented the horizontal precipitation patterns of midlatitude cyclones. However, when these systems move over a mountain range, the horizontal patterns characterizing the different storm sectors are obscured and hard to distinguish. We determined that storm sectors can be distinguished during passage over the Cascades in terms of their vertical structures, as observed by a vertically pointing radar, rather than by horizontal patterns. Moreover, we summarized these distinguishing vertical features, repeatable from storm to storm, in a conceptual model.

During the early storm sector, a deep layer of precipitation, the leading edge echo (LEE), appears aloft and descends toward the