Science Overview Section:

Discussion Papers

What El Niño Is: An Oceanographic Perspective

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El Niño is tracked by observations of sea surface temperature (SST) in the equatorial Pacific Ocean. A plot of the SST in January 1994 over the tropical Pacific shows relatively warm water over the west and relatively cold water at the coast of South America and the equator; water on the order of 22 degrees C off the coast of Peru (Figure 1). This relatively warm water that appears off the coast of Peru in January is what was originally called El Niño. In contrast, the July 1994 plot of SST (Figure 2) shows water at the equator much warmer than 22 degrees, whereas the water off the coast of Peru is 16 degrees. 1994 is a relatively normal year with no large ENSO event going on. Why is the SST off Peru so cold relative to the west? The winds rotate anti-clockwise around a high pressure system in the east Pacific in the Southern Hemisphere. This produces along-coast winds off Peru and winds to the west along the equator in the eastern Pacific. The Coriolis effect then produces offshore flow off Peru and surface divergence at the equator. This produces upwelling in these two regions so that the cold, deeper water comes to the surface. This produces the cold SSTs off Peru and along the equator in the eastern Pacific. In the western Pacific on the equator, this upwelling does not occur, so that the SST is higher than in the east. The east Pacific SSTs are warmest in March/April and coldest in September/October.

The November 1982 plot of SST (Figure 3) shows the mature phase of a very large El Niño event. Sea surface temperature at the equator in the eastern Pacific is warmer than 22 degrees, whereas the normal is less than 22. Why? Those processes normally producing upwelling were not operating at this time. Winds favorable for upwelling along Peru were much weaker than normal. In addition, Kelvin waves propagating West to East along the equator and down the South American coast depress the thermocline and reduce upwelling. Basically the upper ocean warms when not cooled by upwelling. These Kelvin waves are produced by changes in the winds in the west and central tropical Pacific.

The November 1983 SST plot (Figure 4) shows water warmer than 28 degrees along the equator confined west of the dateline. Compared to the year before, sea surface temperatures in the east are 4-6 degrees cooler. Sea surface temperature pattern reflects stronger than normal winds that are favorable to upwelling and that extend little farther west than normal. This is the opposite phase, or cold event. George Philander started to use the term La Niña for this phenomenon. South Americans object to this term (there is no La Niña with capital letters that has any meaning). Cold phase and warm phase are more appropriate.

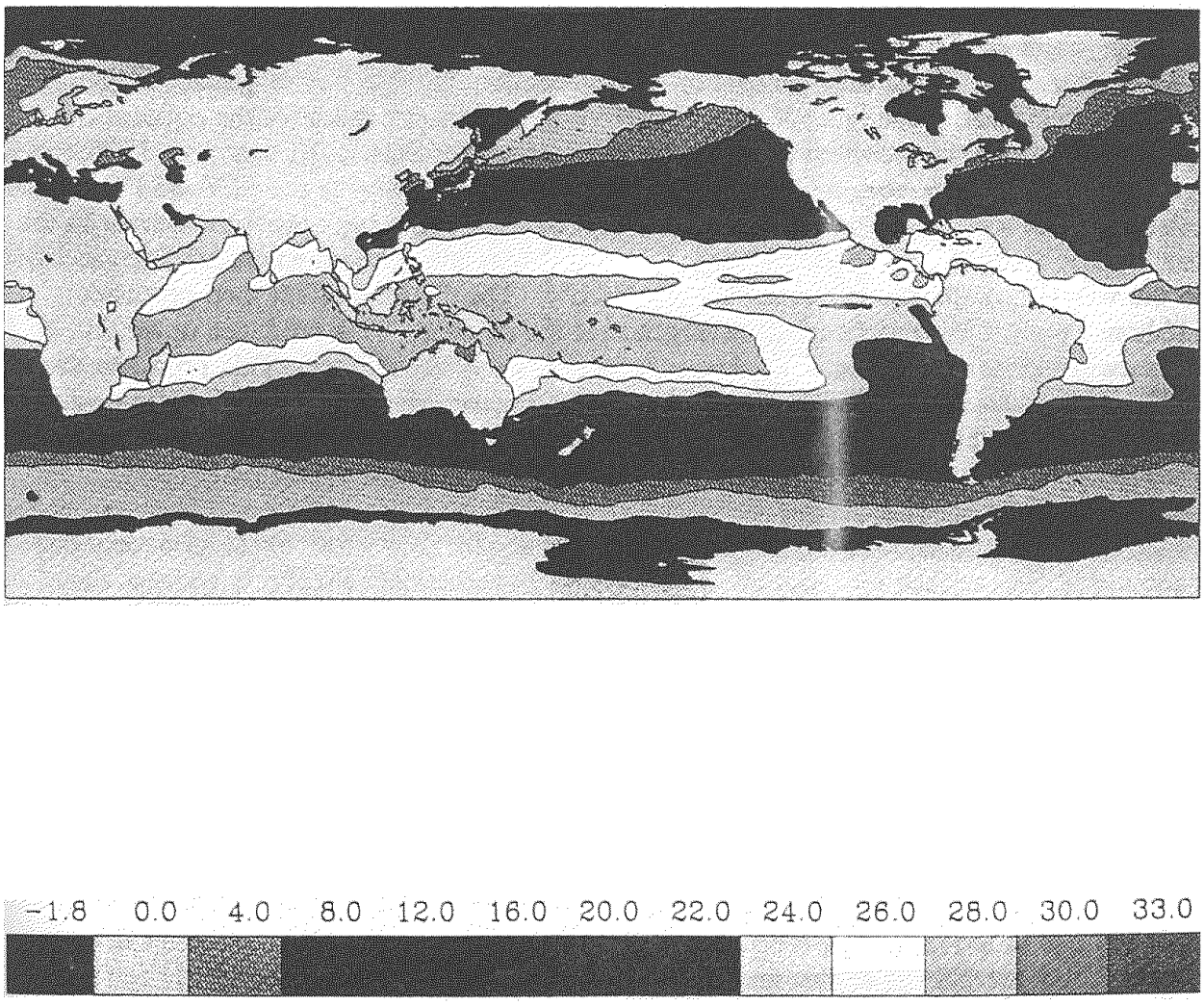
SST(°C) for January, 1994
-1.8
0.0
4.0
8.0
12.0
16.0
20.0
22.0
24.0
26.0
28.0
30.0
33.0

Figure 1

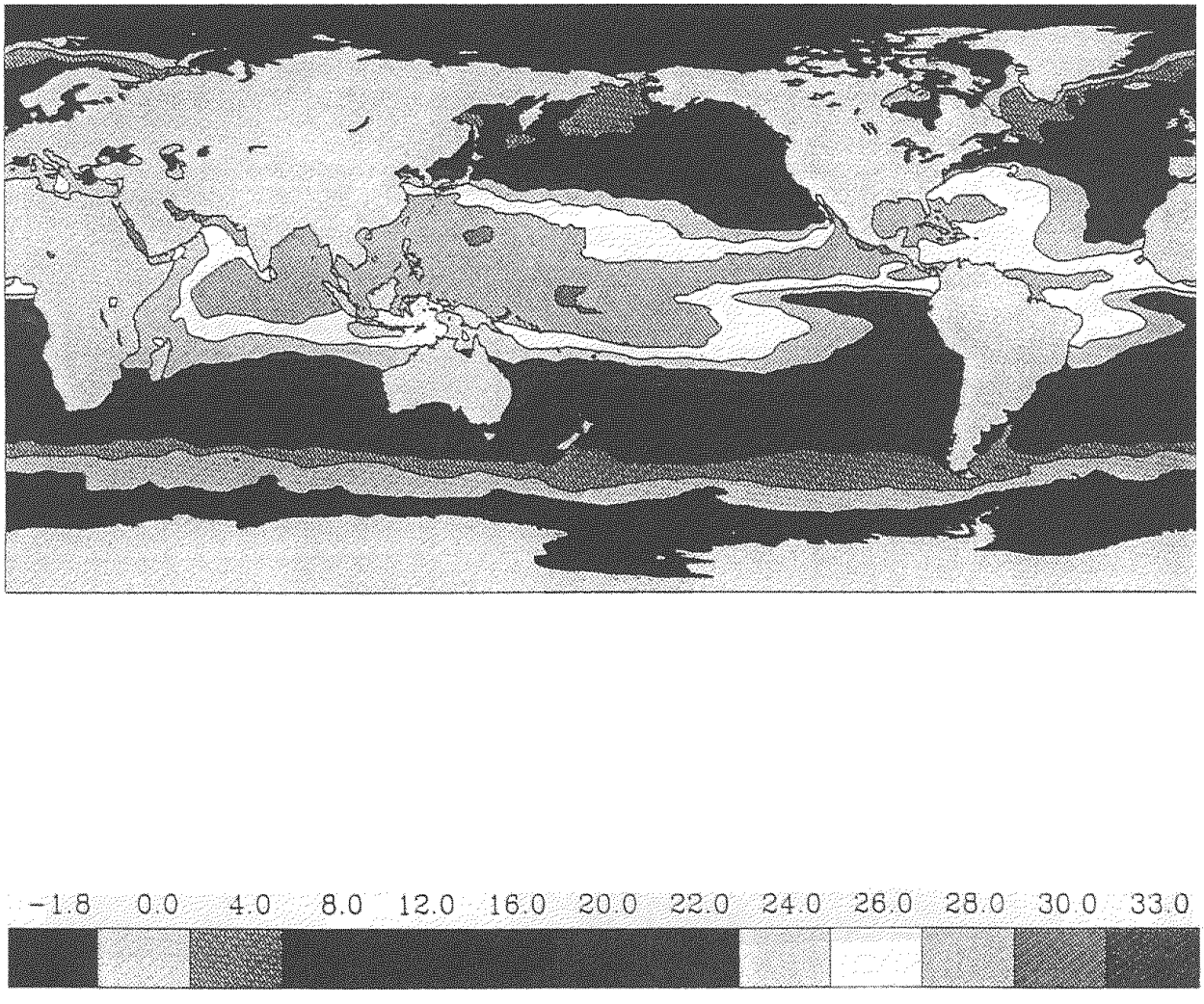
SST(°C) for July, 1994
-1.8
0.0
4.0
8.0
12.0
16.0
20.0
22.0
24.0
26.0
28.0
30.0
33.0

Figure 2