Overview of Benchmark Workshop Objectives,

• Construct a set of model validation tests for tsunami-like nearshore currents and evaluate existing models against these tests
  – Goal is to get a handle on model accuracy and variability, not to advance a “standard”
  – Ideally tests include both offshore and onshore (overland flow) currents, and are taken from both analytical/lab and field datasets
  – Identify any gaps in our modeling ability of these processes
Overview of Datasets – Benchmark #1

• A steady inflow case, to test a model’s ability to properly generate a wake
• Steady inflow with a submerged conical island (no moving boundary)
• Wake / separation generated through spatial gradients of bottom friction
• Data to compare:
  • Time series of velocity components in the wake
  • Can the model get magnitude and frequency of the vortex shedding correct?

SHALLOW-WATER FLOW AROUND MODEL CONICAL ISLANDS OF SMALL SIDE SLOPE. II: SUBMERGED

By Peter M. Lloyd¹ and Peter K. Stansby²

ABSTRACT: Experiments have been conducted to study the unsteady wakes of submerged conical islands. The islands used in the tests have side slopes ranging from 8.0 to 33.1°. Experiments in a shallow-water channel with a steady, subcritical free stream showed vortex shedding to occur in the wake when the water depth above the island apex was relatively small. Flow separation from positions near the island apex was found to be important in producing this unsteady wake. As the water depth was increased the shedding was observed to become less vigorous and eventually stop. All islands tested produced similar results with the angle of the island side slope exerting relatively little influence on the process. The results of wind tunnel visualization studies, which used a rigid top plate to produce the effect of fluid depth, support the results from the water channel. Pictures of the surface flow patterns produced on the islands by the wind action are presented. Two-dimensional (2D) and three-dimensional (3D) shallow-water numerical models with the hydrostatic pressure assumption have been run for comparison with the laboratory measurements. The complex 3D flow observed in the near wake provides a severe test for the models. Although both models were found to reproduce gross features of the submerged island wakes their mode of generation could be quite different in model and experiment.

Not a wave, but best way to test wake generation, role of numerical dissipation in wake generation
MODELERS ASKED TO PRESENT RESULTS FOR THREE DIFFERENT CONFIGURATIONS:

1) Simulation result with dissipation sub-models included, using the roughness information included in the paper to best determine the friction factor. In the papers, the friction factor is estimated to be 0.006 (as a dimensionless pipe-flow-like drag coefficient) or a Mannings n value of 0.01 s/m^{1/3}. If a RE-dependent friction factor formulation is used, then a roughness height, \( k_s \), of \(~1.5 \times 10^{-6} \) m should be used.

2) Simulation results with optimized agreement based on tuning of dissipation model coefficients (e.g. friction factor). Note that this simulation can be skipped if the modelers do not wish to optimize their comparisons.

3) Simulation result with ALL dissipation sub-models NOT included (e.g. a physically inviscid simulation). The purpose of this test is to understand the relative importance of physical vs numerical dissipation for this class of comparison.
Overview of Datasets – Benchmark #2

- Hawaii ADCP network & Pawlak data, 2001
- A number of good candidates; many gages are in relatively deep water (>20 m) and so currents are both tidally affected and linear (wrt water wave)
- Hilo Harbor is a challenging location:
  - Low data sampling rate (6 min), many current oscillations not resolved
  - What level of precision can we expect from a model with regard to modeling currents on real bathymetry?
  - Will a model converge with respect to speed predictions and model resolution?
  - What is the variation across different models, using the same wave forcing, resolution, and bottom friction?

Probably most comprehensive current dataset for a tsunami; data at most interesting & challenging locations not ideal
Modelers asked to provide results for at three different numerical configurations:

1) Simulation result at ~20 m resolution (2/3 arcsec, de-sample the input bathymetry), using a Mannings n coefficient of 0.025 (or approximate equivalent if using a different bottom stress model)

2) Simulation result at ~10 m (1/3 arcsec) resolution using a Mannings n coefficient of 0.025 (or approximate equivalent if using a different bottom stress model)

3) Simulation result at 5 m resolution (1/6 arcsec, or the lowest resolution possible; use bi-linear interpolation), using a Mannings n coefficient of 0.025 (or approximate equivalent if using a different bottom stress model)

Modelers are encouraged to compare simulation results both locally (required by the benchmark) as well as to examine statistical measures of spatial variability between the different resolutions.
Overview of Datasets – Benchmark #3

- New Zealand ADCP / Tauranga Bay
- ADCP in the main channel, five nearby tide stations
- Data sampled at 2 min; resolution good
- Clear tidal modulation of the tsunami signals
  - Tides important
- Models can be forced with water elevation from Abeacon gage
  - No need to specify EQ source, a bit more control

If we want to include a case where the tides may play a role, this is likely the best option.
Overview of Datasets – Benchmark #3

- Drive simulations with measured free surface elevation @ A Beacon
  - ~20 m depth
  - No source modeling / propagation needed
- Tsunami-only simulation
  - Estuary is large wrt to tsunami
  - Small domain (900 by 600 w/ 10m resolution)
  - 12 hours simulation time
  - Drive with tsunami signal extracted from ABeacon
- Tsunami+Tide simulation
  - Estuary is intermediate wrt to tides (need to model entire bay to get tidal entrance velocity signal correct)
  - Large domain (3000 by 3000 w/ 10 m resolution)
  - 60+hours simulation time (need at least one tidal cycle to “warm up” estuary)
Overview of Datasets – Benchmark #4

- Flow through built environment
- Seaside model built at OSU
- Model needs to be able to resolve buildings (including overtopping of buildings) in the topo surface
- Compare with time series of velocities and elevations (some co-located) through “streets”

- Capturing the bore front and getting bottom friction “right” are important to the velocity comparisons
- Incident wave condition defined by a free surface time series (not a solitary wave)

Very nice dataset
Overview of Datasets – Benchmark #4

- Wavemaker or near-wave maker free surface elevation time series (not solitary wave or other “known” wave solution)
- Requires moving shoreline
- Breaking model
- Lateral vertical walls
- Need to be able to handle structures either as vertical walls or an approximate steep slope
Overview of Datasets – Benchmark #5

- Breaking solitary wave past a conical obstacle
- Used in the 2009 “ISEC” workshop at OSU
  - See videos here
  - https://www.youtube.com/watch?v=l4uTHWBpaZg
  - https://www.youtube.com/watch?v=p8LPXs5sz1Y
- Compare with free surface and velocity measurements on the shelf
- PIV derived velocity time series in the wake behind the island
  - See video here:
  - https://www.youtube.com/watch?v=iUQo8G-ZMRQ
- Similar to L&S (steady flow), except with a wave, breaking, overtopping – MUCH more complex
Overview of Datasets – Benchmark #5

- Wavemaker or solitary wave initial condition
- Requires moving shoreline
- Breaking model
- Lateral vertical walls
- Would probably use the same data points used for the ISEC workshop in 2009
- May be additional velocity data available in lee of bump