OpenDA applications

Calibration of DCSM-v6 using OpenDA

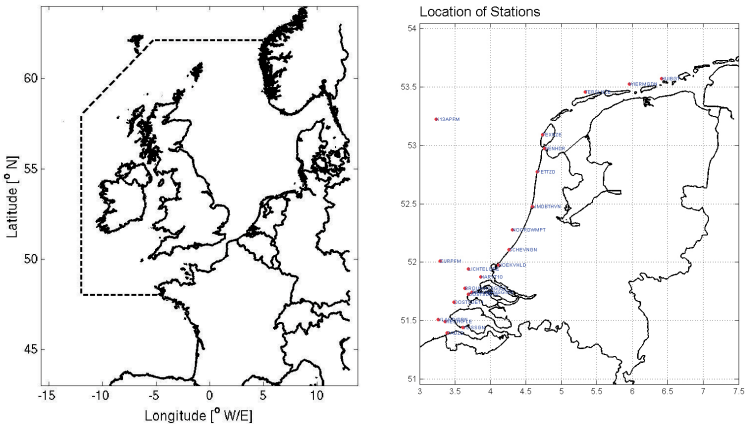

Figure 1: Dutch Continental Shelf Model: version 5 (dashed-line, grid cell ~10x10 km2, 12oW-13oE and 48oN-62o) and version 6 (grid cell ~2x2 km2, 12oW-13oE and 48oN-62oN). The right-hand side picture shows area of interest (Dutch coast) and water-level observation locations used for calibration.

WAQUA/DCSM

The WAQUA-in-Simona/DCSM98 storm surge model, developed by Rijkswaterstaat, Deltares, and KNMI, is being used for day-to-day sea level forecasts by KNMI and Rijkswaterstaat since 1990.

OpenDA and WAQUA

For WAQUA, a so-called “model wrapper” has been made which takes care of structured data exchange between OpenDA and WAQUA, independent of the specifications of the actual WAQUA application.

WAQUA model application

The Dutch Continental Shelf Model (DCSM) is a model for storm surge forecasting, which is operational in the Netherlands. It is developed as an application of WAQUA module of SIMONA, a framework for hydrodynamic modelling of free-surface water systems. WAQUA module is used for modelling 2D schematizations of water system.
The current operational model uses a grid size, which is coarse for nowadays standard. To improve the forecast quality, a new version of DCSM is being developed. Besides using finer both spatial and time grids, it also covers a larger area. OpenDA has been applied to calibrate the bathymetry of this new version DCSM.

DCSM calibration experiment

As the first calibration effort, DCSM v6 is calibrated for tidal signal. In this experiment, OpenDA is applied to optimise the water level output along the Dutch coast. A uniform correction factor for the bathymetry is assigned to the whole model area. The optimization method Dud, which is available in OpenDA, is used to determine this correction factor. For this application, the Dud minimizes a least squares criterion formulated in terms of water level differences over the one month simulation in a user selected set of observation stations (s) in user selected regions (r) of the model domain.

$$GoF = \frac{1}{2}\sum_{r=1}^{r=R\max}\sum_{s=1}^{s=S\max}\sum_{n=1}^{n=N\max} w_{r,s}\left(H_{r,s,n}^{sim}(t) - H_{r,s,n}^{obs}(t)\right)^2 \Big/ \left(\sigma_{Hobs}\right)^2$$

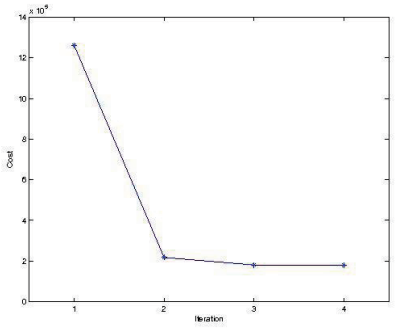

Figure 2: Cost converges on the fourth run.

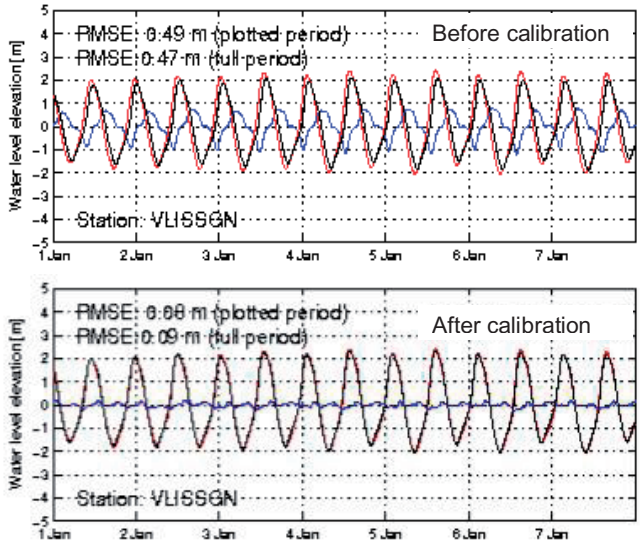

Figure 3: Water level observation (red) and model results (black) before and after calibration at station Vlissingen. The blue lines show water level residual.

Name	RMSE before calibration	RMSE after calibration
BROUWHVSGT02	0.265	0.100
BROUWHVSGT08	0.238	0.101
CADZD	0.366	0.111
DENHDR	0.169	0.082
EURPFM	0.200	0.096
HARVT10	0.248	0.105
HOEKVHLD	0.210	0.120
HUIBGT	0.244	0.076
IJMDBTHVN	0.206	0.085
K13APFM	0.112	0.044
LICHTELGRE	0.248	0.109
NOORDWMPT	0.220	0.104
OOSTSDE11	0.289	0.098
OOSTSDE14	0.274	0.086
PETTZD	0.205	0.071
SCHEVNGN	0.213	0.099
TERSLNZE	0.217	0.086
TEXNZE	0.171	0.064
VLAKTVDRN	0.314	0.118
VLISSGN	0.475	0.110
WESTKPLE	0.258	0.122
WIERMGDN	0.211	0.063
Average	0.243	0.093

Table 1. RMSE water level at stations along Dutch coast, before and after calibration.

Results

Converged on the fourth model run, the Dud algorithm suggests an additive correction factor of 2.56 m to be applied to the bathymetry of the whole model area. This is consistent with the finding of earlier calibration work (Zijl et al., 2008). With this correction, model results are found to be improved at all locations in the domain of interest (Figure 2, for example).

Conclusions

Model interface (wrapper) has been developed for WAQUA to communicate with OpenDA. OpenDA has been shown to produce accurate results of calibration of the DCSM v6 bathymetry. OpenDA is also being applied and tested with other WAQUA-based models. The experience of applying OpenDA for calibration of WAQUA-based models has shown that OpenDA offers an easy-to-use framework for calibration of different models.

References

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Zijl, F., R. Plieger, D. Vatvani, M. Verlaan, H. Gerritsen and D. Twigt (2008), DCSM v6 model setup and calibration of tidal propagation, Technical Report, Deltares, 2008