F130ijsse[001-007]: Lake IJssel

Purpose

Lake IJssel, in the northwest of the Netherlands, displays comparable finite depth wave growth as found in the shallow Wadden Sea interior (Deltares 2008a). As a result, this field site is suitable for complementing the data set for studying the performance of SWAN with respect to finite depth wave growth in the Wadden Sea interior.

Situation

Lake IJssel (Figure 7.1) is approximately 20 by 60 km in size. Up to 1932, prior to the construction of a dam, Lake IJssel and Lake Marken were connected to the Wadden Sea, together forming the Zuiderzee. A significant part of its shores consists of dykes that were constructed between 1928 and 1976. At present, Lake IJssel is a large lake with a typical depth of about 4-5 m, and has a fairly flat, sandy bottom. The lake is therefore shallow compared to its horizontal dimensions. Wind and wave data for this lake are available over the period 1997 to 2007, and have been extensively validated and analysed by Bottema (2007). In addition, these data have been considered in hindcast studies by Alkyon (2005), Bottema (2006) and Van der Westhuysen et al. (2007).

For the investigation of finite depth wave growth, the dominant wind direction sector of SW-W is relevant. For these wind directions, the wave and wind observation station FL2/FL2n is well-situated (see Figure 7.1), and is therefore the focus of this test case. For these wind directions, station FL2/2n has a characteristic fetch length about 20 km. Over this fetch, featuring an approximately constant water depth (except for slight seasonal variation and storm setup), a number of physical processes are found relating to finite depth wave growth: in addition to the deep water source terms (wind input, whitecapping and quadruplet interaction), bottom friction, depth-induced breaking and triad nonlinear interactions (to a small degree, due to the intermediate depths) are found. The relative importance of the various source terms depends on the relative shallowness of the wave condition, and hence on the prevailing wind speed. Since Deltares (2008a) demonstrated the general agreement between finite depth wave fields here and in the Wadden Sea interior, this is considered a relevant field site for a Wadden Sea validation data set.

Case selection

Bottema (2006, 2007) considered the following criteria for selecting a set of 12 representative test cases for Lake IJssel from the records of 1997-2007: (a) stationary conditions, (b) at least 80% of the data is available and reliable, (c) the wind speeds observed at the various wind stations (FL2/FL2n, FL25/FL37 and FL26) differ less than 5-10%, (d) representativeness of test case data and (e) limited thermal effects (small air-water temperature differences). Concerning stationarity, all selected cases have less than a few percent wind speed change per hour, and less than a few degrees wind direction change. Representativeness implies that for given wind conditions, the measured wave conditions should be no outlier with respect to other cases, but rather a central estimate. This is quite important because the random scatter in H_{m0} is typically 15%. From this data set, Deltares (2008a) made a selection of seven test cases, in which preference was given to cases with higher wind speeds and SW-W wind directions. This selection, which is fully applicable to the present purpose, is given in Table 1 below:

Case	Nr	Date	Time	Lake level	U_{10}	U_{dir}	H_{m0}	T_p	$T_{m-1,0}$	T_{m02}
				[m NAP]	[m/s]	[°N]	[m]	[s]	[s]	[s]
IJA	1	02/10/1999	3:00	-0.20	15.2	215	0.89	3.95	3.35	2.71
IJB	2	22/02/2002	4:00	0.08	18.8	215	1.23	4.62	4.25	3.28
IJC	3	27/10/2002	14:20	-0.26	23.2	249	1.61	5.26	5.01	3.75
IJG	4	08/01/2005	13:00	-0.20	19.9	246	1.44	4.92	4.41	3.45
IJH	5	12/02/2005	15:00	-0.39	18.3	286	1.29	5.00	4.23	3.29
IJK	6	18/01/2007	12:00	0.06	22.4	237	1.75	5.09	4.69	3.68
IJL	7	18/01/2007	19:00	0.10	23.5	267	1.68	5.46	4.99	3.70

Table 1: Selected validation cases (and their characteristics) for Lake IJssel, based on Deltares (2008a). Lake level, wind direction and speed pertain to average observations over the lake. Wave parameter observations given for FL2/FL2n. The number Nr refers to the casename, i.e. F130ijsse001 is case IJA etc.

Model setup

These field cases are modelled using a regular computational grid covering the entire lake. Since Lake IJssel is enclosed, no wave boundary conditions are required. Waves and water levels were observed by step gauges and capacitance probes at stations FL2/FL2n, FL5, FL9, FL25/FL37, FL26. The level observations in FL5 are the lowest ones among the available level observation data point for the considered storm moments[1]. The level observations in FL5 provides the constant water level. As mentioned above, only station FL2/FL2n is considered for wave observations in the present case. Wind information was observed at stations FL2/FL2n, FL25/FL37 and FL26. The spatially averaged wind speed and direction of these stations are applied uniformly over all of Lake IJssel. As recommended by Alkyon (2005), no currents or water level setup are included in the model setup.

Both the completeness and quality of this set of observational data is considered as being good. The data set is suitable for studying finite depth wave growth, such as found in the Wadden Sea interior. Hence, these field cases are considered to be suitable to take up as validation cases in SWIVT.

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=0.05 cutfr=2.5
```

[1] In SWIVT, the same water levels as in Bottema (2007) are used. In Bottema (2007), it is stated erroneously that the water levels are obtained by averaging over the stations FL2/FL2n, FL5, FL9, FL25/FL37, FL26.

```
$ --- Numerieke parameter settings
NUM STOPC 0.00 0.01 0.001 99.5 STAT mxitst=50 alfa=0.001

$ *** Integrate over frequency range [FMIN,FMAX] to obtain wave
parameters
QUANT HS TMM10 TM01 TM02 FMIN 0.03 FMAX 1.5
```

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

References

Alkyon (2005). SWAN acceptance tests for RWS RIZA in 2005. Activity Report 3, Wave-current interactions. Alkyon report A1477R3R3, November 2005.

Bottema, M. (2006). Gedrag van het SWAN-golfmodel met en zonder nieuwe diepwaterfysica, met nadruk op korte strijklengtes (in Dutch), RWS RIZA werkdocument 2006.057X.

Bottema, M. (2007). Measured wind-wave climatology Lake IJssel (NL). Main results for the period 1997-2006. Report RWS RIZA 2007.020, July 2007.

Deltares (2008a). Observed finite depth wave growth limit in the Wadden Sea. Deltares Report H5107.35, July 2008.

Van der Westhuysen, A. J., M. Zijlema, and J. A. Battjes (2007). Nonlinear saturation-based whitecapping dissipation in SWAN for deep and shallow water. Coastal Engineering 54, 151-170.

Acknowledgements

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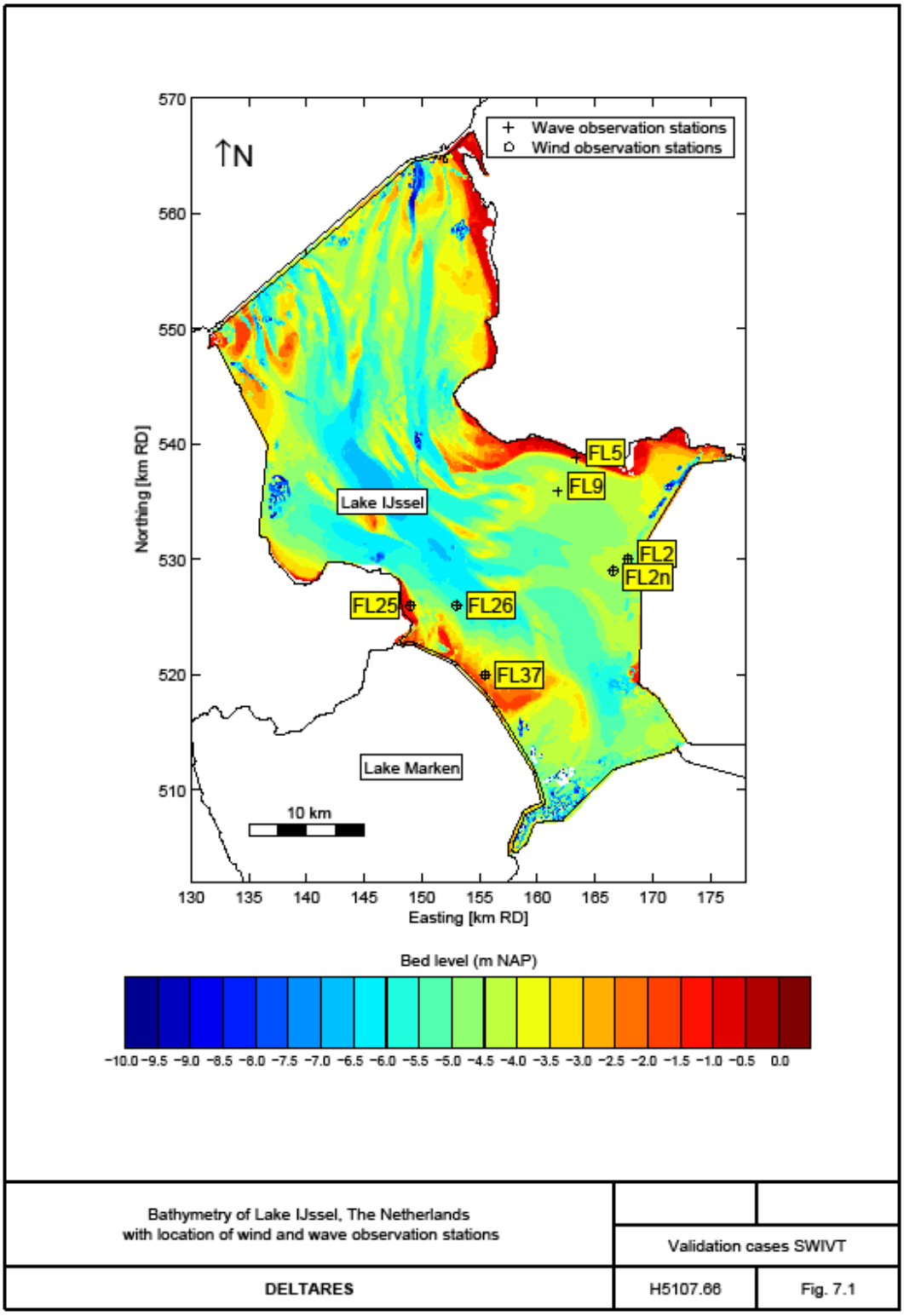
Figure



Bathymetry of Lake IJssel, The Netherlands with location of wind and wave observation stations		
	Validation cases SWIVT	
DELTARES	H5107.66	Fig. 7.1