RADIATIVE TRANSFER AND THE SPECTRAL CHARACTERISTICS OF CORAL REEF BENTHIC COMMUNITIES

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Introduction

Coral reefs are complex ecosystems, where a huge diversity of organisms comprise characteristic communities, creating different geomorphological and ecological zones. Knowledge of the spatial distribution of coral reef benthic communities allows for estimations of reef metabolism (Atkinson and Grigg 1984; Mumby *et al.* 1998) and biogeochemical cycling (Kinsey 1985), and can also indicate the relative magnitudes and frequencies of disturbances, both anthropogenic and natural (Connell 1997).

Since the early- to mid-1970's, digital remote sensing has been recognized as a useful tool for researchers mapping geomorphological reef zones (Green *et al.* 1996). Remote sensing studies of coral reefs have utilized satellite multispectral scanners which have low spatial (10's of meters) and spectral (~100 nm) resolution. The use of a few (2-3) broad spectral bands has allowed the inclusion of various simplifying assumptions into the methods for dealing with water column effects (Maritorena *et al.* 1994). Many algorithms (*e.g.*, Spitzer and Dirks 1987; Maritorena 1996; Tassan 1996) follow Lyzenga's method (1978, 1981), which is based on knowledge of the diffuse attenuation coefficient and computes a single "bottom reflectance coefficient" from two log-transformed wavebands. The method relies on the homogeneity of bottom albedos in an image: pixels which cover substrates absorbing more light in the available wavebands appear darker, and therefore their types and depths may be misidentified. This problem is minimal in broad-band satellite multispectral images, which homogenize large areas (10-40 m) and spectral regions (~100 nm). Most live-bottom (*i.e.*, coral and algae) substrates appear similar under such viewing conditions: the communities mix on spatial scales much less than that of satellite pixel sizes and on spectral scales much less than 100 nm. Therefore, bottom albedos are generally homogeneous in a given scene for a given waveband, and Lyzenga's method produces accurate results (*e.g.*, Morel 1996).

The recent advent of high spatial (1 m) and spectral resolution (1 nm) sensors enables the discrimination on a fine scale of not only a reef's geomorphological zones, but also its major community types: coral, algae and sand. However, the assumptions and algorithms developed for removing water column effects from satellite data should not, in principle, be valid for high spectral and spatial resolution data. The reason is that airborne instruments resolve the ground spatial and spectral features which are mixed in a satellite image.

The work described here is a sensitivity analysis designed to address the ways in which the underwater processes of absorption and scattering of light affect the spectral characteristics of various coral reef substrates. The magnitude and variability of these effects dictate the usefulness of high resolution remote sensing in coral reef environments.