

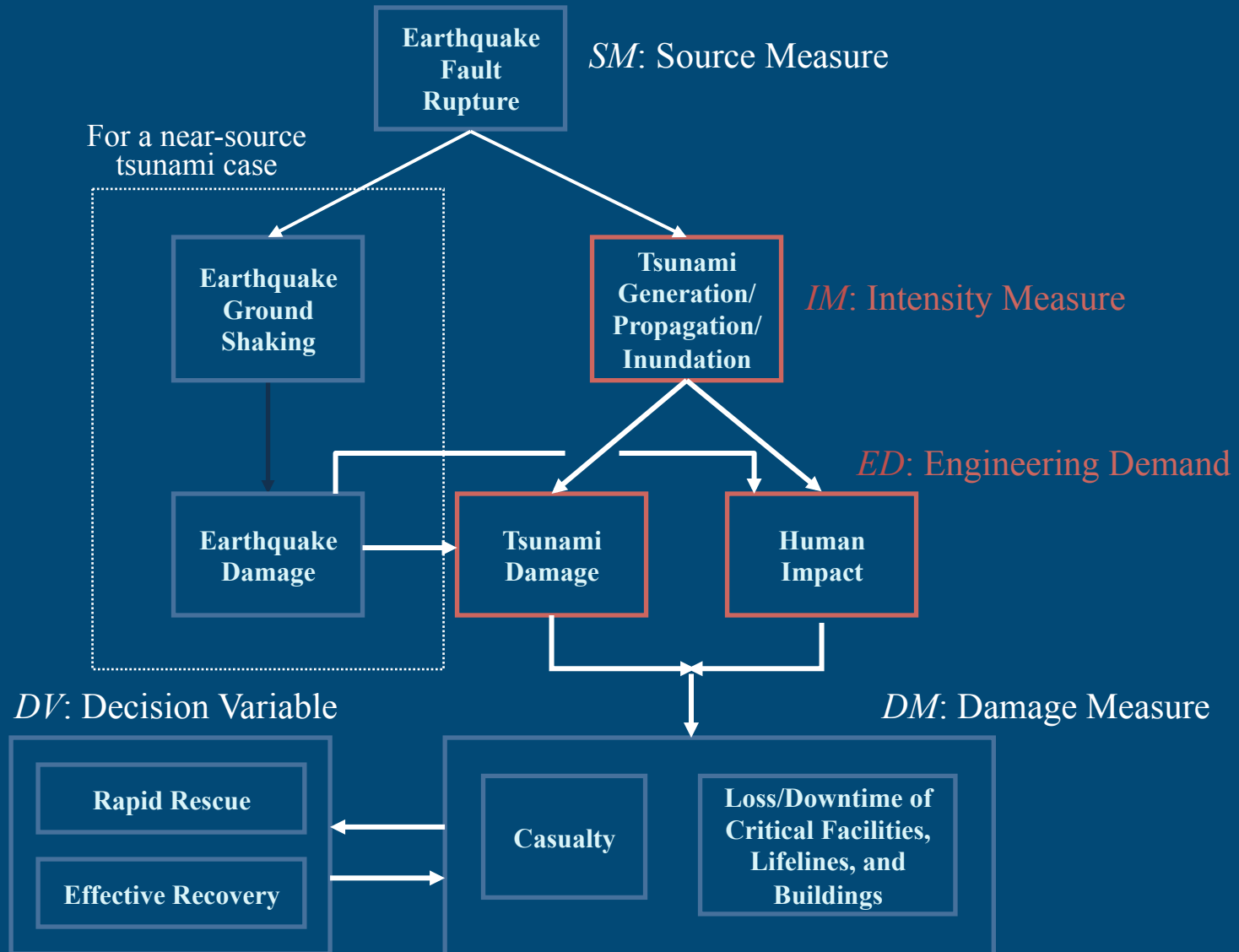
The PBTE Data Explorer

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Performance Based Analysis for Tsunamis



Rationale and Goal

- Use PEER's PBEE methodology for Performance-Based Tsunami Engineering
- Develop a software tool that can extract tsunami simulation data from binary time-series output
- Calculate parameters for structural analysis (such as max specific force, max overturning moment, etc.)
- Allow the user to download entire time series at any point, which they can use to calculate hydrodynamic effects

Initial Prototype

Choose a dataset:

- CC: Water surface elevation
- SC: Flow speed
- UC: X-direction velocity
- VC: Y-direction velocity

Lat: 41.716527769477 ≤ 41.72 ≤ 41.782916656507

Lon: 235.76550923075 ≤ 235.81 ≤ 235.85689811707

Time Series...

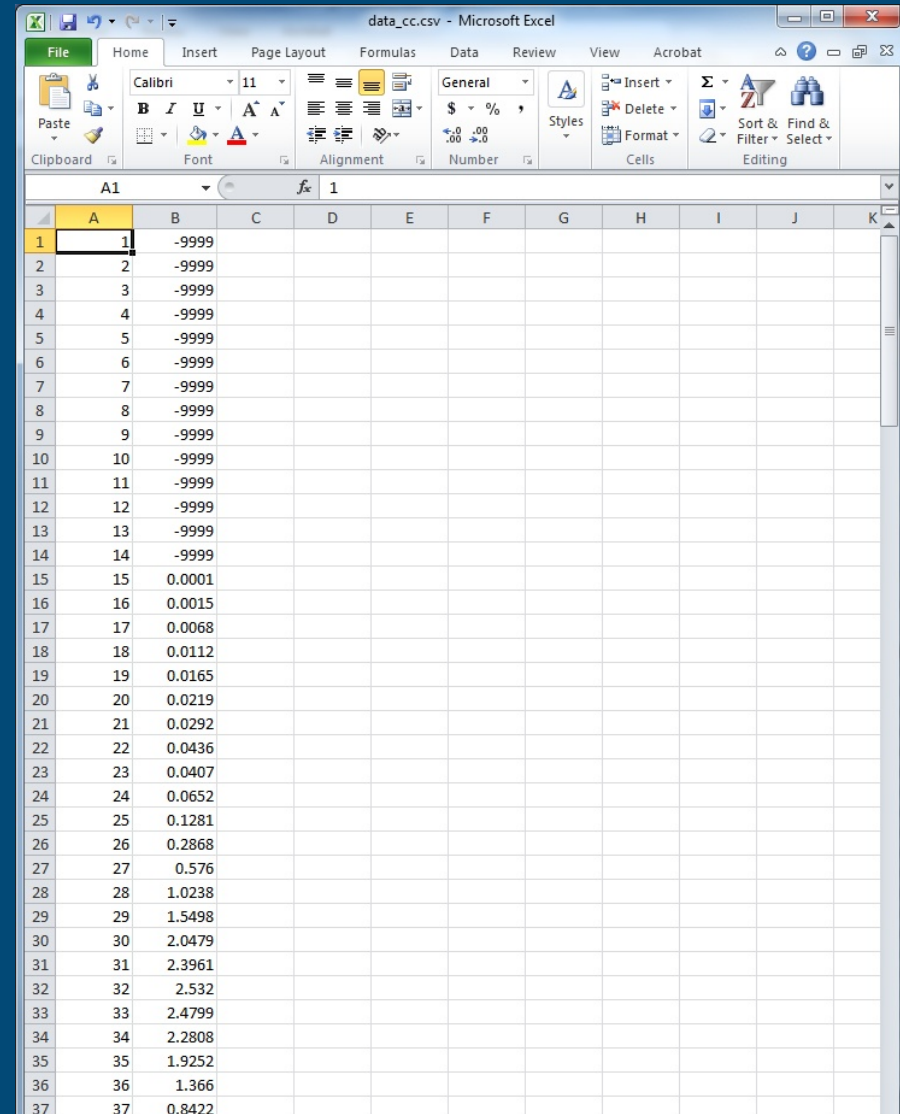
Download...

Lat: 41.72 Y: 679

Elevation: -26 m

Lon: 235.81 X: 481

#	Value
1	-9999
2	-9999
3	-9999
4	-9999
5	-9999
6	-9999
7	-9999
8	-9999
9	-9999
10	-9999
11	-9999
12	-9999
13	-9999
14	-9999
15	0.0001
16	0.0015



System Considerations

Automated data processing and extraction

- Large spatiotemporal datasets
- Processing speed is very important
- Real-time web-based operations

Visualization of spatiotemporal data

- User interactivity
- Helpful to have spatial context
- Dynamic graphing/charting

Design Requirements

- Easy to use web-based interface with fast response
- GIS-based platform with the ability to set a point on a map or enter lat/lon coordinates directly
- Ability to quickly integrate additional tsunami simulation output data for different regions
- On-the-fly interactive charting, determination of max values, and calculation of additional parameters
- Data download in CSV format (opens in Excel)

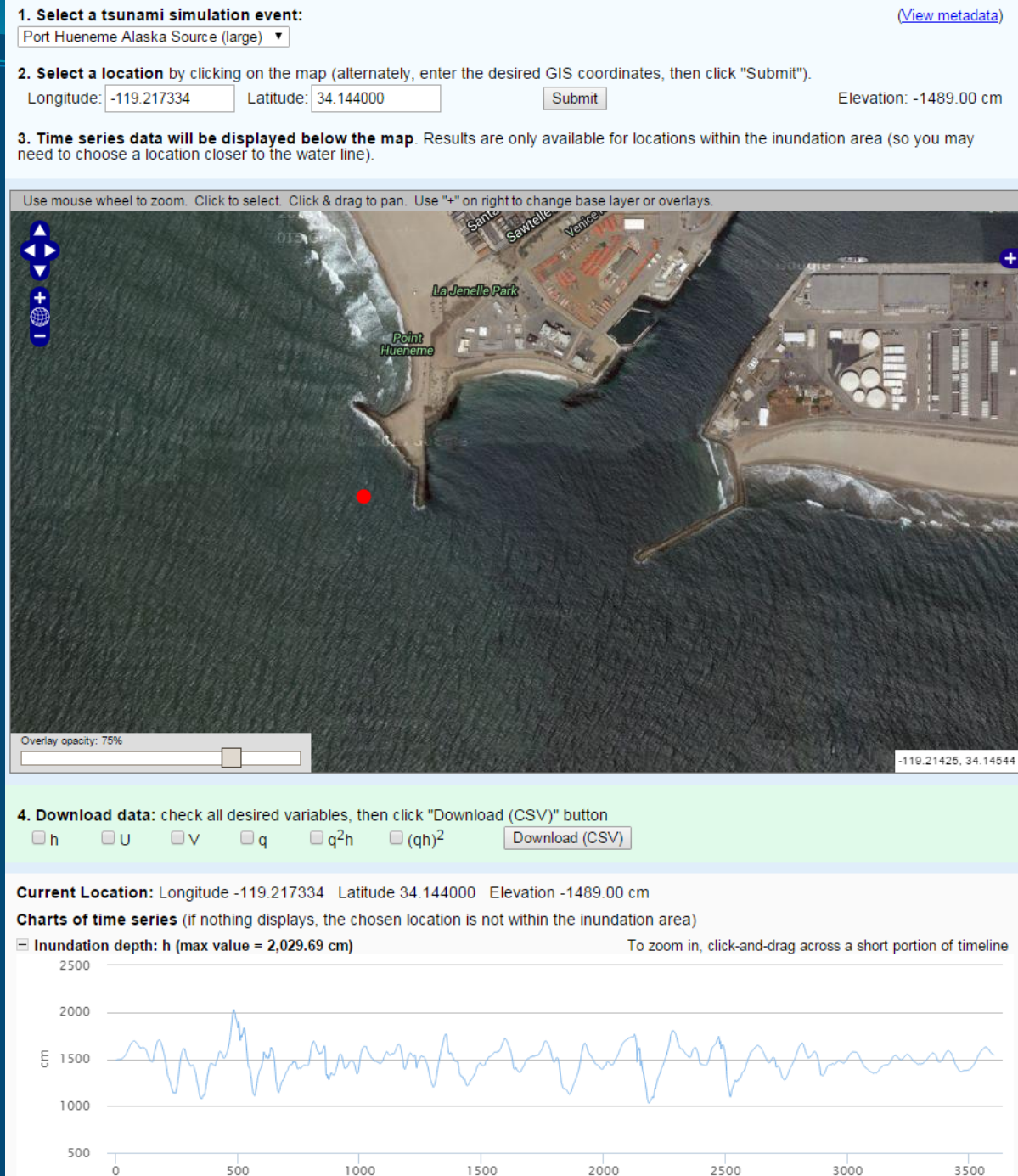
Tsunami Simulation Data

- For Phase I, focused on Port Hueneme, CA area
- Obtained five tsunami simulation output datasets, each from a different source event (thanks Pat!)
- After testing methods of fast data extraction, converted NetCDF output data to BIP, which allows us to quickly extract all time series data at any point
- Wrote a C++ program that can be called to extract time series data and pass it back to the web browser

Technical Details

- Web-based GIS platform -- no special software needed
- Uses open source software for data processing and extraction, web server, and mapping (Python, GDAL, Apache, OpenLayers, etc.)
- JavaScript-based client-side tools offer interactive flexibility for data exploration and visualization

PBTE Data Explorer Interface (Phase I)



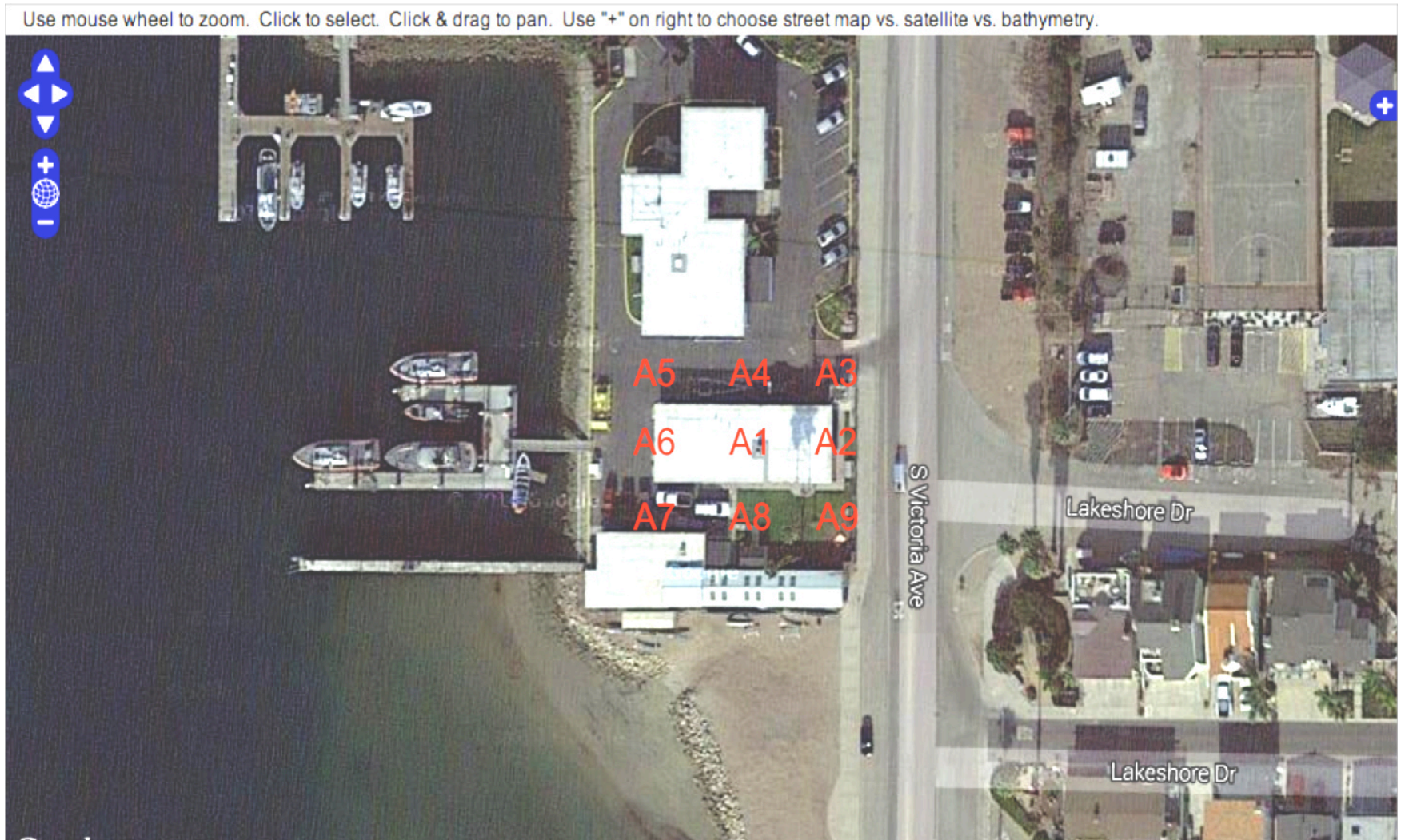
Example: Port Hueneme, CA

Use mouse wheel to zoom. Click to select. Click & drag to pan. Use "+" on right to choose street map vs. satellite vs. bathymetry.



Building

For uncertainty analysis, we take data from nine locations surrounding the building for the case of a beefed-up tsunami originated from Alaska.



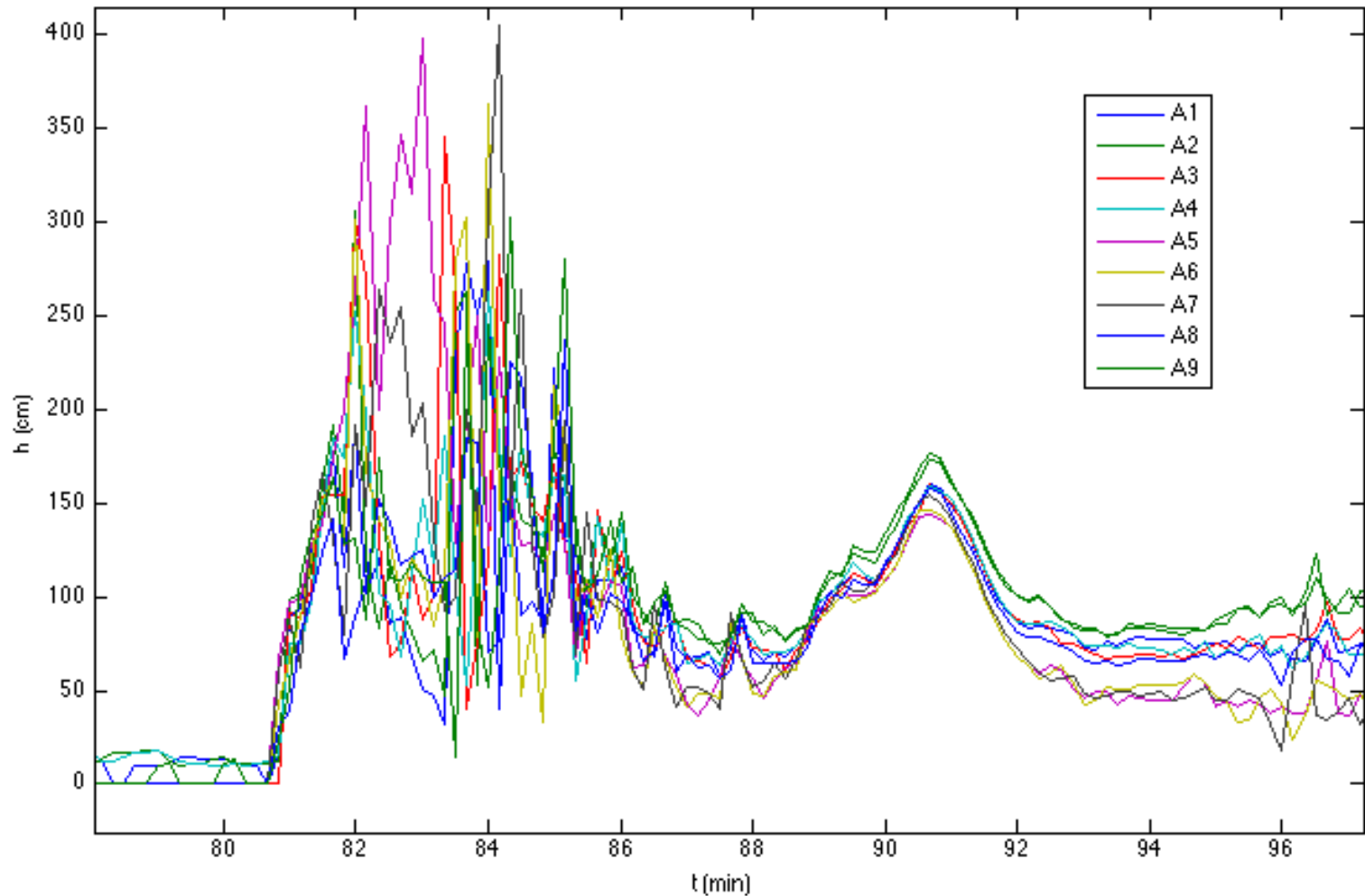
Maximum Values and their Variations

Tsunami flow data at the location of the building

Loc.	Lat.	Lon.	Elev. (cm)	Dist. From A1 (m)	h_{\max} (cm)	q_{\max} (cm/s)	$q^2 h_{\max}$ (m ³ /s ²)	$(qh)^2_{\max}$ (m ⁴ /s ²)
A1	34.161502	-119.222051	171.00	0	278.49	942.03	125.24	284.86
A2	34.161502	-119.221897	160.00	14.2	305.83	888.79	105.53	265.74
A3	43.16160	-119.221897	172.00	17.9	345.55	776.55	91.52	275.94
A4	34.16160	-119.222051	170.00	10.9	262.15	896.56	81.87	201.93
A5	34.16160	-119.222203	181.00	17.7	398.14	744.19	113.86	394.87
A6	34.161502	-119.222203	181.00	14.0	362.76	905.34	108.91	270.11
A7	34.16140	-119.222203	178.00	18.0	404.71	917.14	161.74	410.23
A8	34.16140	-119.222051	175.00	11.4	236.50	946.23	126.83	193.22
A9	34.16140	-119.221897	158.00	18.2	302.40	950.88	123.82	215.41
Average					321.84	885.30	115.48	279.16
StDev					59.46	74.60	23.13	77.69
Variance					3535.5	5565.6	535.22	6035.8

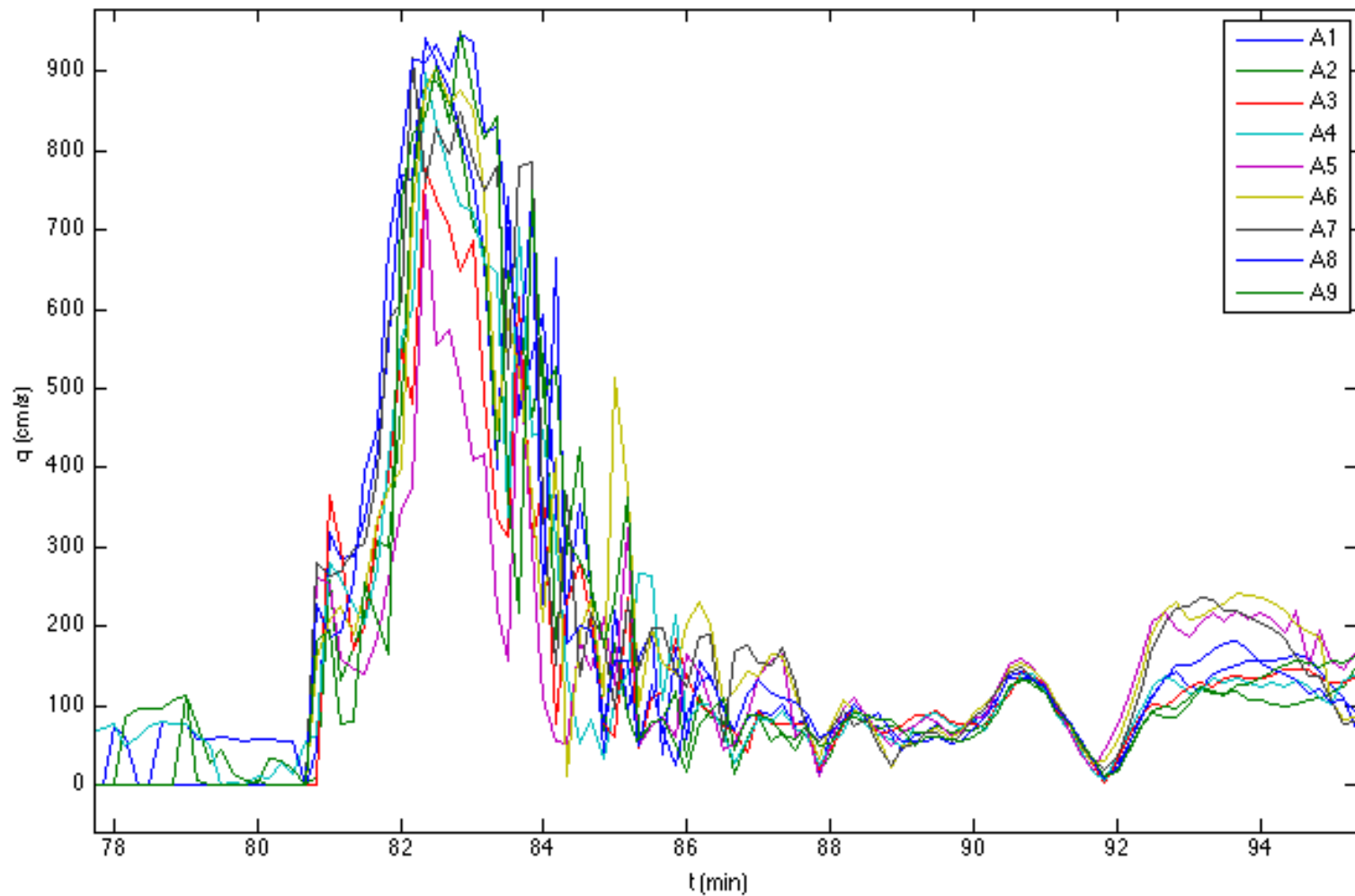
Inundation Depth Time Histories

Inundation depths at the first peak at the nine adjacent locations



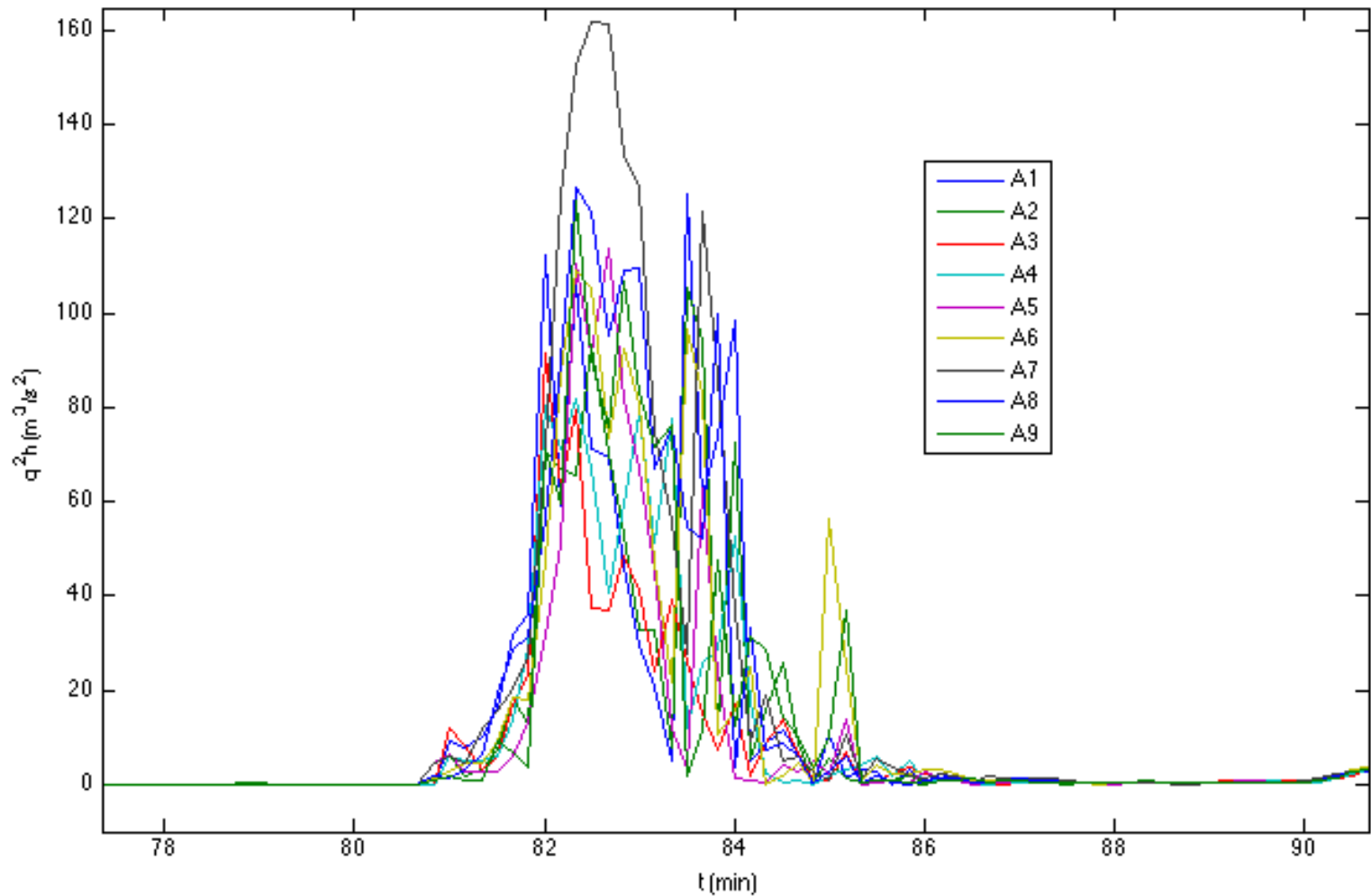
Flow Speed Time Histories

Flow speeds at the first peak at the nine adjacent locations



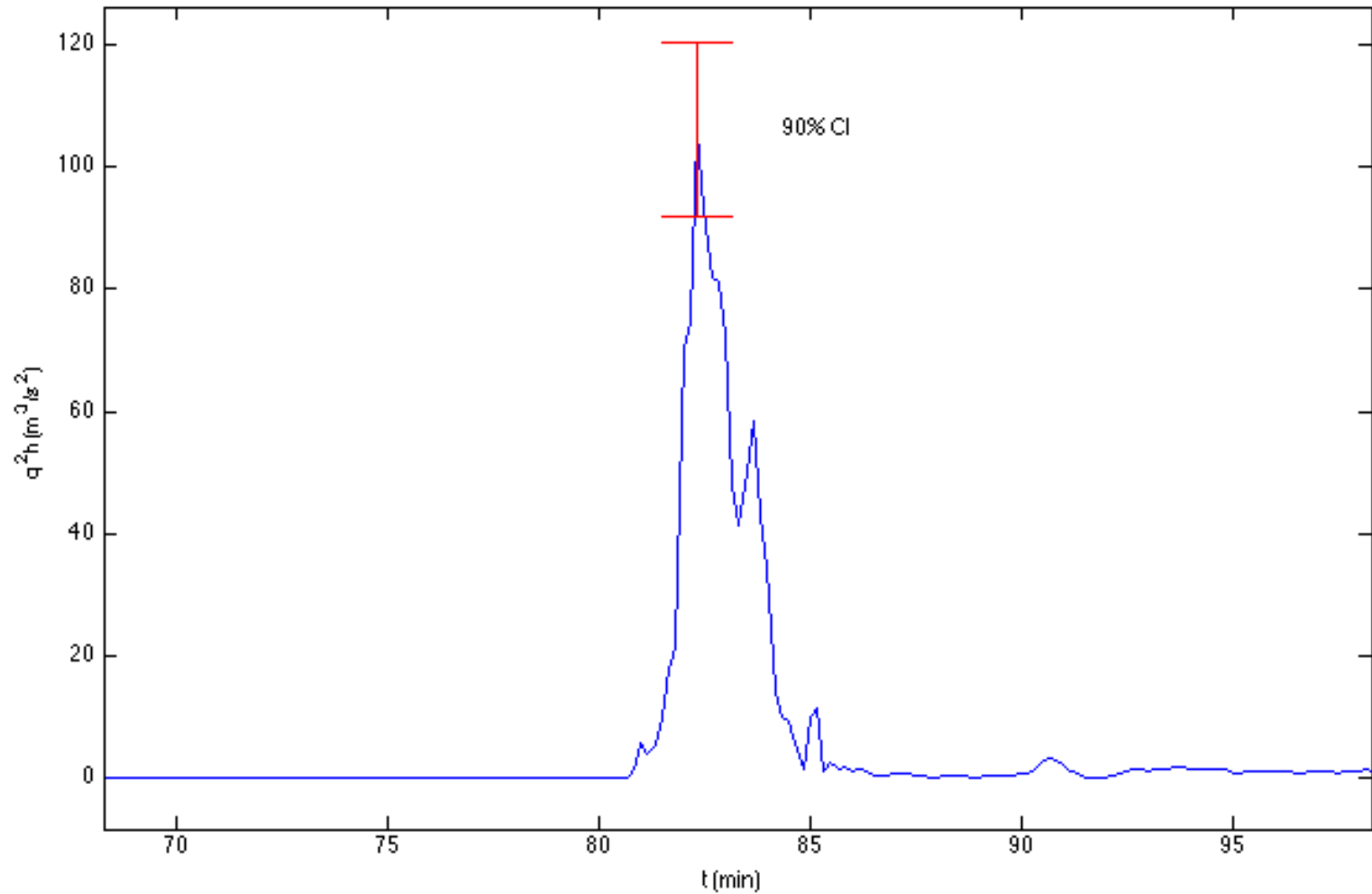
Specific Force ($u^2 h$) Time Histories

Specific force at the nine adjacent locations



Uncertainty

Averaged specific force with 90% confidence interval



Summary & Remarks

- PBTE Data Explorer (a GIS-based portal) allows us to **quickly** and **conveniently** download tsunami intensity measures.
- Retrieved data can be used to estimate hydrodynamic forces, impulse forces, debris impact forces, moments, as well as tsunami induced soil instabilities and buoyancy forces.
- This data retrieval functionality allows us to examine the spatiotemporal data in the neighborhood of a specified location for the purpose of uncertainty analysis.

Summary & Remarks

- The “very fast” data mining and retrieval functionality and its usability make this tool extremely valuable for probabilistic tsunami analysis and the uncertainty quantification.
- The Data Explorer will be extended toward the PBTE methodology, and thanks to PEER. Phase 2 of the development is underway soon.

<http://isec.nacse.org/pbte>

username/password (pbte/peer)