



Forest Monitoring

Topic:

In this tutorial we will use data acquired by the ALOS PALSAR sensor operated by the Japan Aerospace Exploration Agency (JAXA) in the years 2007 and 2010 in order to see man-made changes to a forested area.

ALOS PALSAR data are acquired in L-band at a wavelength of 27 cm. This is a much longer wavelength compared to Sentinel-1 C-band data acquired at 5.5 cm. Therefore ALOS PALSAR

Input Data:

- 4 files = 2 ALOS PALSAR HH-HV pairs acquired at L-band from 2007 and one pair from 2010
 - 2007:
 - S06W056_07_sl_HH_db.tif
 - S06W056_07_sl_HV_db.tif
 - 2010
 - S06W056_10_sl_HH_db.tif
 - S06W056_10_sl_HV_db.tif
- SAR data part of the freely available data set “Global PALSAR-2/PALSAR/JERS-1 Mosaics and Forest/Non-Forest Maps”
- Spatial resolution: 0.8 arc seconds (approx. 25 m at the Equator)

ALOS

- ALOS stands for Advanced Land Observing Satellite
- Operated by JAXA (Japan Aerospace Exploration Agency)

ALOS 1

- launch: 24.01.2006
- end of mission: 12.05.2011 (after a malfunction on 22.04.2011)
- SAR-Sensor PalSAR, operated at L-band (wavelength f 23.62 cm)
- https://www.eorc.jaxa.jp/ALOS/en/alos/a1_about_e.htm

Global PALSAR-2/PALSAR/JERS-1 Mosaics and Forest/Non-Forest Maps are available at:

https://www.eorc.jaxa.jp/ALOS/en/dataset/fnf_e.htm

(free registration required)

Global PALSAR-2/PALSAR/JERS-1 Mosaic and Forest/Non-Forest map

ALOS Home > about PALSAR-2/PALSAR Global Forest / Non-forest Map > Global PALSAR-2/PALSAR/JERS-1 Mosaic and Forest / Non-forest Map

Global PALSAR-2/PALSAR/JERS-1 Mosaic and Forest / Non-forest Map

* These map uses Javascript. Please enable JavaScript on your browser.

25m resolution product

Global

JERS-1 SAR Mosaic:

> 1996

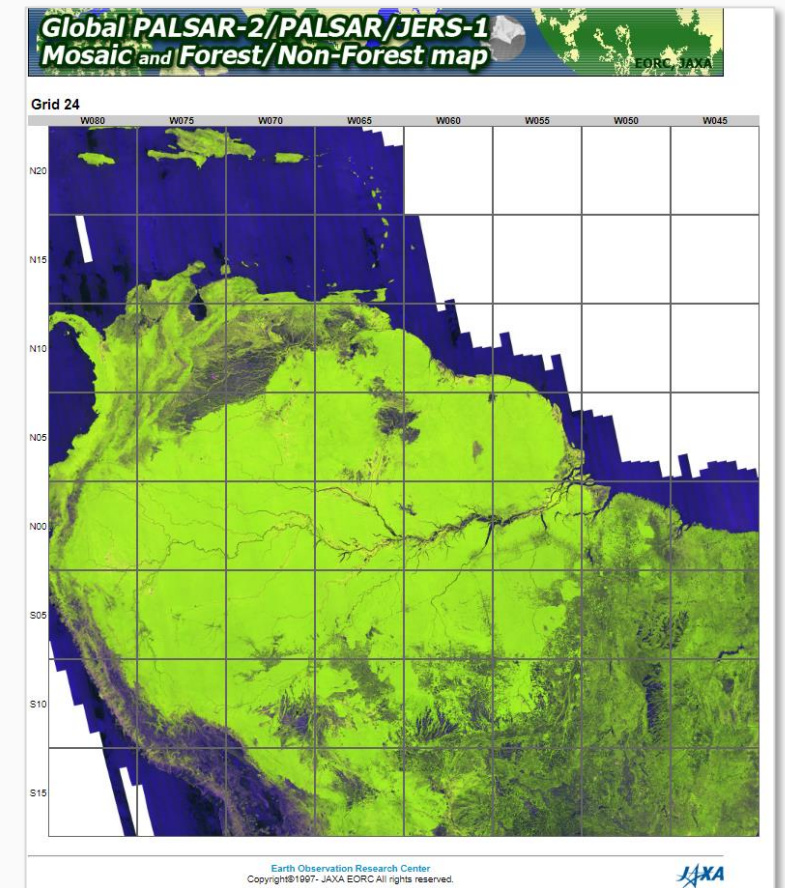
PALSAR/PALSAR-2 mosaic and forest/non-forest (FNF) map:

> 2007 > 2008 > 2009 > 2010 > 2015
 > 2016 > 2017 > 2018 > 2019 > 2020
 > 2021

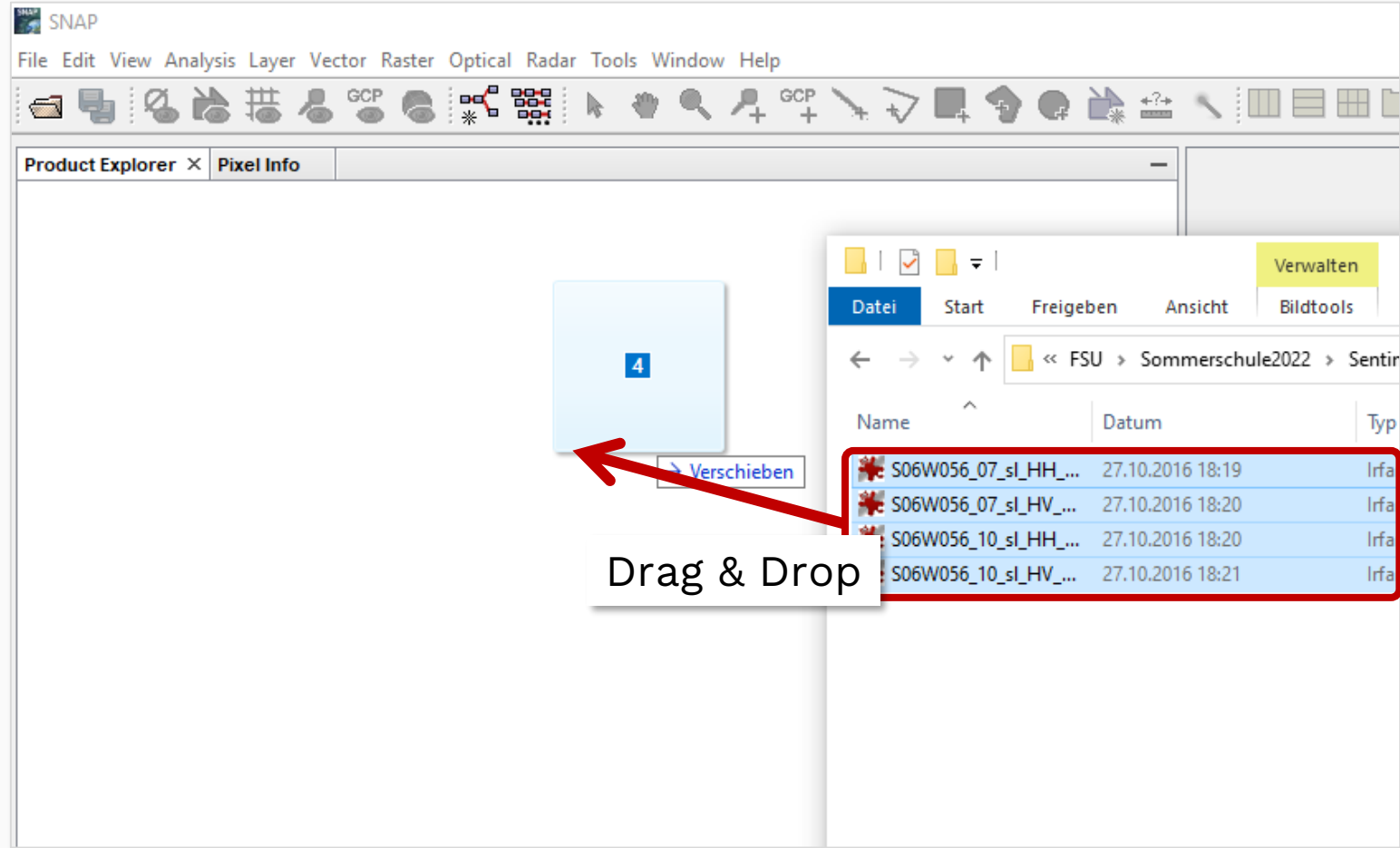
Tropical region (Amazon, Africa, and SE-Asia)

JERS-1 SAR Mosaic:

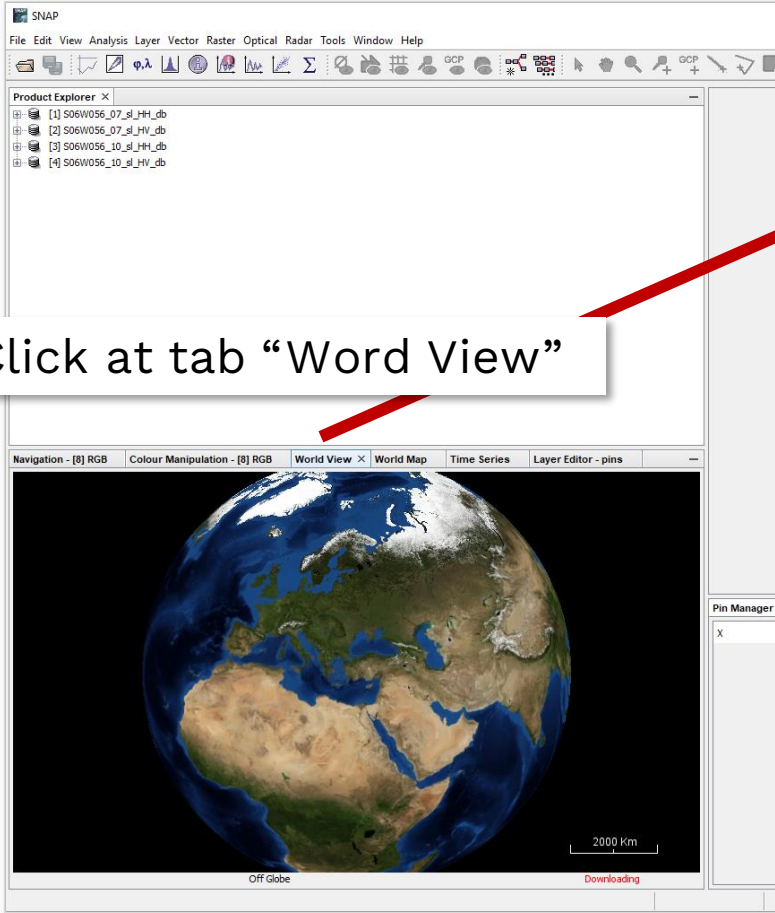
> 1993 > 1994 > 1995 > 1996 > 1997
 > 1998



Load data



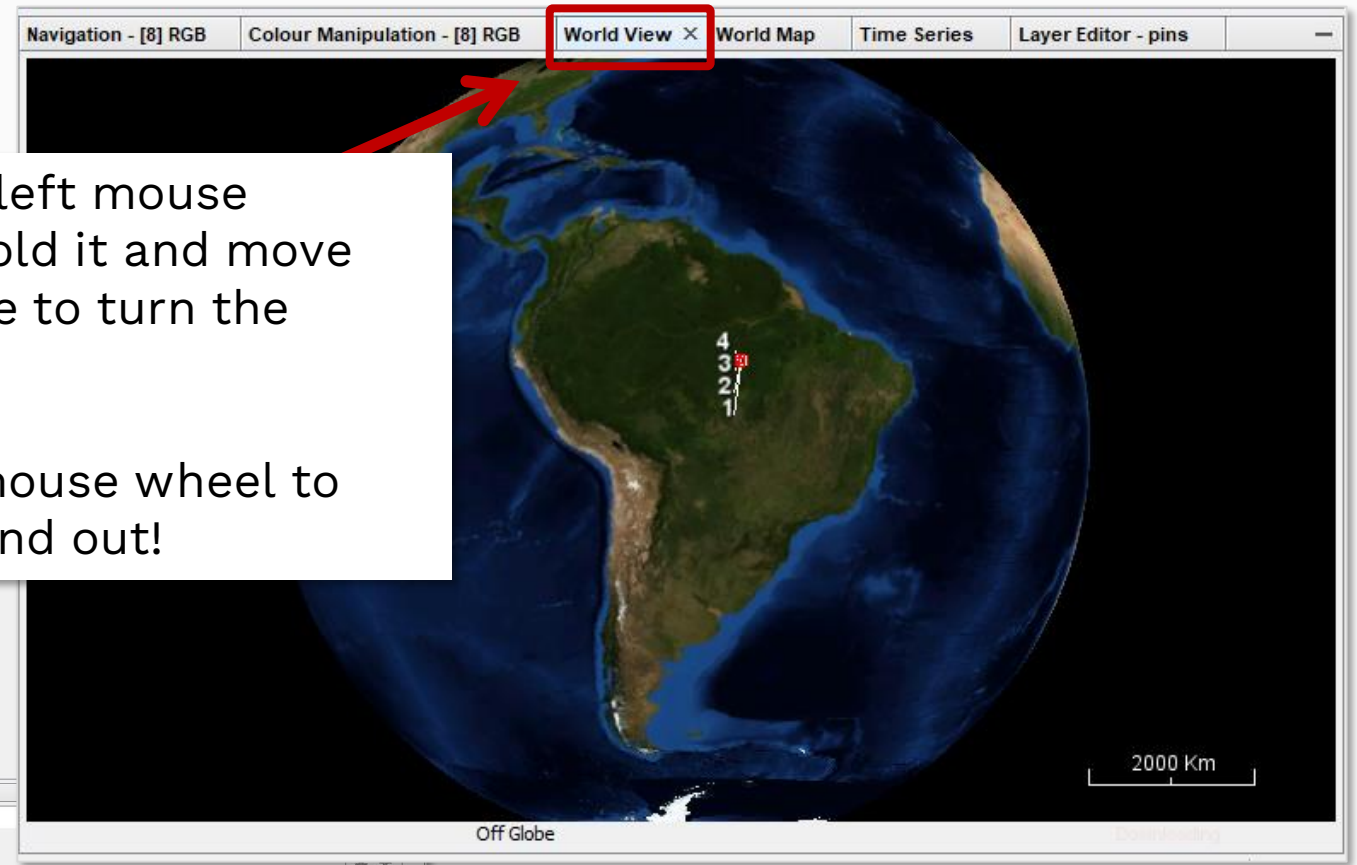
Locate the data



Click at tab "World View"

Click the left mouse button, hold it and move the mouse to turn the globe!

Use the mouse wheel to zoom in and out!



View image bands

Single left mouse click opens the node.

Product Explorer

- [1] S06W056_07_sl_HH_db
 - Metadata
 - Vector Data
 - Bands
 - band_1
- [2] S06W056_07_sl_HV_db
- [3] S06W056_10_sl_HH_db
- [4] S06W056_10_sl_HV_db

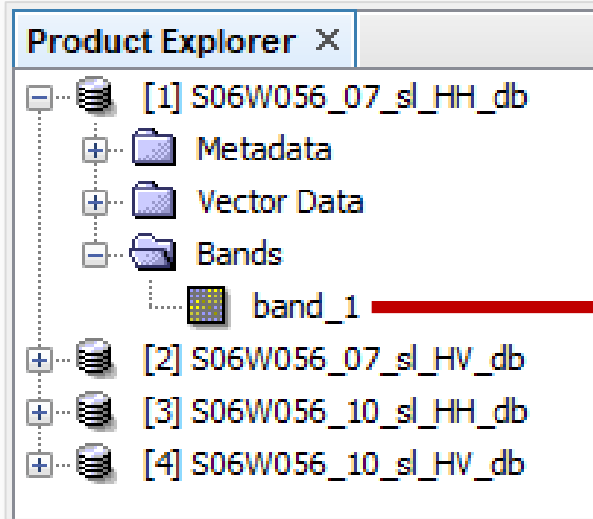
Navigation - [8] RGB Colour Manipulation - [8] RGB World View × World Map Time Series Layer Editor - pins

Off Globe Downloading

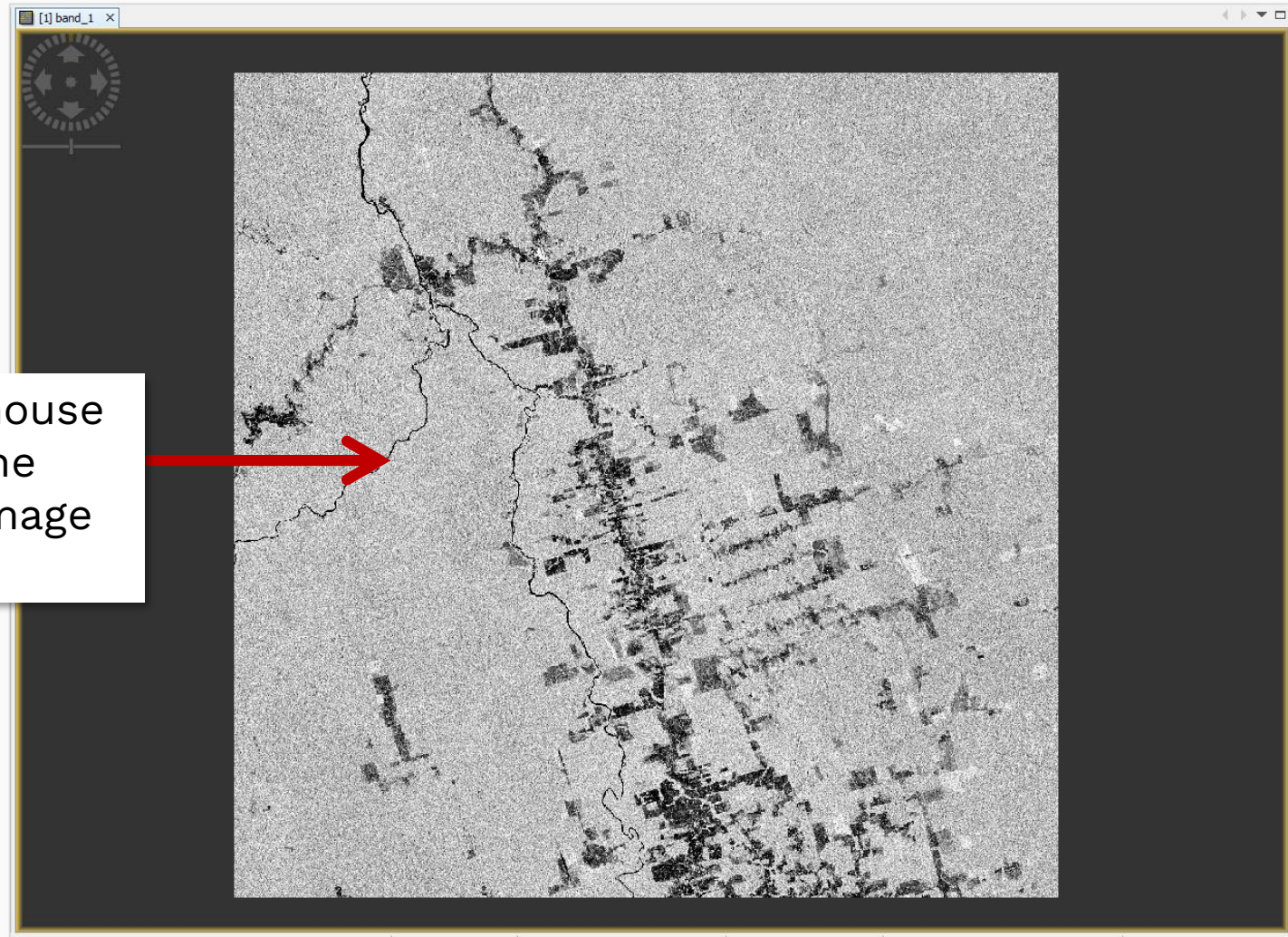
Pin Manager ×

| X | Y | Lon | Lat | Color | Label |
|---|---|-----|-----|-------|-------|
| | | | | | |

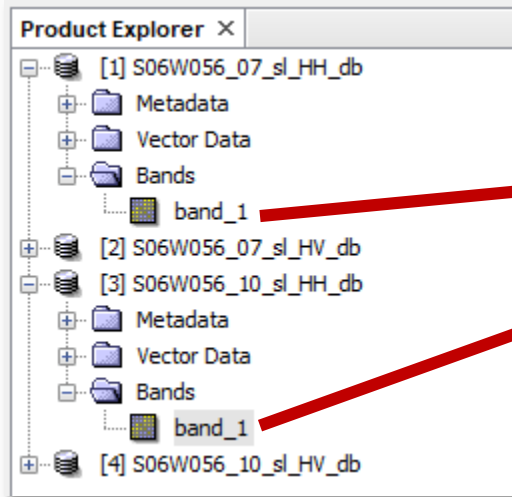
View image bands



Double left mouse click opens the band in the image viewer.

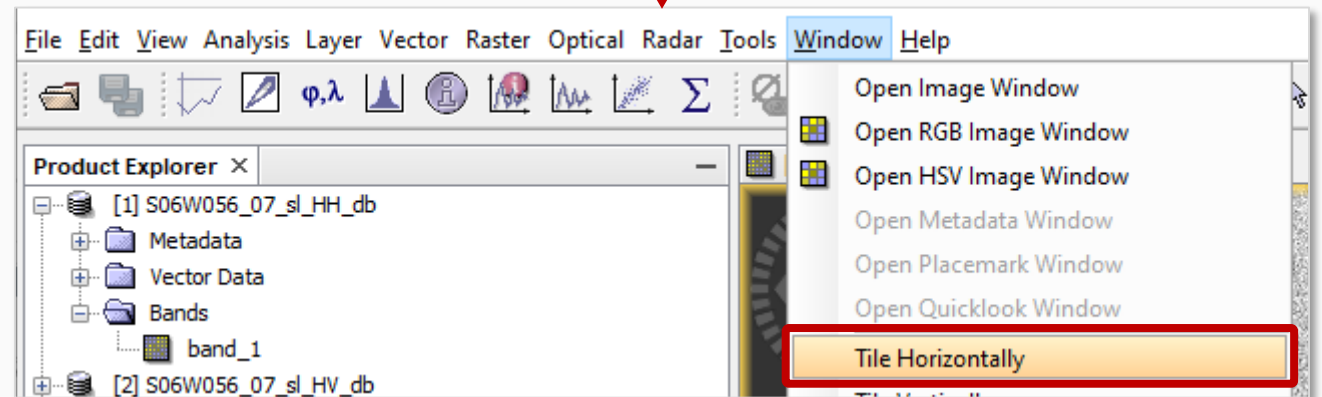


View image bands

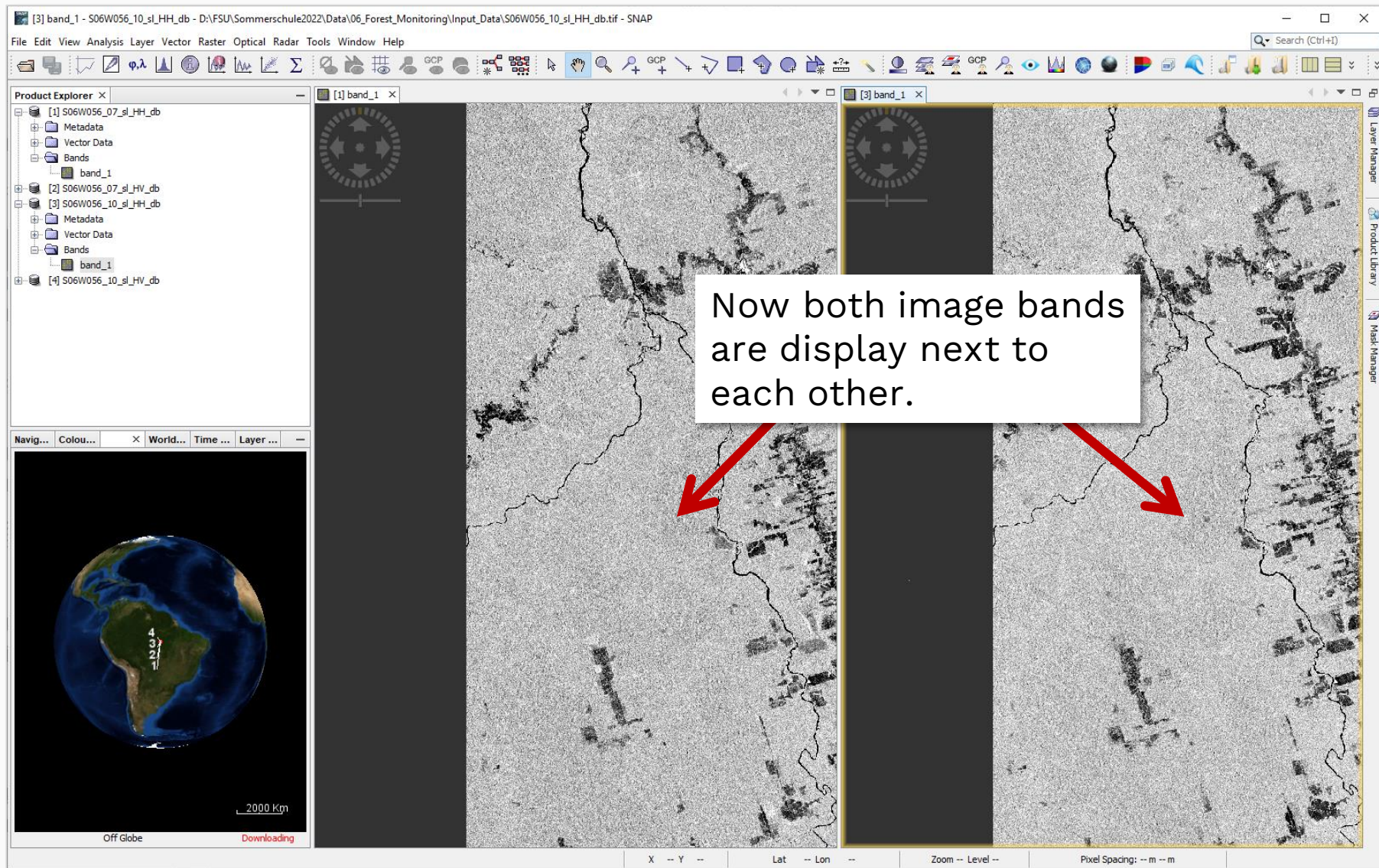


Double left mouse click opens the band in the image viewer. Do this for the HH data from 2007 and 2010!

From the menu, select “Window” -> “Tile Horizontally”!



View image bands



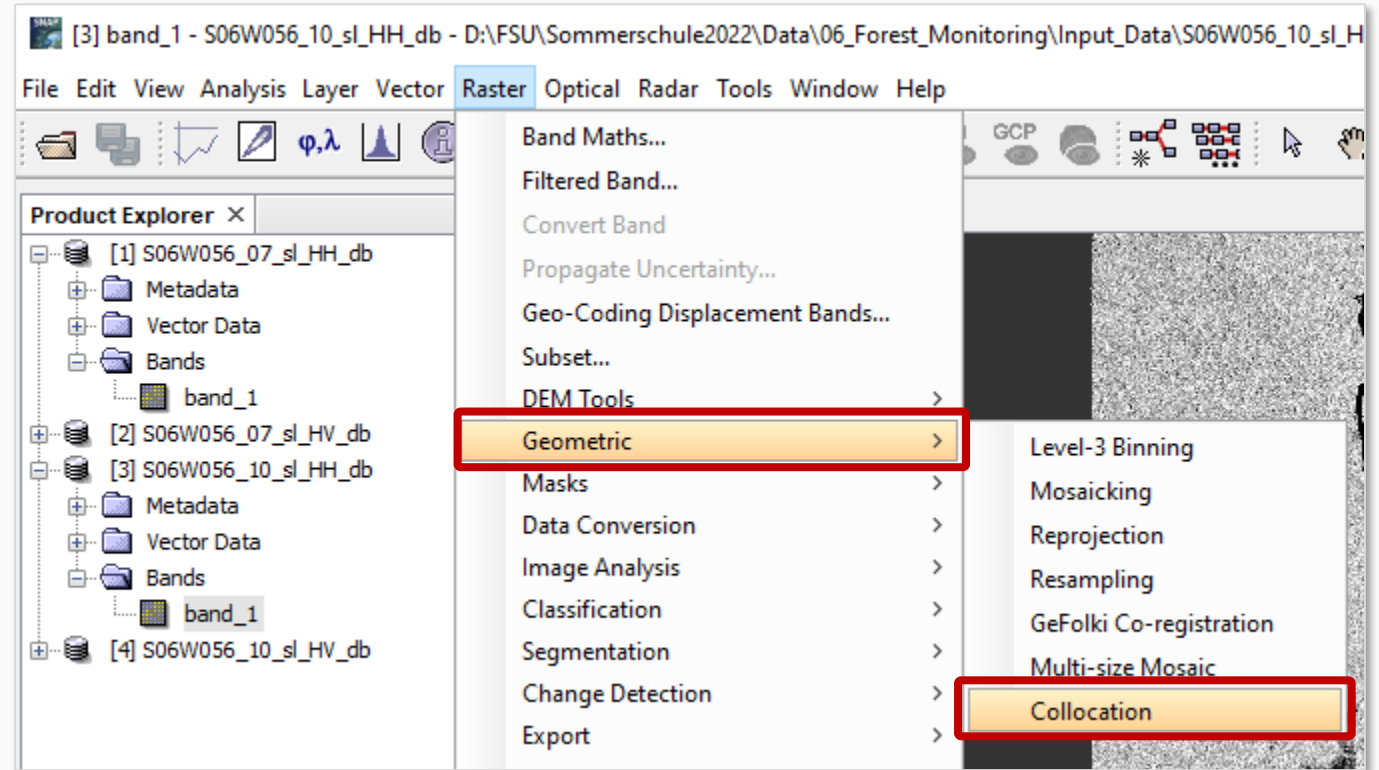
View image bands

The screenshot displays the SNAP (Scientific Data Processing) software interface. The main window shows a grayscale satellite image of a forested area. A red arrow points to the 'Hand' icon in the toolbar, which is used for navigating the image. The interface includes a 'Product Explorer' on the left, a 'Layer Manager' on the right, and a 'Mask Manager' at the bottom right. The toolbar contains various icons for file operations, analysis, and navigation. A text box in the foreground provides instructions on how to use the 'Hand' icon.

Select the “Hand” icon from the toolbar. Click into the image, hold down the left mouse button and move the mouse back and forth to move the image content! Use the mouse wheel to zoom in and out!

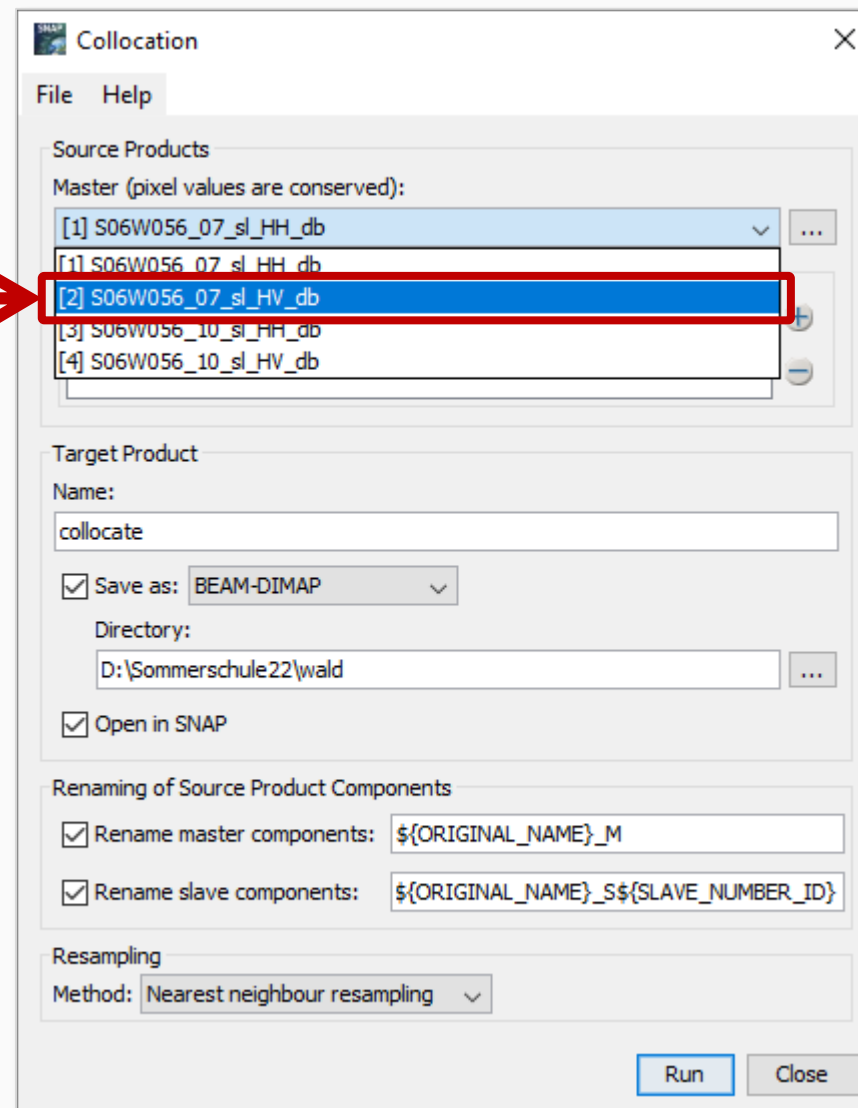
Create Layer Stack

From the menu, select
 “Raster” -> “Geometric” ->
 “Collocation”!



Create Layer Stack

In the drop down menu, select the HV data from 2007!



Create Layer Stack

Collocation

File Help

Source Products

Master (pixel values are conserved):

[1] S06W056_07_sl_HH_db

Slave Products

+

-

Target Product

Name:

collocate

Save as: BEAM-DIMAP

Directory:

D:\Sommersd...

Open in SNAP

Renaming of Source Products

Rename master

Rename slave

Resampling

Method: Nearest

Run Close

Add product(s)...

- Add product file(s)...
- Add directory(s)...
- Add directory recursively...

Add product

- [1] S06W056_07_sl_HH_db
- [2] S06W056_07_sl_HV_db
- [3] S06W056_10_sl_HH_db
- [4] S06W056_10_sl_HV_db

Select all Select none

OK Cancel

As slave product, the HH data from 2007!

Create Layer Stack

Specify the output name as “S06W056_07_sl_HV_HH_db”!

Specify the output directory!

Specify the master components name as “\${ORIGINAL_NAME}_HV”!

Specify the master components name as “\${ORIGINAL_NAME}_HV”!

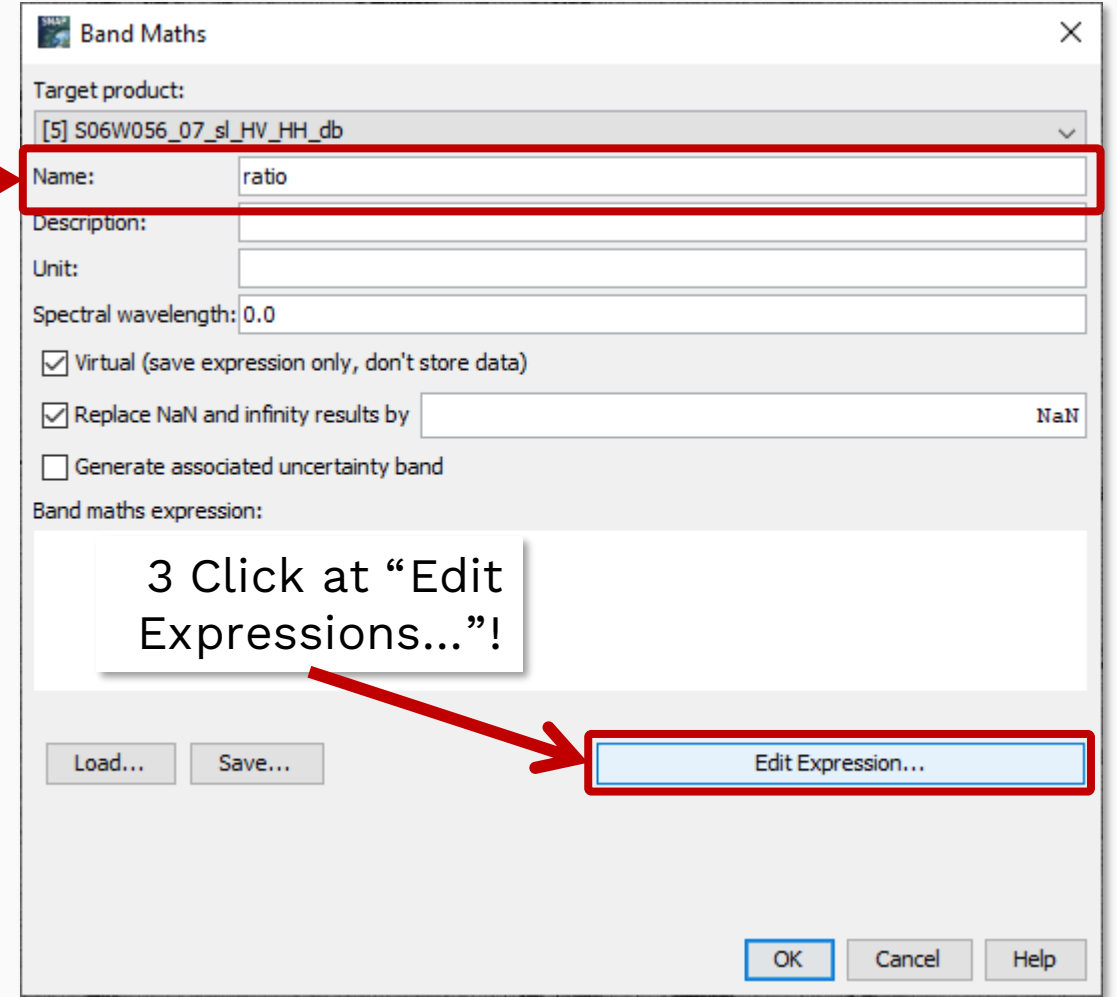
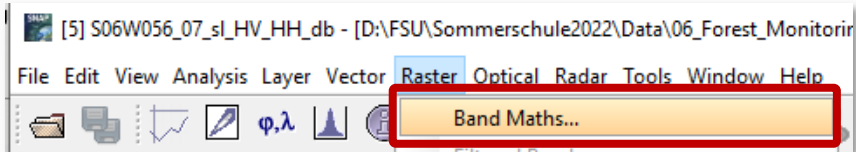
Click “Run”!

Result: Layer Stack with two layers:

Calculate Polarization Ratio

2) Specify the output name as "ratio"!

1) From the menu, select "Raster" -> "Band Maths..."



Calculate Polarization Ratio

Product: [5] S06W056_07_sl_HV_HH_db

Data sources:

- \$5.band_1_HV
- \$5.band_1_HH
- \$5.collocationFlags

Expression: $\$5.band_1_HH - \$5.band_1_HV$

Enter the formula to calculate the polarization ratio of HH and VV!

Please remember: Pixel values are given in dB, which means they are in the logarithmic domain!

Therefore you have to subtract HV from HH!

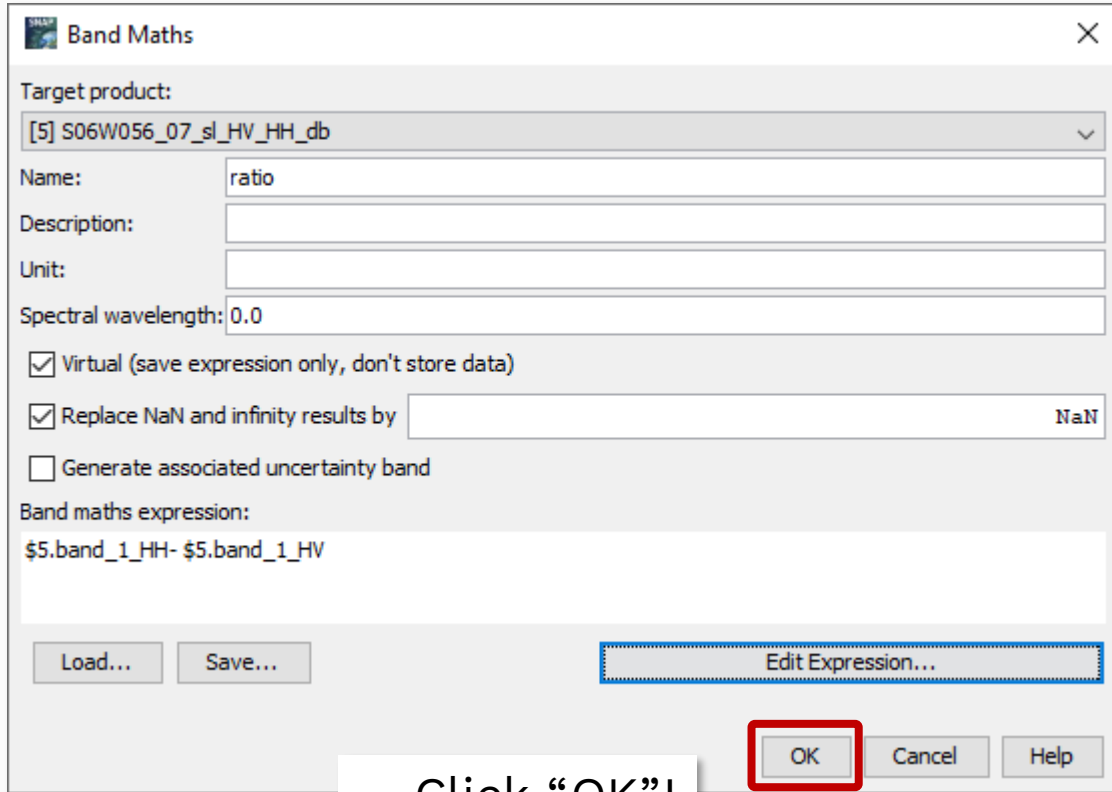
Click "OK"!



Attention! Remember the calculation rules for logarithmic values!

| Linear Values | | Logarithmic Values |
|---|---|--------------------------------------|
| multiplication $\log_a(u \cdot v)$ | → | addition $\log_a u + \log_a v$ |
| division $\log_a \frac{u}{v}$ | → | subtraction $\log_a u - \log_a v$ |
| exponentiation $\log_a u^r$ | → | multiplication $r \cdot \log_a u$ |
| root extraction $\log_a \sqrt[r]{u}$ | → | division $\frac{1}{r} \log_a u$ |

Calculate Polarization Ratio



Band Maths

Target product:
[5] S06W056_07_sl_HV_HH_db

Name: ratio

Description:

Unit:

Spectral wavelength: 0.0

Virtual (save expression only, don't store data)

Replace NaN and infinity results by NaN

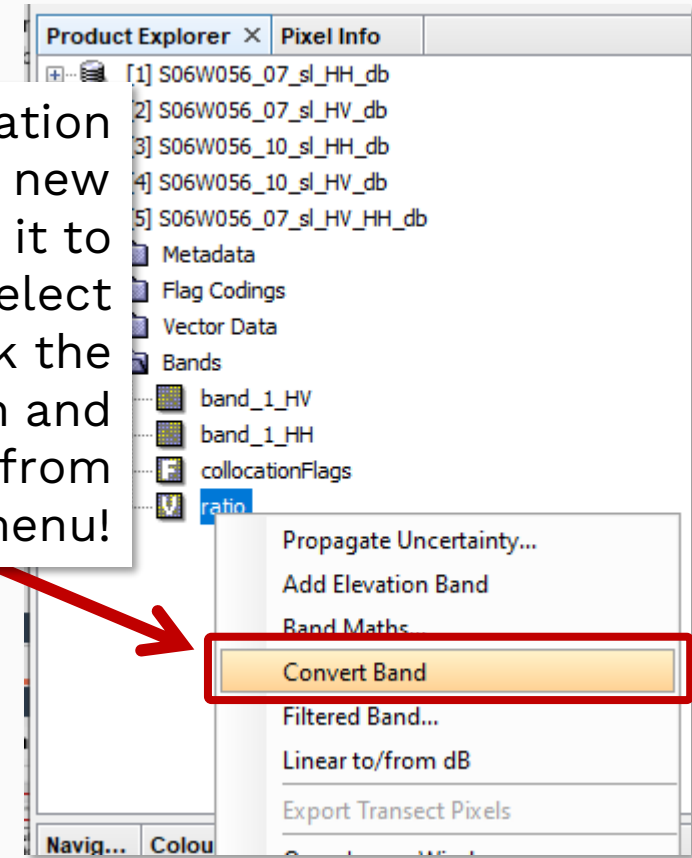
Generate associated uncertainty band

Band maths expression:
\$5.band_1_HH- \$5.band_1_HV

Buttons: Load... Save... Edit Expression... OK Cancel Help

Click "OK"!

The result of the calculation will be added as a new virtual band. To convert it to a permanent band, select the band "ratio", click the right mouse button and select "Convert Band" from the context menu!



Product Explorer × **Pixel Info**

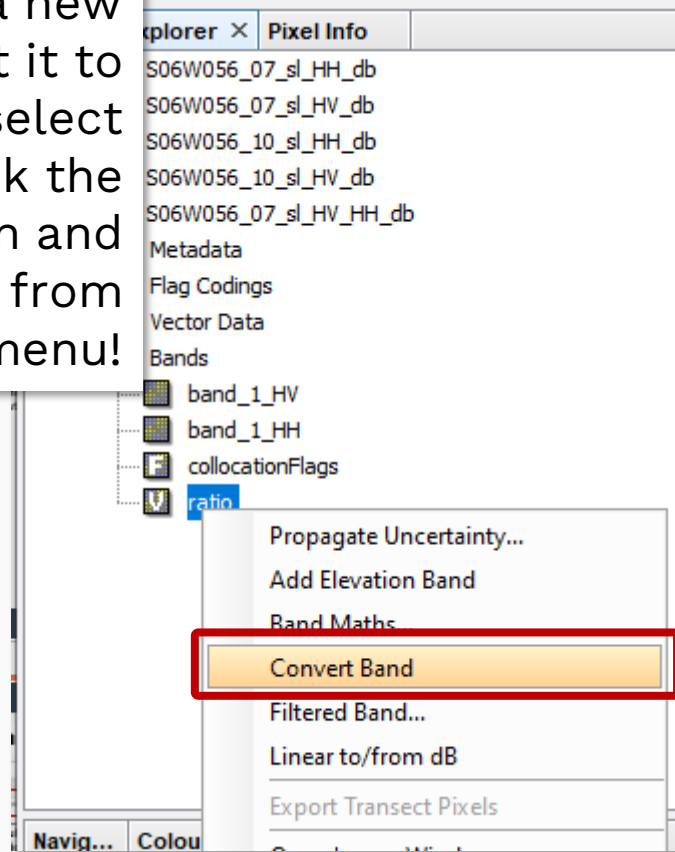
- [1] S06W056_07_sl_HH_db
- [2] S06W056_07_sl_HV_db
- [3] S06W056_10_sl_HH_db
- [4] S06W056_10_sl_HV_db
- [5] S06W056_07_sl_HV_HH_db
- Metadata
- Flag Codings
- Vector Data
- Bands
 - band_1_HV
 - band_1_HH
 - collocationFlags
 - ratio

Context menu for 'ratio':

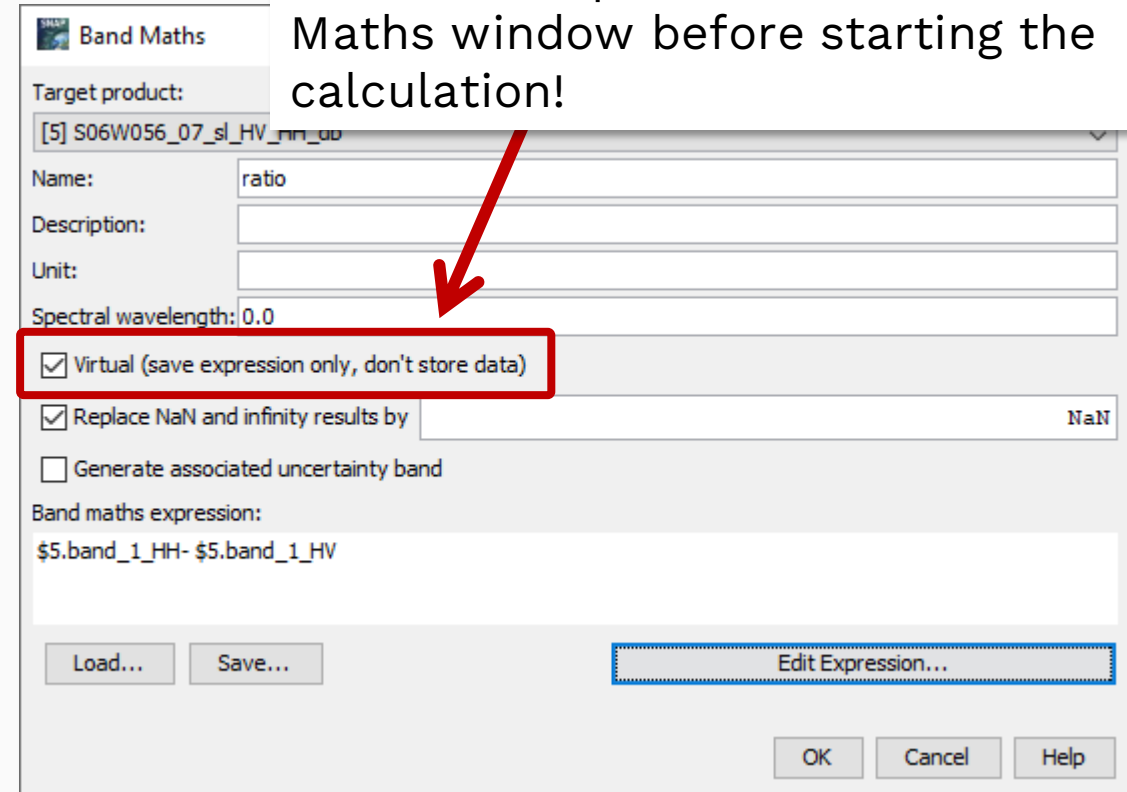
- Propagate Uncertainty...
- Add Elevation Band
- Band Maths
- Convert Band**
- Filtered Band...
- Linear to/from dB
- Export Transect Pixels

Calculate Polarization Ratio

The result of the calculation will be added as a new virtual band. To convert it to a permanent band, select the band “ratio”, click the right mouse button and select “Convert Band” from the context menu!

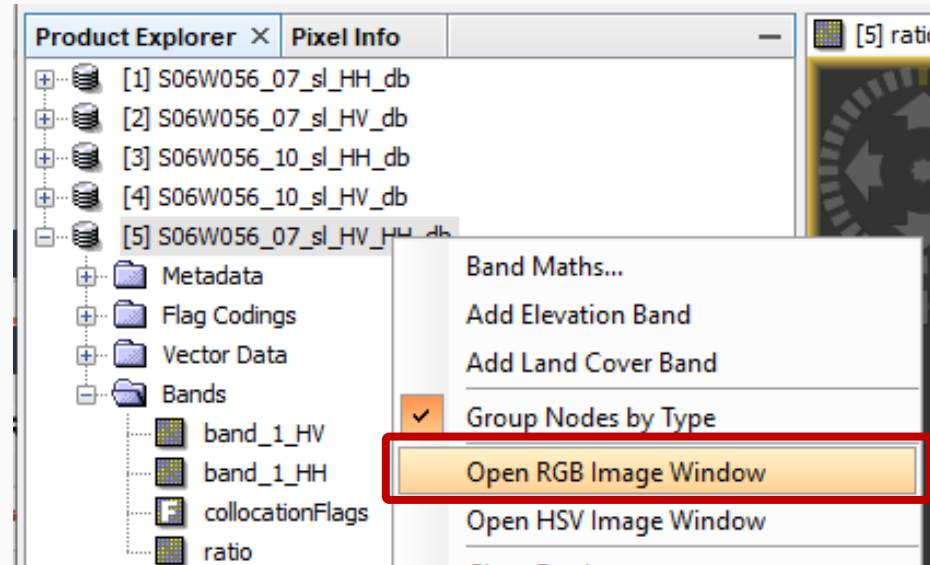


Alternative:
Untick this option in the Band Maths window before starting the calculation!



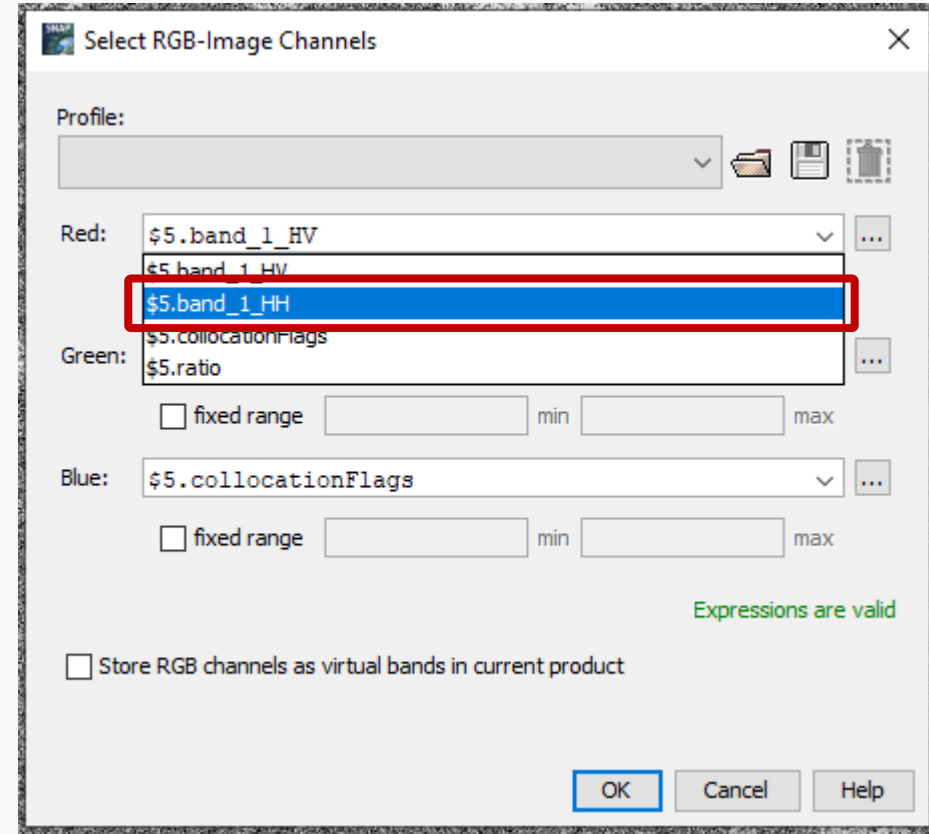
Create RGB-View

In the Product Explorer, select the Layer Stack product name and click the right mouse button!
From the context menu select “Open RGB Image Window”!



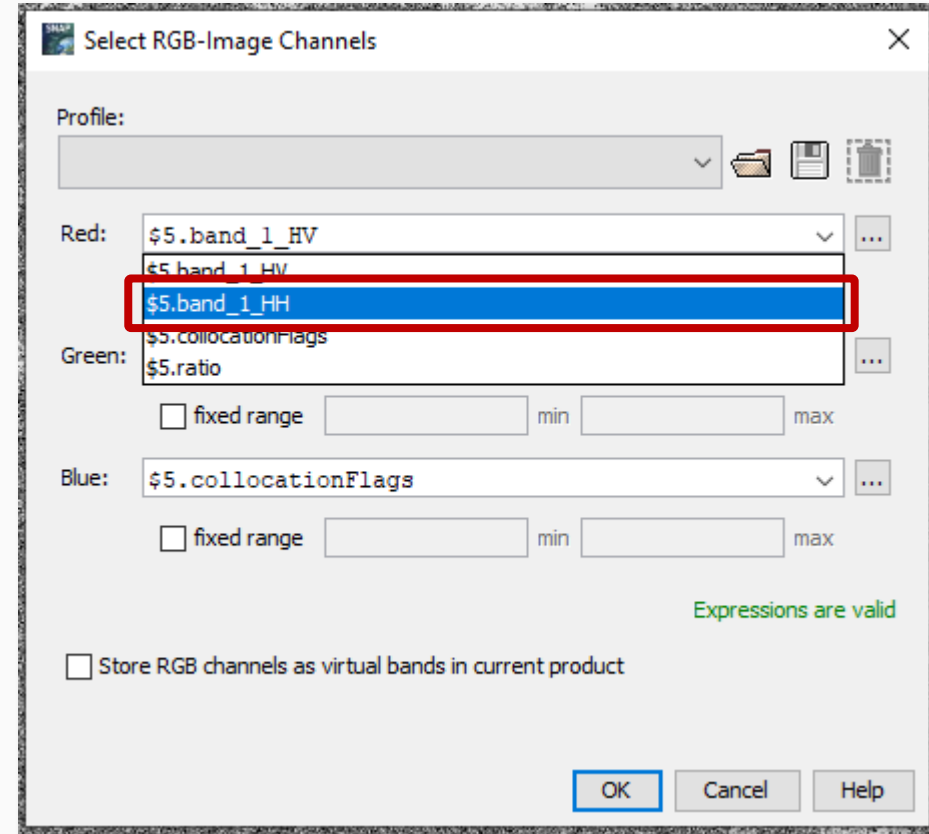
Create RGB-View

To select image bands for the three RGB-Image-Channels, use the drop down menus and select a band from the list!



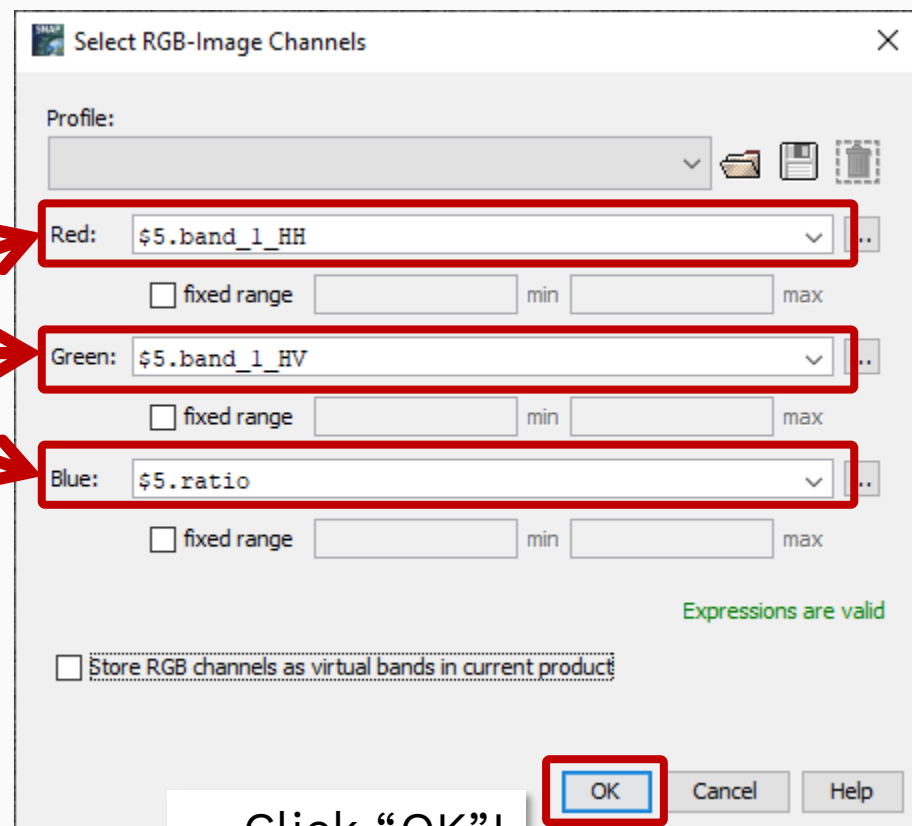
Create RGB-View

To select image bands for the three RGB-Image-Channels, use the drop down menus and select a band from the list!



Create RGB-View

For our exercise, select
 Red: HH band
 Green: HV band
 Blue: ratio



Click "OK"!

Create RGB-View

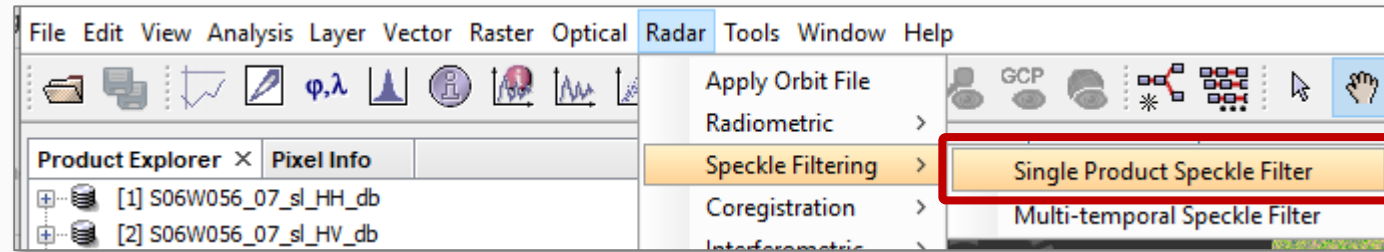
The screenshot shows the SNAP software interface. The main window displays a satellite image with a color scale. The toolbar contains various icons, and the 'Hand' icon is highlighted with a red box. A red arrow points from this icon to a text box containing the following instructions:

Select the “Hand” icon from the toolbar. Click into the image, hold down the left mouse button and move the mouse back and forth to move the image content! Use the mouse wheel to zoom in and out!

The interface also shows a 'Product Explorer' panel on the left with a list of layers, including 'S06W056_07_sl_HH_db', 'S06W056_07_sl_HV_db', 'S06W056_10_sl_HH_db', 'S06W056_10_sl_HV_db', 'S06W056_07_sl_HV_HH_db', 'Metadata', 'Flag Codings', 'Vector Data', and 'Bands'. The status bar at the bottom displays coordinates: X 2031 Y 2293, Lat -6.50956 Lon -55.54867, Zoom 2060.8:1 Level 1, and Pixel Spacing: 0 m 0 m.

Speckle-Filtering

From the menu select “Radar” -> “Speckle Filtering” -> “Single Product Speckle Filter”!



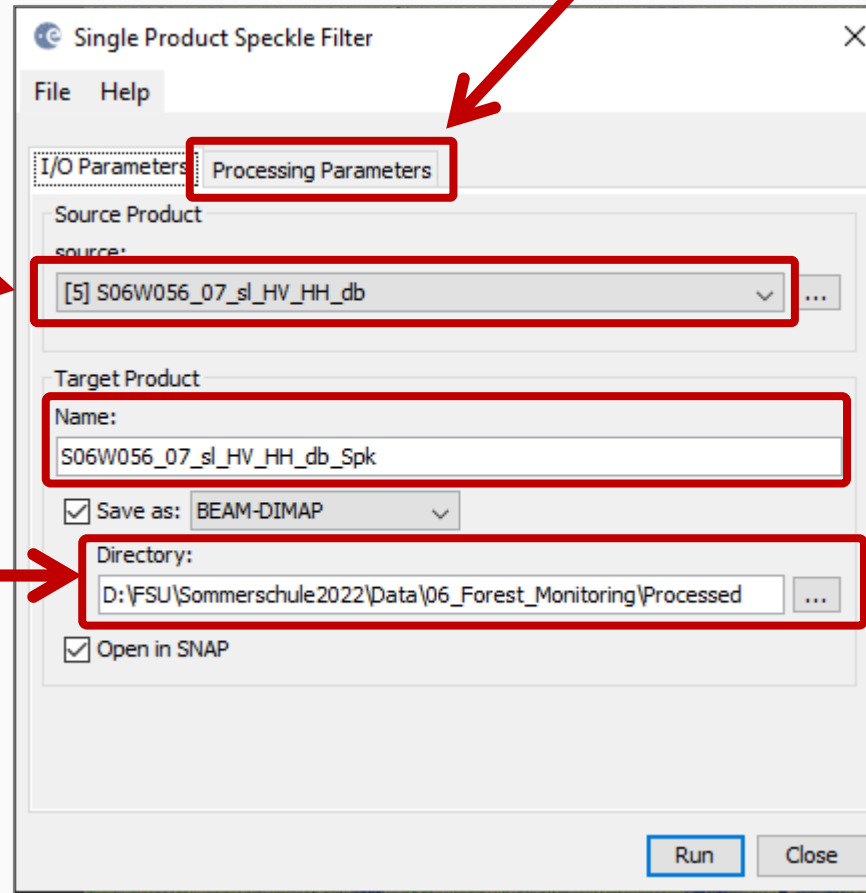
Speckle-Filtering

4) Click the tab "Processing Parameters"!

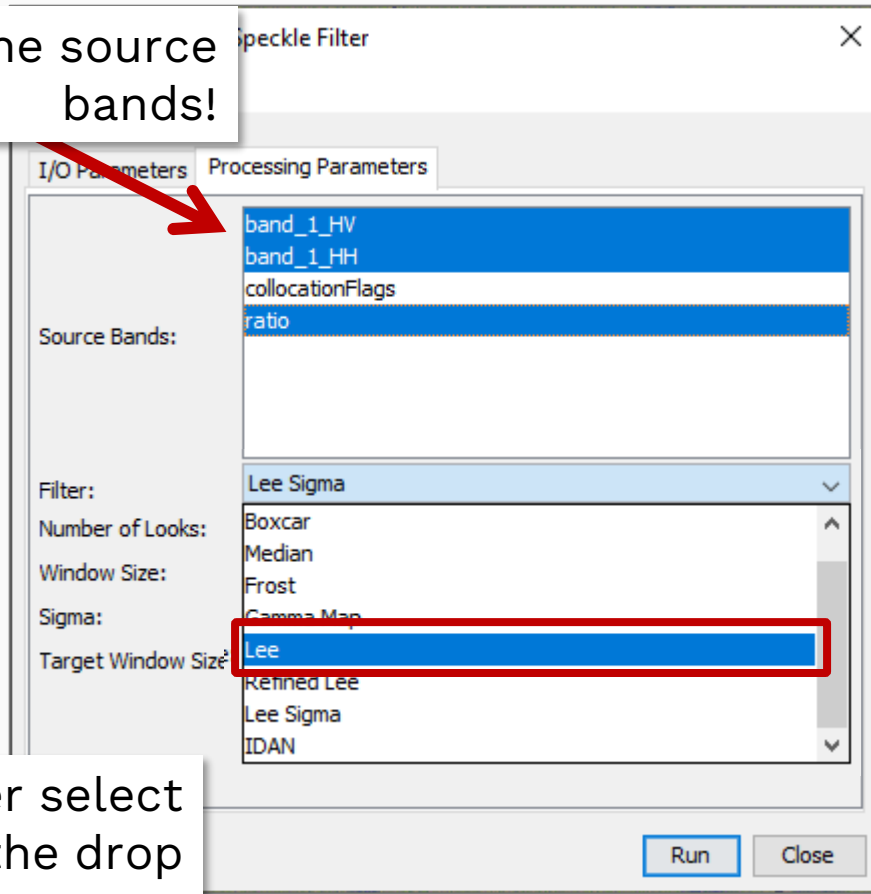
1) The Layer Stack is our source product.

2) SNAP automatically adds "_Spk" at the end of the file name to create the output name

3) Specify your output directory!

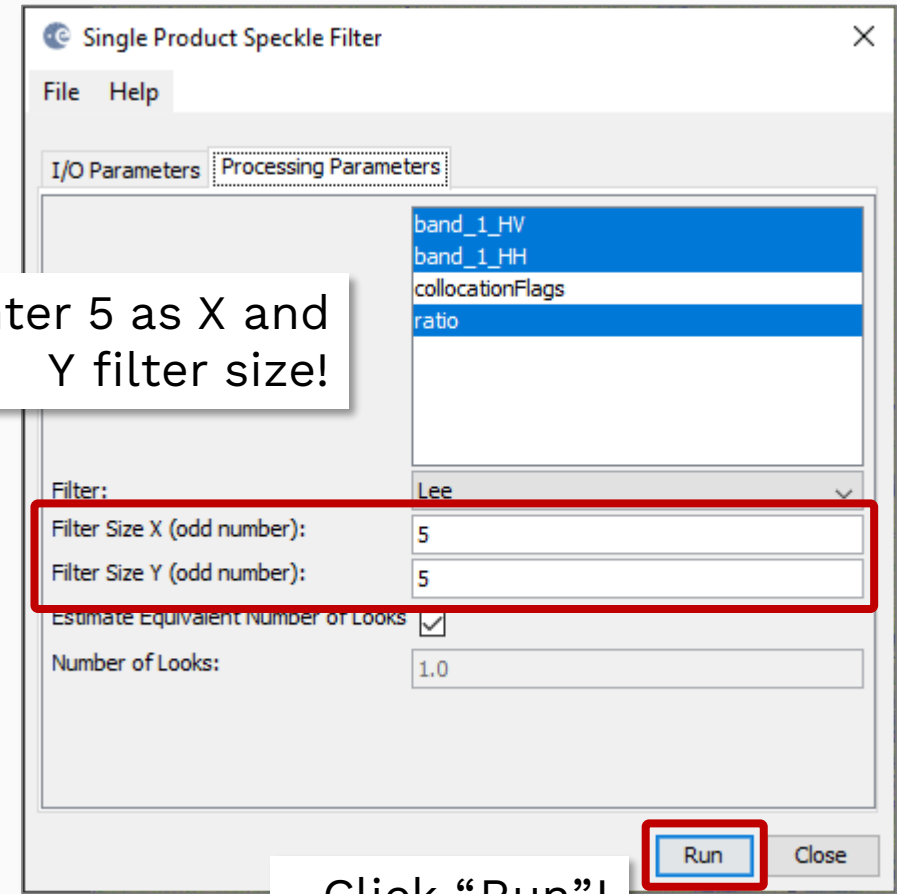


1) Select the source bands!



2) As filter select "Lee" from the drop down menu!

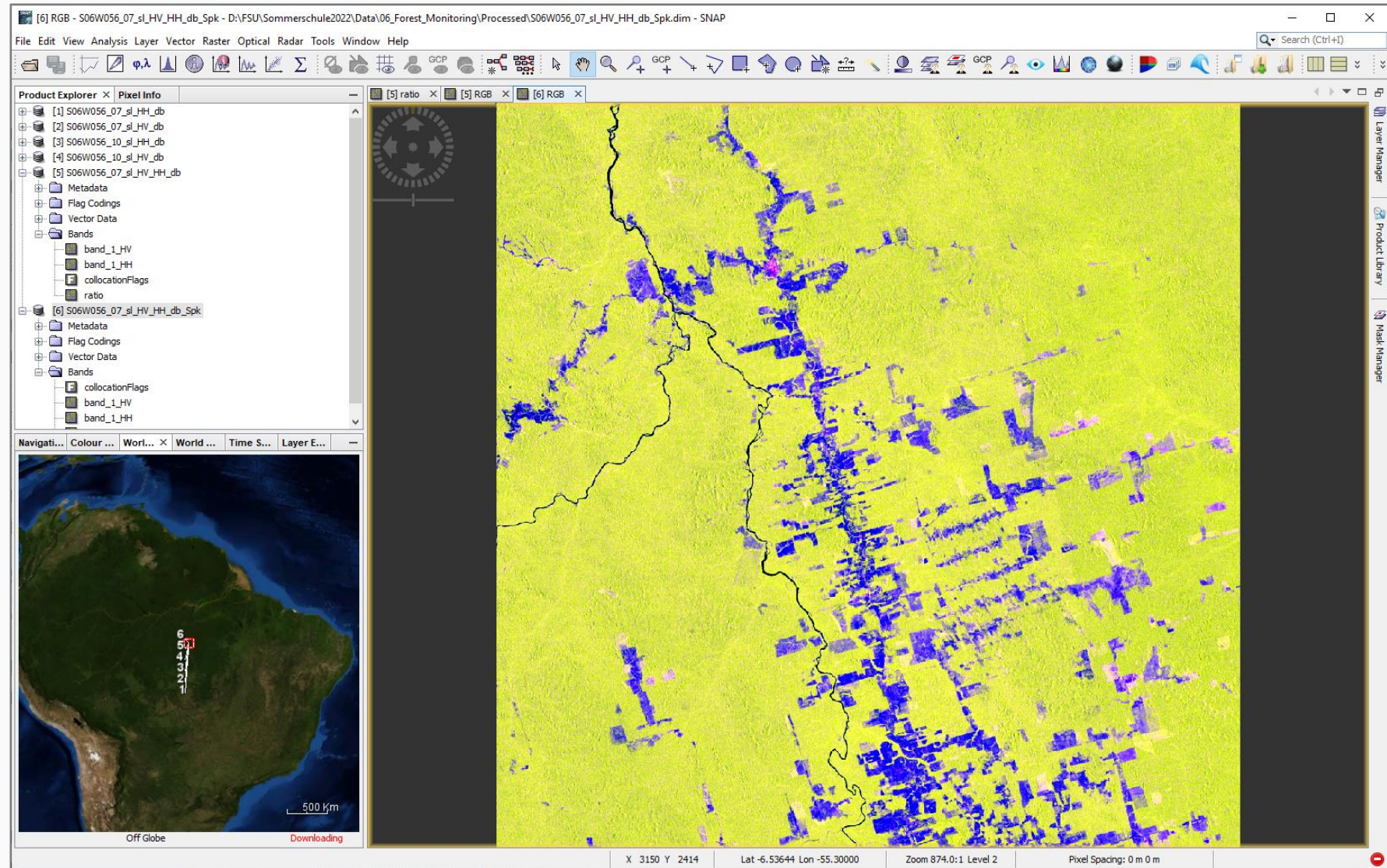
3) Enter 5 as X and Y filter size!



Click "Run"!

Create RGB-Views

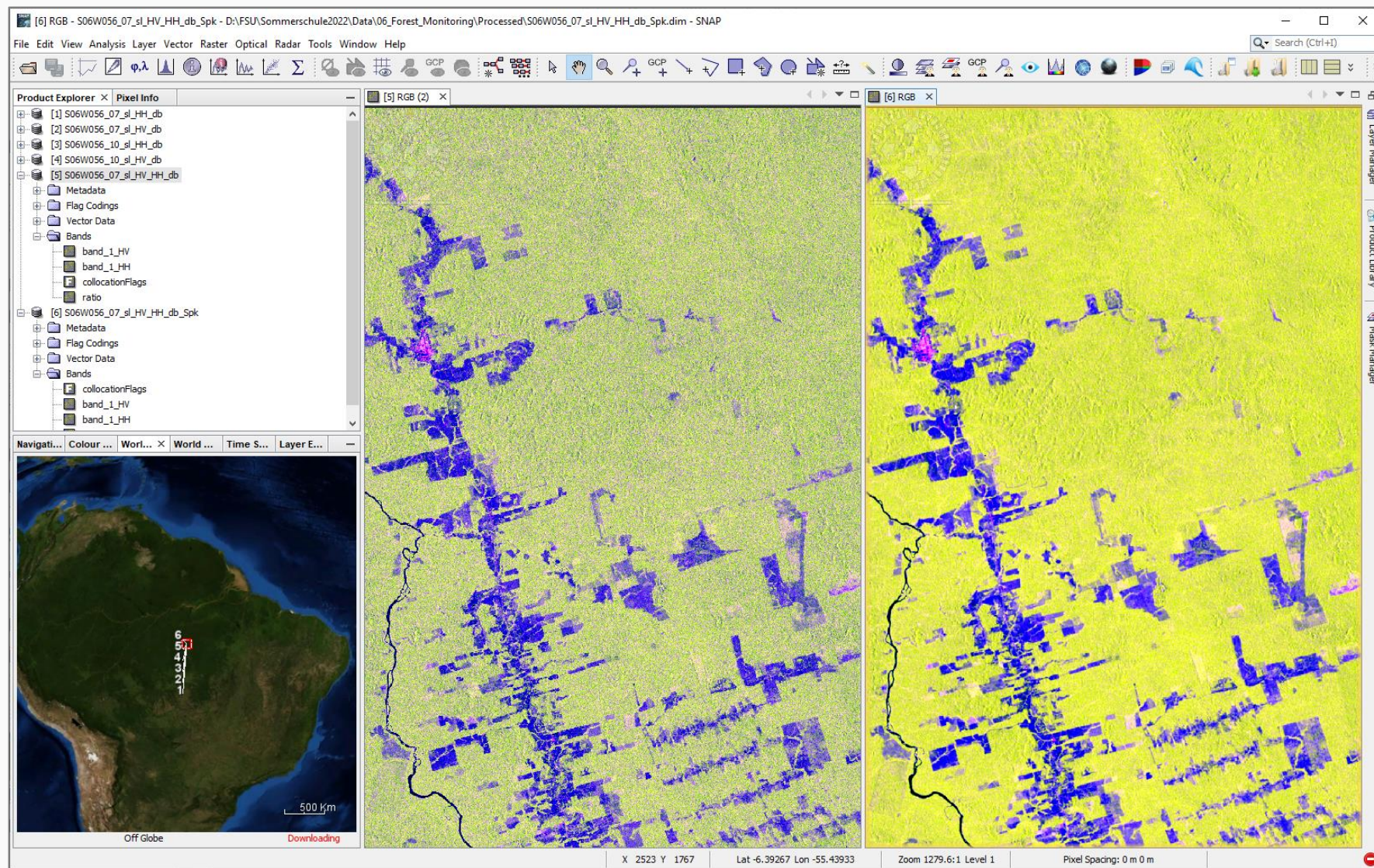
Use the speckle
filtered product to
create an RGB-
View!
View!
See slides 21 – 25.



Compare RGB-Views

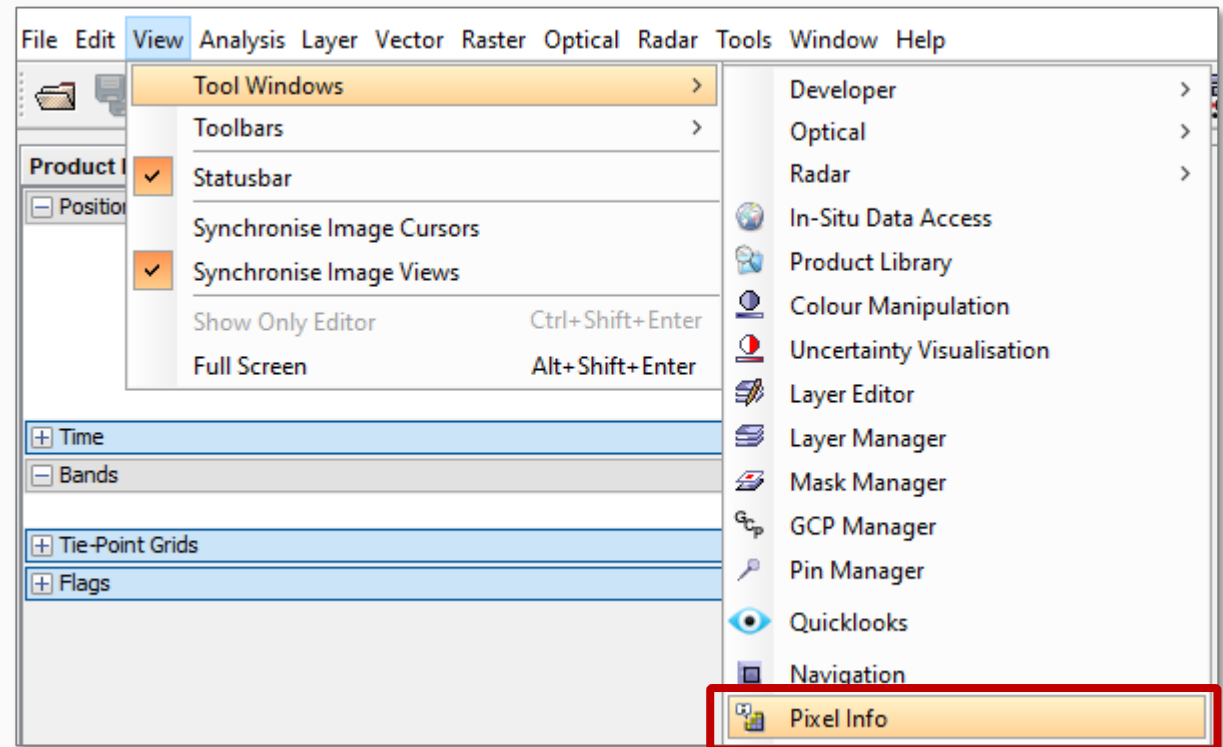
Compare the unfiltered
and the filtered RGB-
Views using horizontal
tiling!

See slides 10 - 12!



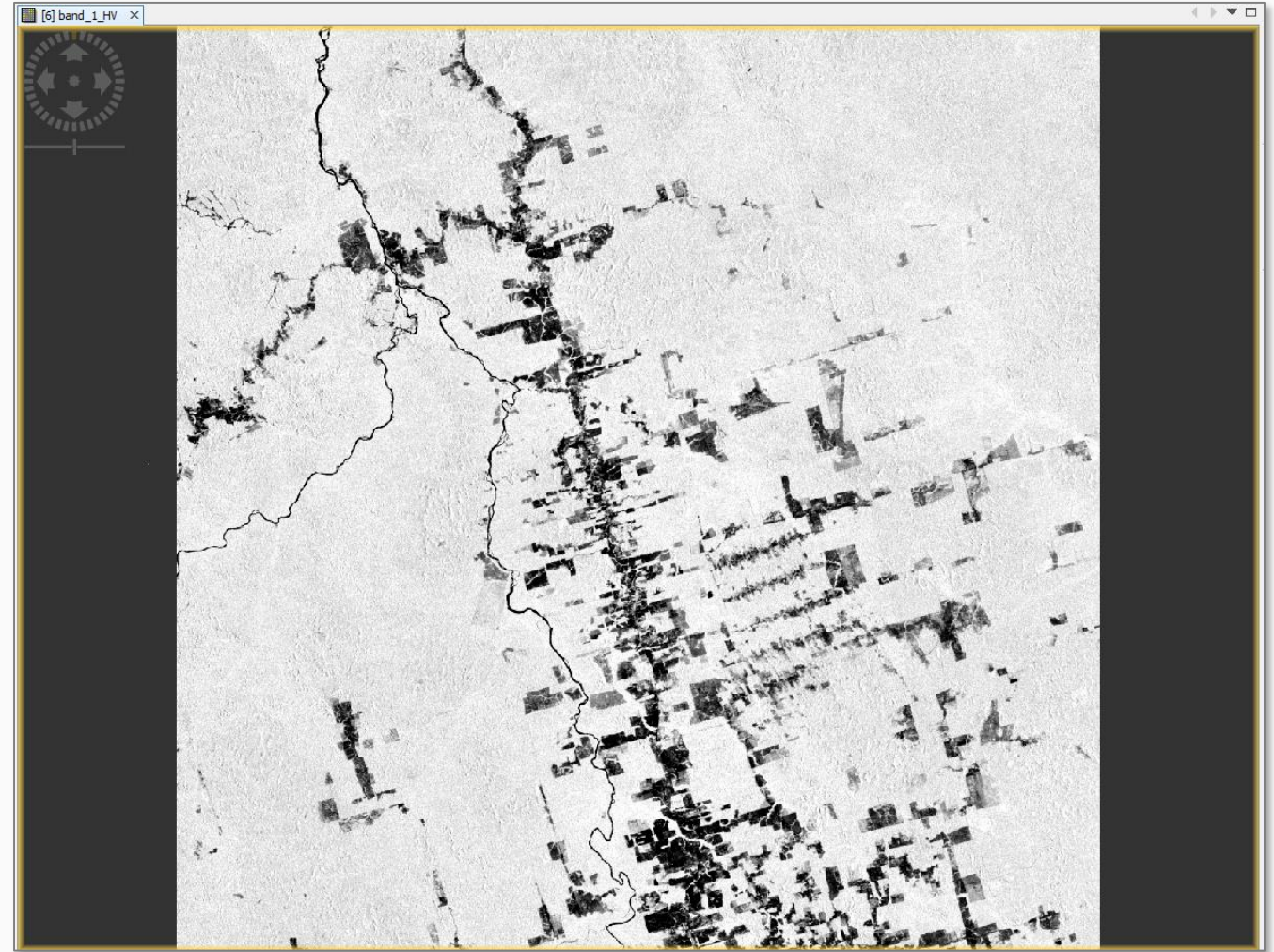
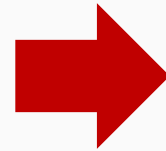
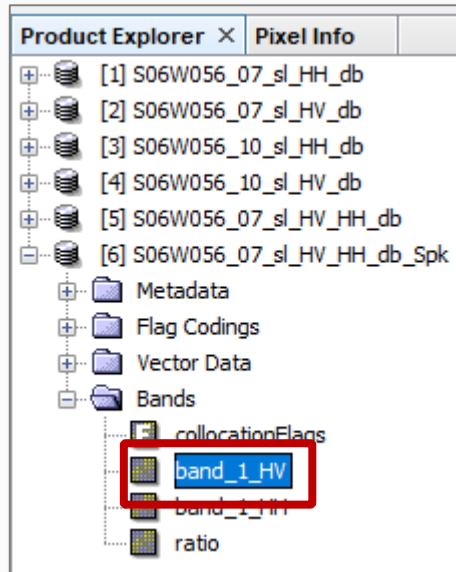
View pixel values

From the menu select “View” ->
“Tool Windows” -> “Pixel Info”!

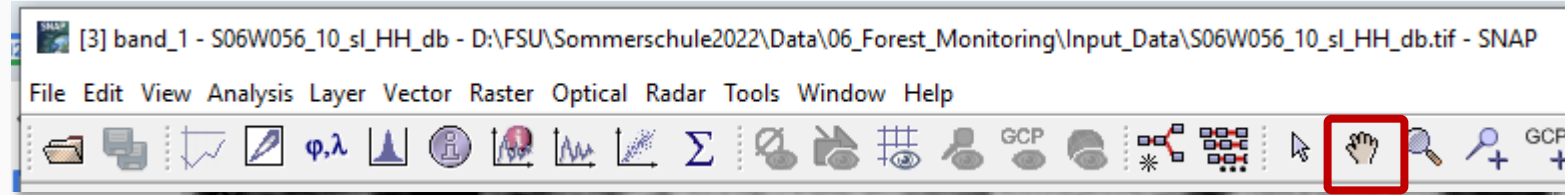


View pixel values

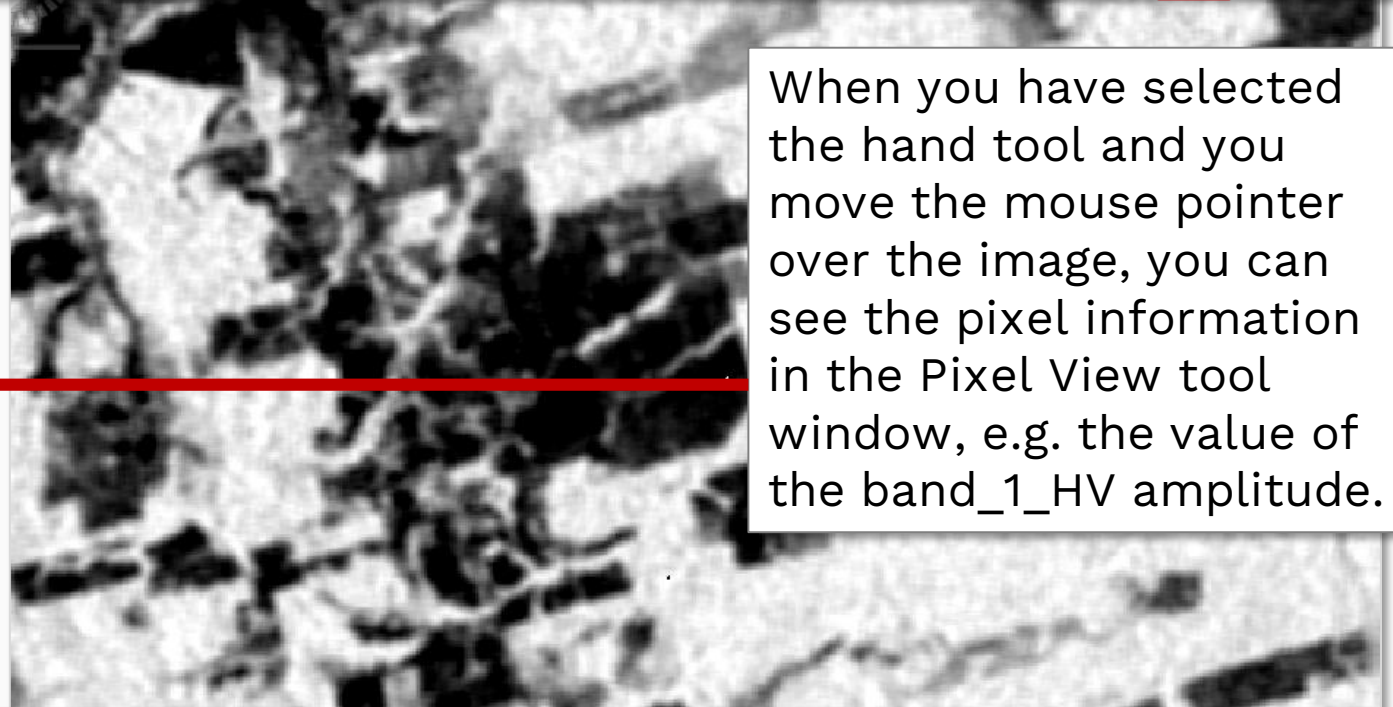
Please open speckle filtered HV data by double-clicking the image band!



View pixel values



| Product Explorer | | Pixel Info X | |
|---------------------|--------------------|--------------|--|
| [-] Position | | | |
| Image-X | 878 | pixel | |
| Image-Y | 2290 | pixel | |
| Longitude | 55°48'17" W | degree | |
| Latitude | 6°30'32" S | degree | |
| Map-X | -55.80477777777778 | ° | |
| Map-Y | -6.509 | ° | |
| [+] Time | | | |
| [-] Bands | | | |
| band_1_HV | -11.31035 | amplitude | |
| [+] Tie-Point Grids | | | |
| [+] Flags | | | |

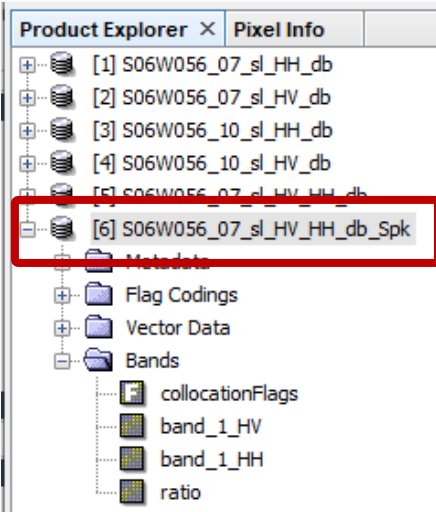


When you have selected the hand tool and you move the mouse pointer over the image, you can see the pixel information in the Pixel View tool window, e.g. the value of the band_1_HV amplitude.

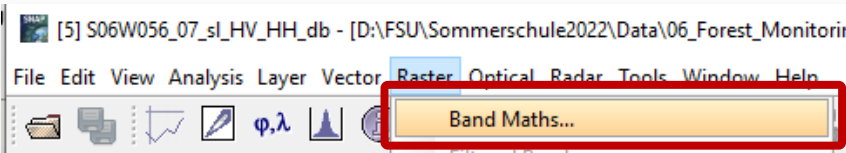
Observe the pixel values of the forested areas (white to light grey areas) and the non-forested areas (dark regions)!
 You will notice that the backscatter values for the forested areas will range between -10 and -12 dB, whereas the non-forested areas show much lower backscatter values in the range from -19 to -22 dB.

Mask area covered by forest

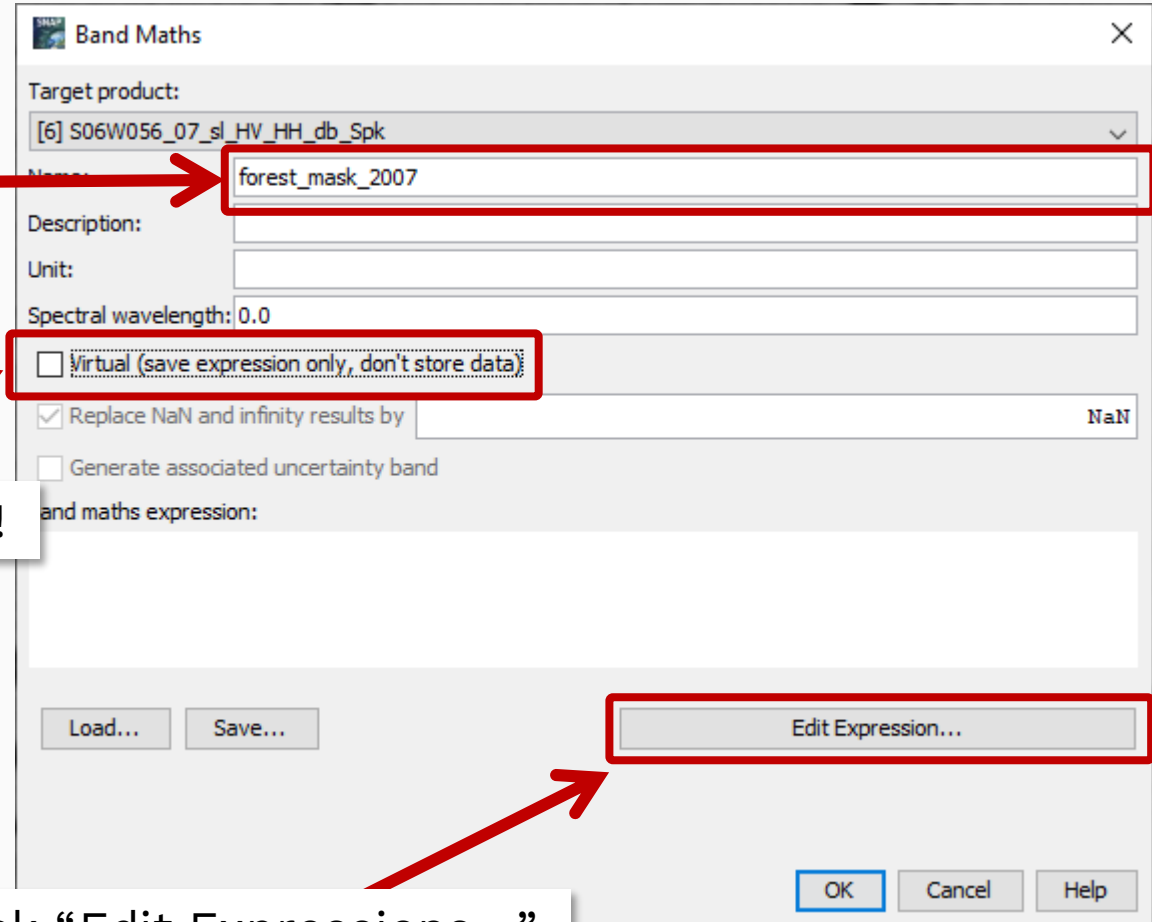
1) Select the speckle-filtered Layer Stack!



2) Open the “Band Maths...” tool



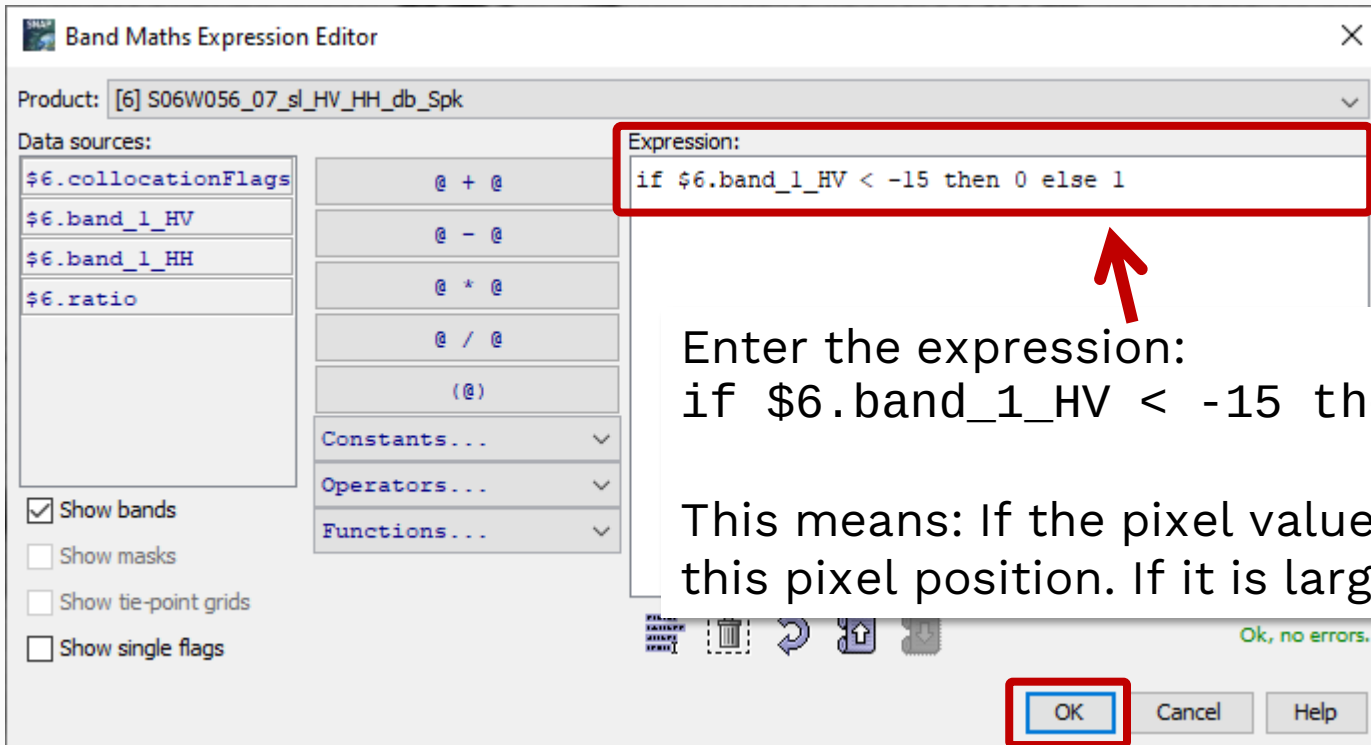
3) Specify the output name as “ratio”!



4) Untick this option!

5) Click “Edit Expressions...”

Mask area covered by forest

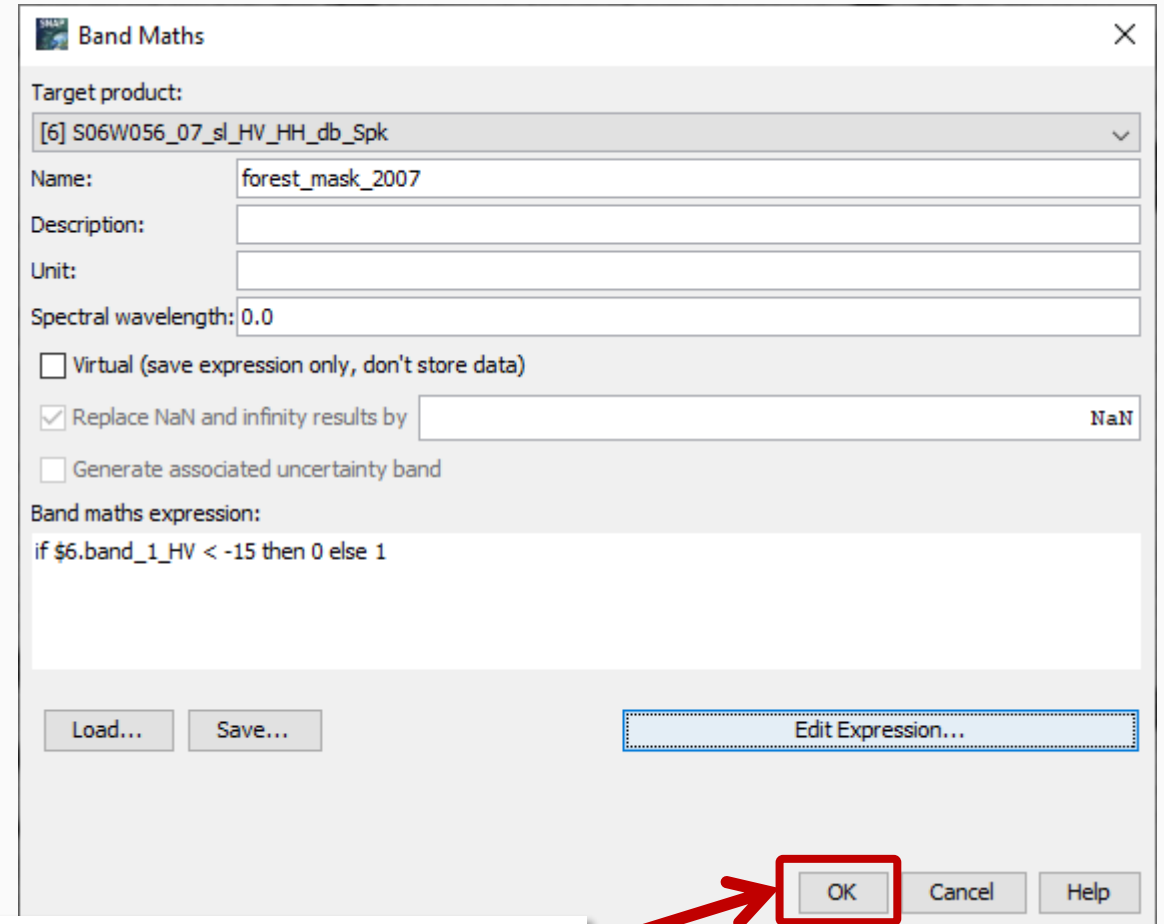


Enter the expression:
`if $6.band_1_HV < -15 then 0 else 1`

This means: If the pixel value of band_1_HV is lower than 15, save a “0” at this pixel position. If it is larger, then save a “1” at the pixel position.

Click “OK” to close the window!

Mask area covered by forest



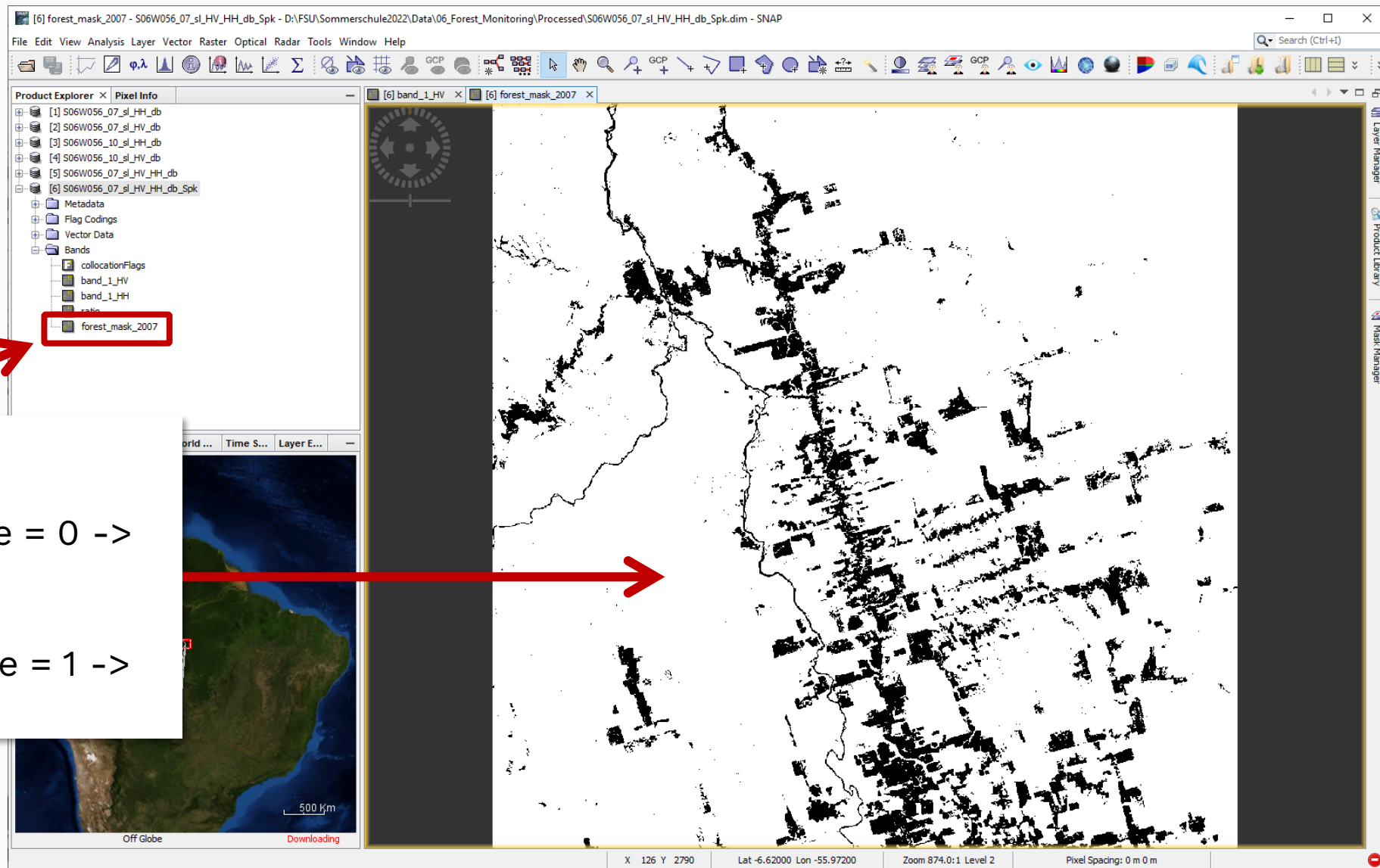
Click "OK" to start the calculation!

Mask area covered by forest

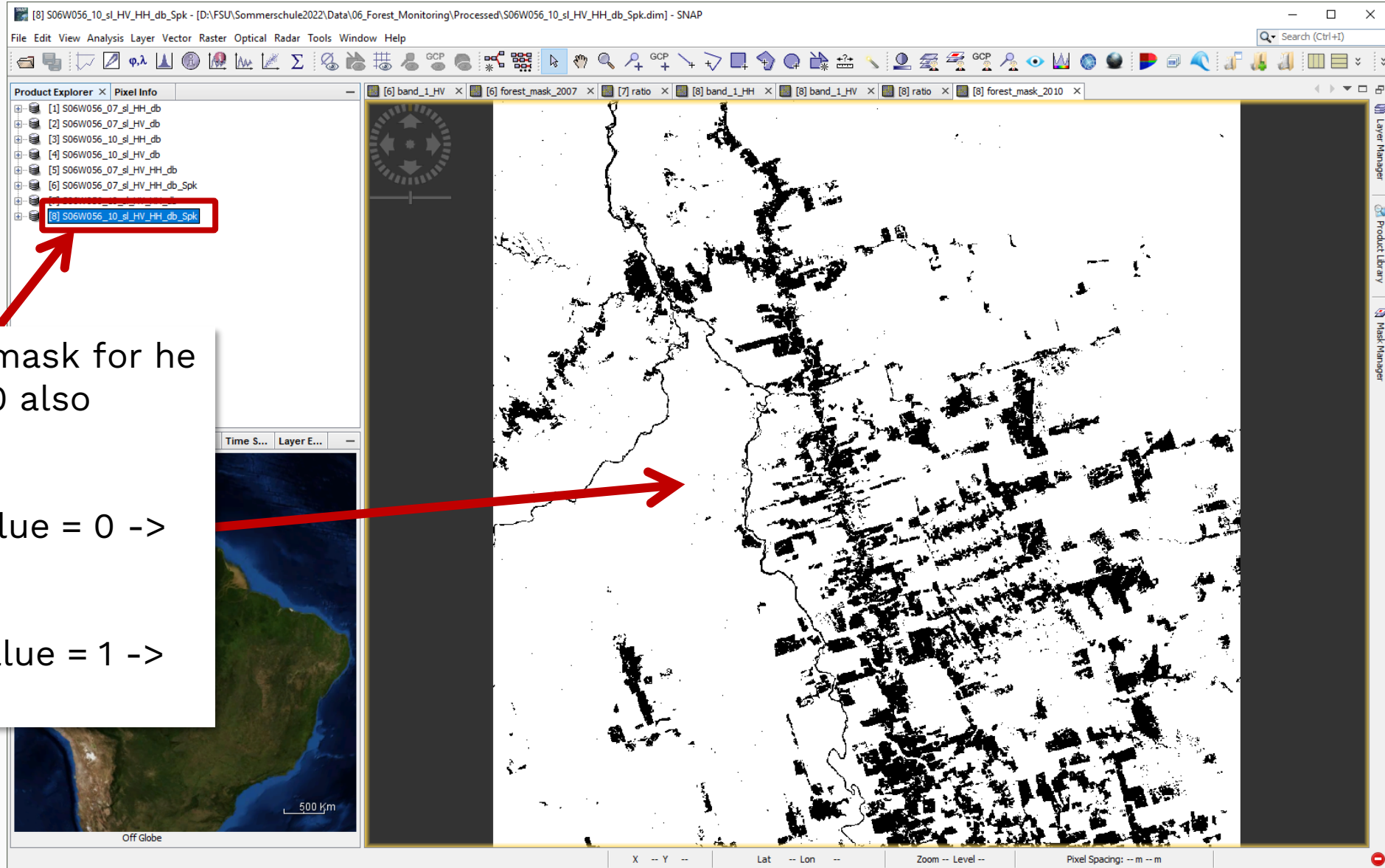
Result:

Black pixels -> Pixel value = 0 -> non-forested area

White pixels -> Pixel value = 1 -> forest area



Repeat these steps for the data set from the year 2010!



The forest-non-forest mask for the data from the year 2010 also contains:

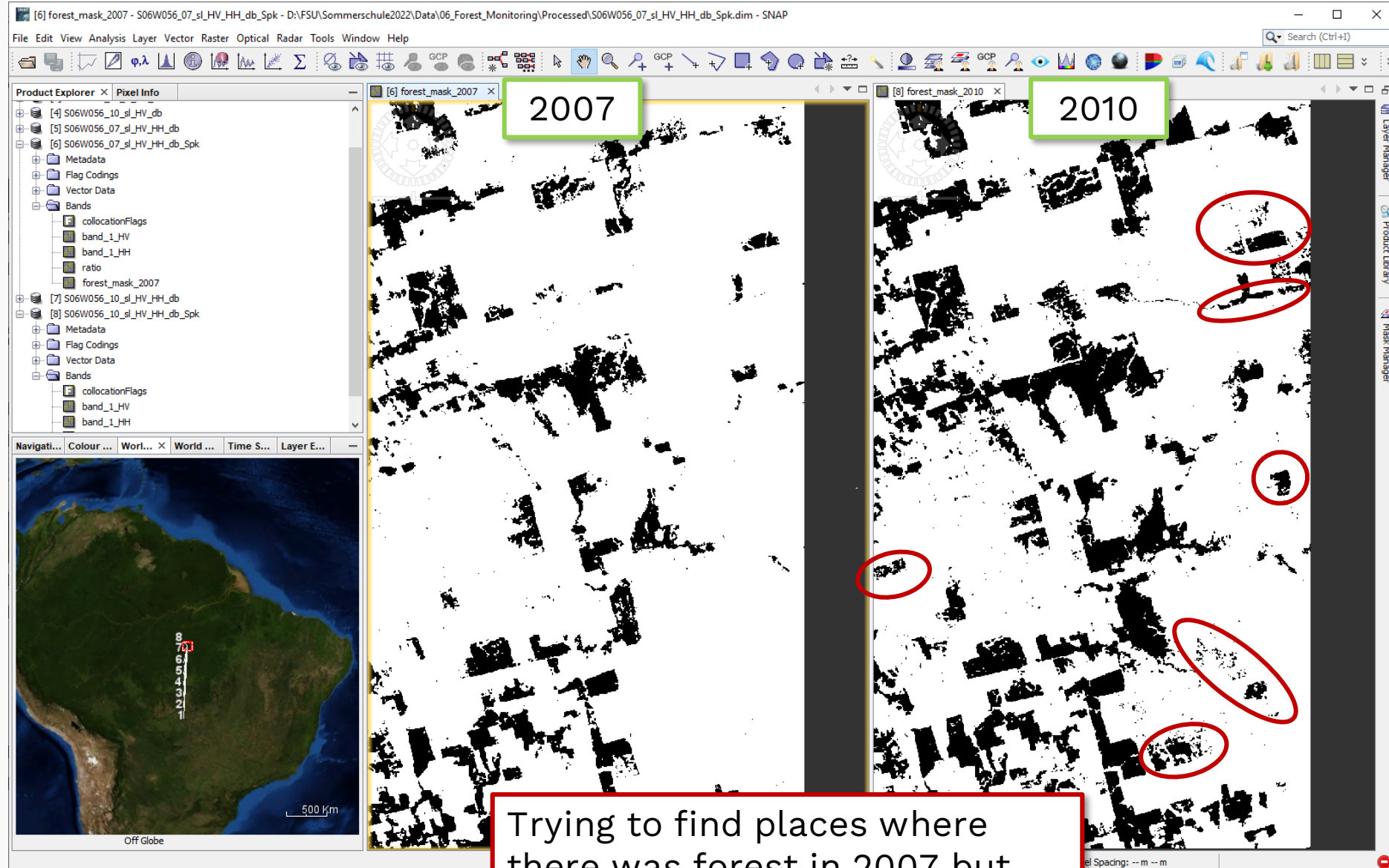
Black pixels -> Pixel value = 0 -> non-forested area

White pixels -> Pixel value = 1 -> forest area

Compare masks

Compare the masks from 2007 and 2010 using horizontal tiling!

See slides 10 - 12!

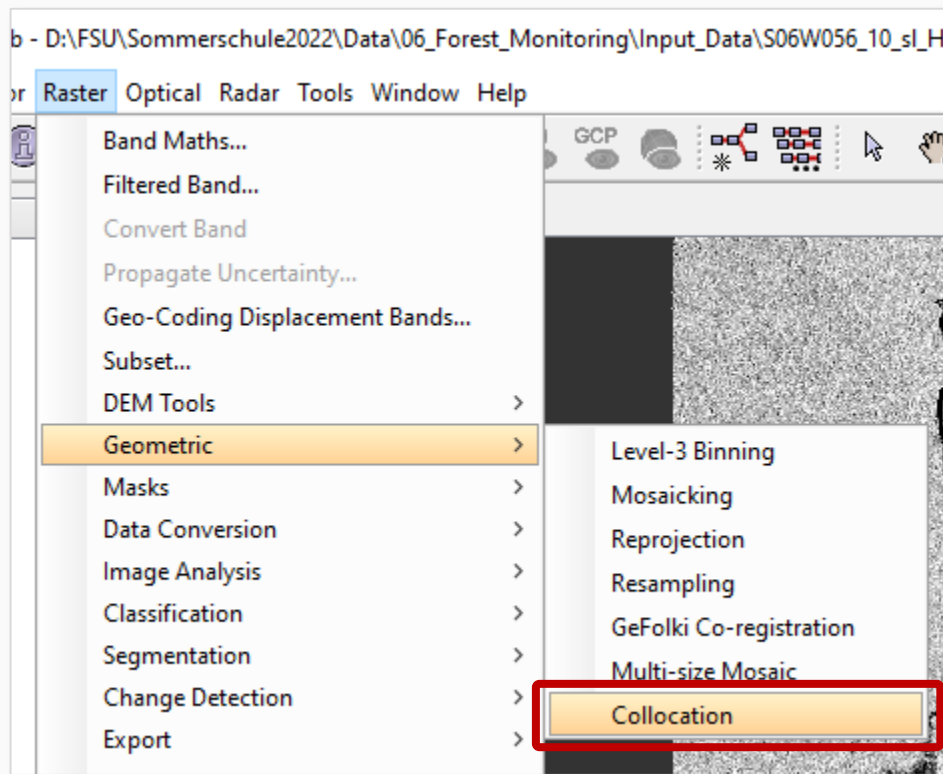


Trying to find places where there was forest in 2007 but not in 2010.

Create Layer Stack

To combine both speckle-filtered products with the forest-non-forest mask in one layer stack, we use the Collocation tool again.

From the menu, select
 “Raster” -> “Geometric” ->
 “Collocation”!



Create Layer Stack

1) As Source Product (Master), select speckle-filtered product containing data and mask for the year 2007!

2) As Slave Product, select speckle-filtered product containing data and mask for the year 2010!

3) Specify the output name, e.g. “collocate”!

4) Specify the output directory!

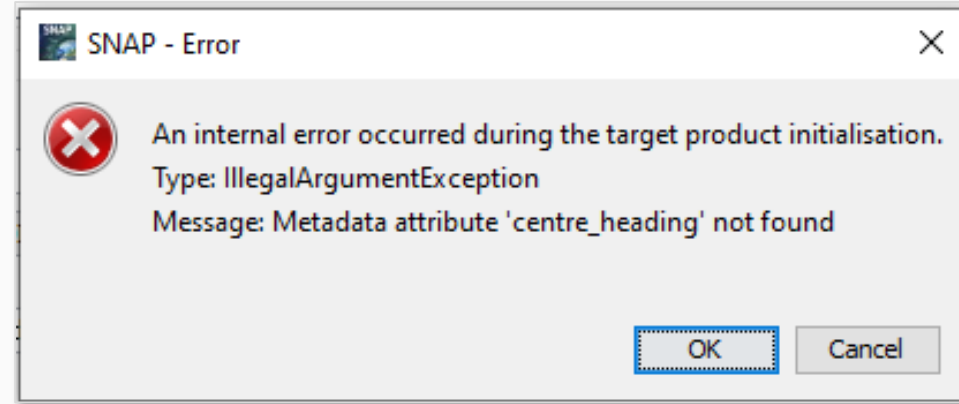
5) Specify the master components name as “\${ORIGINAL_NAME}_2007”!

6) Specify the slave components name as “\${ORIGINAL_NAME}_2010”!

The screenshot shows the 'Collocation' dialog box in SNAP. Red boxes and arrows highlight the following fields:

- Master (pixel values are conserved):** [6] S06W056_07_sl_HV_HH_db_Spk
- Slave Products:** [8] S06W056_10_sl_HV_HH_db_Spk
- Name:** collocate
- Save as:** BEAM-DIMAP
- Directory:** D:\FSU\Sommerschule2022\Data\06_Forest_Monitoring\Processed
- Rename master components:** \${ORIGINAL_NAME}_2007
- Rename slave components:** \${ORIGINAL_NAME}_2010
- Resampling Method:** Nearest neighbour resampling
- Run button:** A red box highlights the 'Run' button at the bottom right.

Click “Run”!



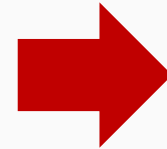
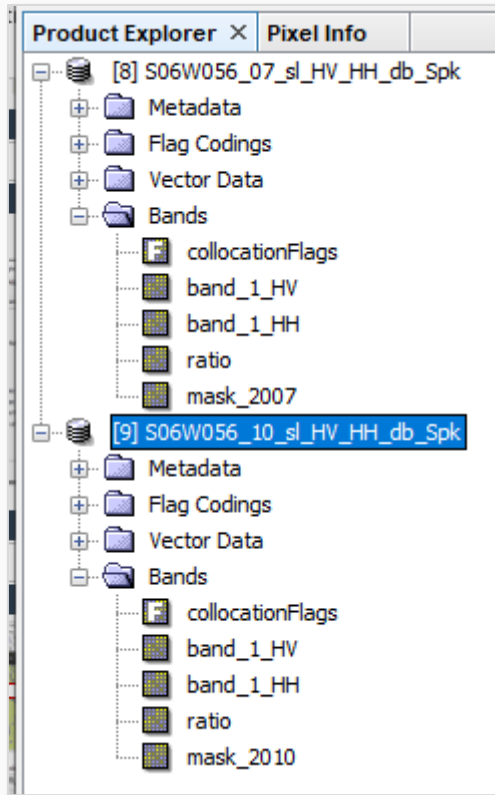
In SNAP 9 an error occurs at this stage of processing!

This was not the case for the last years version of SNAP, version 8. Most probably this will be fixed with on version-9 internal update.

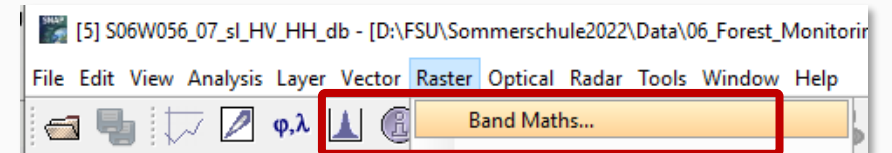
For the moment, we will show you a work-around in the next slides.

Create Layer Stack – Work Around

1) Select the speckle-filtered product with data and mask for the year 2010 in the Product Explorer!



2) Open the “Band Maths...” tool



Create Layer Stack – Work Around

1) Target Product is 2010 data set

2) Enter new band name, e.g. “forest_mask_2007”!

3) Untick this option!

4) Click at “Edit Expression!”

Band Maths

Target product: [9] S06W056_10_sl_HV_HH_db_Spk

Name: forest_mask_2007

Description:

Unit:

Spectral wavelength: 0.0

Virtual (save expression only, don't store data)

Replace NaN and infinity results by NaN

Generate associated uncertainty band

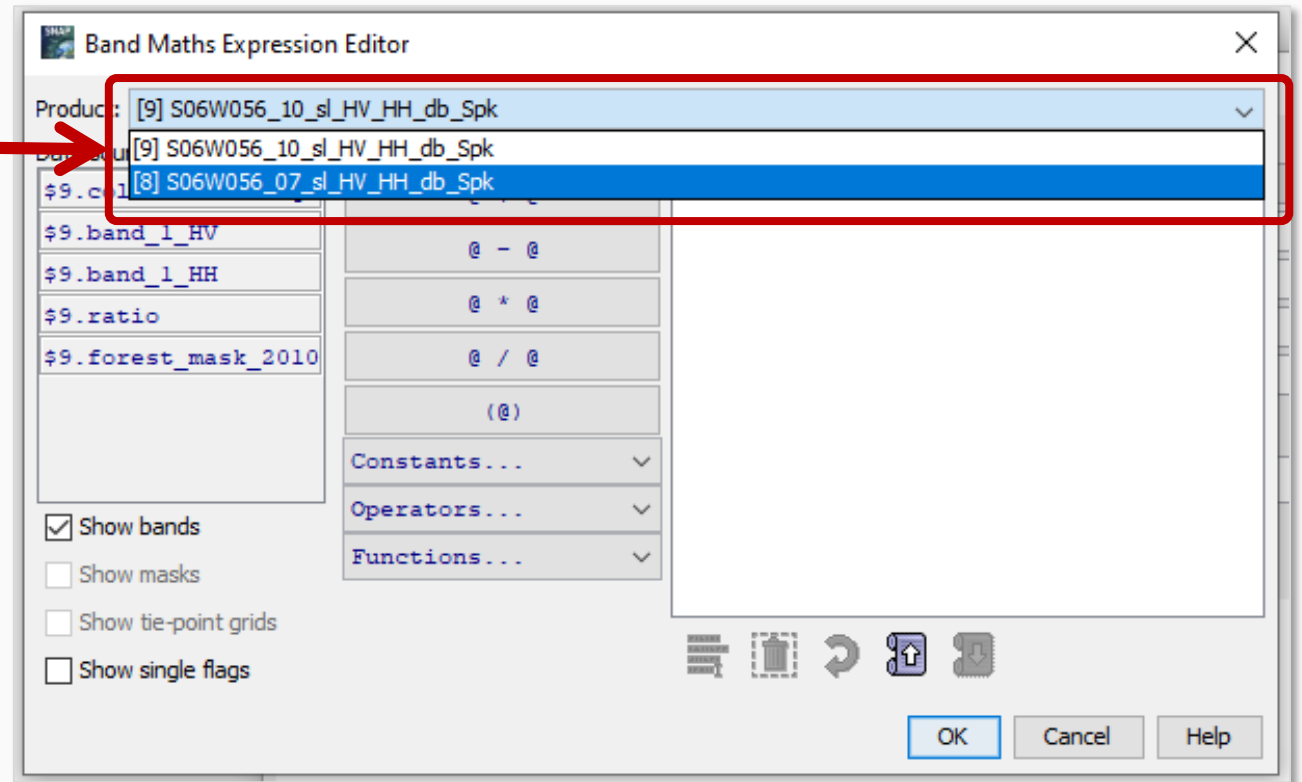
Band maths expression:

Load... Save... Edit Expression...

OK Cancel Help

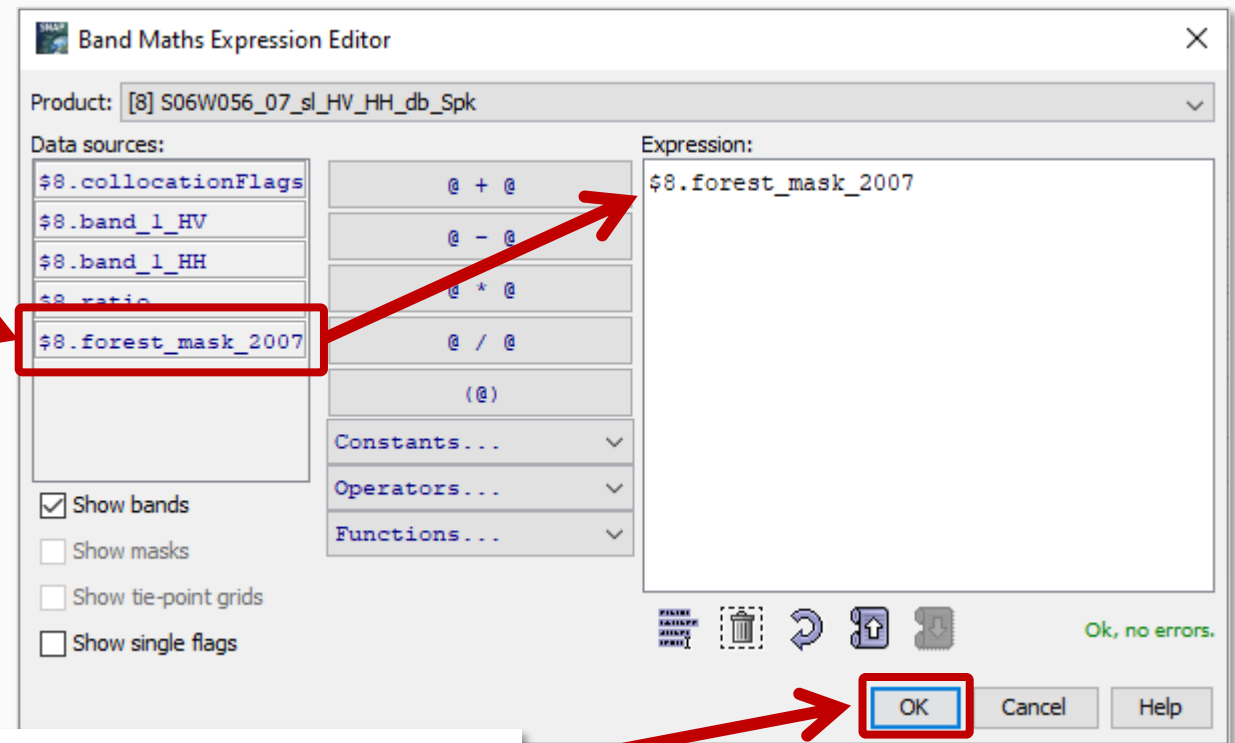
Create Layer Stack – Work Around

1) From the drop down menu, select the 2007 data set!



Create Layer Stack – Work Around

1) With a single mouse click at the entry `$x.forest_mask_2007`, this band is transferred to the Expression entry window.



Click “OK” to close the window!

Create Layer Stack – Work Around

Band Maths

Target product:
[9] S06W056_10_sl_HV_HH_db_Spk

Name: forest_mask_2007

Description:

Unit:

Spectral wavelength: 0.0

Virtual (save expression only, don't store data)

Replace NaN and infinity results by NaN

Generate associated uncertainty band

Band maths expression:
\$8.forest_mask_2007

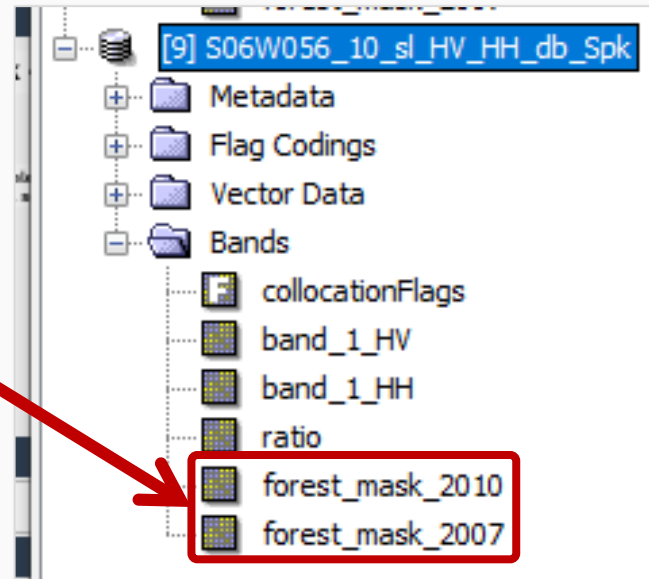
Load... Save... Edit Expression...

OK Cancel Help

Click "OK" to finally transfer the band!

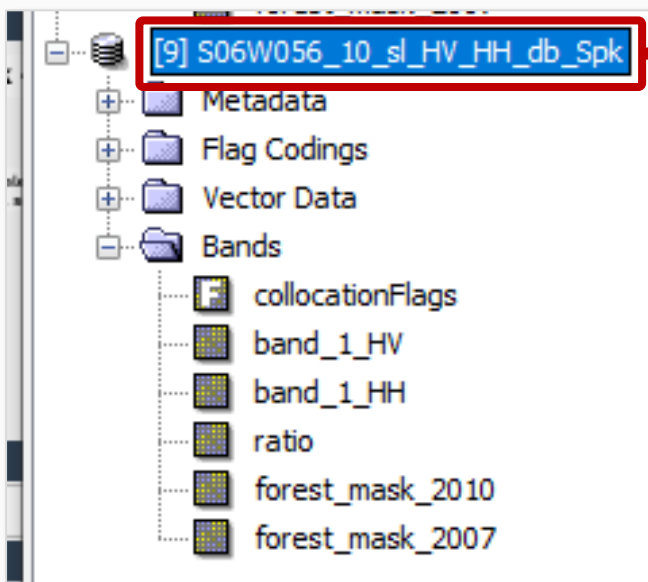
Create Layer Stack – Work Around

As a result, we now have both forest masks in one product.

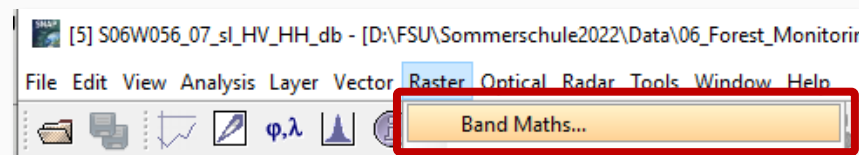


Create Forest Change Product

1) Select the 2010 product containing both forest masks (from the year 2007 and 2010)!



2) Open the “Band Maths...” tool

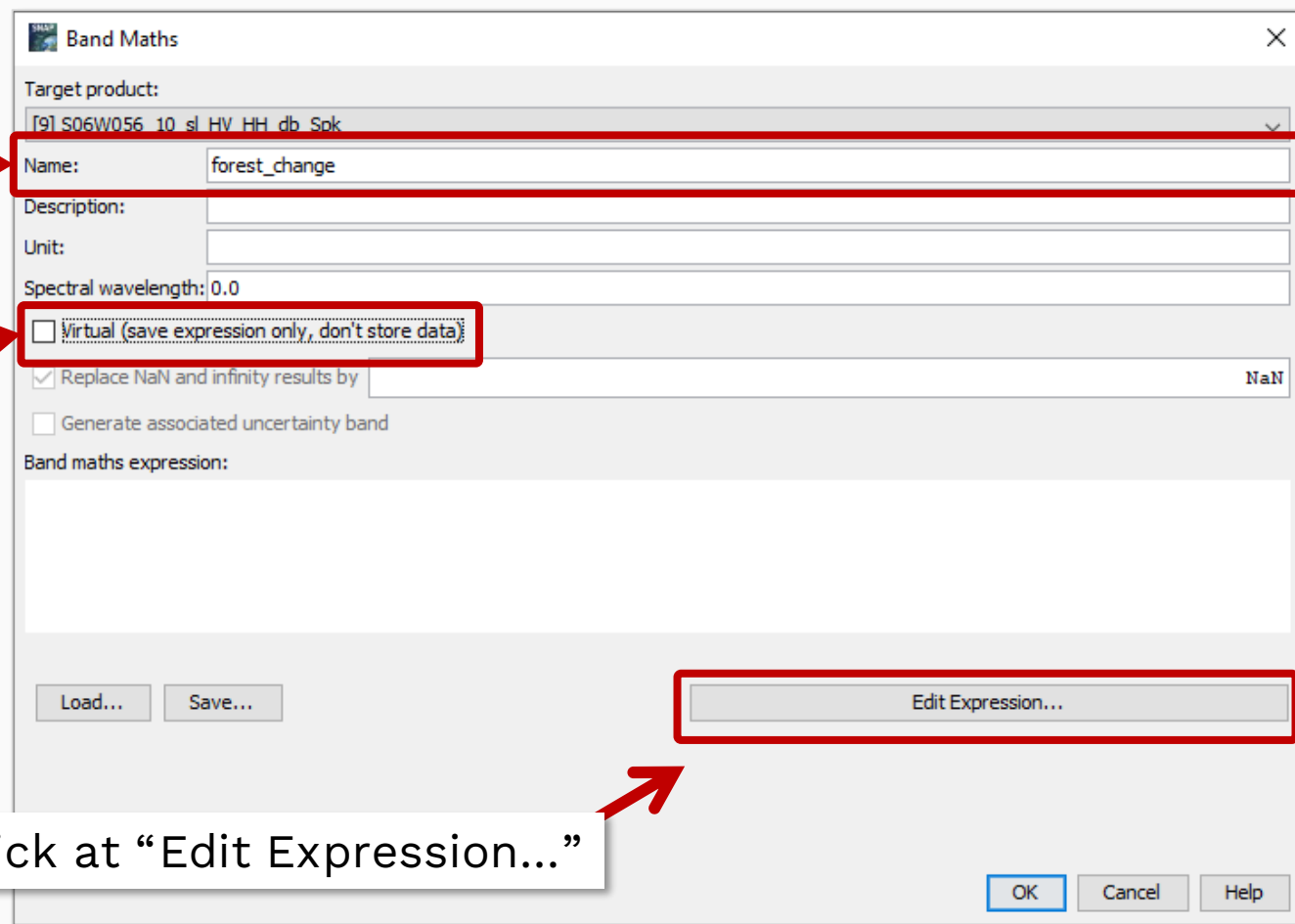


Create Forest Change Product

1) Enter name of new band,
e.g. “forest_change”!

2) Untick this option!

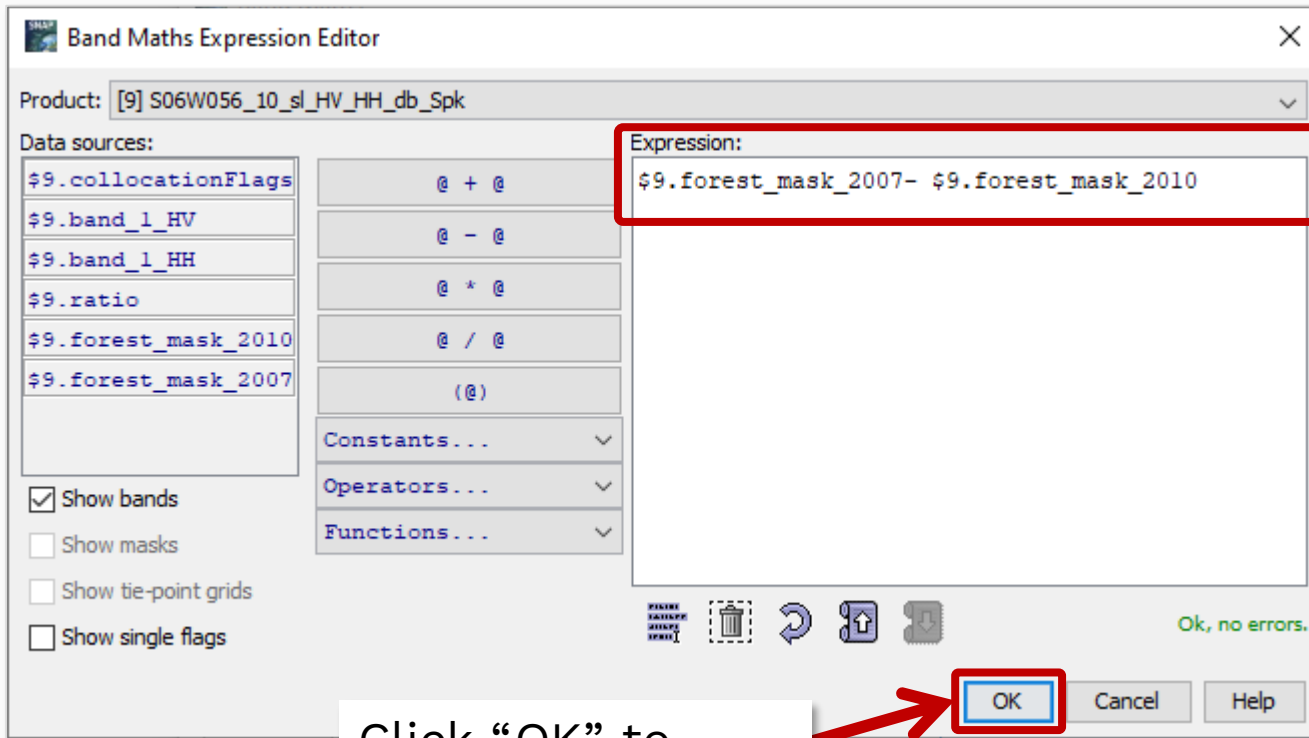
3) Click at “Edit Expression...”



The screenshot shows the 'Band Maths' dialog box with the following fields and options:

- Target product:** [9] S06W056_10_sl_HV_HH_db_Spk
- Name:** forest_change
- Description:** (empty)
- Unit:** (empty)
- Spectral wavelength:** 0.0
- Virtual (save expression only, don't store data)
- Replace NaN and infinity results by NaN
- Generate associated uncertainty band
- Band maths expression:** (empty text area)
- Buttons:** Load..., Save..., Edit Expression..., OK, Cancel, Help

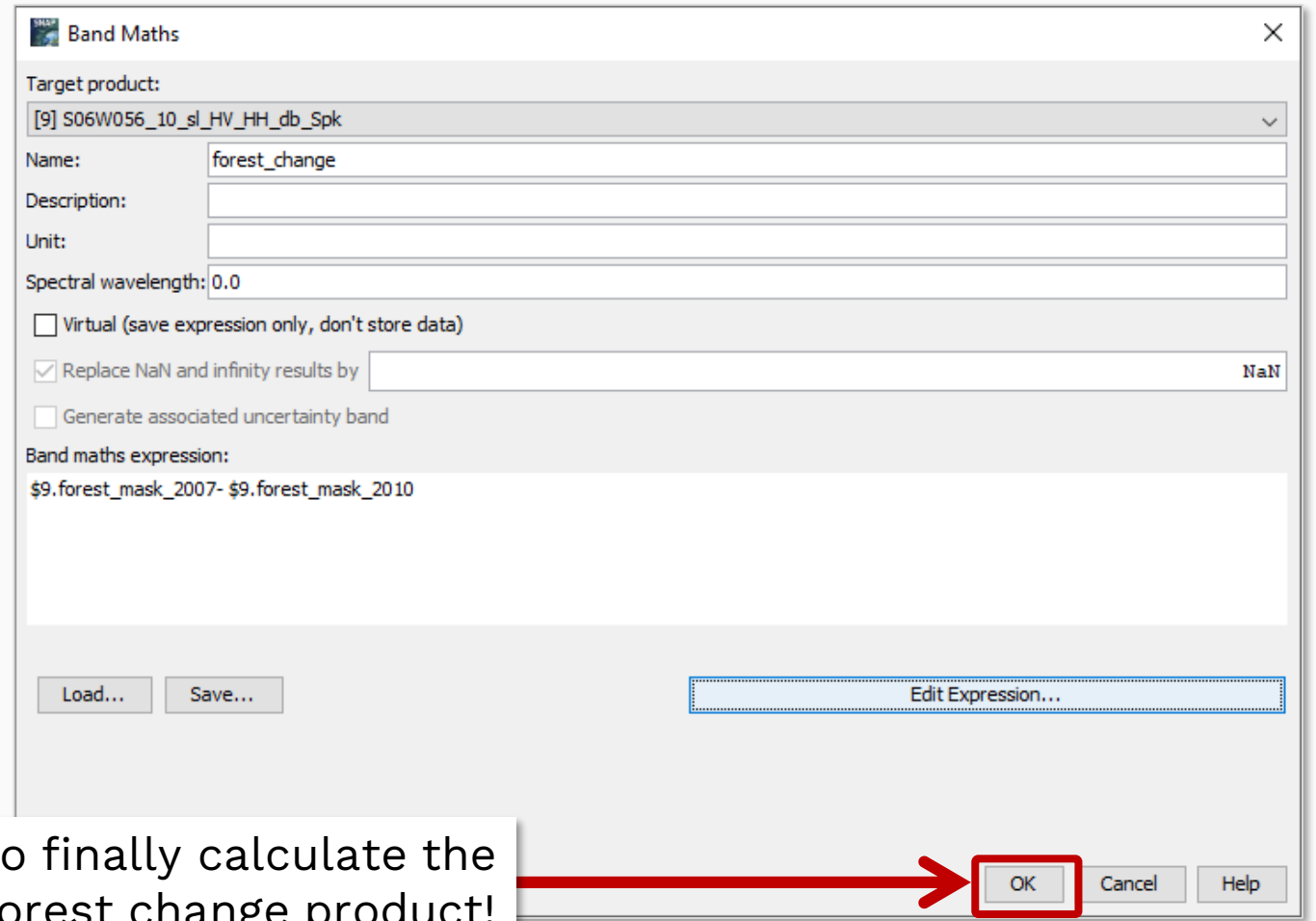
Create Forest Change Product



To calculate the forest change, subtract the 2010 forest-non-forest mask from the 2007 forest-non-forest mask!

Click "OK" to close the window!

Create Forest Change Product



Band Maths

Target product:
[9] S06W056_10_sl_HV_HH_db_Spk

Name: forest_change

Description:

Unit:

Spectral wavelength: 0.0

Virtual (save expression only, don't store data)

Replace NaN and infinity results by NaN

Generate associated uncertainty band

Band maths expression:
\$9.forest_mask_2007- \$9.forest_mask_2010

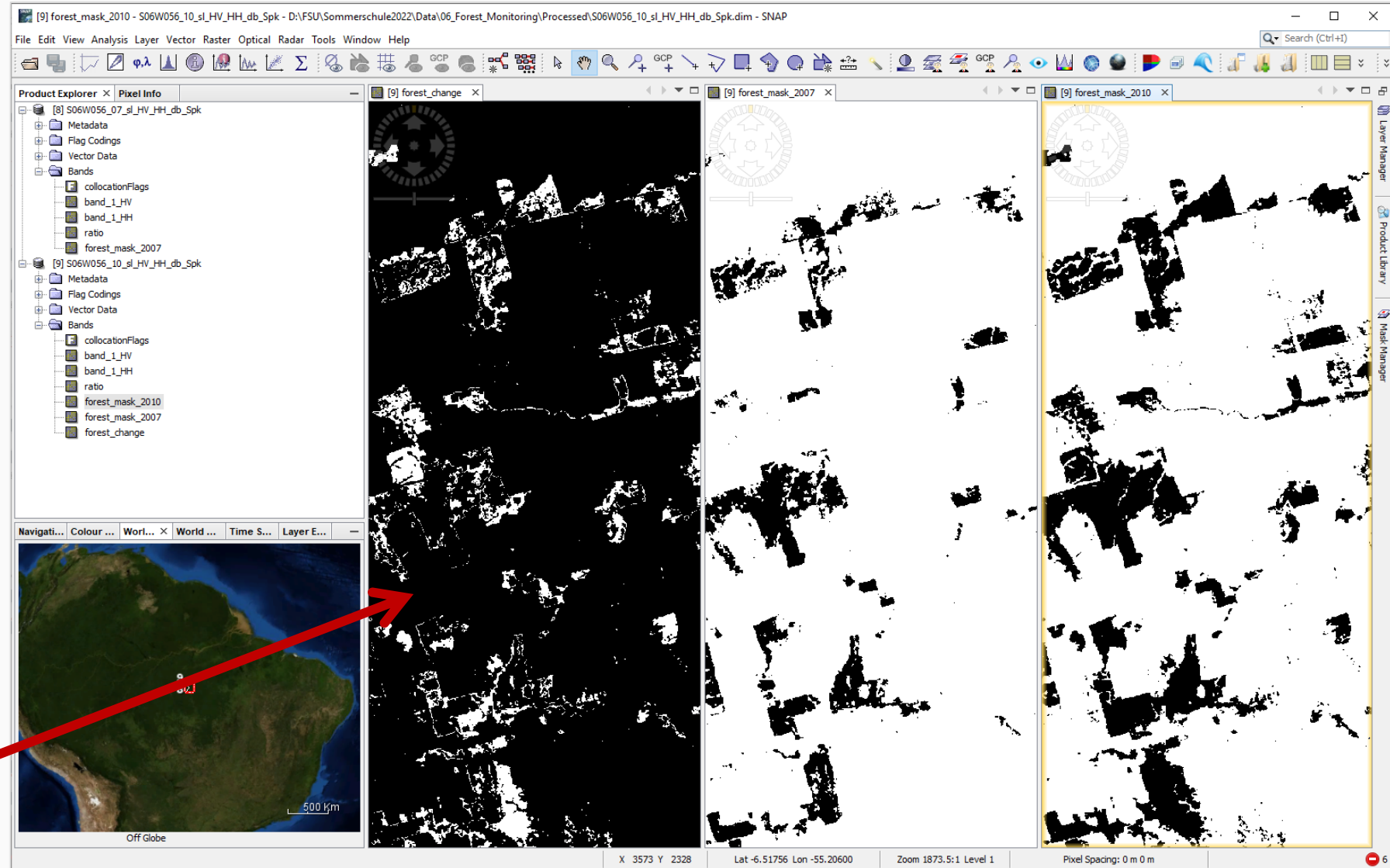
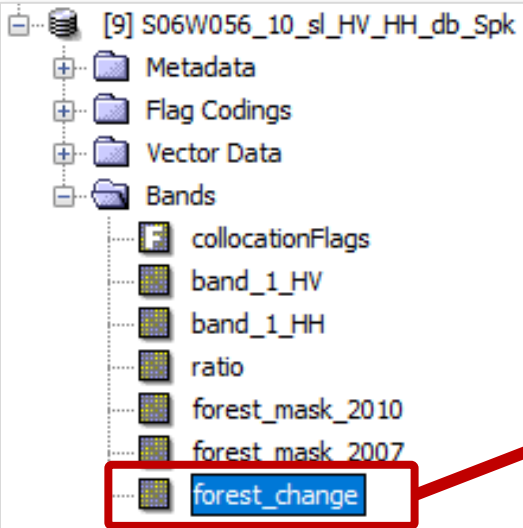
Load... Save... Edit Expression...

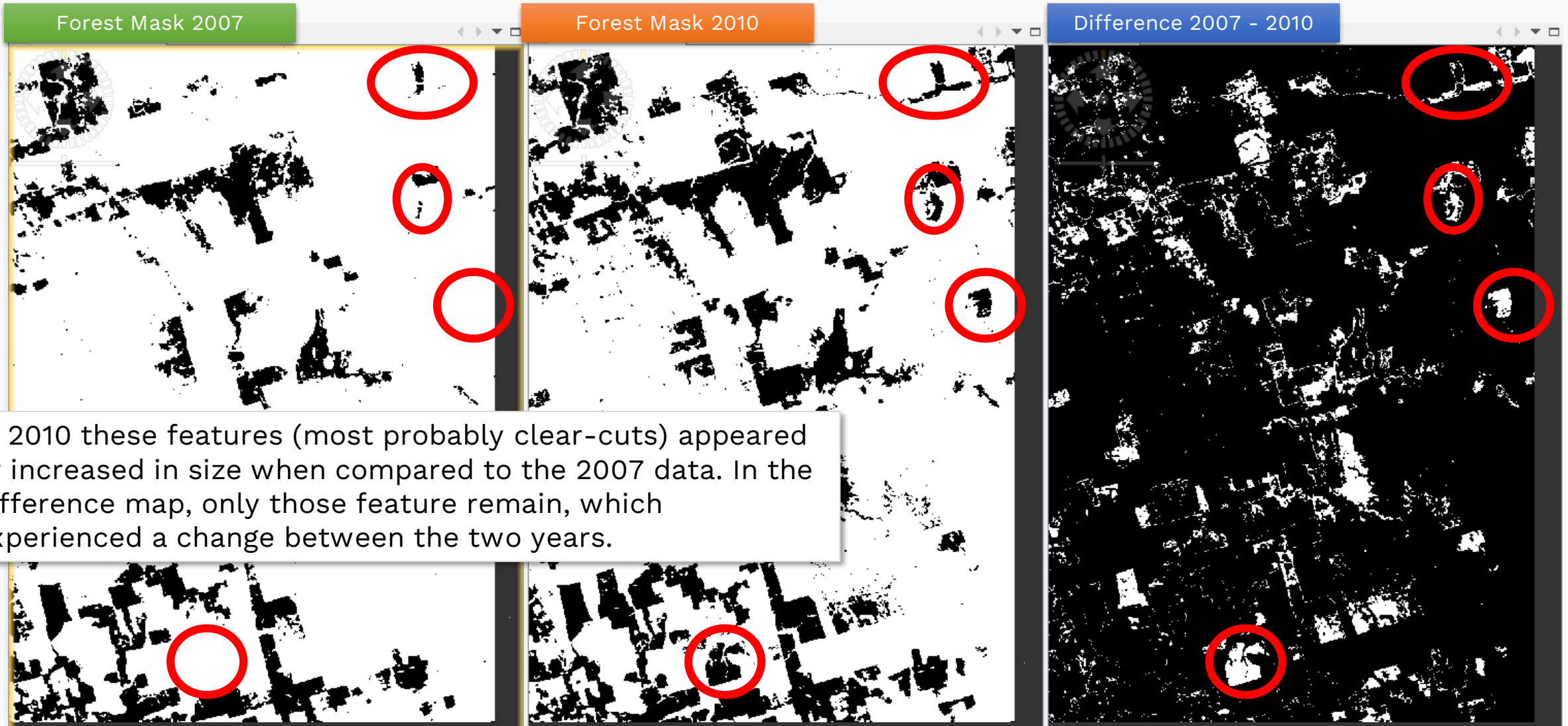
OK Cancel Help

Click "OK" to finally calculate the forest change product!

Create Forest Change Product

As a result, we only get the areas where there was a change between 2077 and 2010.

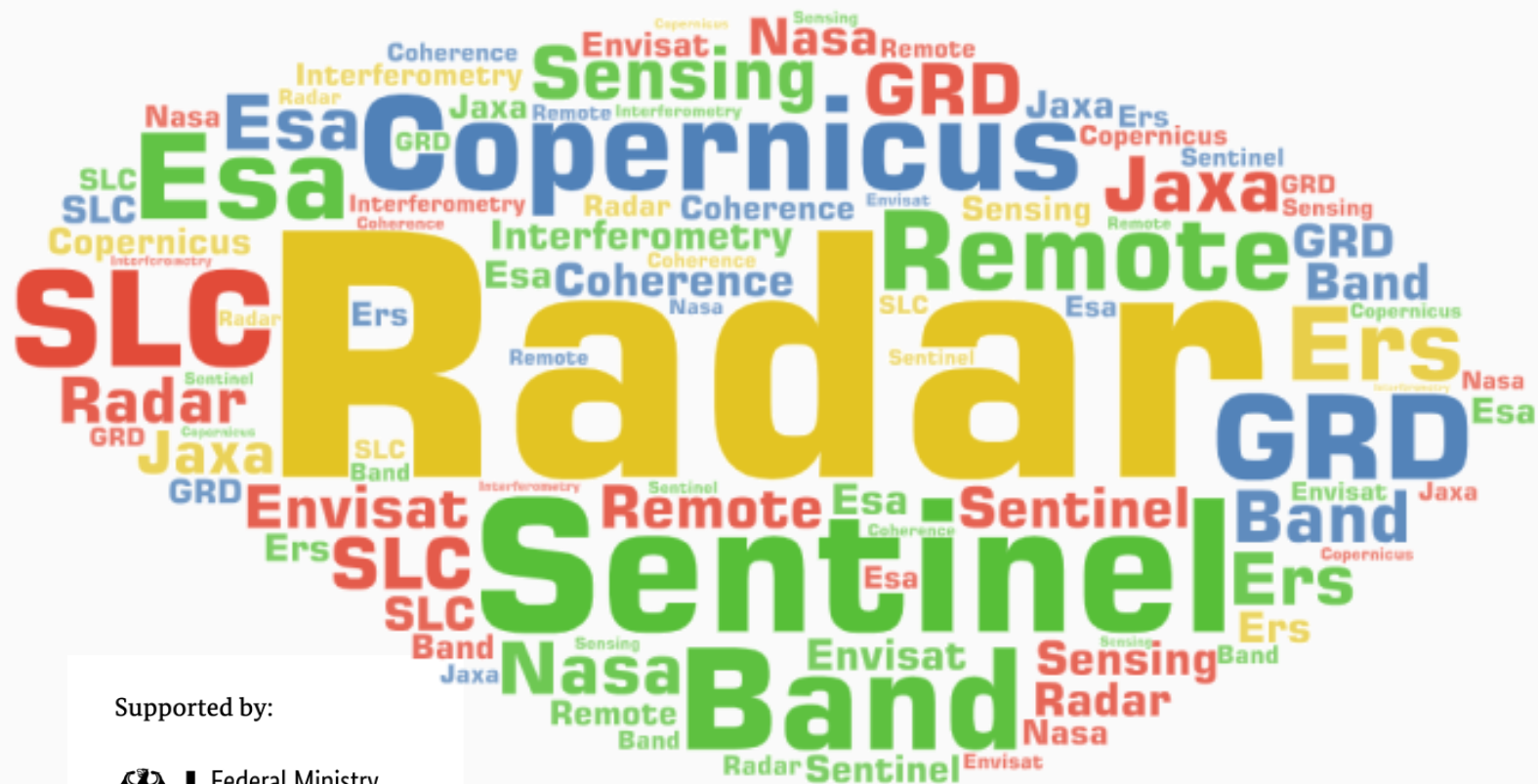




In 2010 these features (most probably clear-cuts) appeared or increased in size when compared to the 2007 data. In the difference map, only those feature remain, which experienced a change between the two years.



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