THE ORFEO TOOLBOX

The open-source swiss knife for remote sensing images processing

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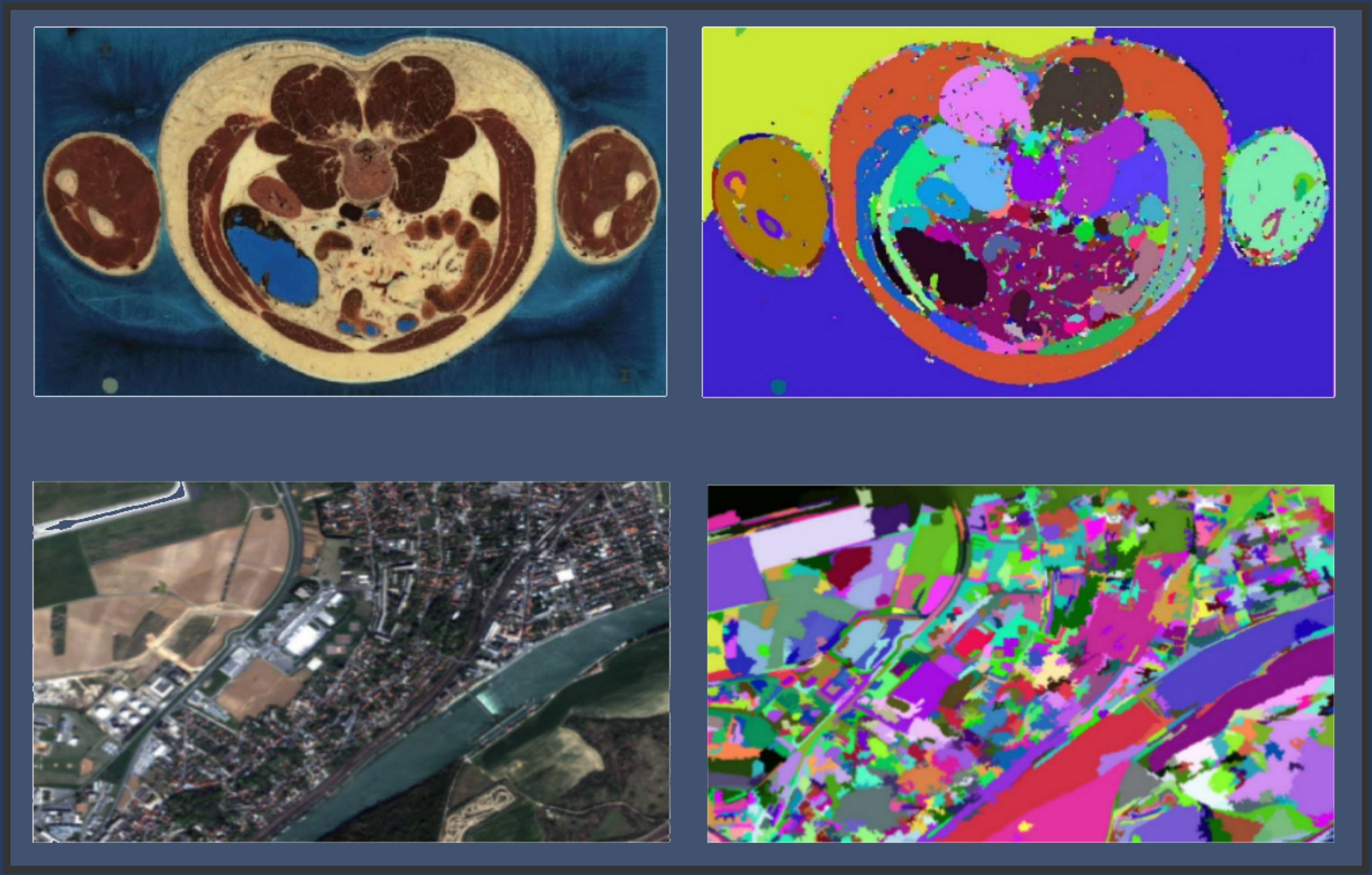
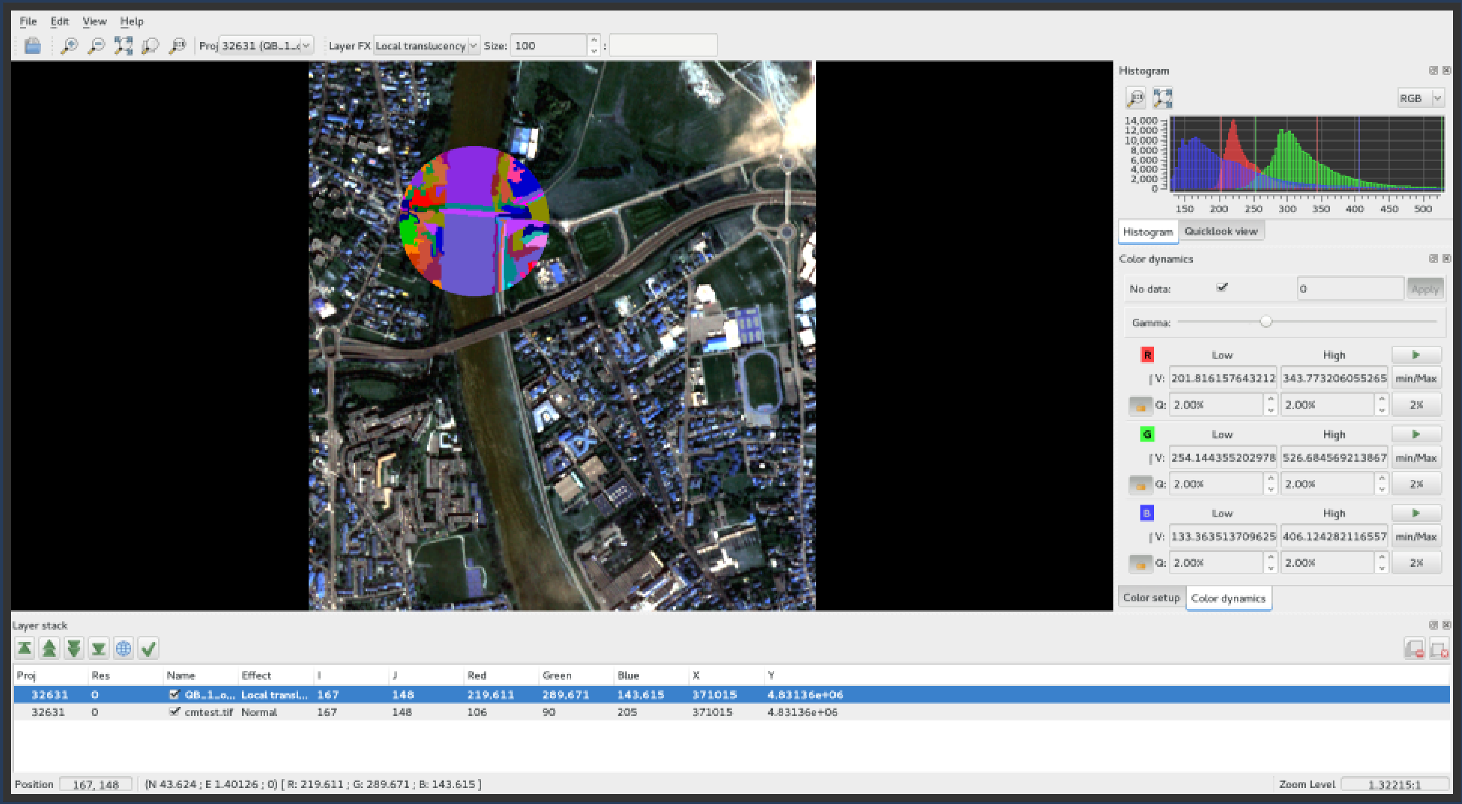
OVERVIEW

WHAT IS ORFEO TOOLBOX?

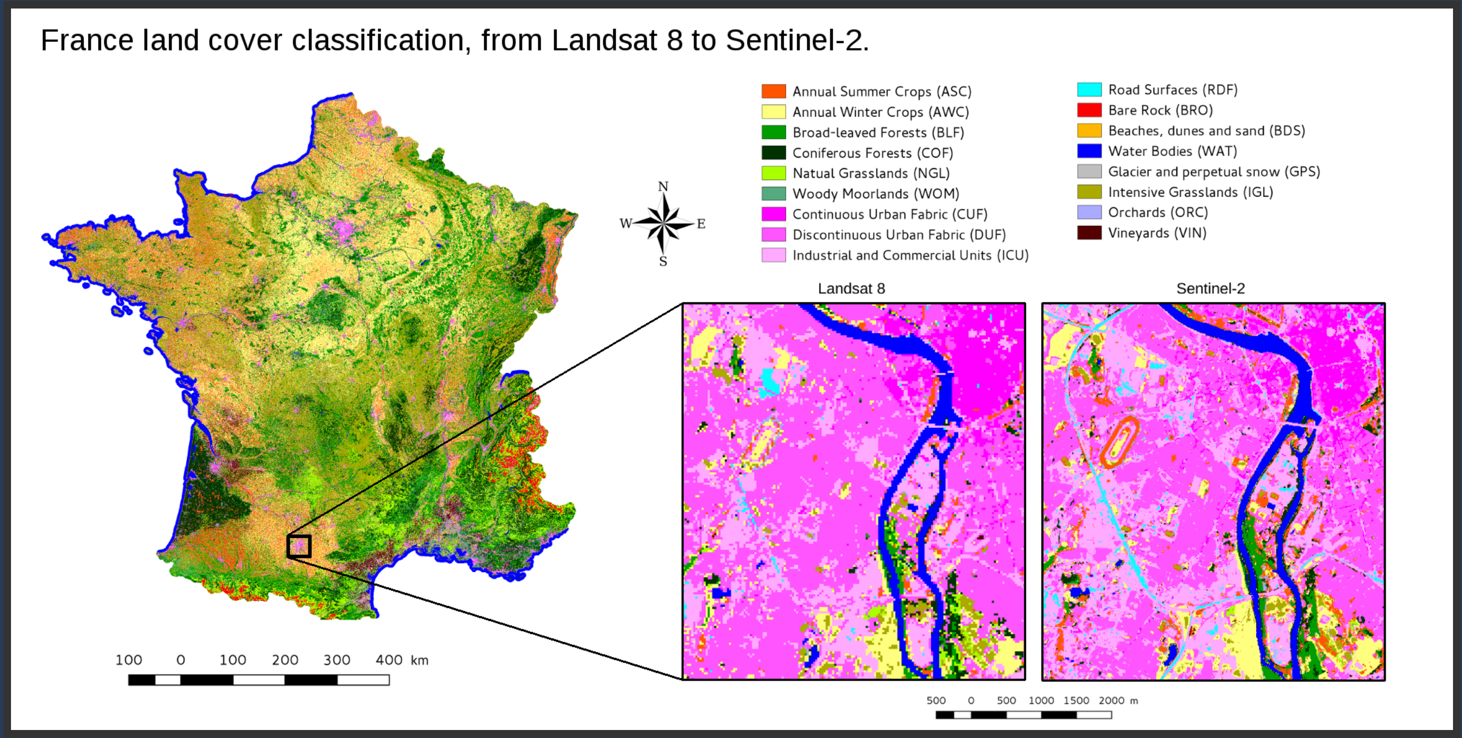
- 90+ remote sensing applications
- Accessible from Bash, GUI, Python, QGIS, Monteverdi, WPS
- Open-source C++ library for image processing
- Built on shoulders of giants (ITK, GDAL, OpenCV, ...)
- Big Data capable, scalable
- Funded and developed by CNES (French Space Agency)
- Used at ESA, mission exploitation platforms, remote sensing labs, teaching...



Taking root in the Insight ToolKit library



Monteverdi : visualization and interaction with OTB applications

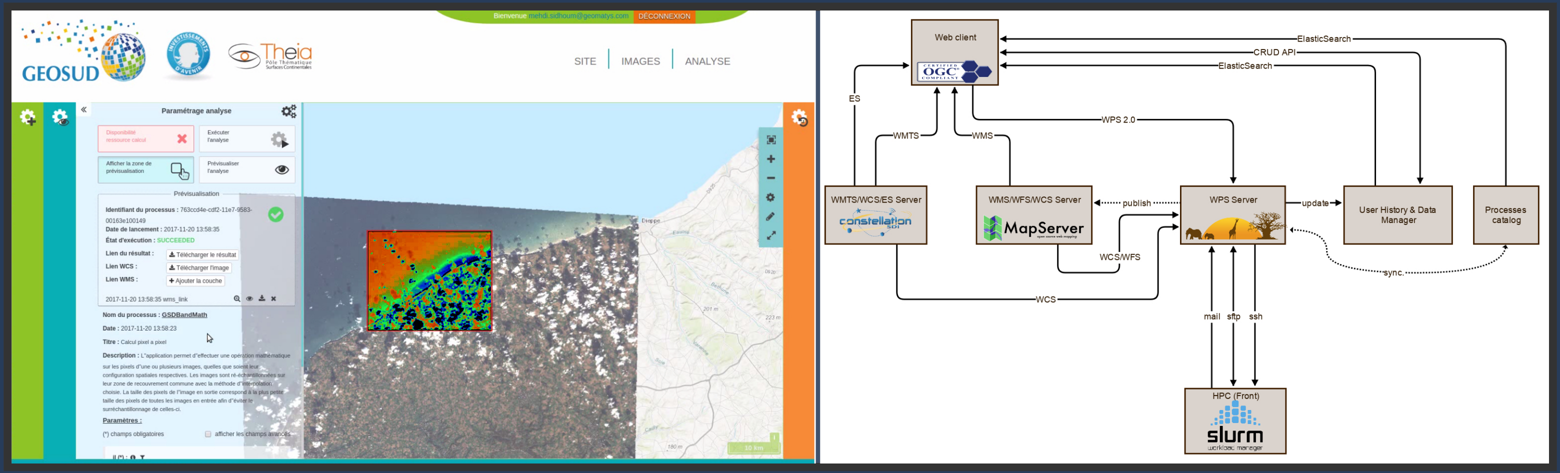


Suitable for large scale processing, land cover mapping at continental scale (Iota2, CESBIO)

http://osr-cesbio.ups-tlse.fr/~oso/

Mosaics of hundreds of very high resolution scenes (GEOSUD)

http://ids.equipex-geosud.fr/



THEIA Geospatial Data Infrastructure remote processing features

http://ids.equipex-geosud.fr/

FEATURES

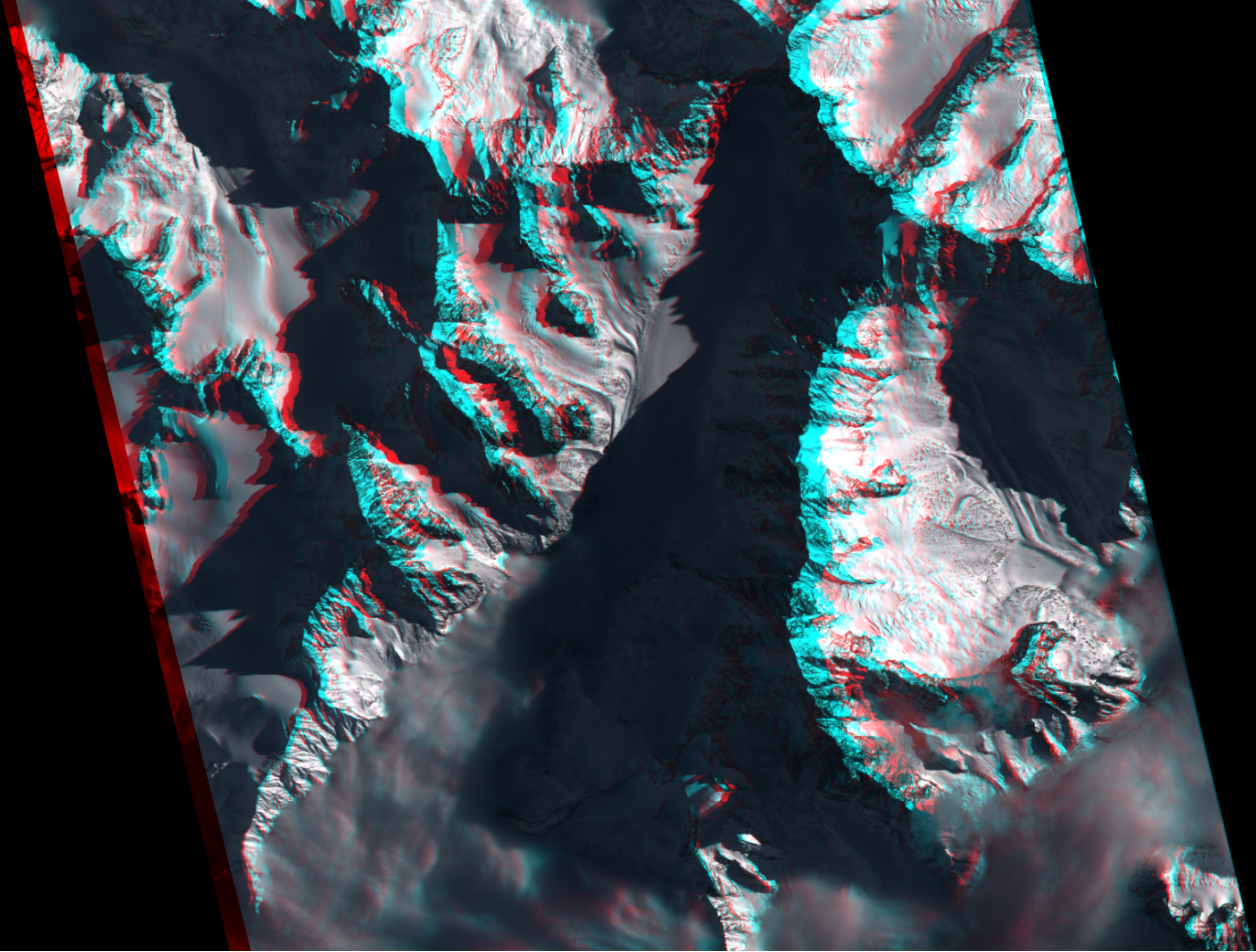
WHAT IS INSIDE THE BOX?

- C++ classes, functions
- User-oriented applications
- Mutli language versatile API (C++, python, ...)

PRE-PROCESSING

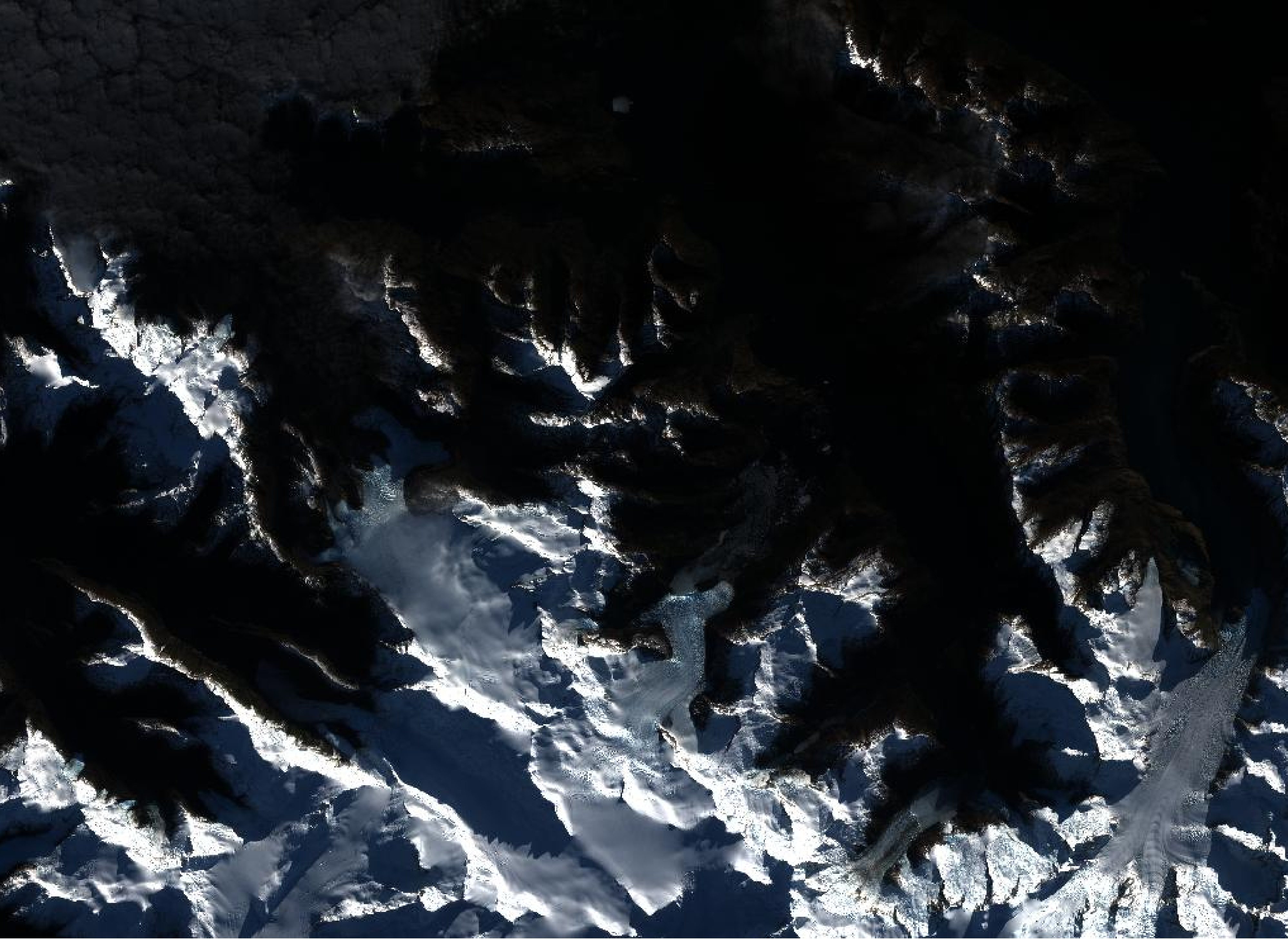
- Radiometric calibration
- Orthorectification
- Resampling
- Pan-sharpening
- Stereo rectification

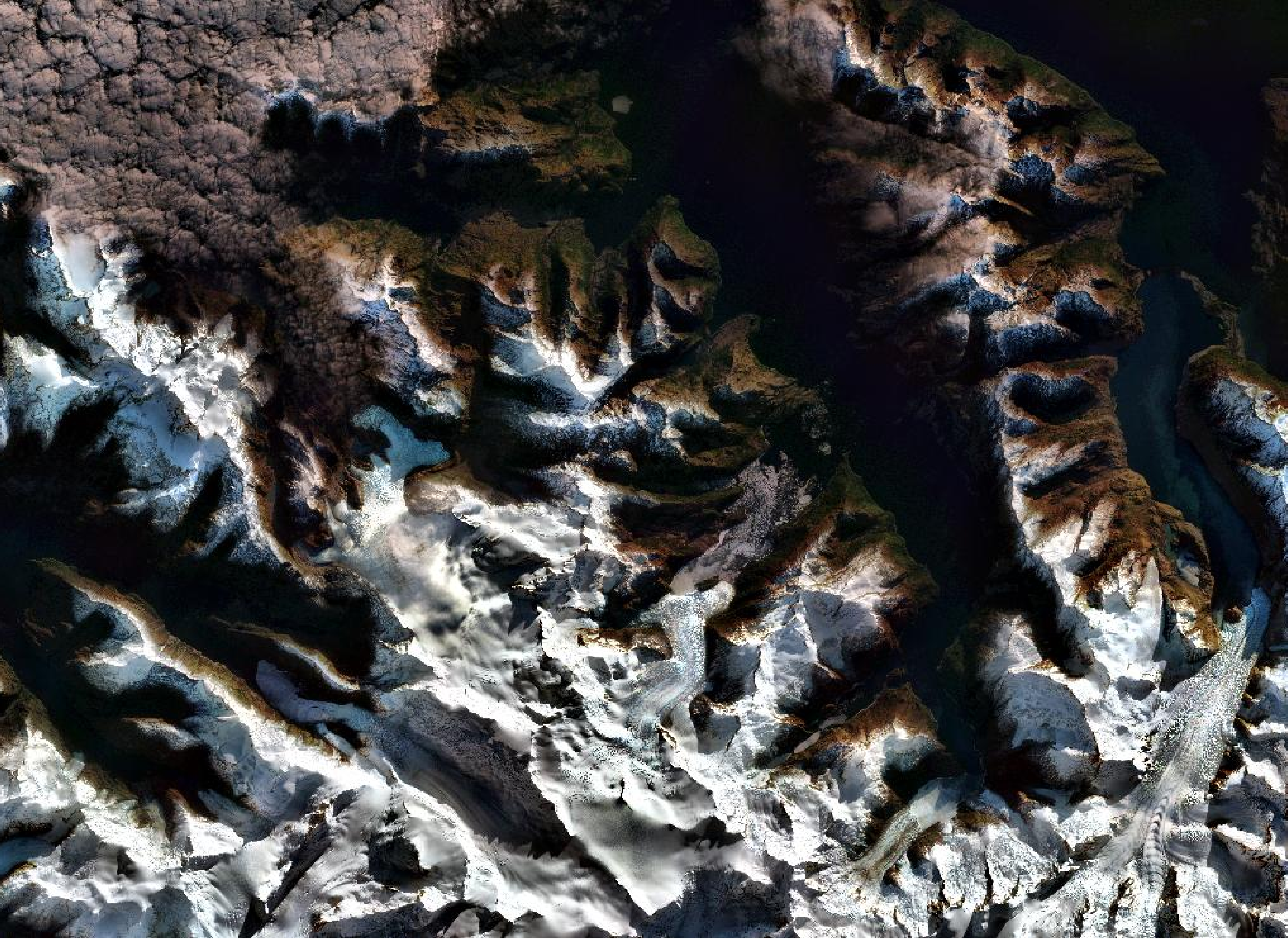
Sensors supported: Sentinels, Pléiades, SPOT5/6/7, Digital Globe satellites Geometric models (thanks to OSSIM), support for DEM (SRTM or GeoTIFF)

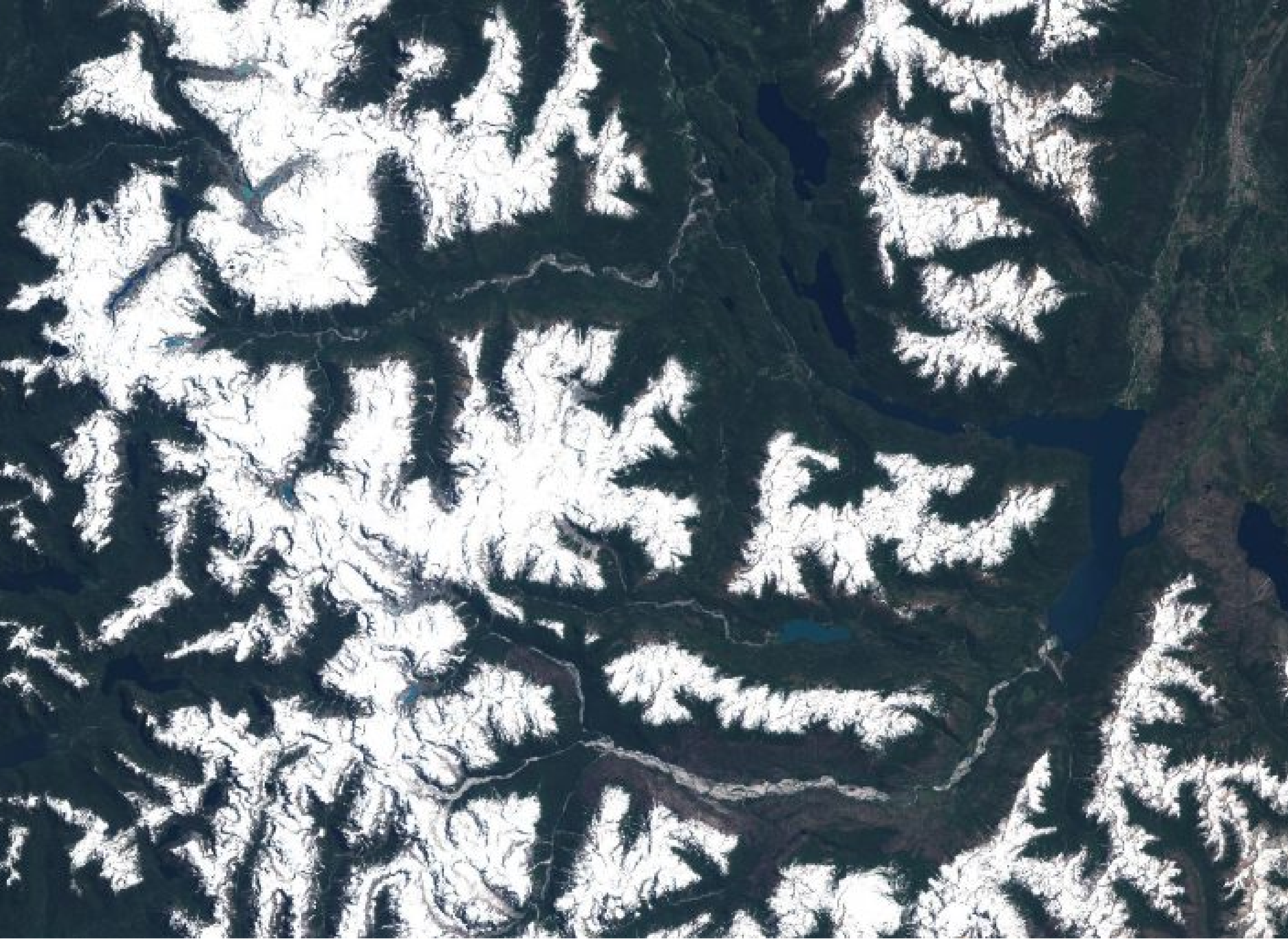


IMAGES AND VECTOR MANIPULATION

- Conversion of raster and vector (GDAL formats)
- ROI/bands extraction, concatenation, splitting, ...
- Band math, color mapping, contrast enhancement, mosaicing, ...
- Linear filtering, Mathematical morphology, ...

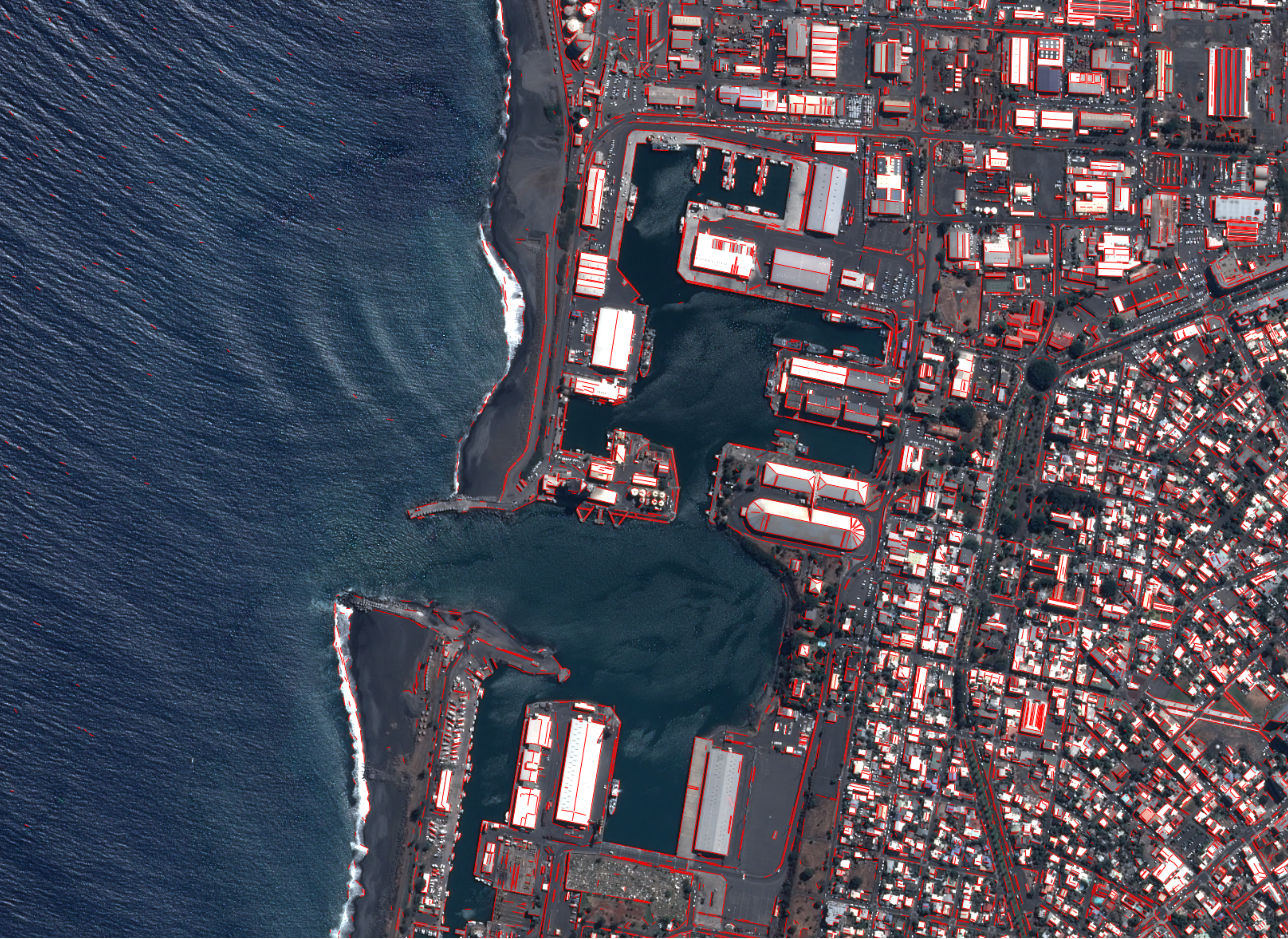






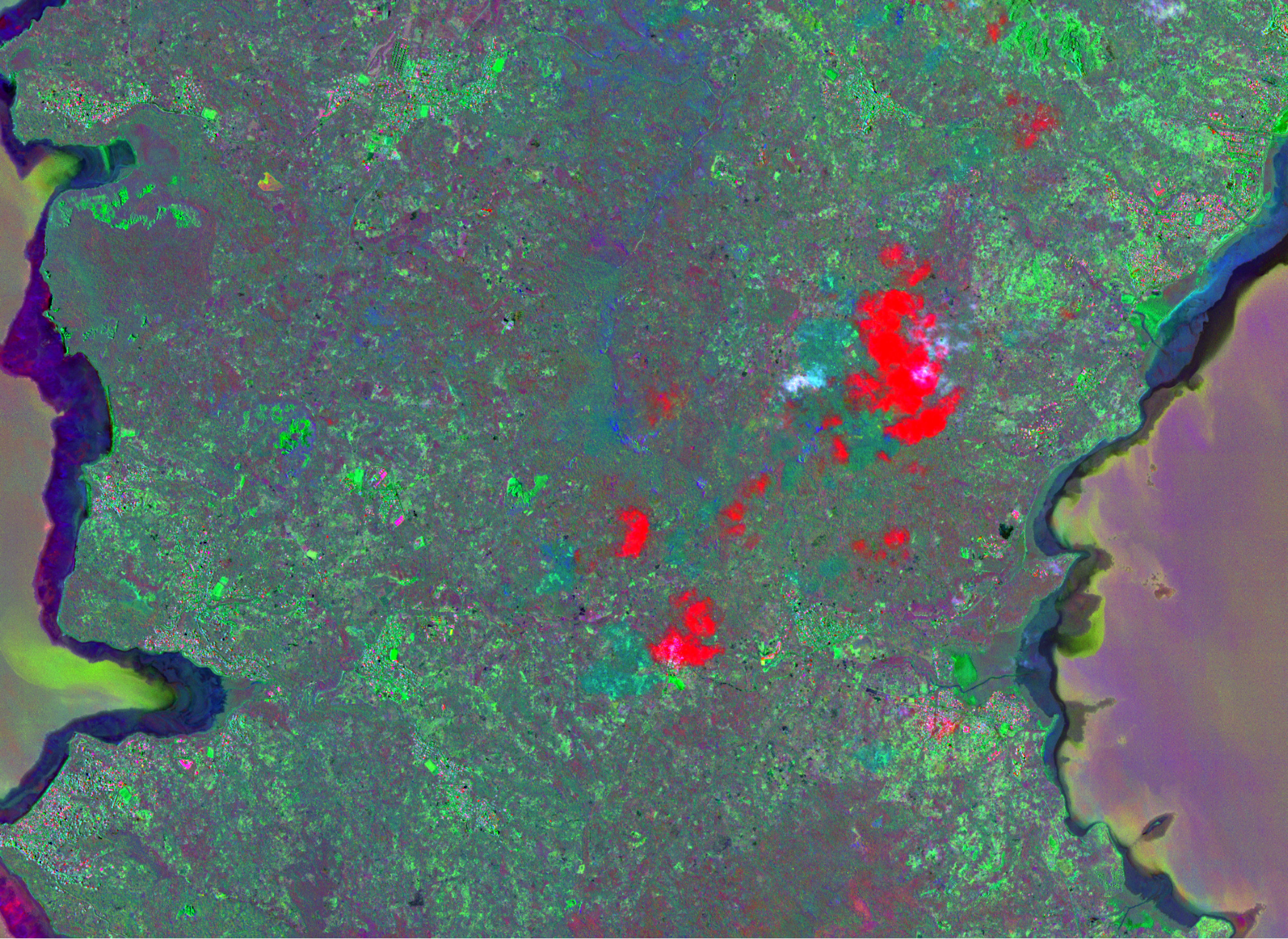
FEATURE EXTRACTION

- Edge detection, scale-invariant feature transform, lines, corners
- Radiometric indices, textures (Haralick, SFS, PanTex)
- Local statistics (Flusser moments, Histogram of Oriented Gradient)
- Keypoints matching (SIFT, SURF. . .)



CHANGE DETECTION

- Classic methods with image metrics comparison
- Multivariate Alteration Detector

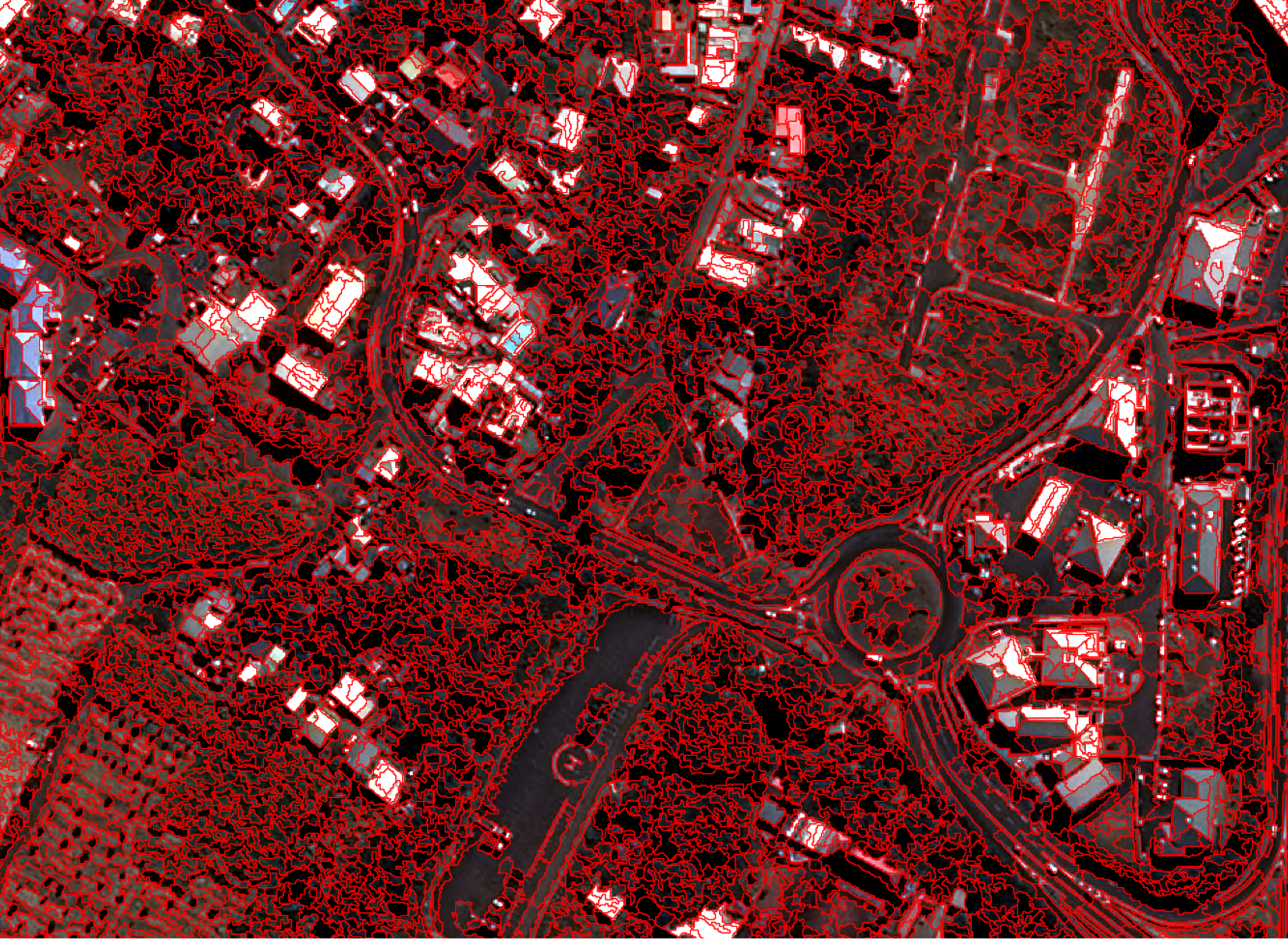


DIMENSIONALITY REDUCTION, HYPERSPECTRAL PROCESSING

- PCA, NAPCA, ICA, MAF, ...
- Dimension estimation, endmembers extraction, Vertex Component Analysis

SEGMENTATION

- Segmentation algorithms : Connected Components, MeanShift, Watershed, GRM, ...
- Methods to apply those algorithms on large dataset
- Vector or raster representation which allow Object Based Image Analysis



CLASSIFICATION

- 9 supervised methods available (including SVM and Random Forests)
- Fusion and regularization of classifications
- K-Means clustering or Kohonen maps
- Object classification (from a segmentation)

INTERACTION

INSTALLATION

Supported platforms:

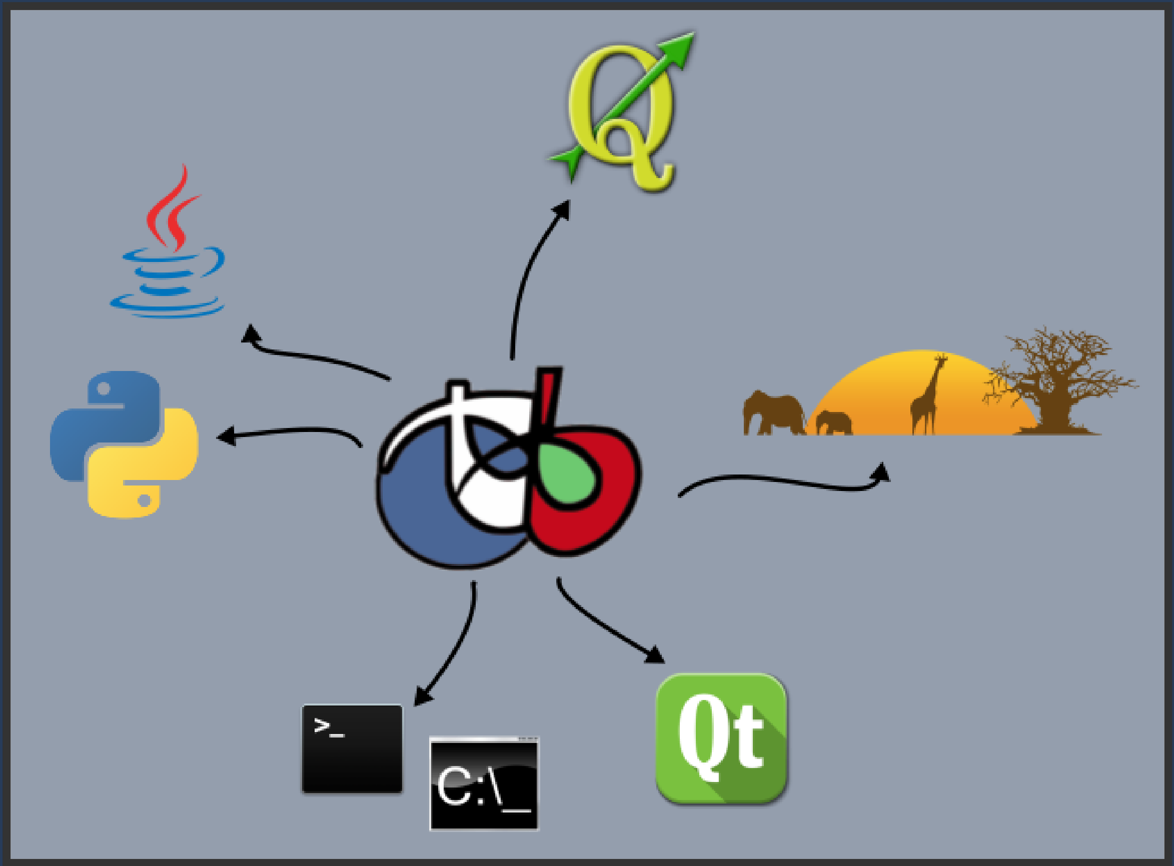
- Windows
- Linux
- Mac OS

SUPPORT

Help and support:

- OTB website (CookBook, User Guide, Python Doc, ...) orfeo-toolbox.org
- OTB Users group
- OTB Developers group
- OTB Gitlab
- Stackexchange (#otb, #otb-applications, ...)

INTERFACES



Type	Value	Description
Integer	<int32>	32bits signed integer. Example : maximum iterations number.
Real	<float>	Single pecision floating point. Example : distance in cartographic units.
String	<string>	String. Example : field name.
Strings list	<string list>	Multiple strings.
Input file	<string>	A file of any kind, as input to an algorithm. For example: a classification rule contained in a text file.
Input files list	<string list>	Multiple input files.
Output file	<string>	A file of any kind, at the output of an algorithm. For example: a text file containing statistics.
Folder	<string>	A folder accessible on the file system of the machine.
Choice	<int32>, <float> or <string>	An entry among the elements of a list of values. For example: in the list {manual; Automatic}, a possible choice is "automatic"
Input image	<string>	An input image, in a format supported by GDAL
List of input images	<string list>	Multiple input images
Input vector data	<string>	An input vector data, in a format supported by GDAL
List of input vector data	<string list>	Multiple vector data
Output image [Pixel type]	<string> [<string>]	This parameter includes a string for the path to the output file and a pixel type for setting the pixel encoding of the output image. We will return to this parameter in section 2.2 of this chapter.
Output vector data	<string>	An output vector data, in a format supported by GDAL / OGR.
Radius	<int32>	The radius of a pixel neighborhood, in pixels per column and per line. For

Applications parameters types

COMMAND LINE INTERFACE

To get help (example with the Convert application:

- otbcli_Convert (quick help)
- otbcli_Convert -help (long help)
- otbcli_Convert -help -param (parameter "param" long description)

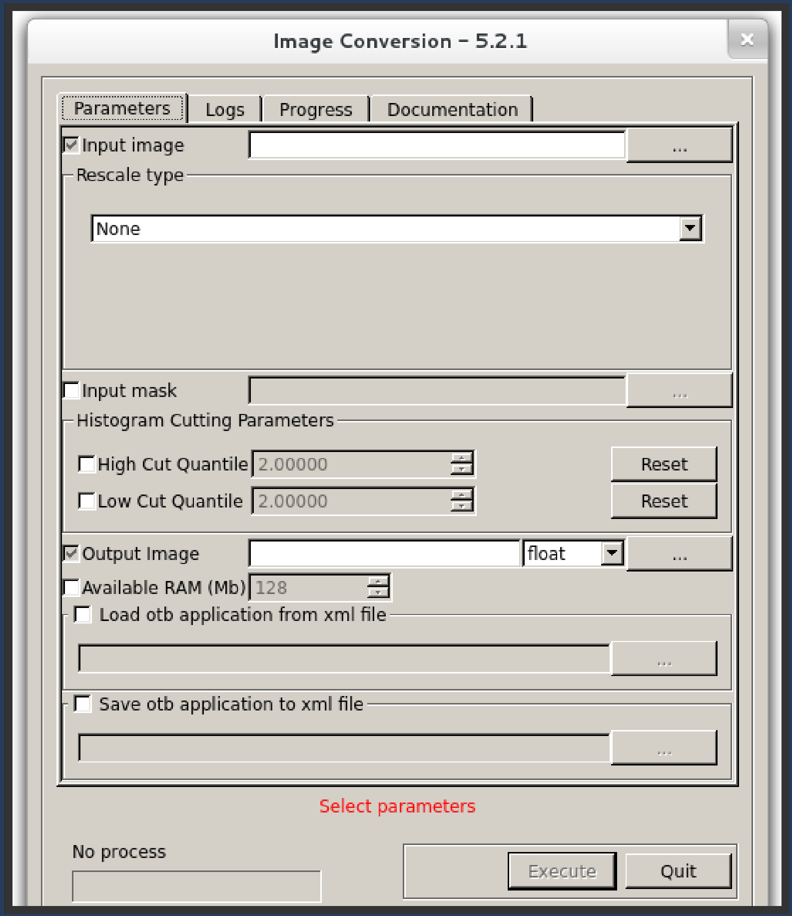
```
This is the Convert application, version 5.11.0
Convert an image to a different format, eventually rescaling the data and/or
changing the pixel type.

Complete documentation: http://www.orfeo-
toolbox.org/Applications/Convert.html

Parameters:
        -progress          <boolean>        Report progress
MISSING -in                <string>         Input image  (mandatory)
        -type              <string>         Rescale type [none/linear/log2]
(mandatory, default value is none)
        -type.linear.gamma <float>          Gamma correction factor
(optional, on by default, default value is 1)
        -mask              <string>         Input mask  (optional, off by
default)
        -hcp.high          <float>          High Cut Quantile  (optional,
off by default, default value is 2)
        -hcp.low           <float>          Low Cut Quantile  (optional, off
by default, default value is 2)
MISSING -out               <string> [pixel] Output Image
[pixel=uint8/uint16/int16/uint32/int32/float/double] (default value is
float) (mandatory)
        -ram               <int32>          Available RAM (Mb)  (optional,
off by default, default value is 128)
        -inxml             <string>         Load otb application from xml
file  (optional, off by default)

Examples:
otbcli_Convert -in QB_Toulouse_Ortho_XS.tif -out
otbConvertWithScalingOutput.png uint8 -type linear
```

>

Name	Type	Value	Mandatory	Default value
progress	boolean[3]	<boolean>		
in	Input image	<string[4]>	Yes	
type	Choice	<string>		« none »
type.linear.gamma	Floating point number	<float>		1
mask	Input image	<string>		
hcp.high	Floating point number	<float>		2
hcp.low	Floating point number	<float>		2
out	Output image	<string>[<string>]	Yes	pixel=float
ram	Integer	<int32>		128
xml	InputProcessXML	<string>		

The Convert application parameters

GRAPHICAL USER INTERFACE



The OTB GUI of the Convert application

PYTHON BINDINGS

- Parametrize and run any OTB application
- Set/Get Input/Output images as Numpy arrays
- Chain in-memory multiple OTB applications together

Name	Designation
uint8	8 bits unsigned integer. Values range : [0 ; 255]
int16	16 bits signed integer. Values range : [-32 768 ; 32 7678]
uint16	16 bits unsigned integer. Values range : [0 ; 65 535]
int32	32 bits signed integer. Values range : [-2 147 483 648; 2 147 483 647]
uint32	32 bits unsigned integer. Values range : [0 ; 4 294 967 295]
float	Single precision floating point (32 bits)
double	Double precision floating point (64 bits)

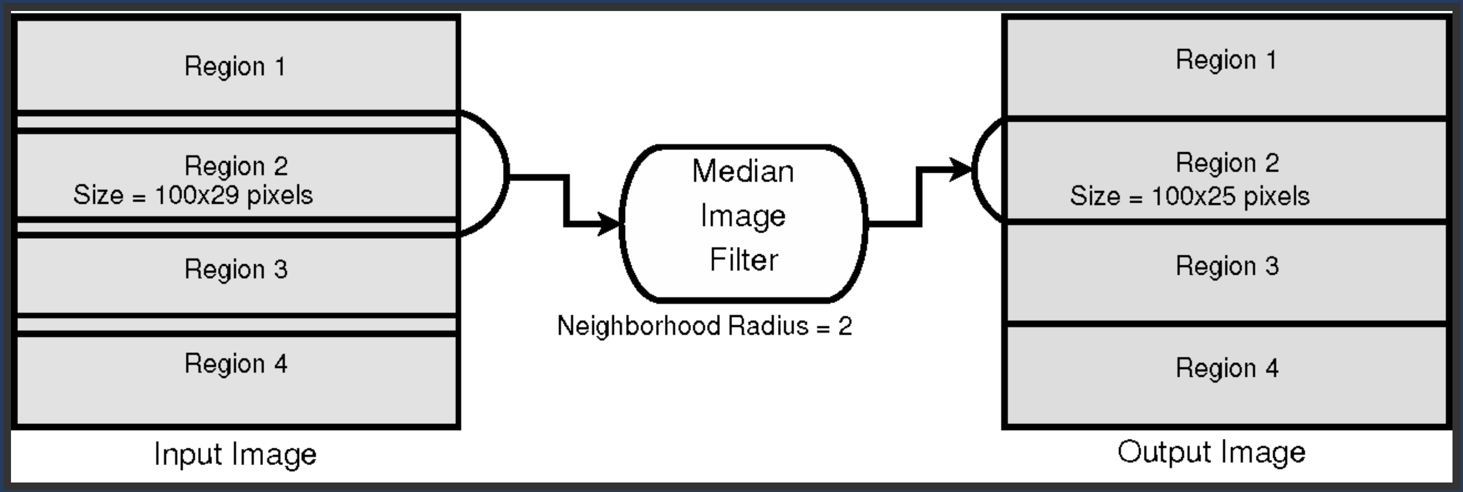
The encoding option of output images parameter

EXTENDED FILENAMES

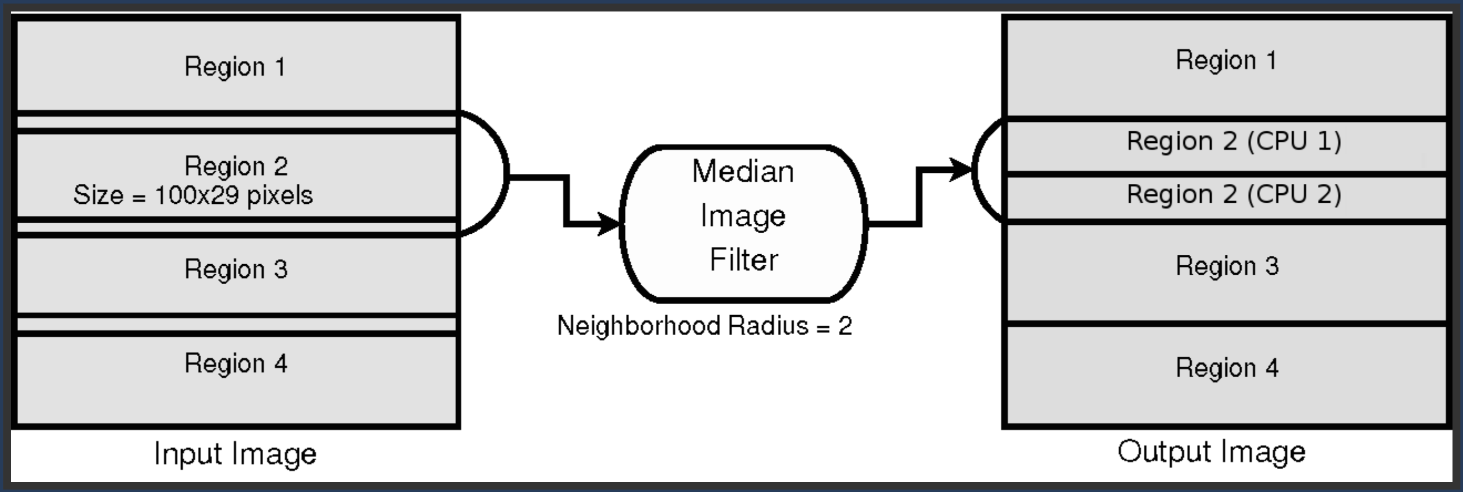
- …/out.tif?&box=startx:starty:sizex:sizey
- …/out.tif?&gdal:co:COMPRESS=DEFLATE

GUTS

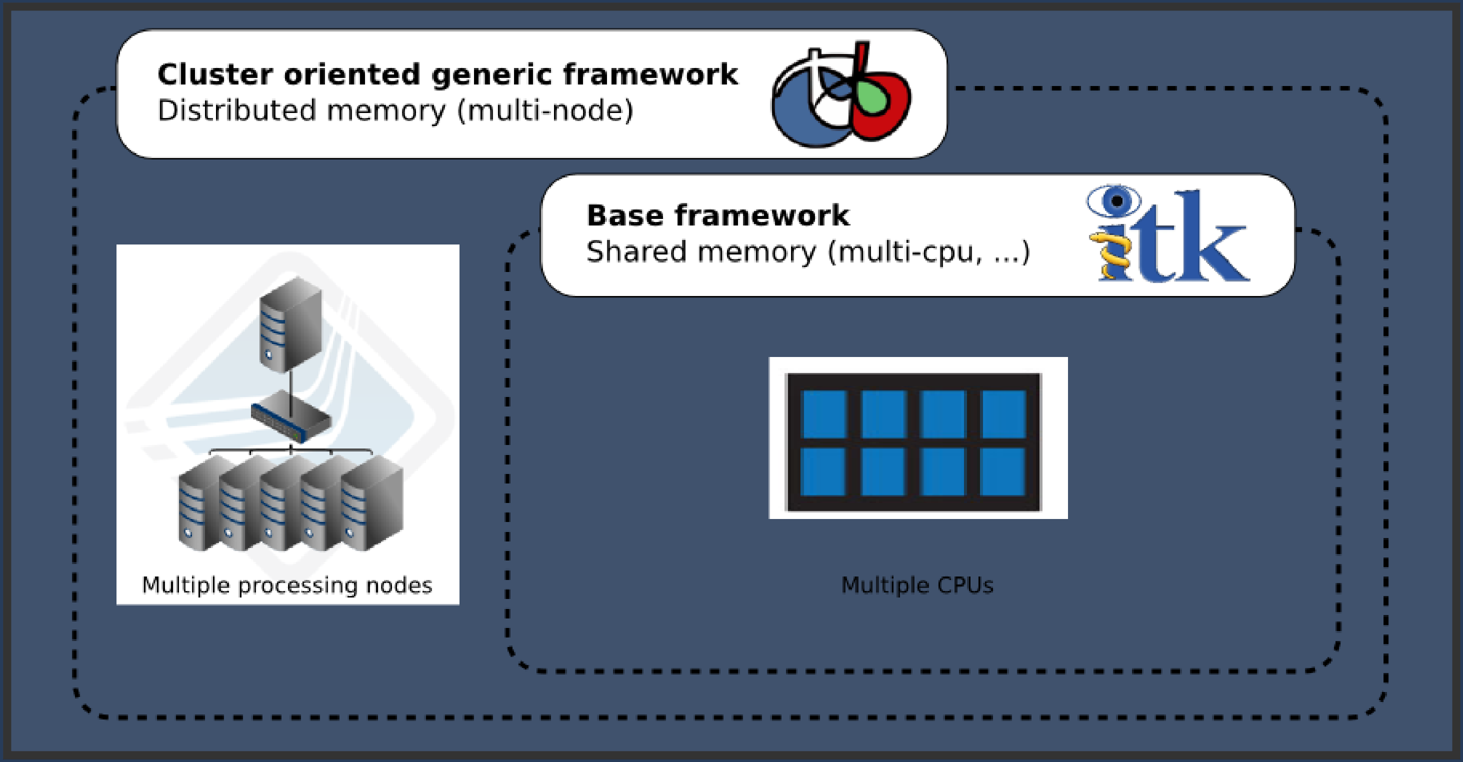
INTERNAL MECHANISMS



The streaming mechanism



Multithreading : process the data with multiple CPUs



Suitable for High Performance Computing architectures like clusters

REMOTE MODULES

WHAT IS REMOTE MODULE?

- Pieces of OTB code (filters, applications ...)
- That can be hosted on any git repository
- With a different licence
- While still being tested and packaged with OTB

Wanna create your own? gitlab.orfeo-toolbox.org/remote_modules/remote-module-template

OFFICIAL REMOTE MODULES

- Feature selection (IRD, INP Bordeaux)
- Generic kernel SVM (CNES)
- Generic Region Merging (GRM): segmentation (CESBIO)
- Mosaic : image mosaicing (IRSTEA)
- Large-scale feature selection with Gaussian mixture models (ENSAT, DYNAFOR)
- Object oriented image analysis (SERTIT)
- otb-bv : Estimation of bio-physical variables with OTB (CESBIO)
- Phenotb (CESBIO)
- Temporal gap-filling (CESBIO)

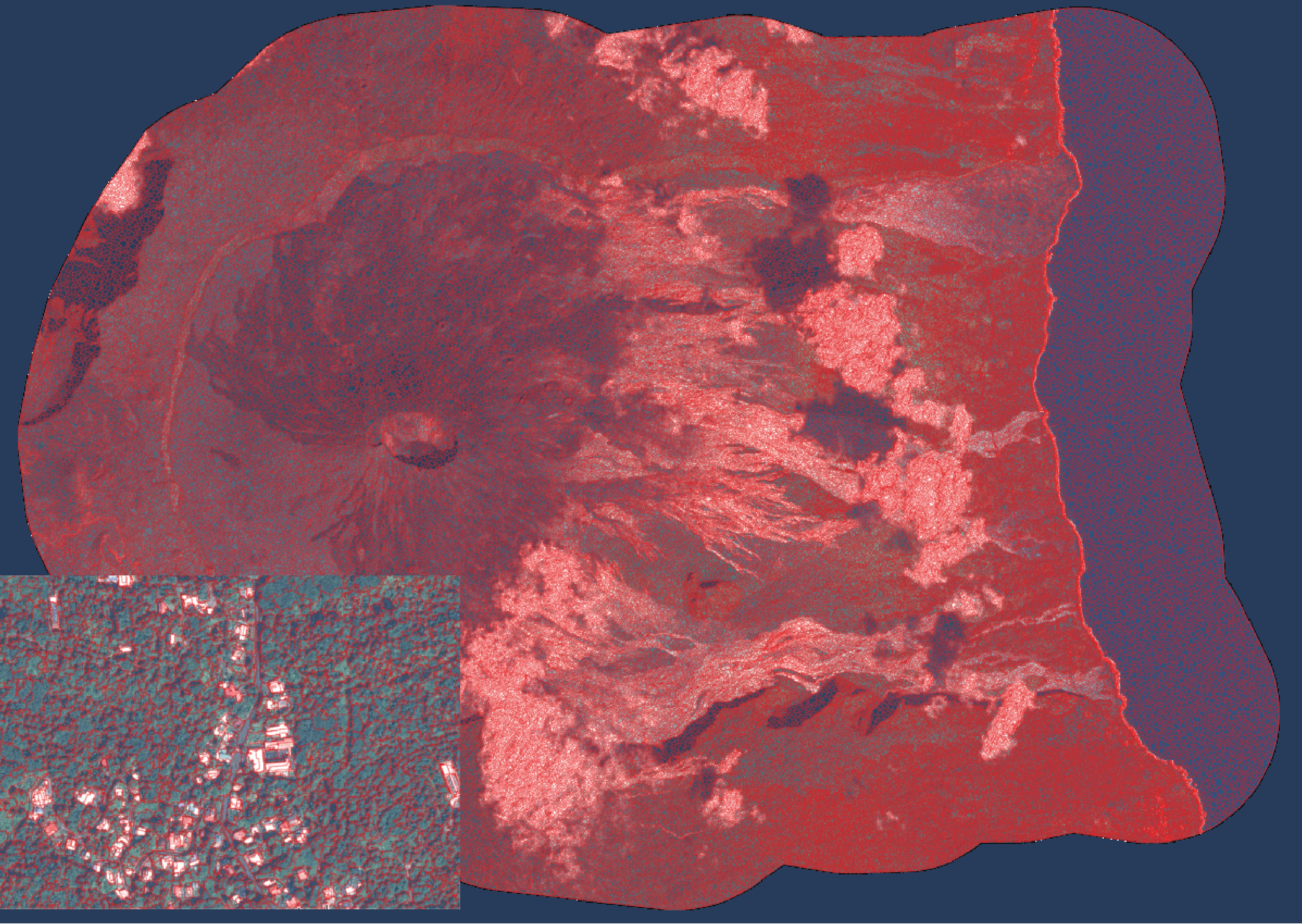
NEW REMOTES MODULES

- LSOBIA: large scale segmentation (CESBIO, CNES, IRSTEA, THALES)
- DiapOTB: interferometry with SAR (CNES, THALES)
- S1 Tiling: preprocess S1 images (CESBIO)
- Soil moisture: retrieve soil moisture from S1 and S2 images (IRSTEA)
- OTBTF: deep learning (IRSTEA)

LSOBIA

- Multithreaded (shared memory context)
- Suited to HPC cluster (distributed memory context)

35k x 25k x 4 PHR 1A XS: 16 minutes (32 nodes of HAL), 3221k polygons



DIAPOTB

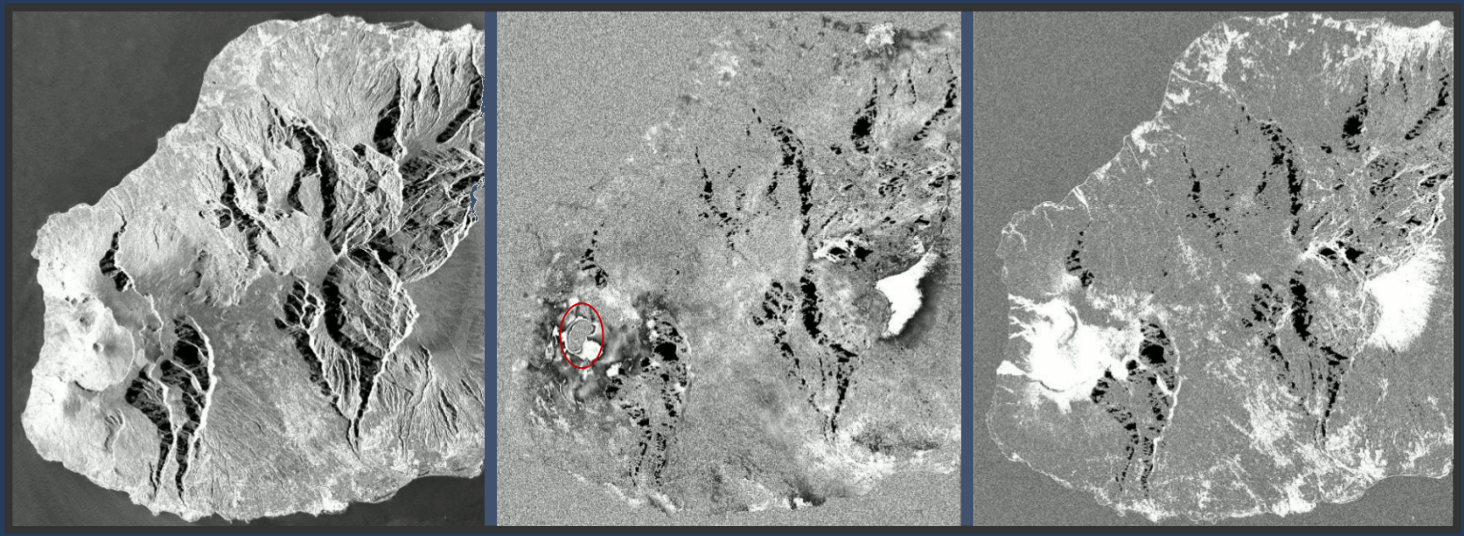
General SAR Applications

- Doppler0 estimation
- MultiLook
- Simulation of SAR image from Digital Elevation Model
- Projection of Digital Elevation Model into SAR geometry

Specific Interferometry Applications

- Deformation grids creation
- CoRegistration
- Interferogram

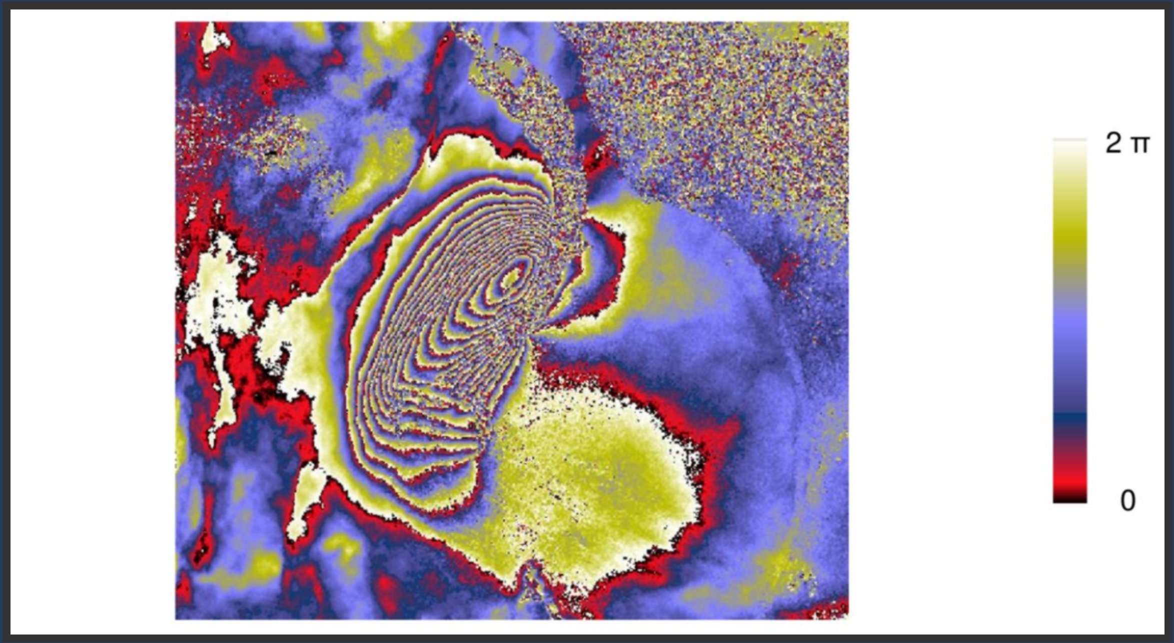
DIAPOTB



Amplitude, Phase, Coherence

(Gaelle Usseglio, Thales services, 2018)

DIAPOTB



Displacement near piton de la fournaise between input images taken on 2016/08/18 and 2016/09/29 with S1-A and S1-B respectivily.

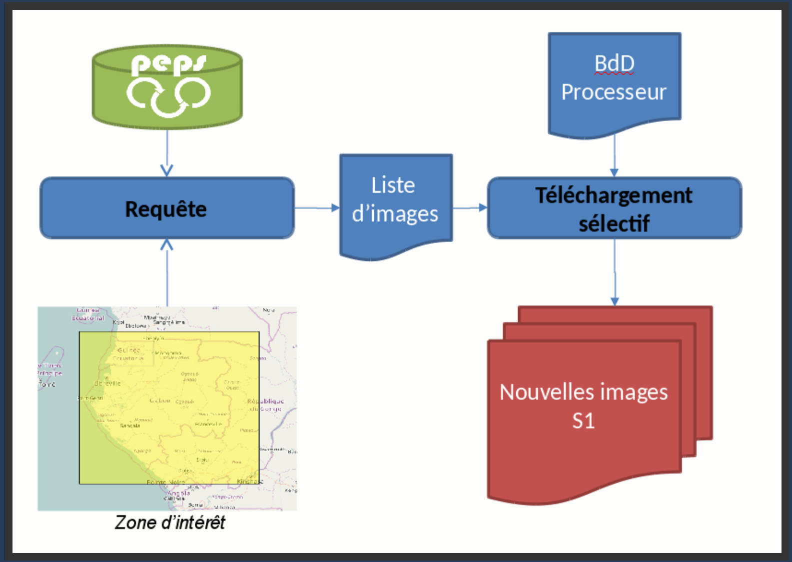
(Gaelle Usseglio, Thales services, 2018)

S1 TILING

From a given region of interest:

- Download S1 images
- Process S1 images
- Temporal filtering of S1 images

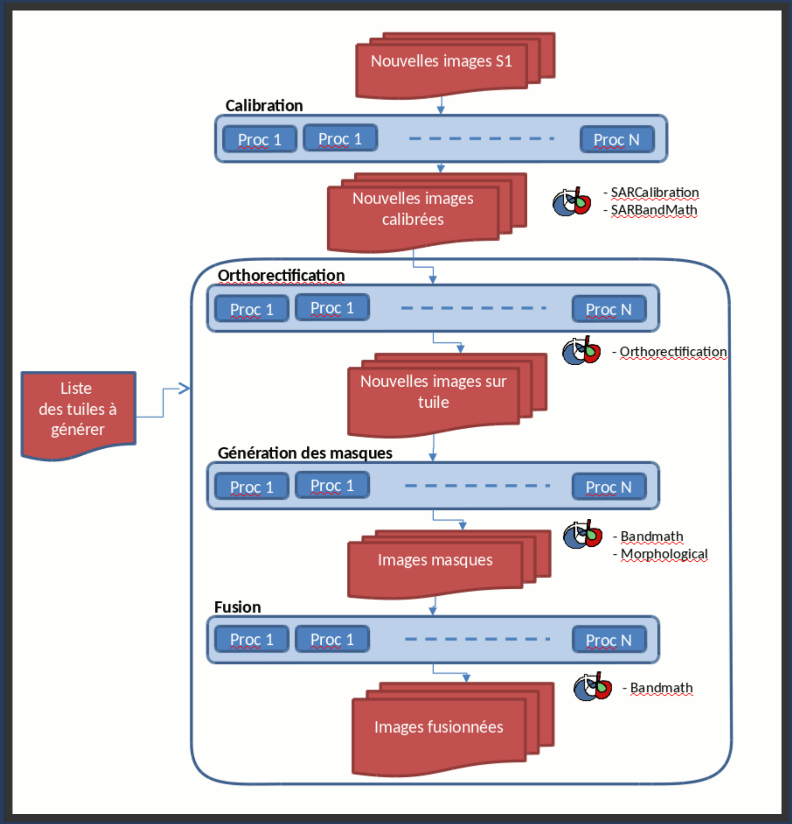
S1 TILING



Step 1: download images

(Thierry Koleck, CESBIO, 2018)

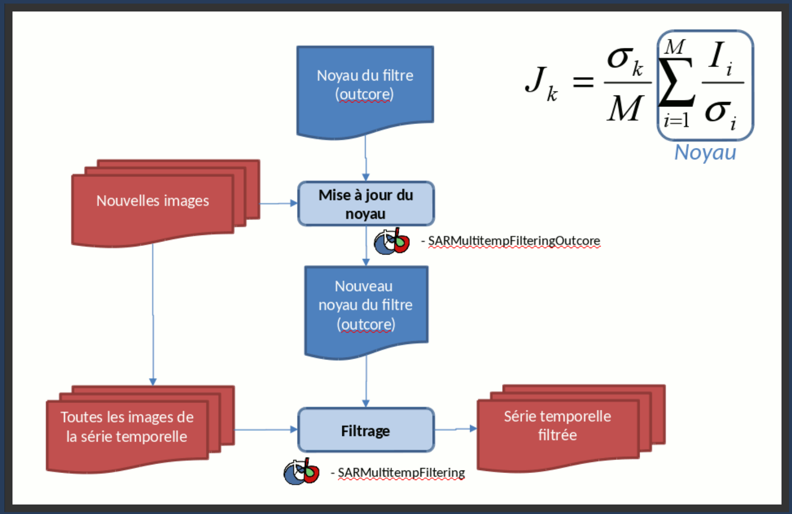
S1 TILING



Step 2: process images

(Thierry Koleck, CESBIO, 2018)

S1 TILING



Step 3: temporal filtering

(Thierry Koleck, CESBIO, 2018)

S1 TILING

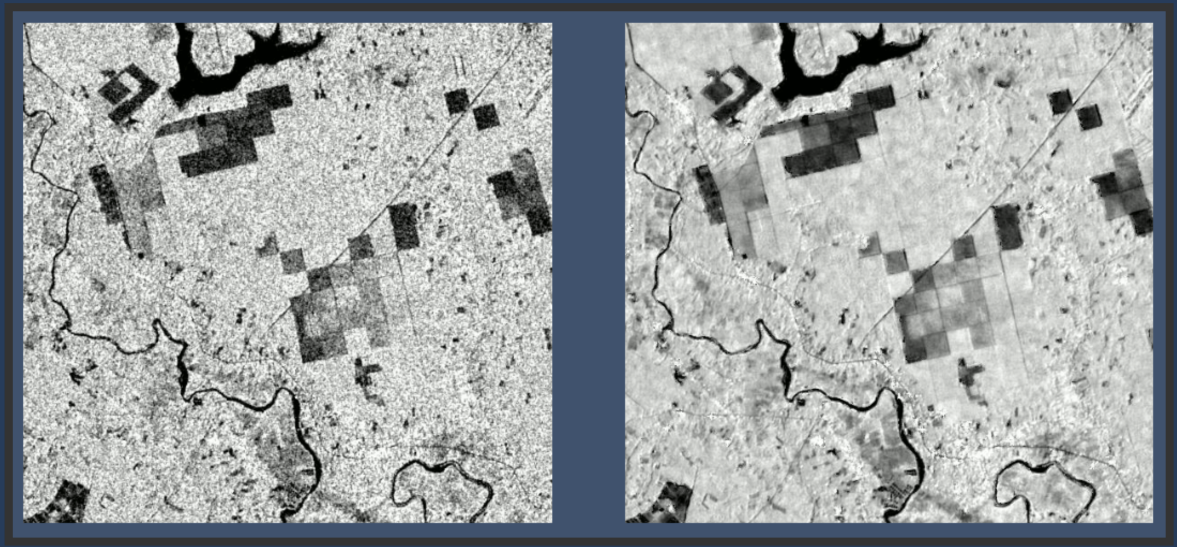


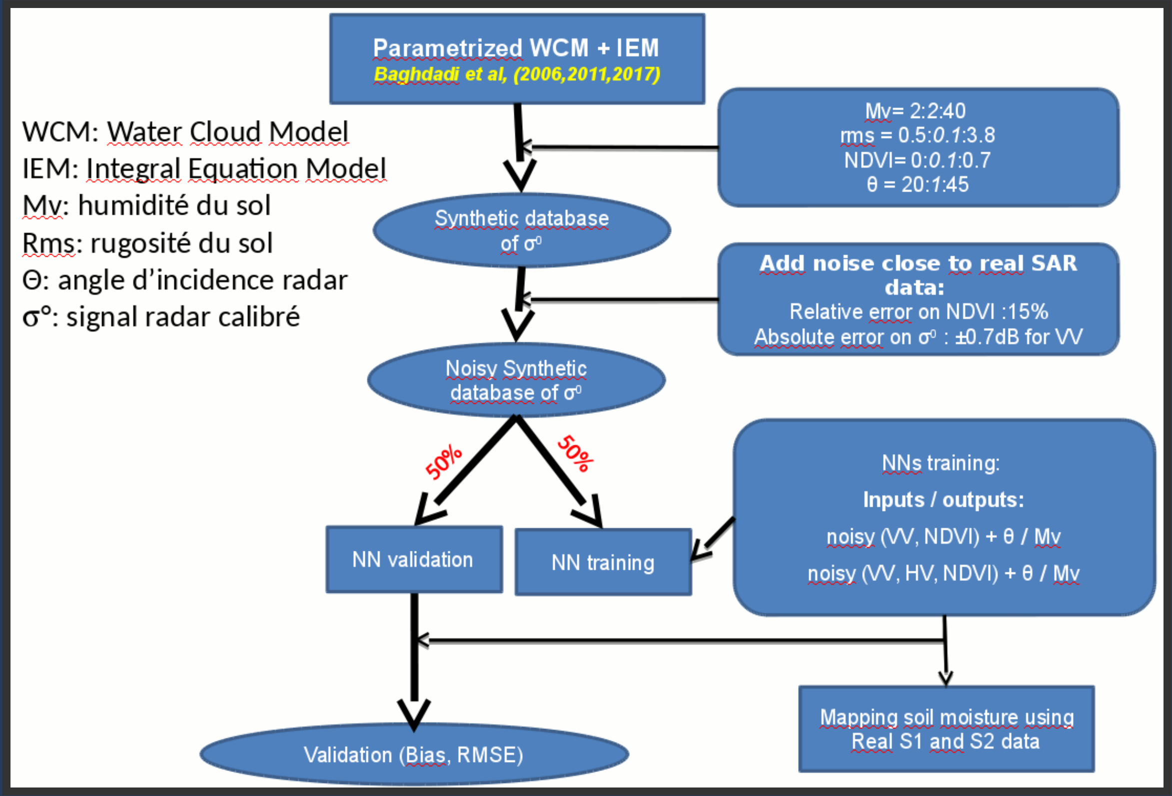
Image before/ after filtering

(Thierry Koleck, CESBIO, 2018)

SOIL MOISTURE

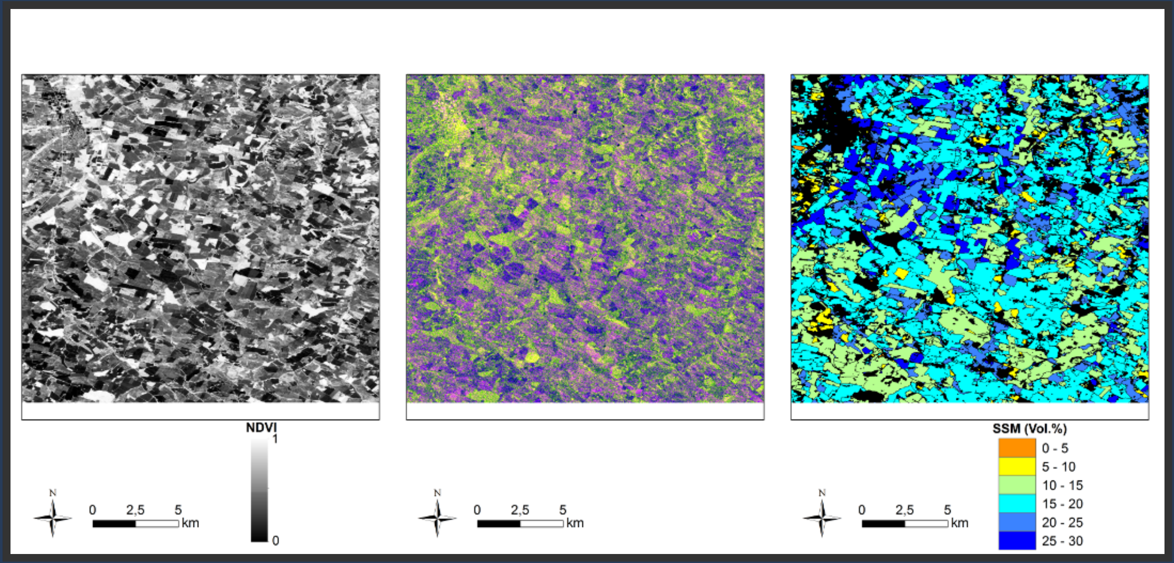
- Based on backscattering model inversion
- Use both SAR and optical data
- Retrieve soil moisture from a (S1, S2) couple of images

SOIL MOISTURE



(Mohammad El-Hajj, IRSTEA, 2018)

SOIL MOISTURE



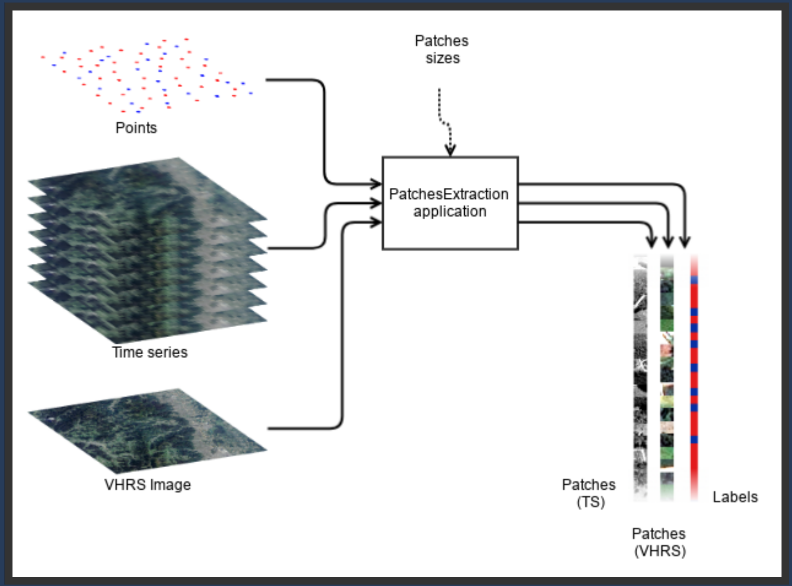
From S2 and S1 data (left and center), soil moisture is retrieved (right)

(Mohammad El-Hajj, IRSTEA, 2018)

OTBTF

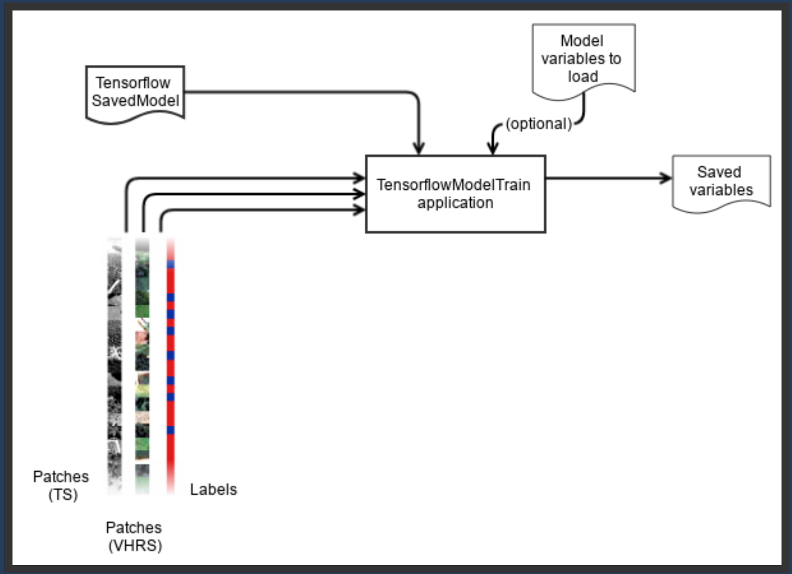
- Based on TensorFlow
- Scalable (no limitation on images size)
- Generic (any type of deep net)
- Easy use of hybrid classifiers
- No coding skills requiered

OTBTF



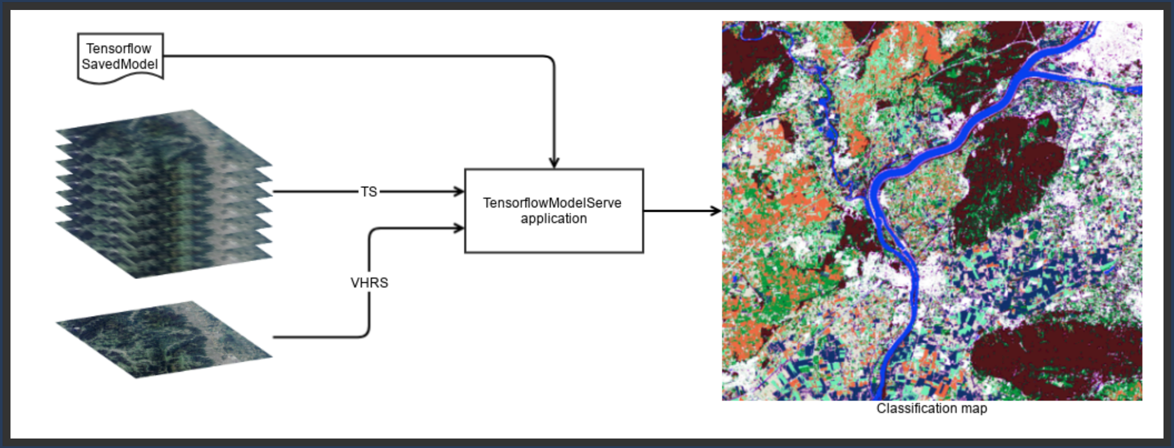
Patches sampling

OTBTF



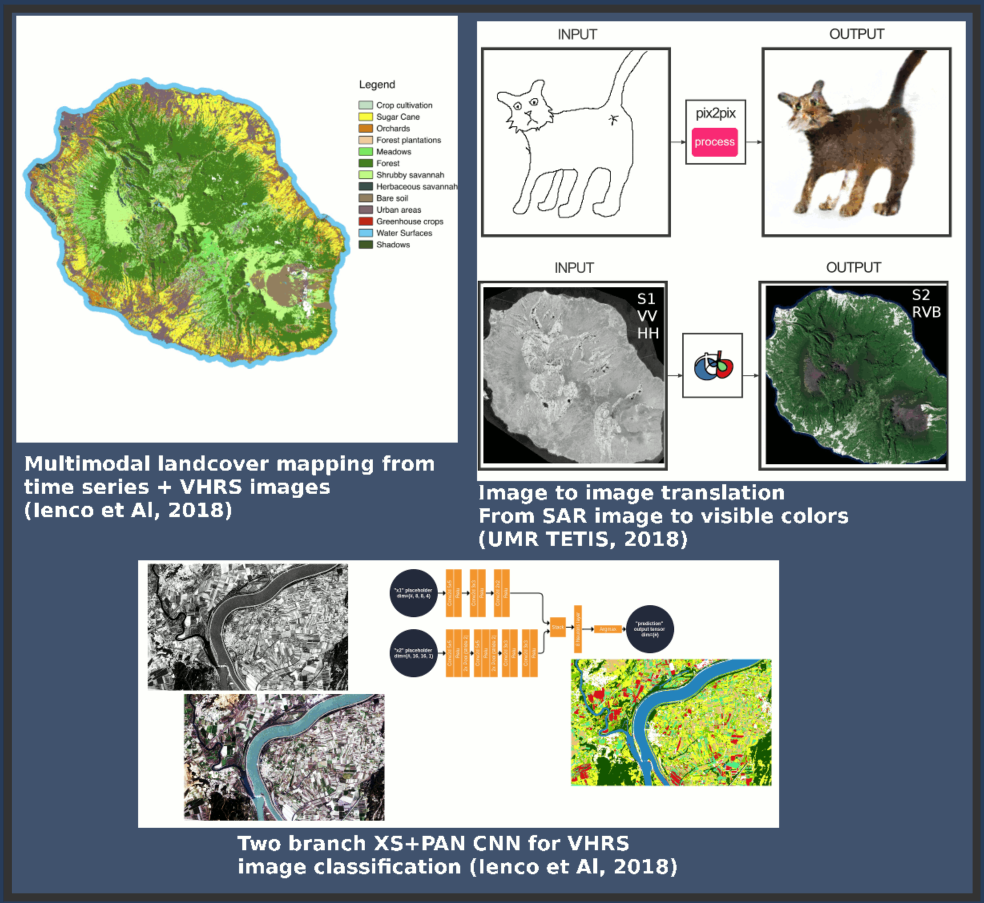
Model training

OTBTF



Model inference

A few deep learning applications for EO (http://mdl4eo.irstea.fr)



Multimodal landcover mapping from time series + VHRS images (Ienco et Al, 2018)

Image to image translation From SAR image to visible colors (UMR TETIS, 2018)

Two branch XS+PAN CNN for VHRS image classification (Ienco et Al, 2018)

NEWS

QGIS INTEGRATION

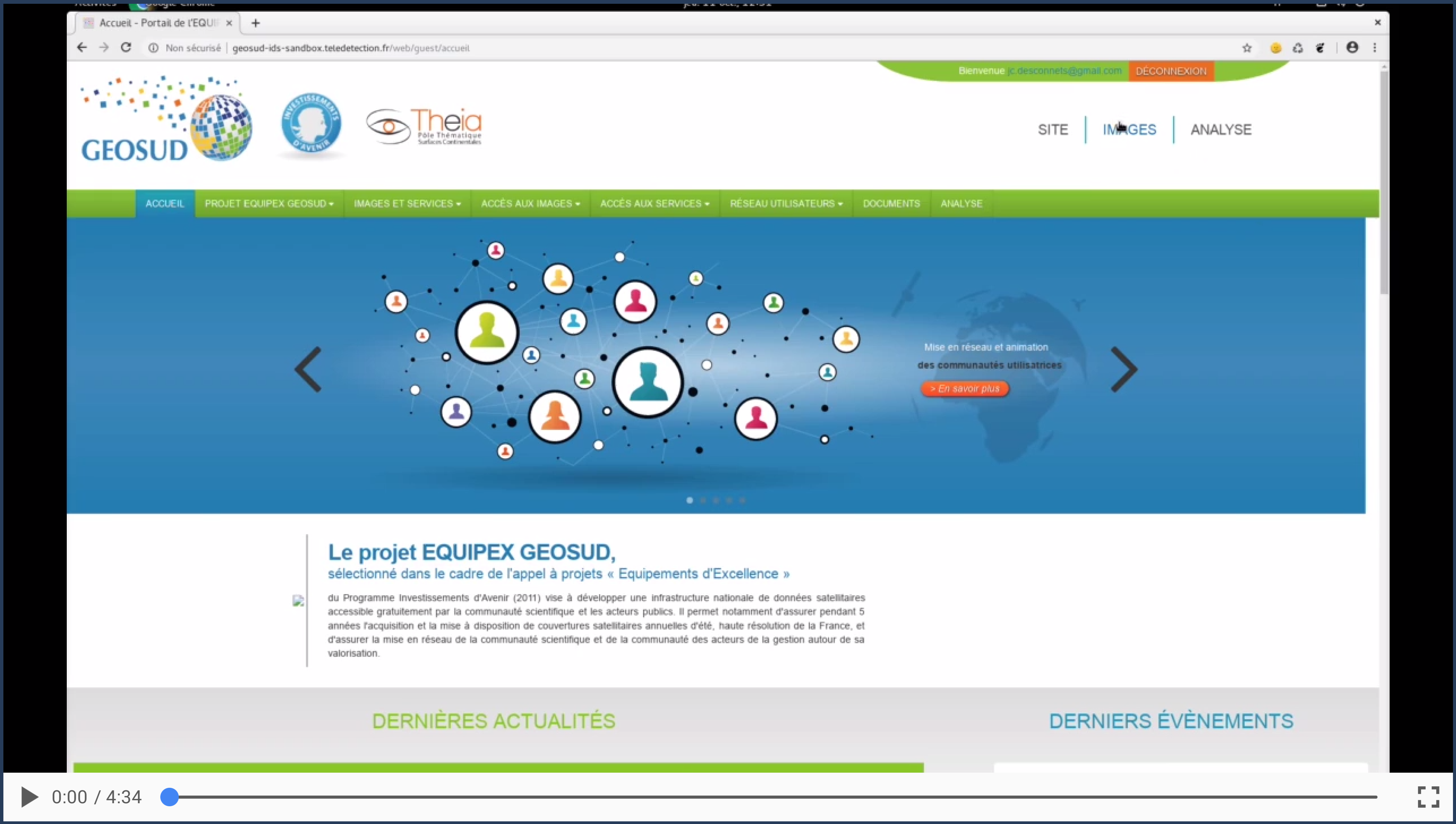
- Ease the integration of new versions of OTB in QGIS
- Support of OTB binary installers in QGIS (out of the box')
- All OTB applications available in QGIS (same name, same documentation...)
- Beta version available as a plugin, hope the plugin will be soon added to QGIS source code!

https://gitlab.orfeo-toolbox.org/orfeotoolbox/qgis-otb-plugin

UPCOMING EVENTS

https://2019.foss4g.org/

IDS Geosud (ouverture prochaine)



Thank you

More on

https://www.orfeo-toolbox.org/

Forum for help:

https://forum.orfeo-toolbox.org/