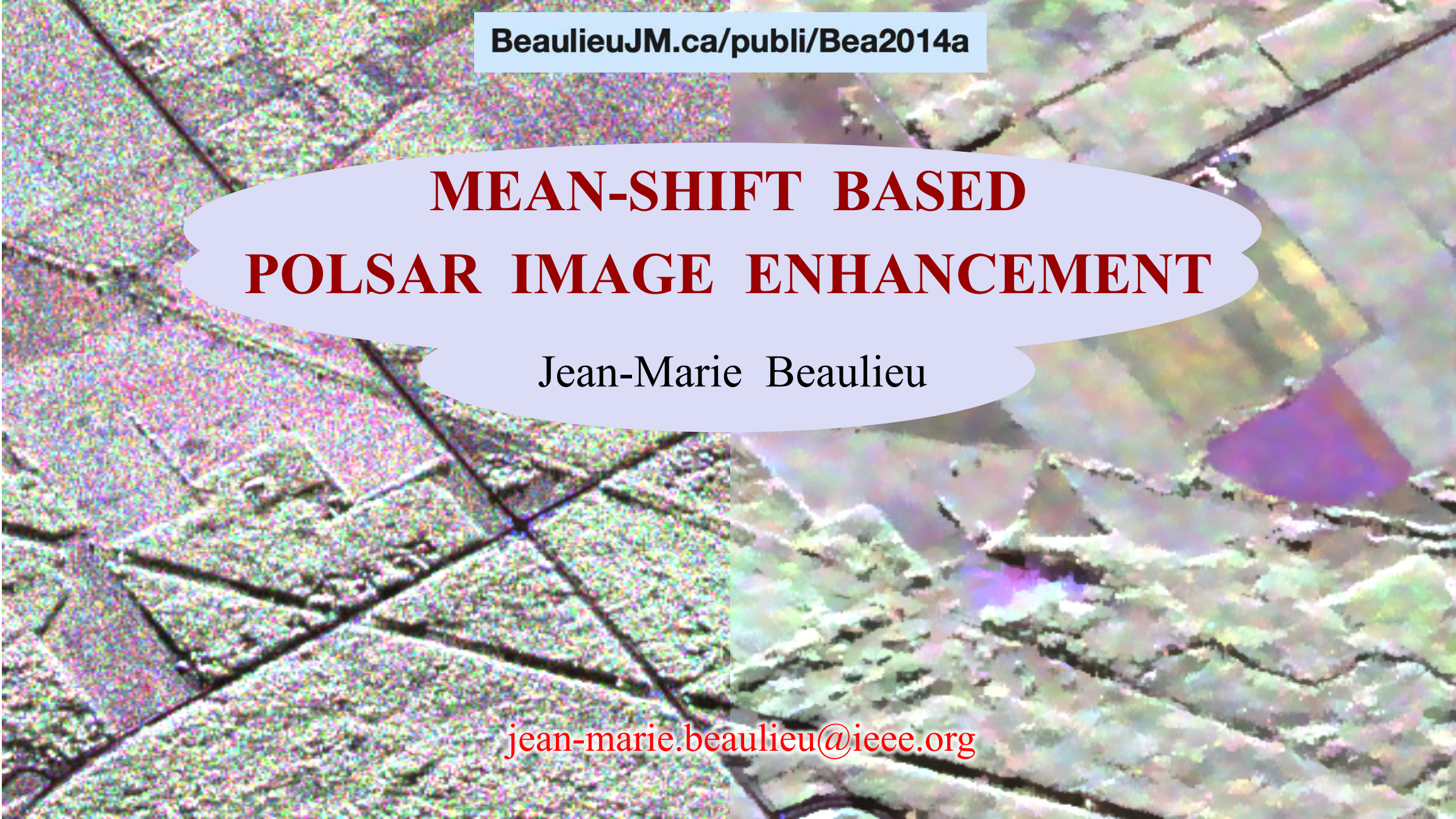

BeaulieuJM.ca/publi/Bea2014a

MEAN-SHIFT BASED POLSAR IMAGE ENHANCEMENT

Jean-Marie Beaulieu

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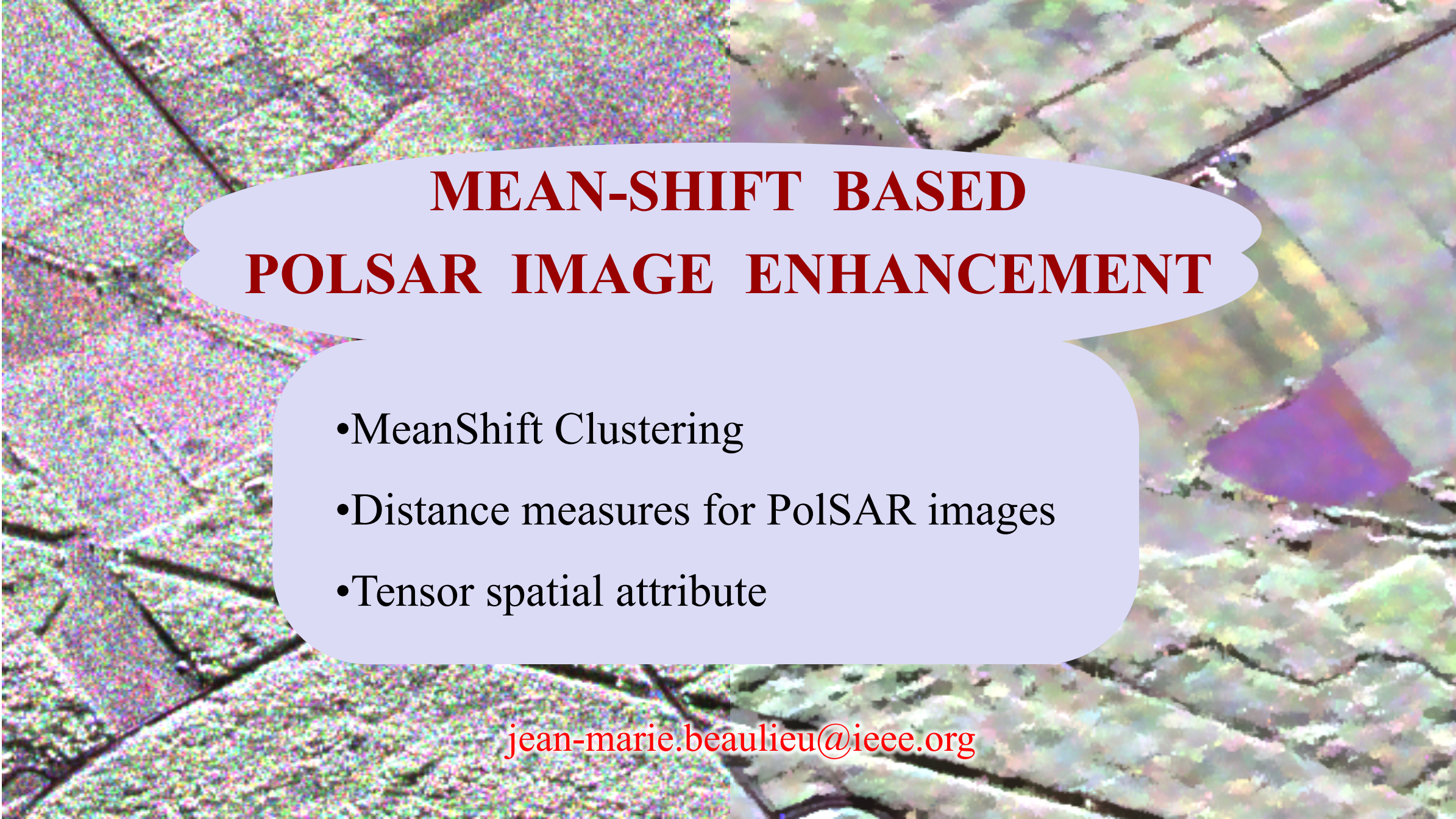

MEAN-SHIFT BASED POLSAR IMAGE ENHANCEMENT

- MeanShift Clustering
- Distance measures for PolSAR images
- Tensor spatial attribute

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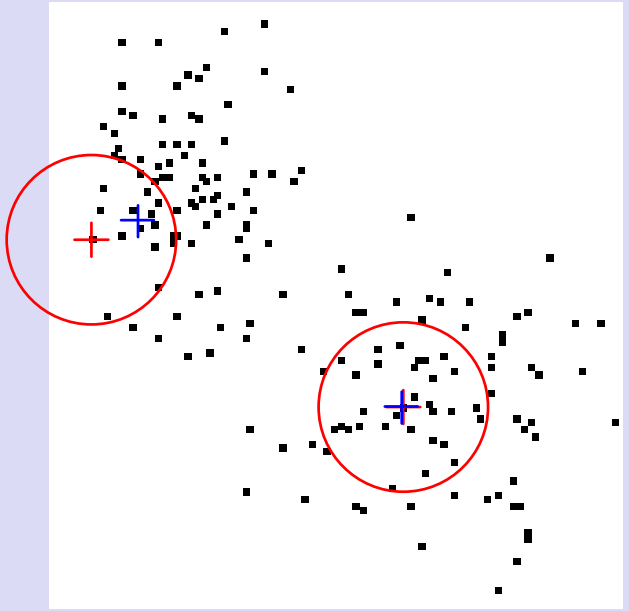
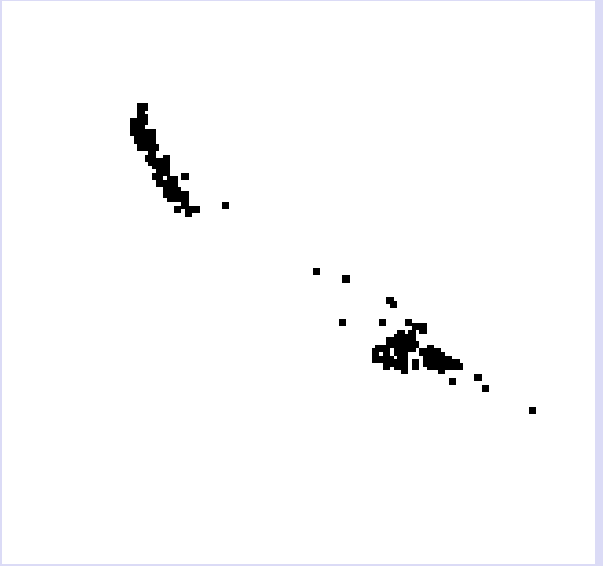
- **Mean-Shift clustering move every data points toward higher probability density zones (modes)**
- **Density → point count over a window (histogram)**
- **Direction toward higher density**
  → position of weighted mean (window)





MEAN-SHIFT

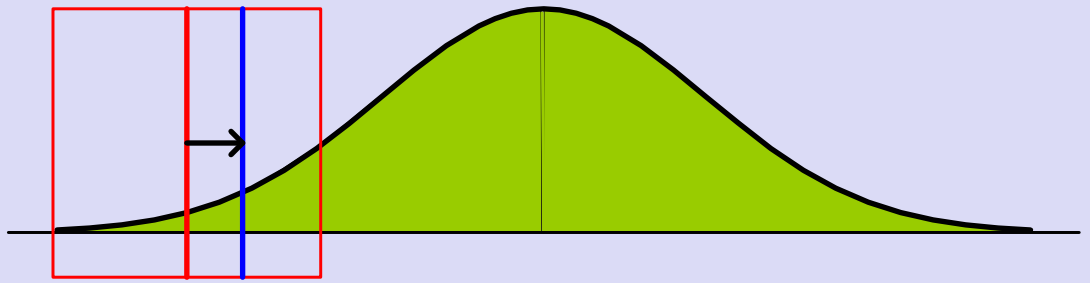
$D_{rad} = D(Z_i, Z_j)^{1/2} \;/\; F_{rad}$

$D_{spatial}$ = Distance between pixels / $F_{spatial}$

$\text{Weight} = \text{EXP}\left[- (D_{rad}^2 + D_{spatial}^2) \right]$

Mean = weighted pixel mean

$\text{Fhift}_R = \alpha\ \text{value}_R + (1-\alpha)\ \text{Mean}_R$ (radiometric value)



- **Radiometric distance D(Z*i*,Z*j*) for PolSar images**
- **Z_k is pixel covariance matrix**
- **Non textured PolSar image**
- **Z_k follows a complex Wishart distribution**

$$p(Z_k \mid \Sigma) = \frac{L^{3L} \left|Z_k\right|^{L-3} \quad \exp\left\{-L\, tr\left(\Sigma^{-1} Z_k\right)\right\}}{\pi^3\, \Gamma(L)\Gamma(L-1)\Gamma(L-2) \left|\Sigma\right|^{L}}$$

- **Log of the likelihood ratio statistic is**

$$D(Z_i, Z_j) = 2\ln\left|\tfrac{1}{2}(Z_i + Z_j)\right| - \ln\left|Z_i\right| - \ln\left|Z_j\right|$$

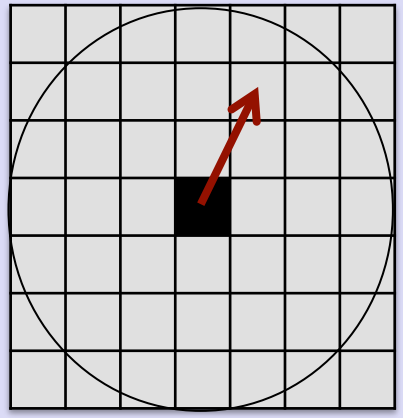
- **Distance between pixels → Euclidian distance**

Gaussian like weight (F*spatial* = σ)

Weight = EXP [- (D*rad*^{2} +D*spatial*^{2})]

Limited to a window (11x11)

Fhift$_R$ = α value$_R$ + (1-α) Mean$_R$



- **Shifting the pixel position**

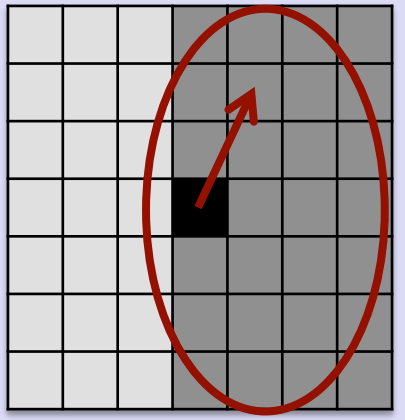
Fhift$_p$ = α value$_p$ + (1-α) Mean$_p$ (pixel position)

Distances between pixels will change

- **Integrating other distances (texture, shape)**
- **Using weight to define a new attribute**

$p_i = (x_i, y_i)$ → pixel position

V_i = position covariance or tensor



$$V_i = \Sigma_j \; w_{i,j} \; (p_j - p_i)\,(p_j - p_i)^t$$

Use V_i ellipse shape (orientation, elongation)

Shape indicate edge orientation

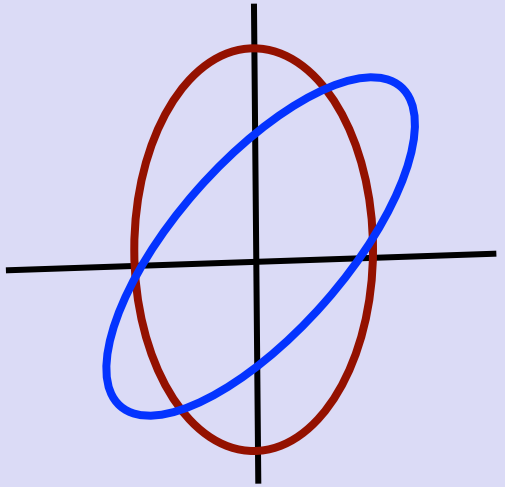
- **Using V_i in weight calculation**

  Use S1 measure of Garcia to calculate the difference between V_i and V_j

  (BMC Evolutionary Biology 2012, 12:222)

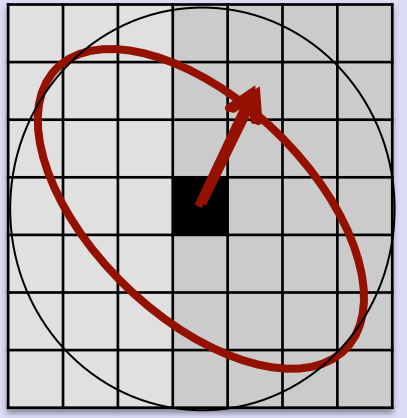
$$D_V = S1(V_i, V_j)^{1/2} \ / \ F_V$$

$$\text{Weight} = \text{EXP}[\ -(Drad^2 + Dspa^2 + D_V^2)\ ]$$



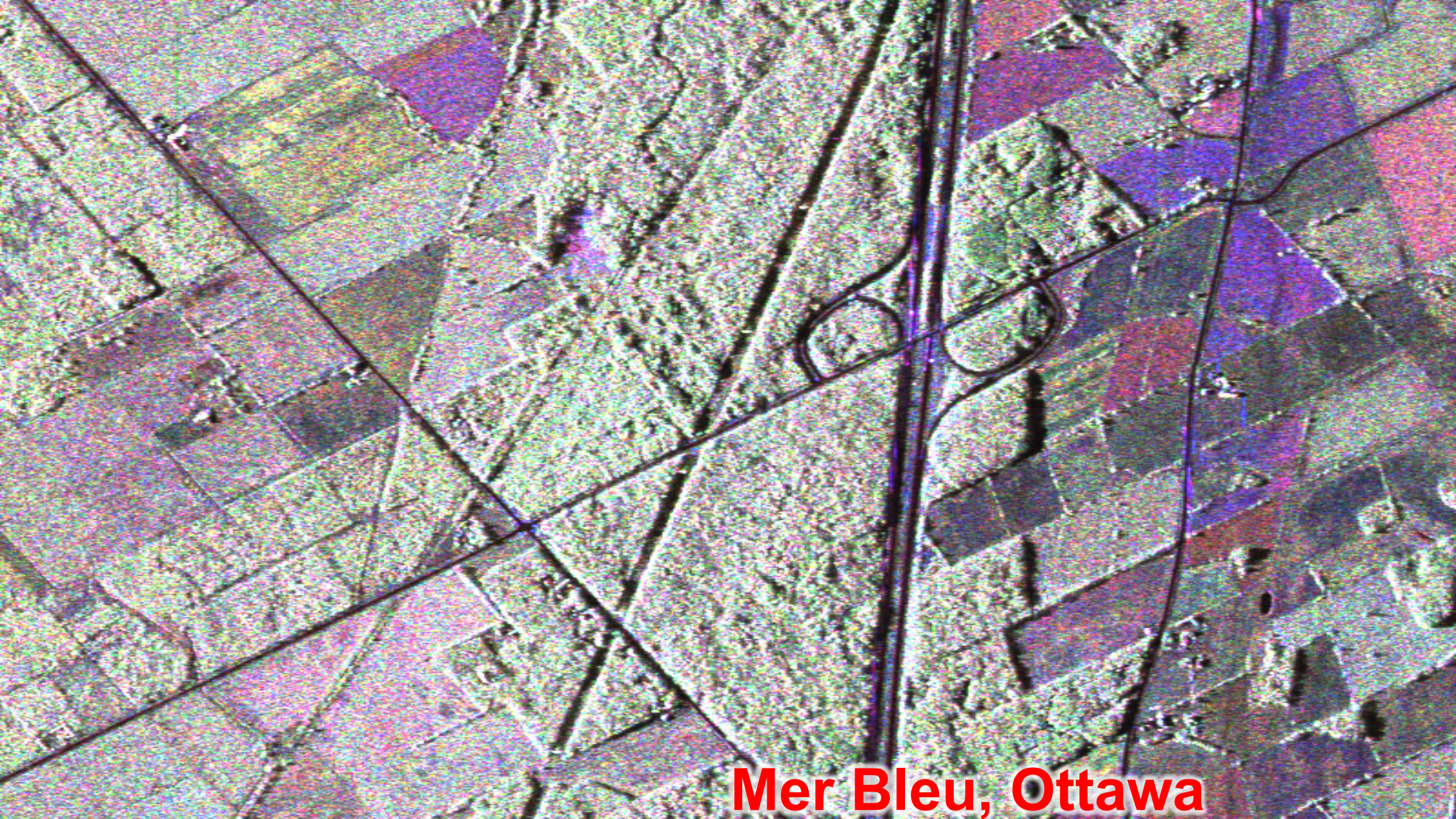
- **Shifting the value of V_i**

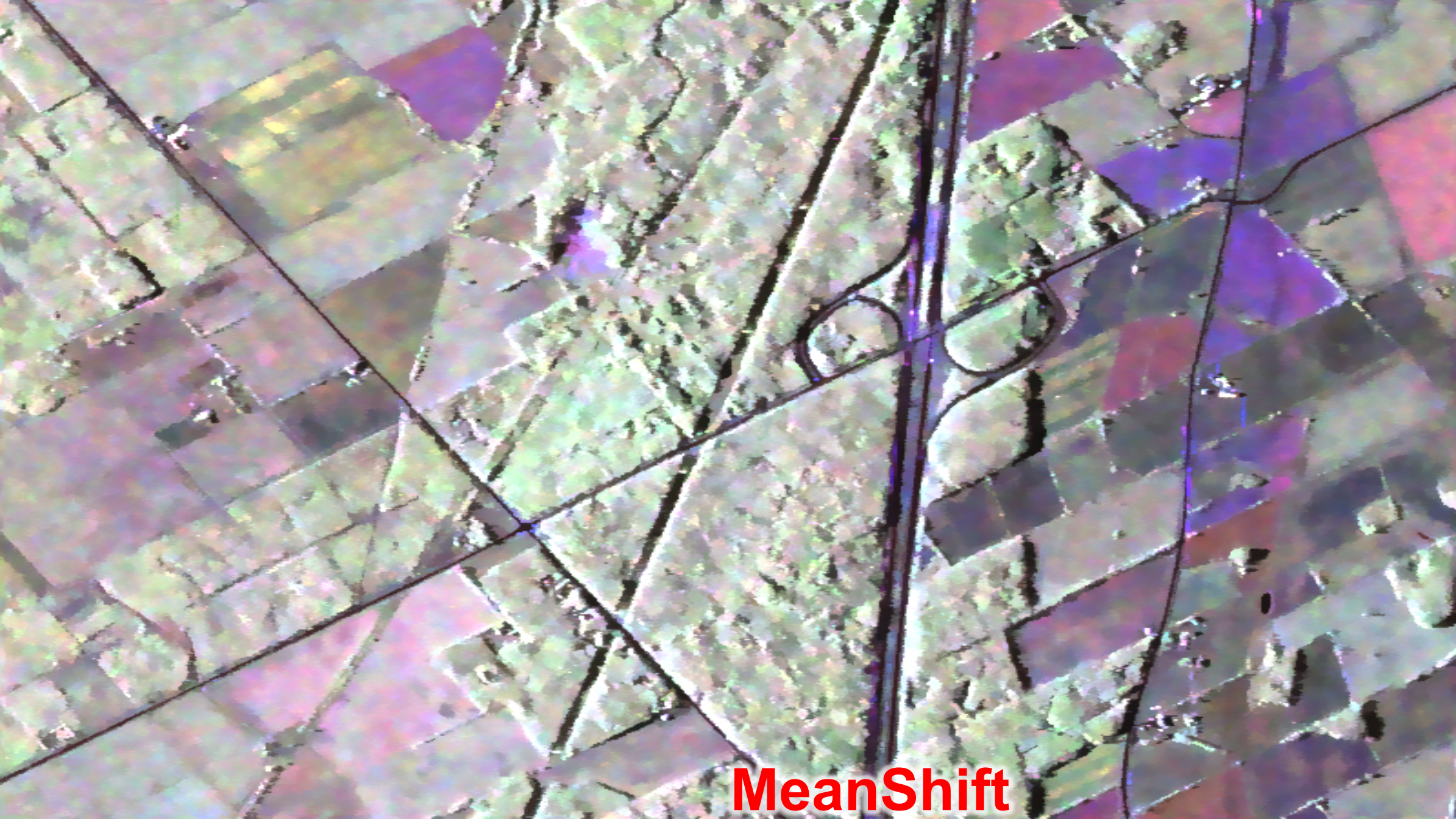
$$\text{Fhift}_V = \ \alpha\ \text{value}_V + (1-\alpha)\ \text{Mean}_V$$

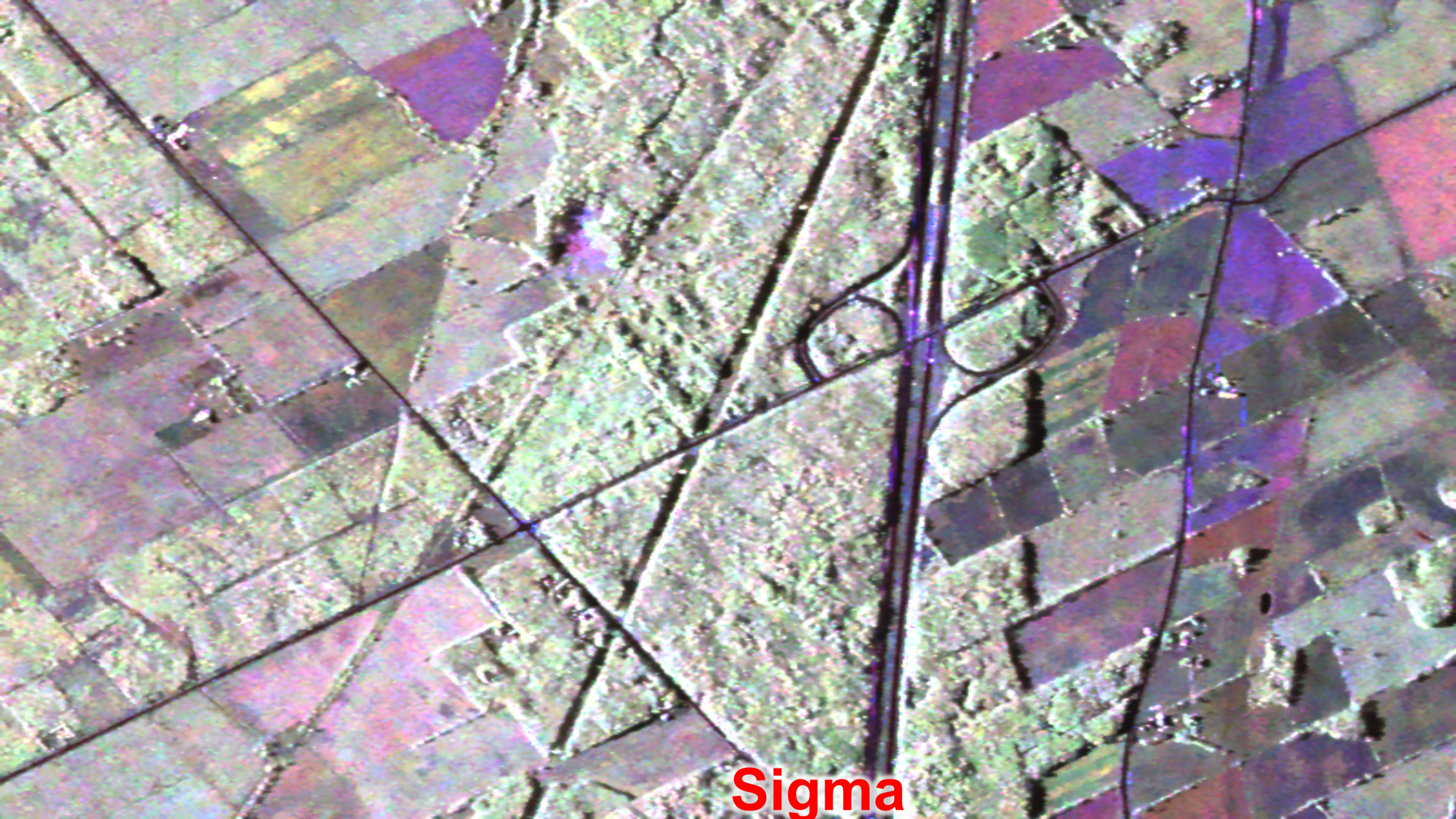


- **Mahalanobis pixel distance**

  Use V_i to calculate Mahalanobis pixel distances

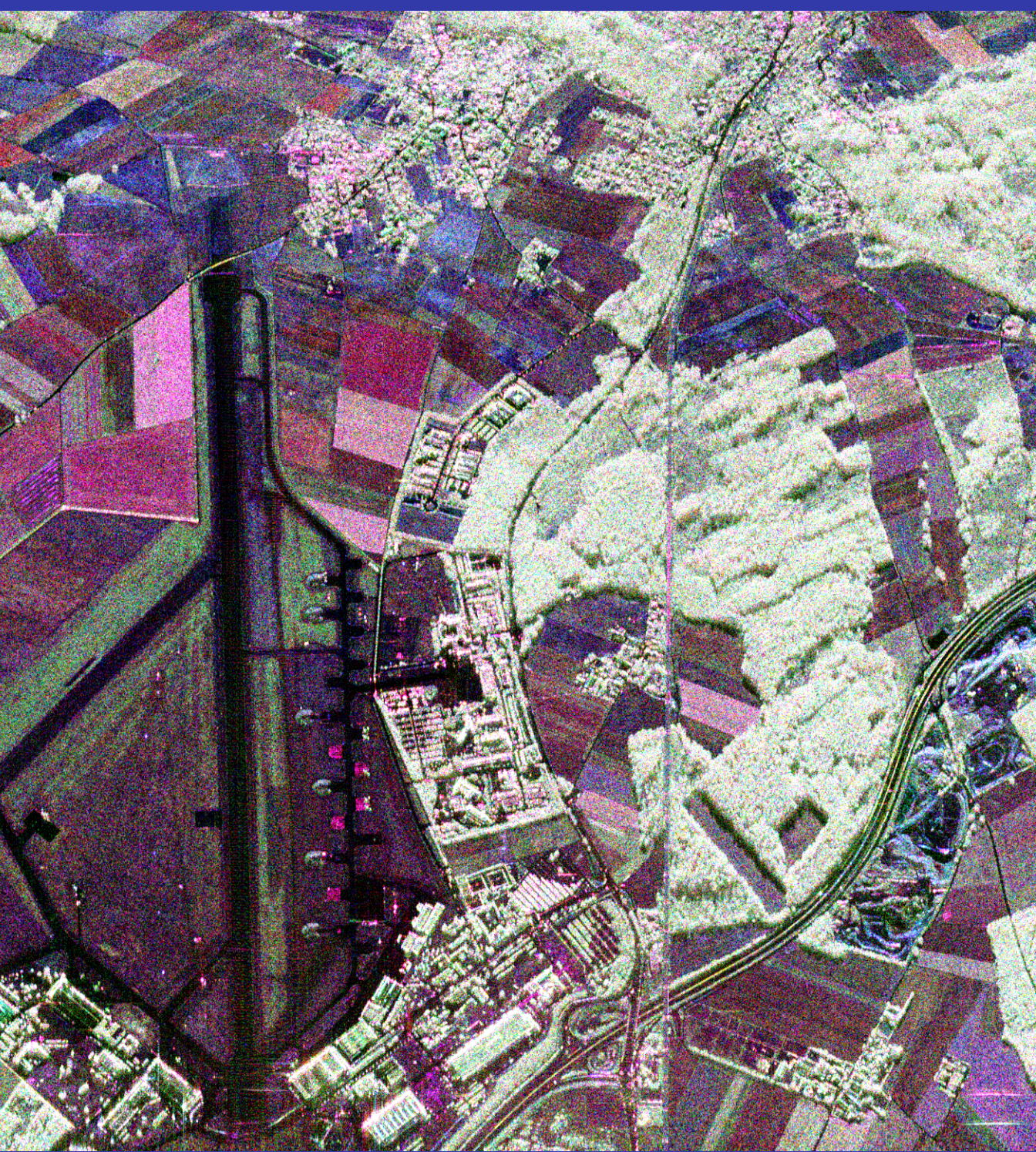

Mer Bleu, Ottawa


MeanShift


Sigma

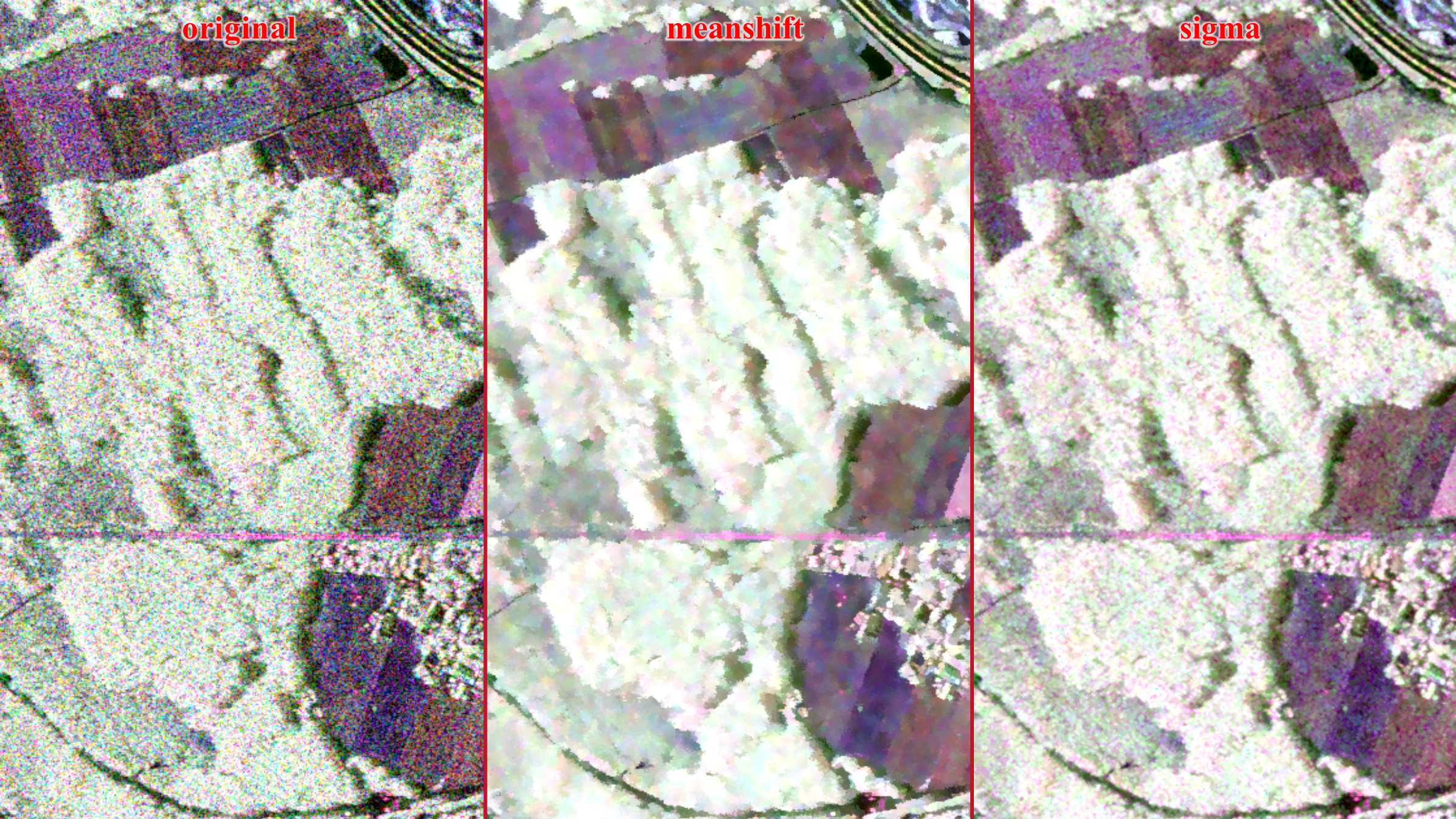

IDAN

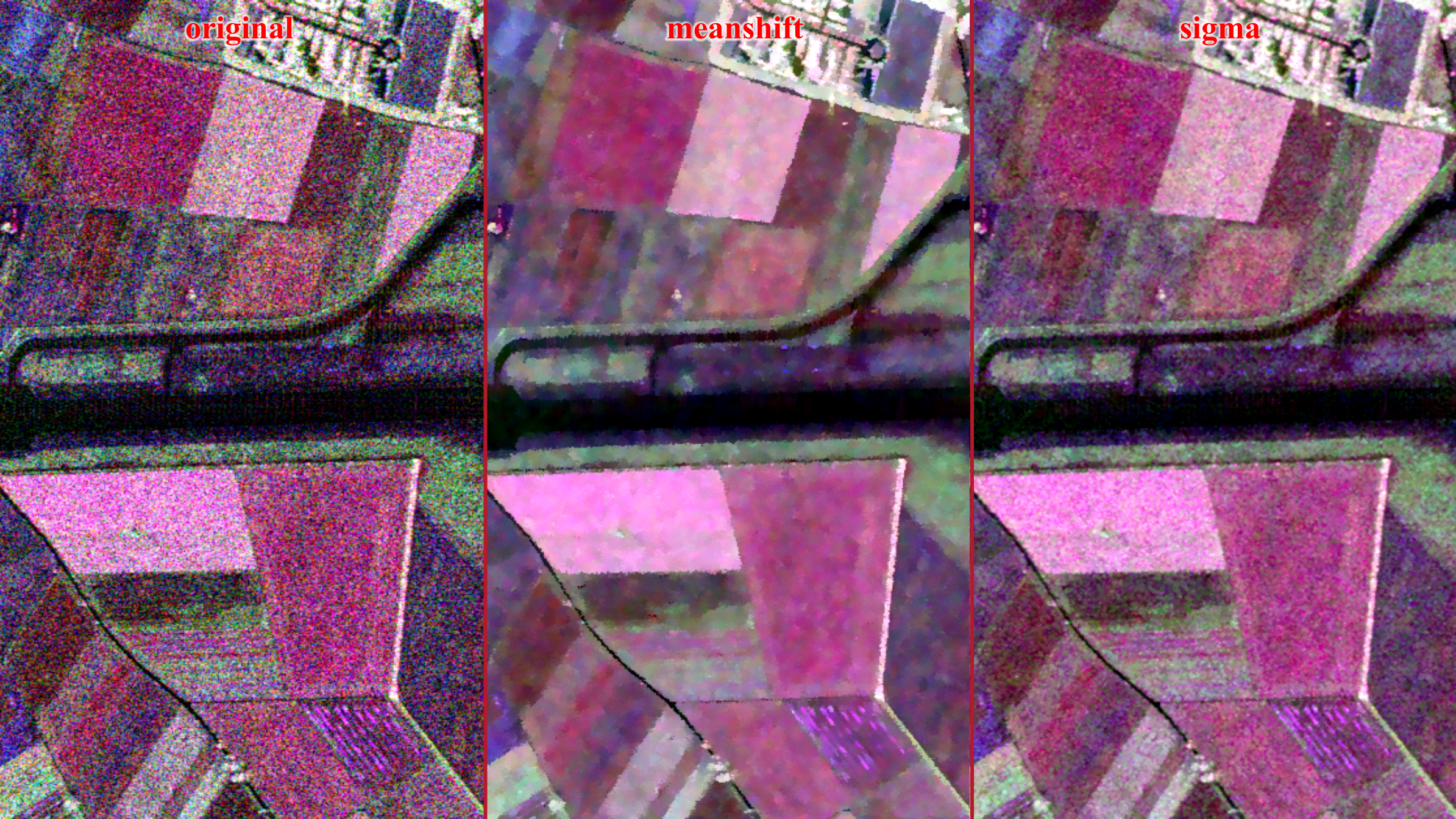
Oberfaffenhofen

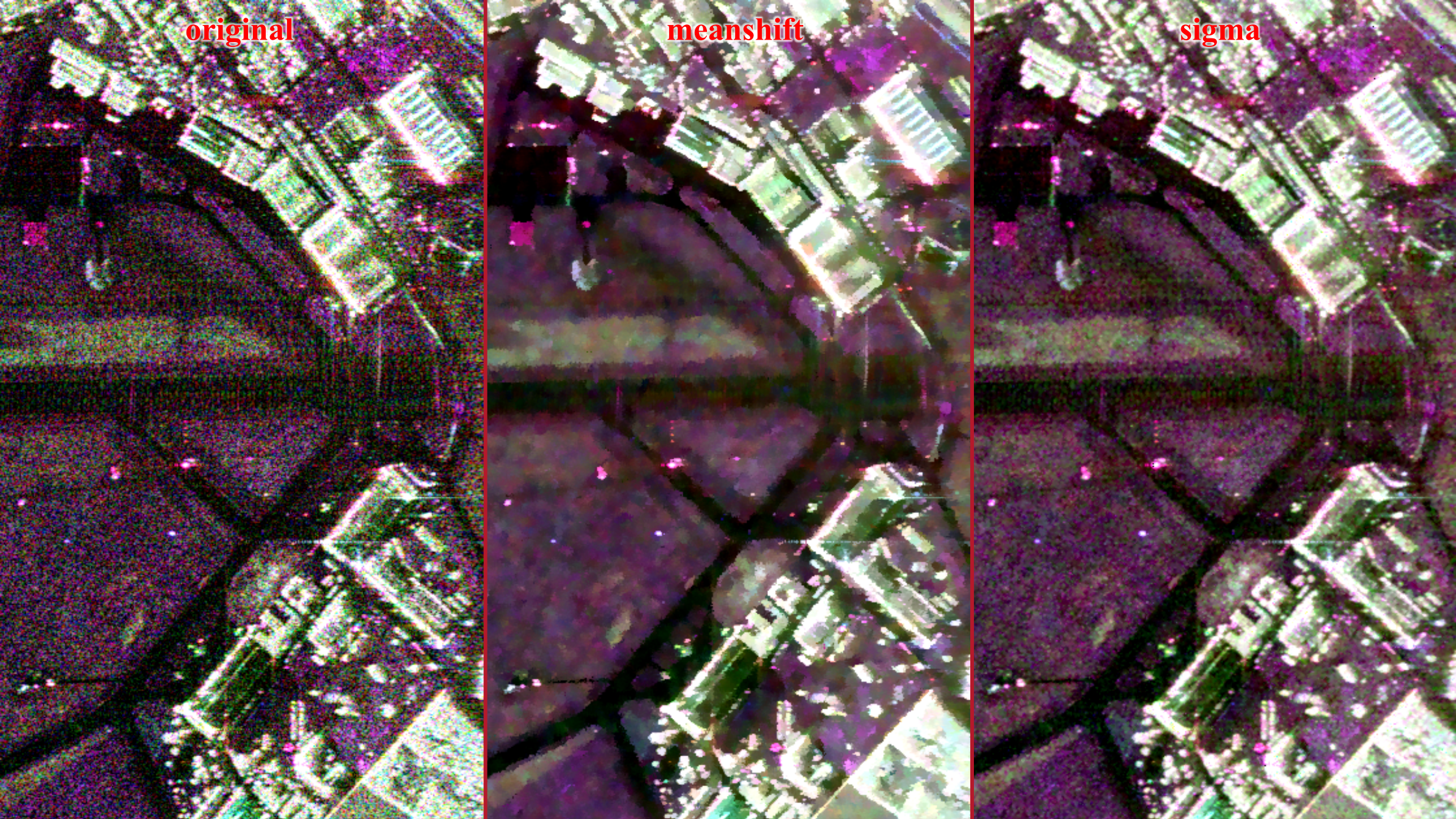


MeanShift

Sigma

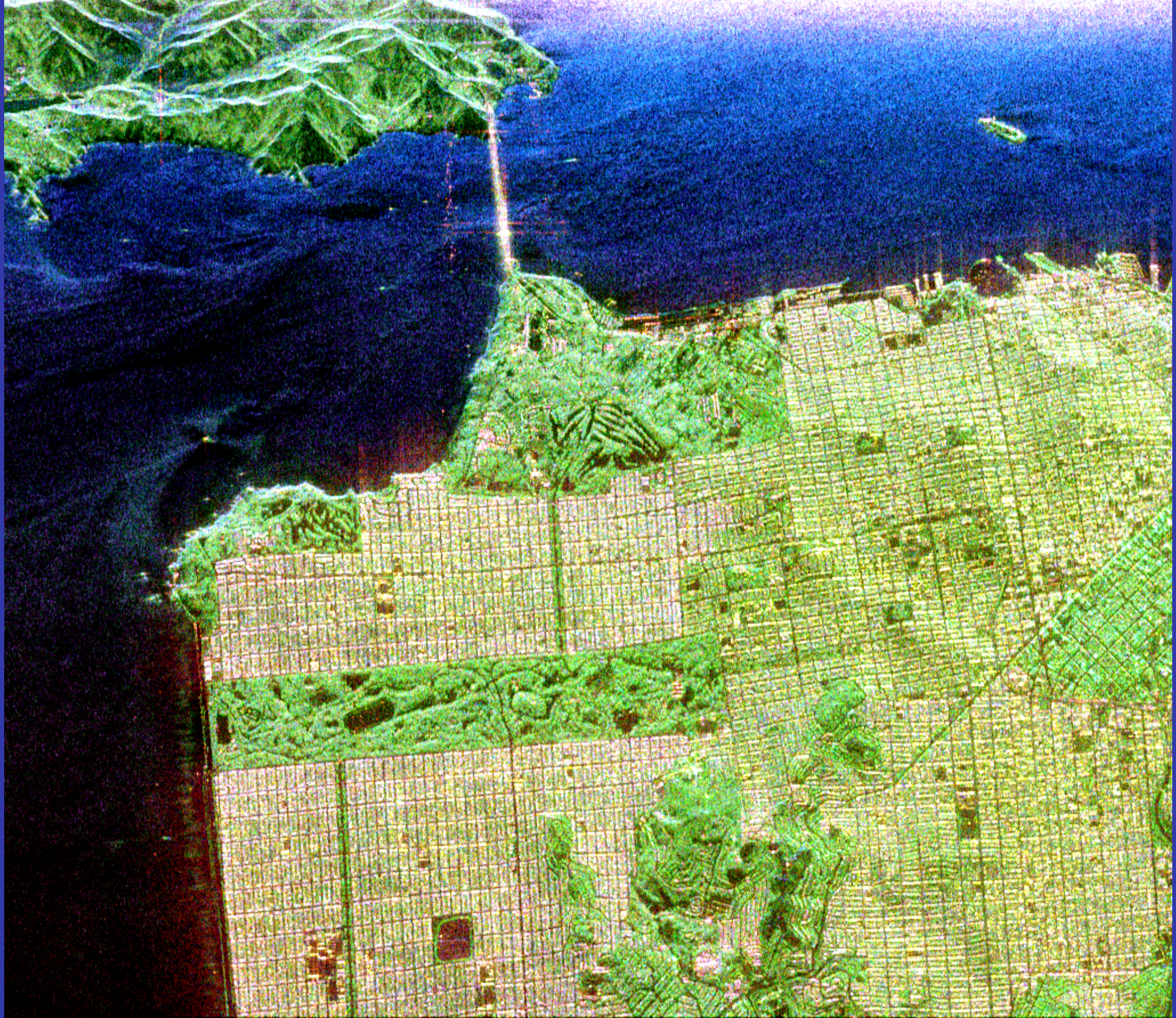

original
meanshift
sigma


original
meanshift
sigma


original
meanshift
sigma


original
meanshift
sigma

San Francisco



MeanShift

Sigma


original
meanshift
sigma

CONCLUSION

- MeanShift can perform good image filtering.
- Position covariance tensor can provide a good textural attribute (ellipse orientation and elongation).
- Spatial attribute can be used in MeanShift to preserve edges.