Assimilation of Remote Sensing Observations to Estimate Surf Zone Bathymetry

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INTRODUCTION

Our goal is to use land-based remote sensing platforms such as video cameras to estimate surf zone bathymetry. Remote sensing in surf zones is challenging because of low signal-to-noise ratios, high background noise, and challenges associated with the Treasure Island (TrAI) environment. The deployment of these technologies in surf zones is also difficult because of the dynamic and unpredictable nature of the environment. The current technologies may be insufficient for obtaining accurate estimates of surf zone bathymetry. Moreover, surf zone bathymetry can change on short time scales.

METHODS

FORWARD MODEL

Alongshore periodic domain
Surface gravity wave dispersion, following Kirby and Dauzat (1980)
Surface wave group energy transformation, 5THW
Comments: boundary conditions at 0 m depth, in the presence of swells, wave- and depth-averaged circulation, RHS

SWATHINE MODEL

Bathymetry treated as uncertain parameter, Gaussian distribution
Parameter estimation using segment state vector approach
Distribution represented by 2400 rectangle ensemble
Ensemble mean bathymetry initialized using validated bathymetric survey
Ensemble covariance initialized to 1 meter of depth
Horizontal length scale of 100 m, 0.5 m in standard deviation

ADDITIONAL TESTING

To assess observation impact, tens of wave observations only, in the presence of swells, same color scheme as above with uncertainty expressed by transparency
Velocity-based based estimates have a smaller footprint due to experiment design, and are more sparse in space
Inherent difficulty in tracking image features
As a result, velocity-based estimates have less bias compared to velocity-based estimates.

THE DEVIANCE

Transitions of data (temporal and seasonal) for each observation type, evaluated over the subregion in which all three observation types were available. In all cases, assimilation of data results in an increase of bathymetric accuracy.

EFFECT OF RANDOM MODEL COUPLING

The above results used the wave dispersion relationship of Kirby and Dauzat (1980), which includes the nonlinear effect of finite wave amplitude

SUMMARY

In this work, we have applied the Ensemble Filters to estimate bathymetry as a model parameter in a wave setting, using a land-based remote sensing observations. Bathymetry estimation is important for nearshore predictions of waves and currents, since bathymetry strongly influences model predictions, can change rapidly, and is difficult to measure directly. The increasing use of remote sensing in the nearshore, including development of new data products, requires data assimilation which will play an increasingly important role in future predictions.

REFERENCES


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