

Research and Operational Applications

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Remote sensing of the Leeuwin Current

A F Pearce

CSIRO Marine Research

Sea levels and ocean temperatures off Western Australia reached record levels during 1999, closely linked with El Niño/Southern Oscillation (ENSO) events. The Southern Oscillation Index (SOI) is derived from the atmospheric pressure difference between Tahiti (in the South Pacific Ocean) and Darwin, and is a measure of the “see-sawing” of the atmospheric pressure between the Pacific and Indian Oceans. During ENSO events, the Pacific Ocean atmospheric pressure is lower than that in the Indian Ocean, leading to a negative SOI. The longest ENSO period of this century occurred between 1990 and 1994 (Figure 1), and in 1997/98 we experienced one of the most intense ENSO events ever. This was followed by an intense La Niña (the opposite phase of ENSO, with high atmospheric pressures in the Pacific Ocean and therefore positive SOIs) in late 1998 and 1999.

Monthly averaged coastal sealevels off Western Australia can be used as an approximate “index” of the strength of the Leeuwin Current, the dominant southward-flowing current off our state, with high sealevels reflecting a relatively strong current. Sealevels tend to be lower during ENSO periods (Figure 1), indicating a weakening of the flow during El Niño periods and generally cooler ocean waters offshore. One consequence of these ENSO events is poorer settlement of rock lobster larvae in the coastal reefs and hence greatly reduced lobster catches 3 to 4 years later, and there are implications for other commercial fisheries as well.

As is evident from Figure 1, sea-surface temperatures (SSTs) off Perth in the autumn of 1999 were the highest of this decade, and indeed the highest since the satellite data became available in 1982. The anomalies were almost 2°C higher than average in April/May/June, and both commercial and recreational fishermen reported anomalously warm water at many places along the west coast during the early part of the year. Temperatures off the Abrolhos Islands were particularly high, reaching 27°C in the warmest part of the Leeuwin Current just west of the Islands (Figure 2). A cross-shelf SST transect (Figure 3) showed that the temperature peaked at almost 28°C, and there was a remarkable 4°C temperature change across the outer boundary of the Current.

Figure 1: Monthly anomalies of sea-surface temperature (SST - small dots), Fremantle sealevel (FMSL - asterisks) and the Southern Oscillation Index (SOI - large dots) for the decade of the 1990s. The ocean temperatures are from the Reynolds satellite-derived dataset (supplemented with surface measurements), while the sealevel data are courtesy of The National Tidal Facility, Flinders University of South Australia, copyright reserved. The anomalies have been calculated by subtracting the mean annual cycle from the individual monthly sealevels and temperatures, and all the data have been smoothed by a 5-month moving average to better illustrate the trends.

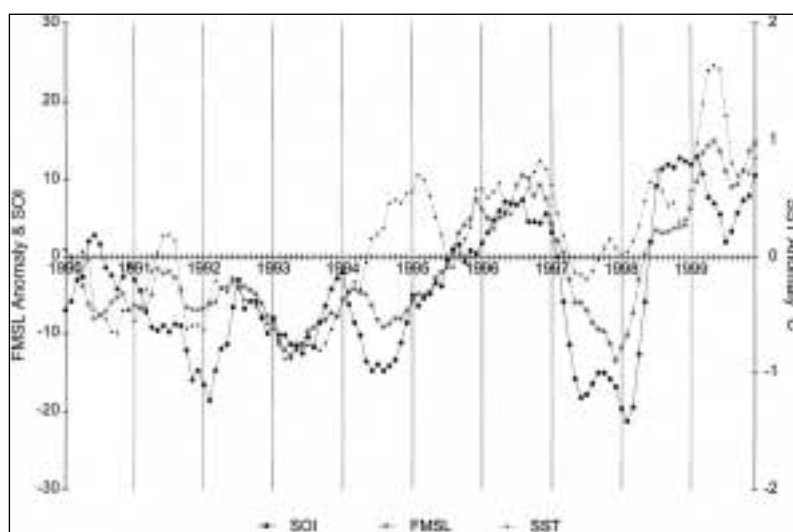


Figure 2: NOAA Advanced Very High Resolution Radiometer (AVHRR) satellite image of the Leeuwin Current (in red) off the Abrolhos Islands on 7th April 1999. The patchy white areas are clouds and the black line marks the approximate edge of the continental shelf.

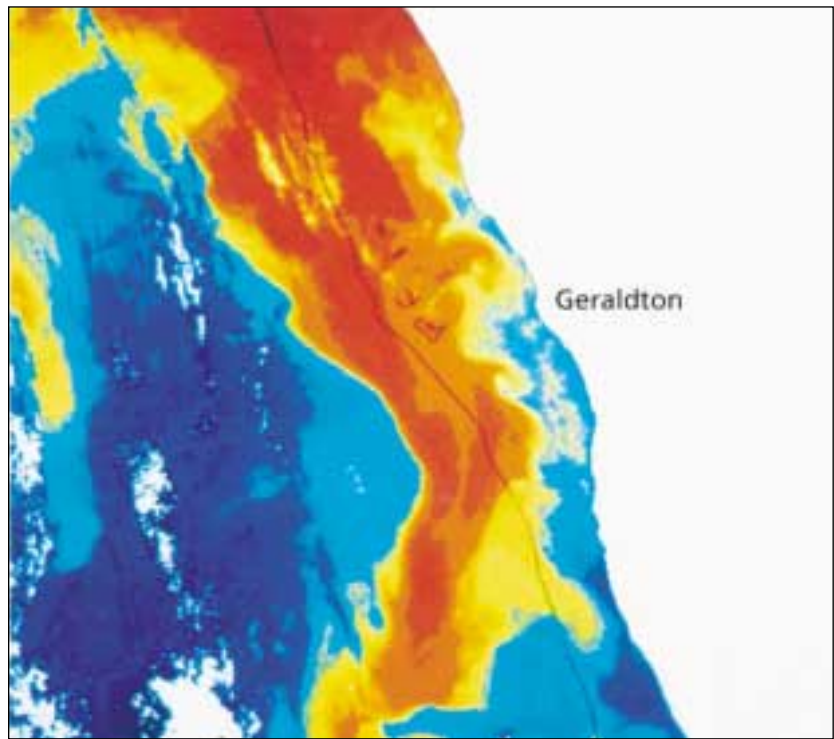
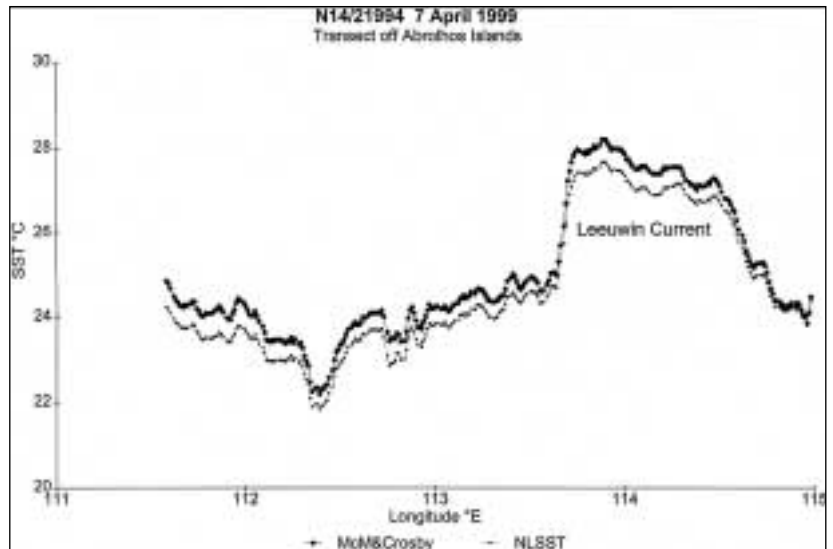


Figure 3: Sea-surface temperature transects across the Leeuwin Current just south of the Abrolhos Islands on 7th April 1999 (see Figure 2). The larger dots are from the McMillin and Crosby SST algorithm, and the smaller dots from the Non-Linear SST.



NOAA imagery is also being used to assist in the oceanographic interpretation of taylor and herring larval distributions sampled during a cruise by the FRV Flinders off Rottnest by Fisheries WA in May 1999 (Figure 4). Tongues of warm Leeuwin Current water (red) are seen penetrating shorewards across the shelf and engulfing Rottnest Island; the cooler coastal water is shown in blue.

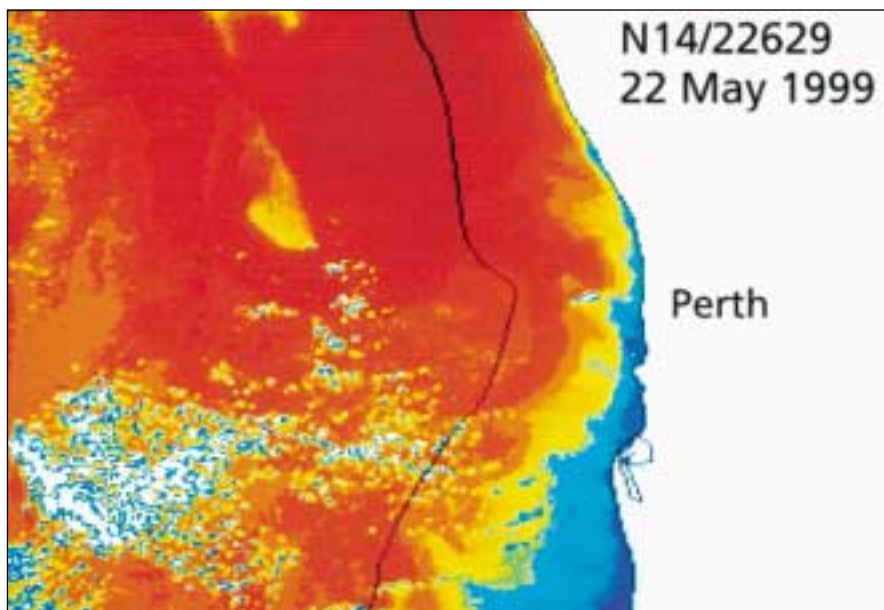


Figure 4: NOAA/AVHRR image of the Leeuwin Current off Rottnest Island on 22nd May 1999, during a Fisheries WA cruise sampling larval fish across the continental shelf. The small patchy blue/white areas are clouds and the black line marks the approximate edge of the continental shelf.

Validation of NOAA/AVHRR sea-surface temperatures (SSTs)

A F Pearce, M J Lynch* and B McAtee*

CSIRO Marine Research

*Remote Sensing and Satellite Research Group, School of Physical Sciences, Curtin University

The surface temperature measurements taken during the 2-year series of Hillarys Transects are being used in validation of SSTs derived from the NOAA-14 AVHRR. The measurements encompassed the full width of the continental shelf off Perth and in all seasons. Excluding the few obvious "outliers" (which were probably due to undetected cloud), the correlation coefficient between the two sets of measurements was 0.945 (Figure 5), with a satellite-bucket bias of 0.19°C and an RMS difference of 0.58°C, very comparable with some earlier measurements off Perth in the mid-1980s using the NOAA-7 and NOAA-9 satellites. About 65% of the differences were less than $\pm 0.5^\circ\text{C}$ and 88% within $\pm 1^\circ\text{C}$.

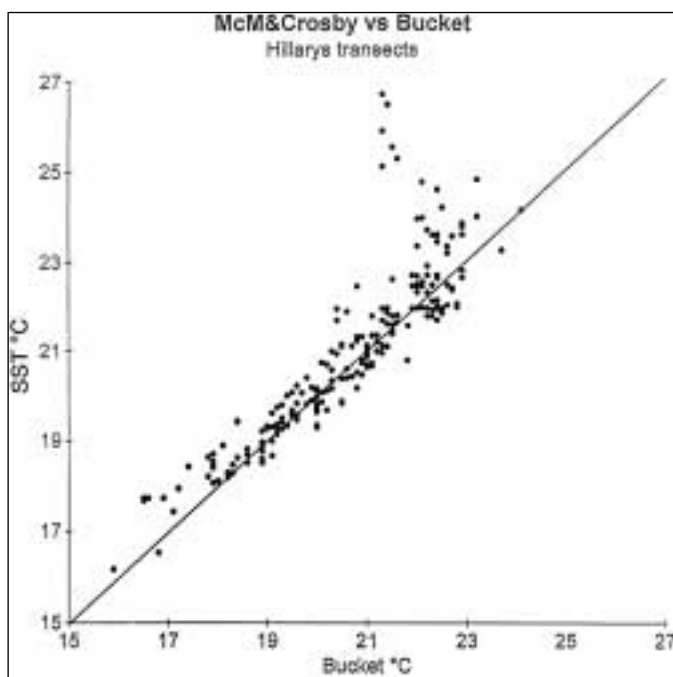


Figure 5: Comparison of SSTs derived from the NOAA-14 AVHRR against surface ("bucket") temperatures during the Hillarys transects 1996 to 1998, using the McMillin and Crosby algorithm.