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CORAL SEA CURRENTS

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The South Equatorial Current brings tropical water westward into the Coral Sea between the Solomon Islands and New Caledonia, then branches near the Queensland Plateau. The East Australian Current branch flows southward along the Great Barrier Reef to enter the Tasman Sea, while the northward-flowing branch forms a clockwise coastal current and partially-closed gyre in the Gulf of Papua, with an exit into the Solomon Sea. These currents strongly influence drift on the outer continental shelf and barrier reef.

INTRODUCTION

The Coral Sea and Great Barrier Reef (Fig. 1) have played a significant role in Australian natural and maritime history. The earliest explorations by navigators such as James Cook, who sailed the Endeavour up the Queensland coast in 1770, revealed the dangers of navigating in a region strewn with extensive coral reefs. Cook's measurements of ship's set produced the first known estimates of flow in the East Australian Current (Jones and Jones 1992). However, knowledge of the major features of the Coral Sea circulation has only accumulated during the latter half of this century. Among the earliest systematic oceanographic studies in the Great Barrier Reef (GBR) are those by Orr (1933a,b) and Moorhouse (1933). Pickard, Donguy and Henin (1977) provide an extensive review of the physical oceanography and climate of the Coral Sea and GBR, including studies by various American, Australian, European, Japanese and Russian oceanographers. Relatively frequent research cruises beginning in the late 50s resulted in significant contributions being made; particularly by oceanographers from the CSIRO, Divisions of Fisheries and Oceanography, the Royal Australian Navy Research Laboratory, the Centre ORSTOM de Noumea, and the Hawaii Institute of Geophysics. By the mid-seventies Wyrtki and Scully-Power had deduced the essential features of the Coral Sea circulation using ship drift data or analyses of temperature and salinity profiles using the classical 'dynamic height' or 'geostrophic method' described by Hamon (1990). Church (1987) and Andrews and Clegg (1989) discuss later work in which high resolution hydrographic sampling and modern volume transport estimation methods revealed important new details of the temporal and spatial variation of geostrophic currents. More recent research conducted by the Australian Institute of Marine Science (AIMS) in collaboration with CSIRO and James Cook University (JCU) and using modern ship-board and *in-situ* current measurement techniques, continues to reveal new phenomena and insights into the dynamics and variability of the Coral Sea circulation. Some of the new results are described here. With continuous monitoring of the oceans by satellites carrying infra-red and microwave remote sensing systems, it is anticipated that a systematic study of the seasonal and inter-annual changes in the surface circulation will be possible over the next decade. Some of these possibilities are described briefly in the concluding section.

Figure 2 shows the major features of the Coral Sea circulation deduced by Andrews and Clegg (1989) based on their analysis of the hydrographic data from an *R.V. Franklin* cruise in 1985. The following general description emerges: The South Equatorial Current (SEC) transports

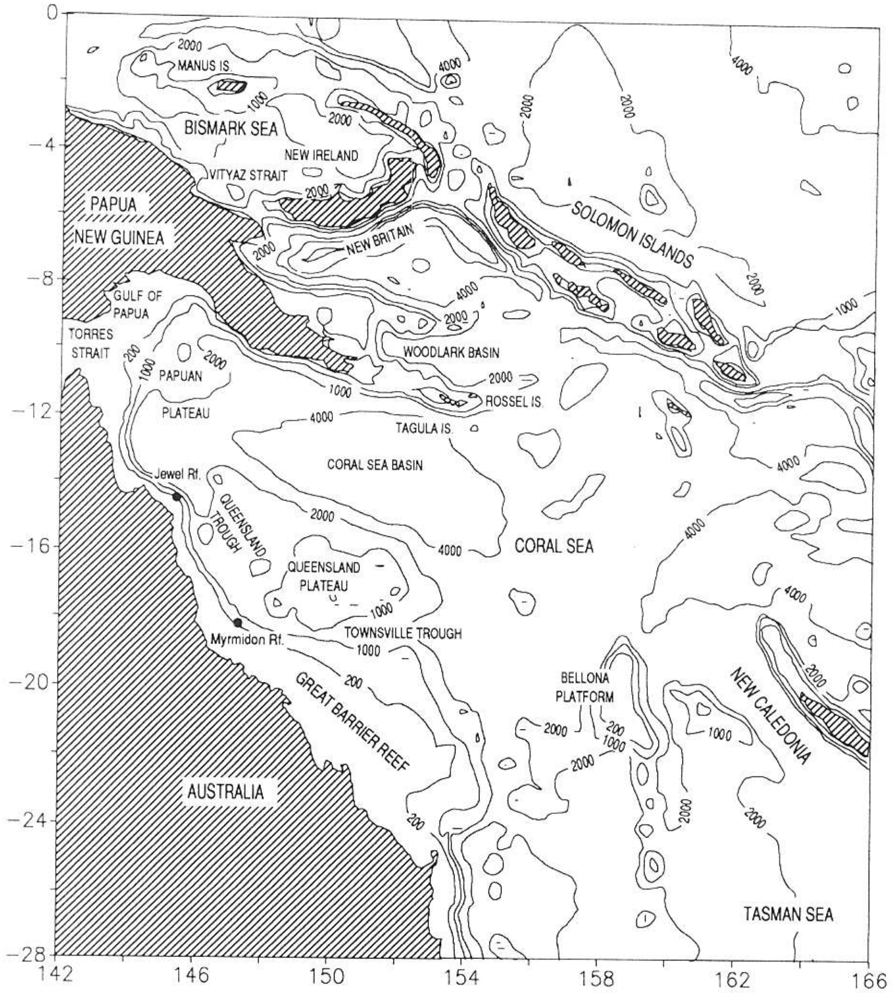

Figure 1. *Chart of Coral Sea showing major bathymetric features and contour lines (m). The 200 m isobath marks the edge of the continental shelf. Locations for AIMS long-term current meter moorings at Jewel and Myrmidon Reefs are also indicated by the solid dots. (Adapted from Hughes, Burrage and Bode 1993,* Deep Sea Res., *in review).*

approximately 25 × 10^6 m^3s^{-1} (or 25 Sverdrup, Sv) of warm equatorial water into the Coral Sea, between the Solomon Islands and New Caledonia, over depths ranging from the surface down to 1 000 m (the total transport through this section from surface to bottom is approximately 35 Sv). Of this, approximately 10 Sv escapes directly into the Solomon Sea, while about 5 Sv escapes immediately southward, towards New Zealand. The remaining flow of about 10 Sv crosses the Coral Sea to divide at the Queensland Plateau into two approximately equal branches. The southern branch is the source for the East Australian Current (EAC) which flows southward along the outer Great Barrier Reef, into the Tasman Sea, then eastward towards New Zealand, thus forming a southern closure of the South Pacific sub-tropical gyre. The northward branch circulates clockwise around the northern Coral Sea and forms a partially closed gyre at the entrance to the Gulf of Papua before entering the Solomon Sea around the tip of the Louisiade Archipelago. This flow, which we call the 'Hiri Current' after the annual 'Hiri' event in which Papuan sea traders sailed across the Gulf of Papua (Hughes, Burrage and Bode 1993), is

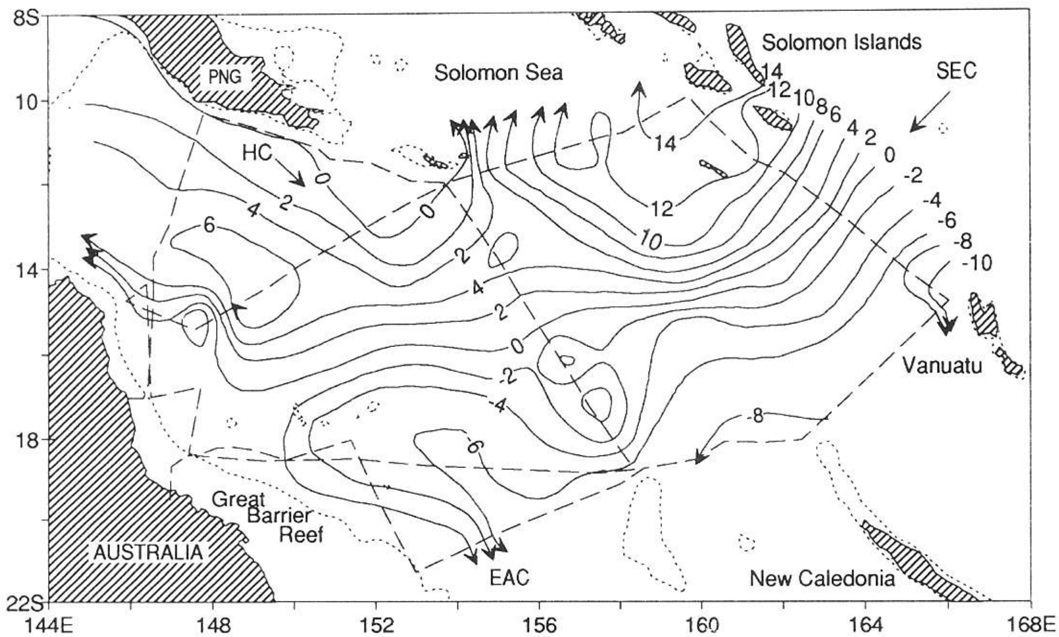

Figure 2. *Coral Sea Circulation for upper 1 000 m in October, 1985 inferred from* R.V. Franklin *hydrography. Differences in value between pairs of streamlines represent volume transport (Sv, 1 Sv=10^6 m^3s^{-1}) flowing between them in the direction of the arrows (hence the 20 Sv SEC inflow between Vanuatu and the Solomon Islands). The South Equatorial Current (SEC), Hiri Current (HC) and East Australian Current (EAC) are indicated. (Adapted from Andrews and Clegg 1989,* Deep Sea Res., **36**: *p. 972).*

thought to be continuous with the New Guinea Coastal Undercurrent (NGCU, Lindstrom *et al.* 1987). The latter ultimately feeds into the equatorial under-current in a northern closure of the South Pacific circulation. Superimposed on this general circulation scheme is a pattern of marked temporal and spatial variability which is of considerable ecological importance. In the following section we present examples of field data from recent investigations which illustrate the major features, some of the observed temporal variability and some significant spatial details.

CORAL SEA CIRCULATION

The South Equatorial Current

Wyrtki (1962a) described a westward flow of 6–26 Sv between Vanuatu and New Caledonia with most of the transport between depths of 100 and 600 m. Scully-Power (1973) found that in winter the SEC carried about 20 Sv westward into the Coral Sea and about 17 Sv into the Solomon Sea, with a maximum inflow at a depth of about 150 m. Surface flows are generally weaker and might at times even be eastward. Near-surface flows estimated from recent Acoustic Doppler Current Profiler (ADCP) and satellite-tracked drifter data suggest typical current speeds of order 0.2 ms^{-1} (about 0.4 knots) westward at a depth of 100 m. In 1991 the ADCP showed the SEC inflow as a band of current of that order of magnitude, having a width of about 350 km.

The precise location of the SEC branch point, and the relative intensity of the southern and northern branches and gyre, appear to vary both seasonally and inter-annually. By analysing data from *R.V. Sprightly* cruises from the period 1980–81, Church (1987) put the bifurcation point in the upper 900 m at about 18°S, but found it near 14°S in the monsoon summer. The analysis of *Franklin* data from 1985 presented by Andrews and Clegg are also consistent with bifurcation near 18°S. Current meter data from a long-term mooring maintained by AIMS on the North Queensland continental slope at 14°21′S since 1988 (see Fig. 1 for location; Burrage *et al.*,

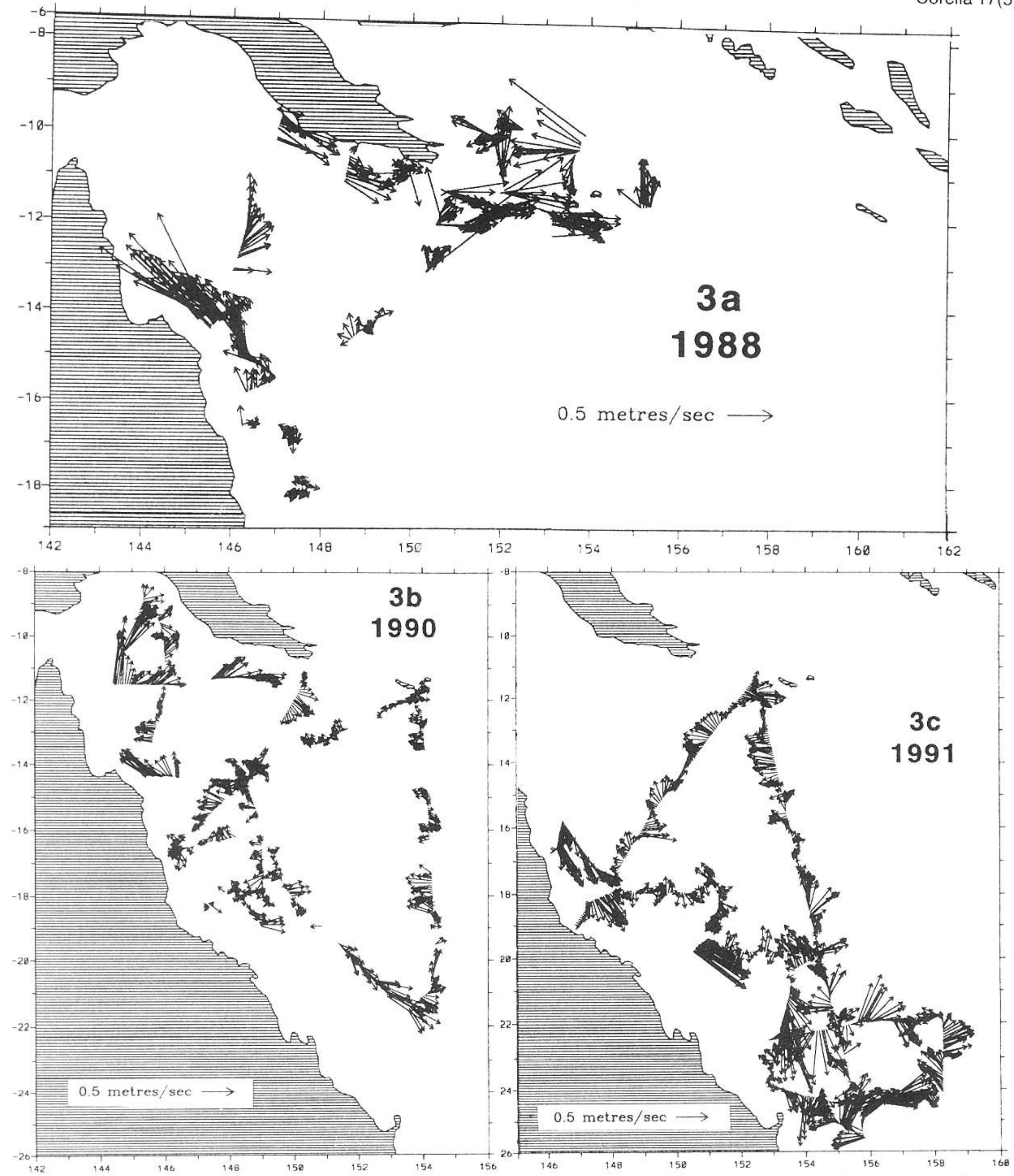

Figure 3. *Acoustic Doppler Current Profiler transects across major Coral Sea currents. The arrows represent the direction and speed of current flow averaged over 20 minute intervals at a depth of approximately 100 m (note 0.5 m s^{-1} velocity scales). Data from a) 22 June–17 July 1988, b) 6 July–1 Aug. 1990 and c) 2–22 Sept. 1991. Spatial coverage was enhanced by increased availability of GPS satellite navigation in later cruises. Currents in the SEC bifurcation area (18°S) were weak during 1988 and 1990 but strongly southward, suggesting a more northward bifurcation, during 1991. (Figures provided by R. D. Hughes).*

unpubl. data) show both northward and southward currents at depths between 35 and 150 m, with predominant southward flow suggesting that the mean bifurcation position in near-surface waters occurs north of 14°S. Some of the differences between observed positions of the bifurcation are due to an apparent variation in its latitude as a function of depth. As a consequence the bifurcation position of the surface flow is further north than that of the depth-averaged flow (Hughes *et al.* 1993).

Flows detected by ADCP aboard *Franklin* during AIMS cruises in 1988 and 1990 showed strong (>1.00 ms^{-1}) currents flowing northward between Jewel and Osprey Reefs at depths of about 100 m (Figs 3a and b). However, in 1991 the flow was strongly to the south at 16°S near Cairns (Fig. 3c). The currents in the bifurcation region as evidenced by hydrographic data, 1990 ADCP observations and satellite tracked-drifter trajectories (Burrage *et al.*, unpubl.), are relatively weak, with an order of magnitude of typically 0.1 ms^{-1} or less.

While it is possible to obtain a near-synoptic view of the Coral Sea circulation in a research cruise of approximately one month duration, the high cost and effort preclude adequate re-sampling on a seasonal and inter-annual basis. Future use of repeated, approximately fortnightly sampling by radar altimeters flown aboard satellites such as ERS1 and TOPEX should facilitate more definite assessments of the temporal and spatial variability in the position of the SEC bifurcation.

The East Australian Current and Under Current

The East Australian Current is the western boundary current of the South Pacific sub-tropical gyre. Such western boundary currents provide a return flow for the equatorward drift ('Sverdrup transport') induced by the sub-tropical wind vortices over each of the major ocean basins. This return flow is intensified near the western boundary by the effects of latitudinal variations in the strength of the Coriolis force ('Beta effect'). Unlike other western boundary currents such as the Gulf Stream (North Atlantic) and the Kuroshio (North Pacific), the EAC is diminished by diversion due to complex bottom topography as well as by 'leakage' from the Pacific into the Indian Ocean through the tropical Indo-Pacific (being less than 20 m deep, Torres Strait is effectively a barrier for large-scale, deep ocean flows).

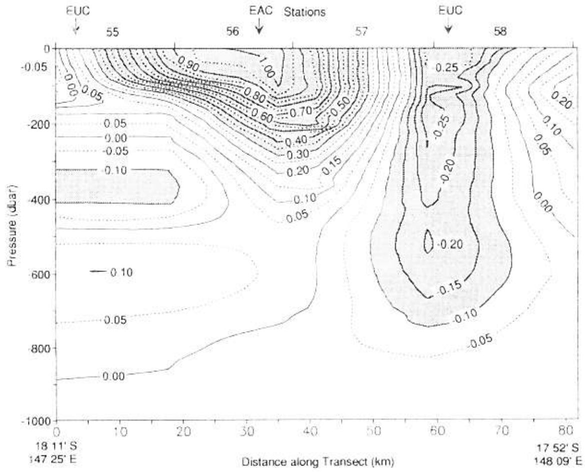

Figure 4. *Geostrophic velocity section ($m\ s^{-1}$) across the East Australian Current (EAC) and the EAC Under Current (EUC) from the 1991* Franklin *cruise (view to the north west). Velocity profiles were estimated at tic marks located between hydrographic stations 90–102. The EAC is indicated by the positive (southward) velocity maximum in the upper 300 m (speeds exceeding 0.3 $m\ s^{-1}$, shaded) and the undercurrent by the underlying negative (northward) maxima (speeds exceeding 0.1 $m\ s^{-1}$ shaded).*

The EAC, fed by the southern branch of the SEC, transports approximately 4 Sv southward through the upper 300 m of the Queensland trough. Associated surface currents, as indicated by ship drift data, are of order 0.4 ms^{-1} (Church 1987). The nett volume flux through the trough is smaller, however (about 3 Sv), due to the compensating effect of a northward flowing undercurrent (Church and Boland 1983). The relative magnitudes of the EAC, the undercurrent and the nett transports vary both interannually and seasonally (Hughes *et al.* 1993). A typical geostrophic velocity section through the Queensland Trough is illustrated in Figure 4. Due to limitations of the geostrophic method, there is an unknown constant offset in the velocity values indicated. However, the vertical variations in horizontal velocity, which are related to tilting of internal constant density surfaces, are significant, and indicative of the EAC and its undercurrent.

The near-surface EAC flow deepens off the southern GBR where it is augmented by inflow from a southern branch of the SEC. Here, surface

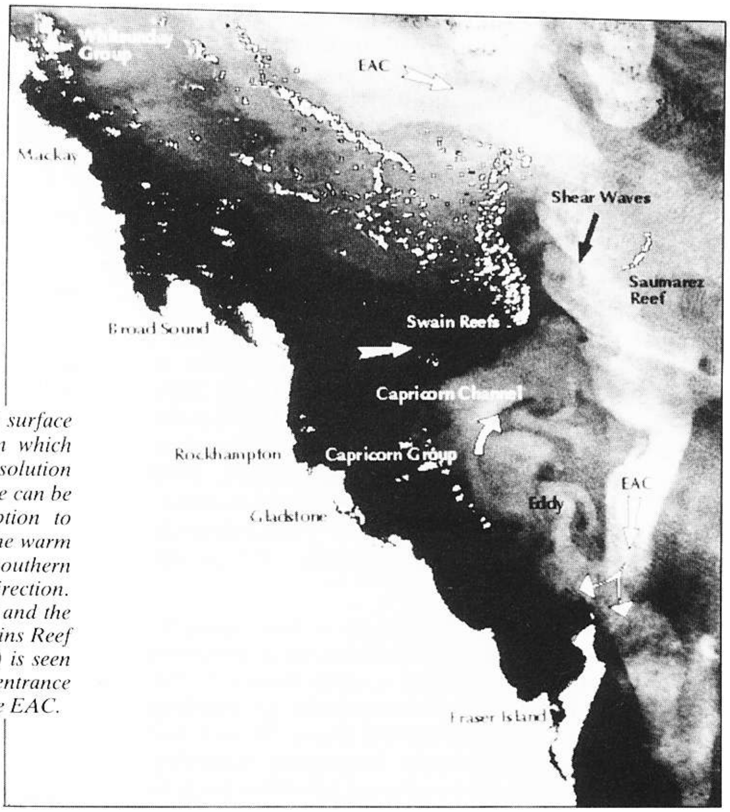

Figure 5. *Grey-scale image indicating relative sea surface temperatures. The brightness temperatures shown which are from channel 4 of the Advanced Very High Resolution Radiometer aboard a NOAA polar orbiting satellite can be corrected for atmospheric water vapour absorption to produce absolute sea surface temperature maps. The warm (lighter tones) EAC is shown interacting with the southern GBR shelf. White arrows indicate inferred flow direction. Shear waves on the western boundary of the EAC and the clockwise rotating mesoscale eddy in the lee of Swains Reef are also indicated. Cold shelf water (darker tones) is seen leaving the shelf east of Broad Sound, crossing the entrance to the Capricorn channel and becoming entrained in the EAC.*

current speeds are of order 0.7 ms^{-1}. It then separates from the southern GBR in the vicinity of the Swains Reefs to meander across the Capricorn channel and reattach to the shelf near Fraser Island. The western boundary of the meandering separated part of the stream (analogous to the Gulf Stream 'cold wall') often shows evidence of wave-like shear instabilities which might contribute to mixing between shelf and Coral Sea waters (Fig. 5). The separation region is filled by a partially-closed mesoscale (order 100 km across) clockwise eddy (Griffin, Middleton and Bode 1987). This eddy drives a northward current along the slope off the Capricorn-Bunker group of reefs and entrains cooler water emanating from the shelf seaward across the Capricorn channel, and into the warmer main stream of the EAC.

Some of the EAC flow is returned by a counter-current located further offshore (Church 1987). This forms a large-scale (order 1 000 km across), partially-closed anti-clockwise gyre in the deep water off the southern Queensland and northern New South Wales coasts. A recent discovery is that this large-scale gyre is fed by intense transient eastward 'jets' of warm, and thus buoyant, EAC water. Hydrographic sections, satellite-tracked drifter trajectories, ADCP data and NOAA satellite imagery obtained during 1991 show that these warm surface jets overlie colder waters flowing north from the Tasman Sea into the southern and central Coral Sea off the southern GBR (Burrage *et al.*, unpubl. data). This finding shows that warm EAC near-surface waters can branch away from the main stream and flow eastward as far as the Chesterfield reefs. The main stream forms meanders and eddies off the New South Wales coast before ultimately separating from the coast near Newcastle. It then crosses the Tasman Sea to return finally into the central Pacific via the northern tip of New Zealand.

The Papua New Guinea Coastal Current and Gulf of Papua Gyre

The northern branch of the SEC in the western Coral Sea forms a western boundary current (the 'Hiri Current'; Hughes *et al.* 1993) which circulates clockwise around the Gulf of Papua, following the northern Queensland and southern PNG continental slopes. Figure 6 is a Geostrophic section across the Hiri current and the SEC. Recent analyses of the data obtained since 1987 supports the speculation by Lindstrom *et al.* (1987) that this northern branch feeds the NGCU along the northern PNG coast. Andrews and Clegg (1989) estimated that of the 20 Sv flow in the northern branch during the 1985 winter, 6 Sv escaped into the Solomon Sea, while 14 Sv recirculated in a closed gyre at the mouth of the Gulf of Papua. From geostrophic principles, the perimeter of the gyre is expected to have warmer and faster flowing current than its interior.

The presence of a closed gyre was confirmed in the summer of 1988 by the trajectory of a satellite-tracked drifter deployed in late October at 14°S,

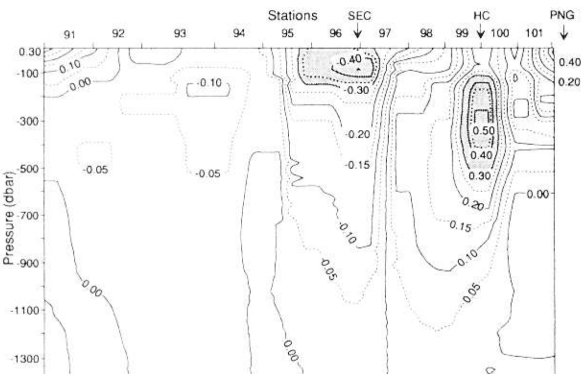

Figure 6. *Geostrophic velocity section across the southern continental slope of PNG and the northern Coral Sea showing the inflowing SEC (stations 95–97) and outflowing Hiri Current (between stations 97 and 102) which feeds the NGCU (view approximately westward). Flows exceeding 0.3 m s^{-1} are shaded. The Hiri Current (HC) is thought to be continuous with the EAC Under Current (EUC) shown in Figure 4.*

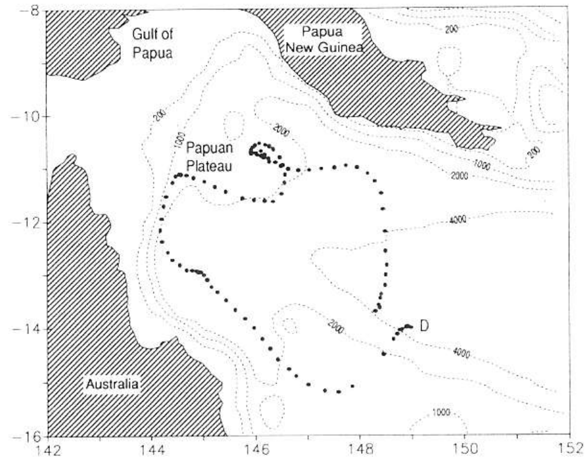

Figure 7. *ARGOS drifter track showing sub-surface drift trajectories. The drifter, drogued to a depth of 100 m, was deployed at 14°S, 149°E (labelled 'D') on 22 October, 1988 and ceased transmissions within about 50 miles of its deployment point on 27 February, 1989.*

149°E (Fig. 7). This performed a clockwise loop of approximately 500 km diameter over a period of four months, at an average speed of 0.24 ms^{-1} and returned to within 90 km of its initial deployment point before ceasing transmissions. The ADCP data obtained from *Franklin* in the 1988 winter (three months prior to release of the drifter) showed northwards flow over the continental slope between Osprey Reef and Jewel Reef (Fig. 3a) of order 0.75 ms^{-1}, and eastwards flow along the southern PNG slope of order 0.5 ms^{-1}. ADCP data from the winter time 1990 *Franklin* cruise shows a similar pattern of partial recirculation in the northern Coral Sea (Fig. 3b), but the flow off Jewel Reef is weaker (of order 0.5 ms^{-1}).

Coral Sea Volume Transports and Currents

Figure 8 is a plot of the estimated upper 1 500 m volume transports through hydrographic transects obtained during AIMS 1990 *Franklin* cruise. Hughes *et al.* (1993) give plots for the other AIMS cruises. The overall picture is as described by Andrews and Clegg based on the 1985 data, but some important new details emerge. While some of the differences can be attributed to different analysis methods, choice of depth of no motion and different cruise track locations, there are significant spatial flow differences suggesting definite seasonal and inter-annual variations.

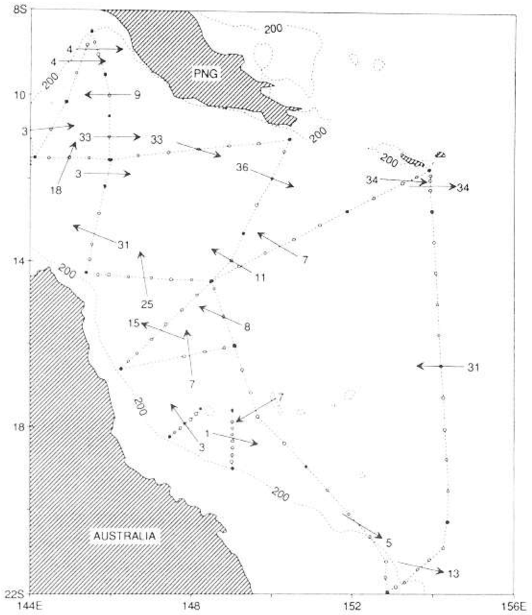

Figure 8. *Volume transports (Sv) for upper 1 500 m from analyses of 1990* Franklin *cruise data. The Transport Estimates represent the total flux above 1 500 m through transects (dashed lines) spanning the solid black hydrographic station marks (circles). (Adapted from Hughes, Burrage and Bode 1993,* Deep Sea Res., *in review).*

In 1988, the Hiri Current carried about 32 Sv northward following the North Queensland continental slope and there was strong outflow along the southern PNG coast which escaped into the Solomon Sea around the tip of the Louisiades. The implied clockwise boundary circulation was associated with the partially closed Gulf of Papua Gyre described above (see the drifter trajectory, Fig. 7). The northward flow between Osprey Reef and Jewel Reef was confirmed by ADCP data from the same cruise (Fig. 3a).

In 1990 (Fig. 8), the actual SEC inflow between the Louisiades and the southern GBR was observed. Details of the source of the Hiri Current (northern branch of the bifurcation) and its exit into the Solomon Sea were again revealed but the transport appeared stronger (about 35 Sv). The EAC (southern branch) was also revealed, with hints of eastward flow near Saumarez Reef.

In 1991, the SEC bifurcation region was displaced northward and the northern branch appeared weaker (about 25 Sv), while the EAC was stronger and originated further north. The EAC branched eastward off the southern GBR and recirculated anti-clockwise in a northward counter current located further offshore. Significant eastward geostrophic volume transports observed again off the southern GBR were related to the strong eastward flowing EAC 'jets' discussed earlier.

FLOW ON THE CONTINENTAL SHELF

Currents on the GBR continental shelf are a combination of tidally-induced flows and more slowly varying 'low-frequency' currents driven by winds and oceanic sea level variations. The deep ocean tides, driven by astronomical tidal variations originating in the Pacific Ocean and Coral Sea are modified by local bathymetry and the semi-permeable reef matrix as they traverse the continental shelf. Recent studies (Andrews and Bode 1988; Griffin, Middleton and Bode 1987; Church, Andrews and Boland 1985; Middleton, Buchwald and Huthnance 1984; Wolanski 1983) indicate that the tidally-induced sea level and current variations on the GBR shelf can be adequately predicted using harmonic analysis of observations combined with analytical or numerical models. Current amplitudes for the major semi-diurnal lunar tidal constituent (M2) are relatively strong (order 0.30 ms^{-1}) in the northern GBR at 10°S decreasing to about 0.10 ms^{-1} at 15°S and are strongly influenced by reef topography. In the central region M2 tidal currents are again stronger (order 0.15 ms^{-1}) and the tidal ellipses traced out by the rotating current velocity vectors are orientated mainly across shore. In the southern GBR at about 23°S they are moderate (order 0.15 ms^{-1}) on the shelf but strong (order 0.40 ms^{-1}) in the Capricorn channel, and the tidal ellipses are orientated diagonally across the shelf. Reinforcement occurs where tidal waves converge around the reef matrix near Mackay. The shape of Broad Sound causes further amplification with the result that the amplitude of the semi-diurnal tide may reach 2.5 m at its entrance with associated M2 tidal currents of order 0.50 ms^{-1}.

Previous studies of the low frequency currents indicate they tend to be in geostrophic balance with the across-shelf sea level slope (Wolanski and Bennett 1983; Burrage, Church and Steinberg 1991) and recent studies (Burrage, Black and Ness 1993; Burrage, Black and Steinberg 1993) have made use of this relationship to make reliable long-term estimates (from 1966–1990) of past along-shelf flows. These estimates are based on linear systems models developed at AIMS, which are forced by historical coastal and offshore water level records. Recent results emphasize the controlling influence of the EAC on currents right across the continental shelf near Townsville, with local winds playing a significant secondary role in the shallower coastal locations. During the 1985 model calibration period mean currents were 0.03 ms^{-1} to the north on the inner shelf, 0.1 ms^{-1} south within the reef matrix (on the outer shelf) and about 0.2 ms^{-1} south at the shelf break. Accordingly, model predictions indicate that currents tend to be strongly southward in the outer shelf and progressively weaker, or more readily reversed in response to local weather events, closer to the coast.

Figure 9 shows a time series of predicted low-frequency, along-shelf currents for the period 1985–1990, together with observed currents for a mid-lagoon site (18°48.8′, 147°8.5′) near Keeper Reef in the central GBR, off Townsville. The long-term mean current at this site is small. The predictive variable is the difference between low frequency sea levels at Townsville Harbour and those at Noumea, New Caledonia (the latter further smoothed to remove local weather influences). Hence, long-term sea level fluctuations in the Coral Sea due to seasonal and climatic factors are thus taken into account.

A long-term plot of predicted current over the full 15 year prediction period emphasizes this seasonal and inter-annual variability (Burrage, Black and Ness 1993). The seasonal signal shows weak southward flows on the outer shelf and northward flows on the inner shelf in April, and strong southward flows at all stations, increasing to seaward, during November. At inter-annual time scales, periods of enhanced southward flow along the continental shelf coincide with El Niño/ Southern Oscillation events.

Linear systems models are presently being developed for the northern GBR region, where the SEC bifurcation and Hiri current are expected to influence the direction and strength of the along-shelf flows. More frequent and stronger northward along-shelf flow events are anticipated in that region.

WATER TYPES OF THE CORAL SEA

Pickard *et al.* (1977), Tomczak (1983) and Andrews (1983) have reviewed and described the major water masses of the Western Coral Sea and GBR lagoon, while Hughes *et al.* (unpubl. data) have analysed more recent cruise data. Four major water 'masses' or 'types' (the distinction between these terms made by Tomczak, 1983 is not essential here) are generally identified.

Coral Sea Surface Water (CSW): Temperature greater than 24°C, salinity from 34.0 to 35.6 ppt. Surface waters tend to be warmer in summer and cooler in winter, and more saline in autumn and fresher in spring. Based on temperature and

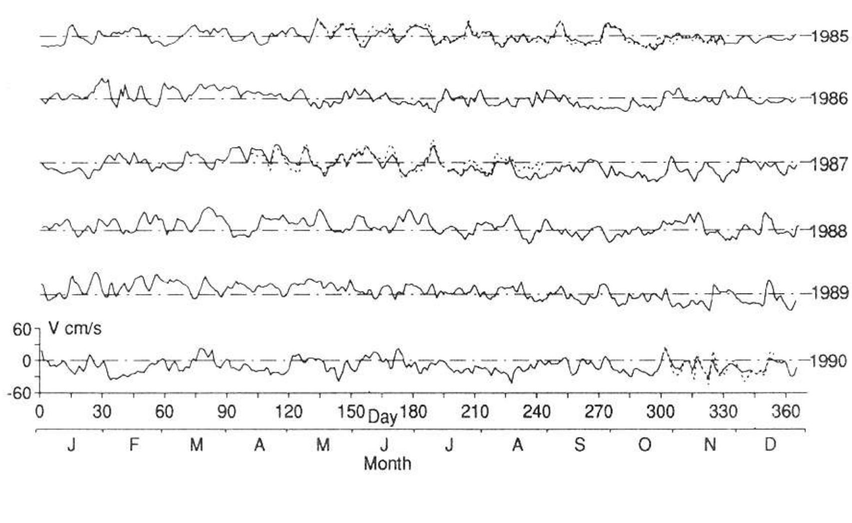

Figure 9. *Six year time series of predicted along-shelf geostrophic currents in the GBR lagoon near Keeper Reef off Townsville (solid line) for the period 1985–1990 and observed currents during 1985, 1987 and 1990 (dotted). Plots for successive years are offset by 120 cm s^{-1}. Significant variability associated with ENSO events appears in longer time series (Adapted from Burrage, Black and Ness 1993,* Cont. Shelf. Res., *in press).*

salinity relationships, inflow from the north-east in summer and from the east in winter was inferred. Donguy and Henin (1975, 1977) found a surface salinity minimum in the Gulf of Papua which they attributed to the effects of run-off from PNG rivers, and another south of New Caledonia at about 30°S. Both were clearly separated from that of the Central Pacific basin.

Great Barrier Reef Lagoon Water (GLW): Though derived mainly from CSW, the modifications are sufficiently strong to justify a separate category (Tomczak 1983). While the temperature difference between GLW and CSW is typically only about 1°C, river run-off, rainfall, evaporation and exchange with the Coral Sea induce relatively large salinity, and hence density, differences. In summer, temperature is about 29°C in the north and centre zones and about 28°C in the south. In winter, temperatures drop to about 24, 22 and 20°C in the north, central and south, respectively. Salinities range from 34.0–36.1, 31.6–35.3 and from 35.2–35.8 ppt in the north, centre and southern zones, respectively; they are freshest in summer (centre) or autumn (north and south), and most saline in spring. Studies by Wolanski and van Senden (1983) and Burrage, Black and Steinberg (1993) show that the reduction in salinity which occurs when the Burdekin River floods significantly modifies the along-shelf current, especially on the inner shelf between Townsville and Cairns.

Sub-Tropical Lower Water (SLW): Temperature 18–25°C, salinity 35.5–36.0 ppt, with the core characterized by the sub-surface salinity maximum. The core depth is 50–150 m in the western Coral Sea, but the water mass surfaces south of about 23°S (e.g. off the southern GBR). Based on the salinity and dissolved oxygen distributions Wyrtki (1962b), inferred inflow from the east.

Antarctic Intermediate Water (AIW): Temperature 4.2–6.0°C, salinity 34.37–34.53 ppt with the core characterized by a salinity minimum. The core depth is 700–1 000 m in the Western Coral Sea. Salinity and oxygen distributions imply inflow from the south east, with branching to north and south in the southern GBR.

The occurrence of these water masses and geographical variations in their temperature and salinity characteristics are generally related to the depth, latitude and proximity to estuarine sources of a given site. With the exception of sites near the continental boundary, they are only weakly dependent upon the locations of the major Coral Sea currents.

INTERACTIONS BETWEEN CORAL SEA AND GBR

Recent studies suggest that changes in intensity and meandering of the SEC in response to large-scale Pacific basin climate and weather events could induce significant changes in water masses and currents on the continental shelf and slope of the GBR. For example, seasonal meandering of the SEC will produce predominantly northward or southward flow along the continental slope and outer shelf between Cairns and Cooktown. This alternating current regime has significant implications for a number of ecological processes such as the spawning of Black Marlin *Makaira indica,* which occurs off Cairns in October.

Recently launched oceanographic satellites such as TOPEX/POSEIDON and ERS-1 which carry microwave radar altimeter systems, can now be used to monitor changes in sea surface height around the globe on a fortnightly or monthly basis. The resulting geostrophic surface current fluctuations can be deduced on monthly or bi-monthly time-scales, and on spatial scales ranging from about 20 to 200 km.

Associated fluctuations in the intensity of the EAC will modulate the southward along-shelf flow in the central and southern regions of the GBR, and change the intensity and character of the recirculating mesoscale eddy spun up by the EAC across the entrance to the Capricorn channel. The distributions of chemical constituents (e.g. nutrients or pollutants) and of marine biological communities (e.g. reef fishes) will also be influenced by mesoscale incursions of the EAC into these regions. Such incursions can be monitored using sea surface temperature (SST) maps derived from the NOAA polar orbiting satellites.

NOAA satellite SST imagery has shown that exchange and mixing of shelf and slope waters in the central and southern GBR may be enhanced by a number of processes including frontal waves and eddies induced by across-front shear of the EAC, by transient jets and sub-mesoscale eddies associated with pulsing of the EAC, and by impingement of the EAC upon the shelf edge near Fraser Island. Similar processes may occur in the northern GBR in response to fluctuations in the Hiri current system. Such phenomena can be tracked using a suite of oceanographic remote sensing methods. In addition to the NOAA satellite imagery, high accuracy thermal infra-red data from the ERS-1 Along-track Scanning Radiometer and synthetic aperture radar imagery from the ERS-1 AMI instrument package have recently become available to Australian oceanographers. Large-scale dispersal of the larvae of mass-spawning corals, the coral predator, Crown of Thorns Starfish *Acanthaster* sp., and various species of fish is also likely to be significantly influenced by such processes. The various remote sensing methods thus have the potential to significantly improve our capability to study larval dispersal processes by enabling more accurate indications of circulation patterns to be obtained, and by allowing direct detection of associated shear zones and surface slicks.

The present challenge in Coral Sea oceanography is to develop effective methods for integrating *in-situ* and remote sensing data with three-dimensional hydrodynamic models so that flow variability can be accurately simulated on seasonal and inter-annual time scales. The resulting simulations could be used to address a variety of questions regarding the evolution and dispersal of the small marine organisms which support the sea bird food chain.

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