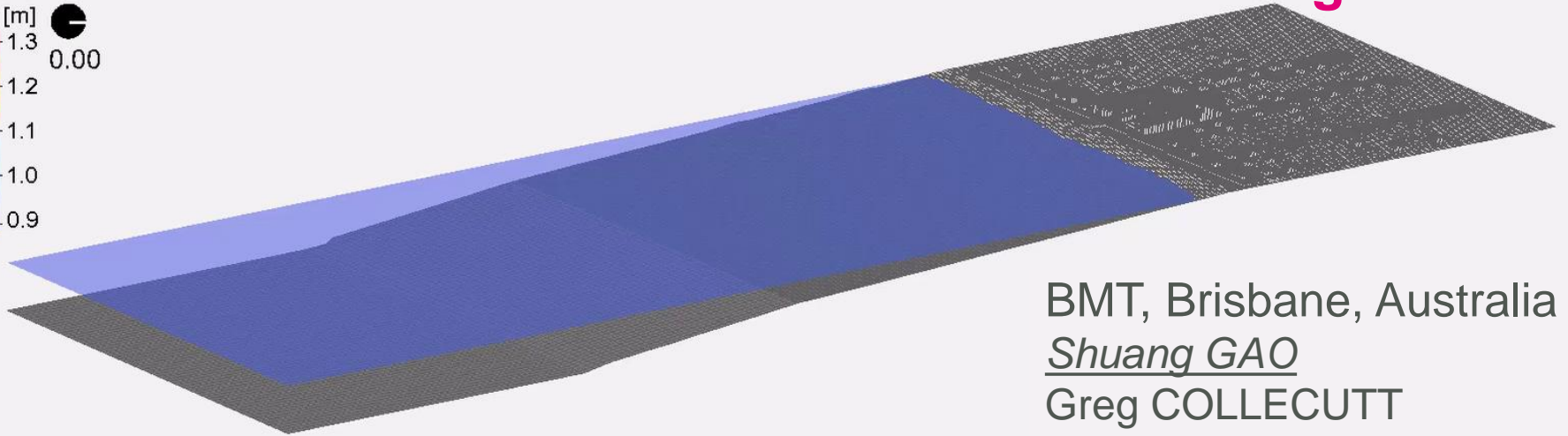
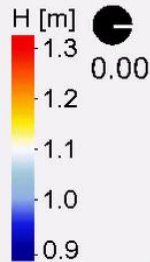


# High Resolution Numerical Modelling of Tsunami Inundation Using Quadtree Method



“Macro-roughness”

BMT, Brisbane, Australia

Shuang GAO

Greg COLLECUTT

Bill SYME

Philip RYAN

# Background

## High Resolution Tsunami Modelling

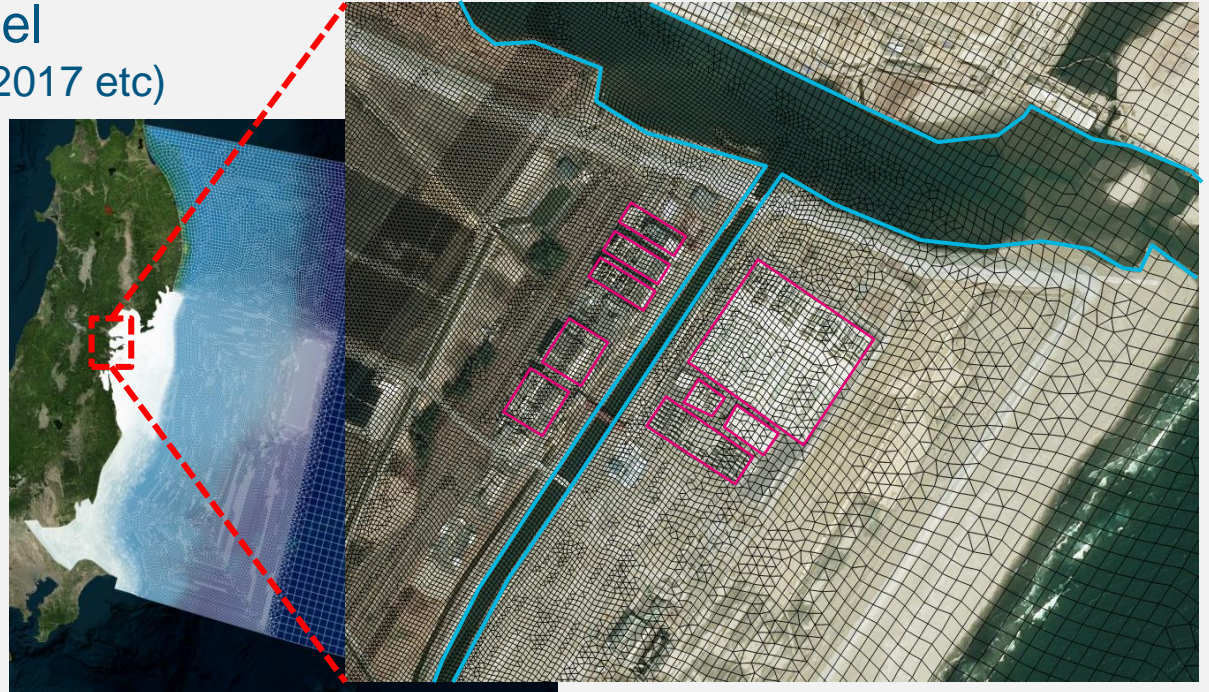
### Unstructured Mesh Model

(Guard et al 2013; Akoh et al 2017 etc)

- Flexible mesh size
- Accuracy
- Time and effort ...orz

### Structured Mesh Model

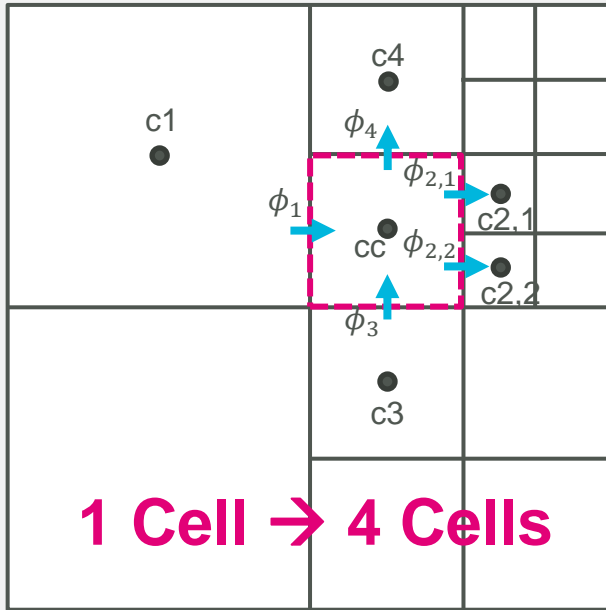
- Easy to build
- **Flexible mesh size?**
- **Accuracy?**



Guard et al 2013

# Quadtree Method

Based on TUFLOW HPC: Collecutt and Syme (2017)



- 2D non linear Shallow Water Equation solver
- Finite Volume Method
- 2<sup>nd</sup> order spatial scheme
- 4<sup>th</sup> order explicit scheme in time (Runge-Kutta method) and adaptive time stepping
- Parallelised for CPU and GPU

# Model Verification

## Tsunami Flume Experiment

Oregon State University: Rueben et al. (2011); Park et al. (2013)

- 1:50 model of a seaside city named Seaside, Oregon, US
- Lidar-surveyed topography
- Optical measurement
- Water level measurement (Thank you Dr Park)
- etc





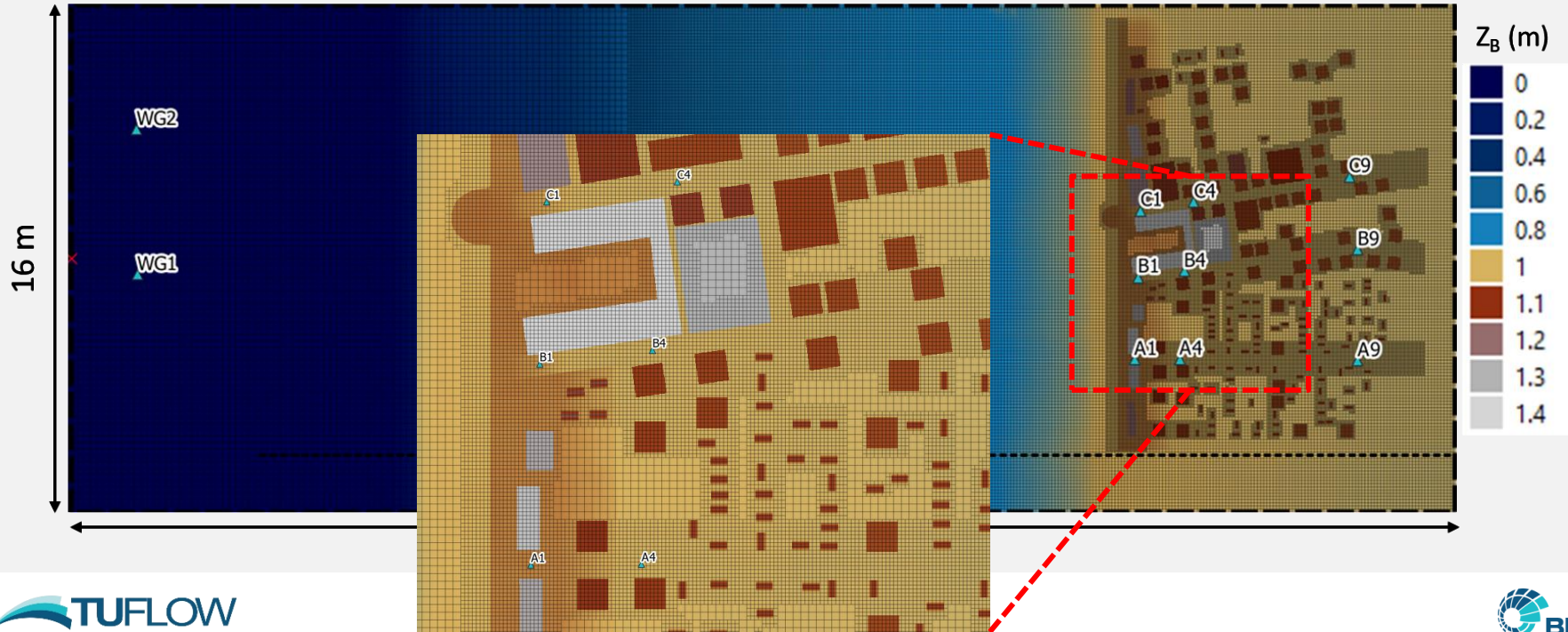
# Model Verification

## Tsunami Flume Experiment

Model mesh 20 cm mesh

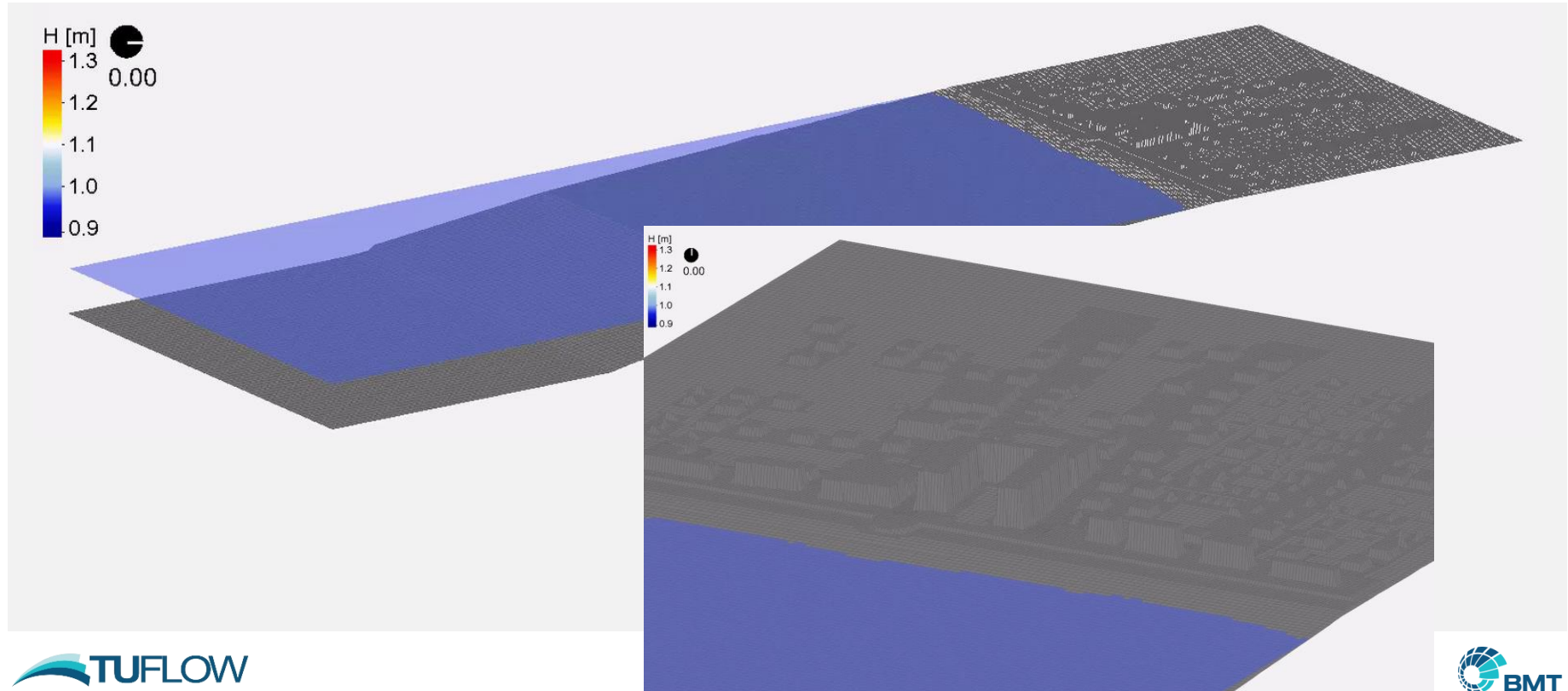
10 cm mesh

5/10 cm mesh



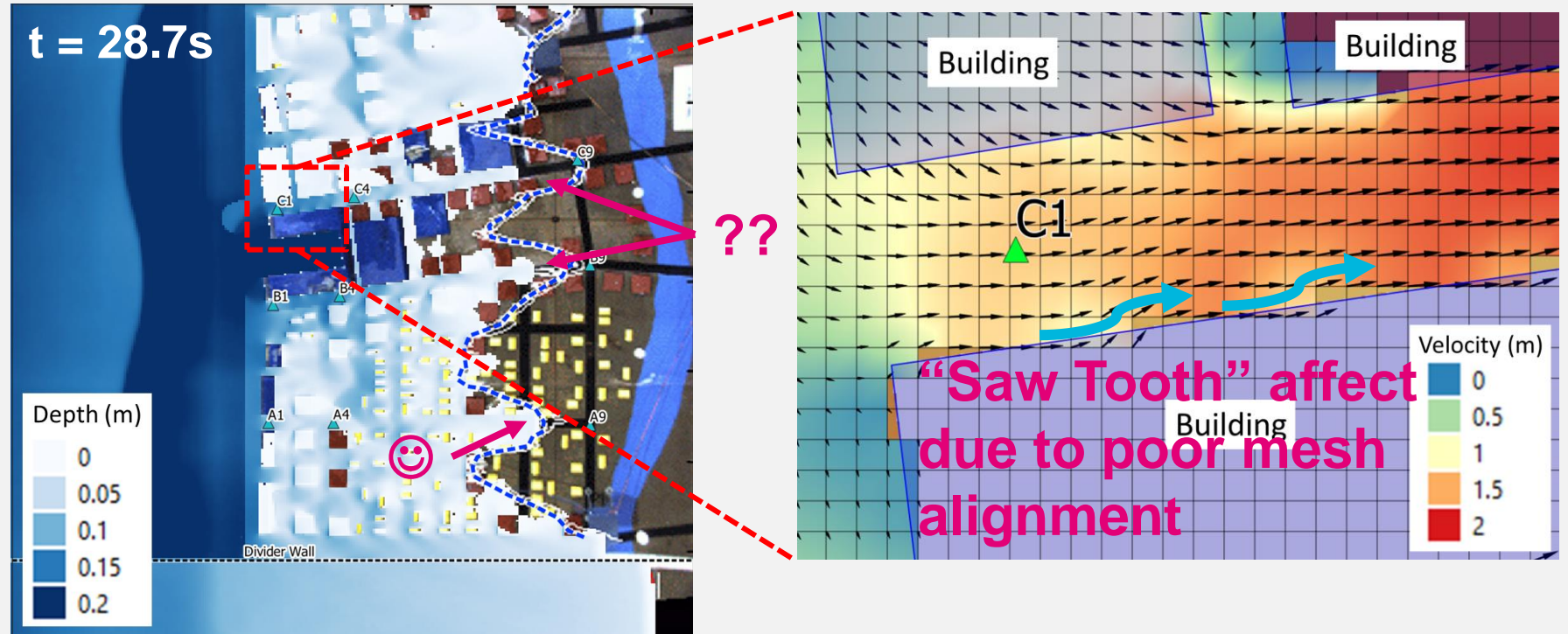
# Model Verification

## Tsunami Flume Experiment



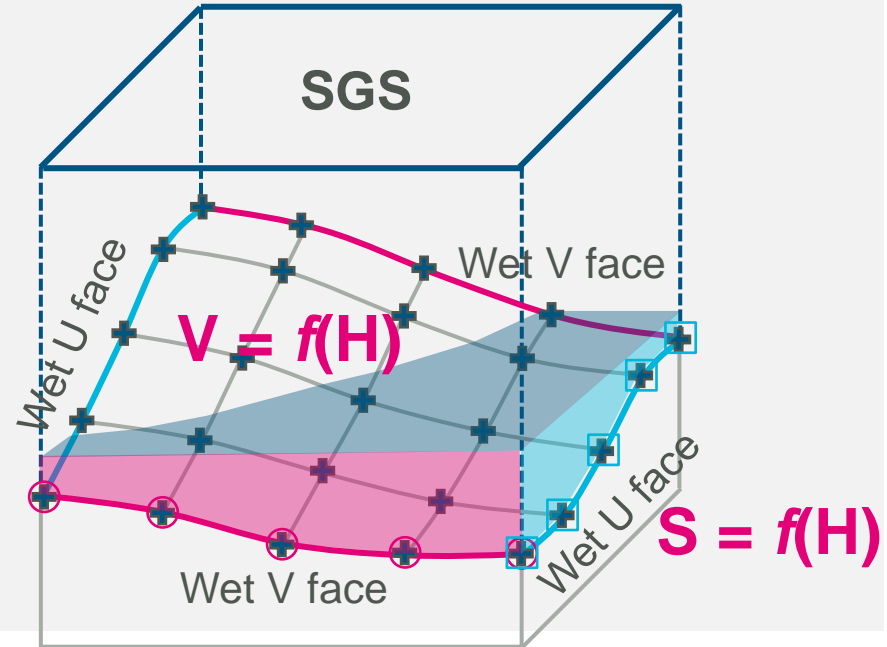
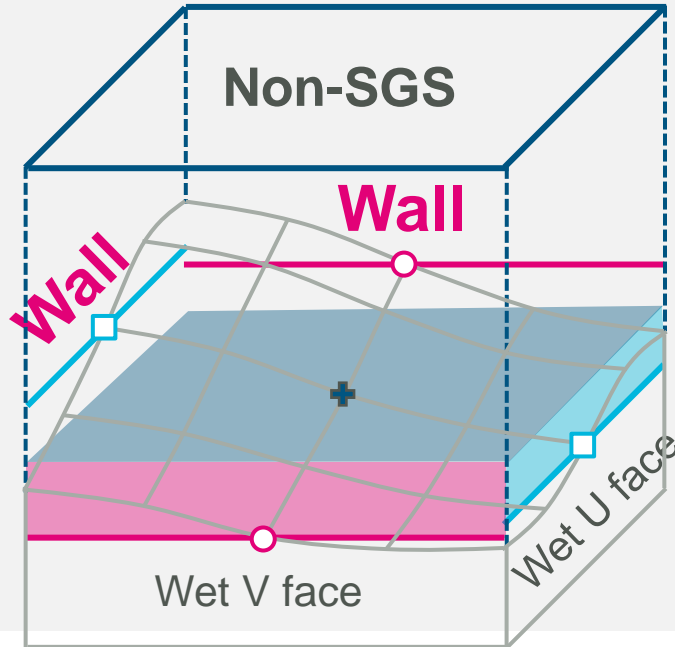
# Model Verification

## Tsunami Flume Experiment



# Quadtree Method + Sub-grid Sampling(SGS)

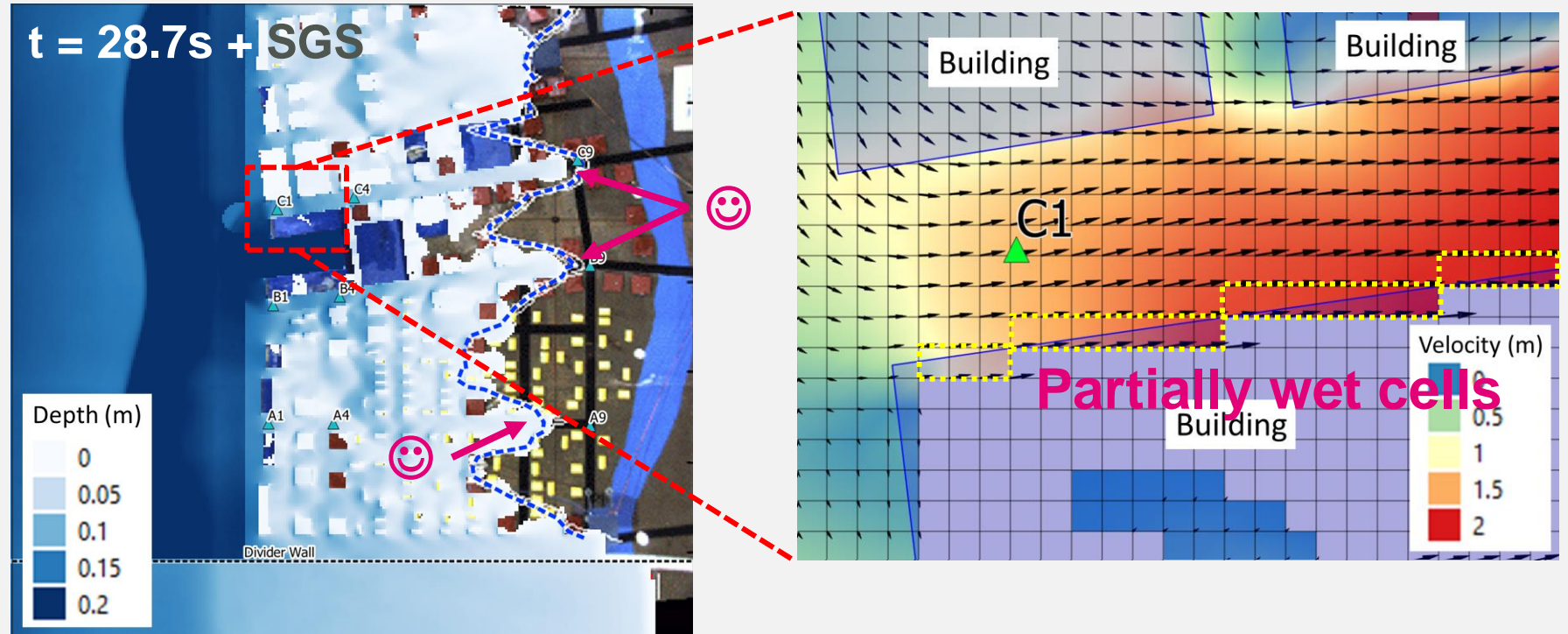
- Shuang GAO, Greg COLLECUTT, Bill SYME (2020) Application of Higher Order Bathymetry Representation in Fixed Grid Shallow Water Solvers, IAHR-ADP, **September 16th 10am~**





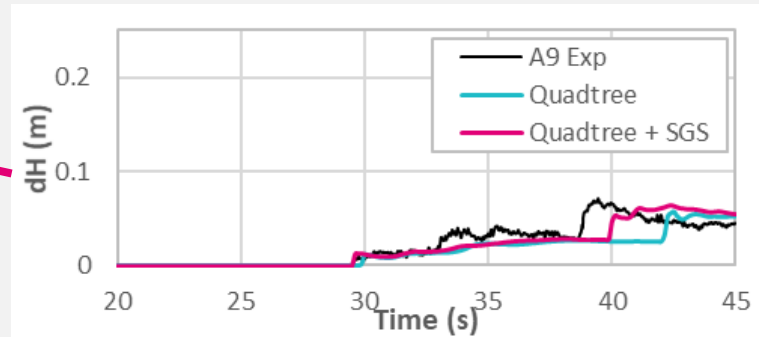
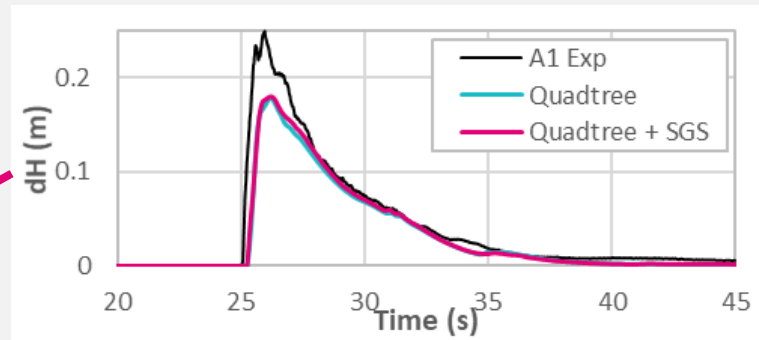
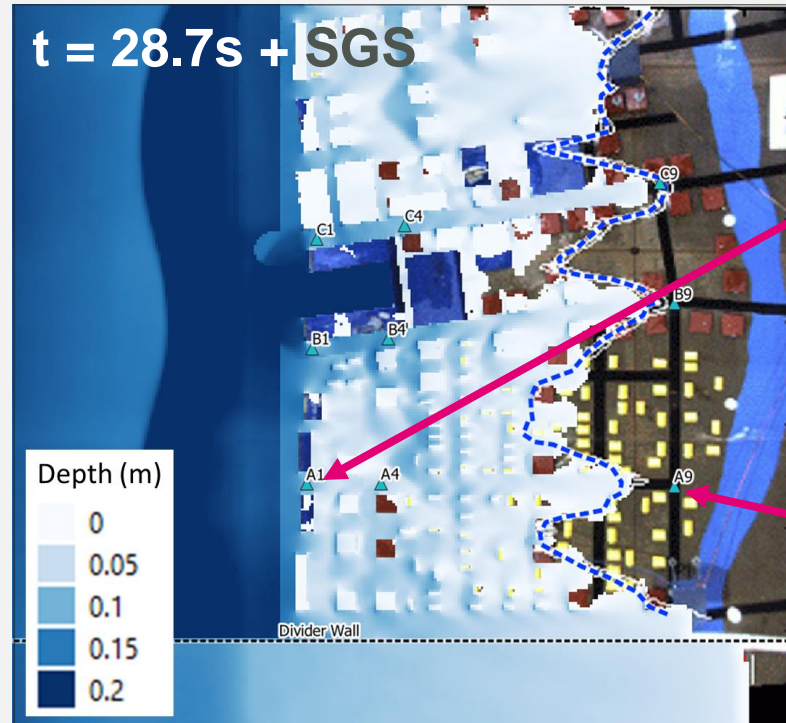
# Model Verification

## Tsunami Flume Experiment (Quadtree + SGS)



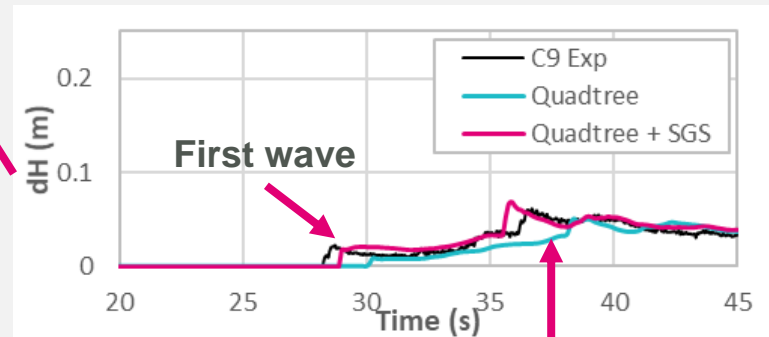
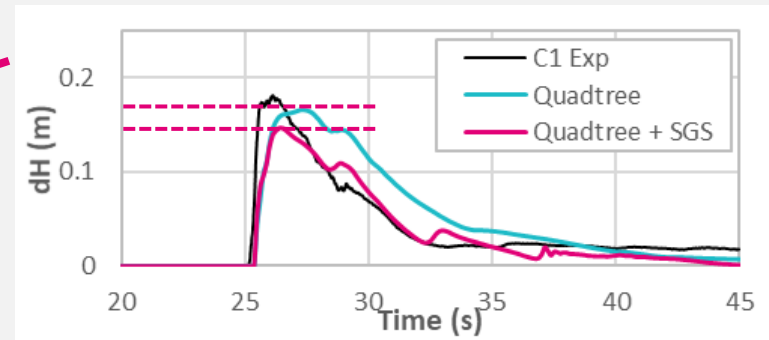
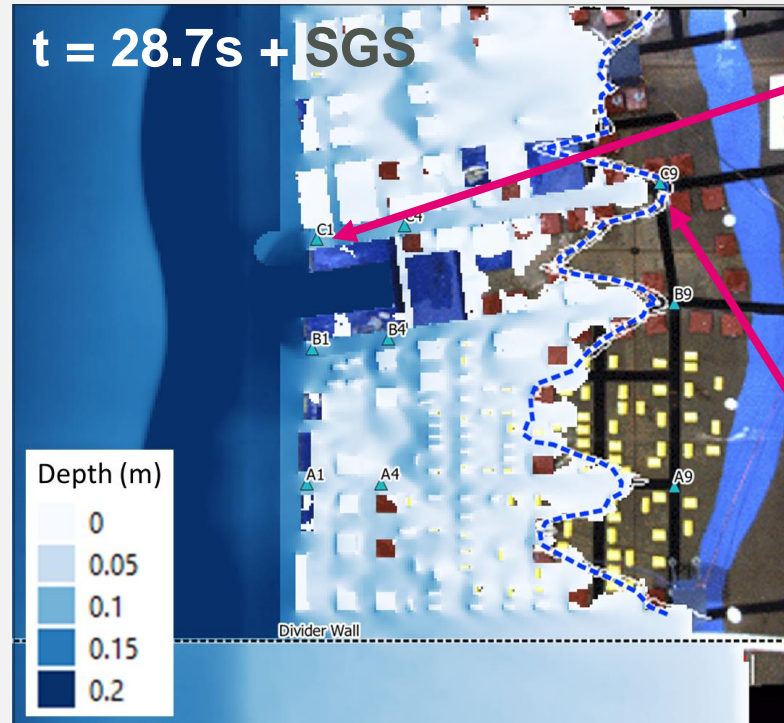
# Model Verification

## Tsunami Flume Experiment (Quadtree + SGS)



# Model Verification

## Tsunami Flume Experiment (Quadtree + SGS)



# Model Verification

## Tsunami Flume Experiment (Quadtree + SGS)

### Simulation time:

- A mid-range laptop with Intel CPU i7-7500U (2.7GHz)
- Nvidia GPU GeForce 940MX (**384** CUDA cores)

|                     | Regular Grid | Quadtree Mesh | Quadtree + SGS |
|---------------------|--------------|---------------|----------------|
| Cell size(cm)       | 5            | 20/10/5       | 20/10/5        |
| Number of Cells     | 284,796      | 72,492        | 72,492         |
| Simulation Time (s) | 358          | 83            | 111            |
| Relative Speed-up   | -            | 4.3           | 3.2            |

- **75%**



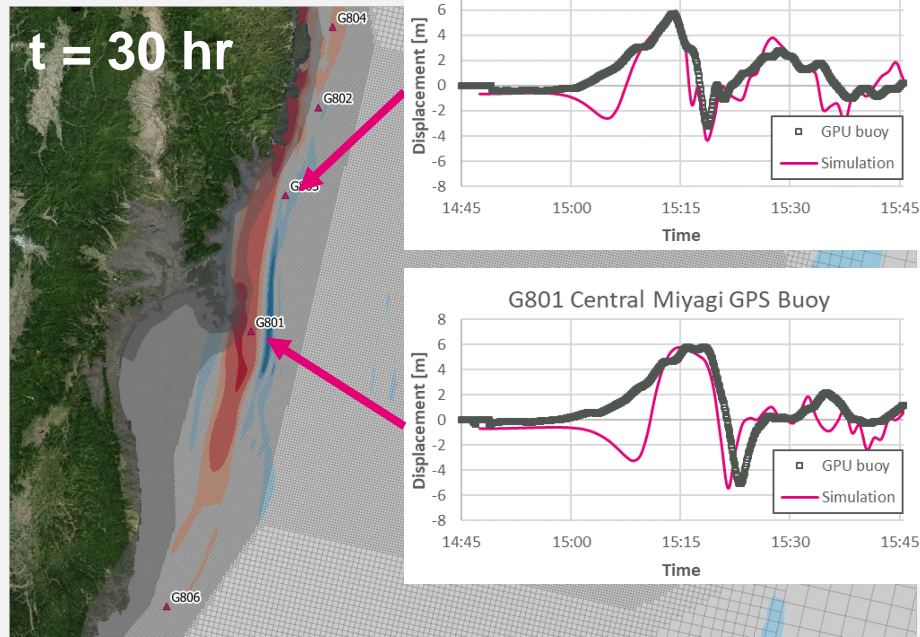
# Conclusions

## Conclusions:

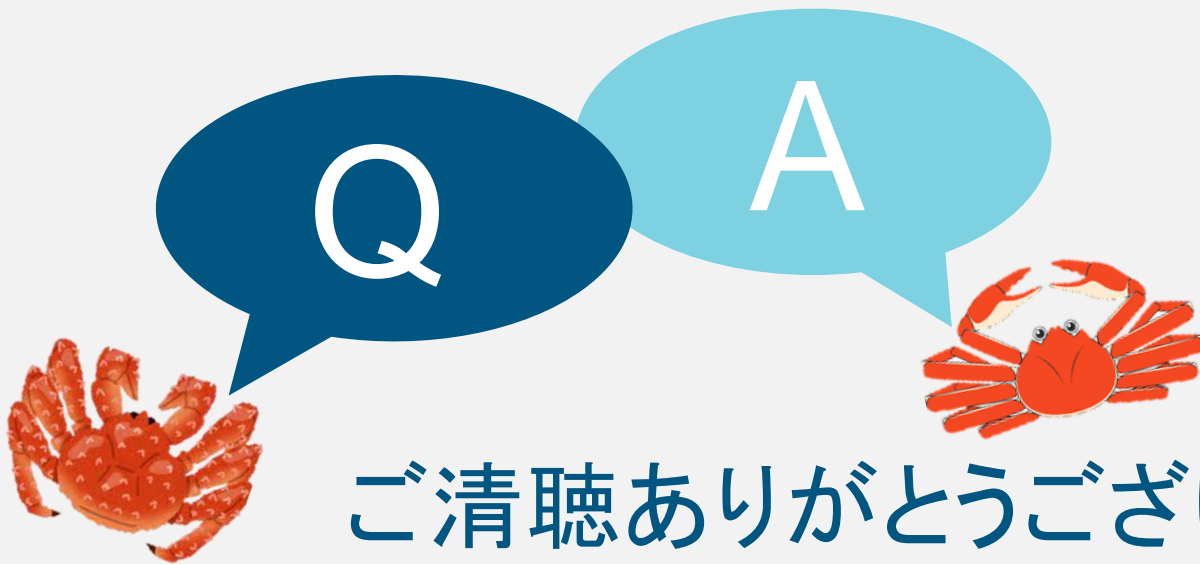
- Promising result for Tsunami **arrival time** and **wave height**
- SGS solves issue with fixed grid mesh alignment with street/building
- Quadtree + SGS = **easy to construct**, **fast** and **high-resolution** numerical tool to support tsunami hazard planning

## Future study:

- Real world model
- Ocean ~ Street scale



# Thank you!



ご清聴ありがとうございました