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→ 4th ADVANCED TRAINING COURSE IN LAND REMOTE SENSING

SAR for Agriculture - Practical

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Hands-on exercise: Objectives

- How creating a ***geocoded and radiometrically normalised time series*** employing ENVISAT ASAR APP (HH/HV) and ERS-2 IMP (VV) ascending and descending products;
- Derive an Index (ratio HH/VV) for monitoring the temporal behaviour of agriculture fields;
- The exercise will be done using the **DAT** (interface), the **Graphic builder** and the **Batch processing Tool.**

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Dataset

Acquisition times:

ASAR APP - **HH** / **HV** polarisation (IS2)

1. *2005-05-11 – Ascending*
2. *2005-06-05 – Descending*
3. *2005-07-10 – Descending*

ERS-2 VV polarisation

1. *2005-05-11*
2. *2005-06-05*
3. *2005-07-10*

Both ascending and descending orbits

Product type: detected (APP/IMP) – 12.5 m pixel spacing – ground range geometry

Look angle mid swath = 23 degrees

28 minutes of difference in the acquisition's time between ERS and Envisat

Place: NordHausen (Germany)

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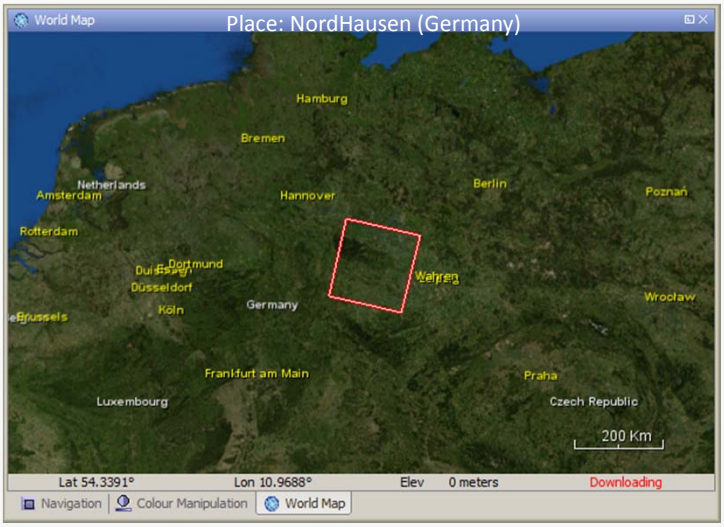
Dataset



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Dataset and Results

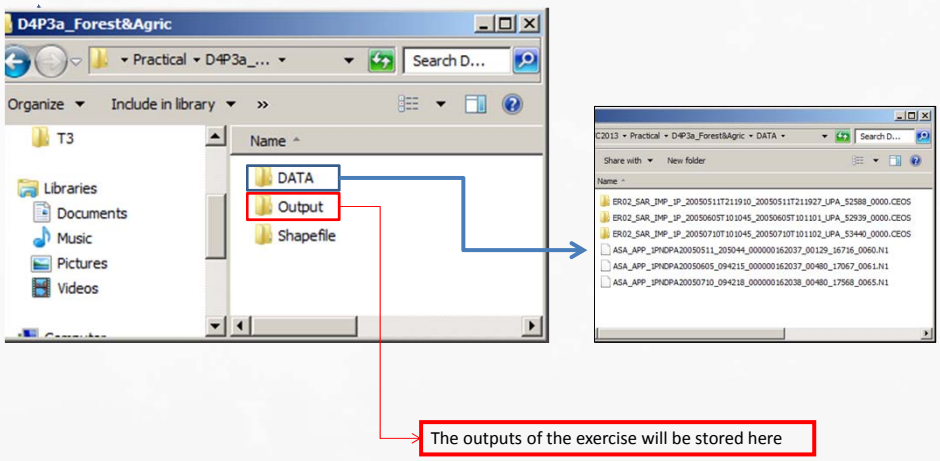
The products are freely available at:

SFTP (port 22): nestbox.esrin.esa.int
Username: nestuser
Password: password

Folder: DATA/NordHausenASAR_ERS

Exercise folder framework

C:\LTC2013\Practical\D4P3a_Forest&Agric\DATA



The outputs of the exercise will be stored here

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Exercise steps

1. Open and Inspect ASAR products
2. Create the processing chain for ASAR using the **Graph Builder**
   - Apply Precise Orbit
   - Multilook
   - Terrain Correction and Radiometric normalisation
3. Apply the processing chain to all ASAR products via the **BATCH Processing** Interface.
4. Open the ERS geocoded data (already processed)
5. Coregistration of ASAR and ERS geocoded images

Using the **DAT**

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Exercise steps

6. RGB visualisation: HV polarisation (ASAR)
7. RGB visualisation (linear and db): VV polarisation (ERS)
8. RGB visualisation: ERS VV – ASAR HV – ASAR HH (05-06-2005)
9. Multitemporal Speckle filtering: ERS-VV
10. Computation of Ratio HH / VV
11. Overlay shape file information
12. Question Time

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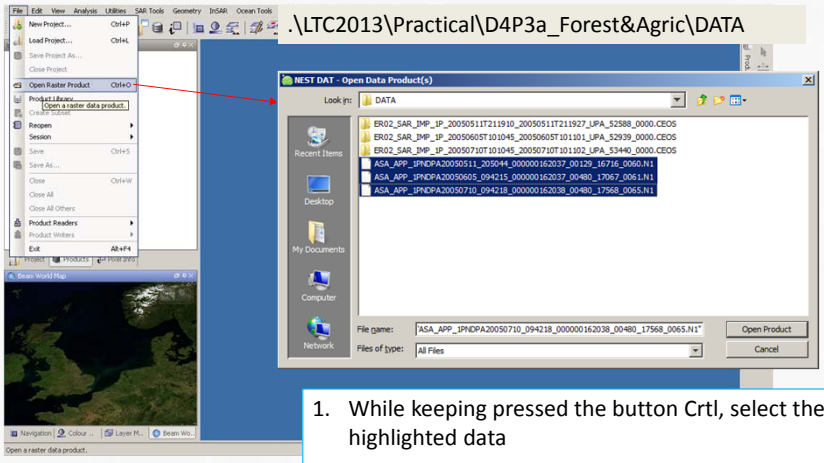
1. Open the ASAR data



1. While keeping pressed the button Crtl, select the highlighted data
2. then click to **Open Product**

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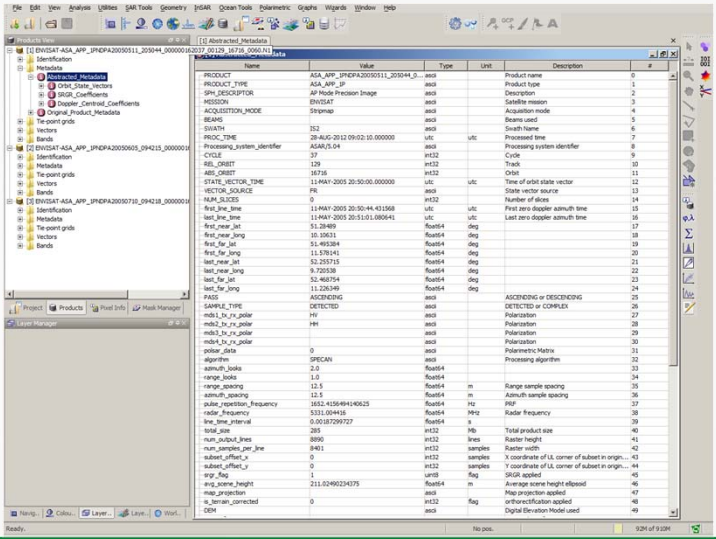
Metadata inspection



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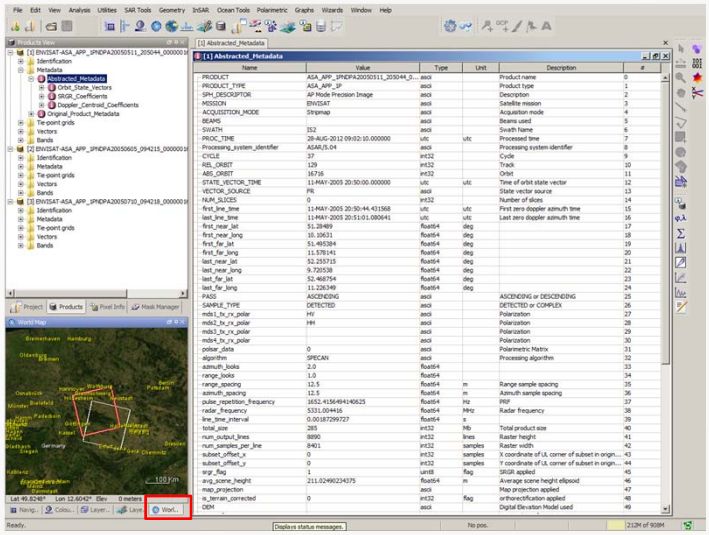
World MAP



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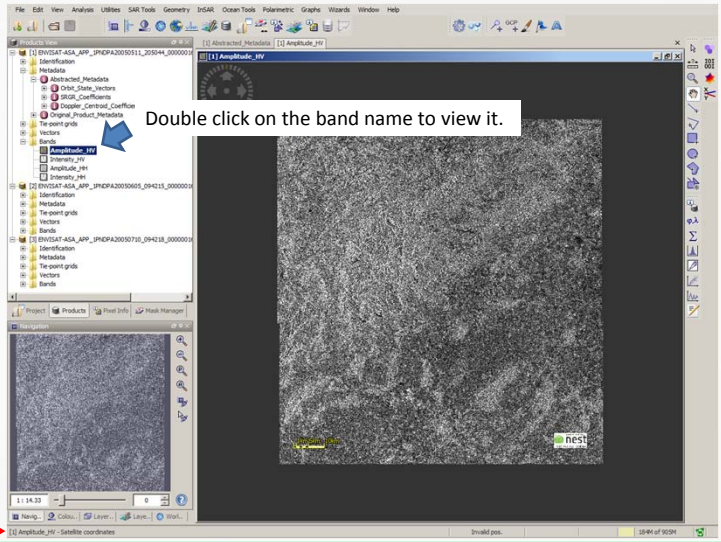
Display the Amplitude Image



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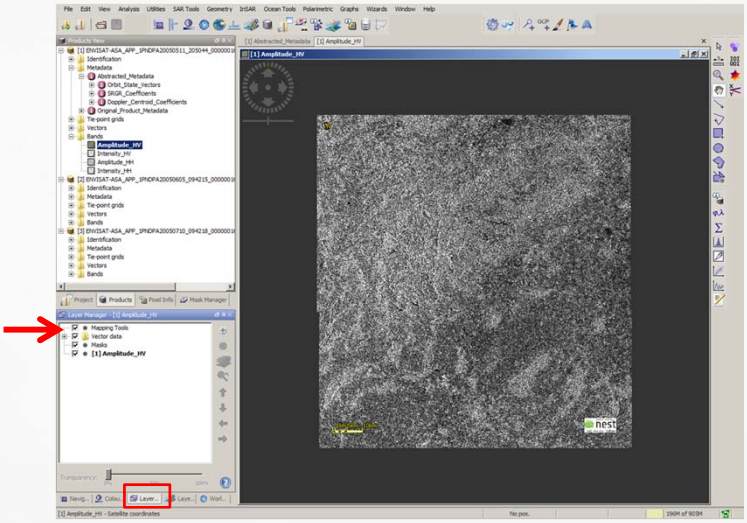
Mapping Tool (Activate/deactivate)



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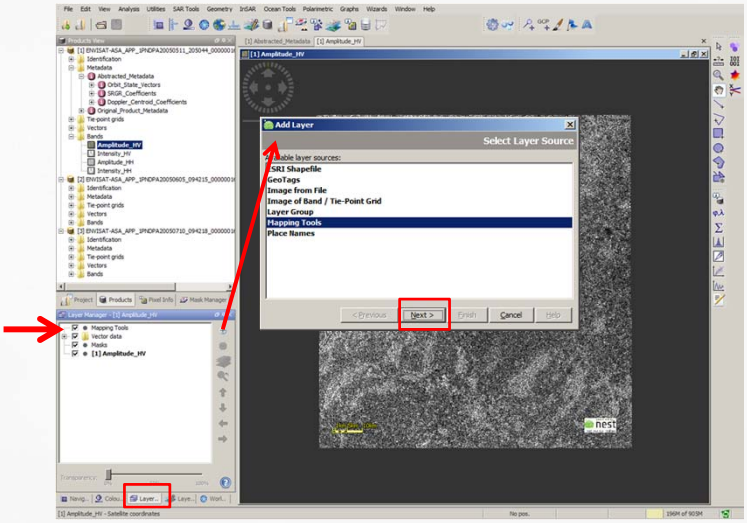
Mapping Tool (Activate/deactivate)



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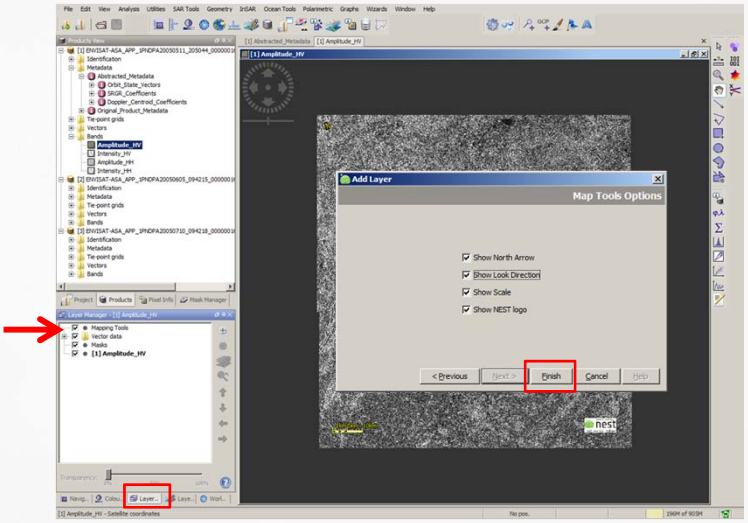
Mapping Tool (Activate/deactivate)



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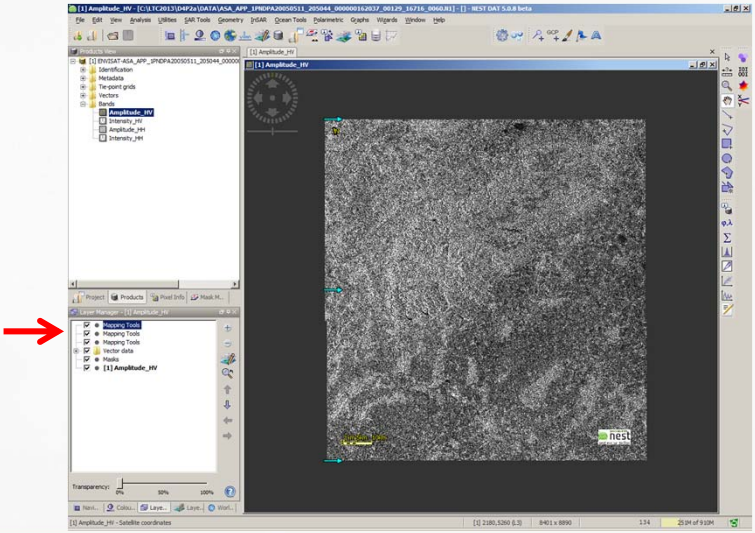
Mapping Tool (Activate/deactivate)



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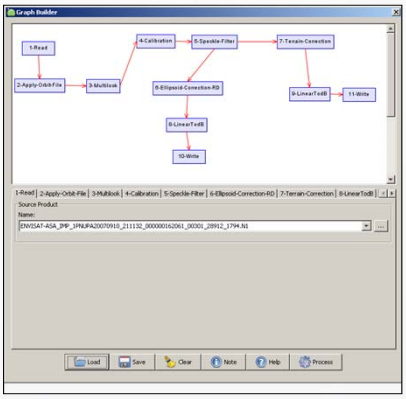
Create the processing chain for ASAR using the Graph Builder



- Apply Precise Orbit
- Multilook
- Terrain Correction and Radiometric normalisation

GRAPH BUILDER

- Visual Graph Processing Framework interface
- Create your own processing chains
- Executed from command line or from GUI
- Allows for *batch processing* on stack of images

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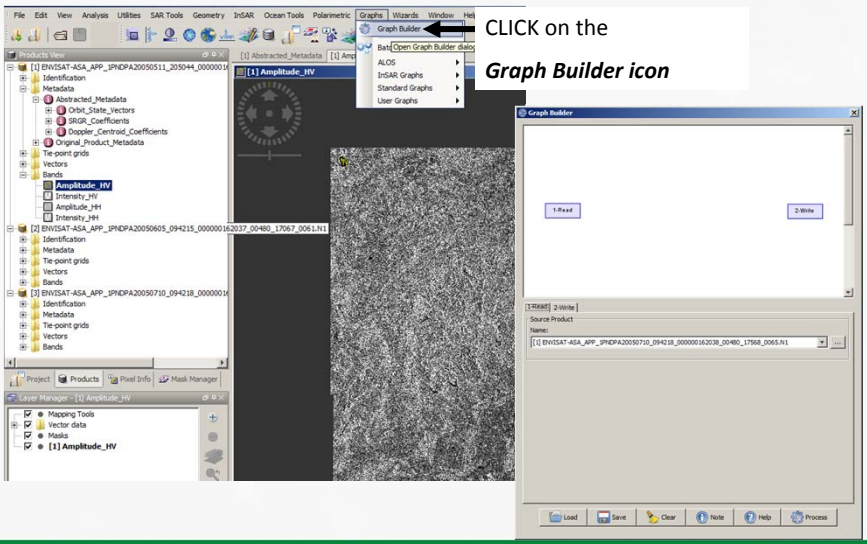
Launch the Graph Builder



CLICK on the

Graph Builder icon

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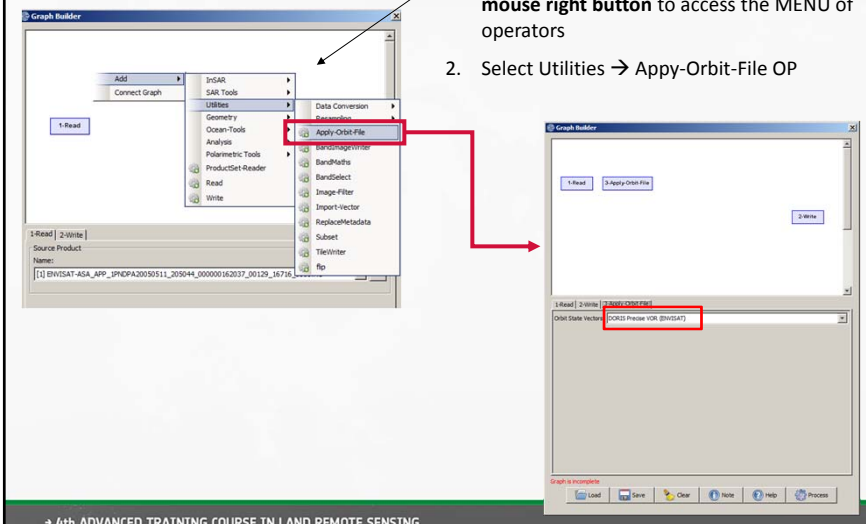
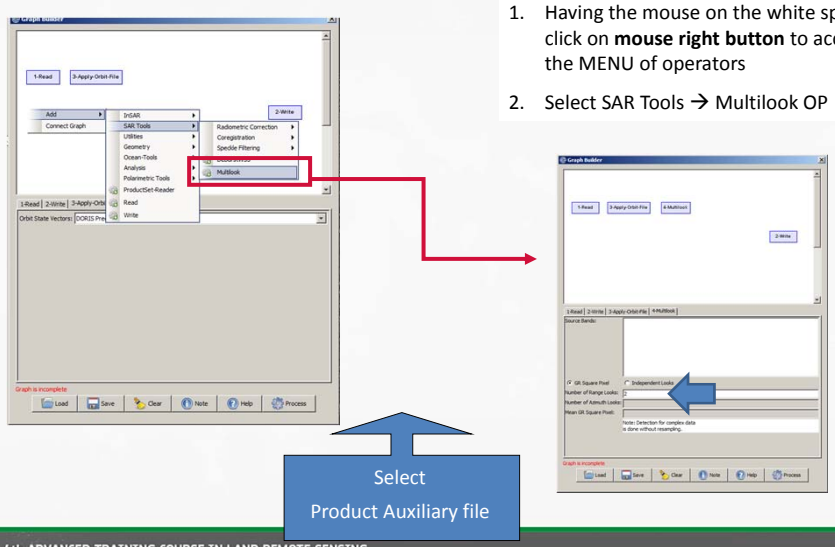
Building the chain for the ASAR image: DORIS Precise Orbit

1. Having the mouse on the white space, click on **mouse right button** to access the MENU of operators
2. Select Utilities → Appy-Orbit-File OP



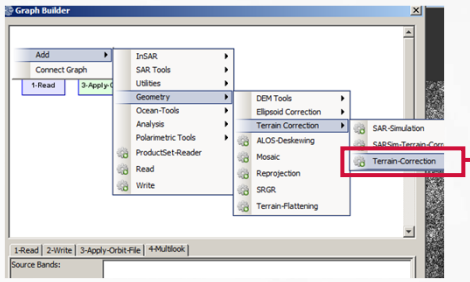
Building the chain for the ASAR: Multilook

1. Having the mouse on the white space, click on **mouse right button** to access the MENU of operators
2. Select SAR Tools → Multilook OP

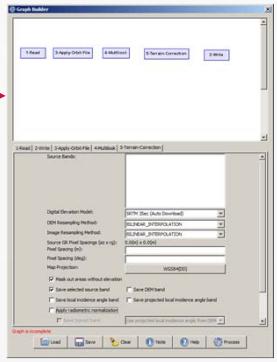


Select
Product Auxiliary file

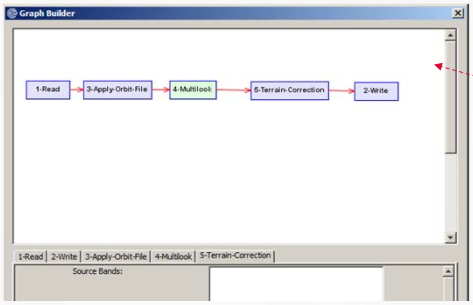
Building the chain for the ASAR: Terrain Correction



1. Having the mouse on the white space, click on **mouse right button** to access the MENU of operators
2. Select Geometry → Terrain correction → Terrain-Correction OP

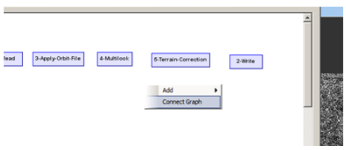


Building the chain for the ASAR



1. Link all the blocks with arrows. To draw the arrow press the left mouse button and link the blocks from right to left

Or push over



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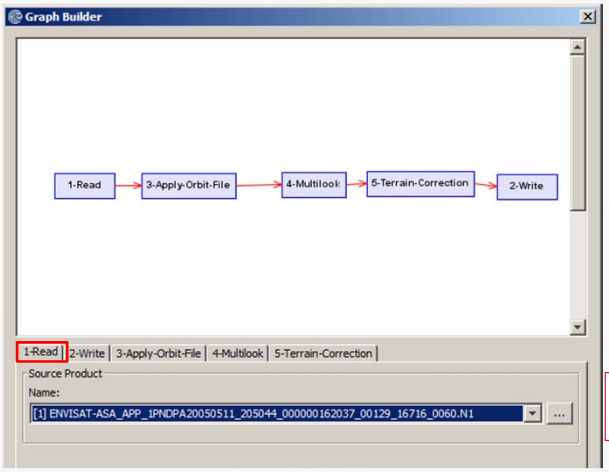
Building the chain for ASAR



Select the first ASAR Product

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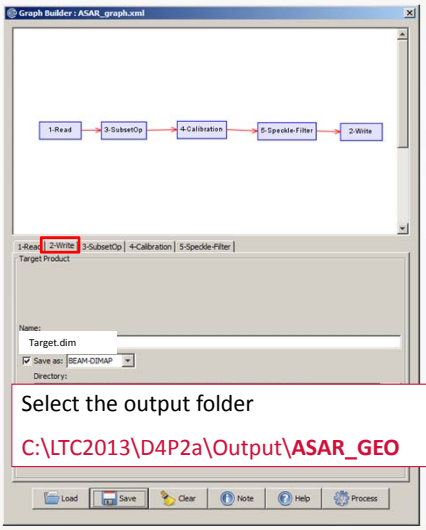
Building the chain for ASAR



Select the output folder

C:\LTC2013\D4P2a\Output**ASAR_GEO**

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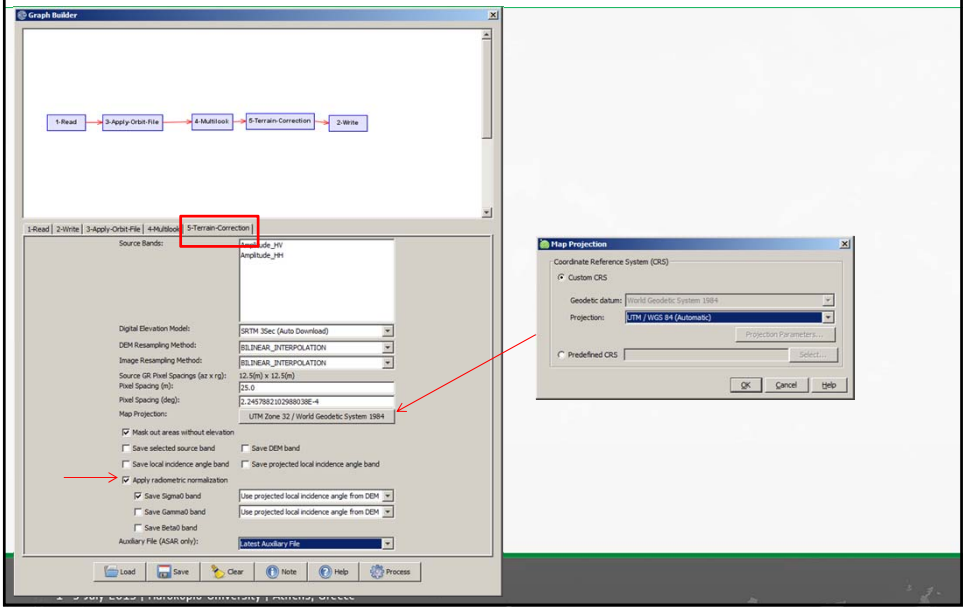
Building the chain for the ASAR : TC



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Radar backscatter: Ellipsoid-normalisation

Conventional Radar Backscatter

- Backscatter coefficients [dB/m^2] are *ratio of scattered to incident power* per unit area:

$$\beta = k \cdot \frac{P_s}{P_i} \qquad \beta^0 = \frac{\beta}{A_\beta} \qquad \sigma_E^0 = \frac{\beta}{\underline{A}_\sigma} \qquad \gamma_E^0 = \frac{\beta}{\underline{A}_\gamma}$$

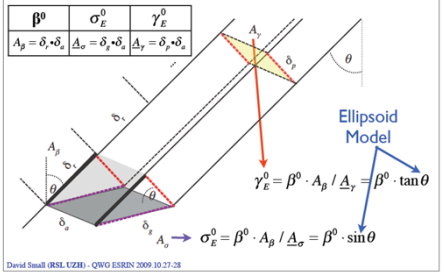
- Known: transmitted & received power P_t & P_r
- Derive: incident & scattered power P_i & P_s from P_t & P_r

$$\beta^0 = k \cdot \frac{f_2(P_r)}{f_1(P_t)} \cdot \frac{1}{A_\beta} \qquad \sigma_E^0 = k \cdot \frac{f_2(P_r)}{f_1(P_t)} \cdot \frac{1}{\underline{A}_\sigma} \qquad \gamma_E^0 = k \cdot \frac{f_2(P_r)}{f_1(P_t)} \cdot \frac{1}{\underline{A}_\gamma}$$

David Small (RSL UZH) - QWG ESRIN 2009.10.27-28

Ground Illuminated Area

β^0	σ_E^0	γ_E^0
$A_\beta = \delta_r \cdot \delta_a$	$\underline{A}_\sigma = \delta_g \cdot \delta_a$	$\underline{A}_\gamma = \delta_g \cdot \delta_r$



David Small (RSL UZH) - QWG ESRIN 2009.10.27-28

Ellipsoid-normalisation

ASAR: Calibrated sigma nought for detected products can be derived as:

$$\sigma^0_{i,j} = \frac{DN^2_{i,j}}{K} \sin\left(\alpha_{i,j}\right)$$

β^0

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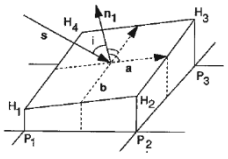
Radar backscatter: slope-normalisation

Normalisation for local variation of scattering area: $\sigma^0_{Norm} = \sigma^0_{Ellipsoid} * \frac{\sin\theta_{DEM}}{\sin\theta_{Ell.}}$ Kellndorfer et al., TGRS, Sept. 1998.

θ_{DEM}

Local incidence angle projected into the range plane

Local incidence angle



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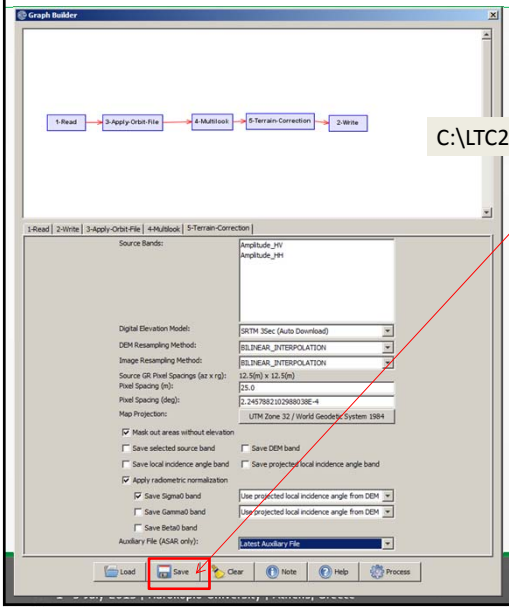
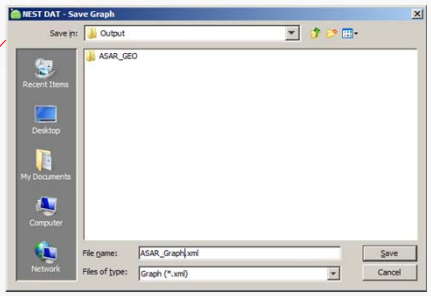
Building the chain for the ASAR



C:\LTC2013\Practical\D4P3a_Forest&Agric\Output



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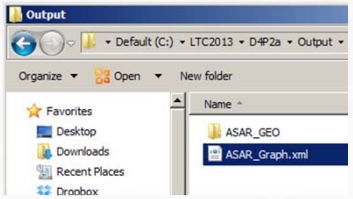
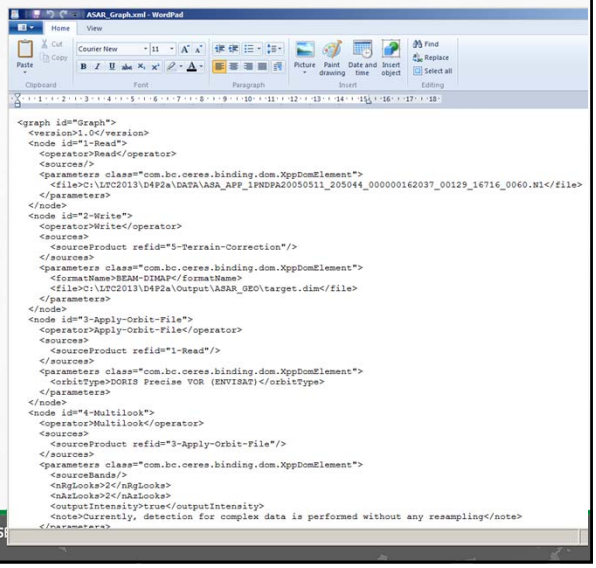
Building the chain for the ASAR





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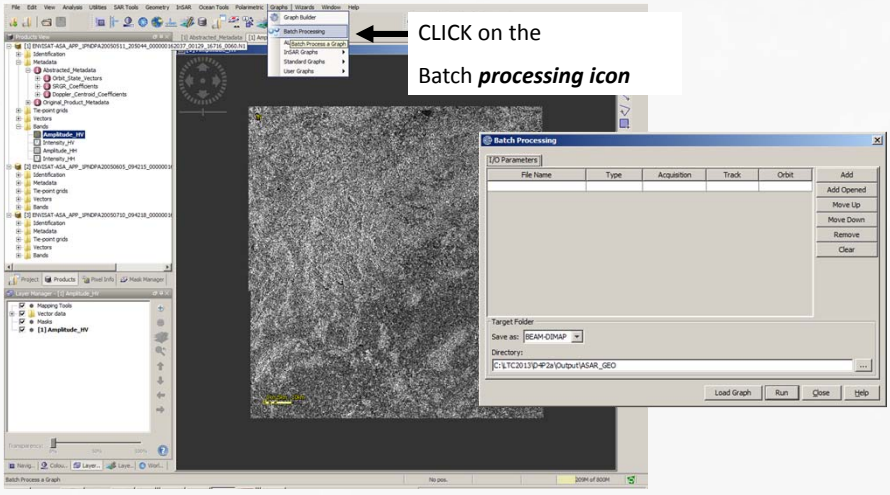
The Batch processing



CLICK on the

Batch ***processing icon***

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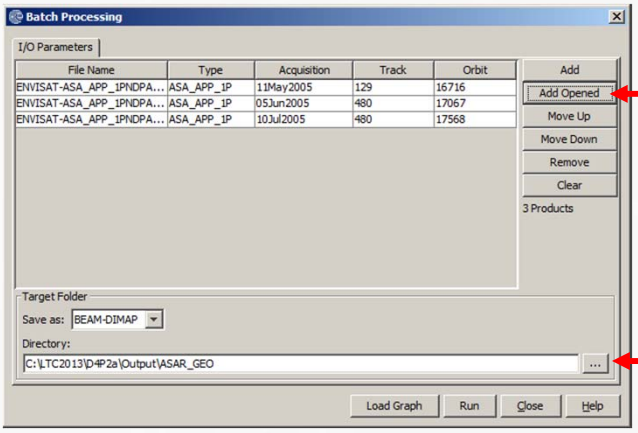
The Batch processing



CLICK on

Add Opened

Select Output directory

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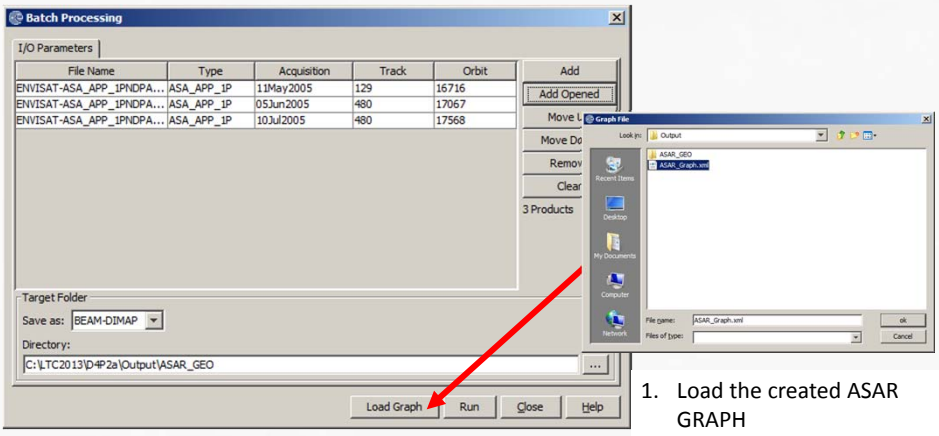
The Batch processing



1. Load the created ASAR GRAPH
2. Start the batch processing
   → ***Click RUN***

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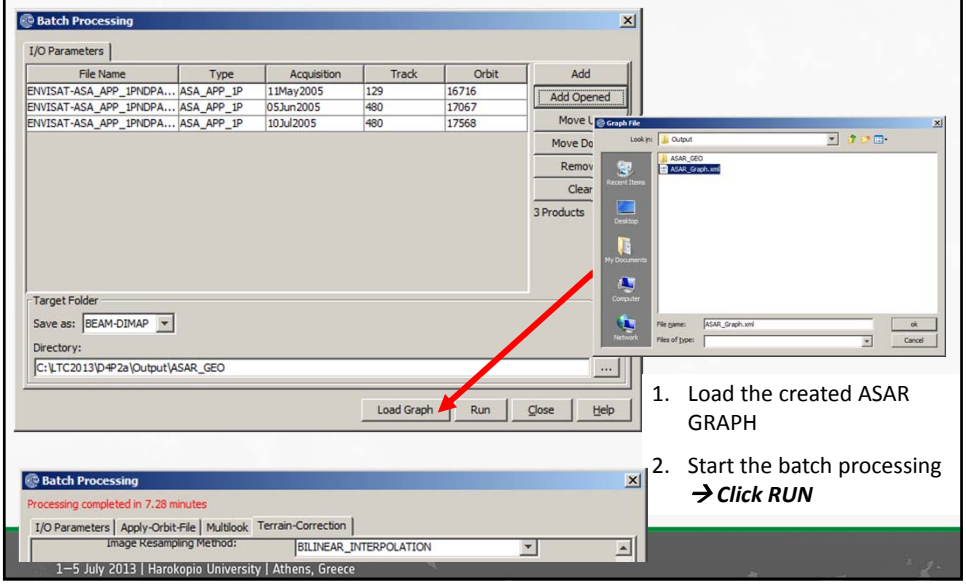
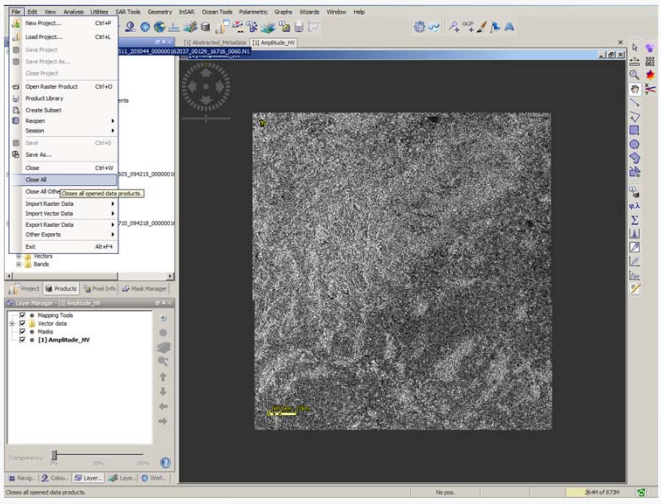
The Batch processing



1. Load the created ASAR GRAPH
2. Start the batch processing
   → ***Click RUN***

Open the GEOCODED ASAR dataset



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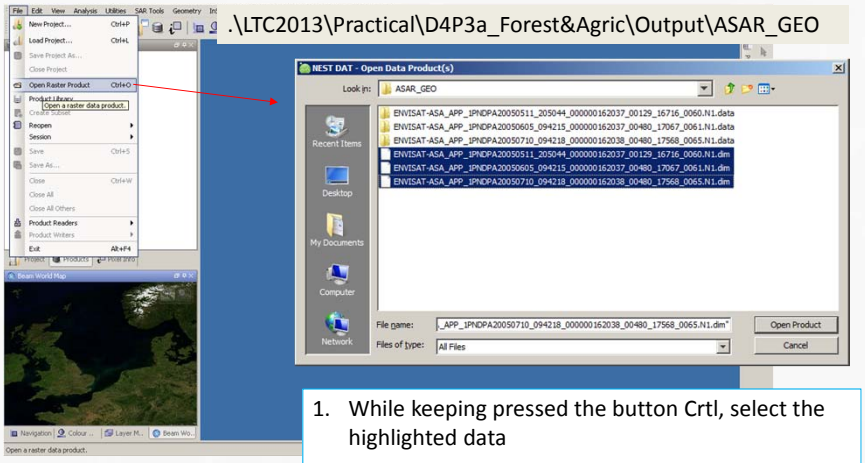
Open the GEOCODED ASAR dataset



1. While keeping pressed the button Crtl, select the highlighted data
2. then click to **Open Product**

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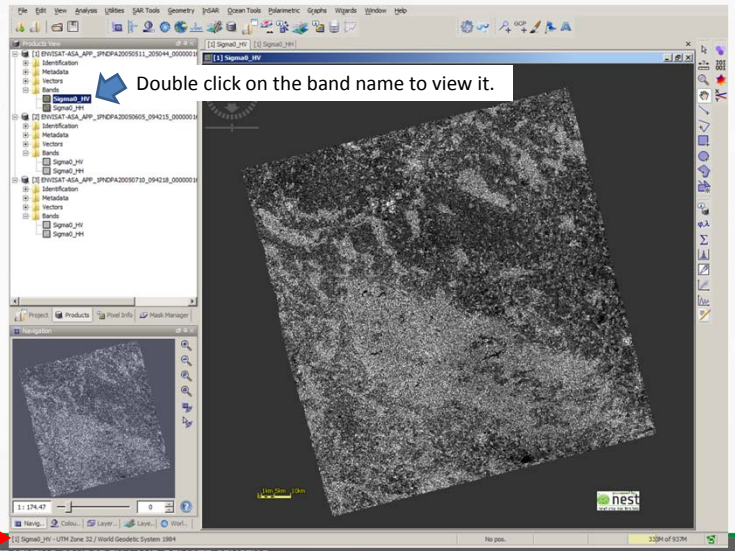
Open the GEOCODED ASAR dataset



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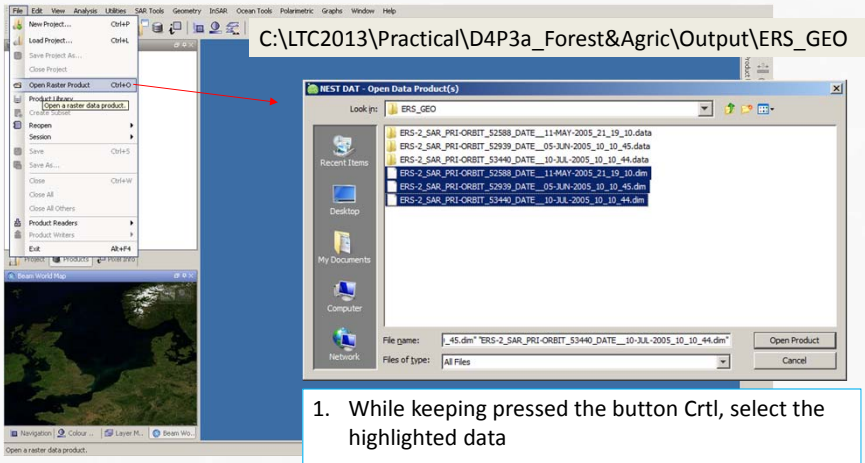
Open the ERS geocoded data (pre-computed)



1. While keeping pressed the button Crtl, select the highlighted data
2. then click to **Open Product**

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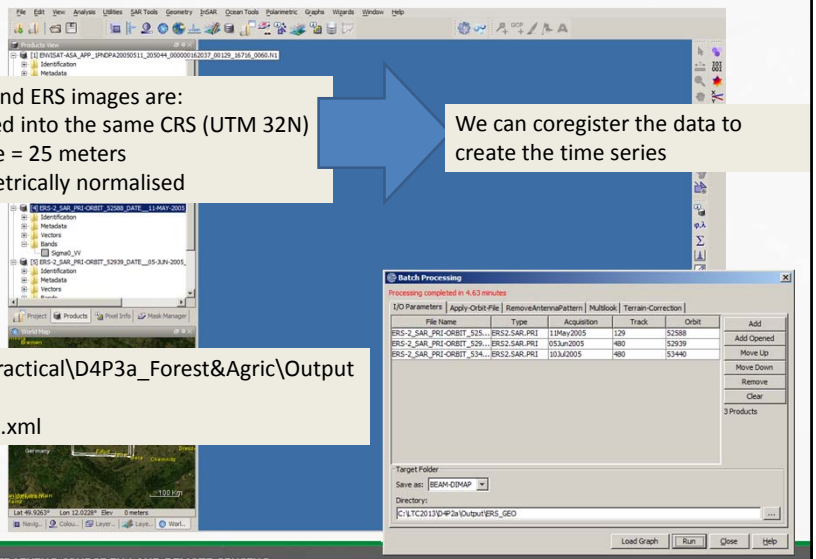
Open the ERS geocoded data (pre-computed)



The ASAR and ERS images are:

- geocoded into the same CRS (UTM 32N)
- Pixel size = 25 meters
- Radiometrically normalised

We can coregister the data to create the time series

C:\LTC2013\Practical\D4P3a_Forest&Agric\Output

→ ERS_Graph.xml

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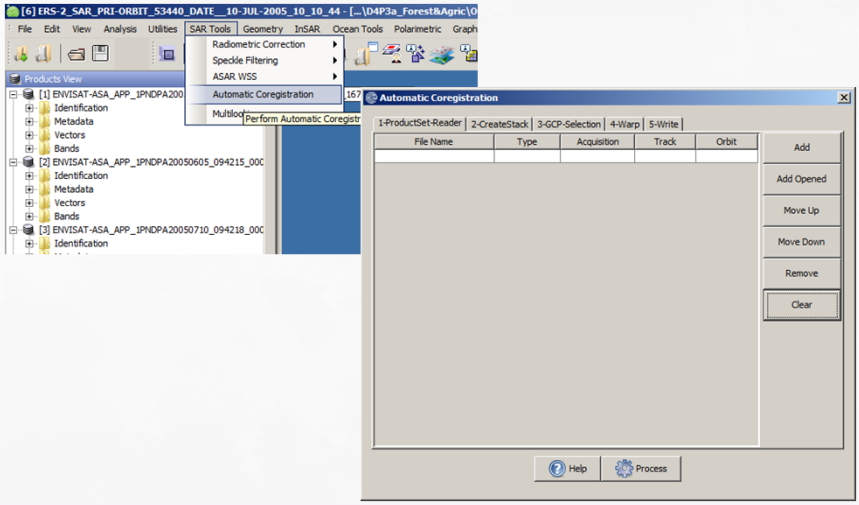
Coregistration of ASAR and ERS geocoded data



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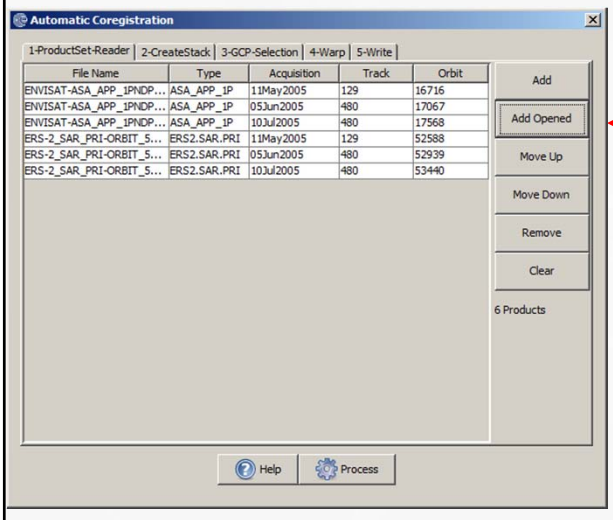
Coregistration of ASAR and ERS geocoded data



CLICK on

Add Opened

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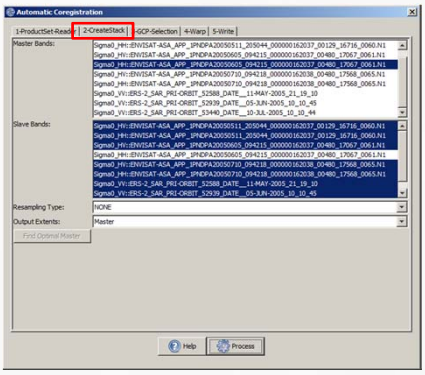
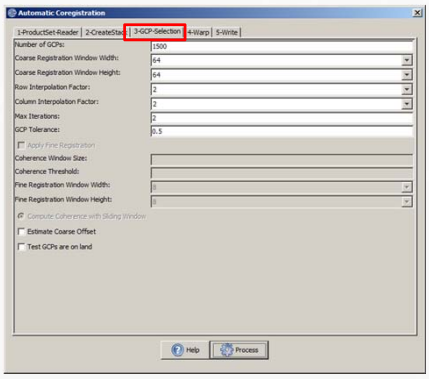
Coregistration of ASAR and ERS geocoded data

Select as a Master: HH - 05062005





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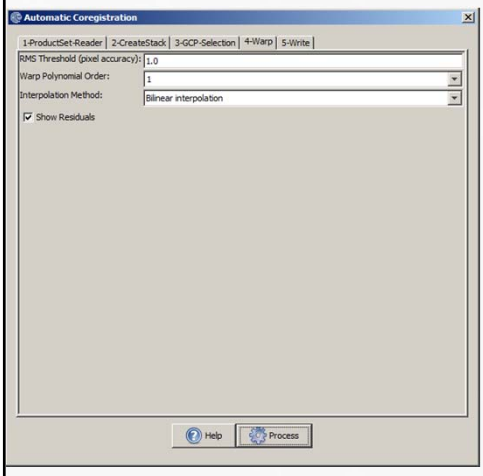
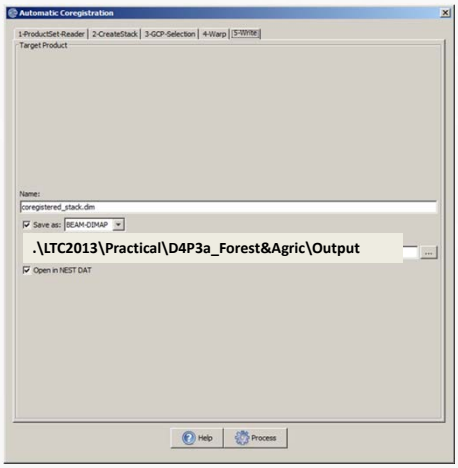
Coregistration of ASAR and ERS geocoded data





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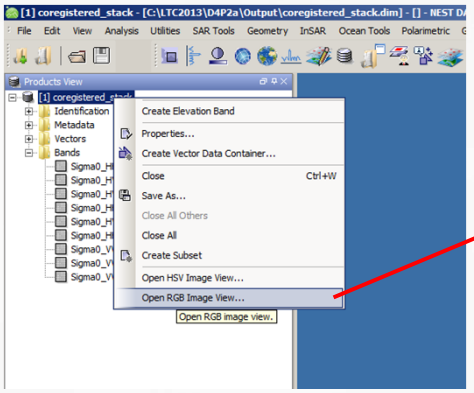
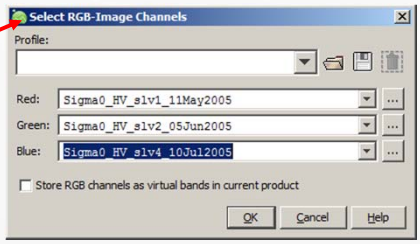
RGB visualisation: HV polarisation (ASAR)



1. Mouse right click over the name of the product
2. Click *Open RGB Image View*
3. Select the dates/bands
4. Click OK



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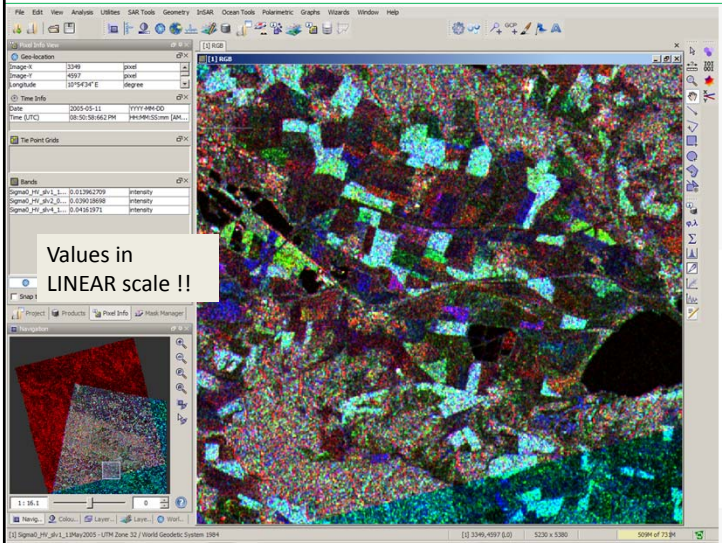
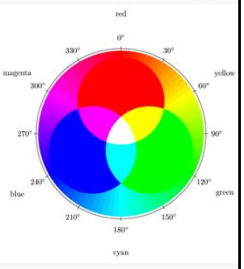
RGB visualisation: HV polarisation (ASAR)





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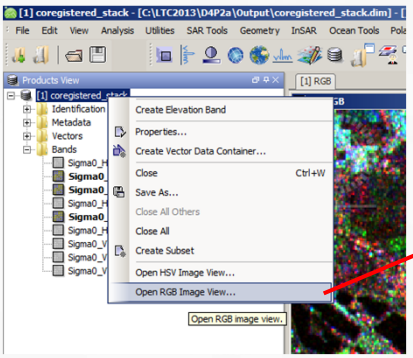
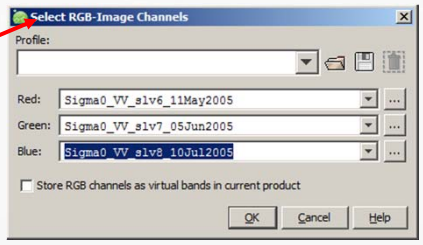
RGB visualisation: VV polarisation (ERS)



1. Mouse right click over the name of the product
2. Click *Open RGB Image View*
3. Select the dates/bands
4. Click OK



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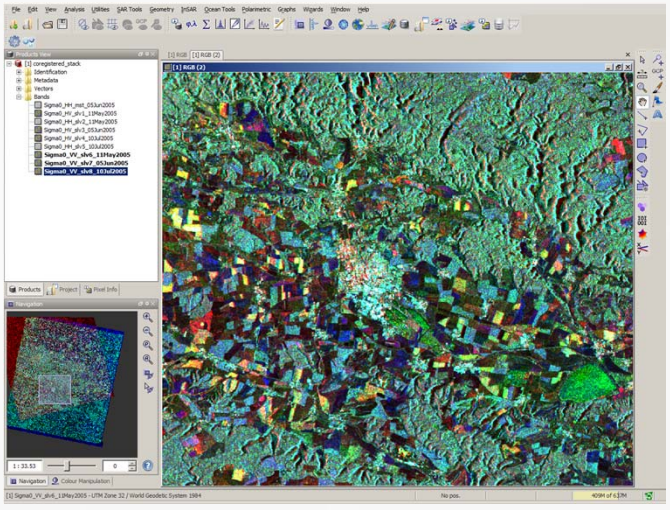
RGB visualisation: VV polarisation (ERS)



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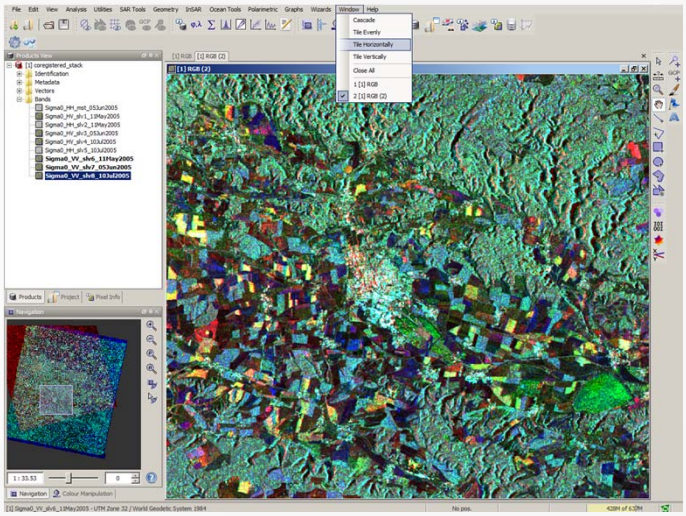
esa

RGB visualisation: ASAR HV vs ERS VV



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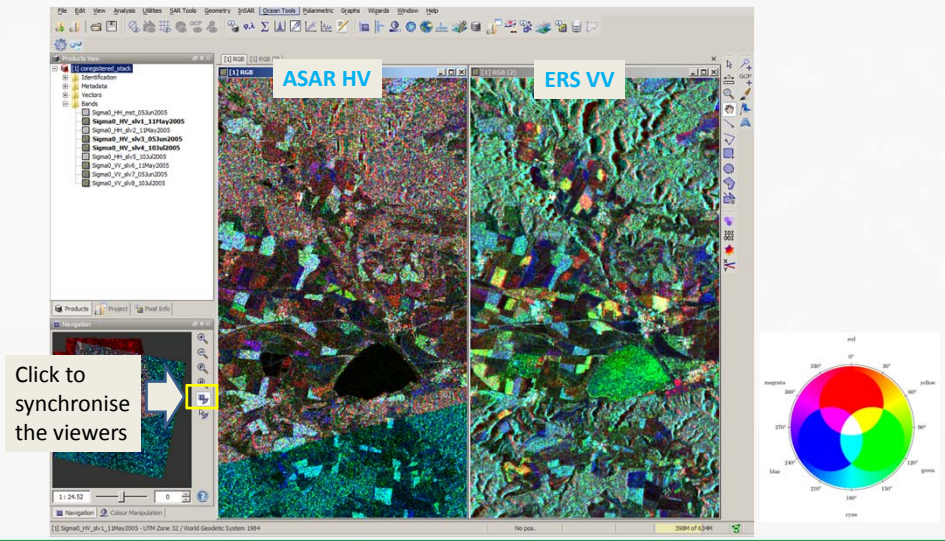
esa

RGB visualisation: ASAR HV vs ERS VV



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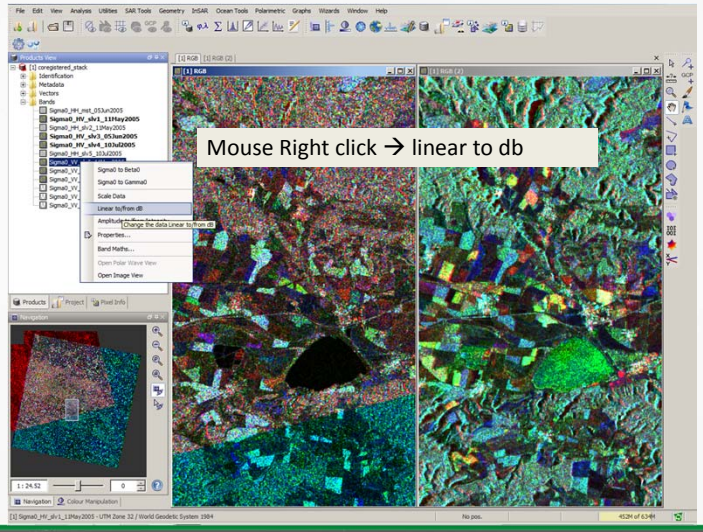
RGB visualisation (db): ERS VV



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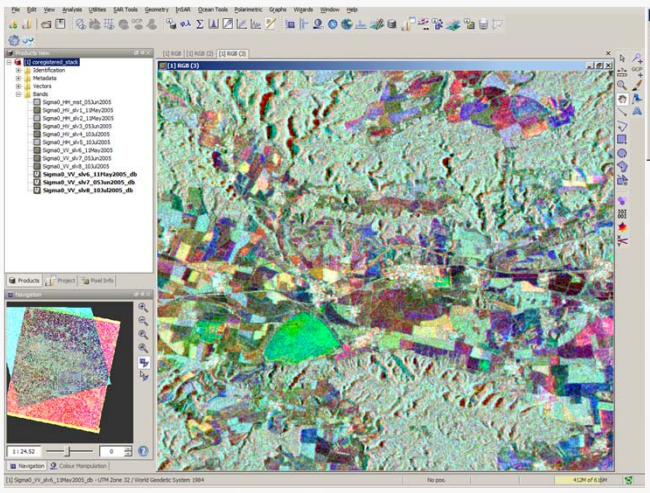
RGB visualisation (db): ERS VV



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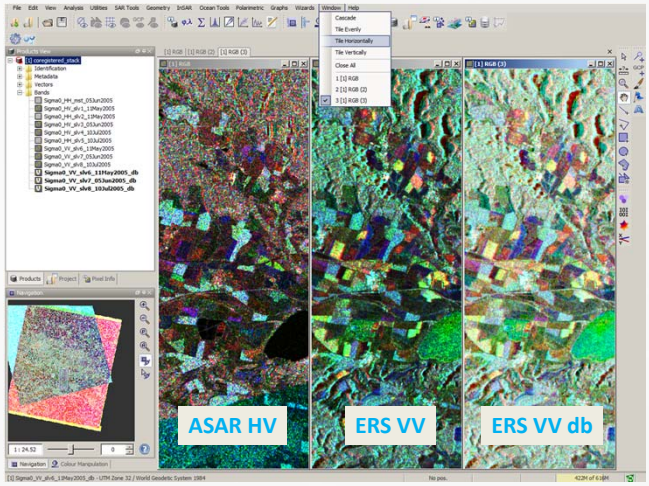
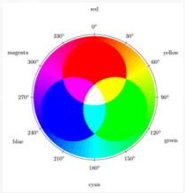
RGB visualisation (db): ERS VV





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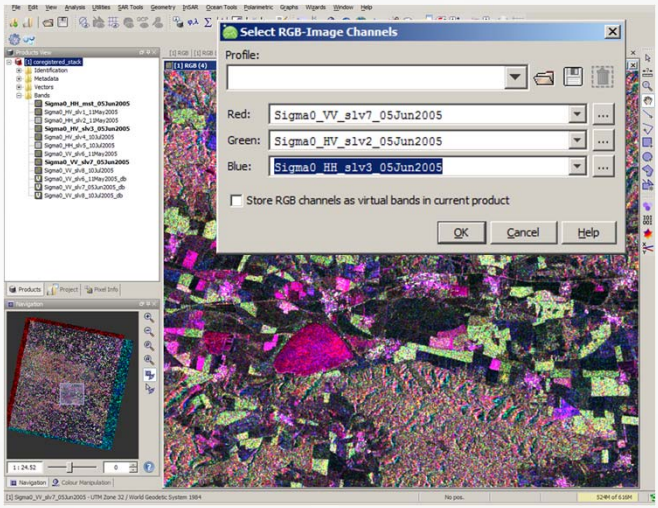
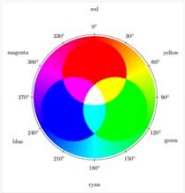
05-06-2005 RGB visualisation: ERS VV – ASAR HV – ASAR HH



Red – ERS VV

Green – ASAR HV

Blue – ASAR HH



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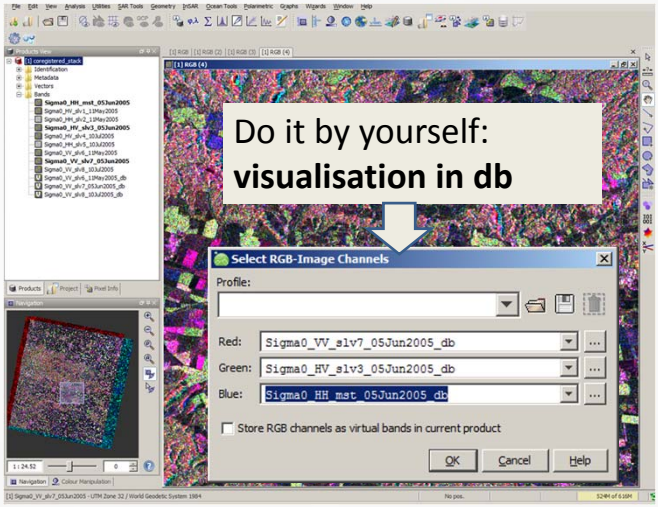
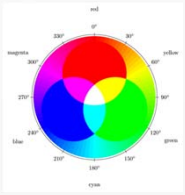
05-06-2005 RGB visualisation: ERS VV – ASAR HV – ASAR HH



Red – ERS VV

Green – ASAR HV

Blue – ASAR HH



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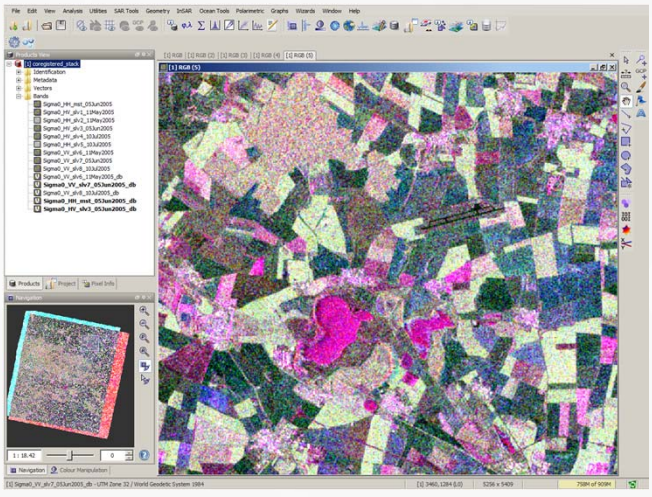
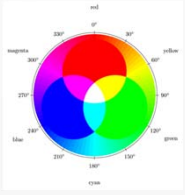
05-06-2005 RGB visualisation (db): ERS VV – ASAR HV – ASAR HH



Red – ERS VV

Green – ASAR HV

Blue – ASAR HH



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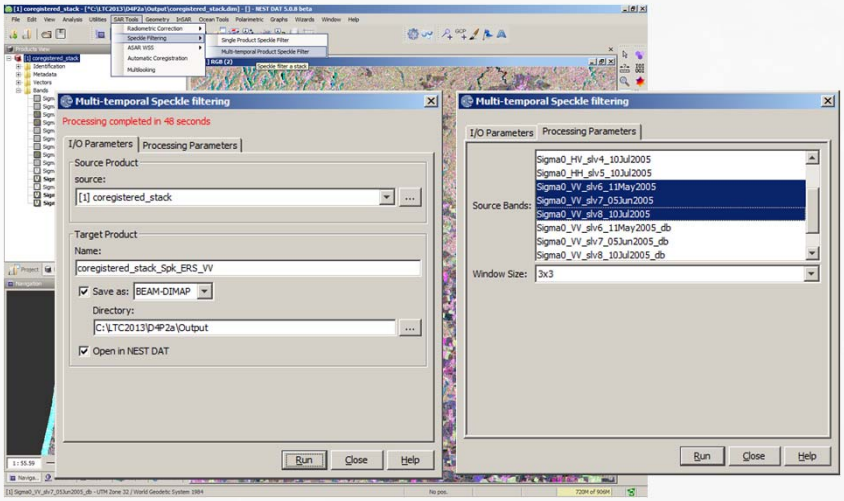
Multitemporal Speckle filtering: ERS-VV



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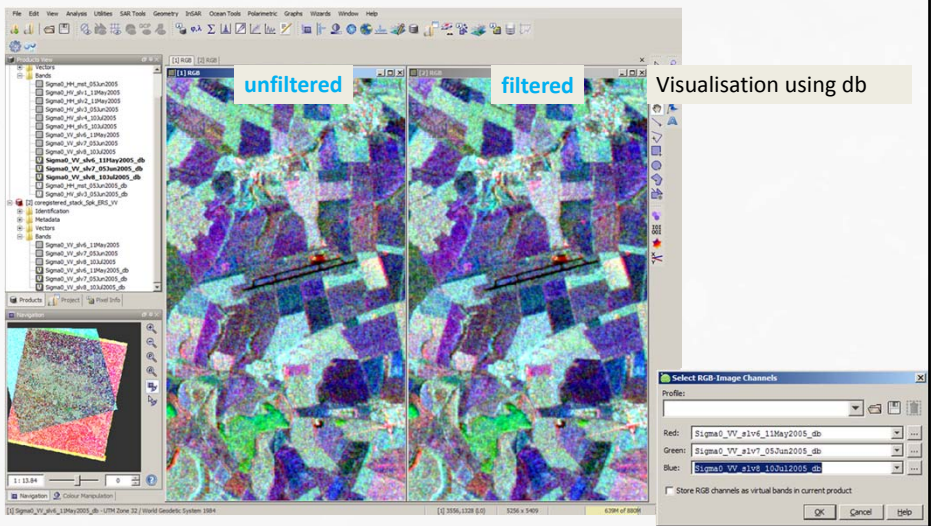
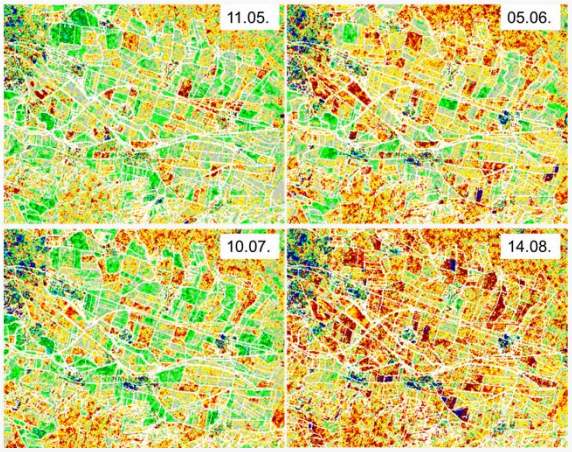
Multitemporal Speckle filtering: unfiltered vs filtered ERS-VV



SAR data interpretation– agriculture: Ratio HH / VV

Ratio HH / VV to monitor the Temporal behaviour of the culture

Example winter wheat field - red (other fields similar):



- < 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 – 0.8
- 0.8 – 1.0
- 1.0 – 1.2
- 1.2 – 1.4
- 1.4 – 1.6
- 1.6 – 1.8
- > 1.8

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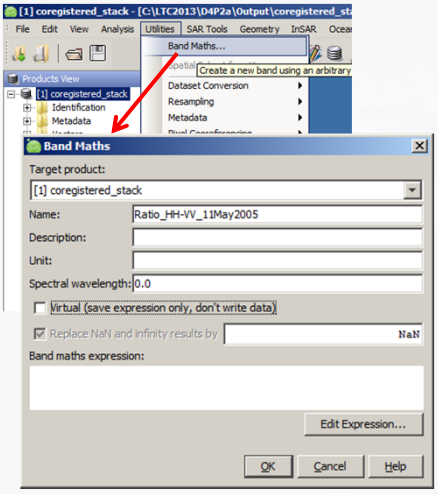
Compute ratio HH / VV (11 May 2005)



1. Utility → Band Maths Op
2. Select Target product: ERS VV
3. Name: write **Ratio_HH-VV_11May2005**
4. Uncheck Virtual option
5. Click to Edit Expression

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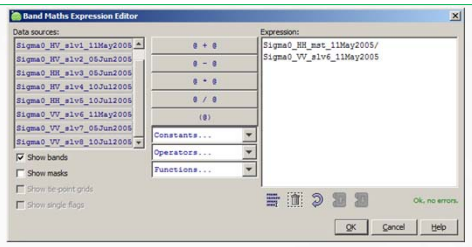
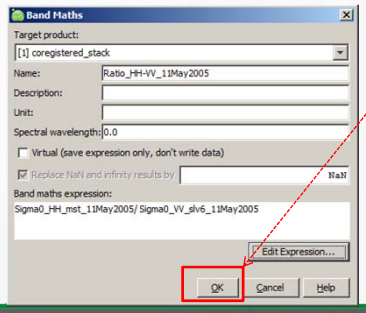
Compute ratio HH / VV (11 May 2005)





6. Write the expression select the bands

7. Click OK

8. Click OK

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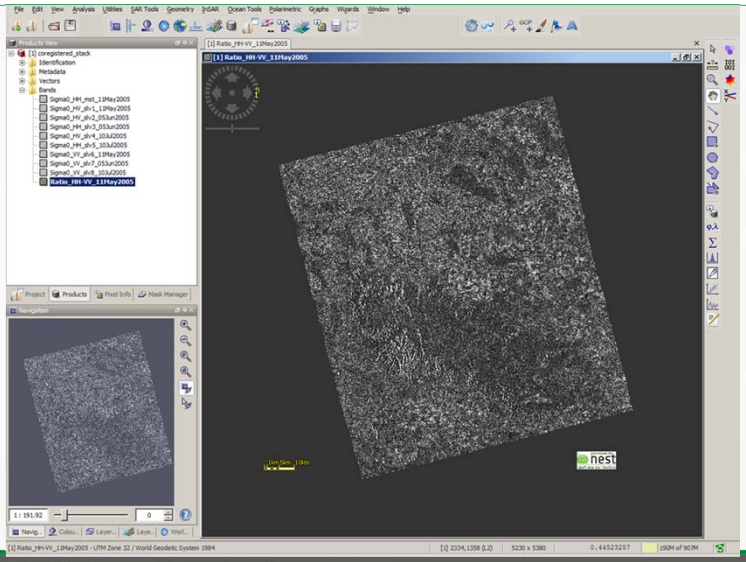
Compute ratio HH / VV (11 May 2005)



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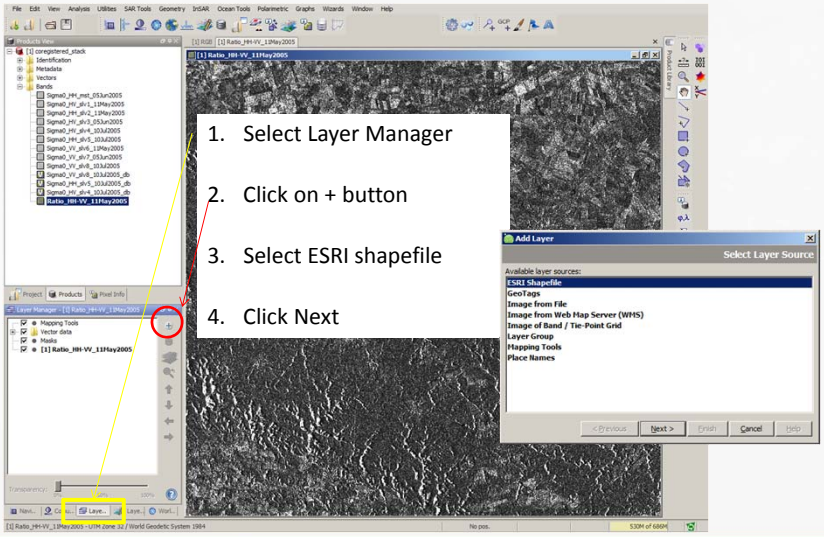
Overlay shape file information



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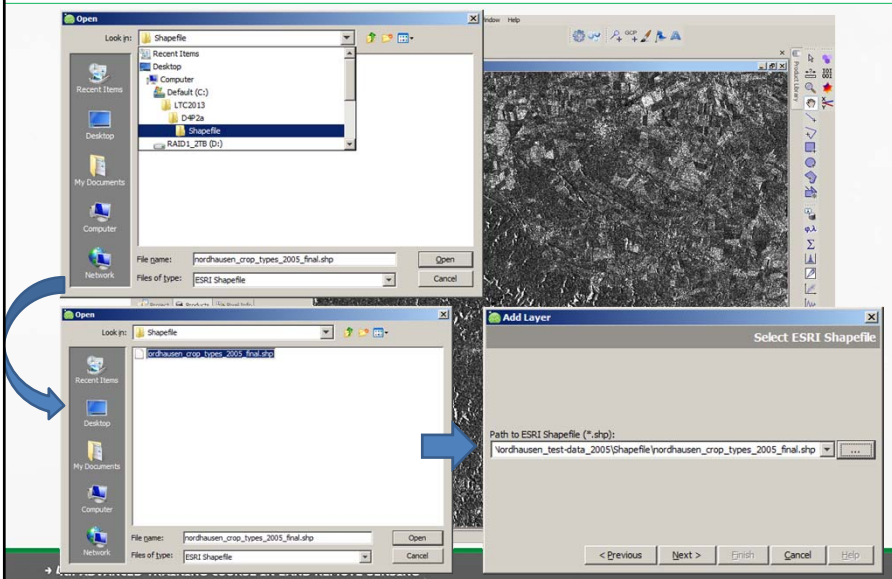
Overlay shape file information



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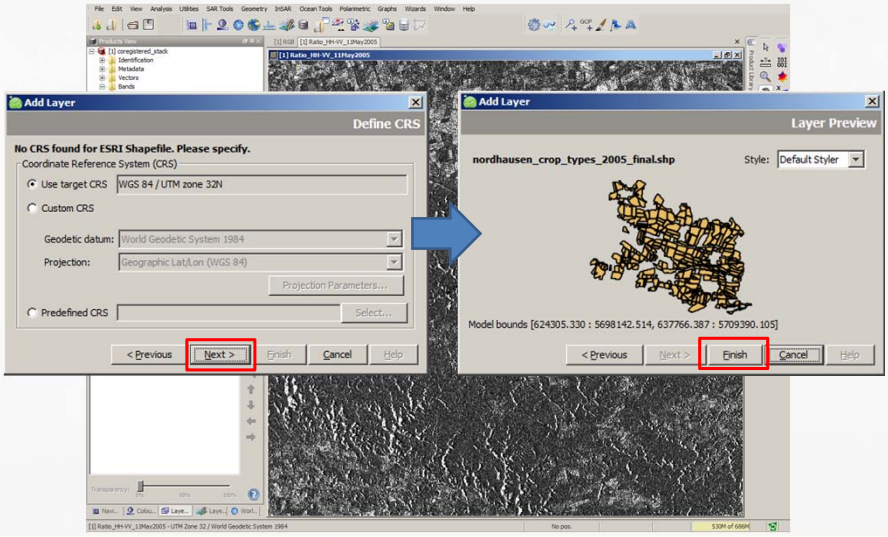
Overlay shape file information



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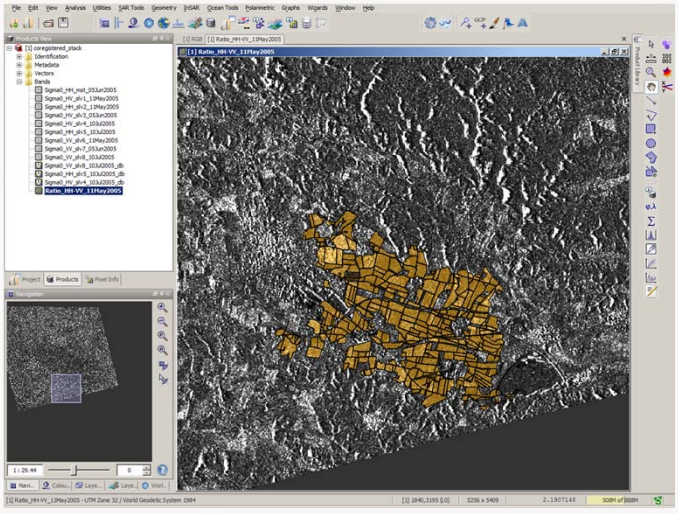
Overlay shape file information



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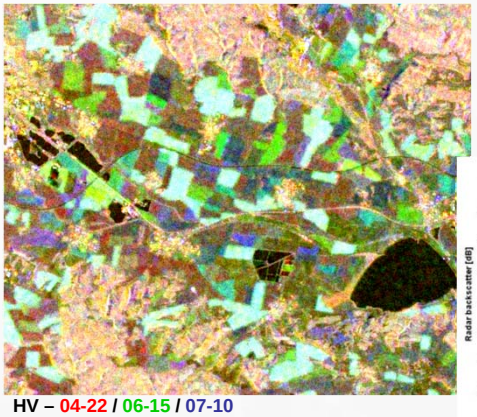
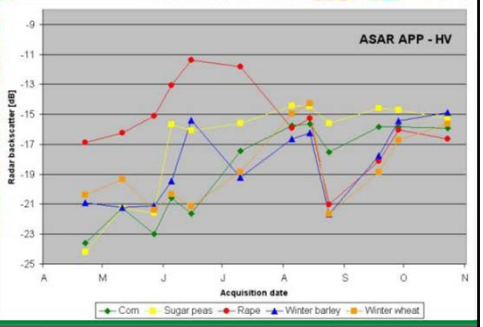
SAR data interpretation– agriculture

Temporal behaviour of Radar backscatter





HV – 04-22 / 06-15 / 07-10

$Mean_{db} = 10*LOG_{10}(Mean_{linear})$

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THANK YOU for your attention!

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