F150ow07z[001-011]: Eastern Wadden Sea and Eems-Dollard Estuary 2007

Purpose

The storm of 9 November 2007 was a dominantly north-northwesterly event. The peak of the storm, related to maximum registered wind speed was U_{10} = 22.2 m/s and occurred at 11:00 am, whereas high water was at 10:00 am. Wind directions changed from 280° at the beginning of the storm to to 320° at the end of the storm.

Based on water level registrations at Delfzijl, the return period of the storm is about ten years, making it a significant storm event. Here, the encountered wave height has a maximum of 8.4 m. This is close to the value 8.59 m, which corresponds to a storm with return period of 100 years[1] (WL, 2004). Therefore, this storm can be considered as a major storm of significant interest for the wave conditions at the mainland dikes. The original SWAN hindcast is described in Alkyon (2008).

Situation

Measured wave data were obtained at six directional wave buoy locations. On the basis of measured wind and wave conditions, eleven time instants were selected for the hindcast. The current and water level conditions were computed using a two-way coupled Delft3D-SWAN model, with which the effect of the waves on the current flow was included. Inclusion of these wave effects was found to improve the accuracy of the simulated water levels. The model settings were chosen to obtain the best possible fit with observed water levels. The current and water level fields of the coupled Delft3D-SWAN computations were interpolated to a finer grid for the actual wave hindcast.

The results of the wave computations show that the tidal inlets effectively block the penetration of North Sea storm waves, as found in previous hindcast studies in tidal inlet of Ameland. Consequently, the wave conditions are mainly locally determined in the eastern Wadden Sea. Measurements, however, showed that wave components with frequencies lower than 0.1 Hz are able to penetrate into the Wadden Sea, but that they are under-predicted by the SWAN model. Model computations showed that they are refracted to the sides of the tidal channels where they are subsequently dissipated on the tidal flats. Thus, they hardly penetrate into the Wadden Sea interior.

Case selection

All 11 moments as originally used in Alkyon (2008) are included in SWIVT. They are gathered in the table below.

[1] Based on a Weibull fit on measured wave heights at SON over a period of 23 years.

RunID	Time instant	Event
1	2007/11/8 19:20	High current velocities; Direction of the current (following current going to 140° North) coincides with direction of waves.
2	2007/11/9 06:20	Highest H_{m0}/d ratio, water level is increasing. High current velocities close to PBW1
3	2007/11/9 07:00	High measured H_{m0}/d ratio; increasing water depth.
4	2007/11/9 07:20	High current velocities. Direction of the current (going to 108° North) in the direction of the main tidal channel.
5	2007/11/9 09:00	Highest water depth (NAP+4.30 m)
6	2007/11/9 09:10	Highest water depth (NAP+4.30 m)
7	2007/11/9 09:30	Highest H_{m0} (1.61 m) at PBW1
8	2007/11/9 09:40	Highest H_{m0} (1.28 m) at UHW1, close to highest water level
9	2007/11/9 10:20	Highest water level (NAP+3.01 m)
10	2007/11/9 11:00	Time instant with the highest wind velocity at Huibertgat.
11	2007/11/9 13:40	High current velocities in tidal channels; Direction of the current opposes (going to 317° North) direction of waves.

Table 1 Selected calibration cases (and their characteristics) from the Eastern Wadden Sea data set. The runId refers to the casename, i.e. f150ow07z001 is case 2007/11/08, 19:20 etc.

Model setup

The bathymetry of the Eastern Wadden Sea is shown in Figure 1. The SWAN computations are computed on a set of nested SWAN grids, see Figure 2. The main grid (Eems; nest 1) covers the Eastern Wadden Sea and the areas around the shallow water wave buoys: PWB1 (nest 2), UHW1 (nest 3) and WRW1 (nest 4). The main grid also provides boundary conditions for the Dollard estuary, in which no wave buoys are located.

Four buoys provide data for validation:

- WEO1 (Westereems Oost), in nest 1
- PBW1 (Pieterburenwad), in nest 2
- UHW1 (Uithuizerwad), in nest 3
- WRW1 (Wierumerwad), in nest 4

For cases f150ow07z006 and f150ow07z007, no measurement data is available in UHW1 and WRW1.

Default settings

The following settings are default for this case:

```
$ --- Fysische parameter settings
GEN3 WESTH
QUAD iquad=2 lambda=0.25 Cnl4=3.0E7
LIMITER ursell=10 qb=1.0
FRICTION JONSWAP cfjon=0.067
BREA CON alpha=1.0 gamma=0.73
TRIAD trfac=0.1 cutfr=2.5

$ --- Numerieke parameter settings
NUM STOPC 0.00 0.01 0.001 99.8 STAT mxitst=80  alfa=0.002
```

The wave parameters are obtained by integration over frequency range 0.03 Hz to 0.50 Hz:

```
$ *** Integrate over frequency range [FMIN,FMAX] to obtain wave
parameters
QUANT HS TMM10 TM01 TM02 FMIN 0.03 FMAX 0.5
```

For the remainder of the settings, we refer to the SWAN command files.

References

Alkyon (2008). SWAN hindcast in the Eastern Wadden Sea and Eems-Dollard estuary. Alkyon report A2191Rr4, December 2008.

WL, 2004: Golfstatistiek op relatief diep water 1979-2002, Appendix I to report Q3770, WL|Delft Hydraulics report Q3770, Nov. 2004.

Acknowledgements

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Figure

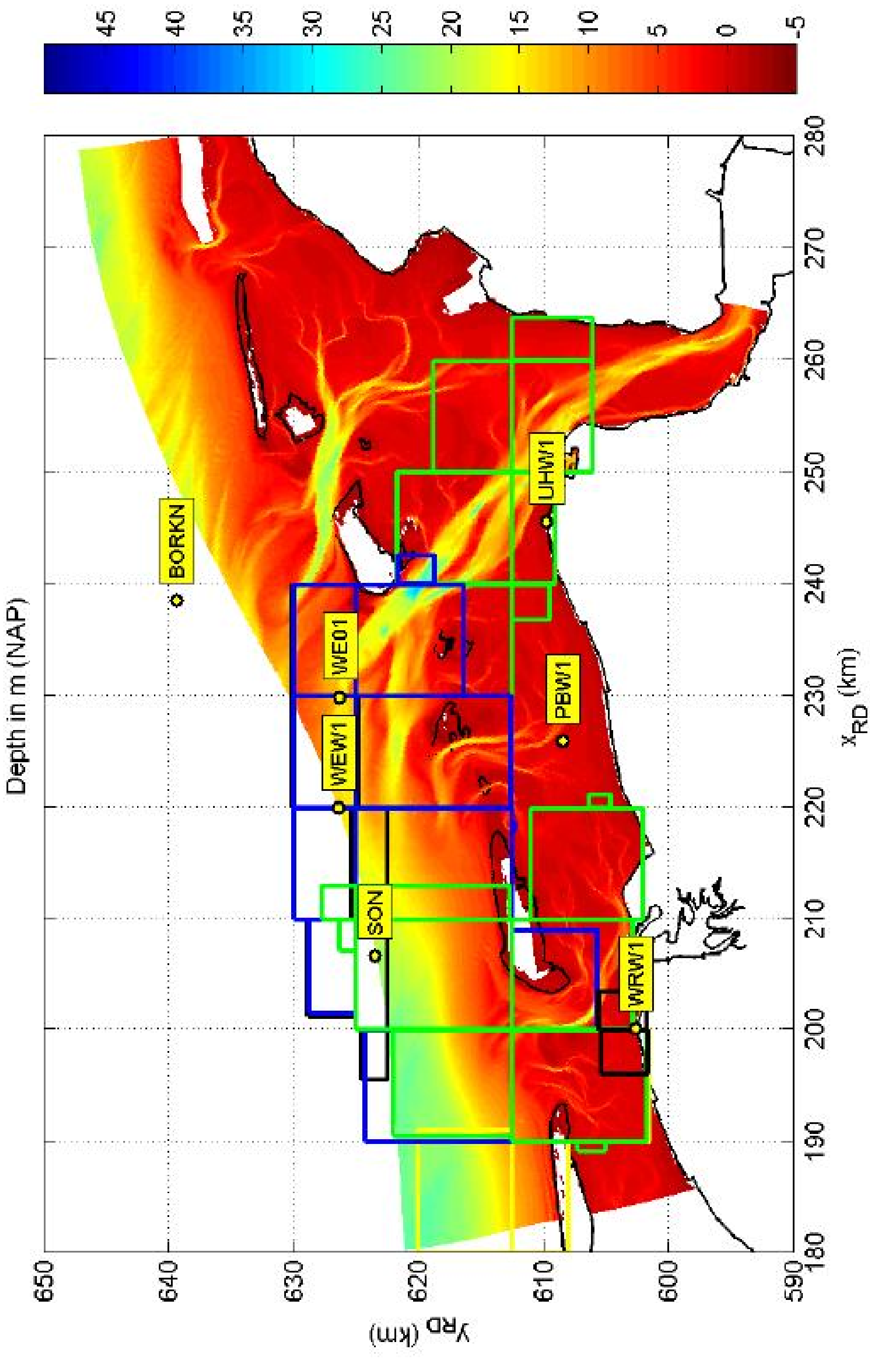

Figure 1. Bathymetry of Eastern Wadden Sea on grid Eems3, buoy locations and outline of data sources

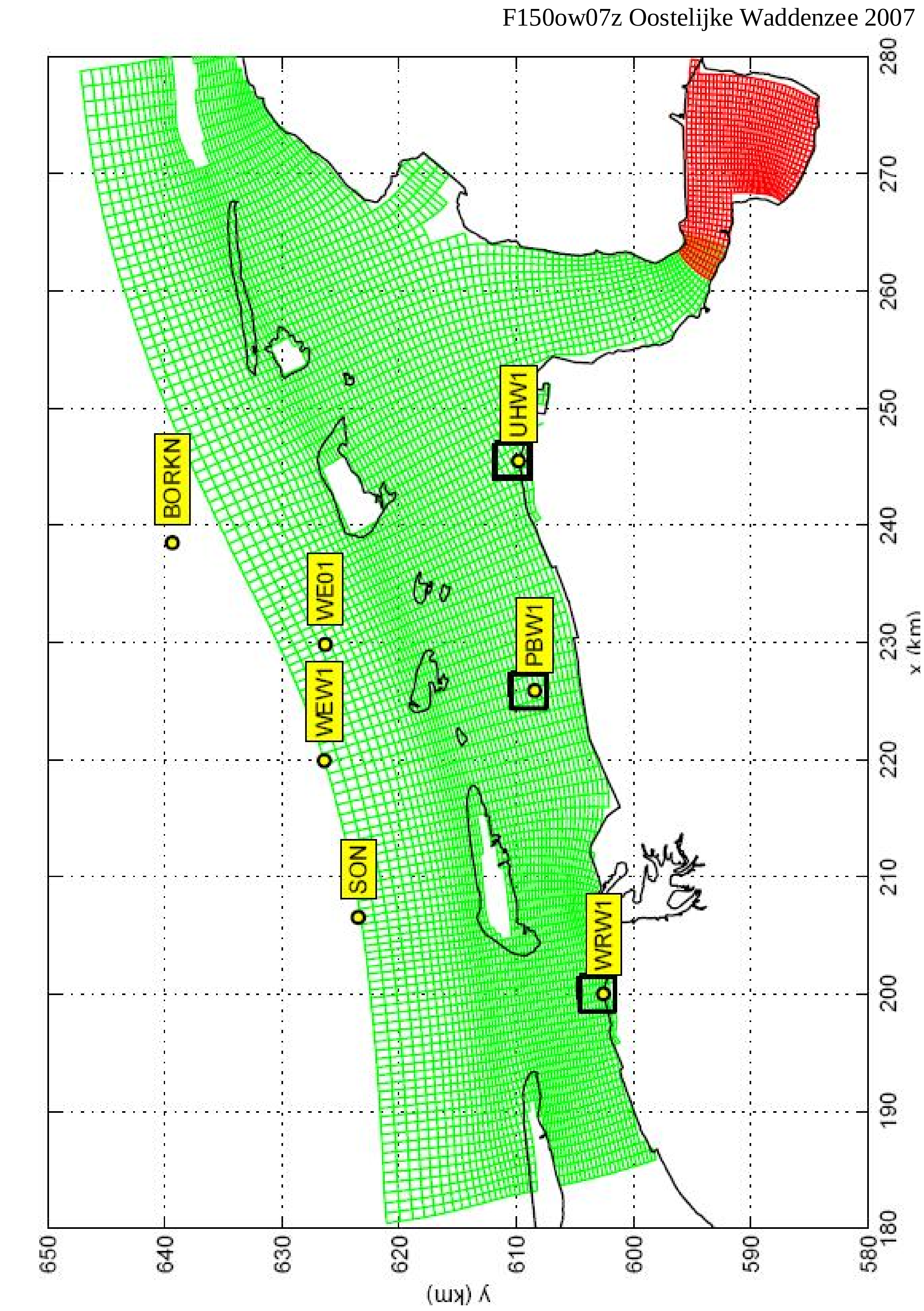

Figure 2. Computational grid and buoy locations. Eems3 (green) and Dollard (red). Every fifth grid line is shown. Outline of detailed grids around buoys PBW1, UHW1 and WRW1 in black.