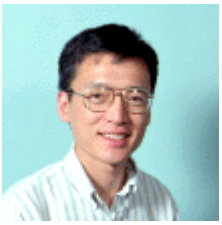
Science Briefing

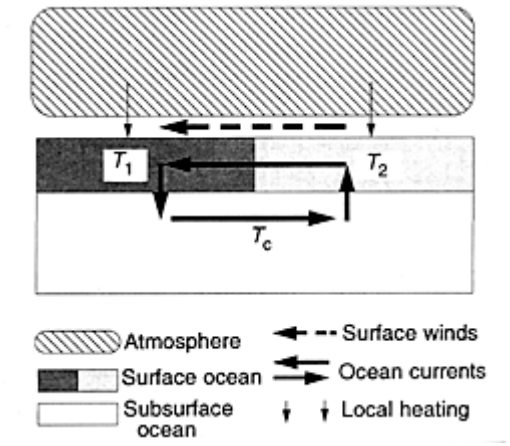
Whether the climate is past or present, research and observations have shown that sea-surface temperatures (SSTs) in the tropical Pacific Ocean rarely exceed 32 degree C. Why? In the early 1990s, Veerabhadran Ramanathan (Scripps Institution of Oceanography) hypothesized a thermostat effect in which tropical showers and thunderstorms increase with sea-surface temperatures. The convection, in turn, would throw thick cloudiness over the region, reducing incoming solar radiation and keeping a lid on temperatures.

De-Zheng Sun, an ASP postdoc working in CGD, has brought forth an alternative explanation for the SST limit in the tropical Pacific. De-Zheng's paper, "Dynamic Ocean-Atmosphere Coupling: A Thermostat for the Tropics," appeared in the 24 May issue of *Science*.



De-Zheng Sun (Photo: Carlye Calvin)

In this new hypothesis, the wind-driven ocean currents regulate the tropical SSTs. Because of the dynamic coupling between the atmosphere and ocean (a key process in the El Nino/Southern Oscillation, or ENSO), the strength of the wind-driven ocean currents in the tropical Pacific changes in tune with radiative heating (solar input and related greenhouse effects). Stronger heating is accompanied by stronger ocean currents, which carry heat both downward and poleward--but away from the tropical ocean surface.



De-Zheng Sun devised a simple two-section model to illustrate his SST thermostat theory. Easterly trade winds, driven by east-west SST gradients, push the surface water westward. The waters descend in the western Pacific and then travel eastward via the deeper ocean to resurface in the eastern Pacific. The trade winds also drive a meridional circulation (not pictured) that moves heat poleward.

In a related set of equations, De-Zheng takes into account solar input and the feedbacks of water vapor and cloudiness. The resulting picture of the ocean-atmosphere system has two modes. One is a theoretical warm equilibrium state with no ocean currents or sustained surface winds. Once the radiative heating is sufficiently strong, the system becomes unstable and automatically shifts to a new equilibrium that resembles the present. Temperature gradients drive wind and water currents that intensify oceanic heat transport, which helps to keep SSTs from increasing beyond 32 degree C.

Oceanic heat transport out of the western Pacific is an important element in De-Zheng's results. While the amount of this transport is relatively small compared to the other forces at work in the tropical Pacific, it grows rapidly as SSTs rise. Other forces, though relatively large, tend to cancel each other out. Thus, says De-Zheng, the oceanic transport is a major factor in the sensitivity of tropical SSTs, one he feels has been overlooked in previous work.

The hypothesis also offers a new theory behind the east-west SST gradients that are critical in sustaining ENSO. De-Zheng is now working on a paper that will discuss the impact of greenhouse-gas increases on the El Nino/Southern Oscillation. "ENSO is a more delicate phenomenon than the overall

climatological structure of the tropics," he says.

At its July meeting, the UCAR Board of Trustees announced the appointment of CGD director Maurice Blackmon as senior scientist. Maurice took the helm of CGD in May 1995 after seven years as director of NOAA's Climate Diagnostics Center. His climate research includes studies of ENSO. While at NCAR in the late 1970s and early 1980s, Maurice helped develop the first generation of the NCAR community climate model.

The board also approved two new affiliate scientists in ACD: Dieter Ehhalt (Institute of Atmospheric Chemistry, Julich, Germany) and Stuart Penkett (University of East Anglia, United Kingdom). Affiliate scientists work closely with NCAR researchers on topics of mutual interest.

In this issue...

Other issues of *Staff Notes*

UCAR
NCAR
UOP

Prepared by Jacque Marshall, jacque@ucar.edu, 303-497-8616