Evaluation of ADCP wave, WAVEWATCH III and HF radar data on the GBR

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Introduction

Wave climate can have a very significant impact on the dynamics of the near-coastal oceans, including geomorphology and currents. This study is a preliminary investigation of the suitability and compatibility of a wave-capable Acoustic Doppler Current Profiler (ADCP) mooring, an HF ocean radar system and the numerical model WAVEWATCH III (WW3), with the focus on the area of the Capricorn and Bunker Groups of reefs and islands, Australia.

Study site

The Capricorn and Bunker Groups of reefs and islands are located within the southern Great Barrier Reef (GBR), Australia. The study site is located on a continental shelf, which is characterised by a concave shape, facing into the prevailing southeasterly wind and dominant swell of the area (Fig. 1). This is a dynamic region for waves from the open ocean, encountering the continental shelf edge and propagating up onto the shelf.

WAVEWATCH III

WAVEWATCH III (WW3), developed by NOAA/NCEP, is a third generation wind-wave model that facilitates the modelling of directional wave spectra (Tolman 2009). In order to obtain both local wind waves and swells in the wave model output, WW3 has to be run on a Pacific-wide scale to allow for the primarily easterly-southeasterly swell to move into the southern GBR. WW3 has one- and two-way nesting capabilities, which reduces the computational expense by allowing for nests outside of the main area of interest to be run at lower resolutions.

Here, three nests have been set up, with the grid size and wind forcing characteristics being listed in Table 1. The largest (Pacific-wide) and the middle (Coral Sea) grids are being forced by Global Analysis and Spectral Prognosis (GASP) winds (Seaman et al. 1995). The forcing of the innermost grid (southern GBR), in turn, is provided by MesoLAPS winds – a mesoscale version of the Limited Area Prediction System (LAPS) (Weinzierl and Smith 2007).

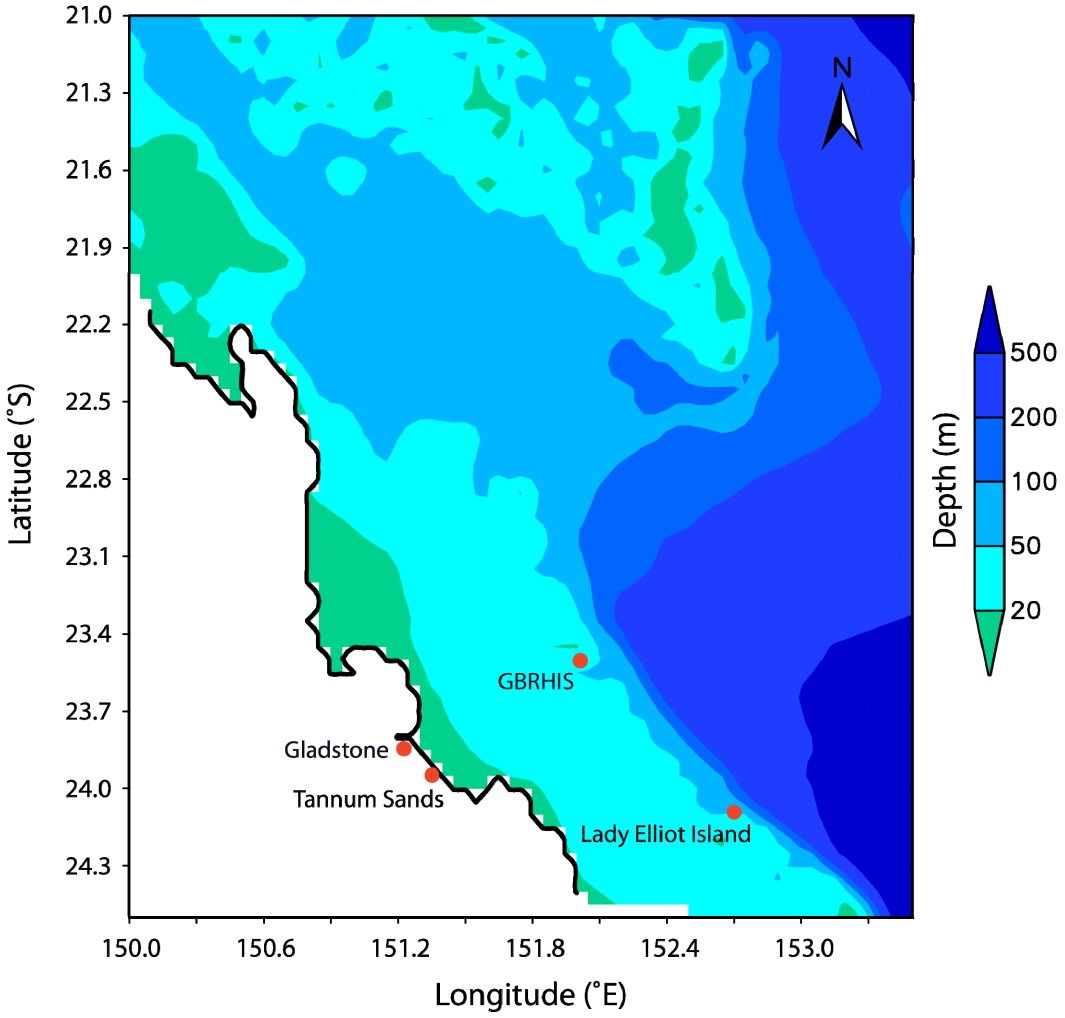

Fig. 1 Bathymetry of the southern Great Barrier Reef region, derived from DBDB2 (Digital Bathymetric Data Base), a 2-minute resolution grid. Also indicated are the locations of the Heron Island South (GBRHIS) ADCP mooring, as well as Lady Elliot Island and Tannum Sands.

Table 1. Grid characteristics of WAVEWATCH III.

nest name	Pacific	Coral	GBR
resolution (°)	1	1/2	1/20
min. latitude (°N)	-70	-35	-24.5
max. latitude (°N)	60	-8	-21
min. longitude (°E)	130	142	150
max. longitude (°E)	260	165	153.5
wind data	GASP	GASP	MesoLAPS
wind resolution (°)	1/2	1/2	1/8

HF ocean radars

Direct measurement of wave parameters can be obtained from the HF radars, stationed at Tannum Sands (23.94°S; 151.37°E) and Lady Elliot Island (24.11°S; 152.72°E) (Fig. 1). Maps of significant wave height are supplied on a 3 km grid independently from each station for ranges up to 75 km from the stations. The WERA radar system has been operational since November 2007 and is mainly used to map surface currents over the continental shelf in this area.

When wave data from the two HF radar stations are combined - and with some spatial and temporal averaging - the radars can generate directional wave spectra (Wyatt 2000, Wyatt 1990). The optimum temporal averaging period is one hour, while the optimal spatial averaging is approximately 10 km. Wind direction can be inferred from HF radar data over the full coverage of grid points by adopting a general form for the directional spread. Phased array HF radars have the capacity to map variations in the significant wave height field (Heron and Heron 1998). Causes for modifications in the significant wave height field include wave setup when the waves are propagating in the direction opposing strong currents, and refraction (Haus et al. 2006).

ADCP mooring

The Great Barrier Reef Ocean Observing System (GBROOS) Heron Island South (GBRHIS) ADCP mooring (23.51°S; 151.96°E) is situated to the south of Heron Island and west of One Tree Island (Fig. 1). GBRHIS is equipped with a Nortek Acoustic Doppler Wave and Current Profiler (AWAC). The AWAC includes a directional wave gauge, which employs Acoustic Surface Tracking (AST) to monitor surface waves. At GBRHIS, the AWAC is located 10 m below the surface on top of a mooring, at a total depth of 46 m. Output is generated every two hours. A typical directional wave spectrum from GBRHIS is shown in Fig. 2.

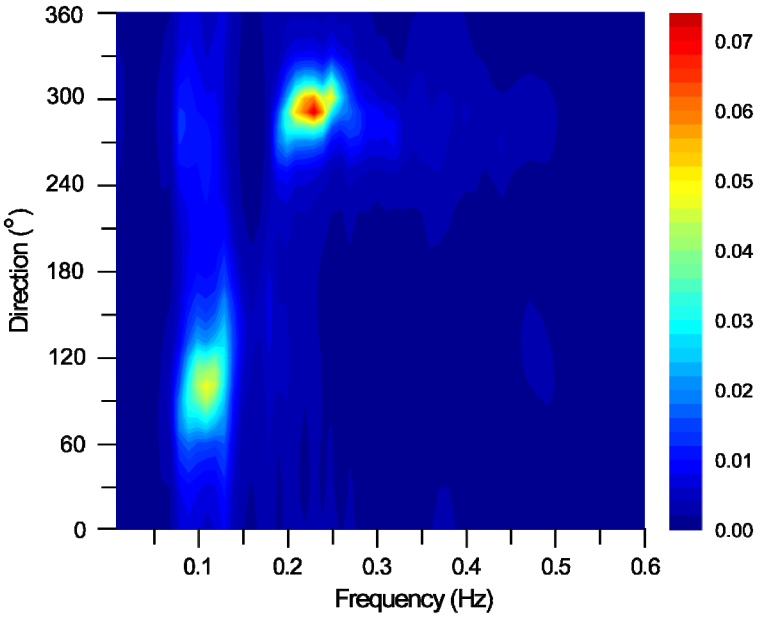

Fig. 2 Directional wave spectrum (m^2/s), from GBRHIS, derived with acoustic surface tracking by an AWAC. The waves, measured at 07:56, 22 February 2008 (UTC), display two distinct peaks. The local wind waves are predominantly from a west-northwesterly direction, whereas the lower frequency swell derives from the east-southeast.

Acknowledgments

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