Summary of NTHMP Tsunami Inundation Benchmark Problems

Contents

Analytical benchmarking:

BP 1: Single wave on simple beach, CASE H/d=0.019 (Page 5, PMEL-135 Report)

Objectives:

1. "Numerical models should calculate the maximum runup of nonbreaking solitary wave within 5% of the calculated value from the analytical solution",
2. "Numerical experiments should be undertaken in a range of depths and compared to each other and to the analytical solution",

Checklist:

1. Numerically compute maximum runup, of the solitary wave,
2. Numerically compute water level ζ/d at $t=25(d/g)^{1/2}$, $t=35(d/g)^{1/2}$, $t=45(d/g)^{1/2}$, $t=55(d/g)^{1/2}$, and $t=65(d/g)^{1/2}$ for the solitary wave ,
3. Numerically compute water level ζ/d as a function of $t(g/d)^{1/2}$ at locations x/d = 0.25 and x/d = 9.95 during propagation and reflection of the wave,
4. Demonstrate scalability of the numerical code.

Laboratory benchmarking:

BP 4: Single wave on simple beach (Page 6 of the PMEL-135 Report)

CASE A: Water Depth, H/d = 0.0185,
CASE C: Water Depth, H/d = 0.3, [1]

Objectives:

1. "Numerical models should calculate the maximum runup of nonbreaking solitary waves within 5% of the measured values in the laboratory,"
2. "For breaking waves, the models should produce predictions within 10% of the measured values"
3. "they [models] should consistently predict the runup variation described in Appendix A3.1 of the PMEL-135 Report***".***

Checklist:

1. Numerically compute water level ζ/d at $t=25(d/g)^{1/2}$, $t=35(d/g)^{1/2}$, $t=45(d/g)^{1/2}$, $t=55(d/g)^{1/2}$, and $t=65(d/g)^{1/2}$, (Case A) ,
2. Numerically compute water level ζ/d at $t=10(d/g)^{1/2}$, $t=15(d/g)^{1/2}$, $t=20(d/g)^{1/2}$, $t=25(d/g)^{1/2}$, and $t=30(d/g)^{1/2}$, (Case C) ,
3. Numerically compute maximum runup (Case A and C),
4. Numerically compute maximum runup R/d versus H/d.

BP 6: Solitary wave on a conical island (Page 6 of the PMEL-135 Report)

CASE B: Water Depth, d = 32.0 cm, Target H/d = 0.10, H/d = 0.096,
CASE C: Water Depth, d = 32.0 cm, Target H/d = 0.20, H/d = 0.181, [2]

Objectives:

1. "The numerical method should stably model two wave fronts that split in front of the island and collide behind it,"
2. "Predictions of the runup on the back of the island where the two fronts collide should not differ by more than 20% from the laboratory measurements,"

Checklist:

1. Show that two wave fronts that split in front of the island and collide behind it,
2. Numerically compute water level ζ/d as a function of $t(g/d)^{1/2}$ at gauges 9, 16, and 22,
3. Numerically compute runup R/d around the island

[1] Case "B" in BP 4 was assumed to be optional (Summary Report, NTHMP MMS Tsunami Inundation Model Validation Workshop, 2011, p. 7)

[2] CASE "A" in BP 6 (Water Depth, d = 32.0 cm, Target H/d = 0.05, H/d = 0.045) was assumed to be optional. (Summary Report, NTHMP MMS Tsunami Inundation Model Validation Workshop, 2011, p. 7)

BP 7: Tsunami runup onto a complex three-dimensional model of the Monai Valley beach (Page 6 of the PMEL-135 Report)

Objectives:

1. ***"*** ... the entire simulation shows how well the code performs in a rapid sequence of withdrawal and runup***",***
2. "Comparison of results from different codes has shown that the maximum runup in these experiments can be calculated within 10%, which is thus the standard,"

Checklist:

1. Snapshots of the numerical solution at the time intervals corresponding to the movie frames 10, 25, 40, 55, and 70. The time interval between frames is 0.5 seconds**,**
2. Numerically compute the water level ζ at gauges 1, 2, and 3,
3. Numerically compute the maximum runup in the narrow valley, representing the Monai Valley**.**

Field benchmarking:

BP 9: Okushiri Island tsunami (Page 8 of the PMEL-135 Report)

Objectives:

1. "Predictions for the maximum runup at Aonae, Okushiri Island, Japan, should not differ by more than 20% from the measurements,"***.***
2. There are several observations which need to be explained by numerical modeling:
   a. Arrival of the first wave to Aonae 5 min after the earthquake should be estimated with the numerical model. Also, a numerical model should reveal two waves at Aonae approximately 10 min apart; while the first wave came from the west, the second wave came from the east,
   b. In addition, two tide gage records at Iwanai and Esashi given in Fig. A35 in ***PMEL-135 Report*** need to be estimated,**.**
   c. Maximum runup distribution around Okushiri Island should compare well with the field measurements (Fig. A36, ***PMEL-135 Report***). High runup height at Hamatsumae, located to the east of Aonae, needs to be explained since Hamatsumae is sheltered against the direct attack of the tsunami by the Aonae point. Also, topography does not suggest any tsunami amplification mechanism at this location,
   d. The highest runup of 31.7 m in a valley north of Monai needs to be approximated with the numerical model (Fig. A37, ***PMEL-135 Report***)**.**

Checklist:

1. Compute runup around Aonae***,***
2. Compute arrival of the first wave to Aonae after the earthquake,
3. Show two waves at Aonae approximately 10 min apart; the first wave came from the west, the second wave came from the east,
4. Compute water level at Iwanai and Esashi tide gauges,
5. Maximum modeled runup distribution around Okushiri Island,
6. Modeled runup height at Hamatsumae, located to the east of Aonae,
7. Modeled runup height at a valley north of Monai.

Comments:

1. Bathymetry probably might have some lateral shifts.

References:

Synolakis, C.E., E.N. Bernard, V.V. Titov, U. Kânoğlu, and F.I. González (2007): Standards, criteria, and procedures for NOAA evaluation of tsunami numerical models. NOAA Tech. Memo. OAR PMEL-135, NOAA/Pacific Marine Environmental Laboratory, Seattle, WA, 55 pp.

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