



COSMO-SkyMed CONSTELLATION: a national space infrastructure



COSMO
SkyMed

OSVALDO PIPERNO

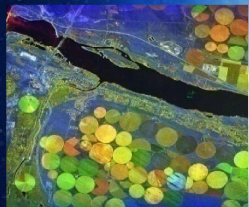
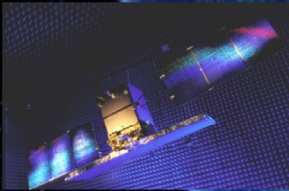
Italian Space Agency

Rome, March 9th 2017, University of TOR VERGATA



The COSMO-SkyMed PROGRAMME

*CO*nstellat*ion* of small Satellites for the Mediterranean basin Observation



- ☐ COSMO-SkyMed is the Largest Italian investment in Space Systems for Earth Observation
- ☐ A National Program conceived by Italian Space Agency (ASI) and funded by It. Ministry of Research & It. Ministry of Defence
- ☐ Managed by ASI in cooperation with the It. MoD
- ☐ Developed by the Italian National Industry (*)



(*) COSMO-SkyMed TEAM

Italian Space Agency

75%



It. Ministry of Defence



25%

CUSTOMERS

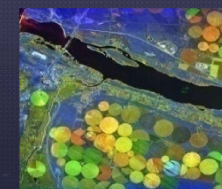
**Thales Alenia Space Italy
Prime Contractor
System Overall**



**Telespazio
Sub-Contractor
Ground Segment**



**E-Geos
Commercial
Provider
(20% ASI & 80% Telespazio)**



SMEs (Spacecraft)

FIRST CONSTELLATION SATELLITES LAUNCH DATES



8 JUN. - 2007
COSMO-1



9 DEC. - 2007
COSMO-2



25 OCT. - 2008
COSMO-3

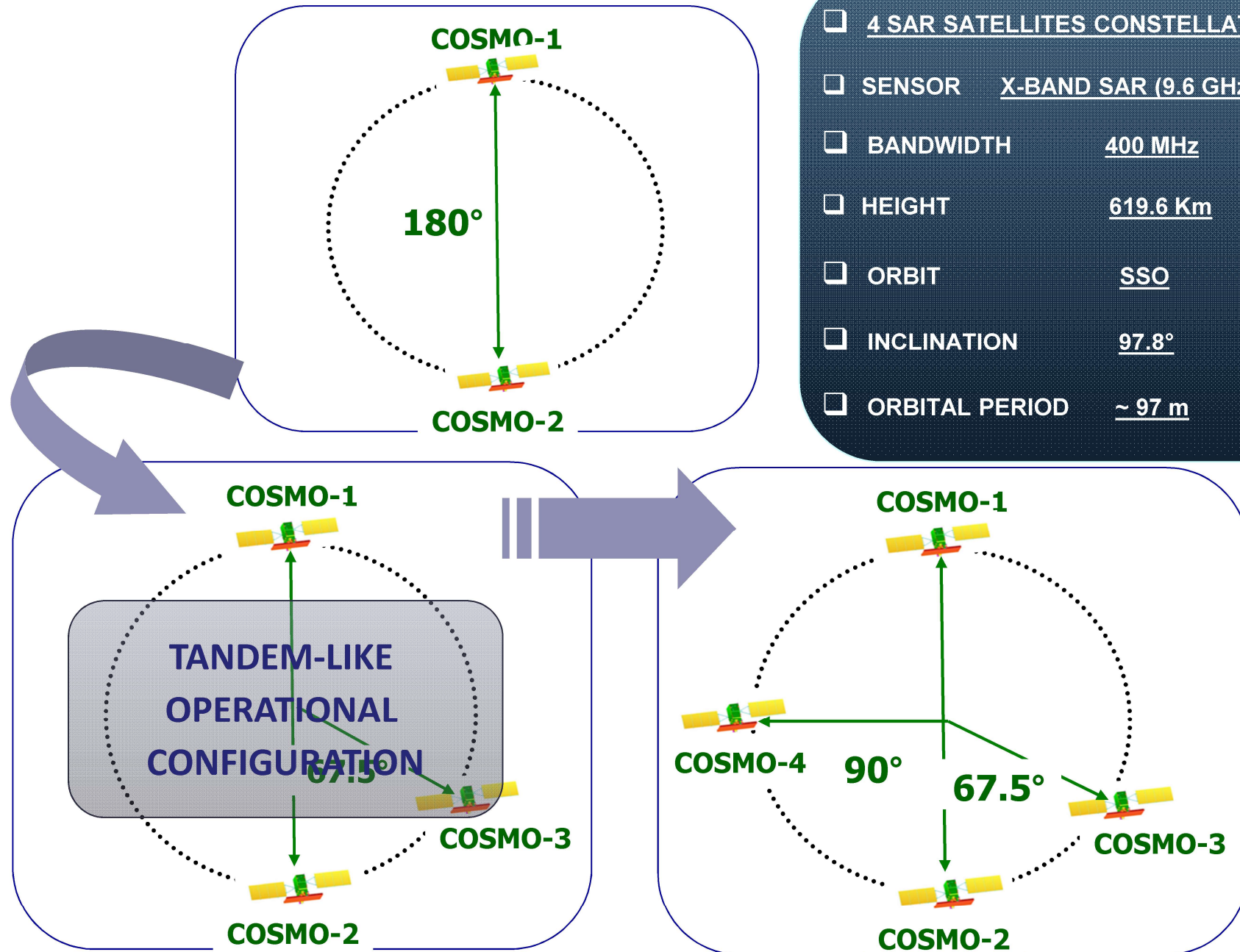
**NO OTHER 4 SAR
SATELLITES
CONSTELLATION
TODAY IN THE EO
OPERATIONAL
SCENE**



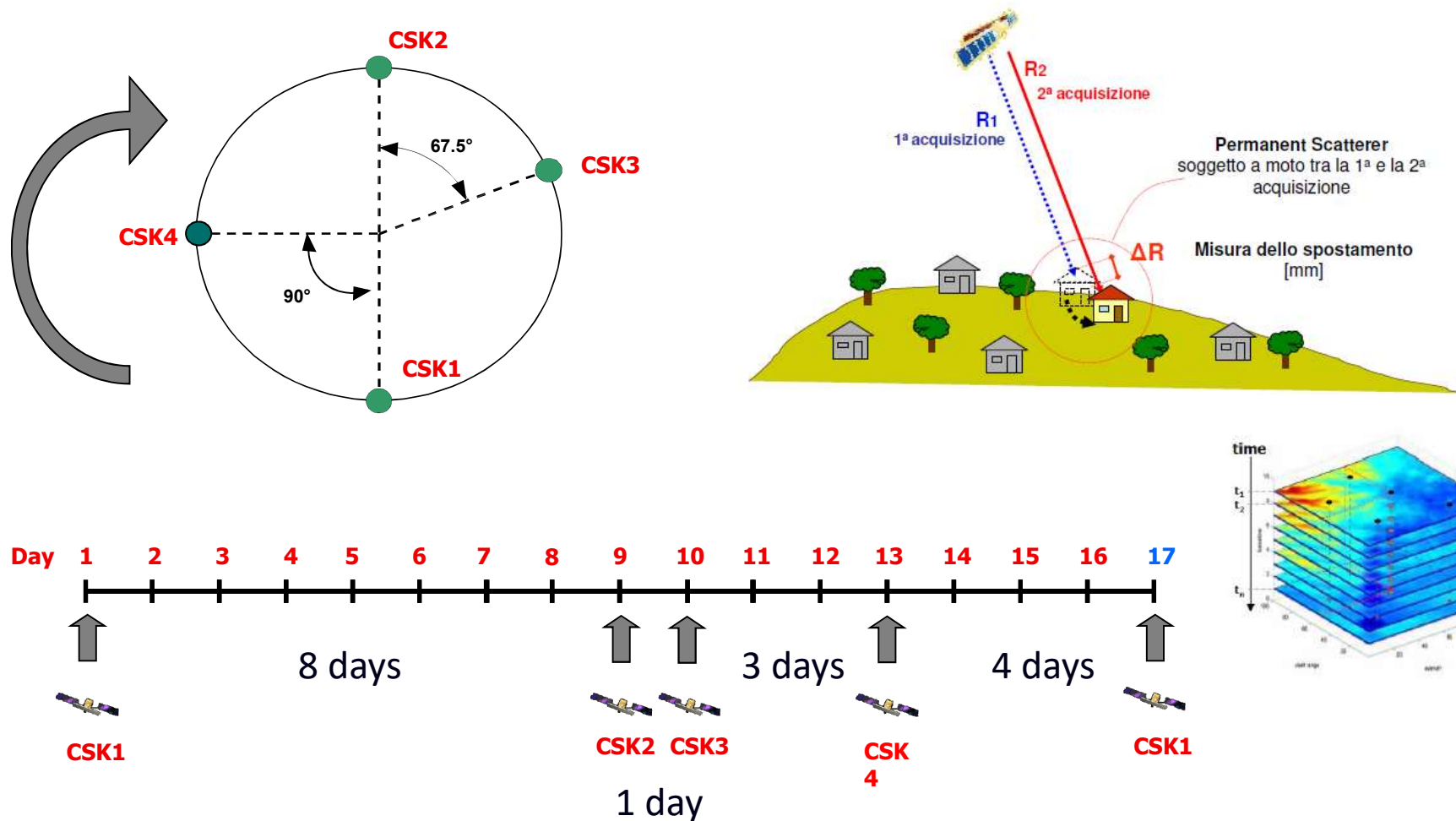
5 NOV. - 2010
COSMO-4

The constellation was completed at the end of 2010 and became fully operational in May 2011.

CONSTELLATION DEPLOYMENT STRATEGY and CONFIGURATION



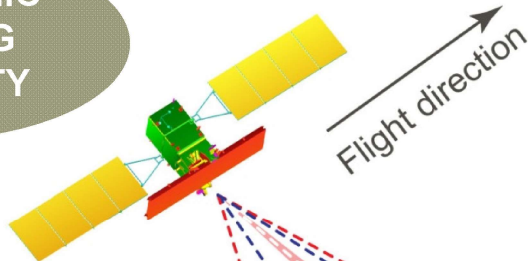
COSMO-SkyMed interferometry



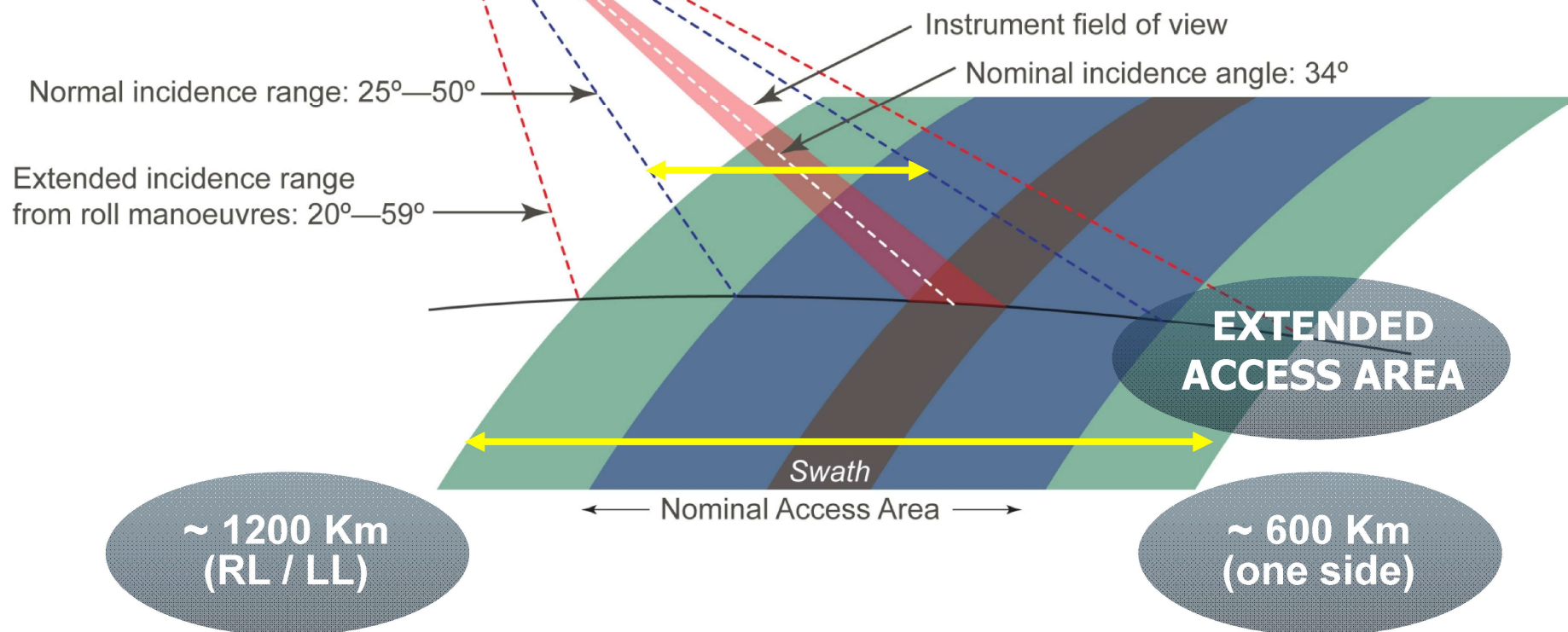
- **Orbital cycle: 16 days**
- **Possibility of interferometric acquisitions (Same orbit direction, same look side, same incidence angle)**

Worldwide global coverage

**ELECTRONIC
STEERING
CAPABILITY**

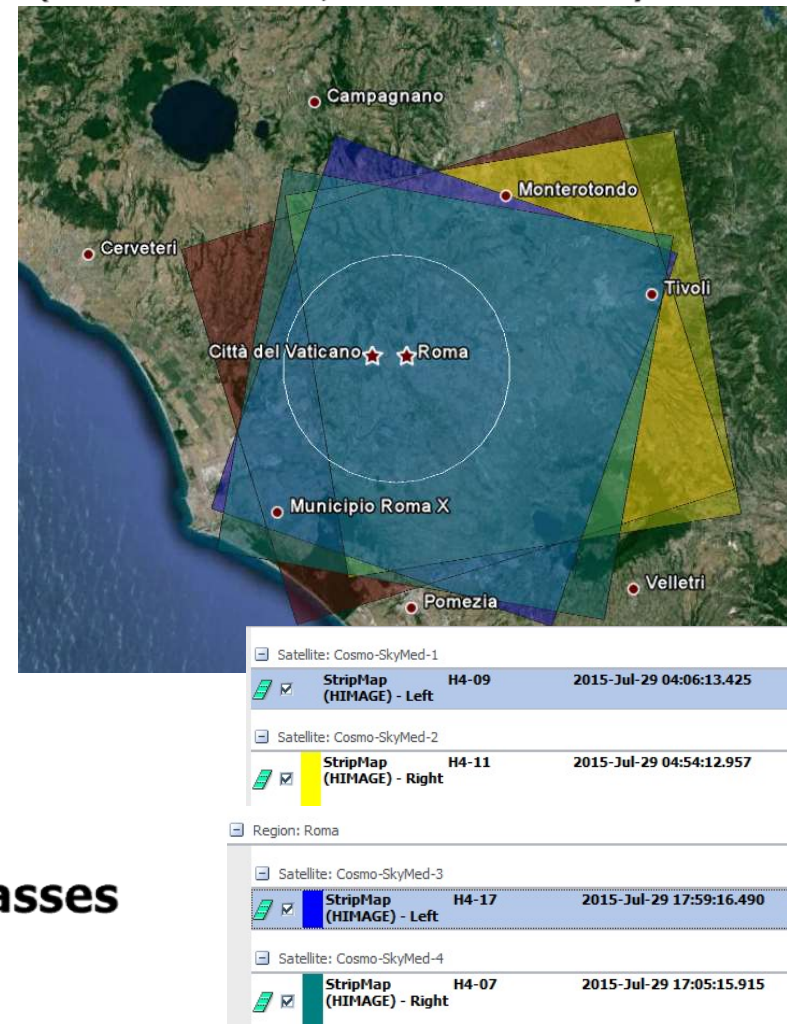
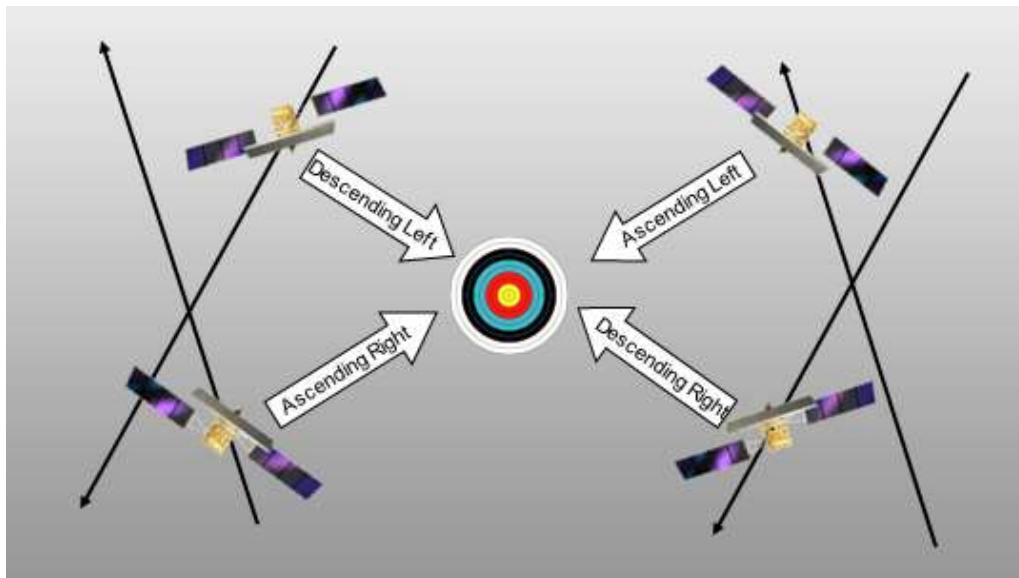


SAR Looking Mode & Incidence Angle		Range of Accessible Latitude
Right & Left (extended)	20°-59.5°	-90.0 ÷ 90.0
Right & Left (nom.)	25°-50.0°	-88.0 ÷ 87.5
Right Only	20°-59.5°	-80.0 ÷ 90.0
Right Only	25°-50.0°	-79.5 ÷ 87.5



Unmatched Revisit

- **At least 4 acquisitions / day (@ equator):**
 - 1 left looking and 1 right looking early morning (ASCENDING, 6 AM local time)
 - 1 left looking and 1 right looking late afternoon (DESCENDING, 6 PM local time)



- **The higher the latitude, the more the passes**

14-Sep-18 00:00:00 UTC
Alt : 45.6461
Lat : 8.6641
LST : 27.2523
RA : 13.113 deg
Range : 2222.0 km
Altitude : 2222.0 km
Intersection Mode ON
Auto Steering ON, Max Area

ROMA, February 27, 2017 - morning

SAR1 H4-16 Asc Right
27/02/2017 04:57 UTC

SAR3 H4-18 Asc Left
27/02/2017 03:51 UTC

SAR2 H4-04 Asc Right
26/01/2017 04:09 UTC



2014-Sep-18 11:00:00 UTC
Lat : 46.2169
Lon : -4.8126
MLST : 10:40:45
SZA : 47.05 deg
Range : 2222.0 km
Altitude : 2222.0 km
Intersection Mode ON
Auto Steering ON, Max Area

ROMA, February 27, 2017 - *afternoon*

SAR4 H4-17 Desc Left
27/02/2017 17:56 UTC

SAR1 H4-22 Desc Right
27/02/2017 16:44 UTC

SAR3 H4-0A Desc Right
27/02/2017 17:14 UTC

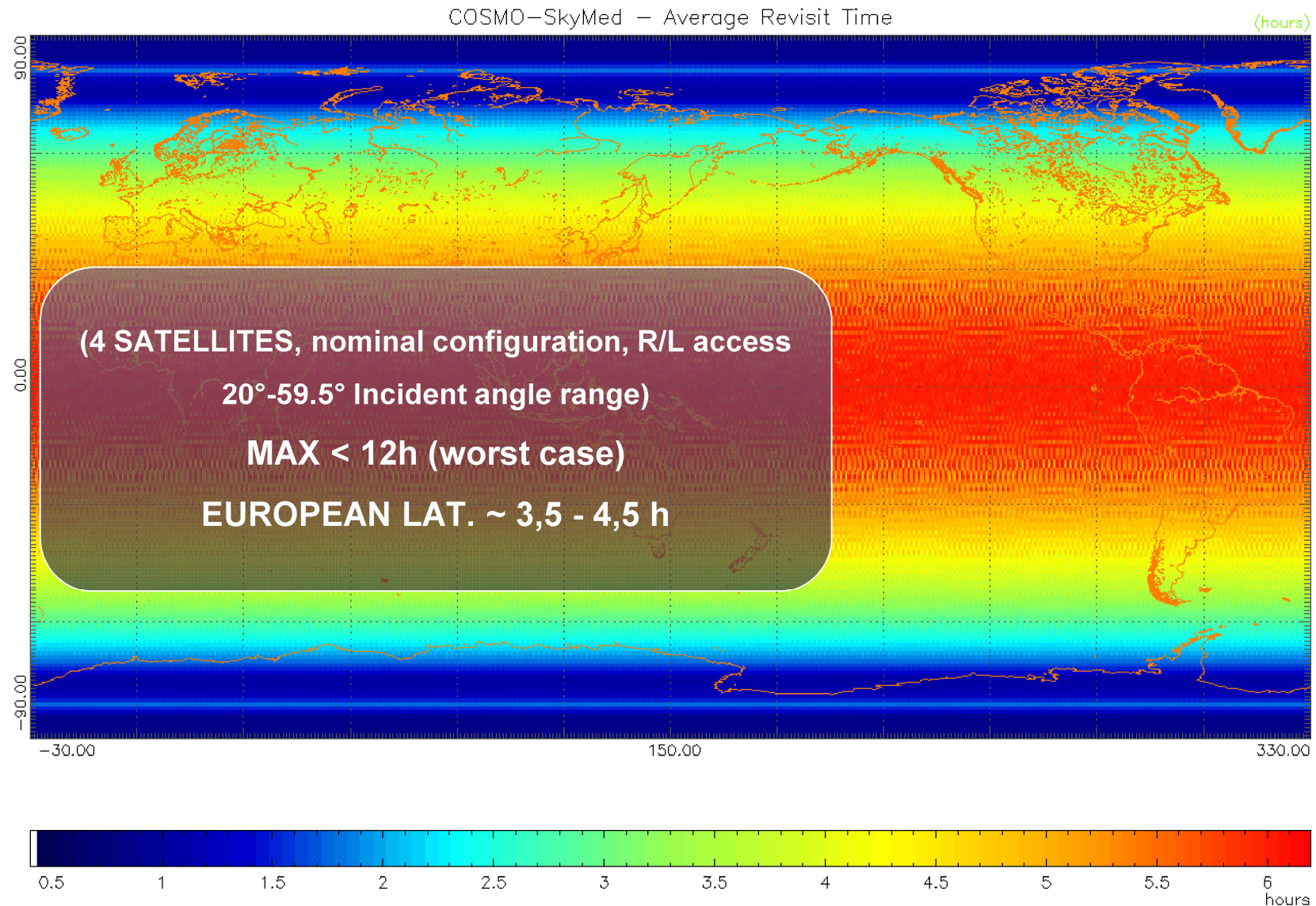
SAR2 H4-0A Desc Left
27/02/2017 17:32 UTC



Image © NASA (visibleearth.nasa.gov)
SAVOIR - Multiscale Swift Planner - © TALLUX SOFTWARE

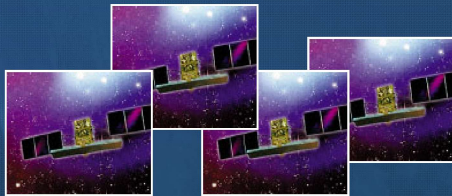
AVERAGE REVISIT TIME PERFORMANCE

FULL CONSTELLATION – RL/LL – EXTENDED INCIDENCE ANGLE RANGE



The previous features are combined with a huge imaging and storage capability

SPACE SEGMENT



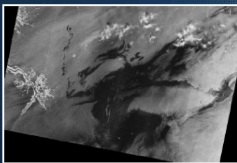
1800 IMAGES / DAY



EACH SAR SATELLITE
CAN ACQUIRE UP TO
450 IMAGES/DAY

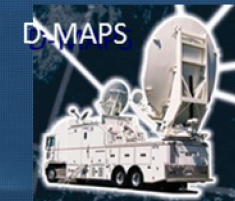
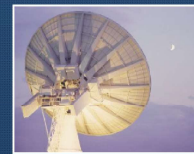


75 NARROW FIELD (SPOT)
IMAGES PER DAY
PER SATELLITE



375 WIDE FIELD
IMAGES PER DAY
PER SATELLITE (375
STRIPMAP or 150
SCANSAR)

GROUND SEGMENT



The Ground Segment is geographically distributed and conceived as modular structure.

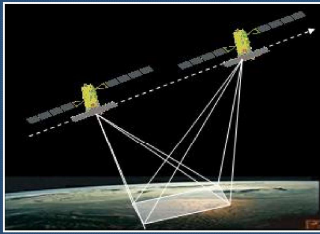
Until March 2016 the daily data volume was 475 images per day of the Civilian User Ground Segment.

Due to the reengineering phase of the system, currently it is possible to download the whole data volume of the constellation (> 1000 images/day), creating, for instance, a consistent data archive and mapping large areas all over the world.

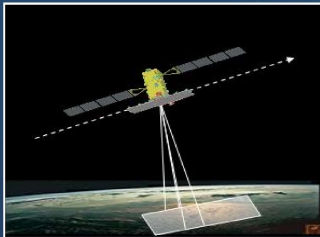
200 Civilian products/day (Lev 1c/1D)

It is planned the possibility to provide Partners/Users with with different architectural UGS solutions, with a “set” of different of different choices customizing *ad hoc* the users needs. needs.

MULTI-MODE ACQUISITION CAPABILITY

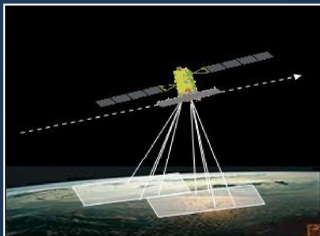


SPOTLIGHT
10 Km X 10 Km
1 m Resol.



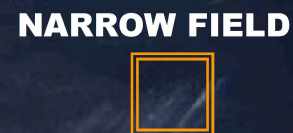
STRIPMAP - HIMAGE
40 Km X 40 Km
3 m Resol.

STRIPMAP - PING PONG
30 Km X 30 Km
15 m Resol.



SCANSAR WIDE
100 Km X 100 Km
30 m Resol.

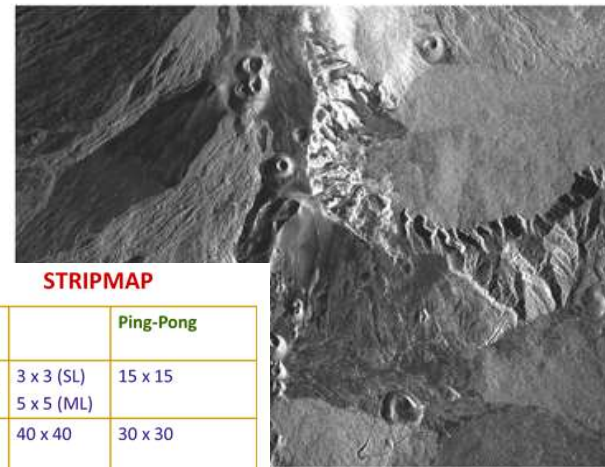
SCANSAR HUGE
200 Km X 200 Km
100 m Resol.





SCANSAR

	WIDE REGION	HUGE REGION
Resol. [m]	30 x 30	100 x 100
Swath [km]	100 x 100	200 x 200
Possible Pol. [T/R]	HH or HV or VH or VV	
Inc. Angles [deg]		



STRIPMAP

		Ping-Pong
Resol. [m]	3 x 3 (SL) 5 x 5 (ML)	15 x 15
Swath [km]	40 x 40	30 x 30
Possible Pol. [T/R]	SINGLE HH or HV or VH or VV	ALTERNATING 2 pol. selectable among HH, VV, VH and HV
Inc. Angles [deg]	25-50 (nominal) 20-59.5 (extended)	

SPOTLIGHT

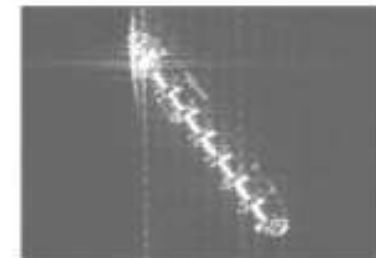
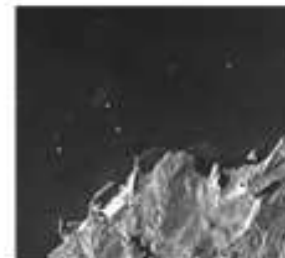
Resol. [m]	1 x 1
Swath [km]	10 x 10
Possible Pol. [T/R]	SINGLE HH or VV
Inc. Angles [deg]	25-50 (nominal) 20-59.5 (extended)

Scansar 200x200 Km
Huge Region R. 100 m

Scansar 100x100 Km
Wide Region R. 30 m

Stripmap 40x40 Km
Himage R. 3 m

Spotlight 10x10 Km
R. 1m



Surveillance/Detection

Recognition

Classification/Identification

COSMO-SkyMed DATA ACCESS

www.asi.it

**INSTITUTIONAL
USERS**



**ASI supports the INSTITUTIONAL
(incl. SCIENTIFIC) data exploitation**



COSMO-SkyMed Catalogue

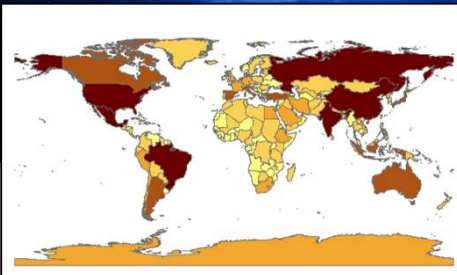
e-geos
AN ASI / TELESPAZIO COMPANY

**COMMERCIAL
USERS**



**e-GEOS supports the
COMMERCIAL data exploitation**

www.e-geos.it



> 1.000.000 scenes in the Civilian catalogue Dec. 2016

Catalogue Browsing



COSMO-SkyMed Catalogue

e-geos
AN ASI / TELESPIAZIO COMPANY

Main Menu

- Home
- Contact Us

Username
XXXXXXXXXX

Password
●●●●●●●●

☐ Remember me

Login

Lost Password?

No account yet? Register



Main Menu

- Home
- User Profile
- Contact Us
- Catalogue
- Request Info

Hi [Redacted]

Logout

Search by Map
Search by 4 corners
Search by KML file
Search by Shape file
Search by 2 rectangle corners
Search by Record Number

COSMO-SkyMed Catalogue

AN ASI / TELESPIAZIO COMPANY

Main Menu

- Home
- User Profile
- Contact Us
- Catalogue
- Request Info

Hi, saccospica

Logout

Map data ©2013 Google

Termini e condizioni d'uso Segnala un errore nella mappa

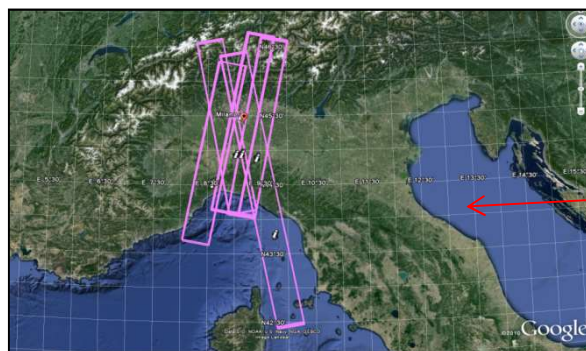
Explore Map

Trace a Search Area

Clear area

Advanced Search

Search | Reset for new search



<p>Search by Map</p> <p>Search by 4 corners</p> <p>Search by KML file</p> <p>Search by Shape file</p> <p>Search by 2 rectangle corners</p> <p>Search by Record Number</p>	<p>Search by Map</p> <p>Search by 4 corners</p> <p>Search by KML file</p> <p>Search by Shape file</p> <p>Search by 2 rectangle corners</p> <p>Search by Record Number</p>
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COSMO-SkyMed Catalogue

AN ASI / TELESPIAZIO COMPANY

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Map data ©2013 Google

Termini e condizioni d'uso Segnala un errore nella mappa

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Trace a Search Area

Clear area

Advanced Search

Search | Reset for new search

GENERAL CONDITIONS FOR THE PROVISION OF COSMO-SkyMed PRODUCTS

ANNEX I

GENERAL CONDITIONS FOR THE PROVISION OF COSMO-SkyMed PRODUCTS

Definitions

Agreement

The ad

SkyMed

Contractors and Consultants

Natural persons

Original PRODUCT

Herein or High the ter

Ancillary Data

Techni PROD

Derived Product

Product which that th whole

Protected Product

Product charac of the are Pr

Purposes of Use

PROD agreeer of the frame been a

User

The na terms (attach

Affiliated User

The na a Join author

Use

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Joint Project

Specifi Affiliat

ANNEX II

LICENCE to USE

1. Parties to the Licence

On the one part, the Agenzia Spaziale Italiana ("ASI" – Italian located in Viale Liegi 26, 00198 Roma, and on the other part, the also referred to as the User,

2. Object of the Licence

The definitions contained in the General Conditions for the prov be deemed as entirely reproduced, used and applicable to the pr This Licence to Use confers to the User a non-exclusive right to in the Project Form (Annex III) under the terms and conditions sp The User shall guarantee and notify ASI the written acceptance to avail itself of, concerning the respect of the PRODUCTS in Contractors and consultants shall not be authorised to keep cop Products once performed their contractual or consultancy activi After the PRODUCT delivery, ASI hereby reserves the right to PRODUCT utilization, ensuring confidentiality of the information. The User shall not disclose, reproduce, transfer or make in information or any ancillary data supplied by ASI together with a

The transfer in whole or in part of this Licence to Use or any of sub-licences or similar assignments to third parties is explicitly p ASI.

Such prohibition shall apply to any provisions of this Licence to any reason whatsoever.

3. Intellectual Property Rights

The COSMO-SkyMed System PRODUCTS, object of this Licen the Italian Republic. Under Article no. 2 of the Interdepartment ASI is the owner of the intellectual property rights pertaining to satellites

The PRODUCTS are protected by the Italian and international c by the satellites or anyway present in the archives are protect protection under Directive EU 96/9 dated 11th March 1996, a Legislative Decree no. 169 dated 6th May 1999. The User hereby acknowledges that COSMO-SkyMed® and C itself to reproduce the trademark as follows: COSMO-SkyMed®

The User hereby acknowledges ASI copyright over the PROD copyright notice irrespective of the supporting device of the PROD "COSMO-SkyMed Product - ©ASI - Agenzia Spaziale Ita Reserved"

Within the limits of its own business, the User hereby guarantees the respect of the ASI's intellectual property rights over the PRODUCTS and commits itself to promptly notify in writing to ASI of any unlawful use, including that of third parties, of the supplied PRODUCTS or of the Protected Products processed under the terms of this Licence to Use.

ANNEX 3

PROJECT FORM

INTRODUCTION

The main goal of the Project Form is to provide an explicit and detailed des who signed the specific Agreement with ASI and is proposing the present pro The User's needs must be made explicit in terms both of activity purpose SkyMed data takes acquisition and typology/volume of required programming/production from archived data) to allow the necessary feasi System operational chain.

The following fields are included in the Project form:

- PROJECT TITLE
- PRIMARY APPLICATION DOMAIN / UTILIZATION SCOPES
- EXECUTIVE SUMMARY (PROJECT DESCRIPTION)
- END USER INFORMATION (PROJECT RESPONSIBLE)
- PROJECT TEAM:
 - USERS
 - AFFILIATED USERS
 - CONTRACTORS/CONSULTANTS
- PLANNING OF THE ACTIVITIES (Optional)
- PROJECT REQUESTS DETAILS (See nested excel file)
- ANNEXES (If considered necessary by the User Himself)

Should you have any problem in filling/submitting the Project Form, please d

1) at the following address:

ASI
Viale Liegi, 26
00198 Roma - Italy
e-mail csk.help@asi.it

2) or directly contacting the COSMO-SkyMed Mission Manager

Alessandro Coletta
e-mail: alessandro.coletta@asi.it

ANNEX 4

AMOUNT DUE FOR THE PROVISION OF COSMO-SKYMED PRODUCTS AND PAYMENT MODALITIES

Economic conditions for the provision of COSMO-SkyMed Products are specified in the following Table:

RANGE	TYPOLOGY	TASKING (NEW PROGRAMMING)	PROCESSING FROM ARCHIVE DATA	
			< 6 months	> 6 months
A	up to 50 products	<ul style="list-style-type: none"> ▪ € 100,00 = for any SCANSAR /STRIPMAP product. ▪ € 200,00 = for any SPOTLIGHT product. 	€ 100,00 = for any kind of product	€ 50,00 = for any kind of product
B	between 51 and 100 products	<ul style="list-style-type: none"> ▪ € 340,00 = for any SCANSAR /STRIPMAP product. ▪ € 680,00 = for any SPOTLIGHT product. 	€ 100,00 = for any kind of product	€ 50,00 = for any kind of product
C	> 100 products	<ul style="list-style-type: none"> ▪ € 430,00 = for any SCANSAR /STRIPMAP product. ▪ € 860,00 = for any SPOTLIGHT product. 	€ 100,00 = for any kind of product	€ 50,00 = for any kind of product

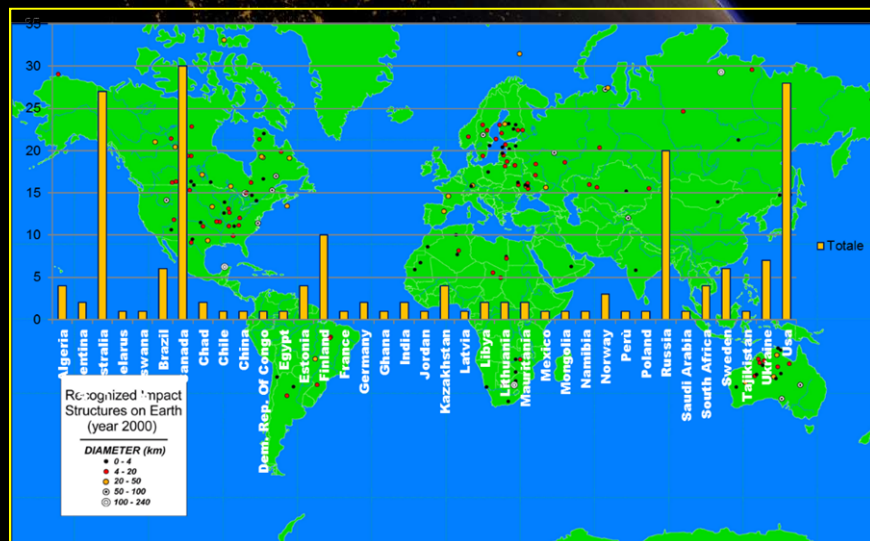
The total amount due to ASI is estimated according to the Products requests as reported in the Project Form (Annex III), unless further operational needs, not currently predictable, occur and it is equal to € (state also the number in letters).

ASI shall proceed to cash in the amounts due on the competent fiscal year and indicate to the counterpart on the relevant invoice the payment modalities and conditions.

SYSTEM EXPLOITATION (a quick overview)

INTERNATIONAL COOPERATIONS

Ex. ASI-JAXA, ASI-CONAE, ASI-UKSA,
ASI-ESA, ASI-NASA, Copernicus
contributing mission



NATIONAL PROJECTS

System's Owners

- "MAPITALY" PROJECT
- OPEN CALL "PMI"
- ASI's Projects (Pilot Projects, ecc)

Institutional Users

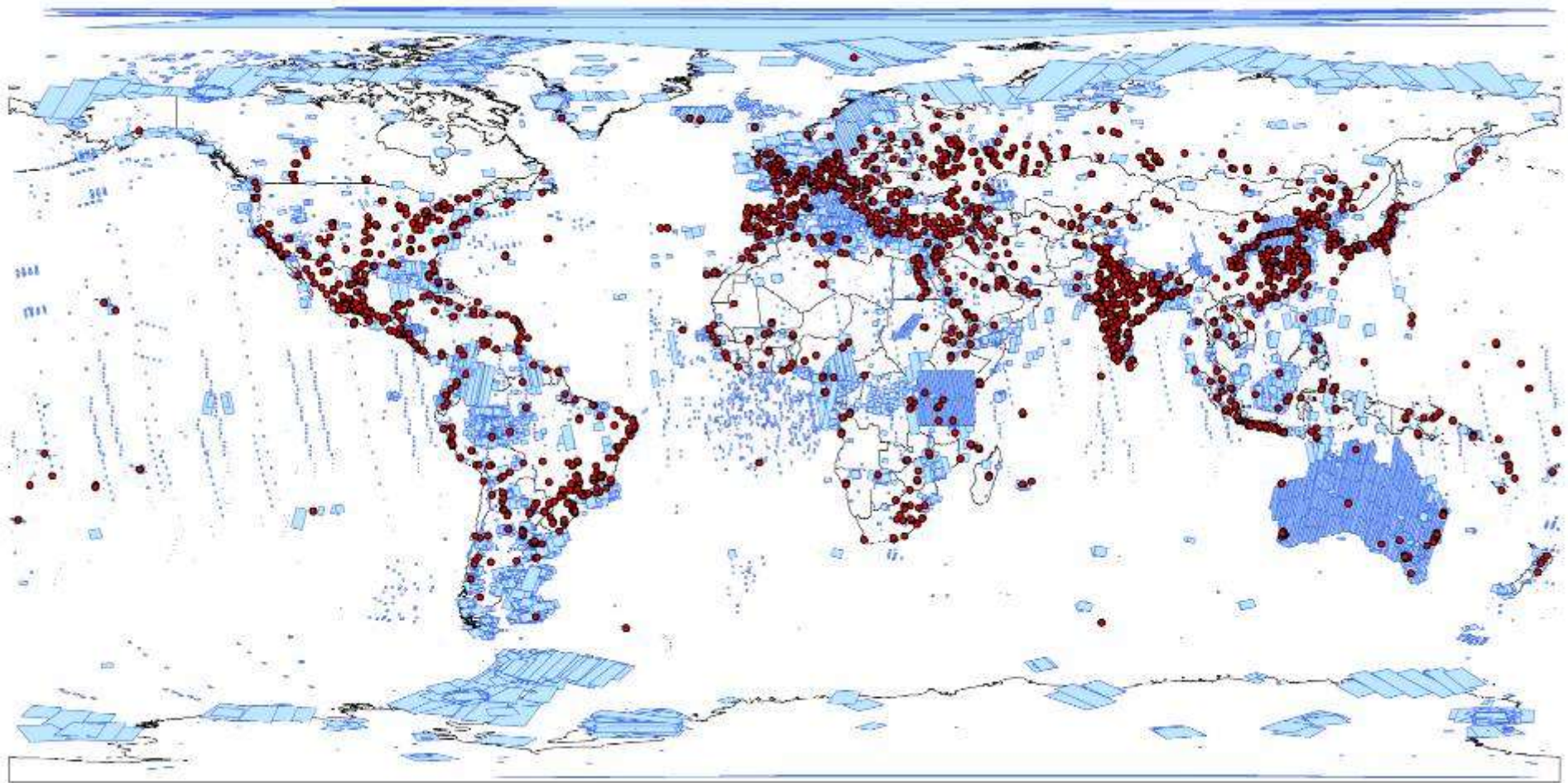
INTERNATIONAL PROJECTS

System's Owners

- SCIENTIFIC OPEN CALL
- AO ASI-CSA
- Project "MAP CRATERS"
- BACKGROUND MISSION

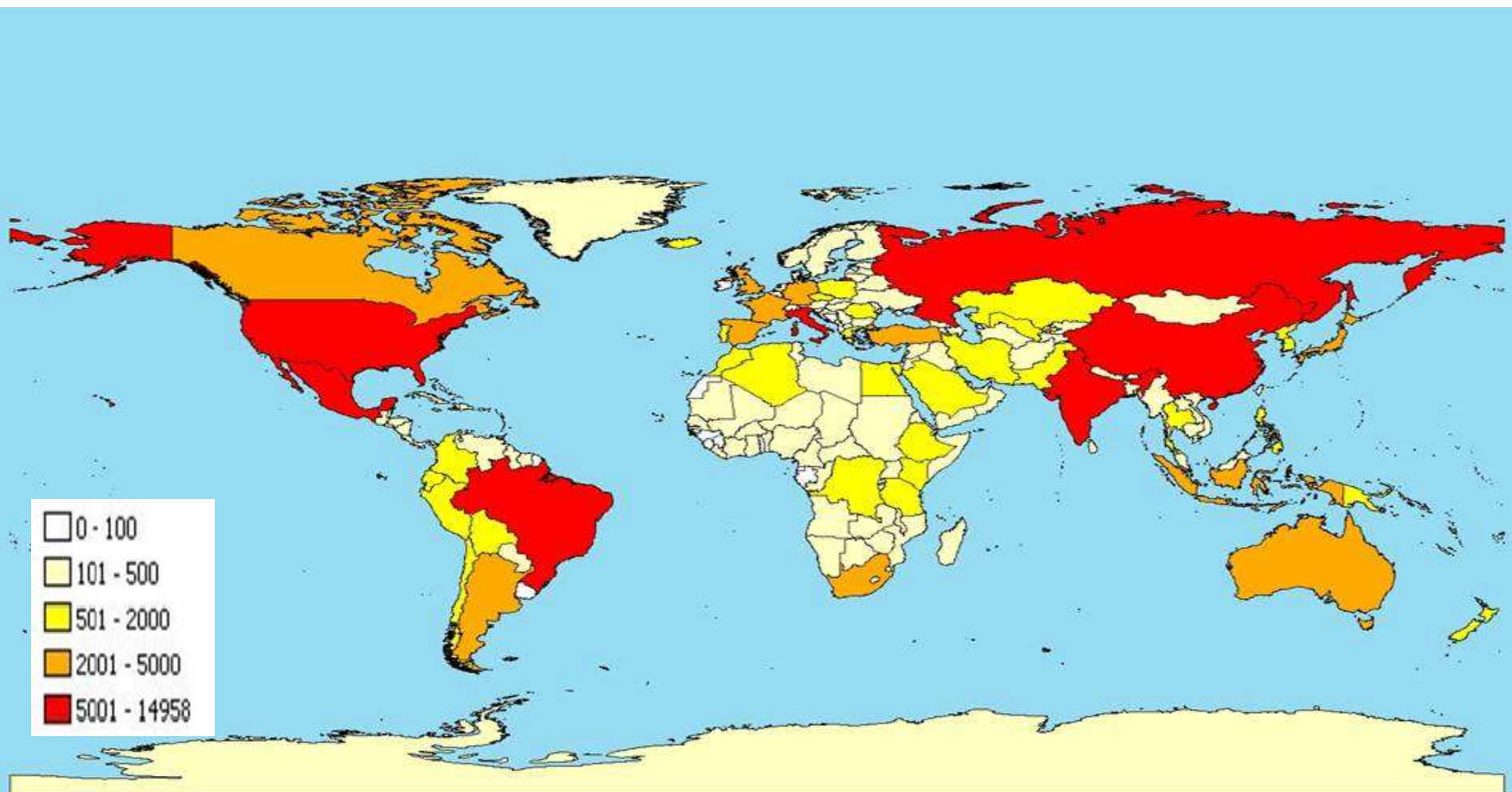
Institutional Users

COSMO-SkyMed Background Mission



Images provided by courtesy of e-Geos

COSMO-SkyMed data distribution

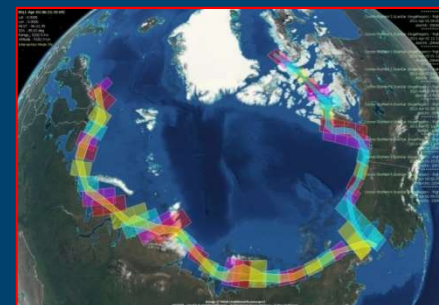


> 1.000.000 scenes in the Civilian catalogue (Dec. 2016)

- Started in May 2011
- Planned in order to create an archive of images for interferometric applications and to maximize the system exploitation during the operational lifetime of the constellation

Some of the main targets of the COSMO- SkyMed Background Mission:

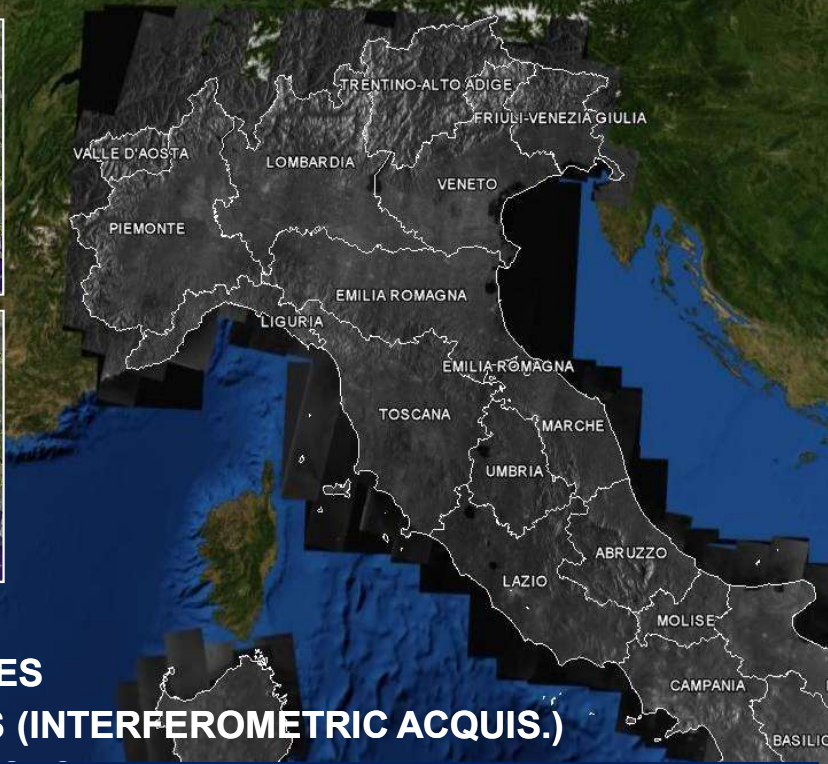
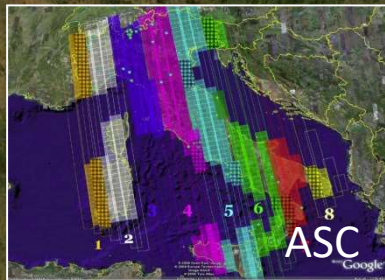
Tipology	Frequency of observation	Number of Sites
Cities (population >100.000 units)	16 days	748
Extended cities (>500.000 units)	16 days	222
UNESCO sites	16 days	96
Volcanoes	16 days	74
Infrastructures	16 days	2
Oil & Gas mining	16 days	6



- Specific Sites (eGeos/ASI)
- Large Areas Mapping (ASI)
- Polar Areas (ASI) → Polar Space Task Group (WMO)

53 Greenland glaciers
12 Antarctica glaciers

MAPPING: ITALY STRIPMAP MOSAIC (from 2009)



USE OF 4 SATELLITES
16 DAYS PASSAGES (INTERFEROMETRIC ACQUIS.)

- ASI has moved a proposal to realize a monitoring plan of the building and infrastructural heritage over the Italian territory by exploiting the COSMO-SkyMed system (PS ITALIA project).
- Monuments as well as archaeological and architectural sites of interests are a significant part of this heritage. Around 50 Italian sites are part of the UNESCO sites

Acquisition geometry	Constant and lying in the range 25°-35.5° (incidence angle)
Beam	HI-01 (24.9°-28.4°) HI-03 (27.7°-31°) HI-04 (30.7°-33.8°) HI-05 (32.4°-35.5°)
Polarization	HH
Acquisition Mode	Right (nominal)
Revisit time	16 days
Image mode	Stripmap Himage



RISK MONITORING AND MANAGEMENT OF EMERGENCIES

OCEAN AND ICE MONITORING

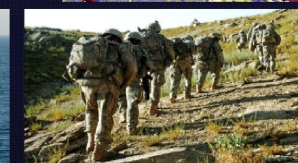
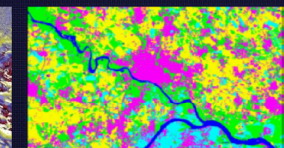
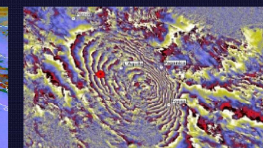
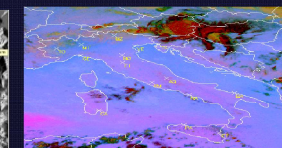
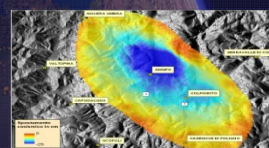
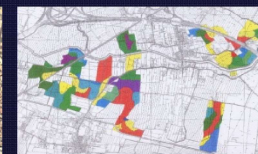
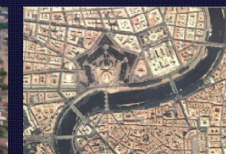
MONITORING AND MANAGEMENT OF COASTAL LINES AND INLAND WATERS

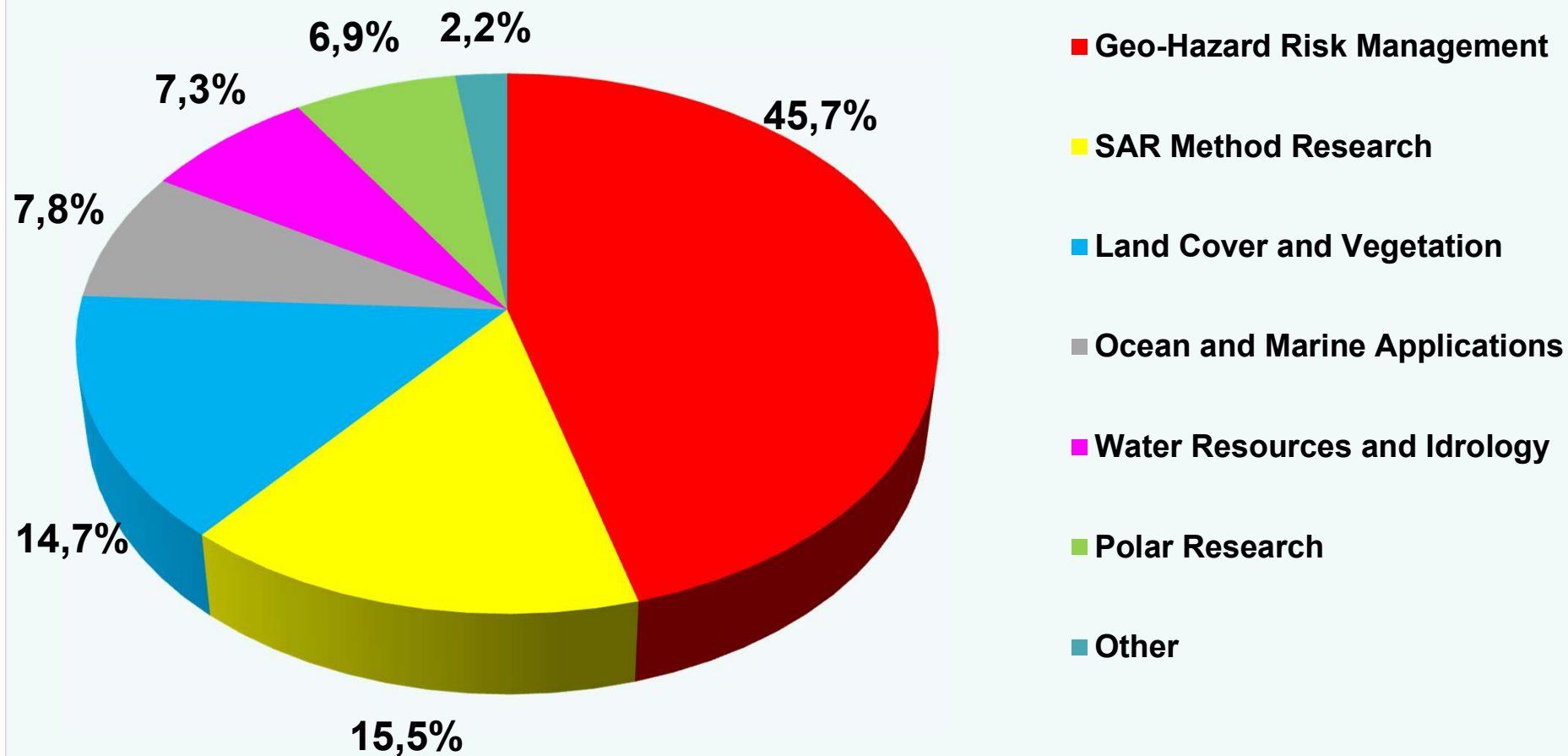
MONITORING AND MANAGEMENT OF FORESTRY AND AGRICULTURAL RESOURCES

TECHNICAL CARTOGRAPHY – URBAN PLANNING

SCIENTIFIC APPLICATIONS

SECURITY APPLICATIONS

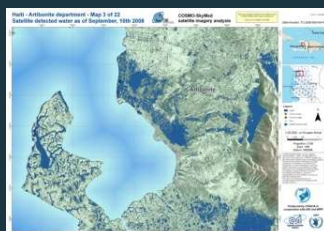




Percentage based on distributed products considering the main application domains (2014-2016).

THANKS TO THE SHORT REVISIT TIME, COSMO-SkyMed HAS BEEN LARGELY USED DURING EMERGENCY SITUATIONS.

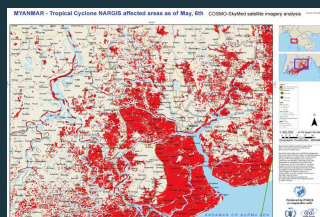
HAITI IKE & HANNA HURRICANES



OKLAHOMA CITY TORNADO



MYANMAR CYCLONE NARGIS



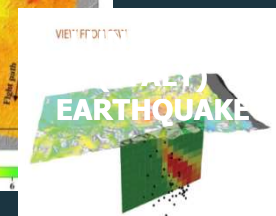
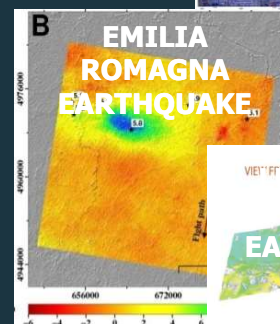
CRUISE SHIP DISASTER (ITALY)



GULF OF MEXICO LOUISIANA OIL SPILL



BANGLADESH CYCLONE AILA



2008

2009

2010

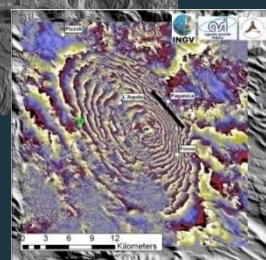
2011

2012

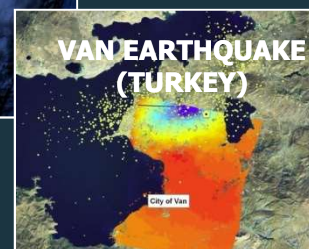
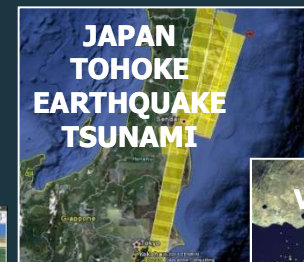
2013

2014

SICHUAN EARTHQUAKE

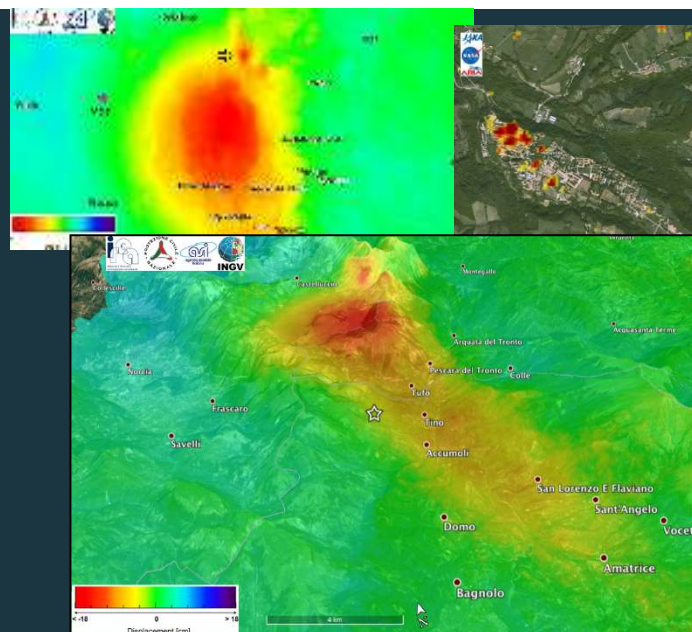


L'AQUILA – ABRUZZO EARTHQUAKE



THANKS TO THE SHORT REVISIT TIME, COSMO-SkyMed HAS BEEN LARGELY USED DURING EMERGENCY SITUATIONS.

APRIL 25 (M 7.8) and
MAY 12 (M 7.3)



ITALY
EARTHQUAKES

AUGUST 24, 2016
OCTOBER 30, 2016

Amatrice, Accumoli,
Norcia,

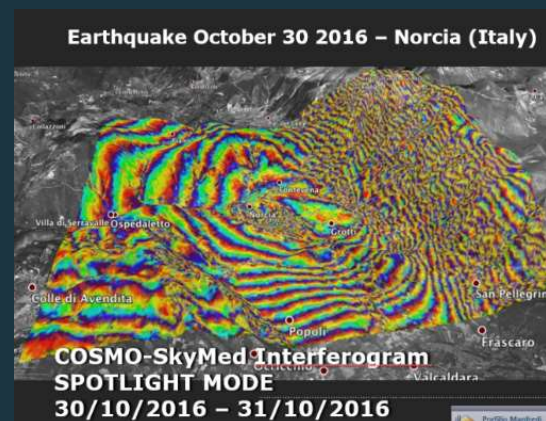
2015



NEPAL
EARTHQUAKE

**TO SUPPORT THE
INTERNATIONAL
EMERGENCY
SITUATION ASI
PROVIDED FREE OF
CHARGE DATA TO THE
WHOLE
INSTITUTIONAL
USERS COMMUNITY**

2016



Crisis Management applications

Phase of *Emergency cycle*

	What users want	What Earth Observation Information can do
<i><u>Early Warning</u></i>	disaster anticipation	regular monitoring
<i><u>Crisis</u></i>	<ul style="list-style-type: none"> • damage assessment • support to logistics 	<ul style="list-style-type: none"> • damage assessment • support to logistics
<i><u>Post crisis</u></i>	monitoring of recovery operations	monitoring of recovery operations

Type of *Risks*

	What users want	What Earth Observation systems can do
<i><u>Floods</u></i>	visible water extent	<ul style="list-style-type: none"> • dynamic monitoring of flood extent • affected infrastructures
<i><u>Fires</u></i>	<ul style="list-style-type: none"> • visible burnt areas • possible Hot Spots 	<ul style="list-style-type: none"> • Burnt Scar Mapping • very frequent Hot Spot service
<i><u>Earthquakes</u></i>	<ul style="list-style-type: none"> • detailed damage assessment • conditions of infrastructures 	<ul style="list-style-type: none"> • building damage assessment • status of critical infrastructures • road conditions analysis



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THE AGENCY

THE AGENCY

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Calls

COSMO-SkyMed Constellation: data utilization

25 Feb 2015

Open Call for national and international Scientific Community

>>

PERMANENTLY OPEN COSMO-SkyMed Constellation

Open Call for Science

Italian Space Agency



Selected projects are supported for a maximum of two years, through the provision of a maximum of 100 free of charge COSMO-SkyMed scenes

- ❖ **80 Archive products**
- ❖ **20 Tasking (new acquisitions)**

<http://www.asi.it/en/agency/calls-and-opportunities/calls/cosmo-skymed-constellation-data-utilization>



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Calls

COSMO-SkyMed Constellation: data utilization

25 Feb 2015

Open Call for national and international Scientific Community

COSMO-SkyMed OPEN CALL for "NATIONAL SMEs"

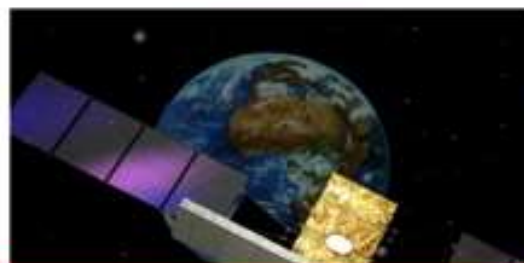
Bando PMI sui dati COSMO-SkyMed

L'edizione 2016 della Call prevede la possibilità di richiedere anche dati di archivio

di Redazione ASI

[Follow @ASI_spazio](#)

Lunedì 07 Marzo 2016



L'Agenzia Spaziale Italiana rinnova il suo impegno per la promozione dell'utilizzo dei dati della missione COSMO-SkyMed (CSK) attraverso la riemissione del Bando Open Call per Piccole e Medie Imprese-Utilizzo dei dati COSMO-SkyMed per la realizzazione di applicazioni, prodotti e servizi innovativi.

Il nuovo testo, a differenza del precedente, prevede la possibilità per PMI, spin-off accademici e start-up di richiedere anche dati di archivio oltre a dati derivanti da nuove acquisizioni.

Selected projects are supported for a maximum of two years, through a provision of a maximum of **100 free of charge COSMO-SkyMed scenes from both**

- ❖ **archive**
- ❖ **new acquisitions**

Topics:

Mainly addressed to

- ❖ monitoring of infrastructures and building stock
- ❖ surveying of archaeological heritage in cooperation with institutions
- ❖ developing of new tools and SAR methods.

riguardano il
e prodotti esistenti, la
oni, servizi e prodotti
one della Terra derivat
stellazione COSMO-

Open Call

per

Piccole e Medie Imprese

Utilizzo dei dati COSMO-SkyMed

Agenzia Spaziale Italiana



An Open Call for national SME's community was published on the ASI website to promote the exploitation of COSMO-SkyMed data and the improvement of existing applications or the development of new technologies and algorithms based on EO information **and to stimulate the whole of the Italy's industrial fabric (SMEs), which is strategic for the Country.**

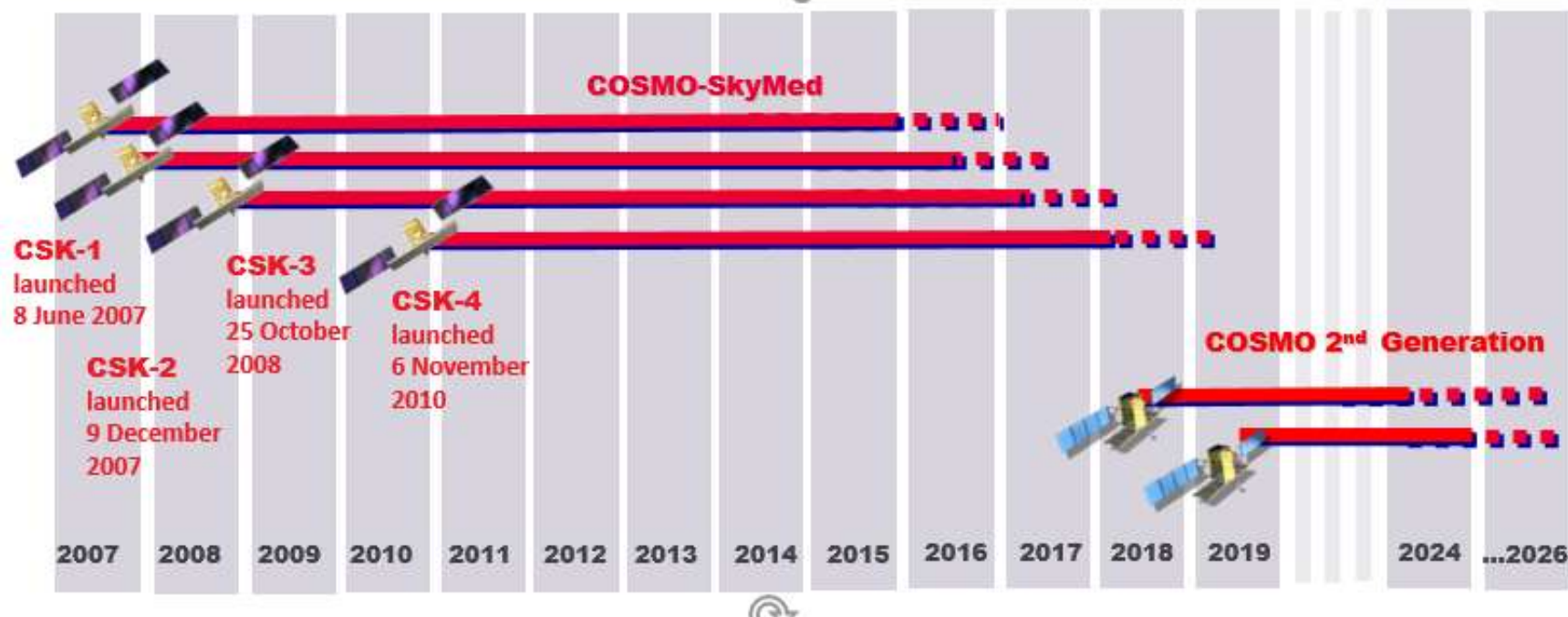
COSMO Second Generation DEPLOYMENT SCENARIO AND PROSPECTIVE



COSMO-SkyMed constellation is FULLY DEPLOYED AND OPERATIONAL since mid 2011.

CSG satellites will replace the CSK satellites that reached the end of life

With the launch of the first CSG satellite planned in 2018, CSG **will provide operational continuity at least until 2025.**





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