Los Alamos
NATIONAL LABORATORY
EST. 1943

LA-UR-19-26204
Approved for public release; distribution is unlimited.

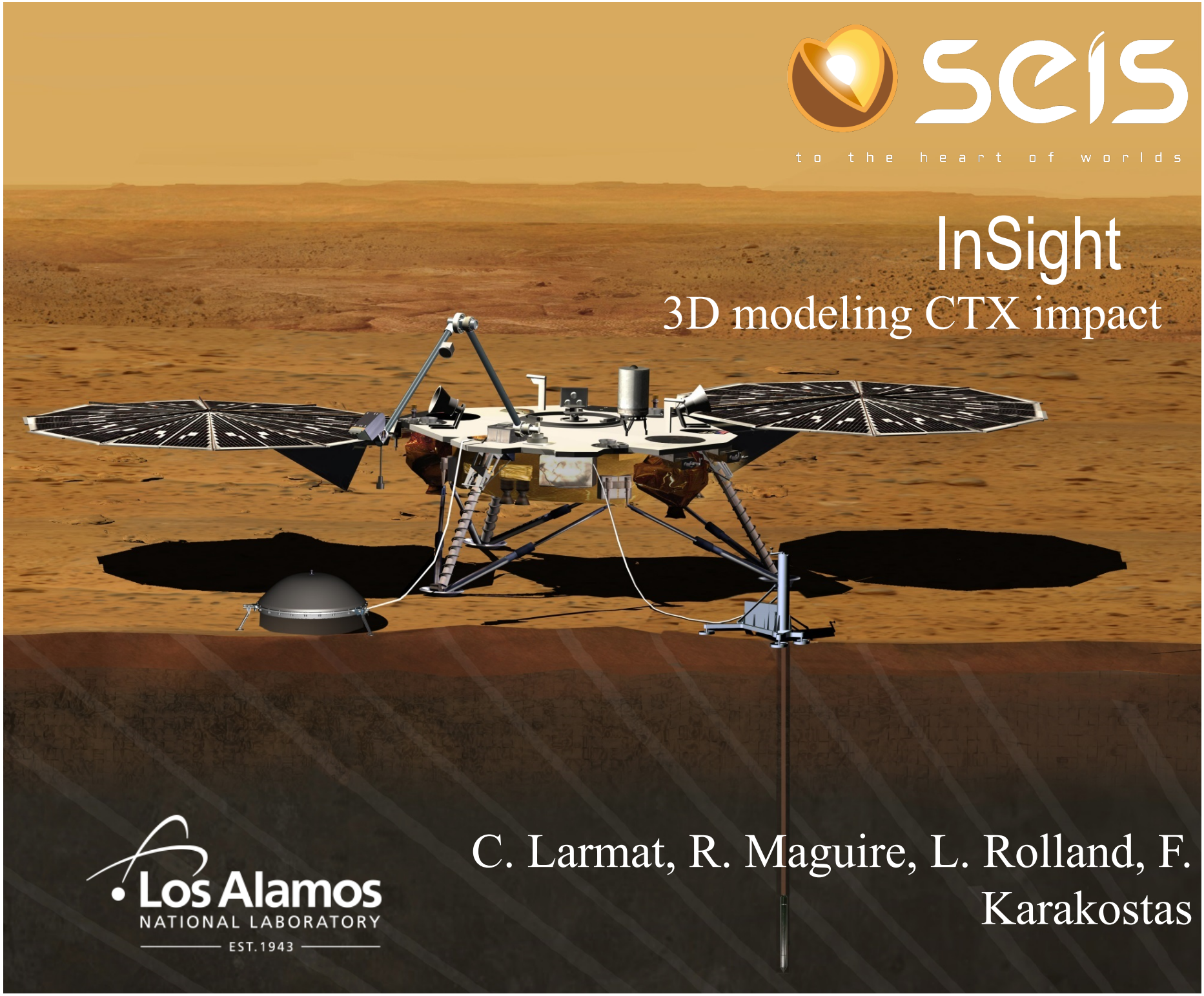
Title: InSight, 3D modeling CTX impact

Author(s): Larmat, Carene
Maguire, Ross
Karakostas, Foivos
Rolland, Lucie

Intended for: Insight Impact Working Group

Issued: 2019-07-01

Disclaimer:
Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by Triad National Security, LLC for the National Nuclear Security Administration of U.S. Department of Energy under contract 89233218CNA000001. By approving this article, the publisher recognizes that the U.S. Government retains nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.


seis
to the heart of worlds
InSight
3D modeling CTX impact
C. Larmat, R. Maguire, L. Rolland, F. Karakostas
Los Alamos
NATIONAL LABORATORY
EST.1943

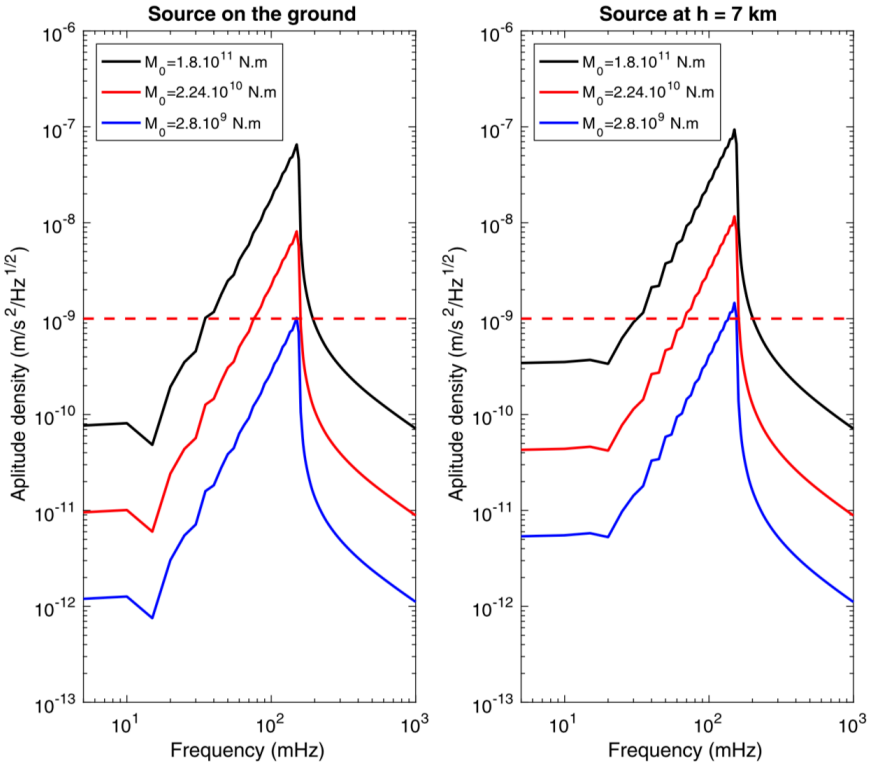
Outline

- Introduction
- Model
  - Surface topography
  - Vertical model
- Results
  - Acoustic/elastic modeling with a resolution of 3s
  - Seismic only with a resolution of 0.5s (2Hz)

Introduction

- Previous modelings:
  - Karakostas et al., 2018
  - Daubar et al., 2018
  - Garcia et al., 2017

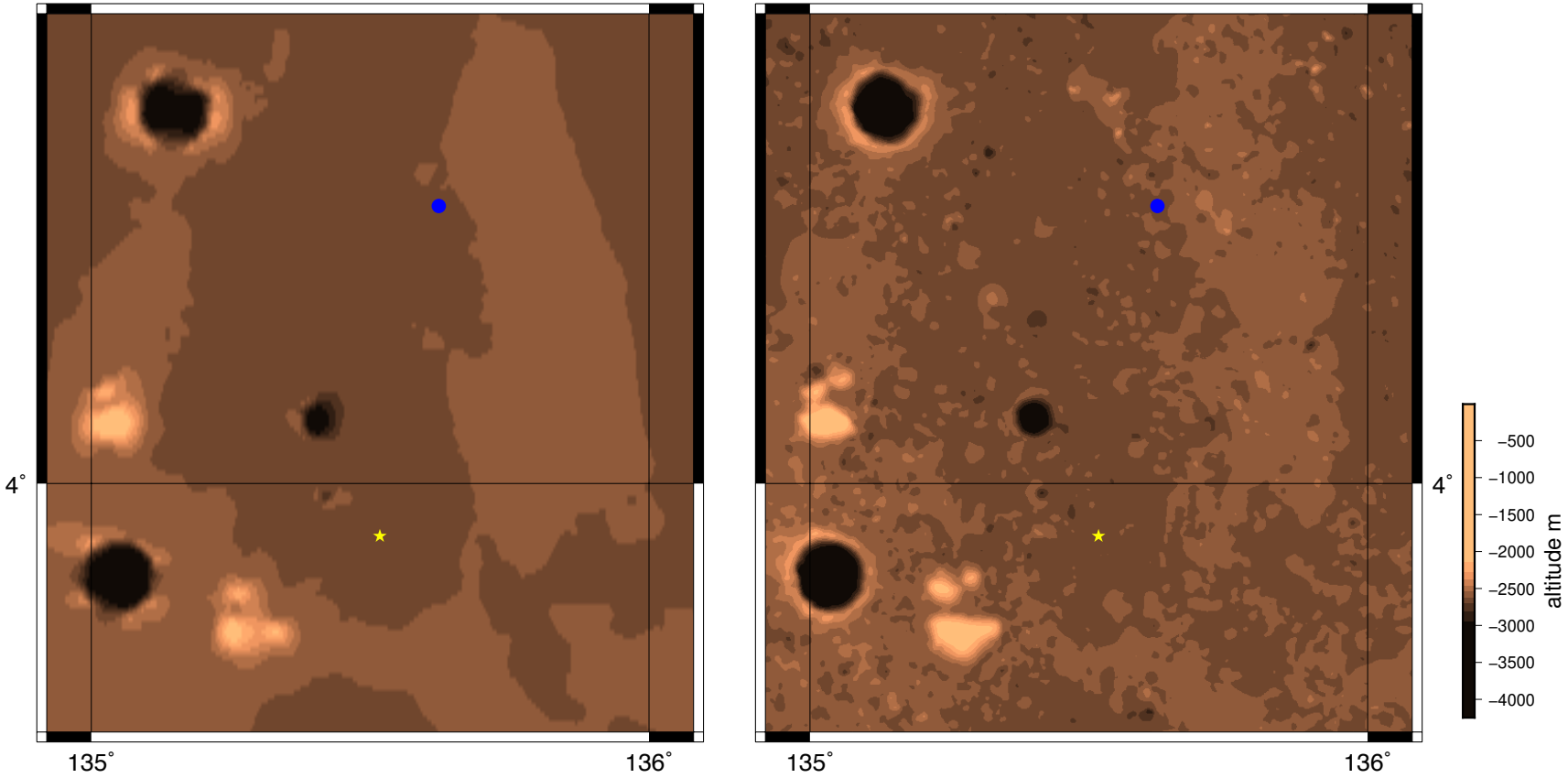
- SPECFEM3D (Komatitsch et al., 1999, 2002): spectral element method, elastic, acoustic and poro-elastic modeling, gravity, GPU-accelerated, anisotropy.



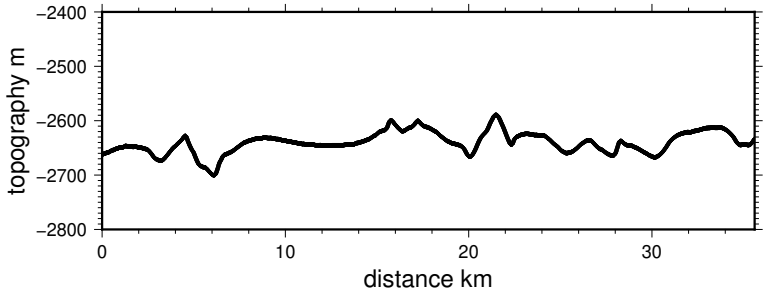
Amplitude at 5km of impact. Impact of meteorite of 2, 1 and 0.5m of diameter respectively.

Topography model.

MOLA DEM 463m HRSC DEM 100m (Golombek et al., 2016)

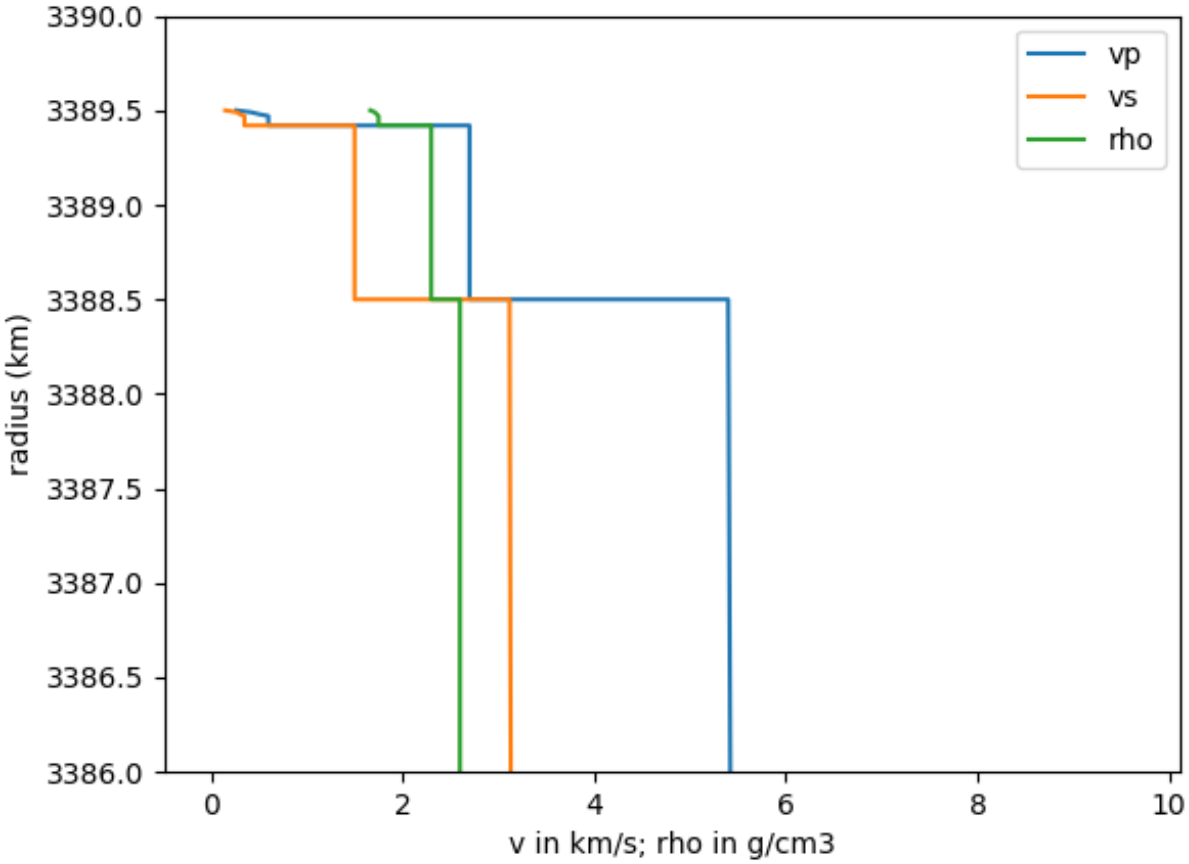


profile along great circle



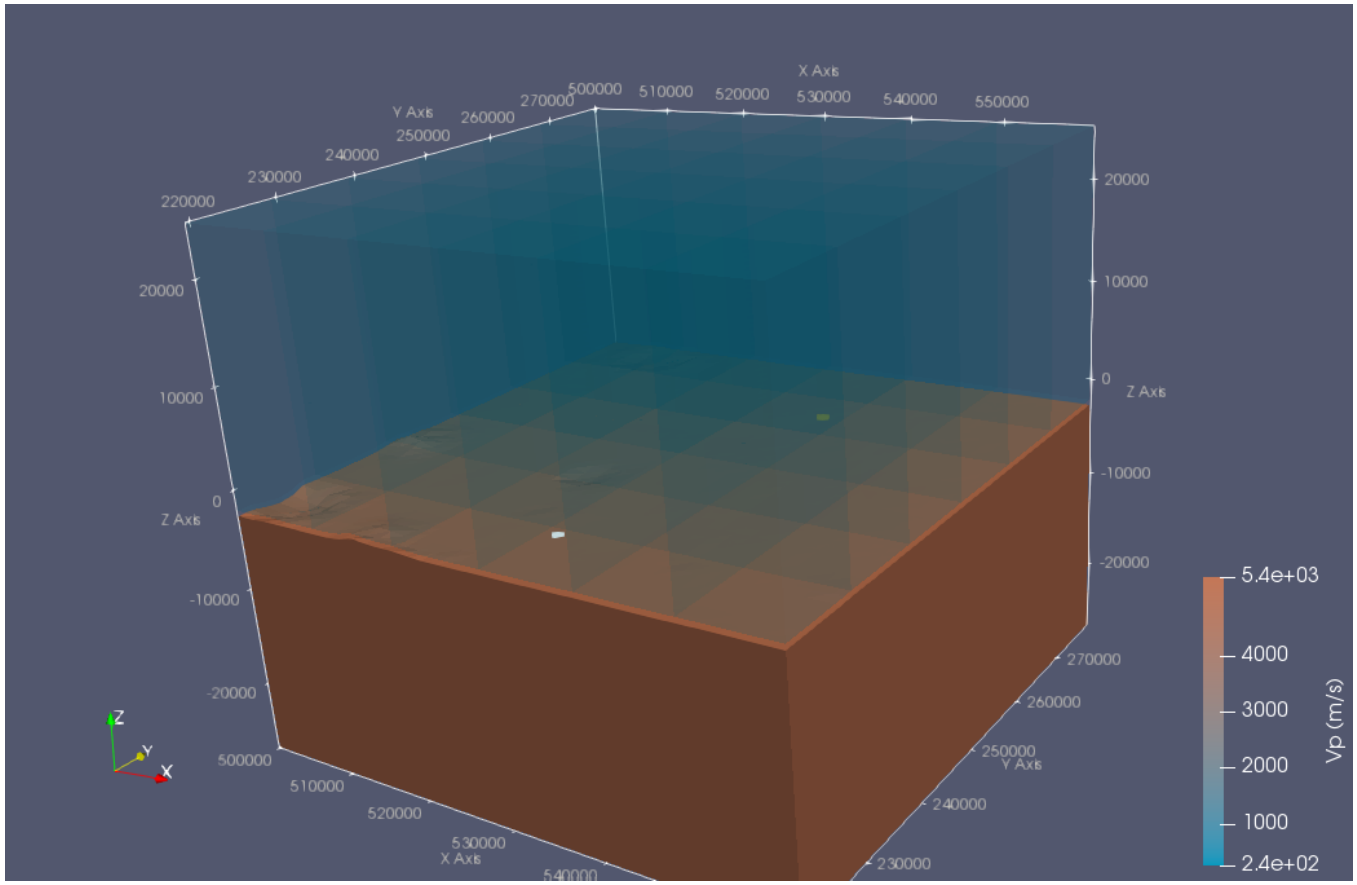
Vertical model

Model EH45Tcoldcrust1rq (Rivoldini et al. 2011).



- Regolith layer of 80m with the shallowest 20m with Vp=265m/s and Vs=150m/s
- Subsequent layer of 1km with Vp = 2700m/s and Vs 1500m/s
- Subsequent layer with a slow gradient.

Seismic acoustic model

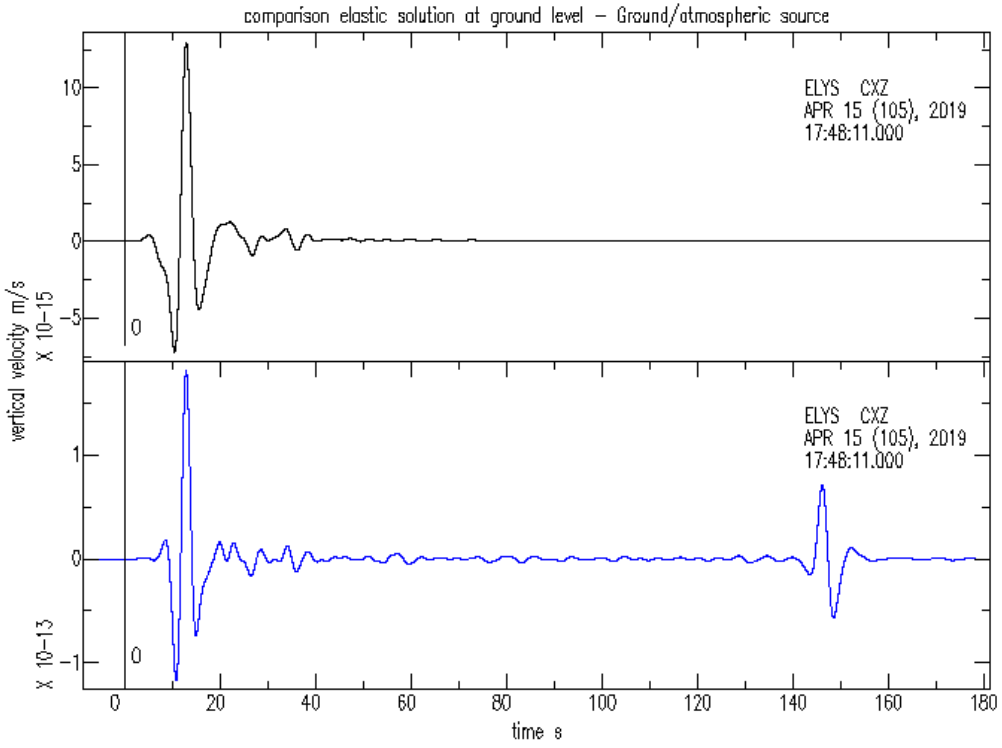


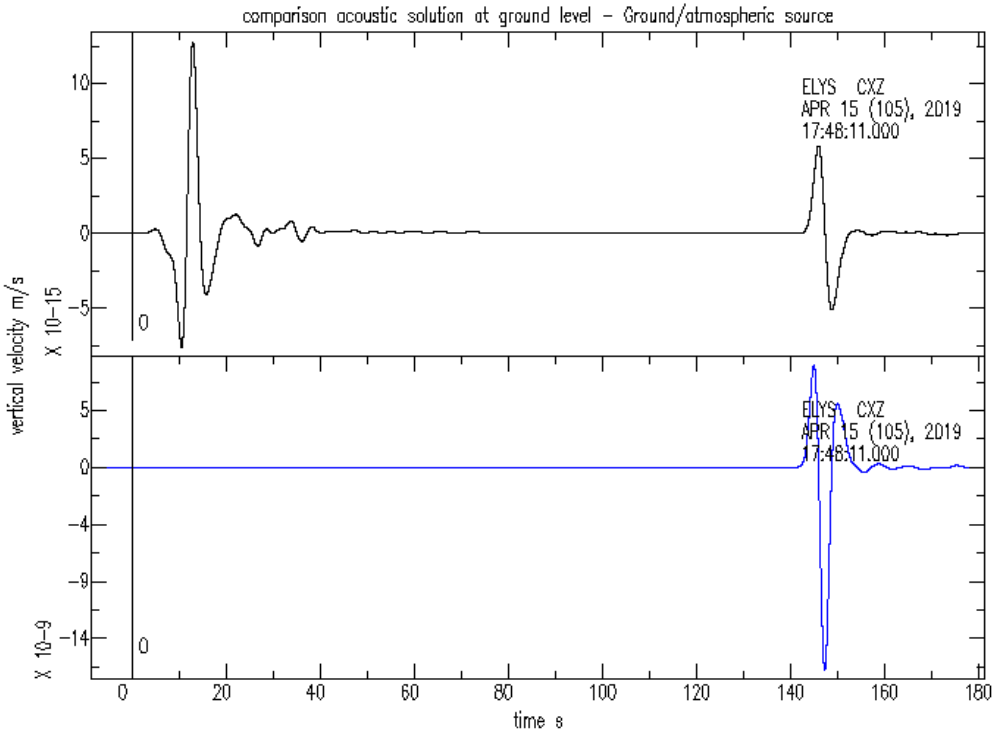
Total elastic elements: 4.7M
Total acoustic elements: 4.7M

Element size between 250m and 500m
Minimum period resolved 3s

432 processors; 4hrs to compute 140s of signal

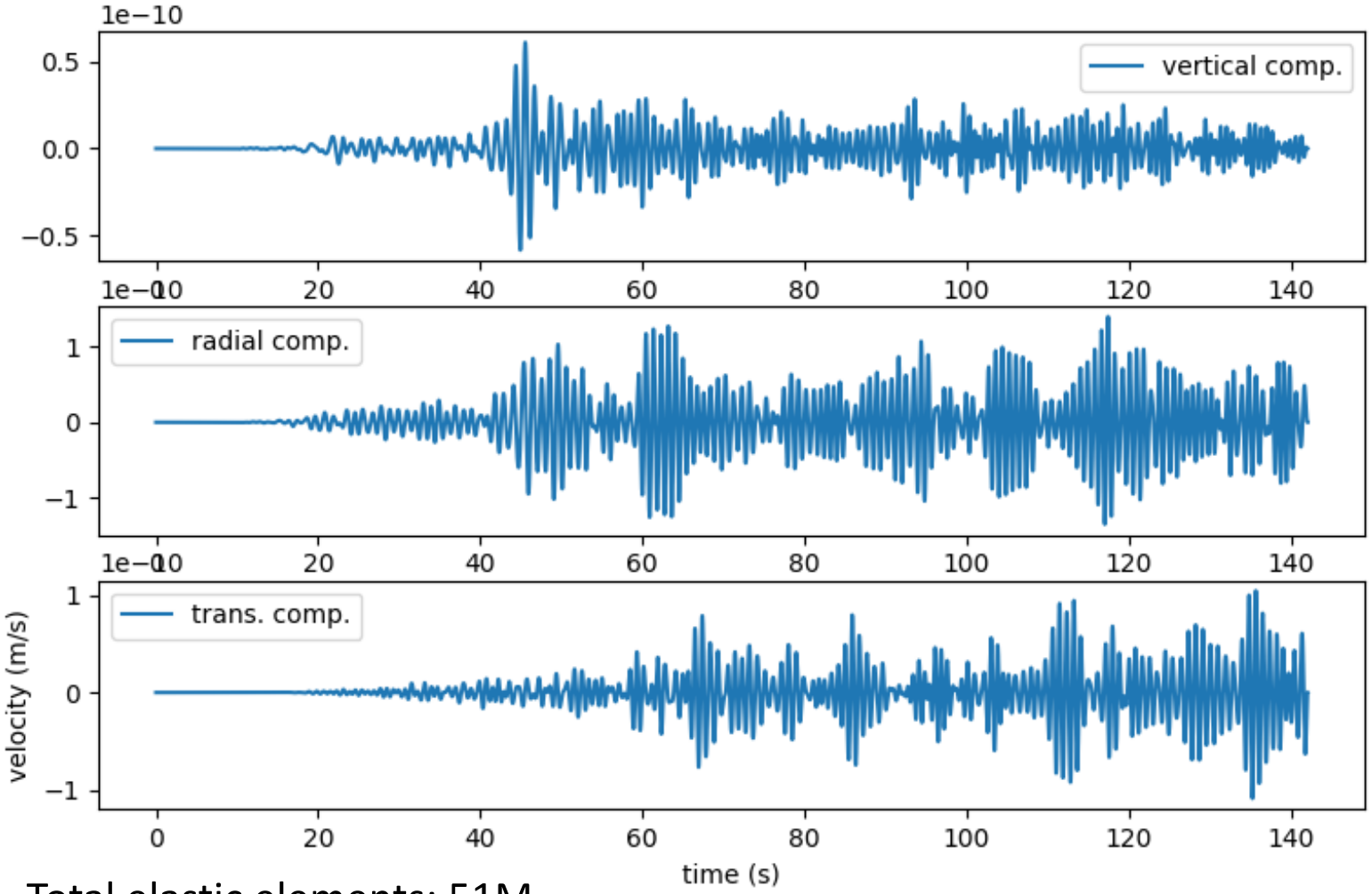
Difference source in the acoustic and elastic domain





Vertical component modeled at Insight with a seismic source of Mw=-1.76. In black, the source was into the ground mimicking a perfect coupling into the ground, in blue the source was in the atmosphere, mimicking a "partial" coupling. On the left, waveform at the ground level. On the right, waveforms in the acoustic domain. Notice the difference of amplitude on the acoustic wave.

Higher resolution – seismic modeling only

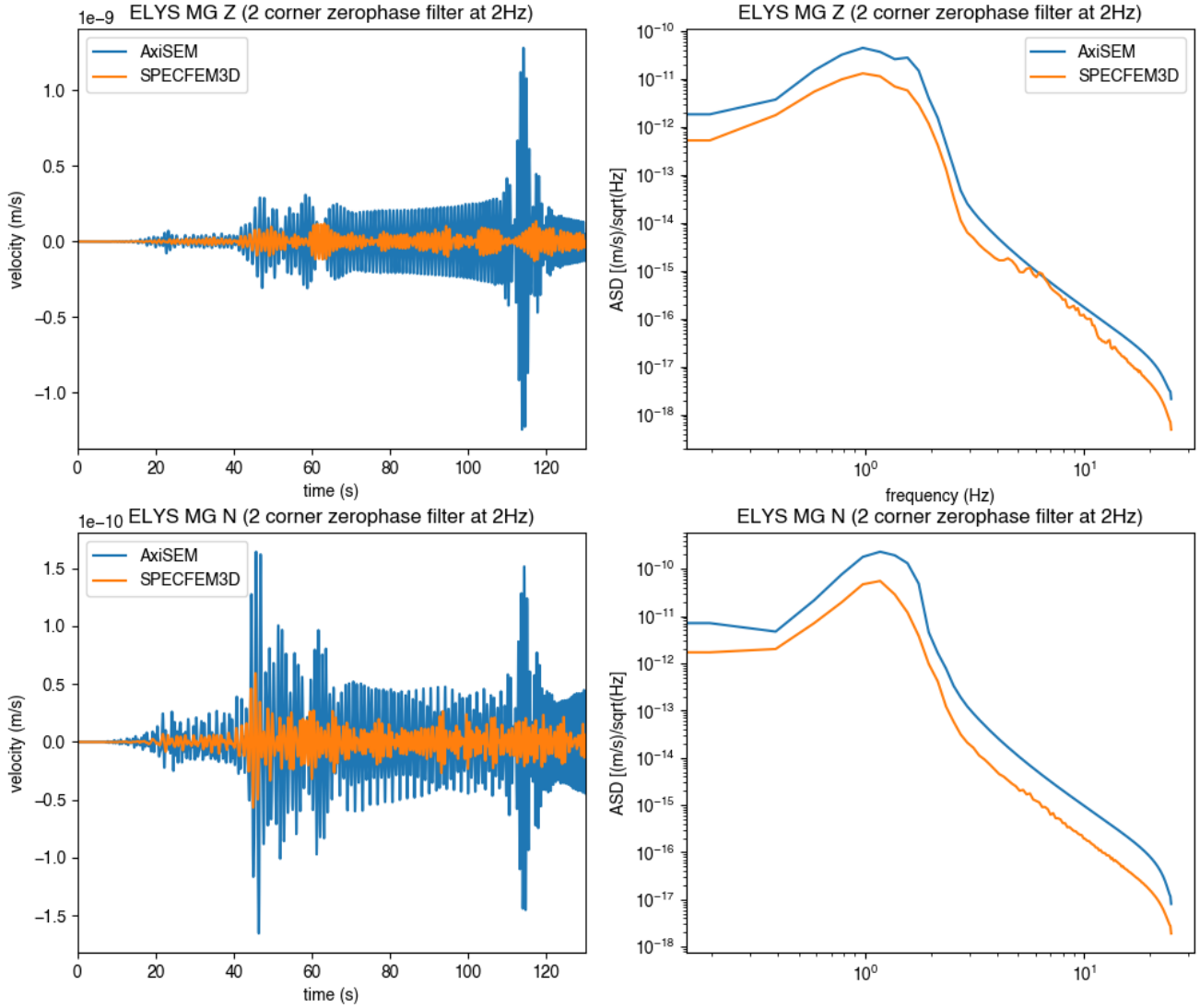


Total elastic elements: 51M
Total acoustic elements: 0M

Element size between 25 and 500m (doubling): Minimum period resolved 0.5s
4608 processors; 16hrs to compute 140s of signal

C. Larmat et al., 07/01/2019-7

Benchmarking with AXISEM



- Working on benchmarking between SPECFEM3D and AXISEM.
- Need hypothesis, data on the thickness of the regolith layer.

Conclusions

- Working on benchmarking between SPECFEM3D and AXISEM.
- Need hypothesis, data on the thickness of the regolith layer.
- Need to develop a 3D model of scattering.