Research and Operational Applications

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Remote sensing of the Leeuwin Current

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During 2000, Advanced Very High Resolution Radiometer (AVHRR) satellite images were used in a number of oceanic studies off Western Australia, covering the tropics (Dampier) to the south coast (Esperance). Locally-received imagery has also been used in longer-term modelling studies of the water properties and circulation in the south-eastern Indian Ocean by CSIRO Marine Research in Hobart.

Hillarys Transects

The set of Hillarys Transect papers are in the final stage of preparation, covering the physics, chemistry, chlorophyll, light and plankton across the continental shelf off Perth (see previous reports for Transect details). AVHRR-SST (Sea Surface Temperature) images are being extensively used to assist interpretation of the position and thermal structure of the Leeuwin Current and its relationship to the shelf waters covered by the Transect. The seasonally-reversing cross-shelf temperature gradient can be explained by air-sea heating/cooling processes near the coast and alongshore advection by the Leeuwin and Capes Currents (the former stronger in winter than in summer, and the latter only between about October and March), complemented by cross-shelf mixing processes.

A sample transect in February (**Figure 1a**, representing summer) shows the generally featureless thermal structure while the Leeuwin Current is weak; there was warming near the coast, and the cooler Capes Current was flowing mid-shelf. In winter by contrast (**Figure 1b**, for August), the Leeuwin Current was flowing strongly and was clearly defined in the SST transect, being over 2°C warmer than the offshore waters.

South-eastern Indian Ocean (acknowledgements David Griffin, CSIRO Marine Research, Hobart)

As part of a Fisheries Research and Development Corporation (FRDC) study of oceanic processes in the south-eastern Indian Ocean, WASTAC SST imagery is complementing TOPEX satellite data to verify surface currents derived from the altimeter and thus assist in modelling the trajectories of particles simulating rock lobster larvae. This project, in which Fisheries WA is collaborating, is attempting to simulate the year-to-year changes in settlement of the puerulus stage of the western rock lobster in our coastal reef system. The model is successfully reproducing the offshore dispersal of the early-stage larvae after hatching in summer, and tracks the open-ocean drifting phase. Many of the larvae are either lost way offshore or to the south, but a number of later-stage larvae are able to return to the coast to settle.

Esperance

At the request of Fisheries WA, an analysis has been undertaken of sea temperature variability in coastal waters off Esperance, on the Western Australian south coast. While some continuous temperature logger data were available from the Esperance harbour, AVHRR images and sea-surface temperature transects were analysed to show the larger-scale variability and in particular the thermal structure of the Leeuwin Current in that area.

There were clearly pronounced seasonal changes in the thermal structure of the water, largely associated with the seasonal strengthening of the Leeuwin Current in autumn. In February (**Figure 2a**) and April, the water temperature was almost constant across the shelf, decreasing only slowly southwards into the Southern Ocean; the Leeuwin Current was weak and poorly defined. By September (**Figure 2b**), the Leeuwin Current was flowing strongly eastwards along the outer shelf, with characteristic offshoots and eddies carrying pools of warm water well southwards into the Southern Ocean.

The SST transects (**Figure 3**) reveal the finer detail. In summer and autumn (represented by the February and April curves respectively), thermal gradients across the Leeuwin Current were weak. By July, the Current was flowing strongly; there was a band of cooler water near the coast (not resolved in the colour image) and a very strong frontal region of over 3°C at the shelf-break. In September, this was weakening, and it contracted further during spring (October) before returning to the summer situation in December.

Dampier

AVHRR images were also prepared to complement other oceanographic measurements as part of a review of oceanographic processes in the Dampier Archipelago. A team of Australian and international biologists participated in the Woodside Dampier Marine Biological Workshop held in the Dampier Archipelago between 25 July and August 2000, conducting field studies of the ecology of the coastal waters. The results of the Workshop will be published by the Australian Museum, complementing the Proceedings from previous workshops held in Albany, Rottnest Island and the Houtman Abrolhos Islands.

An oceanographic review paper of the Dampier region is being prepared by a team of oceanographers, and will include seasonal NOAA-AVHRR SST images (**Figure 4**) to illustrate the major thermal features of the North West Shelf during the year 2000, as well as two images during the period of the Workshop itself. The January image (**Figure 4a**) shows the cool Ningaloo Current (with possible upwelling) intruding north-eastwards past Barrow Island and towards Dampier, into the generally warm and otherwise featureless water mass, with warm water along the coast due to coastal warming.

In winter, heat loss to the atmosphere results in a band of cooler water in the shallower coastal waters with an appreciable temperature rise to the warmer waters at the edge of the continental shelf (**Figure 4b**); this is unlikely to be associated with upwelling which generally occurs (weakly) during the summer months. There is a much larger seasonal temperature change in the near-coastal waters around Dampier and in Exmouth Gulf than further offshore. A variety of eddy-like features are apparent along the outer shelf, probably associated with stronger alongshelf currents (including the Leeuwin Current) in winter.

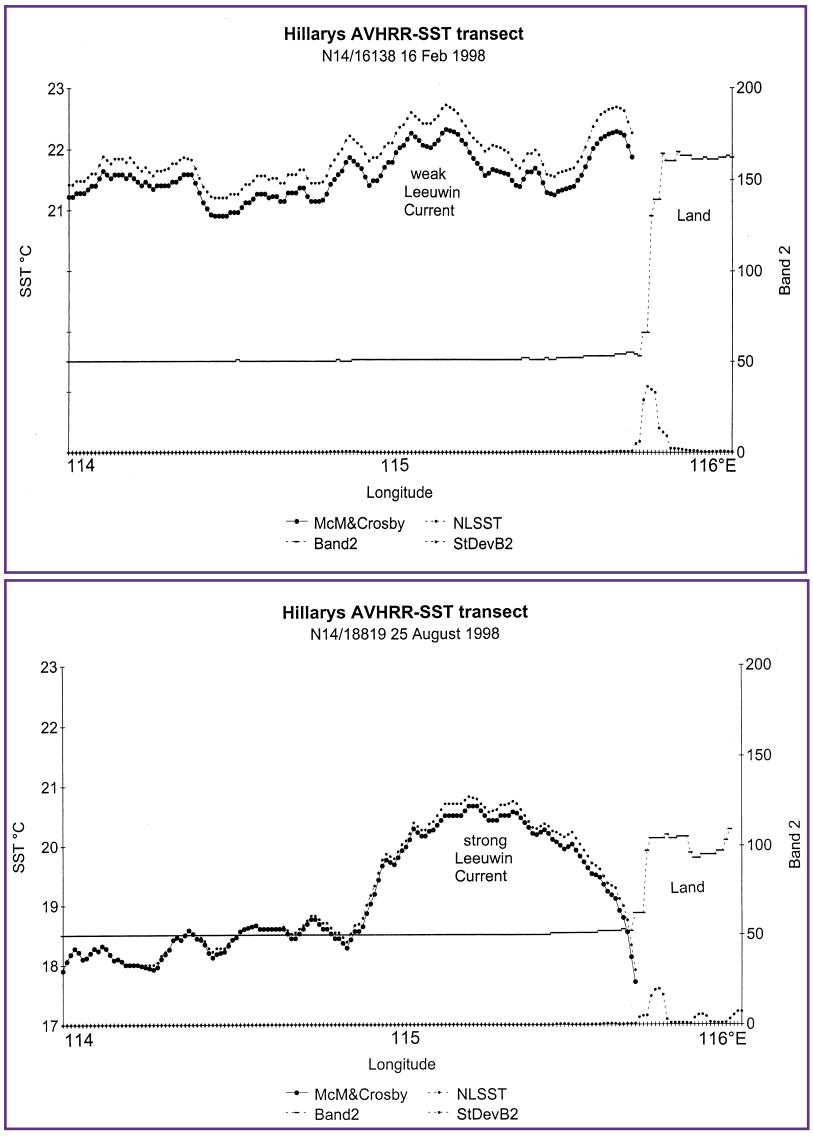

Figure 1: AVHRR-SST transects across the Leeuwin Current along (and westwards of) the Hillarys Transect in (a) February and (b) August 1998. The solid dots are the SST derived from the McMillin and Crosby algorithm, the small matching dots from the NOAA-14 NLSST. The horizontal dashes/line are raw counts in Band 2 and the small dots along the bottom axis are the standard deviation of 3-pixel moving segments in Band 2, both of these showing land (on the right of each transect) and the presence of clouds.

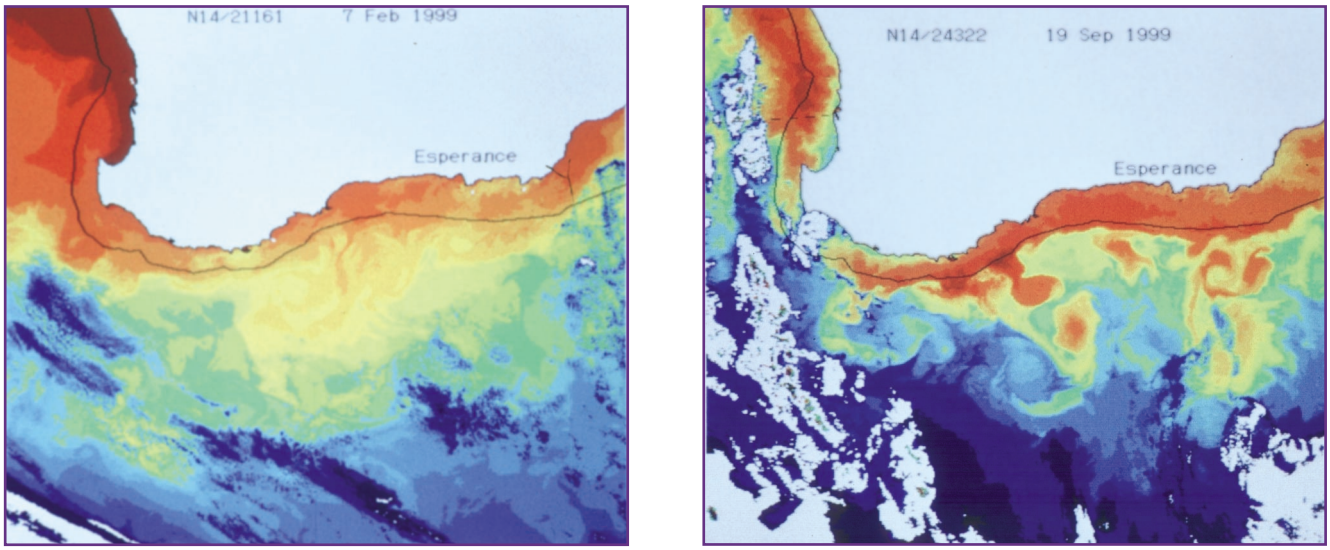

Figure 2: AVHRR images of the south coast in (a) February and (b) September 1999, showing the brightness temperature in AVHRR Band 4. Warmest water is shown in red, cooling through yellow and green to the coolest water in blue. The black line marks the approximate edge of the continental shelf. Satellite data by courtesy of WASTAC.

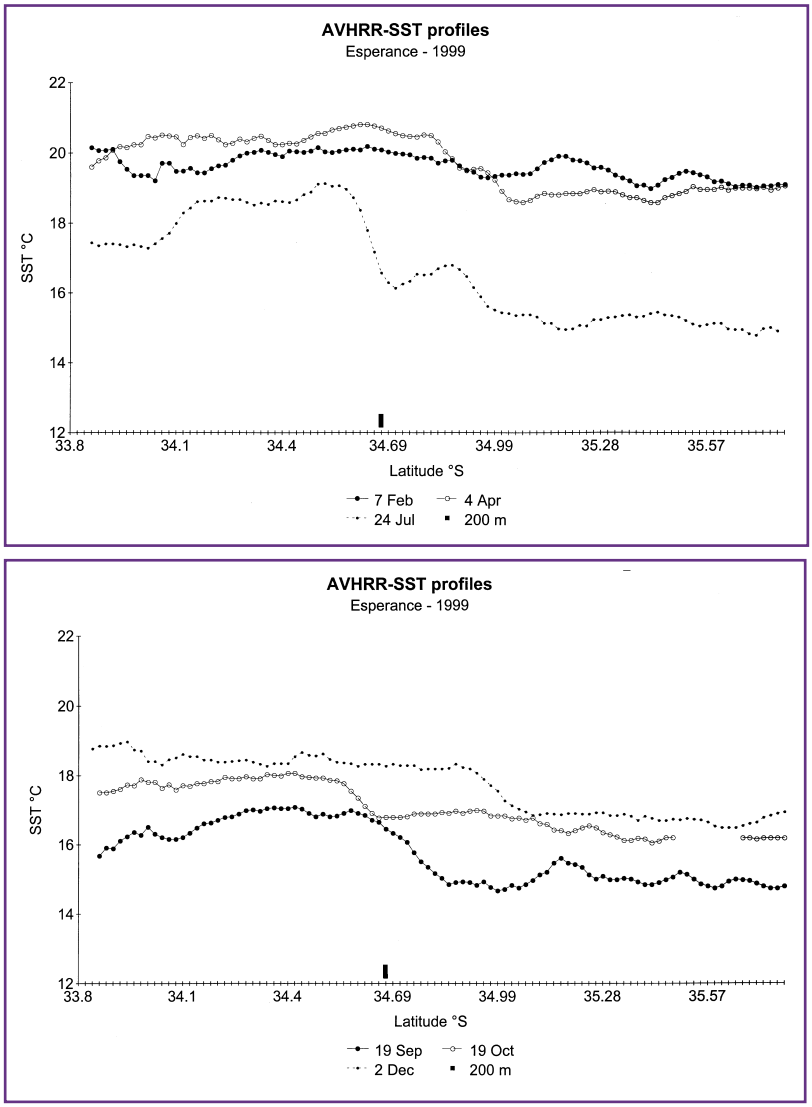

Figure 3: Sea-surface temperature profiles across the Leeuwin Current south of Esperance in 1999. The edge of the shelf is indicated by the black bar near 34.69°S.

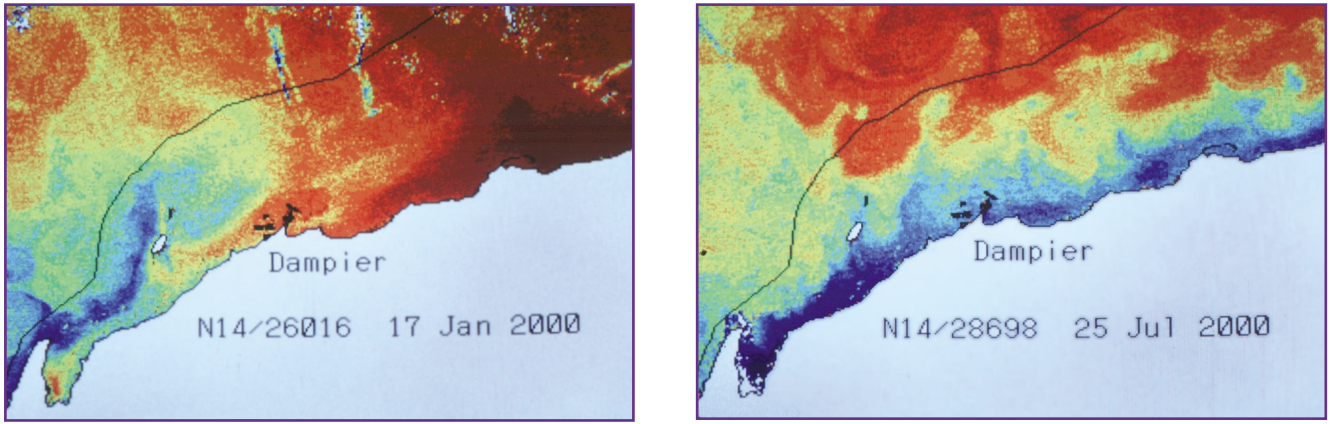

Figure 4: NOAA/AVHRR images showing the derived SST along the North West Shelf in (a) January and (b) July 2000. Details as in **Figure 2**.