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Wind-driven Water Circulation and Its Impact on Seabed Sediment Transport in the Australian Northeast

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ABSTRACT

Wind-driven currents play a crucial role in large-scale sediment transport and long-term seabed evolution in the Australian Northeast region. For the first time the real wind climatic data, with temporal and spatial variations, were used to model the detailed water circulation patterns. The wind climate is dominated by two distinctive winds, the northwest monsoon, and the southeast Trade Wind. Four typical circulation patterns forced by the seasonal winds have been identified and investigated. The lateral variations in sediment character are closely related to the distinctive oceanographic conditions driven by the wind climate.

KEY WORDS: Wind-driven current; seabed; sediment; numerical model.

INTRODUCTION

The simulation area covers the Gulf of Carpentaria (GOC), the Torres Strait, north-western part of Coral Sea and the eastern part of Arafura Sea. GOC is a modern epicontinental sea. Smart (1977) showed that the Gulf was probably an inland lake until rising sea-level permitted flooding from the Arafura Sea. Over three decades several separate cruise surveys have been carried out by different organizations for different purposes.

From Nov 1981 to May 1982, the summer monsoon season, the wind-driven circulation on the northern Great Barrier Reef continental shelf was investigated by water current observations (Wolanski and Thomson, 1984). All the current meters were deployed 5 m above the bottom. The low-frequency sea level and the currents are reported to be highly coherent with the local wind. Some noticeable low-frequency non-tidal oceanic fluctuations were found alternating northward and southward. The low-frequency currents were dominated by events, largely wind-driven. There is no evidence of any strong currents coming from Torres Strait and continuing down the coast as previously believed. The study concludes that the currents were generated by local wind rather that the Torres Strait inflow. However, the wind-driven current data did indicate southward flow in offshore areas and northward flow inshore. The particular mean currents are Turtle Cay 0.05 m/s southward, Middle Banks 0.04 m/s southward, Capman Reef 0.07 m/s northward, Bird Island 0.02 m/s northward, and Shortland Reef 0.01 m/s northward. This feature will be explained by our circulation model.

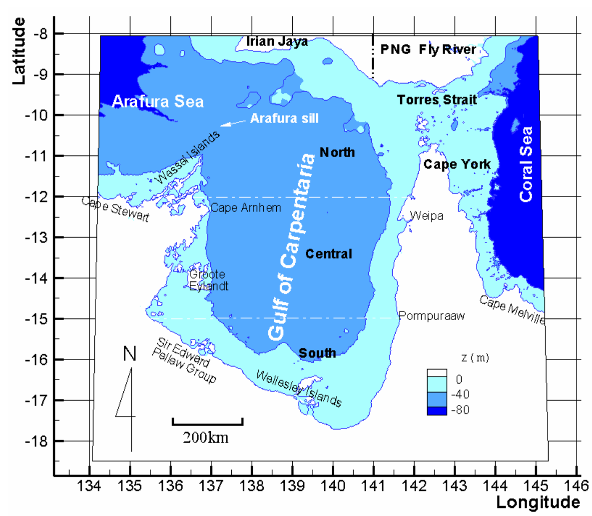

Figure 1. Map of the studied region showing bathymetry.

Burrage (1993) studied the Coral Sea Current. Using Acoustic Doppler Current Profiler (ADCP) and satellite-tracked drifter data, a northward-flowing branch of South Equatorial Current at north Coral Sea along the GBR was found in winter at a depth of about 100 m. The southern branch is the source for the East Australian Current (EAC). The bifurcation point varies seasonally and inter-annually around 18°S (south of our studied area).

However, Seabed sediment transport in the study area, particularly in the western and north-western parts (Arafura Sea and Gulf of Carpentaria) are poorly known.

In the Gulf of Carpentaria, tidal and non-tidal currents were measured for 4-10 days in July, September, November cruises of 1970, and the March cruise of 1971 off Weipa by CSIRO (Cresswell, 1971). Current