An important advantage of the air extraction technique over other CO_2-reduction technologies is that the location of the extraction does not need to be near the location of the emissions. As a result, the management of emissions from vehicles and existing infrastructure throughout the world could be significantly improved, and linking carbon sources to distant disposal sites could be made easier. (SOURCE: The Earth Institute at Columbia University)

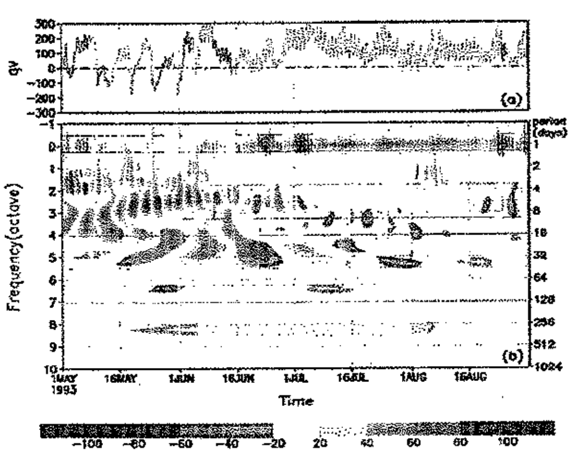
CONFERENCE NOTEBOOK

WEATHER AND THE LOCAL NATURE OF CLIMATE

Climate has traditionally been described as the average weather, or more generally, as a statistical description of both the mean state and deviations from that state. The definition influences how we think about climate, including the diagnostics and remediation of biases in climate models. A common practice, for example, is to evaluate the sensitivity of some mean circulation feature (e.g., the Icelandic Low) to a change in model formulation (e.g., gravity wave drag). Given the great disparity in the scales and physics of these two items, any attribution of cause and effect must follow from some changes in the mean fields, and a complex connection through, for instance, the large-scale mean circulation induced by the localized dissipation of waves. It is difficult to determine cause and effect; it is also difficult, at the evolved state of our current climate models, to link model formulation and model performance.

Another way to view the relationship between weather and climate is to consider the weather as transport events whose accumulated effects determine the features of the climate system. Weather is, at a fundamental level, the response of the atmosphere to spatial heterogeneity of energy (temperature). The atmosphere works to smooth out this energy distribution and, hence, transports mass, heat, momentum, and water. While it is tempting to construct heuristic models of transport as the average of transport processes, this leads to an interpretation of transport as, first and foremost, diffusive. Transport in the atmosphere is, however, not diffusive; irreversibility is associated with strong transient events that are dissipated through either diabatic physics, phase changes (conversion processes), or nonlinearity (wave breaking).

This interpretation of the link between weather and climate naturally leads to a more local interpretation of weather as climate processes. A concrete example of this is illustrated in the figure at left—adapted from Schubert et al. (1998)—which is a wavelet analysis of moisture flux over central Texas in 1993. In May there is variability in the 4–8-day time period, which is easily correlated with the baroclinic-scale waves of the springtime weather. In the summer, this behavior stops, and there is the prominent diurnal signal of the Great Plains low-level jet. These mechanisms are largely responsible for supplying the summer continent with moisture, hence driving precipitation. The seasonal change is represented by



(a) North–south moisture flux (m s^{-1} g kg^{-1}) 32°N, 97.5°W (central Texas) for May–Aug 1993. Flux is derived from the GEOS-1 reanalysis. (b) Real part of wavelet transform as a function of frequency (period) from May–Aug 1993. Color bar shows the square of the amplitude at each frequency [(m s^{-1} g kg^{-1})^2]: positive is northward flux, and negative is southward flux. The wavelet analysis is calculated from nine years of GEOS-1 assimilated observations. The wavelet analysis shows the period oscillations evident in the observations. Following the time axis, it reveals on, say, 1 June that the 4- to 8-day-period wave of the baroclinic oscillation of synoptic highs and lows was important. On, for example, 1 August, the 1-day-period wave of the nocturnal low-level jet was important. (ROOD)

THE WAR(MING) OF THE WORLDS

Earth hasn't cornered the planetary market on warming. A recent study in the journal *Nature* revealed that Mars is experiencing climate change that increased surface air temperatures on the Red Planet by 0.65°C from the 1970s to the 1990s. According to the research, dust on the planet's surface reflects sunlight and keeps down temperatures, but violent storms disrupt the dust and stifle this albedo effect, causing the absorption of more heat and, subsequently, higher temperatures. The study noted that this positive feedback is taking place on Mars, with a cyclical pattern of warmer temperatures causing stronger winds, which spreads more dust around, which leads to still warmer temperatures. According to the research, an increasing number of huge storms have been observed on Mars over the last 30 years, although the cause has yet to be determined.

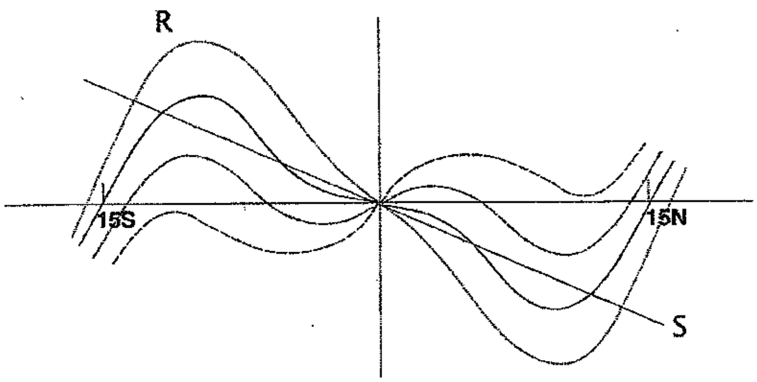
a change in transport mechanism. This example shows that climatologically important features, such as continental moisture and seasonal transitions, are directly related to dynamical mechanisms that are important weather features. The representation of these mechanisms and their change is important for developing climate-change information that is useful on regional scales, and for determining which local and regional mechanisms must be represented in climate models.

This local view of climate as the accumulation of weather-related transport events is a useful construct for both diagnosing errors in climate models and providing more robust information for development of climate-change adaptation strategies. It relies on the self-consistent representation of weather-scale dynamical processes in climate models, which is a distinctly different problem from numerical weather prediction. This concept has been successfully applied to the remediation of North Atlantic sea-ice bias in the Community Climate System Model.—RICHARD B. ROOD (UNIVERSITY OF MICHIGAN). *"Bias in Climate Models: A Weather-Scale Approach to Their Understanding," presented at the Presidential Forum, San Antonio, Texas, 15–18 January 2007.*

WHY SIMULATING THE ITCZ IN GCMS IS SO DIFFICULT

The Intertropical Convergence Zone (ITCZ) in global climate models (GCMs) is highly sensitive to model physics, particularly the cumulus parameterization scheme. Yet, knowledge of the model physics used in GCMs is inadequate, at best, to accurately represent the forcings on the ITCZ, which ultimately makes it very difficult to simulate in GCMs. Our research looks at how the high sensitivity of the ITCZ to the model physics arises and how it is related to the types of systematic ITCZ errors we see, including the "false double ITCZ."

In earlier work, we used an aquaplanet GCM having a zonally uniform sea surface temperature (SST) with a global-scale Gaussian latitudinal profile and a pole-to-Equator difference of 29°C. Previous experiments in which the latitudinal SST profile was moved north and south during a seasonal cycle without changing its shape revealed that the latitudinal location of the ITCZ was determined by a balance of two forcings. The first forcing (*S*) pushes the ITCZ toward the latitude of the SST peak. Thus, if the ITCZ is located south of the Equator, it experiences a northward push when the SST peak is at the Equator. The second forcing (*R*) is caused by the Earth's rotation. A positive value means southward forcing.



A schematic diagram showing line *S*, representing the northward forcing on the ITCZ due to the SST peak, and forms of curve *R* (relative to line *S*), which varies according to the model physics and represents the southward forcing on the ITCZ due to Earth's rotation. Note: *S* and *R* have the same units (s^{-2}). (CHAO ET AL.)