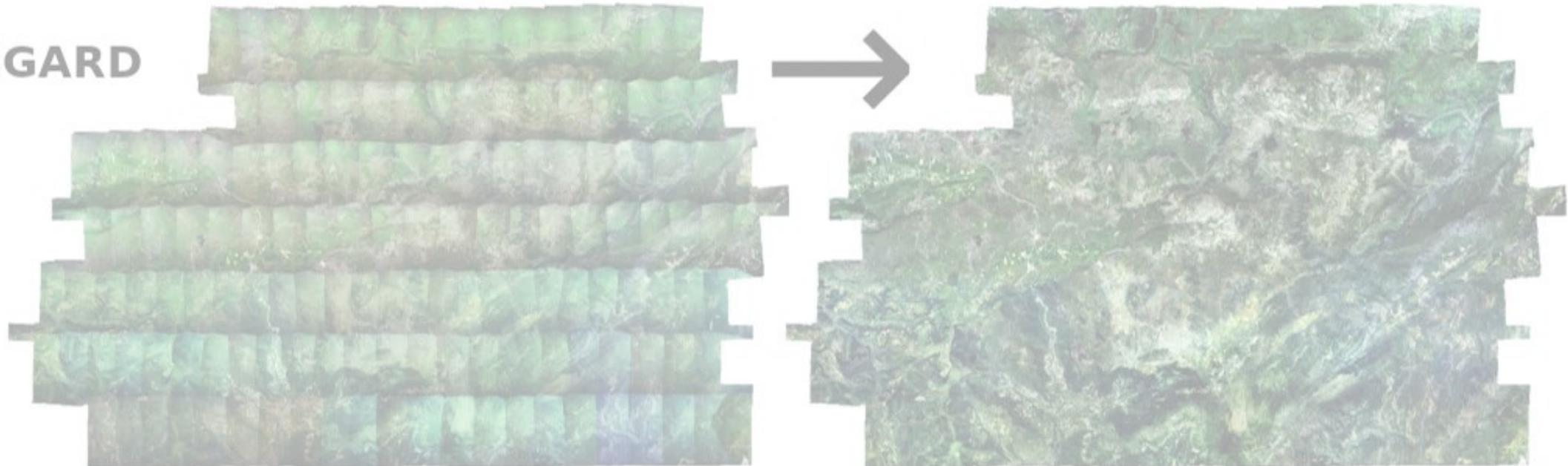


IMPROVING LOCAL ADAPTIVE FILTERING METHOD EMPLOYED IN RADIOMETRIC CORRECTION OF ANALOGUE AIRBORNE CAMPAIGNS

Lâmân LELÉGARD

Arnaud
LE BRIS

Sébastien
GIORDANO



Lab on Geographic Information Science for
sustainable development and smart cities

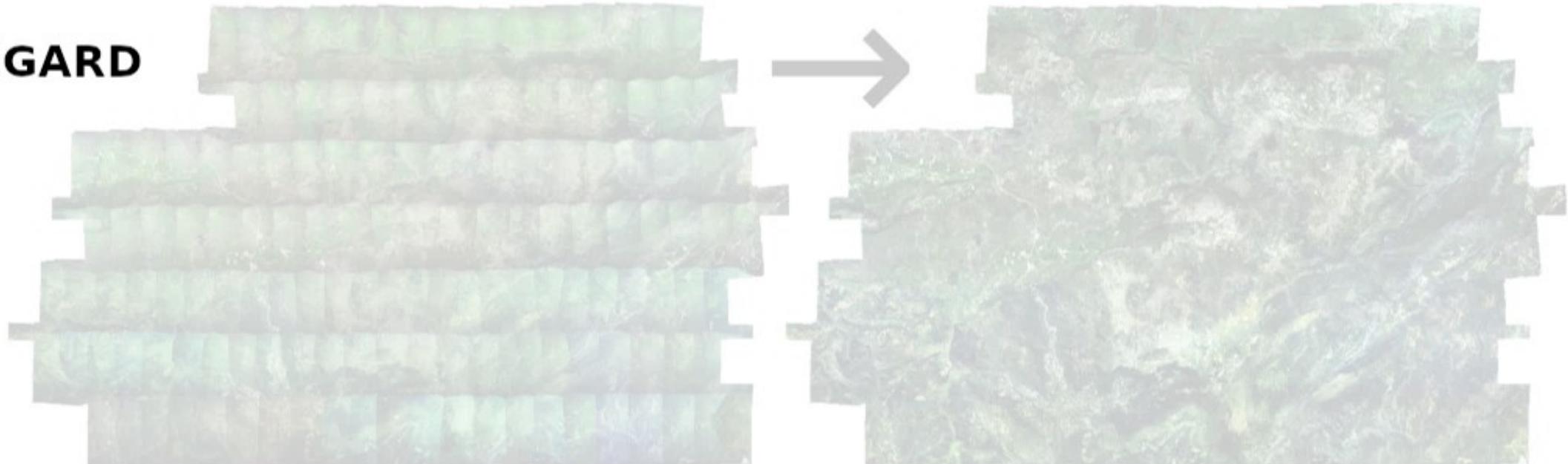


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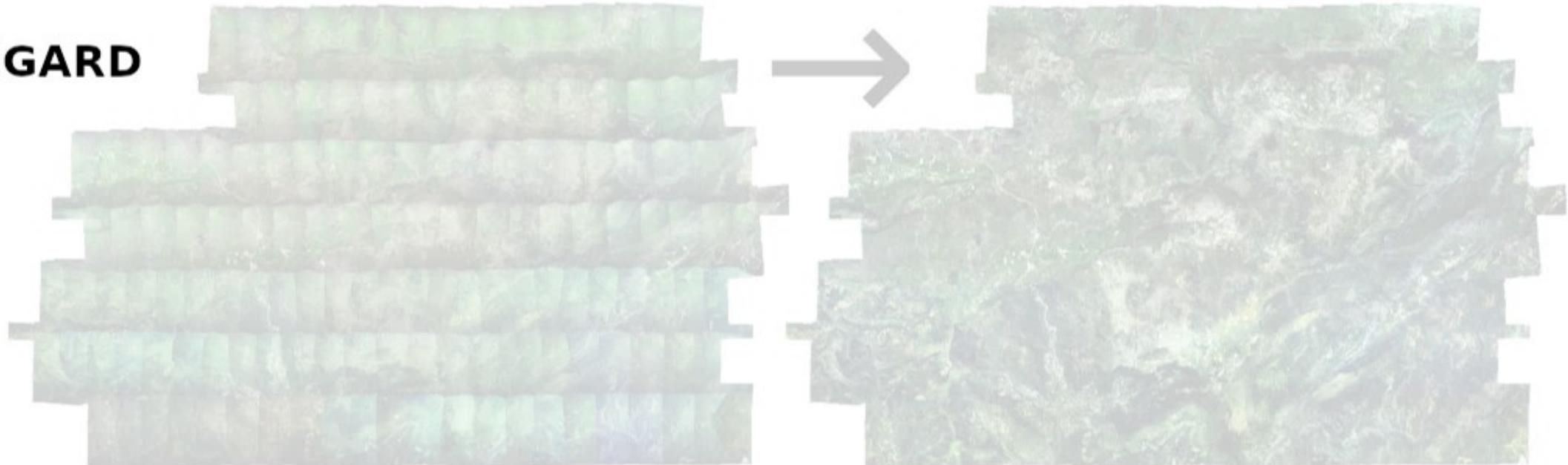


IMPROVING LOCAL ADAPTIVE FILTERING METHOD EMPLOYED IN RADIOMETRIC CORRECTION OF ANALOGUE AIRBORNE CAMPAIGNS

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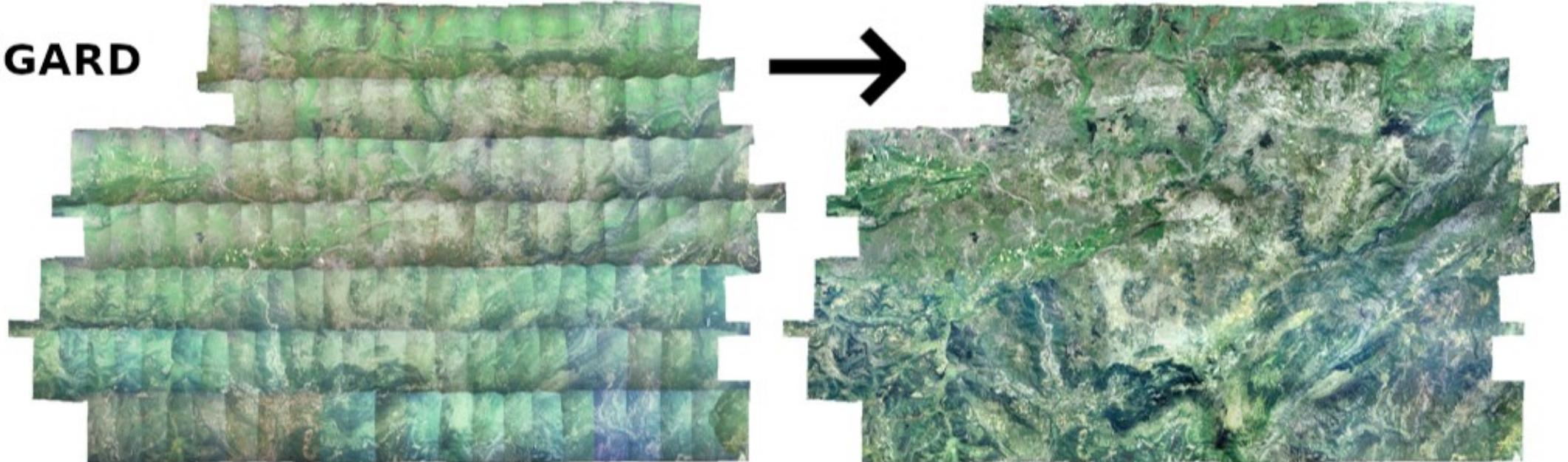


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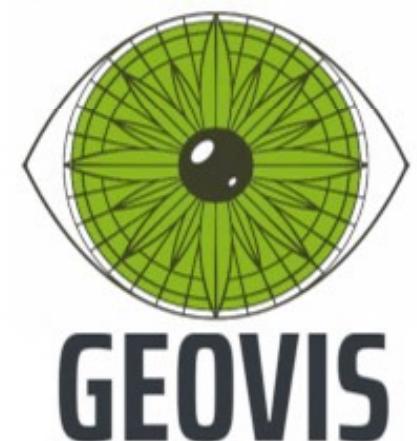
Lâmân LELÉGARD

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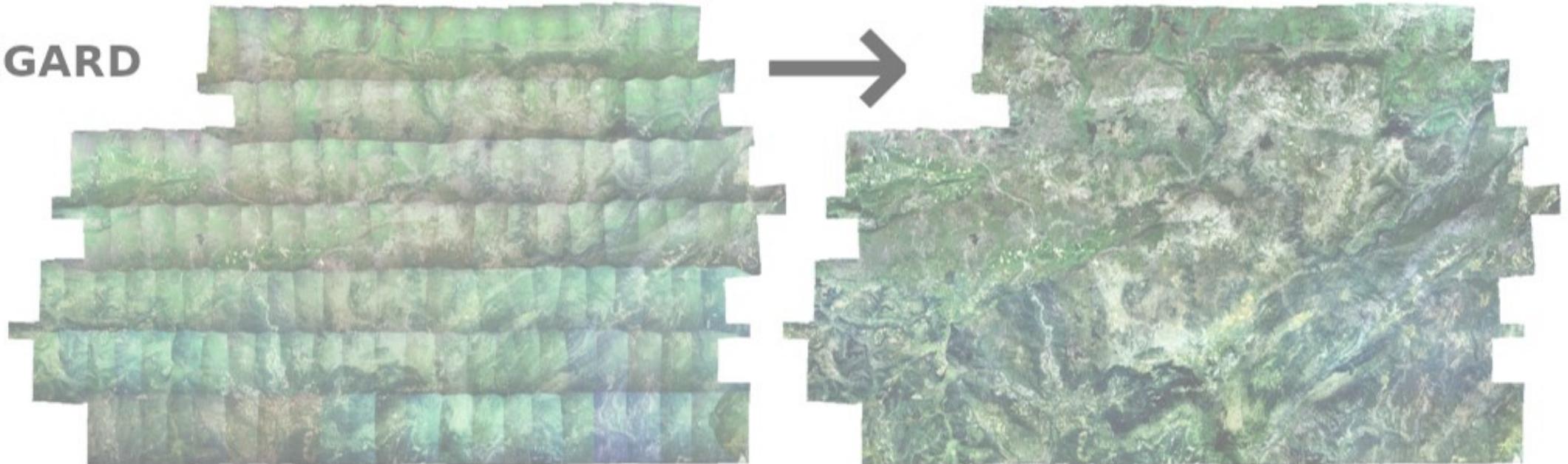


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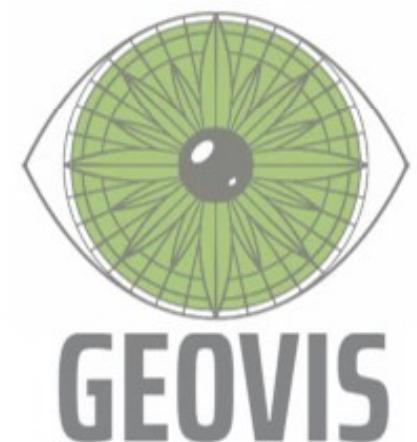
Lâmân LELÉGARD

Arnaud
LE BRIS

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GIORDANO



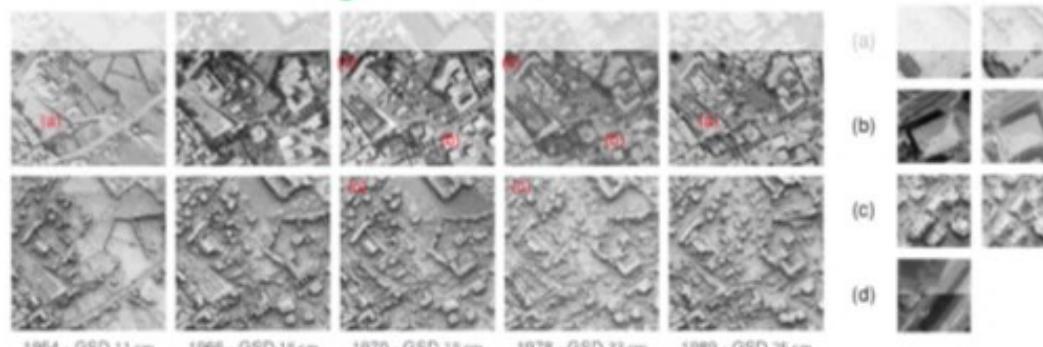
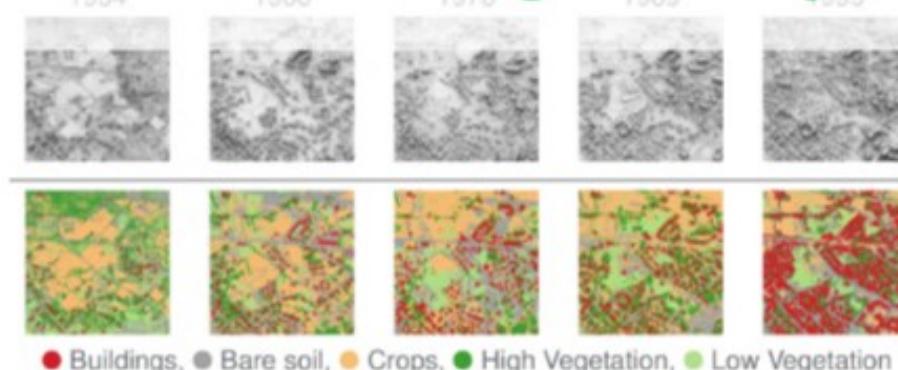
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HIATUS

Historical Image Analysis for Territory evolUtion Stories



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HIATUS ANR project 2019-2023

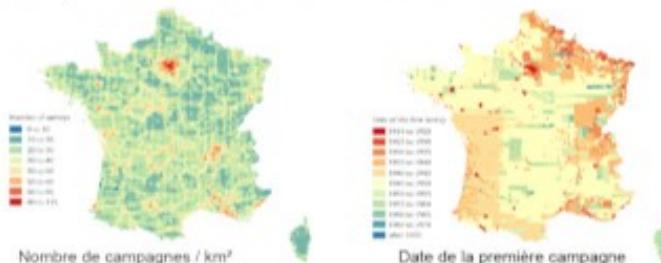
Historical Image Analysis for Territory evolUtion Stories

HIATUS project aims at developing new automatic methods to exploit historical photogrammetric aerial campaigns to design products for the description of the evolutions of the territories.

[More information...](#)

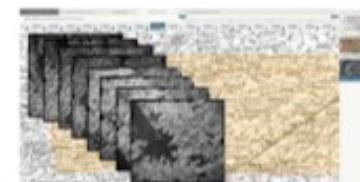
Source: <https://anr-hiatus.github.io/>

Les prises de vues aériennes d'archives



→ Les prises de vues aériennes anciennes :

- Présentes partout
- Séries temporelles longues
- Numérisées et diffusées



<http://remonterletemps.ign.fr>

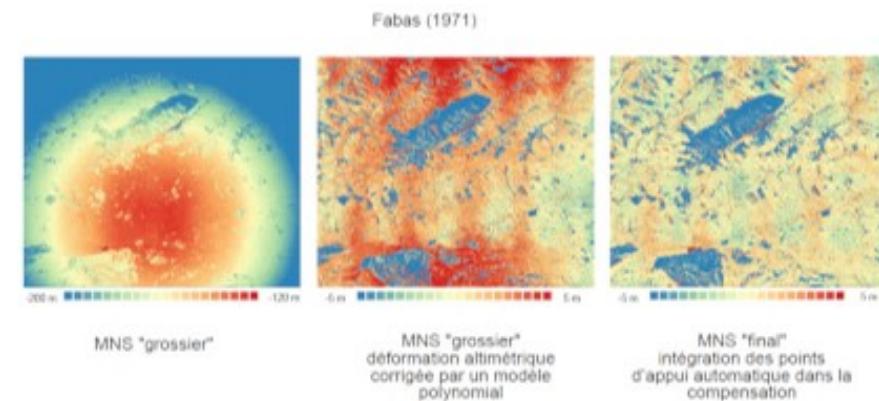
Prises de vues aériennes d'archives ?

- Acquisitions multi-vues → accès à une information 3D...
mais nécessite de les remettre en géométrie / géoréférencer



Points d'appui automatiques : résultats

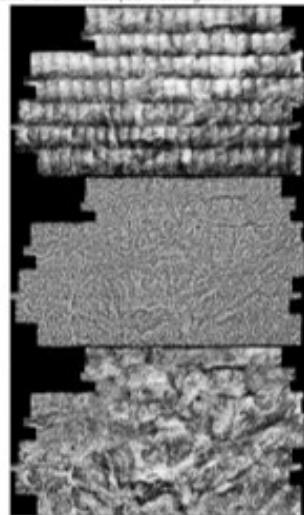
Ecarts altimétriques entre le MNS ancien obtenu et le MNS référence



Radiométrie des images

Comment égaliser la radiométrie pour obtenir une mosaïque homogène ?

- Méthode non paramétrique
- Correction statistique gain / offset

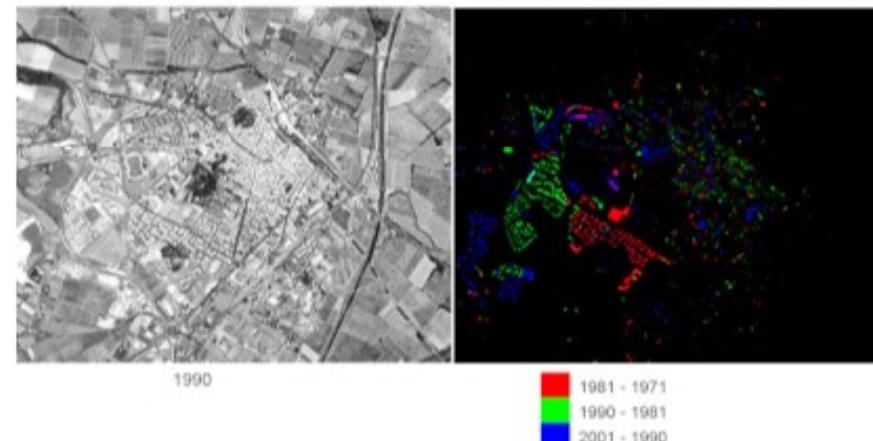


[Voir vidéo L. Lelegard \(JR 2020\)](#)

Classification OCS et analyse des évolutions ?

Cas d'étude : dater la construction des bâtiments à partir de séries de MNS

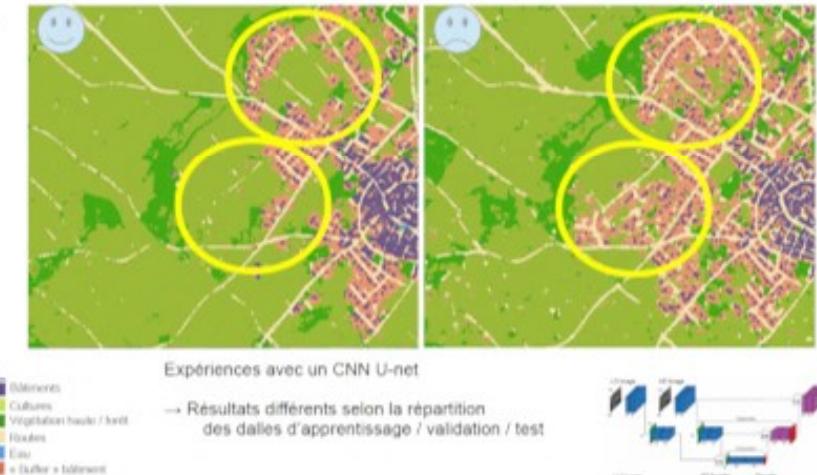
- Focalisation sur les bâtiments de la BDTopo actuelle
- Calcul MNSn(t2) – MNSn(t1)



Segmentation sémantique de l'OCS

Comment entraîner un classifieur?

→ Diachronisme entre images historiques et BD disponibles



Source: https://anr-hiatus.github.io/fichiers_pdf/HIATUS-SFPT.pdf

CONTEXT

Comparer

Photographies aériennes 2000–2005

avec

Photographies aériennes 2006–2010

Rechercher un lieu

+ -



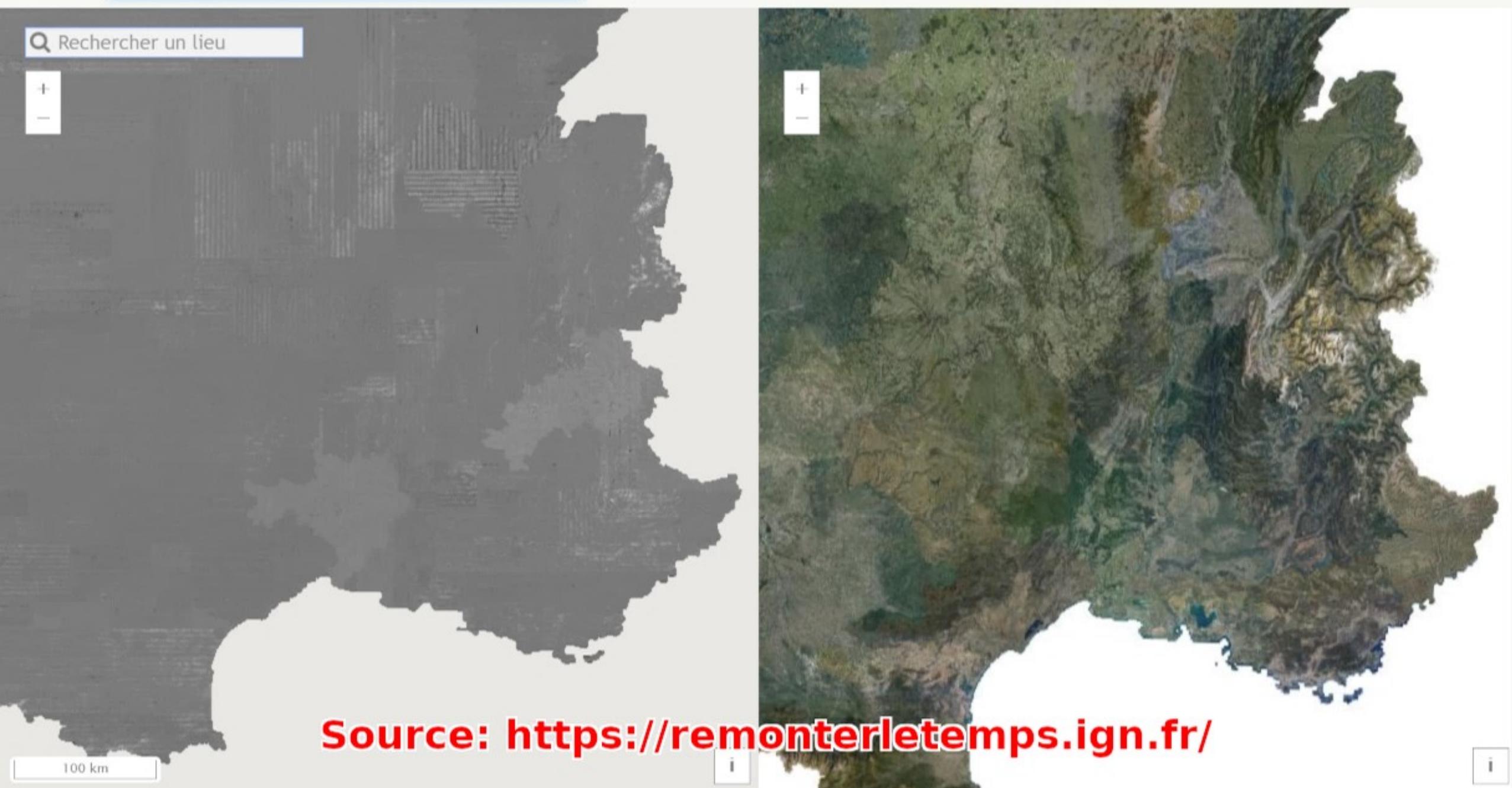
Source: <https://remonterletemps.ign.fr/>

Comparer

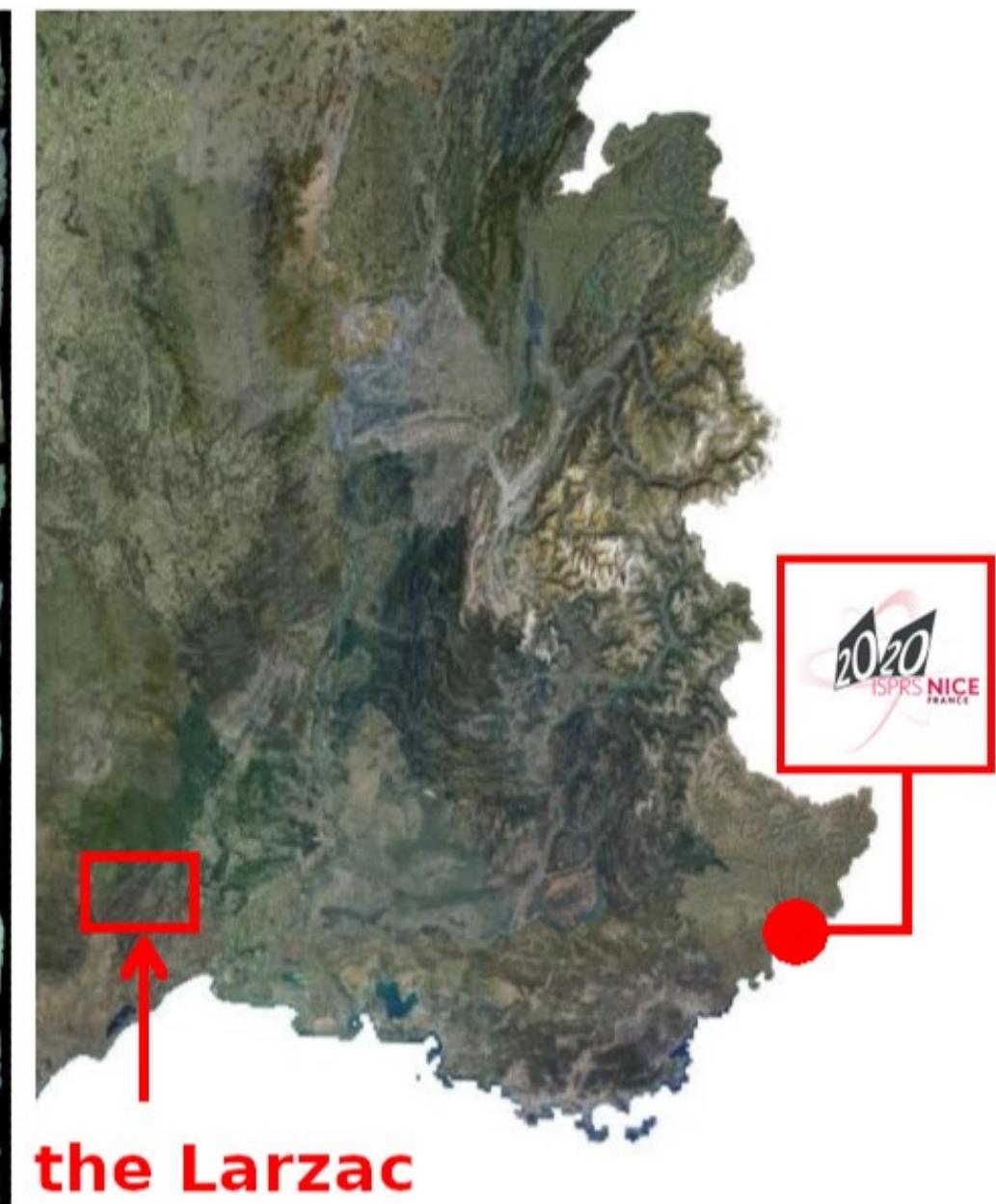
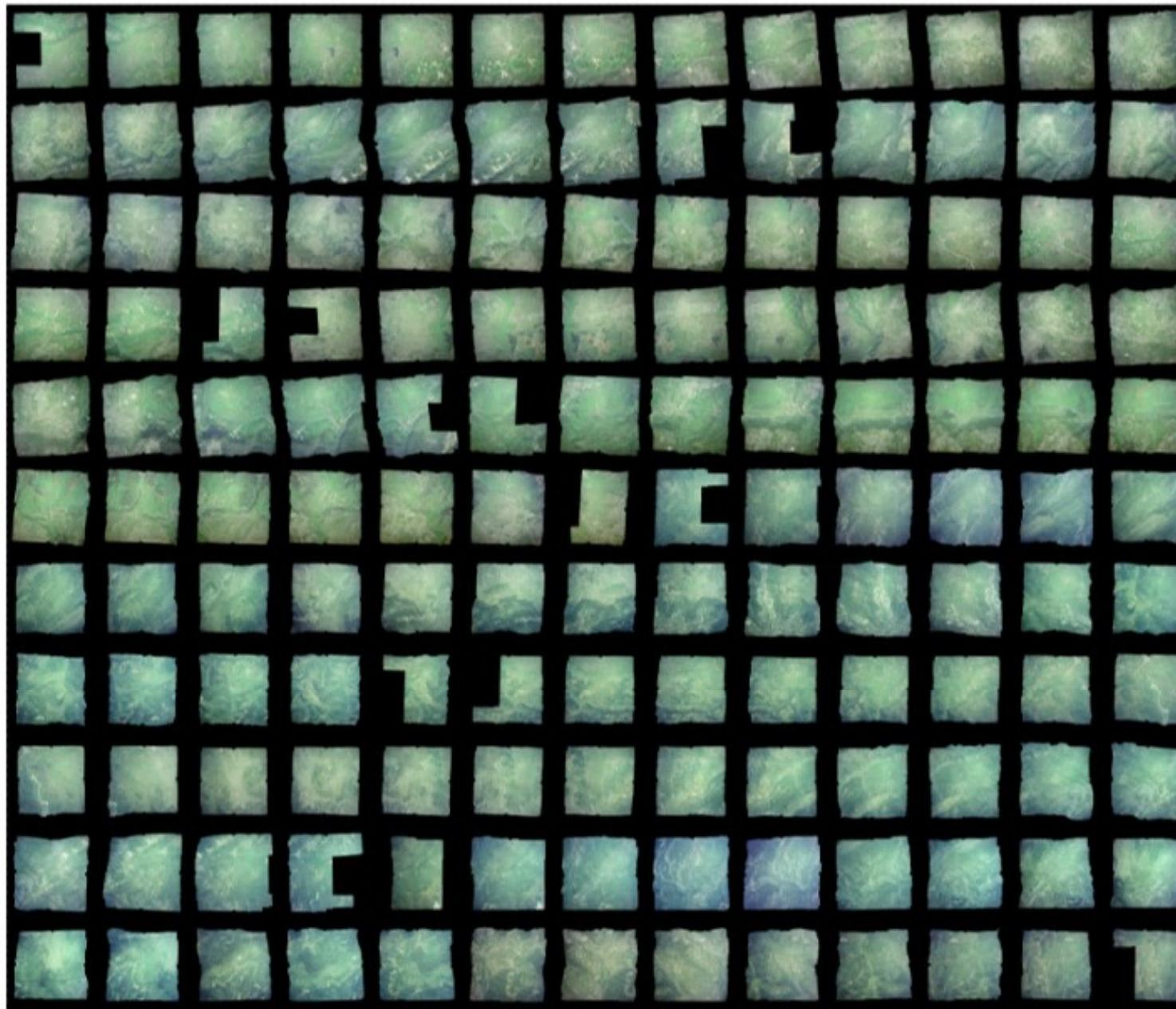
Photographies aériennes historiques 1950-1965

avec

Photographies aériennes 2006-2010

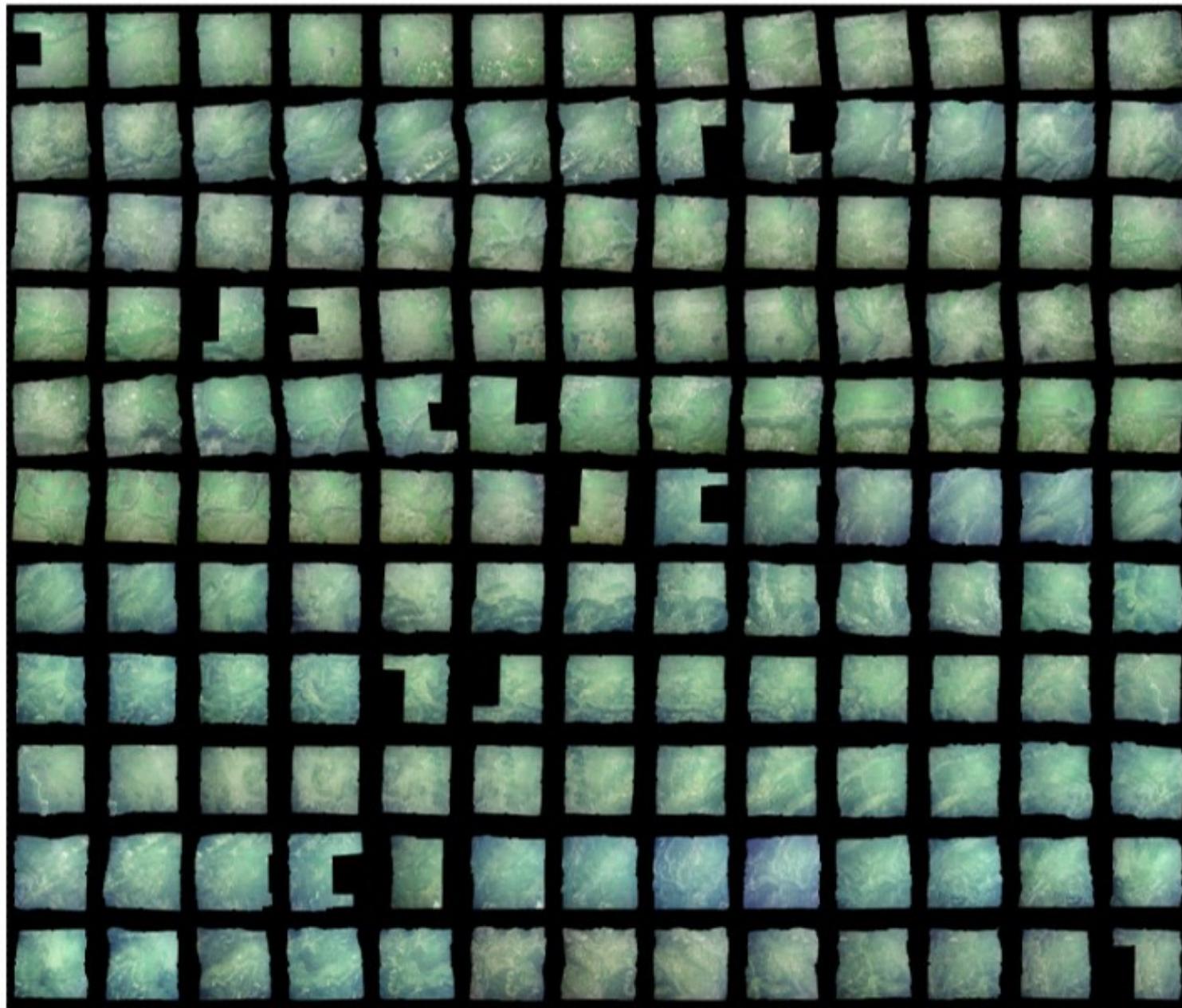


Larzac - dataset of 143 ortho-images



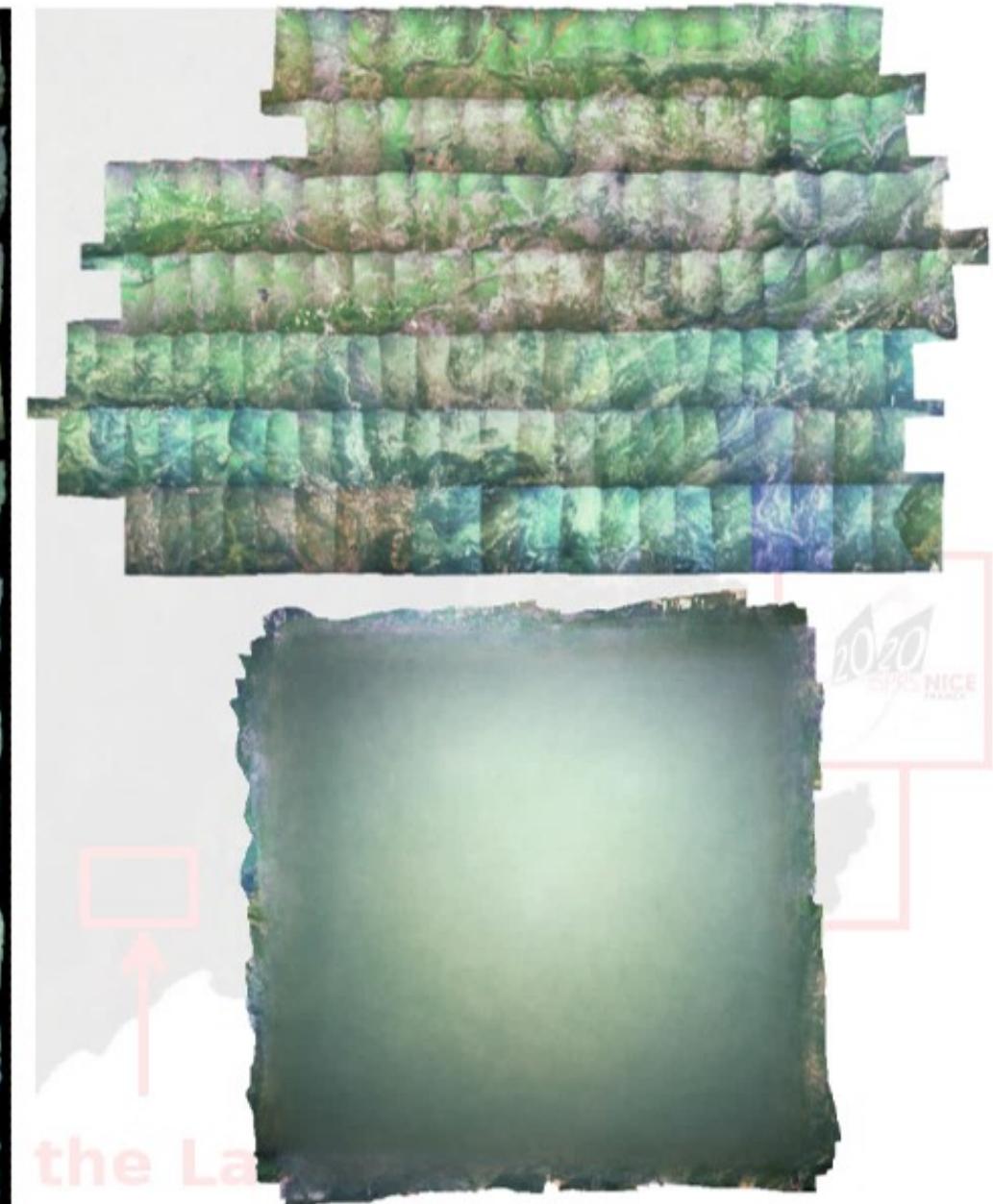
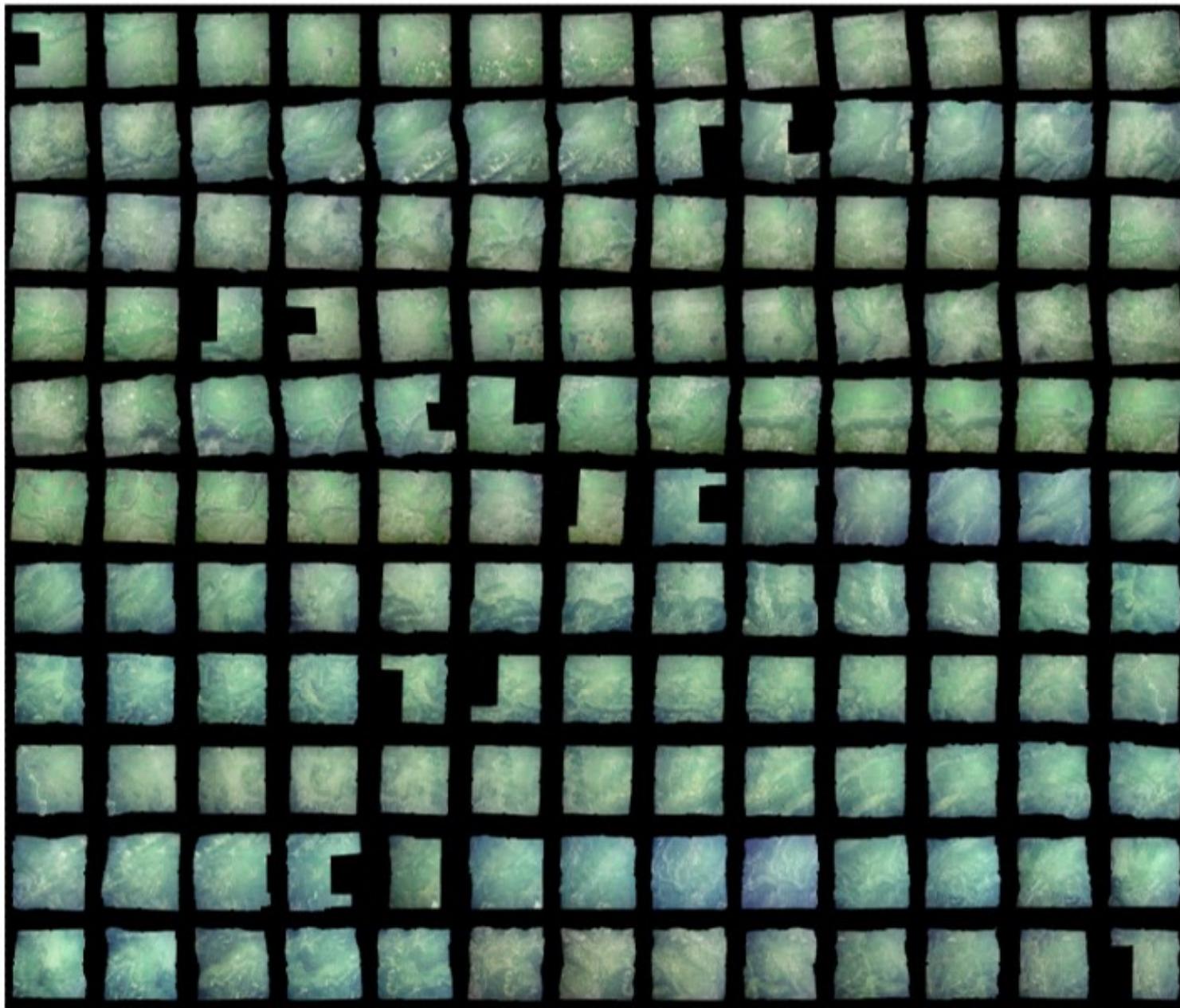
the Larzac

Larzac - dataset of 143 ortho-images

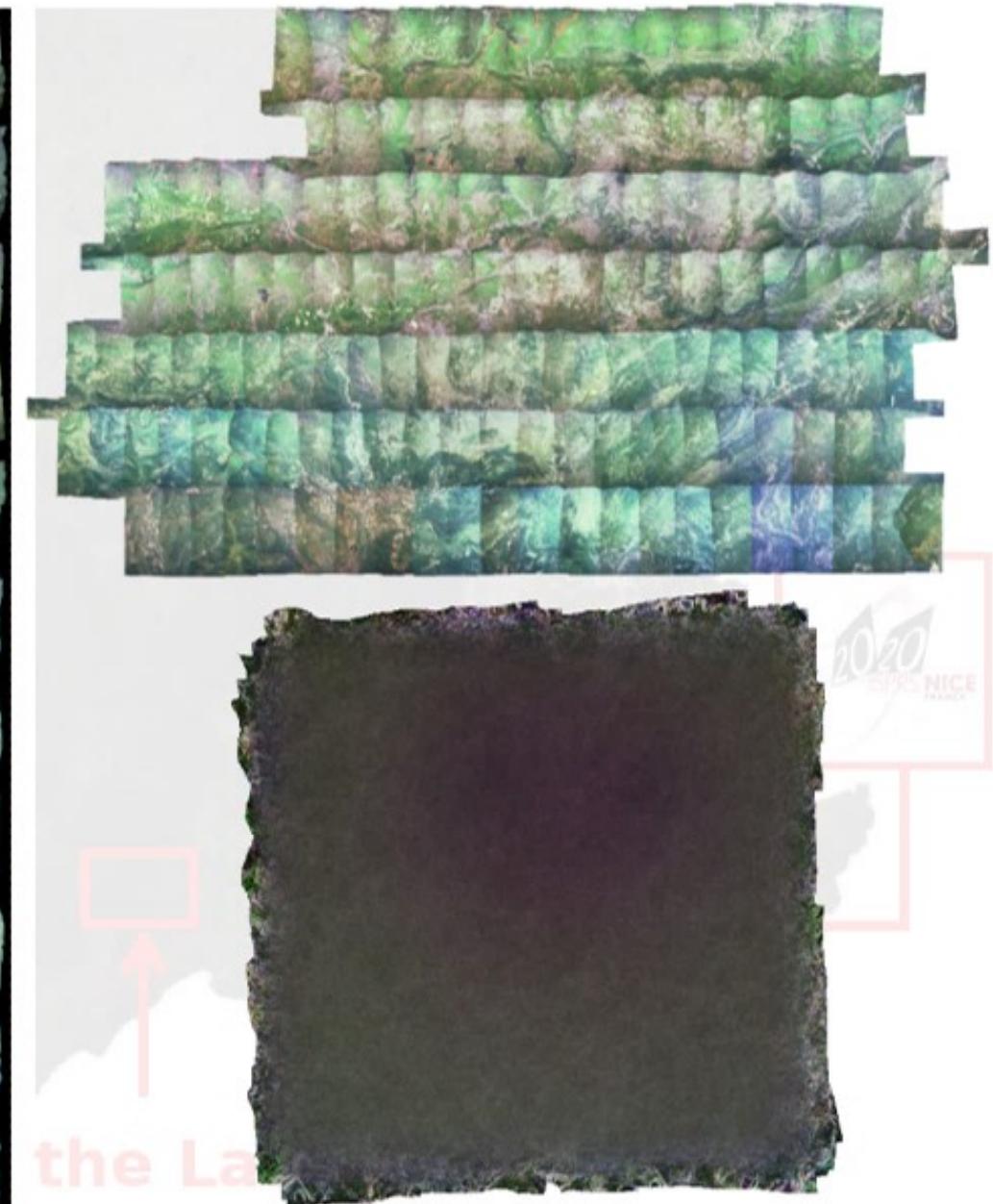
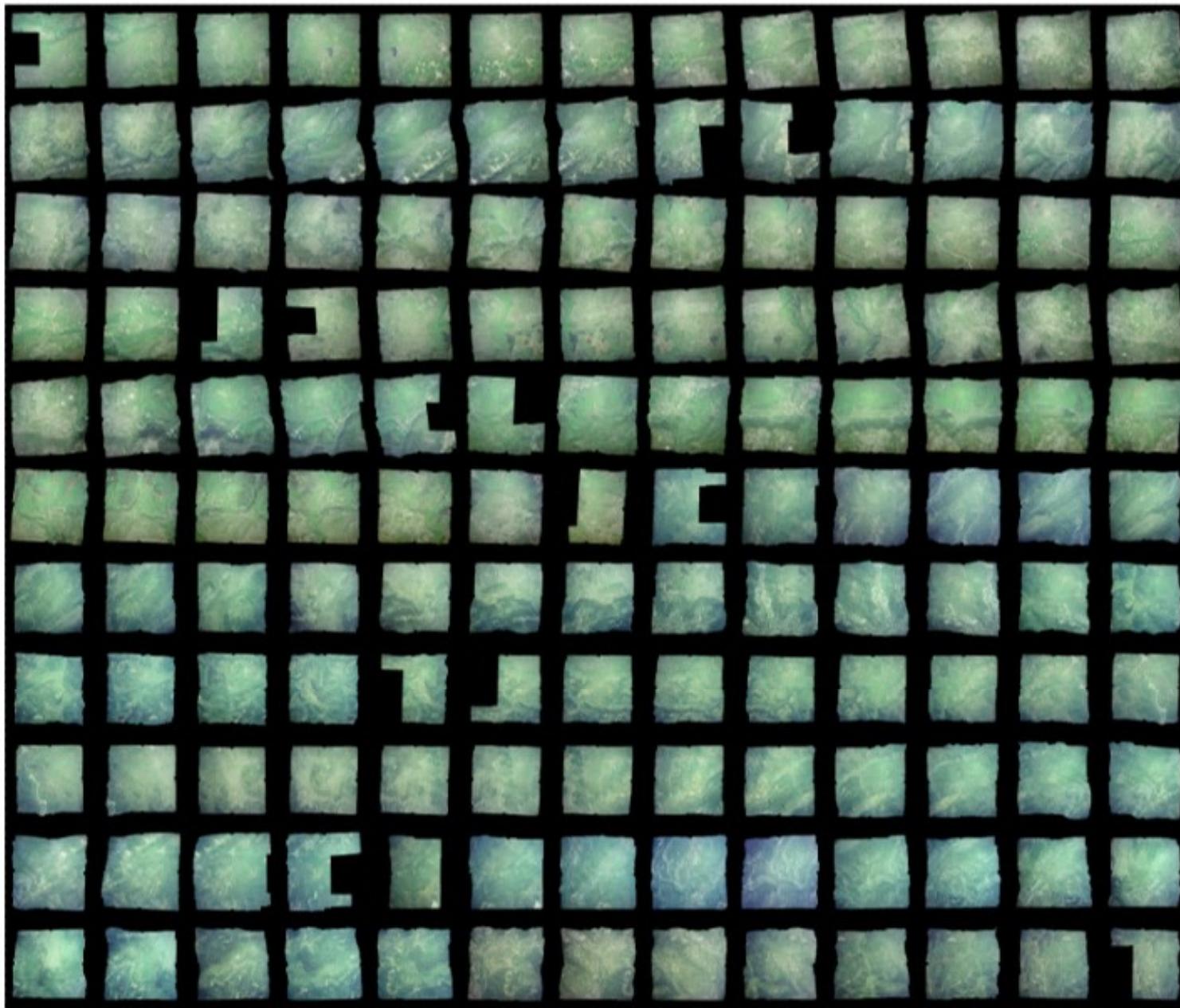


the Larzac

Larzac - dataset of 143 ortho-images



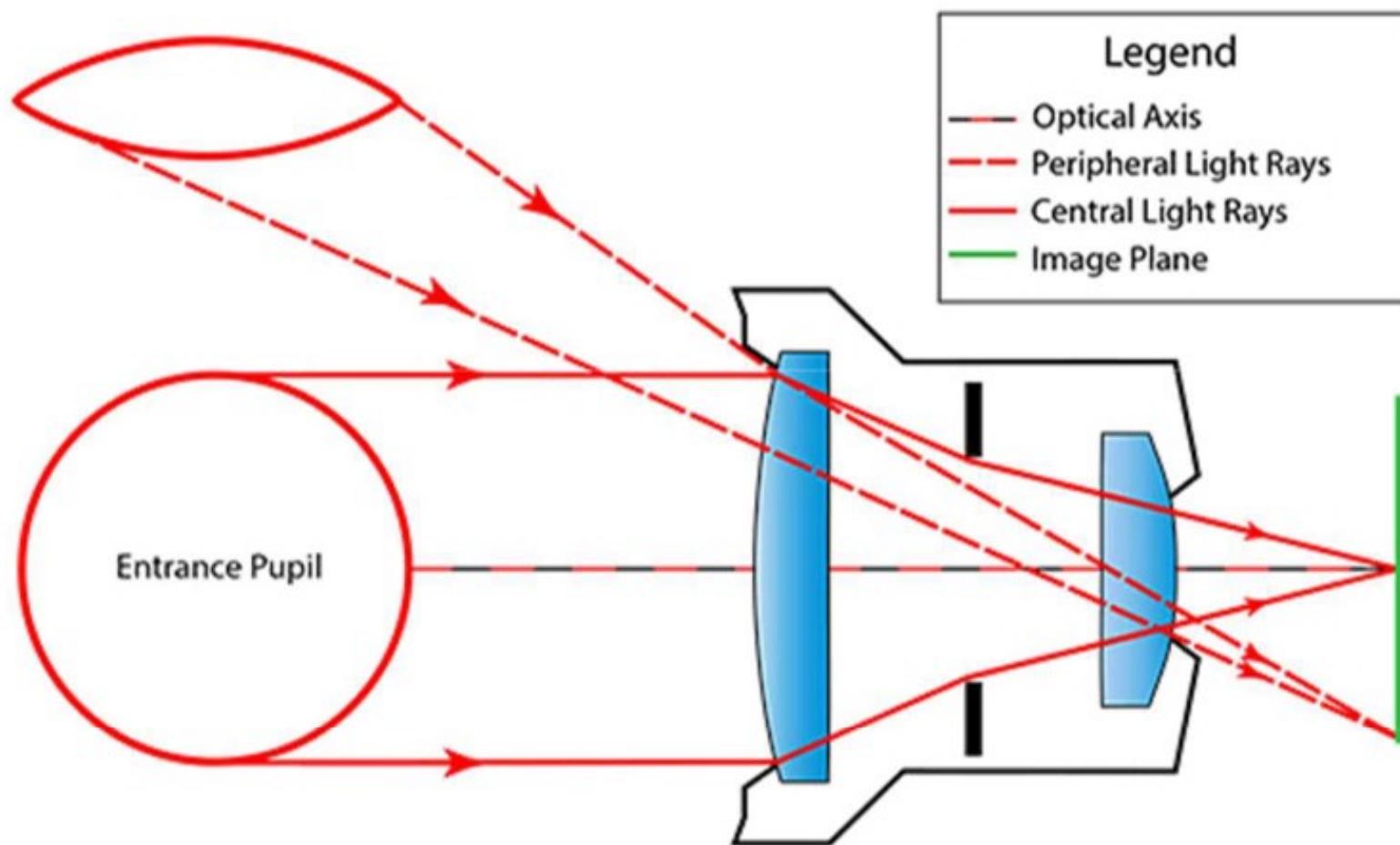
Larzac - dataset of 143 ortho-images



OPTICAL VIGNETTING

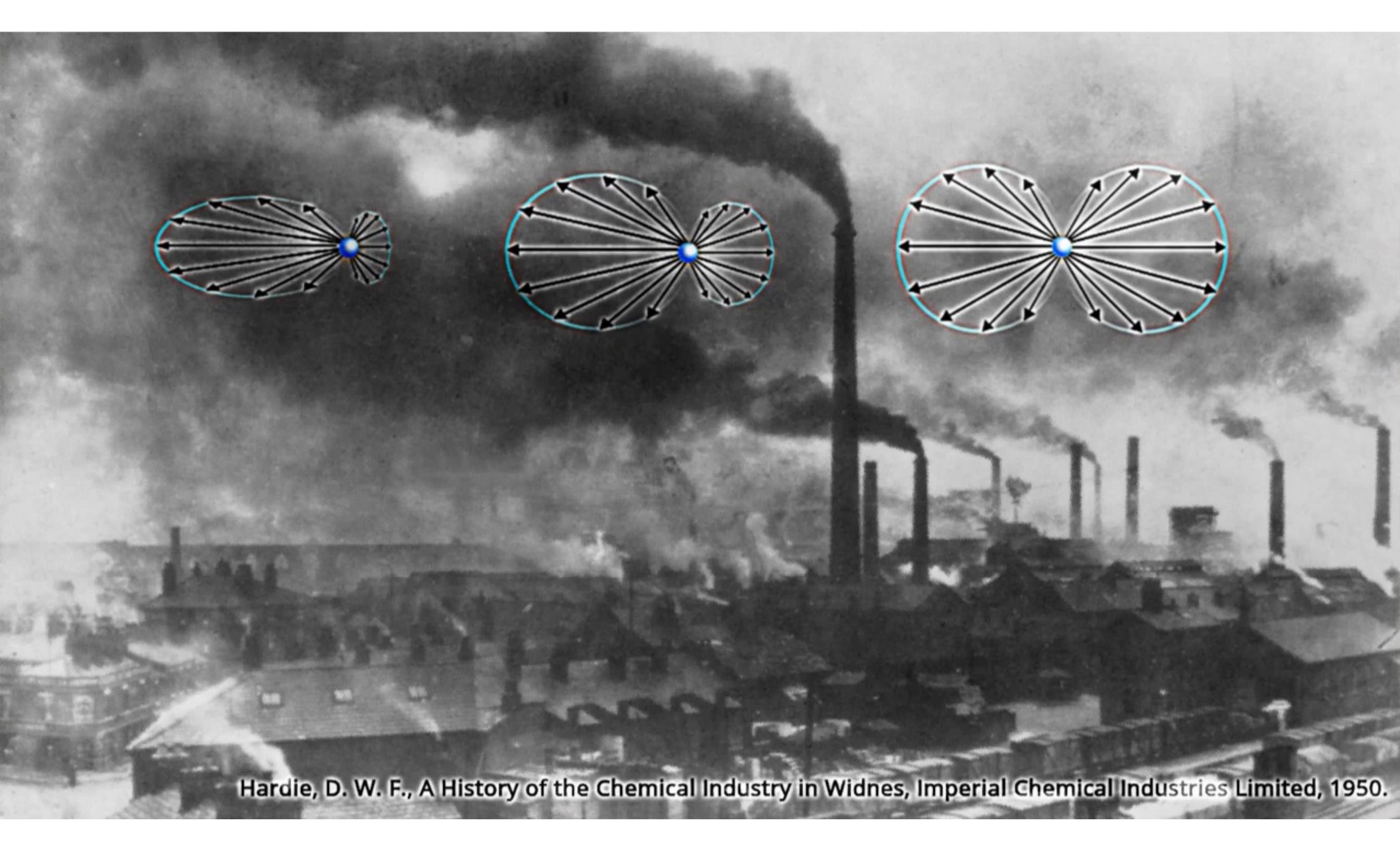


Optical Vignetting

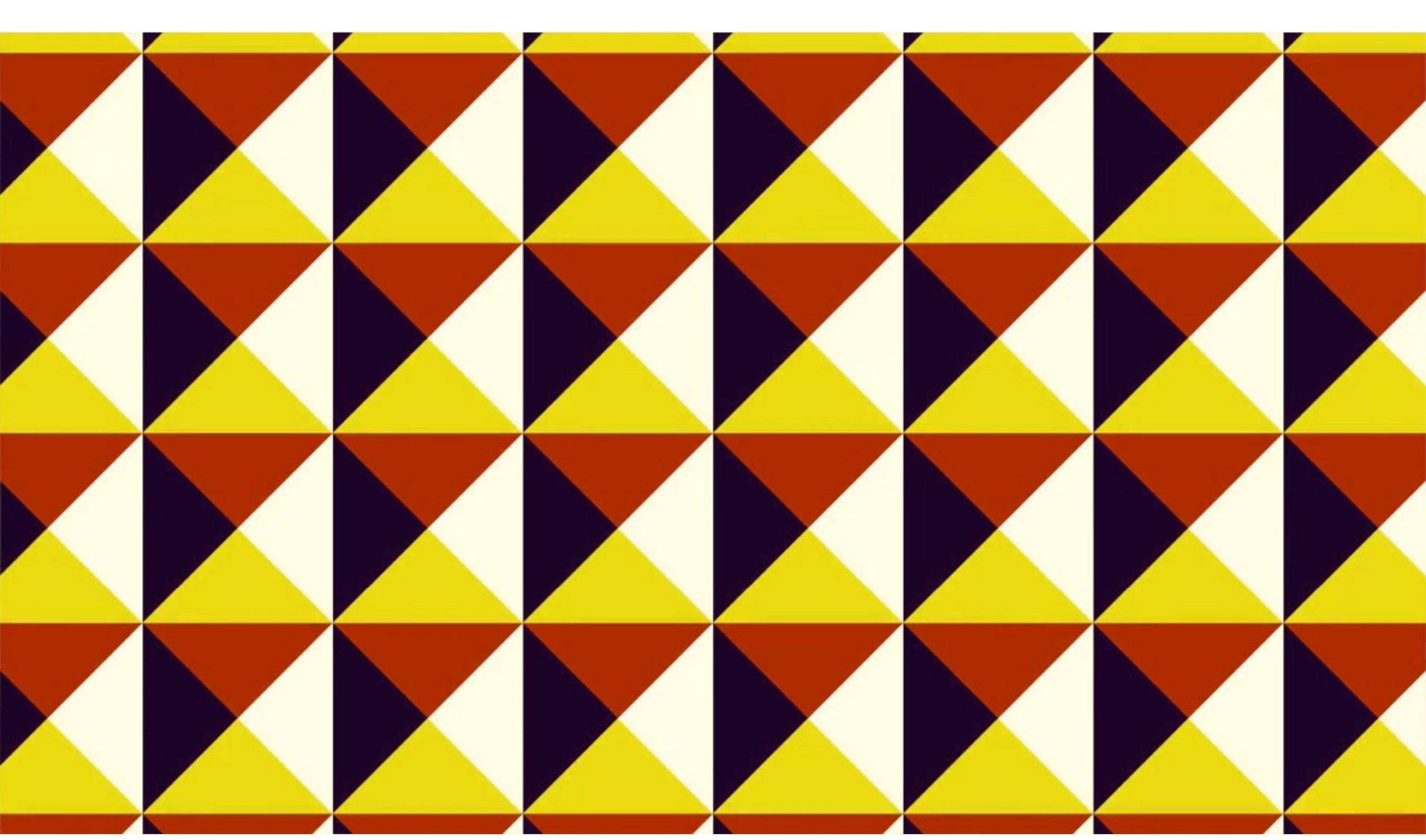


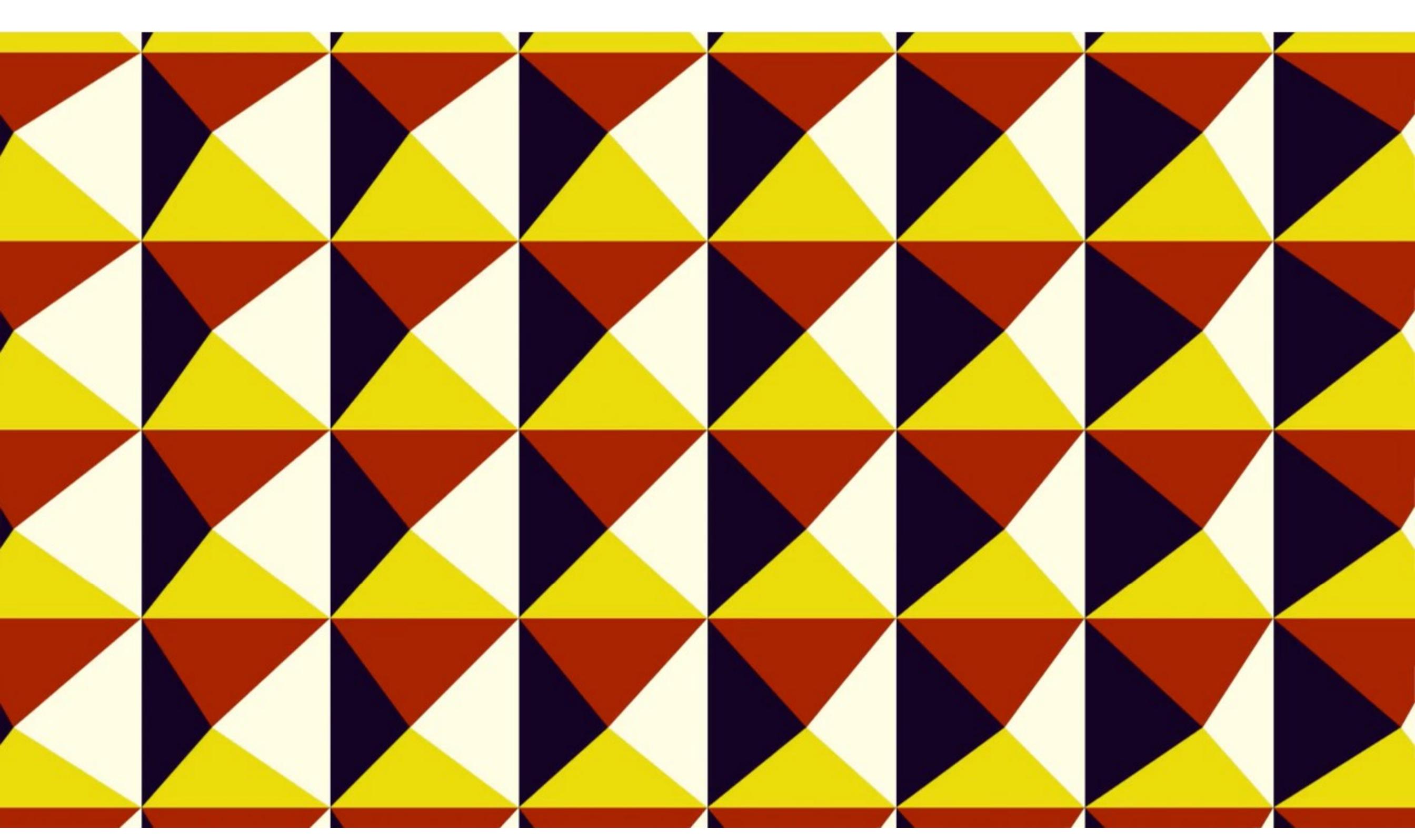
Source : <https://photographylife.com/what-is-vignetting>

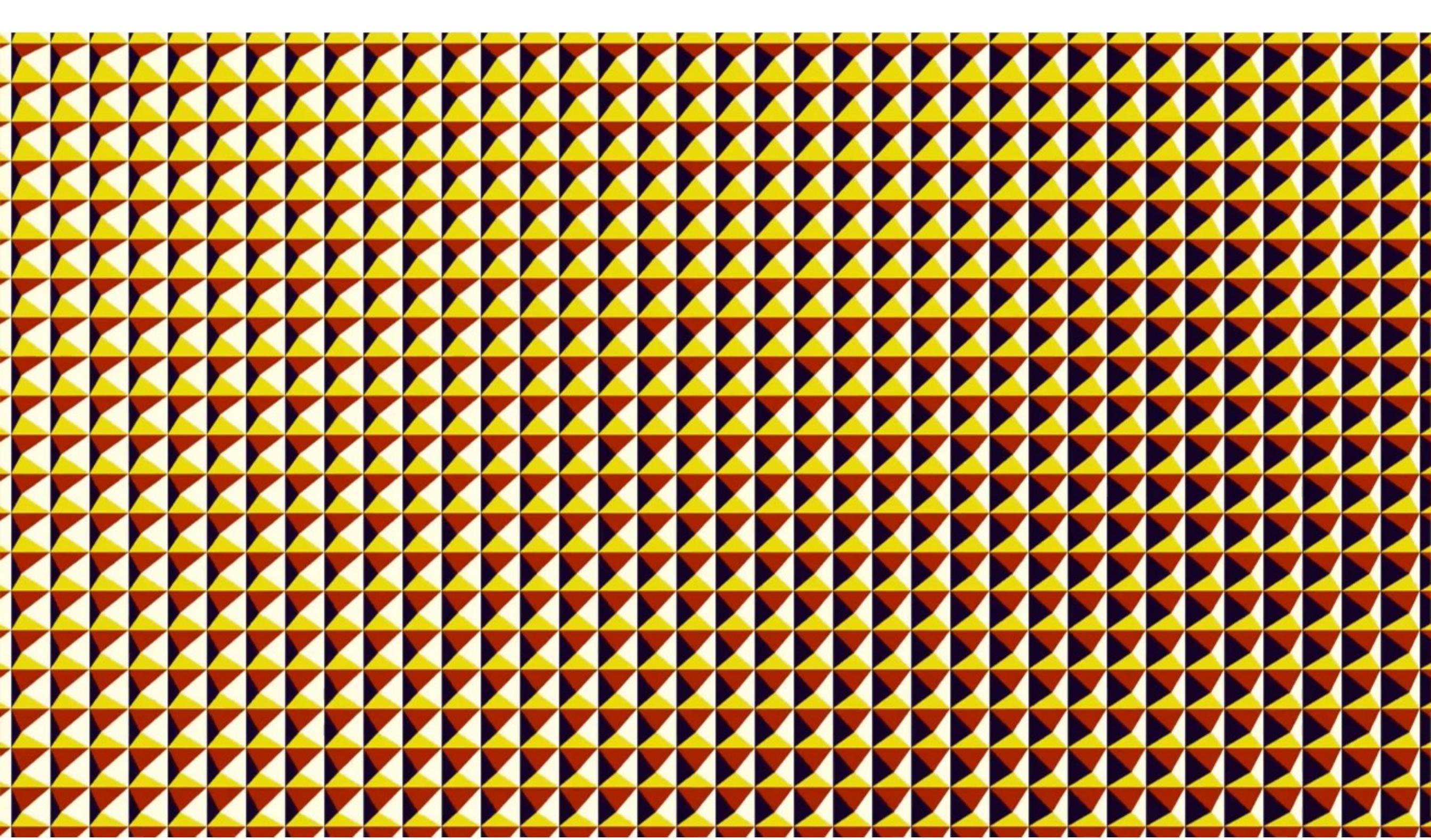


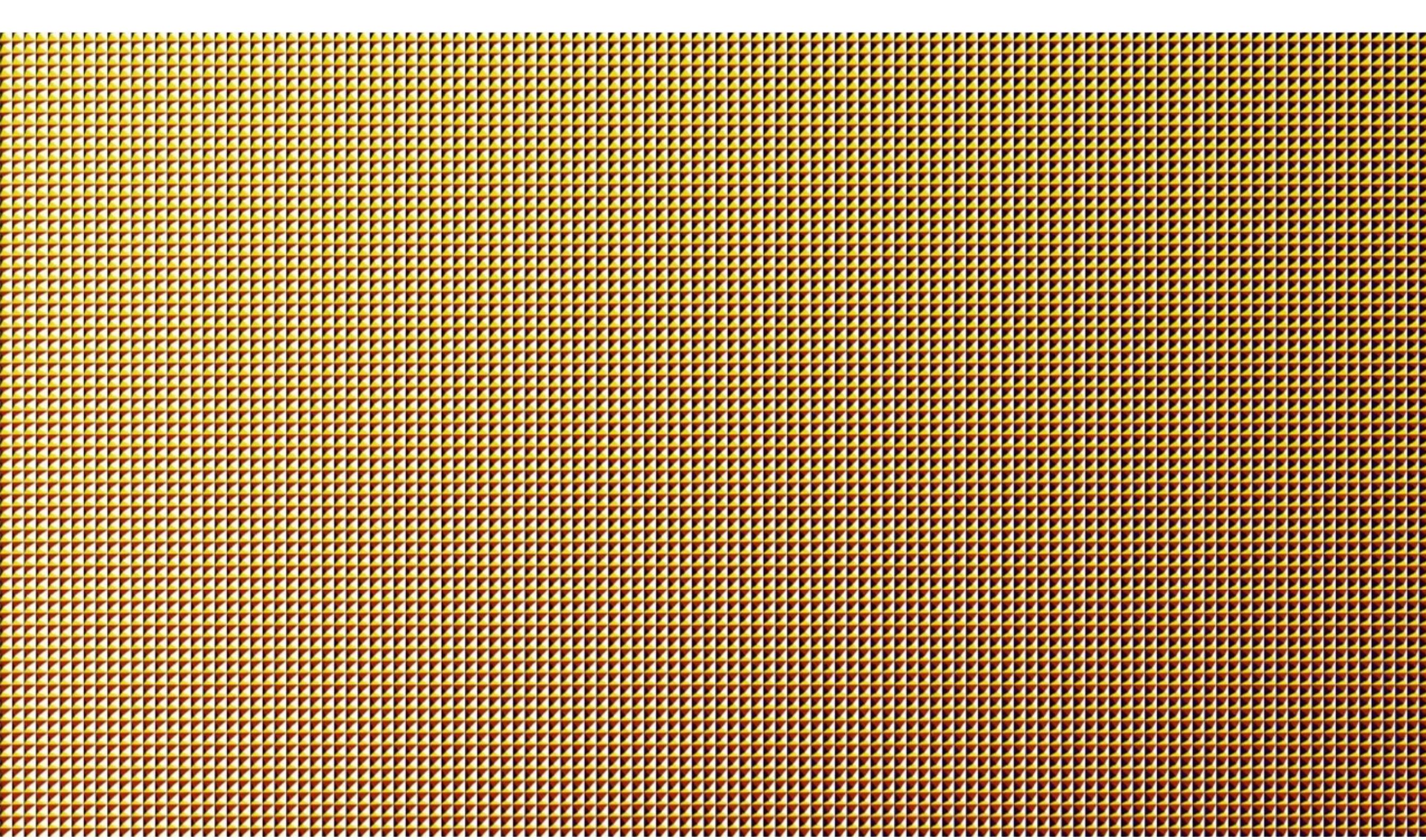


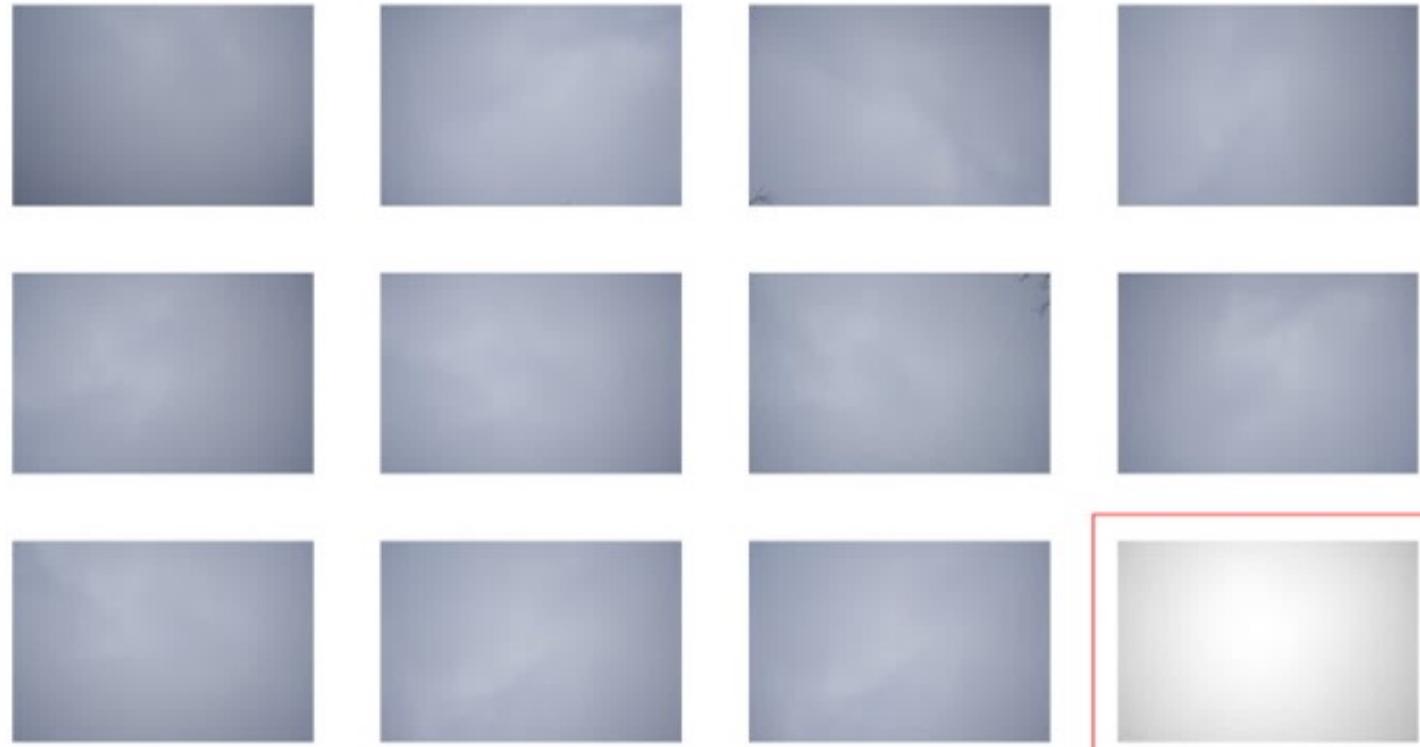
Hardie, D. W. F., A History of the Chemical Industry in Widnes, Imperial Chemical Industries Limited, 1950.



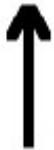






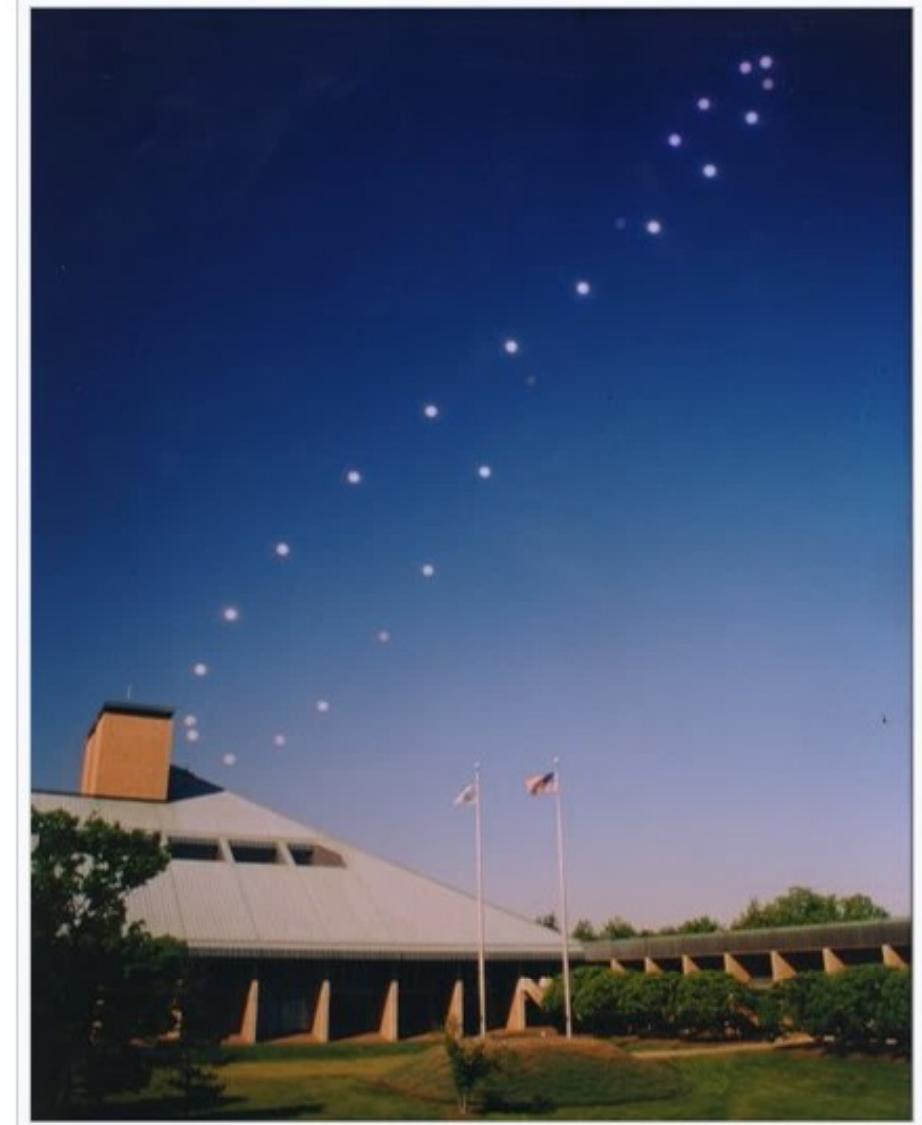


Sources:



[http://dionysos.ign.fr/jr/jr18/presentations/
Presentation_Lelegard_et_al.pdf](http://dionysos.ign.fr/jr/jr18/presentations/Presentation_Lelegard_et_al.pdf)

<https://en.wikipedia.org/wiki/Analemma> →



Afternoon analemma photo taken in 1998–99 in Murray Hill, New Jersey, USA, by Jack Fishburn. The Bell Laboratories building is in the foreground.



(a)



(c)

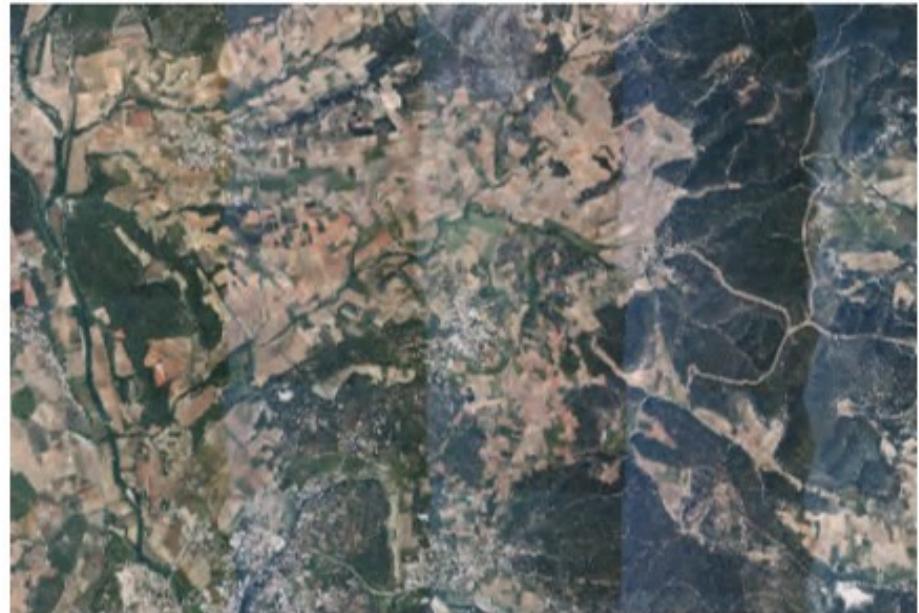
A Radiometric Aerial Triangulation for the Equalization of Digital Aerial Images and Orthoimages

Laure Chandelier and Gilles Martinoty

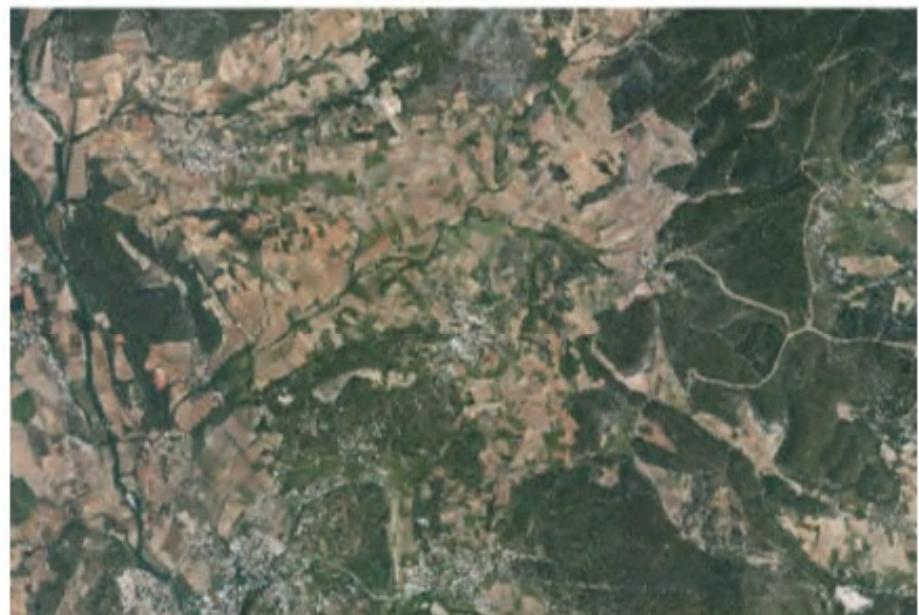


(b)

Photogrammetric Engineering & Remote Sensing
Vol. 75, No. 2, February 2009, pp. 193–200.
0099-1112/09/7502-0193/\$3.00/0
© 2009 American Society for Photogrammetry
and Remote Sensing



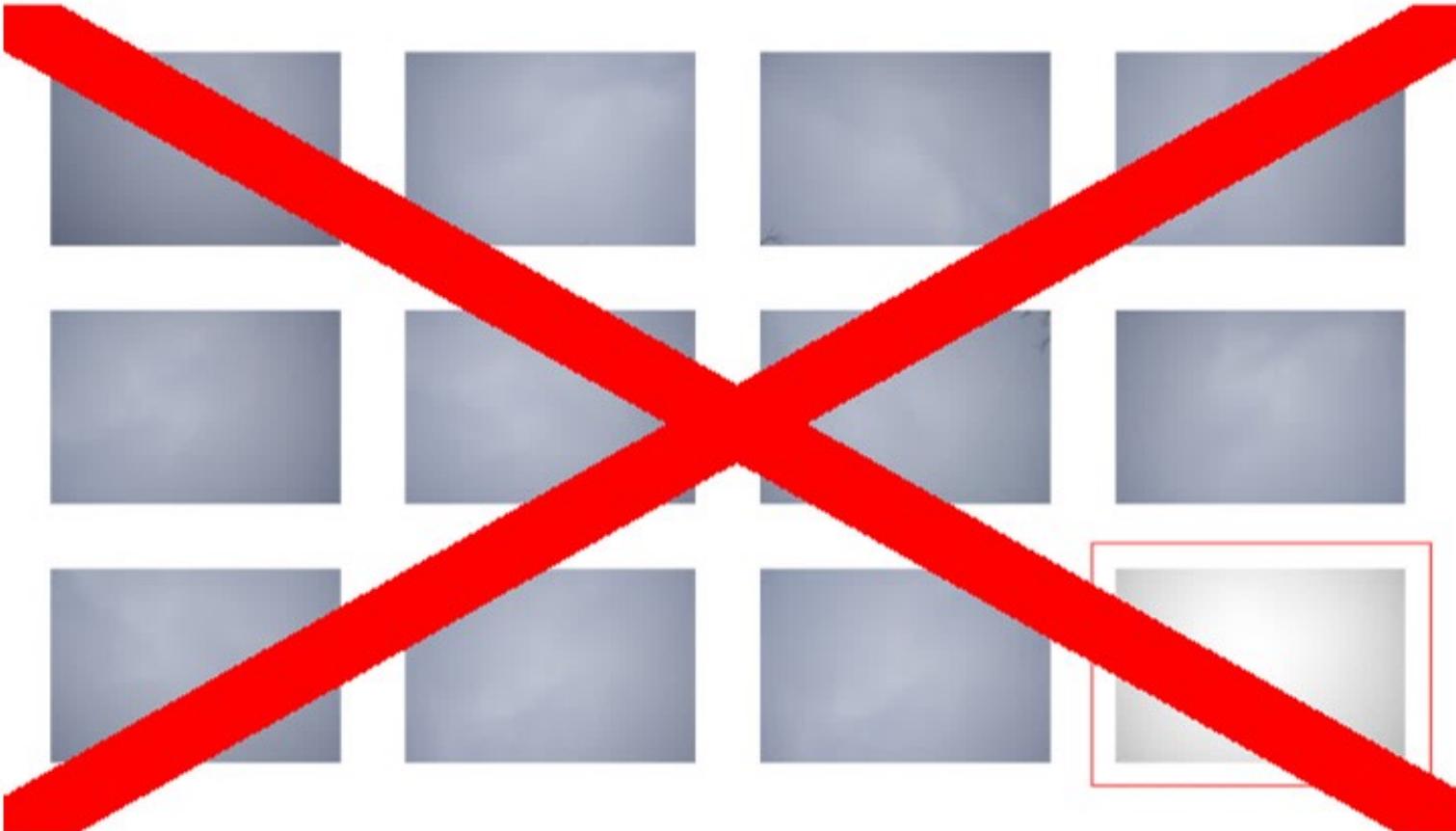
(a)



(b)

Plate 1. Correction of an image with the radiometric model: (a) Image before processing.
(b) Hot spot model, and (c) Image after processing.

Plate 3. Enlargement of radiometric corrections on the Gard: (a) orthoimage created from the initial aerial images only corrected for exposure time and sun zenith angle effects, and (b) orthoimage corrected with the presented method.



?



Afternoon analemma photo taken in 1998
in Murray Hill, New Jersey, USA, by Jack
Pemburn. The Bell Laboratories building is in
the background.

**WALLIS
FILTERING**

$$Img'(x, y) = \frac{\sigma_0}{\sigma_{Img}} \cdot (Img(x, y) - \mu_{Img}) + \mu_0$$



$$Img'(x, y) = \frac{\sigma_0}{\sigma_{Img}} \cdot (Img(x, y) - \mu_{Img}) + \mu_0$$



$$Img'(x, y) = \frac{\sigma_0}{\sigma_{Img}} \cdot (Img(x, y) - \mu_{Img}) + \mu_0$$



$$Img'(x, y) = \frac{\sigma_0}{\sigma_{Img}} \cdot (Img(x, y) - \mu_{Img}) + \mu_0$$



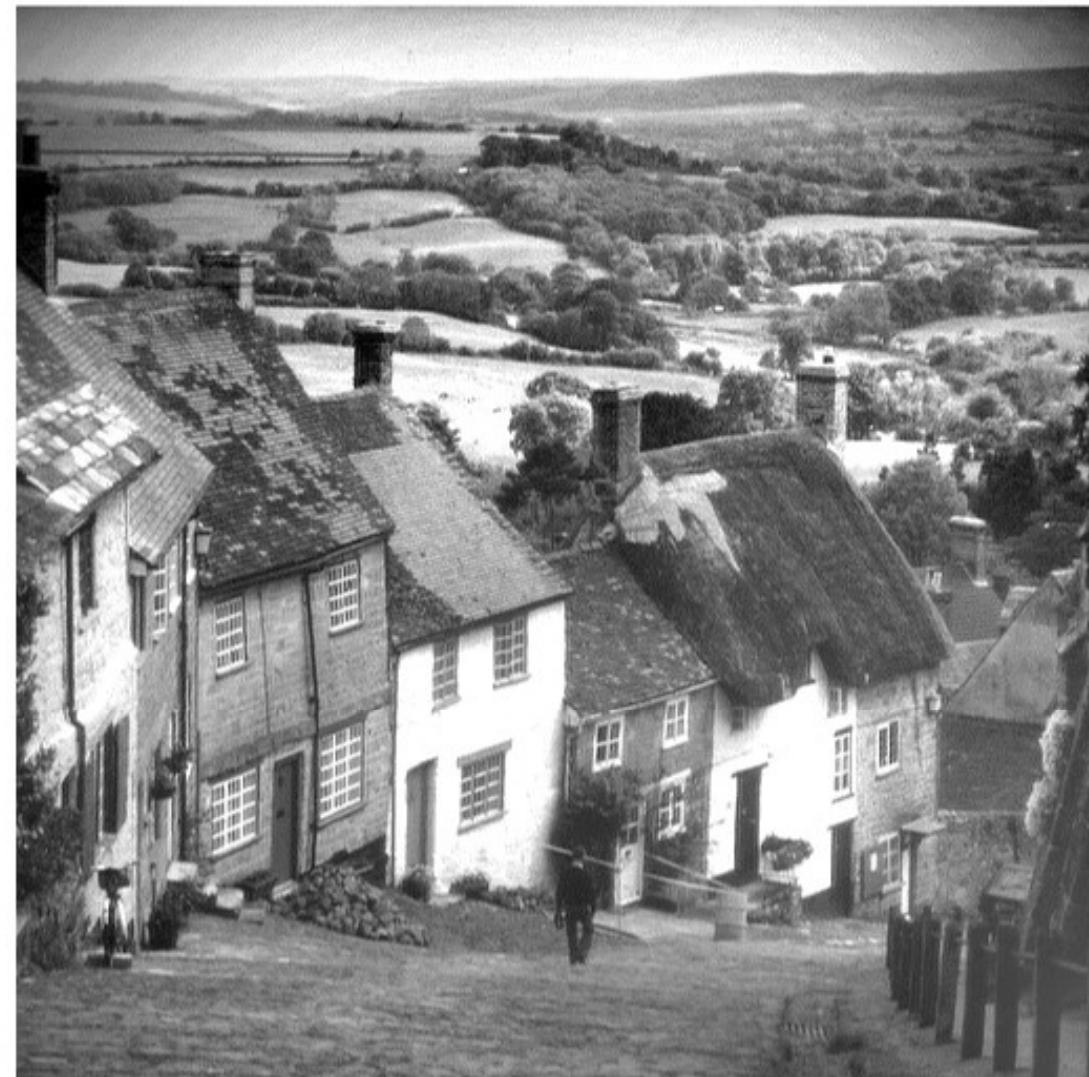
$$Img'(x, y) = \frac{\sigma_0}{\sigma_{Img}} \downarrow \cdot (Img(x, y) - \mu_{Img}) + \mu_0$$



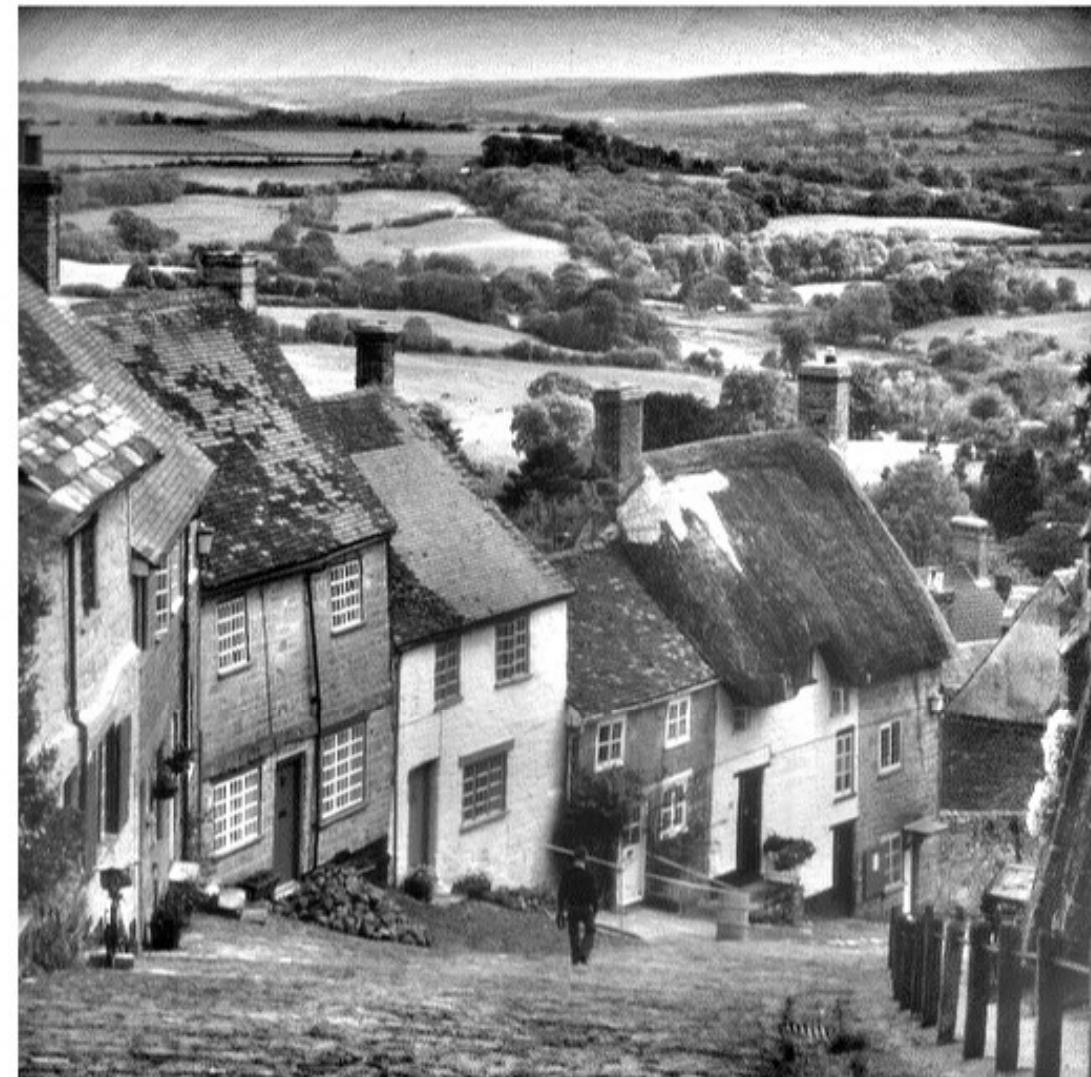
$$Img'(x, y) = \frac{\sigma_0}{\sigma_{\underline{w}}(x, y)} \cdot (Img(x, y) - \mu_{\underline{w}}(x, y)) + \mu_0$$



$$Img'(x, y) = \frac{\sigma_0}{\sigma_{\underline{w}}(x, y)} \cdot (Img(x, y) - \mu_{\underline{w}}(x, y)) + \mu_0$$

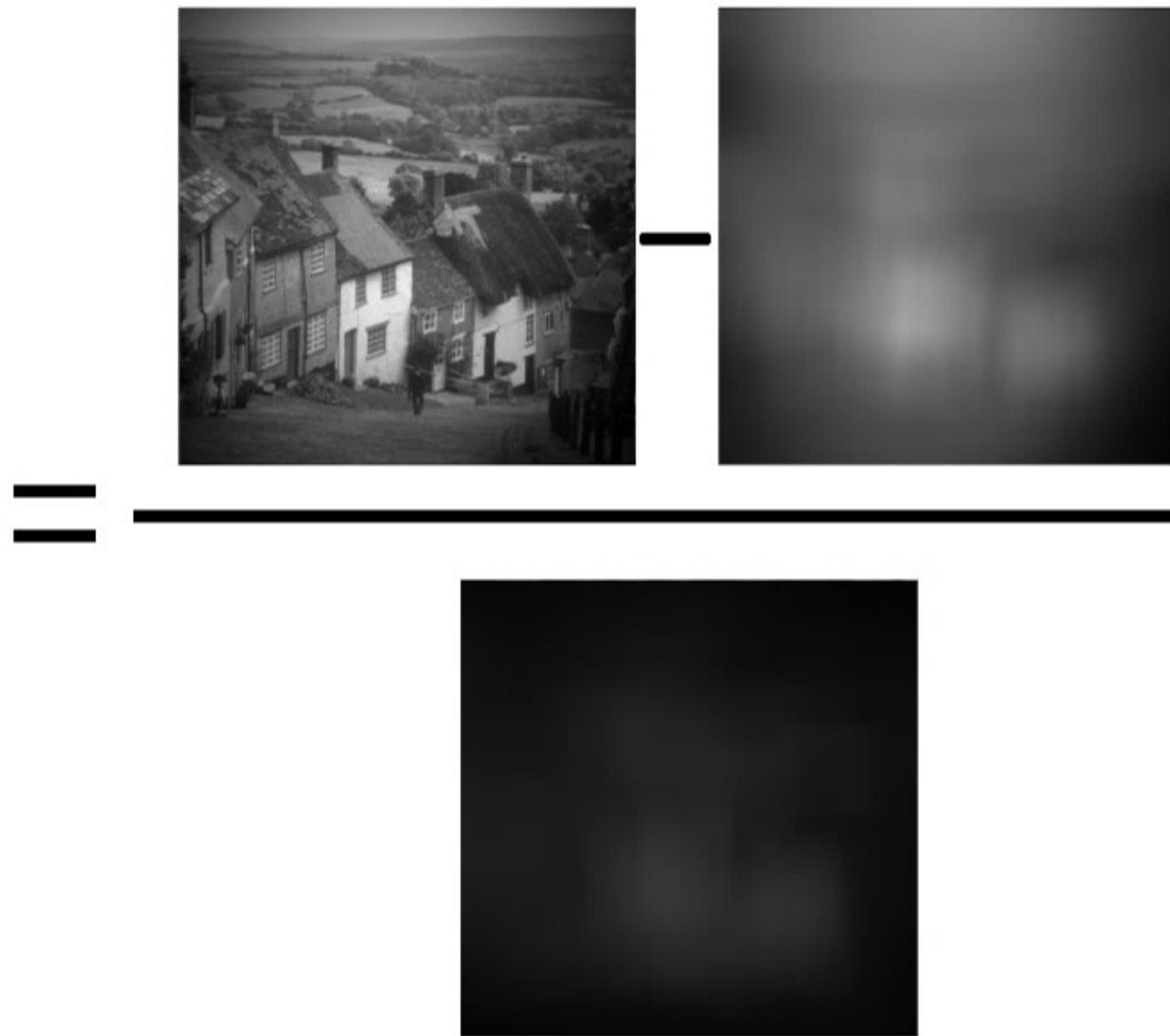


$$Img'(x, y) = \frac{\sigma_0}{\sigma_{\underline{w}}(x, y)} \cdot (Img(x, y) - \mu_{\underline{w}}(x, y)) + \mu_0$$



$$Img'(x, y) = \frac{\sigma_0}{\sigma_{\underline{w}}(x, y)} \cdot (Img(x, y) - \mu_{\underline{w}}(x, y)) + \mu_0$$

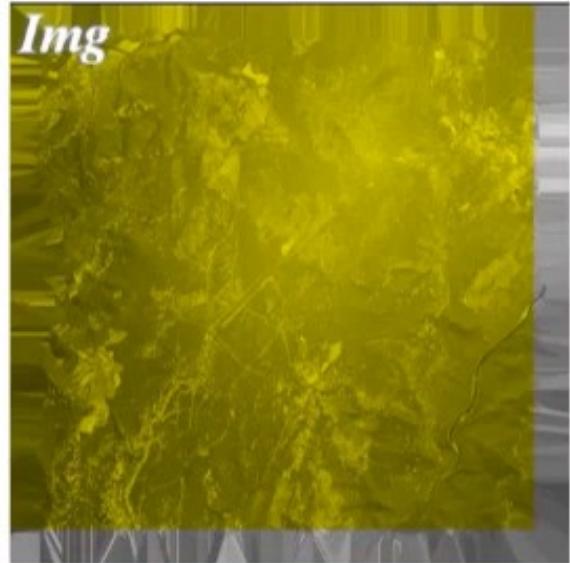




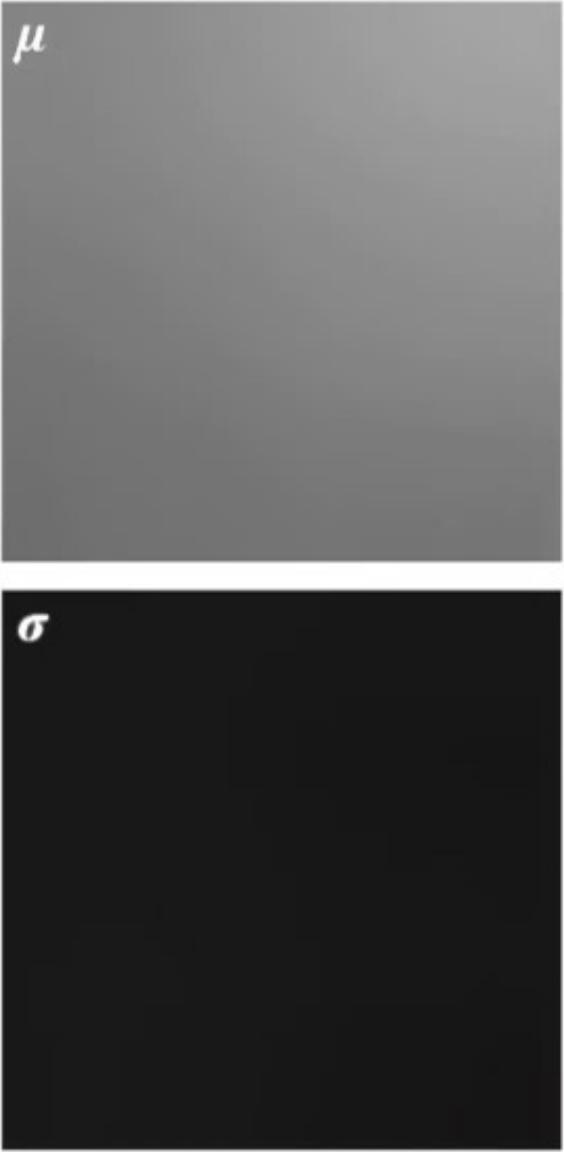
DESIRED
STANDARD
DEVIATION

DESIRED
MEAN

$\mu \rightarrow$ Local mean of the image Img performed on a square window of radius ρ (= blur convolution of Img with a radius ρ)

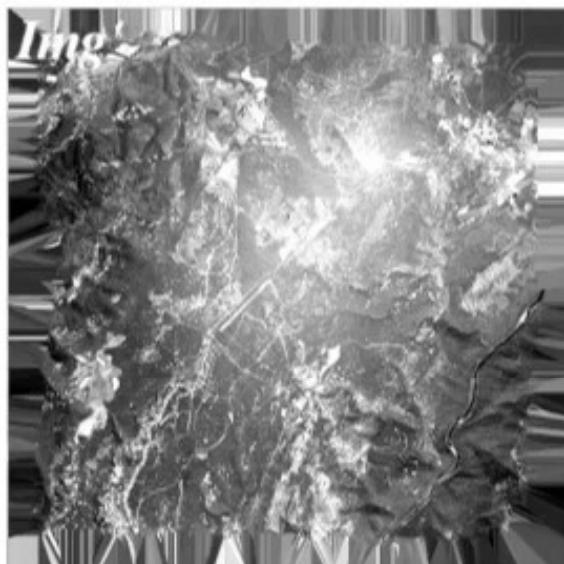


$\sigma \downarrow$
Local standard deviation of the image Img performed on a square window of radius ρ

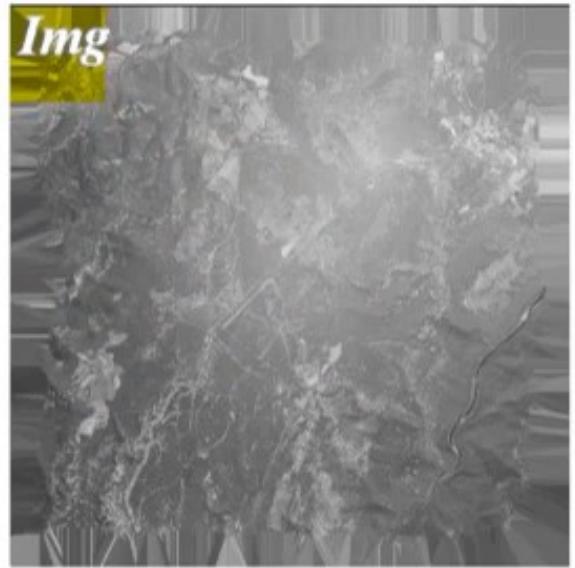


$$Img' = \sigma_o \cdot \frac{(Img - \mu)}{\sigma} + \mu_o$$

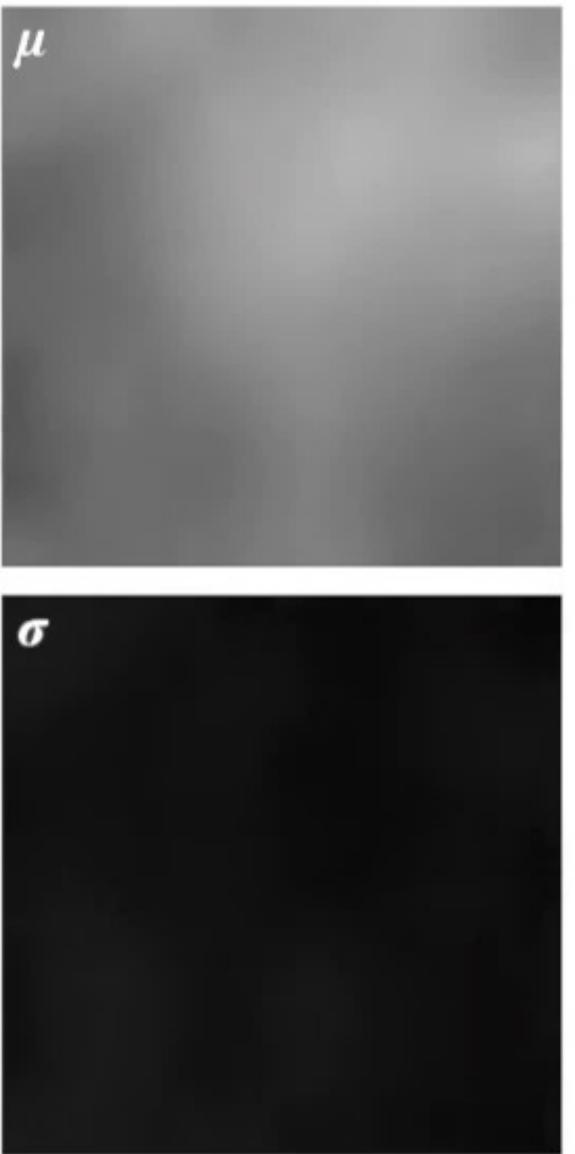
desired standard deviation
↓
 Img'
desired mean
↓



$\mu \rightarrow$ Local mean of the image Img performed on a square window of radius ρ (= blur convolution of Img with a radius ρ)



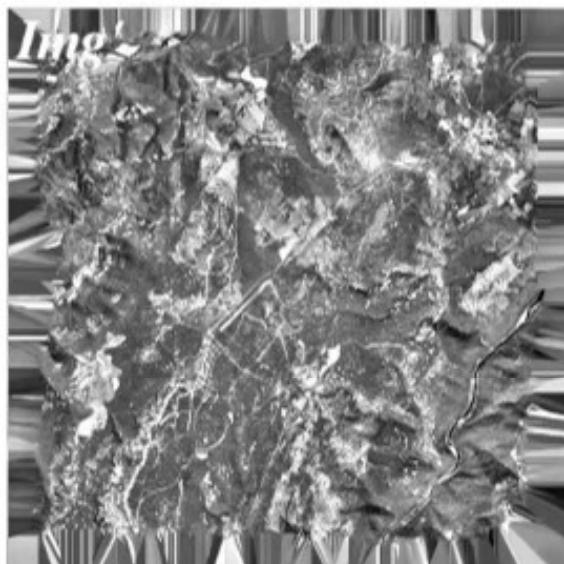
$\sigma \downarrow$
Local standard deviation
of the image Img performed
on a square window of radius ρ



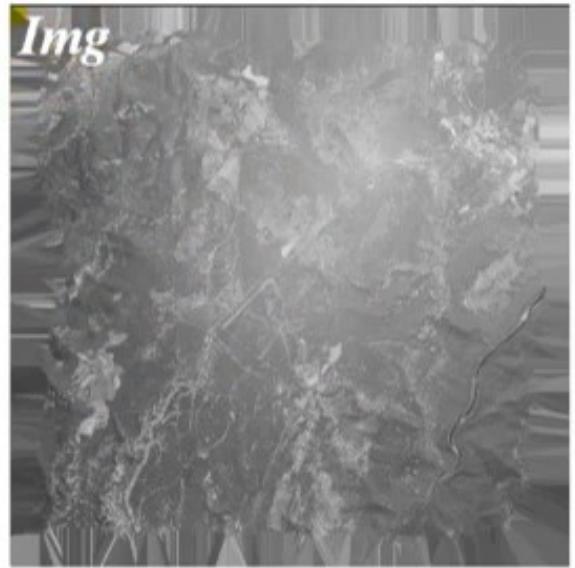
desired
standard
deviation

$$Img' = \sigma_o \cdot \frac{(Img - \mu)}{\sigma} + \mu_o$$

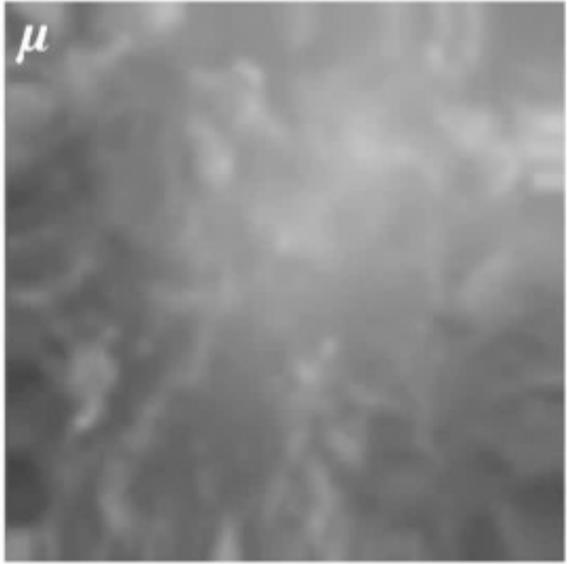
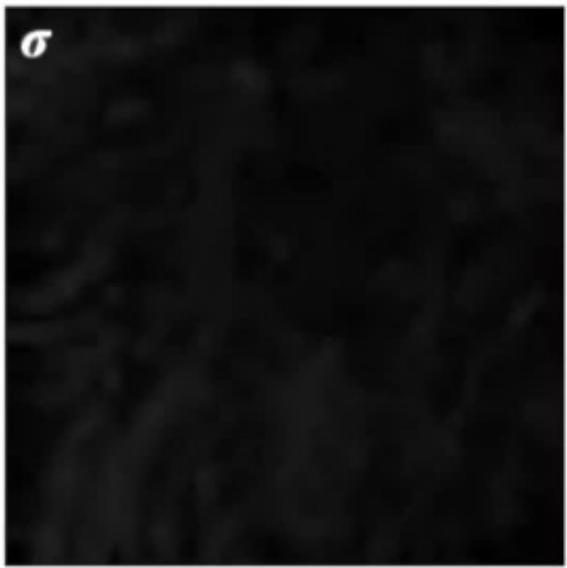
desired
mean



$\mu \rightarrow$ Local mean of the image Img performed on a square window of radius ρ (= blur convolution of Img with a radius ρ)

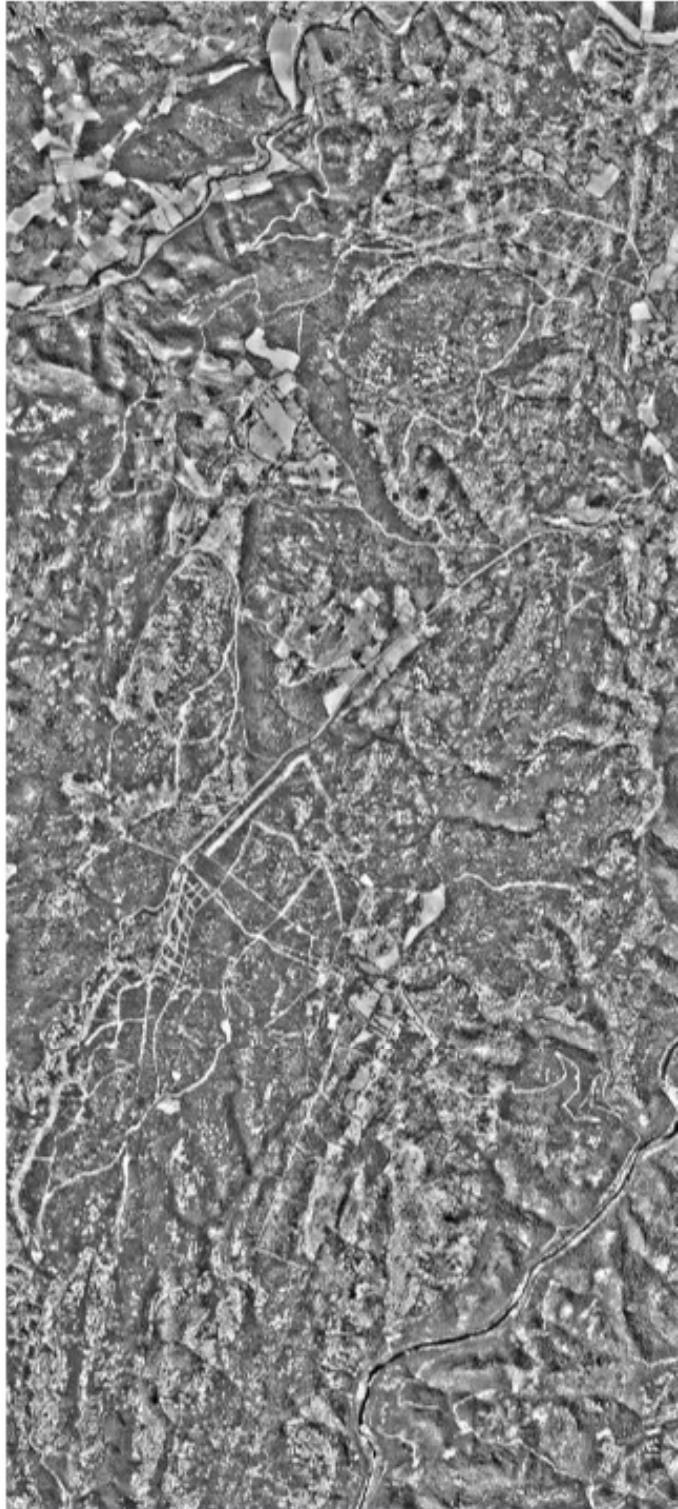
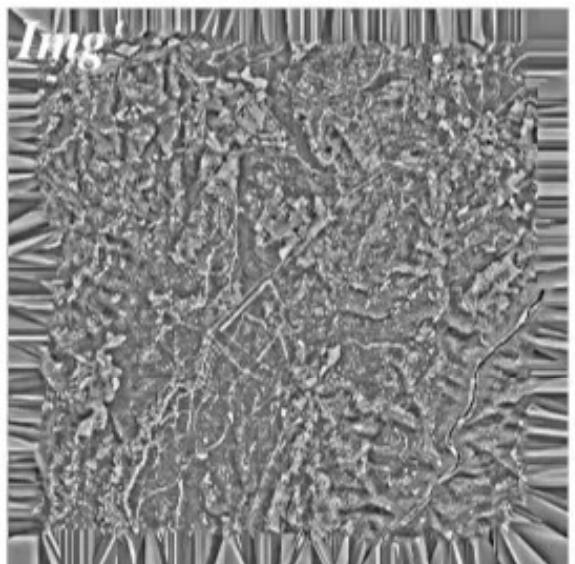


$\sigma \downarrow$
Local standard deviation of the image Img performed on a square window of radius ρ



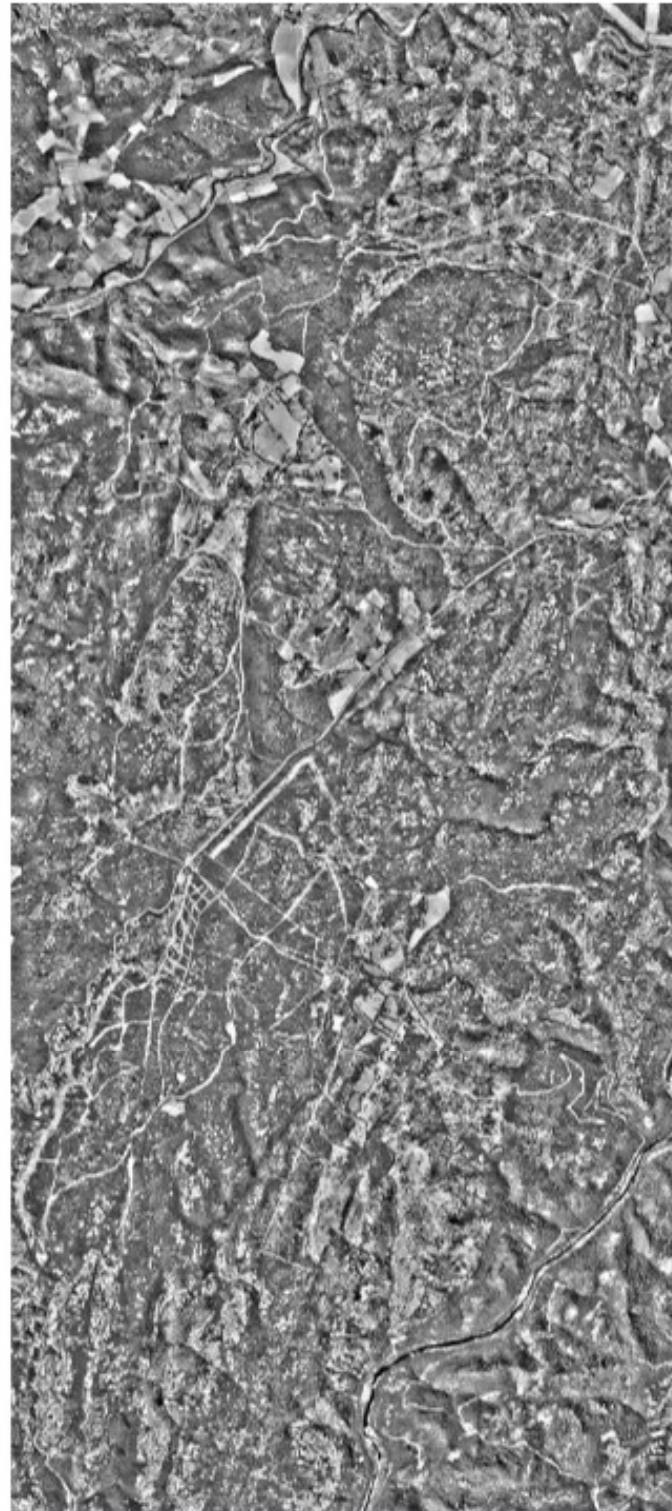
desired standard deviation
desired mean

$$Img' = \sigma_o \cdot \frac{(Img - \mu)}{\sigma} + \mu_o$$



?

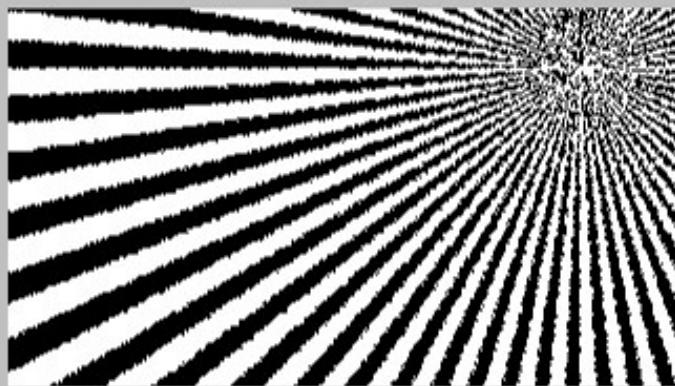
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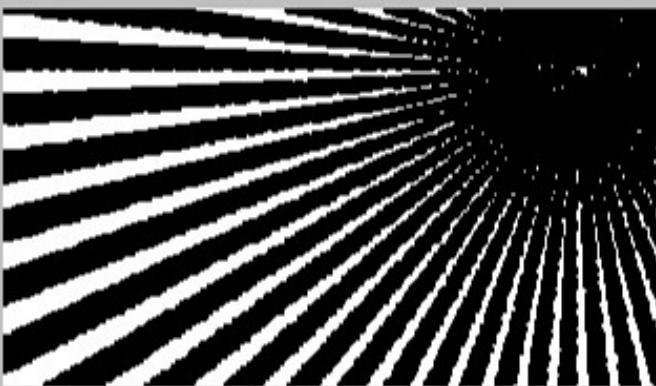
**INVARIANCE
BY CLOSING
& OPENING**



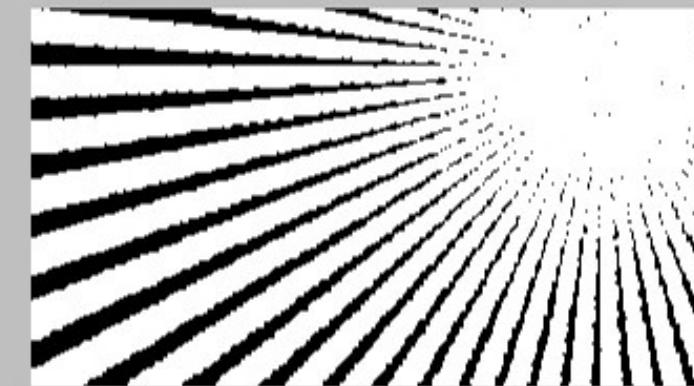
ORIGINAL



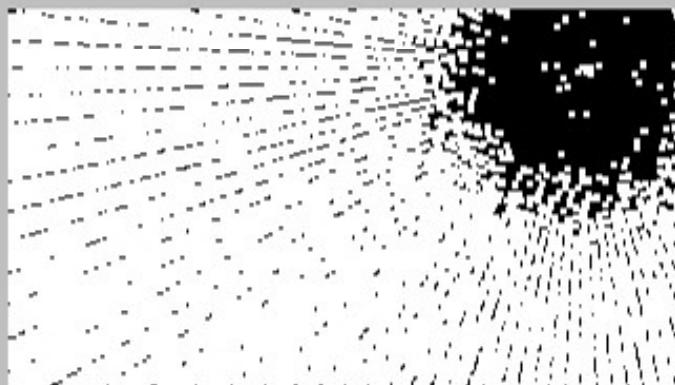
EROSION 3X3



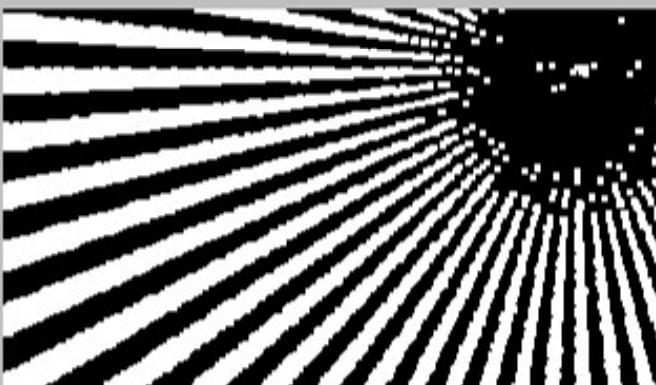
DILATION 3X3



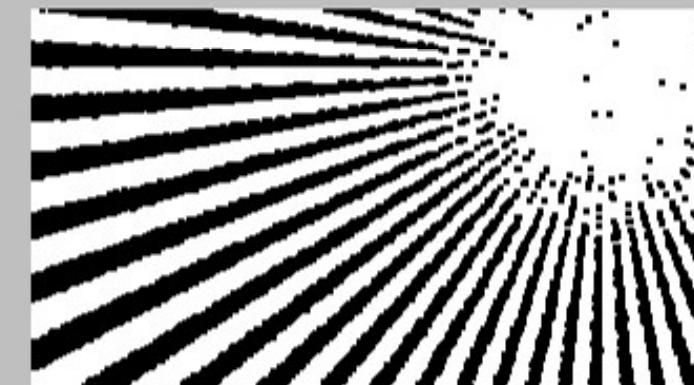
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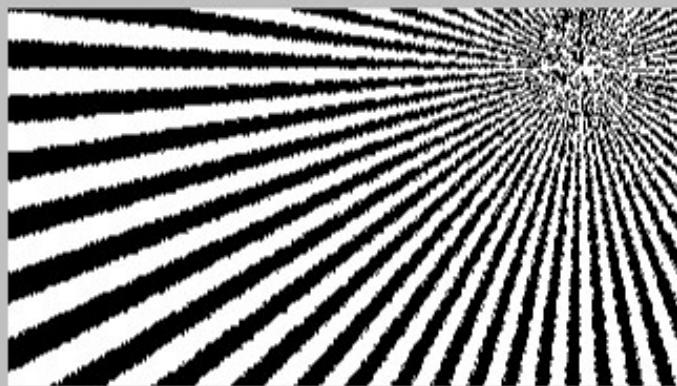
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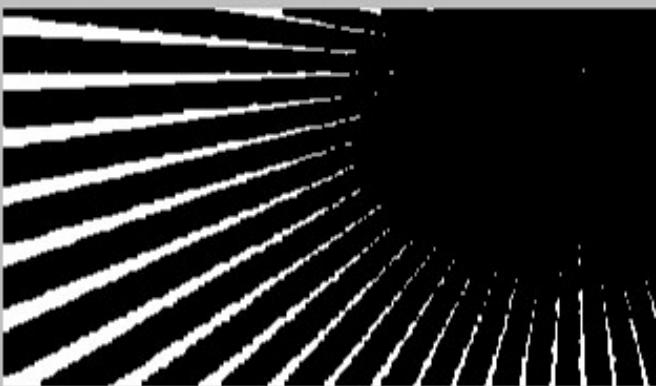
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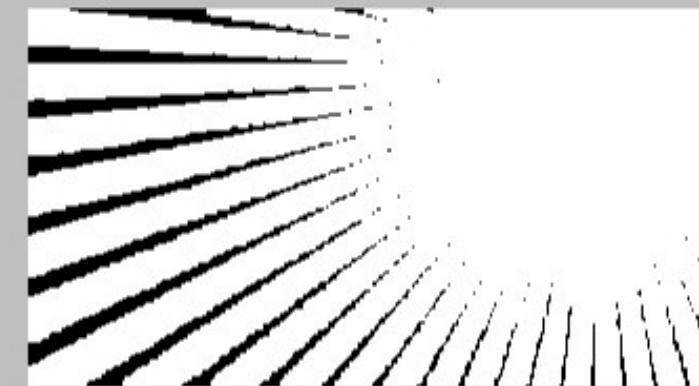
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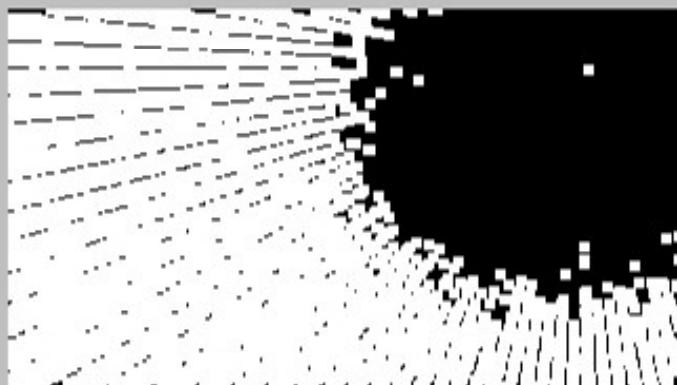
EROSION 5X5



DILATION 5X5



INVARIANCE 5X5



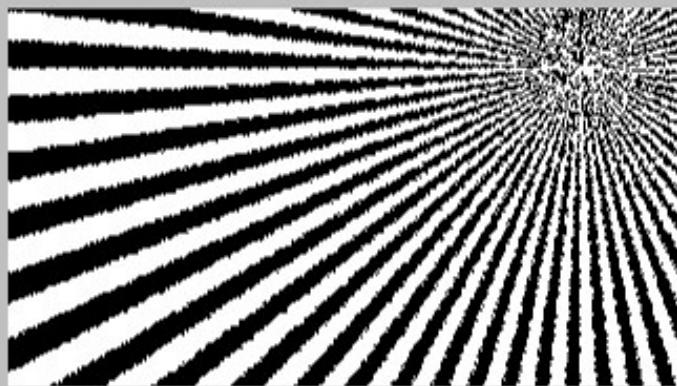
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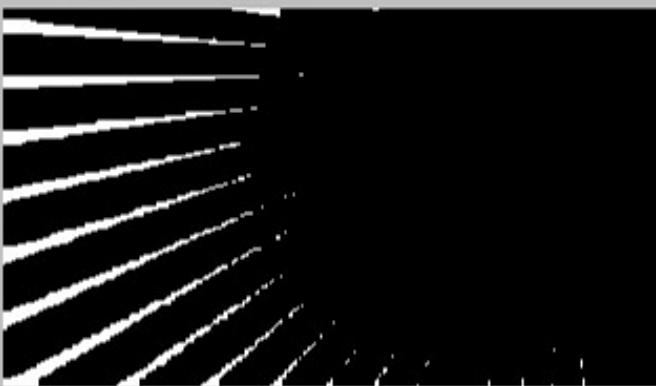
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ORIGINAL



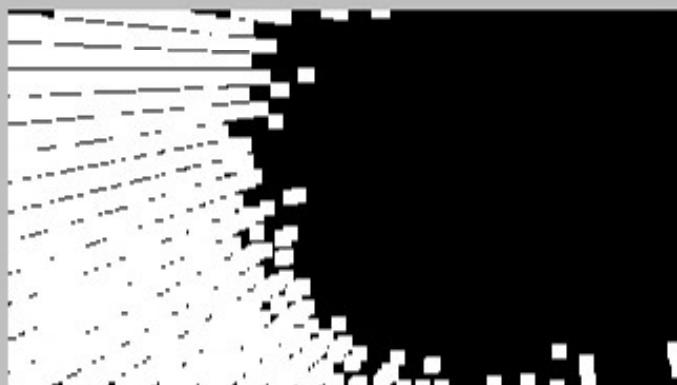
EROSION 7X7



DILATION 7X7



INVARIANCE 7X7



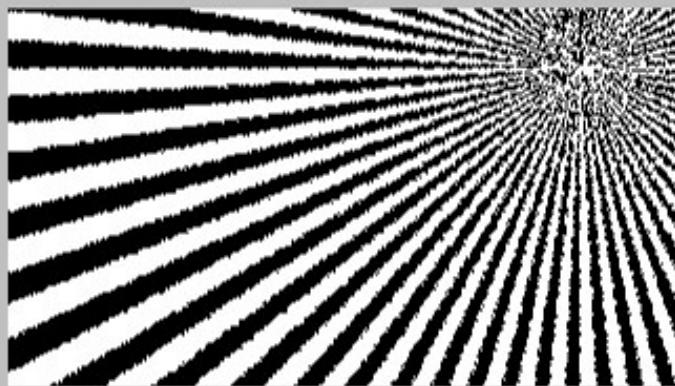
OPENING 7X7



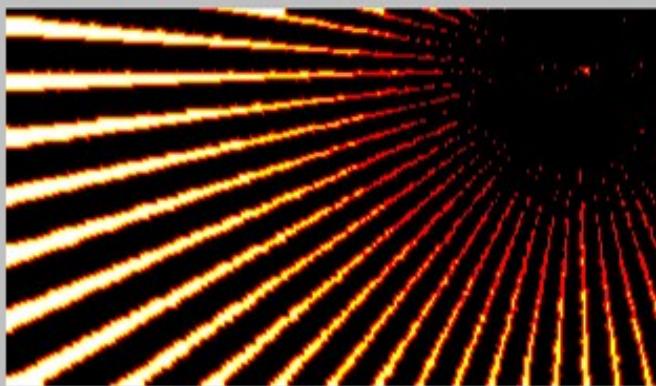
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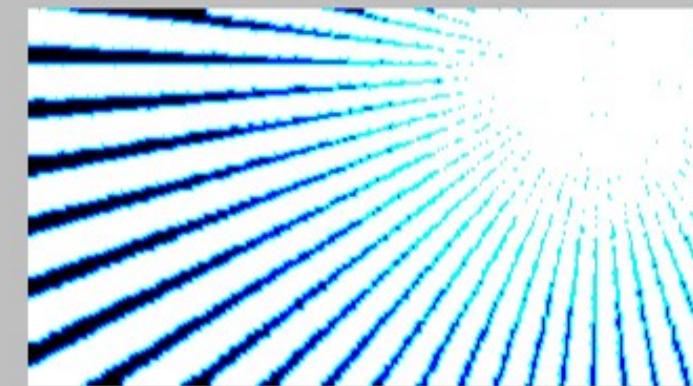
ORIGINAL



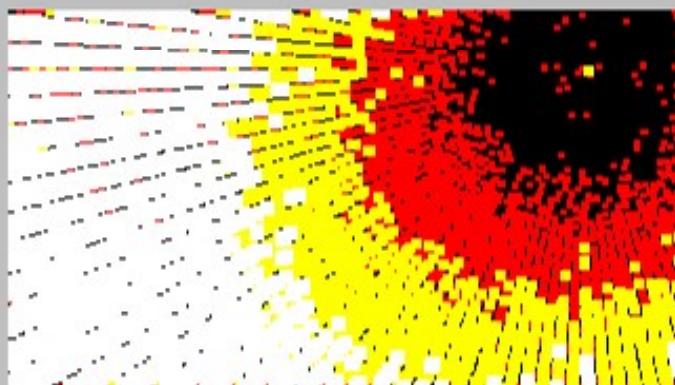
EROSION 5X5



DILATION 5X5



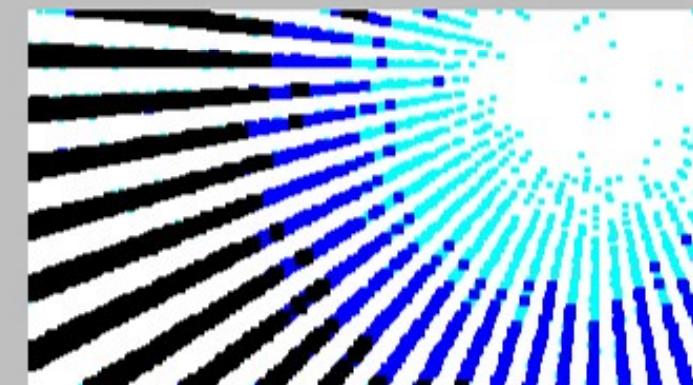
INVARIANCE 5X5

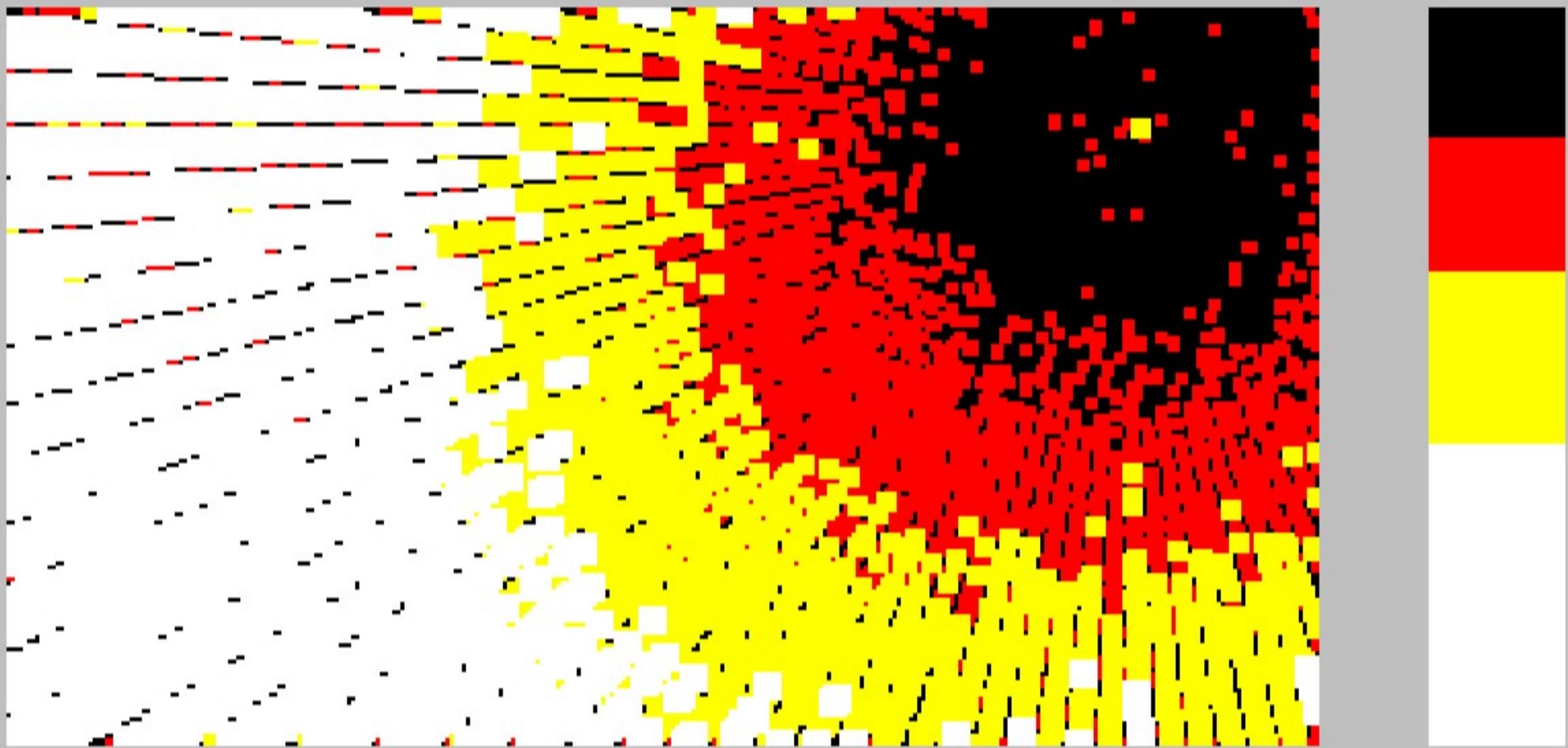


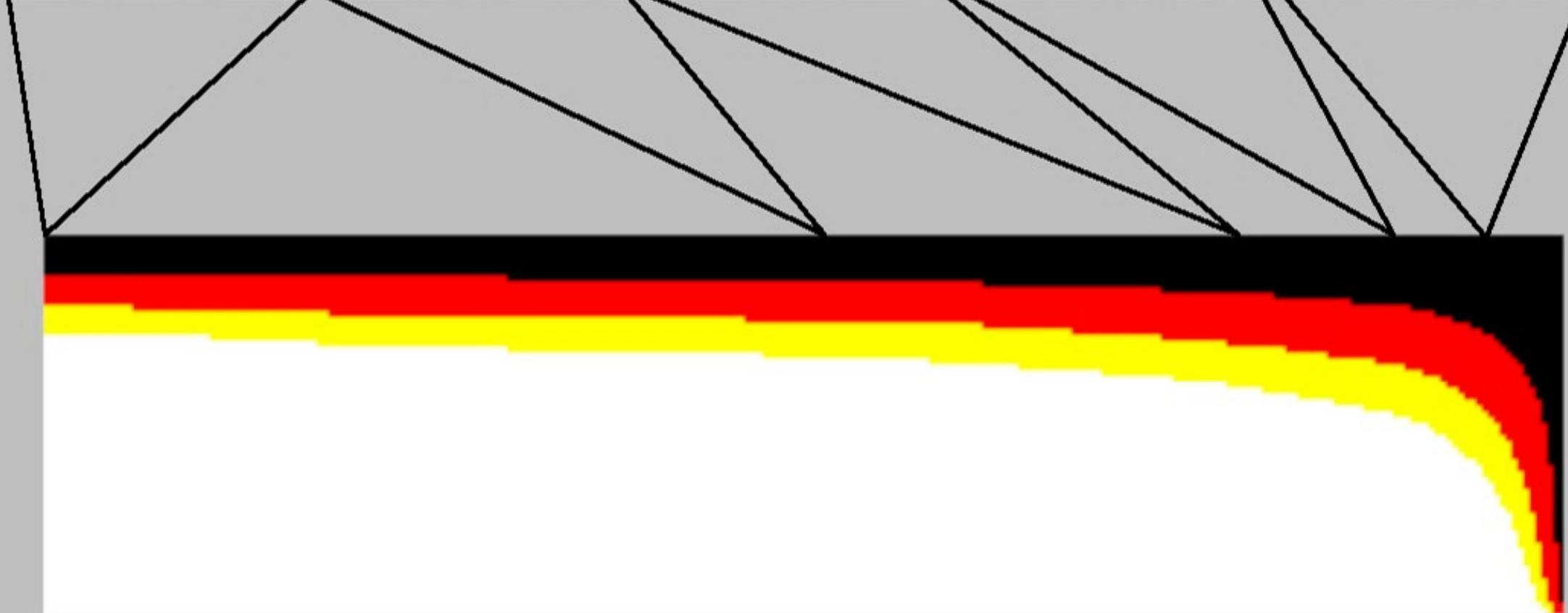
OPENING 5X5

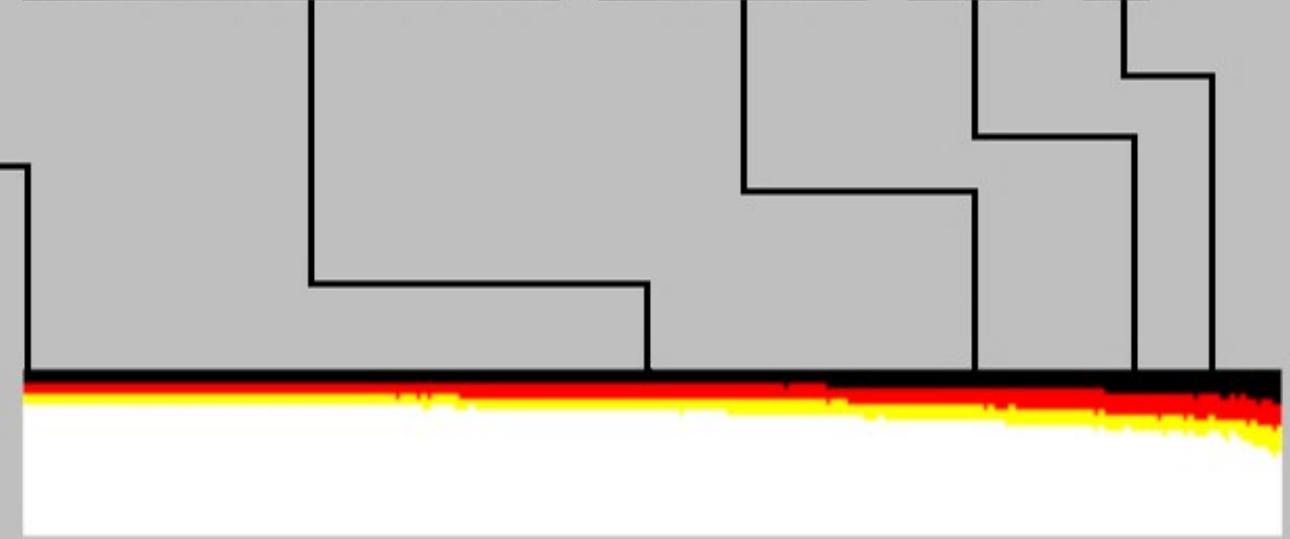


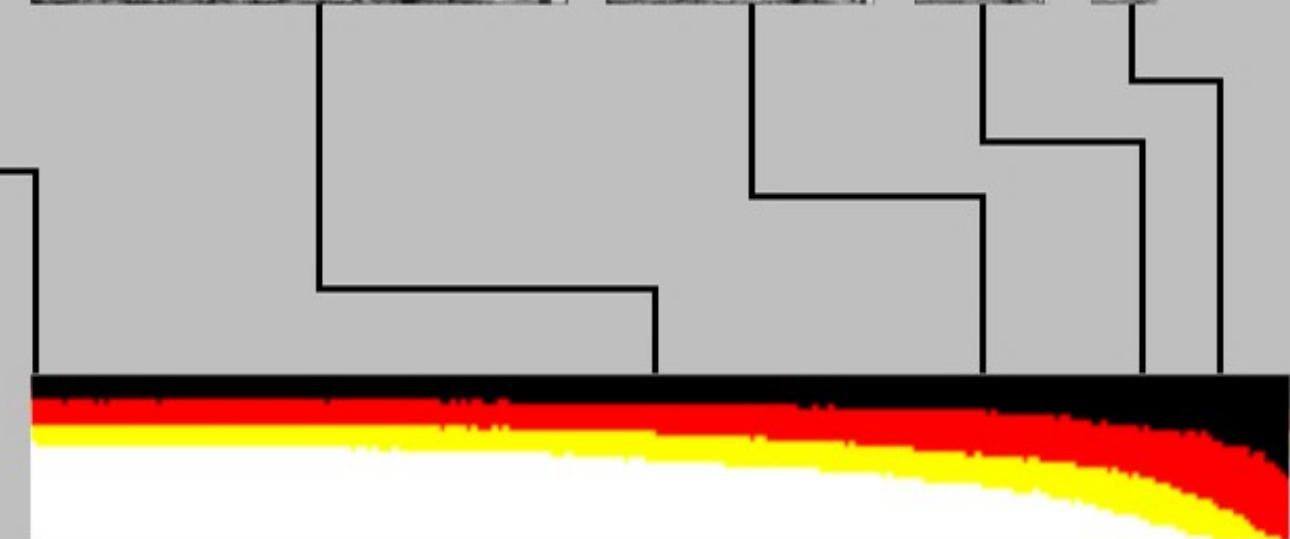
CLOSING 5X5

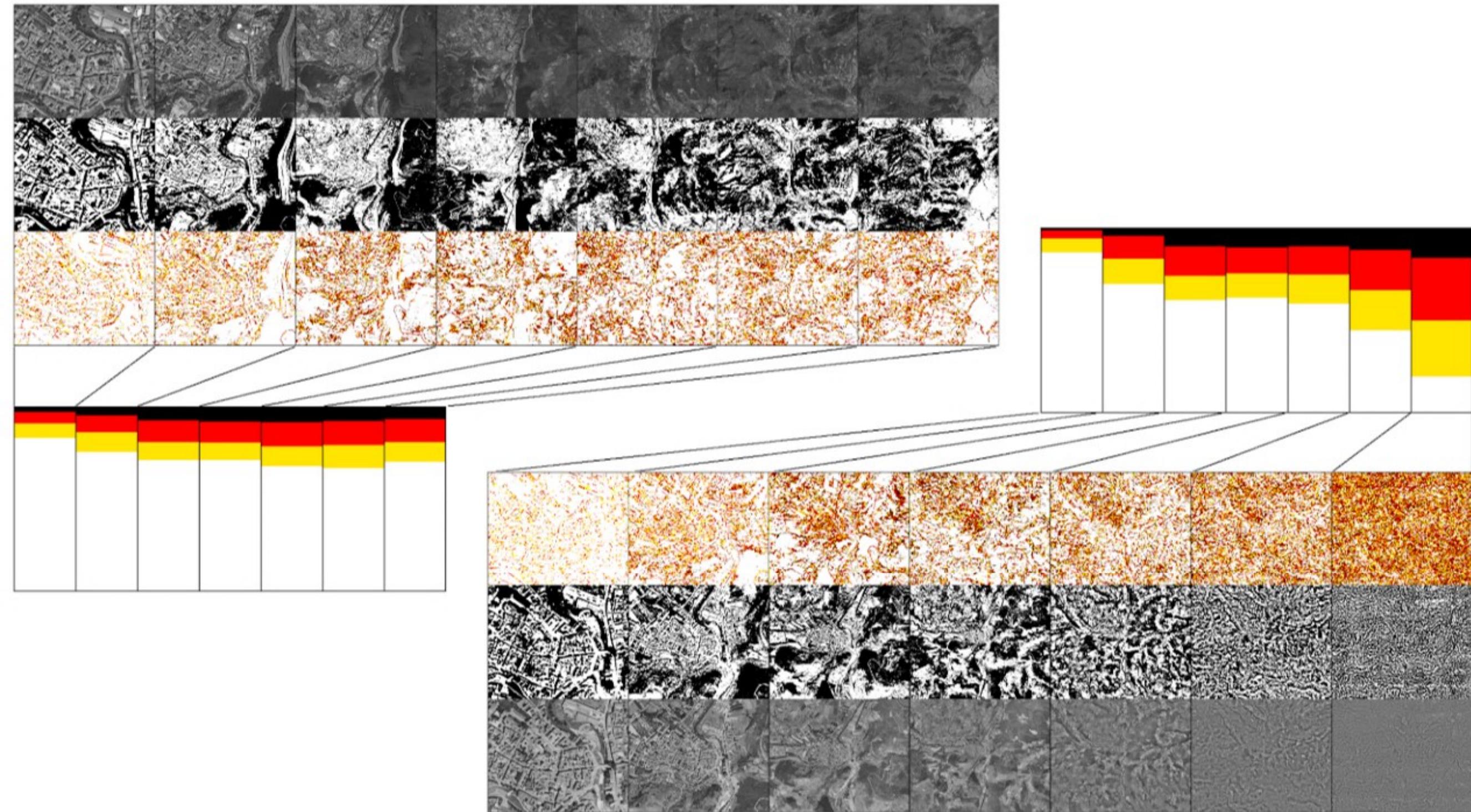


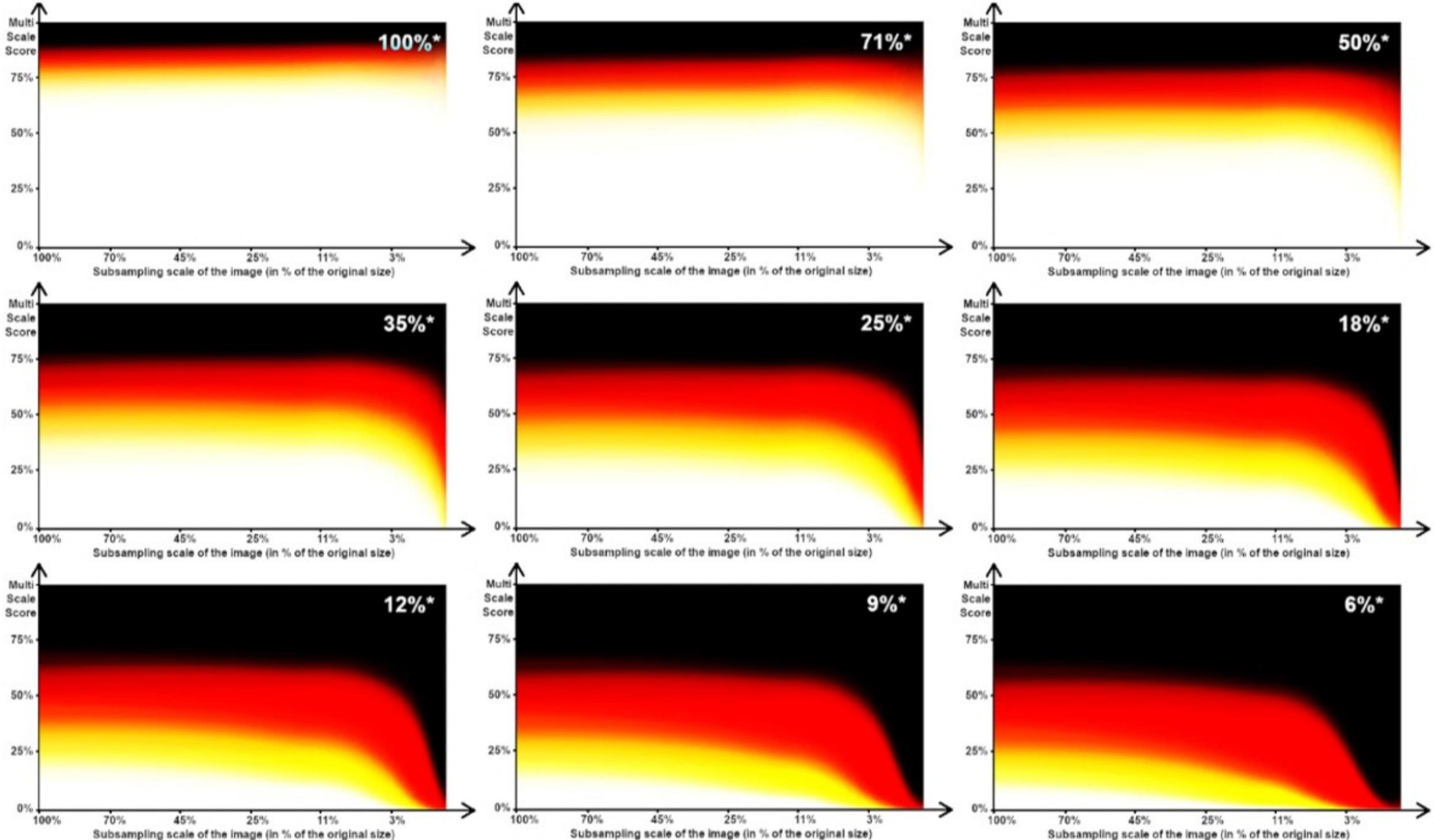






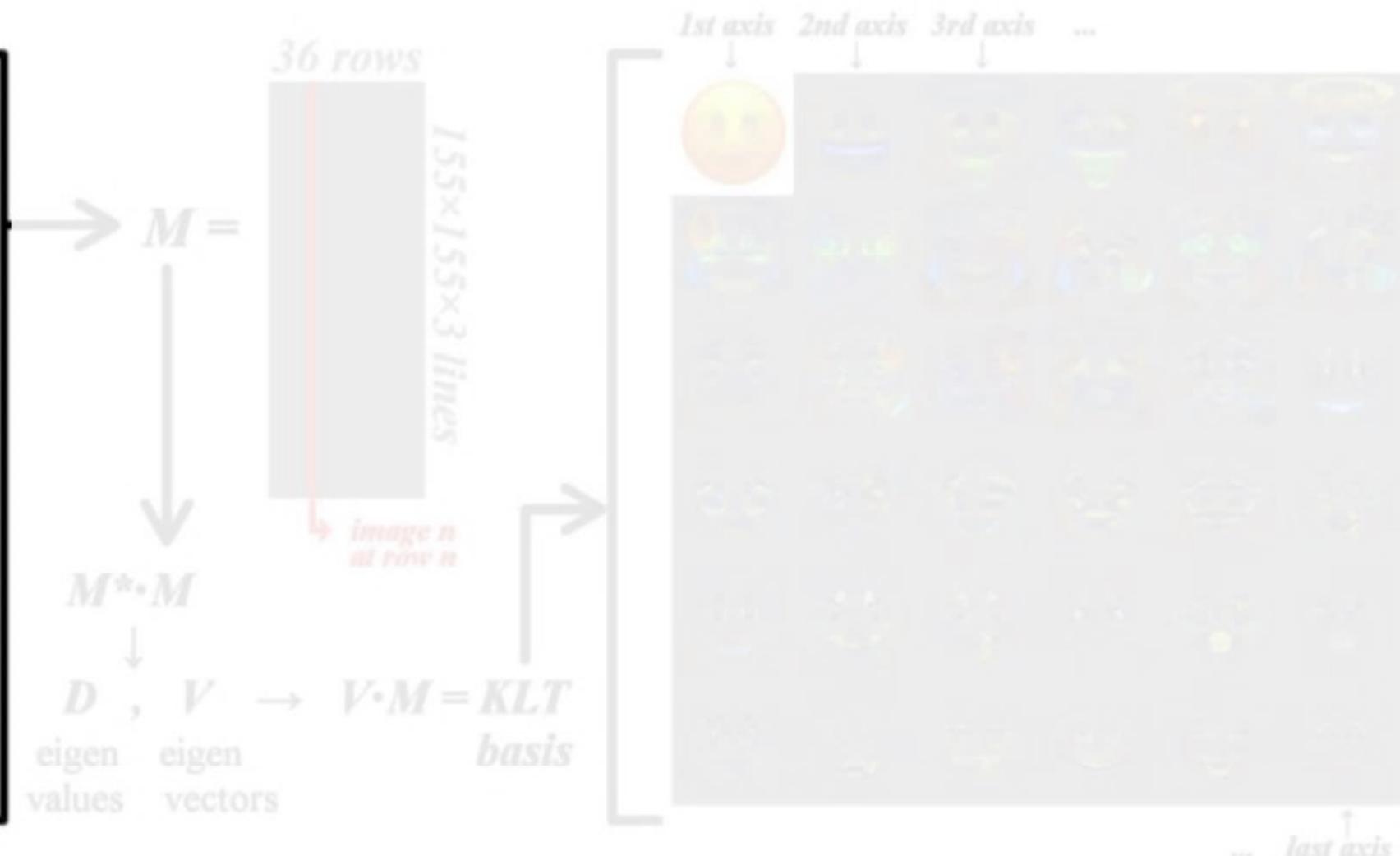






**OPTIMAL
WINDOW
SIZE?**

set of 36 images $155 \times 155 \times 3$



Karhunen-Loève transform.

set of 36 images $155 \times 155 \times 3$



$M =$

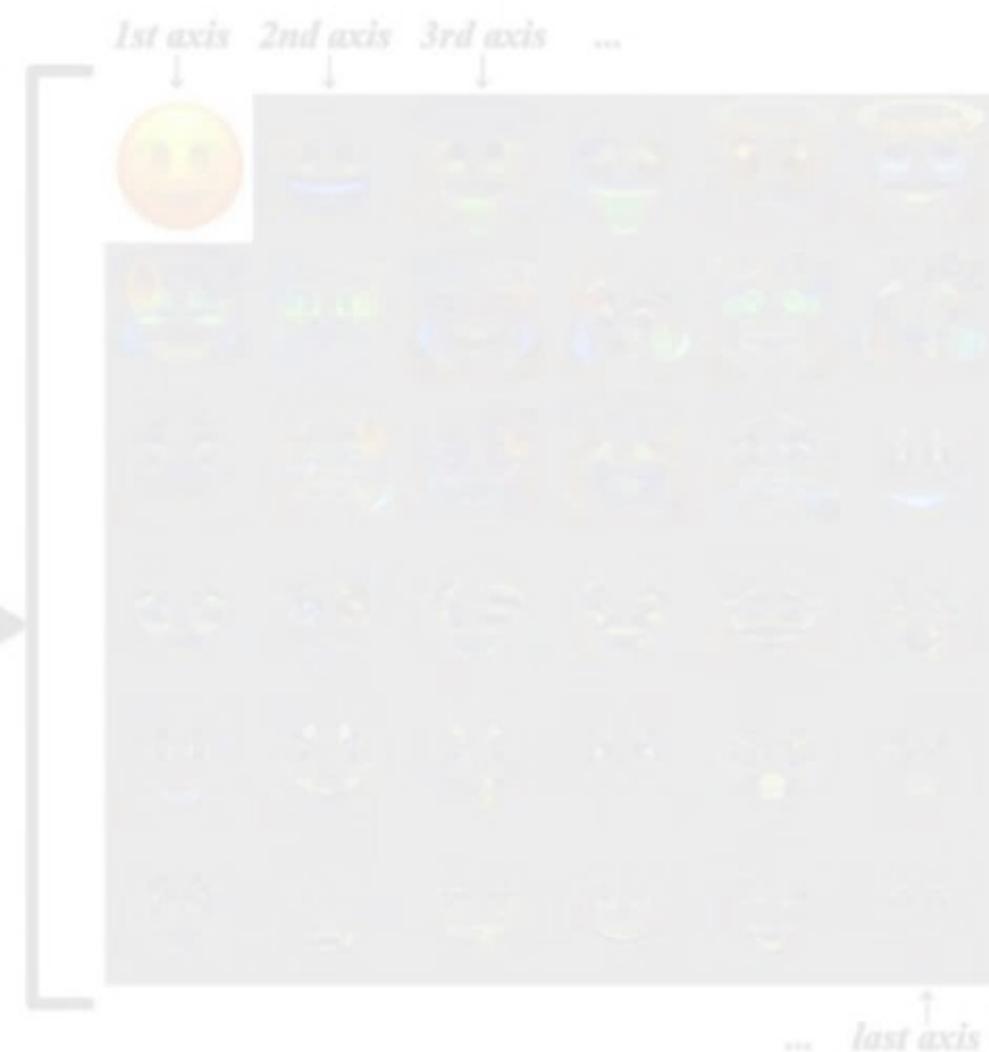
36 rows
155 × 155 × 3 lines

image n at row n

$M^* M$

D , V →
eigen eigen
values vectors

$V \cdot M = KLT$
basis



Karhunen-Loève transform.

set of 36 images $155 \times 155 \times 3$



$$\rightarrow M =$$

$$M^* \cdot M$$

D , V
eigen values eigen vectors

36 rows

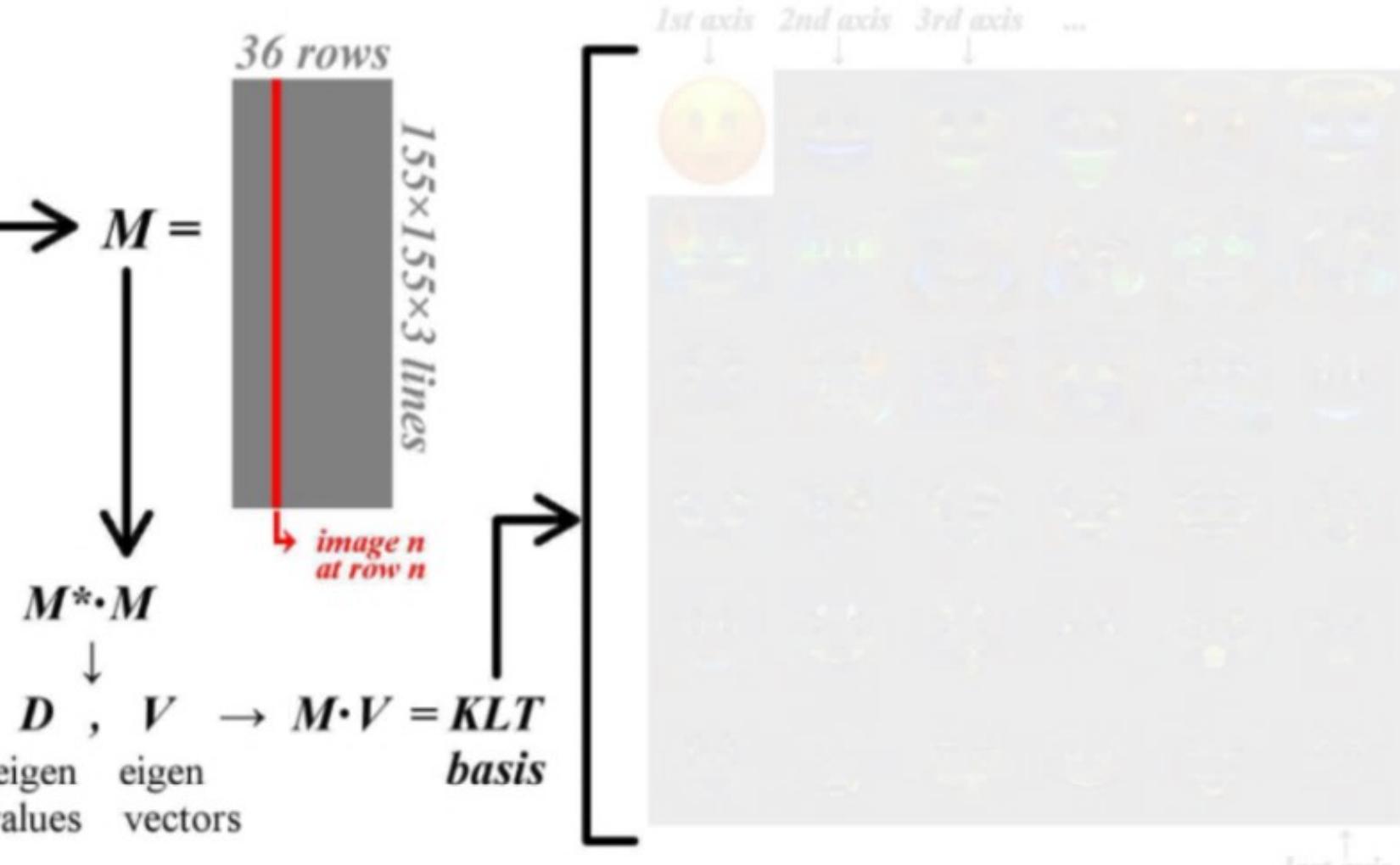
$155 \times 155 \times 3$ lines

image n
at row n



Karhunen-Loève transform.

set of 36 images $155 \times 155 \times 3$



Karhunen-Loève transform.

set of 36 images $155 \times 155 \times 3$



$$M =$$

$$M^* \cdot M$$

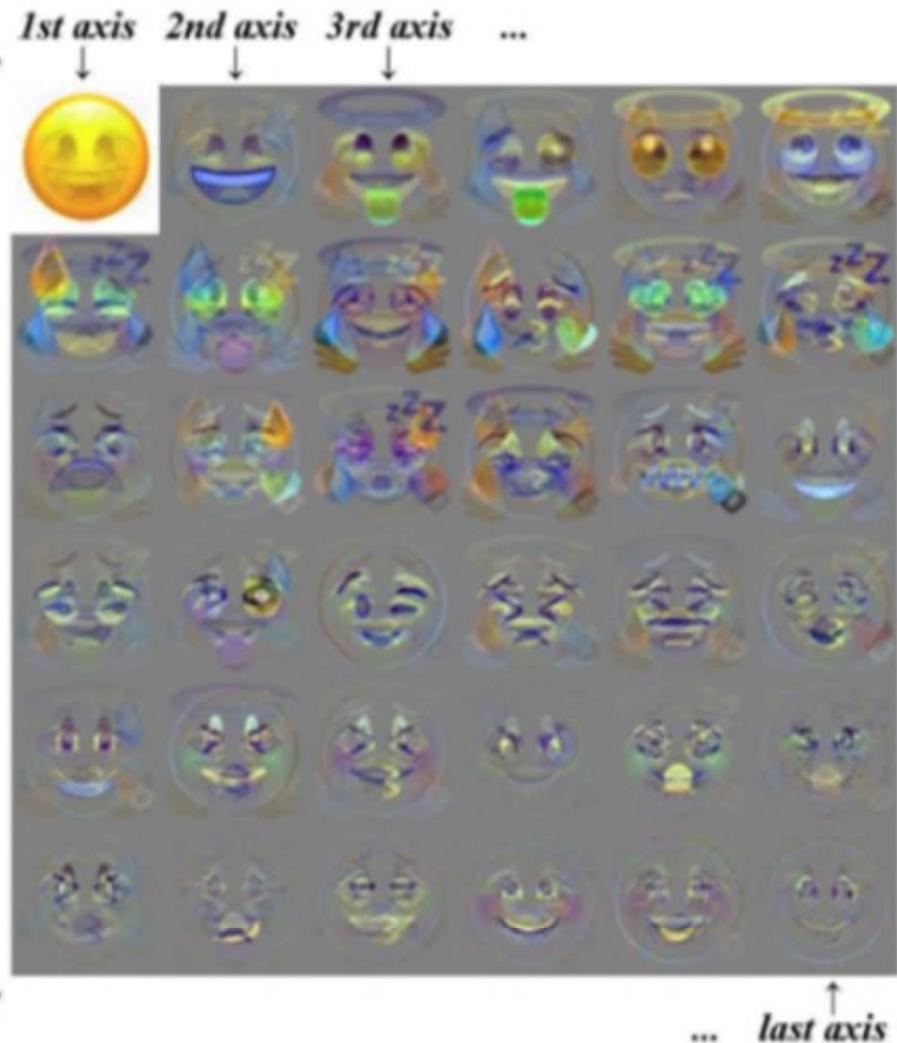
D , V \rightarrow eigen values
eigen vectors

36 rows

$155 \times 155 \times 3$ lines

image n at row n

$$M \cdot V = KLT \text{ basis}$$



Karhunen-Loève transform.

set of 36 images $155 \times 155 \times 3$



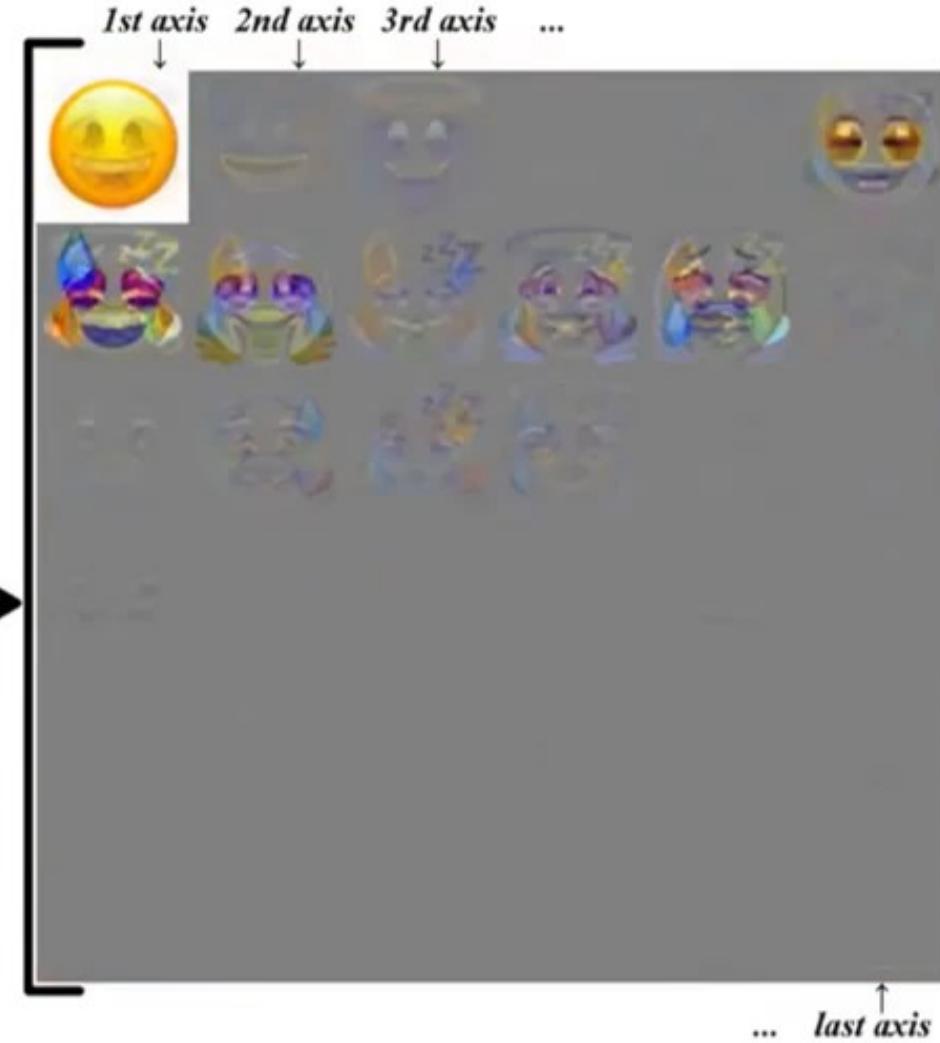
$$M =$$

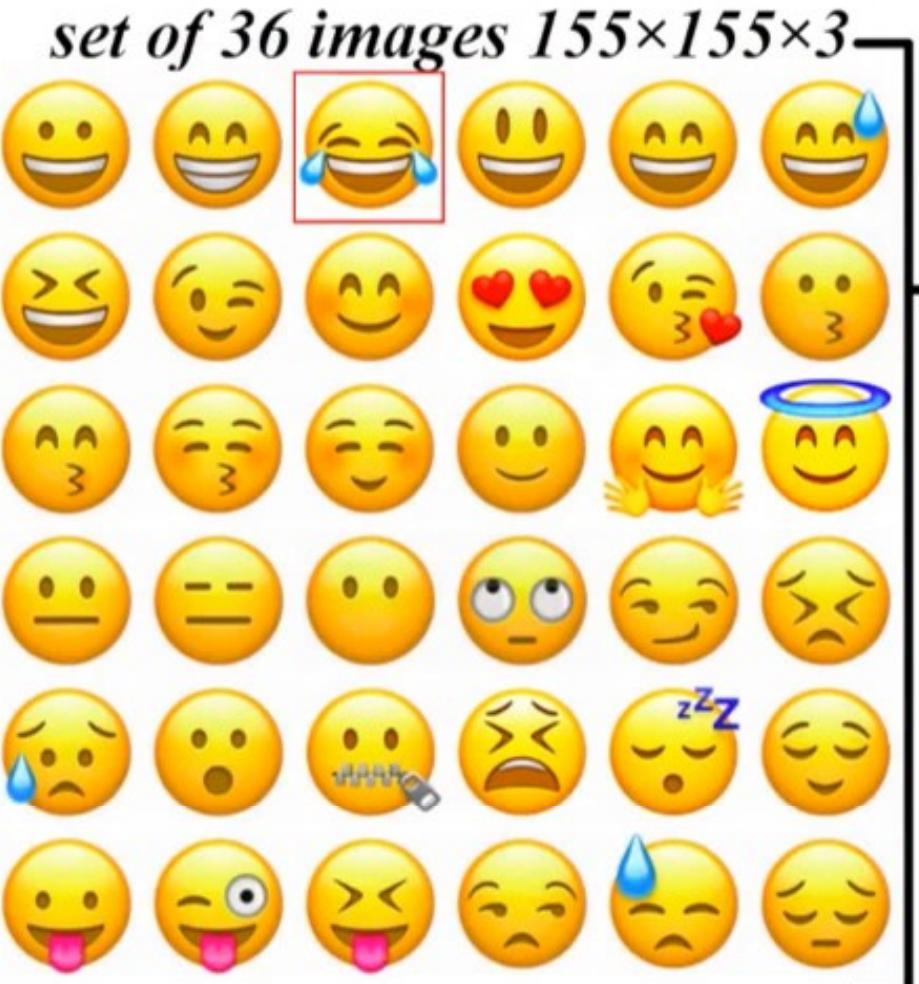
36 rows
 $155 \times 155 \times 3$ lines

*image n
at row n*

$$M^* \cdot M$$

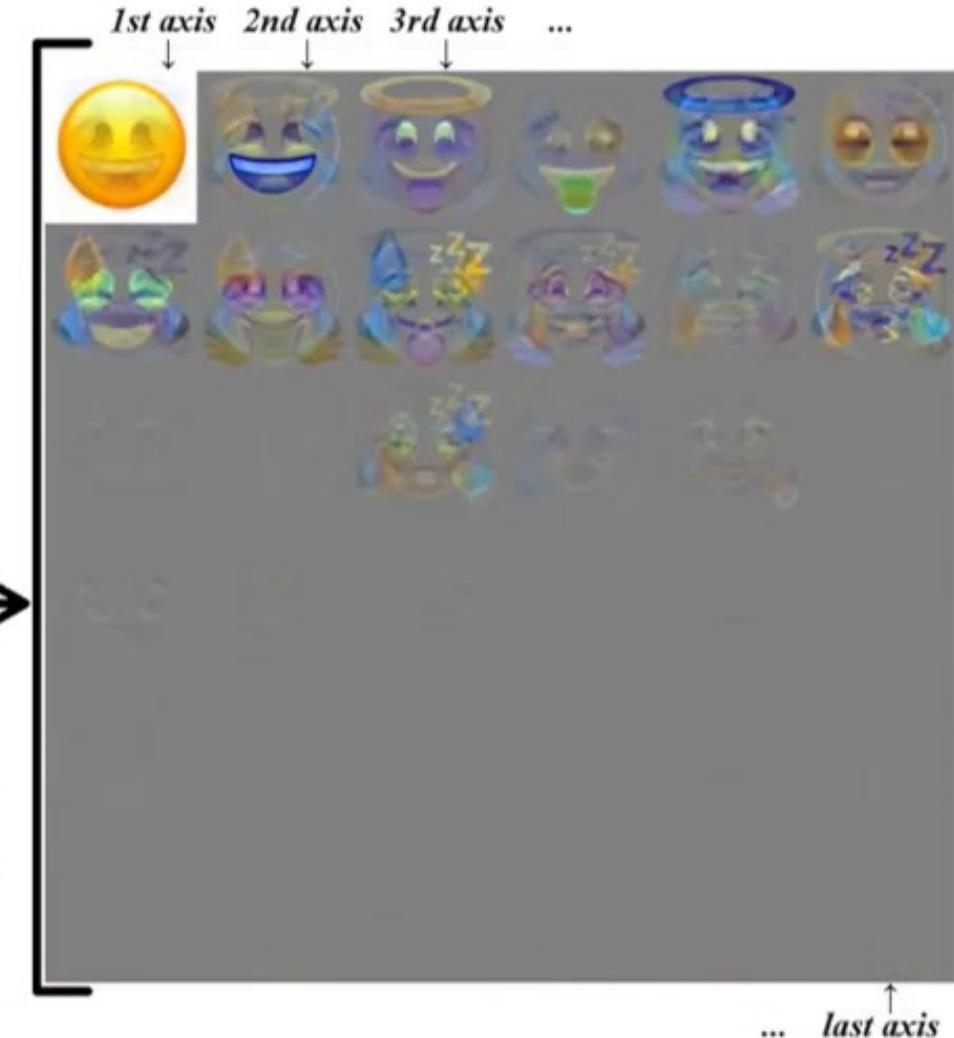
D, *V* → *V* · *M* = *KLT basis*
eigen eigen
values vectors





$$M = \begin{matrix} 36 \text{ rows} \\ 155 \times 155 \times 3 \text{ lines} \\ \downarrow \text{image } n \text{ at row } n \end{matrix}$$

$$M^* \cdot M \downarrow \begin{matrix} D, V \rightarrow V \cdot M = KLT \\ \text{eigen values} \quad \text{eigen vectors} \end{matrix}$$



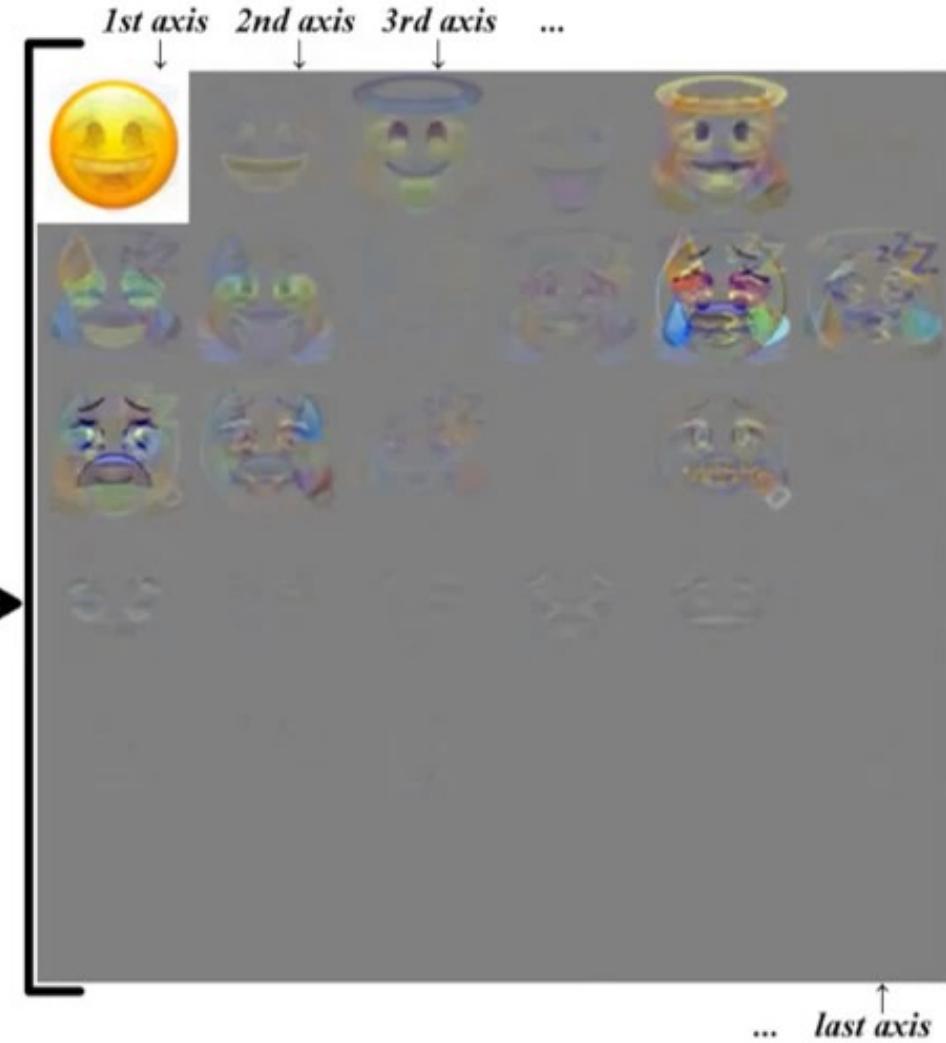
set of 36 images $155 \times 155 \times 3$

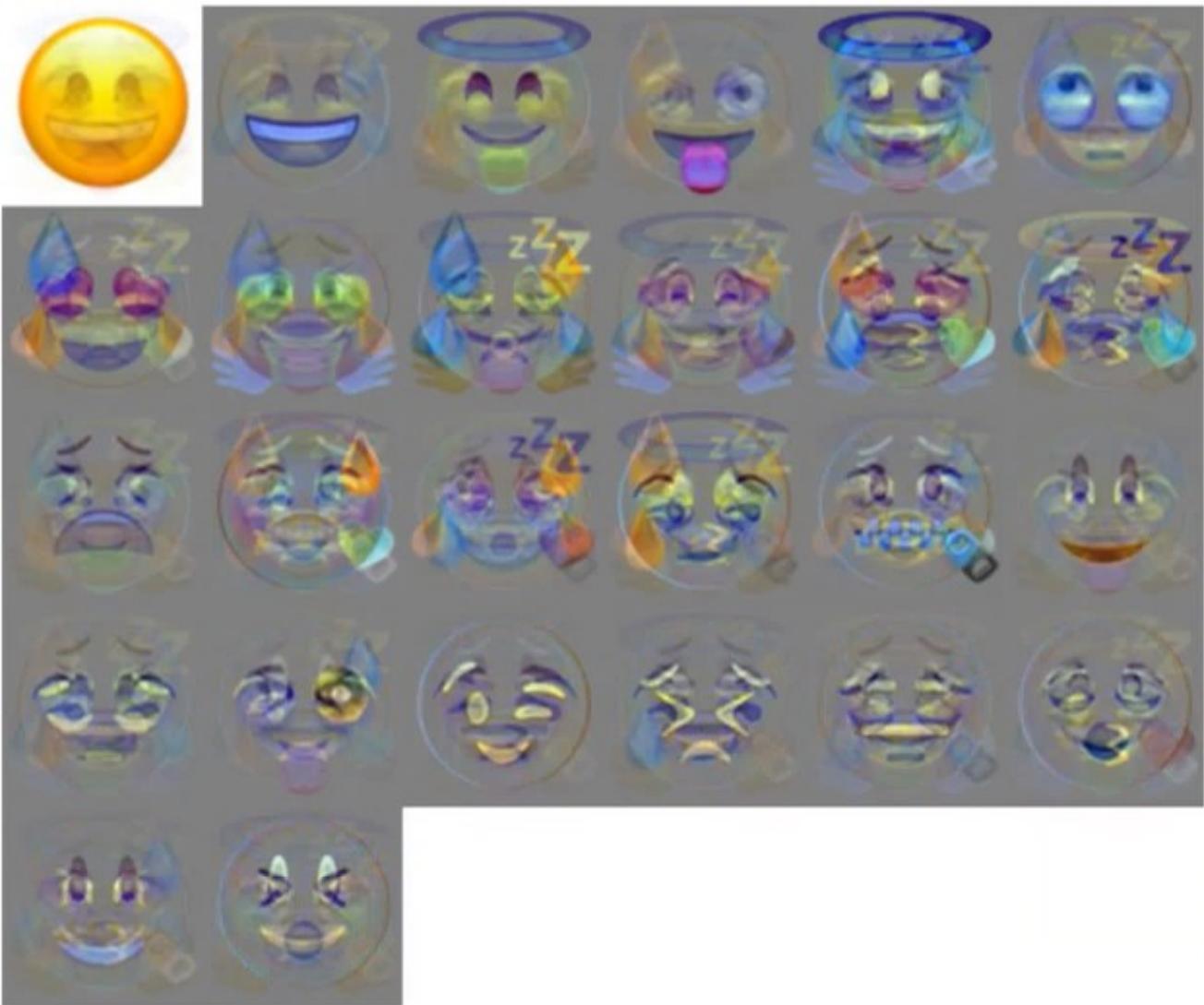


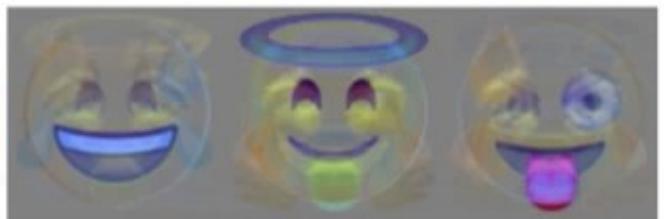
$$M = \begin{matrix} 36 \text{ rows} \\ 155 \times 155 \times 3 \text{ lines} \\ \downarrow \text{image } n \text{ at row } n \end{matrix}$$

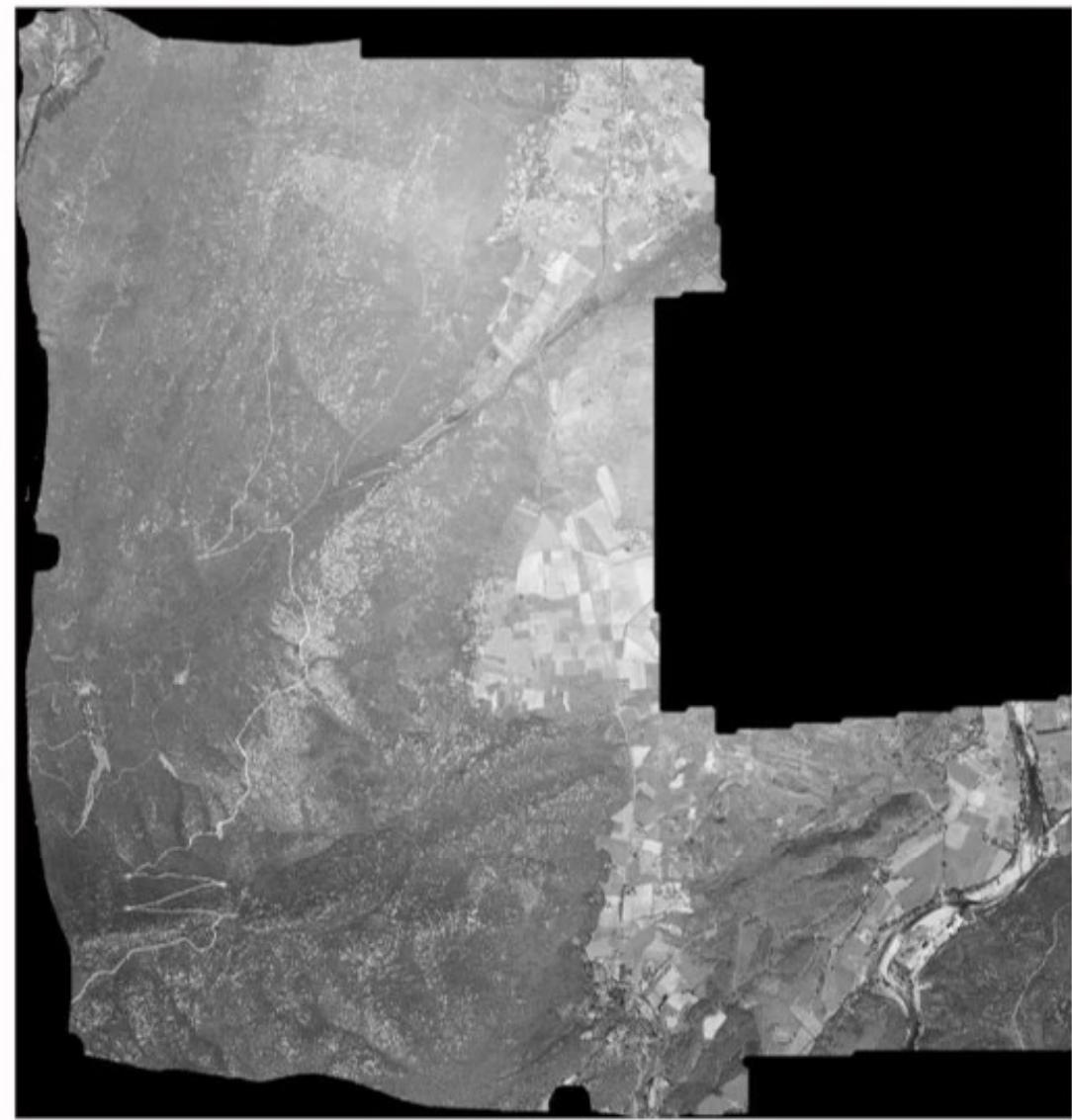
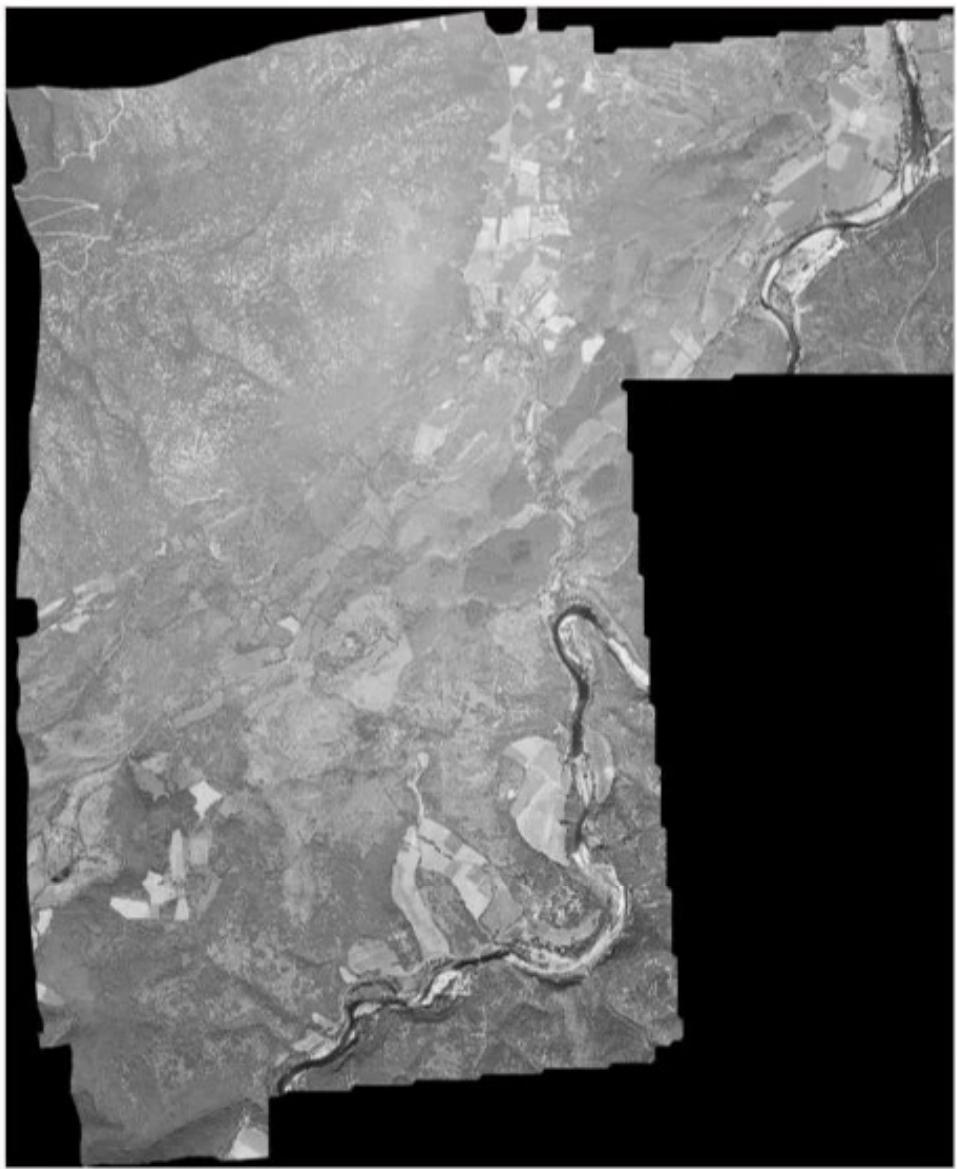
$$\begin{matrix} M^* \cdot M \\ \downarrow \\ D, V \rightarrow V \cdot M = KLT \text{ basis} \end{matrix}$$

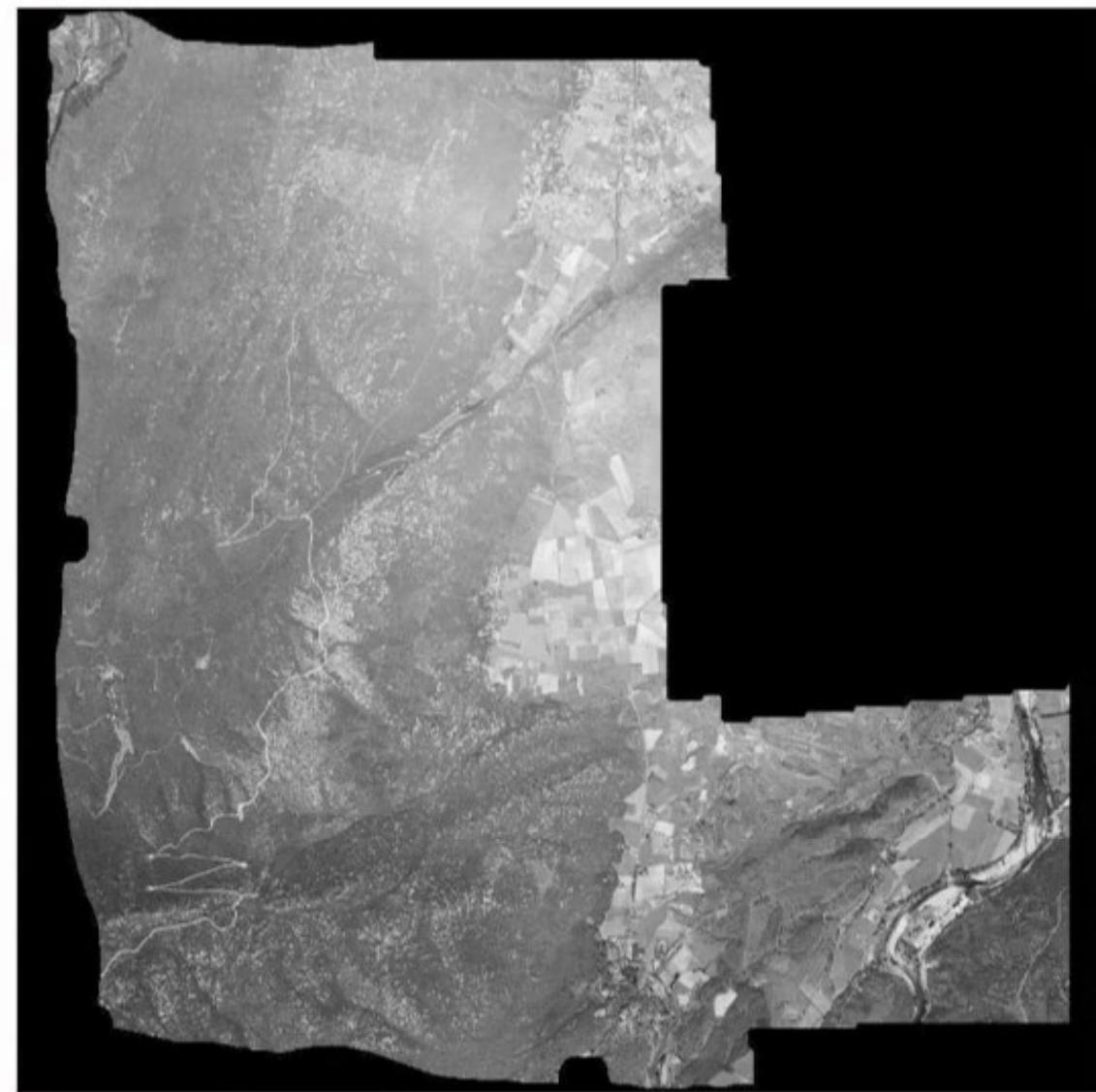
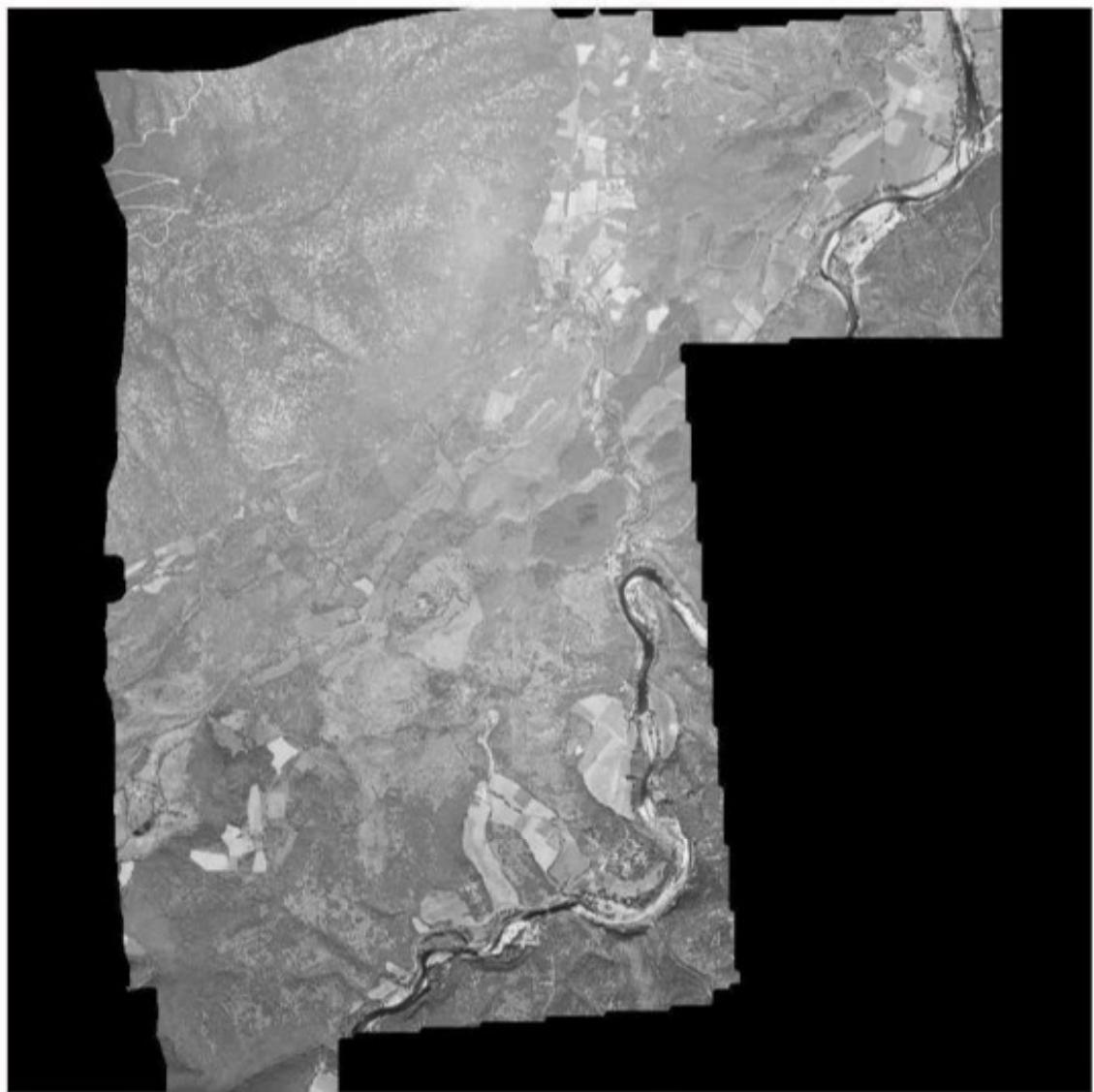
eigen values eigen vectors

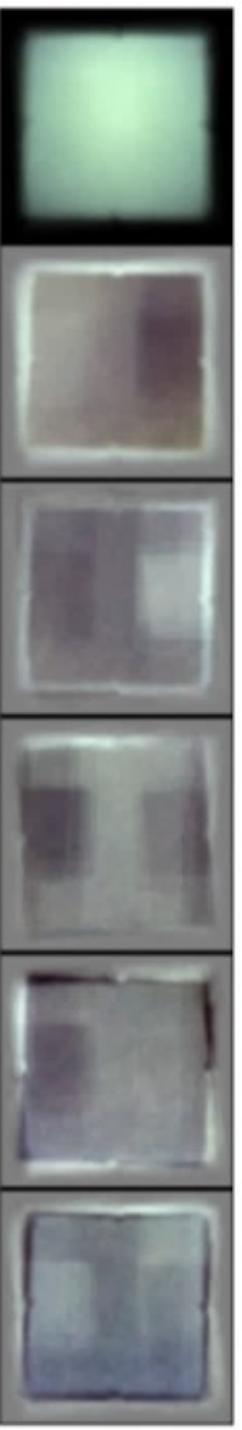
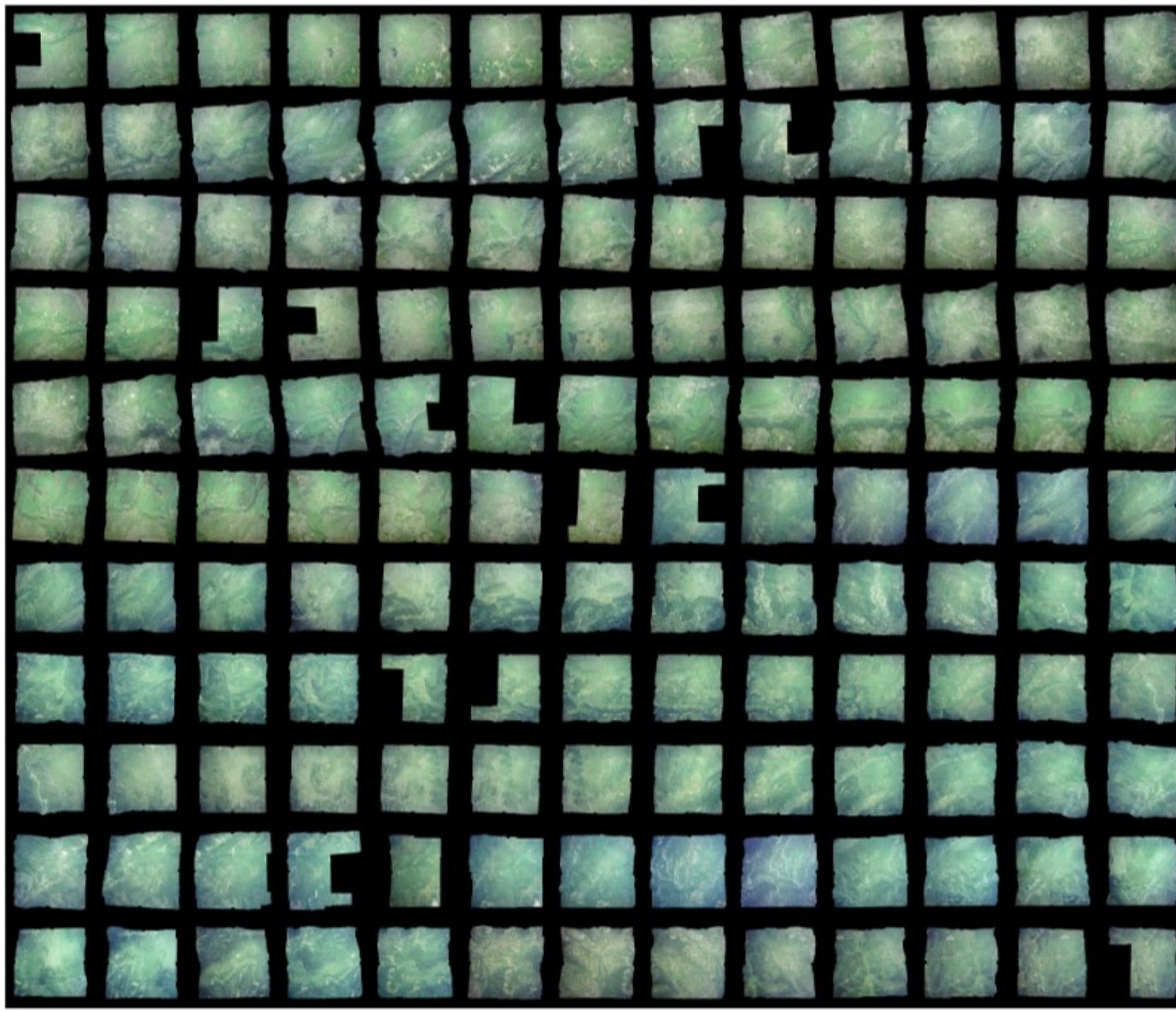


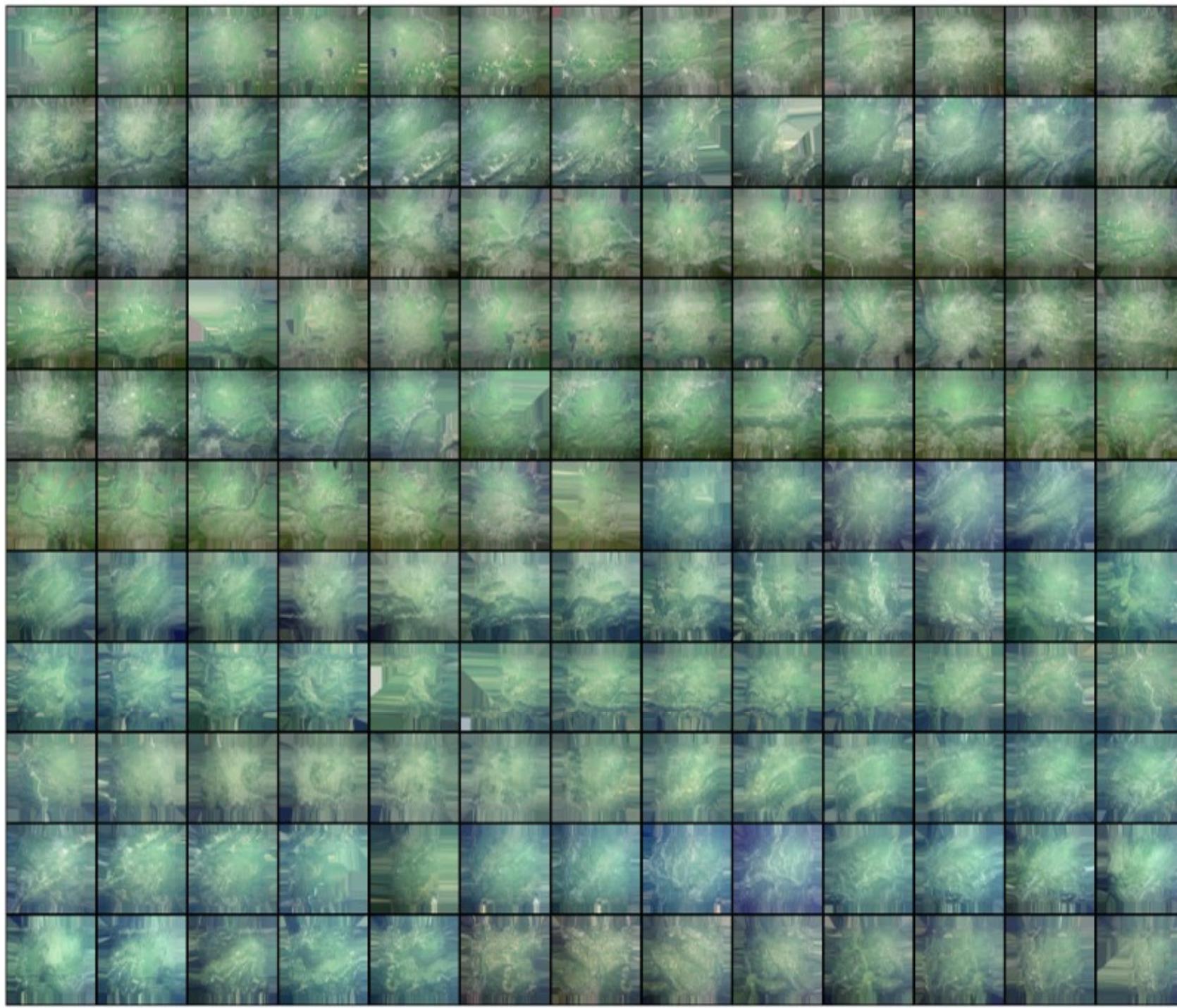


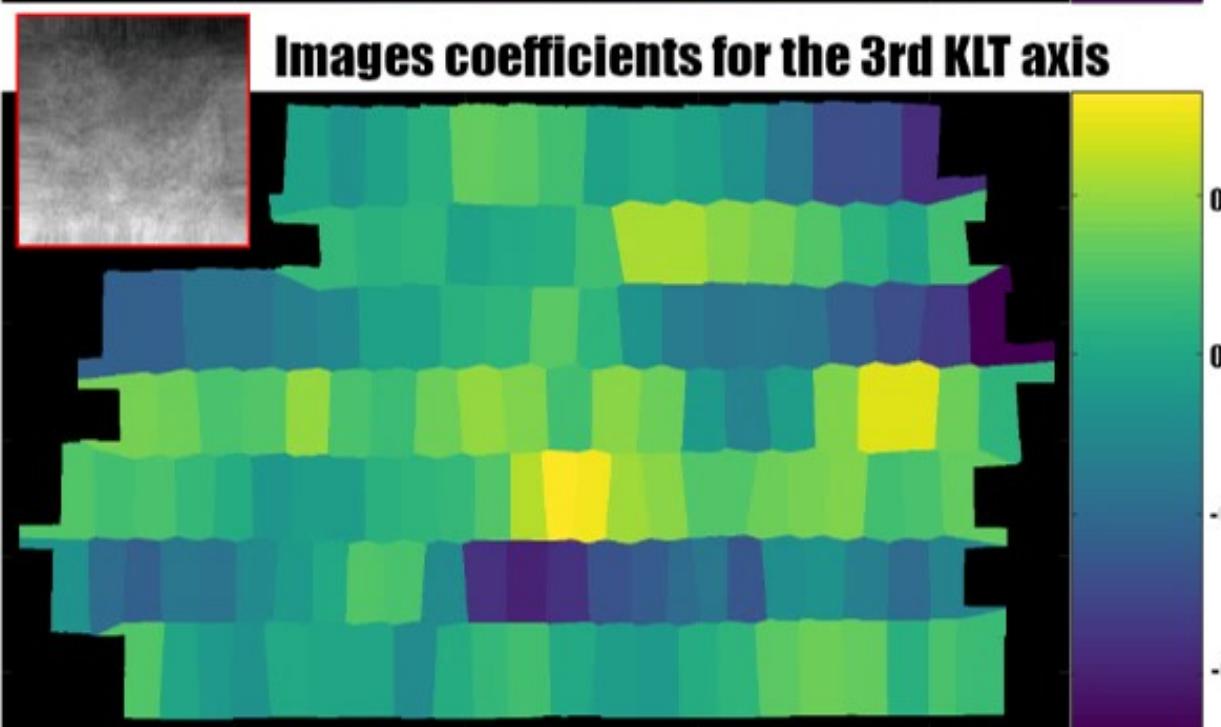
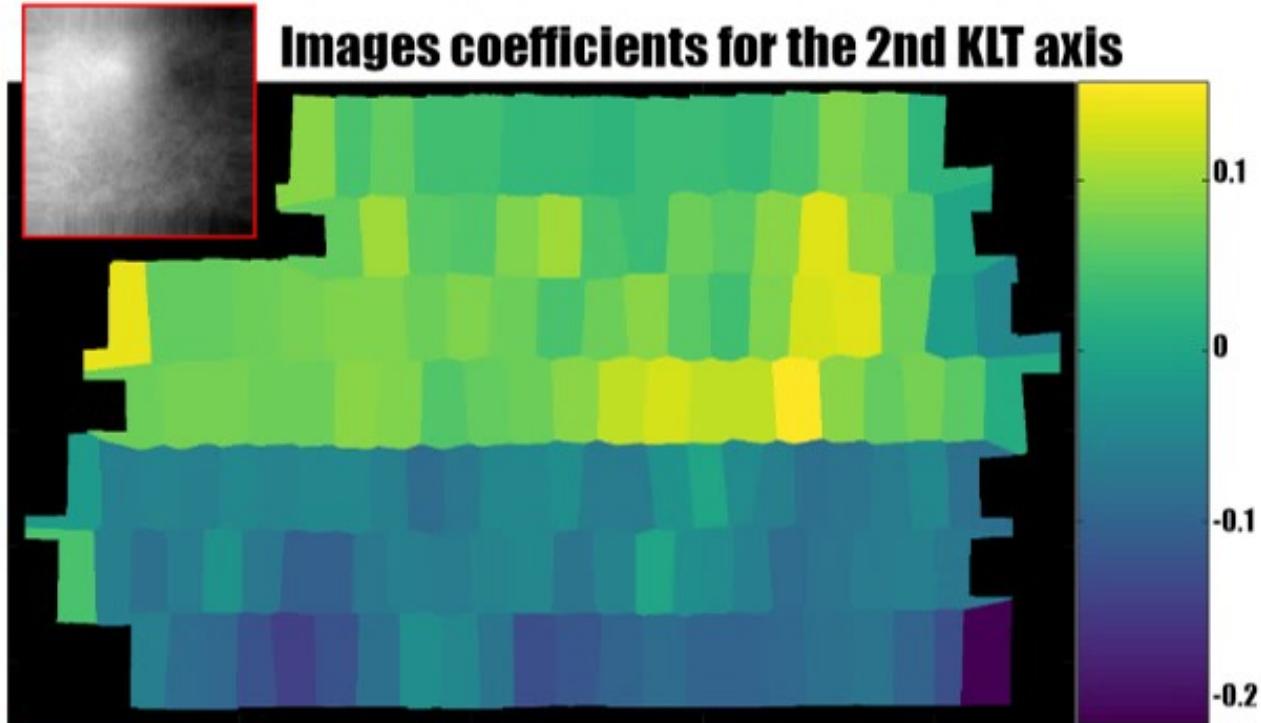
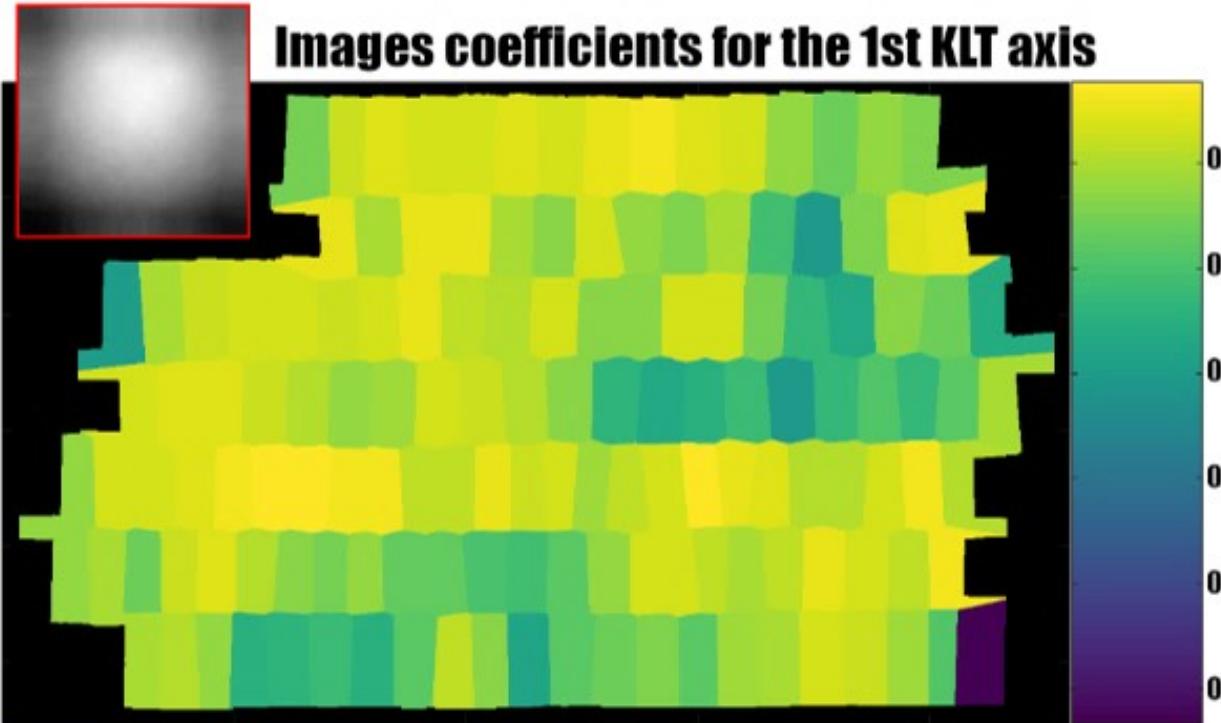










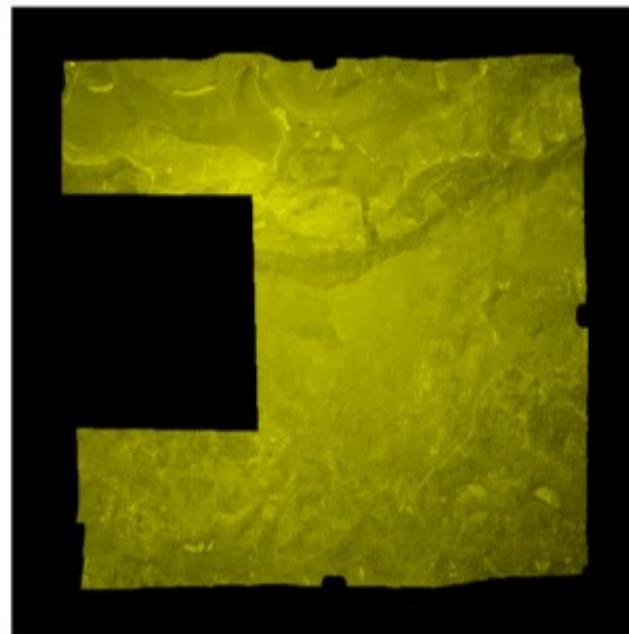


Moran's I

$$I = \frac{\sum_{i=1}^N \sum_{j=1}^N p_{ij} \cdot (u_i - \bar{u}) \cdot (u_j - \bar{u})}{\sum_{i=1}^N \sum_{j=1}^N p_{ij}} \cdot \left(\frac{\sum_{i=1}^N (u_i - \bar{u})^2}{\sum_{i=1}^N (u_i - \bar{u})^2} \right)$$

Moran's I

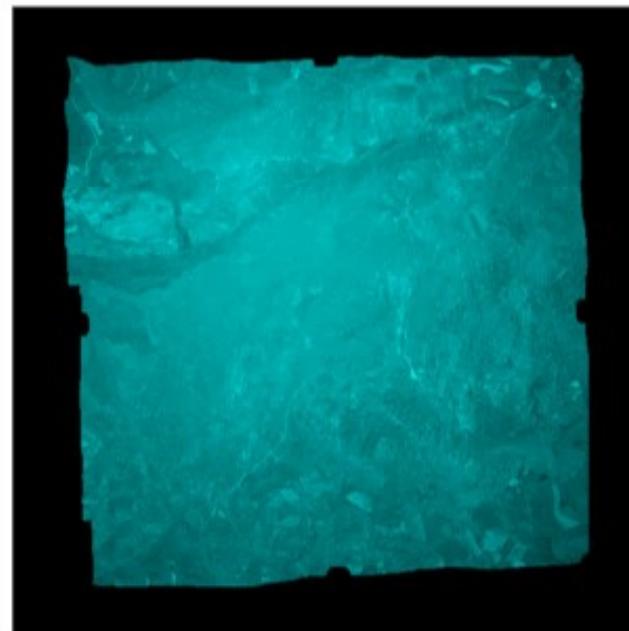
$$I = \frac{\sum_{i=1}^N \sum_{j=1}^N p_{ij}}{\sum_{i=1}^N \sum_{j=1}^N \underline{p_{ij}}} \cdot \left(\frac{\sum_{i=1}^N \sum_{j=1}^N p_{ij} \cdot (u_i - \bar{u}) \cdot (u_j - \bar{u})}{\sum_{i=1}^N (u_i - \bar{u})^2} \right)$$



$$p_{ij} \neq p_{ji}$$

Moran's I

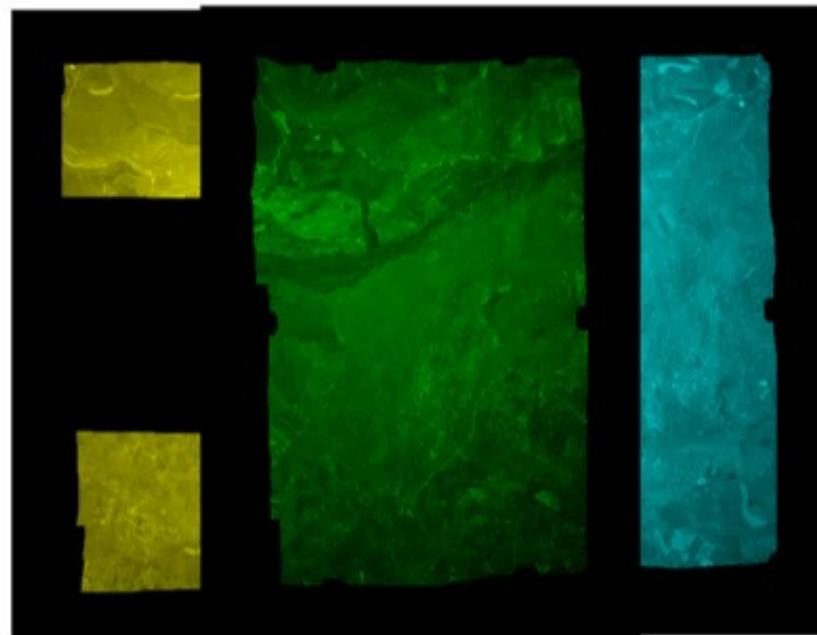
$$I = \frac{\sum_{i=1}^N \sum_{j=1}^N p_{ij}}{N^2} \cdot \left(\frac{\sum_{i=1}^N \sum_{j=1}^N p_{ij} \cdot (u_i - \bar{u}) \cdot (u_j - \bar{u})}{\sum_{i=1}^N (u_i - \bar{u})^2} \right)$$



$$p_{ij} \neq p_{ji}$$

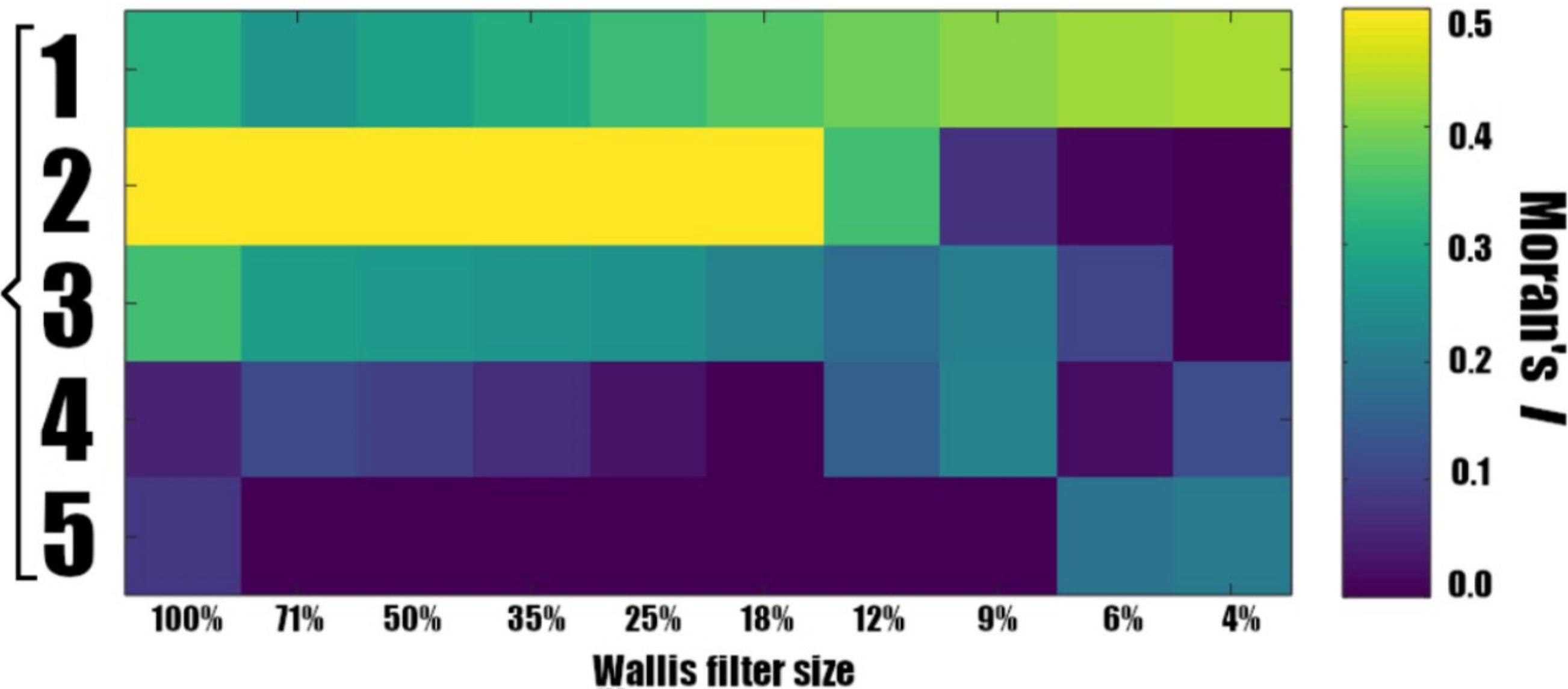
Moran's *I*

$$I = \frac{\sum_{i=1}^N \sum_{j=1}^N p_{ij}}{\sum_{i=1}^N \sum_{j=1}^N \underline{p_{ij}}} \cdot \left(\frac{\sum_{i=1}^N \sum_{j=1}^N p_{ij} \cdot (u_i - \bar{u}) \cdot (u_j - \bar{u})}{\sum_{i=1}^N (u_i - \bar{u})^2} \right)$$

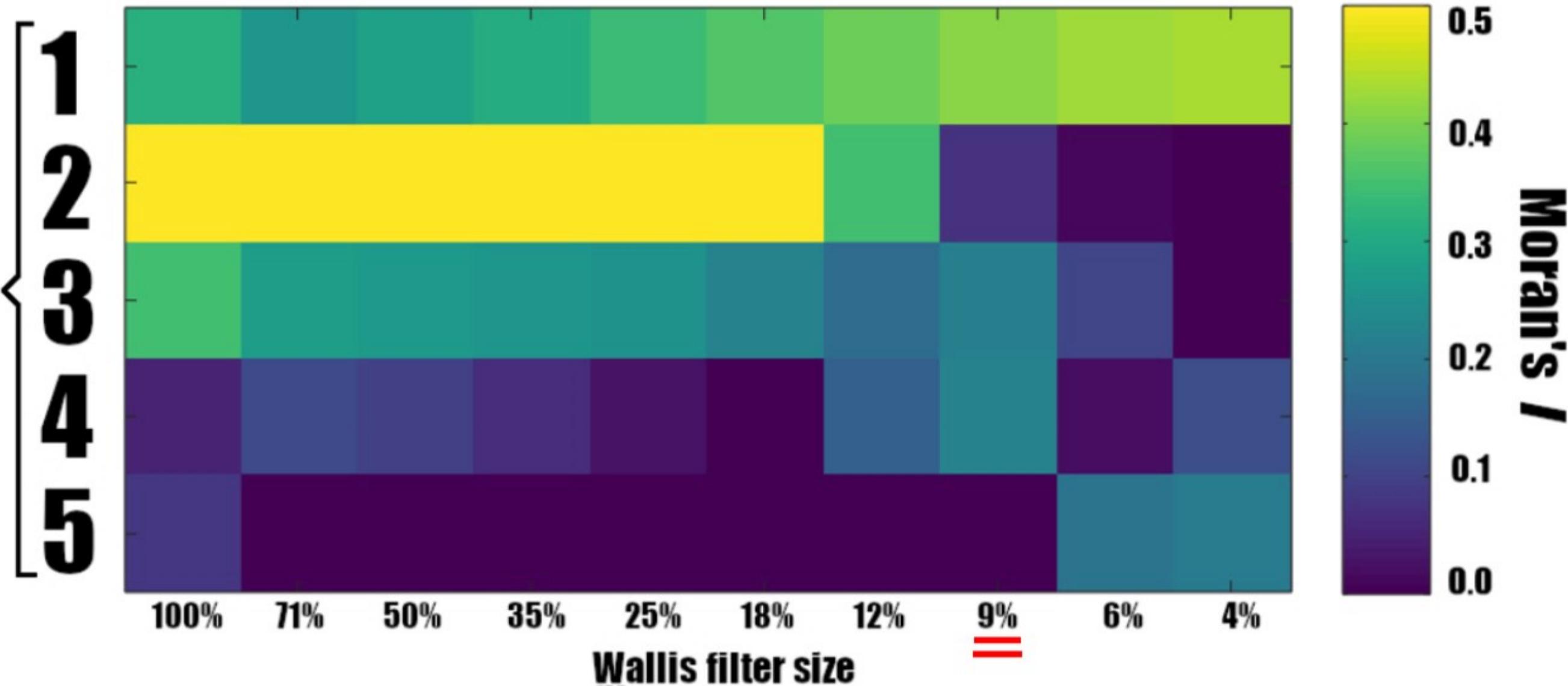


$$p_{ij} \neq p_{ji}$$

KLT axes

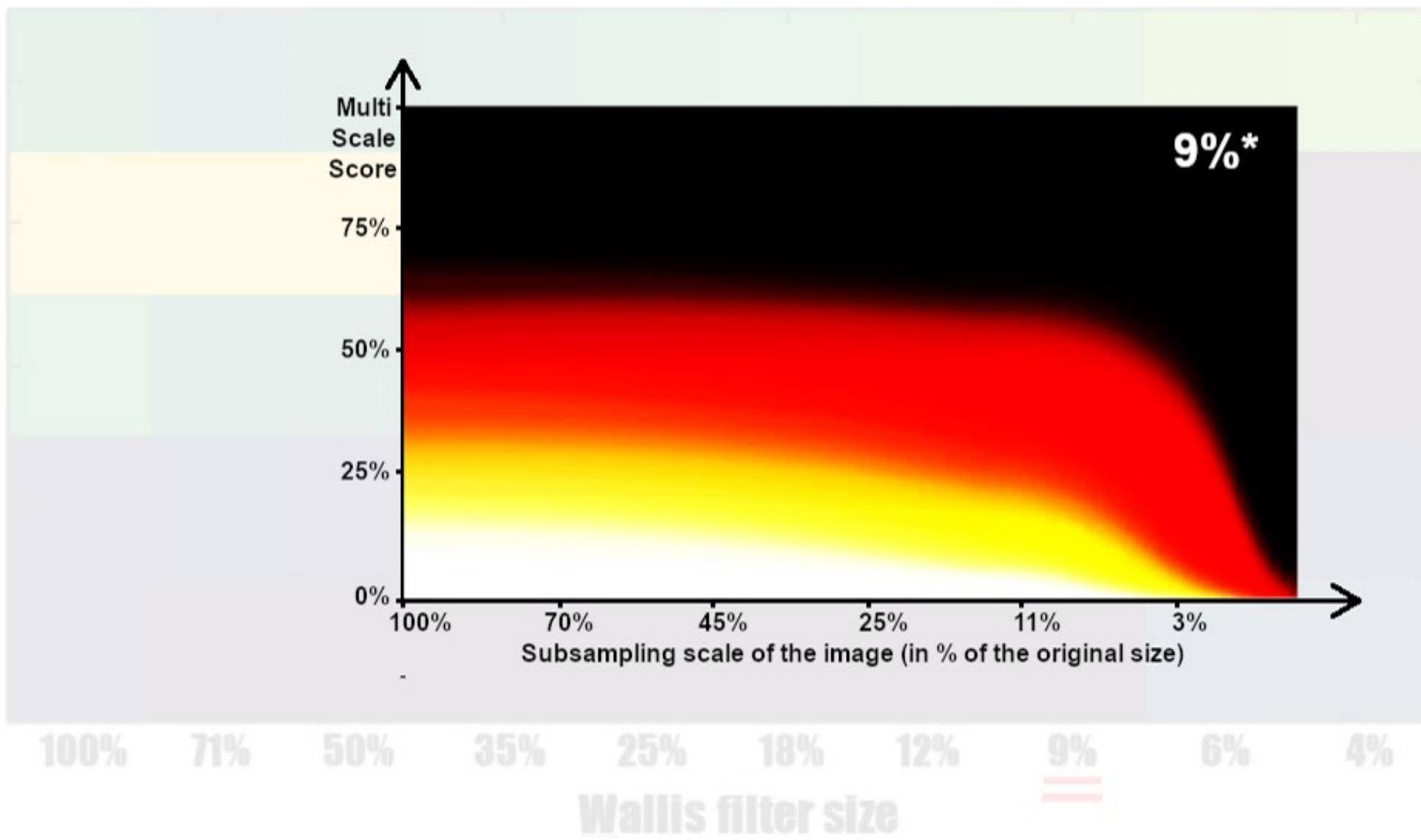


KLT axes

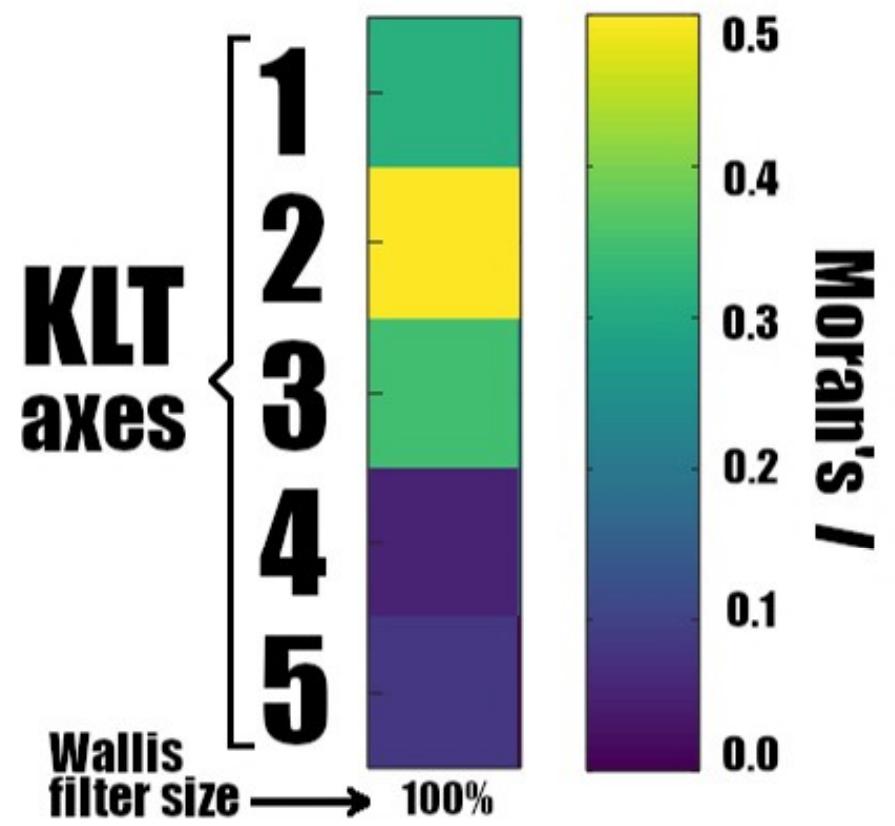
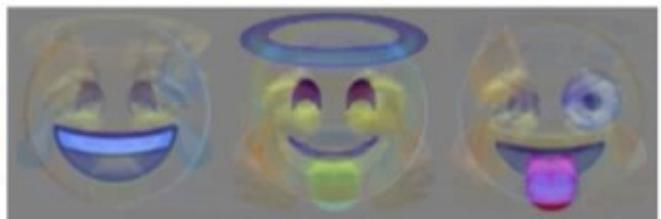


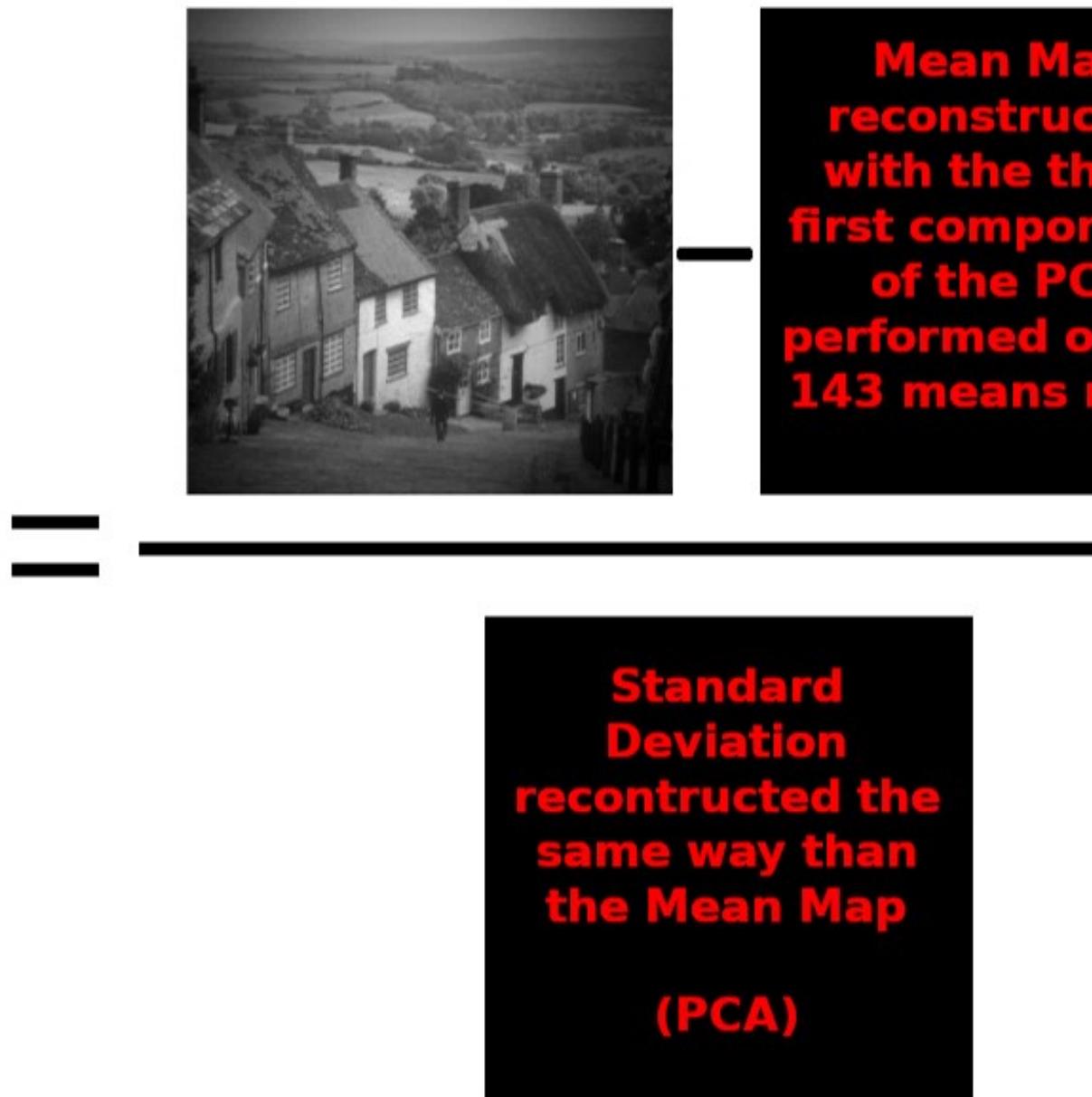
KLT axes

1
2
3
4
5



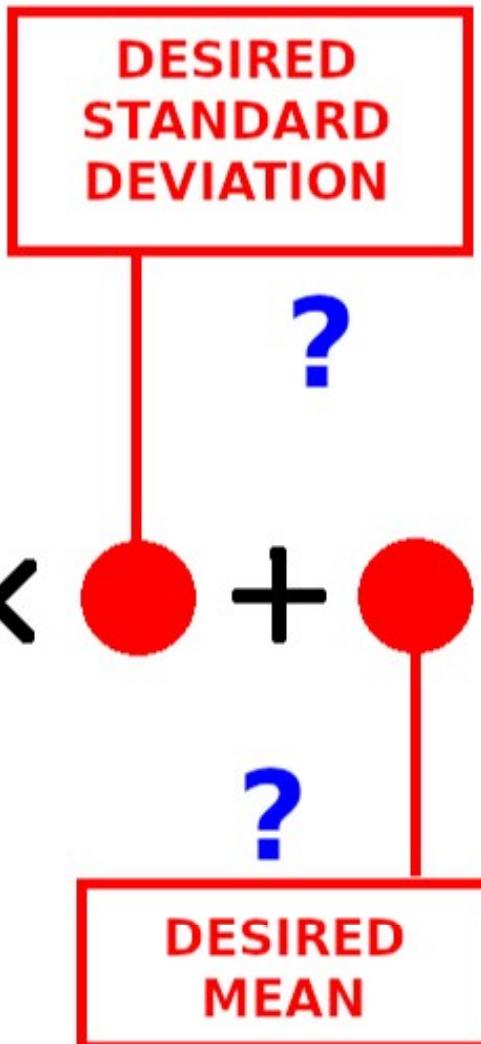
IMPROVING "WALLIS" CORRECTION WITH PCA

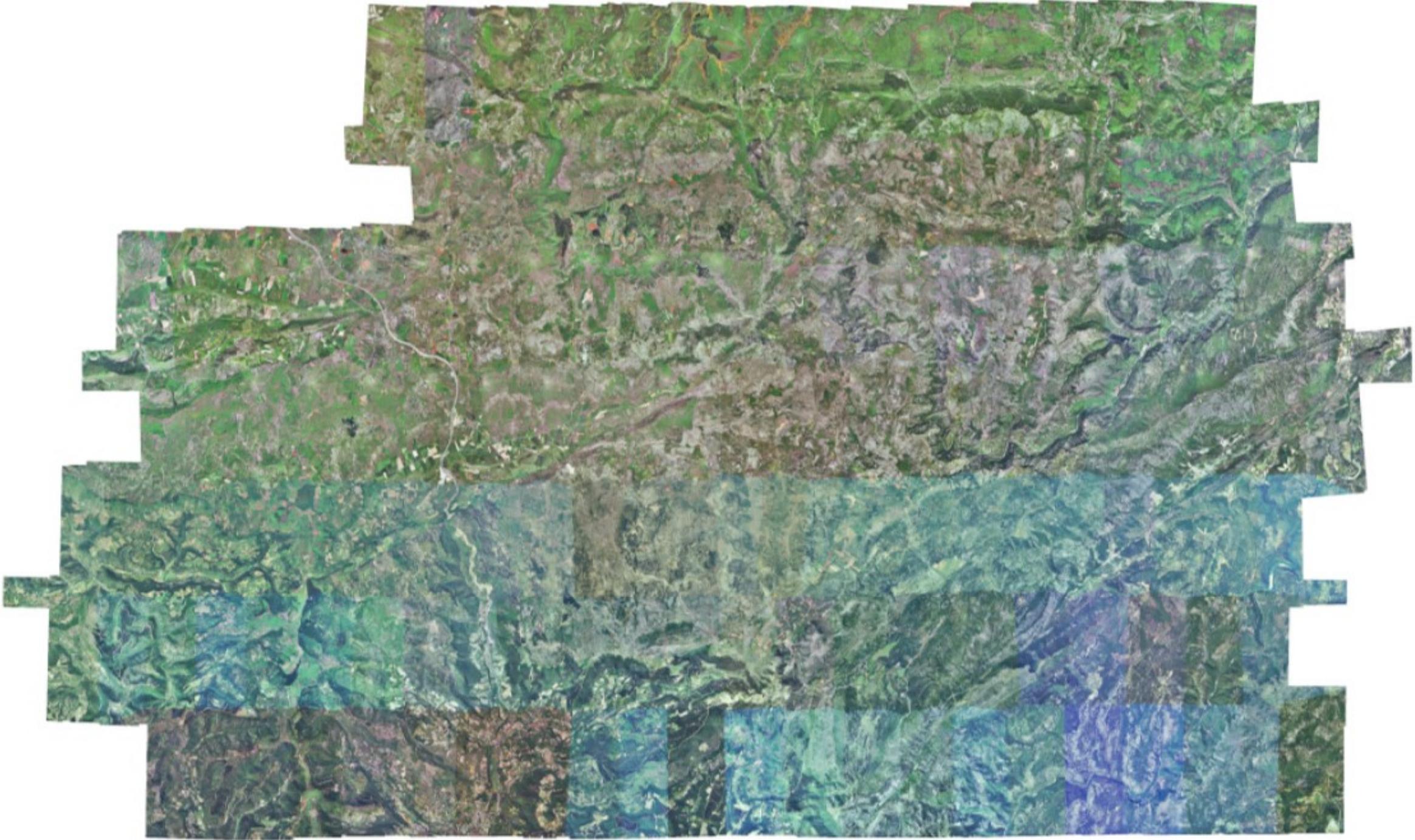


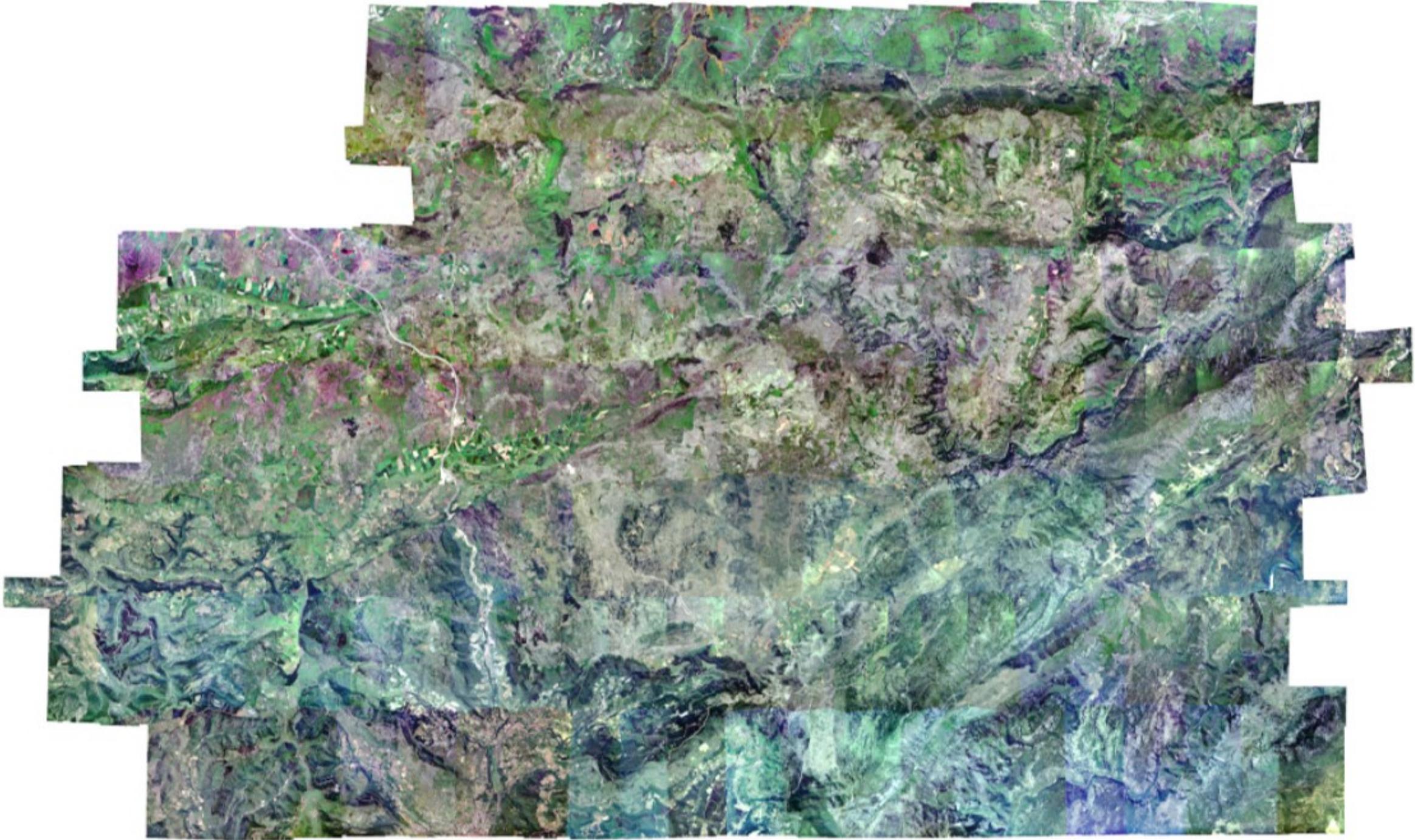


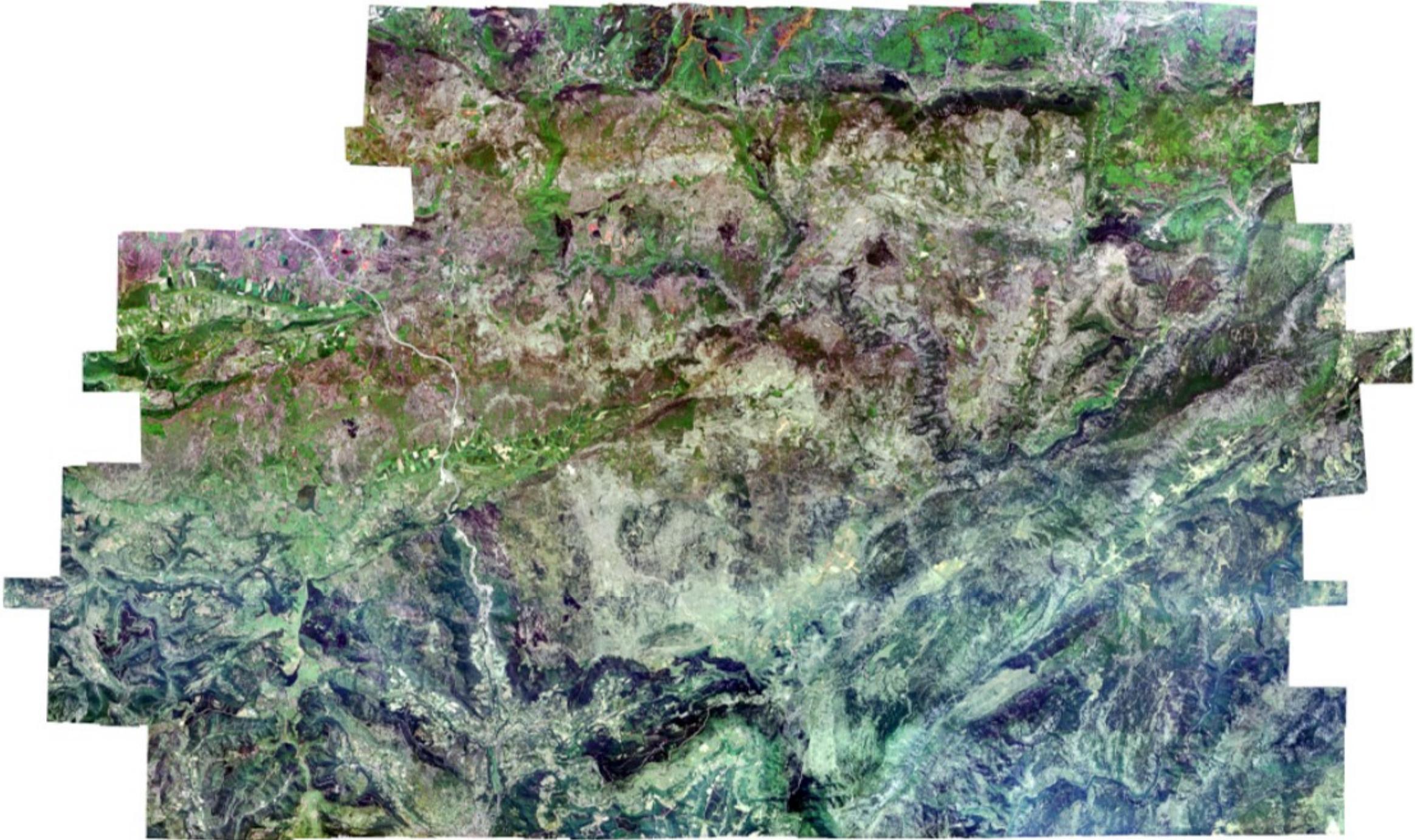
Mean Map
reconstructed
with the three
first components
of the PCA
performed on the
143 means maps

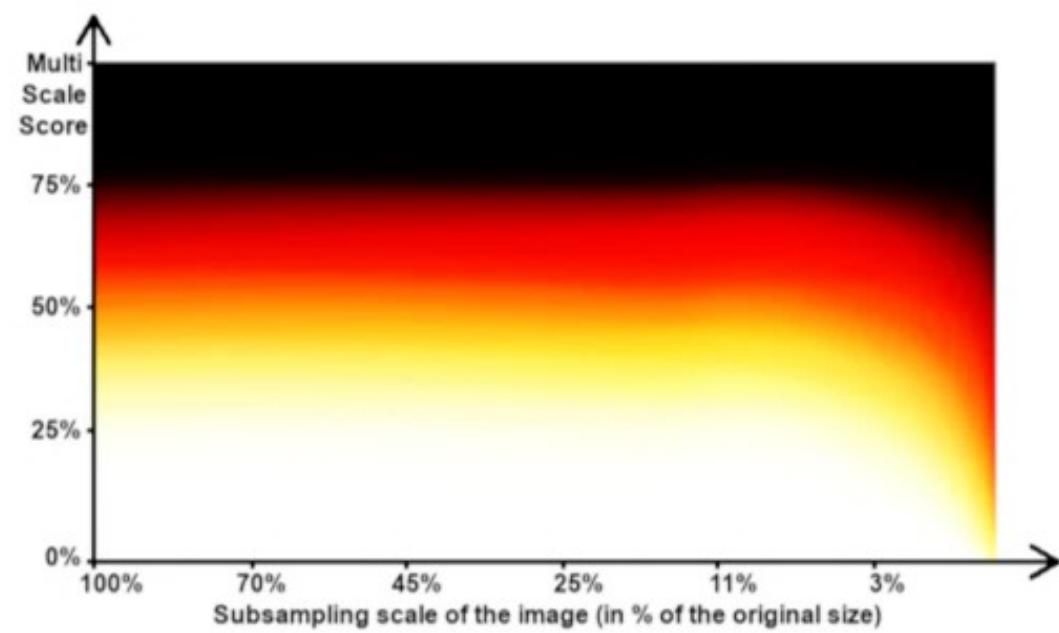
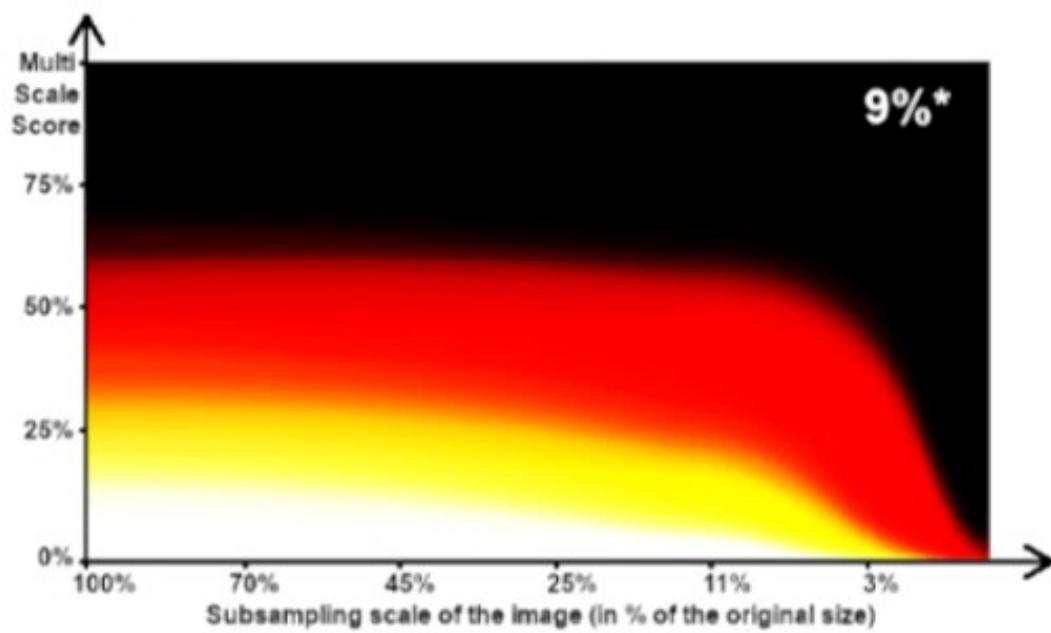
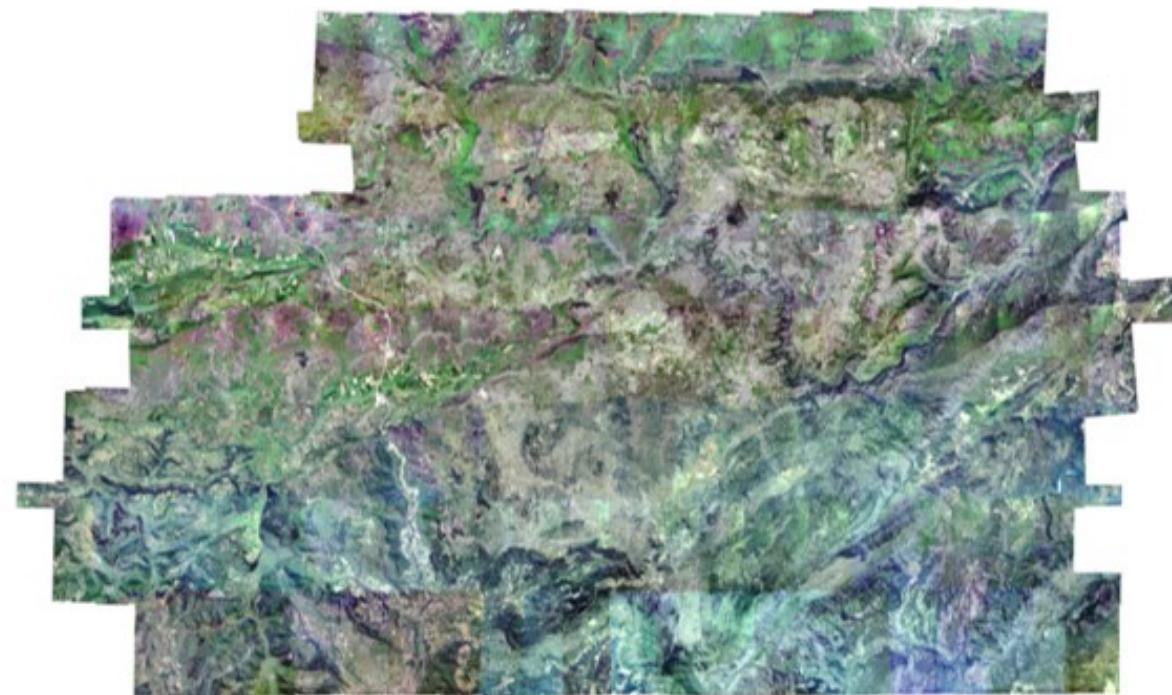
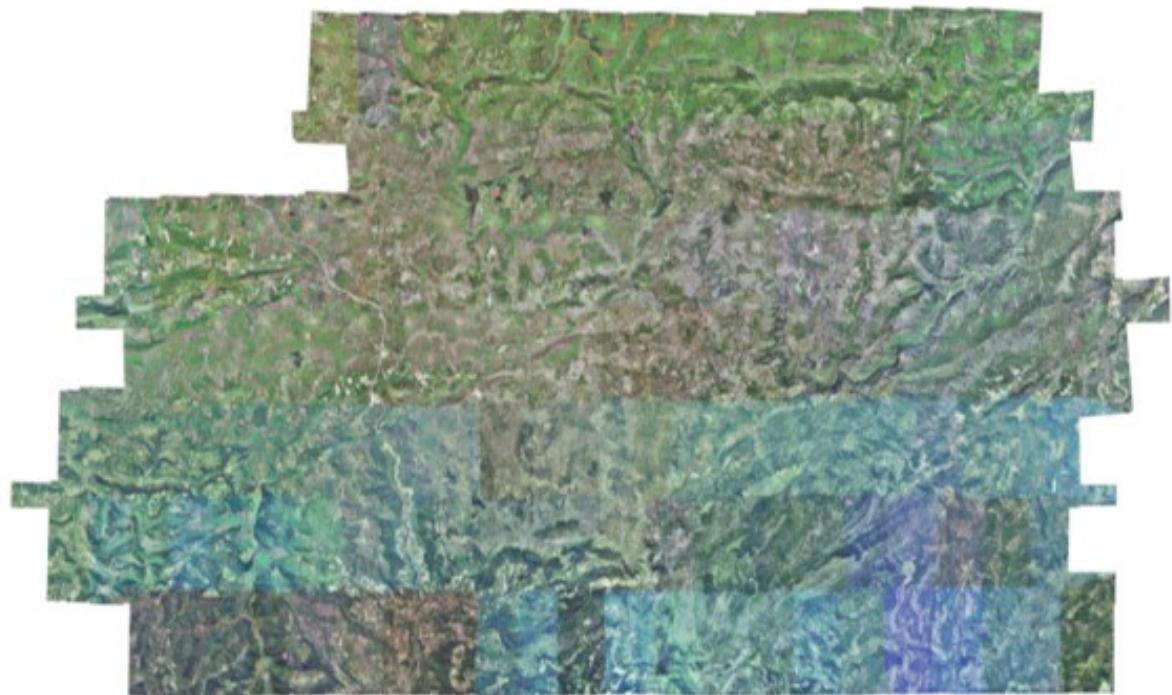
Standard
Deviation
reconstructed the
same way than
the Mean Map
(PCA)



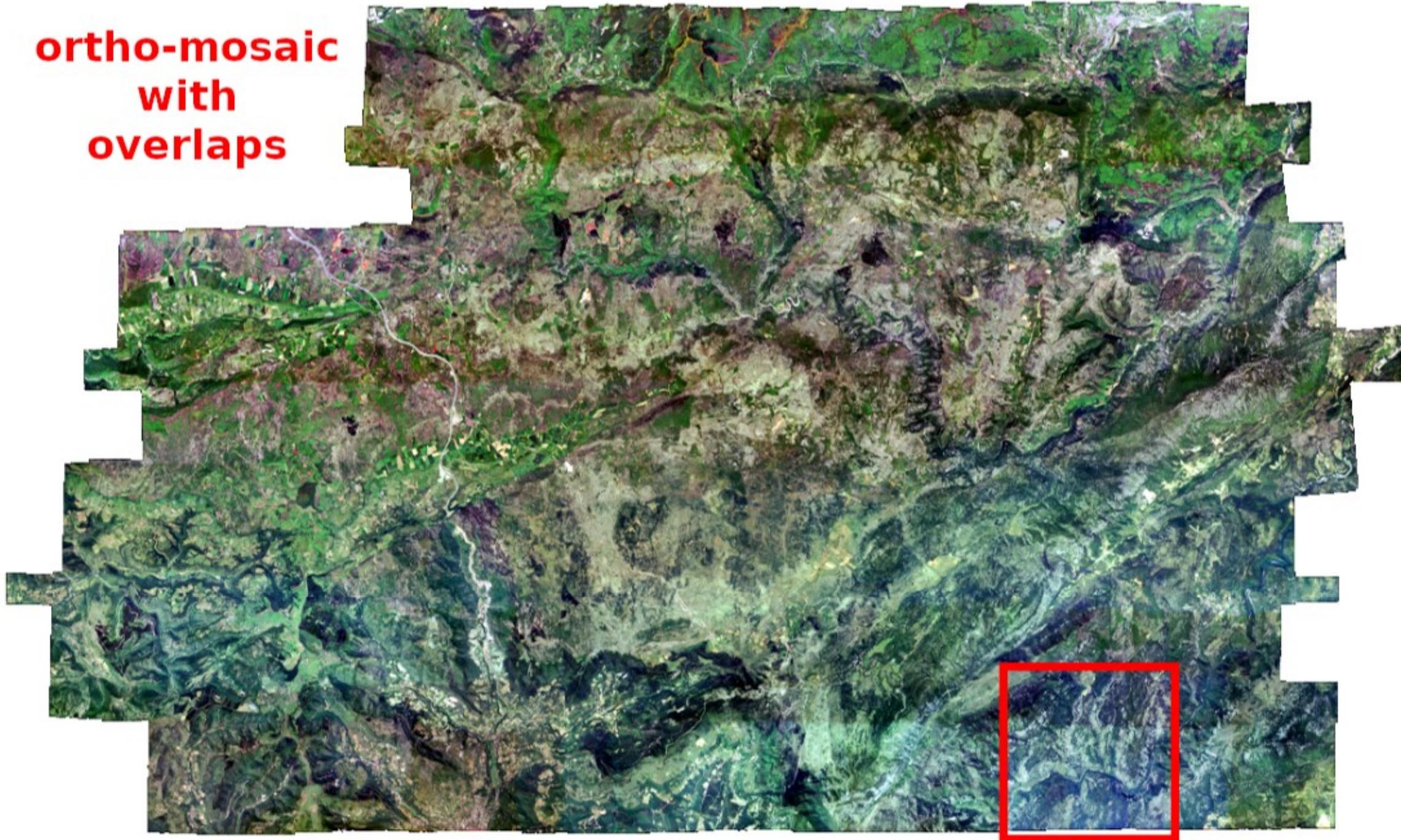






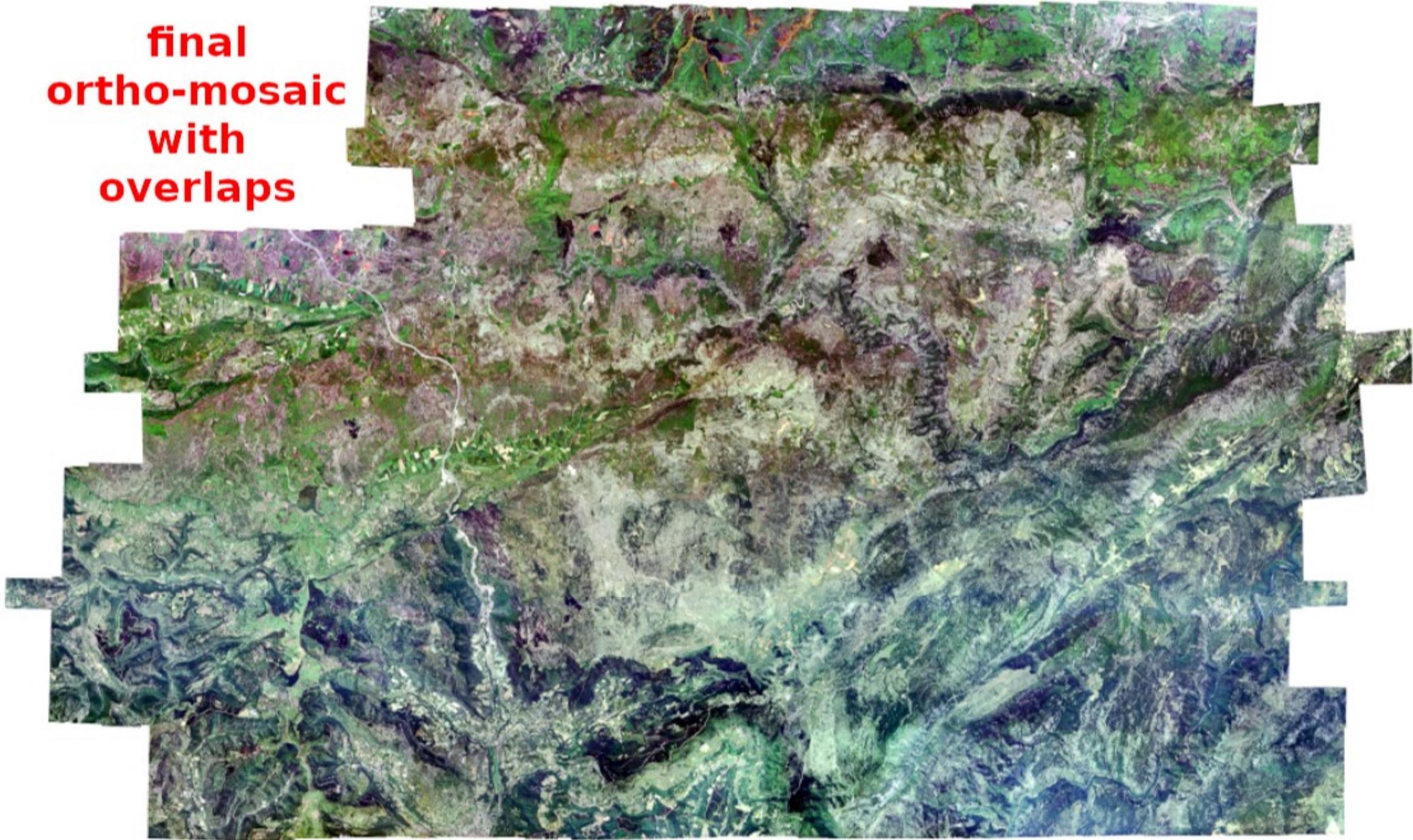


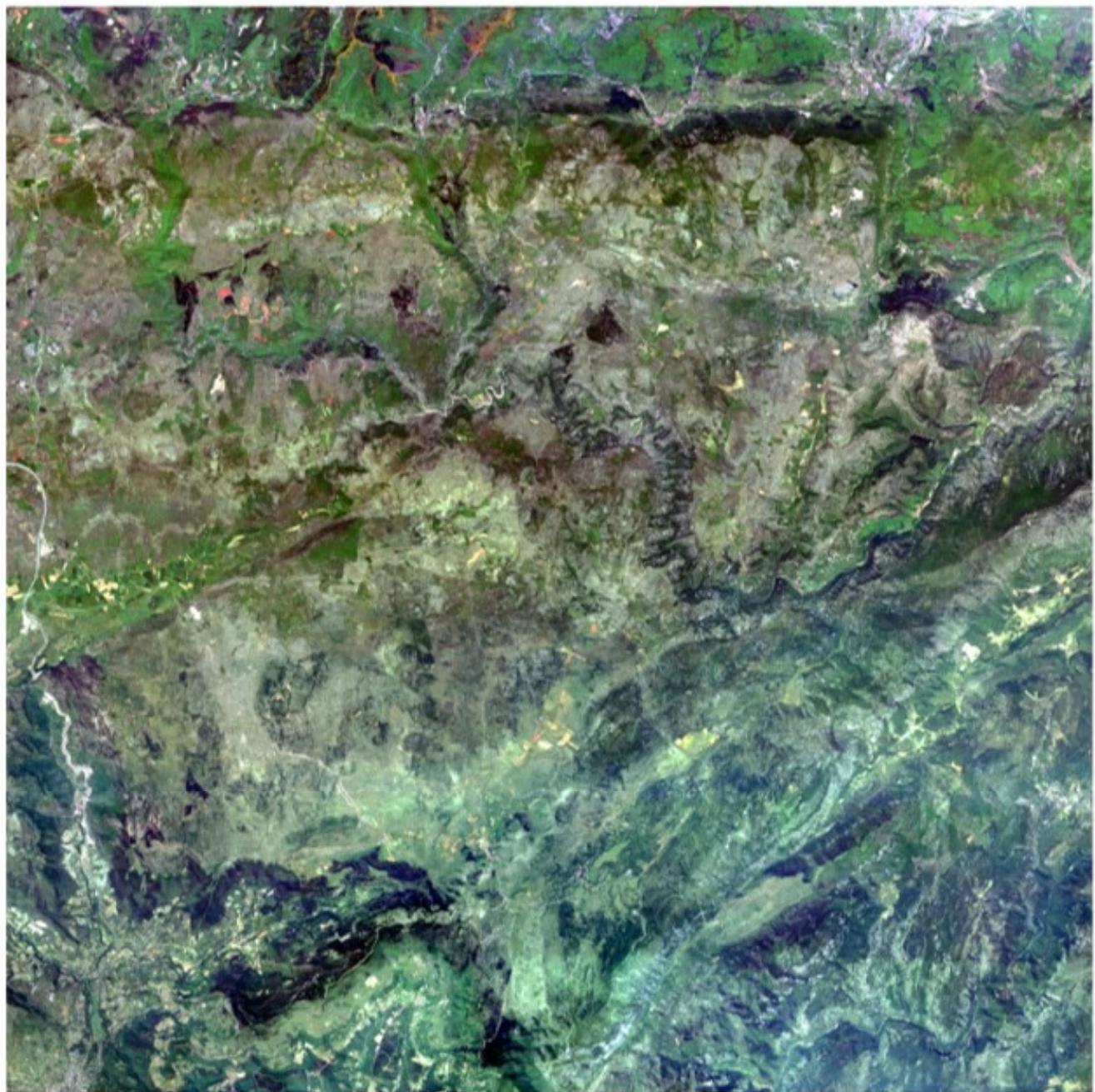
**ortho-mosaic
with
overlaps**

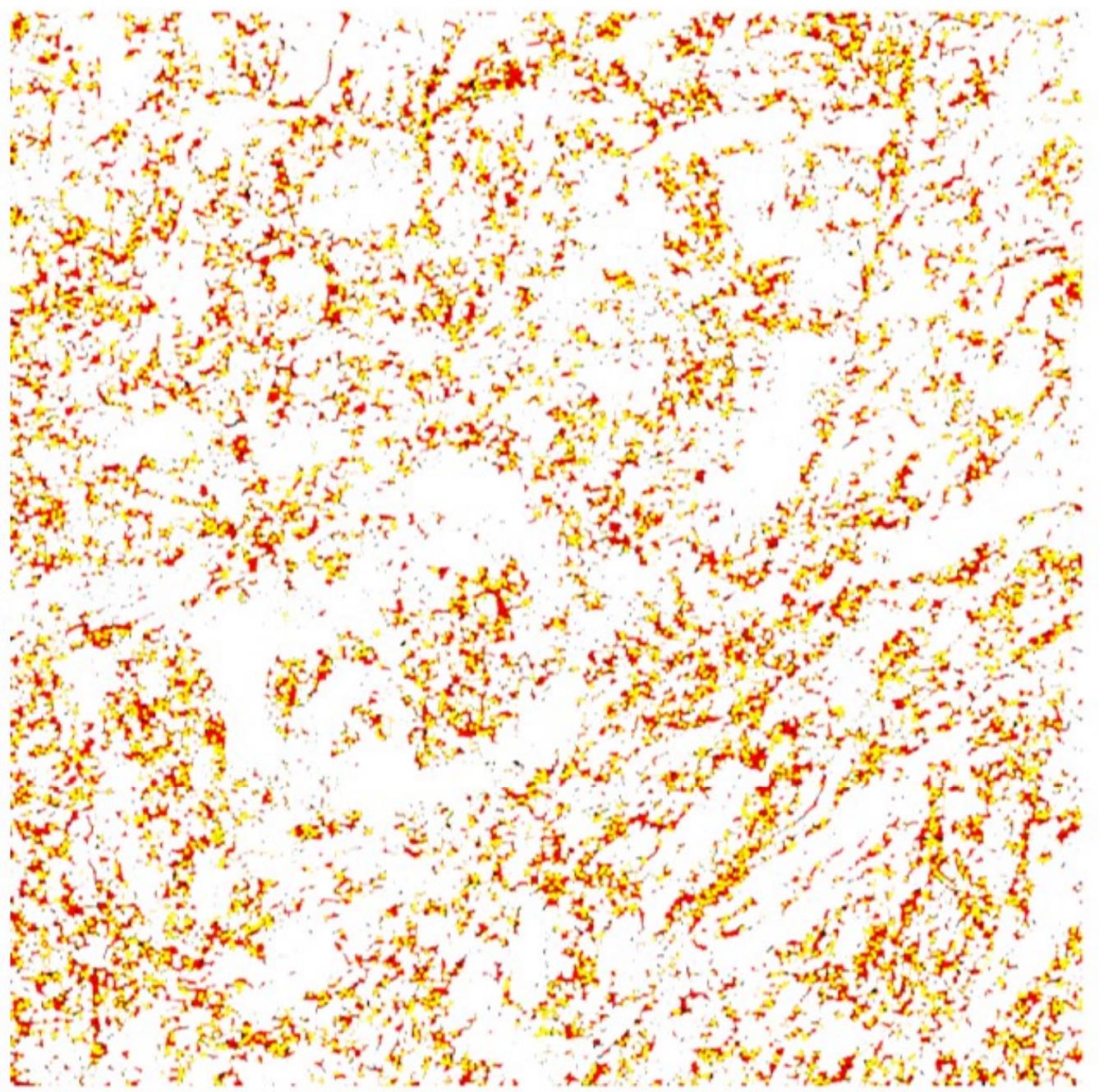
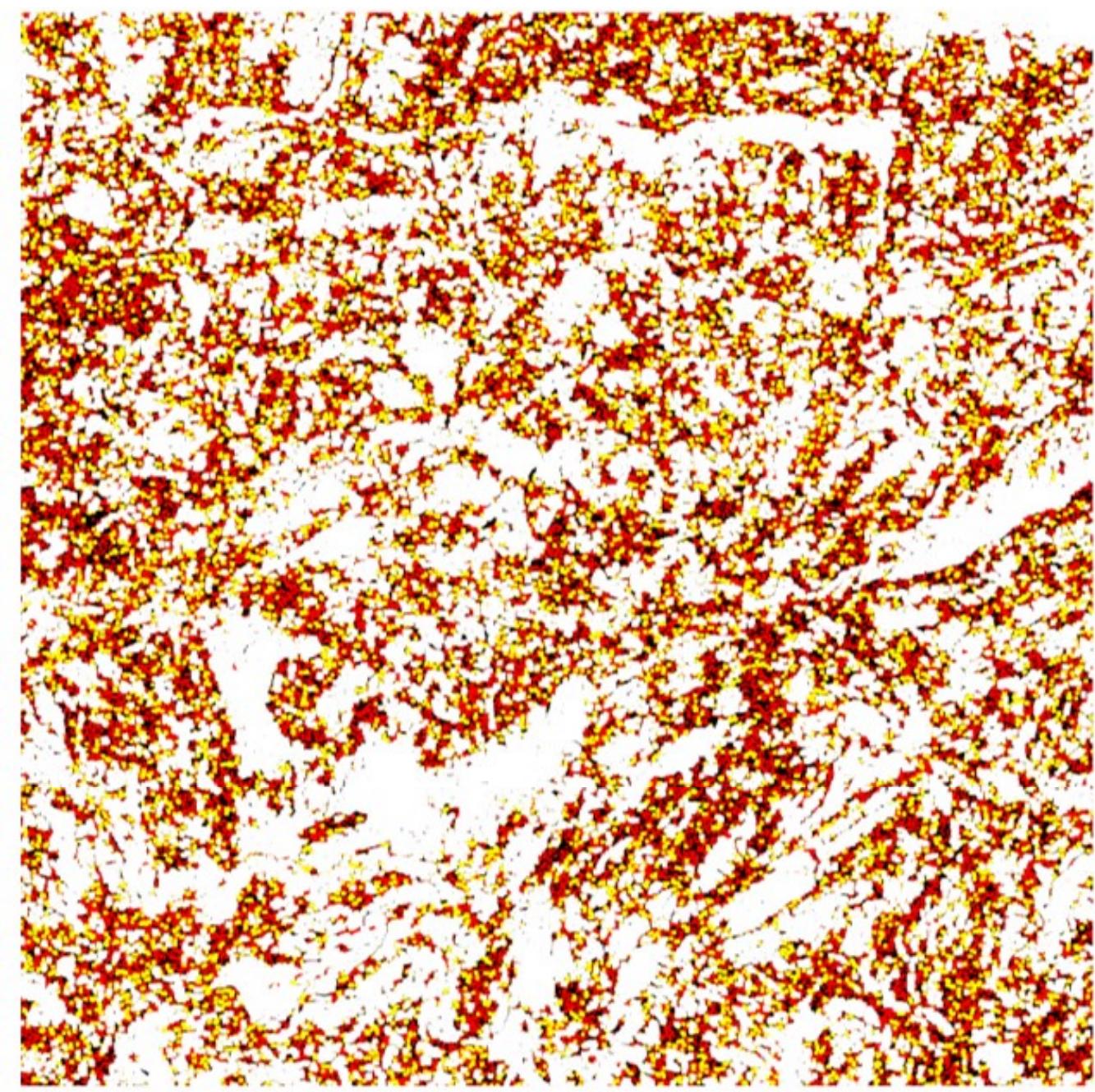




**final
ortho-mosaic
with
overlaps**



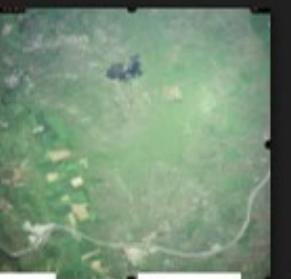
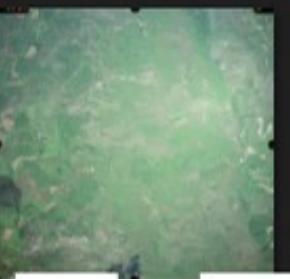
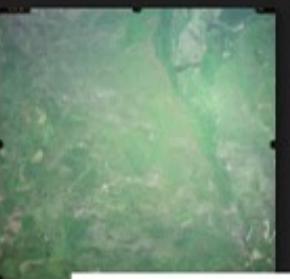




**FUTURE
WORK**

FUTURE

WORK



OIS-Reech_IGNF_
PVA_1-0_1996-0
5-29_C96SAA12
52_1996_FD30-...

OIS-
PVA_1-0_1996-0
5-29_C96SAA12
52_1996_FD30-...

OIS-Reech_IGNF_
PVA_1-0_1996-0
5-29_C96SAA12
52_1996_FD30-...

PVA_1-0_1996-0
5-29_C96SAA12
52_1996_FD30-...

-Reech_IGNF_
PVA_1-0_1996-0
5-29_C96SAA12
52_1996_FD30-...

GNF_1-0_1996-0
5-29_C96SAA12
52_1996_FD30-...

IGNF_1-0_1996-0
5-29_C96SAA12
52_1996_FD30-...

OIS-Reech_IGNF_
PVA_1-0_1996-0
5-29_C96SAA12
52_1996_FD30-...



OIS-Reech_IGNF_
PVA_1-0_1996-0
5-29_C96SAA12
52_1996_FD30-...



OIS-Reech_IGNF_
PVA_1-0_1996-0

FUTURE

1_143

2_002

2_004

2_007

2_010

2_011

2_012

2_013

2_014

2_015

2_016

2_017

2_020

2_021

2_022

2_023

2_024

2_025

2_026

2_027

2_030

2_031

2_032

2_033

2_034

2_035

2_036

2_037

WORK

THANK
YOU