Comparison of data from Oregon tsunami scenarios to the ASCE 7 2475-yr scenario and tsunami force calculations

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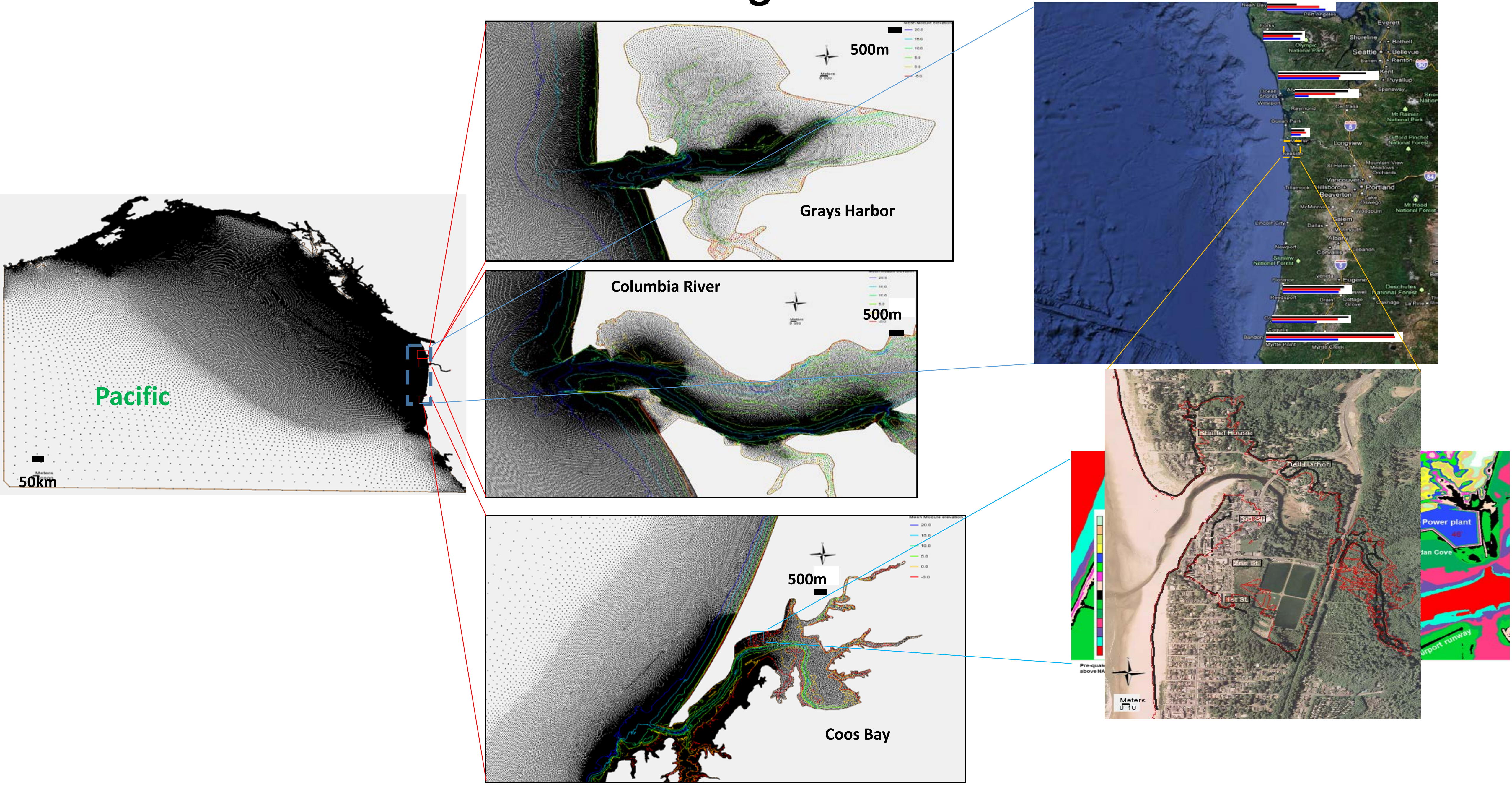
Designing for Tsunamis: New Oregon Data & Anticipated changes to the Building Code, Portland, OR, May 2015

Outline

- ❑ Prior DOGAMI tsunami CSZ sources and simulations
- ❑ Simulation with ASCE 7 source and comparisons for 3 coastal regions of Oregon
- ❑ Energy Grade Line analysis for DOGAMI and ASCE scenarios
- ❑ Main goals
  - o To see if we can utilize any of the existing sources for ASCE force calculation
  - o To compare results (max. surface elevation and speed) from ASCE method and our 2D model

Cross-scale tsunami modeling for OR coastal communities

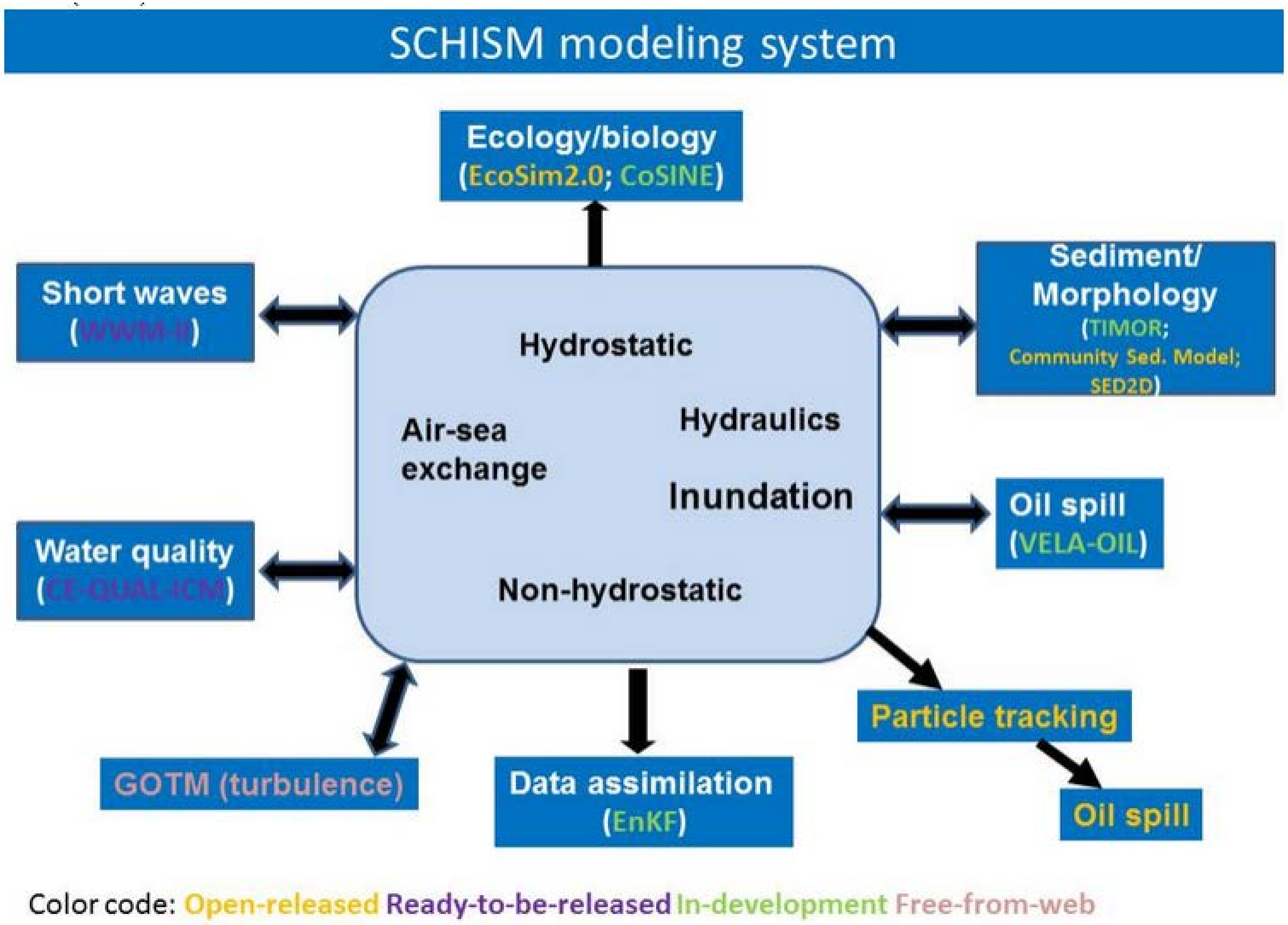


SCHISM: Semi-implicit Cross-scale Hydroscience Integrated System Model

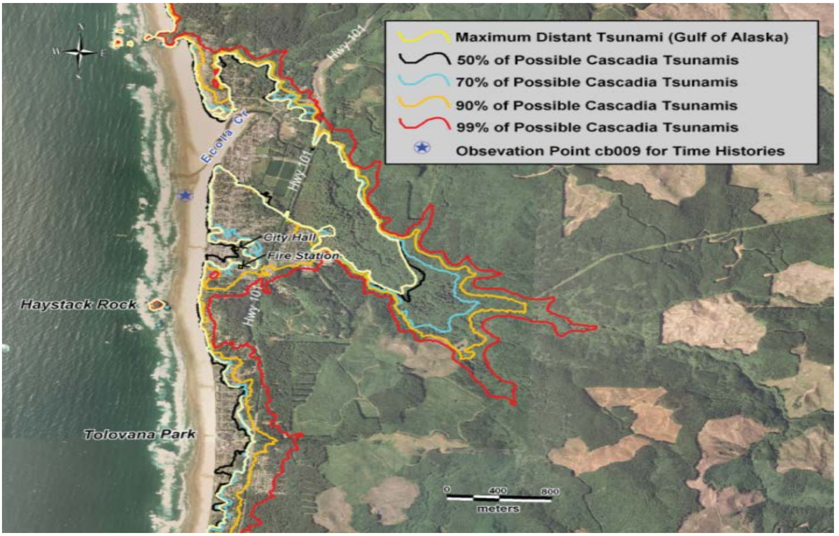
- A derivative product of SELFE, distributed with Apache v2 license
- Galerkin finite-element and finite-volume approach: ***generic*** unstructured grids (mixed triangles and quadrangles)
  - ELCIRC (Zhang et al. 2005), UnTRIM (Casulli 1990; 2010), SUNTANS (Fringer 2006): finite-difference/volume approach →orthogonal grid
- **Semi-implicit** time stepping: no mode splitting → large time step and no splitting errors
- **Eulerian-Lagrangian** method (ELM) for advection → more efficiency & robustness
- All matrices are positive, definite, sparse and symmetric (robust solver)
- Hybrid *SZ* coordinates or **LSC^2** (Zhang et al. 2015) in the vertical: one grid with 1D/2D/3D capability
- Configurable
  - Cartesian or spherical coordinates
  - 2D or 3D
  - Hydrostatic or non-hydrostatic
- Mass conservative transport (upwind/TVD/…)

www.schism.wiki

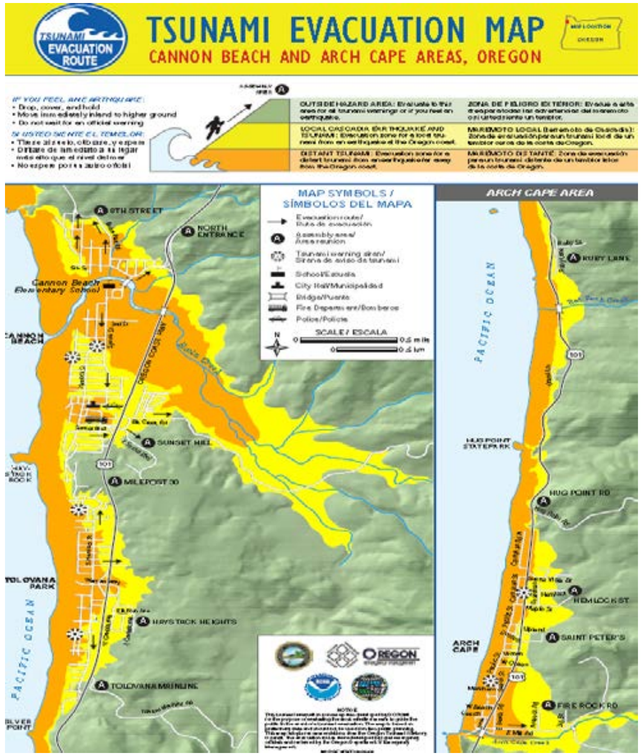
- Includes higher – more forthcoming
- Fully parallelize
- Well-benchmar
- Operationally t
- *Has evolved int*
- Software engin
  - svn server for a
  - Continuous soft
  - Unit & regressi
  - automatic test m
- Open source ar a ***verifiable*** and ***comprehensive*** n



Evacuation maps for OR coastal communities



http://www.oregongeology.org/tsuclearinghouse/

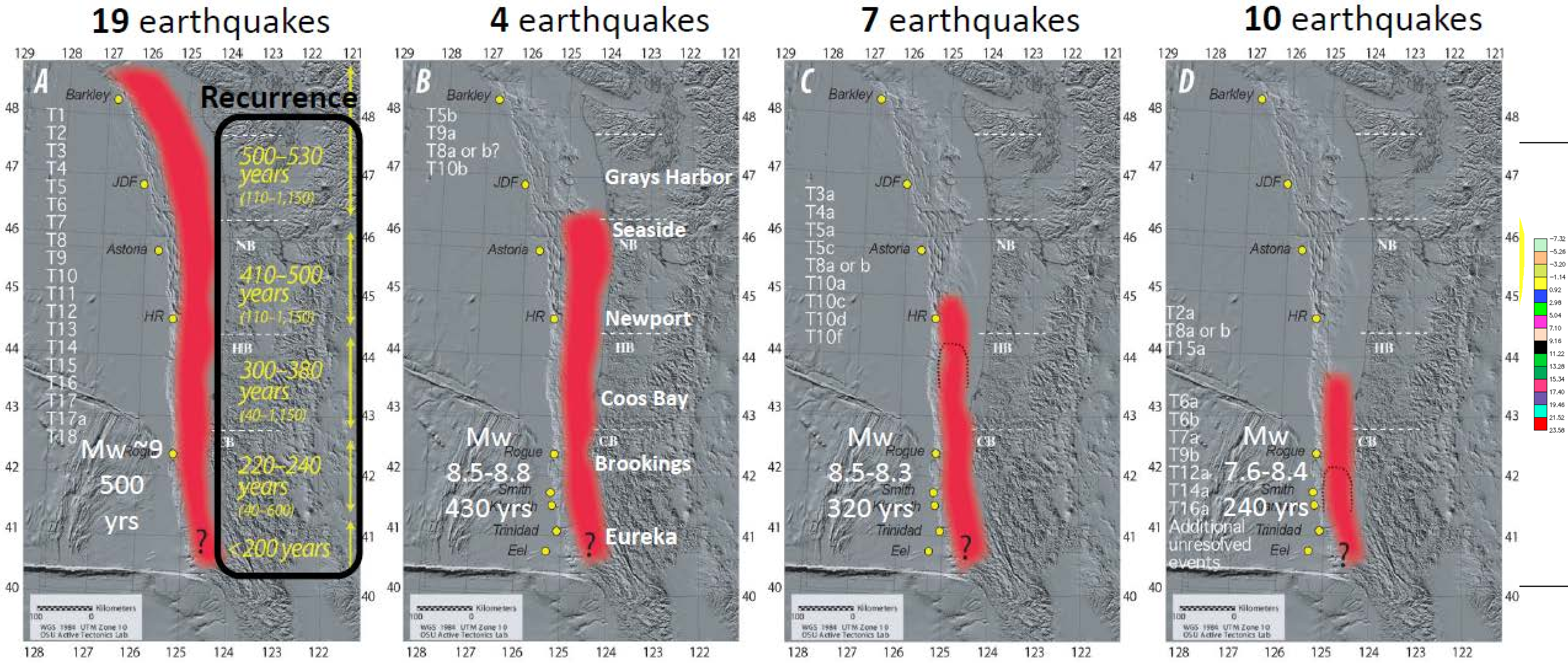


Zoomable Map Viewer!

Model set-up

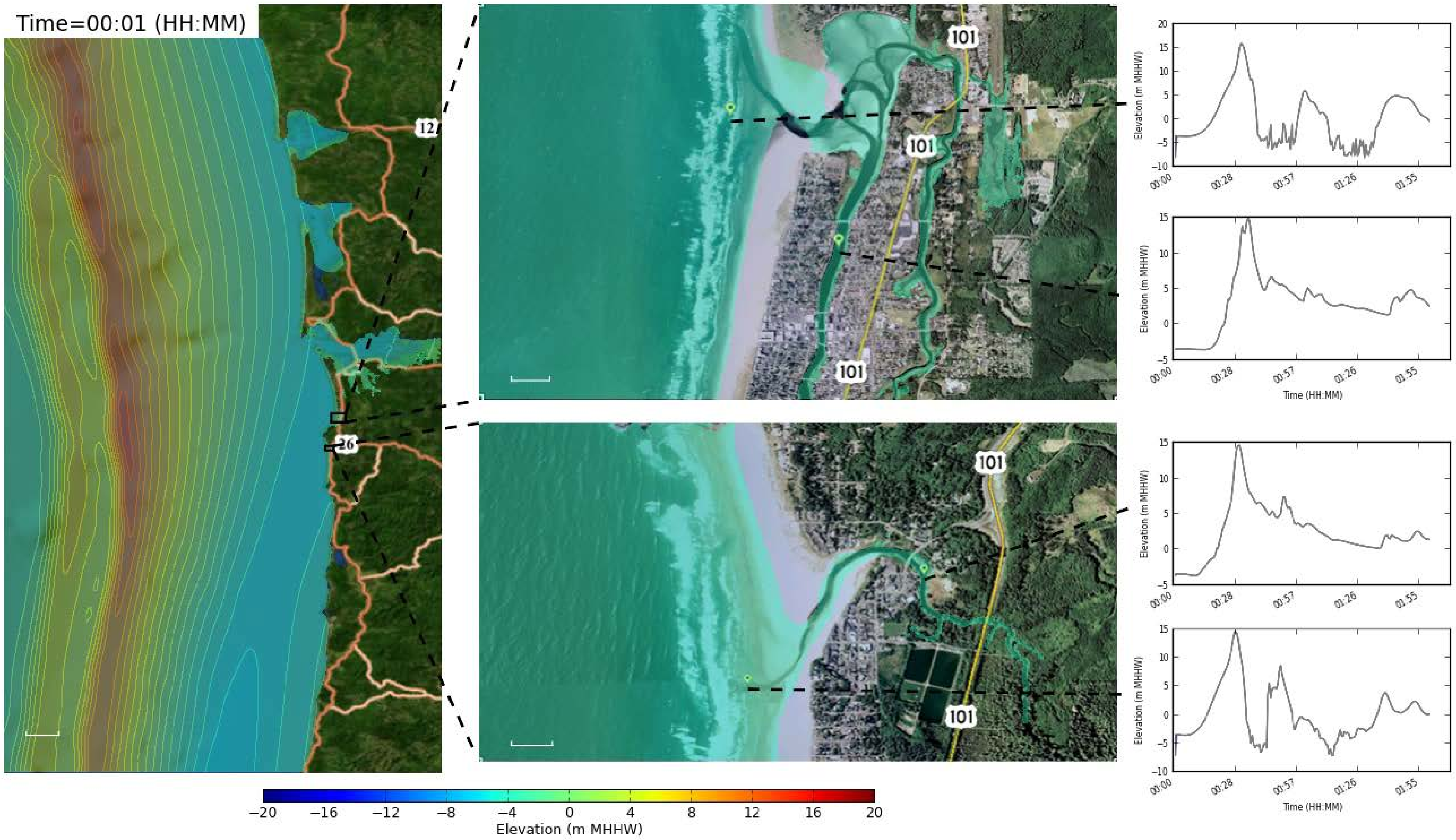
- Use same high-resolution grids we generated before for each region of OR coast
  - Large domain to avoid wave reflection
  - Variable grid resolution: offshore, 20m @ shoreline, reaching ~5m onshore (up to 4.4 million nodes, 9 million triangles)
- PMEL Unit sources from Yong Wei for ASCE simulations
- Parameters: 0 friction (conservatism; also tested *n*=0.025); 1 vertical layer (2DH)
- 2-12 hour simulations that cover wave generation, propagation and inundation
- Outputs: elevation & velocity at all nodes and times every 40 sec; maximum of elevation & velocity

Seaside



Source models

XXL1



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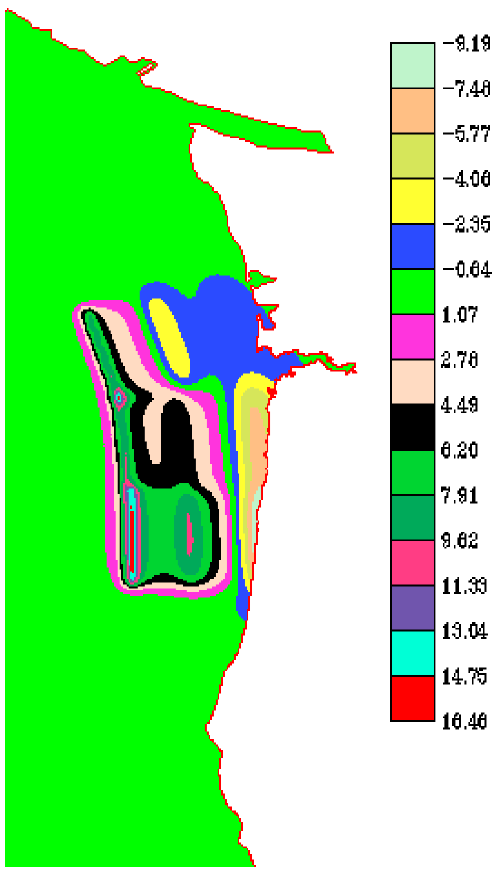
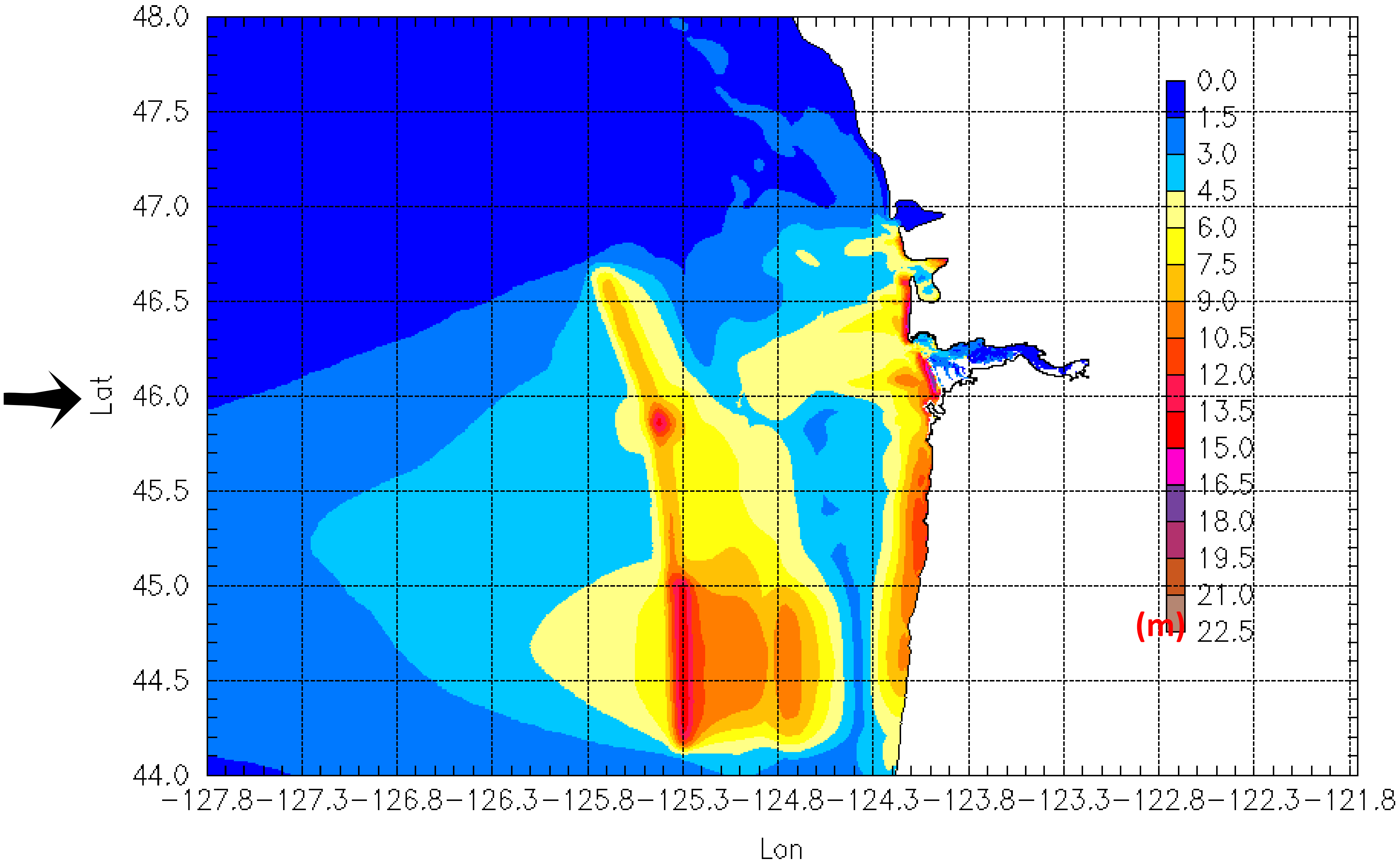
12
26
101
Elevation (m MHHW)
Time (HH:MM)
00:00
00:28
00:57
01:26
01:55
−20
−16
−12
−8
−4
0
4
8
12
16
20
Elevation (m MHHW)

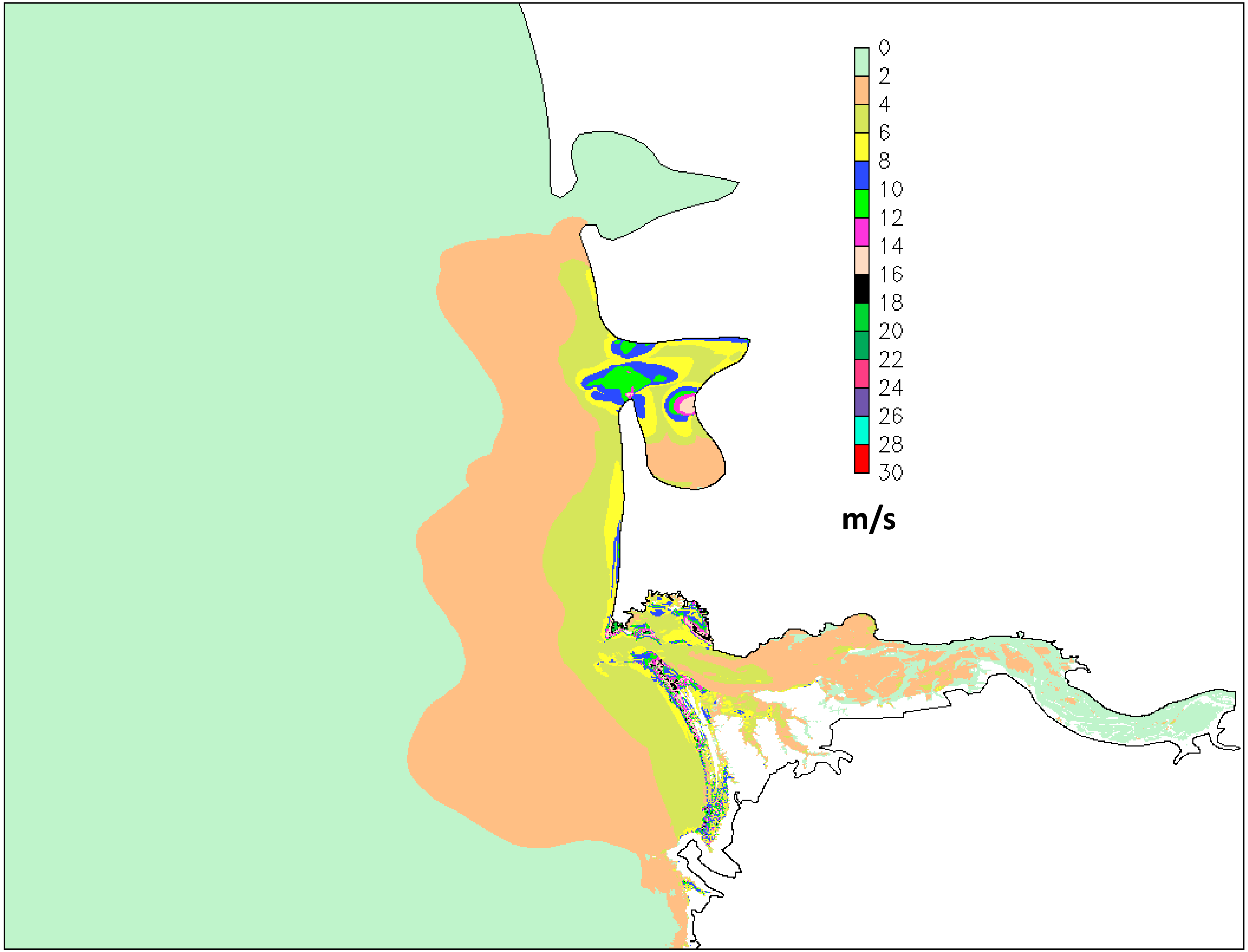
Max. elevation (ASCE source)

Deformation (c/o Yong)

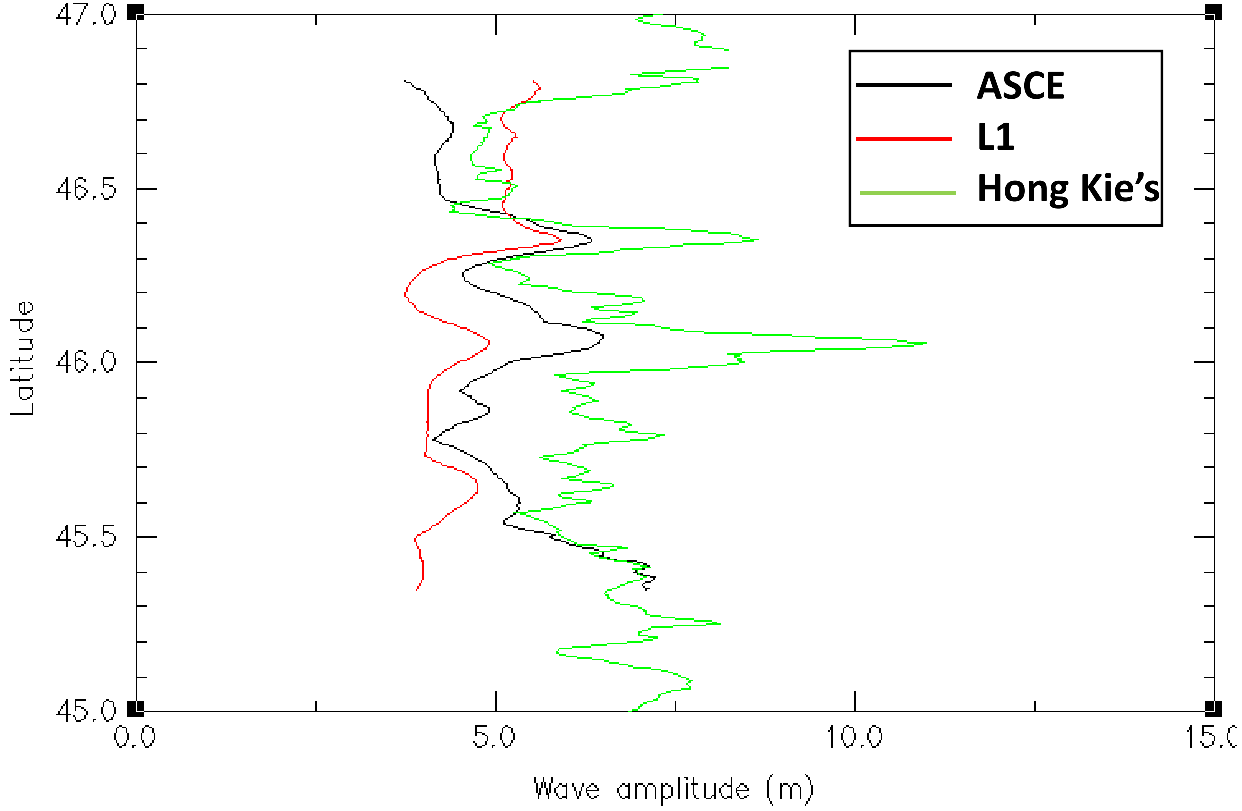


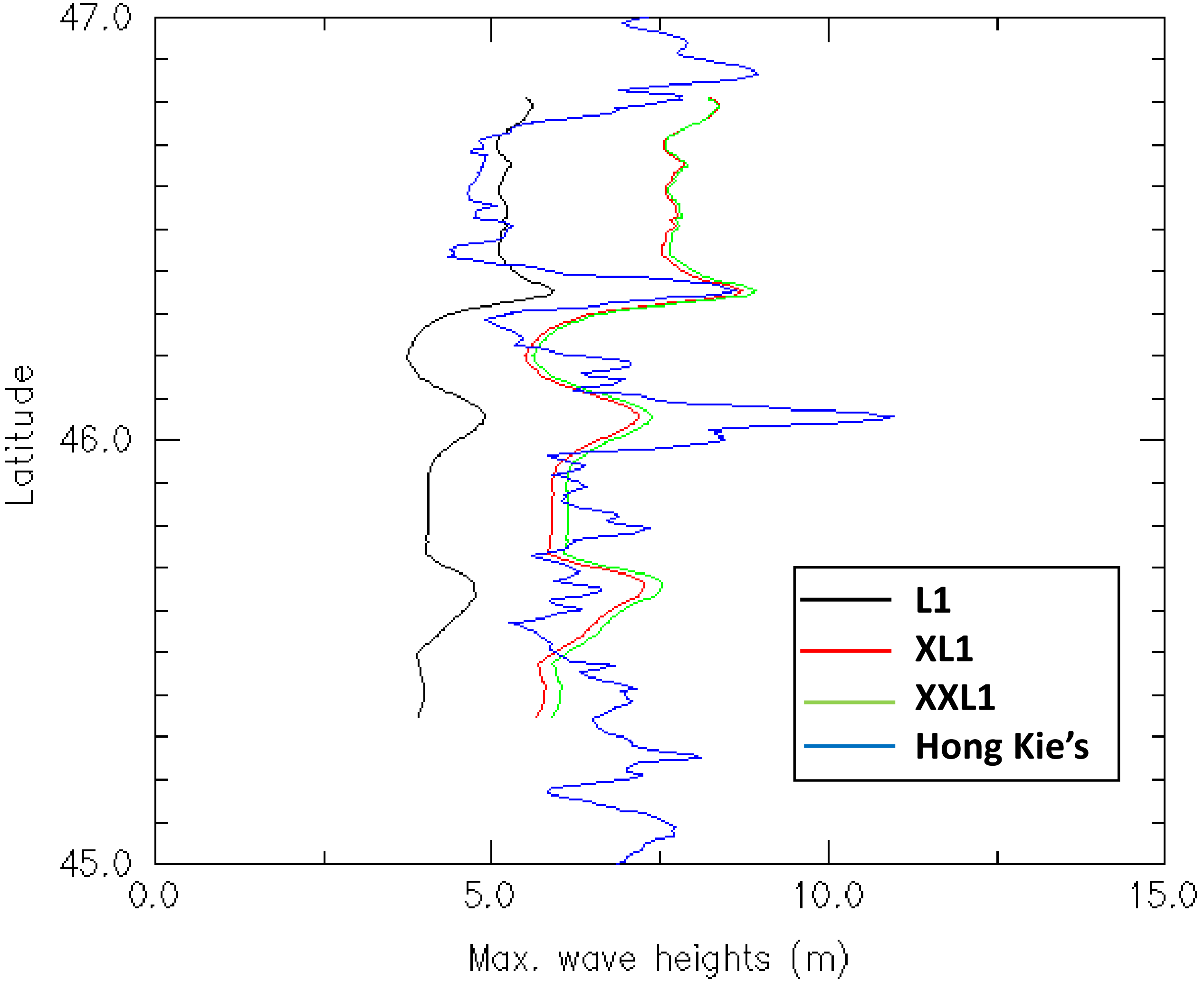


Max. Velocity (ASCE source)

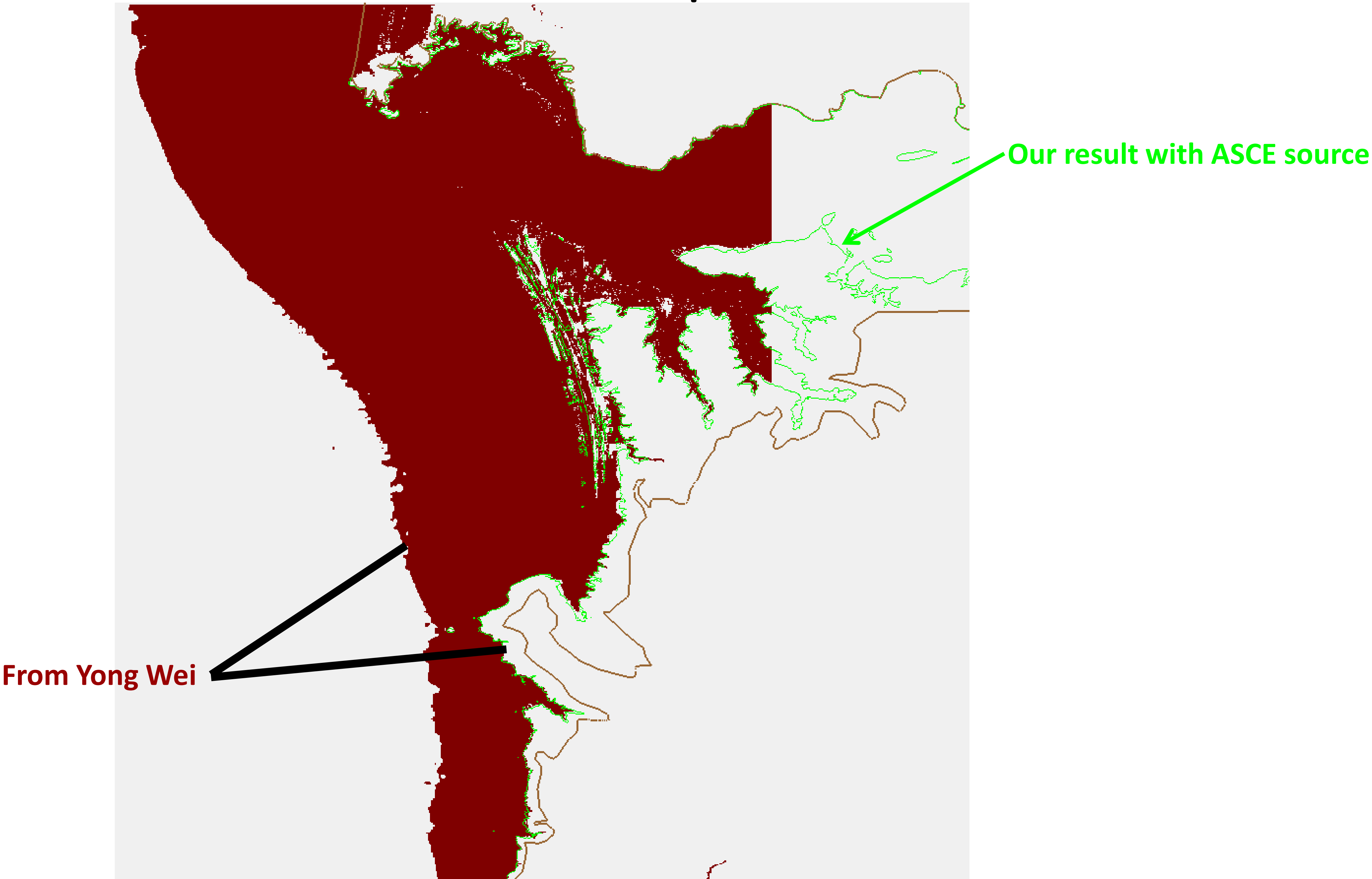


Seaside comparison @100m isobath





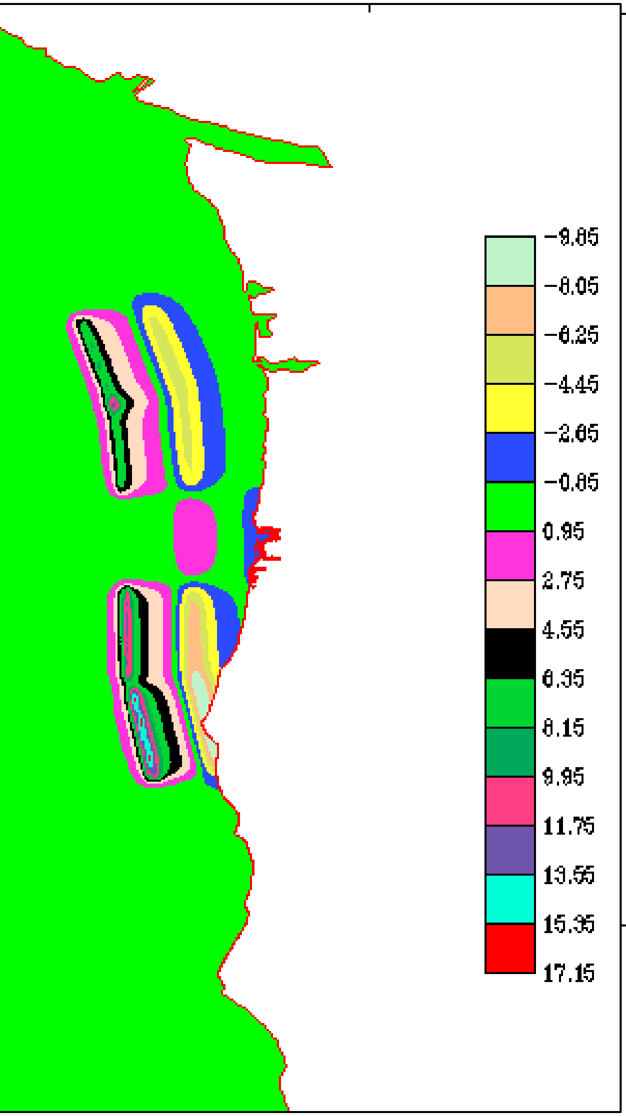
Inundation comparison



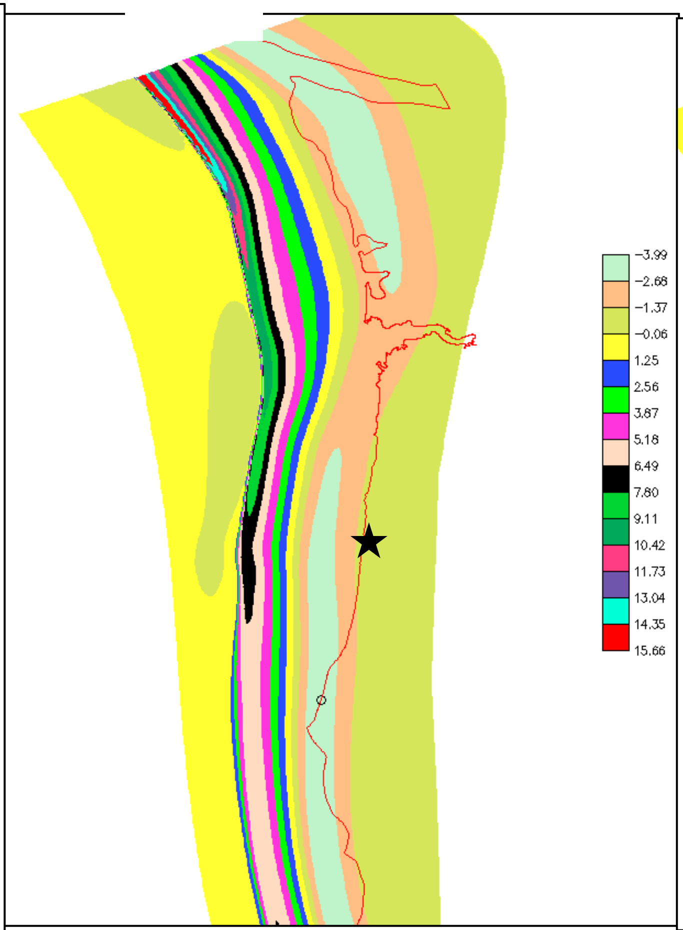
Newport

Source (c/o Yong Wei)

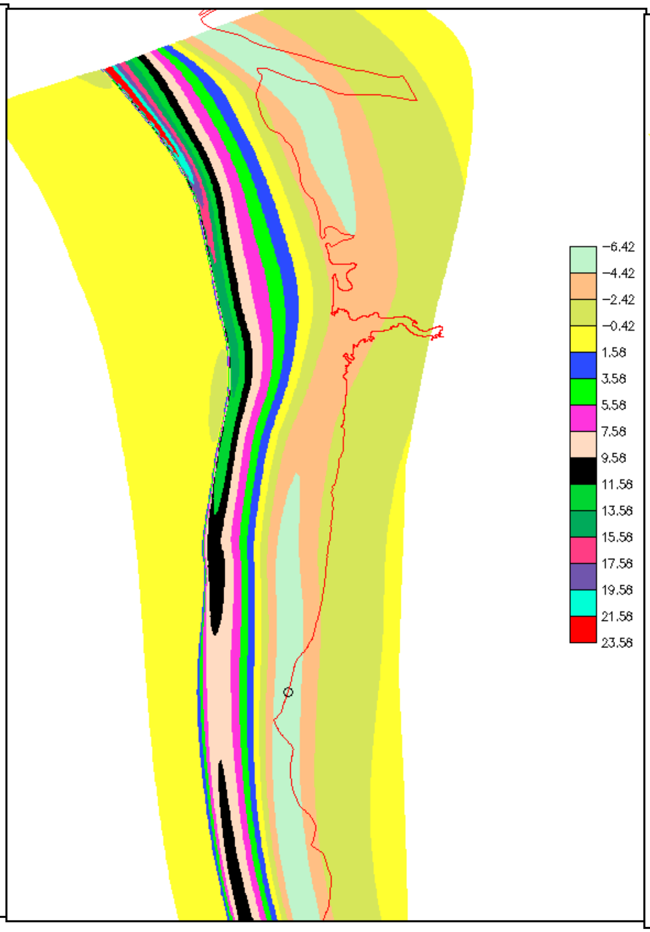
Valid: 44.5N and 45.445N



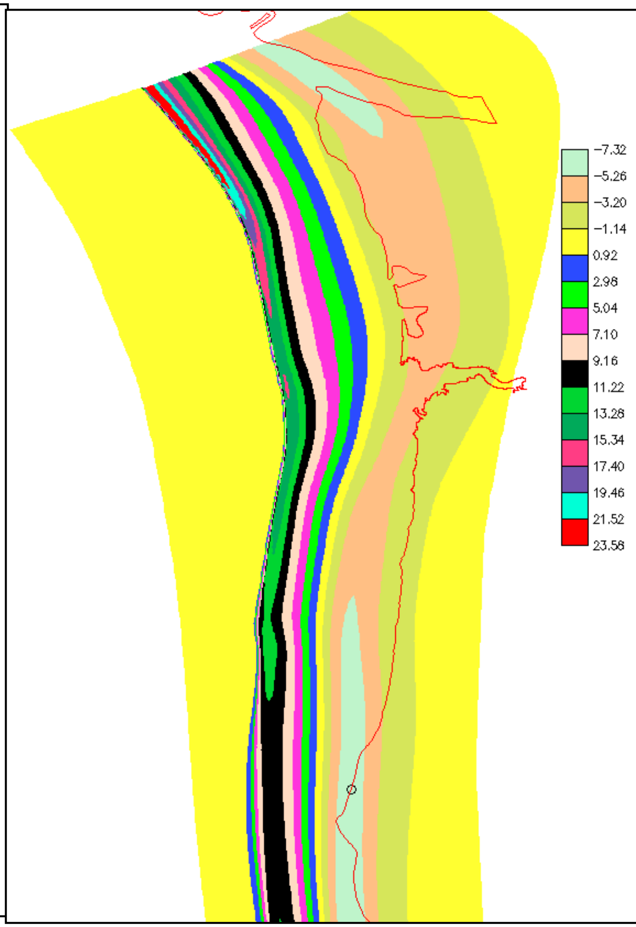
L1



XL1

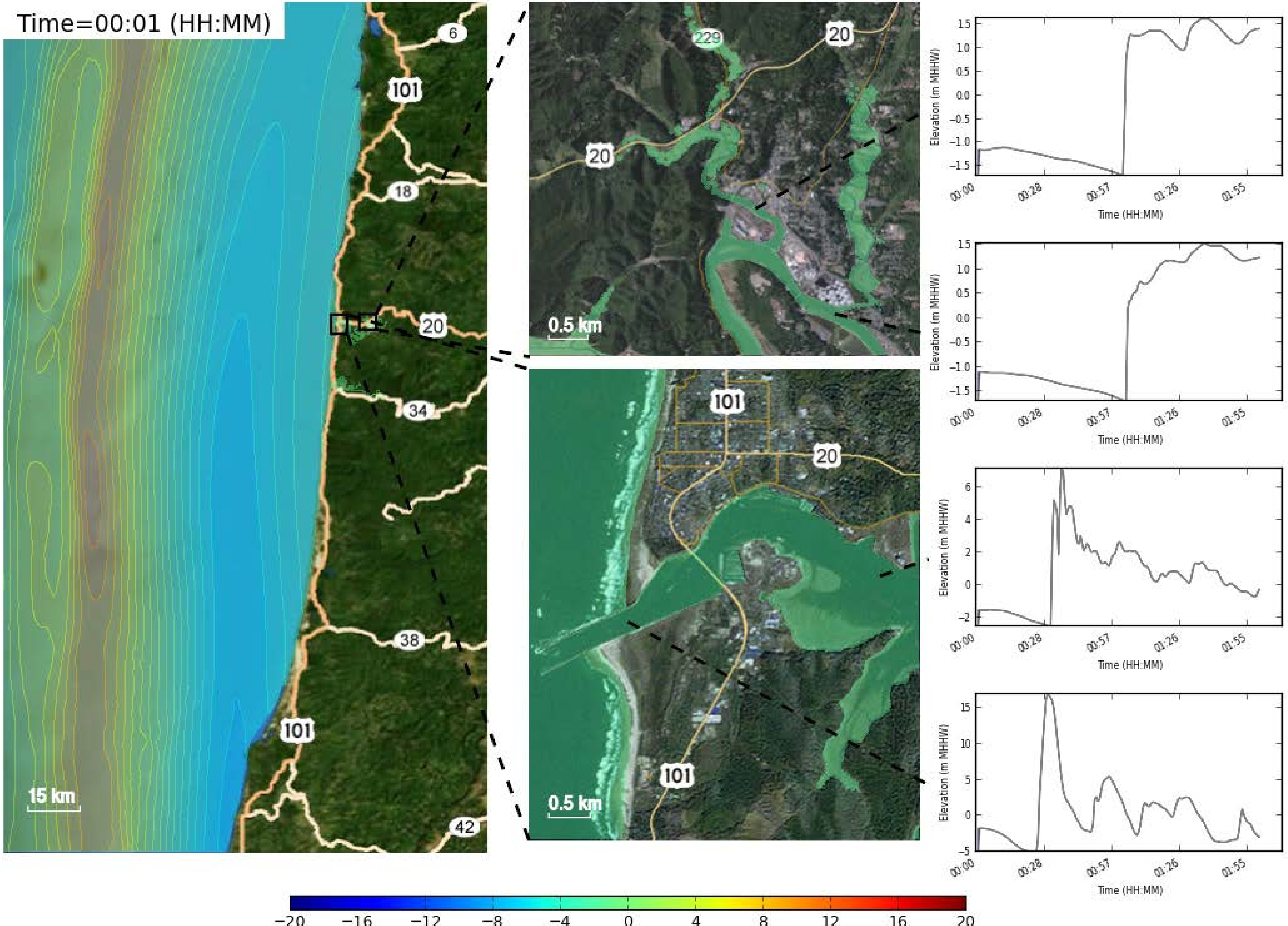


XXL1



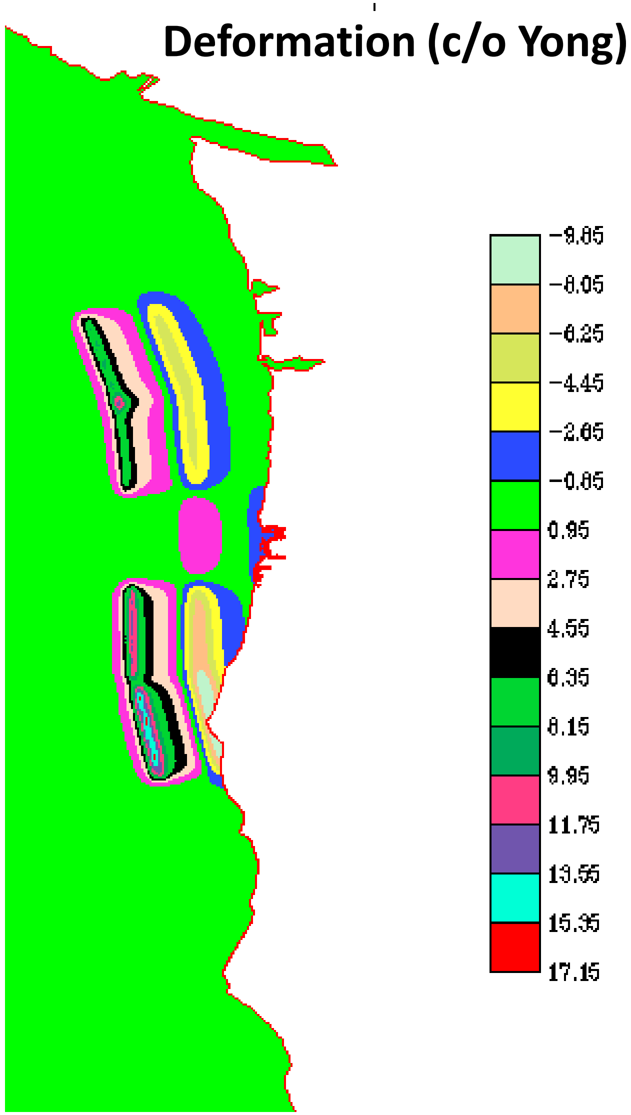
Source models

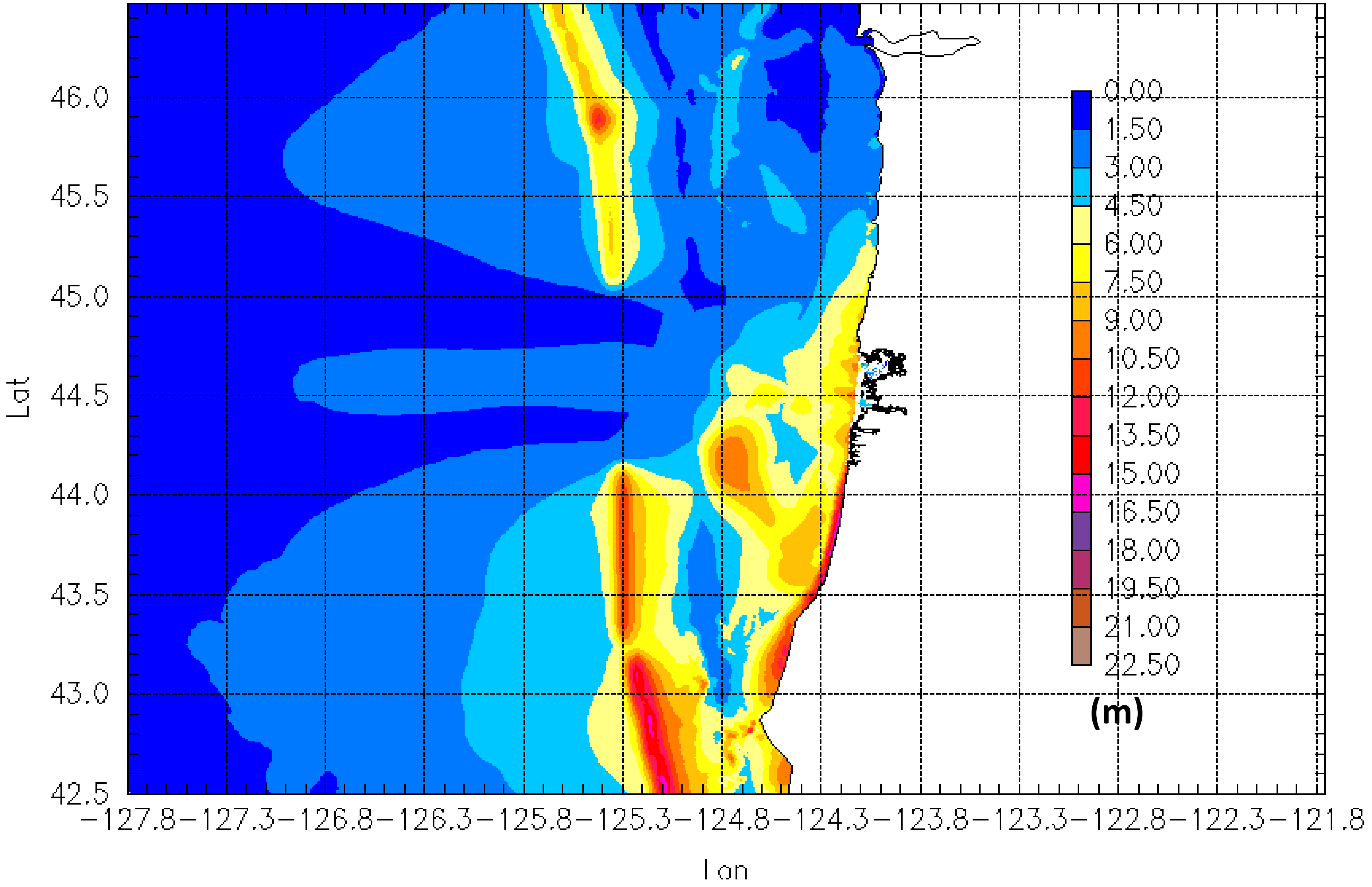
XXL1



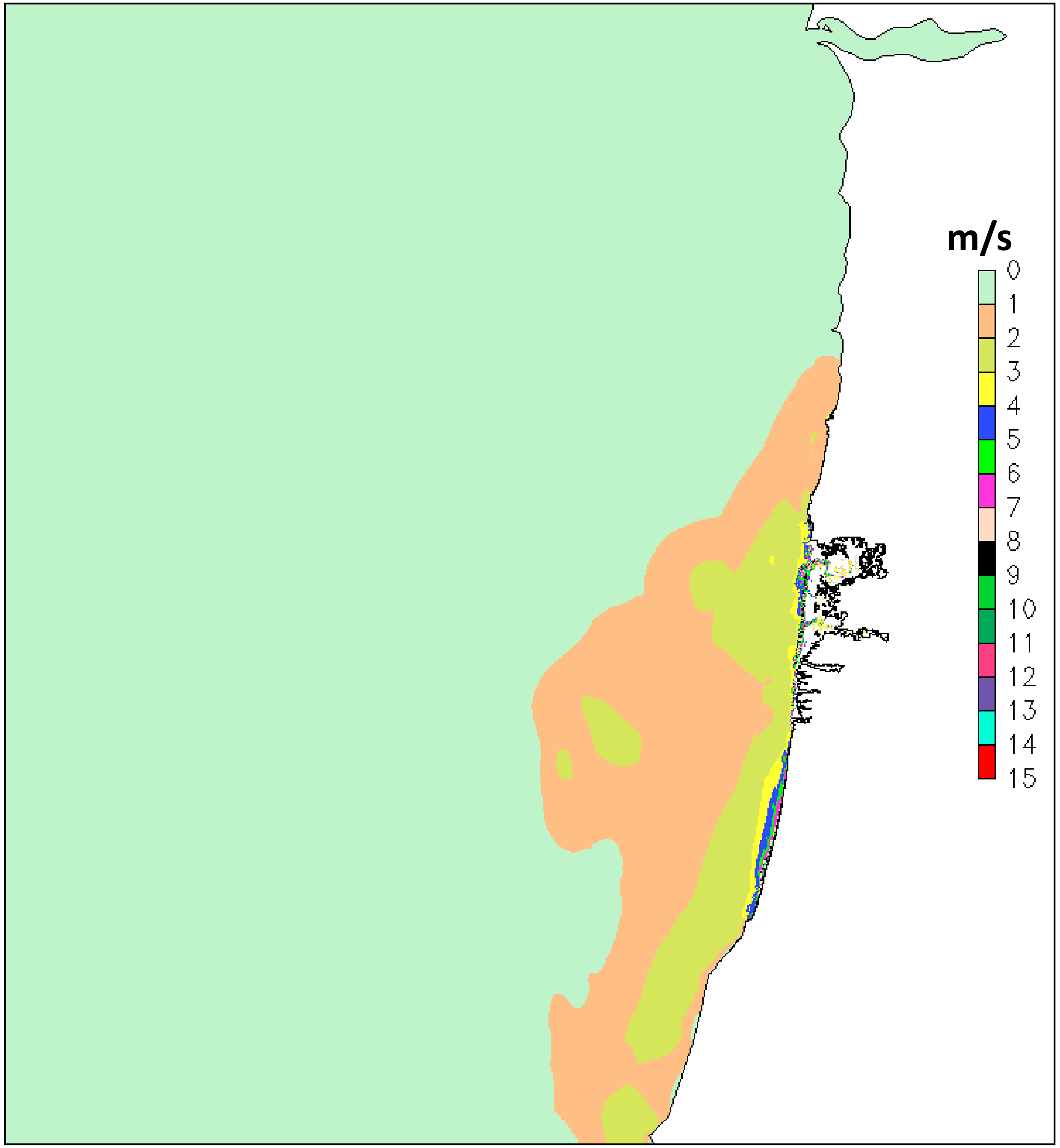
Time=00:01 (HH:MM)
6
101
18
20
34
38
101
42
15 km
229
20
20
0.5 km
101
20
101
0.5 km
Elevation (m MHHW)
Time (HH:MM)
00:00
00:28
00:57
01:26
01:55
−20
−16
−12
−8
−4
0
4
8
12
16
20

Max. Elevation (ASCE source)

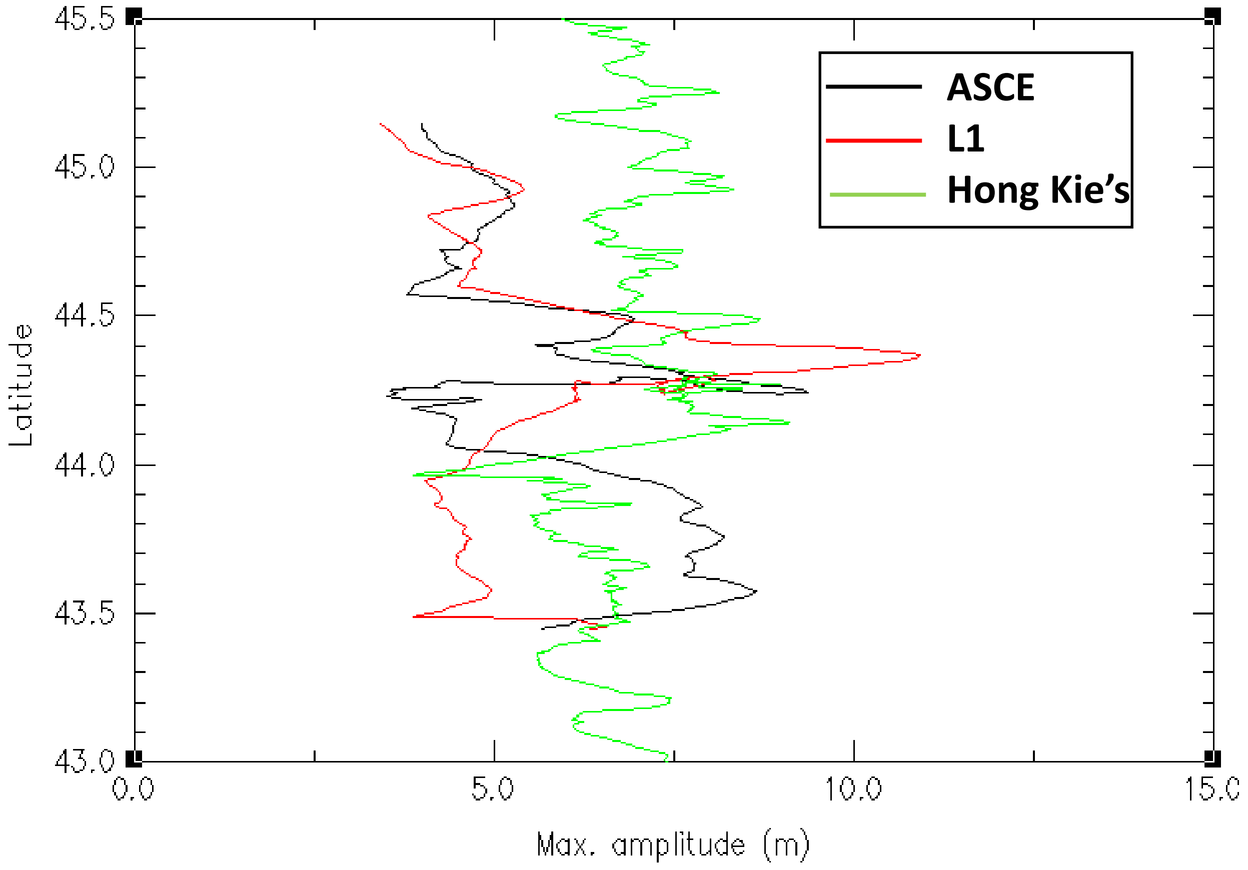


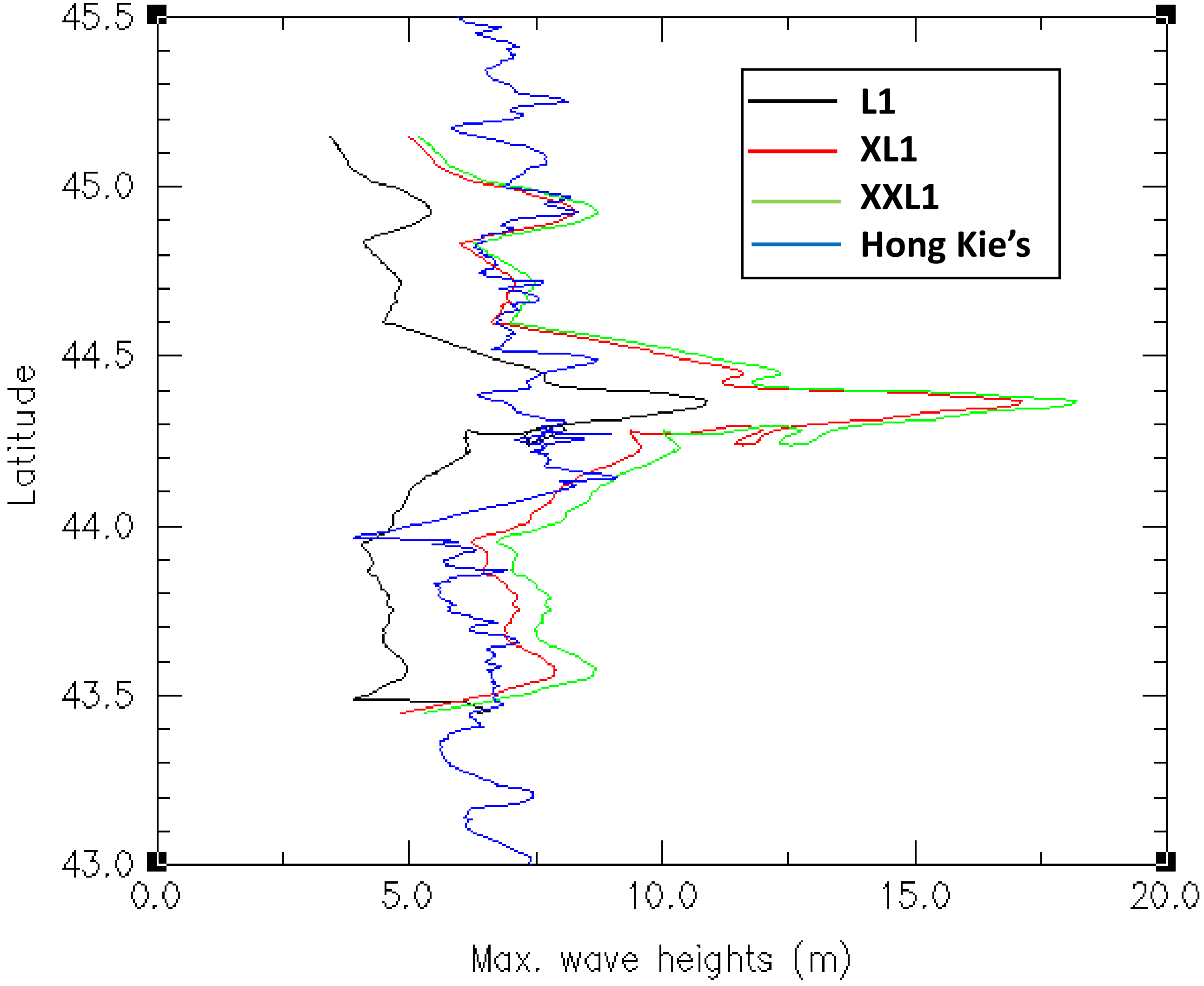


Max. velocity

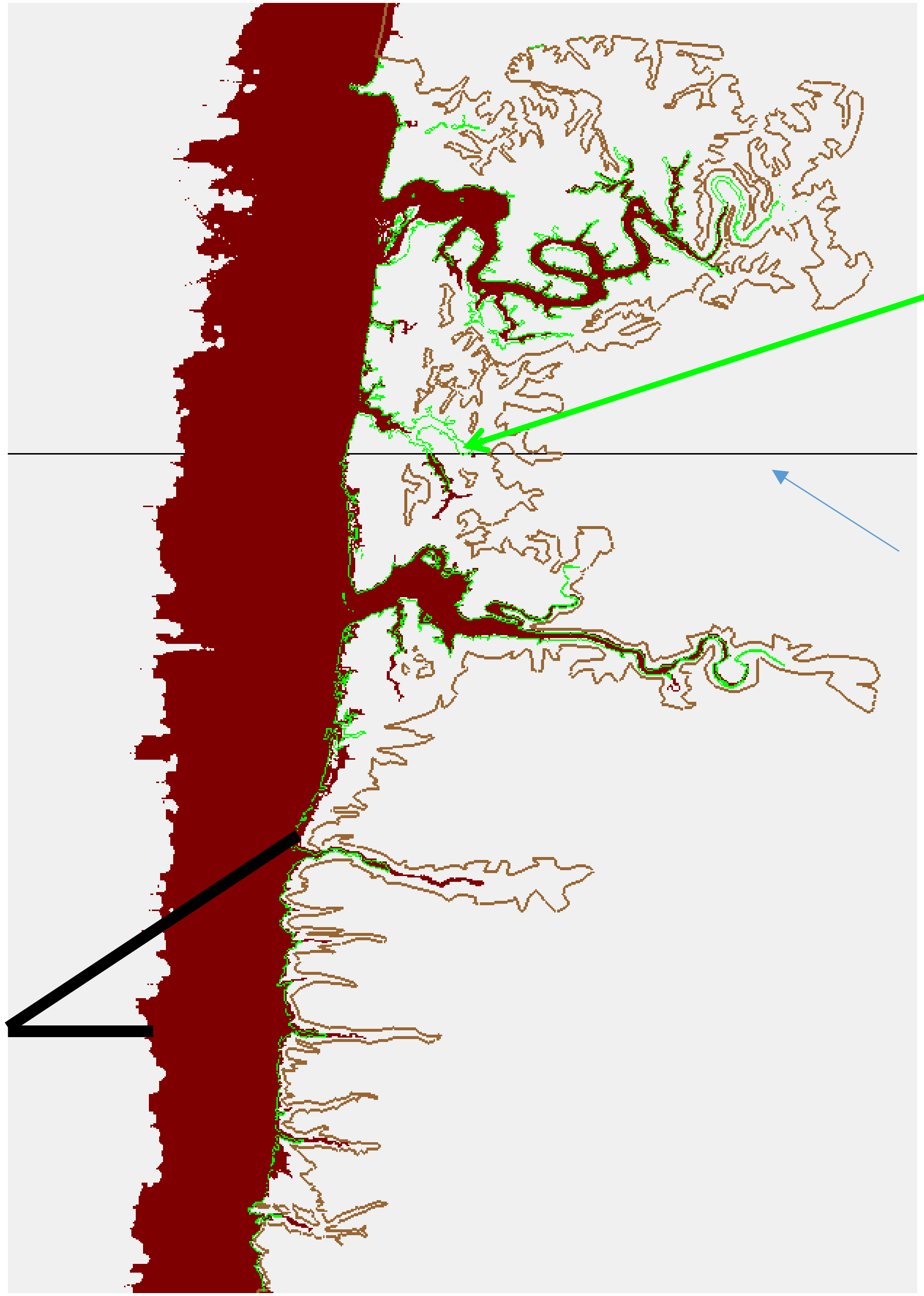


Newport comparison @ 100m isobath

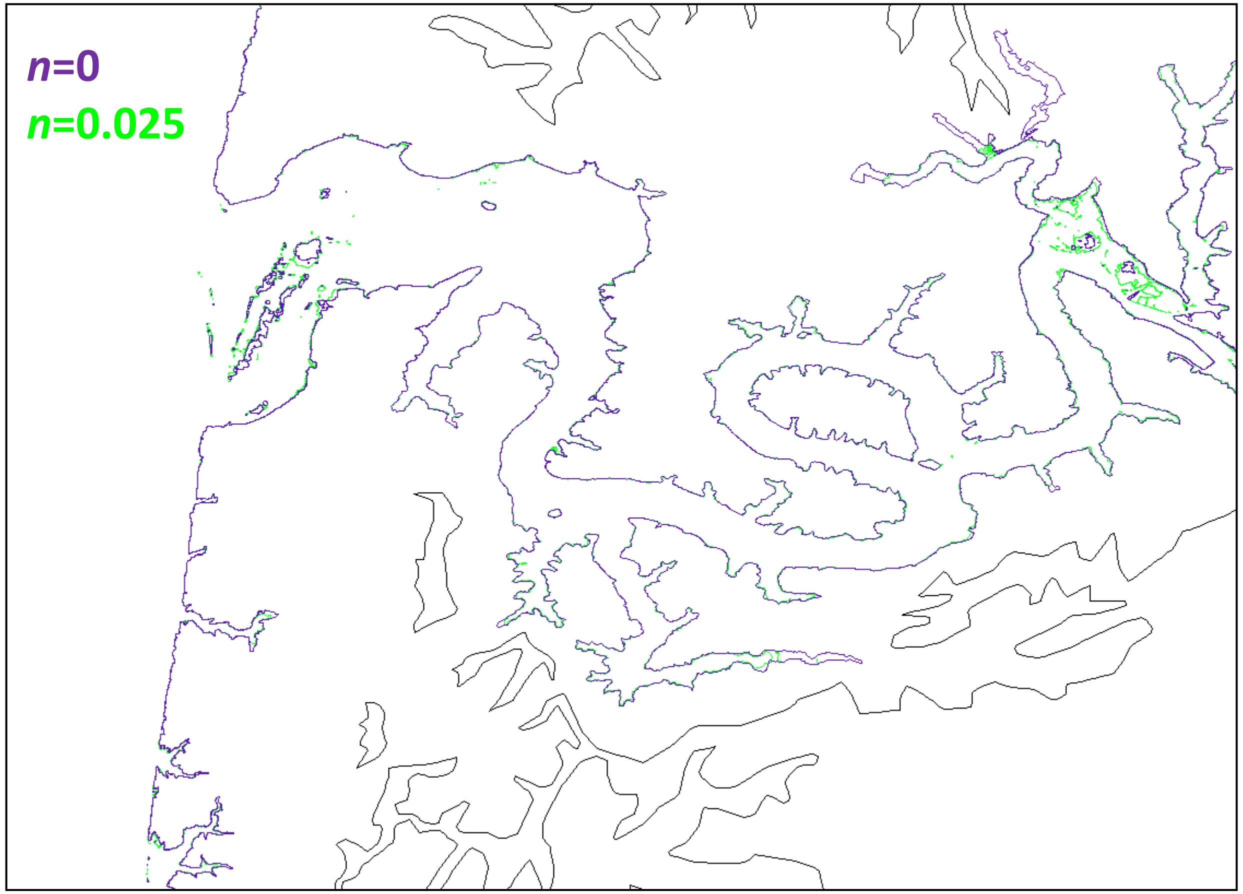




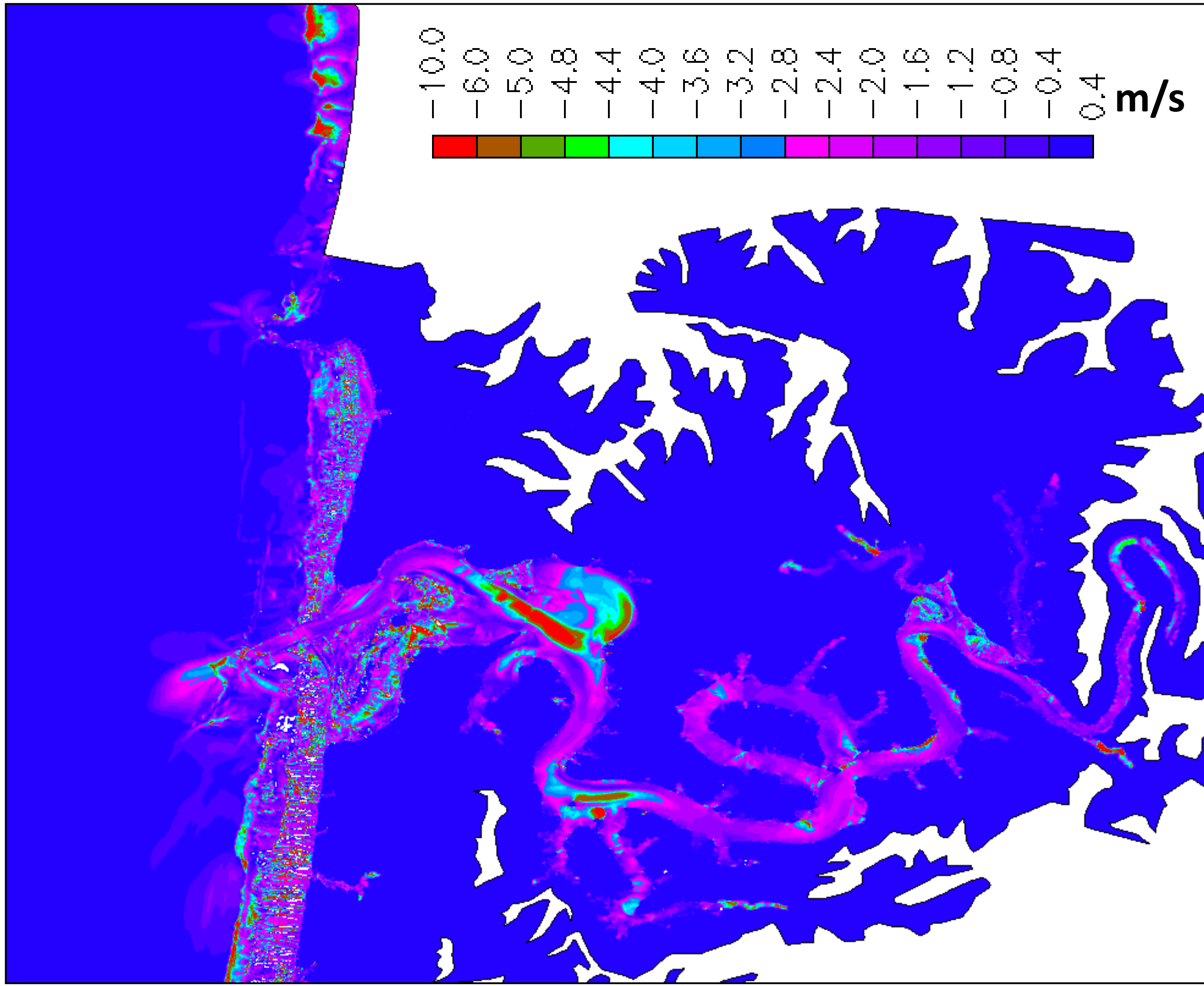
Inundation comparison



Effects of bottom friction



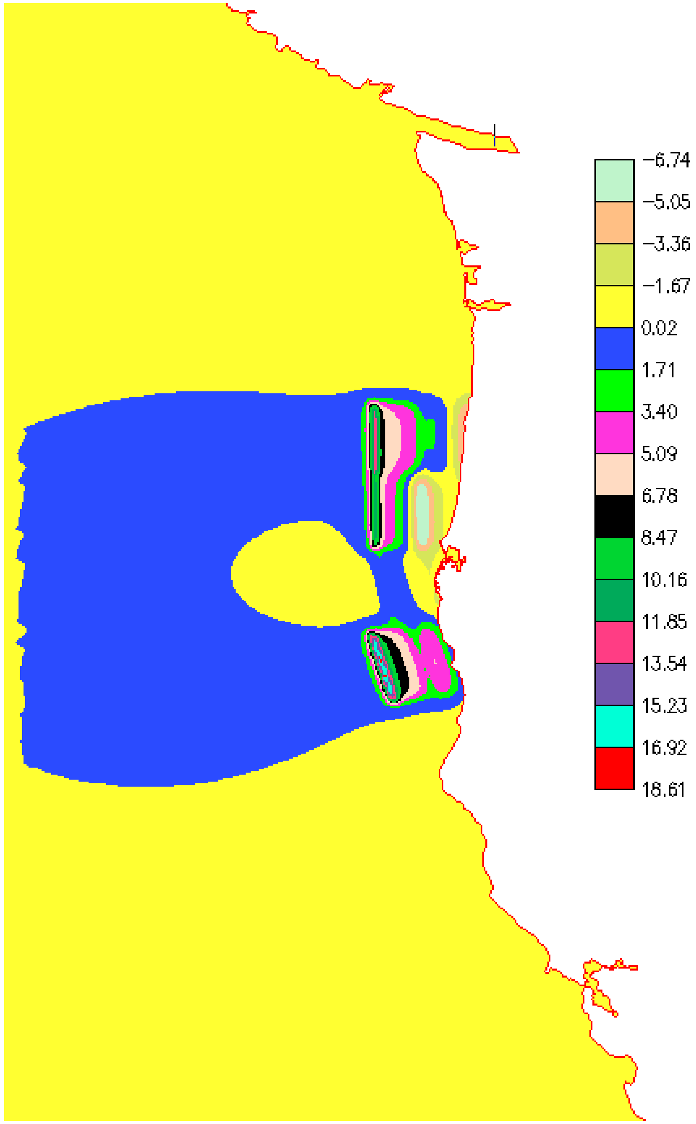
Differences in max. velocity



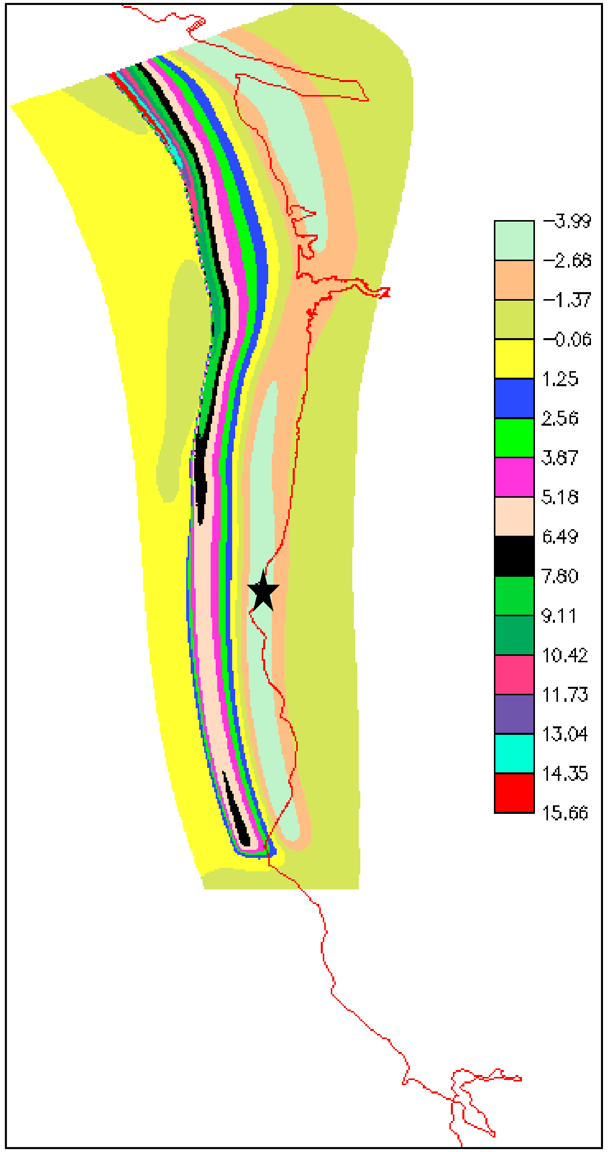
Bandon

Source (c/o Yong Wei)

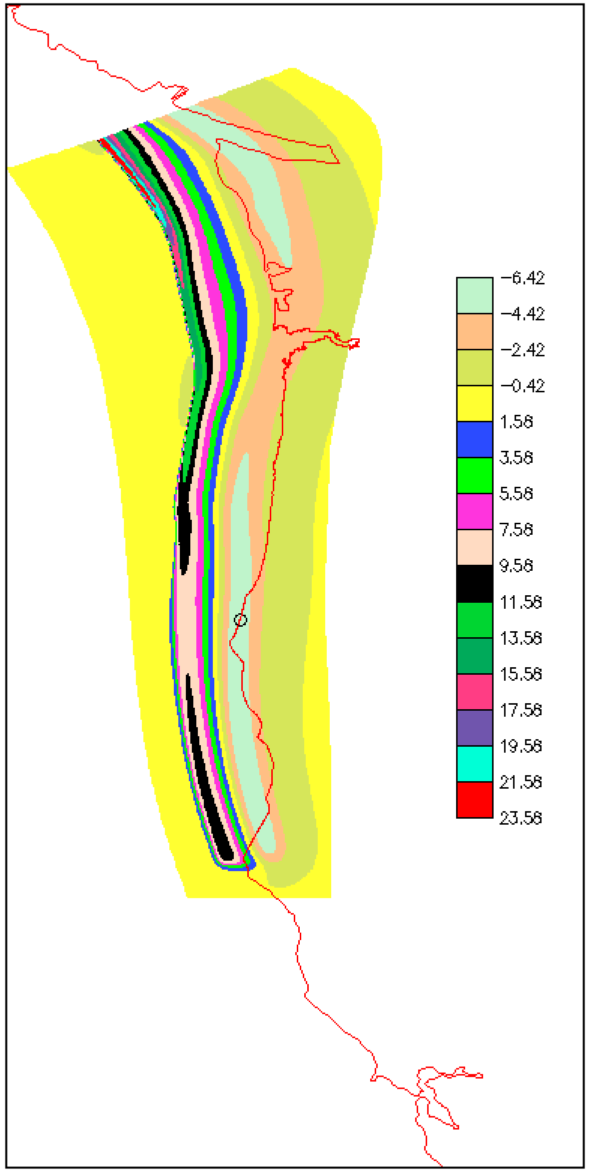
Valid: 43.2N to 44.5N



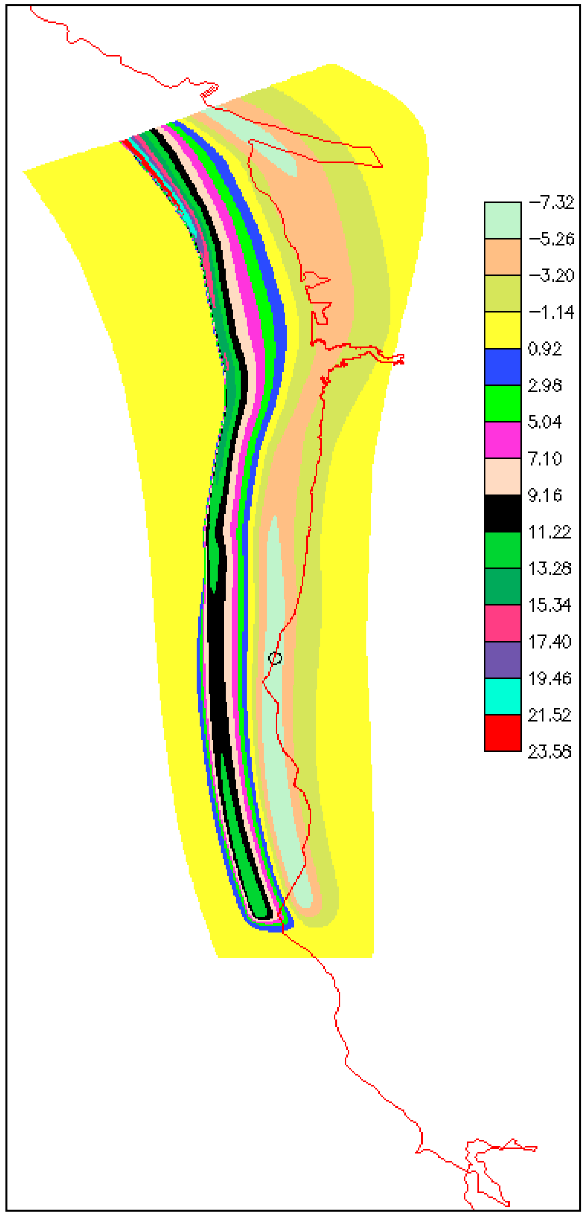
L1



XL1



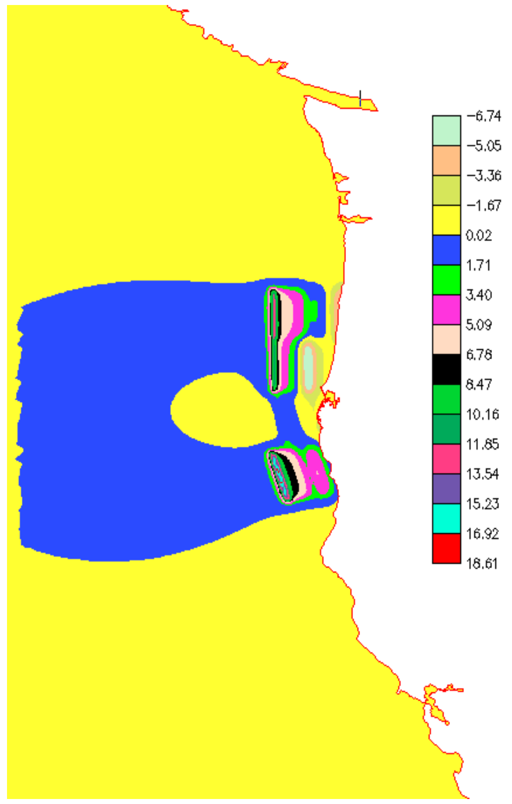
XXL1

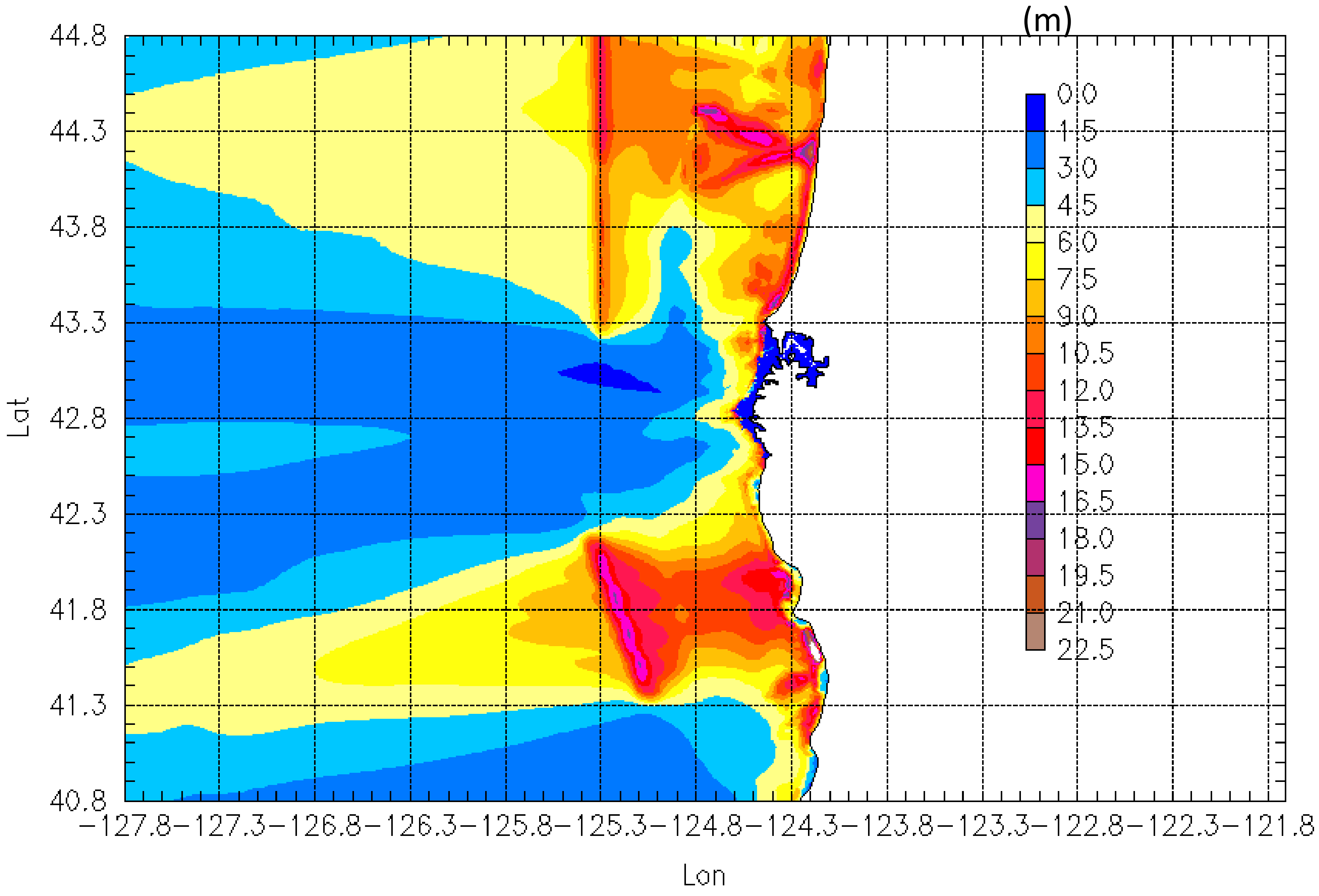


Source models

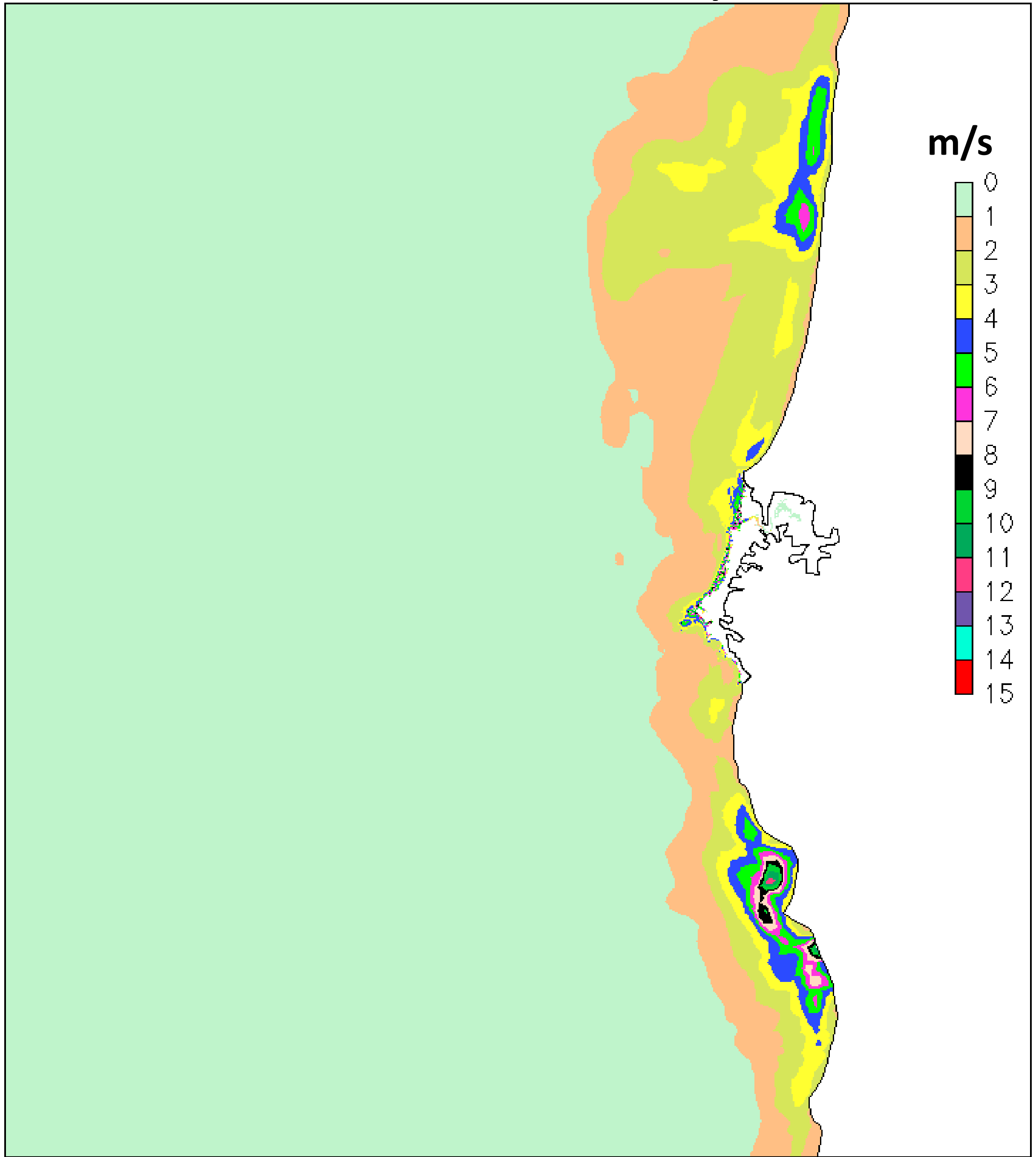
Max. elevation

Deformation

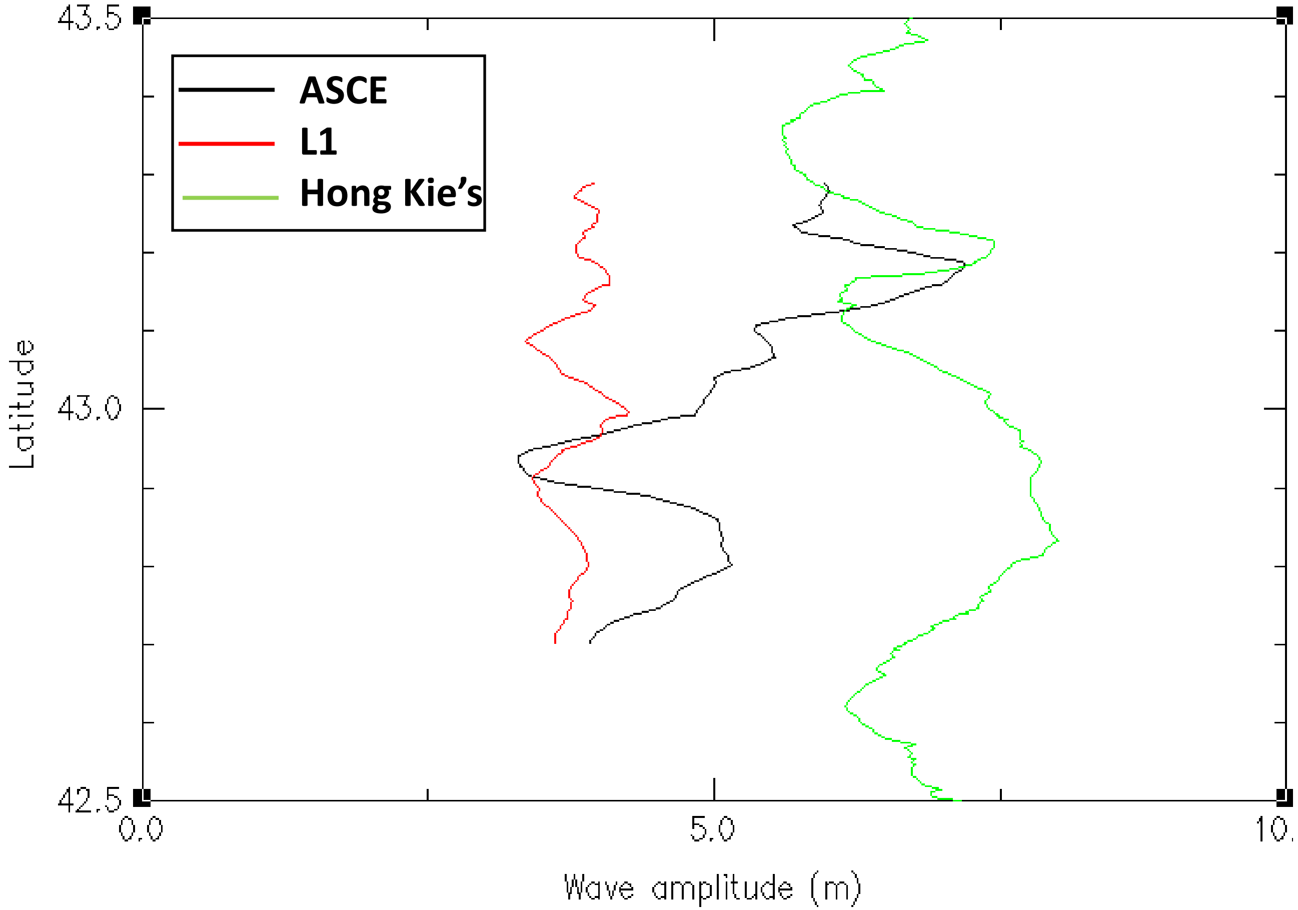


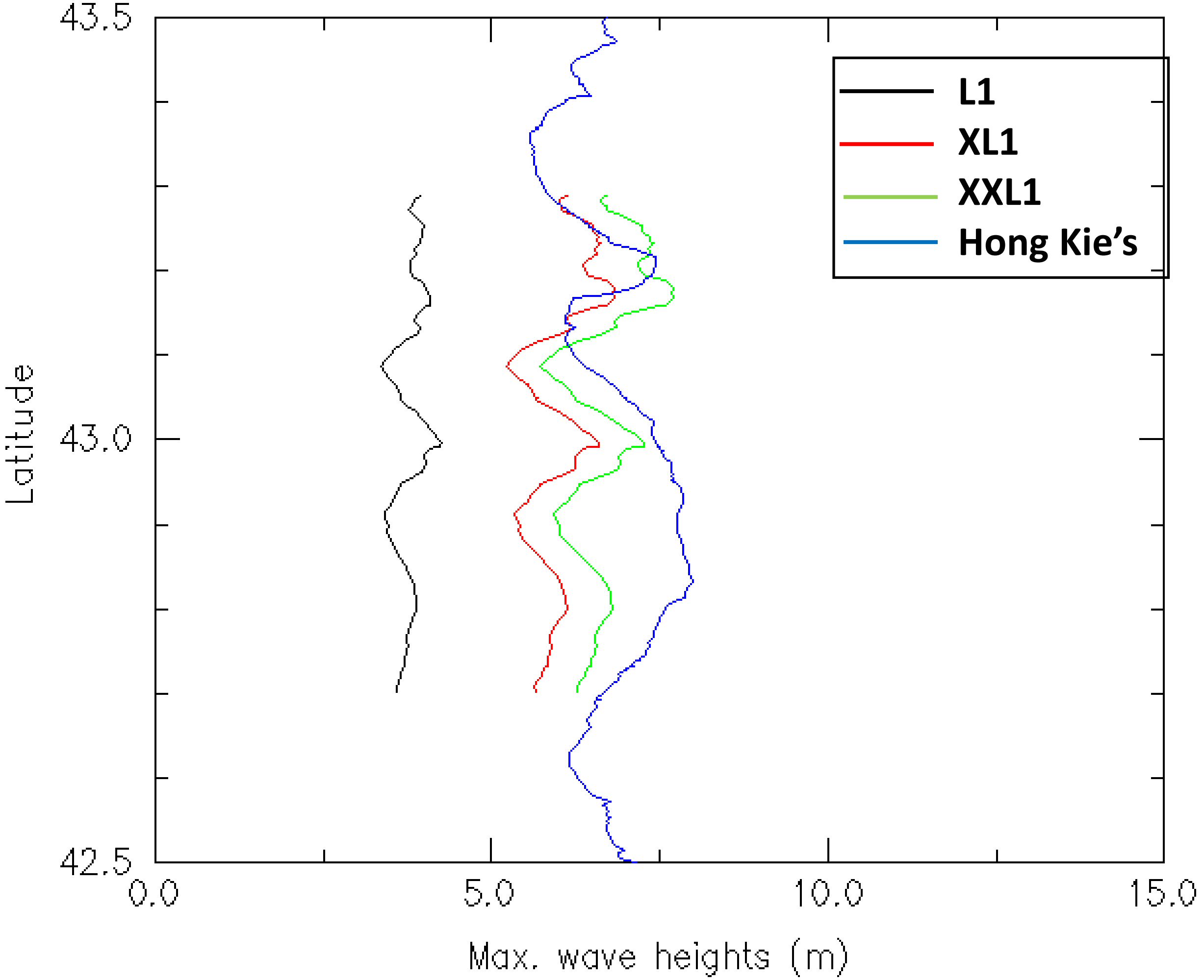


Max. velocity

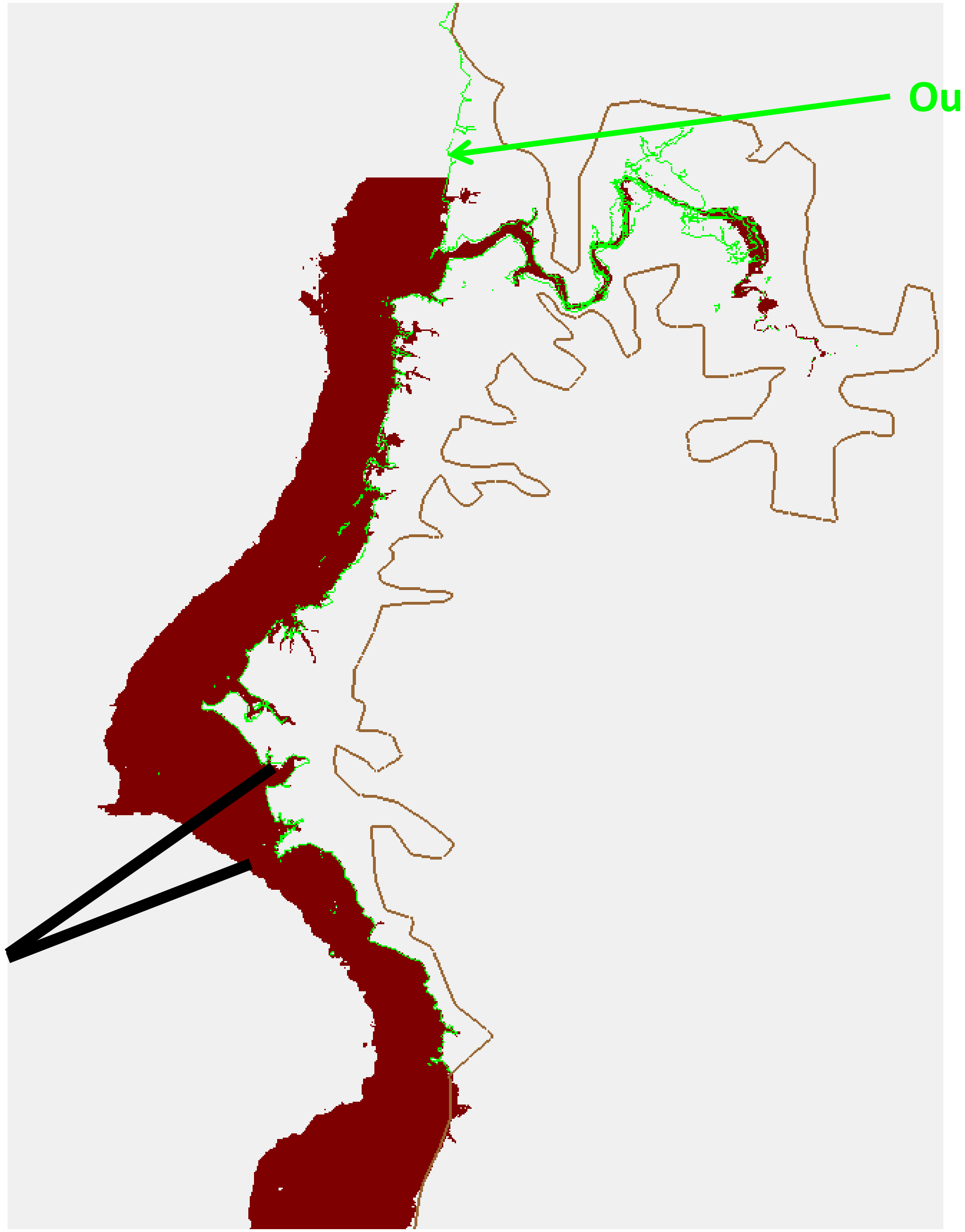


Bandon comparison @ 100m isobath





Inundation comparison



Energy Grade Line analysis comparisons

Preliminary results

Energy Grade Line Analysis

$$E_{i+1} = E_i + (\varphi_i + s_i)\Delta x_i$$

$$E_i = h_i\left(1 + \frac{1}{2}F^2{}_{ri}\right)$$

$$s_i = \frac{gn^2 F^2{}_{ri}}{h^{1/3}}$$

$$F_{ri} = \alpha\sqrt{1 - \frac{x_i}{x_R}} = \frac{u_i}{\sqrt{gh_i}}$$

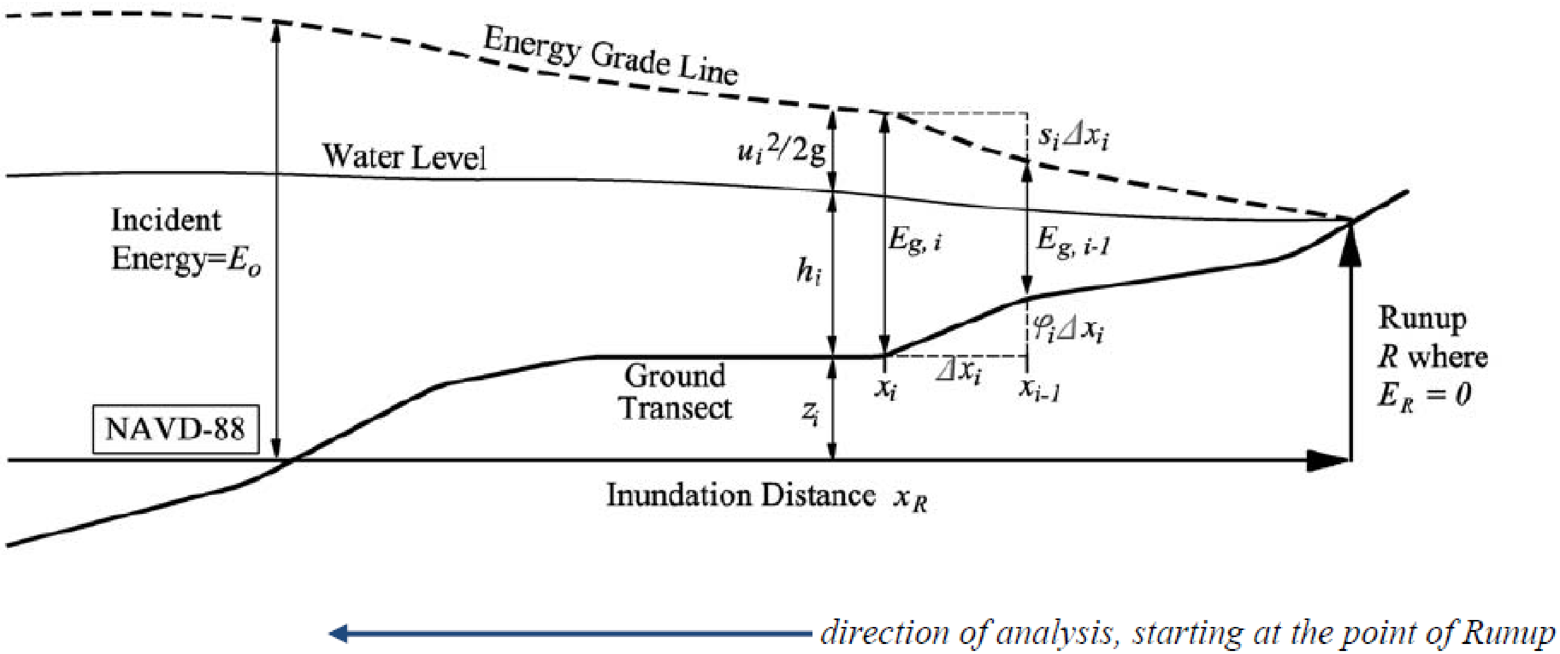
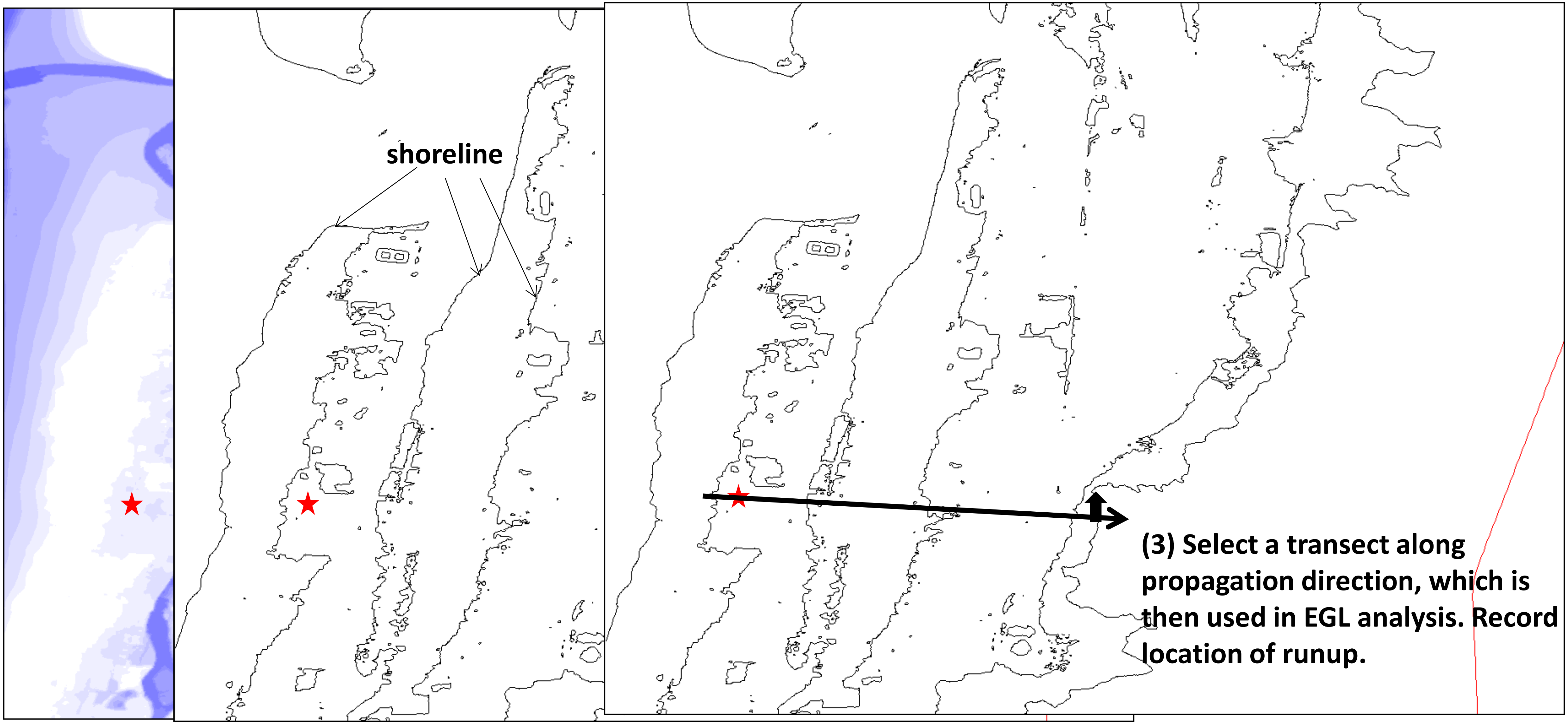


Figure 6.6-1 Energy Method for Overland Tsunami Inundation Depth and Velocity

R = Design tsunami runup elevation above NAVD88 datum
x_R = Design inundation distance inland from NAVD88 shoreline
z_i = Ground elevation above NAVD88 datum at point i

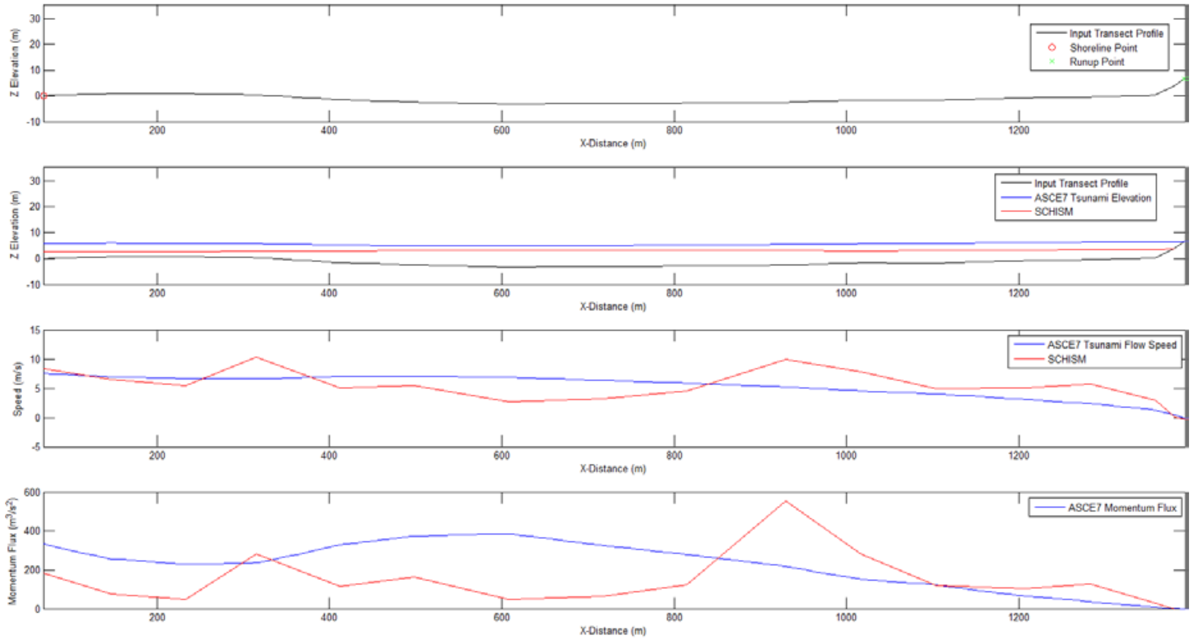
ASCE 7, Chapter 6

EGL with Yong's sources

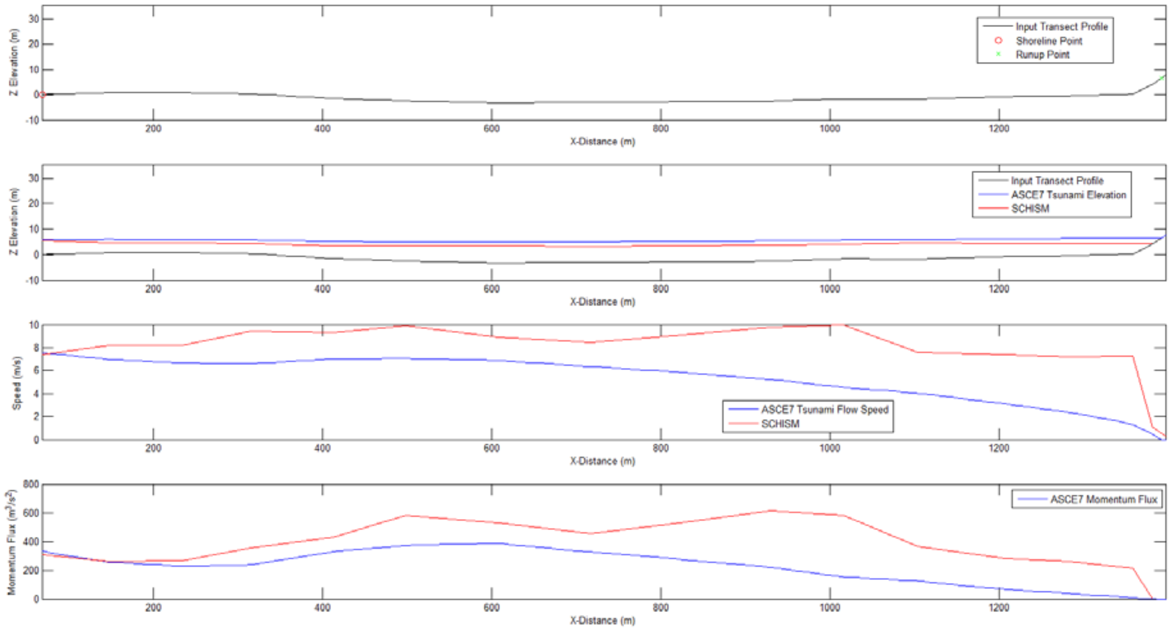


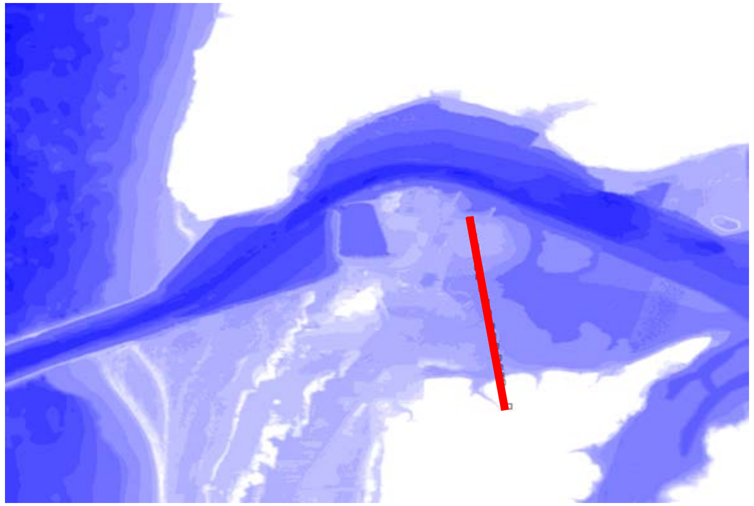
Newport, transect 4

ASCE source (*n*=0)



L1

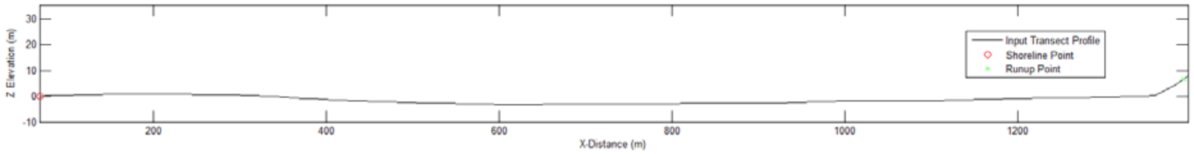


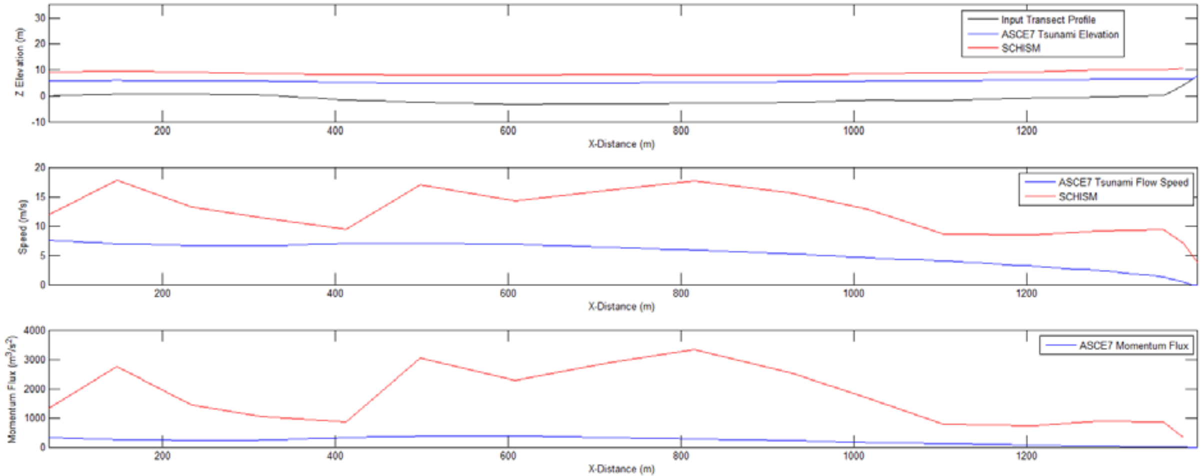


EGL (ASCE 7)

SCHISM

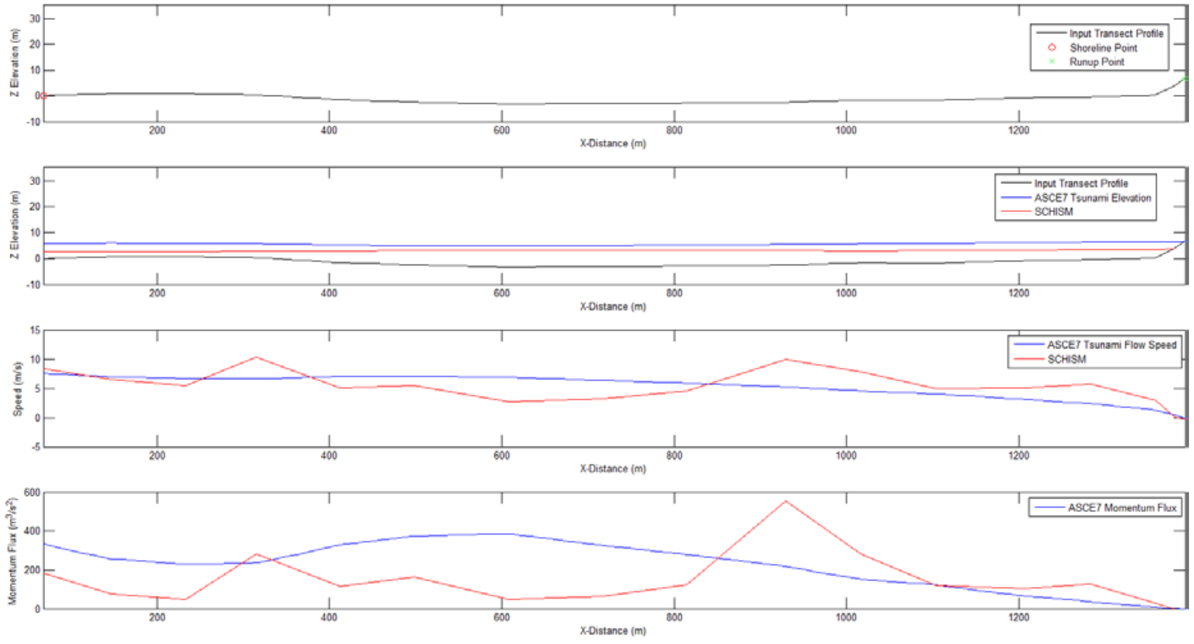
XXL1

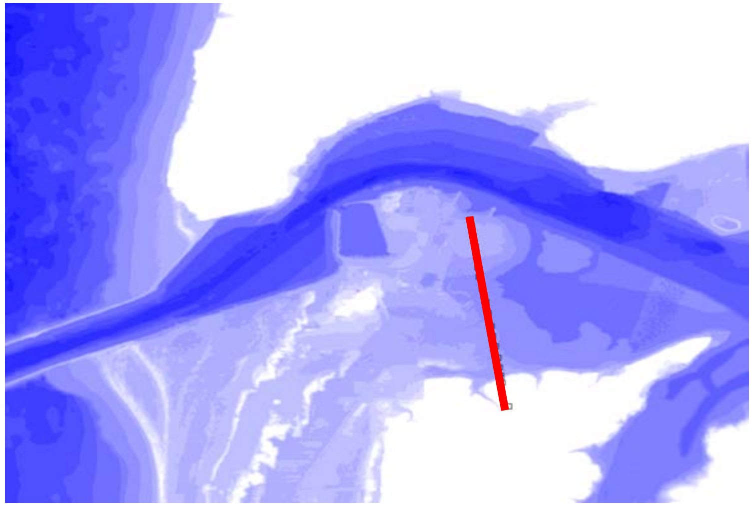




Newport, transect 4

ASCE source (*n*=0)



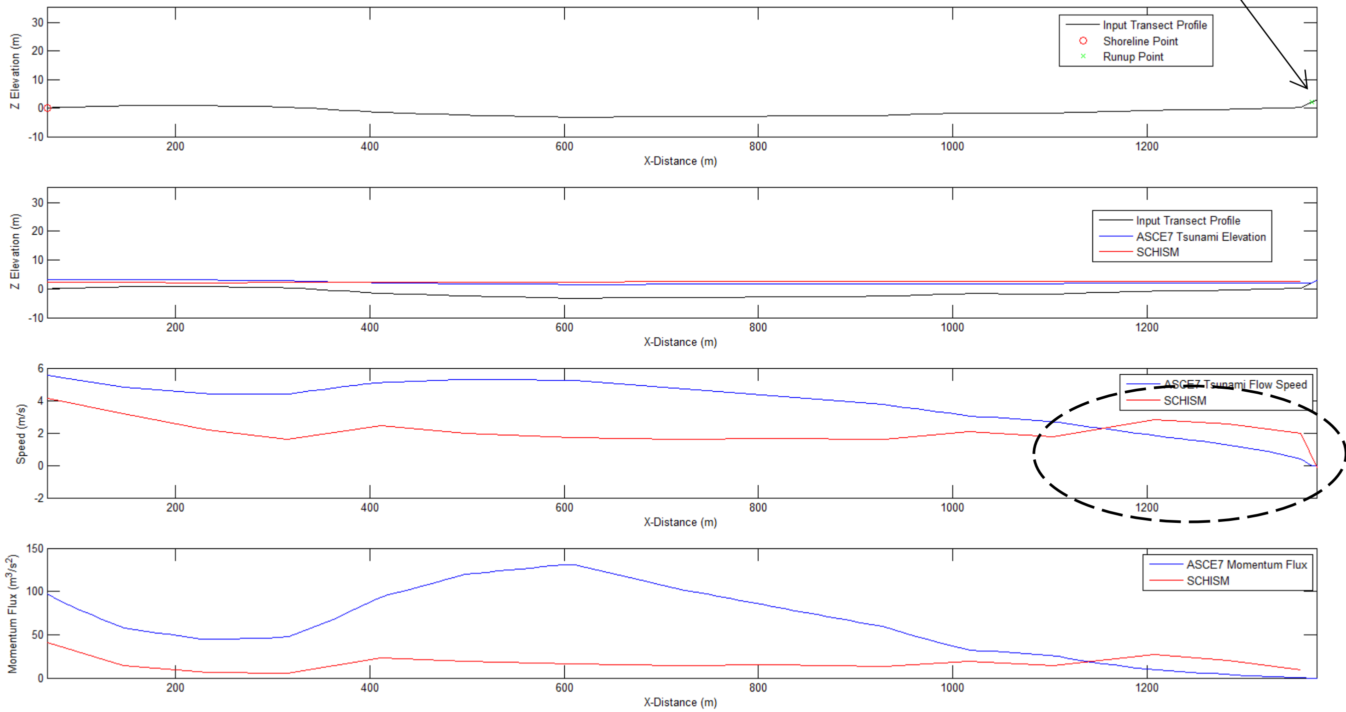


EGL (ASCE 7)

SCHISM

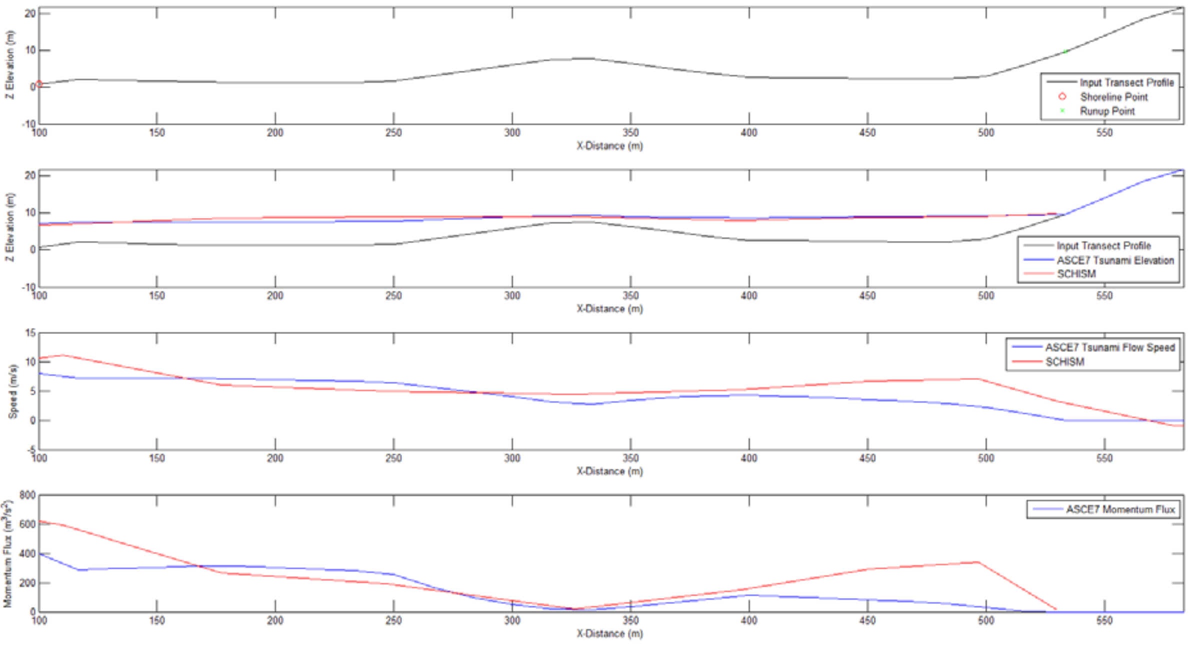
Runup location changed!

ASCE source (*n*=0.025)

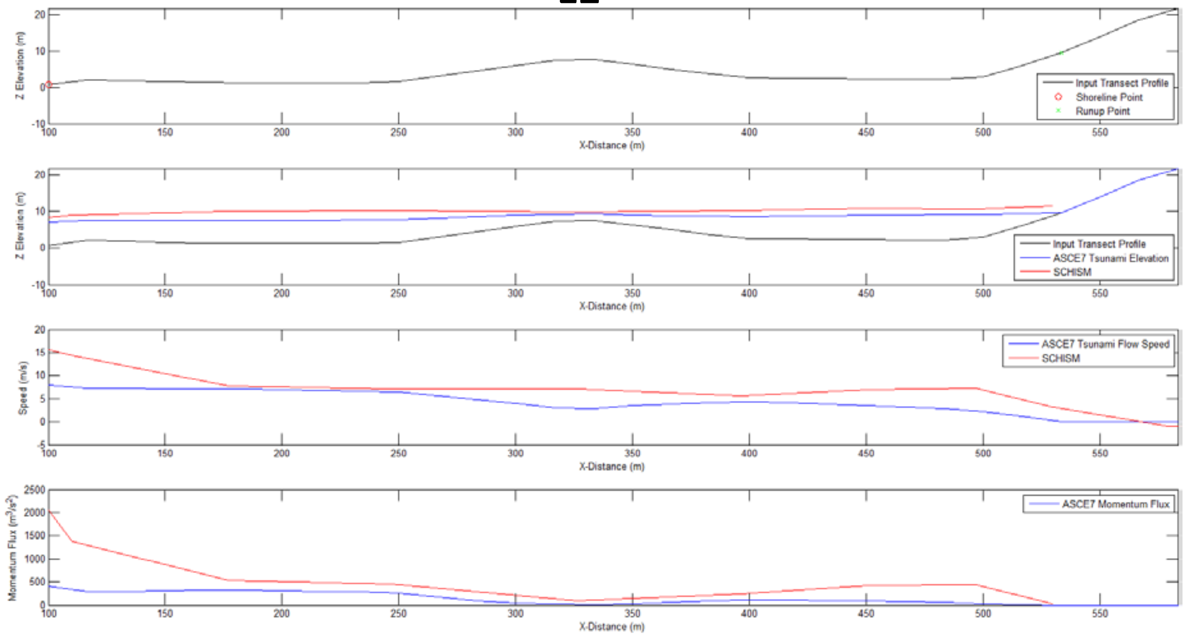


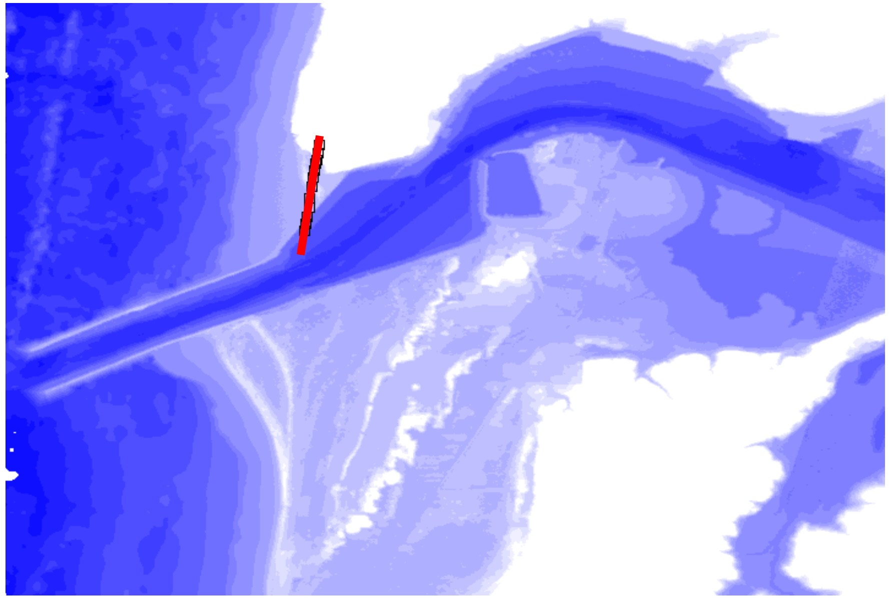
Newport, transect 5

ASCE source (*n*=0)



L1

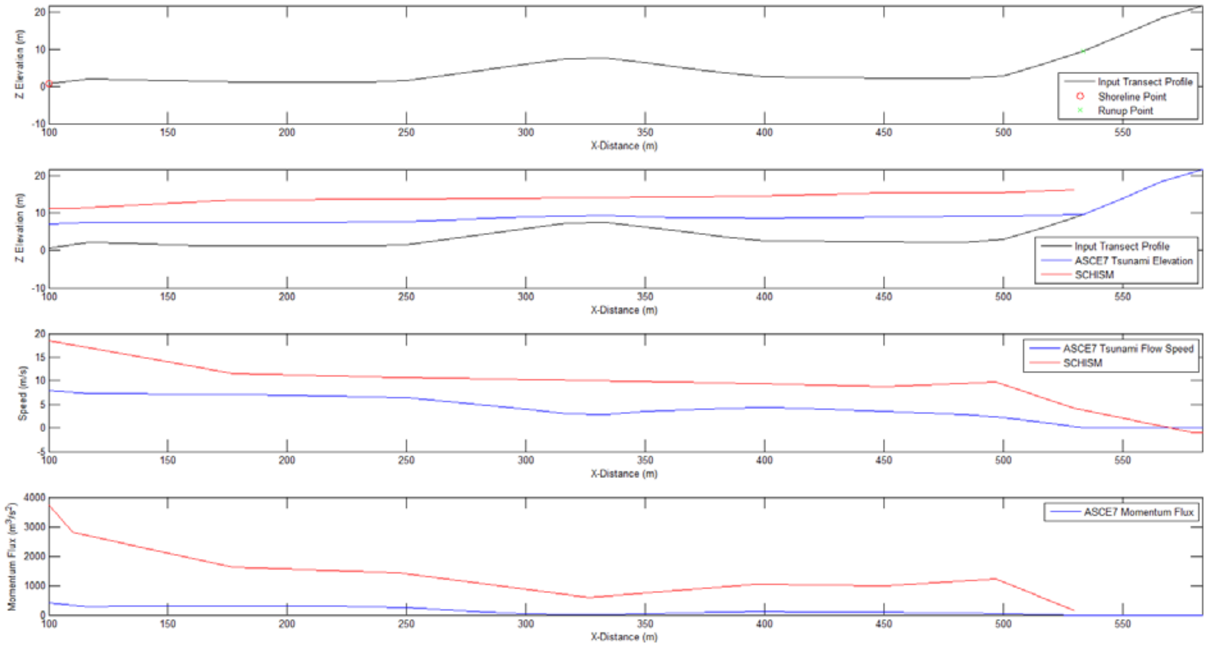




EGL (ASCE 7)

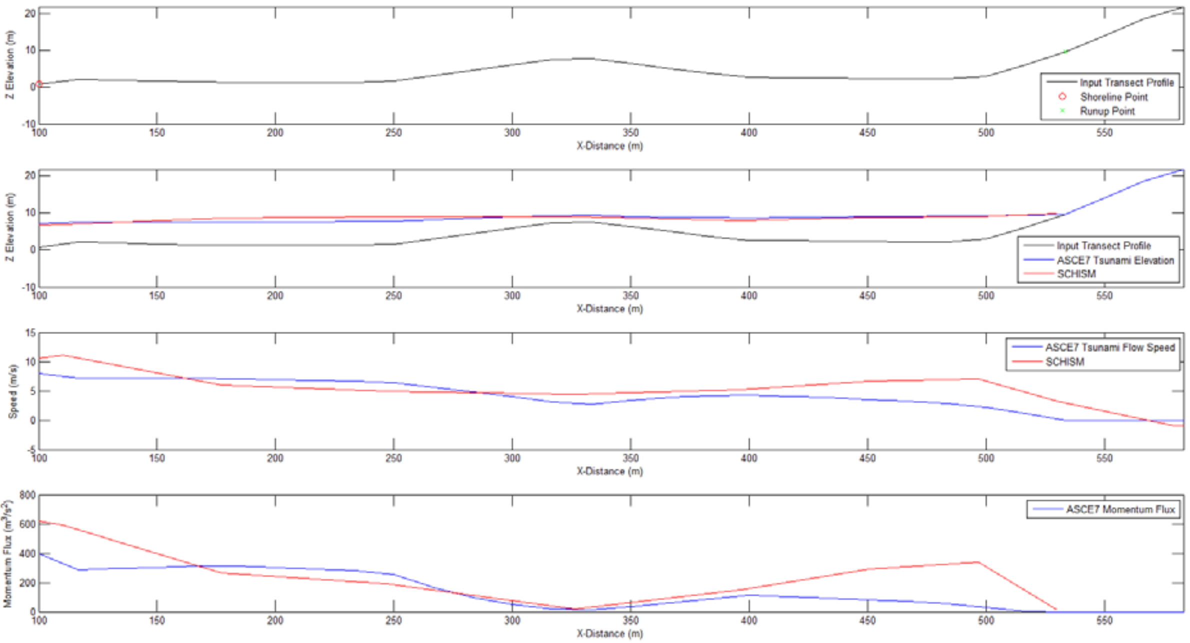
SCHISM

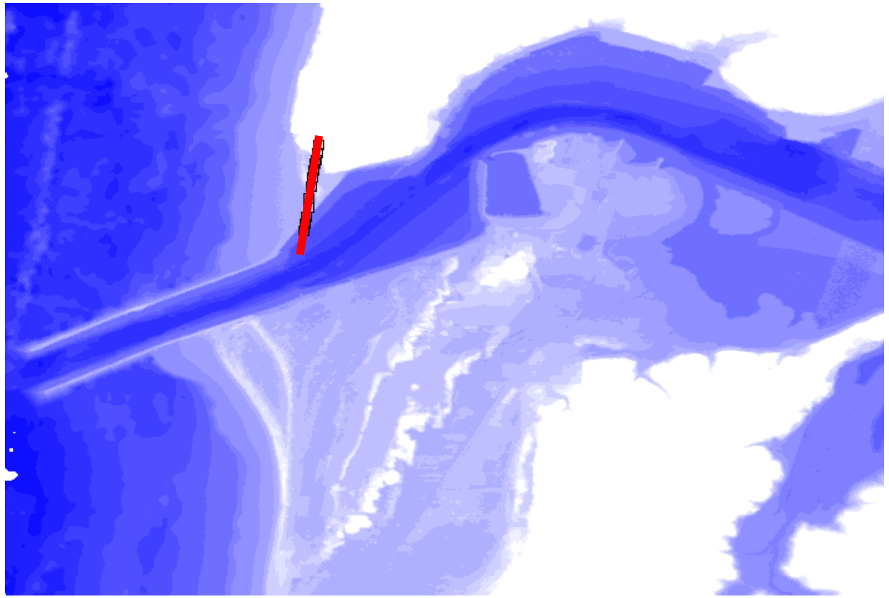
XXL1



Newport, transect 5

ASCE source (*n*=0)



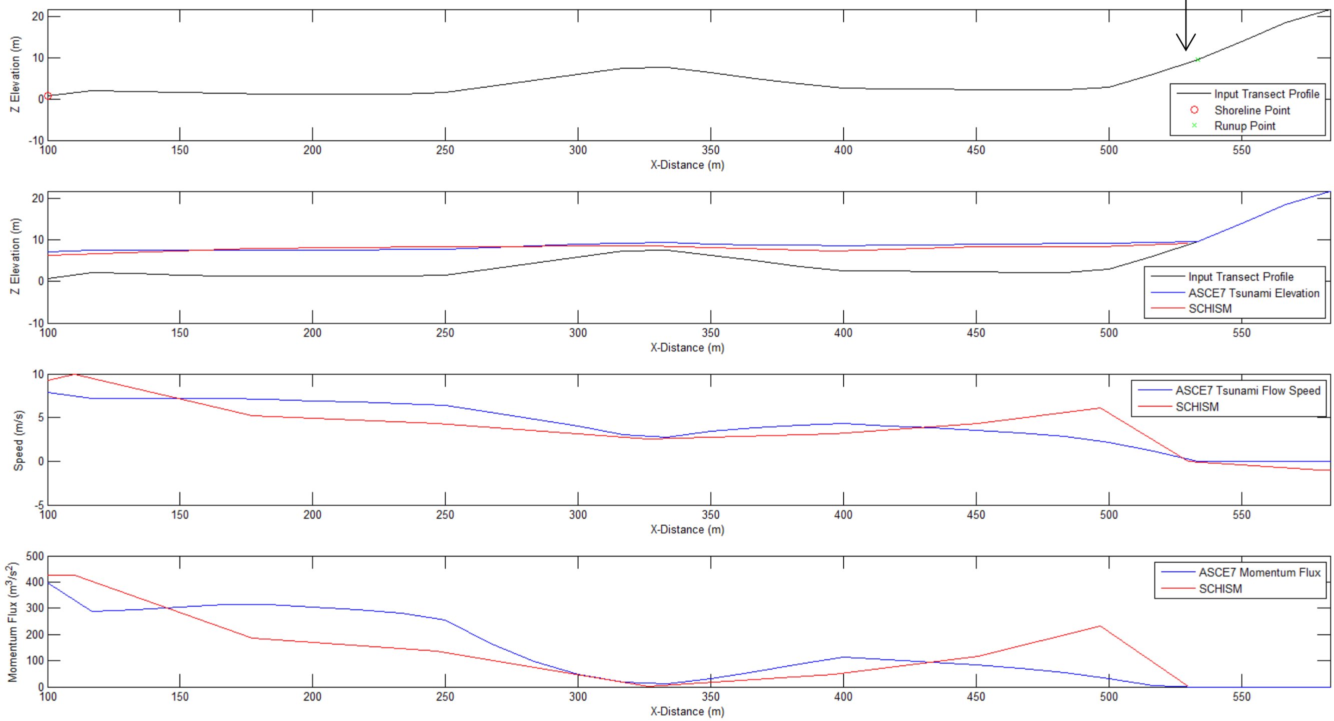


EGL (ASCE 7)

SCHISM

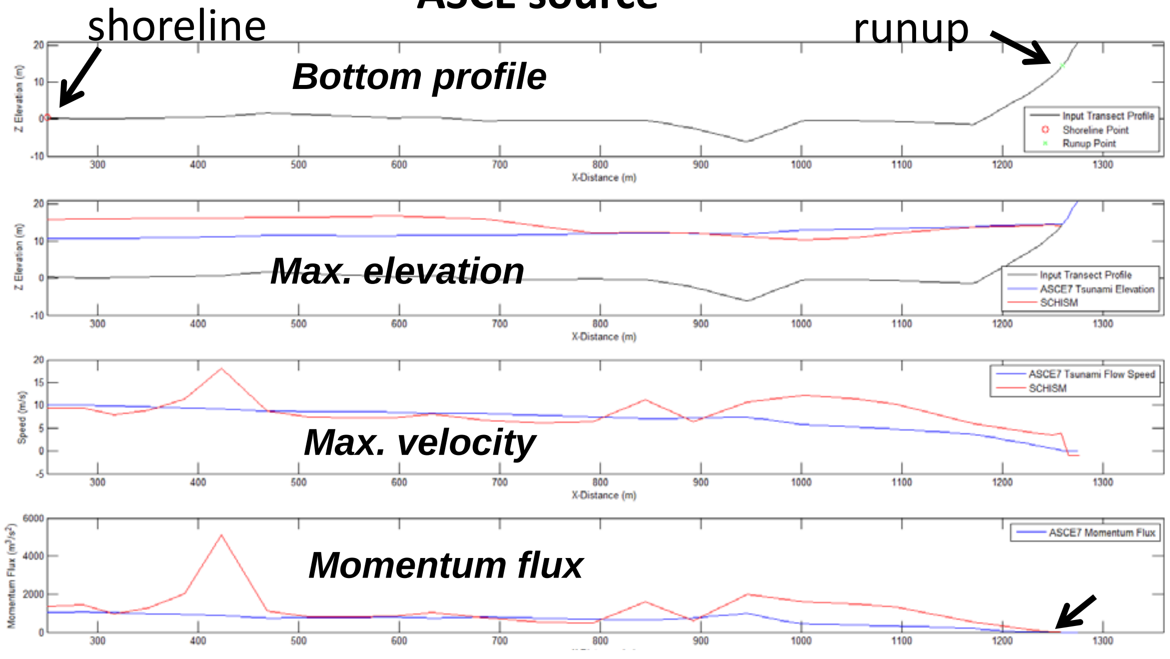
Runup location **unchanged**

ASCE source (*n*=0.025)

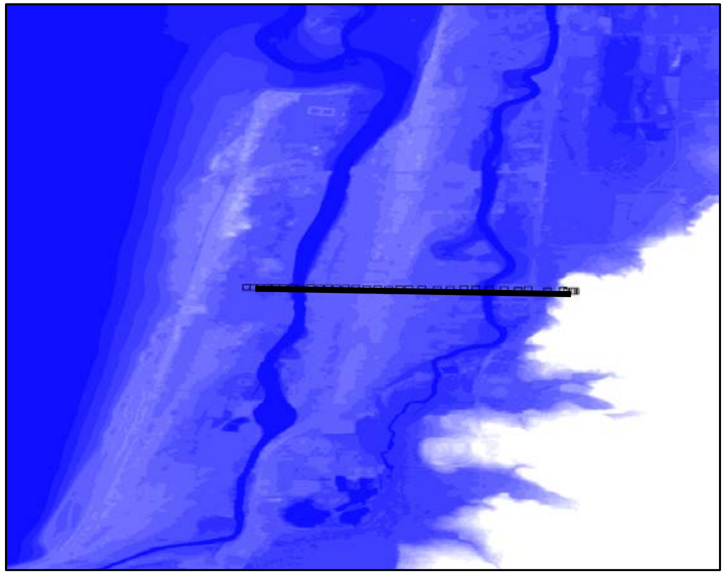


Seaside, transect 1

ASCE source

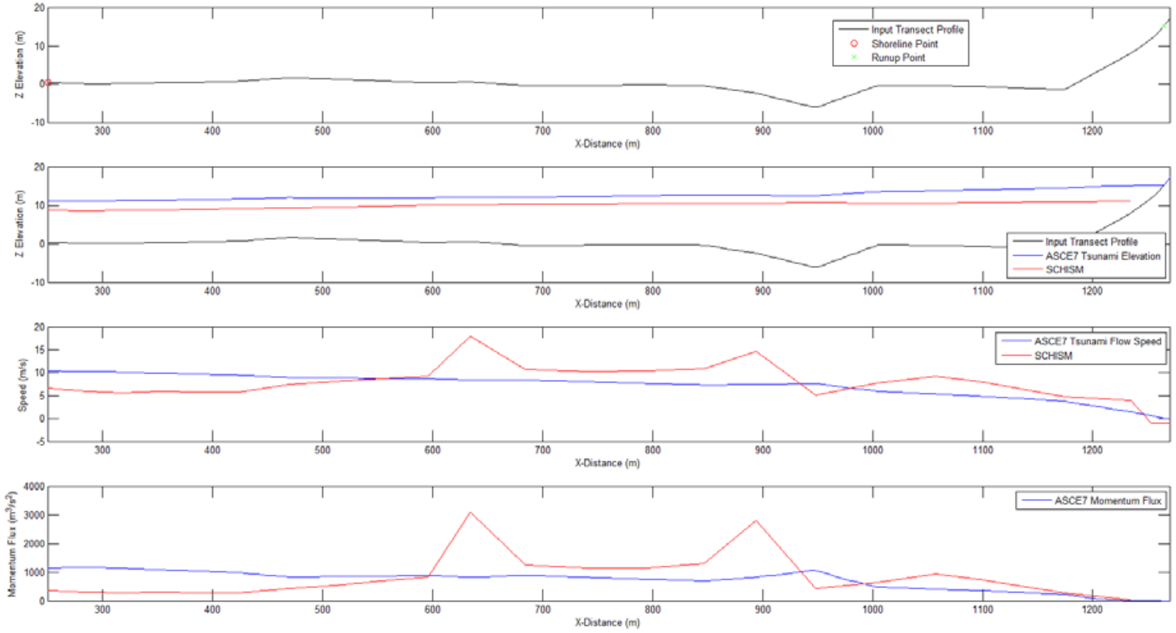


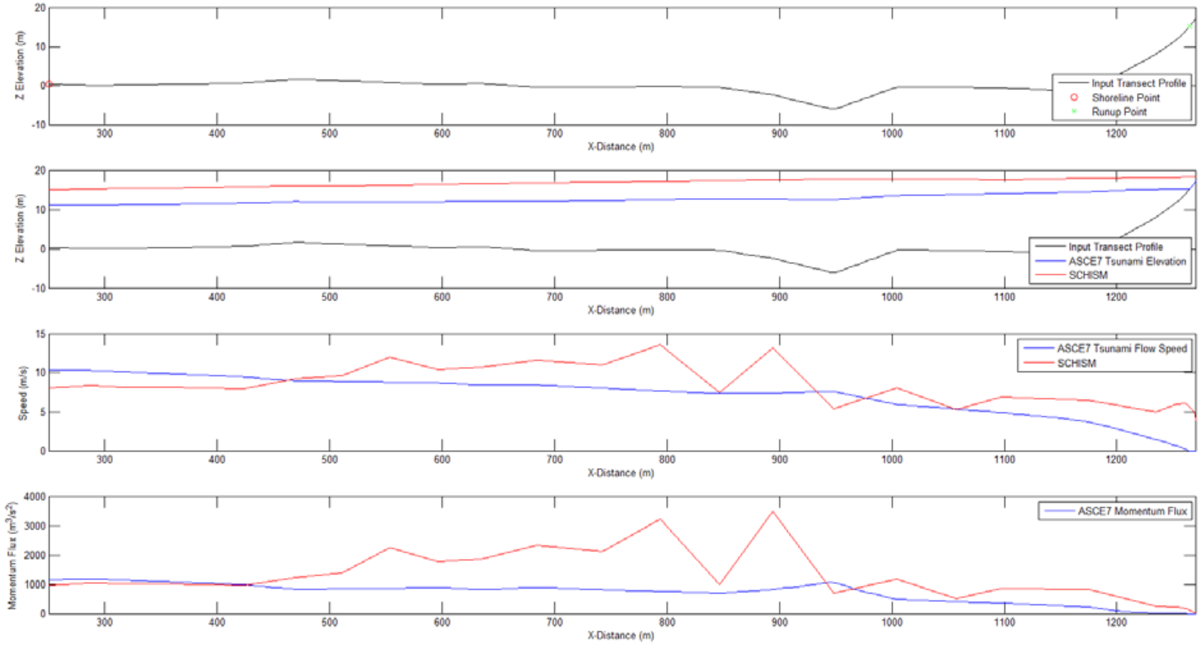
Distance (m)



EGL (ASCE 7)
SCHISM

L1

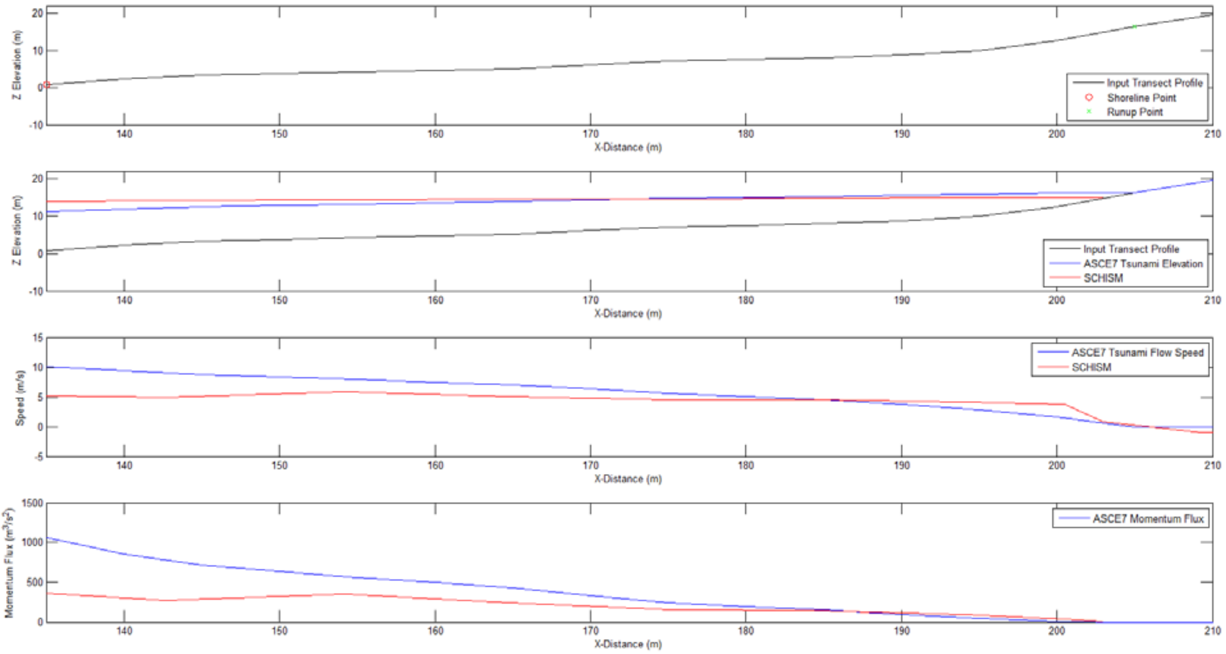




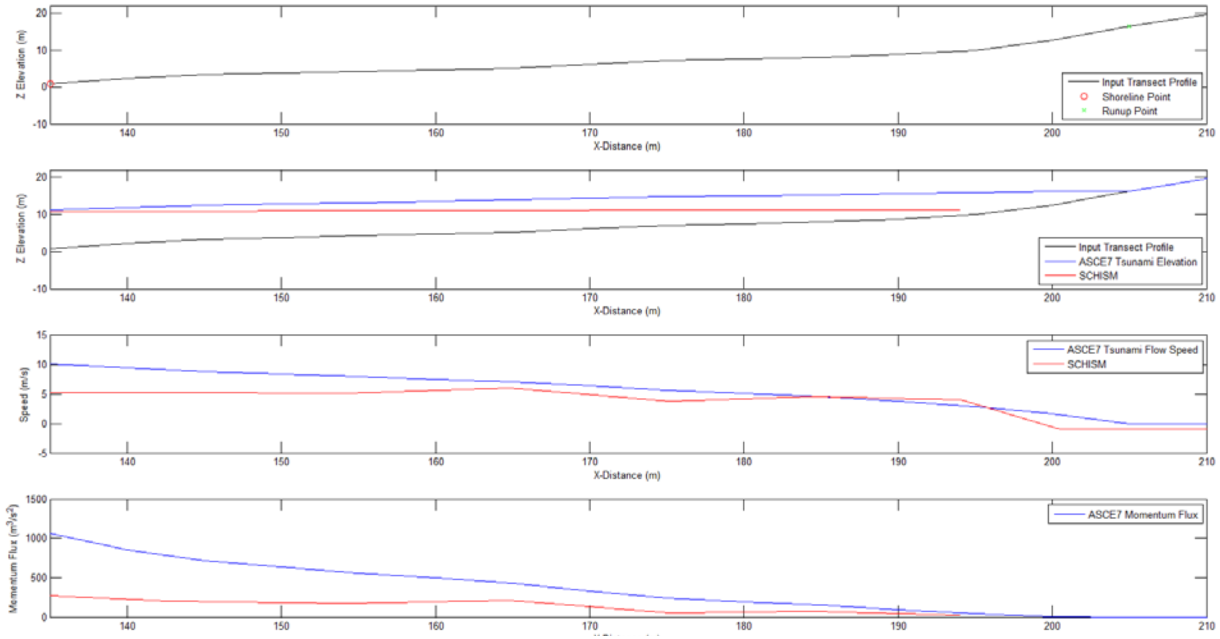
XXL1

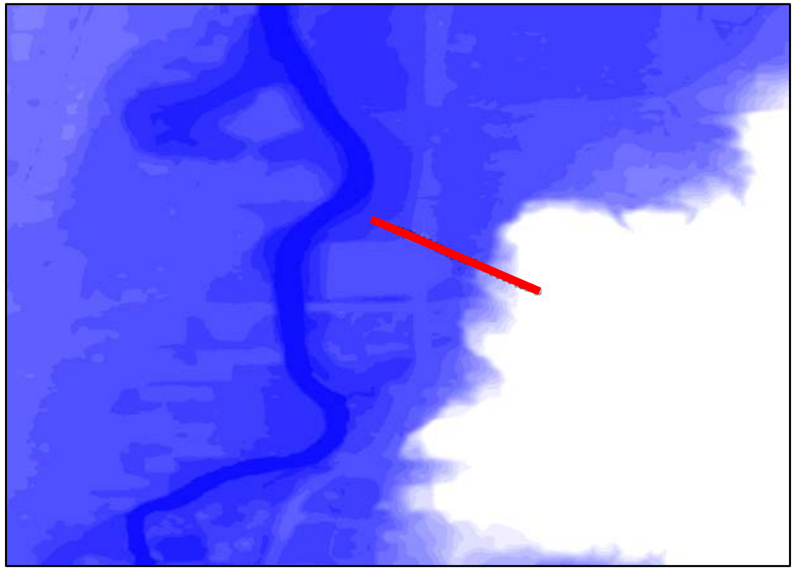
Seaside, transect 2

ASCE source



L1

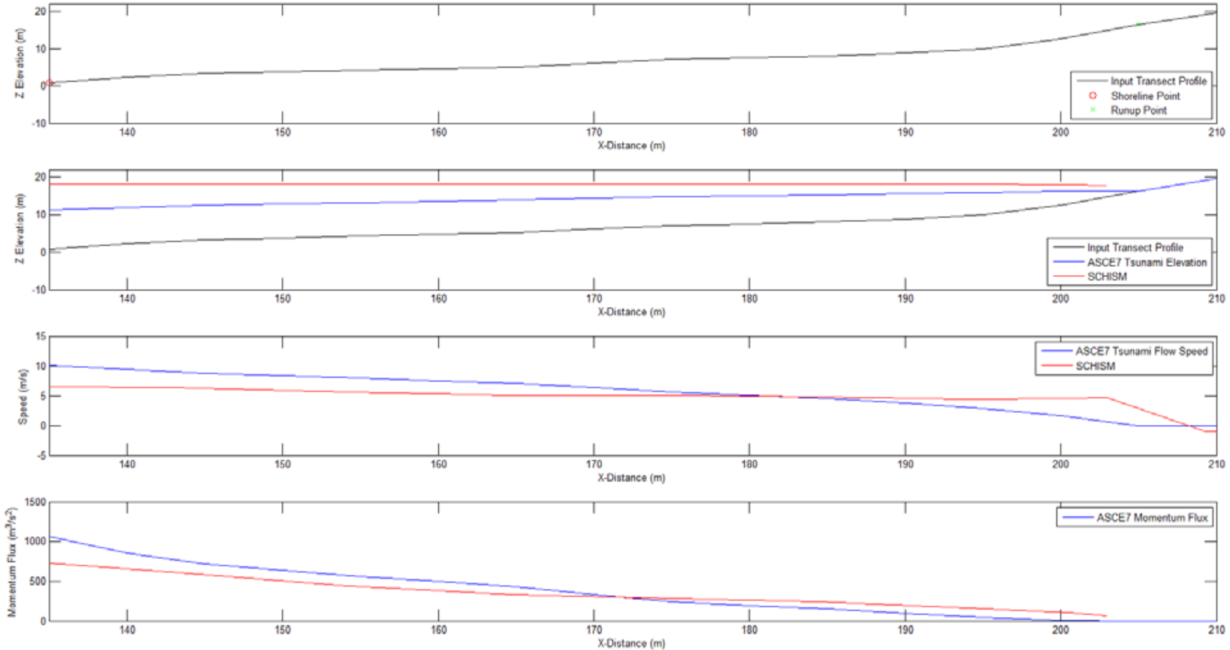




EGL (ASCE 7)

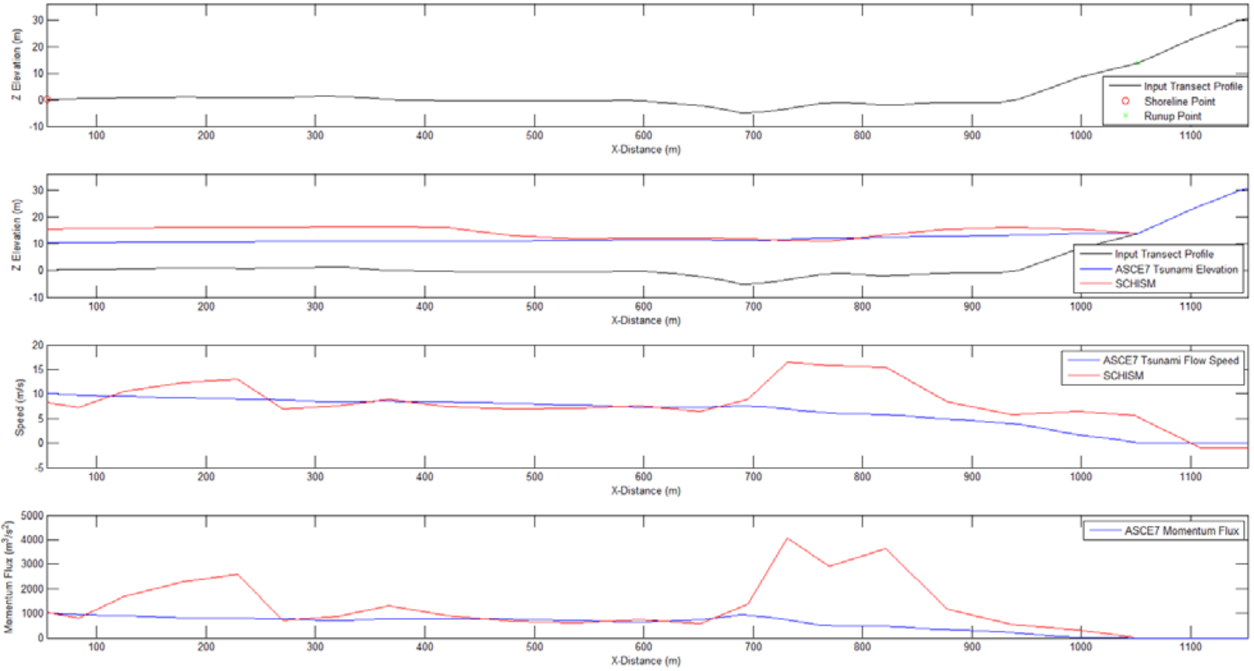
SCHISM

XXL1

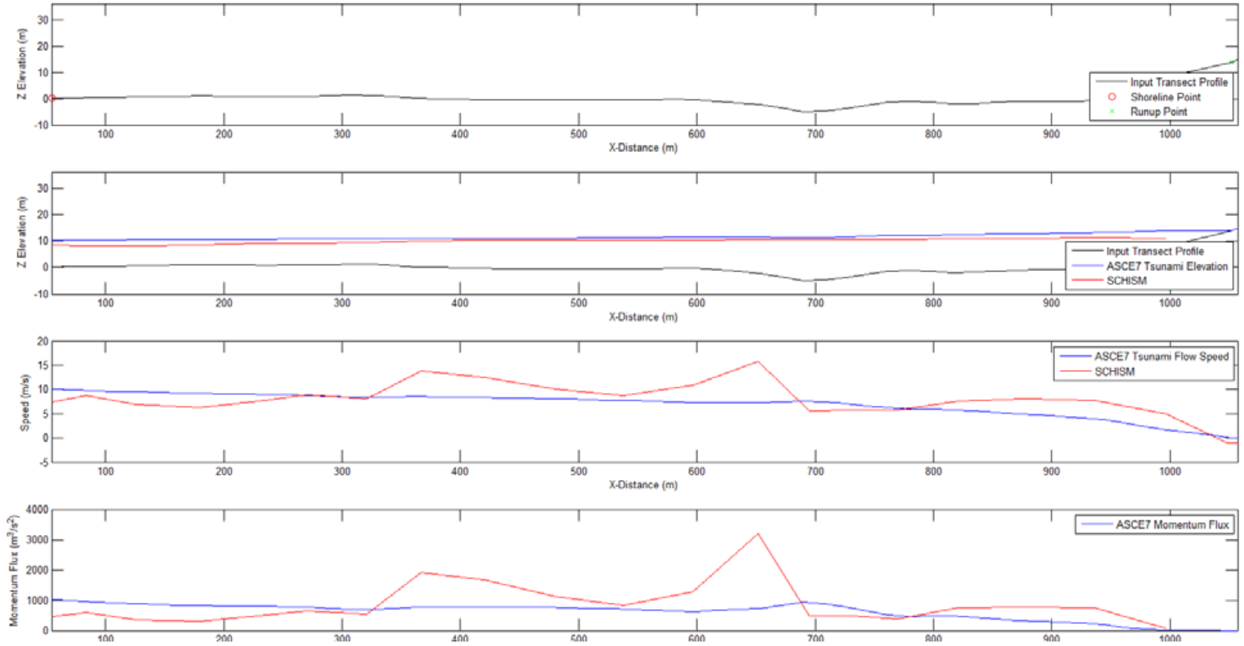


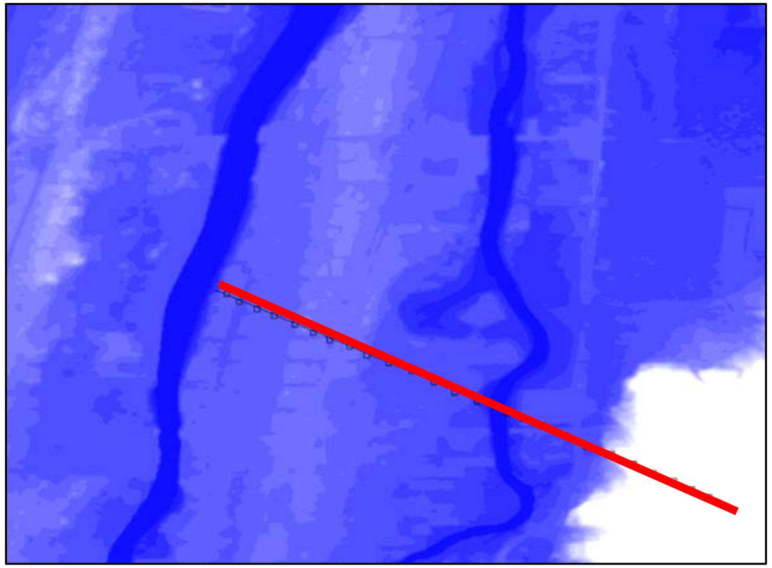
Seaside, transect 3

ASCE source



L1

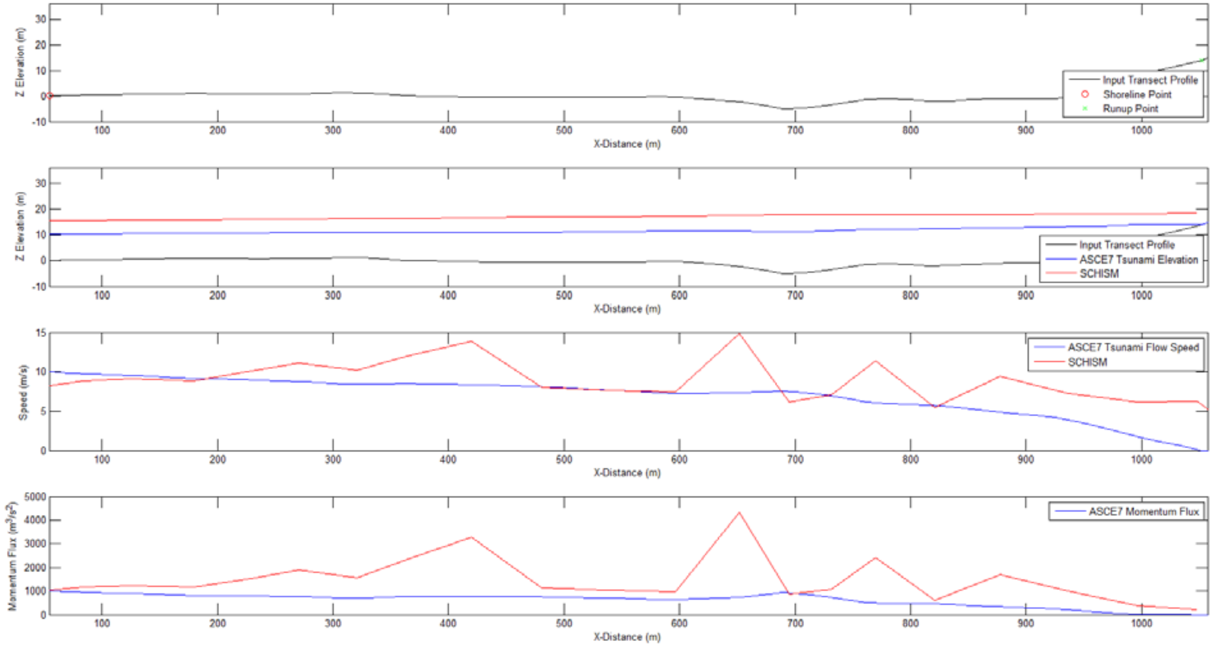




EGL (ASCE 7)

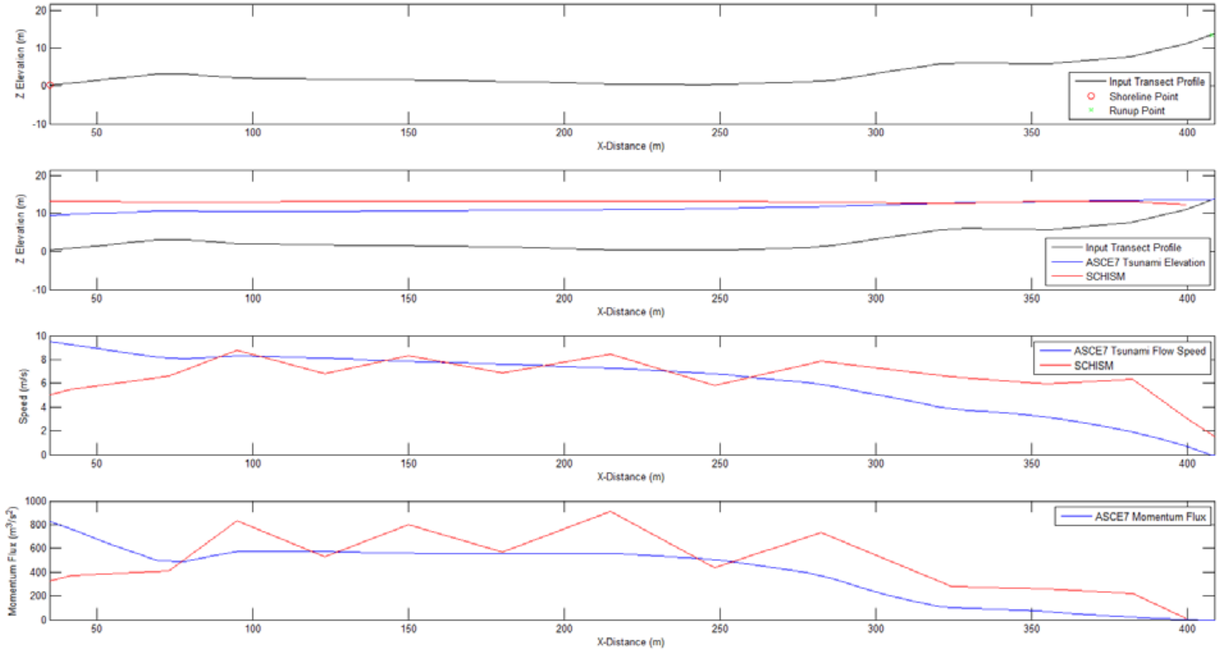
SCHISM

XXL1

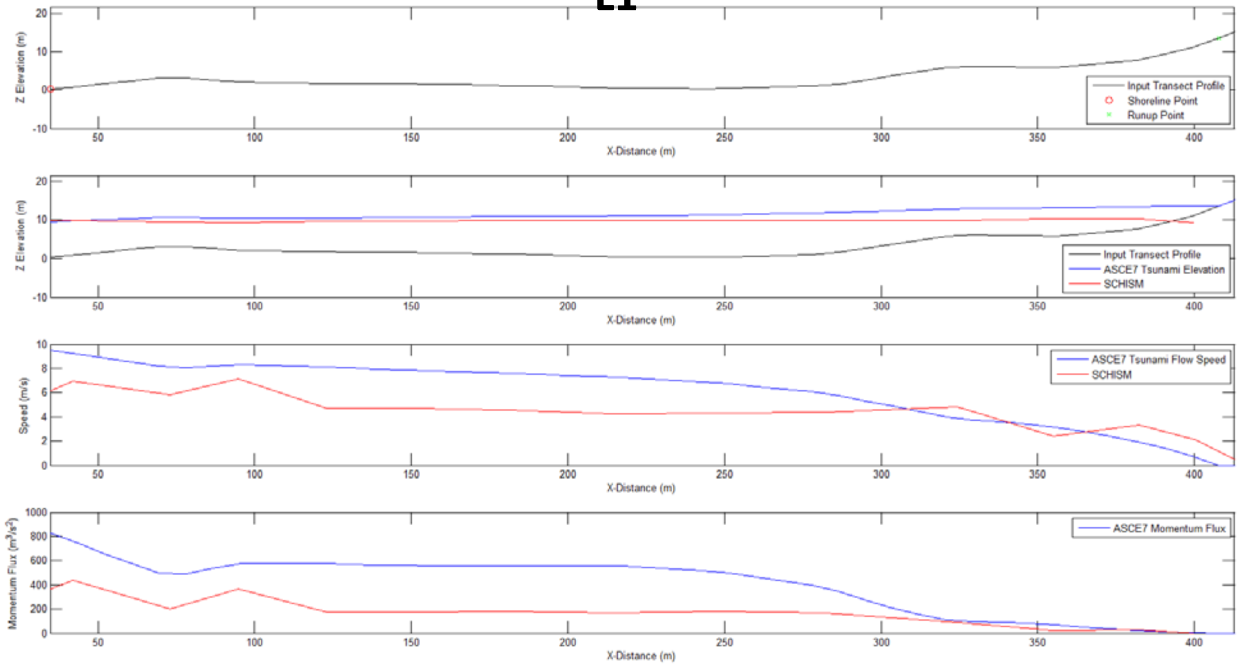


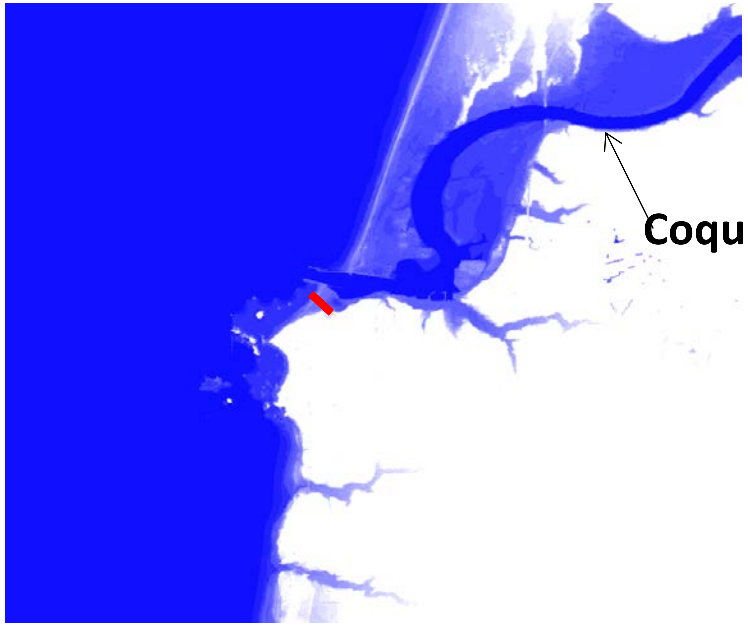
Bandon, transect 6

ASCE source



L1

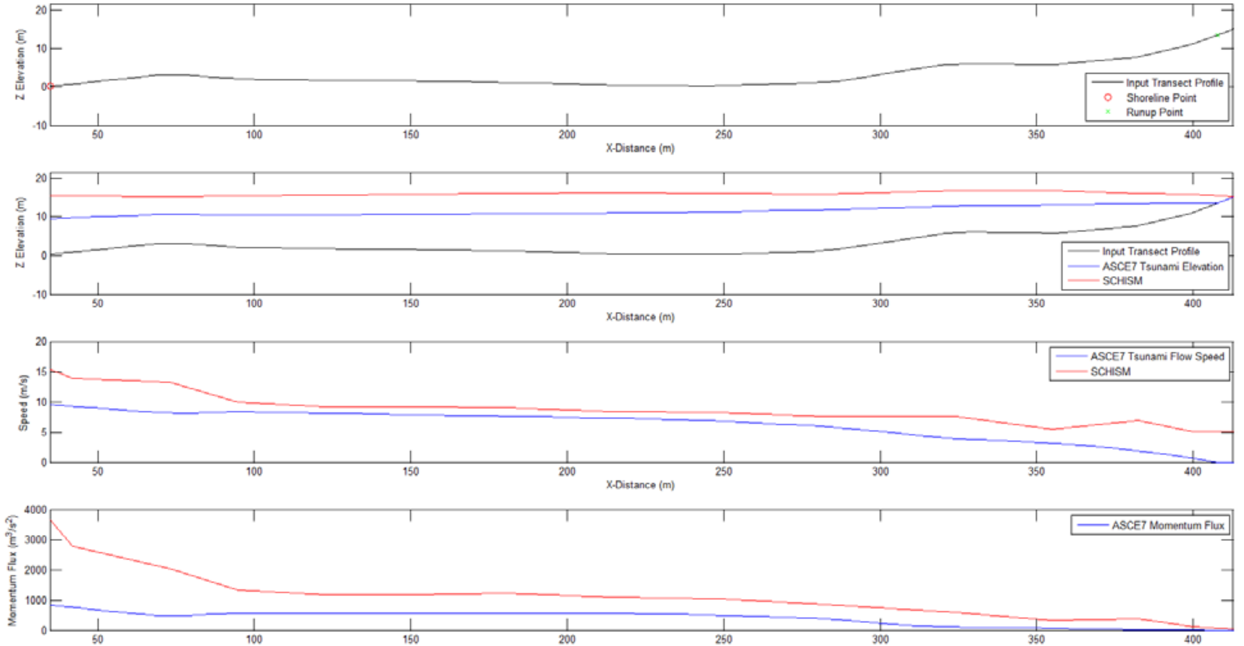




EGL (ASCE 7)

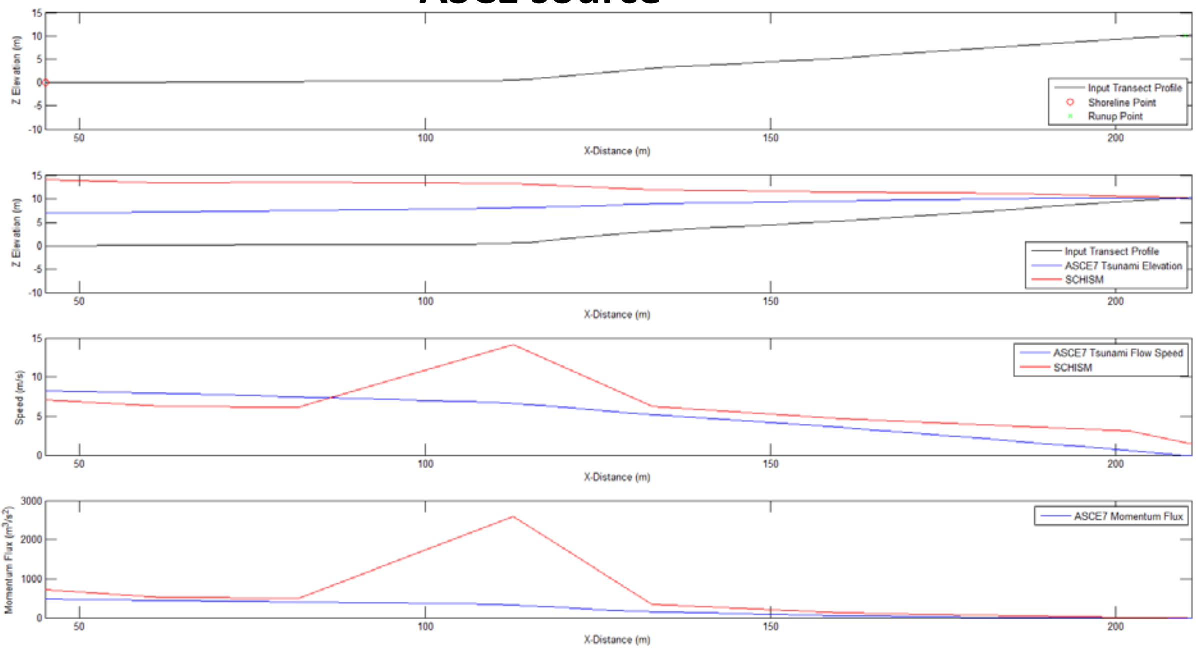
SCHISM

XXL1

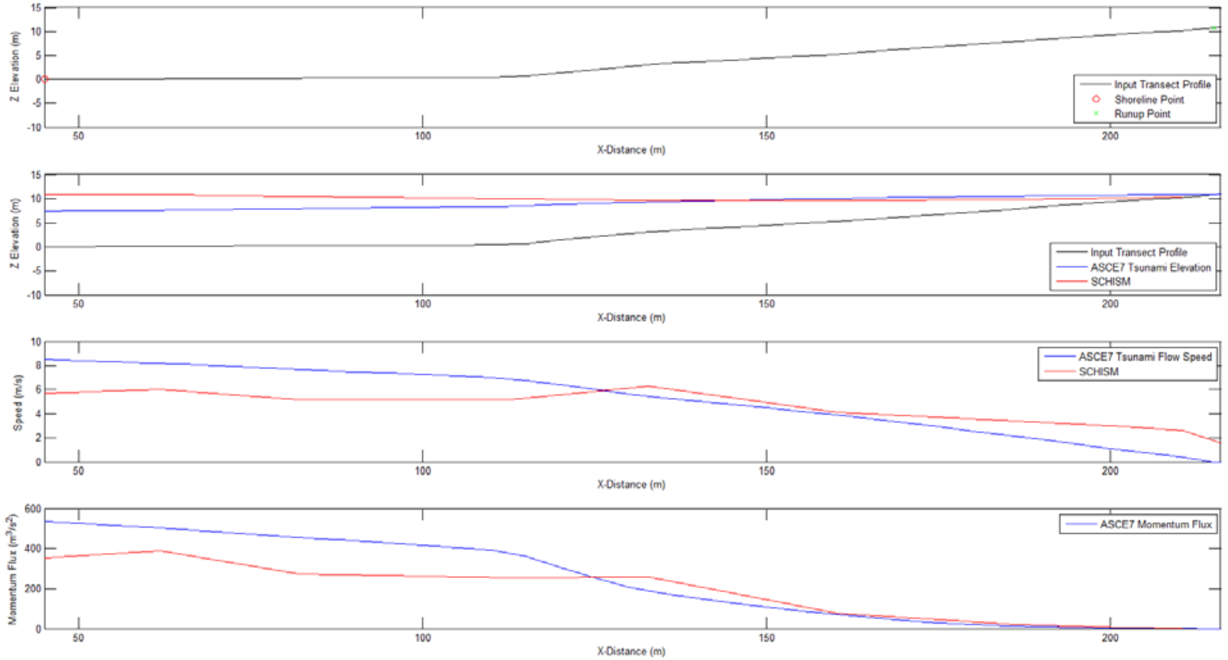


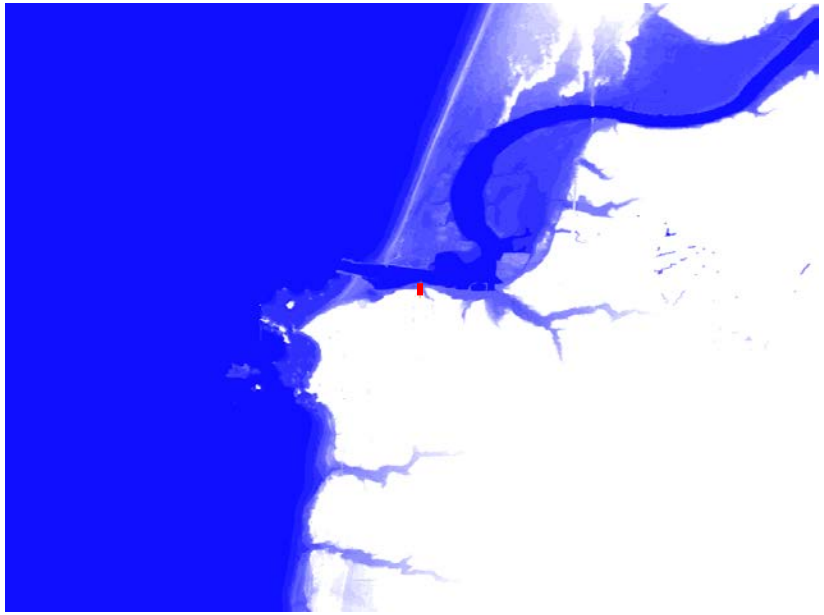
Bandon, transect 7

ASCE source



L1

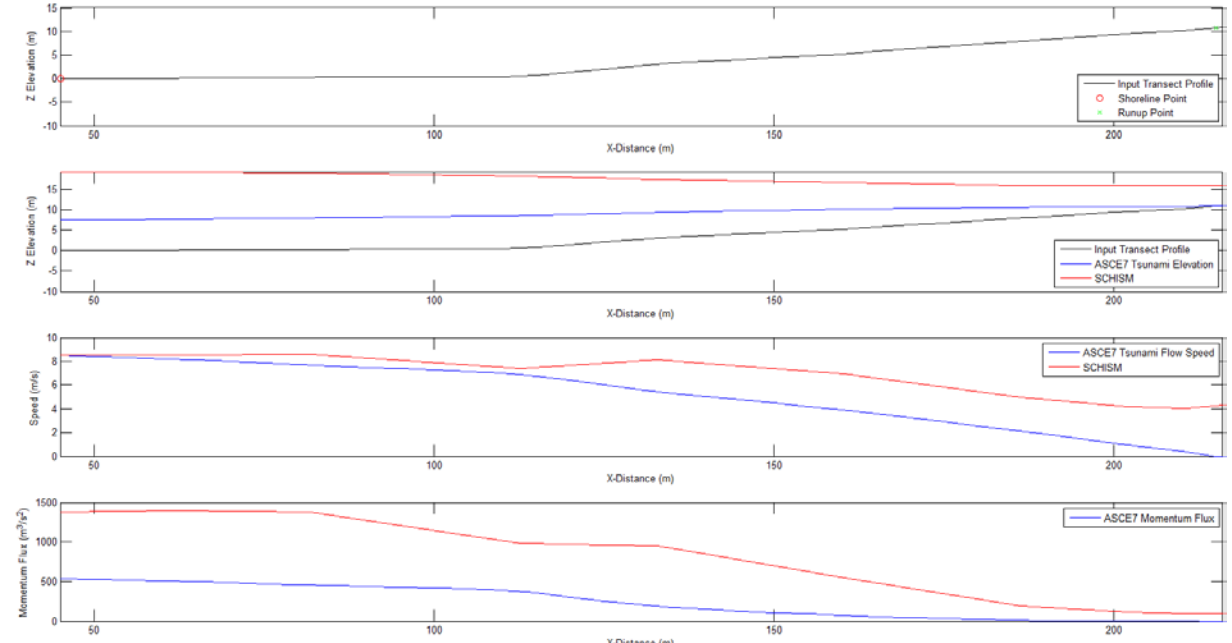




EGL (ASCE 7)

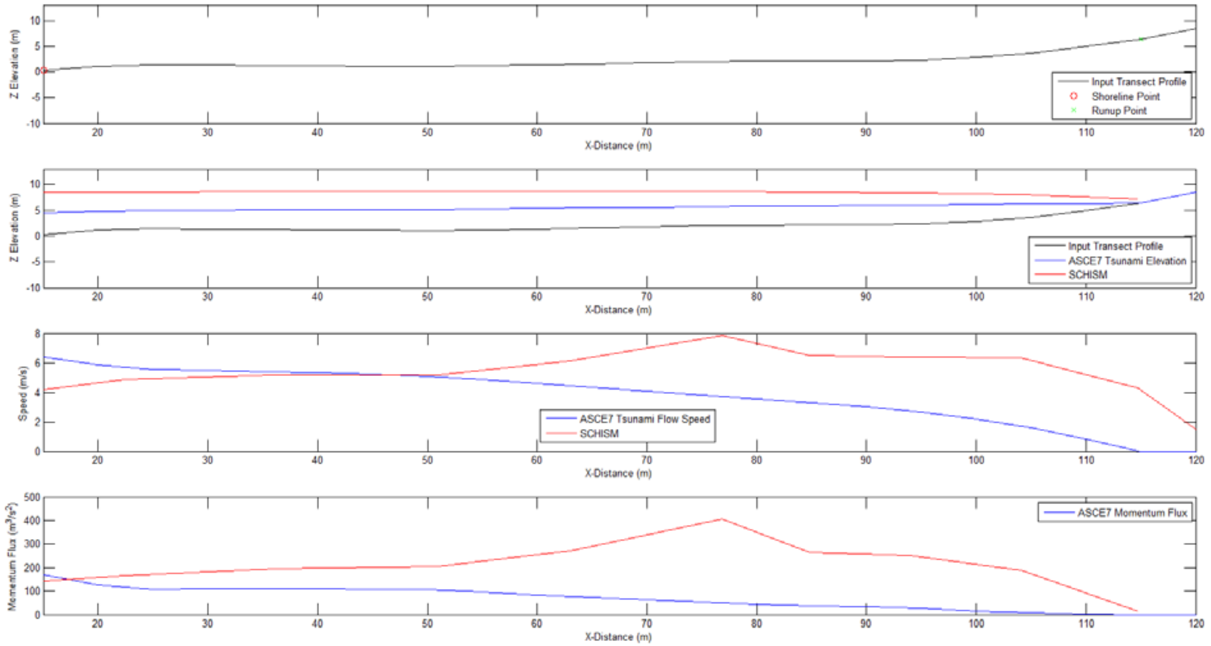
SCHISM

XXL1

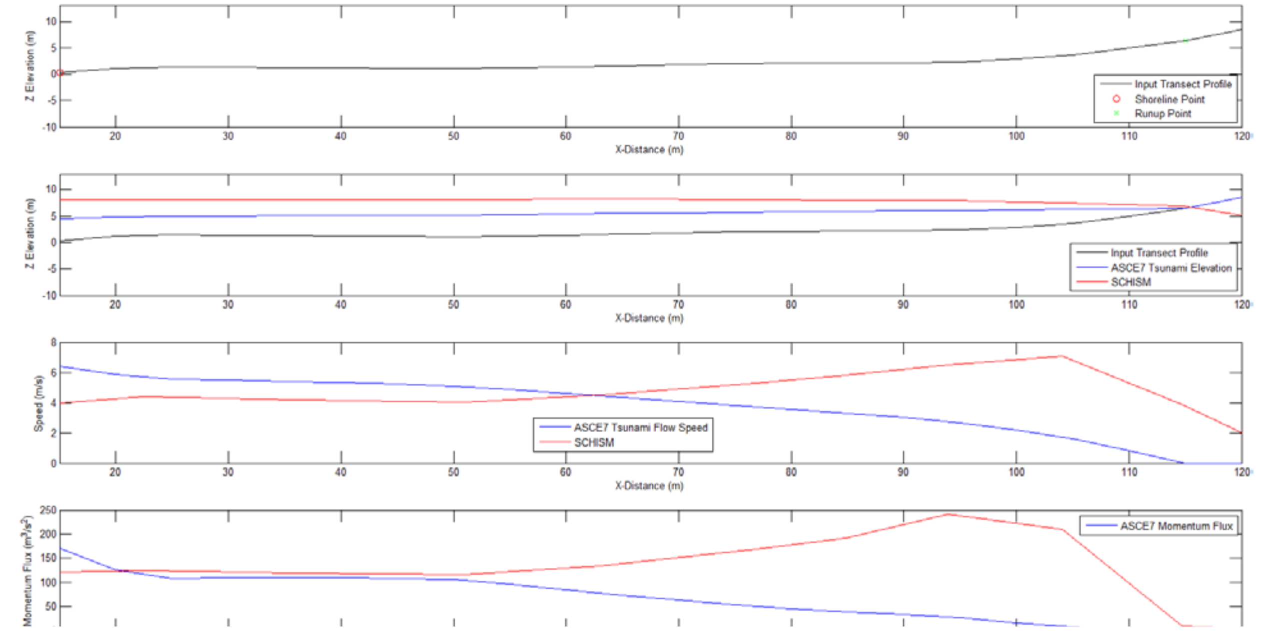


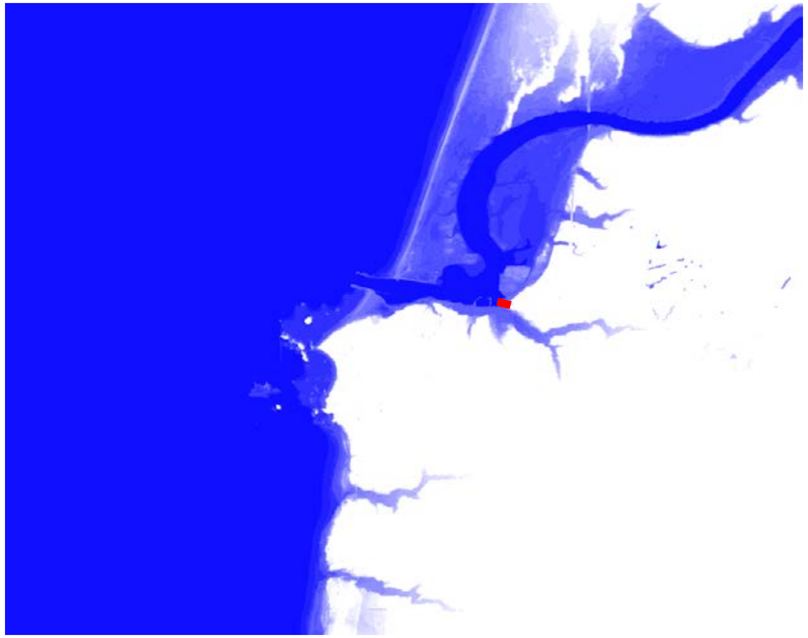
Bandon, transect 8

ASCE source



L1

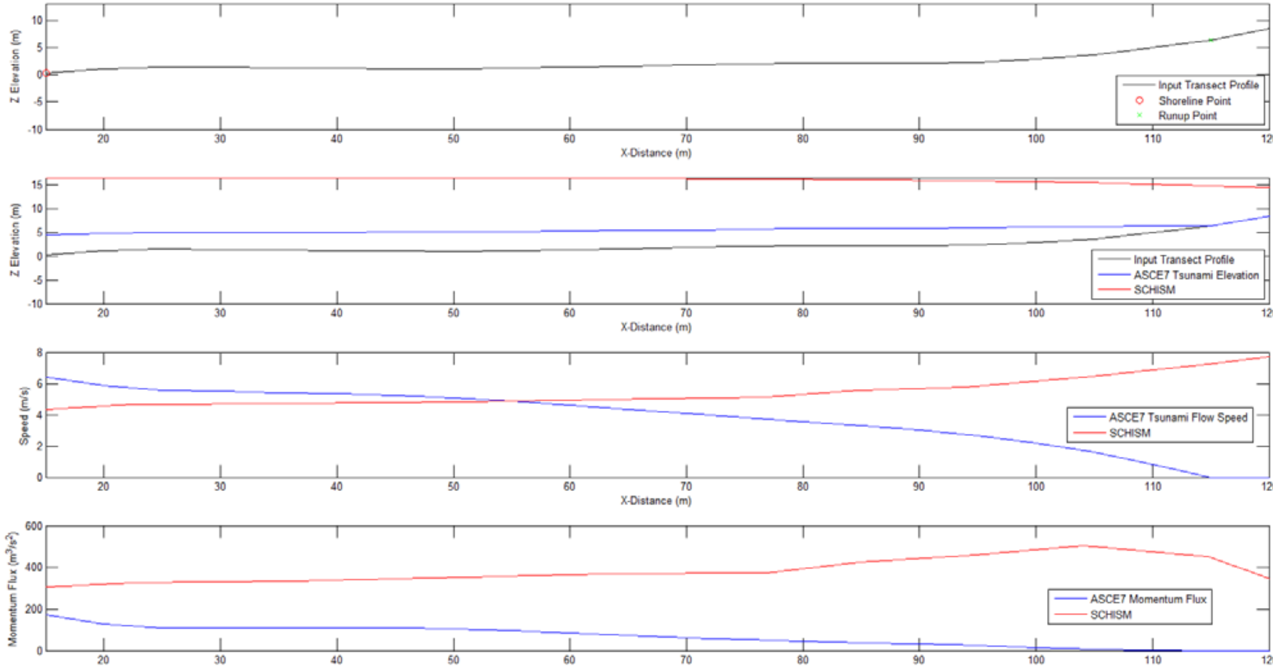




EGL (ASCE 7)

SCHISM

XXL1



Preliminary conclusions

- ASCE tsunami inundation is similar to L1
- Some similarities are observed between EGL and our model results
- Need to redo EGL analysis to use more resolution in transects; also the momentum flux calculation needs to be revised for both EGL and our model