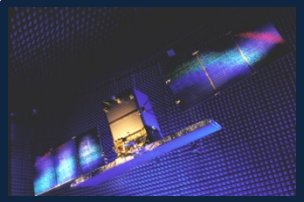
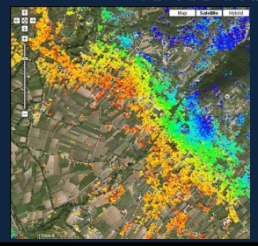
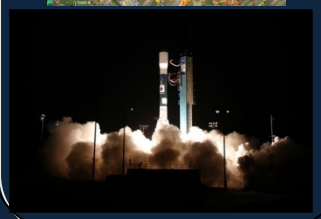






COSMO-SkyMed
Earthquakes in Haiti and L'Aquila

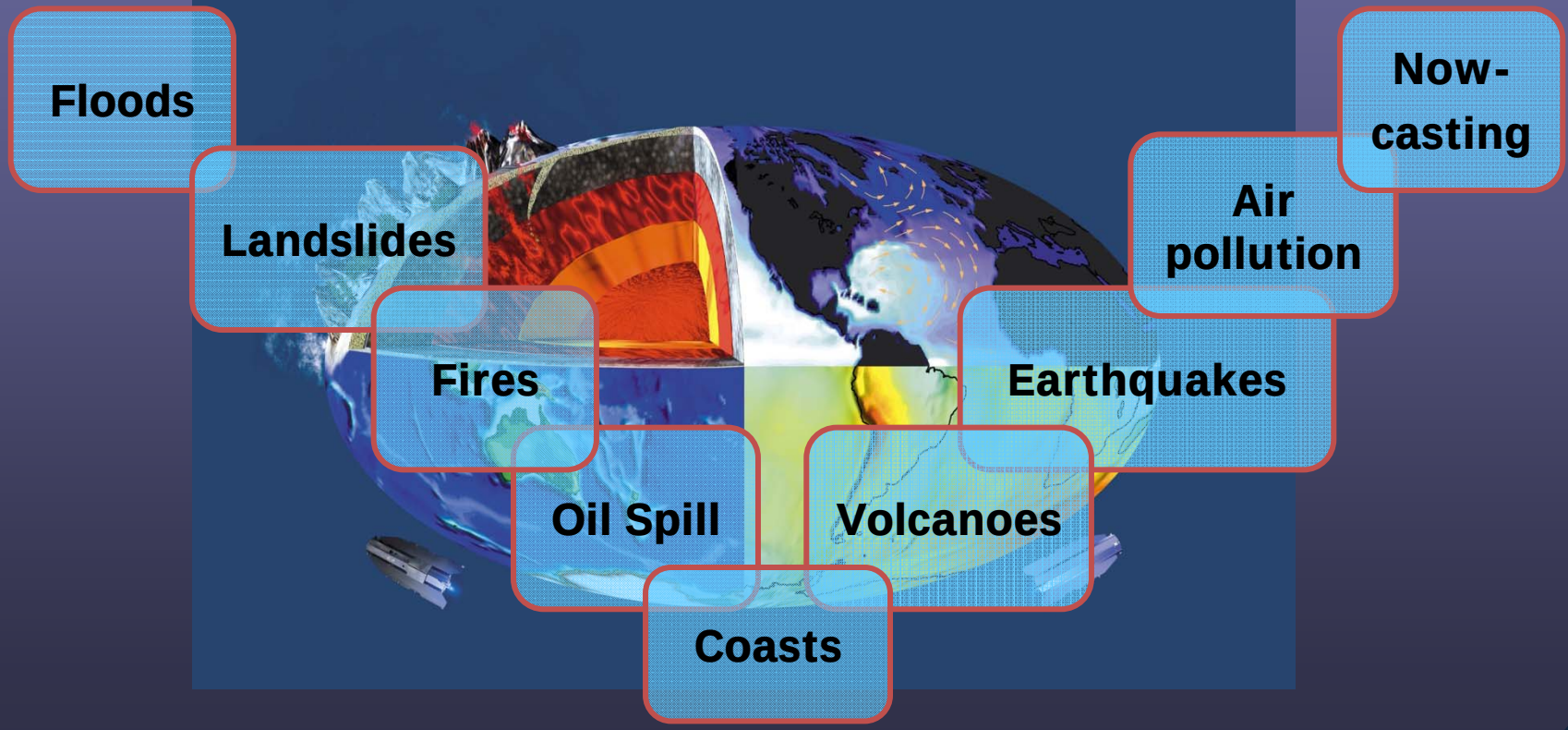
Laura Candela
Romeo Pernice
Italian Space Agency

National on-going activities

- **COSMO-SkyMed and the ASI Applications' program**
  - **Pilot Projects to prove whether EO data could be used to better manage natural and man induced disasters;**
  - **COSMO-Skymed as main resource in managing Emergency Response;**
- **ASI is Centre of Competence for the Earth Observation in the National Civil Protection System**
- **ASI is supporting Italian Civil Protection Department in managing events**
  - **Earthquake in L'Aquila**
  - **Earthquake in Haiti**

ASI EARTH OBSERVATION PILOT PROJECTS

DEVELOPMENT OF DEMO SERVICES FOR ENVIRONMENTAL RISK MONITORING



Use of EO data for Hazard Support

ASI main target is to improve utilization of existing and planned EO satellite data in order to support Civil Protection community in every phase of risk management cycle and in the environmental monitoring

→ **pre-operational application**

Players of this process:

- Users
- Scientists
- Industries

The partnership between Earth Observation (EO) Community and Users is aimed to enforce the role of satellite data in the National System of Civil Protection, developing EO-based systems and new operational procedures.

The National Civil Protection Service

The national early warning system
(DPCM 27/02/2004)

...**is able** to share and exchange information, through common standards and procedures and it is targeted the general real time forecast and assessment of the risk scenarios...

is provided by DCP and Regions by the "Centri Funzionali" National Network, along with the "Centri di Competenza" involved in hazard assessment and surveillance activities....

"Centro Funzionale" = Centre for Forecasting and Surveillance of Effects to support the civil protection Authority decisions (CFSE)

ASI - Centro di Competenza per l'Osservazione della Terra (Centre of excellence for Earth Observation) in the Italian Civil Protection System

Use of EO data for Hazard&Risk assessment and Civil Protection actions

There have been research and operational demonstrations that illustrate the potential usefulness of EO satellite data for a broader range of hazards, and PC has started to use EO data for PC activities, even if " … *the operational application of these data is still quite limited*" (*).

PC target is to foster improved utilization of existing and planned Earth Observation (EO) satellite data to support users in every phase of risk management cycle (Pre-disaster, Emergency response, Post Disaster).

(*) CEOS Report on Disaster Management

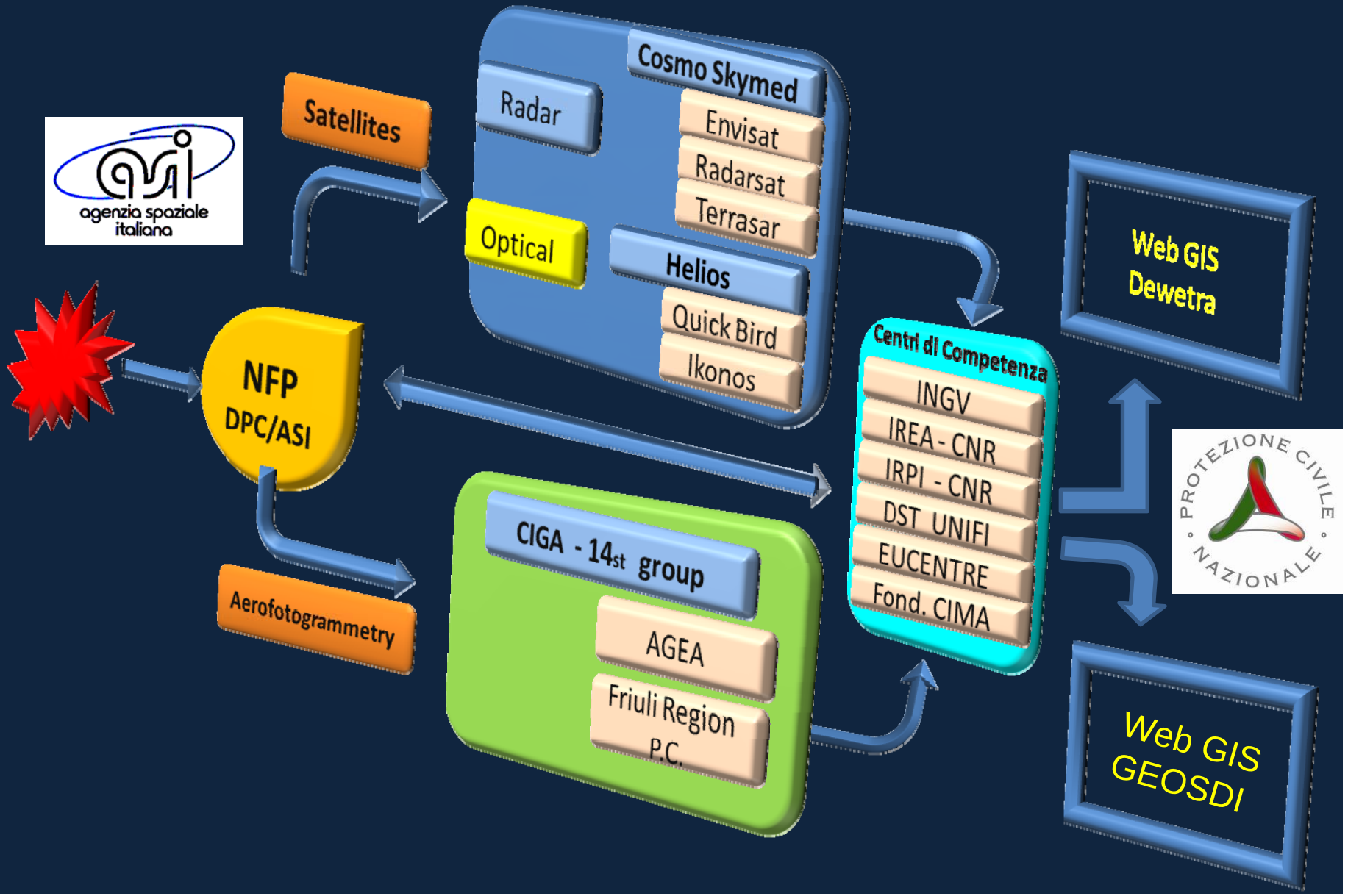
Needs and EO products in Emergency Response

Information Needs

- **Reference maps**
  - Place names, human and economical assets, infrastructures
  - Updated background (especially outside EU)
  - Available **within 6 hours**
  - Scale 1:100,000 (overview) – 1:25,000 (tactical)
  - TAKING ADVANTAGE OF EXISTING GIS AND MODELS
- **As**
  -
  -
  -
  -
  -

	Product content	Service requirements
Reference	Population: location and density Critical infrastructures (communication, transportation, energy, health & sanitation). Topography Major Rivers. Place names Vulnerability maps where available	Available within 6 hours Scale:1:100,000 (overview) and 1:10,000 to 1: 25,000 (detailed)
Assessment	Location & extent of damage (at local, country and regional scales). Type and severity of damage (at local, country and regional scales) Temporal situation assessment of disasters such as oil spills, floods, fires, etc	Available within 12-24 hours, Scale: 1:50,000 (overview) and 1: 10,000 (detailed)

ASI National Focal Point in emergency response



L'Aquila earthquake

ASI and DPC activate National Focal Point
(pre-operational)

Italy

L'Aquila (Abruzzo) Earthquake

06 April 09

Time: 3:32 a.m.

6.3 magnitude

ASI was activated at 7:00 a.m.

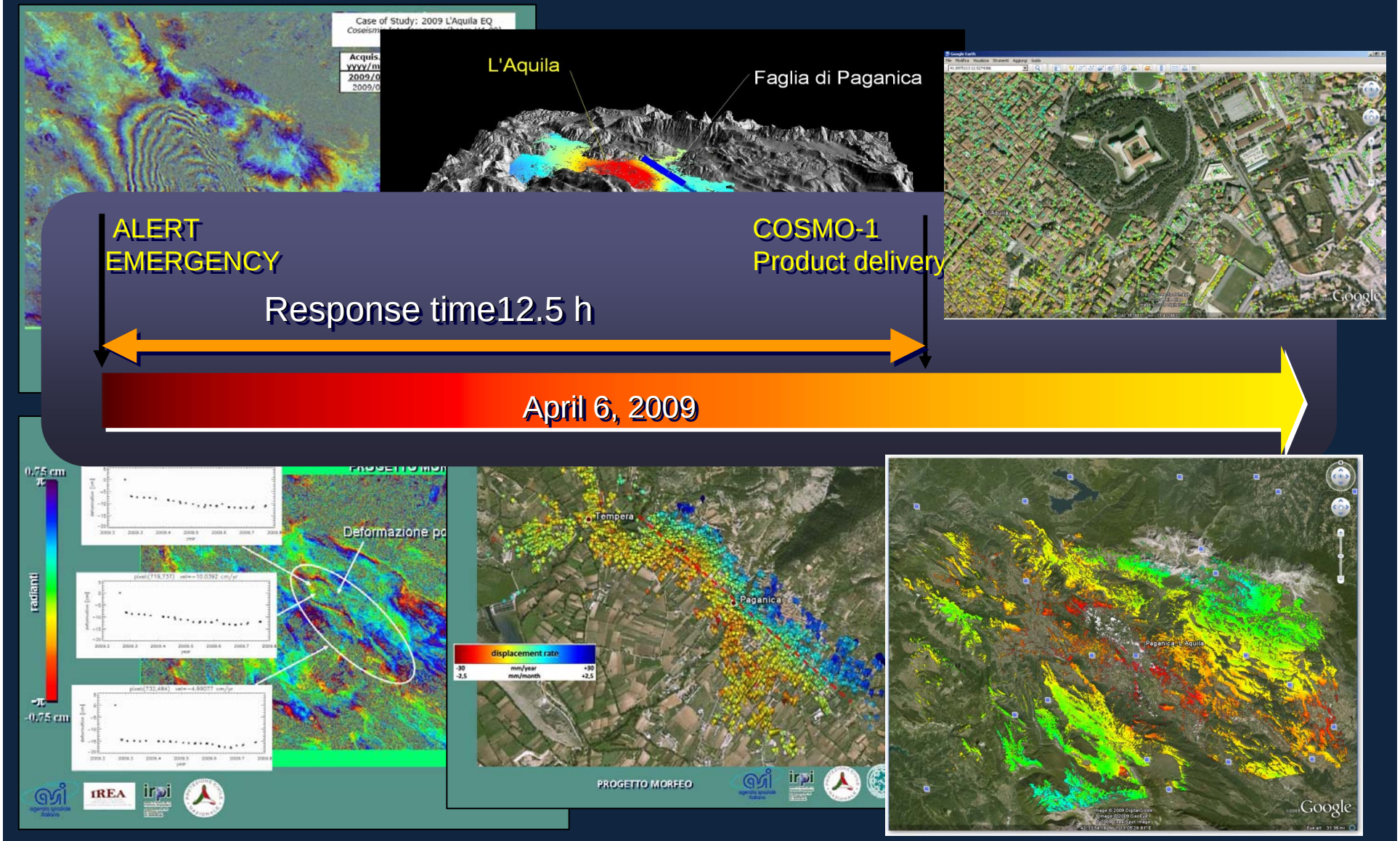
Flow request CosmoSkymed

Time	Date	Acquisition
7.30	06/04/09	Request acquisitions
17.29	06/04/09	1st usefull passage
4.24	07/04/09	Sar 3 (spot)
4.54	07/04/09	Sar 1 (strip)
05.12	08/04/2009	strip
16.59	08/04/2009	strip
17.1	08/04/2009	strip
18.05	08/04/2009	spot

Crisis mode

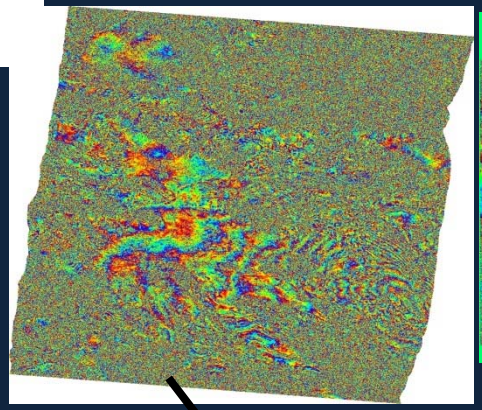
COSMO SkyMed
KEEPING AN EYE ON THE WORLD

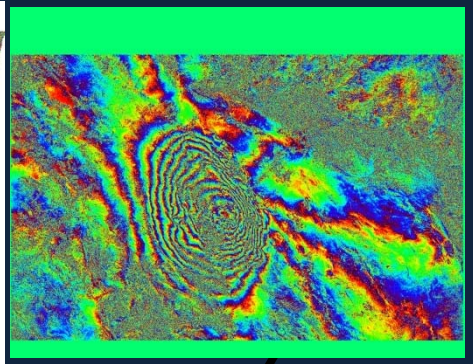
COSMO-SkyMed
L'Aquila ABRUZZO April 6°, 2009



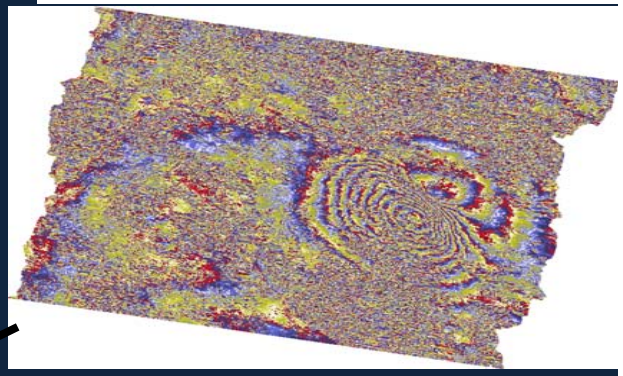
Interferometric analysis IREA-CNR

COSMO-SkyMED





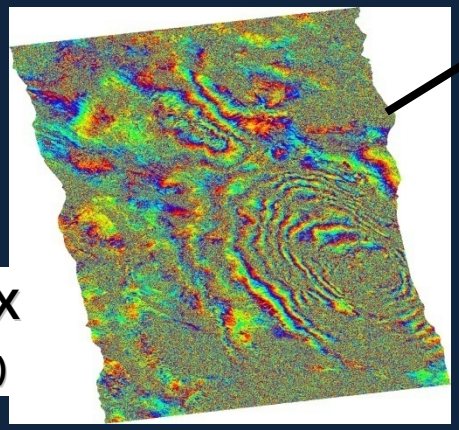
ENVISAT (DESCENDING)



L' Aquila Earthquake
Mw = 6.3

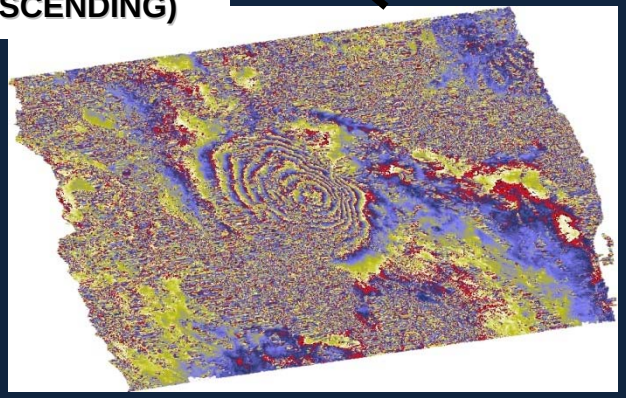
Timeline

06.04 08.04 10.04 12.04 15.04 16.04



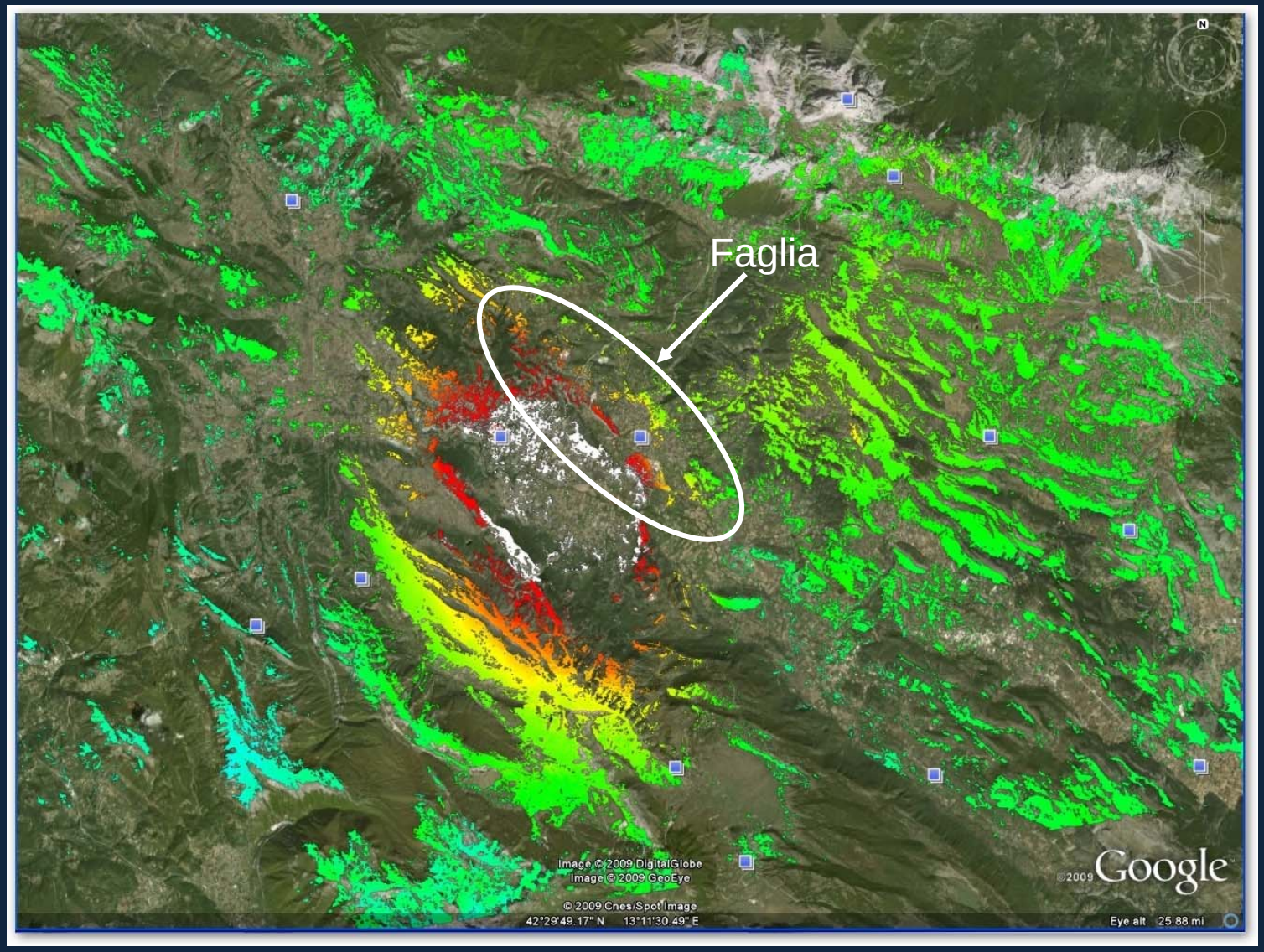
TerraSAR-X (ASCENDING)

ENVISAT (ASCENDING)

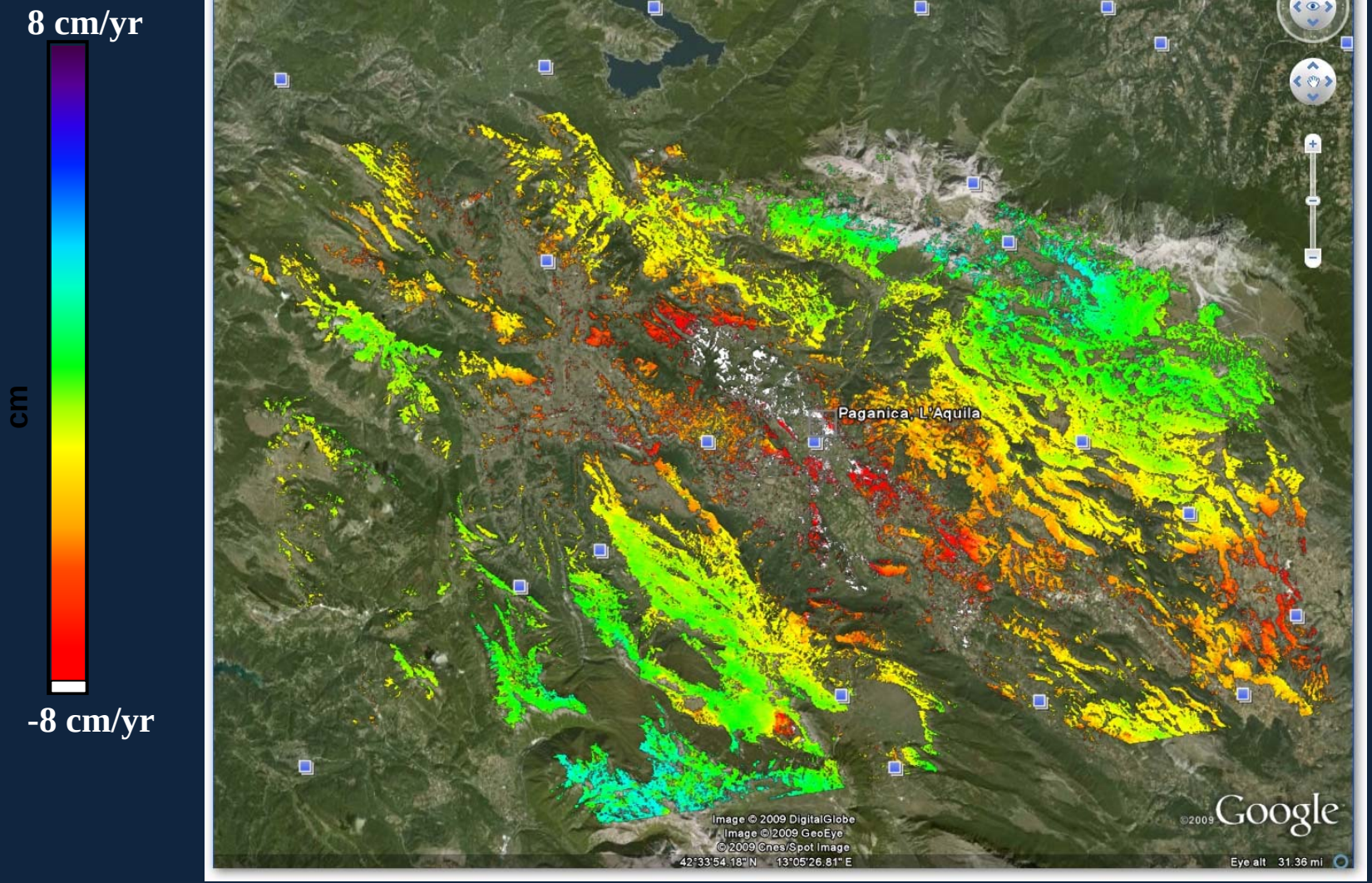


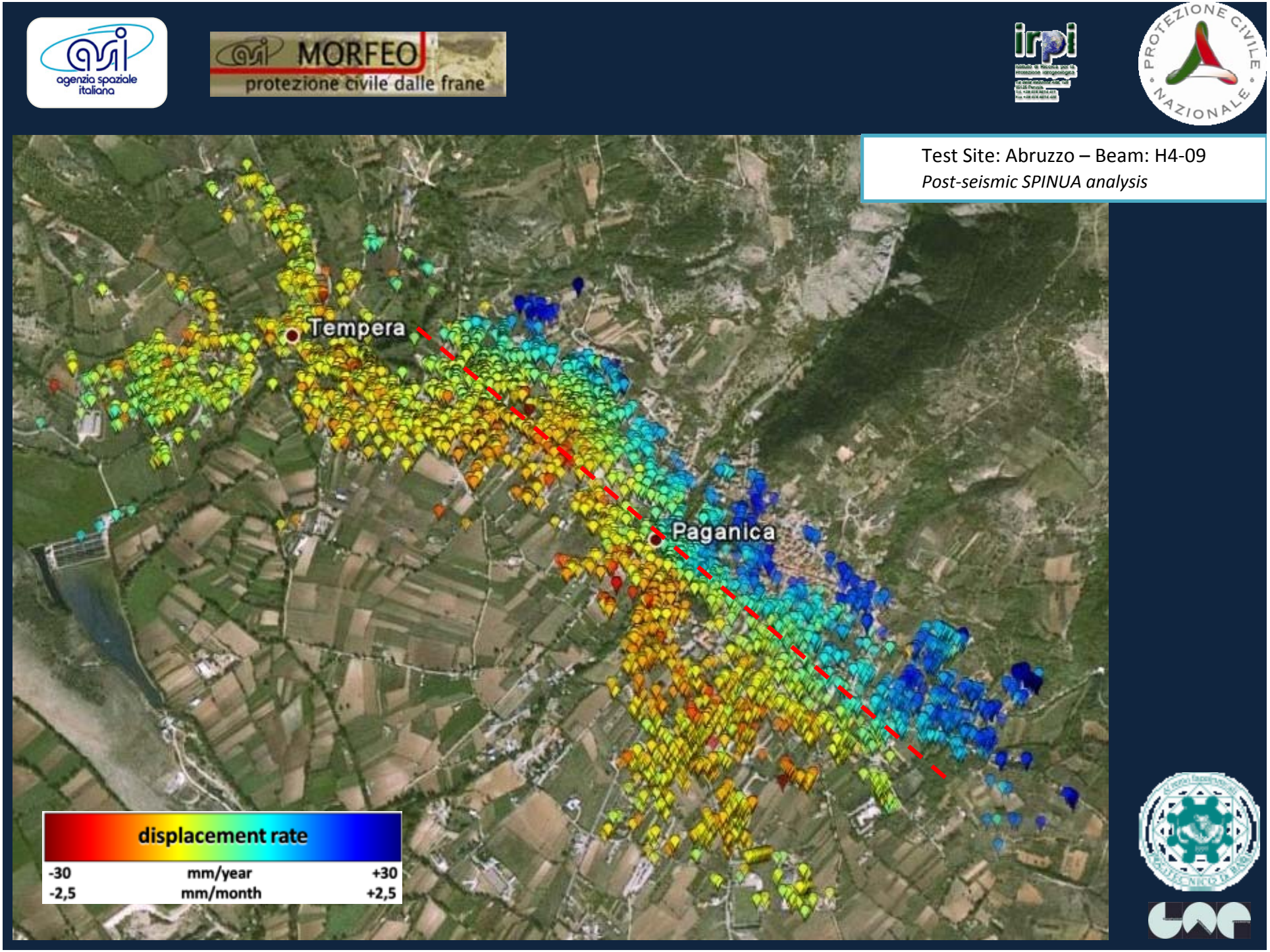
IREA

Co-seismic displacements: 4/4/09 - 12/4/09



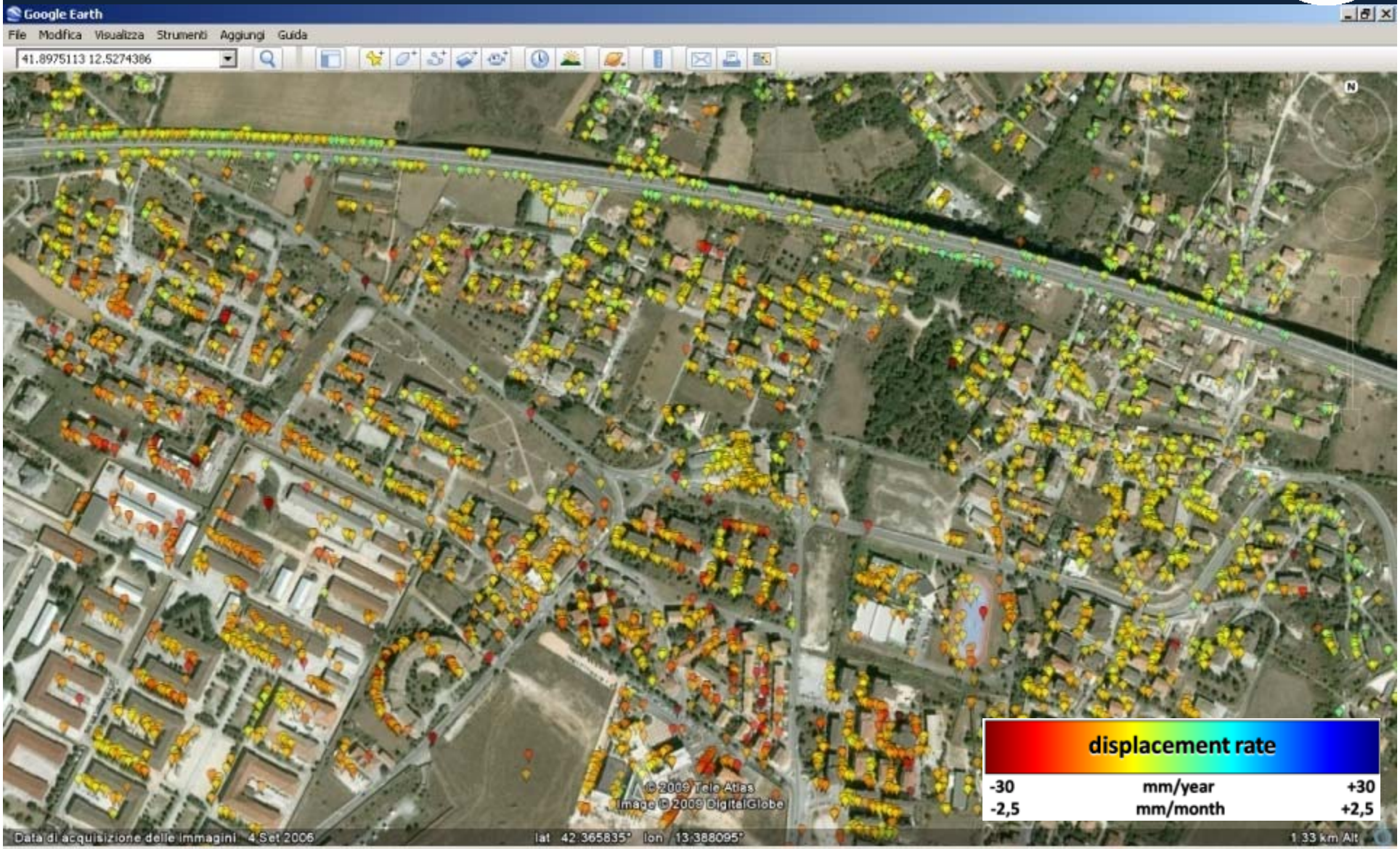
Post-seismic monitoring

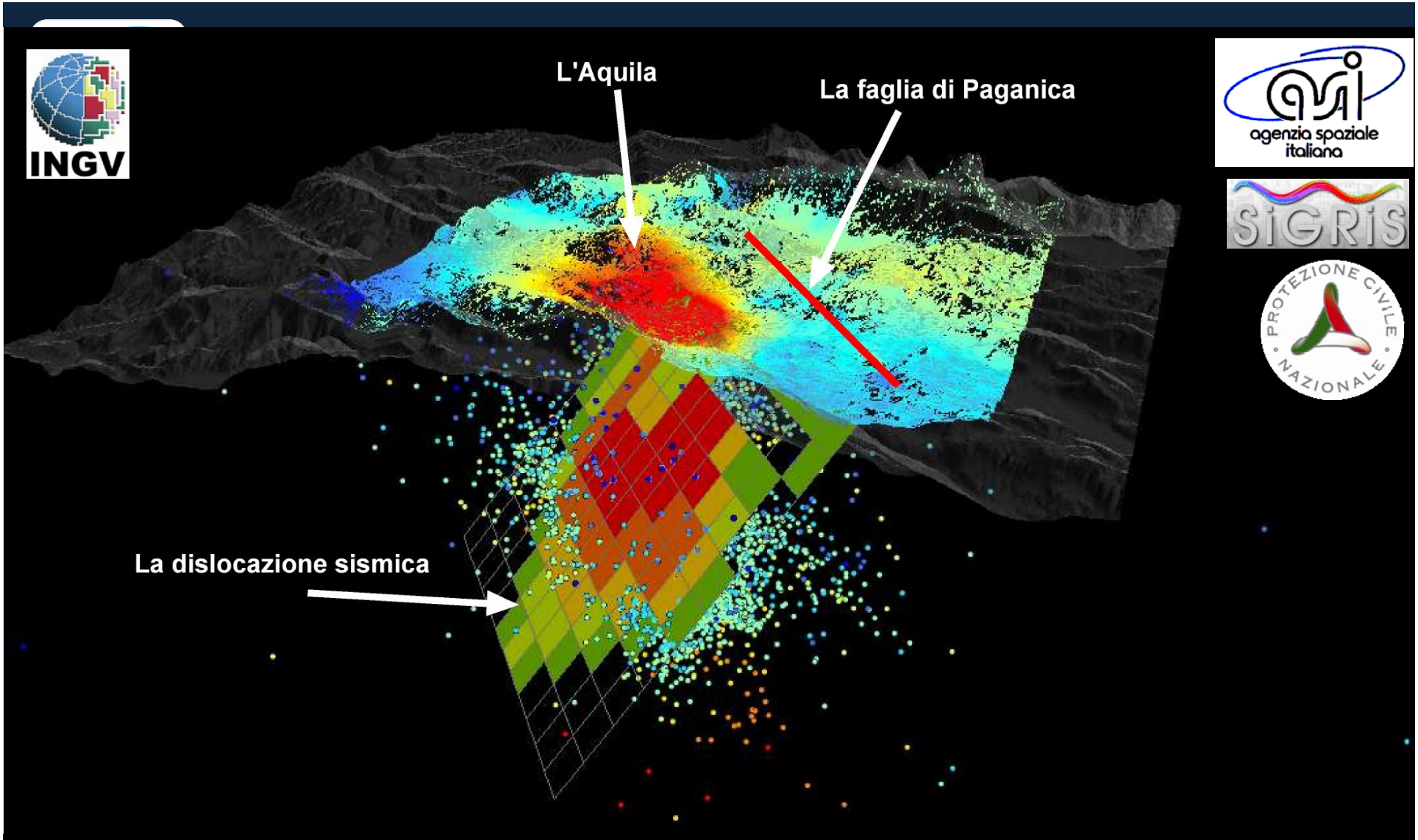



Test Site: Abruzzo – Beam: H4-09
Post-seismic SPINUA analysis
Tempera
Paganica
displacement rate
-30 mm/year +30
-2,5 mm/month +2,5

Test Site: L'Aquila – Beam: H4-09

Post-seismic SPINUA analysis





La massima dislocazione sul piano di faglia (in rosso) corrisponde al massimo abbassamento del suolo (-25 cm) misurato dal satellite COSMO-SkyMed

Cosmo SkyMed imaging on L'Aquila

Date / time	Mode	Orbit	Pol.	Look	Angle	Sat.
06/04/09 17.29.29	Strip	Desc	VV	Right	21.8	SAR1
07/04/09 04.24:36	Strip	Asc	HH	Left	30.6	SAR1
07/04/09 04.54:39	Spot	Asc	HH	Right	19	SAR3
08/04/09 05.12:41	Strip	Asc	HH	Right	41	SAR3
08/04/09 16.59:20	Strip	Desc	VV	Right	51.6	SAR3
08/04/09 17.17:25	Strip	Desc	HH	Right	36	SAR2
08/04/09 18.05:28	Spot	Desc	HH	Left	37.5	SAR1

Acquiring up to 6 images per days, using all possible modes and viewing geometries.
During the following month over 100 images were acquired, ~3 per day on average.
Dense coverage allowed by the high flexibility of the system (right and left looking side capability on the orbit passes, using variable incidence angles)
For six months, COSMO perform sistematic interferometric acquisitions over the whole area of interest (6 acquisitions every 16 days)

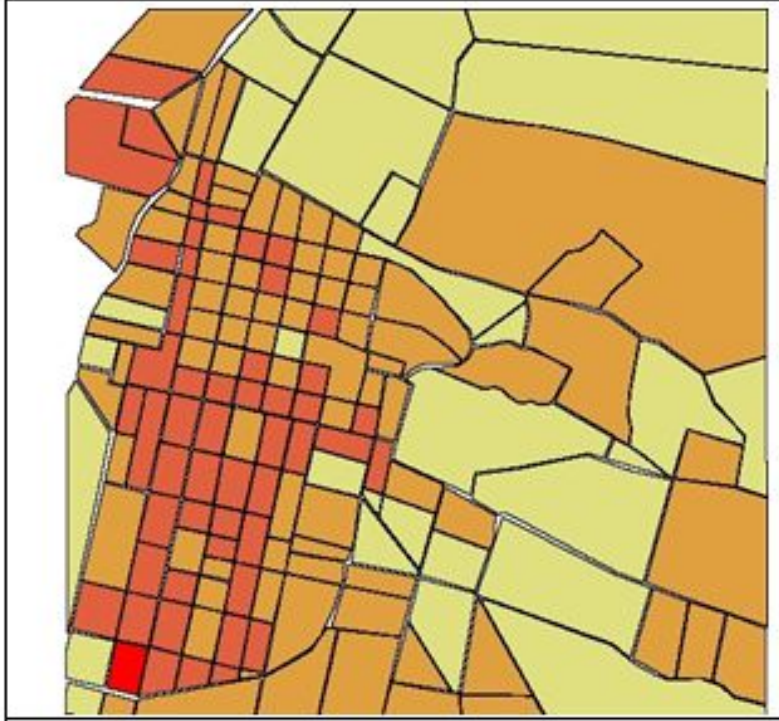
Earthquake in HAITI

First COSMO-SkyMed acquisition

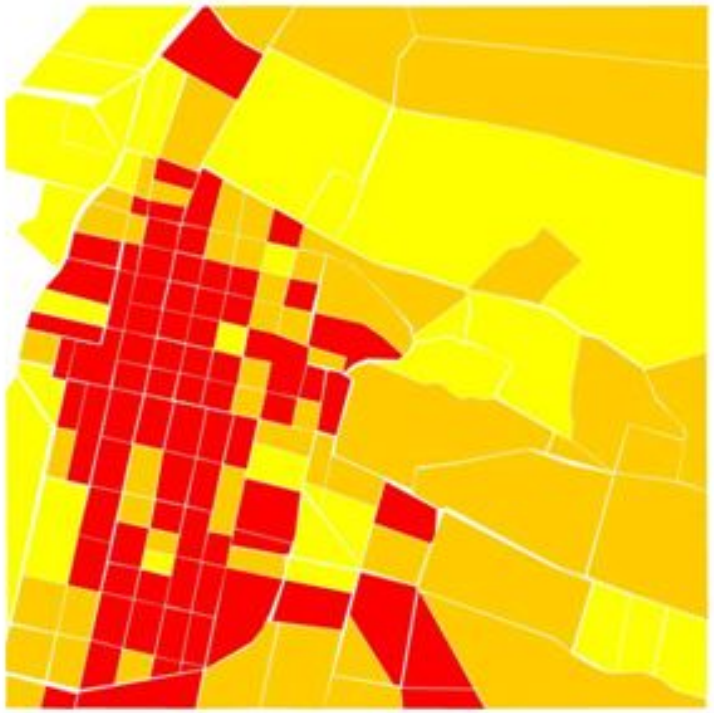
14 Jan 2010

Data acquisizione	Sensor mode	Look side	Orbit	Sar
10/09/2008 10.31.05	HI	Left	Ascending	SAR 1
10/09/2008 22.47.54	HI	Right	Descending	SAR 1
26/04/2009 22.51.49*	HI	Right	Descending	SAR 2
12/12/2009 11.02.04	S2	Right	Ascending	SAR 2
01/01/2010 22.37.03	HI	Right	Descending	SAR 2
14/01/2010 22.30.47*	S2	Right	Descending	SAR 1
14/01/2010 23.18.46*	HI	Left	Descending	SAR 2
15/01/2010 22.48.46*	HI	Right	Descending	SAR 1
15/01/2010 23.18.45	HI	Left	Descending	SAR 3
16/01/2010 23.36.47	S2	Left	Descending	SAR 3
17/01/2010 10.19.29*	S2	Left	Ascending	SAR 3
17/01/2010 23.24.49	S2	Left	Descending	SAR 1
18/01/2010 22.36.44	HI	Right	Descending	SAR 3
19/01/2010 10.25.39	HI	Left	Ascending	SAR 1
19/01/2010 10.55.25*	HI	Right	Ascending	SAR 3
20/01/2010 22:42:24	HI	Right	Descending	SAR 1
21/01/2010 11.01.27	S2	Right	Ascending	SAR 1
23/01/2010 22.48.41	HI	Right	Descending	SAR 2
23/01/2010 23.36.40	S2	Left	Descending	SAR 1
24/01/2010 22.48.40	HI	Right	Descending	SAR 3
25/01/2010 23.24.48	S2	Left	Descending	SAR 2
29/01/2010 11.01.22	S2	Right	Ascending	SAR 2
30/01/2010 11.01.21	S2	Right	Ascending	SAR 2

Mappe delle classi di danno sul centro di Port-au-Prince



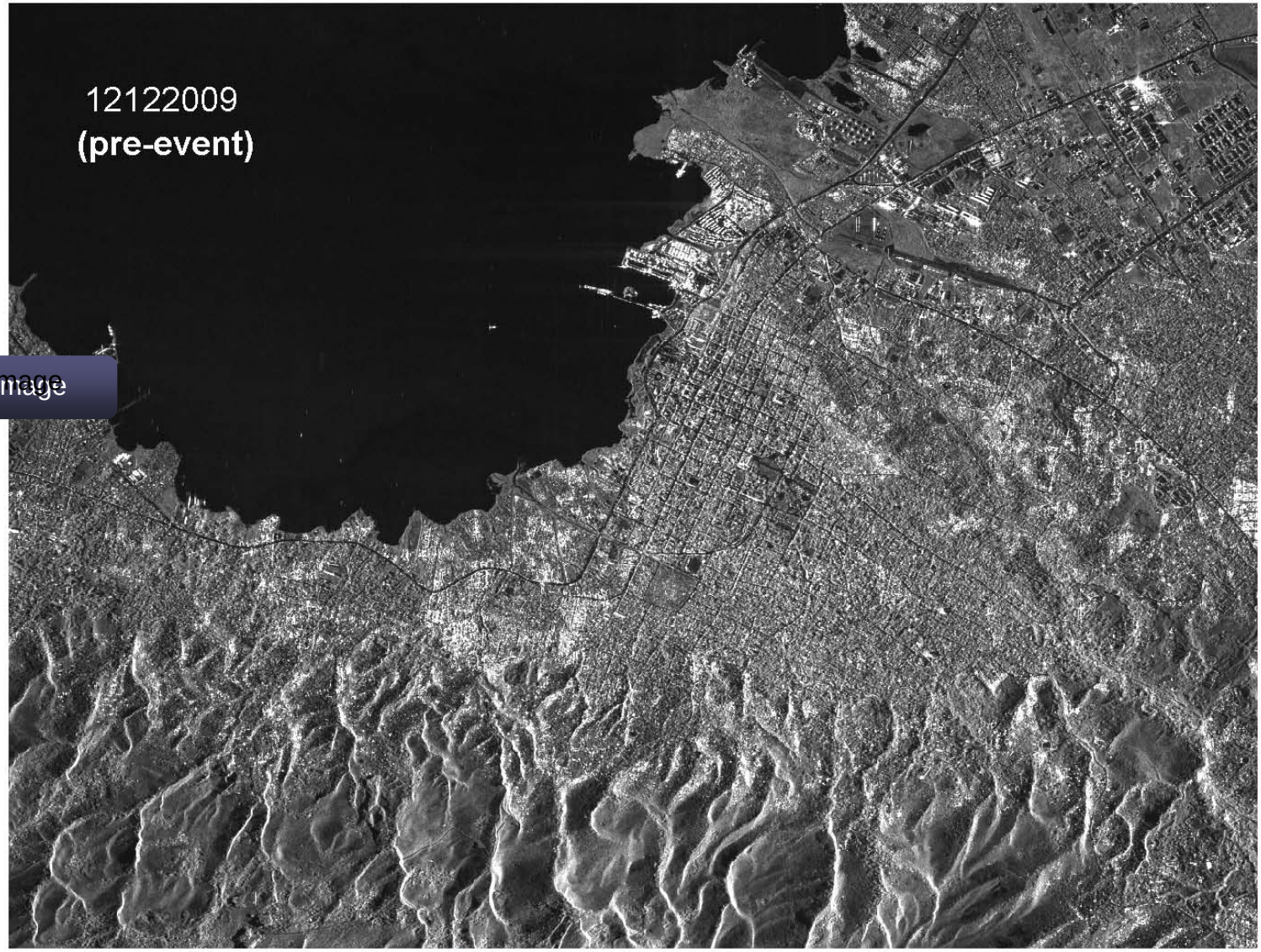
Mappa dei danni su ipotesi formulata



Mappa dei danni derivata da mappa Charter

Eucentre – Damage map (using COSMO-Skymed data)

COSMO-SkyMed Sisma Haiti Gennaio 2010



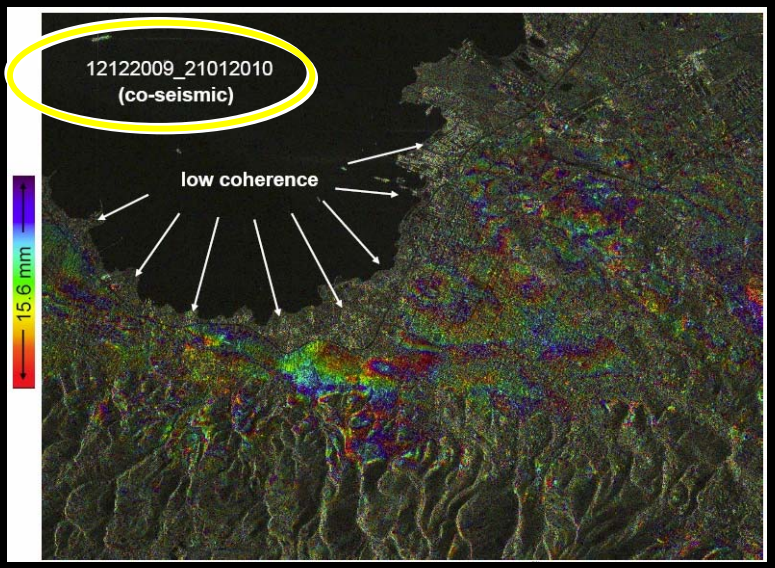
Spotlight 2 Image

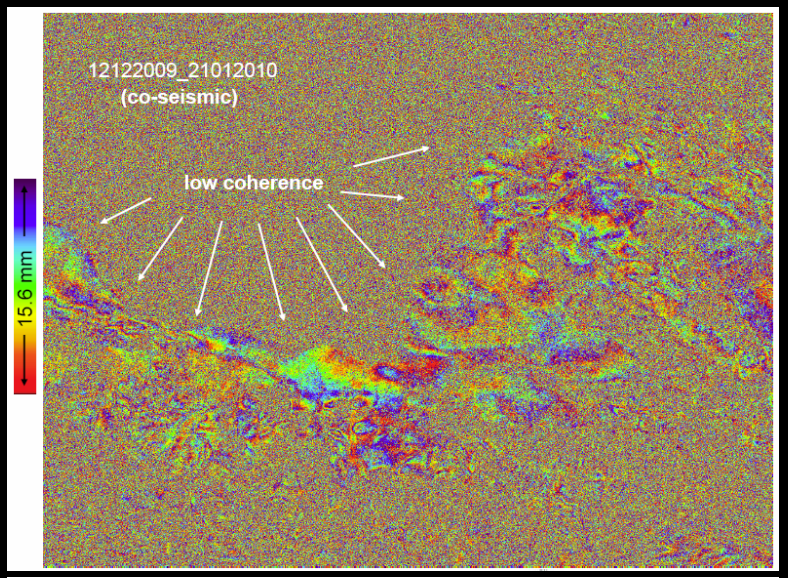
COSMO-SkyMed Sisma Haiti Gennaio 2010

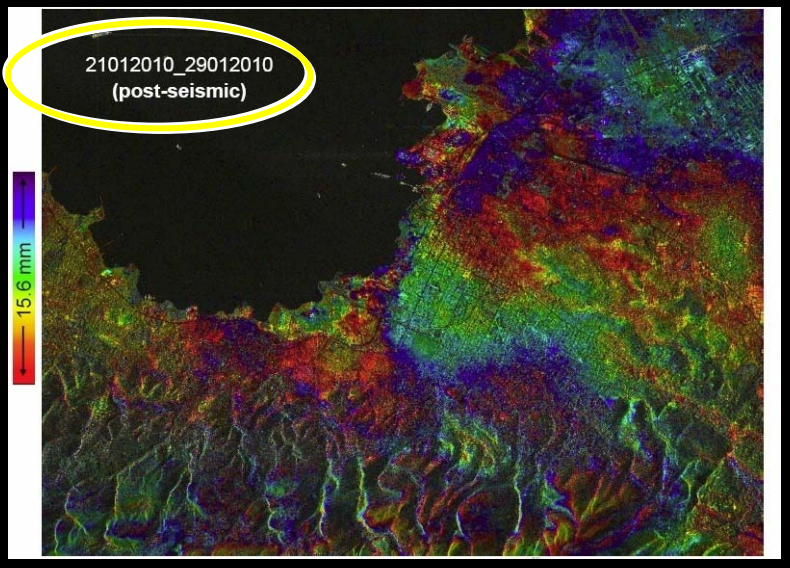
Spotlight 2 Image

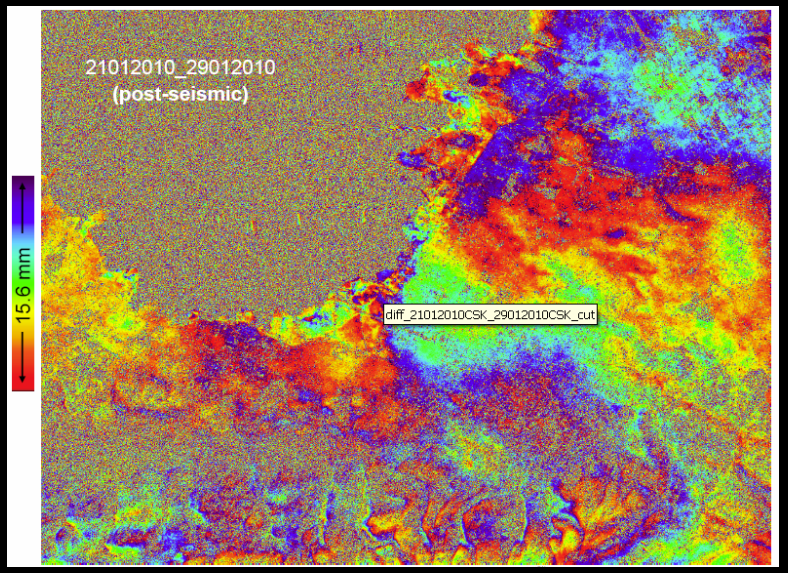
COSMO-SkyMed Sisma Haiti Gennaio 2010

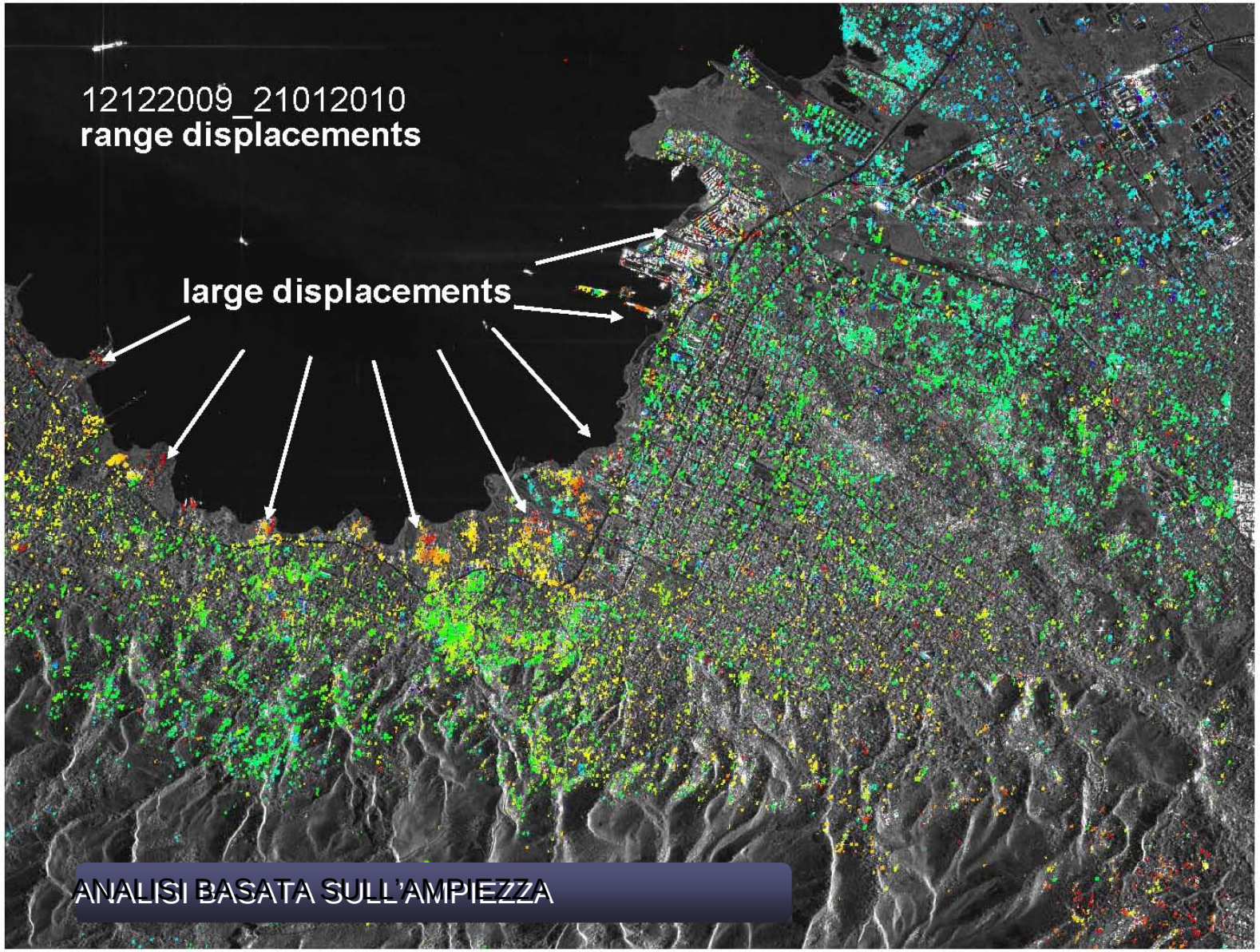
Interferogrammi Spotlight 2





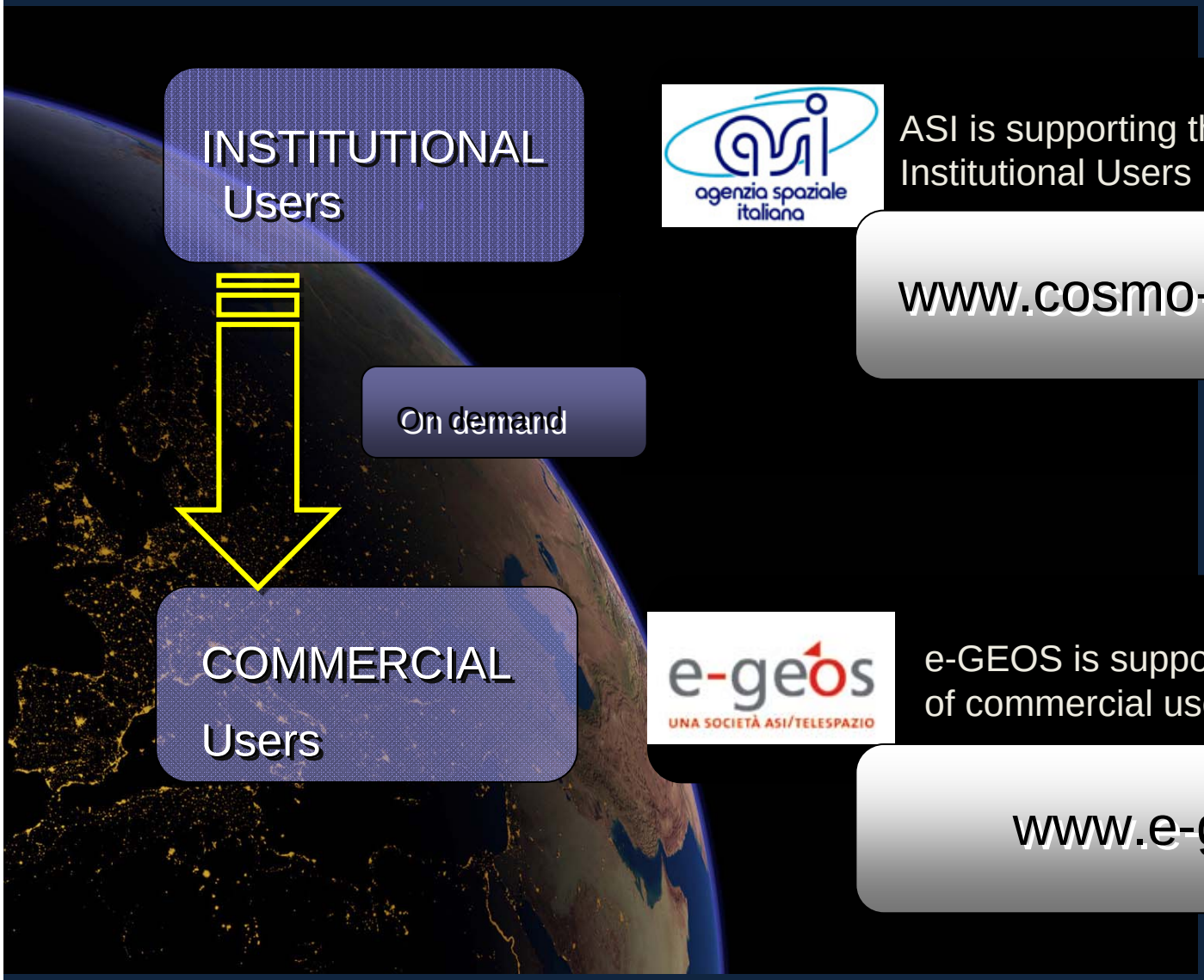






ANALISI BASATA SULL'AMPIEZZA

CIVIL USERS – COSMO-SkyMed



INSTITUTIONAL Users

On demand

COMMERCIAL Users

ASI is supporting the data exploitation of Institutional Users

www.cosmo-skymed.it

e-GEOS is supporting data exploitation of commercial users

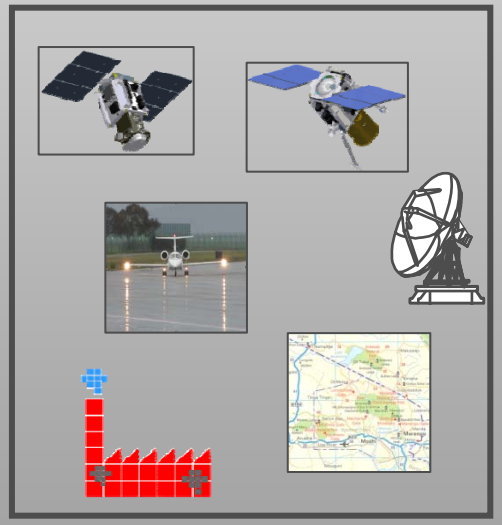
www.e-geos.it

What is e-GEOS?

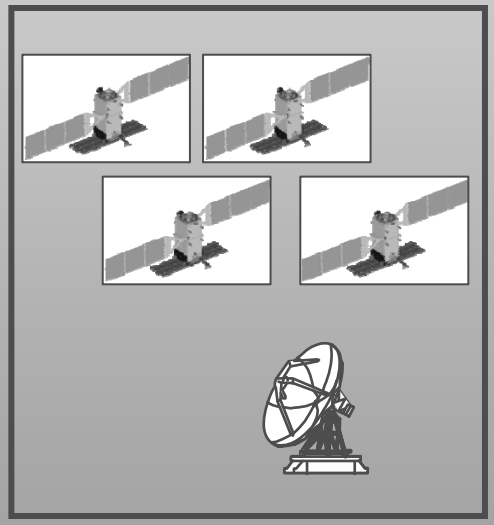
e-geos
AN ASI / TELESPAZIO COMPANY

TELESPAZIO
A Finmeccanica / Thales Company

agenzia spaziale italiana



EO Division



COSMO-SkyMed

Mission

To be a leading player
in the geo-spatial information business

- ***with*** **an integrated offering of products, application solutions and services**
- ***based*** **on radar and optical data from both multi-satellite and aerial platforms,**
- ***leveraging*** **COSMO-SkyMed operational capabilities**

Multi-Satellite and Aerial Data Provider

- **COSMO-SkyMed: world-wide Exclusive data distributor**
  - Operator of COSMO-SkyMed User Ground Segment in Matera (Italy)
- **GeoEye-1 and IKONOS: exclusive distribution in Europe and Northern Africa**
  - imaging capability in Neustrelitz, Germany
- **QuickBird-2, WorldView-1/2: DigitalGlobe European Master Distributor**
- **Radarsat 1 – 2: MDA partner in Europe**
  - direct reception agreement in Matera (Italy)
- **IRS (P6, Cartosat-1/2, 1C/1D): exclusive distribution in Europe**
  - direct reception agreement in Neustrelitz (Germany)
- **EROS A – EROS B: agreement with ImageSat**
- **Envisat, ERS 1-2, ALOS and Landat: ESA partner**
- **ASTER: agreement with ERSDAC**
- **SPOT, Formosat-2 and Kompsat-2: agreement with SpotImage**
- **Aerial data: Telaer system**
  - multispectral, radar, lidar


Site Monitoring


Analysis & Intelligence


Border Control


Mapping


Maritime Surveillance


Crisis Management

Emergency Responce -ER- to Disaster


Haiti Earthquake


L'Aquila Earthquake

ER for Haiti Earthquake

e-GEOS has played an active role at:

- **National level**

  a. dedicated **W**eb**M**ap**S**ervice hosted by e-GEOS serving the very first GeoEye images of Haiti in the Civil Protection crisis room;
  b. COSMO-SkyMed data processing.

- **International level**

- **(UN-DFS, It. MoD, It. MAE, ES Red Cross, ITHACA/WFP)**
  - a. G-MOSAIC Rapid Mapping service (damage assessment and roads trafficability over Port-au-Prince, Jacmel and Leogane);
  - b. Cooperation with ITHACA to perform damage assessment.

Focus: G-MOSAIC Rapid Geographic Reporting

EC FP7 Pilot Project for GMES Security

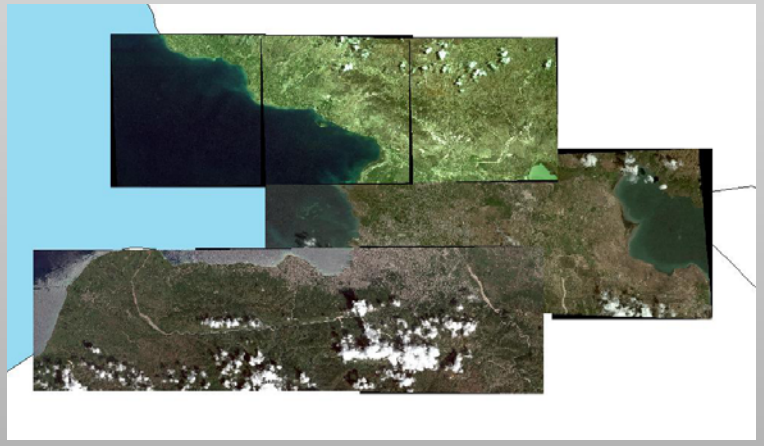
activated on January 14th, 2009 by:

UN-DFS, It. MoD, It. MAE, ES Red Cross

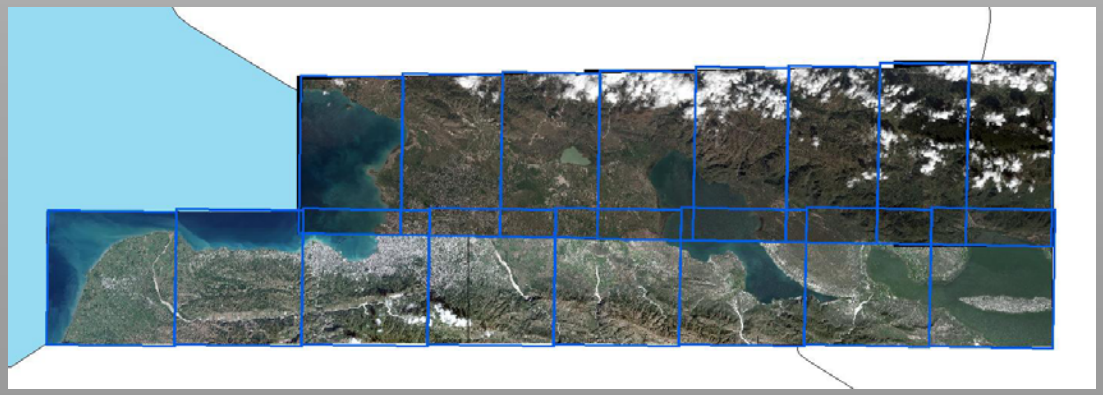
- ***Products provided*** **(**vector [shp,kml]+ digital maps**):**
  - Damage assessment (building)
  - Trafficability analysis (GO, Lim. GO, NO GO)
  - Report on harbour and airport conditions
- ***Area covered***
  - Port-au-Prince (16.01.2010)
  - Leogane (22.01.2010)
  - Jacmel (22.01.2010)
  - Port-au-Prince → Leogane (on going)

ER for Haiti Earthquake

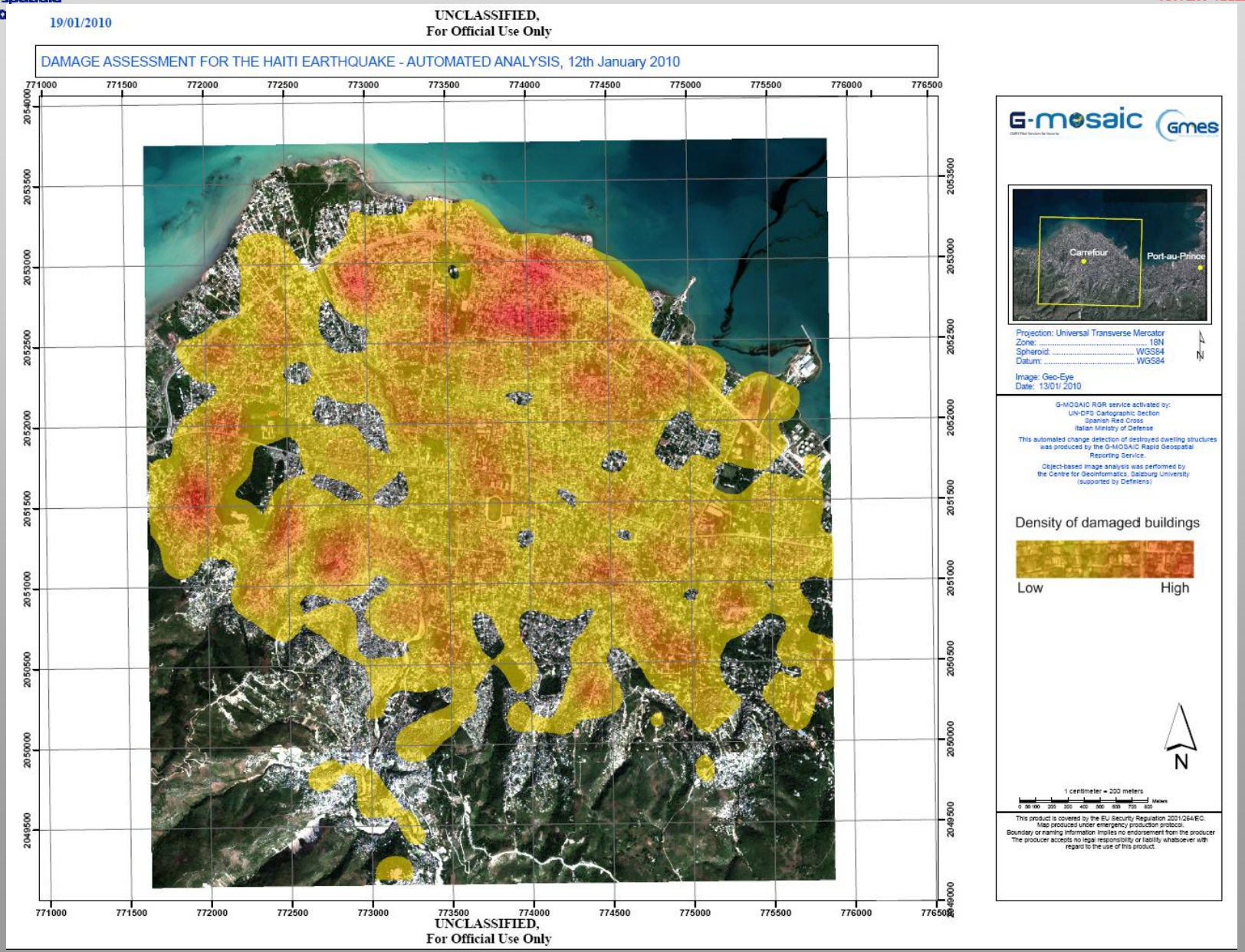
- **Immediate analysis of best available data:**
  - GeoEye-1 before the event



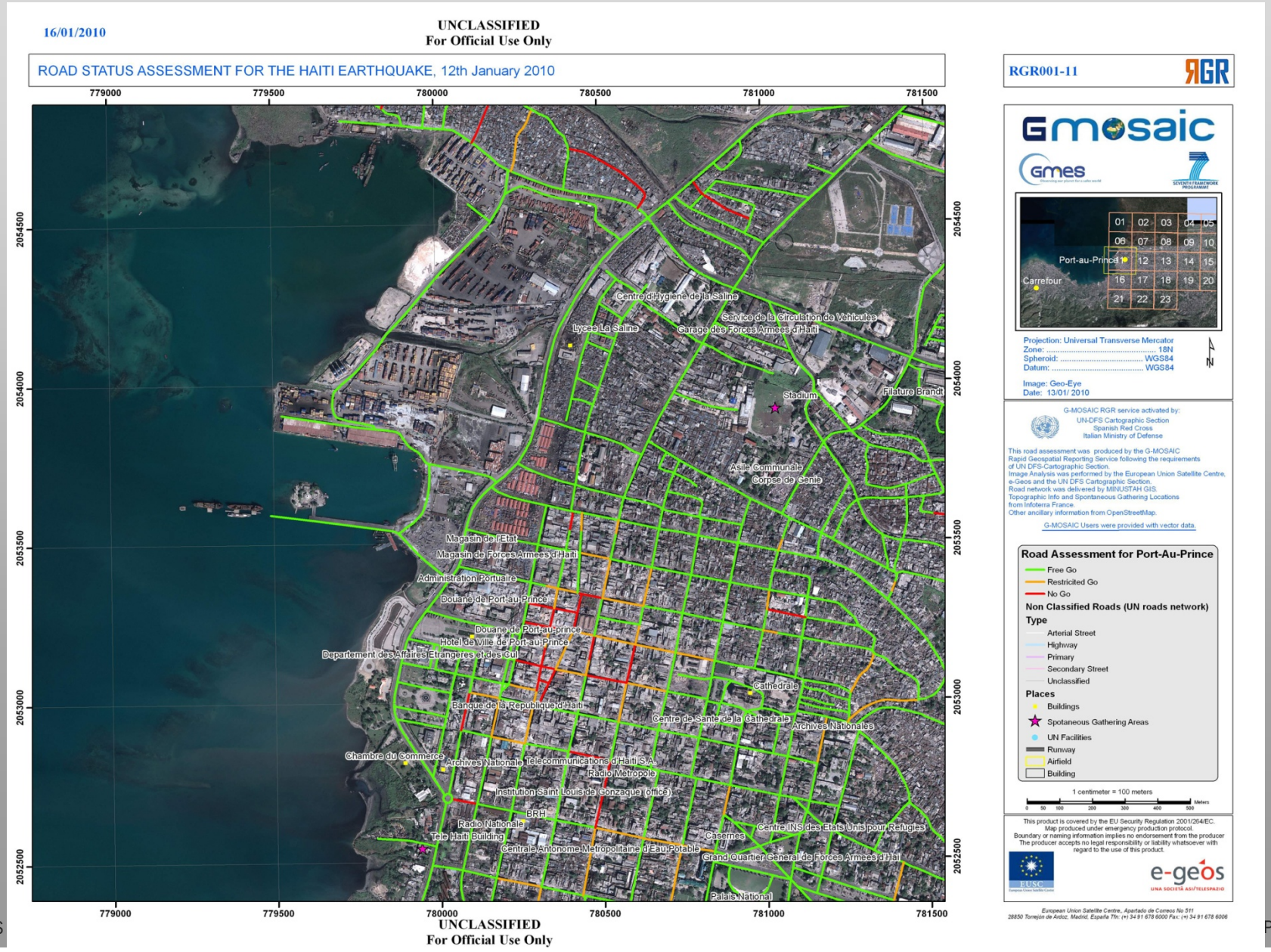
  - GeoEye-1 few hours after the terrific event



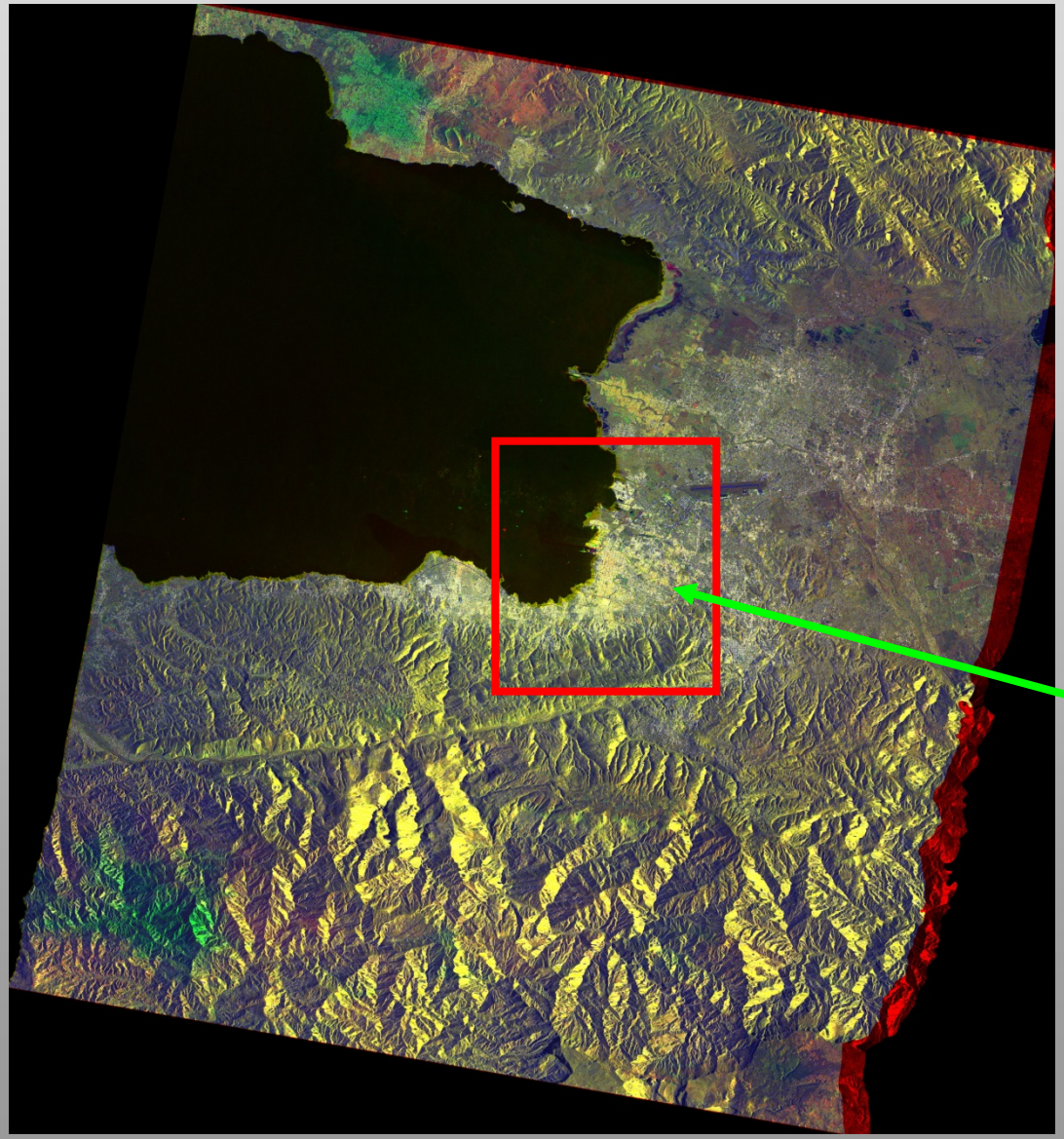
ER for Haiti Earthquake



Road Status Map (PaP)



Product example: Cosmo-SkyMed MultiTemporal Coherence analysis



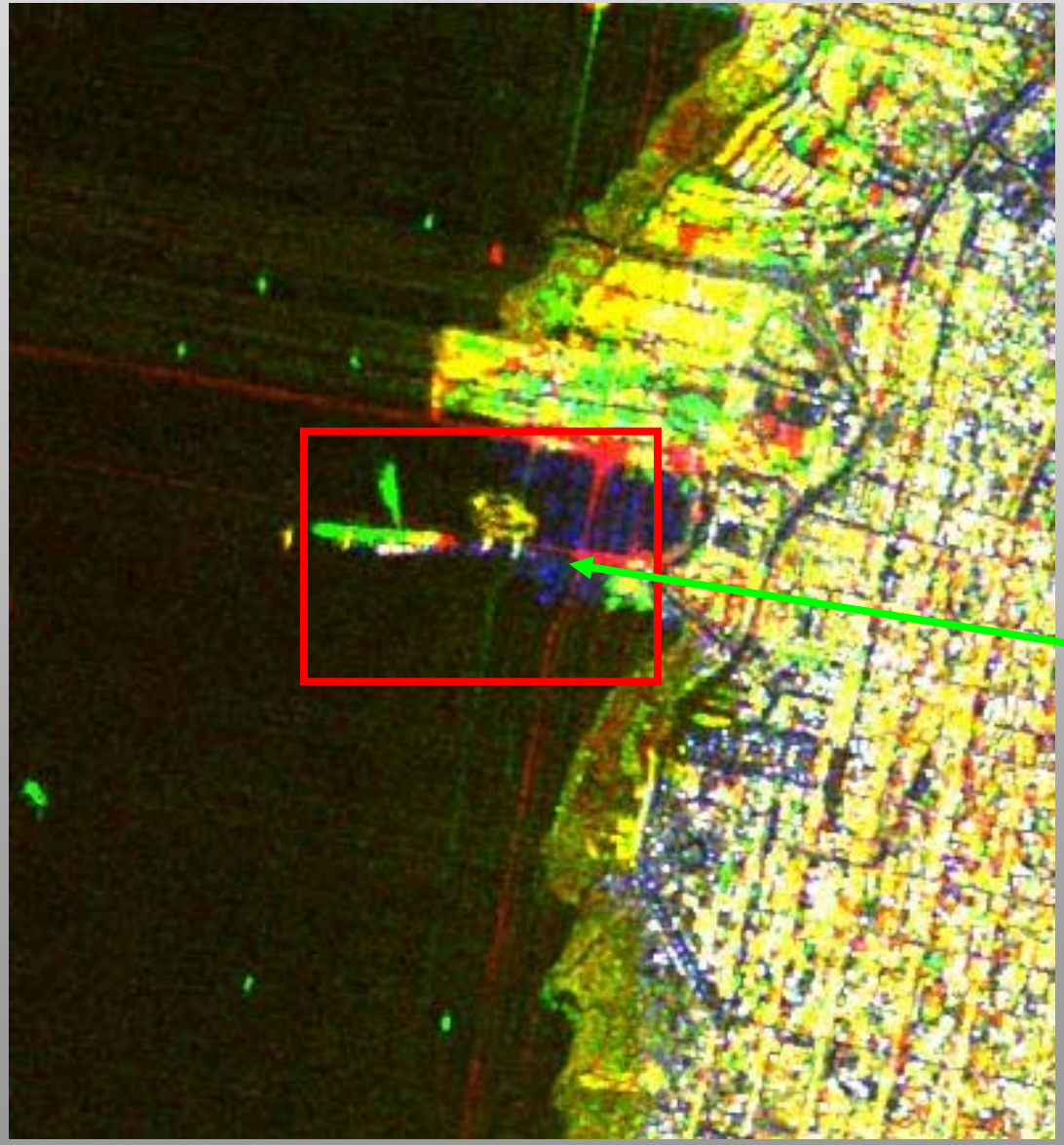
Red : SAR detected amplitude image - 2009, Apr. 26th

Green : SAR detected amplitude image - 2010, Jan 15th

Blue : coherence value

Port-au-Prince metropolitan area

Product example: Cosmo-SkyMed MultiTemporal Coherence analysis



Red : SAR detected amplitude image - 2009, Apr. 26th

Green : SAR detected amplitude image - 2010, Jan 15th

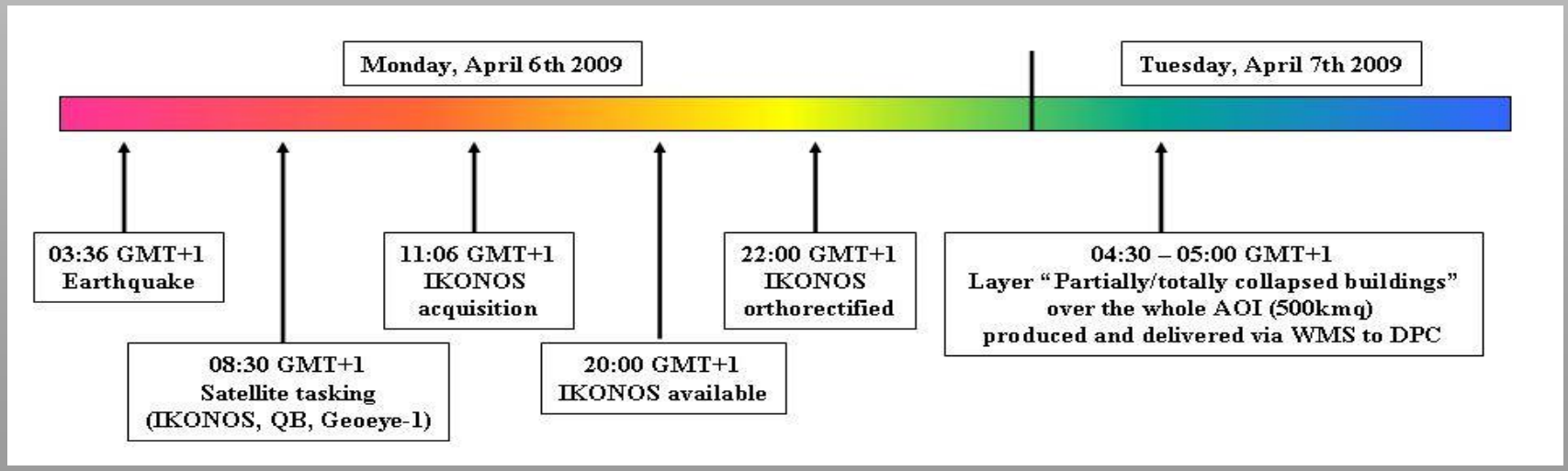
Blue : coherence value

Collapsed port installation

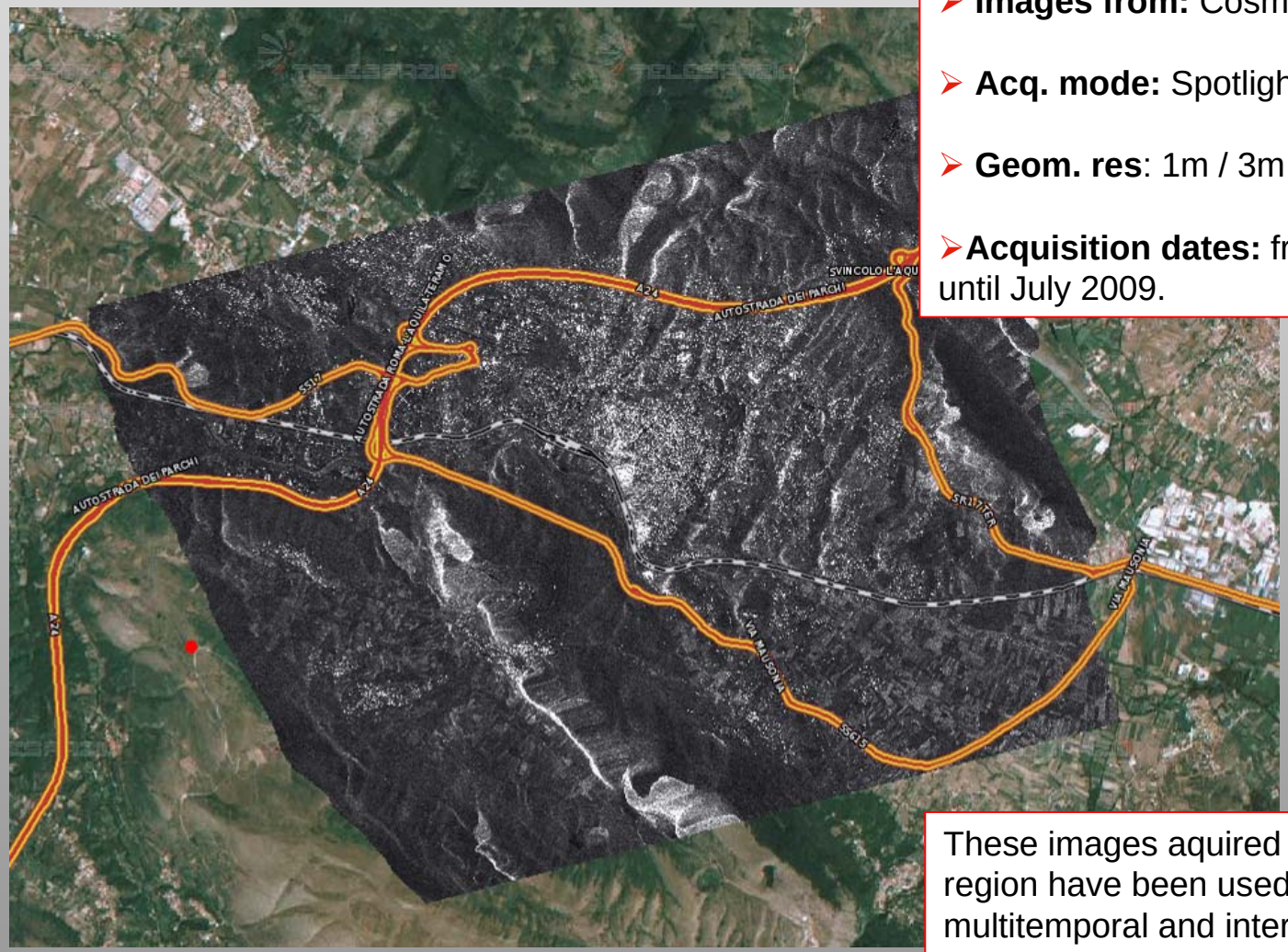
ER for L'Aquila Earthquake

e-GEOS has played an active role at:

a. dedicated services via Web by e-GEOS for imageries and assessment data for the Authorities;
b. COSMO-SkyMed data acquisitions and processing

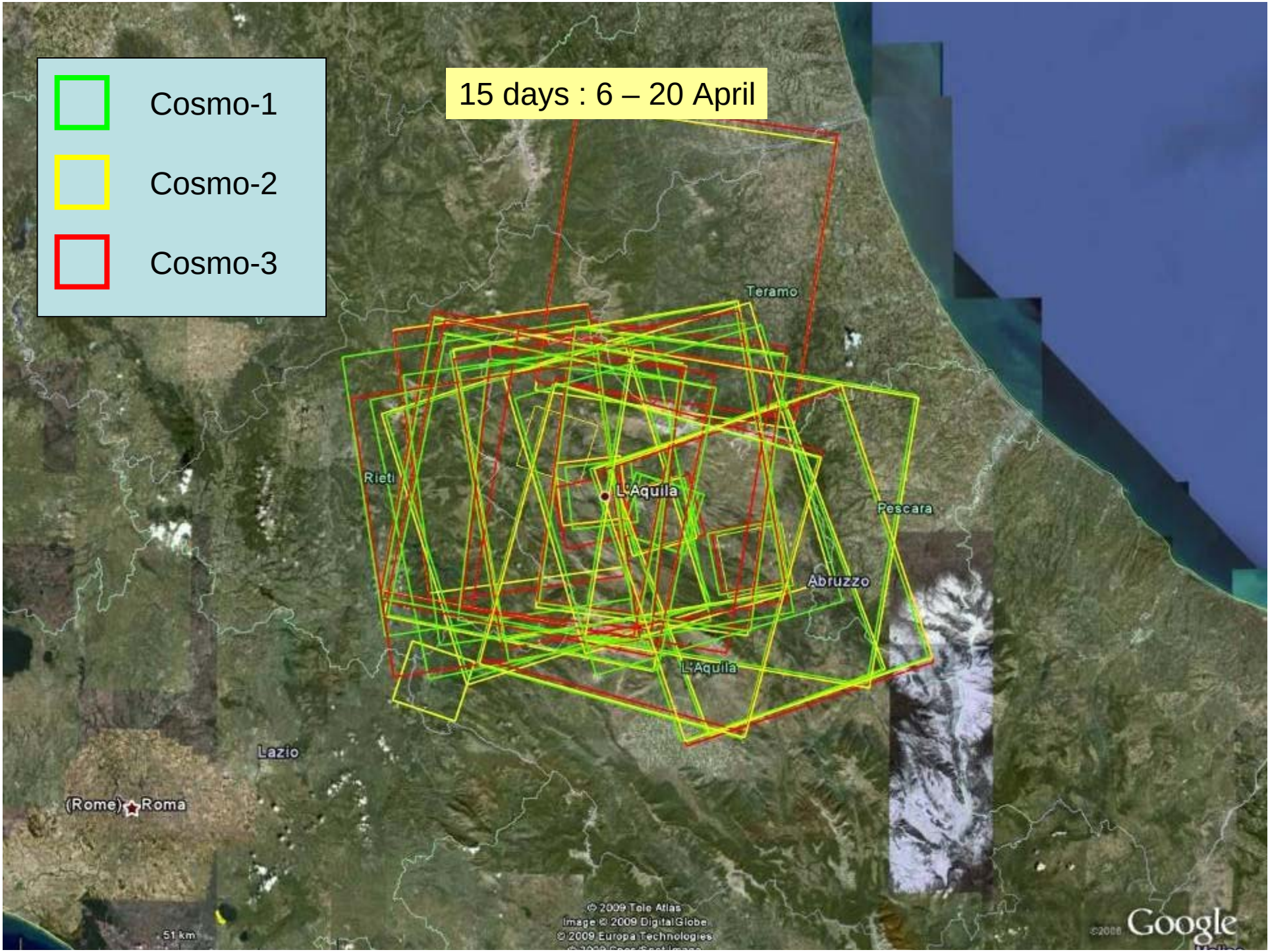


Cosmo-SkyMed acquisition details

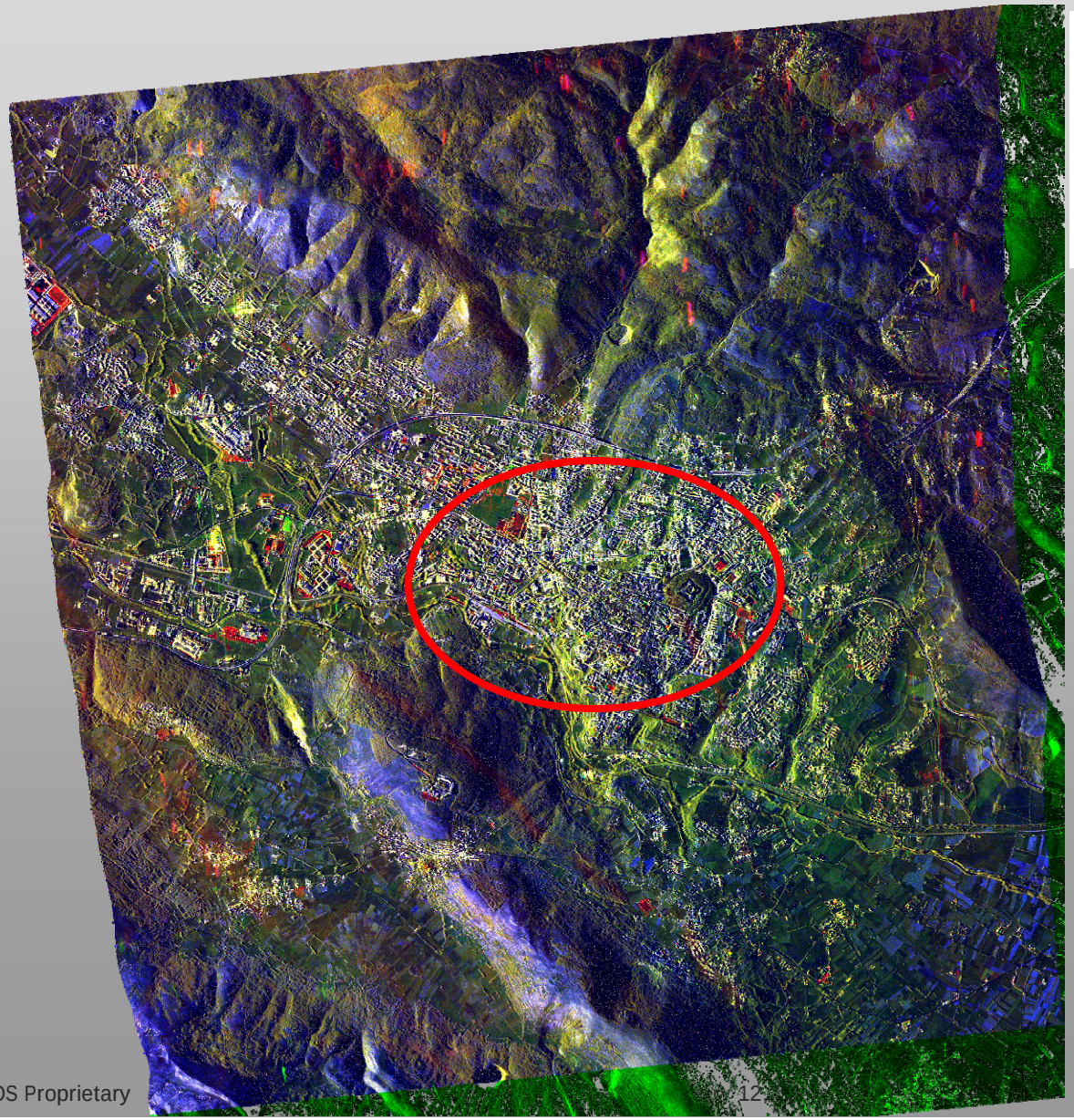


- **Images from:** Cosmo SkyMed
- **Acq. mode:** Spotlight-2 / Himage
- **Geom. res**: 1m / 3m
- **Acquisition dates:** from April 6th 2009 until July 2009.

These images aquired over L'Aquila region have been used for both multitemporal and interferometric analysis.


Cosmo-1
Cosmo-2
Cosmo-3
15 days : 6 – 20 April
Teramo
Rieti
L'Aquila
Pescara
Abruzzo
L'Aquila
Lazio
(Rome)
Roma
51 km
© 2009 Tele Atlas
Image © 2009 DigitalGlobe
© 2009 Europa Technologies
Google

Change Detection – Coherent Multitemporal Analysis

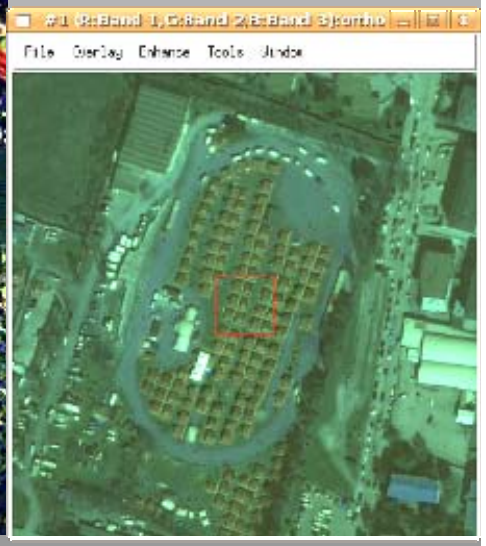


Red : SAR detected amplitude image - 2009, april 14th

Green : SAR detected amplitude image - 2009, april 05th

Blue : coherence value

Change Detection : Coherent Multitemporal analysis

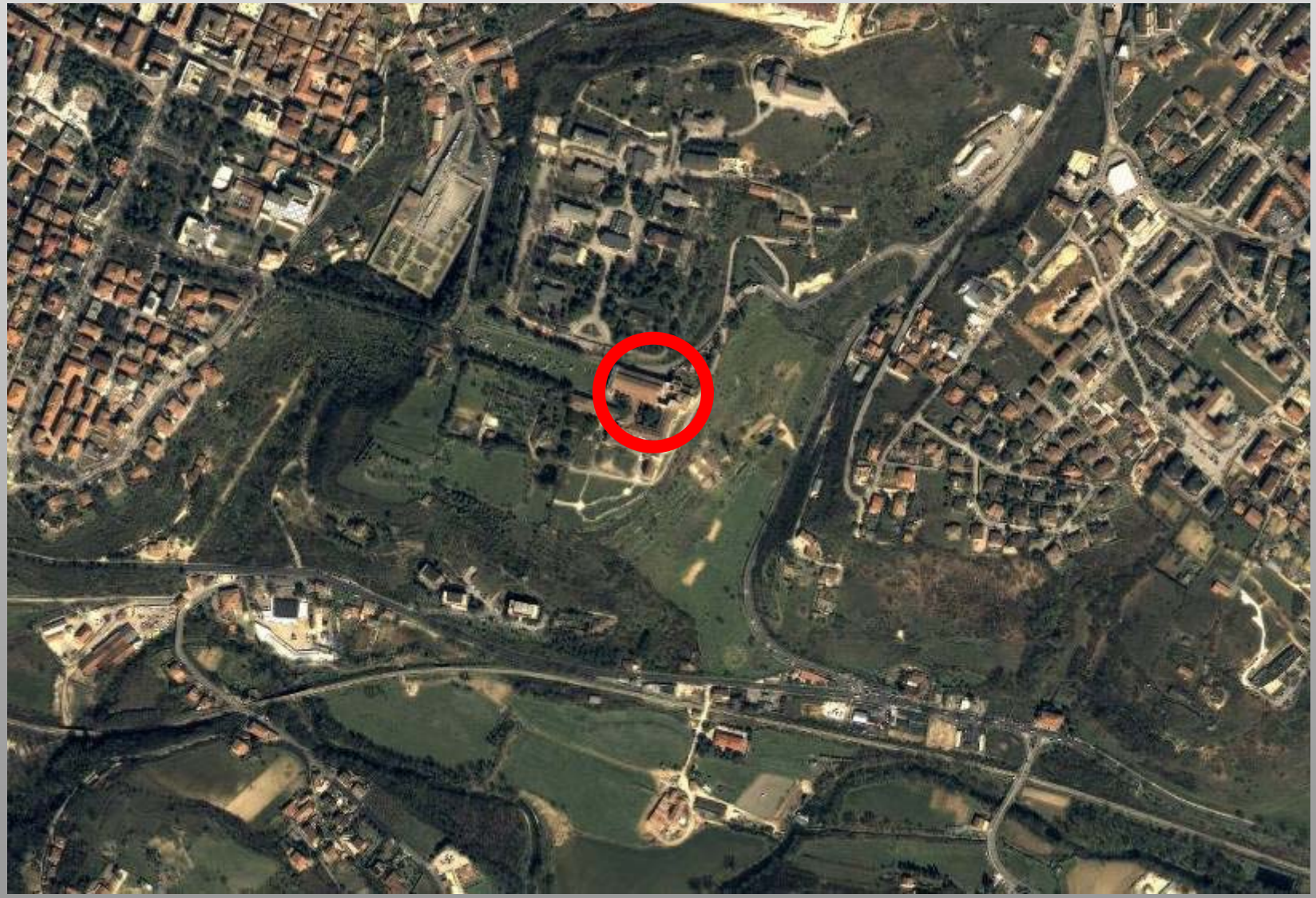


Red : SAR detected amplitude image - 2009, april 14th

Green : SAR detected amplitude image - 2009, april 05th

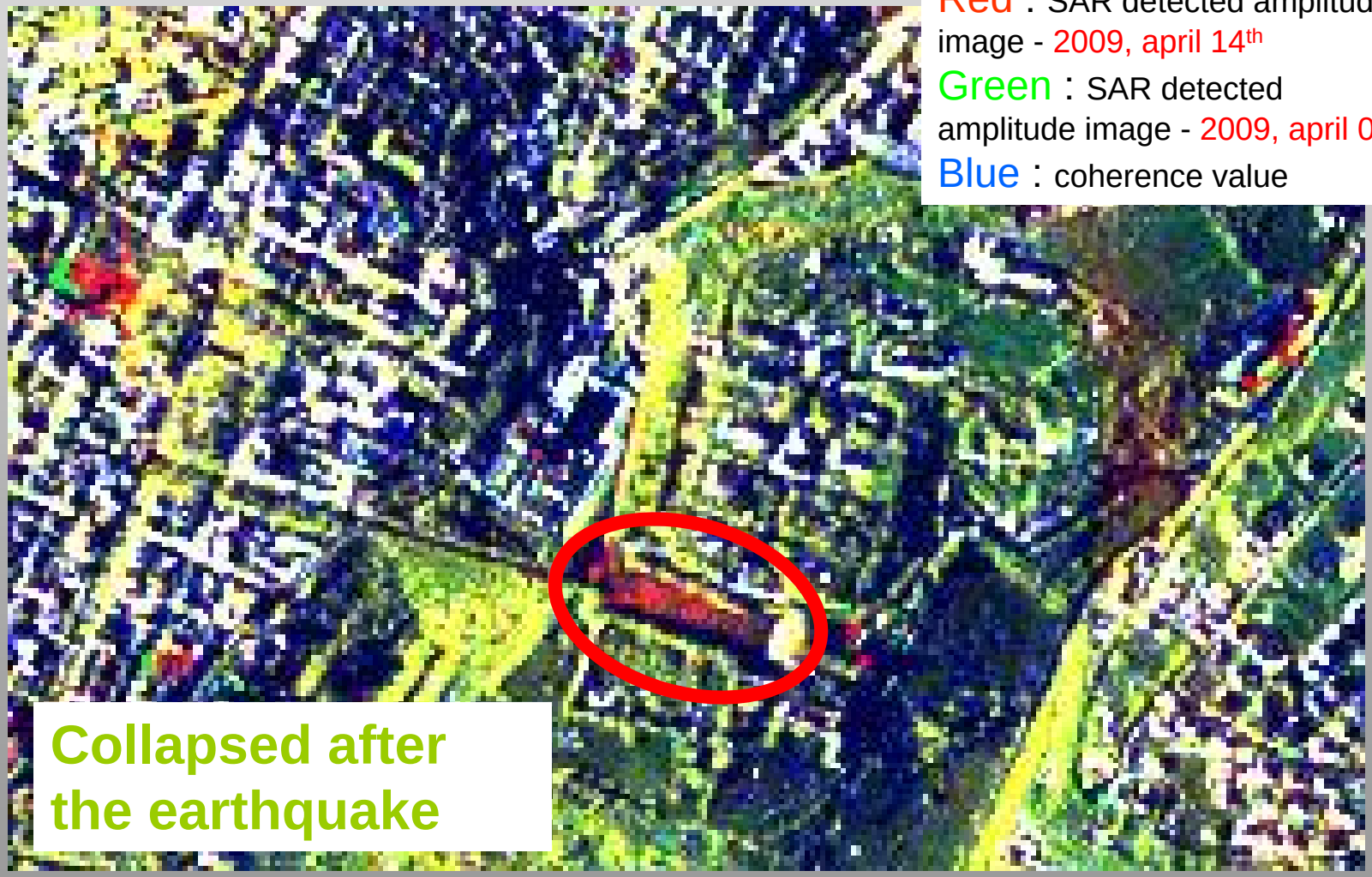
Blue : coherence value

Post-Event Ortophoto – L'Aquila (Collemaggio)



Coherent Multitemporal Analysis – L'Aquila (Collemaggio)

Red : SAR detected amplitude image - 2009, april 14th
Green : SAR detected amplitude image - 2009, april 05th
Blue : coherence value



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