



# SPRINT

**SP**aceborne **RA**dar **IN**terferometric **T**echniques  
for Humanitarian Demining Land Release

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HOLECZ)



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## Aim of the project



To find out a plausible limit of a minefield from the interpretation/analysis of a stack of ERS & Envisat images

(Potential consequence : suspected mined area reduction)

*Relation between human activities and interferometric coherence*

*Minefields are zones that preserve interferometric coherence through time*

FP7 TIRAMISU project

*(Toolbox Implementation for Removal of Anti-personnel Mines, Submunitions and UXO)*

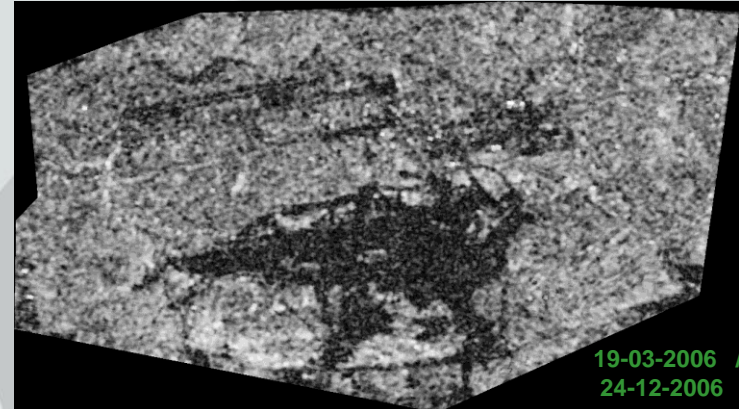
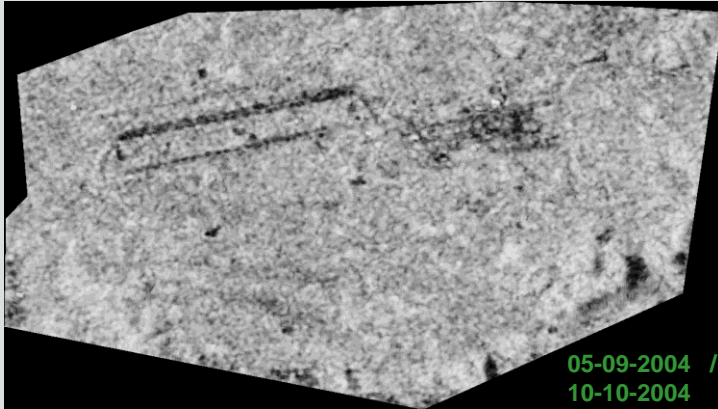
- aims at providing the foundation for a global toolbox that will cover the main mine action activities -



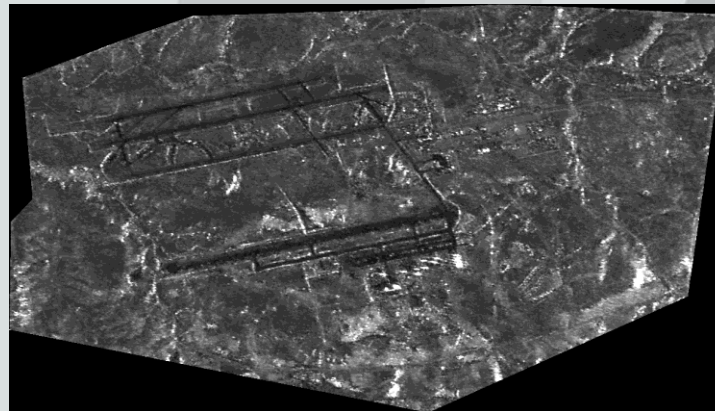
DEFENSIE  
LA DÉFENSE

# Background

## Coherence



ASAR AMPLITUDE 28-03-2010



Nevatim airport, Israel

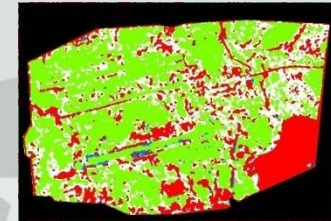
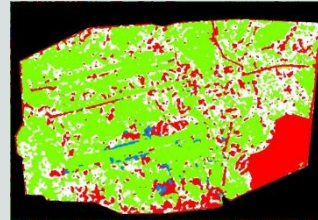
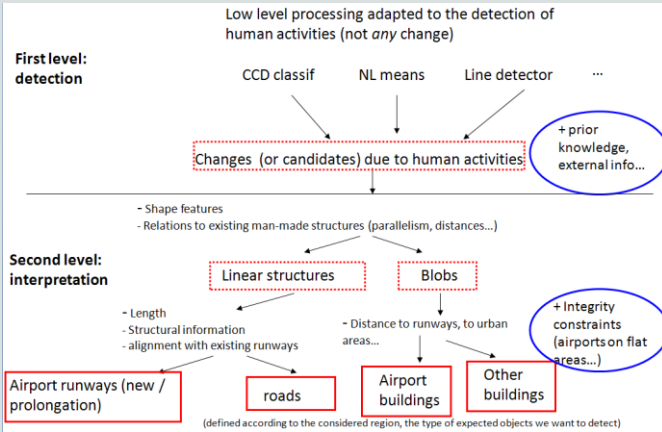
BEODays, November 19-20, 2013

.be

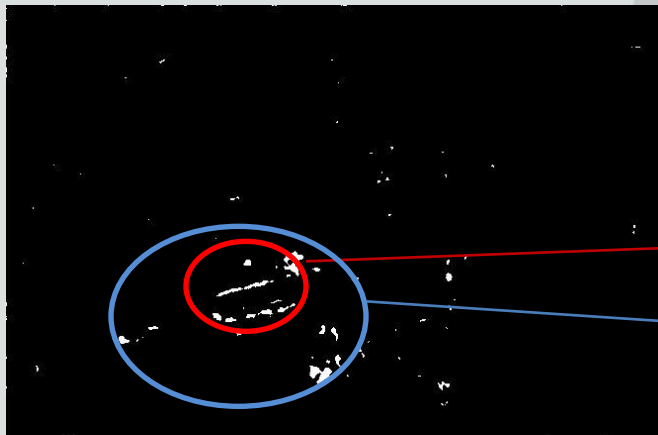


# Background

## Relation between human activities and interferometric coherence



(1 – low, 2 – medium, 3 – high coherence)  
 11, 12, 21 – green  
 22 – white  
 23, 32, 33 – red  
 13 – blue  
 31 – purple



Two straight and parallel lines:  
 Works on a new runway of the airport !







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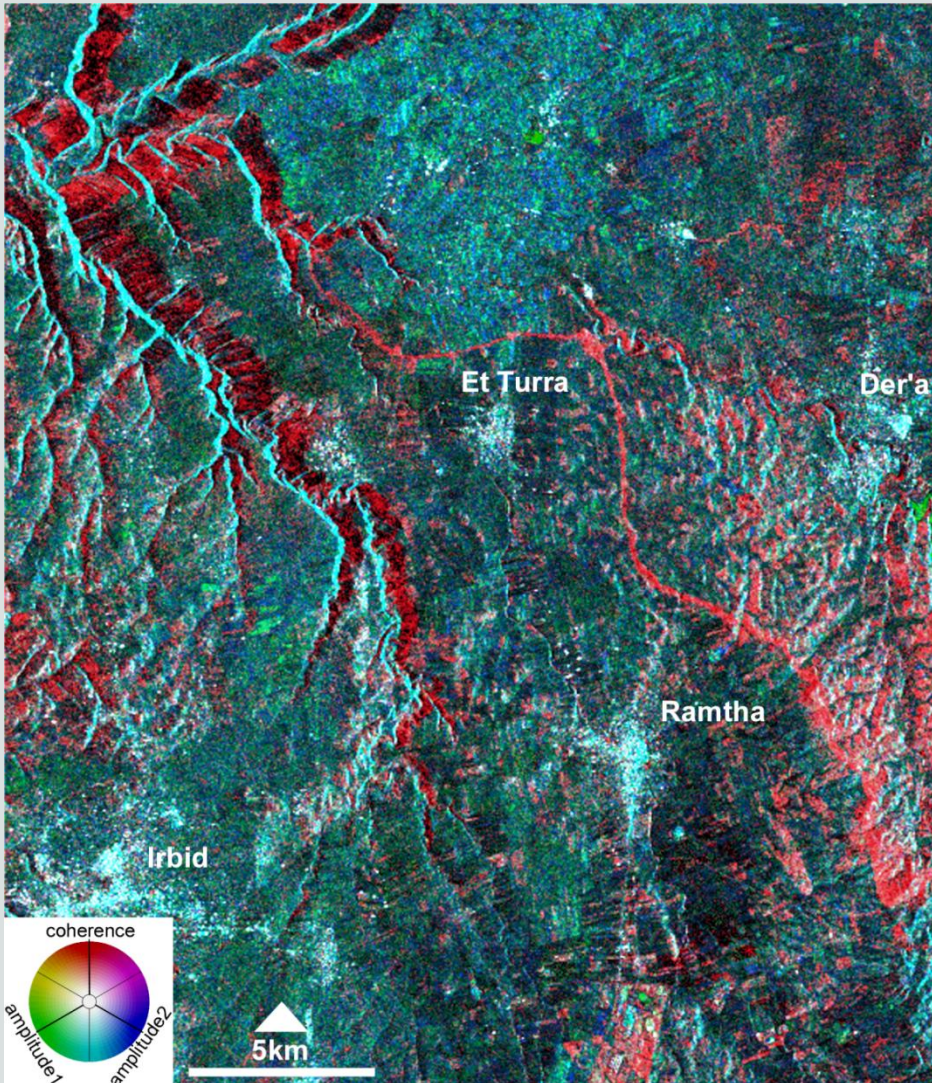
# Background

Minefields are zones that preserve interferometric coherence through time

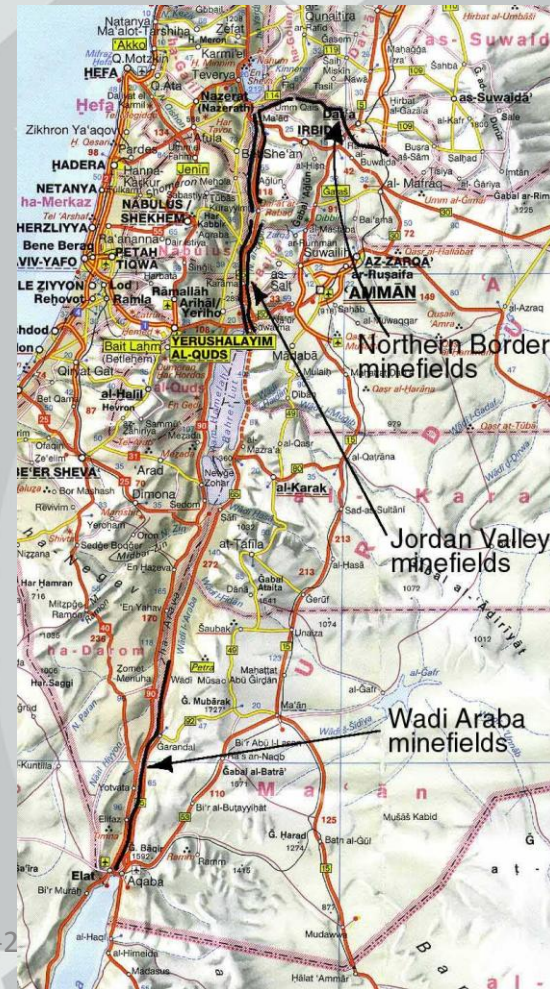


Minefield along the borderline between Jordan and Syria

Colour composition of ERS images - 70 days between two acquisitions - Dates: 29 July 1995 – 7 October 1995



## National study







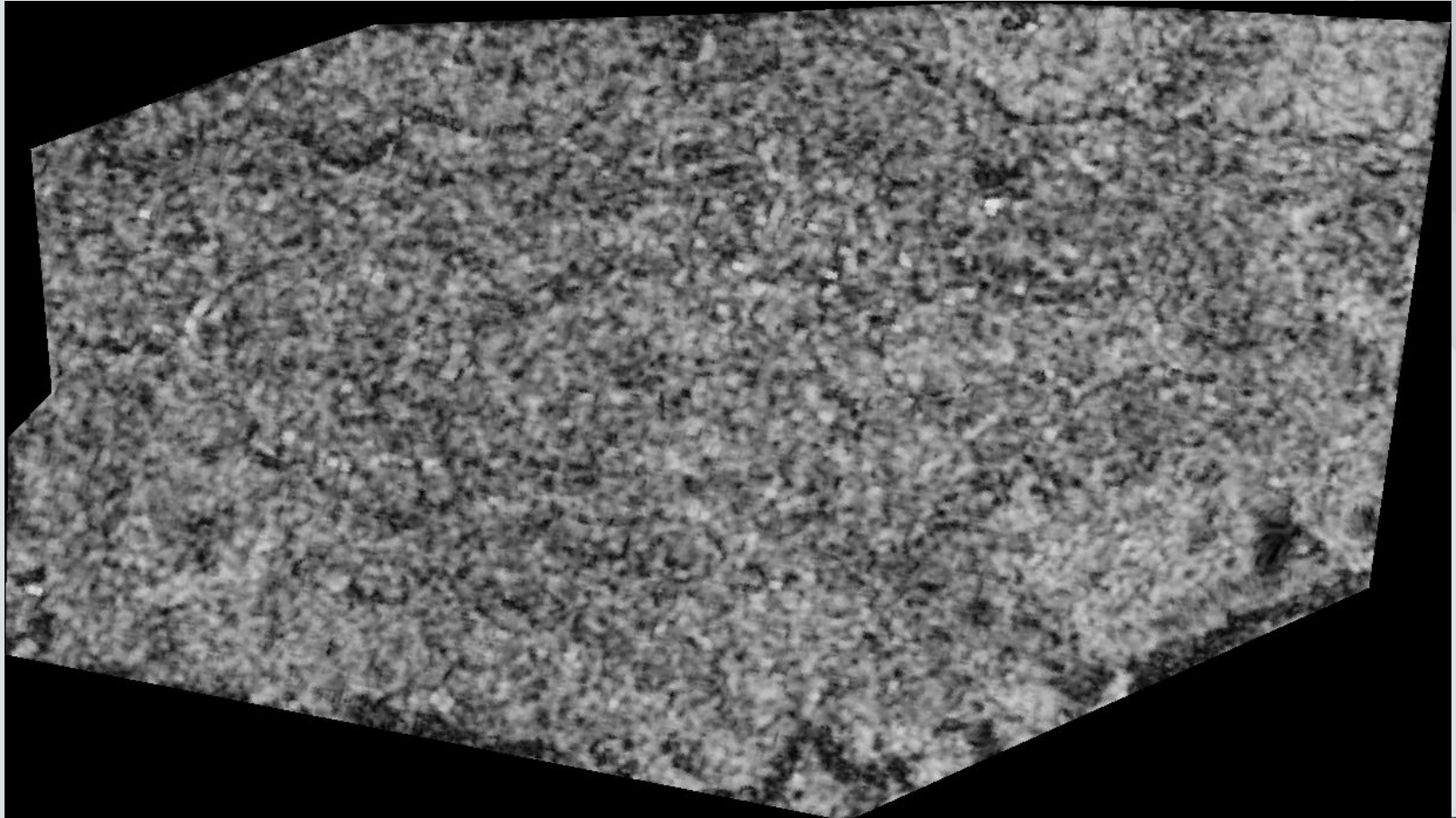
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LA DÉFENSE

# Background

*Limitations*

**COHERENCE**

**14-11-2004 / 19-12-2004**







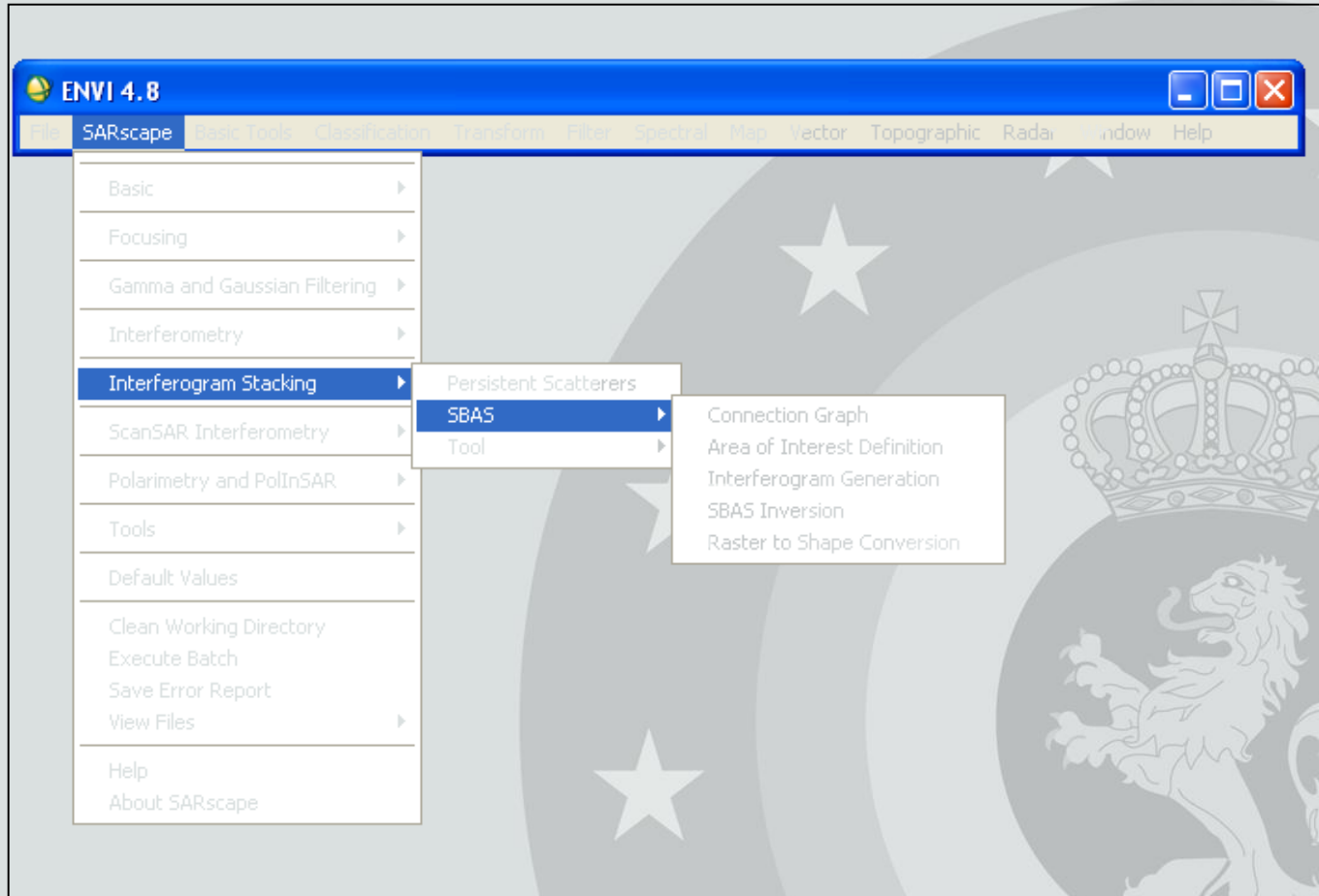


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# Background Tools



## A. Sarcape/SBAS



B. Available data processing and fusion tools and methodologies developed in other projects

# Method

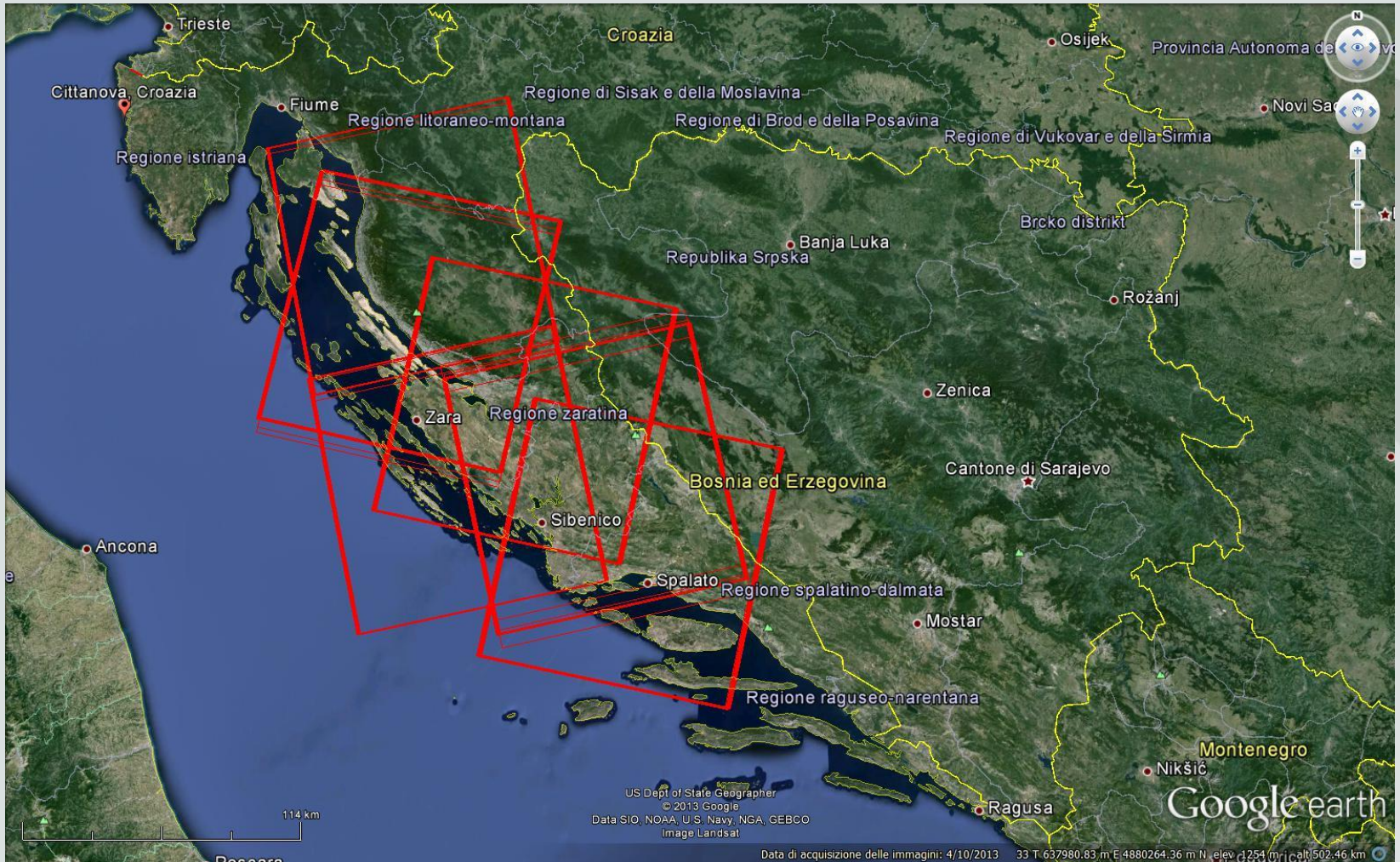
1. Selection of case studies in Croatia (e.g. reject steep slopes and moisture)
2. Image data selection (Asc/Dsc) from 1991 till 2011
3. Image data stacking & processing (adapted SBAS/Sarscape). Set up of a data cube
4. Detection of plausible limits of a minefield
  - data analysis and fusion inside the data cube
  - fusion with other sources (visible images, context information)
5. Validation in Information Management System for Mine Action (IMSMA)
  - use of the true limits provided by CROMAC



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# Method

## Selection of case studies in Croatia



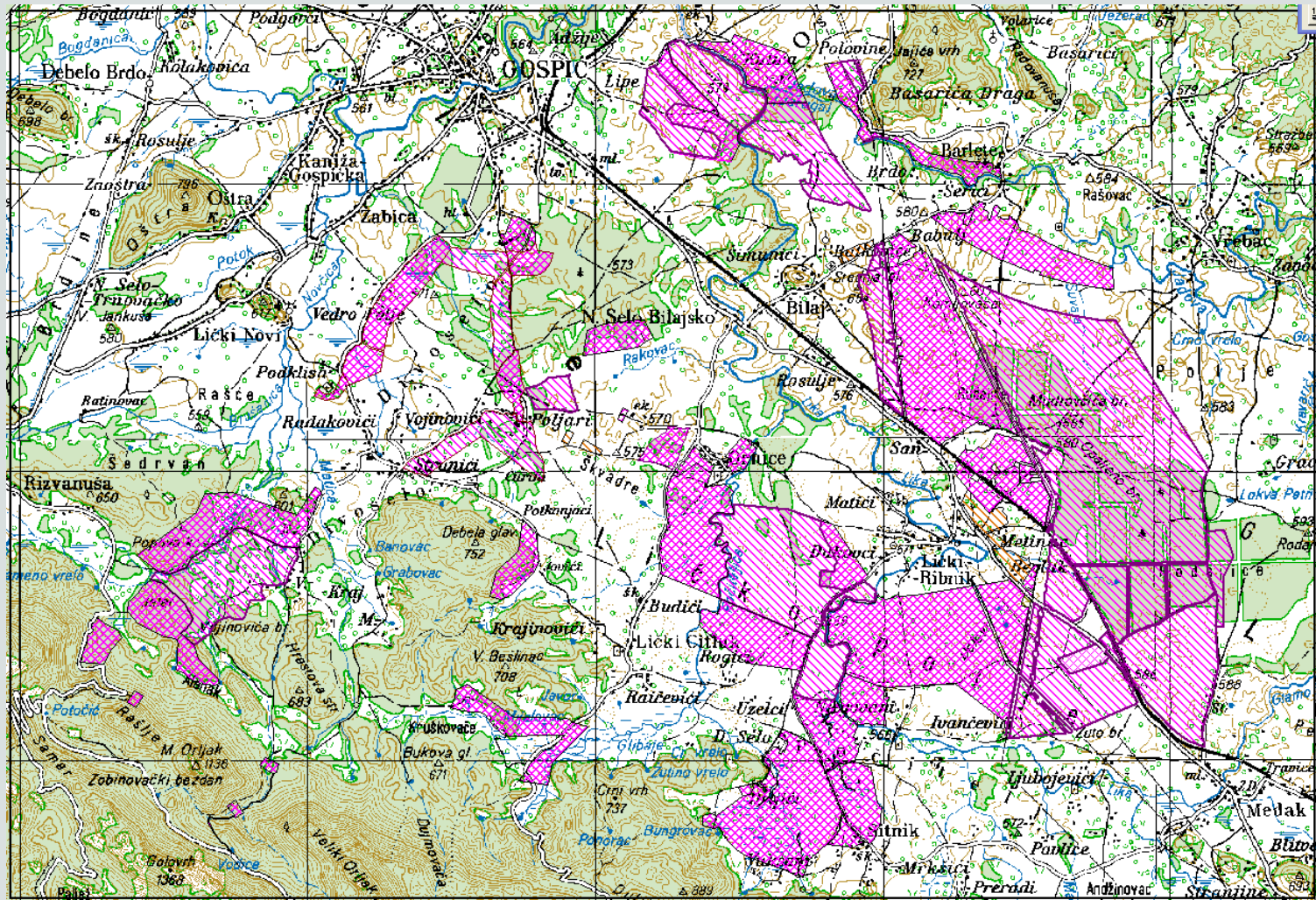




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# Method

## GOSPIC : 26 test areas



Suspected hazardous and confirmed hazardous areas shown in hatched and crosshatched red polygons (data from 2009)

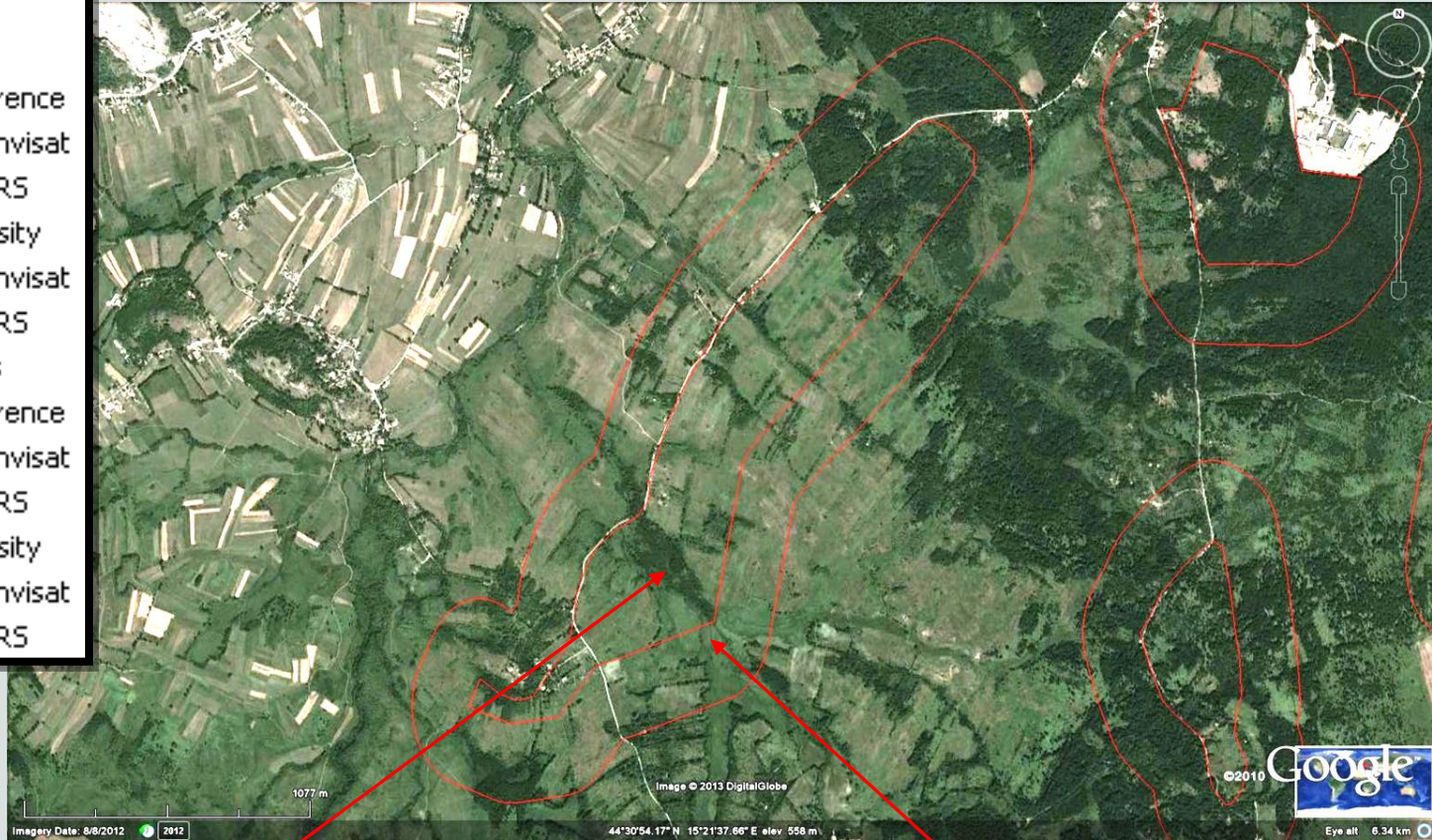
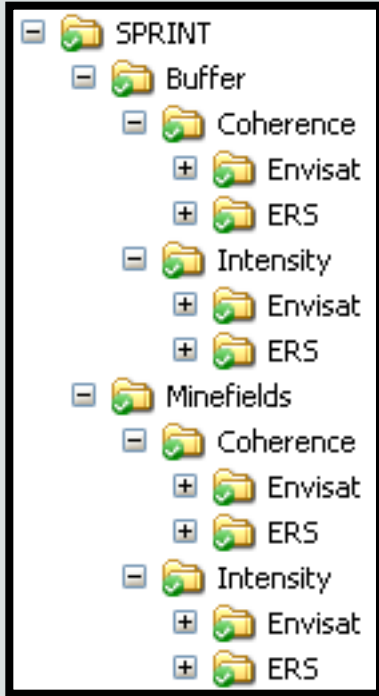




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# Method

## Image data selection



Minefield

Buffer



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# Method

## Stacking approach: 42 ERS + 40 Envisat (1992-2010)



Mission	Product	Start	Stop	Orbit	Track	Pass
ERS-1	SAR_IM0_OP	1992-08-01 21:09:48.07	1992-08-01 21:10:04.07	5470	315	A
ERS-1	SAR_IM0_OP	1993-07-17 21:09:42.36	1993-07-17 21:09:58.36	10480	315	A
ERS-1	SAR_IM0_OP	1995-05-01 21:09:44.07	1995-05-01 21:10:00.07	19842	315	A
ERS-2	SAR_IM0_OP	1995-06-06 21:09:53.02	1995-06-06 21:10:09.02	670	315	A
ERS-1	SAR_IM0_OP	1995-07-10 21:09:49.07	1995-07-10 21:10:05.07	20844	315	A
ERS-2	SAR_IM0_OP	1995-07-11 21:09:54.29	1995-07-11 21:10:10.29	1171	315	A
ERS-1	SAR_IM0_OP	1995-08-14 21:09:51.07	1995-08-14 21:10:07.07	21345	315	A
ERS-2	SAR_IM0_OP	1995-08-15 21:09:55.26	1995-08-15 21:10:11.26	1672	315	A
ERS-1	SAR_IM0_OP	1995-09-18 21:09:48.50	1995-09-18 21:10:04.50	21846	315	A
ERS-2	SAR_IM0_OP	1995-09-19 21:09:54.20	1995-09-19 21:10:10.20	2173	315	A
ERS-2	SAR_IM0_OP	1996-03-12 21:09:48.95	1996-03-12 21:10:04.95	4678	315	A
ERS-2	SAR_IM0_OP	1996-06-25 21:09:51.75	1996-06-25 21:10:07.75	6181	315	A
ERS-2	SAR_IM0_OP	1996-07-30 21:09:50.21	1996-07-30 21:10:06.21	6682	315	A
ERS-2	SAR_IM0_OP	1996-09-03 21:09:48.53	1996-09-03 21:10:04.53	7183	315	A
ERS-2	SAR_IM0_OP	1996-10-08 21:09:48.20	1996-10-08 21:10:04.20	7684	315	A
ERS-2	SAR_IM0_OP	1997-04-01 21:09:45.99	1997-04-01 21:10:01.99	10189	315	A
ERS-2	SAR_IM0_OP	1997-06-10 21:09:48.33	1997-06-10 21:10:04.33	11191	315	A
ERS-2	SAR_IM0_OP	1997-08-19 21:09:47.88	1997-08-19 21:10:03.88	12193	315	A
ERS-2	SAR_IM0_OP	1998-04-21 21:09:44.30	1998-04-21 21:10:00.30	15700	315	A
ERS-2	SAR_IM0_OP	1998-06-30 21:09:37.87	1998-06-30 21:09:53.87	16702	315	A
ERS-2	SAR_IM0_OP	1998-09-08 21:09:44.94	1998-09-08 21:10:00.94	17704	315	A
ERS-2	SAR_IM0_OP	1999-04-06 21:09:44.31	1999-04-06 21:10:00.31	20710	315	A
ERS-2	SAR_IM0_OP	1999-06-15 21:09:39.97	1999-06-15 21:09:55.97	21712	315	A
ERS-1	SAR_IM0_OP	1999-08-23 21:09:27.80	1999-08-23 21:09:43.80	42387	315	A
ERS-2	SAR_IM0_OP	1999-08-24 21:09:37.86	1999-08-24 21:09:53.86	22714	315	A
ERS-2	SAR_IM0_OP	1999-11-02 21:09:41.02	1999-11-02 21:09:57.02	23716	315	A
ERS-2	SAR_IM0_OP	2000-05-30 21:09:38.39	2000-05-30 21:09:54.39	26722	315	A
ERS-2	SAR_IM0_OP	2000-08-08 21:09:52.68	2000-08-08 21:10:08.68	27724	315	A
ERS-2	SAR_IM0_OP	2001-05-15 21:09:27.49	2001-05-15 21:09:43.49	31732	315	A
ERS-2	SAR_IM0_OP	2001-07-24 21:09:01.81	2001-07-24 21:09:17.81	32734	315	A
ERS-2	SAR_IM0_OP	2001-08-28 21:08:45.32	2001-08-28 21:09:01.32	33235	315	A
ERS-2	SAR_IM0_OP	2002-04-30 21:08:03.79	2002-04-30 21:08:19.79	36742	315	A
ERS-2	SAR_IM0_OP	2002-07-09 21:08:11.50	2002-07-09 21:08:27.50	37744	315	A
ERS-2	SAR_IM0_OP	2002-08-13 21:08:17.60	2002-08-13 21:08:33.60	38245	315	A
ERS-2	SAR_IM0_OP	2003-02-04 21:08:11.07	2003-02-04 21:08:27.07	40750	315	A
ERS-2	SAR_IM0_OP	2003-04-15 21:08:05.61	2003-04-15 21:08:21.61	41752	315	A
ERS-2	SAR_IM0_OP	2003-09-02 21:08:20.77	2003-09-02 21:08:36.77	43756	315	A
ERS-2	SAR_IM0_OP	2005-09-06 21:08:22.54	2005-09-06 21:08:38.54	54277	315	A
ERS-2	SAR_IM0_OP	2008-06-17 21:09:40.88	2008-06-17 21:09:56.88	68905	315	A
ERS-2	SAR_IM0_OP	2008-07-22 21:09:42.44	2008-07-22 21:09:58.44	69307	315	A
ERS-2	SAR_IM0_OP	2008-08-26 21:09:40.69	2008-08-26 21:09:56.69	69808	315	A
ERS-2	SAR_IM0_OP	2009-06-02 21:10:54.61	2009-06-02 21:11:10.61	73816	315	A

Mission	Product	Start	Stop	Orbit	Track	Frame	Swath	Pass	Delivery
ENVISAT-1	ASA_IM0_OP	2003-06-24 20:39:42.75	2003-06-24 20:39:57.84	6882	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2003-07-29 20:39:47.44	2003-07-29 20:40:02.53	7383	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2003-09-02 20:39:50.66	2003-09-02 20:40:05.75	7884	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2003-11-11 20:39:43.83	2003-11-11 20:39:58.92	8886	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2004-06-08 20:39:48.87	2004-06-08 20:40:03.96	11892	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2004-07-13 20:39:49.37	2004-07-13 20:40:04.46	12393	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2004-08-17 20:39:46.98	2004-08-17 20:40:02.07	12894	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2004-10-26 20:39:49.56	2004-10-26 20:40:04.65	13896	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2005-01-04 20:39:40.57	2005-01-04 20:39:55.66	14898	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2005-02-08 20:39:43.88	2005-02-08 20:39:58.97	15399	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2005-03-15 20:39:42.31	2005-03-15 20:39:57.40	15900	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2005-05-24 20:39:49.78	2005-05-24 20:40:04.87	16902	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2005-08-02 20:39:48.57	2005-08-02 20:40:03.66	17904	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2005-10-11 20:39:47.69	2005-10-11 20:40:02.78	18906	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2005-12-20 20:39:40.41	2005-12-20 20:39:55.50	19908	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2006-02-28 20:39:36.48	2006-02-28 20:39:51.57	20910	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2006-05-09 20:39:41.06	2006-05-09 20:39:56.15	21912	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2006-07-18 20:39:47.57	2006-07-18 20:40:02.66	22914	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2006-12-05 20:39:45.53	2006-12-05 20:40:00.62	24918	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2007-02-13 20:39:39.54	2007-02-13 20:39:54.63	25920	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2007-04-24 20:39:39.72	2007-04-24 20:39:54.81	26922	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2007-07-03 20:39:43.18	2007-07-03 20:39:58.27	27924	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2007-09-11 20:39:40.51	2007-09-11 20:39:55.60	28926	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2007-11-20 20:39:36.42	2007-11-20 20:39:51.51	29928	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2008-01-29 20:39:36.12	2008-01-29 20:39:51.21	30930	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2008-03-04 20:39:36.65	2008-03-04 20:39:51.74	31431	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2008-04-08 20:39:36.01	2008-04-08 20:39:51.10	31932	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2008-06-17 20:39:37.40	2008-06-17 20:39:52.49	32934	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2008-08-26 20:39:35.52	2008-08-26 20:39:50.61	33936	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2008-11-04 20:39:34.22	2008-11-04 20:39:49.31	34938	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2009-01-13 20:39:33.45	2009-01-13 20:39:48.54	35940	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2009-03-24 20:39:32.85	2009-03-24 20:39:47.74	36942	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2009-06-02 20:39:35.63	2009-06-02 20:39:50.72	37944	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2009-08-11 20:39:35.88	2009-08-11 20:39:50.97	38946	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2009-10-20 20:39:31.11	2009-10-20 20:39:46.20	39948	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2009-12-29 20:39:29.72	2009-12-29 20:39:44.81	40950	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2010-03-09 20:39:28.16	2010-03-09 20:39:43.25	41952	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2010-05-18 20:39:26.07	2010-05-18 20:39:41.16	42954	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2010-07-27 20:39:27.74	2010-07-27 20:39:42.83	43956	315	873	I2	A	y
ENVISAT-1	ASA_IM0_OP	2010-10-05 20:39:24.02	2010-10-05 20:39:39.11	44958	315	873	I2	A	y







# Stacking approach: coherence – various combinations

The screenshot displays a Windows file explorer window with a complex directory structure. The address bar shows the path: `C:\Documents and Settings\academy\Documents\Bsp\Bsp164517_1_Nadaf01913\Bsp\Cheronev\1.xls`. The left sidebar shows the 'Folders' pane with a tree view including 'Bsp164517\_1', 'Bsp164517\_2', 'Bsp164517\_3', 'Bsp164517\_4', 'Bsp164517\_5', 'Bsp164517\_6', 'Bsp164517\_7', 'Bsp164517\_8', 'Bsp164517\_9', 'Bsp164517\_10', 'Bsp164517\_11', 'Bsp164517\_12', 'Bsp164517\_13', 'Bsp164517\_14', 'Bsp164517\_15', 'Bsp164517\_16', 'Bsp164517\_17', 'Bsp164517\_18', 'Bsp164517\_19', 'Bsp164517\_20', 'Bsp164517\_21', 'Bsp164517\_22', 'Bsp164517\_23', 'Bsp164517\_24', 'Bsp164517\_25', 'Bsp164517\_26', 'Bsp164517\_27', 'Bsp164517\_28', 'Bsp164517\_29', 'Bsp164517\_30', 'Bsp164517\_31', 'Bsp164517\_32', 'Bsp164517\_33', 'Bsp164517\_34', 'Bsp164517\_35', 'Bsp164517\_36', 'Bsp164517\_37', 'Bsp164517\_38', 'Bsp164517\_39', 'Bsp164517\_40', 'Bsp164517\_41', 'Bsp164517\_42', 'Bsp164517\_43', 'Bsp164517\_44', 'Bsp164517\_45', 'Bsp164517\_46', 'Bsp164517\_47', 'Bsp164517\_48', 'Bsp164517\_49', 'Bsp164517\_50', 'Bsp164517\_51', 'Bsp164517\_52', 'Bsp164517\_53', 'Bsp164517\_54', 'Bsp164517\_55', 'Bsp164517\_56', 'Bsp164517\_57', 'Bsp164517\_58', 'Bsp164517\_59', 'Bsp164517\_60', 'Bsp164517\_61', 'Bsp164517\_62', 'Bsp164517\_63', 'Bsp164517\_64', 'Bsp164517\_65', 'Bsp164517\_66', 'Bsp164517\_67', 'Bsp164517\_68', 'Bsp164517\_69', 'Bsp164517\_70', 'Bsp164517\_71', 'Bsp164517\_72', 'Bsp164517\_73', 'Bsp164517\_74', 'Bsp164517\_75', 'Bsp164517\_76', 'Bsp164517\_77', 'Bsp164517\_78', 'Bsp164517\_79', 'Bsp164517\_80', 'Bsp164517\_81', 'Bsp164517\_82', 'Bsp164517\_83', 'Bsp164517\_84', 'Bsp164517\_85', 'Bsp164517\_86', 'Bsp164517\_87', 'Bsp164517\_88', 'Bsp164517\_89', 'Bsp164517\_90', 'Bsp164517\_91', 'Bsp164517\_92', 'Bsp164517\_93', 'Bsp164517\_94', 'Bsp164517\_95', 'Bsp164517\_96', 'Bsp164517\_97', 'Bsp164517\_98', 'Bsp164517\_99', 'Bsp164517\_100'. The main pane shows a grid of files with columns for Name, Date modified, Type, and Size. The files are organized into folders and subfolders, with names containing alphanumeric strings and file extensions like '.doc' and '.docx'. The window title is 'C:\Documents and Settings\academy\Documents\Bsp\Bsp164517\_1\_Nadaf01913\Bsp\Cheronev\1.xls'.

## On-going work

- The 6-month project ends December 31, 2013
- We are currently busy with:
  - Segmentation and classification through analysis of stacks of
    - ENVISAT amplitude
    - ERS amplitude
    - ENVISAT coherence
    - ERS coherence
  - Combination of the above results using various fusion methods
  - Reduction of mine suspected zones based on all the above
  - Validation using ground-information
- Hoping to see you during the next BEODays with a summary of our results 😊