RESEARCH AND OPERATIONAL APPLICATIONS
CSIRO MARINE RESEARCH

AVHRR-DERIVED SEA TEMPERATURES AROUND ROTTNEST ISLAND

Alan Pearce and Fabienne Faskel (Edith Cowan University)

The occasional mortality of corals at Rottnest Island has led to an increased interest in water temperatures around the Island. As so little temperature information exists in that area, Advanced Very High Resolution Radiometer (AVHRR) sea-surface temperature (SST) data were used to examine seasonal temperature variability over the 7-year period 1995 to 2001 and to assess whether temperature extremes were in any way related to observed coral bleaching episodes in 1996 and 1998/9 (Faskel, 2001).

The 6-year time-series included data from both NOAA-14 and NOAA-16, clearly showing the seasonal cycle and some interannual variability (**Figure 1**). Summer peaks were generally around 23°C and the winter troughs about 19°C; the warmest summer was in 1998/99 when temperatures exceeded 24°C (coinciding with a record strong Leeuwin Current for that time of year), and the coolest winters were in 1995 and 2000. At the monthly time-scale, there was little regional variability between the three selected sites, although the water in shallow Thomson's Bay was slightly warmer in summer and cooler in winter than at the other two sites. While the thermal stress tolerance of *Pocillopora damicornis* is not known, this coral species is believed to be near the southern limit of its distribution and elevated local temperatures are therefore unlikely to be significant; the temperature data suggested, however, that the bleaching was not associated with cool episodes either, and the observed mortality events must therefore be due to other non-thermal causes.

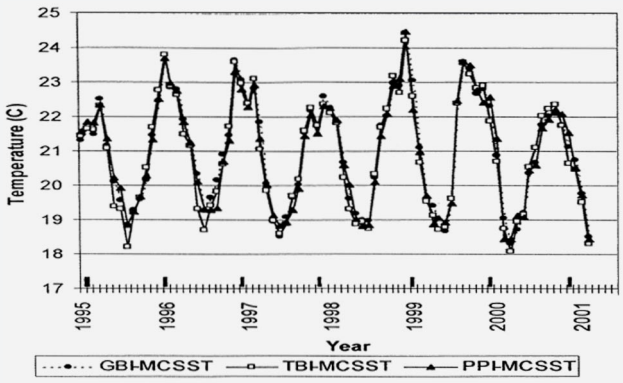

Figure 1: Satellite-derived water temperatures at 3 sites off Rottnest Island between 1995 and 2001: Geordie Bay (filled circles), Thomson's Bay (open squares) and Parker Point (filled triangles), from Faskel (2001).

Because of uncertainty about using 1-km resolution satellite data so near the coast, the AVHRR-SSTs were compared with *in situ* (temperature logger) measurements during 2001. The temperature loggers were installed at 3 selected sites (Geordie Bay, Thomson's Bay and Parker Point), with both a nearshore and an offshore (about 1 km from the coast) mooring. Some data were unfortunately missing from the Parker Point sites (where the main reef of *Pocillopora damicornis* coral is found) because of loss of the loggers, but reasonably good coverage was received for the two northern sites. As may be expected, the satellite-derived temperatures agreed better with the offshore loggers than with the nearshore measurements where "land-contamination" of the satellite pixels was more of a problem and also because of much higher spatial and temporal temperature variability in the coastal bays than further offshore.

Satellite images of the area assisted in interpretation of the temperature changes (**Figure 2**). On occasion tongues of warm Leeuwin Current water (shown in red) penetrated across the continental shelf towards the coast (cool coastal water in blue), sometimes bathing the north shore of the Island and at other times appearing to "wrap-around" the southern coast of Rottnest, matching surface observations undertaken by Dr Barry Hutchins (WA Museum).

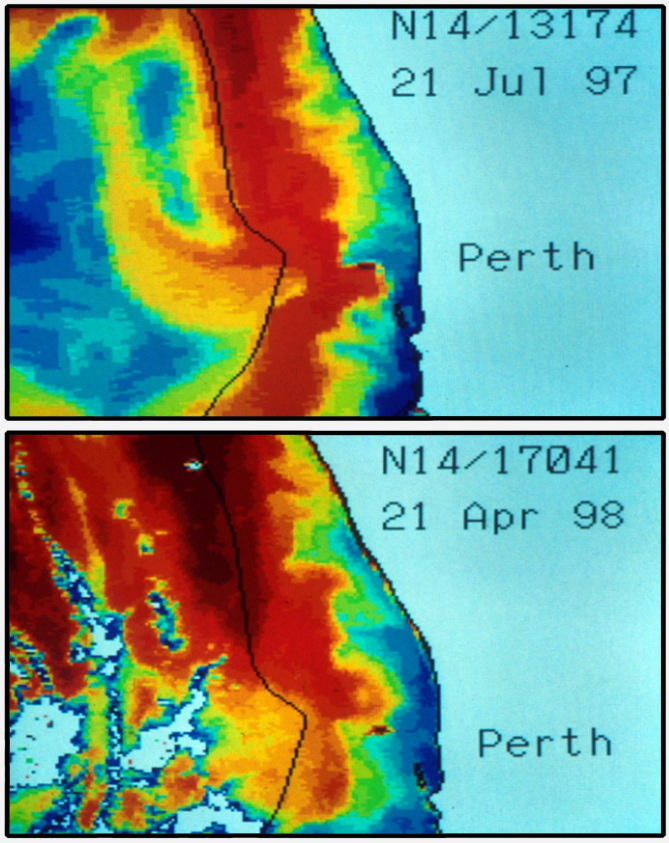

Figure 2: Satellite images of the Leeuwin Current off Perth in July 1997 (upper image) and April 1998 (lower image), showing modes of Leeuwin Current interaction with Rottnest Island. Warmest water is shown in red and the coolest in blue; the black line marks the edge of the continental shelf. NOAA-AVHRR data courtesy of WASTAC.

THE TEMPERATURE REGIME IN SOUTHERN GEOGRAPHE BAY

Alan Pearce, Ross Bromell (Busselton Jetty E & C Association) and Wendy Green (Murdoch University)

Sea temperatures are being monitored at the end of the Busselton Jetty to complement marine ecological studies in southern Geographe Bay, using small TidBit temperature loggers recording at 15-minute intervals. The project commenced in February 2001 and is scheduled to continue for at least two more years to show the seasonal and some interannual variability of the nearshore water temperatures. The highest monthly mean temperature recorded so far was 21.4°C in February and the lowest 15.5°C in August; the extreme recorded temperatures were 14.7°C in both July and August and 23.9°C in March. **Figure 3** shows seasonal AVHRR-SST images of Geographe Bay, illustrating the change between coastal heating in summer and the pronounced heat loss from the shallow nearshore waters to the atmosphere in winter. The warm Leeuwin Current was evident flowing southwards along the outer continental shelf.

The Jetty water temperatures are also being used to validate AVHRR sea-surface temperatures (SSTs). Comparison between the AVHRR-SSTs and the logged values (**Figure 4**) indicates that the main temperature variations were generally reproduced by the satellite data although there were occasions when the satellite value differed from the *in situ* measurements by up to 2°C -- these instances will be

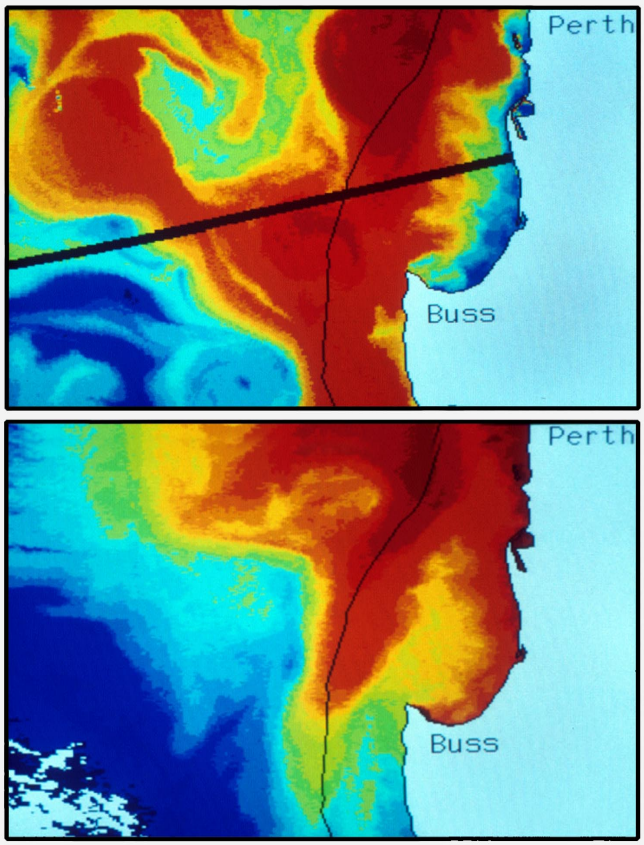

Figure 3: AVHRR images of water temperatures in and around Geographe Bay in March (upper image) and July 2001 (lower image). Other details as in Figure 2; the thick diagonal black line represents a data drop-out. NOAA-AVHRR data courtesy of WASTAC.

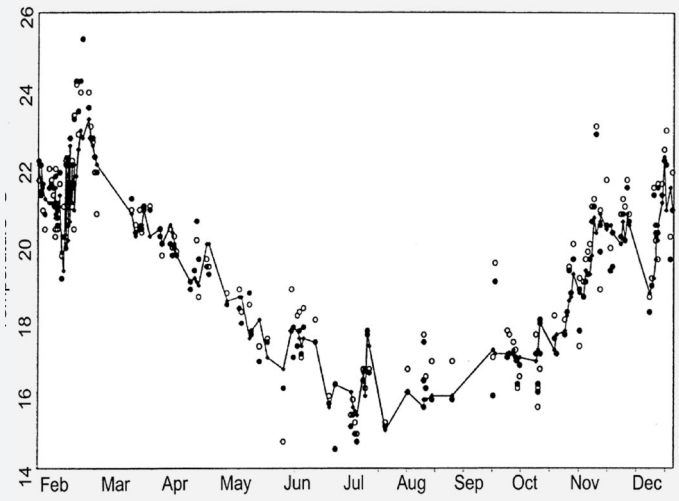

Figure 4: Time series of satellite temperatures off Busselton (filled circles are MCSST and open circles are the McMillin and Crosby algorithm) in 2001 compared with the recorded temperatures on the same days (solid line) .

examined in more detail. Overall, the correlation between the AVHRR-SST and the Tlogger was 0.95 for the MCSST algorithm and 0.93 for the older McMillin and Crosby algorithm; 76% of the MCSST temperatures were within ±0.5°C (and 90% within ±1°C) of the *in situ* measurements -- these are encouraging results bearing in mind proximity to the coast and the high variability of such nearshore waters.

This study is being complemented by similar temperature measurements at Woody Island off Esperance where recording commenced in May 2001, courtesy of McKenzie Island Cruises who operate the daily ferry across to Woody Island. As yet, the satellite data for that area have not been analysed.

AVHRR TRANSECTS ACROSS THE LEEUWIN CURRENT

Alan Pearce and Chris Ten Seldam (Murdoch University)

Following some earlier work on surface temperature gradients across the Leeuwin Current, monthly digital SST transects were extracted from AVHRR data over the period 1996 to 1999 to derive gradient indices which may represent the strength of the Current and also yield information on the width and position offshore of the Current boundaries. The latitude selected was 31°54'S, just north of Perth to avoid Rottnest Island, between longitudes 112°E and the coast. The surface temperatures were smoothed to reduce small-scale variability, and the along-transect SST gradients were computed.

The distinction between summer transects (when the Leeuwin Current is traditionally weak) and the winter plots was generally clear, with very much stronger SST gradients along the offshore boundary of the Current during the winter months. The gradients for each 1-degree longitude band across the Current clearly followed the expected seasonal pattern with higher indices between about April and September. However, interannual variability (which has been previously associated with sealevel changes and *El Nino*/Southern Oscillation (ENSO) events) was not evident despite the intense 1997/98 ENSO event which was sandwiched between two strong *La Nina* periods.

Analysis of the "width" and position of the Leeuwin Current relative to the shelf-break proved unreliable because of difficulties in unambiguously identifying the boundaries of the Current, particularly the coastal boundary where localised SST gradients obscured the larger-scale pattern.

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