DInSAR ground deformation estimation and Swarm Observations of ULF Pulsation Activity for the 2016 Central Italy Earthquake sequence

Ioannis Papoutsis, Charalampos Kontoes, Georgios Balasis and Omiros Giannakis

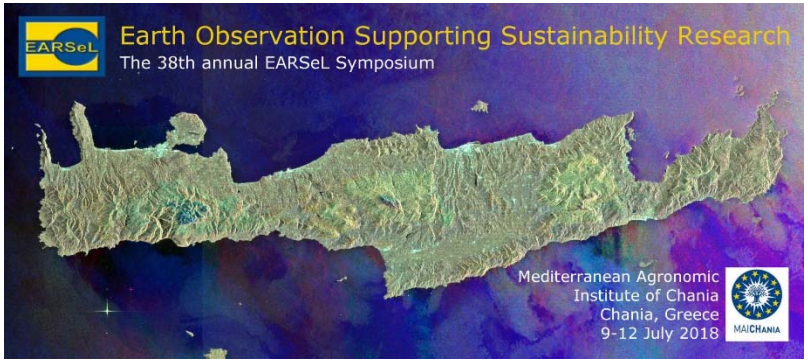
GeoHub Service

BEYOND Centre of Excellence for EO-based monitoring of Natural Disasters

www.beyond-eocenter.eu

Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS)

National Observatory of Athens (NOA)



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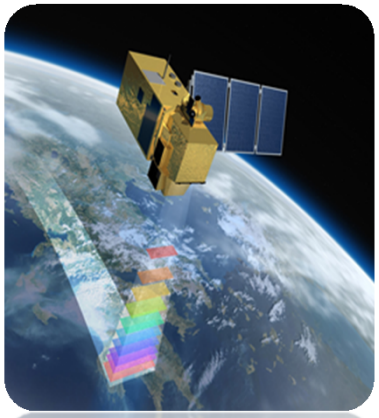
Monitoring Systems

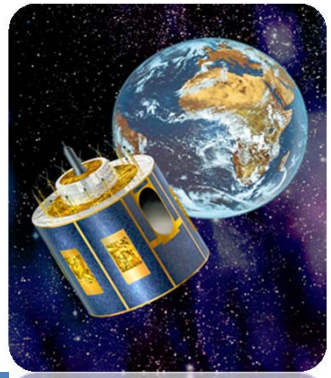


Polar orbit satellites

X-/L-band Station

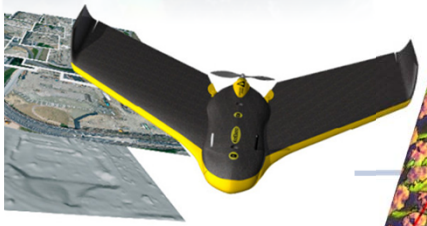
Sentinel Mirror Site

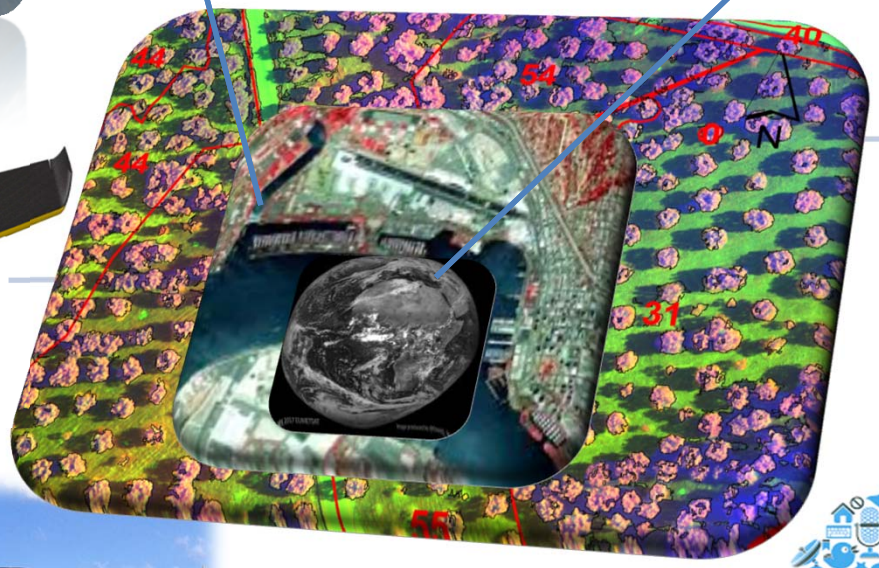
DATA → ANALYSIS → INFORMATION



Geostationary orbit satellites

MSG Seviri





in-situ

In-situ platforms & networks

UAVs

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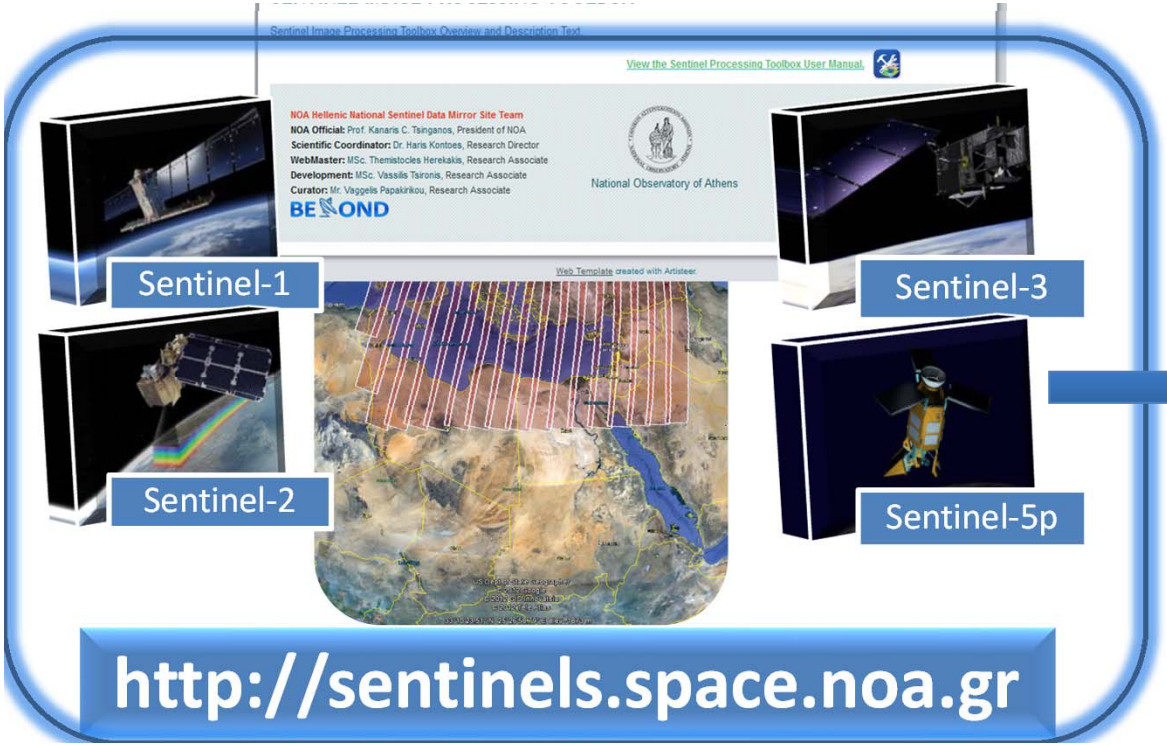
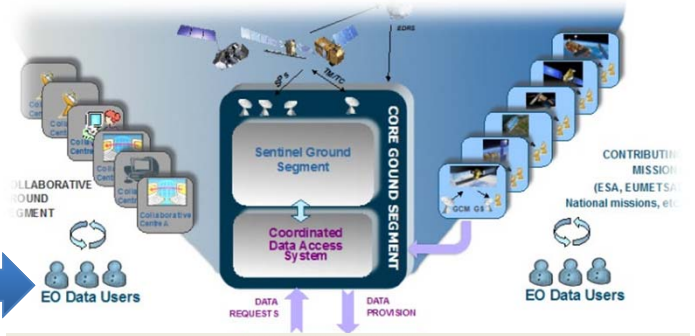
Hellenic National Sentinel Data Mirror Site / ESA-NOA Agreement





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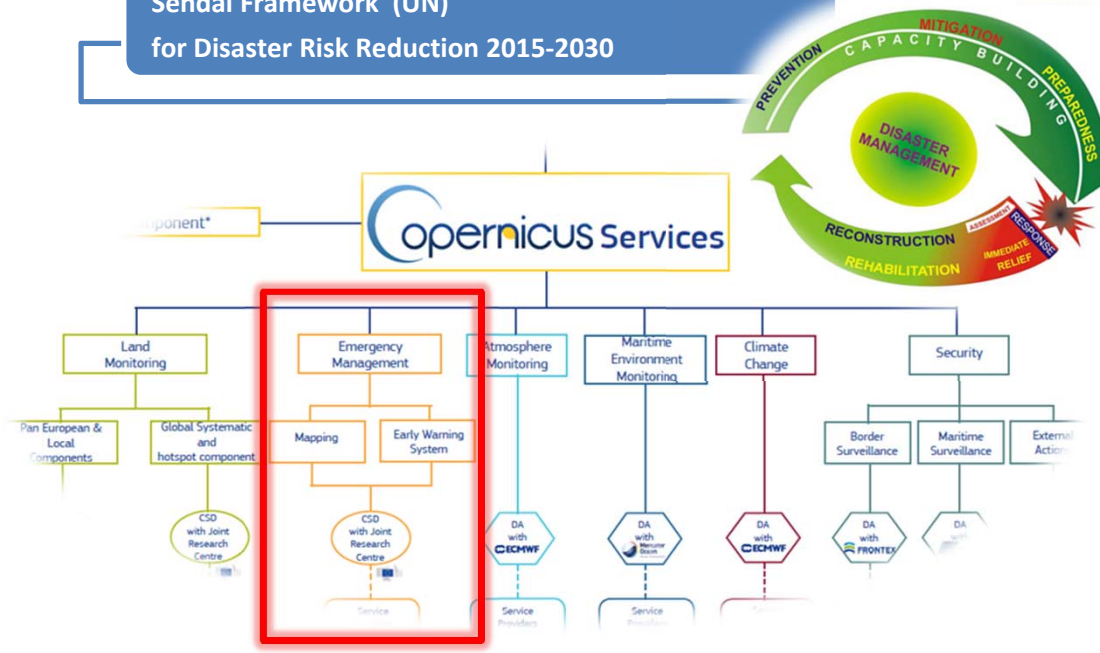
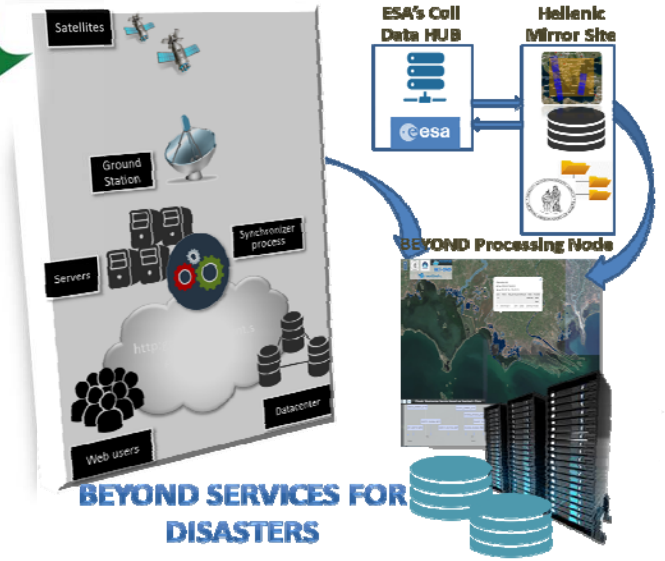
The role of the BEYOND EO Center of Excellence in the European EO Programme Copernicus for emergency management worldwide: Prevention - Preparedness - Risk Assessment - Response - Mitigation

Regulation (EU) No 377/2014 - Copernicus

Copernicus Work Programme

Sendai Framework (UN)
for Disaster Risk Reduction 2015-2030





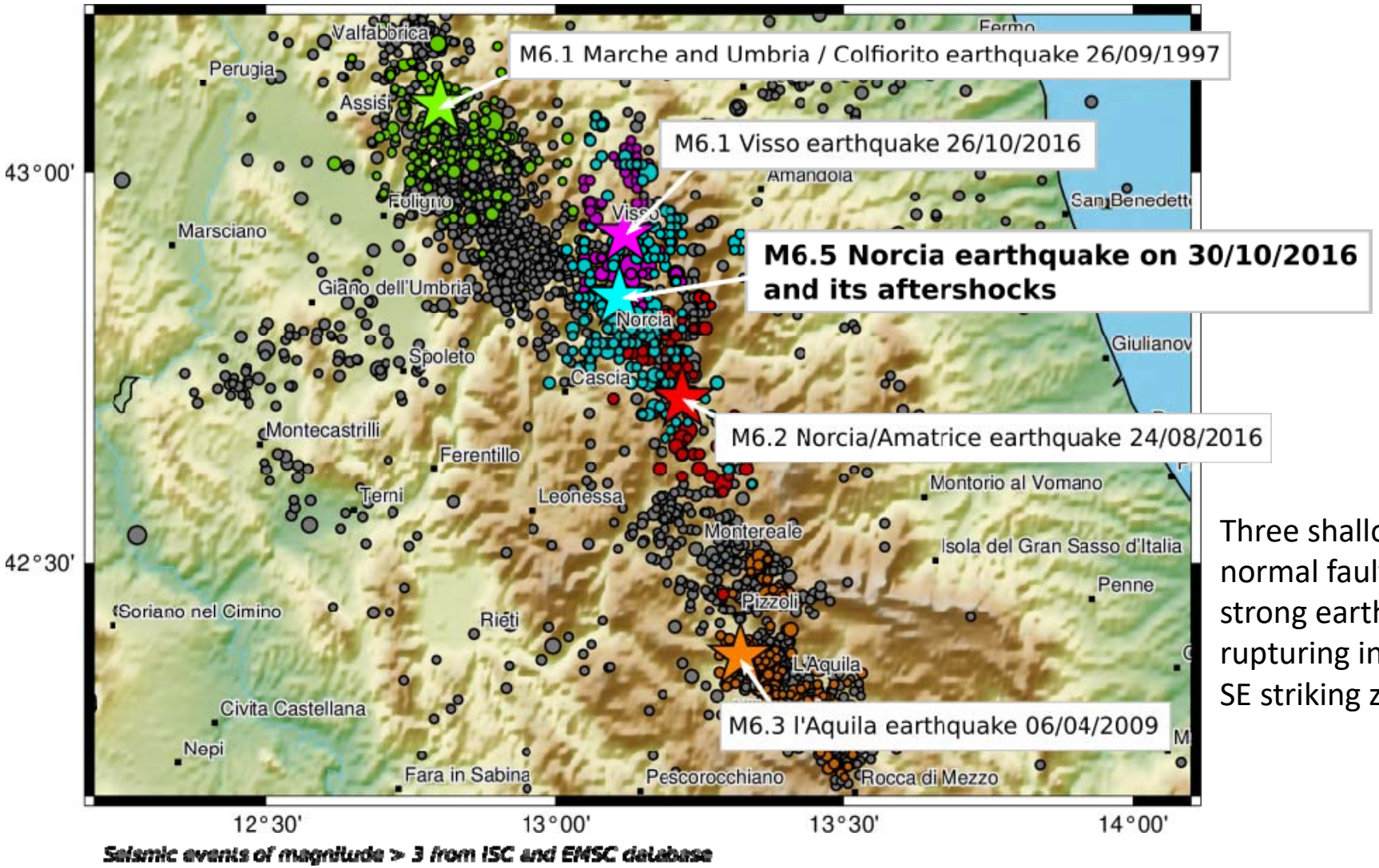
FireHub

GeoHub

AirHub

FloodHub

Distribution of main seismic sequences in Italy from 1997 to 02/11/2016

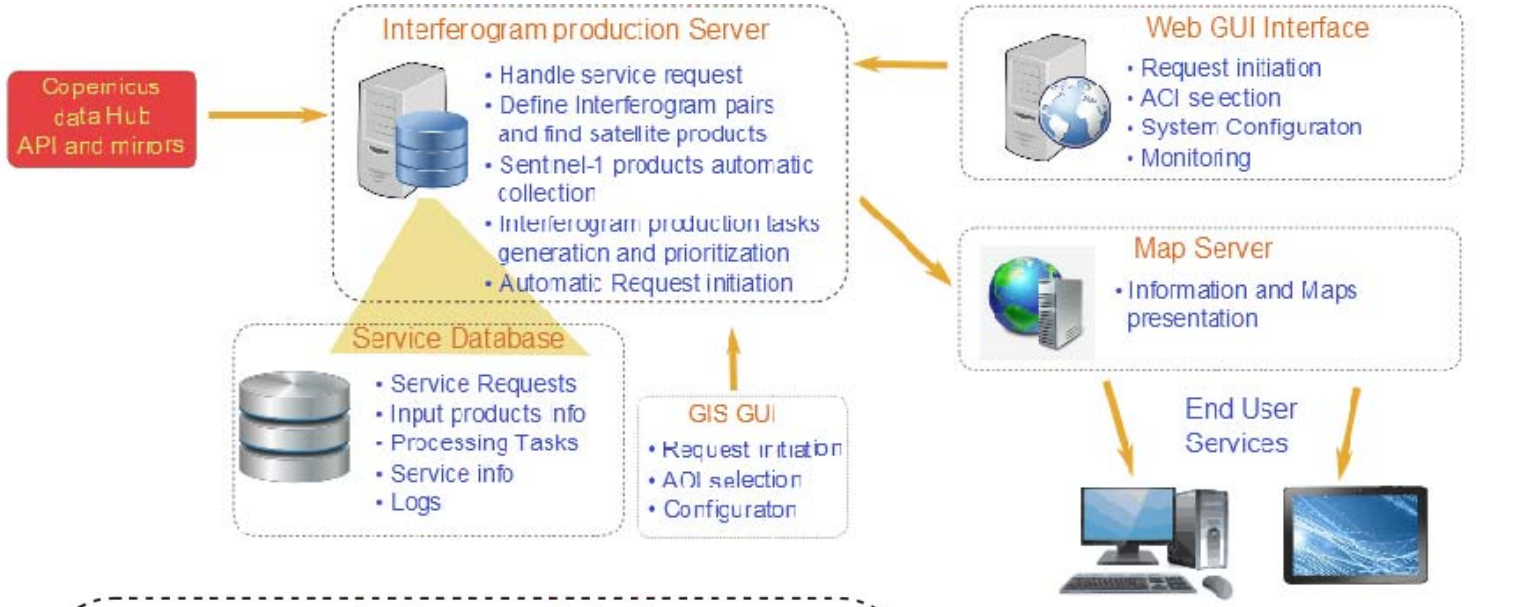


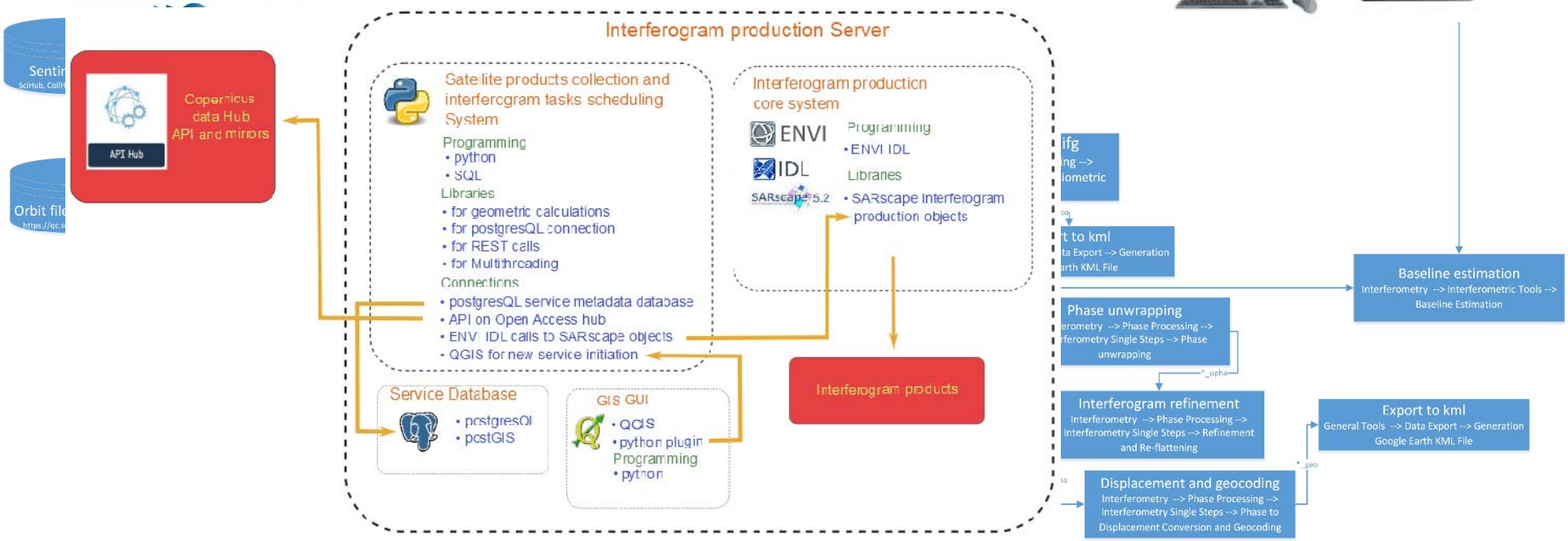
Seismic events of magnitude > 3 from ISC and EMSC database

Three shallow, normal faulting very strong earthquakes rupturing in an NW–SE striking zone

A fully aut
deformation

- GeoHub c
- Download
- Processing





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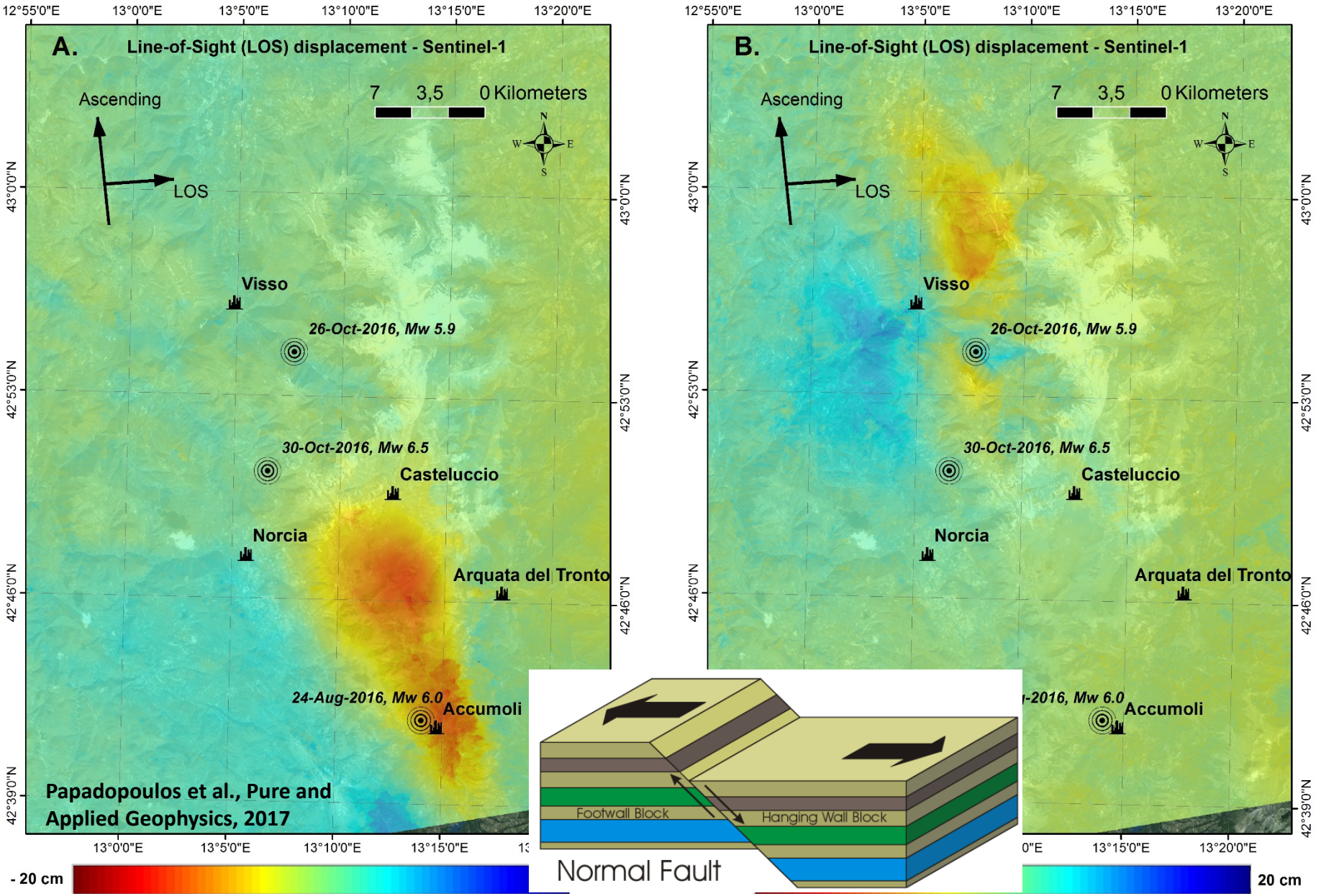

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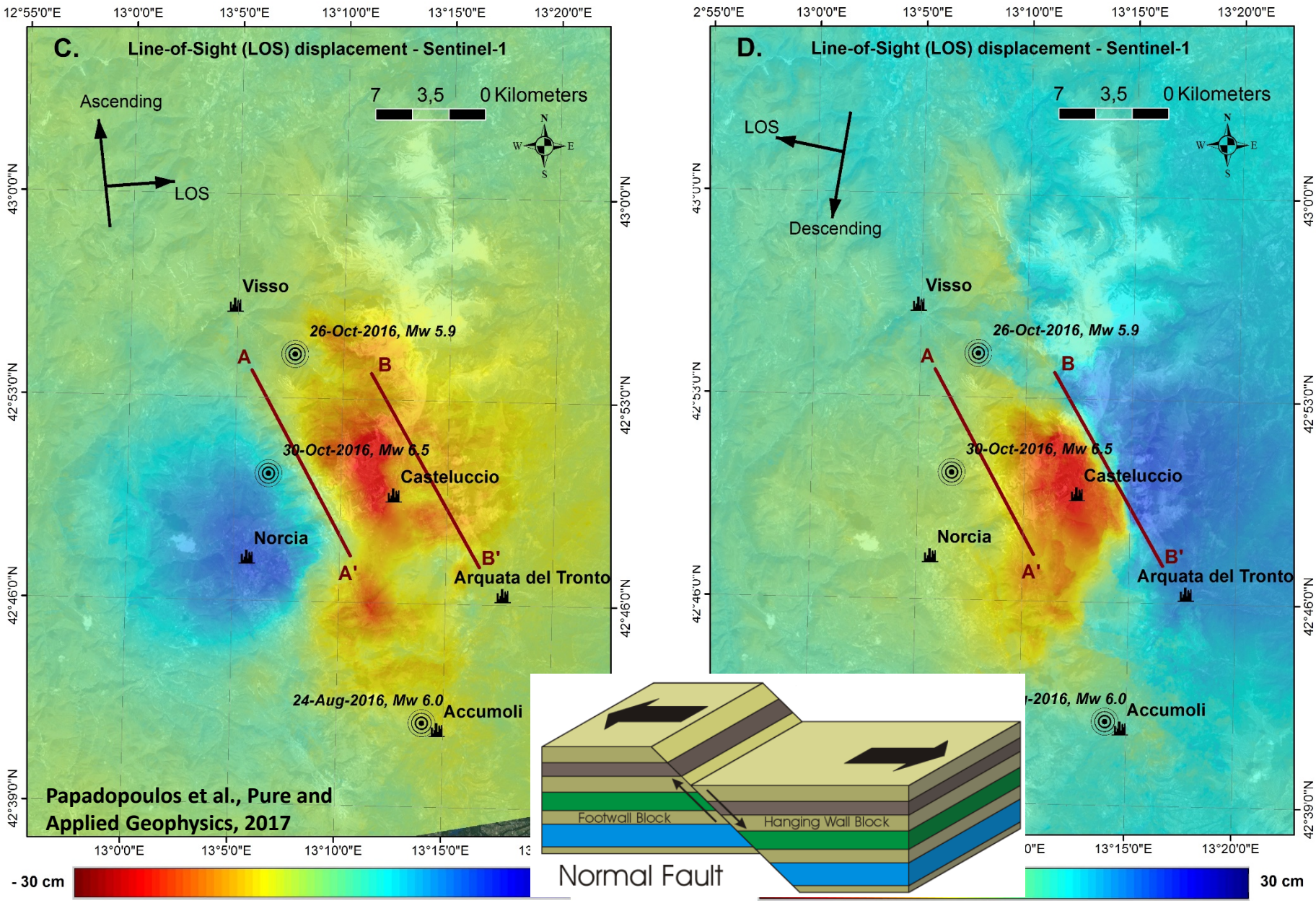
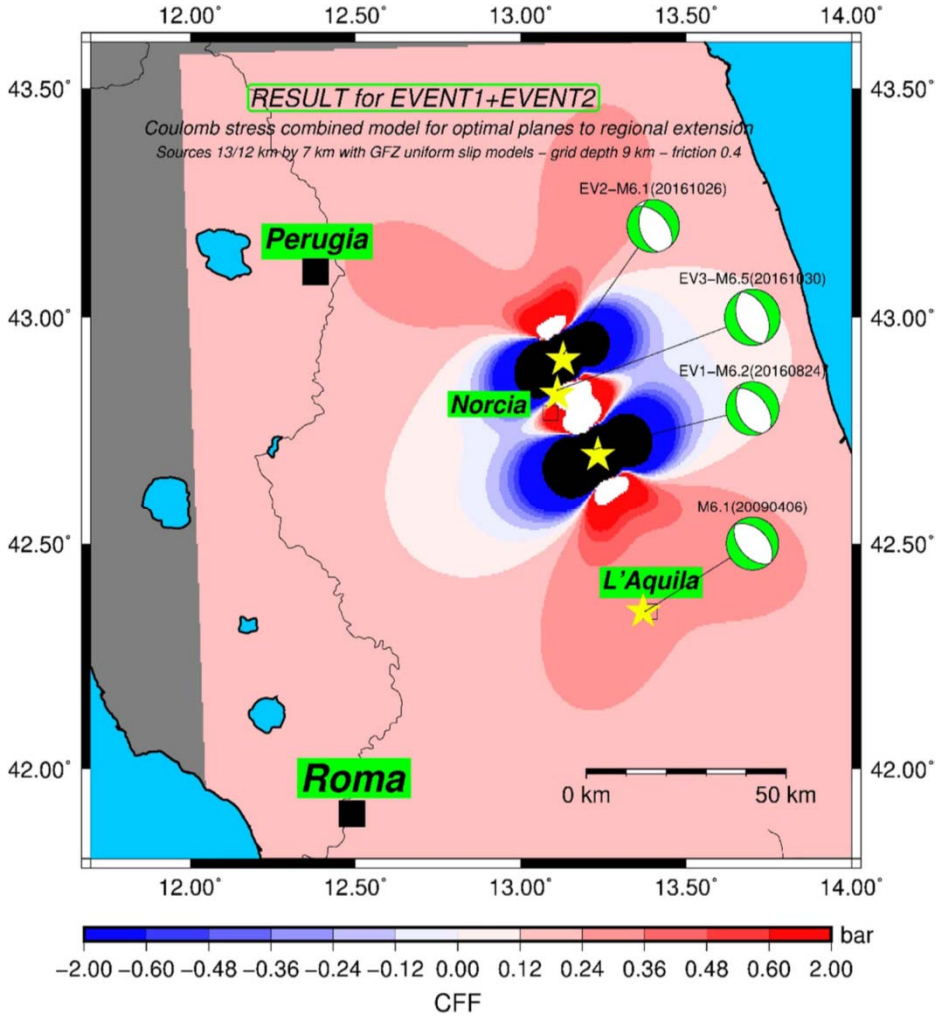


Conclusions

- Showed ground deformation directivity from events 1 and 2 towards event 3, which is consistent with the rupture process directivity
- Based on rupture directivity and ground deformation pattern, we put forward the hypothesis that the area of the second event was stress loaded by the first one and that both the first and second earthquake events caused stress loading in the area, where the third event ruptured.
- Coulomb stress-transfer modelling yields strong evidence in favor of our hypothesis.

Papadopoulos et al., Pure and Applied Geophysics, 2017



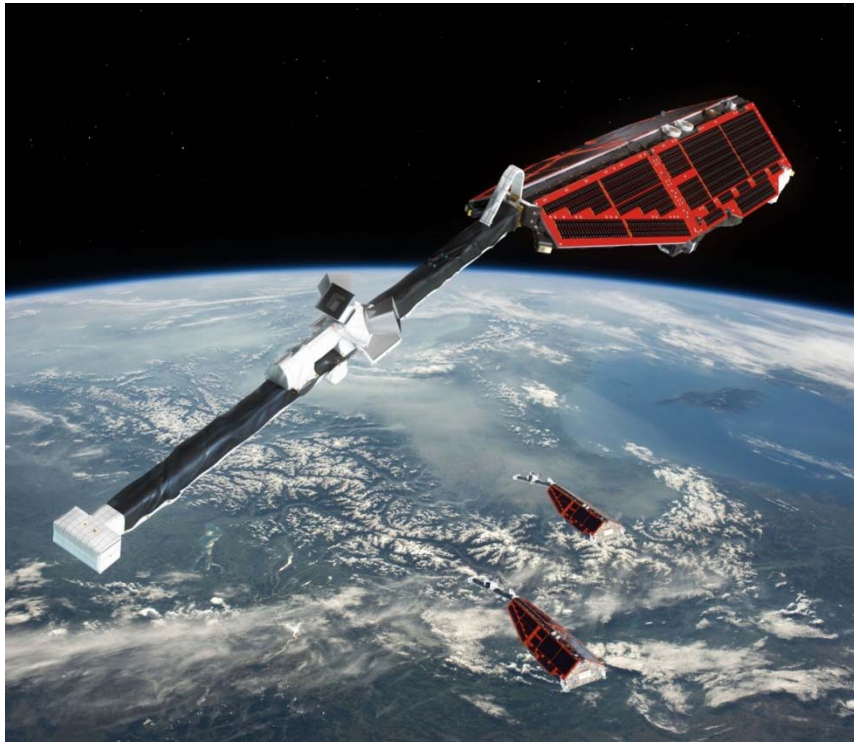
Swarm mission

Each satellite is measuring:

- Strength and direction of the magnetic field
- Plasma conditions and characteristics
- Location

The Constellation:

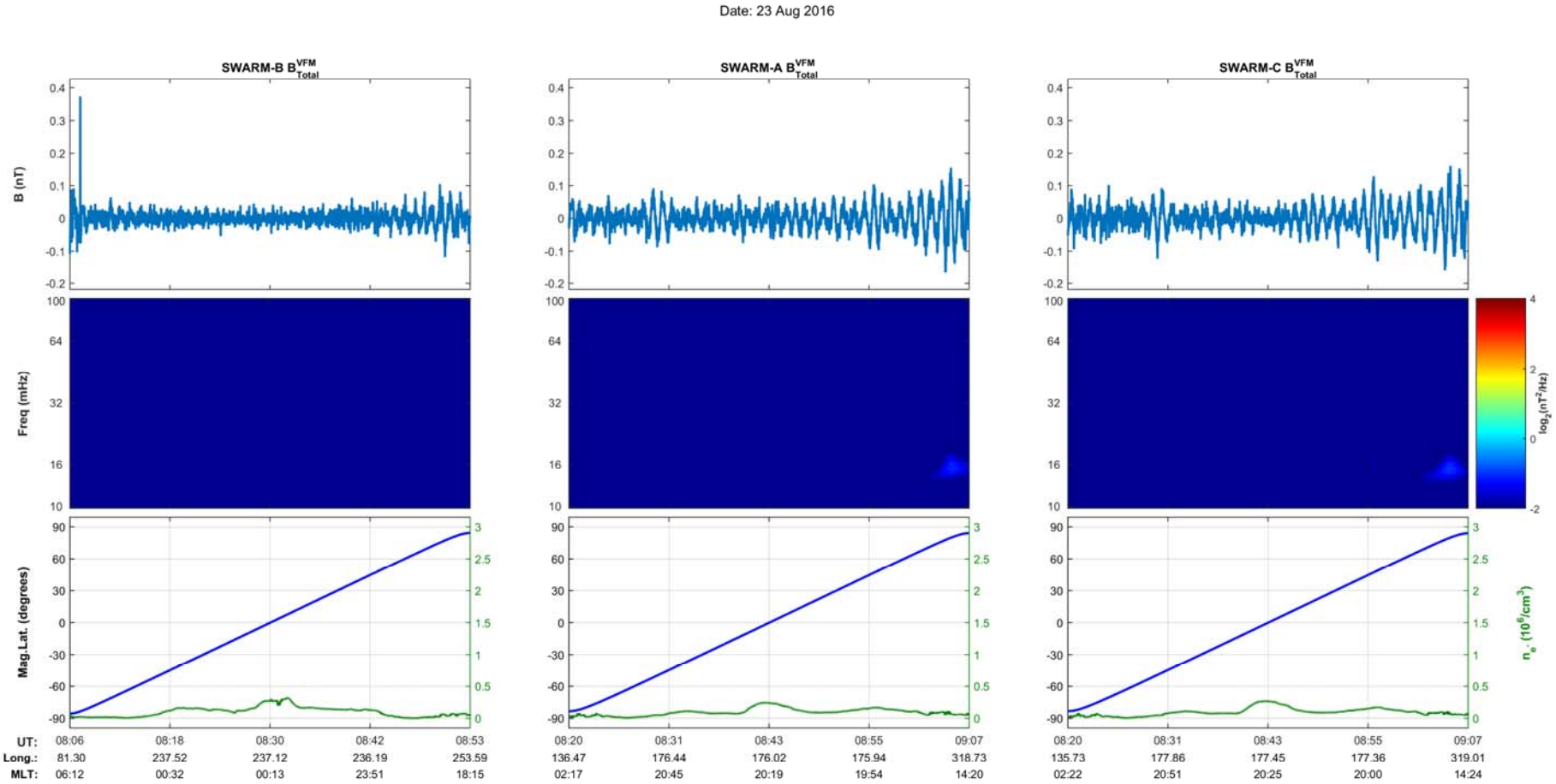
- 3 identical satellites:
  2 side-by-side in low orbit (<460km)
  1 in higher orbit
  (< 530km)
- three orbital planes for optimal coverage in space and time



ULF Wave Activity & Earthquakes

- There have been several studies suggesting that ULF pulsations may be associated with earthquakes [Fraser-Smith et al., 1990; Hayakawa et al., 1996].
- The majority of these studies refers to the detection of these signals in ground-based magnetometer measurements (Hayakawa et al., 2015; Contoyiannis et al., 2016; Potirakis et al., 2016 and references therein].
- On the other hand, there is only a handful of studies that have been attempted to correlate ULF pulsations with seismic activity from space-borne measurements [e.g., Balasis and Mandea, 2007 for CHAMP satellite and Walker et al., 2013 for DEMETER satellite].

Central Italy Earthquake (24/08/2016, 01:36:33 UT)



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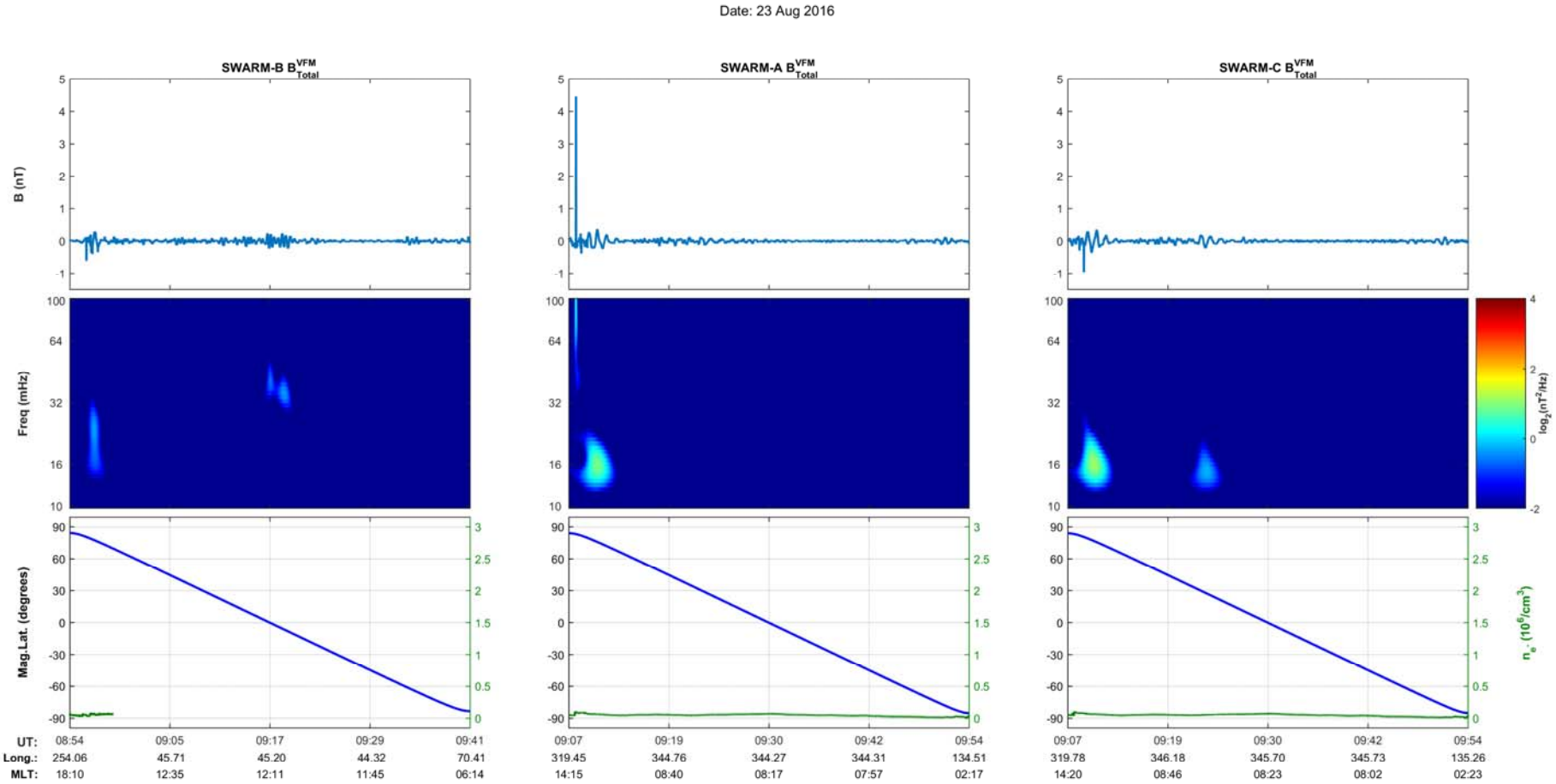
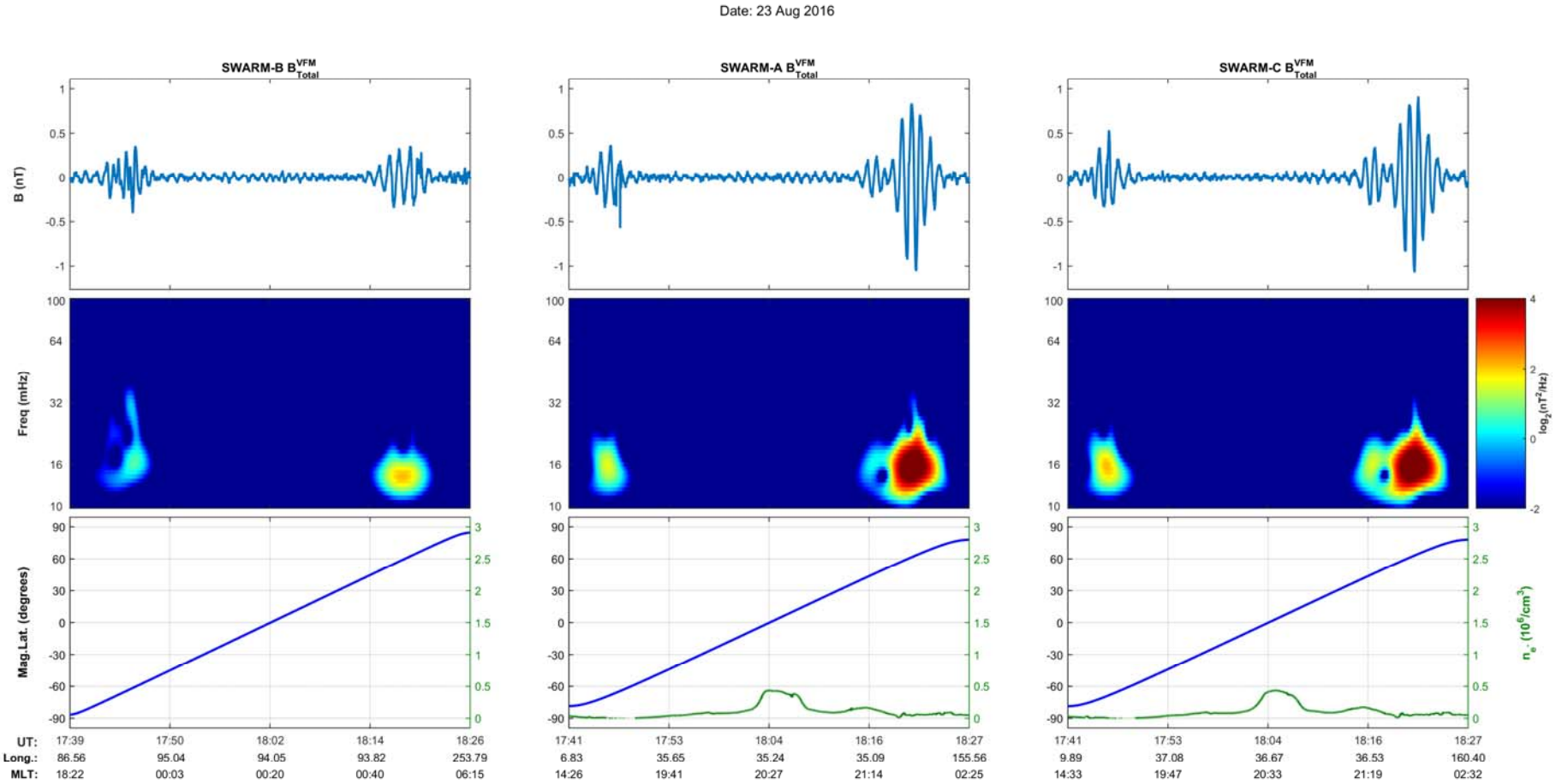
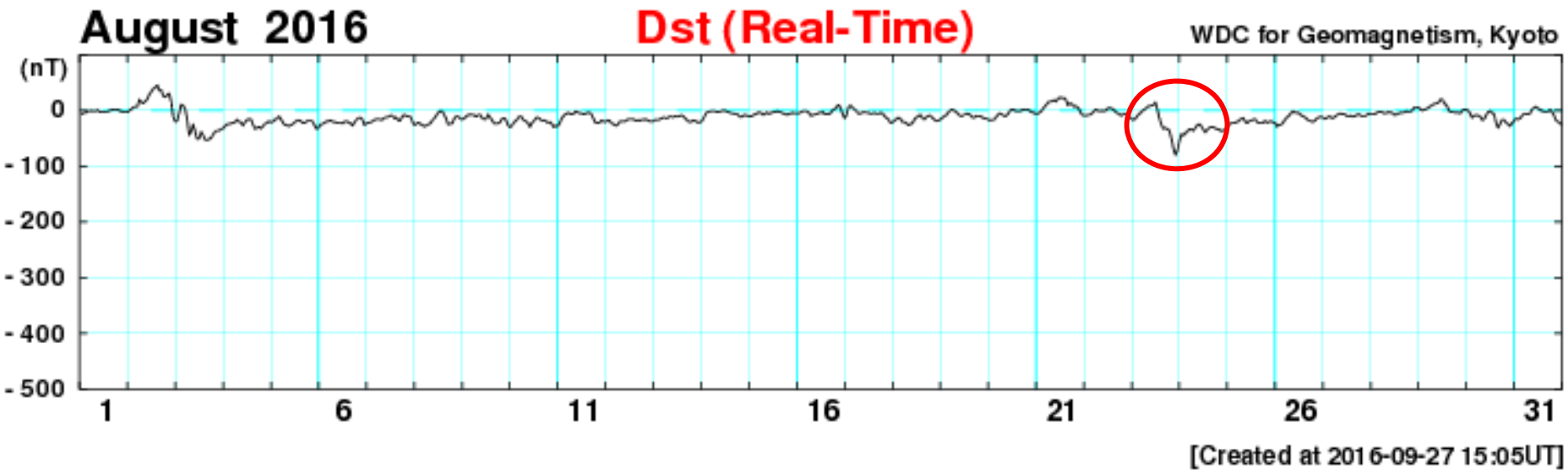


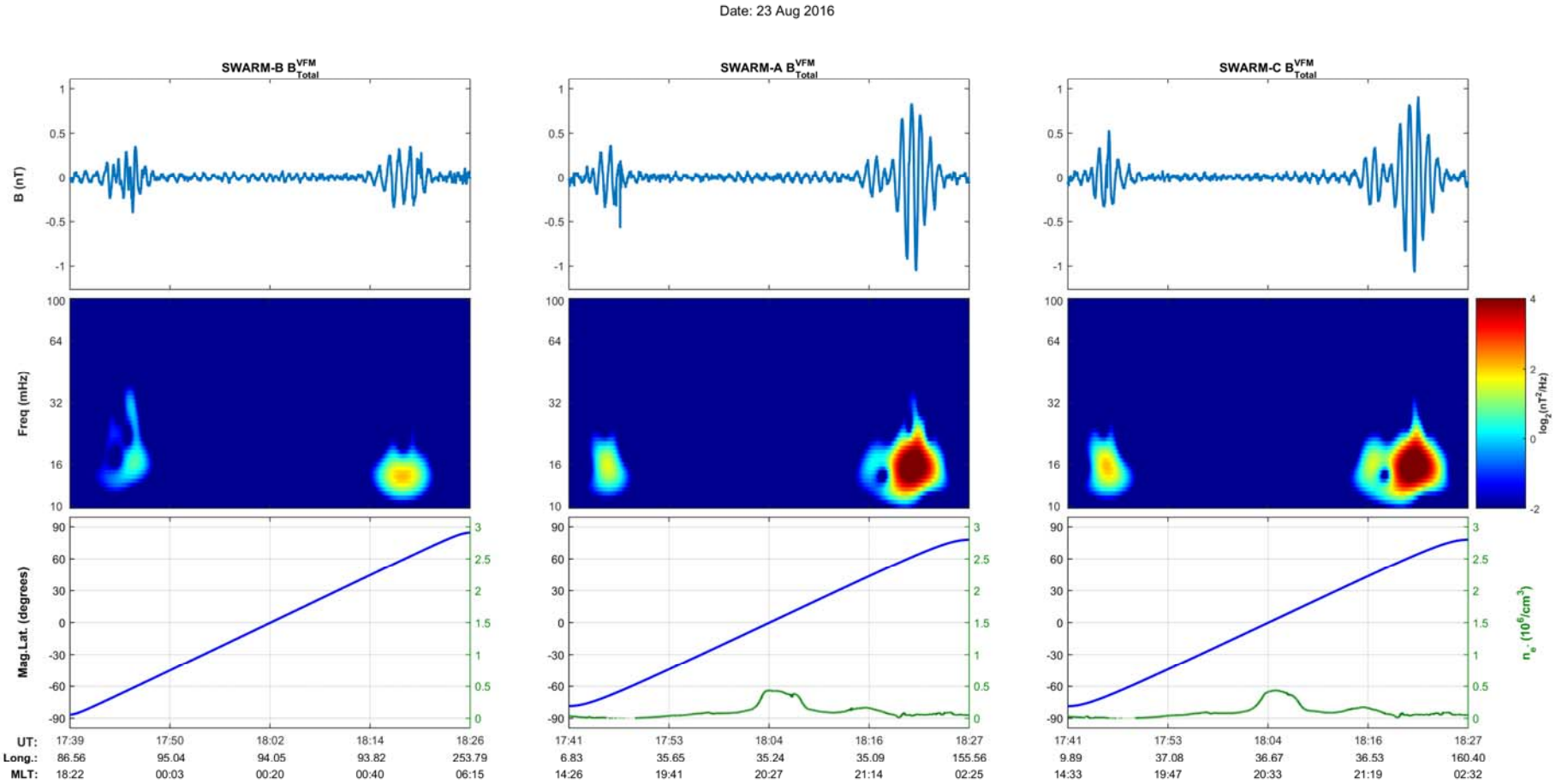
Central Italy Earthquake (24/08/2016, 01:36:33 UT)



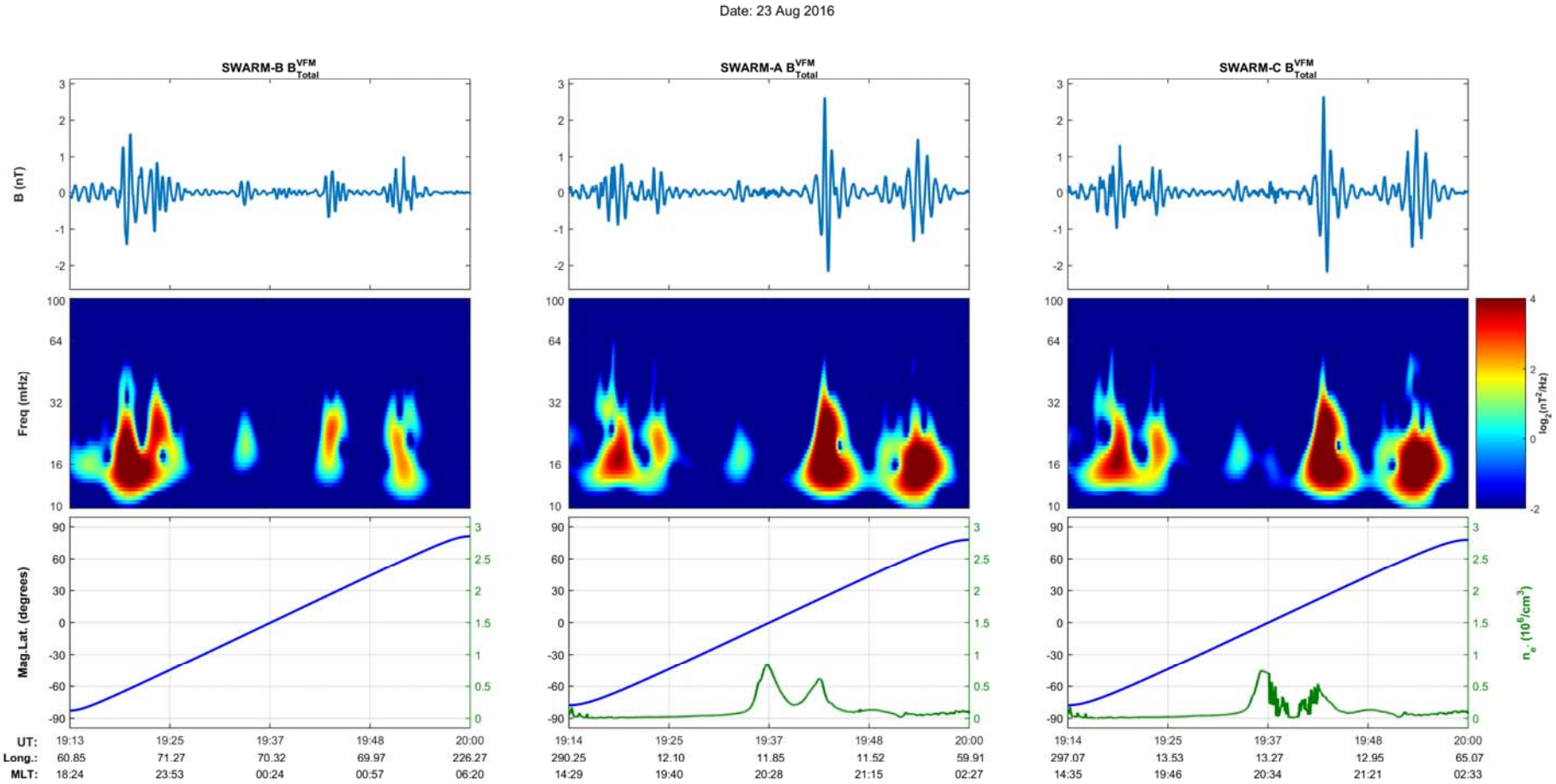
Central Italy Earthquake (23/08/2016, 22:00 UT, Dst = -80 nT)



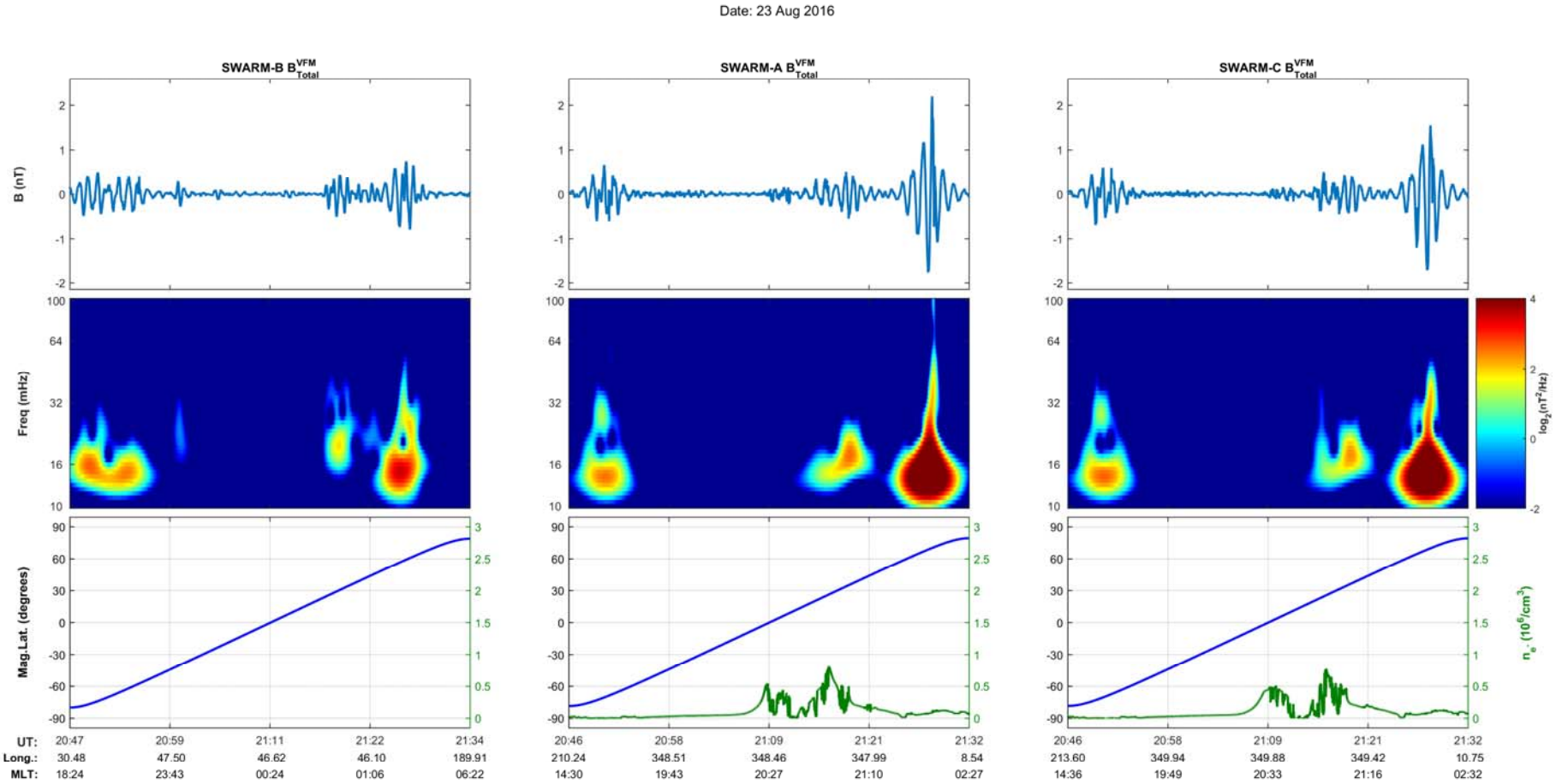
Central Italy Earthquake (24/08/2016, 01:36:33 UT)



Central Italy Earthquake (42.71°, 13.17°)



Central Italy Earthquake (42.71°, 13.17°)



Summary

- Swarm offers a great opportunity to study ULF waves in the topside ionosphere with unprecedented detail leading to new science discoveries.
- Additionally, Swarm may provide new possibilities towards improving the current state-of-the-art in studying satellite data with respect to earthquake-related signals through:
  - The exploitation of lower (1 Hz) but more importantly higher (50 Hz) resolution magnetic field data as well as electric field data from the Swarm mission.
  - The combination with ground magnetic field measurements when conjunctions between Swarm and ground magnetic stations occur.

Thank you for your attention!

ipapoutsis@noa.gr