3. PHYSICAL OCEANOGRAPHY

While there have been several reviews of physical oceanographic processes in the GBR (Pickard et al., 1977; Andrews and Pickard, 1990; Wolanski, 1991) relatively little is known regarding the detailed behaviour of water currents within the two study boxes (Cresswell and Greig, 1978; Andrews, 1983; Wolanski and Pickard, 1985; Andrews and Furnas, 1986). Few measurements of currents have been made within either the Cairns and Tully boxes. The overwhelming bulk of oceanographic current measurements made to date in the central GBR have been made south of Palm Passage where the shelf is wider and reefs are dispersed. Local flows within the reef matrix are strongly affected by topographic steering around individual reefs, groups of reefs and coastal features (Hamner and Hauri, 1977, 1981; Hamner and Wolanski, 1988; King and Wolanski, 1991; Wolanski, 1983, 1986, 1991). This complexity of flow leads to subtle spatial variability in the distribution of biological and chemical variables (e.g. Wolanski et al., 1989; Liston et al., 1992). However, the magnitude of variability in surface temperature and chlorophyll signals is such that acceptable descriptions of regional distributions can be made from discrete samples (Liston et al., 1992). Cross-shelf tidal currents are generally slower than 20 cm sec^{-1}, (Andrews and Bode, 1988; Wolanski, 1983), with local accelerations as waters are deflected around reefs.

In the absence of winds, geostrophic pressure gradients associated with the East Australian Current (hereafter EAC) drive a southward (poleward) flowing longshore current through the reef matrix. Wolanski and Pickard (1985) showed that current speeds at Green Island were well correlated with regional wind stress. Mean southward residual current velocities on the continental slope average 30 cm sec^{-1} (Burrage et al., 1991). Currents on the shelf may briefly reach 60 cm sec^{-1}, but in most cases are < 50 cm sec^{-1} (Wolanski and Pickard, 1985). At this maximal velocity, parcels of water would require 41 and 54 hours, respectively, to pass unimpeded through the Cairns and Tully boxes. Because of the hydrographic impedance of the numerous reefs within each box and the presence of Cape Grafton, it is unlikely that north-south transit times or residence times of water parcels would be this brief. A cross-shelf line of reefs at the northern end of the Cairns box (Undine Reef, St. Crispin Reef) would appear to block significant southerly flow on the outer shelf, though detailed current measurements are needed to confirm this. The presence of terrestrial muds along the northern side of Cape Grafton suggests the presence of a persistent eddy feature in the southern end of the Cairns box.

In shallow waters near the coast, buoyancy effects associated with riverine freshwater inputs and wind stress episodically overcome the southward pressure gradient and drive northward flowing boundary currents along the coast (Wolanski and Pickard, 1985; King and Wolanski, 1991). Tongues of fine terrestrial sediments extend northward from all of the major rivers along the coastal strip. This northerly flow along the coast brings freshwater and nutrients derived from the Herbert, Tully and Murray Rivers into the southern end of the Tully box.

Near-surface exchanges of water between water masses on the outer shelf and EAC, driven by wind stress, tidal currents, internal waves and topographically generated shear (Andrews and Gentian, 1982; Andrews and Furnas, 1986; Wolanski and Pickard, 1983), are at present not adequately quantified on the regional scale and are likely to be highly variable in time and space (Andrews and Furnas, 1986; Wolanski et al., 1988).