National Aeronautics and Space Administration

Simulating Atmospheric Impacts: From Pebble- to Mountain-Size Meteoroids

Marian Nemec
NASA Ames Research Center

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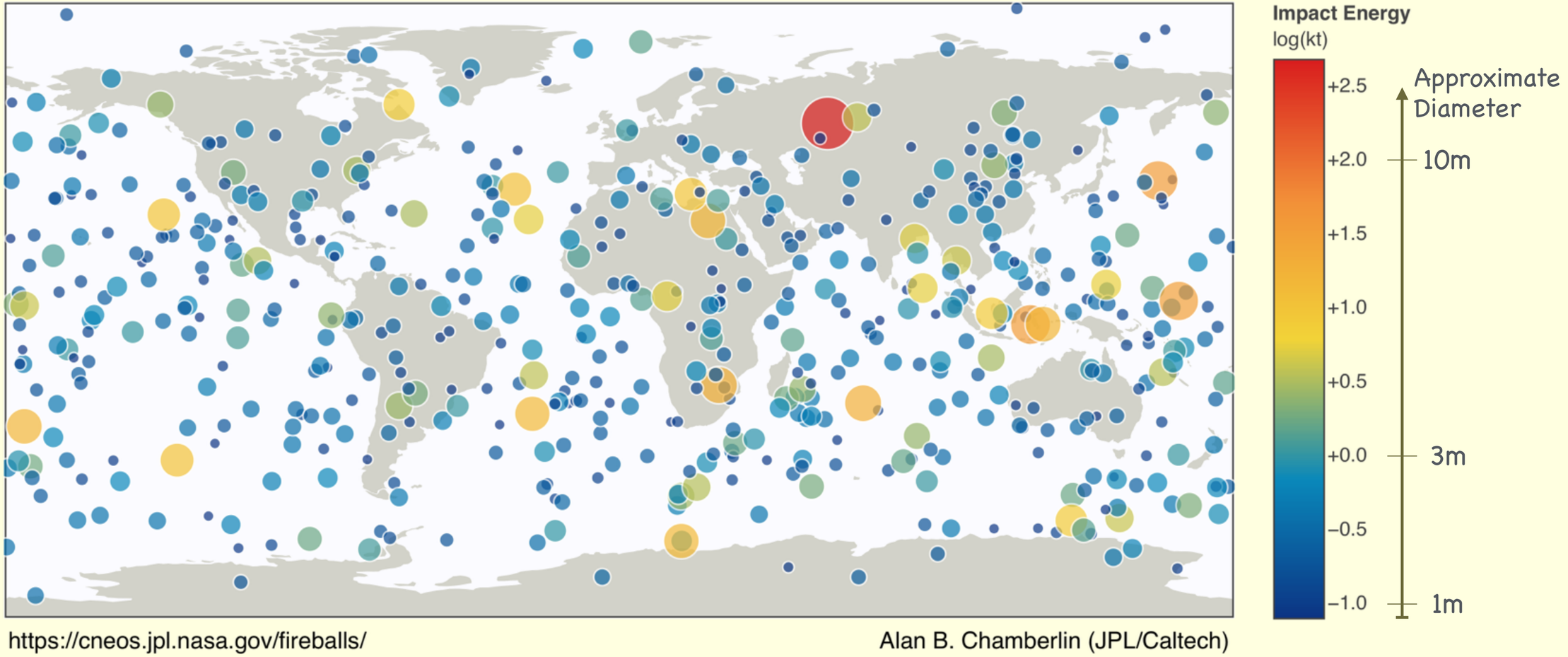
www.nasa.gov

Fireballs Reported by US Government Sensors

(1988-Apr-15 to 2017-Oct-26)



https://cneos.jpl.nasa.gov/fireballs/

Alan B. Chamberlin (JPL/Caltech)

Meteoroid flux: ~50 tonnes each day (primarily sand-grain to centimeter-size bodies)

ATAP Overview

Asteroid Threat Assessment

Ames Research Center

Asteroid Properties

Entry Physics

Surface Hazards

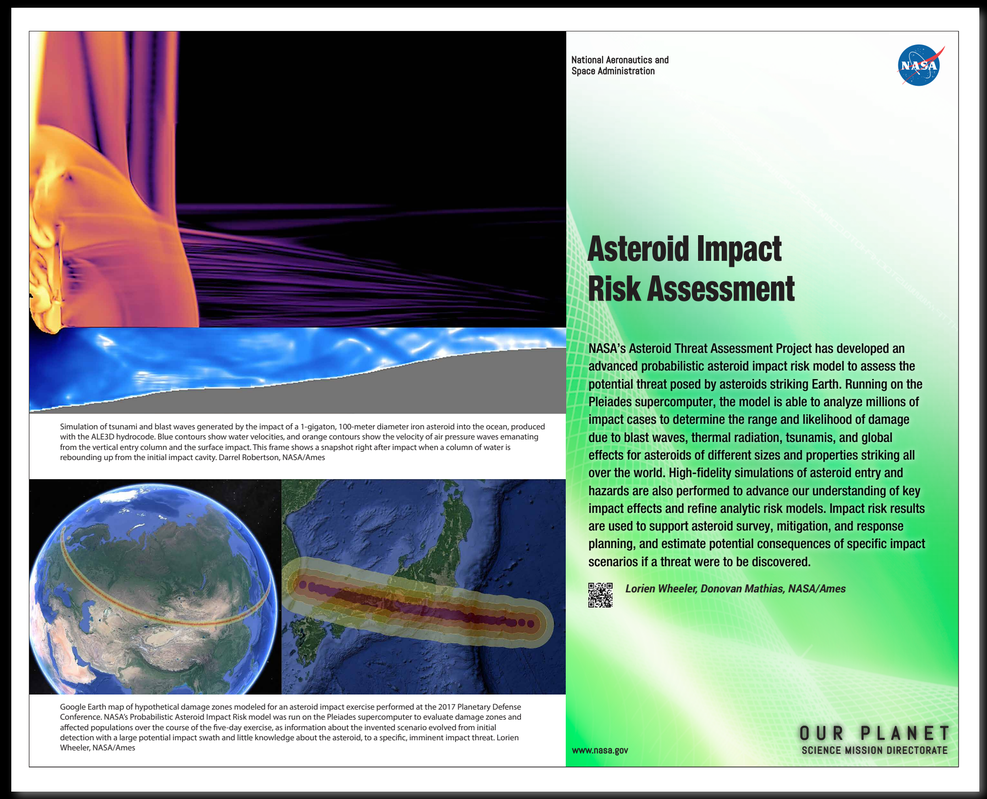
Damage & Risk

Characterization
- Measurements
- Inference
- Data aggregation
- Property database website

Entry Simulations & Testing
- Coupled aerothermodynamics
- Ablation & radiation modeling
- Arc jet testing

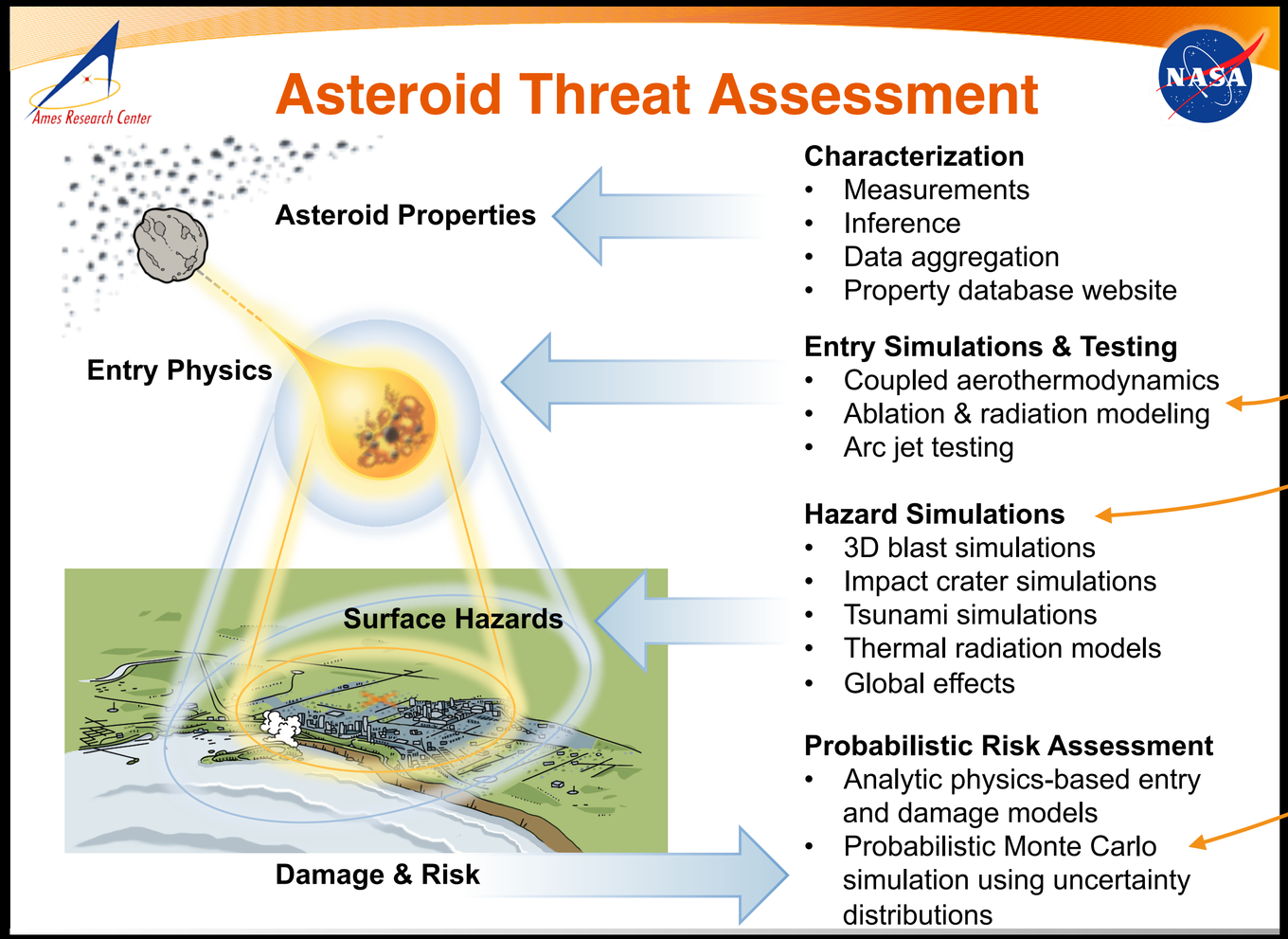
Hazard Simulations
- 3D blast simulations
- Impact crater simulations
- Tsunami simulations
- Thermal radiation models
- Global effects

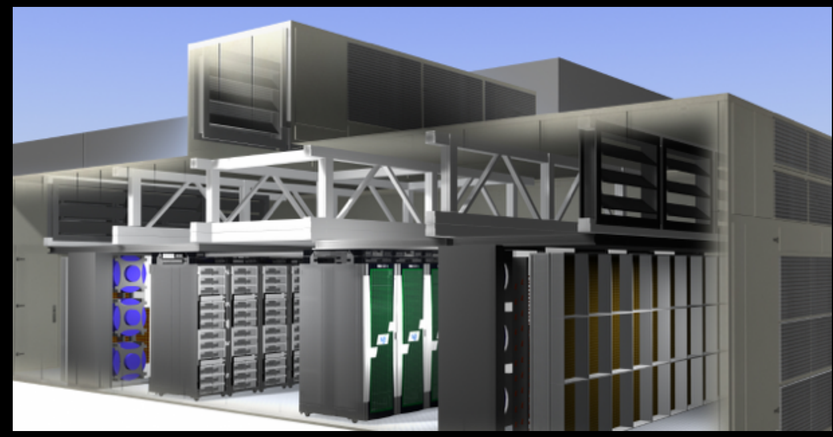
Probabilistic Risk Assessment
- Analytic physics-based entry and damage models
- Probabilistic Monte Carlo simulation using uncertainty distributions



"Asteroid Threat Assessment Project" presentation to Small Bolide Assessment Group

ATAP Supercomputing





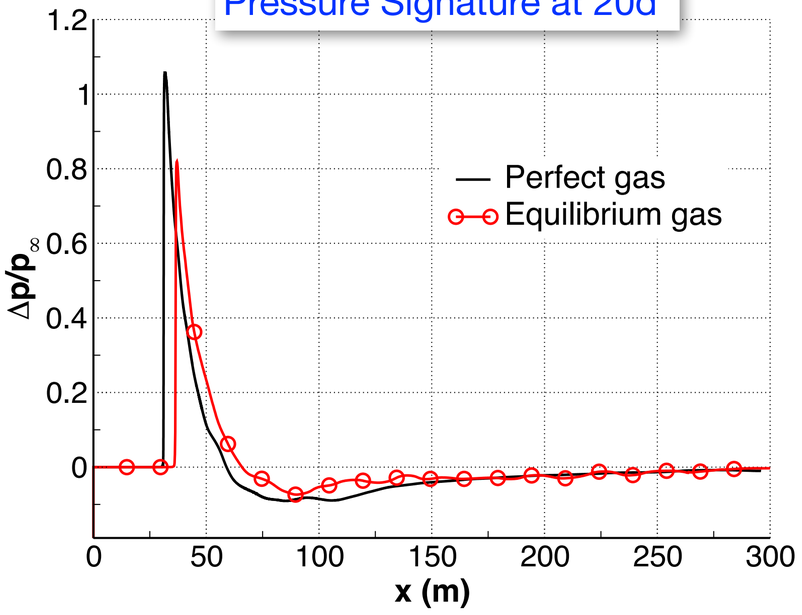
"Asteroid Threat Assessment Project" presentation to Small Bolide Assessment Group

Propagation and Overpressure Prediction

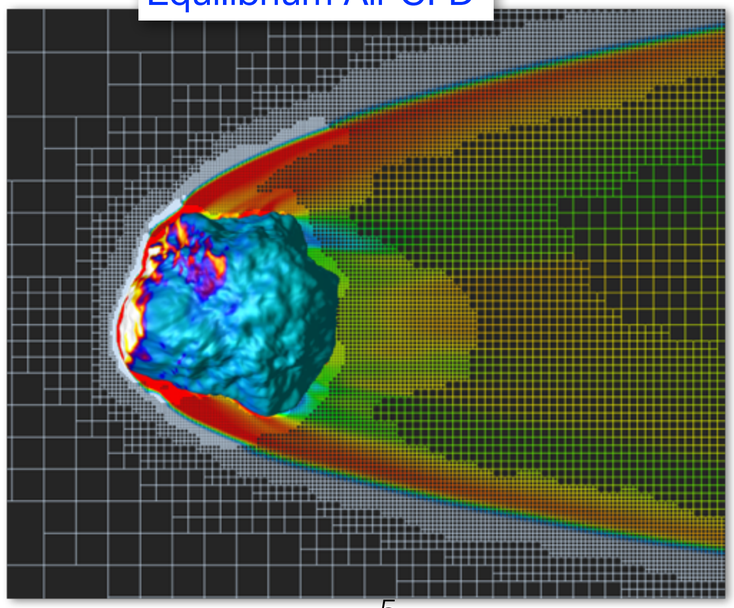
ATAP - Prediction of meteor-generated sonic boom

- Obtained observations for a small meteor from 2008 and backed out conditions
- Performed CFD simulations for both sphere and rock-like shapes w/ Cart3D using equilibrium air
- Propagate near-field pressure 74 km to observatory using sonic-boom propagation code
- Currently obtaining recorded ground signature from observatory for comparison

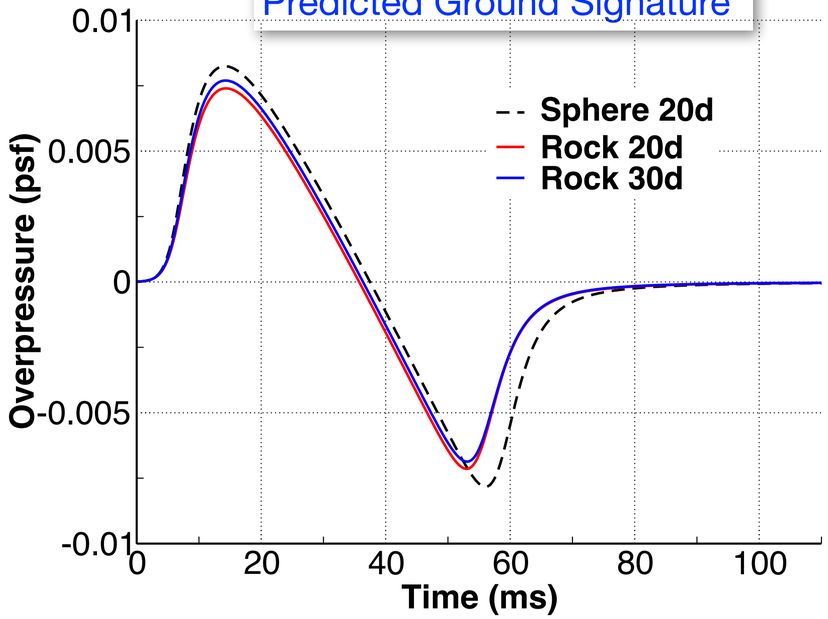
Pressure Signature at 20d



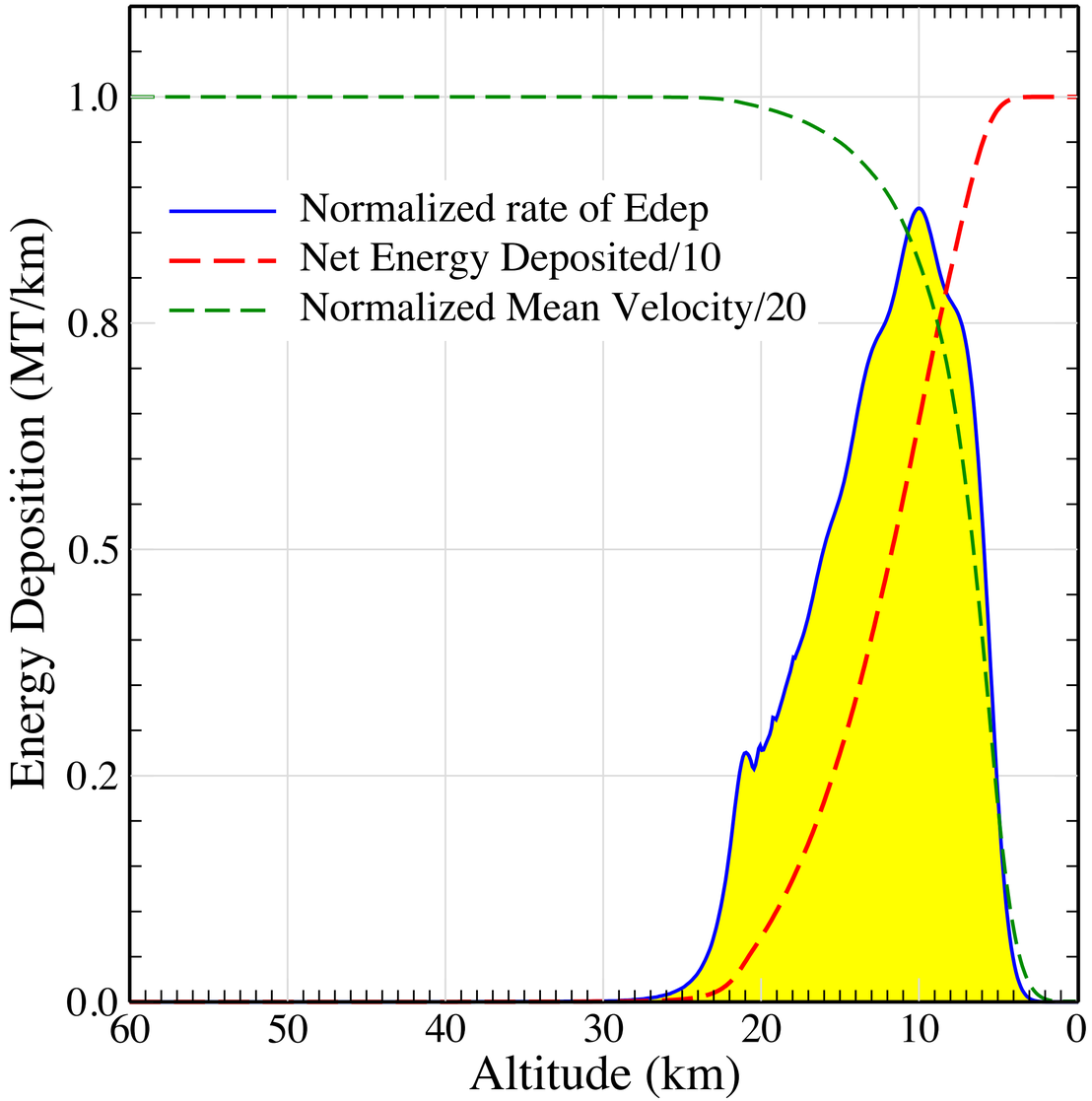
Equilibrium Air CFD

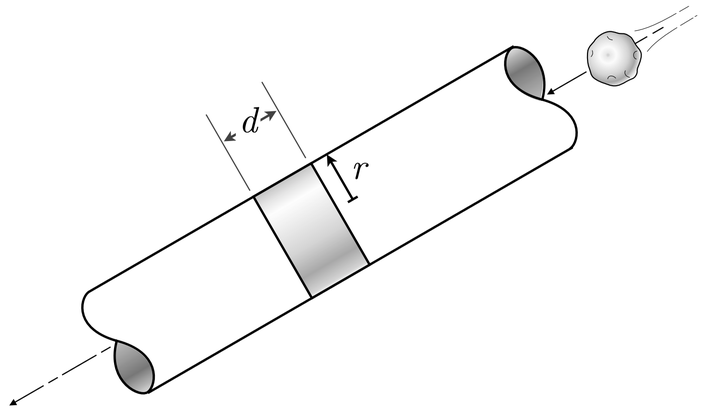


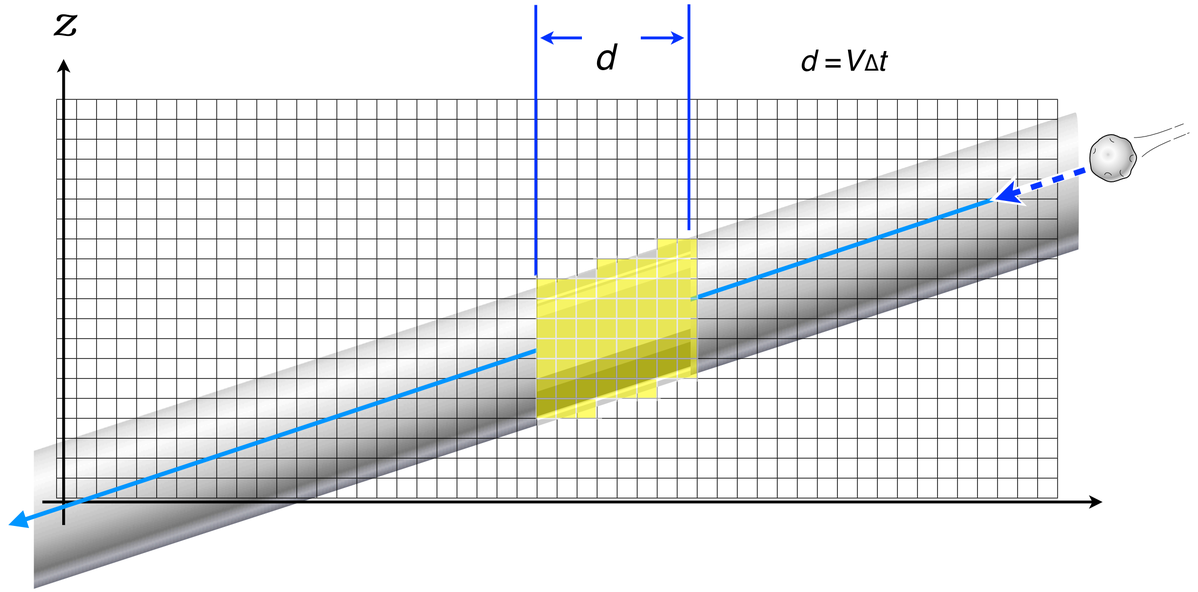
Predicted Ground Signature



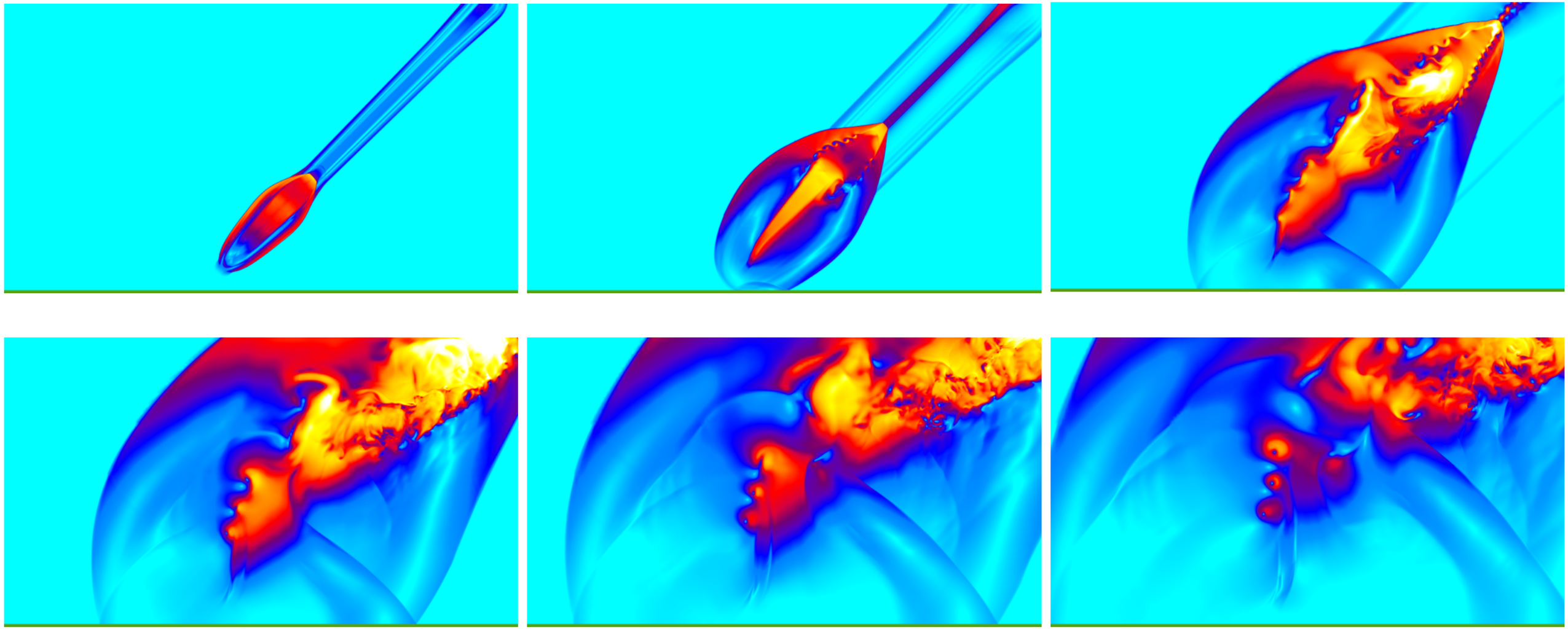
Airbursts: Flow-field Initialization



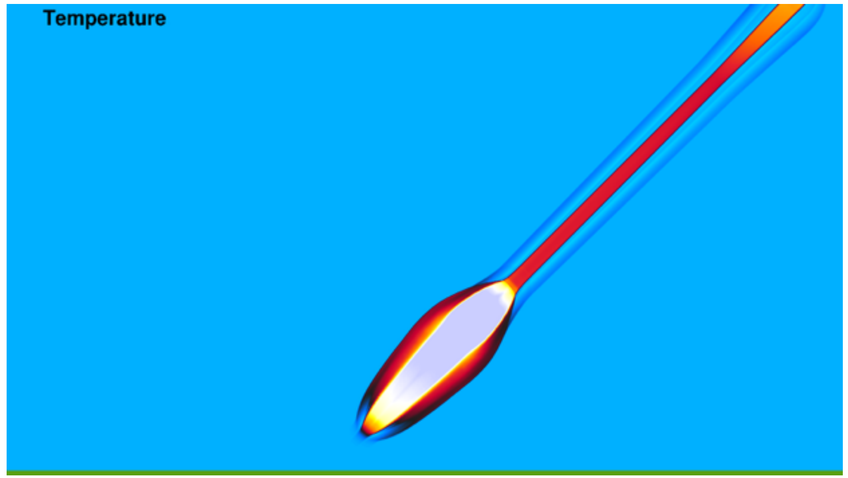


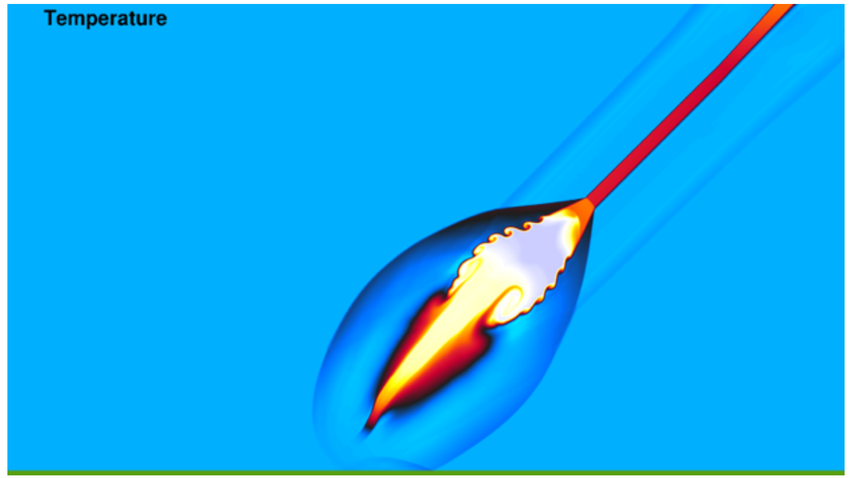


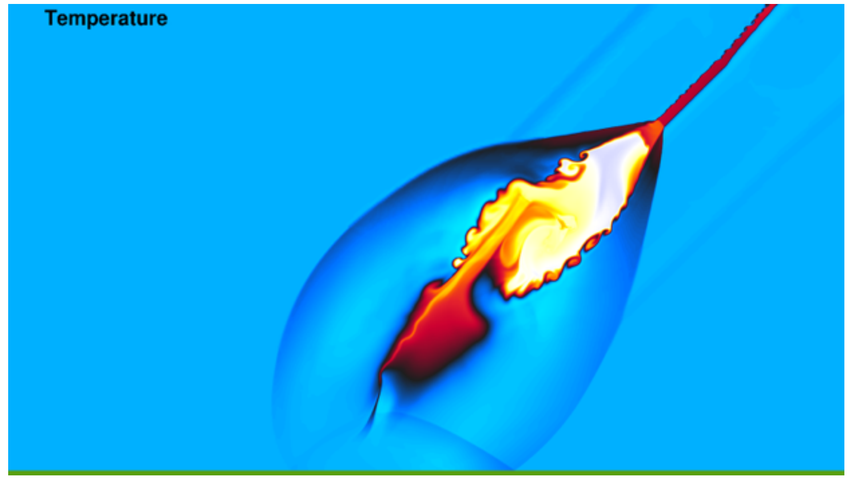
Mach Contours

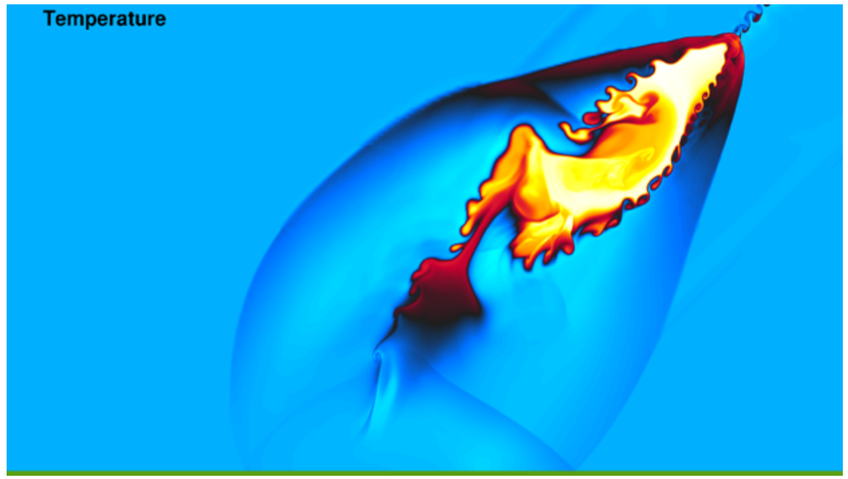


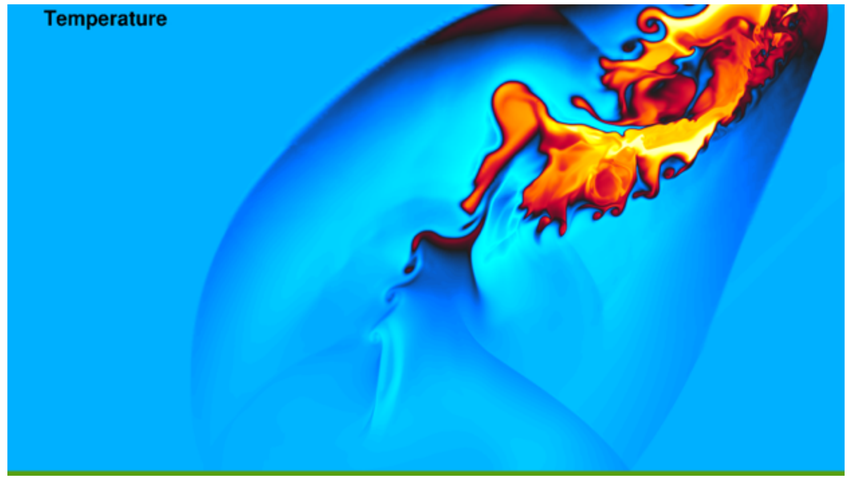
Temperature Contours

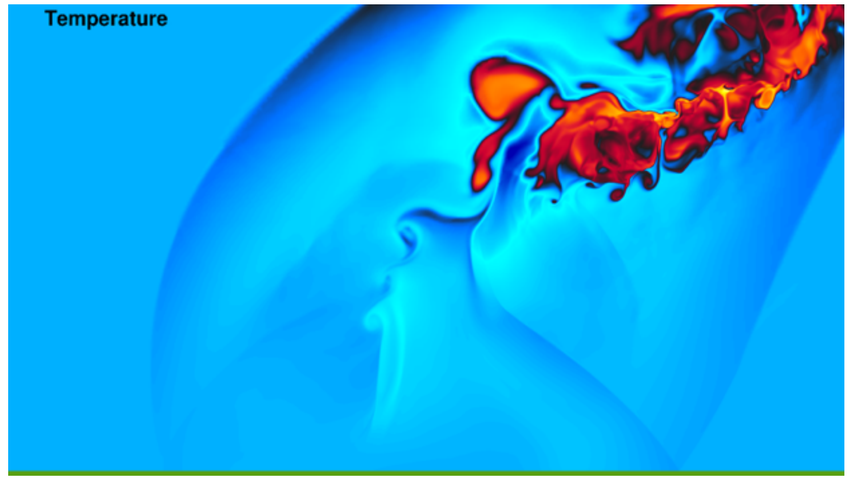






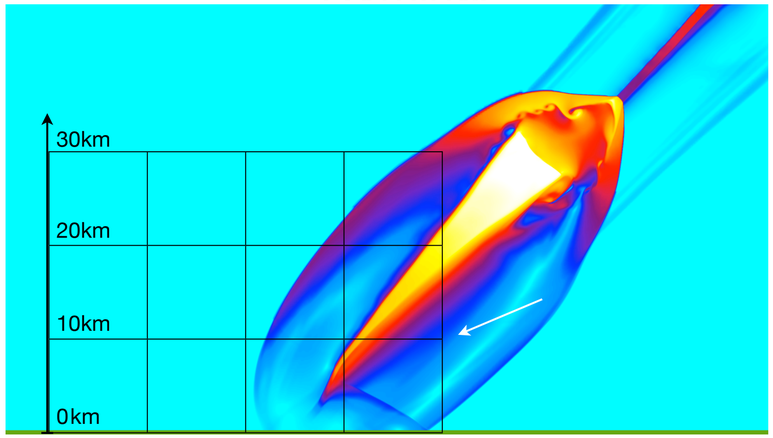


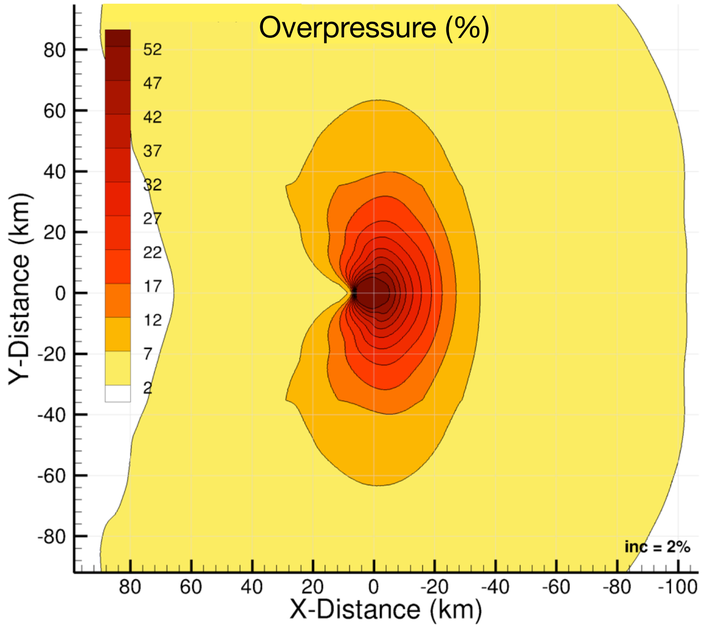




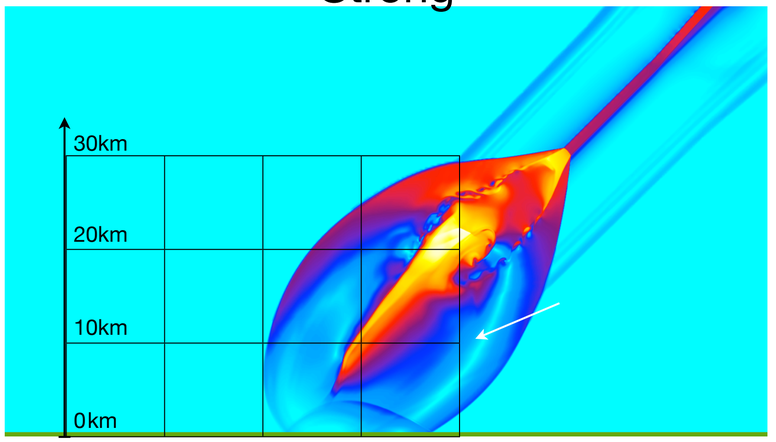
Ground Overpressure

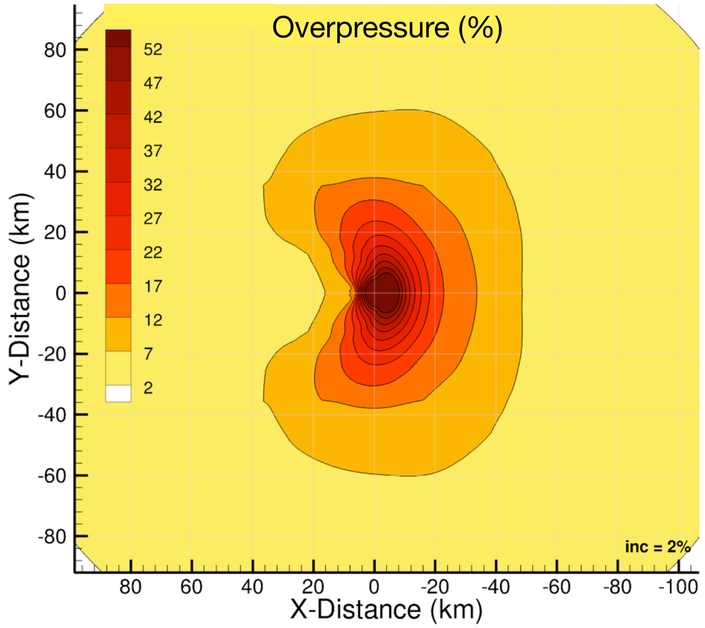
Nominal



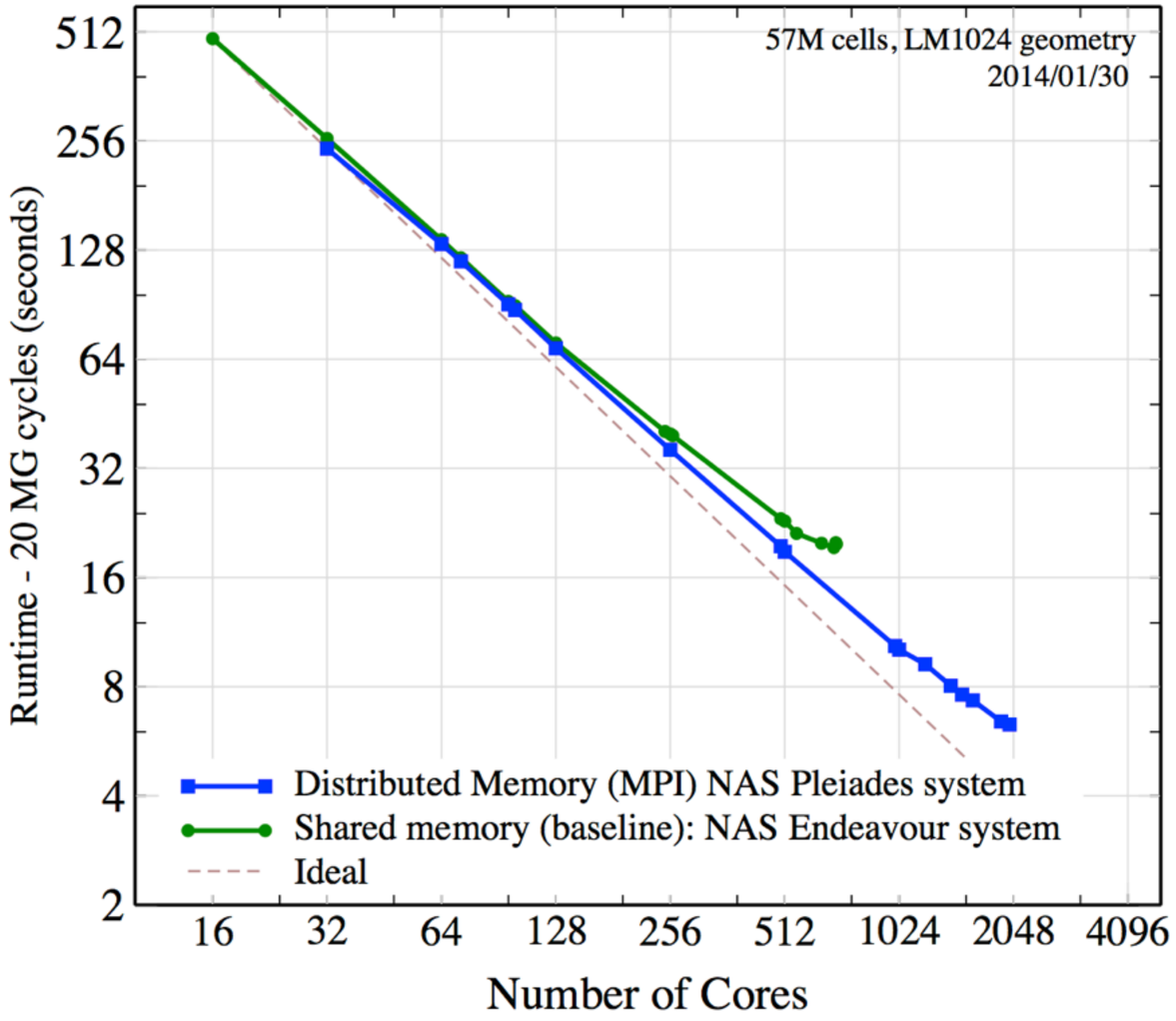


"Strong"





HPC Perfomance

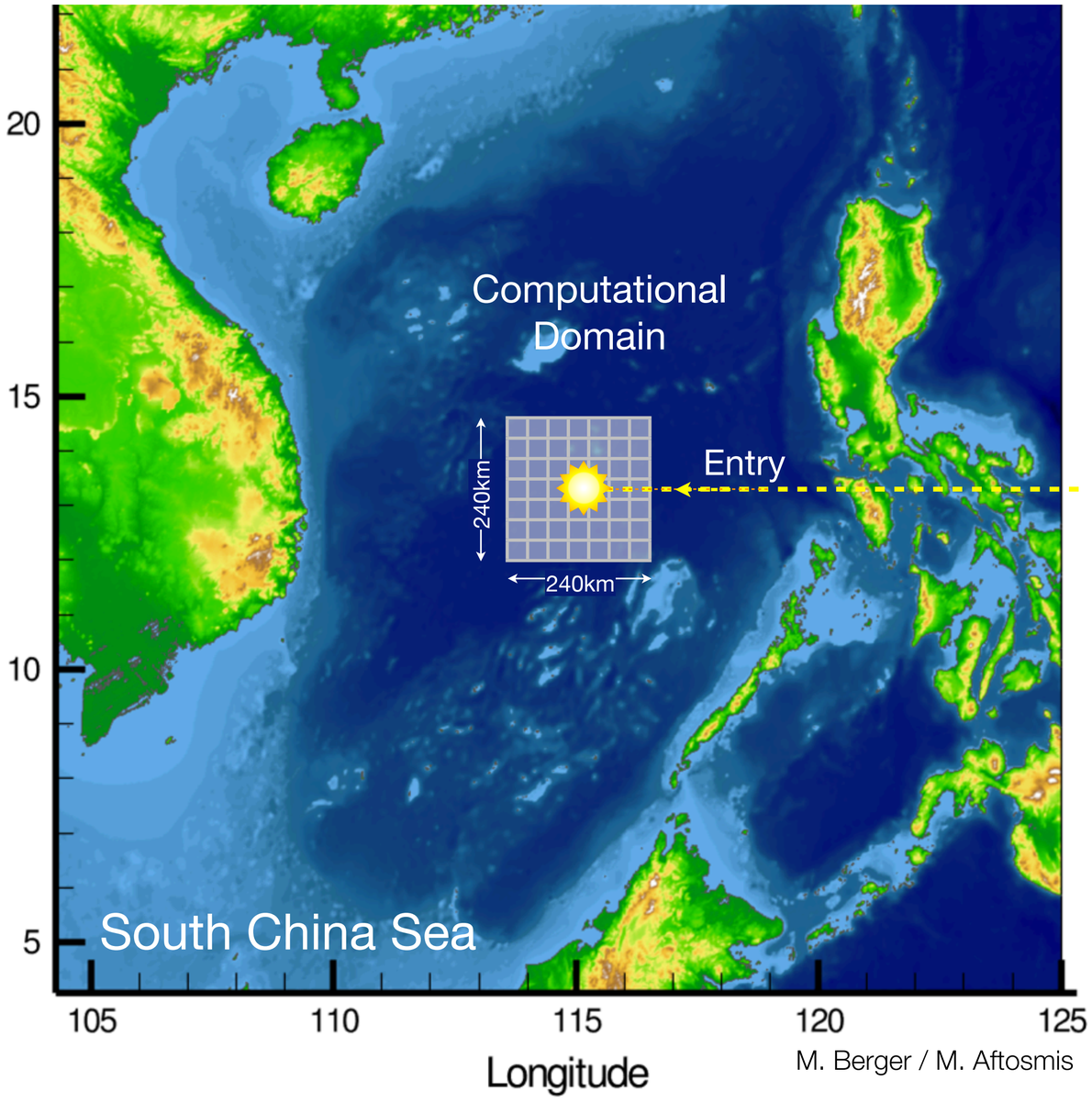


Tsunami Coupling

- Ground footprint evolution drives tsunami
- Coupled Cart3D surface pressure to GeoClaw package (U.Wash + NYU) for tsunami simulation

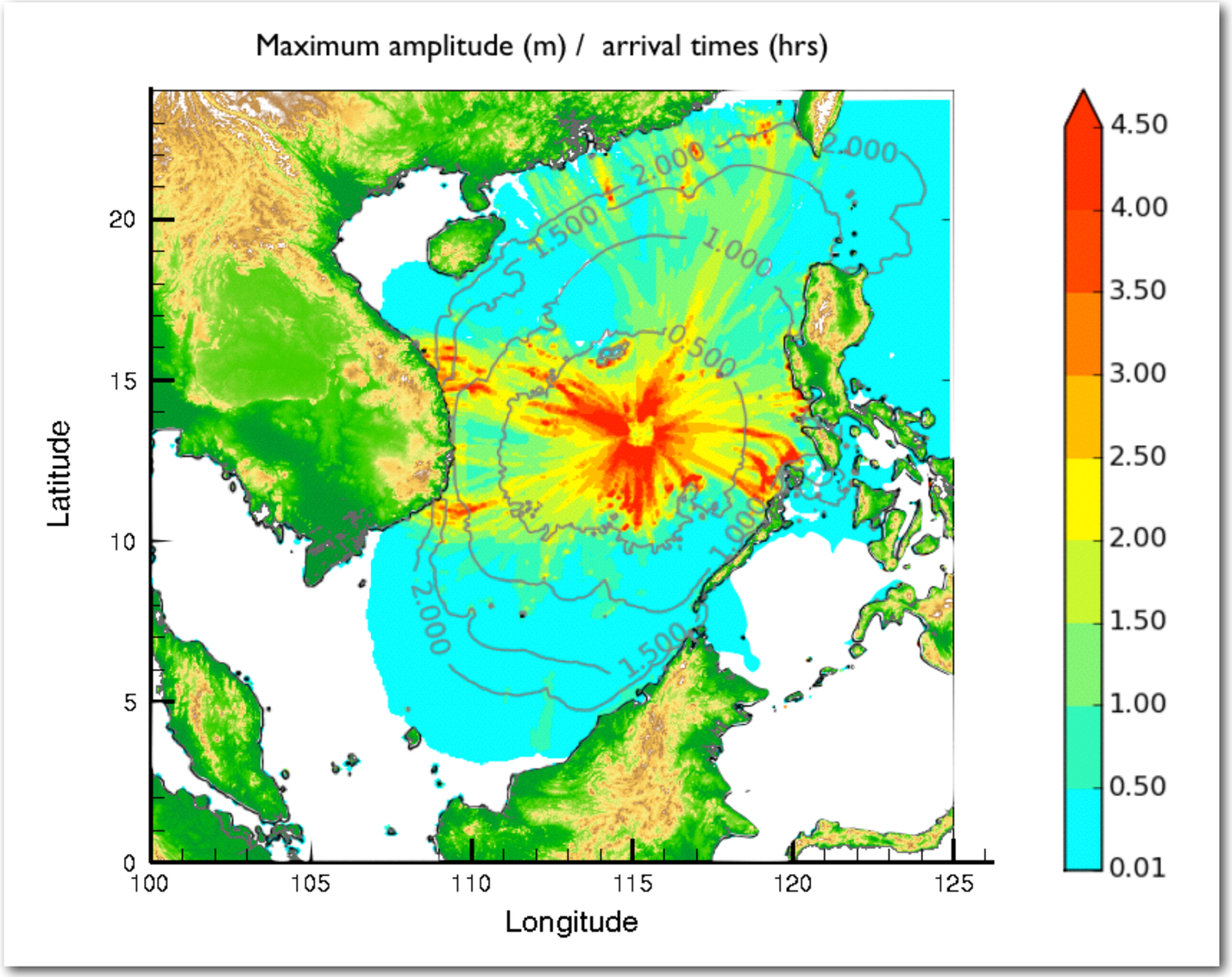
South China Sea, 200m diameter

- Domain Extent:
  240 x 240 x 80 km high ~58,000 km^2 of surface
- ~105 M total cells
- 20 m resolution along trajectory,
- 80 m resolution at sea level
- 3D time-dependent simulations using Cart3D
- Resources
  (1000 cores x ~12 hrs) on NAS Pleiades system



M. Berger / M. Aftosmis

Tsunami



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