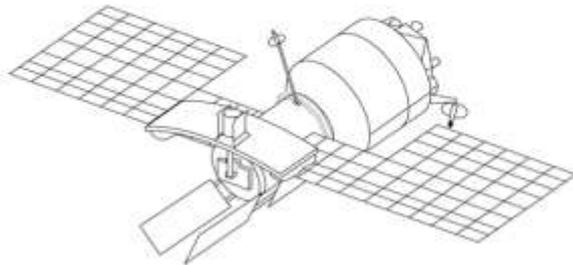




# The BEYOND Center of Excellence for monitoring natural disasters from space



Ioannis Papoutsis

**National Observatory of Athens**  
Institute for Astronomy, Astrophysics, Space  
Applications & Remote Sensing



MOWE-IT  
16 September 2014  
Thessaloniki, Greece



FP7-Regpot-2012-23-1

# Outline

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- ❖ What is BEYOND?
  - Earth Observation
  - Ground based infrastructure
  
- ❖ Overview of the services
  
- ❖ EO and transport
  - Forest wildfires monitoring
  - Flood risk modelling and flood extend
  - Smoke dispersion estimation
  - Geophysical hazards mapping
  - Construction activity monitoring

# What is BEYOND?

## Objective

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**BEYOND** aims to maintain and expand the existing state-of-the-art and interdisciplinary research potential, by

**Building a Centre of Excellence for Earth Observation based monitoring of Natural Disasters**

**AOI:** The south-eastern Europe, with a prospect to increase its access range to the wider Mediterranean region through the integrated cooperation with more than 20 **twining organizations**

# What is BEYOND?

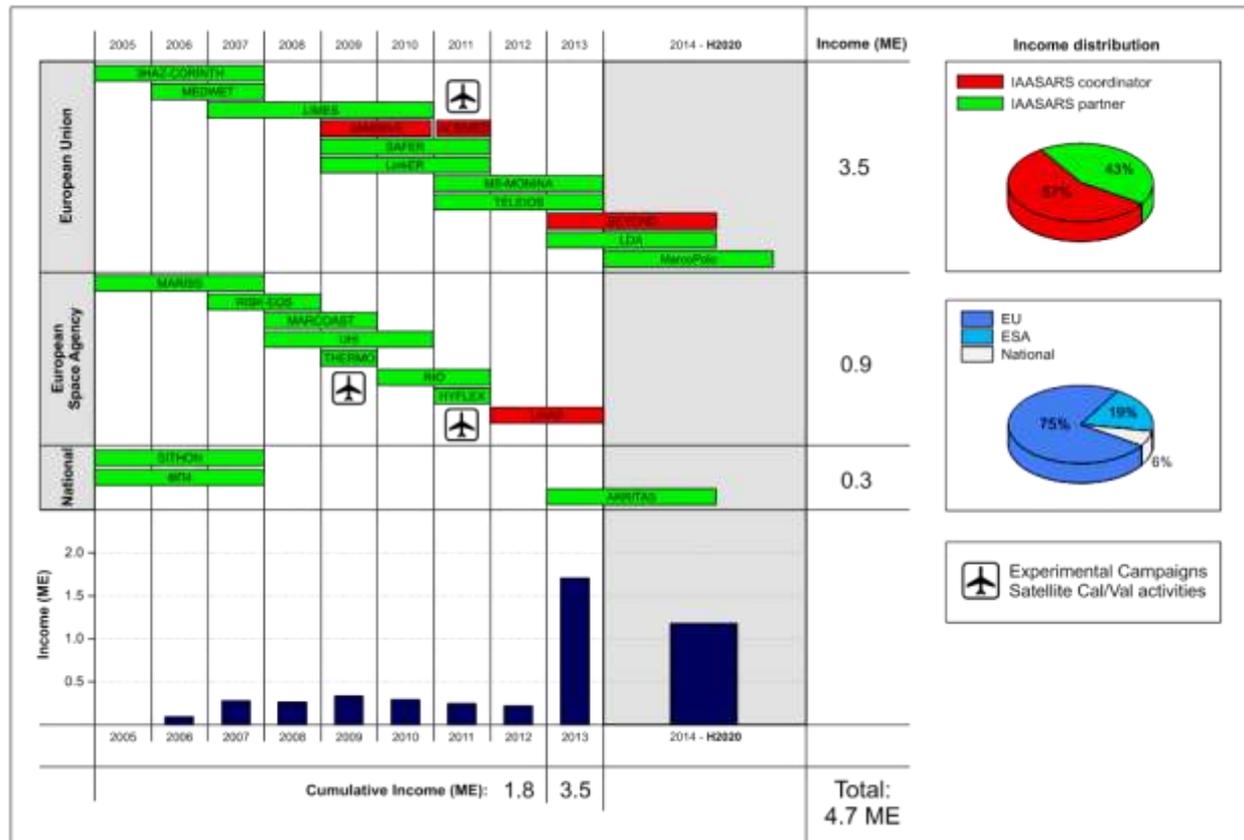
## Services development



LDA Large-scale demonstrators in support of GMES and GNSS based services in Athens, Greece, GMES/DG ENTR

MASSIVE: Mapping Seismic Vulnerability and Risk of Cities, European Commission - DG ENV A.3 – Civil Protection

TELEIOS—Virtual Observatory Infrastructure for Earth Observation Data, FP7-ICT-2009-5



LinkER - Supporting the implementation of an operational GMES service in the field of emergency management, Invitation to Tender No: ENTR/08/028

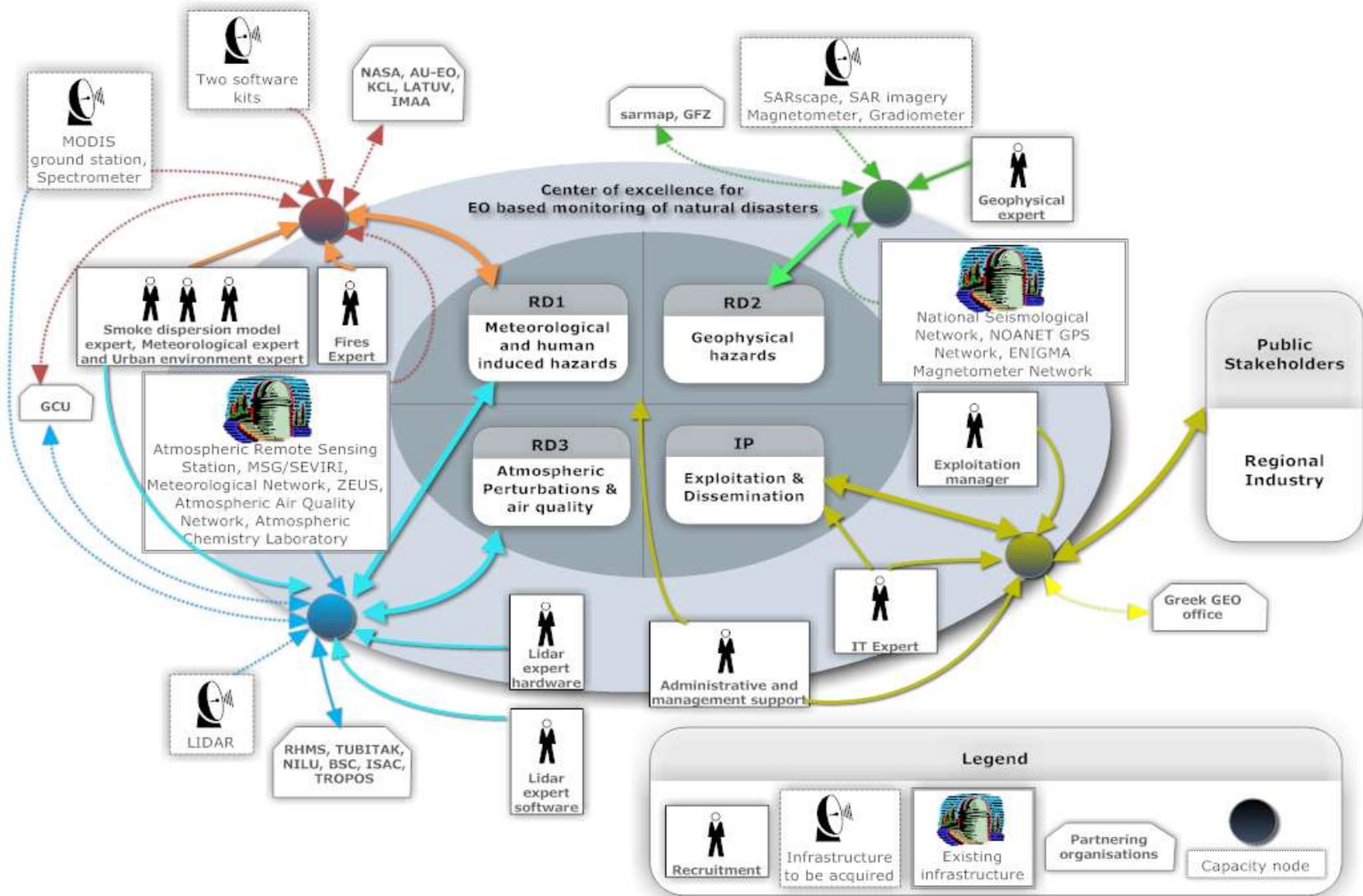
SAFER – EMERGENCY: Building Emergency Response Core Service, FP7-2007-SPACE-1/ GMES Collaborative Project

RISK-EOS Extension to Greece - Promotion of the GSE RISK-EOS fire services portfolio in Greece, EarthWatch GMES Services Elements, ESA/GSE

MARCOAST/ISSUE-OS - Integrated system for suspect vessels emergency tracking – OIL SPILLS

# What is BEYOND?

## Concept



# What is BEYOND?

## Infrastructure

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Integrated satellite based observational solutions

- X-/L- band acquisition station for (EOS Aqua and Terra, NPP, JPSS, NOAA, Met Op, FengYun) (part of the DB network)
- MSG SEVIRI Acquisition station (part of EUMETSAT's network)
- Access to NOAA's Collaborative Ground Segment (Mirror Site) dedicated to ESA Sentinel missions (Copernicus), allowing near real time acquisition of S-1, S-2, and future S3, S5P satellite missions
- Access to NOAA's in-situ monitoring seismological, magnetometer, and GPS networks



**IAASARS/NOA MSG SEVIRI Acquisition station**



**IAASARS/NOA X-/L-band Acquisition station**

# What is BEYOND?

## Infrastructure



Operation of the mobile lidar of ESA by IAASARS

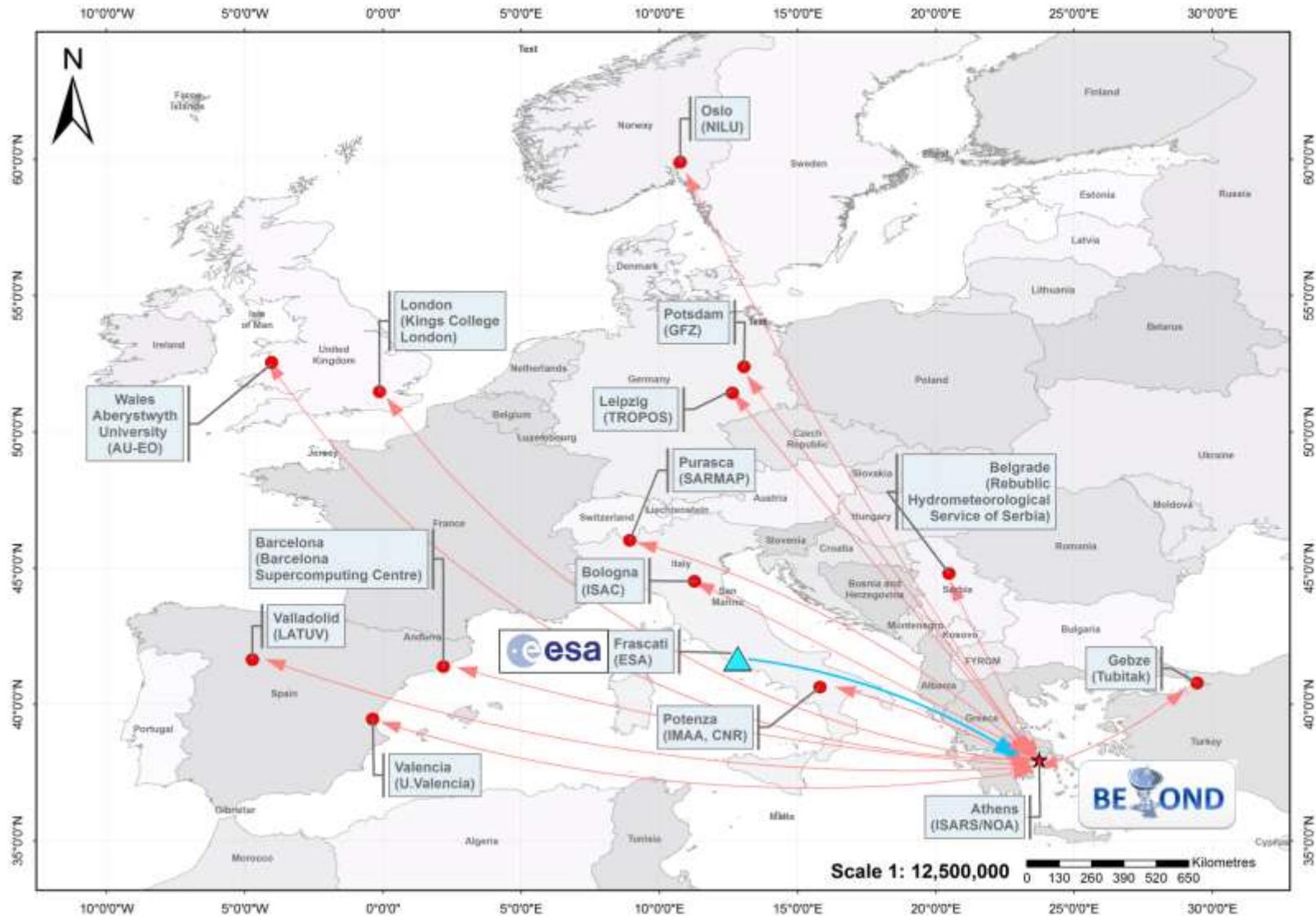


Development of a state-of-the-art multi-wavelength lidar to be installed in Crete (FKL), in the framework of the BEYOND project, part of the EARLINET network



# What is BEYOND?

## Partnering organizations



# Overview of the services

1/2



Service	Status	End Users	Scale
<b>EMERGENCY RESPONSE/EMERGENCY SUPPORT-METEO RELATED HAZARDS</b>			
Real Time Fire Monitoring	Operational GMES Standard	Fire Brigades, Civil Protection, Public, Private Sector	National Regional
Rapid Fire Mapping	Operational GMES Standard	Fire Brigades, Civil Protection, Forestry Services, Min of Env	Regional Local
Disaster Event Mapping & Damage Ass.	Operational GMES Standard	Forestry Services, Min of Env (DG for Nat. Vegetation/Forest Protection)	Local
Seasonal/Diachronic Fire Mapping & Damage Ass.	Operational GMES Standard	Forestry Services, Min of Env (DG for Nat. Vegetation/Forest Protection, Cadastral Org, Fire Brigades)	National
Wild Fire Smoke Dispersion	Research/ Preoperational	Fire Brigades, Civil Protection, Min of Env	Regional Local
Saharian Dust Episodes	Research/ Preoperational	Civil Protection, Min of Env, Public	National
Flood Risk	Research/ Preoperational	National Electric Power Org, Min of Development, Local Authorities, Civil Protection	Regional Local
Heat Waves Risk	Research/ Preoperational	Min of Public Health, Local Authorities, Medical Science	Local

Web service

Web service

Delivered

To be Delivered as  
V1.0 in 2014

To be Delivered as  
V1.0 in 2015-2016

# Overview of the services

2/2



EMERGENCY RESPONSE/EMERGENCY SUPPORT- GEO- HAZARDS			
Earthquake related crustal deformation field	Operational GMES Standard	Anti-seismic Planning & Protection Org, EQ Scientists	Local
Volcano related surface velocity field	Operational GMES Standard	Anti-seismic Planning & Protection Org, Local Authorities, EQ Scientists	Local
Landslide related surface velocity field	Research	Anti-seismic Planning & Protection Org, Local Authorities, Entrepreneurs, Civ. Eng, Geologists	Local
ATMOSPHERIC DISTURBANCES - CLIMATOLOGY			
3D-Climatology	Operational GMES Standard	Cal/Val Industry, Global Atm Monitoring Networks	Global
Atmospheric Episodes	Research	Cal/Val Industry, Global Atm Monitoring Networks, Medical Science	Local
LULC CHANGE MONITORING – UAV / AIRBORNE / SATELLITE			
Urban Mapping	Operational GMES Standard	World Bank, EIB, Min of Env, Cadastral Org	Local
UAV Damage Recording	Research/ Preoperational	Anti-seismic Planning and Protection Organisation	Local
Ecosystem Monitoring and Mapping (Forests/Wetlands)	Operational	Min of Env, Hellenic Biotope & Wetlands Center, Cadastral Org	National Regional

Delivered

To be Delivered as V1.0 in 2014

To be Delivered as V1.0 in 2015-2016

Web service

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

Fires & Floods

Geophysical hazards

Atmospheric disasters

Weather-related disasters

# EO & Transport

## Forest wildfires

### Regional Real Time Fire Monitoring - NOA's MSG SEVIRI Station

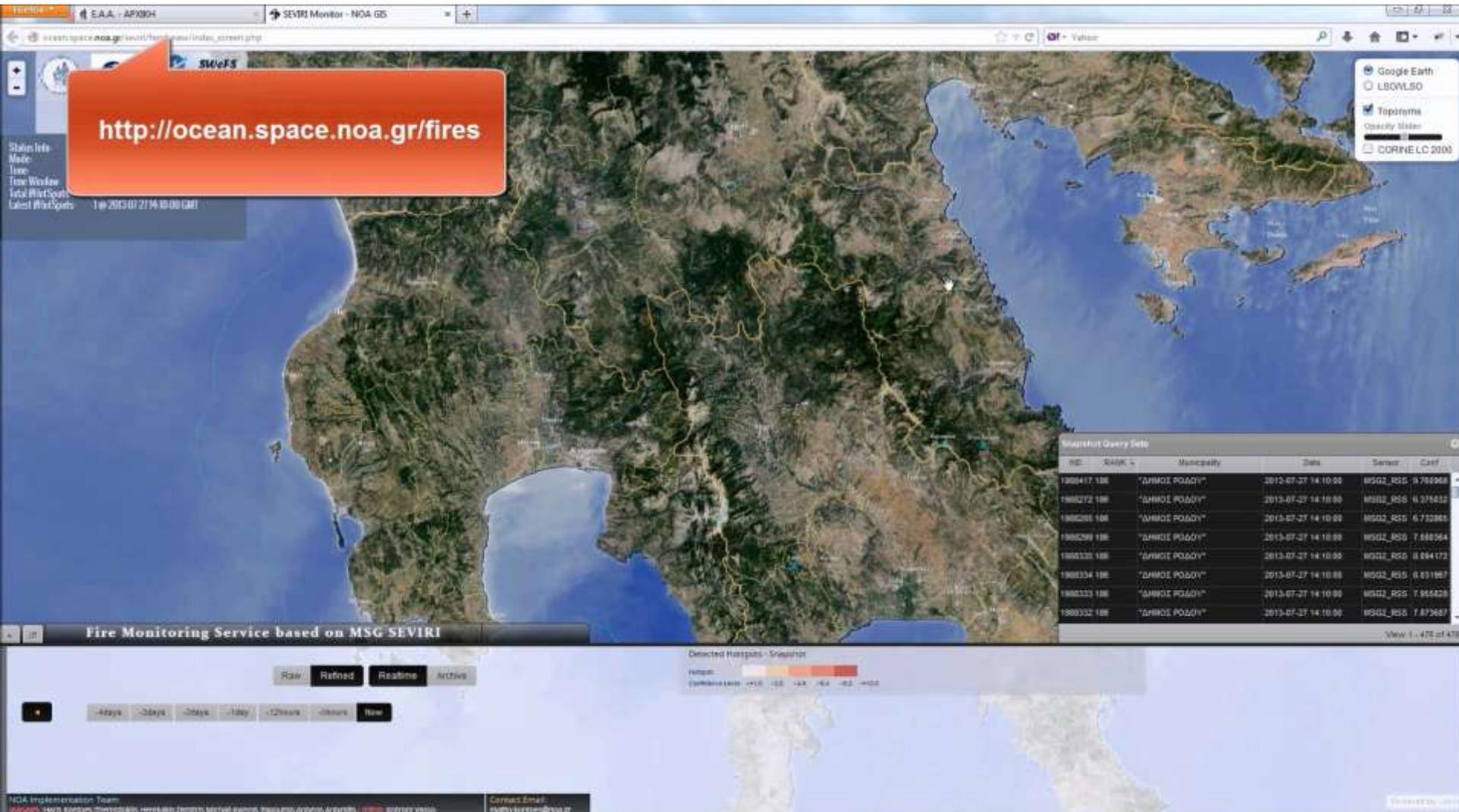


The collage features several key elements:

- Central Image:** A satellite view of Greece with a large red "EMERGENCY" stamp overlaid. Dashed white arrows point from this central image to various fire locations.
- AliveriEuboea Fire:** A large fire burning in a wooded area.
- Olympia site Fire:** A fire burning near ancient stone ruins.
- Korinthos Fire:** A fire burning in a wooded area.
- Stira Euboea Fire:** A fire burning in a wooded area.
- Parnon Mt Fire:** A fire burning in a wooded area.
- Taygetos Mt Fire:** A fire burning in a wooded area.
- Megalopolis Fire:** A fire burning near a building at night.
- Oitilon Fire:** A fire burning in a wooded area.
- Fire Planes:** Two images showing fire planes dropping water on fires.
- Control Room:** An image showing a person working at a computer workstation in a control room.

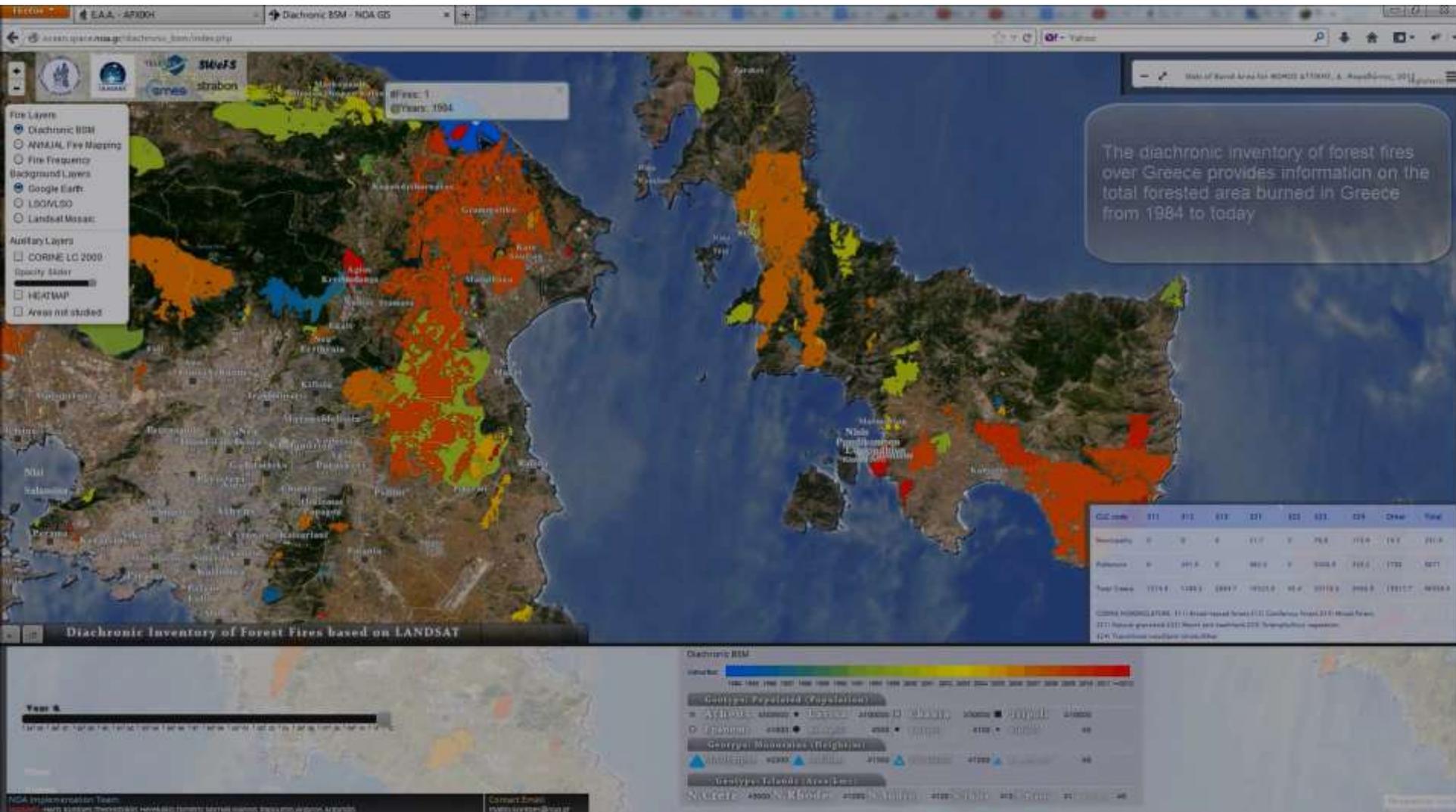
# EO & Transport

Forest wildfires: <http://ocean.space.noa.gr/fires>

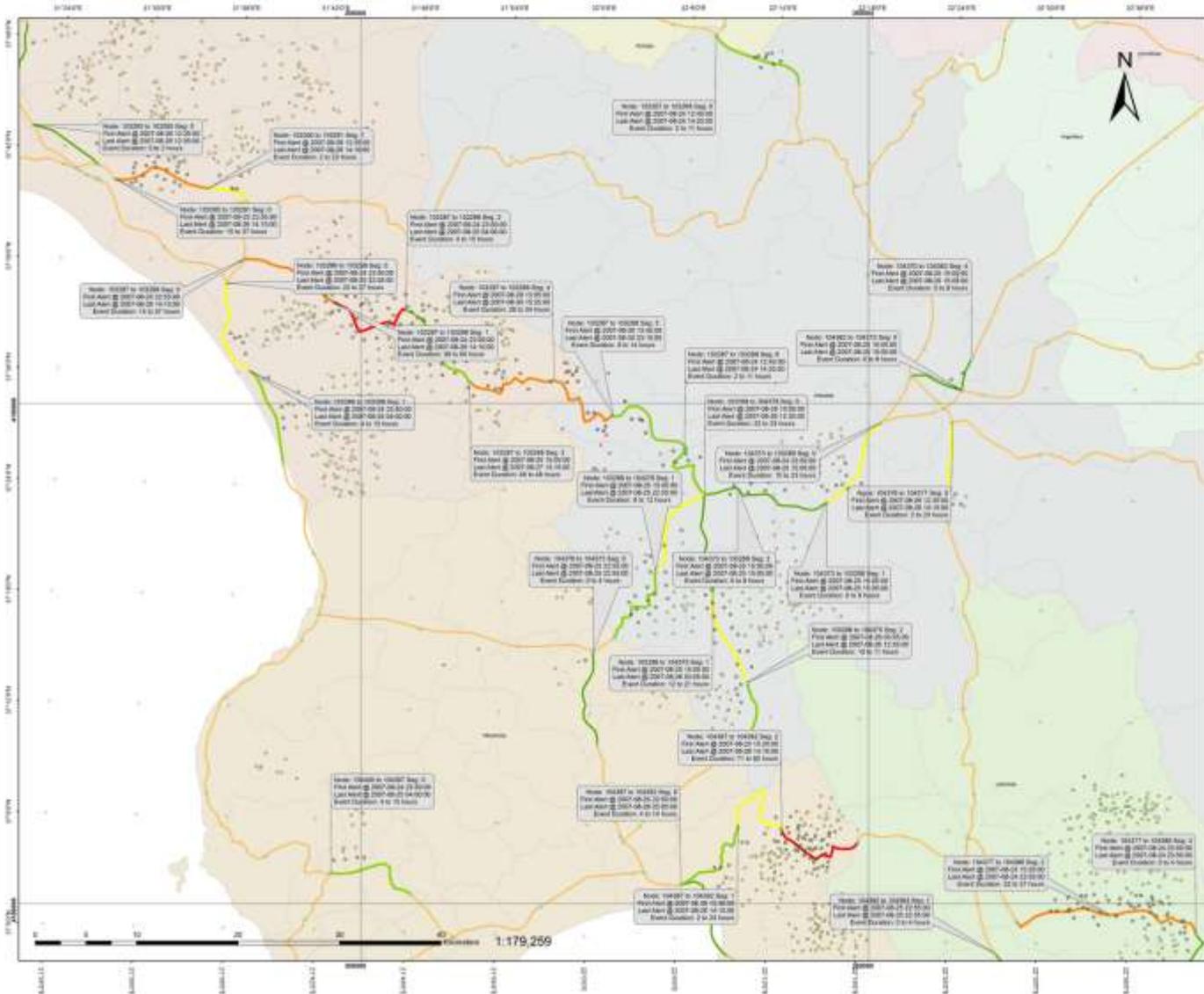


# EO & Transport

Forest wildfires: <http://ocean.space.noa.gr/bsm>



# EO & Transport Forest wildfires



**Ploponnissos - 2007 Fires  
Road Network Effects Analysis**

**HotSpot onset**

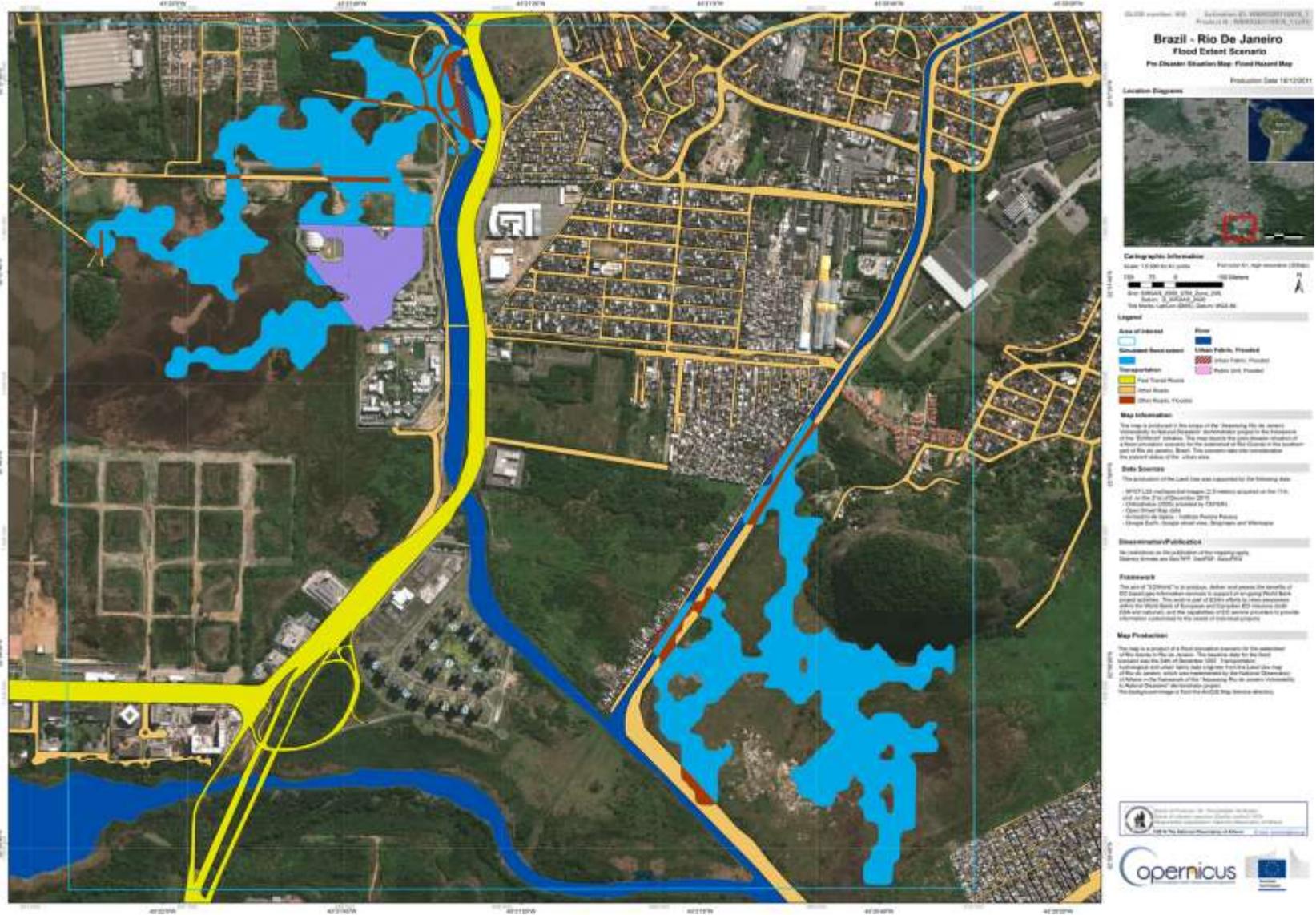
- 2007-08-20 12:00
- 2007-08-21 00:00
- 2007-08-21 12:00
- 2007-08-22 00:00
- 2007-08-22 12:00
- 2007-08-23 00:00
- 2007-08-23 12:00
- 2007-08-24 00:00
- 2007-08-24 12:00
- 2007-08-25 00:00
- 2007-08-25 12:00
- 2007-08-26 00:00
- 2007-08-26 12:00
- 2007-08-27 00:00
- 2007-08-27 12:00
- 2007-08-28 00:00
- 2007-08-28 12:00
- 2007-08-29 00:00
- 2007-08-29 12:00
- 2007-08-30 00:00

- Hotspots affecting Road Network Segments (<=1500m)
- Road Segment Nodes

**Road Segments Affected by Fire Events  
Duration (hours)**

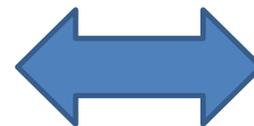
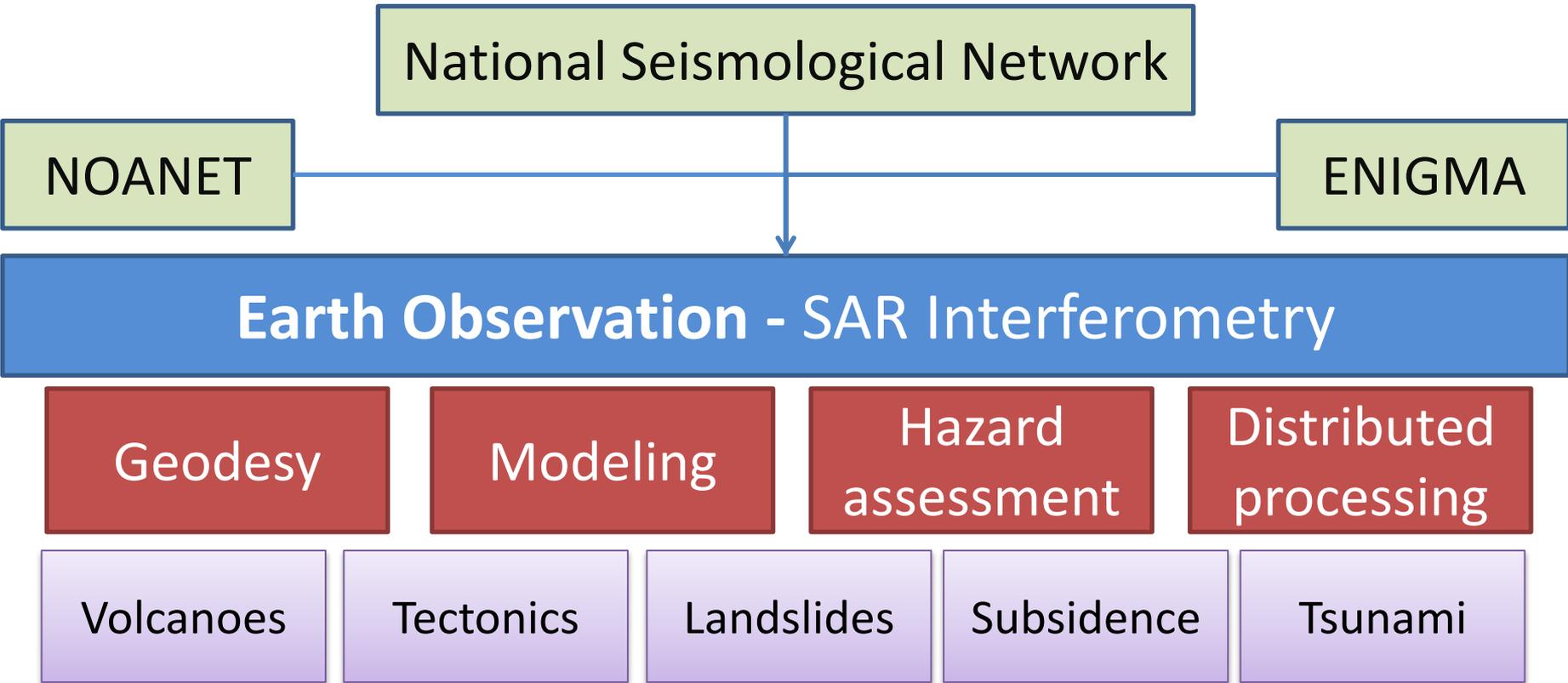
- 2 - 8
- 9 - 15
- 16 - 27
- 28 - 48
- 49 - 92
- Road Segments not affected

# EO & Transport Floods



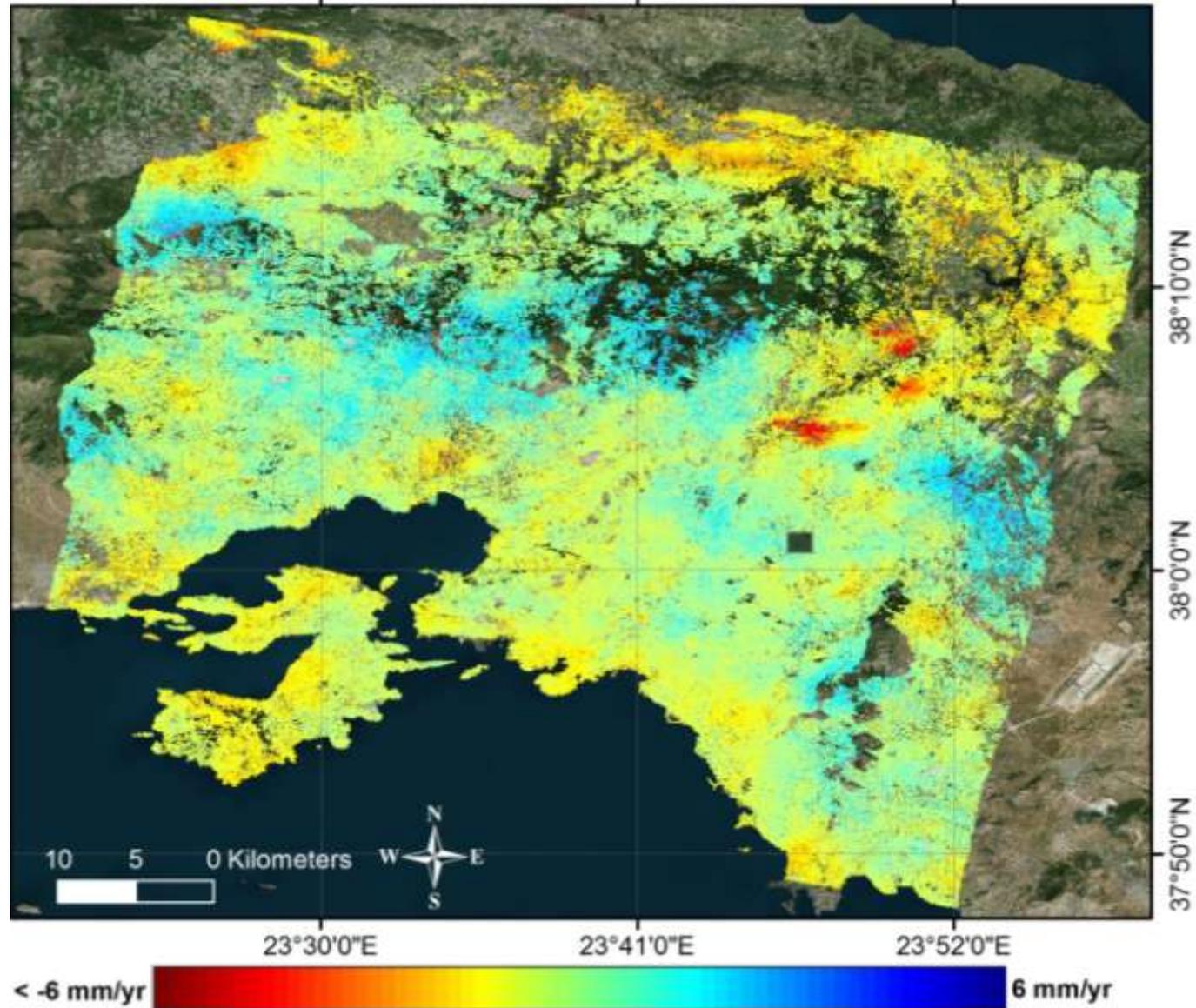
# EO & Transport

## Geodetic measurements from Space



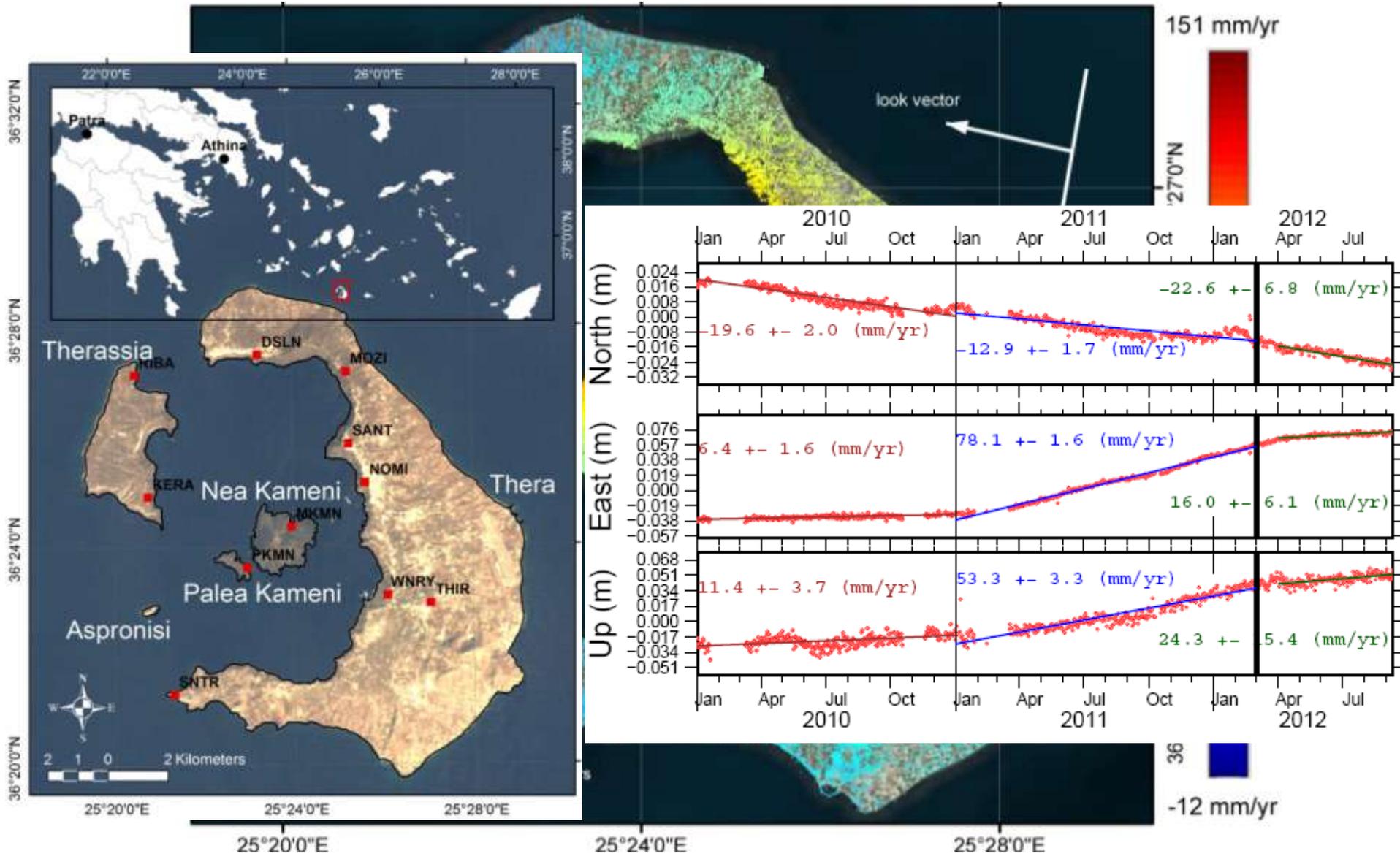
# EO & Transport

## Construction activity monitoring



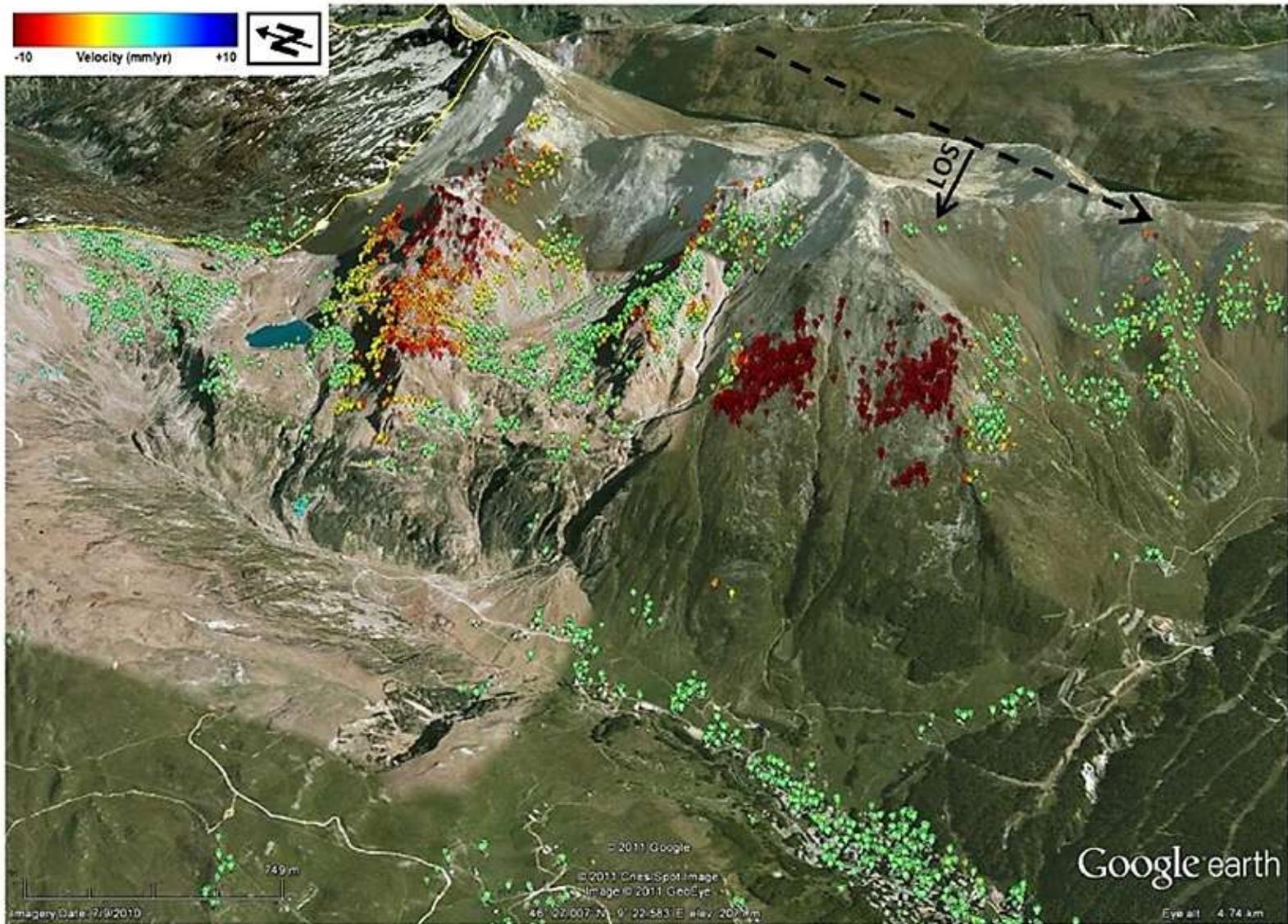
# EO & Transport

## Geophysical hazards - Volcano



# EO & Transport

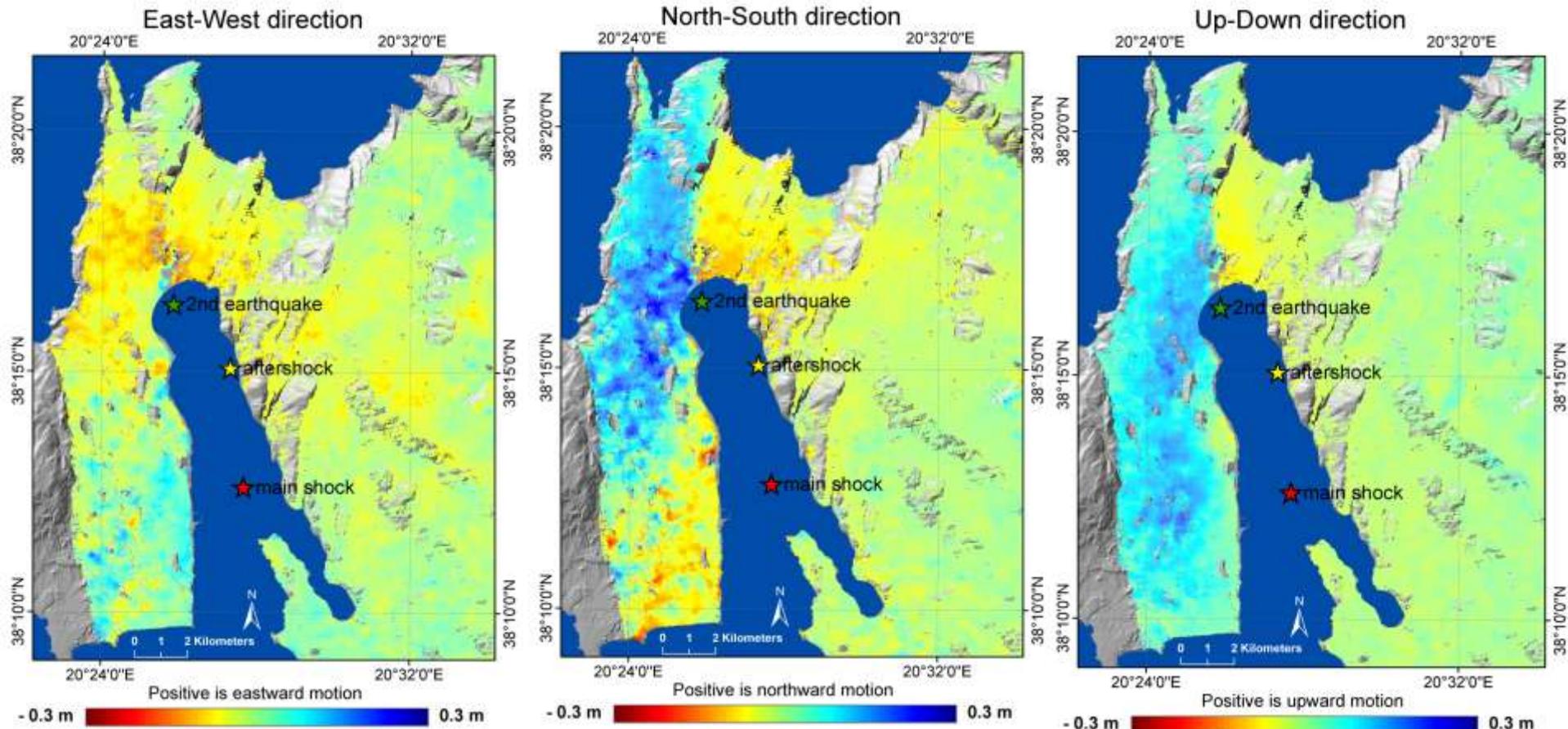
## Geophysical hazards - Landslide



# EO & Transport

## Geophysical hazards - Earthquake

3D crustal deformation from TerraSAR-X & COSMO-SkyMed data



# EO & Transport

## Geophysical hazards - Earthquake



### UAV Flight Preparation



# EO & Transport

## Geophysical hazards - Earthquake

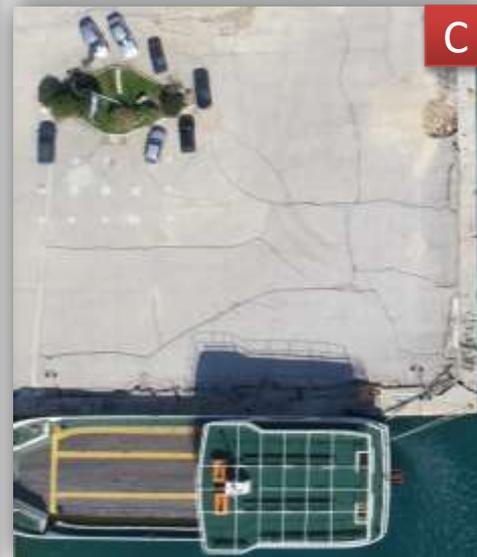
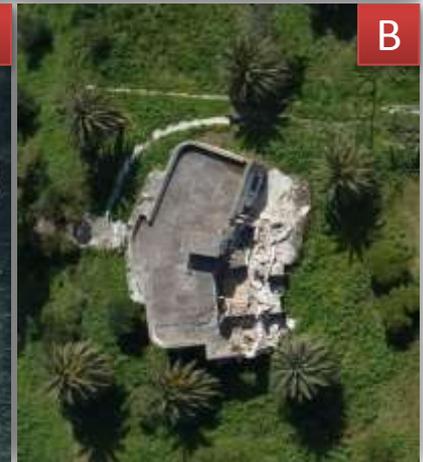
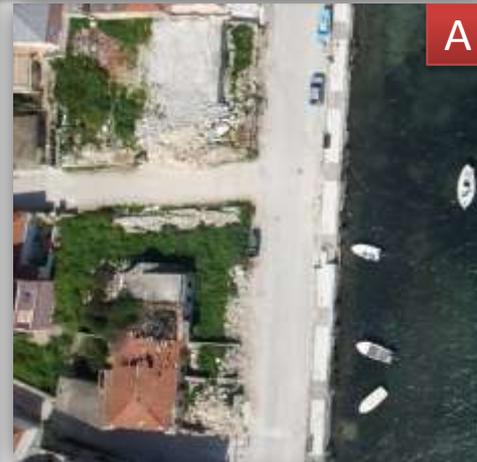
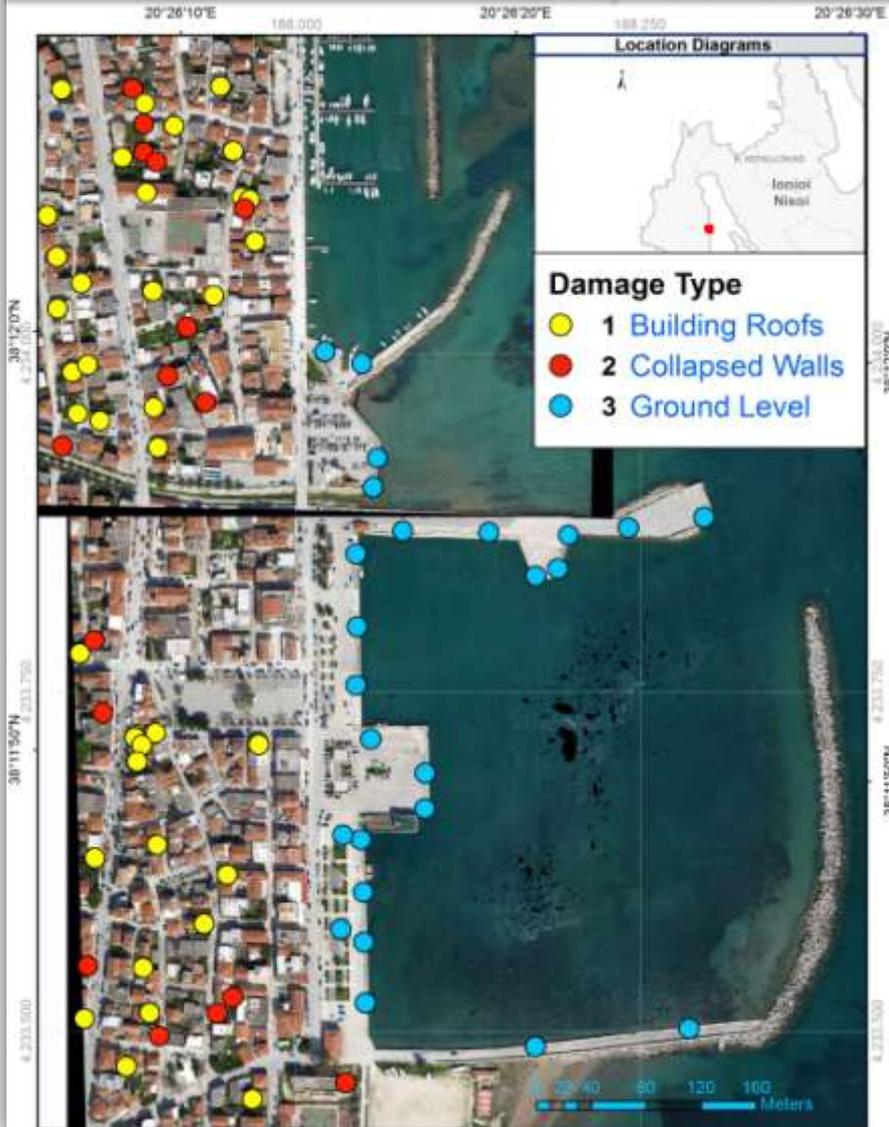
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# EO & Transport

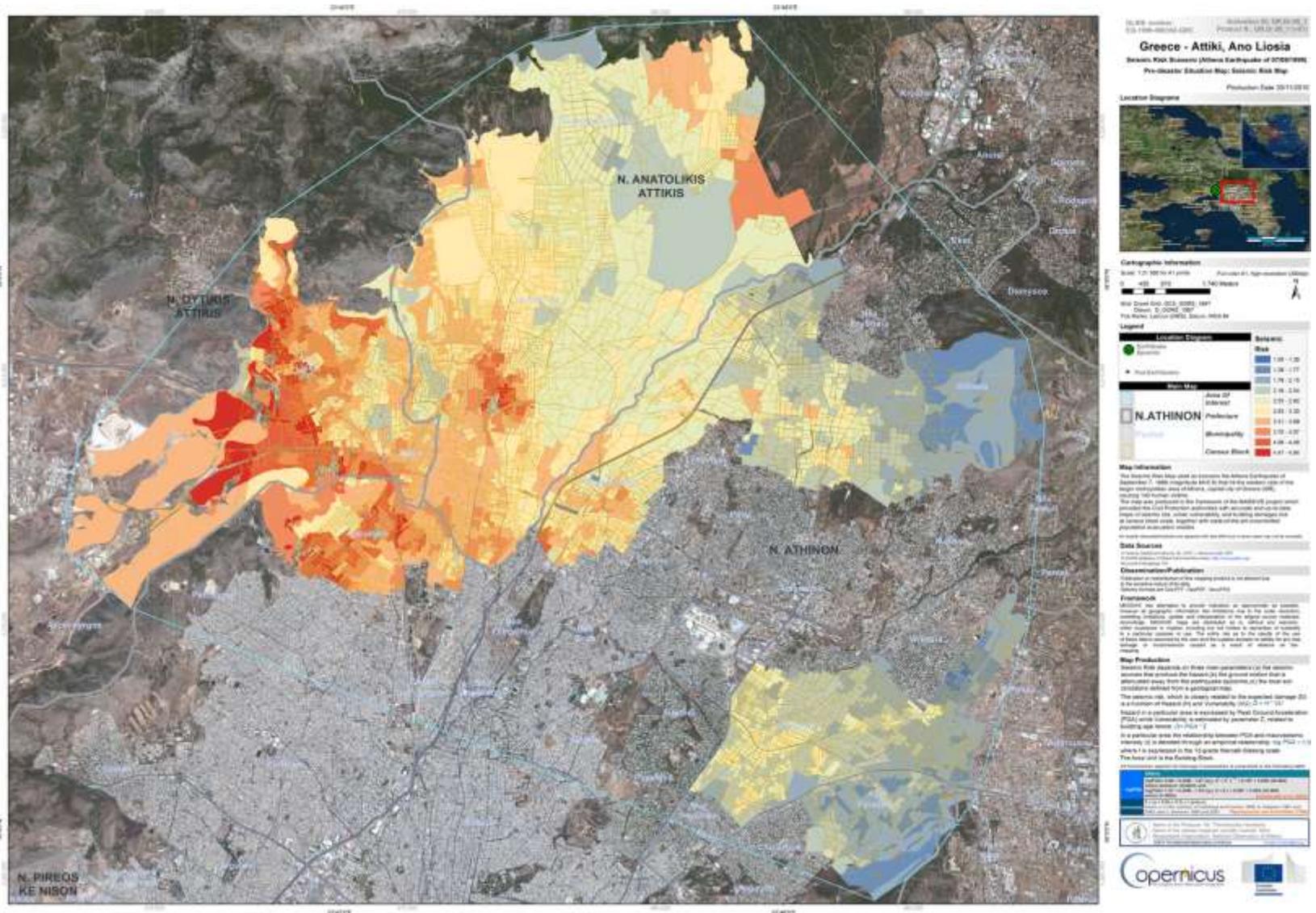
## Geophysical hazards - Earthquake

Cephalonia Island – Town of Lixouri



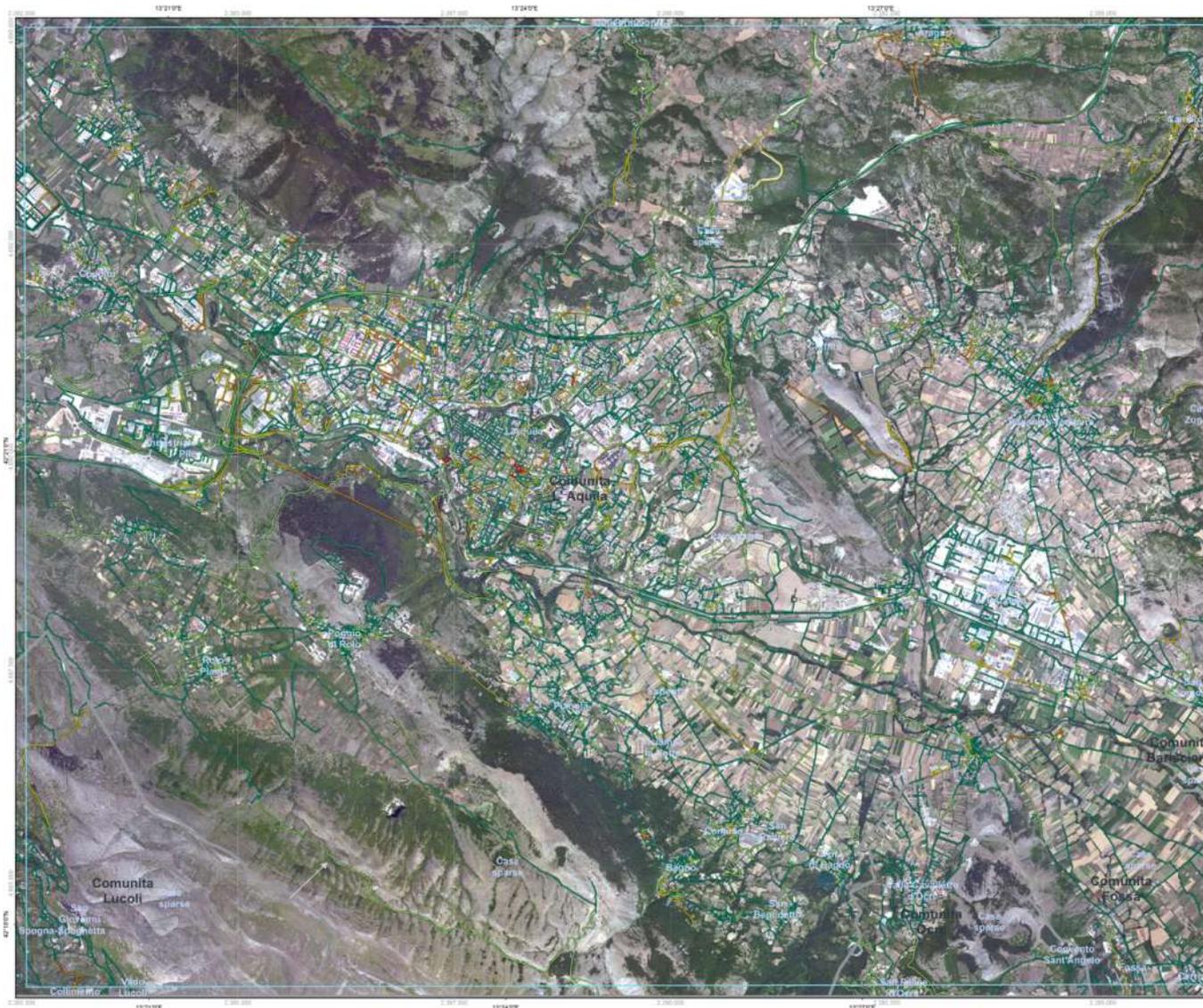
# EO & Transport

## Geophysical hazards - Earthquake



# EO & Transport

## Geophysical hazards - Earthquake



GLIDE number: EQ-2009-80072-ITA      Activation ID: IT.E.00\_1  
 Product N.: IT.E.00\_1 (v01)

### ITALY - Abruzzo Region, L'Aquila

#### Population Uncontrolled Evacuation

Pre-disaster Situation Map: Evacuation Map      Production Date 30/11/2010

**Location Diagrams**



**Cartographic Information**

Scale: 1:20 000 for A1 print      Full color A1, High resolution (300dpi)

Scale: 0      500      1 000 Meters

Local projection: Marche Meris Italy 2,  
 UTM, Meris, Meris, Datum: D, Meris, Meris,  
 Tok Spher, Lat/Lon (DMS), Datum: WGS 84

**Legend**

Location Diagram	Evacuation Model
Point Annotations	CCP
Main Map:	
Area Of Interest	0 - 8
Comune (Municipality)	9 - 20
Comune Subdivisions	21 - 41
Comune Block	42 - 95
City Block	96 - 232

**Map Information**

The Population Uncontrolled Evacuation Map used as scenario the earthquake 09/04/2009 that struck the city of L'Aquila in the Abruzzo Region of Italy (71) on April 6, 2009, causing 310 human victims. The area considered on the map is an area of about 500 km<sup>2</sup> around the L'Aquila municipality.

The map was produced in the framework of the MASE-08 project which provided the Civil Protection authorities with accurate and up-to-date maps of seismic risk, urban vulnerability, and building damages risk at census block scale, together with state-of-the-art unattributed population evacuation models.

All newly measured features are depicted with blue lines in a same color map or in the same color.

**Data Sources**

© ISTAT - Italian Central Institute of Statistics, version date 2010  
 © ISTAT - Italian Central Institute of Statistics, version date 2010  
 Account ID: 8194448, File

**Dissemination/Publication**

Publication or redistribution of this mapping product is not allowed due to the sensitive nature of the data.

Delivery formats are GeoPDF, GeoPDF, GeoPDF, GeoPDF.

**Framework**

MASE-08 was designed to provide information on earthquake risk assessment, based on geographic information from various sources due to the wide extension, complexity, and dynamic nature of the data. The information is organized according to MASE-08 rules and is distributed as a set of data layers, which are organized or updated, including but not limited to, according to a particular purpose or use. The entire risk is the result of the use of these data is authorized by the user and the user accepts responsibility for any loss, damage or inconvenience caused as a result of reliance on the mapping.

**Map Production**

The evacuation model scenarios in a locally defined area of the network, the regional level might be difficult to establish. An administrative region is identified which is able to compute the risk for each area the worst possible scenario as far as the degree of population to be evacuated is concerned. Then, the area is identified in the degree to which evacuation difficulty exists. The maps of potential evacuation difficulty are used in conjunction with scenario maps to provide a distribution of evacuation routes and evacuation planning maps.

Name of the Producer: GeoIT - The Italian Institute  
 Name of the Insest (Quart) Country: ISTAT  
 Responsible Organization: National Institute of Statistics  
 ©2010 The National Institute of Statistics



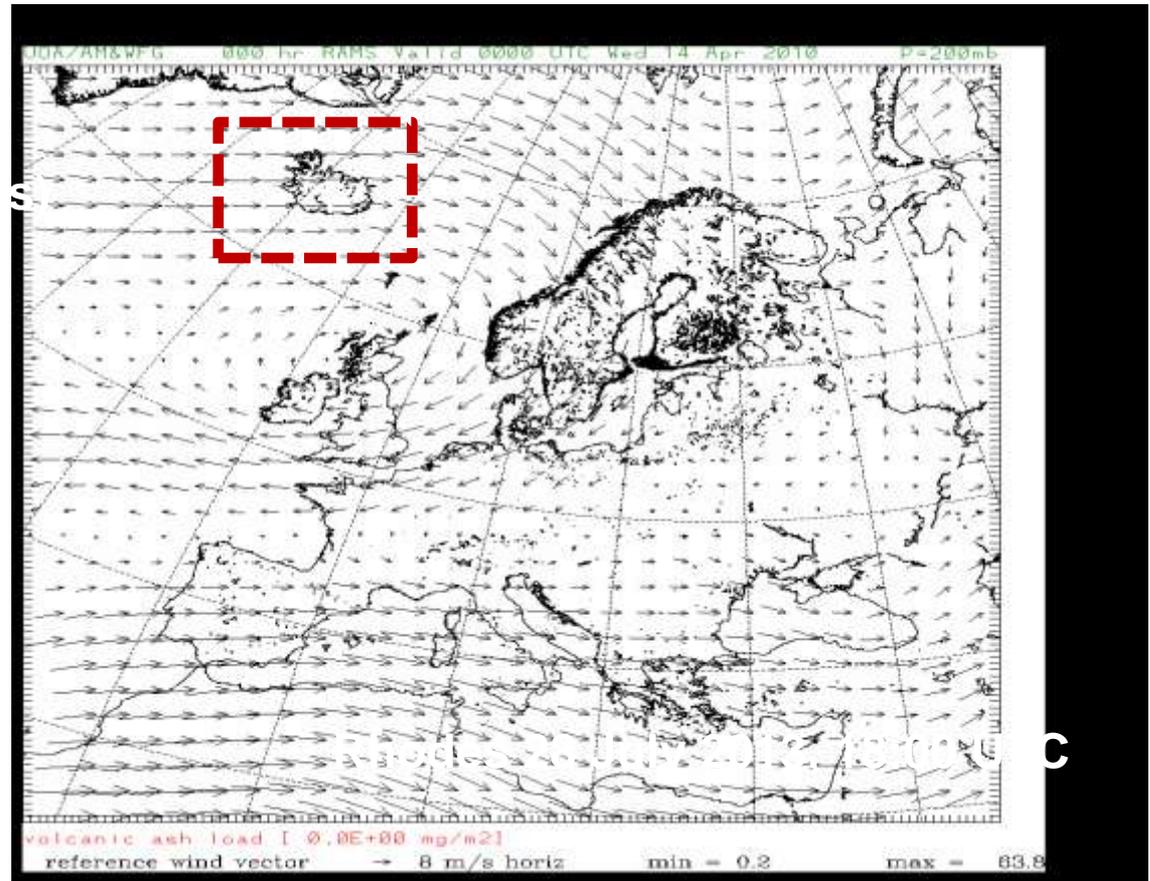

# EO & Transport

## Modeling dispersion of volcanic ash



Dispersion of particles from volcanic eruptions has significant implications for:

- Health
- Weather and climate
- Aviation Safety



RAMS simulation of volcanic ash dispersion from Eyjafjallajökull - Iceland, 14-20 April 2010

# EO & Transport

## Modeling dispersion of volcanic ash

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Examples of recorded aviation incidents related to volcanic ash



KLM Flight 867, 15 December 1989



British Airways Boeing 747-200, 24 June 1982

# EO & Transport

## Modeling dispersion of volcanic ash



Dispersion of volcanic ash is controlled by:

1. Particle size distribution
2. Injection height
3. Weather pattern



Satellite image of volcanic ash from Etna , July 24, 2001. (NASA SeaWiFs)



- Mapping of active volcanoes and their potential for ash cloud emissions for the development of an early warning system
- The system is based on WRF / FLEXPART simulations

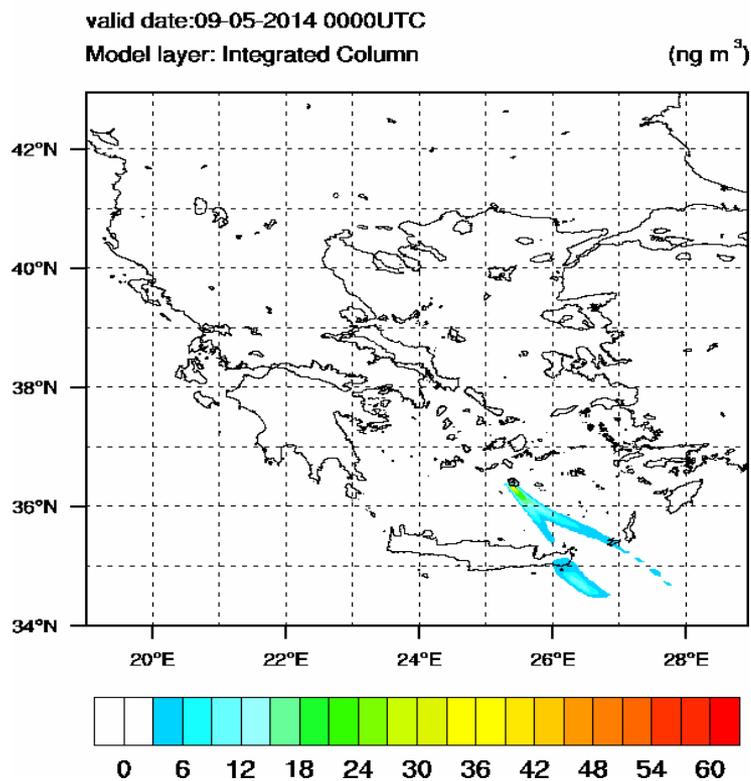
# EO & Transport

## Modeling dispersion of volcanic ash

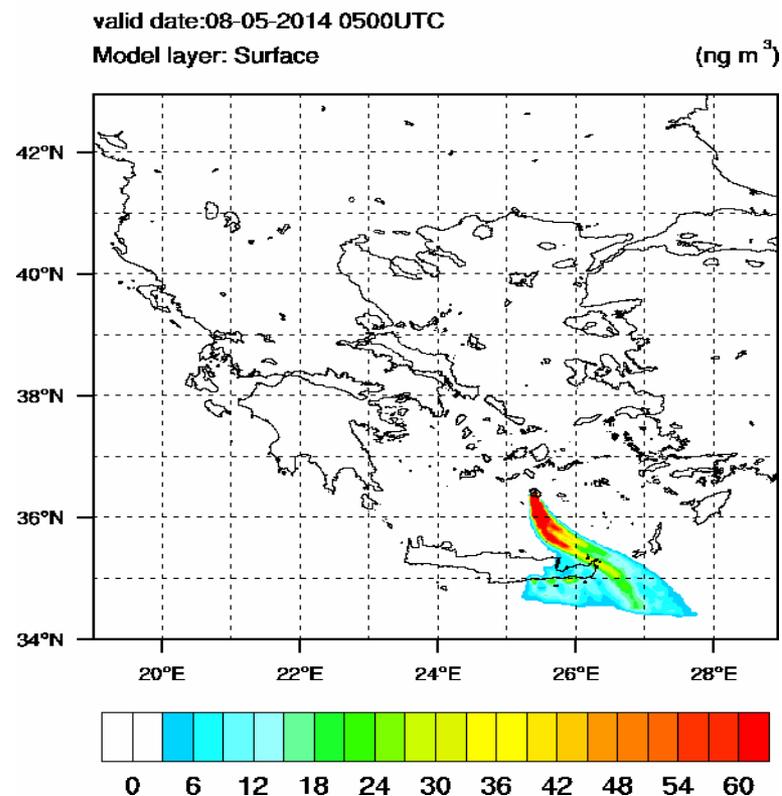


- Preliminary results from the early warning system developed in the framework of BEYOND
- The specific hypothesis assumes 60 hours of continuous emissions at 1.5 km height column
- More work is underway for the identification of Santorini potential emission characteristics

**FLEXPART - NOA**  
Airborne Volcanic Ash



**FLEXPART - NOA**  
Deposited Volcanic Ash

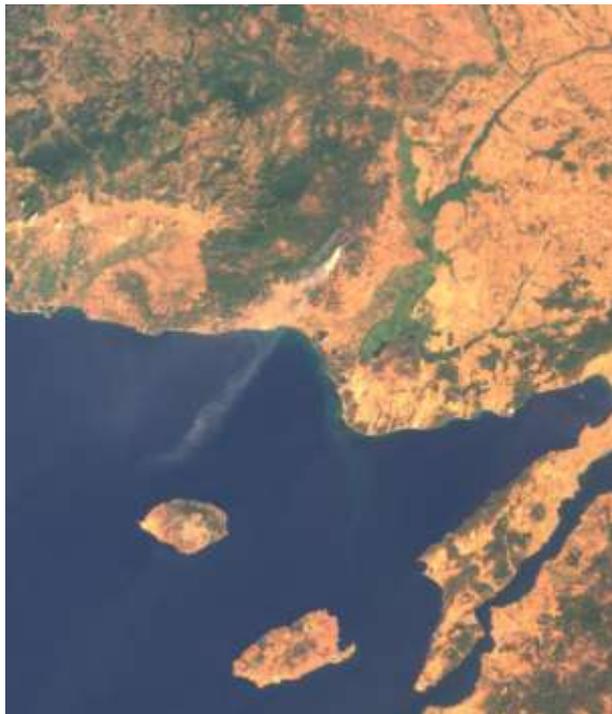


# EO & Transport

## Fire smoke dispersion



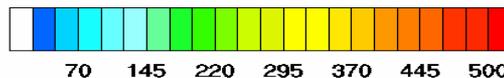
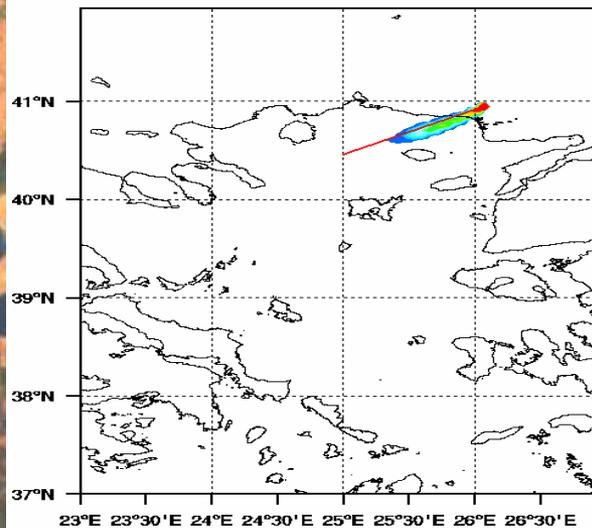
### Forecasting Vertical structure of smoke plume Cross section of Organic Carbon concentration (ng m<sup>-3</sup>)



MISR satellite image  
24 August 2011, 08:00 UTC

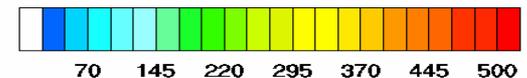
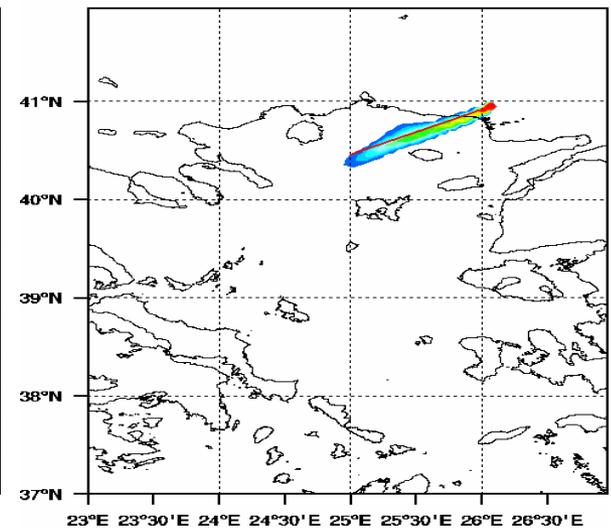
**FLEXPART - NOA**  
Biomass Burning (Organic Carbon -OC)

valid date:24-08-2011 08UTC  
Model layer: Integrated Column (ng m<sup>-3</sup>)



**FLEXPART - NOA**  
Biomass Burning (Organic Carbon -OC)

valid date:24-08-2011 09UTC  
Model layer: Integrated Column (ng m<sup>-3</sup>)



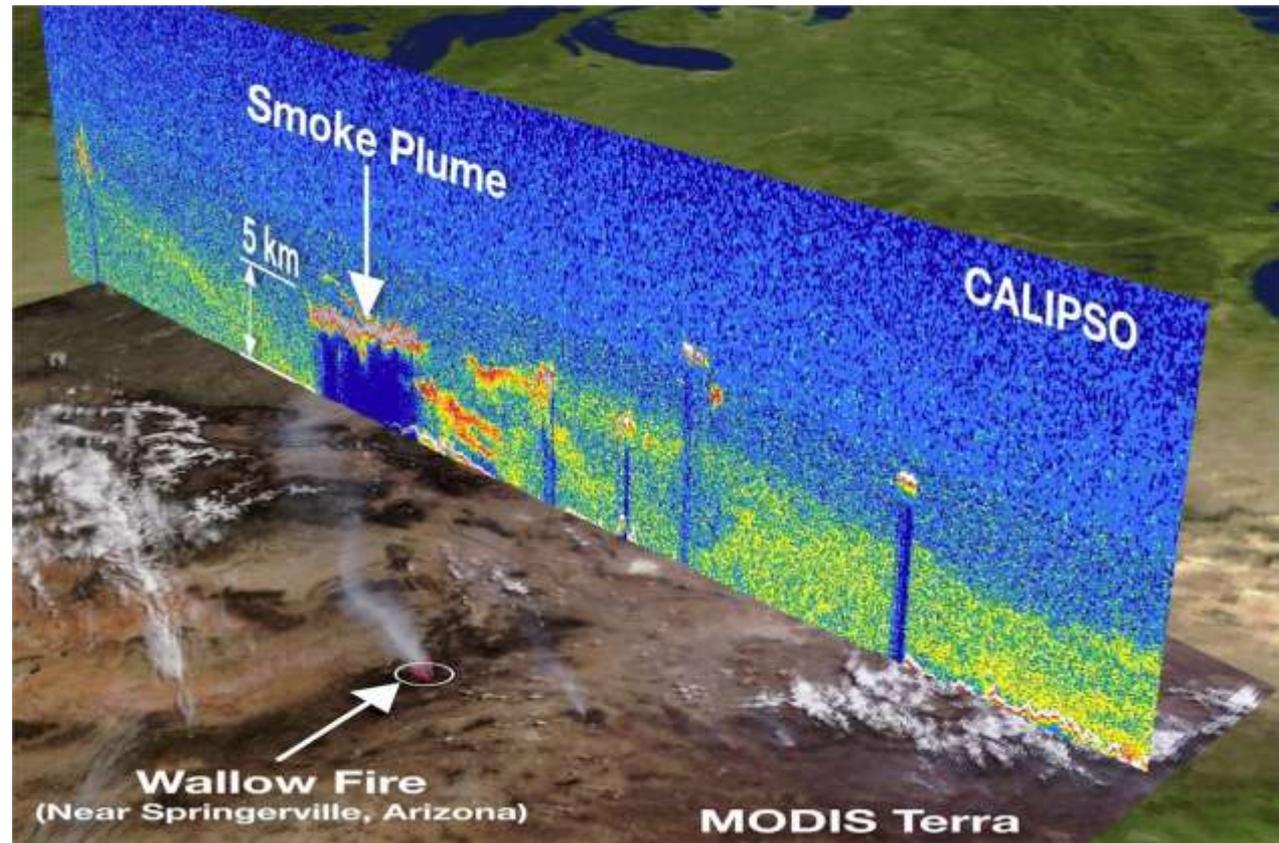
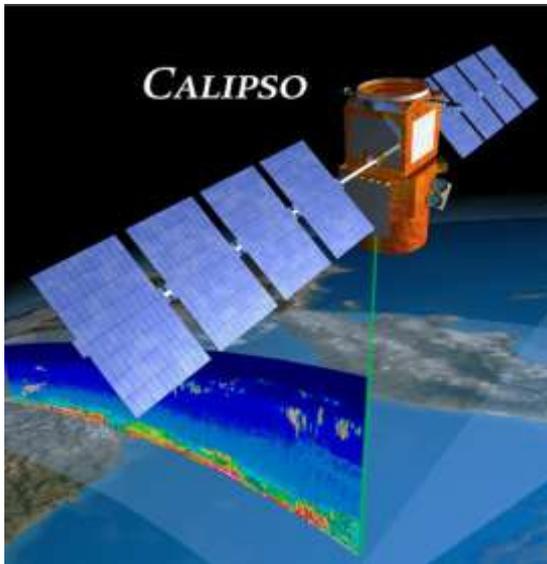
Simulated concentration of Organic Carbon (ng m<sup>-3</sup>) 24  
August 2011, 08:00 (left) and 09:00 (right) UTC

# EO & Transport

## 3D climatology



Global 3D climatology of aerosols and clouds based on 4-year CALIPSO observations



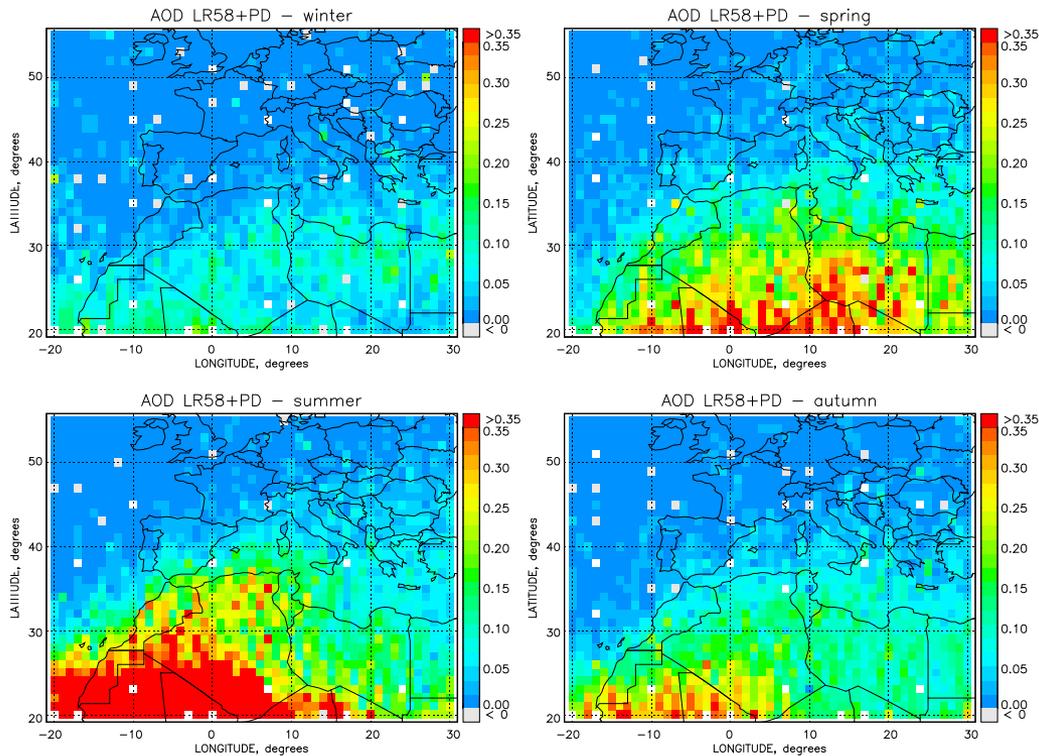
Global AOD at VIS (532 nm) from LIVAS 4-year averages of CALIPSO observations

# EO & Transport

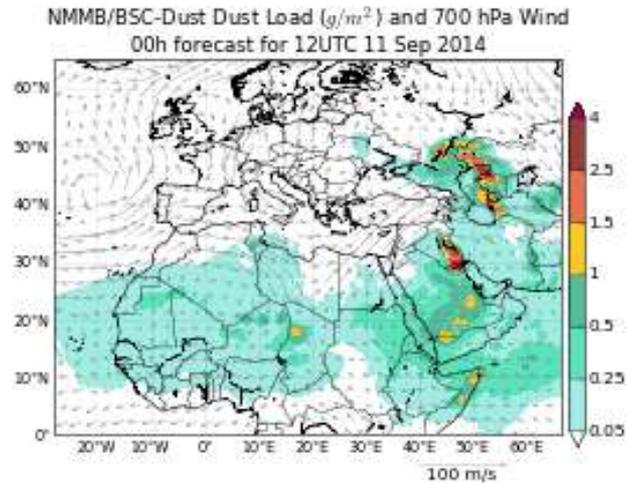
## Dust monitoring



### BEYOND dust product based on CALIPSO



### North Africa-Middle East-Europe



Seasonal geographical distribution of pure Saharan dust particles over Europe and North Africa

# EO & Transport

## Wind storm



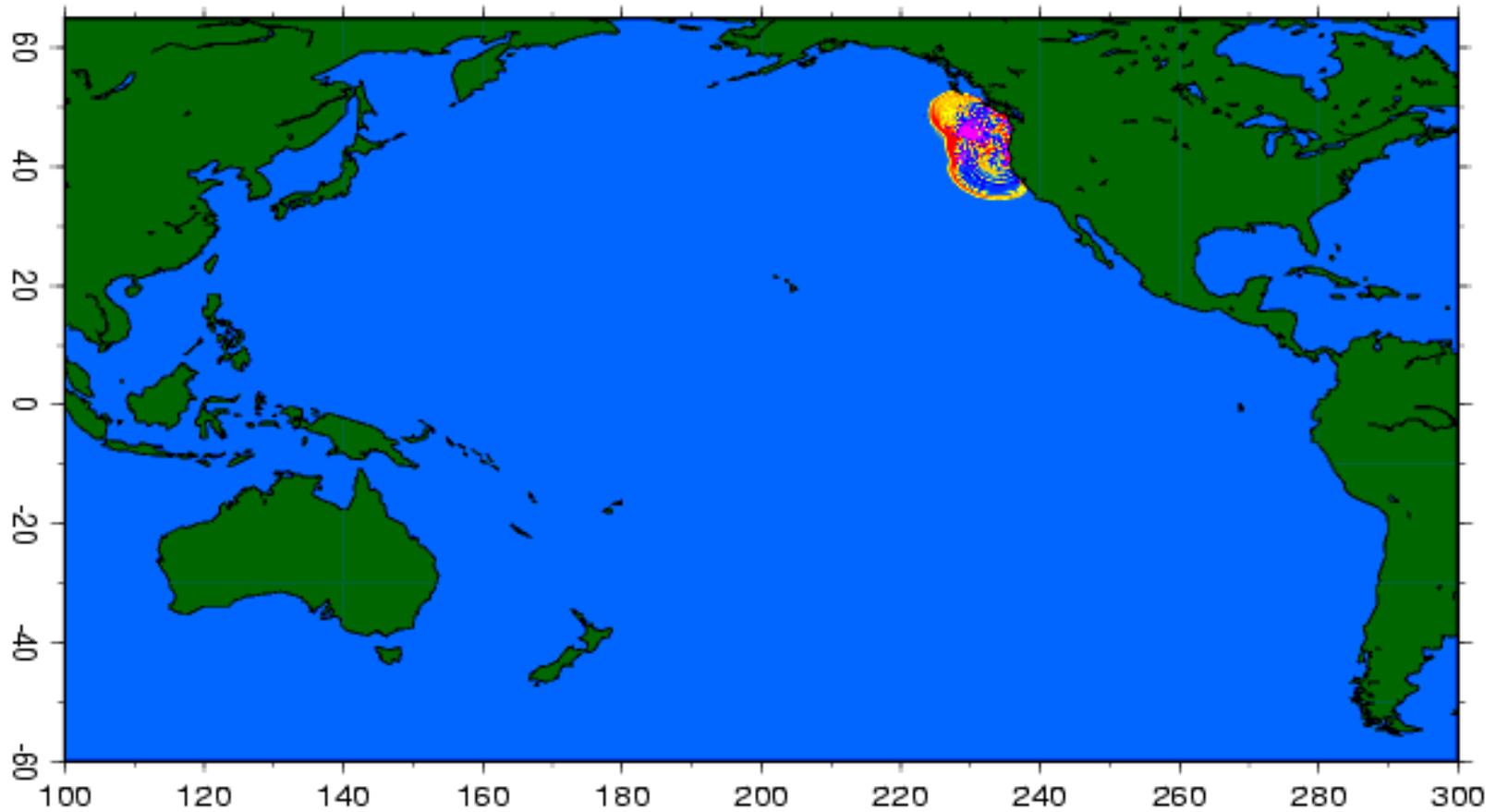
# EO & Transport

## Tsunami

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01 hour



# Conclusions & remarks

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- ✓ BEYOND Center of Excellence is a key player for monitoring natural disasters from space
- ❖ Integration of air-, ground- and space instrumentation
- ❖ Key activities include:
  - Pre-disaster situation maps (hazard mapping, risk analysis, evacuation modeling, etc.)
  - Emergency Response/Support products and services
  - Post-disaster monitoring (detailed damage assessment, reconstruction/rehabilitation mapping, vulnerability assessment etc.)
- ❖ Several products can be used to increase resilience to natural disasters, affecting the Transport System

# Questions?



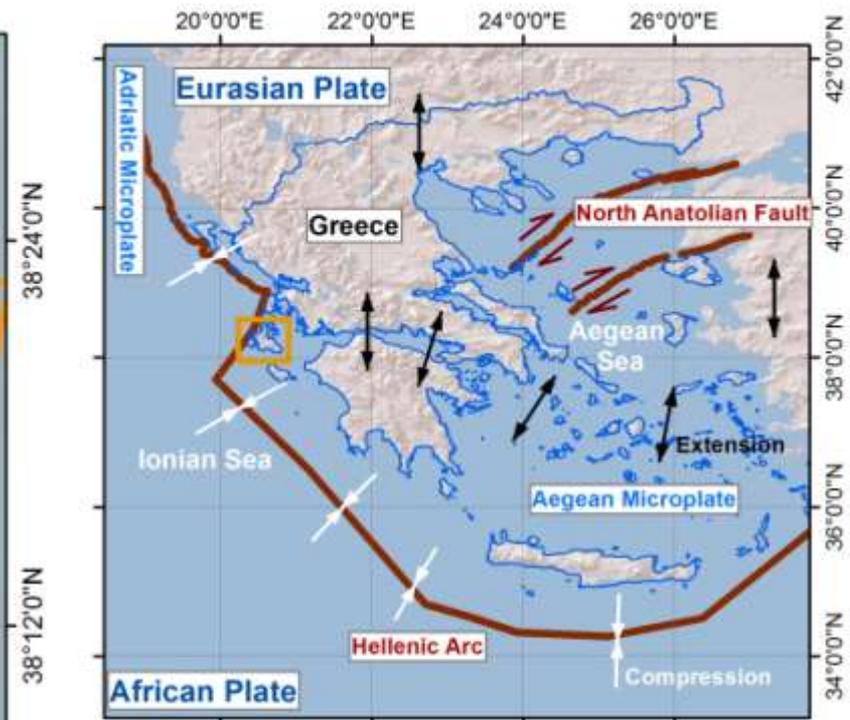
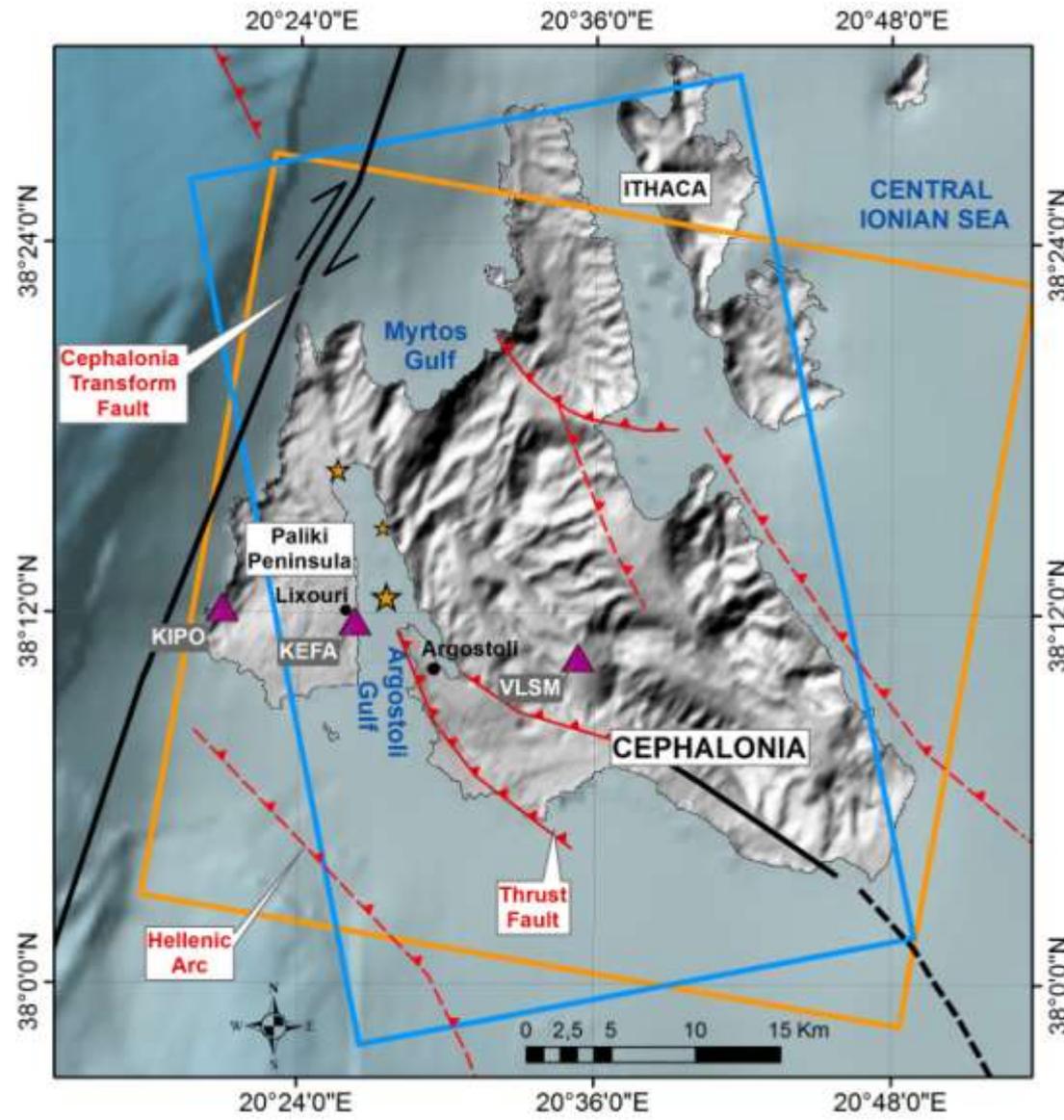
## Thank you!



[ipapoutsis@noa.gr](mailto:ipapoutsis@noa.gr)

<http://beyond-eocenter.eu>

# Cephalonia earthquakes



### Mapped faults

- Strike-slip inferred
- Strike-slip
- - - Reverse inferred
- ▲▲ Reverse

### GPS stations

- ▲ cGPS

### Main earthquake events

- ★ 26/1/2014 ML 5,1
- ★ 3/2/2014 ML 5,7
- ★ 26/1/2-14 ML 5,9

### SARframes

- COSMO-SkyMED
- TerraSAR-X