UCIS4EQ applied to the M7.1 2017 earthquake in Puebla (México).

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-- MOTIVATION --

Urgent Computing for Natural Hazards links:

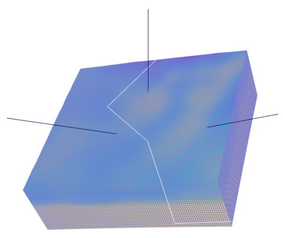
- High-Performance Computing State-of-art physics-based simulation codes
- Readily available data
-
- High-Performance Data Analytics

To provide insights into the impact and potential damages immediately after the occurrence of an extreme event

Resilience Workflow: to provide fast outcomes using a fully automatic workflow

analysis

Source location
Magnitude estimation
Grid generation
Ask for resources

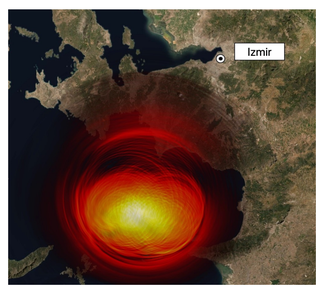


pre-processing

SALVUS
IMAGE EVERYTHING

HPC simulations

Launch in supercomputer
Filter data
Build maps
Uncertainty quantification
Reach conclusions



post-processing

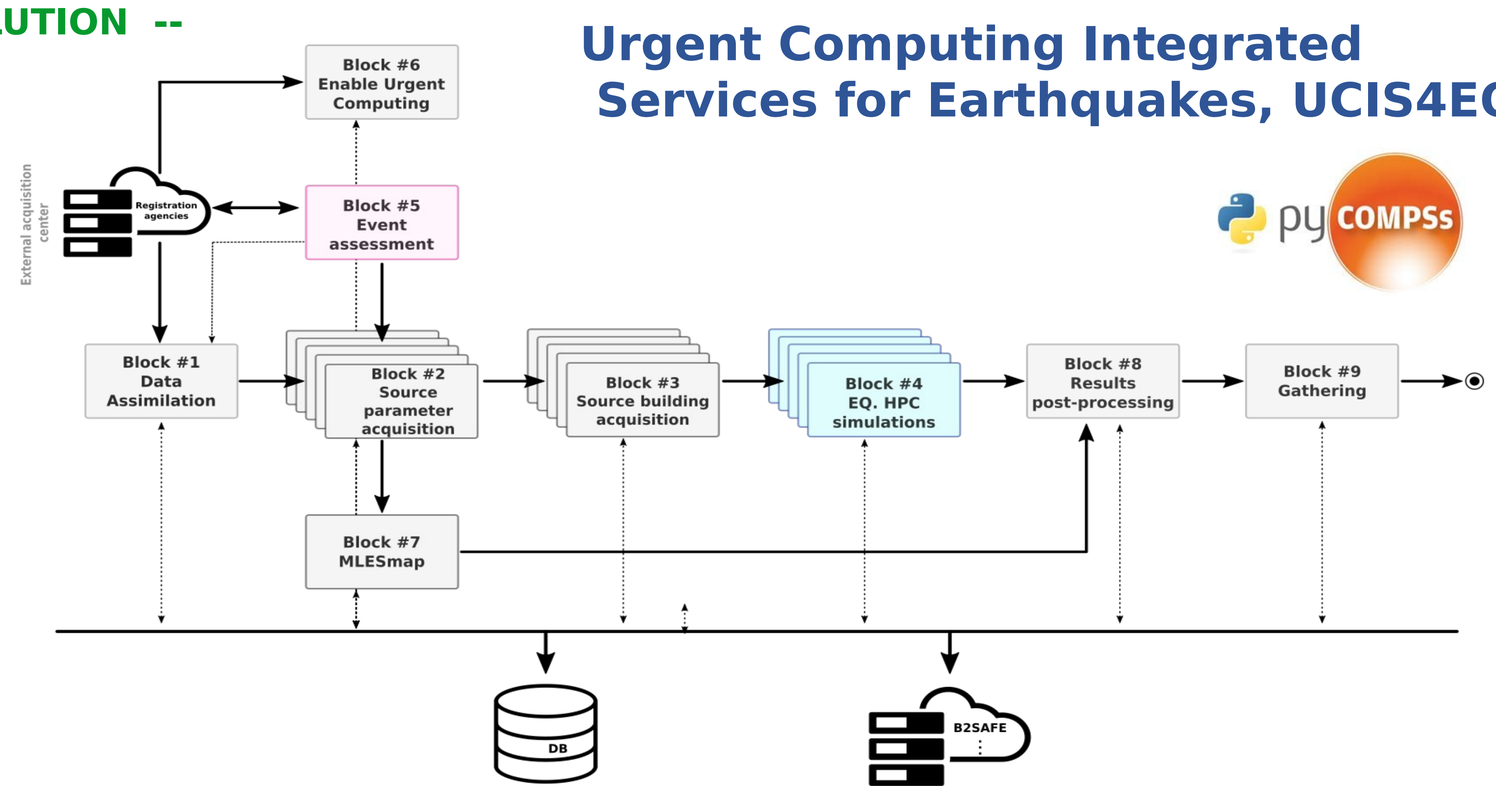
minutes / hours

3D-physics based seismic simulations:

- Full time-histories
- Uniform sampling in space
- Sensitive in different ways to uncertainties than current approaches
- The high resolution of this approach can complement the information of the GMM.

-- SOLUTION --

Urgent Computing Integrated Services for Earthquakes, UCIS4EQ



- Based on containerised micorservices,
- Fully orchestrated by the PyCOMPSs workflow manager
- Automatically prepare and manage physics-based deterministic simulation suites for rapid synthetic results.
- UCIS4EQ delivers estimates of relevant ground motion parameters, such as peak ground velocity, peak ground acceleration, or shaking duration, with very high spatial resolution

-- USE CASE --

Earthquake*:

Magnitude: Mw 7.1,
Date: 19/9/2017
Hypocenter:
latitude: 18.55
longitude: -98.489
depth: 48 km

Social impact*:

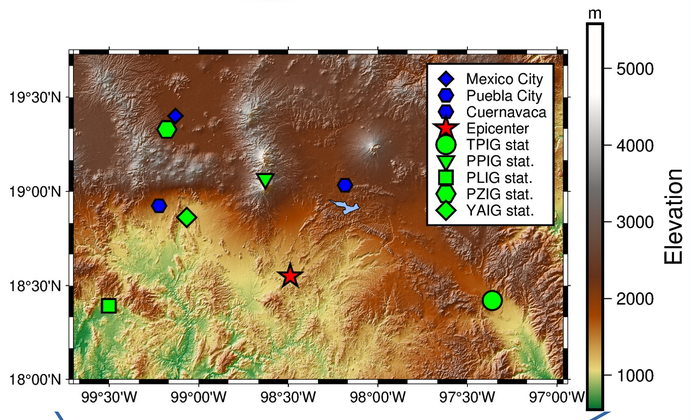
~ 320 people killed

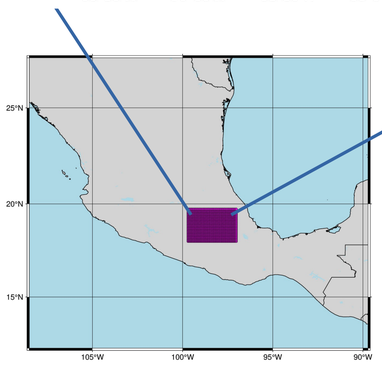
~ At least 6,000 people injured.

~ 44 buildings collapsed

Source parameters*:

Strike: 300
Rake: -83
Dip: 44





Simulation domain:

depth_in_m: 100 km
max_latitude: 19.7
max_longitude: -97.0
min_latitude: 18.0
min_longitude: -99.7

References

*https://earthquake.usgs.gov/earthquakes/eventpage/us2000ar20/

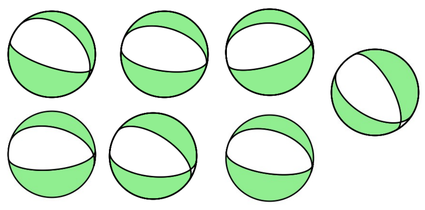
[1] Monterrubio-Velasco, M., Carrasco-Jimenez, J. C., Rojas, O., Rodríguez, J. E., Fichtner, A., & Puente, J. D. L. (2022). Frontiers in Earth Science, 339.

[2] Graves, R., & Pitarka, A. (2014). Seismological Research Letters, 86(LLNL-JRNL-741227).

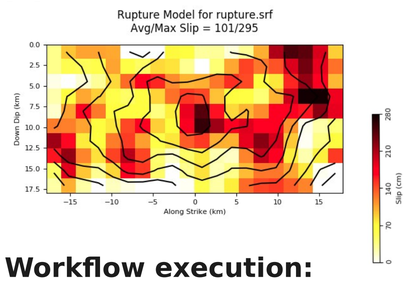
-- RESULTS --

Workflow configuration:

Ensemble sources [1]: 14



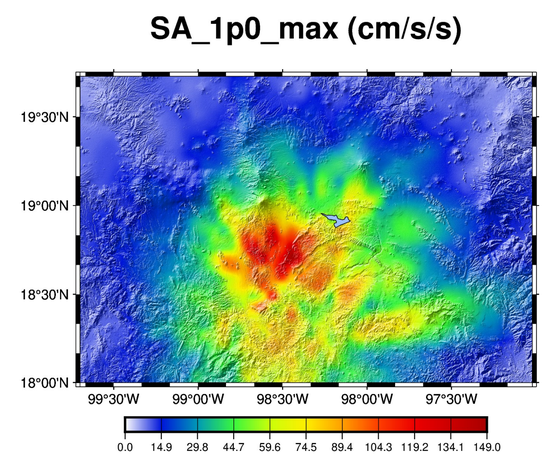
Finite-fault solution: based on Graves-Pitarka rupture generator [2]:

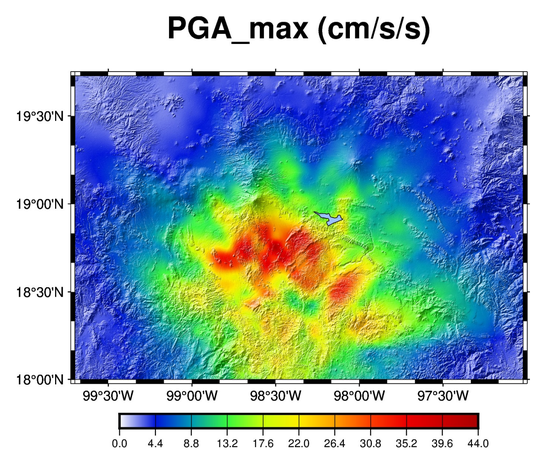


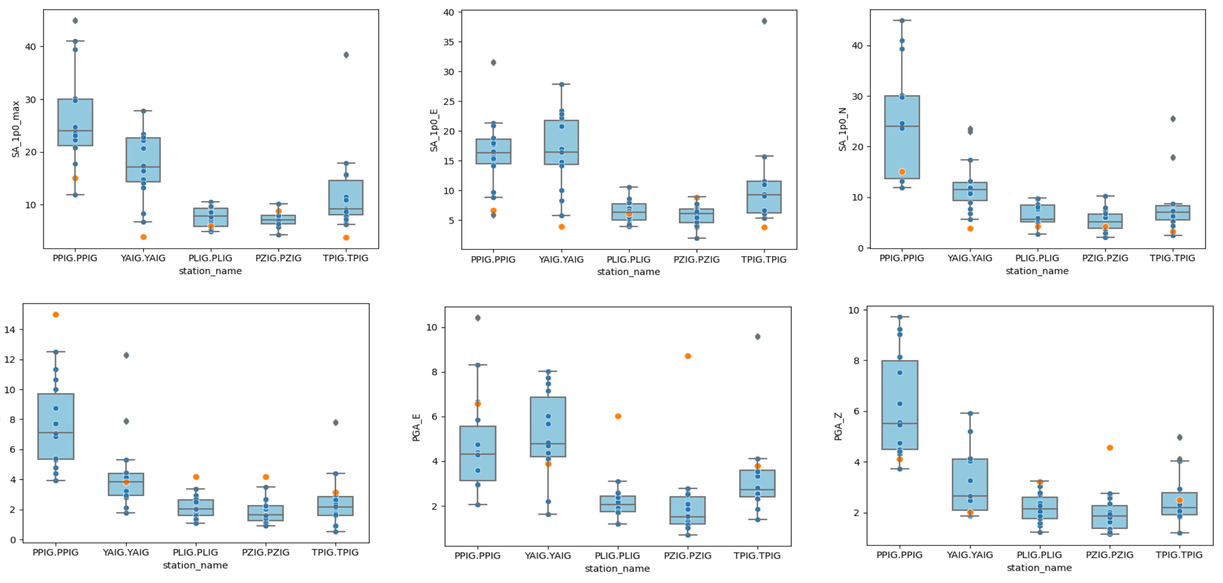
Workflow execution:

Resources: 480 CPUs
Maximum frequency: 1 Hz
N. mesh elements: 407346
N. time steps: 70668
Velocity Model: Global 3-D Earth Model Spiral 1.4

Wall time: 1:45







We thank personnel of Servicio Sismológico Nacional (SSN, Mexican National Seismological Service) for station maintenance, data acquisition and distribution.

-- TO TAKE HOME --

- **Successful execution** of UCIS4EQ for the Mw7.1 Earthquake in Puebla 09/19/2017.
- UCIS4EQ enables **uncertainty quantification strategies** to study the effects of input parameters from physics-based simulations and real values. This use case will study the geological model of the Earth, the source parameters, and the finite fault solutions in the results.
- To increase the maximum simulated frequency and reduce the solution time, **GPU's** will be used.
- Amplification effects must be considered
- To offer an operational service on level 0 HPC machines, it is necessary to **enable urgent access computing mode,** helping to reduce waiting times in queues and allowing faster and more useful results for end users.

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