DISPLACEMENT BASED ERROR METRIC FOR MORPHODYNAMIC MODELS

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1. Introduction

The quality of a morphological prediction is often expressed by an overall grid-point based skill score based on the Mean Squared Error (MSE) between the predicted and observed bed levels (Sutherland et al., 2004). Although the MSE is a good measure of the overall error between model and observations, it tends to penalize rather than reward the model's capability to provide information on features of interest such as scour holes, accumulation zones and migrating tidal channels; a feature that is predicted correctly in terms of timing and size but is (slightly) misplaced leads to a relatively large MSE as compared to a smoother forecast. This makes it difficult to demonstrate the skill of a high variability prediction (Anthes, 1983).

Our aim is to overcome this inherent limitation of the MSE and other grid-point based error metrics. To that end, we introduce a new distance measure for 2D morphological change that explicitly takes (dis)agreement in spatial patterns into account.

2. Method

In order to quantify the (dis)agreement in spatial patterns, we employ an image warping method that determines the deformation of the predicted morphology necessary to match the observations more closely. The result is a vector field of displacements that gives information on the spatial errors.

Both the displacement field and the average displacement for a pair of observations and predictions provide valuable information about the model performance. In addition, we present a combined error metric that rewards forecasts for which a large error reduction can be obtained by relatively small displacements.

The image warping method is based on the Demon's algorithm (Thirion, 1998) and bears similarities to optical flow techniques designed to estimate motion. We use an extended version that allows for intensity variations.

3. Results

First, the accuracy of the image warping method has been tested for a constructed example where the displacement fields and co-occurring random intensity errors at various scales are known exactly. Next, an idealized case has been studied of a tidal inlet developing from an initially very schematized geometry (Roelvink, 2006) as modelled by Delft-3D. This idealized case has allowed the generation of a large variety of spatial patterns that we are currently using to test the combined error metric.

As an example, Figure 1 shows the displacement vector field between two computed morphological fields, one with and the other without Coriolis.

The full conference paper and presentation will include the application of the displacement method to real-life cases for which pairs of predicted and measured morphology are compared and ranked.

3. Conclusions

We have developed an error metric for morphodynamic models that explicitly takes (dis)agreement in spatial patterns into account. It rewards forecasts for which a large error reduction can be obtained by relatively small displacements. The displacement fields between predictions and observations are determined by using an image warping method.

Preliminary results indicate that the quantification of forecast performance by an error metric based on displacement fields better reflects the qualitative judgment of experts than the traditional grid-point based error metrics do.

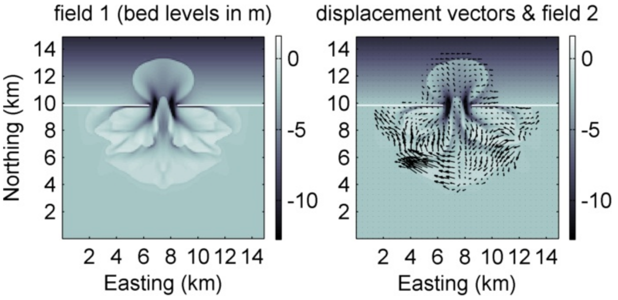

Figure 1: Example of the image warp. Left: field 1 calculated with Delft3D without Coriolis, right: field 2 calculated including Coriolis & the displacements of field 2 necessary to closely match field 1 (average displacement 350 m). After the warp the MSE has been reduced with 70% .

References

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