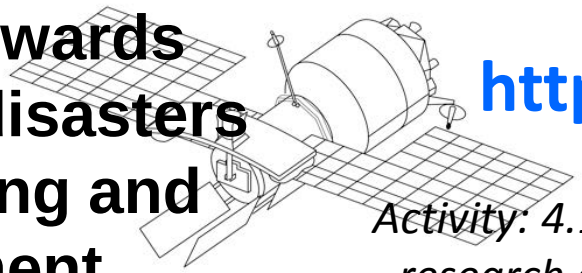
The European Center of Excellence BEYOND for the effective exploitation of satellite time series towards natural disasters monitoring and assessment



BEYOND

Building a Centre of Excellence for EO-based monitoring of Natural Disasters

http://www.beyond-eocenter.eu

Funded under FP7-REGPOT-2012-2013-1

Activity: 4.1 Unlocking and developing the research potential of research entities established in the EU's Convergence regions and Outermost regions

Dr Haris KONTOES
Research Director of IAASARS/NOA
Project Coordinator

FP7-Regpot-2012-23-1

BEYOND Concept

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

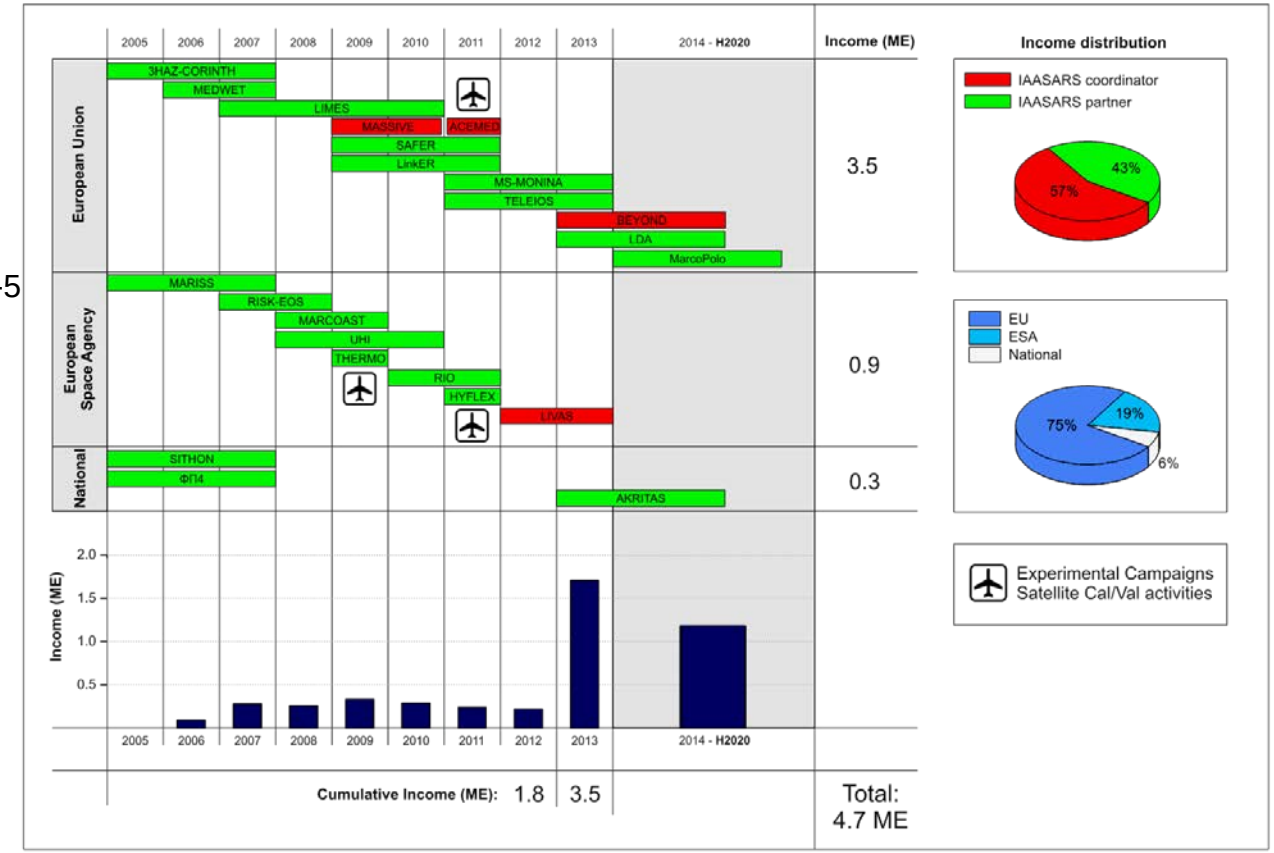
in south-eastern Europe, with a prospect to increase its access range to the wider Mediterranean region through the integrated cooperation with more than 20 **twining organizations**

BEYOND Heritage

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

LIMES (Land and Sea Integrated Monitoring for European Security/GMES / EC DG Enterprise

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

BEYOND Financial Aspects

FP7 REGPOT 2012-2013 funding – Period 2013-2016

TOTAL	ALL WPs		P.M.	Person-nel Costs	Travel	Other direct costs	Sub-contract	Indirect	Total
			469	1207980	245864	599100	109000	143706.08	2305650

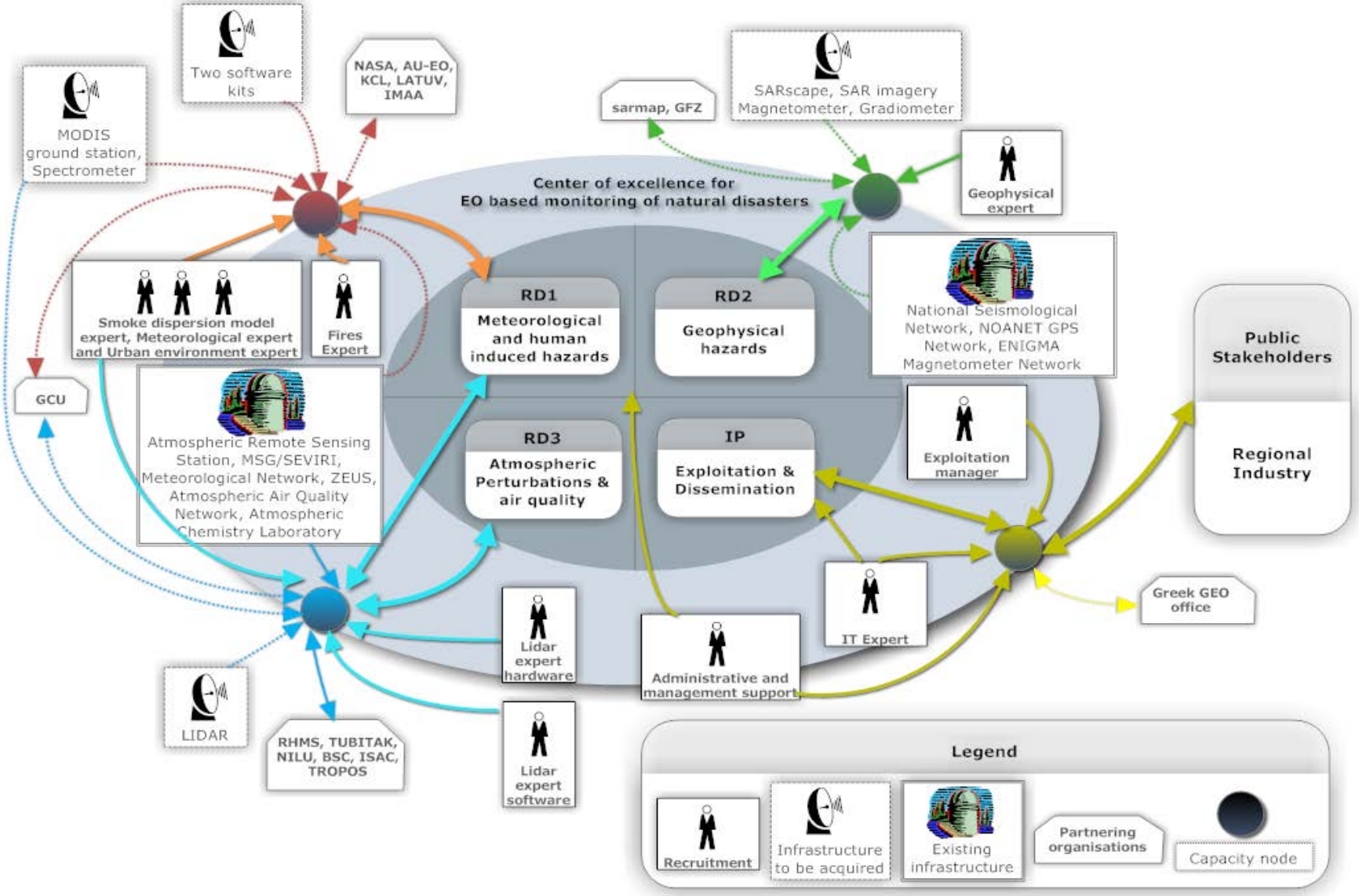
Total costs WP1	MANAGEMENT		24	73181	12000	0	6000	5962.67	97143.67
Total costs WP2	PERSONNEL RECRUITMENT		356	863438	0	3100	0	60657.66	927195.66
Total costs WP3	INFRASTRUCTURE AND CAPACITY BUILDING		49	149401	0	596000	70000	52178,07	867579,07

Total costs WP4	DISSEMINATION		21	64029	114196	0	23000	12475,75	213700,75
Total costs WP5	EXCHANGE OF KNOW-HOW AND EXPERIENCE		10	30490	119668	0	0	10511.06	160669.06
Total costs WP6	EXPLOITATION AND INTELLECTUAL PROPERTY DEVELOPMENT		9	27441	0	0	10000	1920,87	39361,8721

2.3 MEuros EC Contribution

Additional funding from Structural Funds ~270KEuros

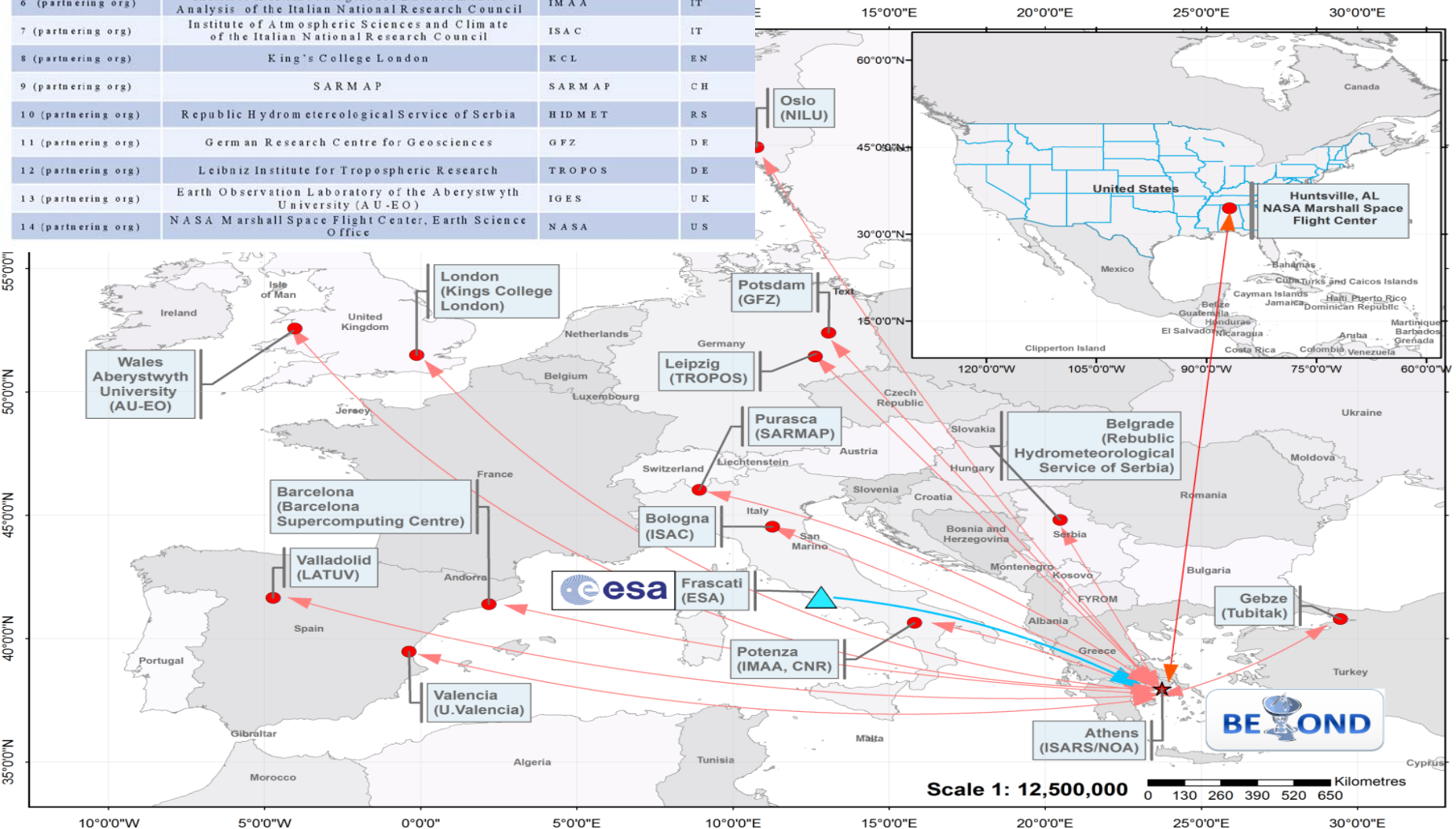
BEYOND
How to achieve goals?



BEYOND Twining Organisations- Know How Exchange

Participant	Participant Organisation name	Participant Short Name	Country
1 (Applicant)	Institute for Space Applications and Remote Sensing (National Observatory of Athens)	ISARS/NOA	GR
1 (partnering org)	Global Change Unit (Image Processing Laboratory) University of Valencia		ES
2 (partnering org)	Remote Sensing Laboratory of the University of Valladolid	LATUV	ES
3 (partnering org)	Barcelona Supercomputing Center	BSC	ES
4 (partnering org)	Norwegian Institute for Air Research	NILU	NO
5 (partnering org)	Scientific and Technological Research Council of Turkey– Marmara Research Center	TUBITAK	TR
6 (partnering org)	Institute if Methodologies for Environmental Analysis of the Italian National Research Council	IMAA	IT
7 (partnering org)	Institute of Atmospheric Sciences and Climate of the Italian National Research Council	ISAC	IT
8 (partnering org)	King's College London	KCL	EN
9 (partnering org)	SARMAP	SARMAP	CH
10 (partnering org)	Republic Hydrometereological Service of Serbia	HIDMET	RS
11 (partnering org)	German Research Centre for Geosciences	GFZ	DE
12 (partnering org)	Leibniz Institute for Tropospheric Research	TROPOS	DE
13 (partnering org)	Earth Observation Laboratory of the Aberystwyth University (AU-EO)	IGES	UK
14 (partnering org)	NASA Marshall Space Flight Center, Earth Science Office	NASA	US

Partnering Organisations



BEYOND Observation & Monitoring Infrastructures

Setting up 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 NOA'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 NOA's in-situ monitoring seismological, magnetometer, and GPS networks**

IAASARS/NOA MSG SEVIRI Acquisition station

IAASARS/NOA X-/L-band Acquisition station

Infrastructure Capacity Building

BEYOND/NOA Observation & Monitoring Networks

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.

Infrastructure Capacity Building

BEYOND Services/Products Archiving and Delivery

- **Cover research/product/service generation requirements for a broad portfolio of natural disaster phenomena** as
- Earthquakes
- Volcanoes
- Landslides
- Wildfire monitoring and mapping
- Smoke and toxic gasses dispersion
- Dust storms
- Air quality
- Floods
- Urban Heat islands

Centre of Excellence for

EO-based monitoring of Natural Disasters

- Fires & Floods
- Urban environment
- Geophysical hazards
- Atmospheric & weather related disasters

Service Capacity Building

(three research domains of BEYOND, **RD1: Meteorological and human induced hazards**, **RD2: Geophysical hazards**, and **RD3: Atmospheric pollution and air quality)**

BEYOND Services/Products Archiving and Delivery

- **Wildfire services**
  - **Real Time Fire Monitoring**
  - Rapid Fire Mapping
  - Burn Scar Mapping
  - **Diachronic Burnt Area Mapping and Damage Assessment**

Specified and validated according to the GMES standards

Service Capacity Building

Real Time Fire Monitoring in Greece – Peloponnesus 2007

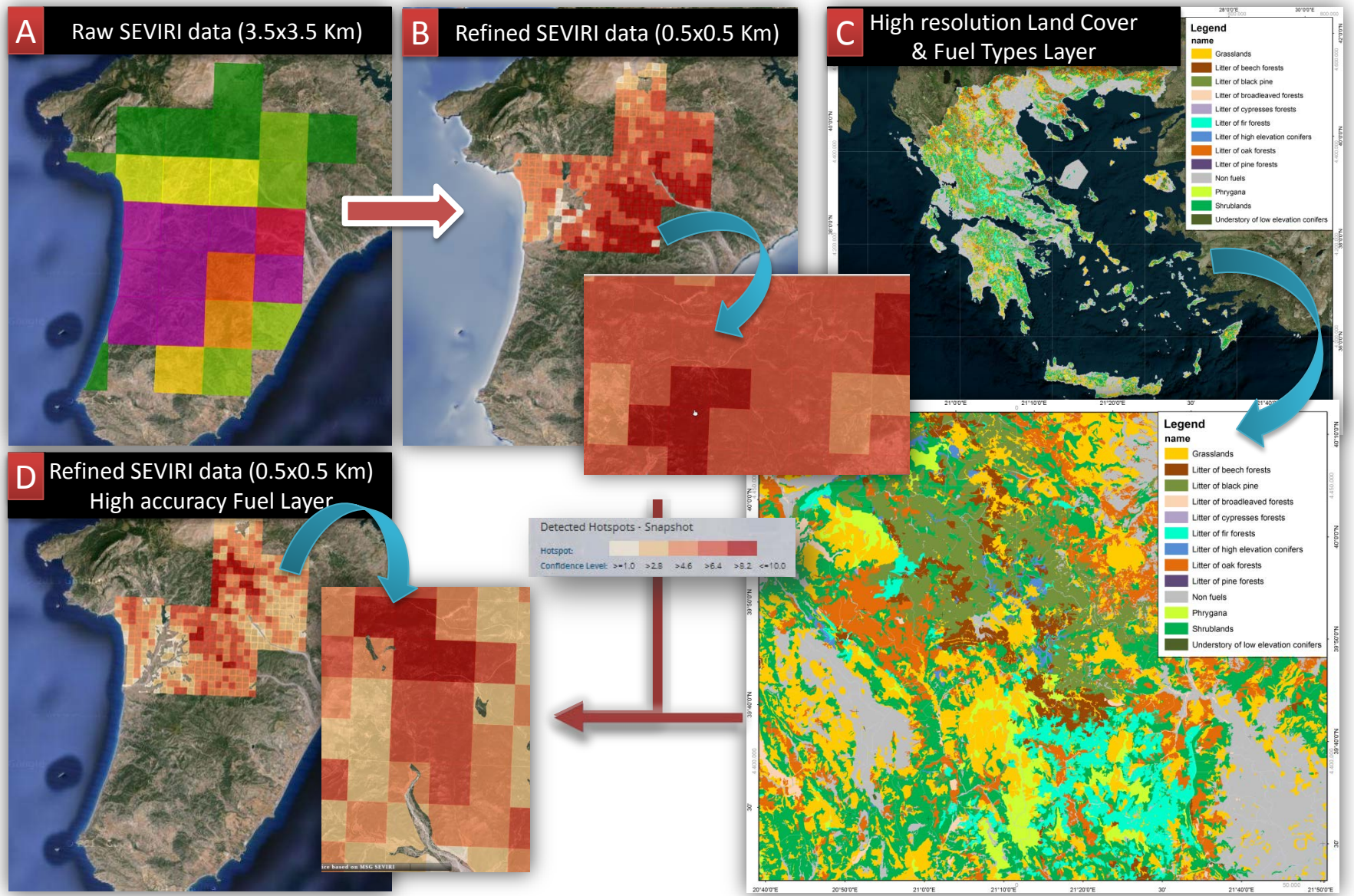
Regional Real Time Fire Monitoring - NOA's MSG SEVIRI Station

SEVIRI MIR 070823_1030 UTC

POTENTIAL FIRE

CONFIRMED FIRE

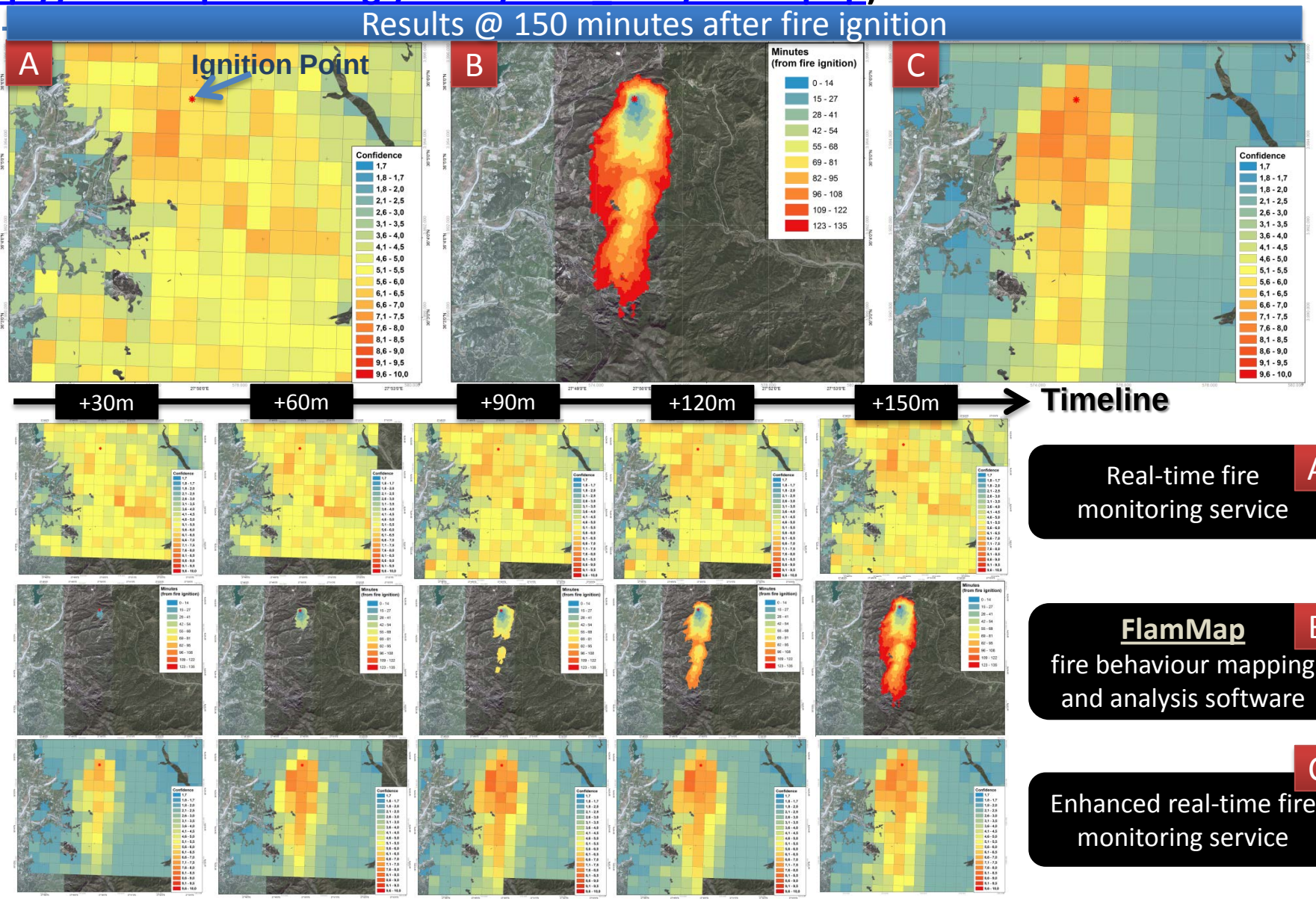
On-line Fire Services dissemination Through NOA‘s dedicated web interface (http://ocean.space.noa.gr/seviri/fend_new/index.php)



Model driven real-time service

On-line Fire Services dissemination Through NOA's dedicated web interface (http://ocean.space.noa.gr/seviri/fend_new/index.php)

BE-OND

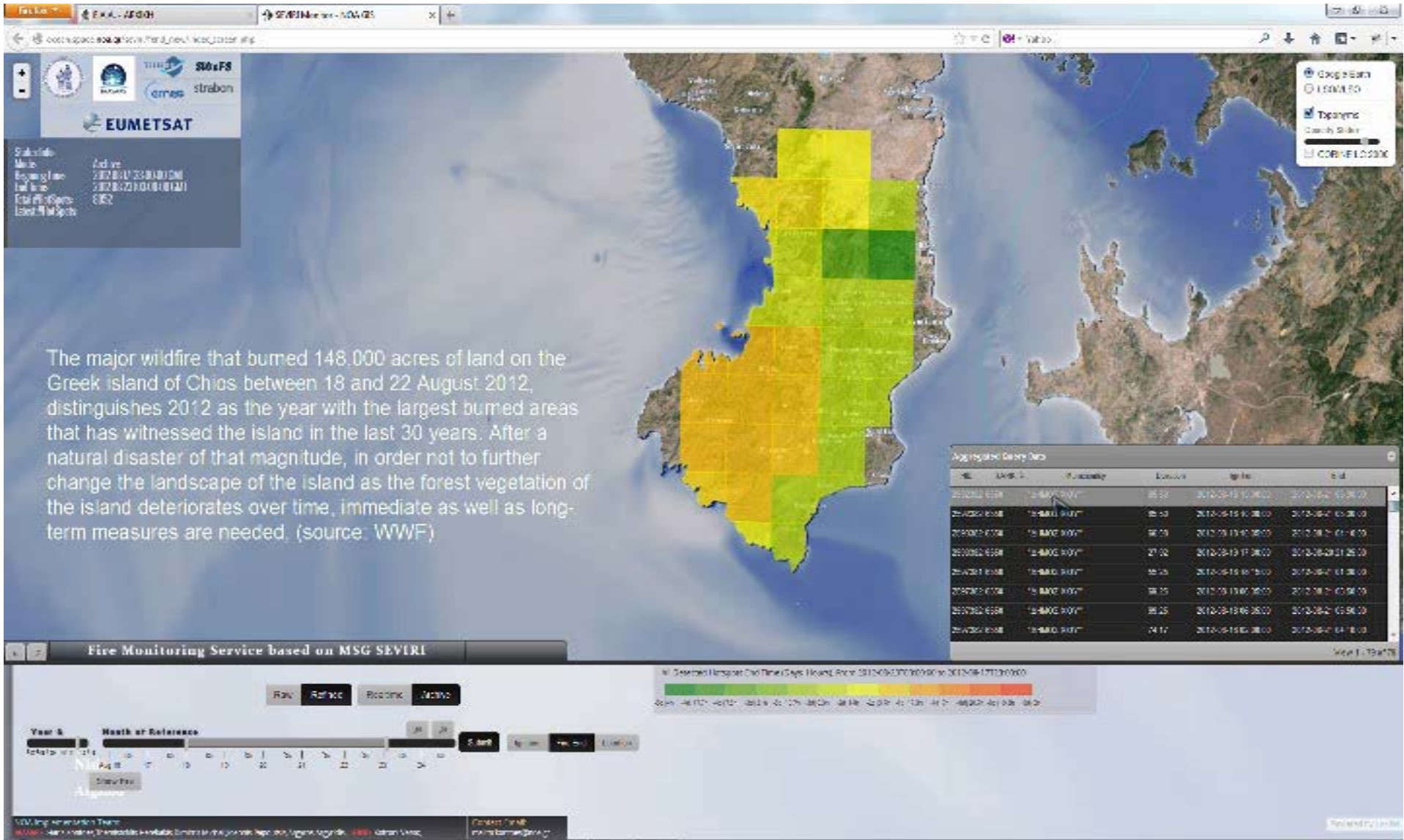


Real-time fire monitoring service **A**

FlamMap **B**
fire behaviour mapping and analysis software

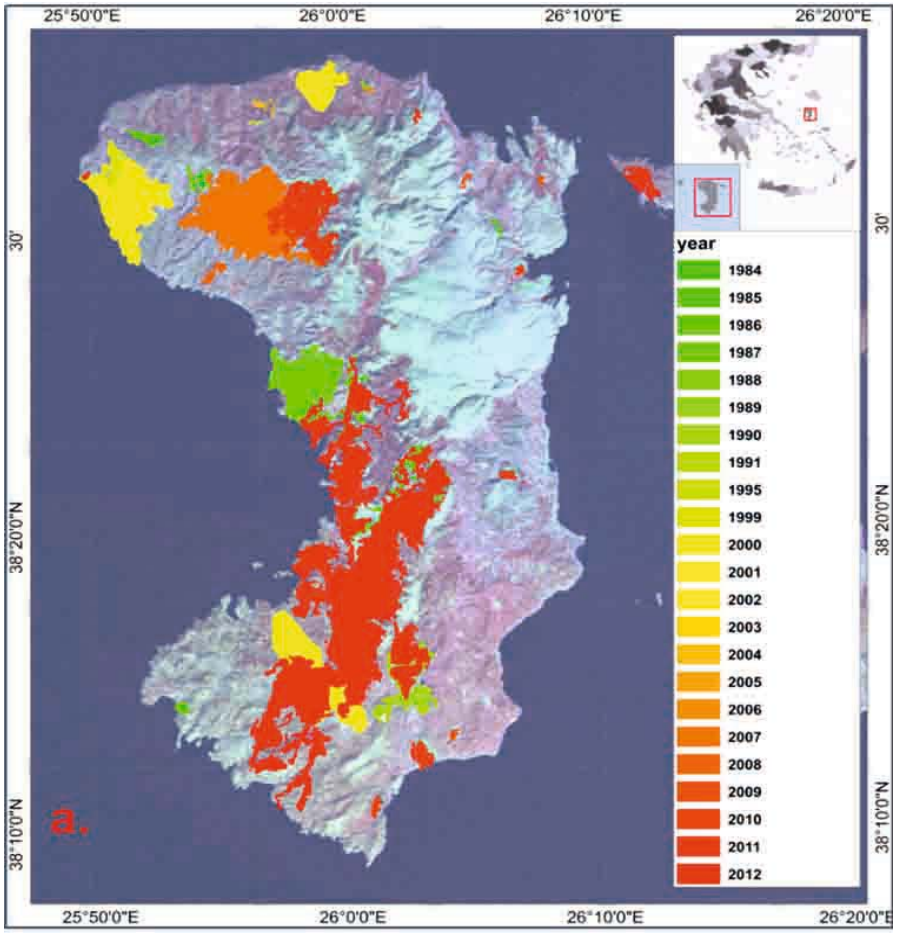
Enhanced real-time fire monitoring service **C**

On-line Fire Services dissemination Through NOA‘s dedicated web interface (http://ocean.space.noa.gr/seviri/fend_new/index.php)



Diachronic Burn Scar Mapping & Damage Assessments at HR

On-line dissemination through NOA‘s dedicated web interface (http://ocean.space.noa.gr/diachronic_bsm/index.php)



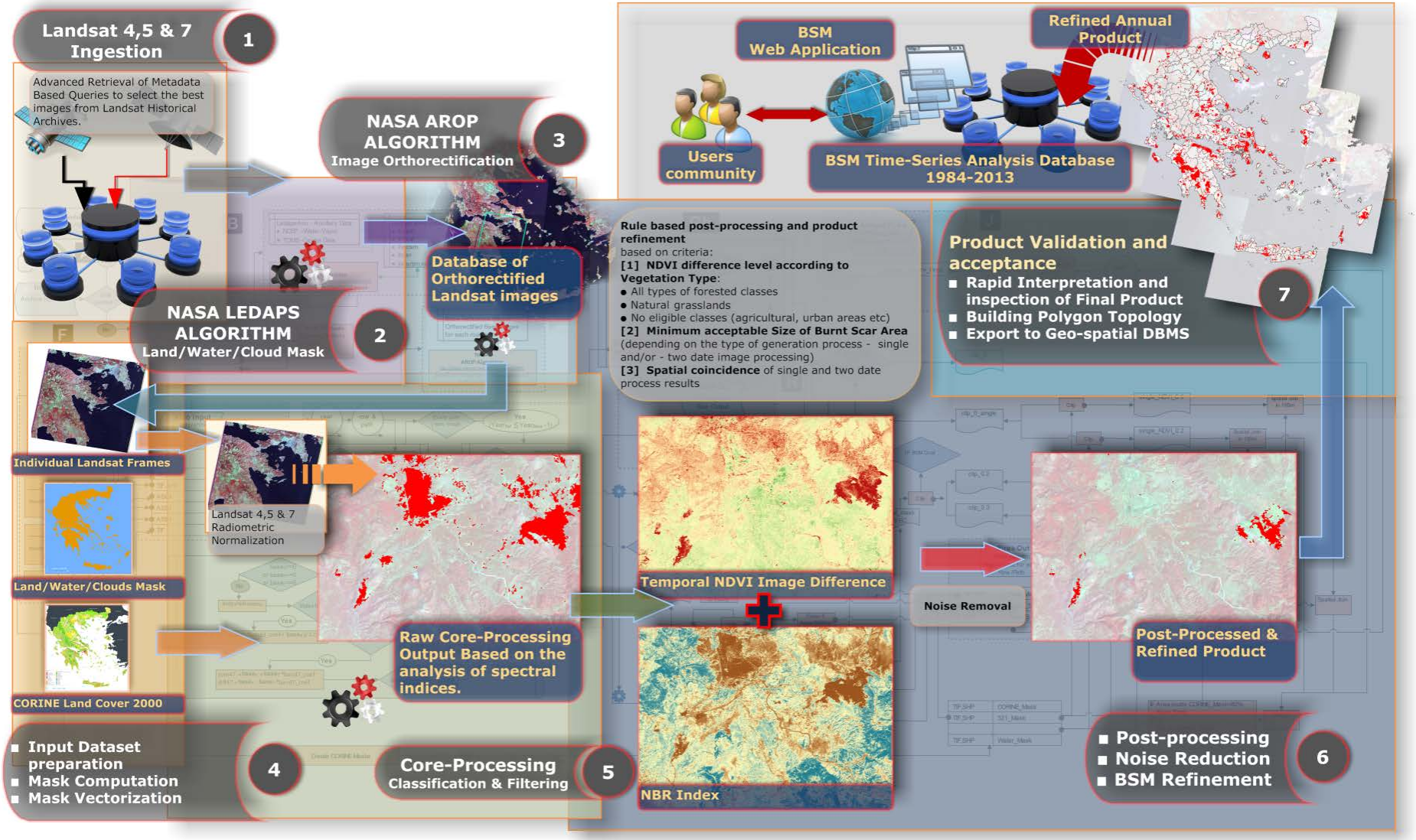
A fully automatic time - series analysis was performed over a large number (545) of Landsat TM 4,5 and Landsat ETM 7,8 historical images over Greece covering the period from 1984 to 2013. The product of the aforementioned procedure was a diachronic burn scar mapping and damage assessment geospatial database.

A complex processing chain comprising of 6 sub-processes has been developed.

2.7 Terabytes of intermediate data were produced while 21 days of machine time was demanded.

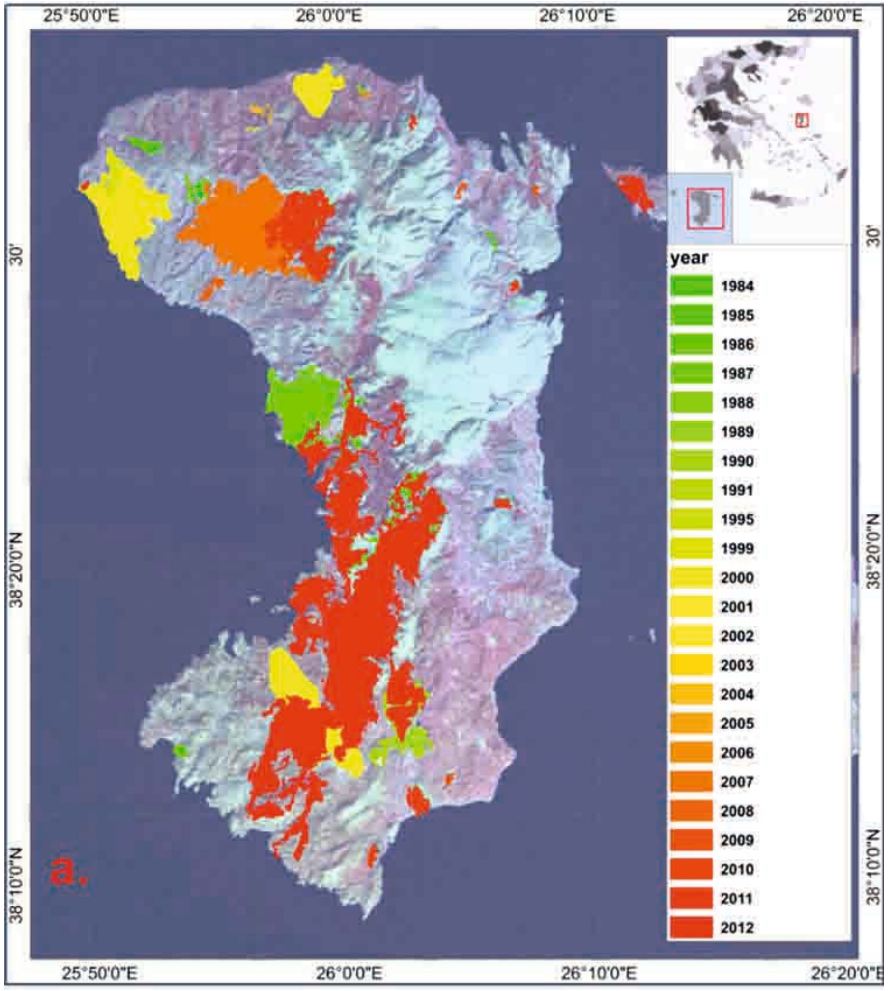
Diachronic BSM Algorithm

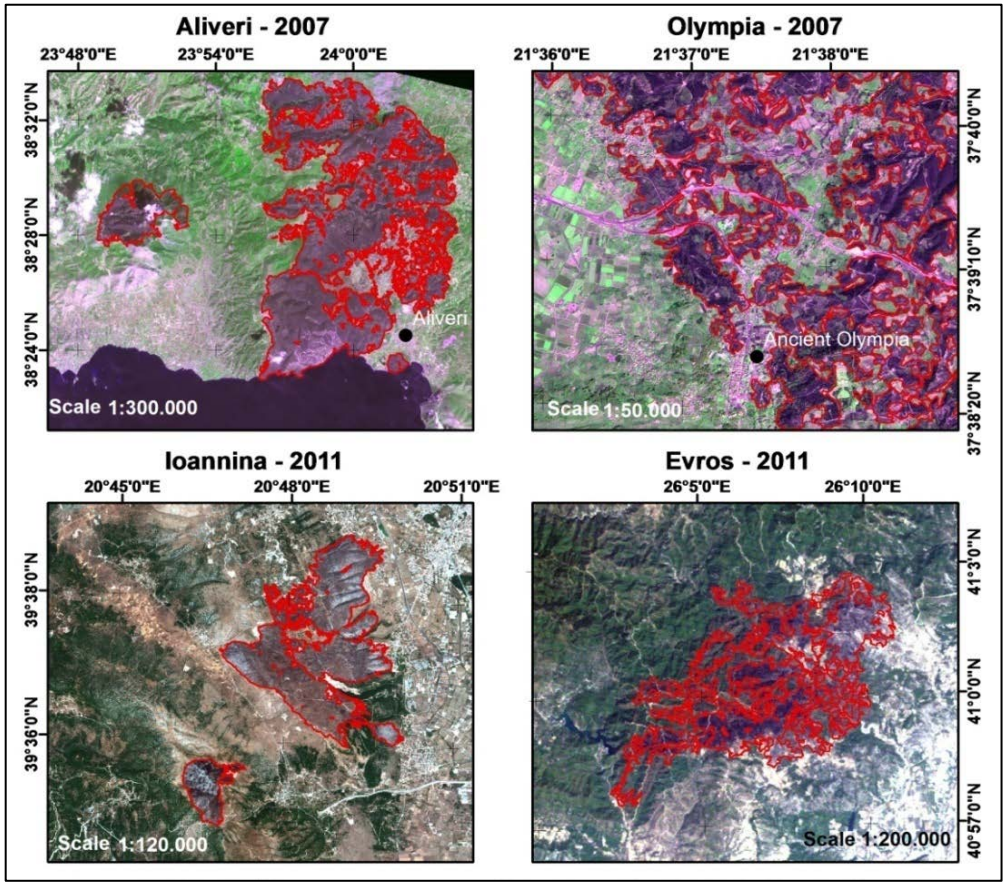
On-line dissemination through NOA's dedicated web interface (http://ocean.space.noa.gr/diachronic_bsm/index.php)



Diachronic Burn Scar Mapping & Damage Assessments at HR

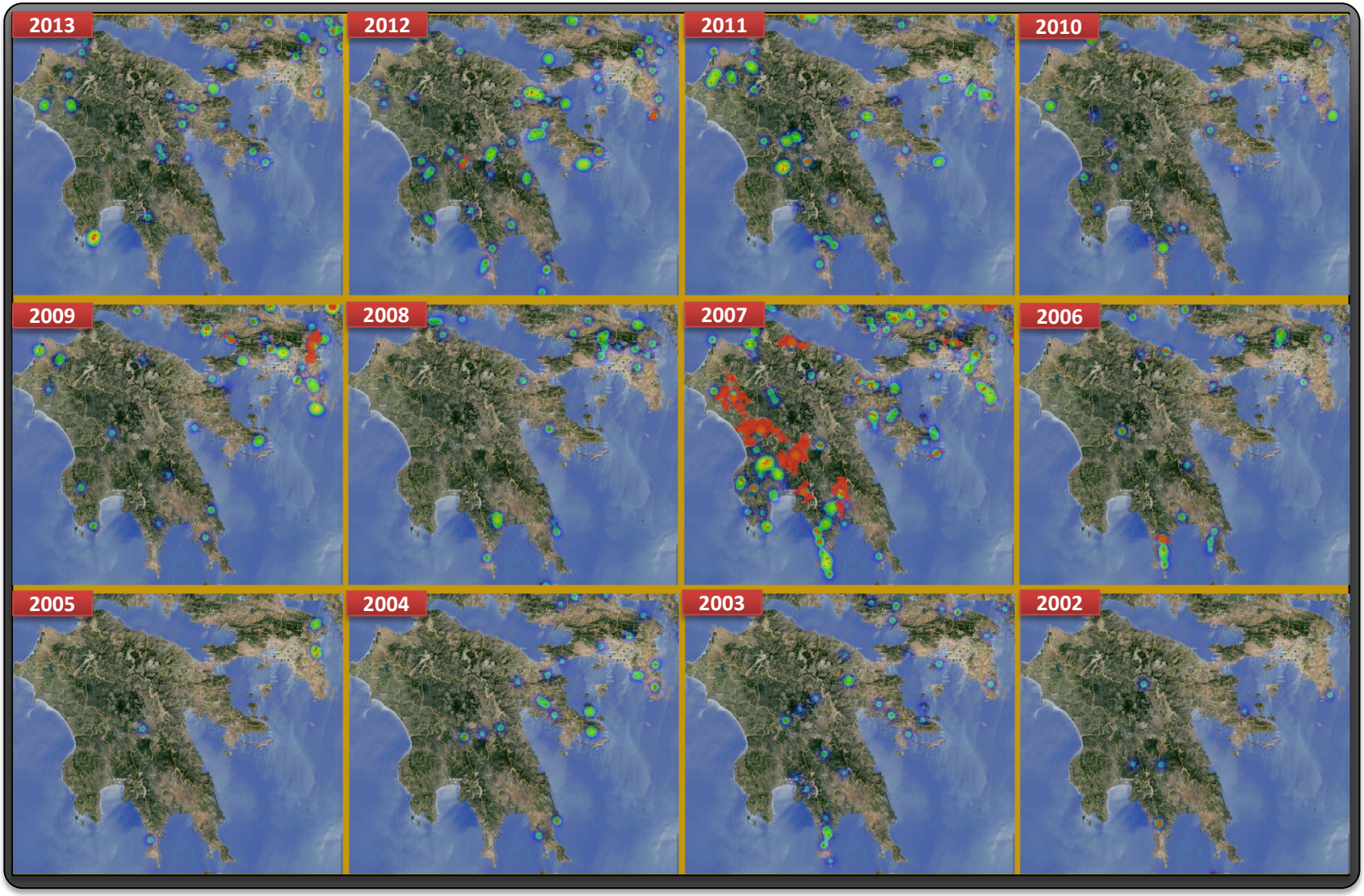
On-line dissemination through NOA‘s dedicated web interface (http://ocean.space.noa.gr/diachronic_bsm/index.php)





BSM Annual Heat Map

On-line dissemination through NOA's dedicated web interface (http://ocean.space.noa.gr/diachronic_bsm/index.php)



Diachronic Burn Scar Mapping

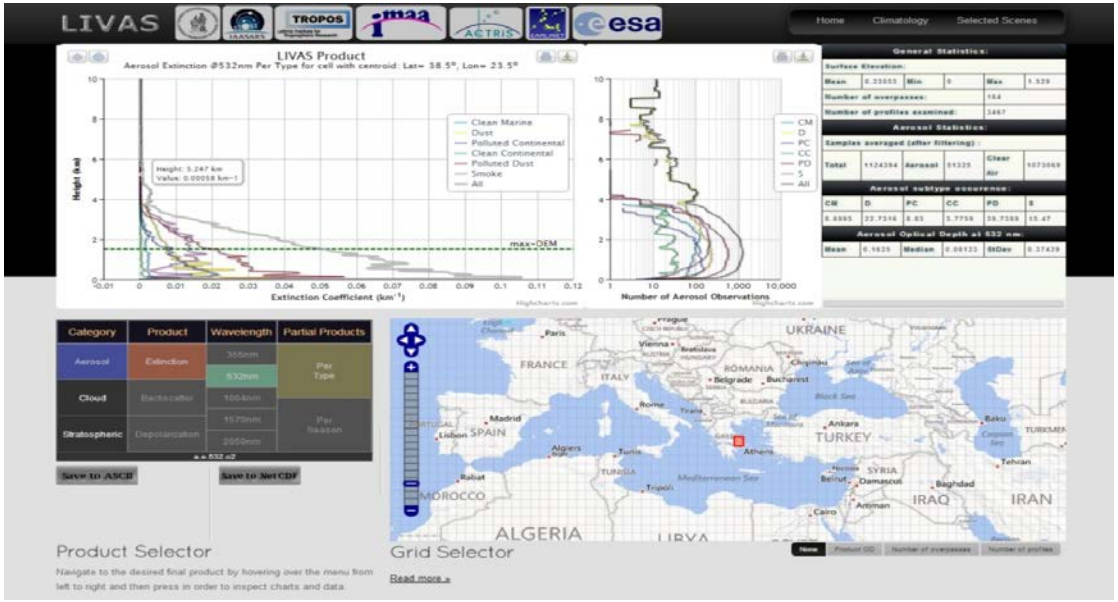
On-line dissemination through NOA's web interface (http://ocean.space.noa.gr/diachronic_bsm/index.php)

BEYOND Services/Products Archiving and Delivery

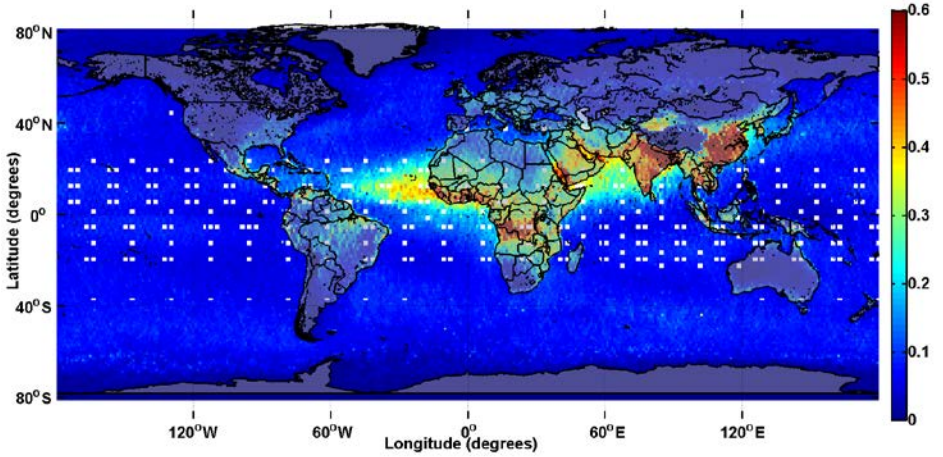
- **Atmosphere related services**
  - 3-D Aerosol and Cloud Distribution (3-D Aerosol Optical Depth)
  - Monthly Assessment of Dust Dispersion

Service Capacity Building

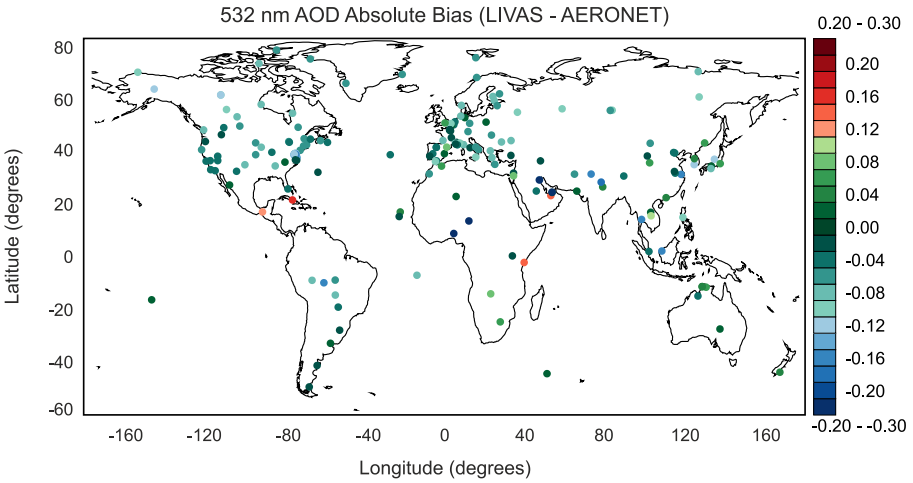
Global 3D climatology of aerosols and clouds
LIVAS portal under BEYOND (1x1 degree resolution)



BEYOND - LIVAS webportal: http://lidar.space.noa.gr:8080/livas/

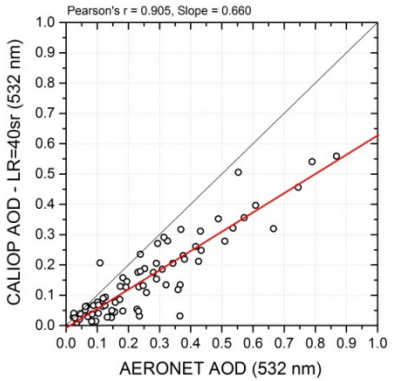


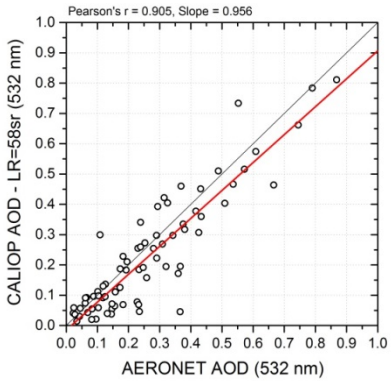
Global AOD at VIS (532 nm) from LIVAS 4-year averages of CALIPSO observations

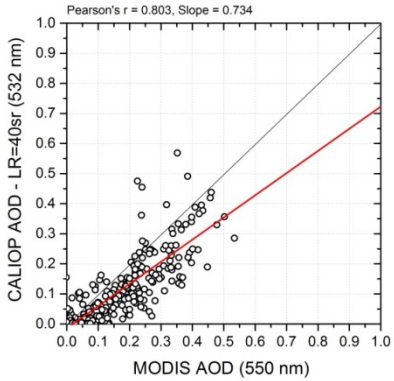


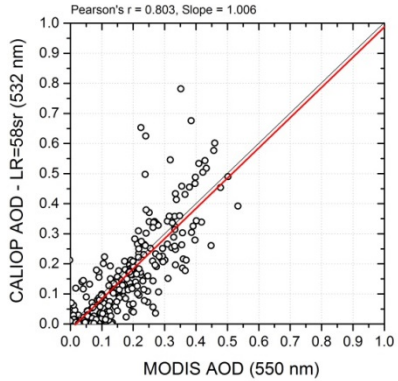
LIVAS AOD evaluation against AERONET

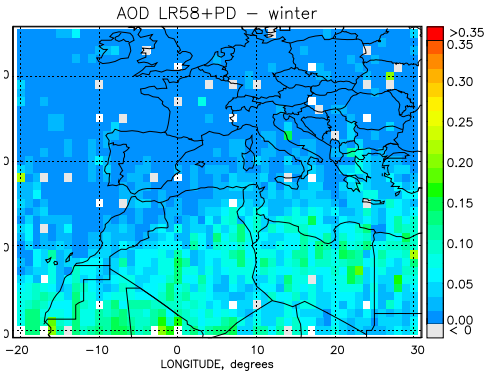
Global 3D climatology of aerosols and clouds
BEYOND dust product based on CALIPSO

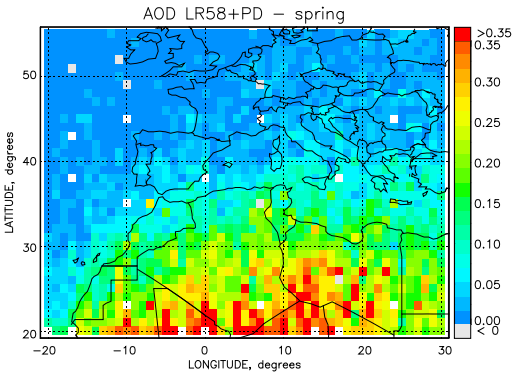


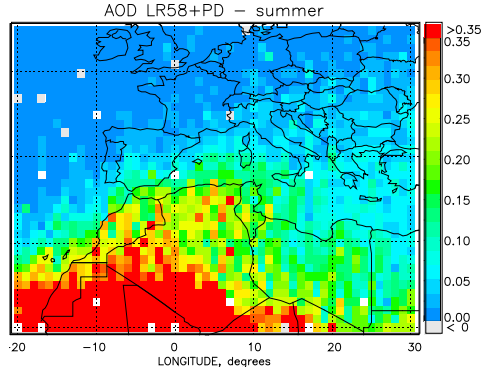


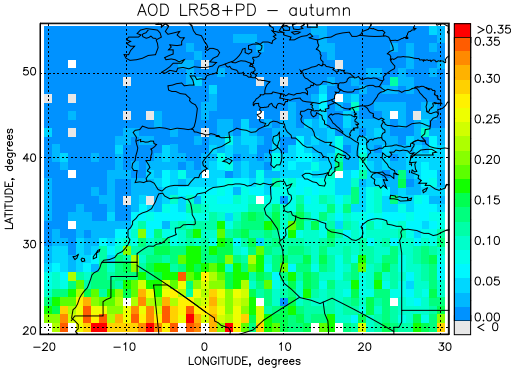








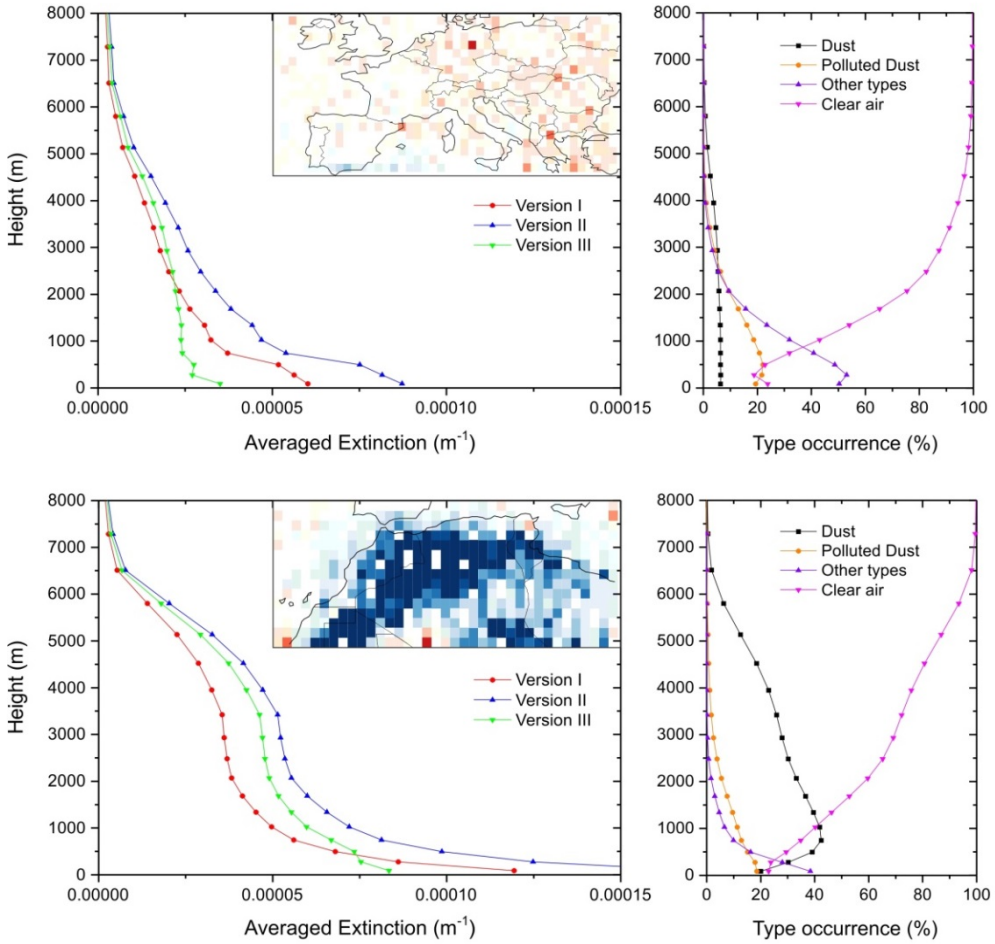




BEYOND dust product validation against AERONET (upper-right) and MODIS (lower-right), in comparison with the original CALIPSO product (left)

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

Global 3D climatology of aerosols and clouds
BEYOND dust product based on CALIPSO



The dust product of BEYOND is provided with a vertical resolution of 60m. The LIVAS BEYOND products are currently used as the Reference Atmospheric Model (RAM) by ESA for simulation tests in hardware and software level of future lidar missions like ADM-Aeolus and EarthCARE Earth Explorers.

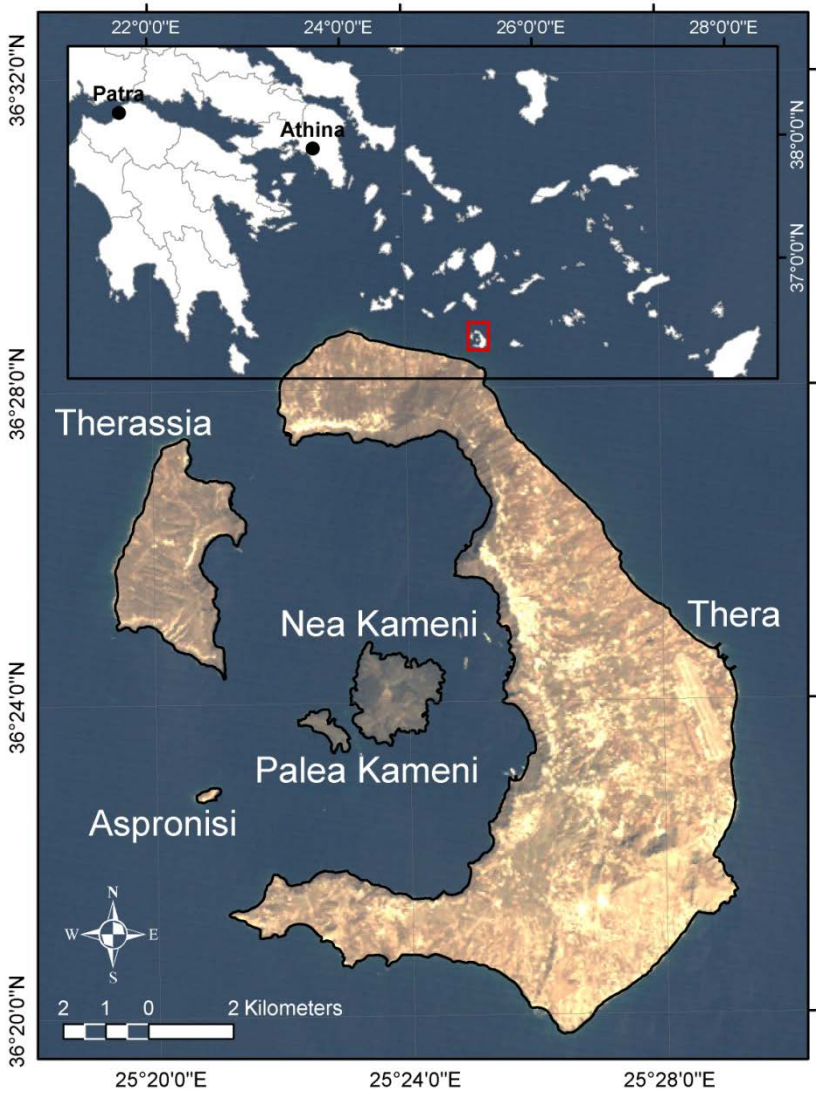
BEYOND Service/Products Archiving and Delivery

- **Geo-Hazards**
  - **Time-series for monitoring rapidly & slowly evolving phenomena due to Volcanoes, Earthquakes, Landslides, Surface Subsidence**

Service Capacity Building

Background information on Santorini

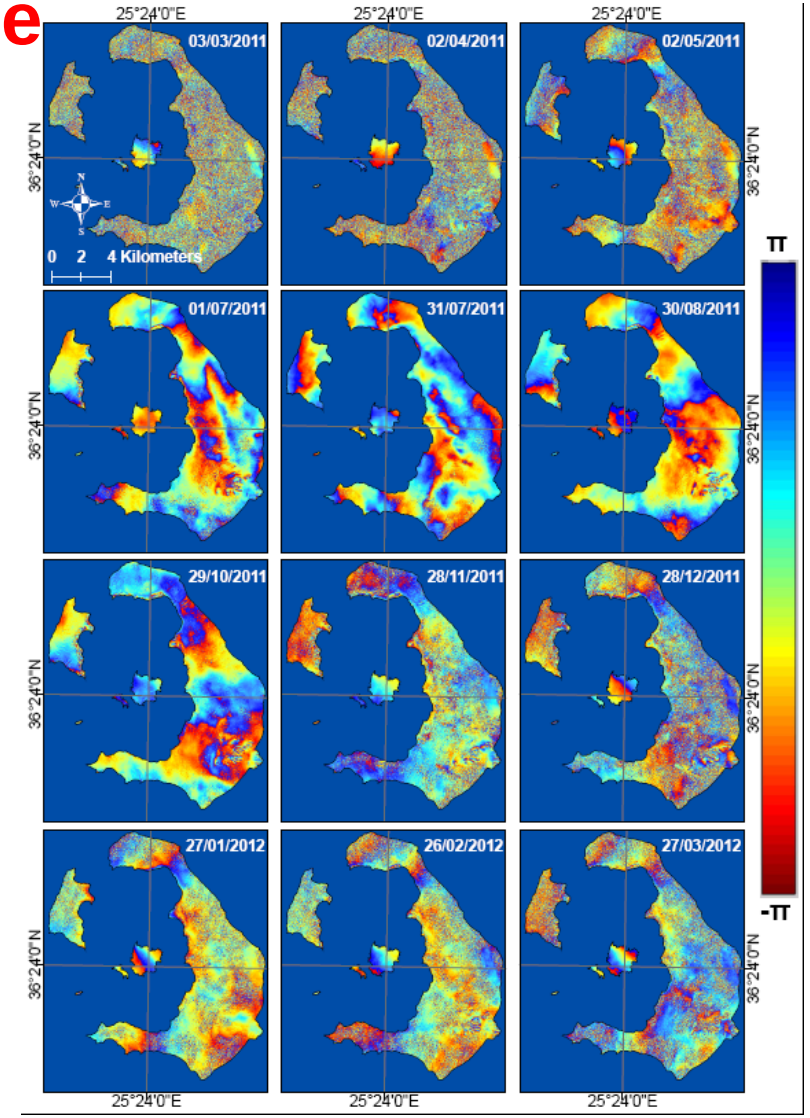
- Santorini Volcanic Complex is the most active part of the South Aegean (Hellenic) Volcanic Arc.
- Several eruptions led to the present form of the Kameni islands (197 BC, 46 AD, 726, 1570, 1707, 1866, 1925, 1939, 1950)
- Most recent seismic sequence ended in 1950
- Since then, Santorini volcano has been in a ‘quite’ phase, with insignificant deformation (confirmed by GPS and InSAR)



Time-series for monitoring rapidly evolving phenomena

The Santorini inflation episode

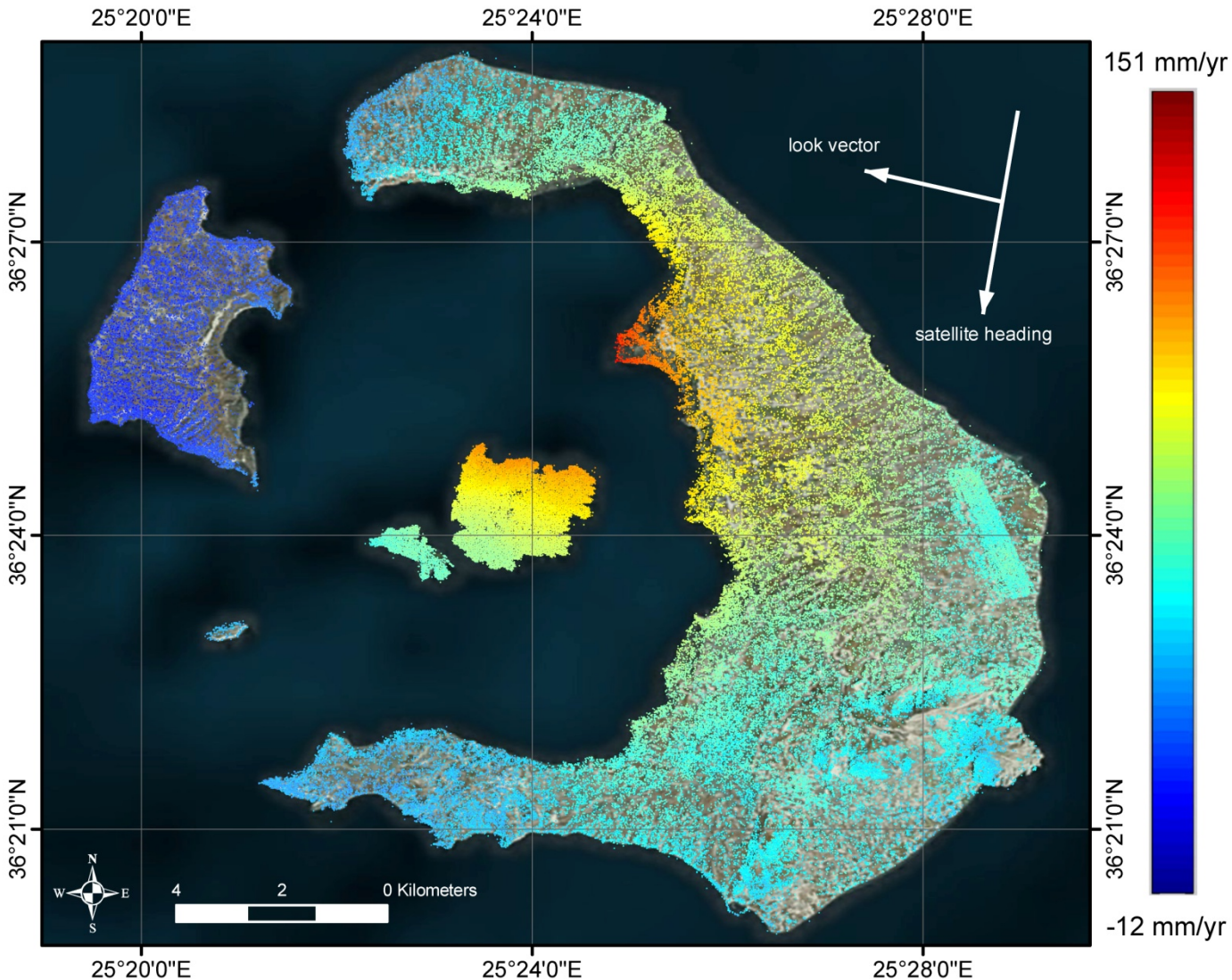
- ASAR ENVISAT, descending mode
- Last orbit before the end of the mission in April 2012
- Time span: March 2011 – March 2012
- Short spatial & temporal baselines
- Swath I6, leading to increased sensitivity to the E-W horizontal components
- S/W: Gamma, ROI_PAC, DORIS, StaMPS
- Persistent Scatterer Interferometry techniques (PSInSAR & SBAS)
- Papoutsis et al., Geophysical Research Letters, Jan. 2013



Time-series for monitoring rapidly evolving phenomena

The Santorini inflation episode

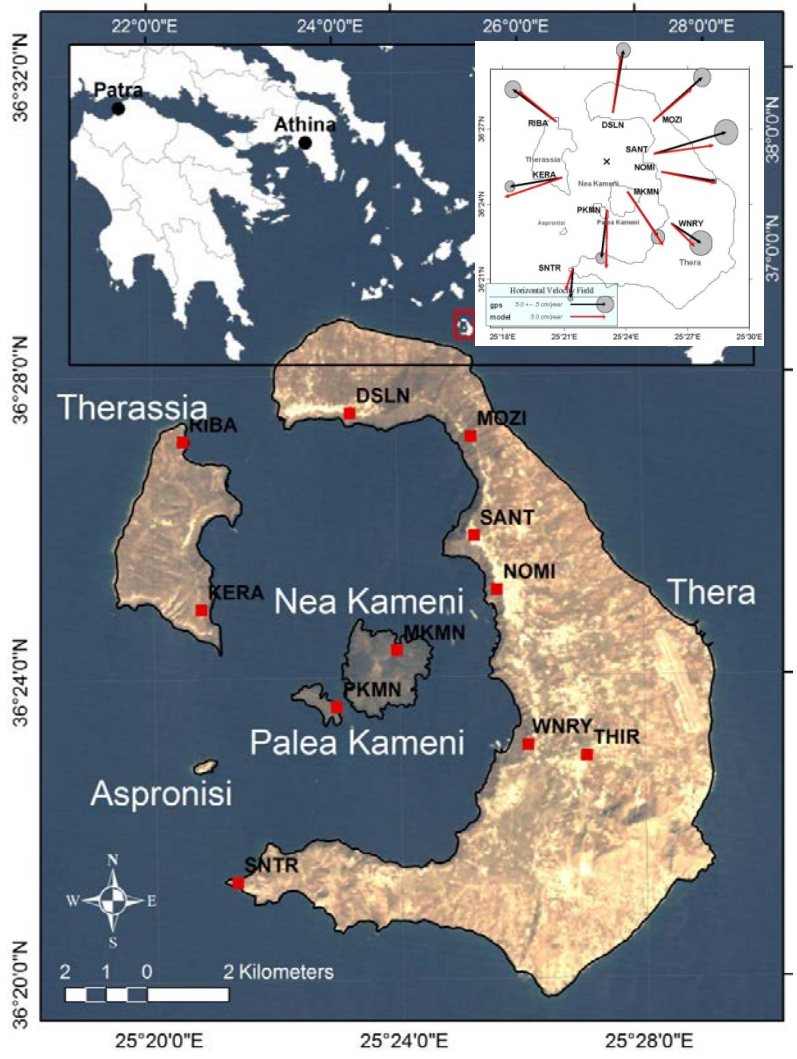
- Wide coverage and highly accurate velocity maps
- High spatial resolution of the deformation pattern
- Uplift with a radial decaying pattern in amplitude and velocity from the center of deformation
- **150 mm/yr maximum deformation**

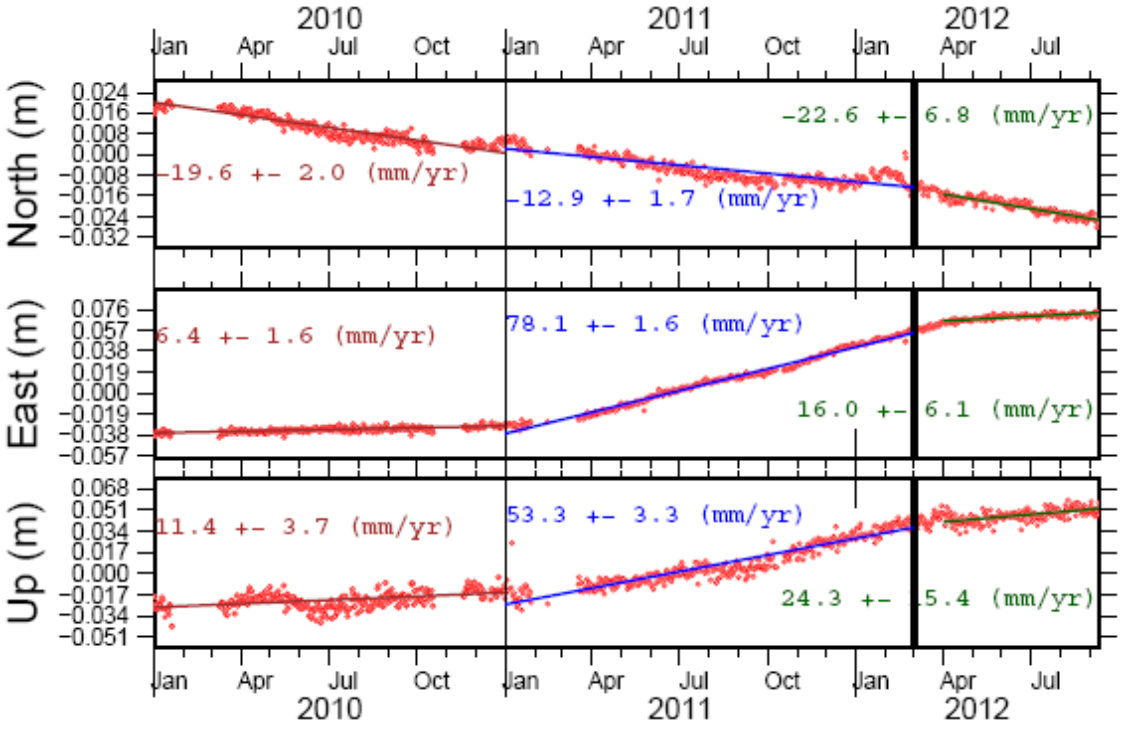


Time-series for monitoring rapidly evolving phenomena

The Santorini inflation episode

Time-series monitoring with in-situ GPS stations





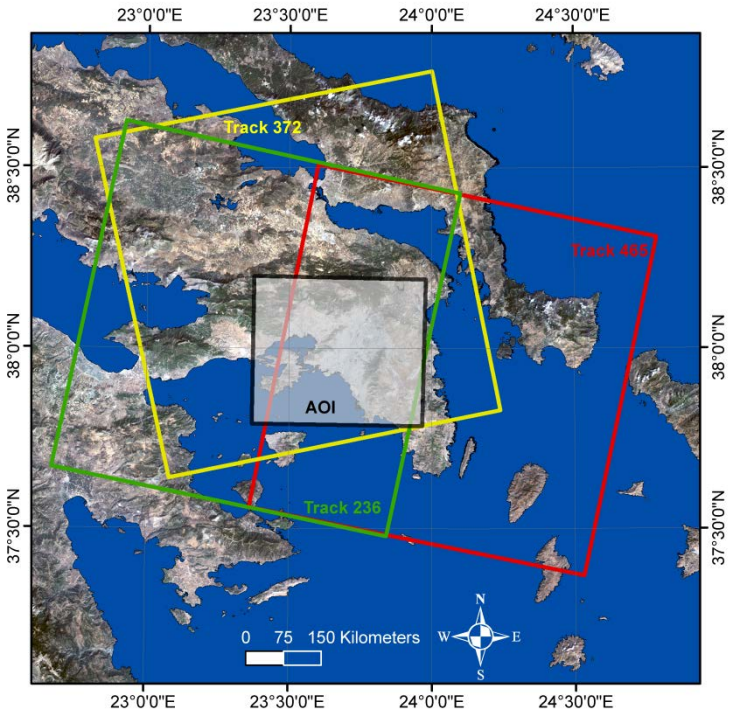
Time-series for monitoring slowly evolving phenomena

Diachronic mapping of crustal deformation in Attica

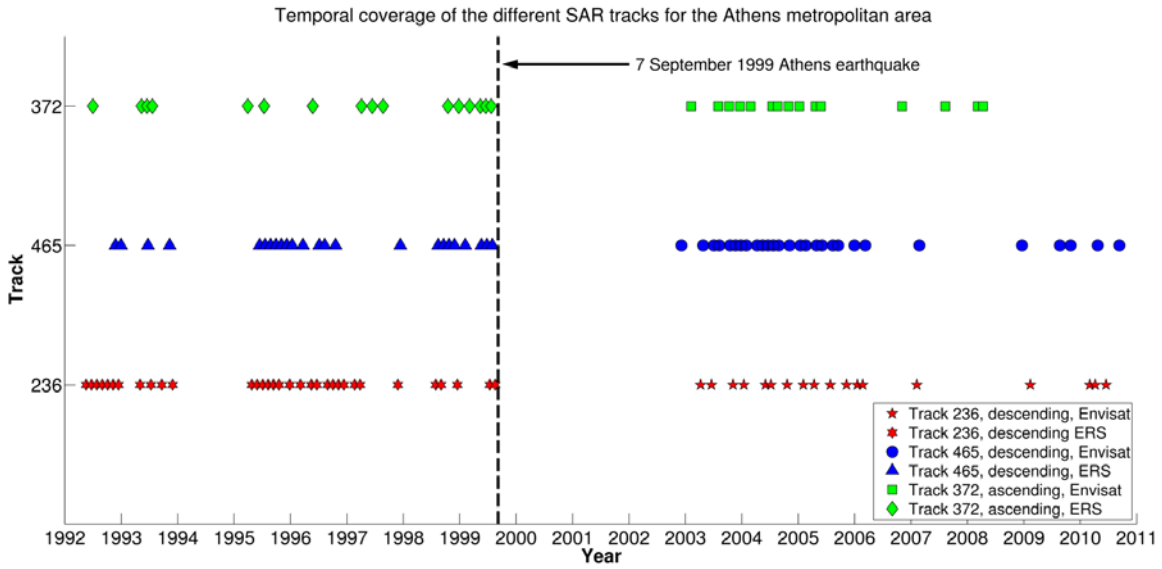
The interferometric stacks processed

Stack	Time interval	Satellite track	Satellite	Mode	Total scenes
I	1992-1999	236	ERS	Descending	37
II	1992-1999	465	ERS	Descending	30
III	1992-1999	372	ERS	Ascending	18
IV	2003-2010	236	Envisat	Descending	18
V	2002-2010	465	Envisat	Descending	28
VI	2003-2008	372	Envisat	Ascending	15

Two descending and one ascending tracks



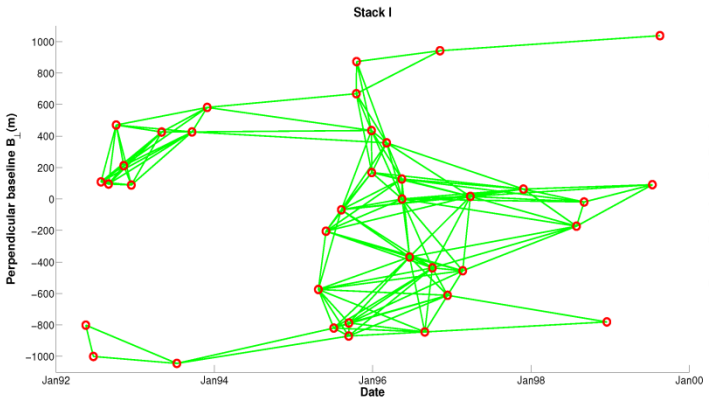
Temporal coverage of the six stacks

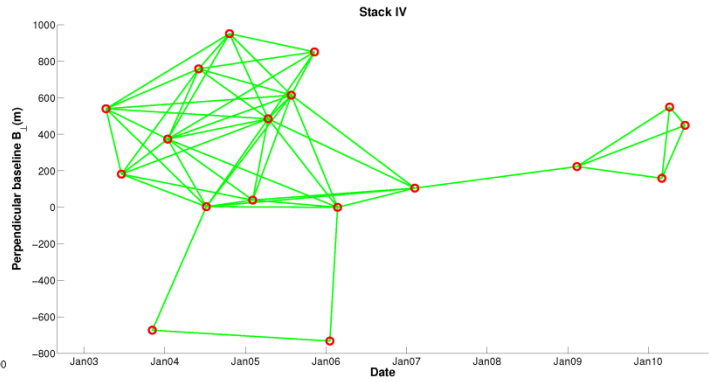


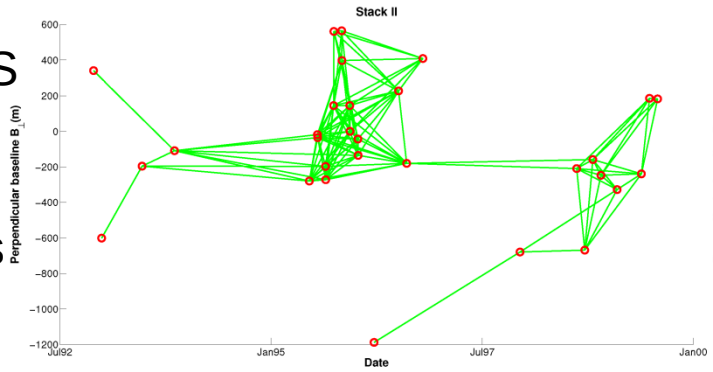
Time-series for monitoring slowly evolving phenomena

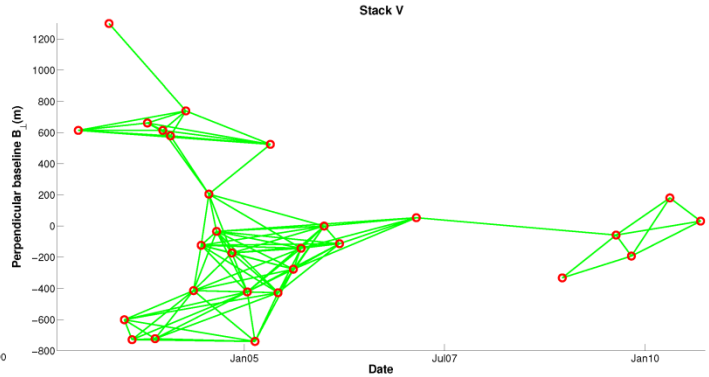
Diachronic mapping of crustal deformation in Attica

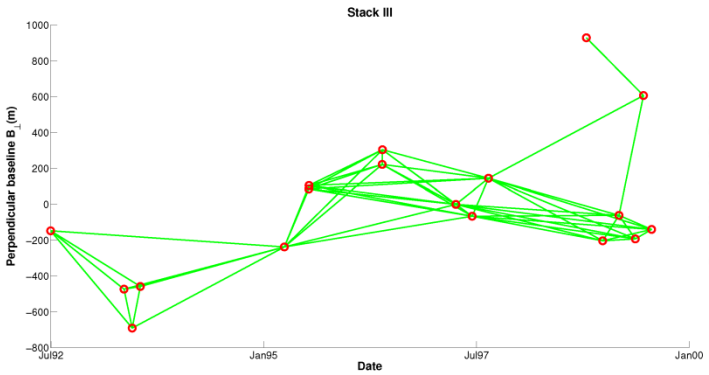
- Formed more 500 interferograms for PSInSAR and SBAS
- Each stack was analysed in patches (more than 5 million pixels per patch)
- Processed more than 700 patches independently => ~ 4 TB of data

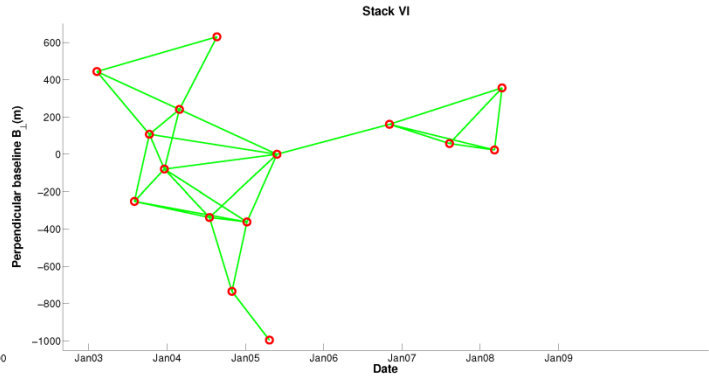








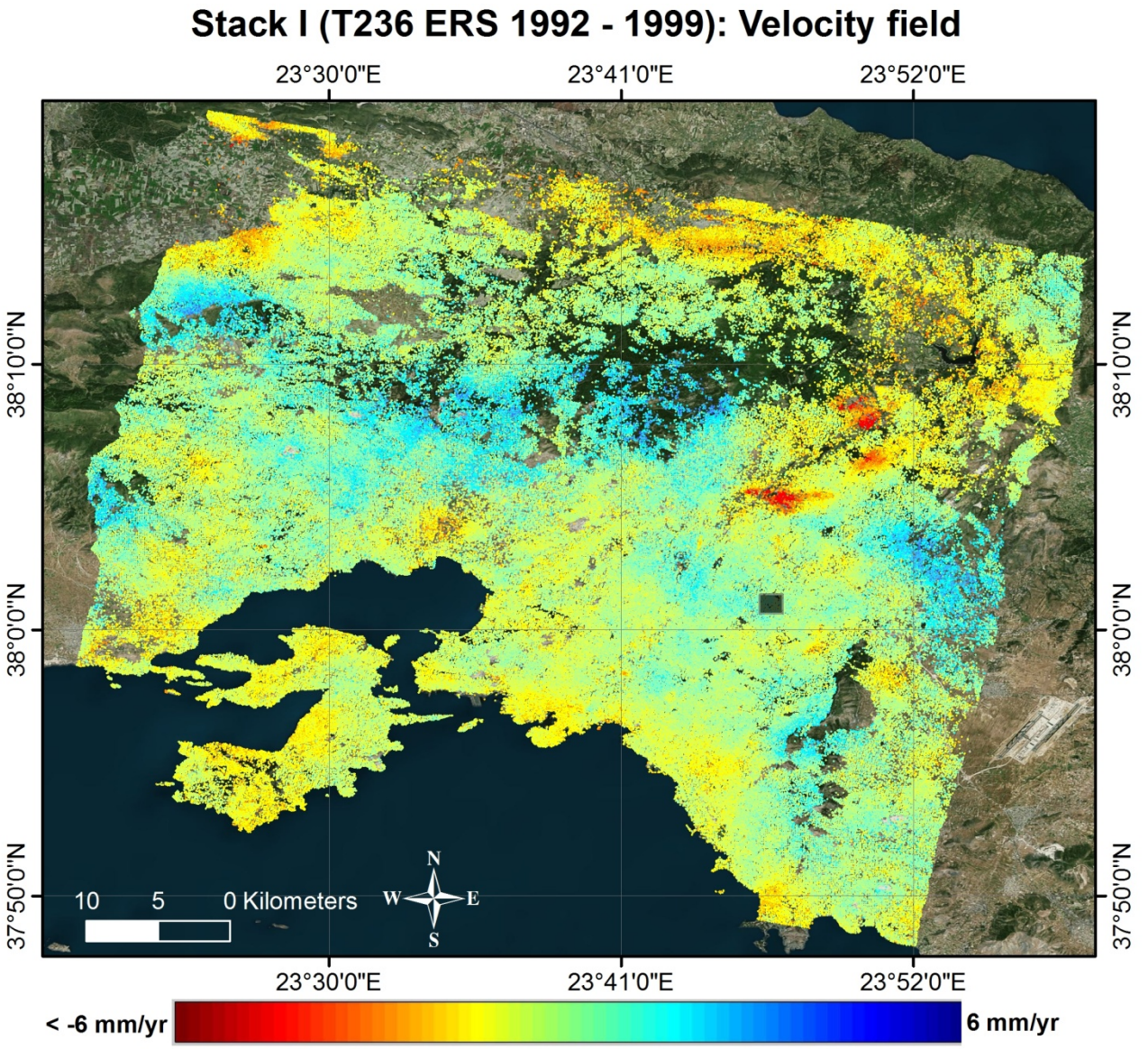




Time-series for monitoring slowly evolving phenomena

Diachronic mapping of crustal deformation in Attica

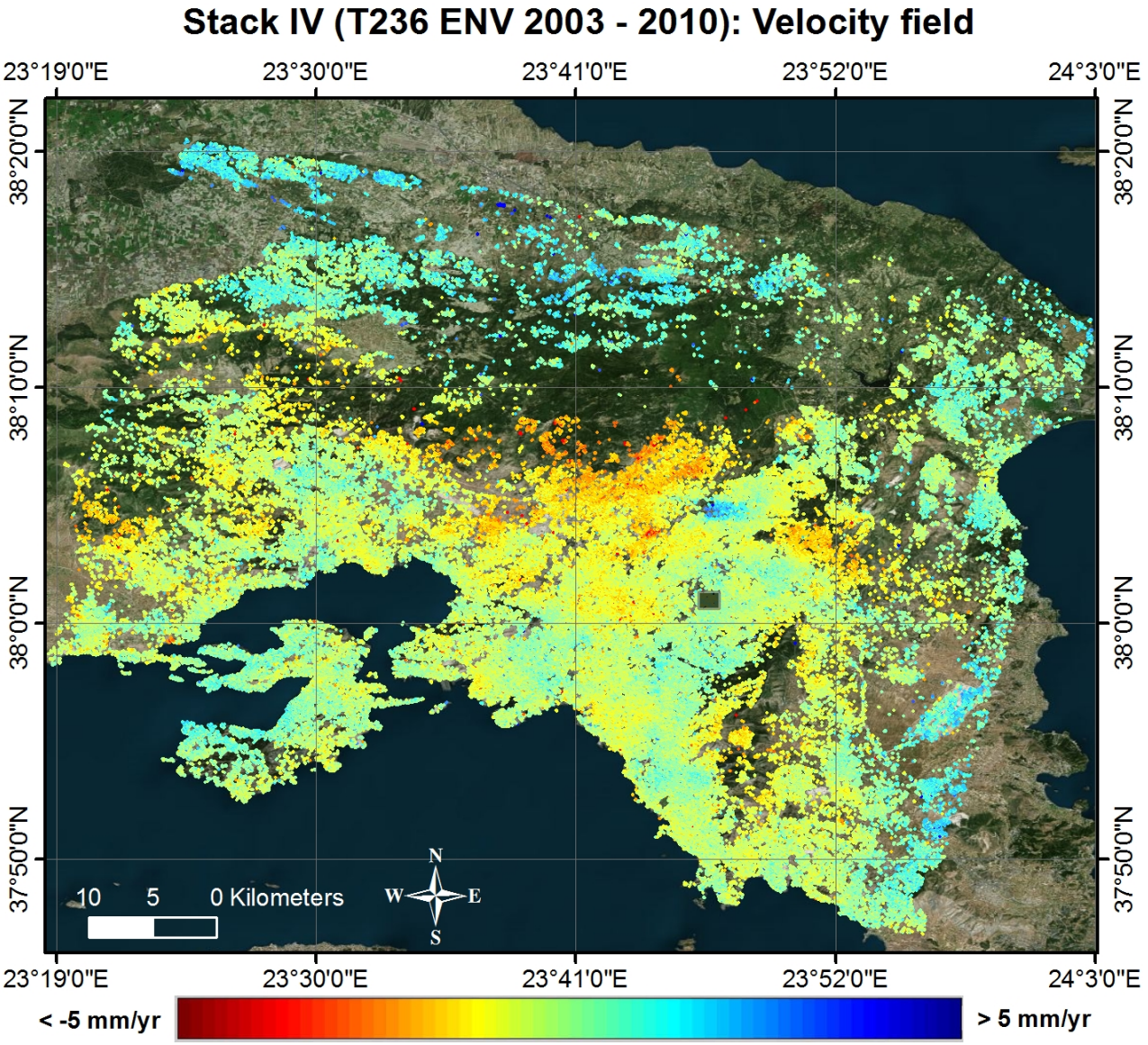
- Identified permanent scatterers even in non-urban area
- Large field of view
- High Permanent Scatterer density, increased spatial sampling of the deformation signal



Time-series for monitoring slowly evolving phenomena

Diachronic mapping of crustal deformation in Attica

- Kifissia was subsidising in 1992-1999 and has been uplifting since 2002
- Deformation observed is attributed to water extraction activities that ceased in 1996. Since then Kifissia is in a physical restoration phase

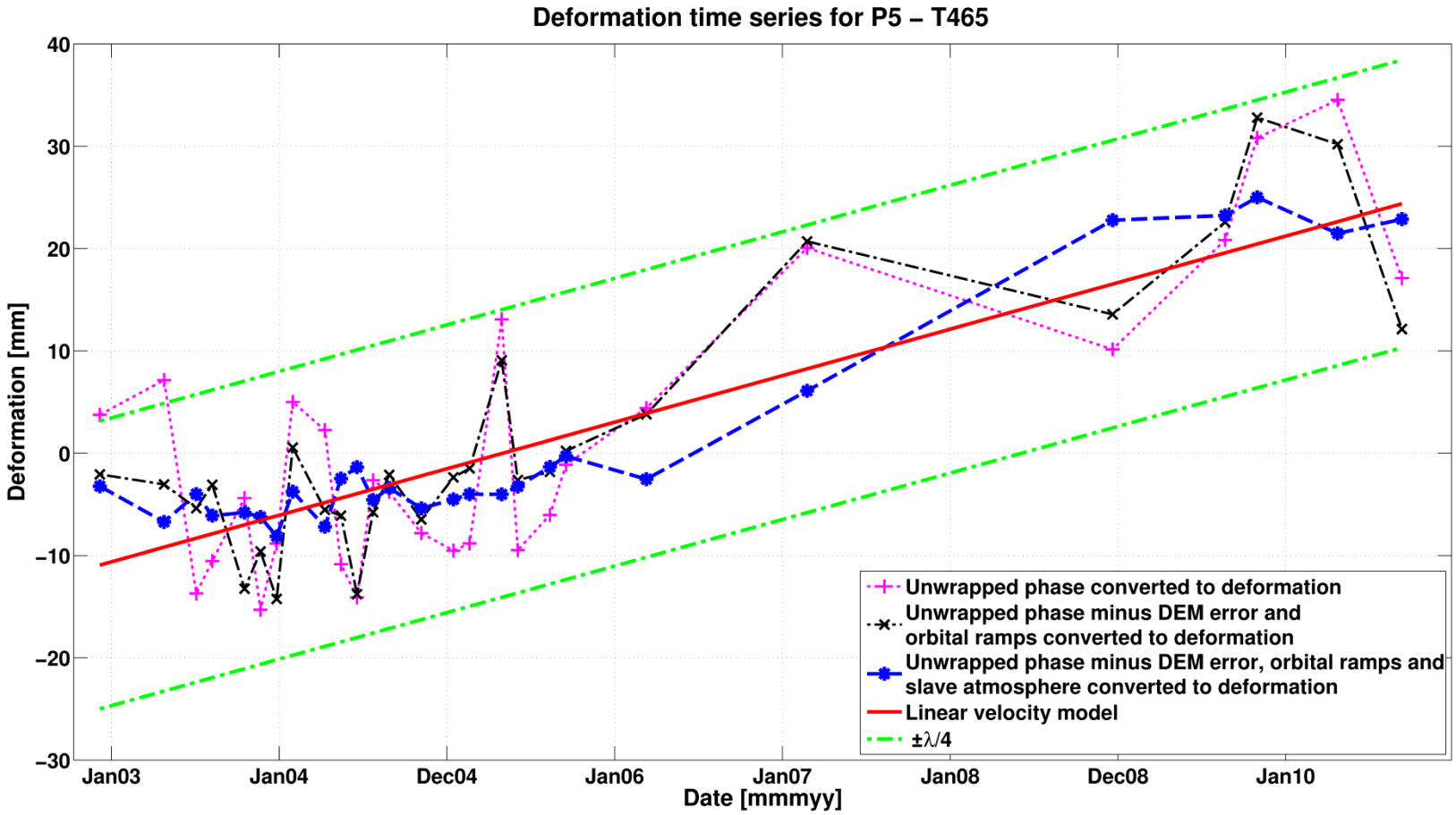


Time-series for monitoring slowly evolving phenomena

Diachronic mapping of crustal deformation in Attica

Deformation histories show the non-linear motion in Kifissia

1992-1999



Thank you for your attention!

For more information

http://www.beyond-eocenter.eu