DAILY COASTAL UPWELLING INDEX DERIVED FROM MODIS SST DATA AND SURF ZONE THERMISTORS

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1. INTRODUCTION

Upwelling indices are commonly calculated using wind stress measurements [1]. They describe the physical process which causes upwelling but may not accurately predict the presence or absence of cold, nutrient rich, upwelled water reaching the surf zone. Cold, nutrient-rich, upwelled water plays an important role in surf zone ecosystems and therefore needs to be quantified. Here a daily coastal upwelling index is defined and calculated for 5 years of data from 8 sites along the west coast of South Africa. The indices of 2 sites are additionally compared to offshore temperature moorings to study stratification changes during upwelling and relaxation.

2. METHODS

A daily coastal upwelling index is defined as

$$UI = \frac{T_{offshore} - T_{onshore}}{T_{offshore} - T_{bottom}}.$$

$T_{offshore}$ is calculated as the average of a 1° square of pixels of a MODIS SST image. The pixels are located 190 km offshore, at a distance far enough from the coast not to be affected by upwelling. $T_{onshore}$ is the 7 am temperature measured by the surf zone thermistors. Seven am was chosen because it is before the sun has begun to heat up the water and rocks which the thermistors are attached to and after the heat from the previous day's solar heating has dissipated. T_{bottom} is the historically measured temperature of the source water off the west coast of South Africa. This index is similar to the index described by [2] except $T_{offshore}$ represents the current situation offshore instead of the SST climatology and $T_{onshore}$ represents the temperature in the surf zone instead of the minimum SST pixel value. The minimum SST pixel value is generally separate from the coast; therefore this index is a much better representation of current conditions affecting surf zone organisms than the index in [2].

3. RESULTS

The upwelling index was calculated for 5 years of data from the 8 sites along the west coast of South Africa shown in Figure 1. Of the 8 sites, 4 were shown to be upwelling centers. Temperature moorings were deployed slightly offshore of the 2 northern sites to verify that the index was correctly describing the upwelling process. Figure 2 shows the changes in stratification with upwelling at the 2 sites. Almost all stratification disappeared at Columbine during strong upwelling. Stratification lessened but was still present at Elands Bay as the upwelling grew stronger.

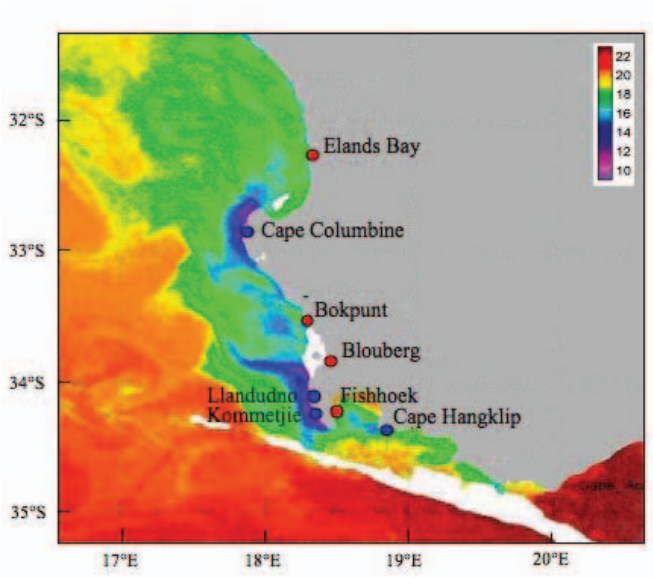

Fig. 1 Sample MODIS daily SST image showing the 8 study sites [3]. The sites with blue circles are upwelling centers and the red circles are downstream sites.

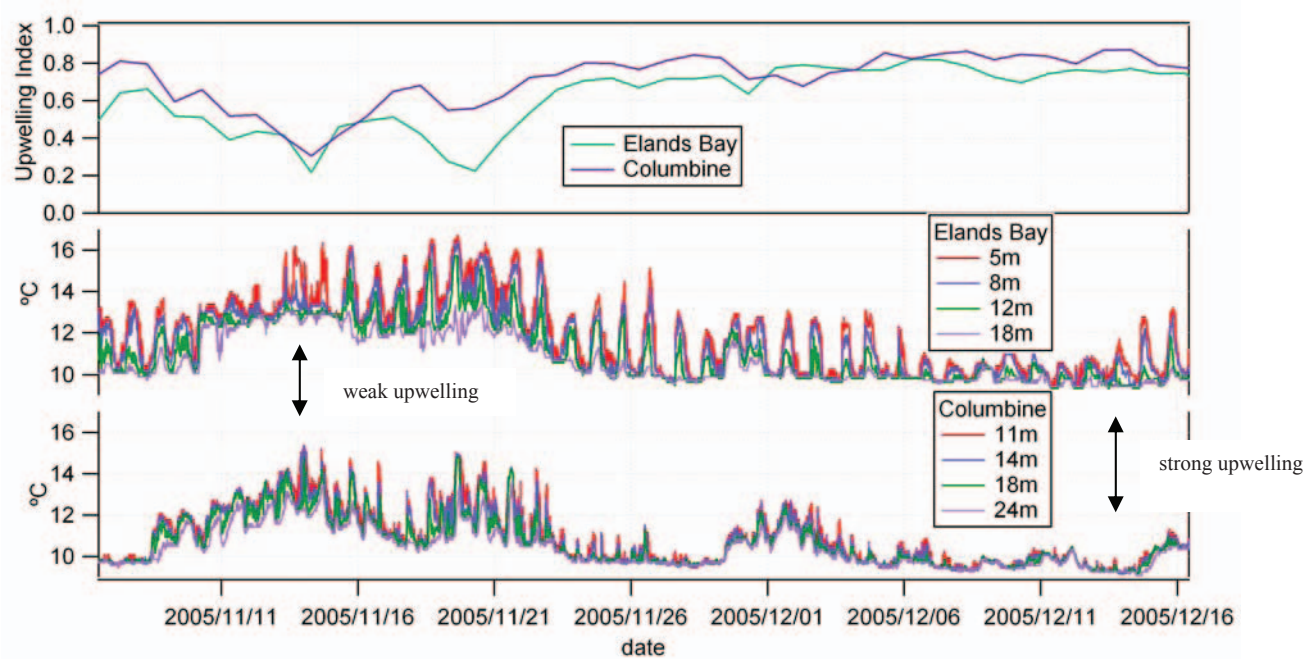

Fig. 2 Time series of the upwelling index for the Elands Bay and Columbine sites. Offshore thermistor moorings show stratification changes during weak and strong upwelling.

4. REFERENCES

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