A NUMERICAL MODEL
OF THE FORMATION
OF THE SEA SURFACE TEMPERATURE
IN THE EQUATORIAL PACIFIC

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Thomas Bongers

Thesis Committee

Klaus Wyrtki, Chairman
Brent Gallagher
Lorenz Magaard
Peter Muller

I. INTRODUCTION

The heat budget and the sea surface temperature (SST) of the equatorial Pacific are of considerable importance to investigations of and for estimations of the strength of equatorial upwelling, of the variability of the equatorial current system, of transequatorial heat transport and of the local and regional variations of the equatorial climate (Wyrtki, 1981; Hastenrath, 1981). Figure 1 shows the SST of the equatorial Pacific in March and in September (Robinson, 1976). In March a sequence of pools of cool water stretches from the South American coast to the dateline. In September a tongue of cool water is clearly visible, stretching from the Galapagos Islands to 170^{o} west. Part of this cool water originates in the upwelling regions off Peru and Ecuador. It is transported via the SEC towards the equator. From 90^{o} west on the tongue is an equatorial phenomenon, proceeding westward with the SEC. Maintained by the climatological equatorial upwelling (Wyrtki, 1981), the cool tongue is influenced by numerous processes such as zonal advection, poleward advection in the Ekman layer on either side of the equator, meridional advection towards the equator associated with the east-west pressure gradient, meridional diffusion of heat towards the equator, zonal diffusion of heat and the depth of the mixed layer. The importance of the annual signal of these processes for the SST has yet to be closely examined at least for a significant part of the equatorial Pacific.

Due to the growing interest in the El Nino phenomenon, several studies concerning the SST, heat budget and the propagation of SST anomalies along the equator have been made. Recent works include the investigations of Wyrtki (1981), who used estimations of the heat budget of the equatorial Pacific for an analysis of the strength of equatorial upwelling and the importance of the zonally advected waters from the upwelling areas off Peru. Understanding the annual cycle of the SST and its implications for the heat budget is important for future estimations of the relative importance of these two processes. Horel (1981) analyzed similarities in the SST between the annual signal and the signal of a typical El Nino event. He suggested that the annual signal is dominant east of 120° west, whereas the interannual fluctuations, especially the El Nino signal dominate in the central Pacific. A quantitative understanding of the factors contributing to the annual cycle of the SST would benefit future investigations.

A numerical model will be constructed, solving the heat conservation equation for the surface mixed layer of the equatorial Pacific. The simulation of the forcing functions will be kept as simple as possible. This model will be used to examine the effect of the mean, of the amplitude, and of the phase of the forcing functions on the SST. Particularly, the model will be used to study the influence of the phases of net surface heat exchange, upwelling and zonal advection on the SST in the east and central equatorial Pacific. The mean annual variation will be simulated and compared to data from Reynolds (1982). The response of the SST to small changes in the forcing functions will be investigated. Case studies dealing with anomalous current conditions and anomalous temperatures at the eastern boundary will be carried out to partially simulate effects associated with a typical El Nino event.

It will be shown that the balance between net surface heat flux and entrainment heat flux is the most determining factor in the annual signal of the SST of the equatorial Pacific. Furthermore the poleward heat transport is the most important advective flux in the annual heat budget.