WORLDWIDE MULTITEMPORAL CHANGE DETECTION USING SENTINEL-1 IMAGES

Elise Colin Koeniguer
ONERA / DTIS

Fabrice Janez
ONERA / DTIS

Jean-Marie Nicolas
Telecom ParisTech

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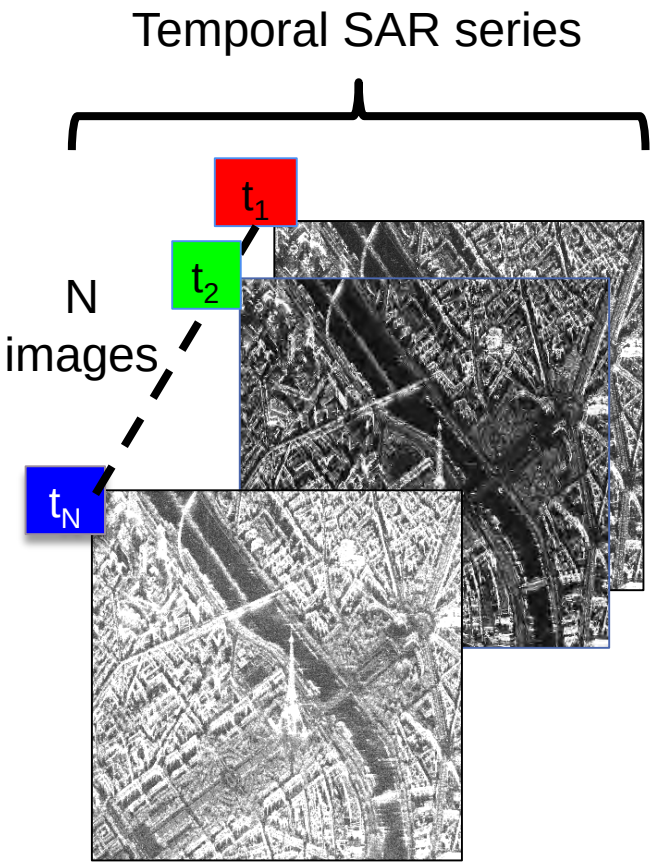
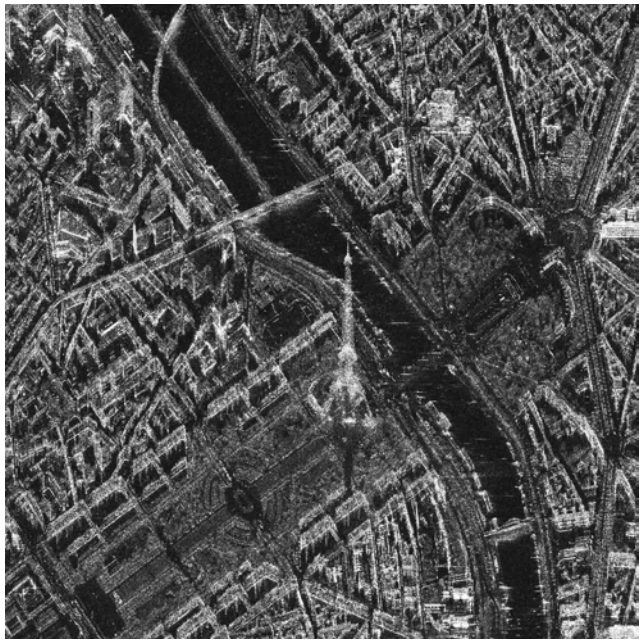
A new dimension: time



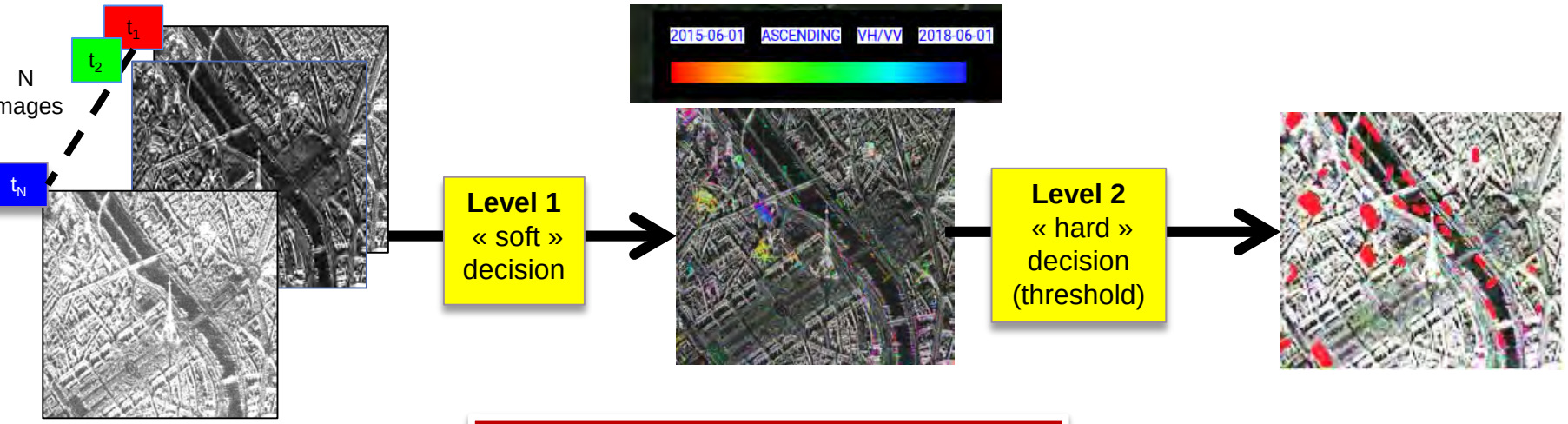


Change detection
In N images
N >>2

Change detection: our framework

2 levels of product

Input: temporal SAR series | Product: visualization | Product: detection



Our change detection criterions

A « **generic** » criterion

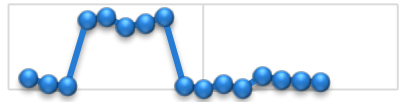
$$CV = \frac{\sigma}{\mu}$$

High change detection performance for artificial or natural objects

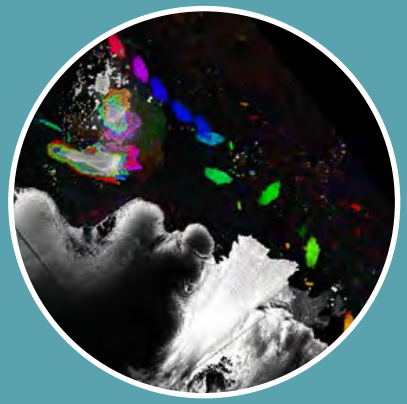
« **Specific** » criterions

$f_1(CV)$ *Point-event detection*

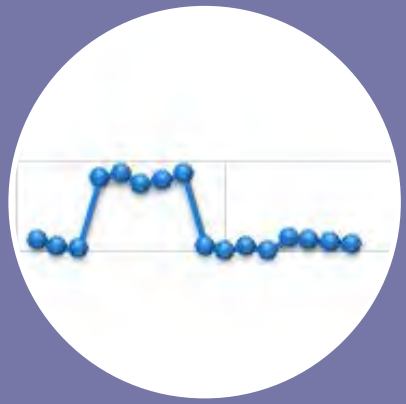
$f_2(CV)$ *Step signal transition*



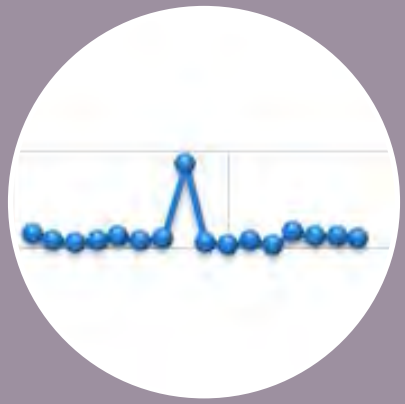
Outline



Activity Visualization



Construction site detection



Point-event detection

Worldwide demonstration

Visualization

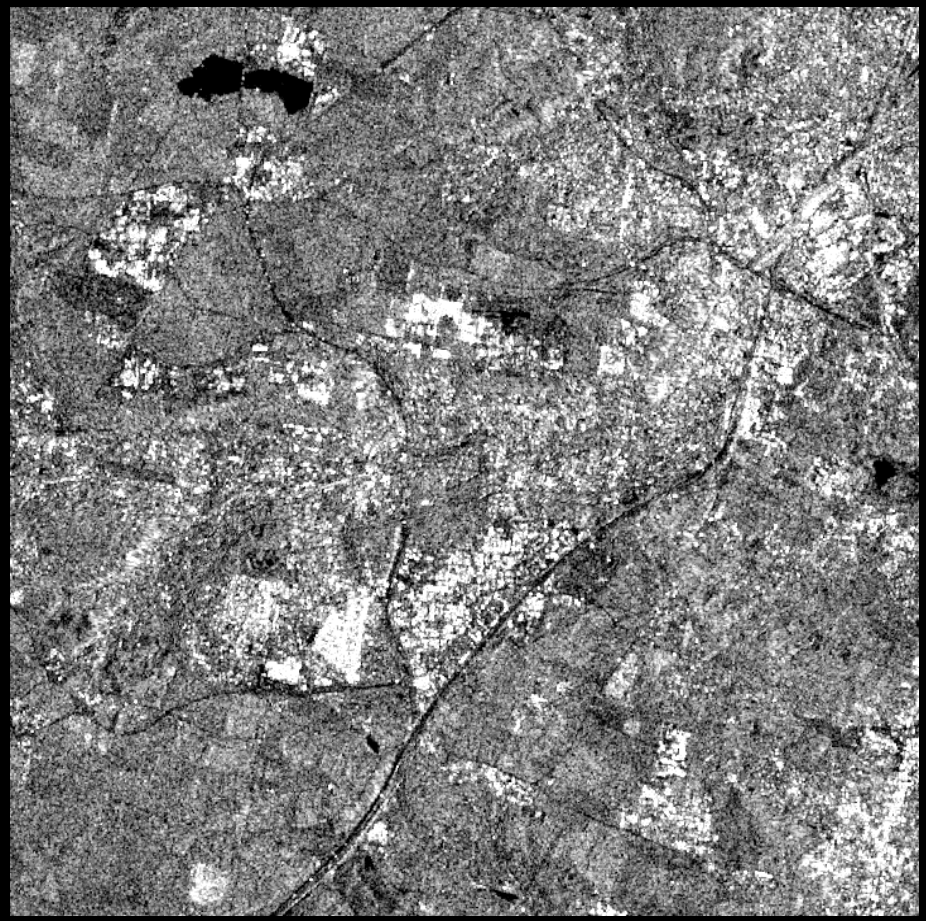
Rapid and EAsy Change detection in radar TIme-series by Variation coefficient

Remote sensing becomes temporal

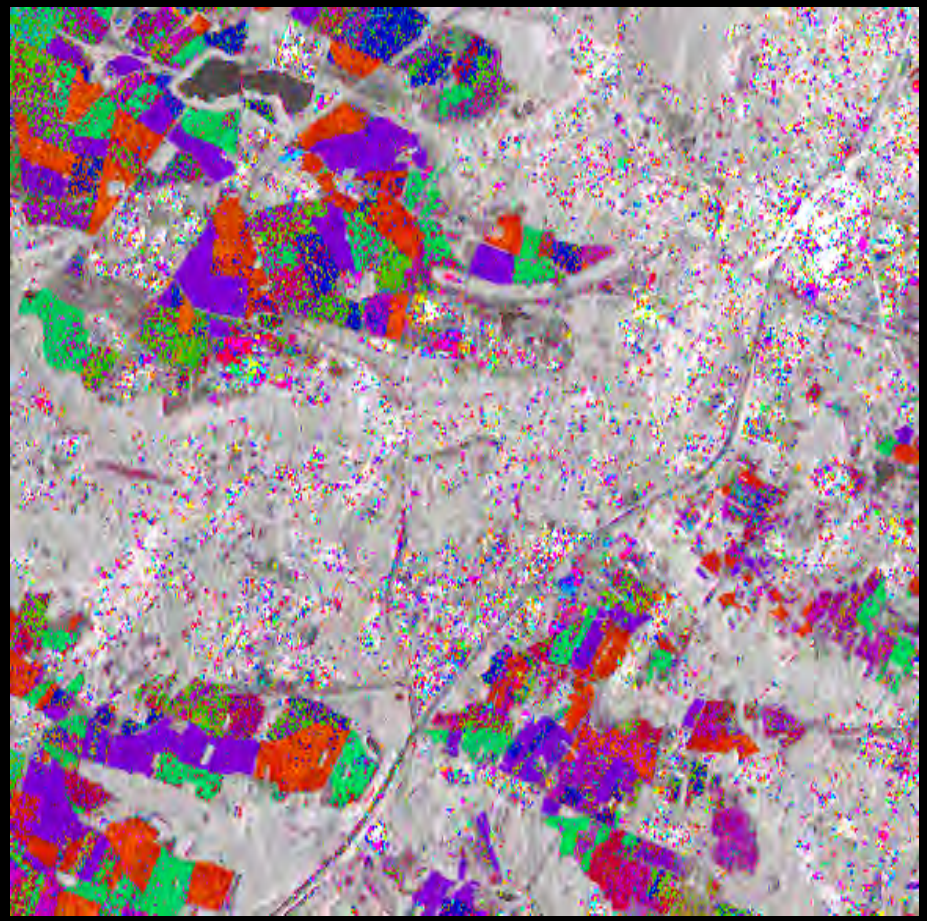
In Sentinel 2 time-series:

Sentinel 2 images, Palaiseau (France), 2015 -2018

Sentinel 1 time-series, from 2015 to 2018

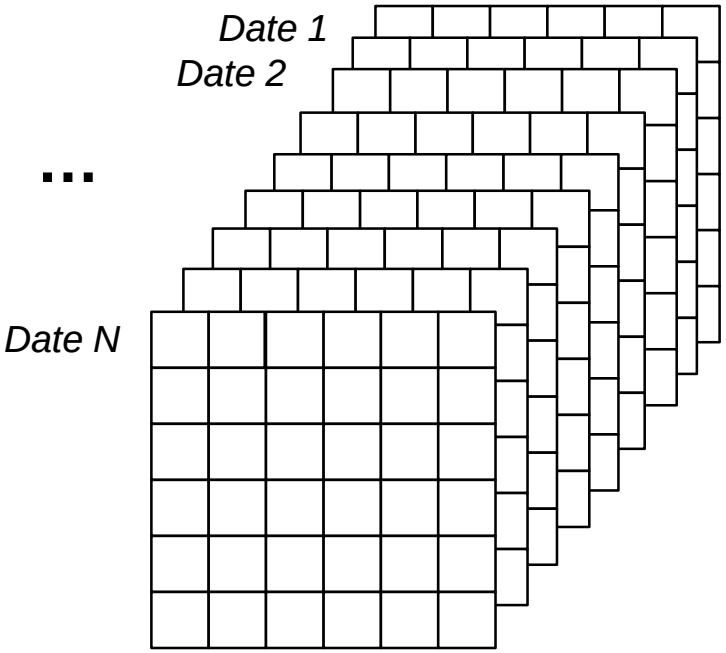


Synthetic information

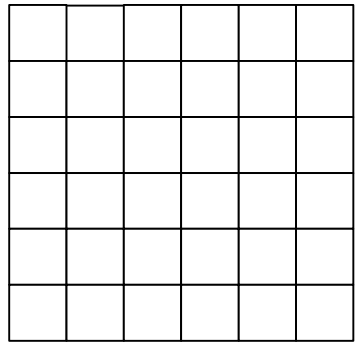


2015 2018

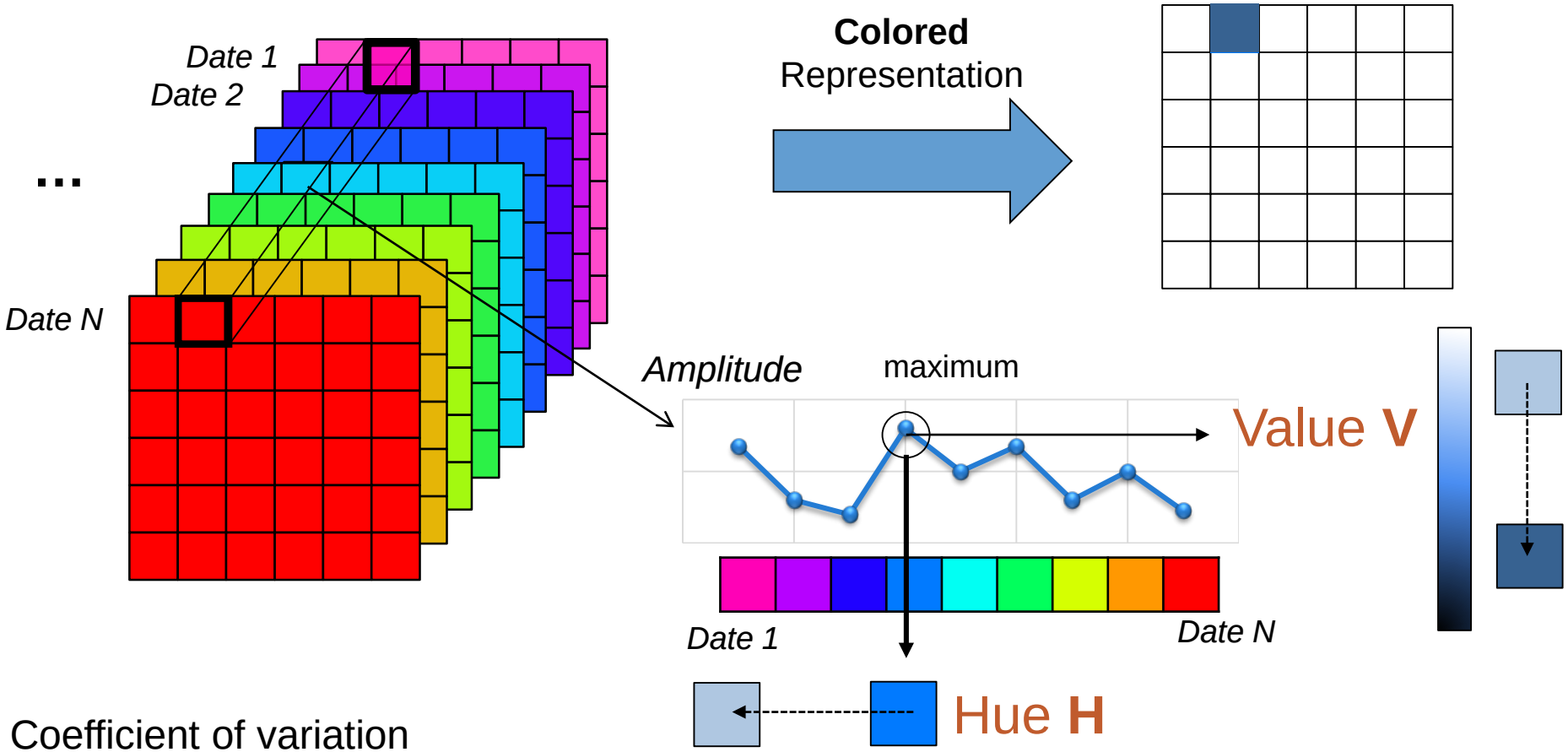
Synoptic



Colored
Representation



Synoptic



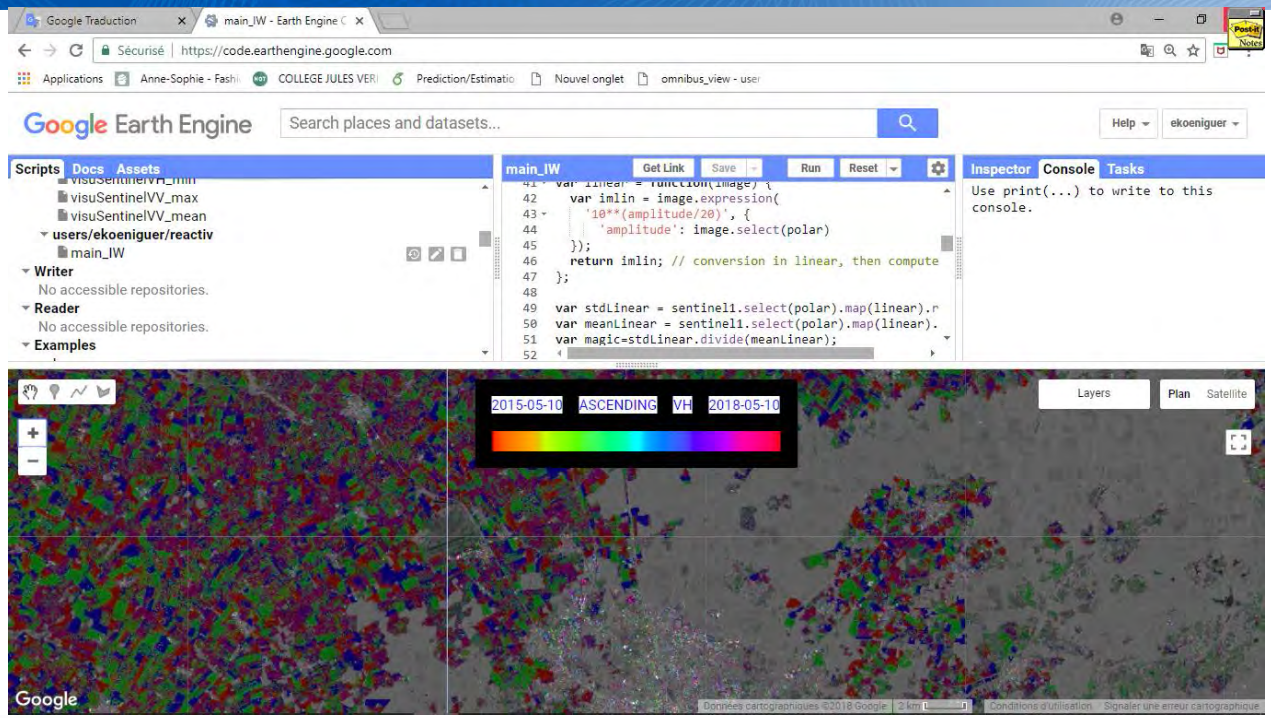
Coefficient of variation

$$CV = \frac{\sigma}{\mu} = \frac{standard\ deviation}{mean}$$

Permanent scatterer

Change

Use of the Google Earth Engine platform



Why ?

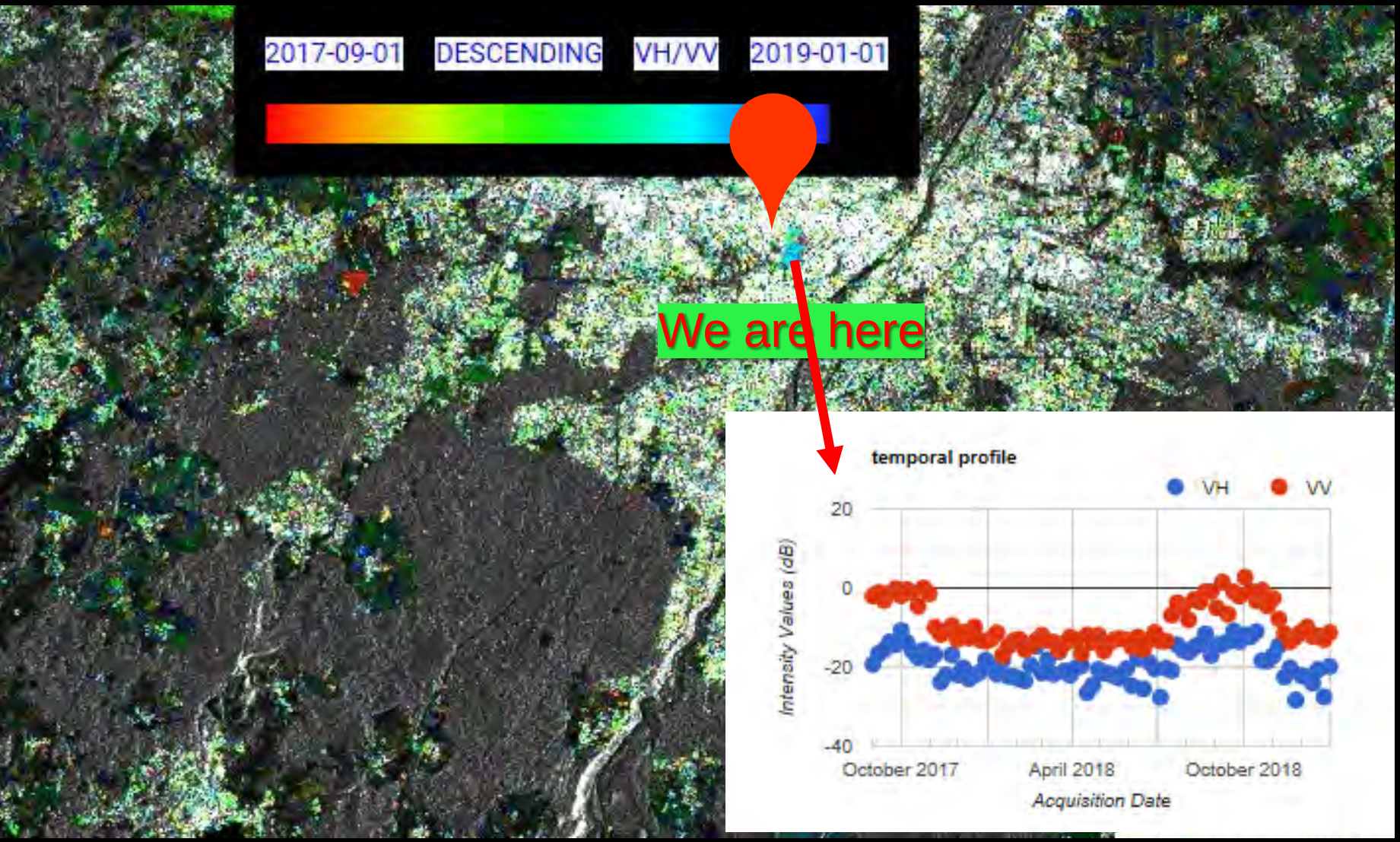
- Enables worldwide demonstration!

Regrettable choice

- dynamics, coregistration
- no SLC : polarimetric/coherent information is lost

Urban

Sentinel 1, Google Earth Engine



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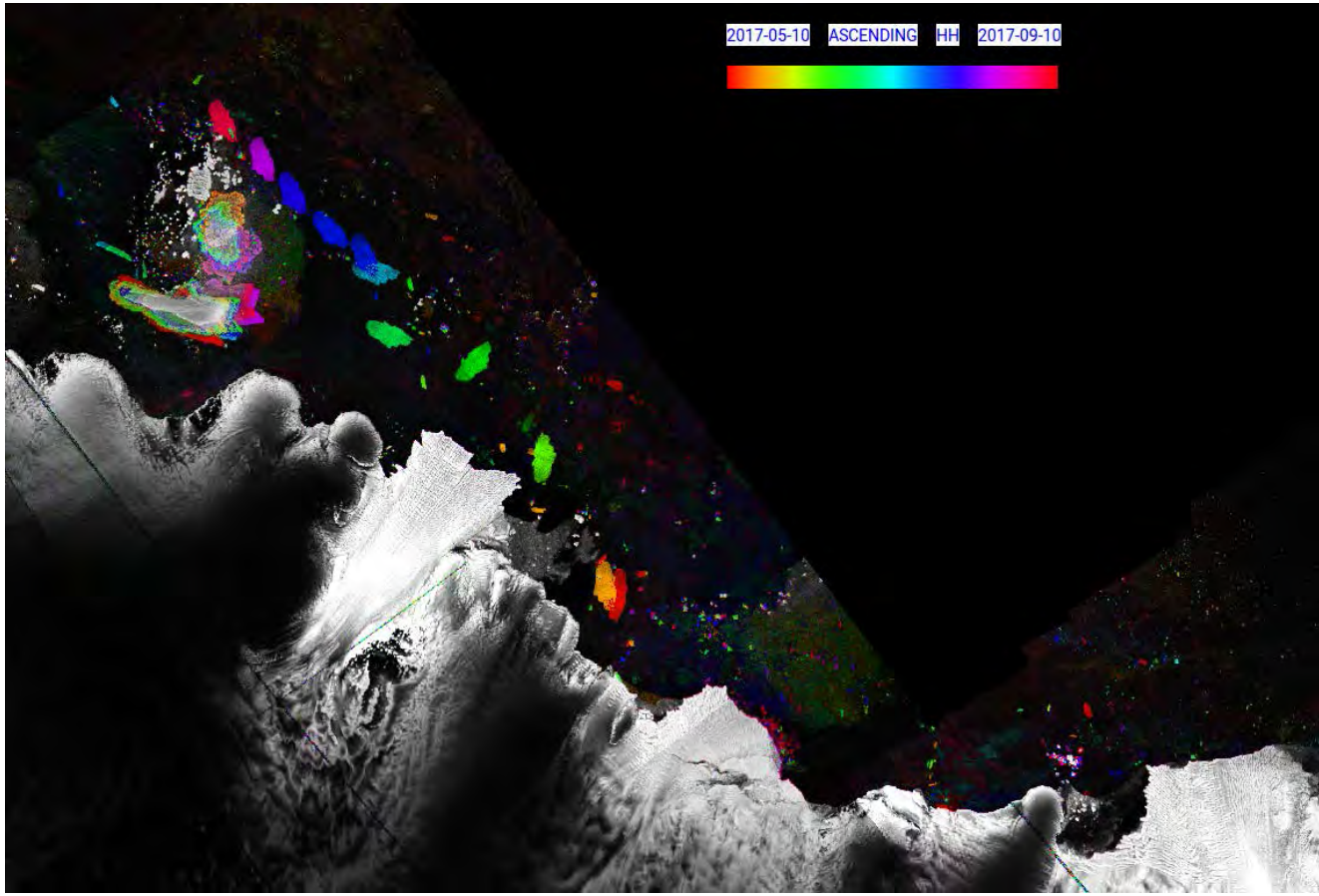
Icebergs tracking

Sentinel 1, Google Earth Engine



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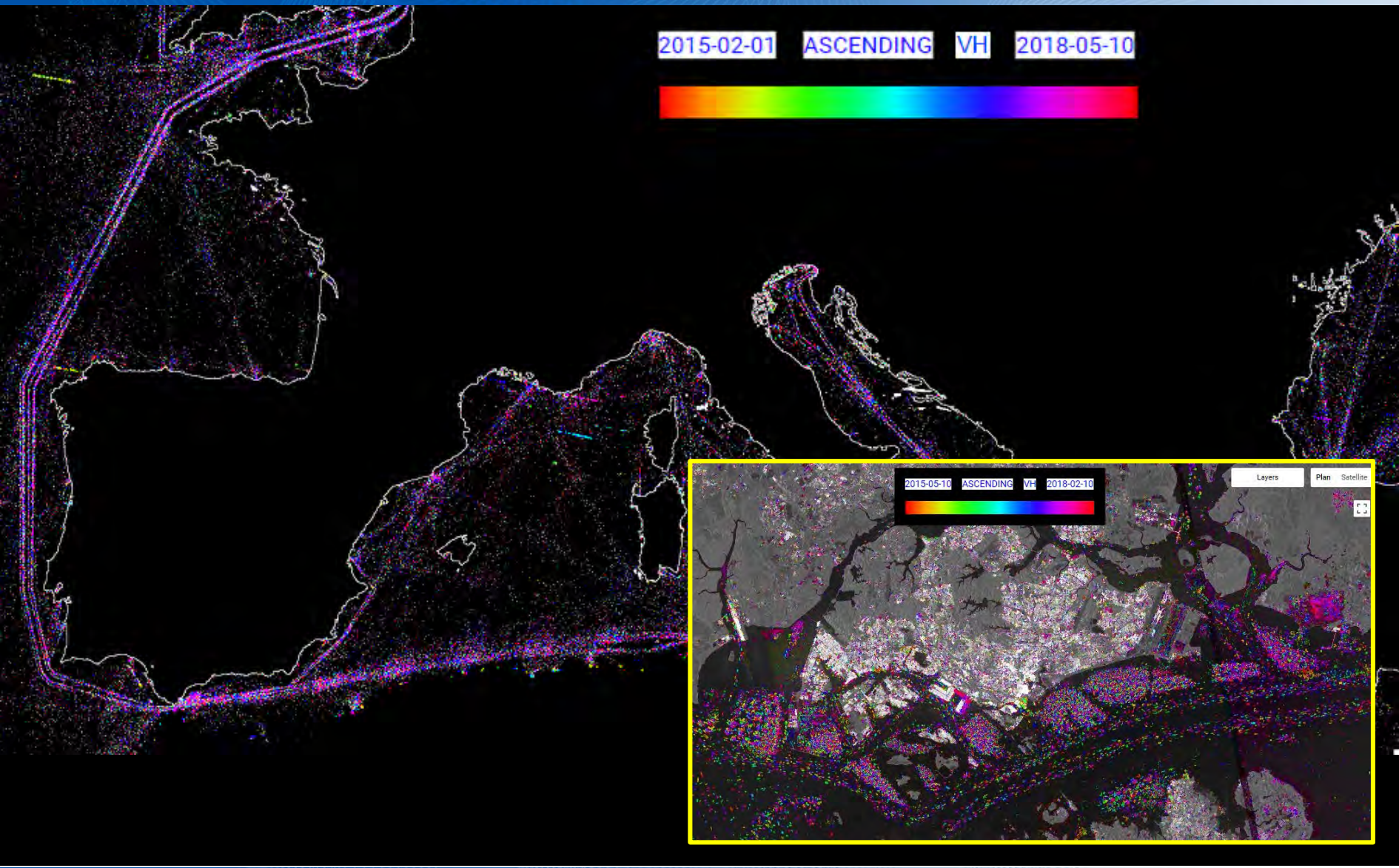
Maritime traffic

Sentinel 1, Google Earth Engine



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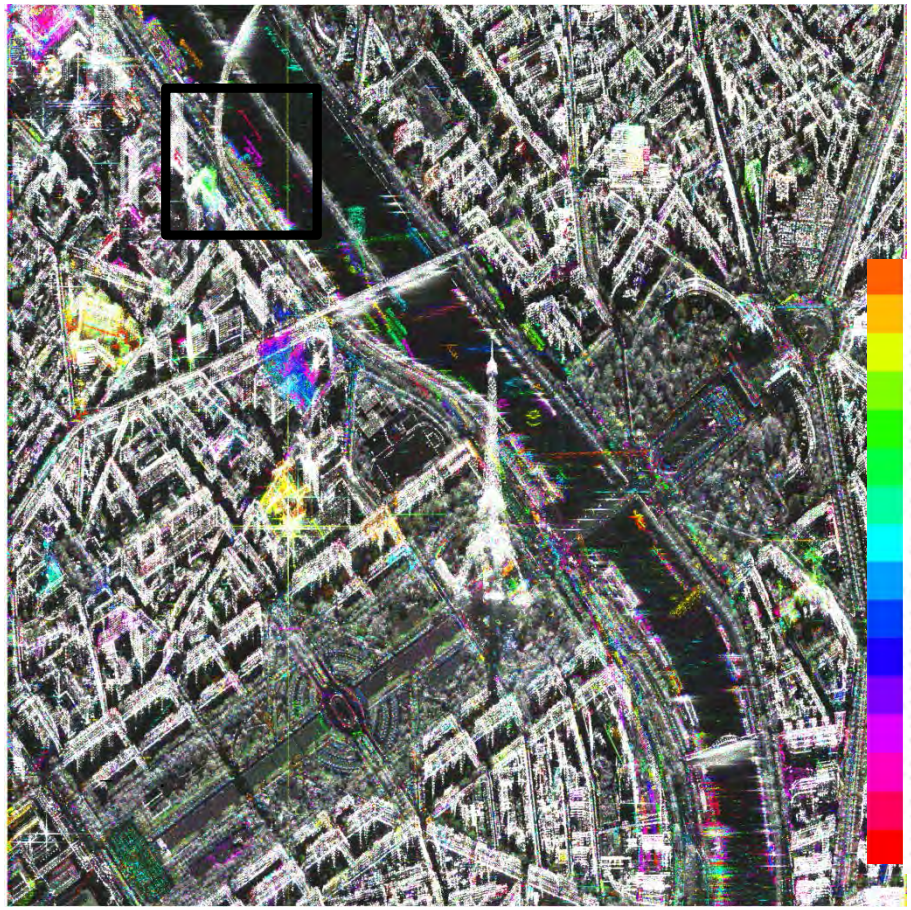
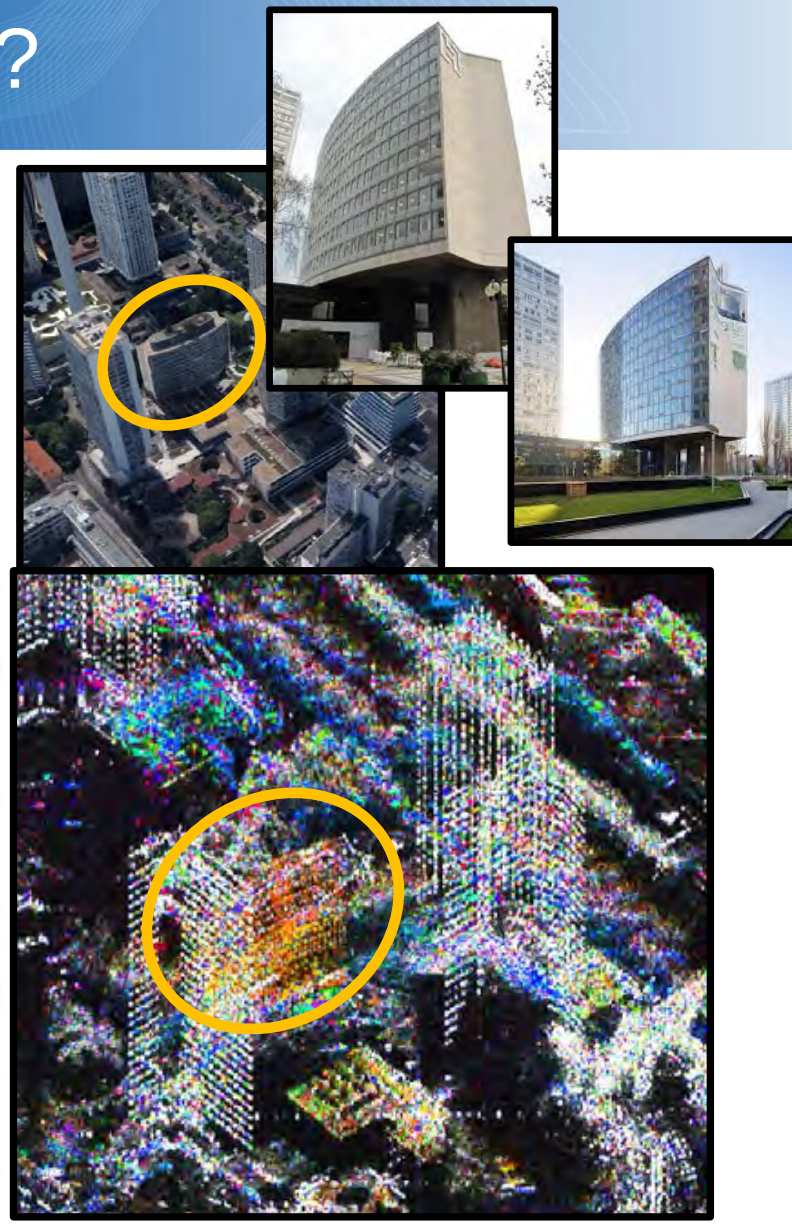
What about High resolution?

TerraSAR-X (DLR)





- (1m)
- (25 cm)

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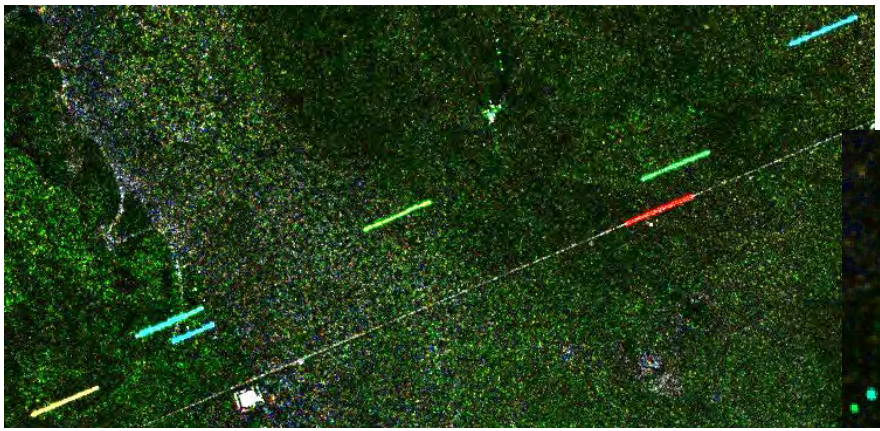
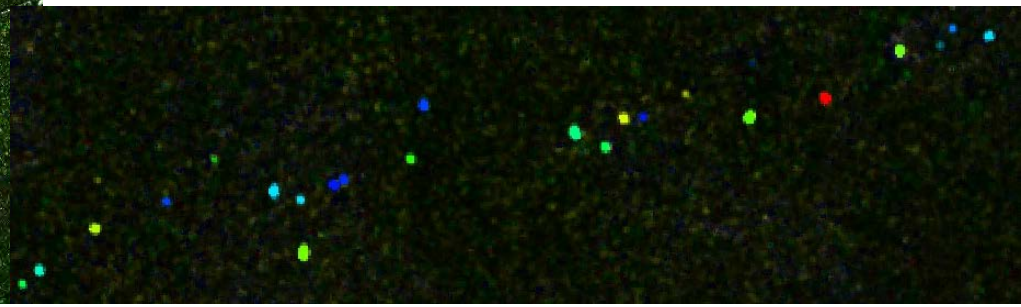
Vehicle detection

Sentinel 1
VV/VH

Finsch Petra Diamond Mine, South Africa





Trains

Trucks

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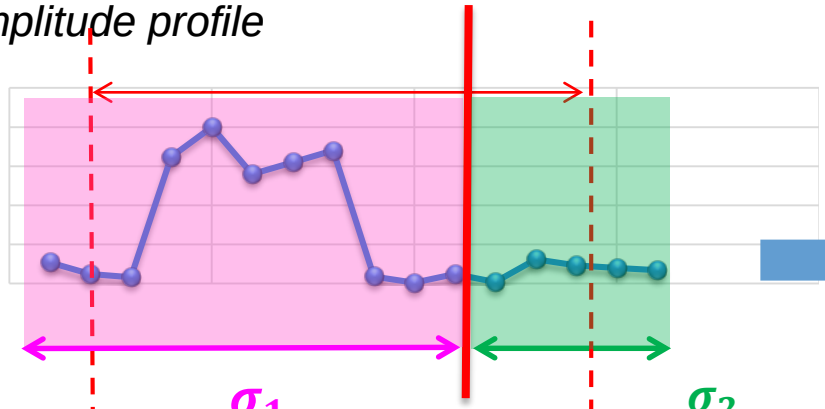
OVER BUILDINGS

Parameters to analyze a specific event

Amplitude profile



$CV_1 = \frac{\sigma_1}{\mu_1}$ $CV_2 = \frac{\sigma_2}{\mu_2}$

$$CV = \frac{\sigma}{\mu}$$

highlights any kind of changes from « stable » speckle

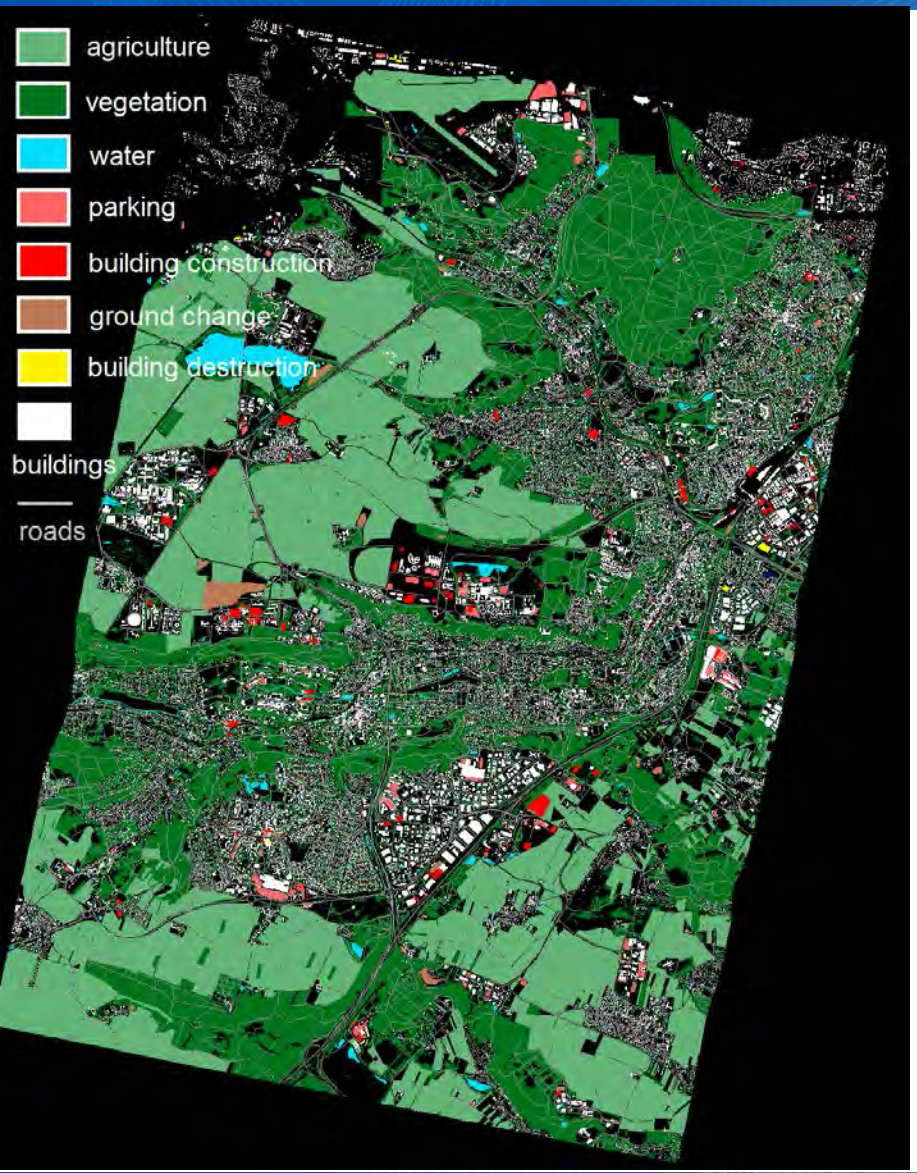
$$\min\left(\frac{CV_1}{CV_2}, \frac{CV_2}{CV_1}\right)$$

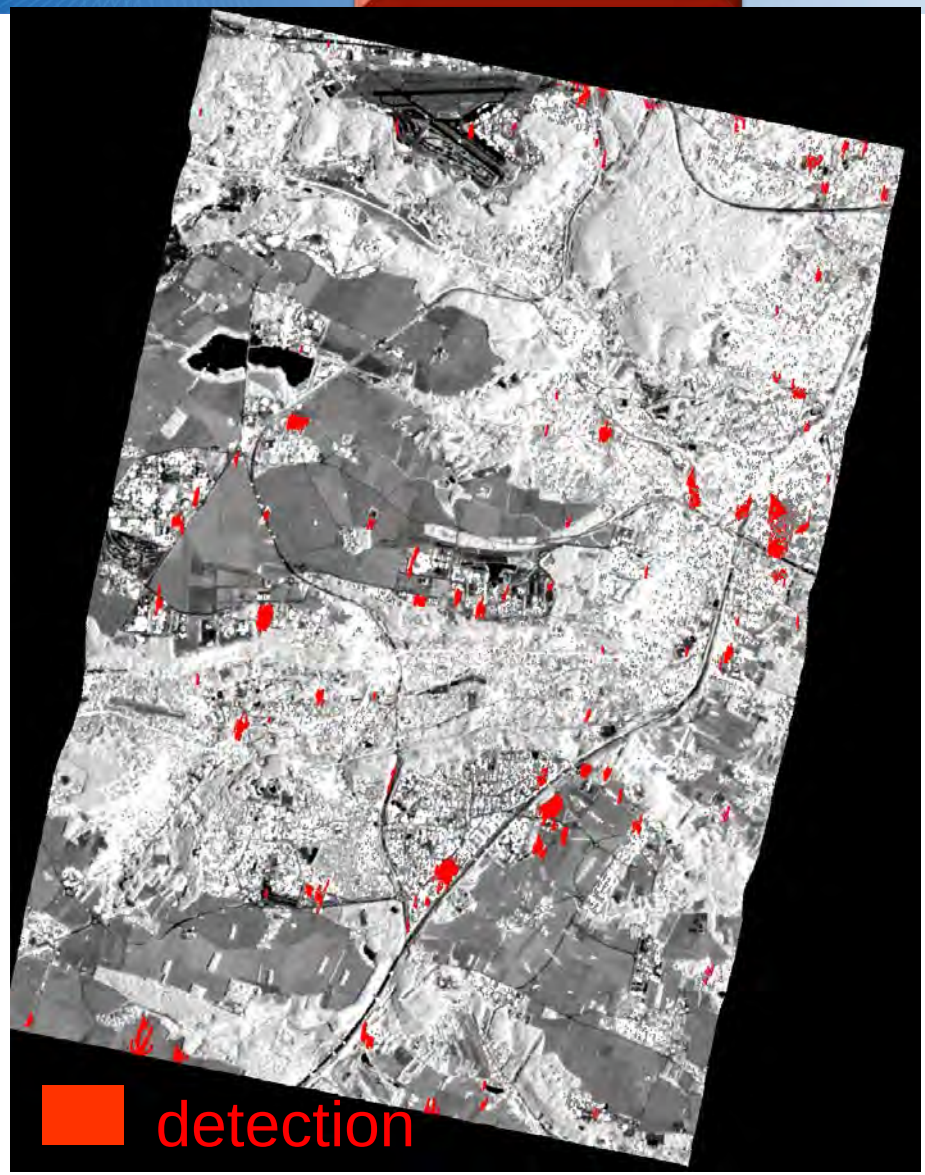
$$R = 1 - \sum_S \min\left(\frac{CV_1}{CV_2}, \frac{CV_2}{CV_1}\right)$$

highlights constant piecewise signals

Results

Sentinel 1
VV/VH





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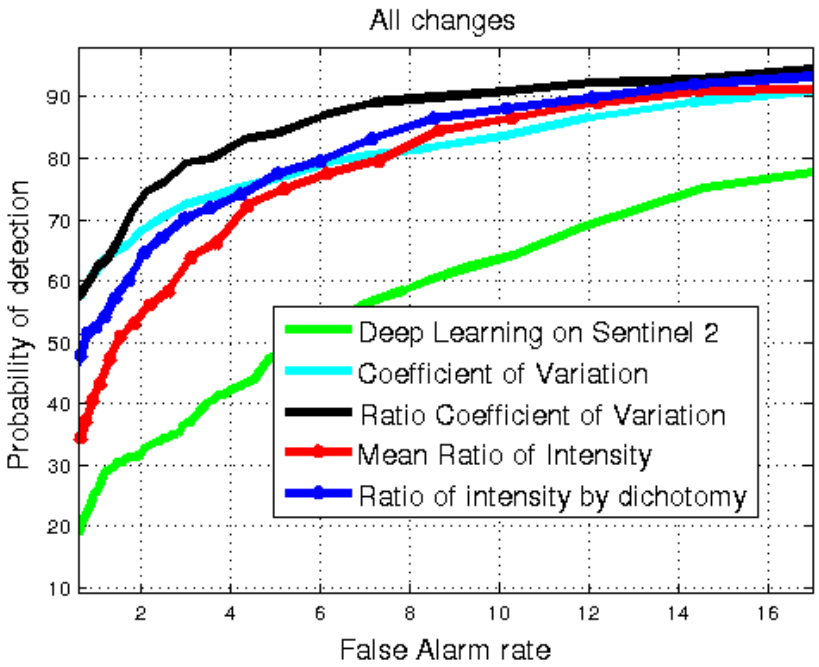
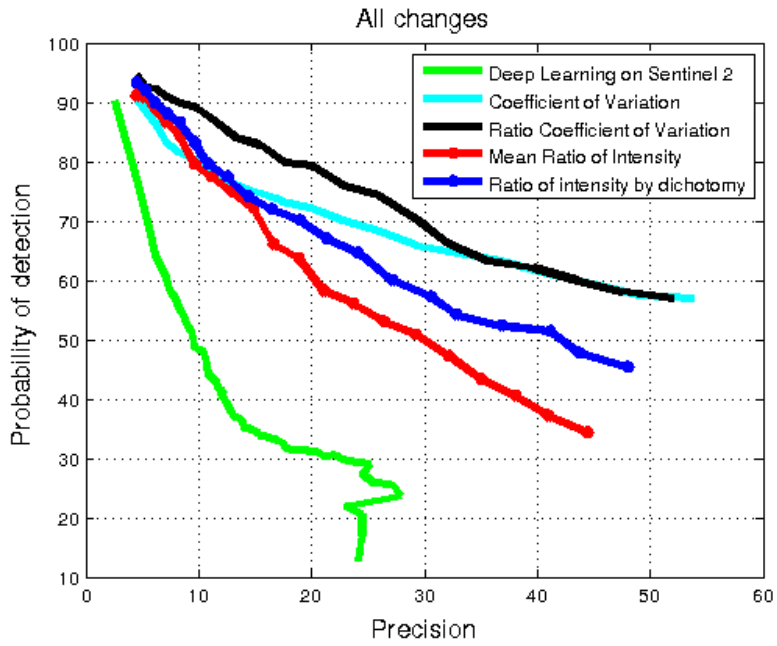
Results

Sentinel 1
VV/VH

Coefficient of Variation and specific CV ratio oompared to:

- Radar intensity based criterions
- Deep learning on Sentinel 2 images





PhD Onera
Rodrigo Caye Daudt

TIME-SERIES

FOR POINT-EVENTS

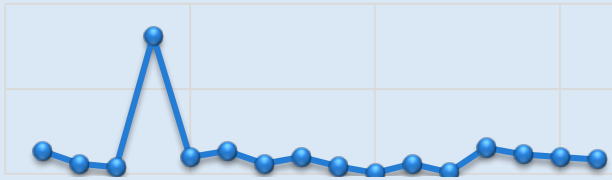
Detection of one-point event

$$R = 1 - \min\left(\frac{CV_1}{CV_2}, \frac{CV_2}{CV_1}\right)$$

CV_1 computed without max value

CV_2 computed without min value

Amplitude profile EXAMPLE 1



without maximal value

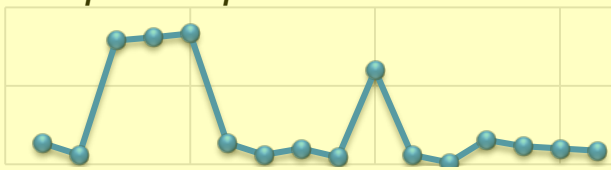
CV_1 low

without minimal value

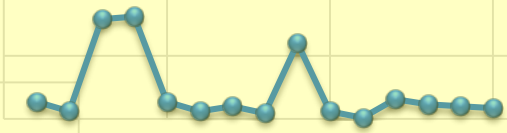
CV_2 high

$R \approx 1$

Amplitude profile EXAMPLE 2



without maximal value



CV_1 high

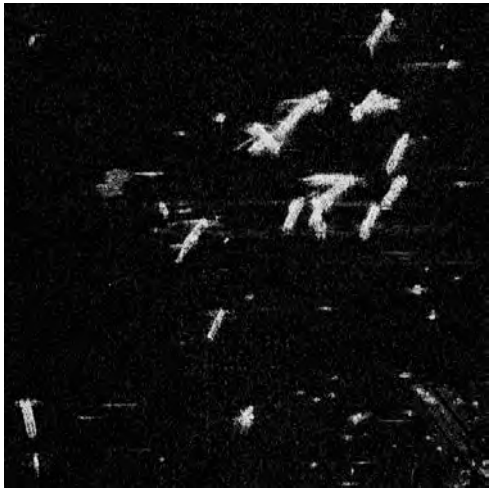
without minimal value

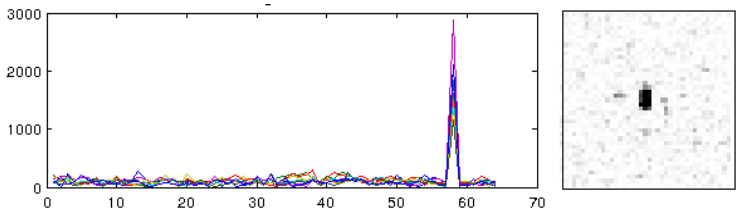
CV_2 high

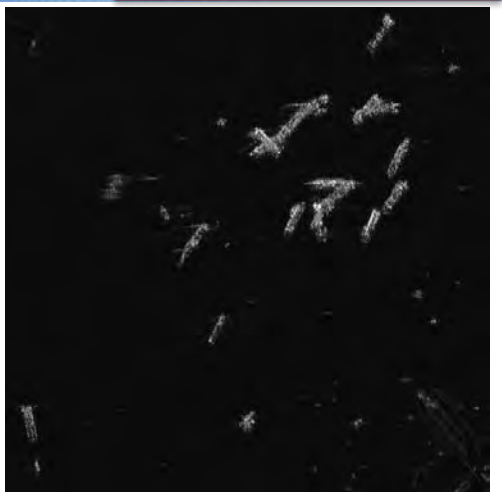
$R \approx 0$

Comparison between CV and ratio of CV

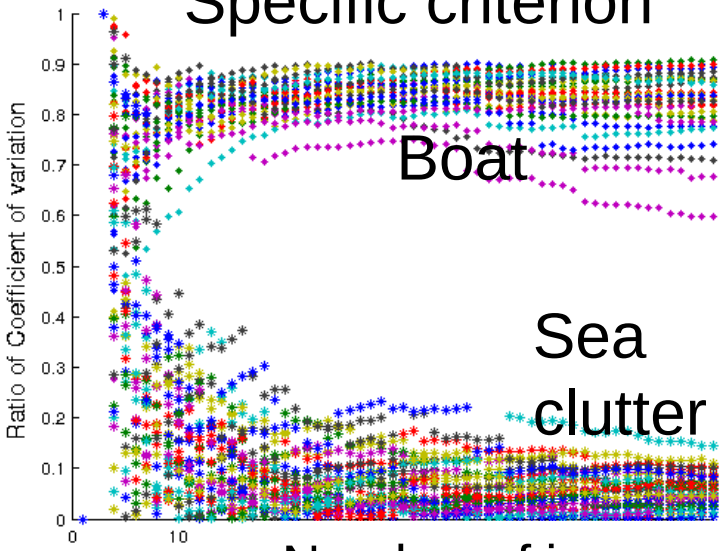
UAVSAR
VV/VH



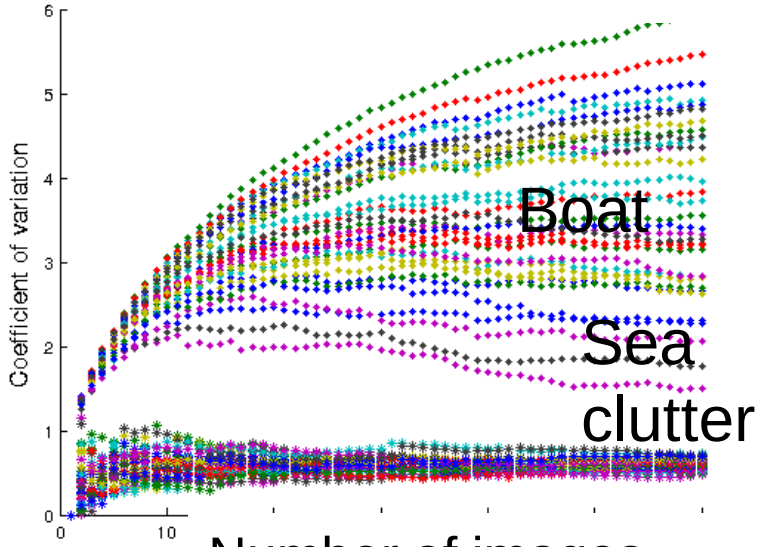




Specific criterion



Coefficient of variation



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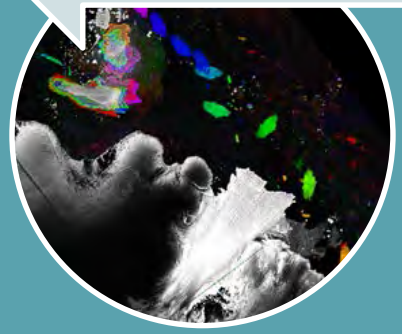
Summary

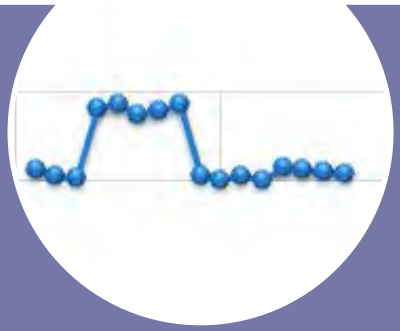
Worldwide demonstration



Visualization

Powerful tool to see all kinds of change

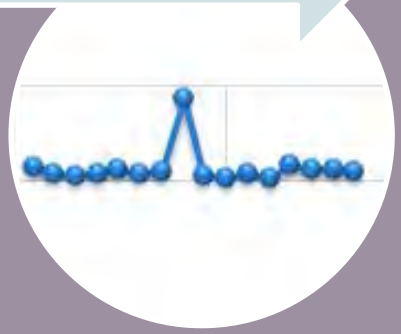
Based on theoretical study on coefficient variation statistics



Construction site detection

Very good performance compared to:

- state of the art in SAR time-series
- optical best known results based on deep learning



A new dedicated detector

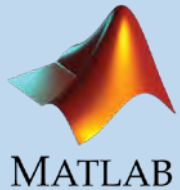
More specific than CV

Requires more than 20 images

Thanks for your attention

Avalaible code sources

https://github.com/elisekoeniguer/REACTIV



TERRASAR-X images have been provided by DLR
UAVSAR images – NASA-JPL

Next:

- implementation on European GEP platform
- *Post doc position about fusion with optical images! CNAM – Onera*