

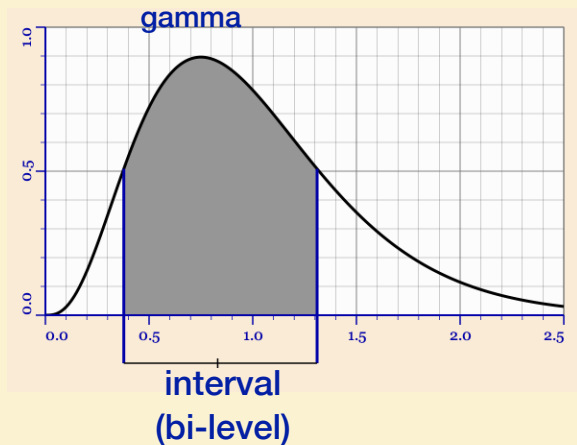
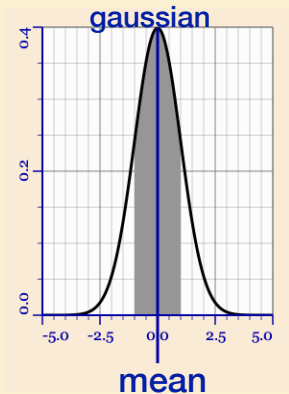
# Edge Preserving Bi-Level Set SAR Image Filter

**Jean-Marie Beaulieu**

- Bi-Level Set is used for SAR Image filtering.
- The histogram of between pixel variations is used to show edge preservation.

## ■ Large dispersion of radar signal and asymmetric distribution

- using a value interval
- limits → two values or thresholds (bi-level)
- region → set of pixels



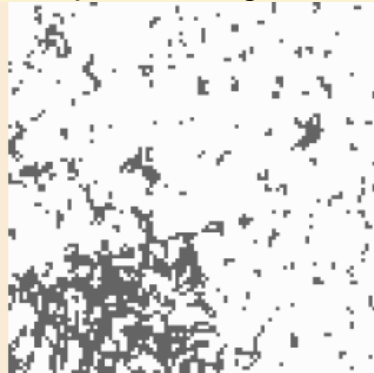
## ■ Pixel set and regions

- an interval defines a pixel set in gray
- region → interconnected pixels

Image



pixel set - regions



pixel set - regions



Histograms

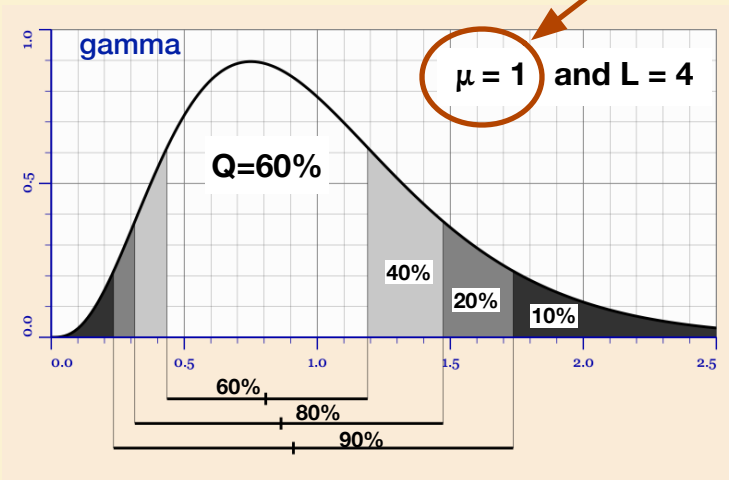


Intervals

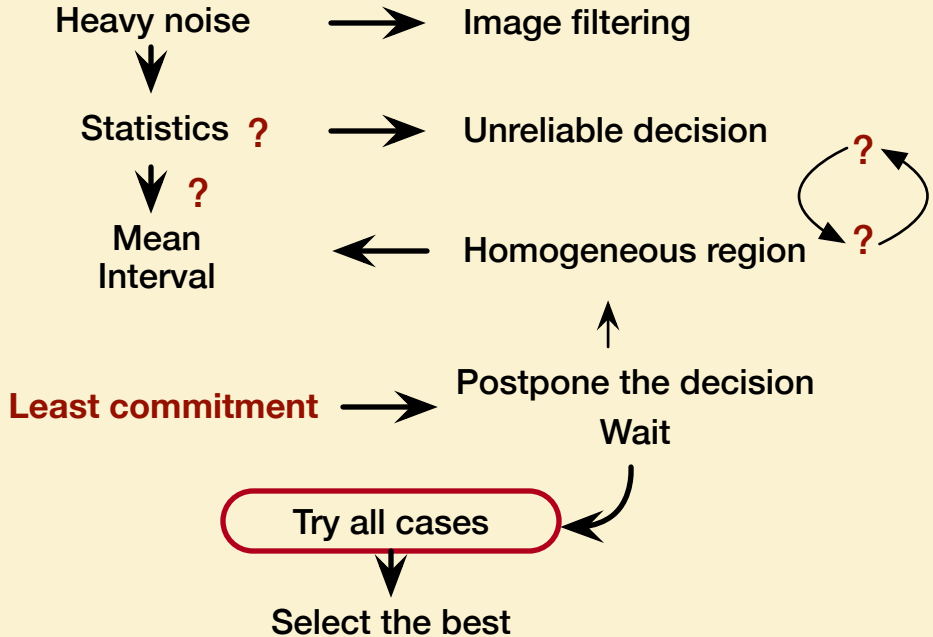


## ■ Interval width and position

- adjusted from cumulated probability (Q=60%)
- increasing with the mean - multiplicative noise
- geometric progression of the width and position
- which interval should be selected?

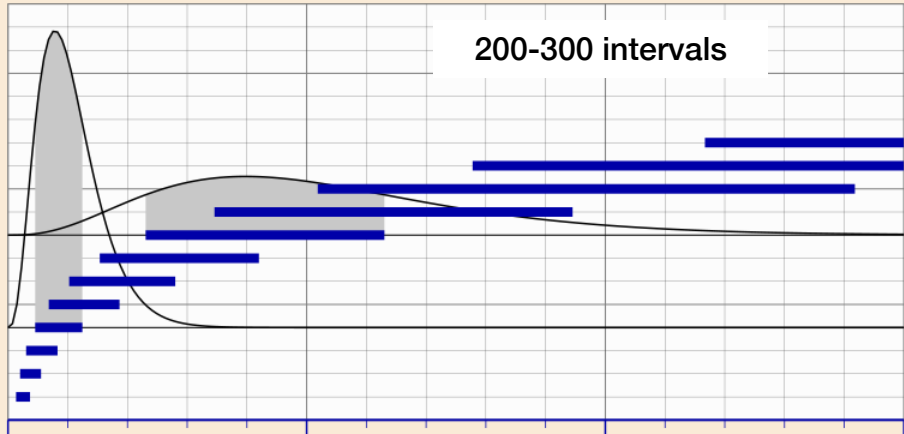


## ■ Which interval should be selected?



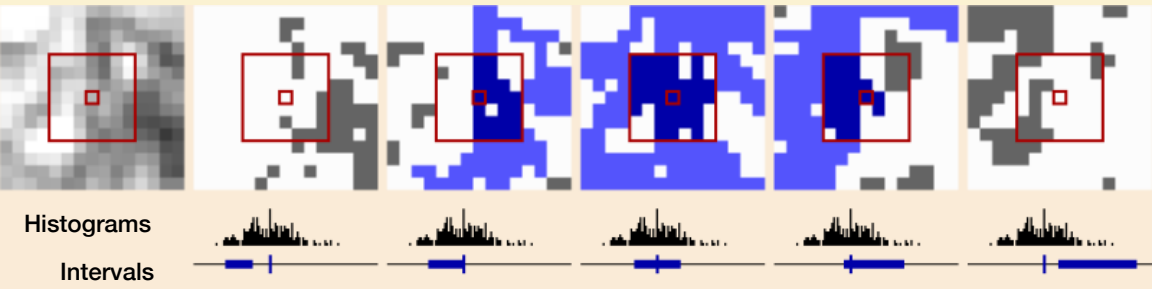
## ■ List of intervals

- increasing with the mean - multiplicative noise
- geometric progression of the width and position
- should span the complete image value range



## ■ Selection for each pixel

- the interval with the largest region (blue)
- use only the pixels in a window and
- connected to the central pixel (dark blue)
- used for filtering - mean value output

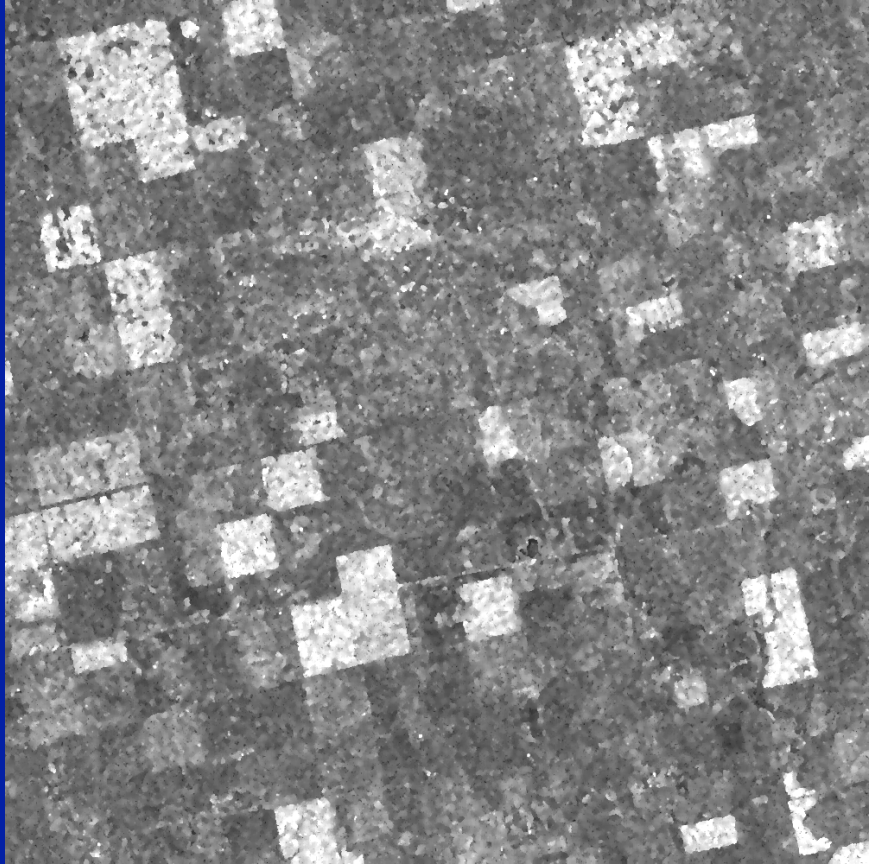


**Original**  $L=4$  (1000x1000)

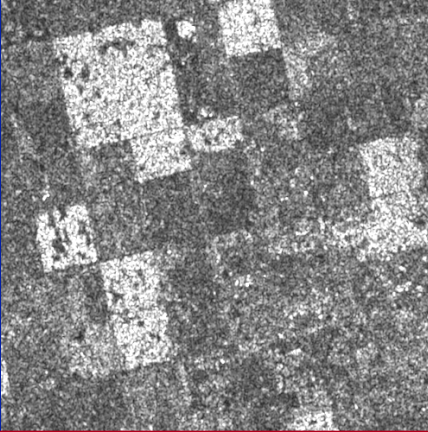




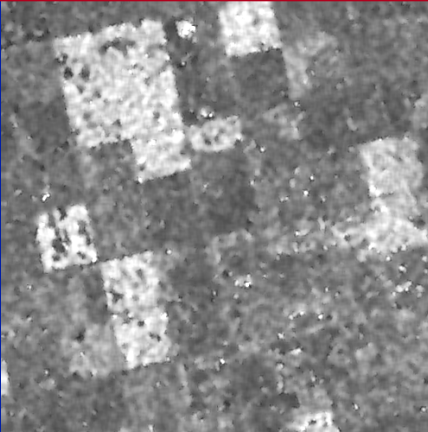
**Bi-Level Set**  $W=7 \times 7$



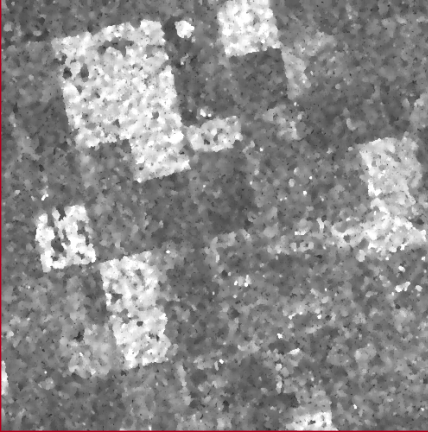
**Original**



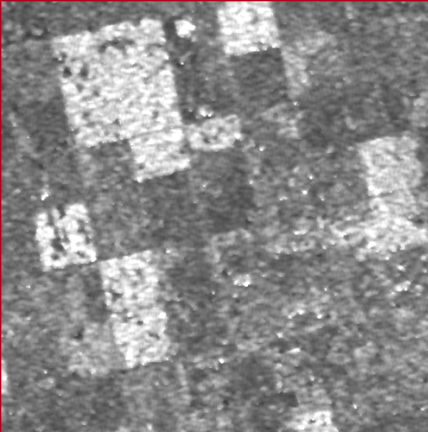
**Gamma**



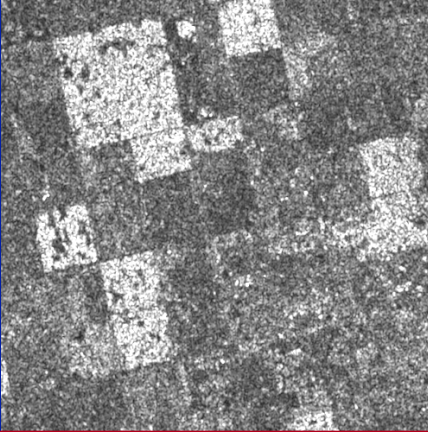
**Bi-Level Set**



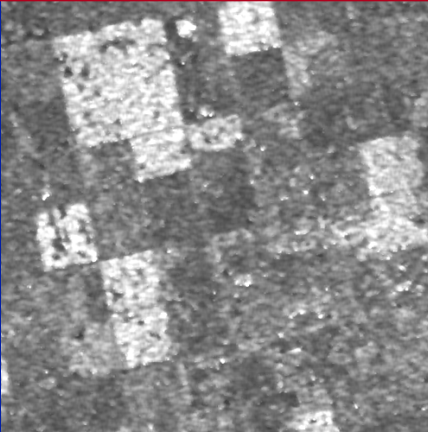
**Refined Lee**



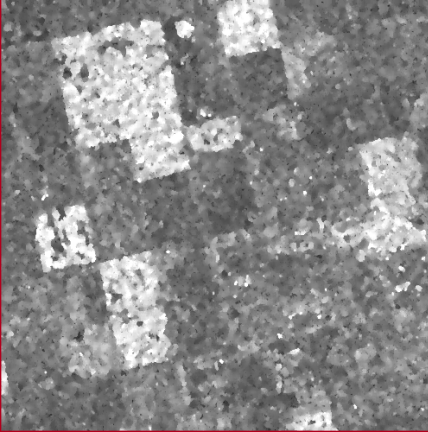
**Original**



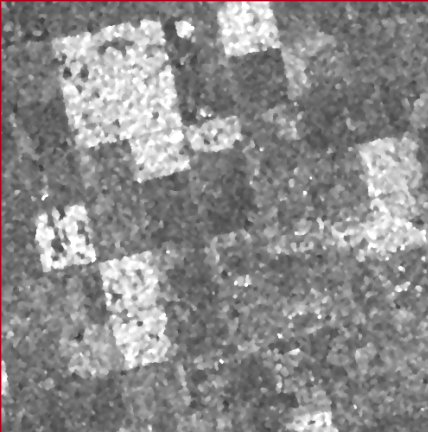
**Refined Lee**

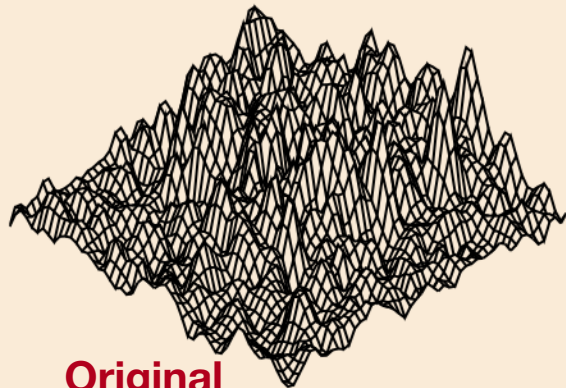


**Bi-Level Set**

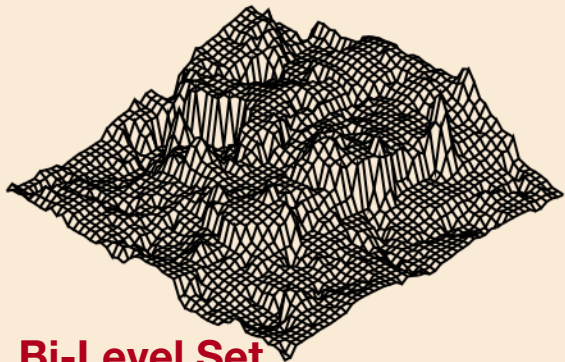


**Mean Shift**

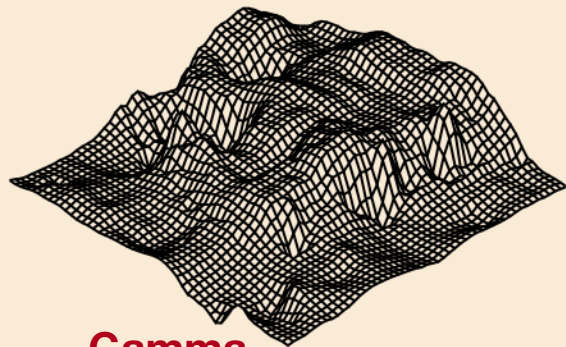




**Original**



**Bi-Level Set**

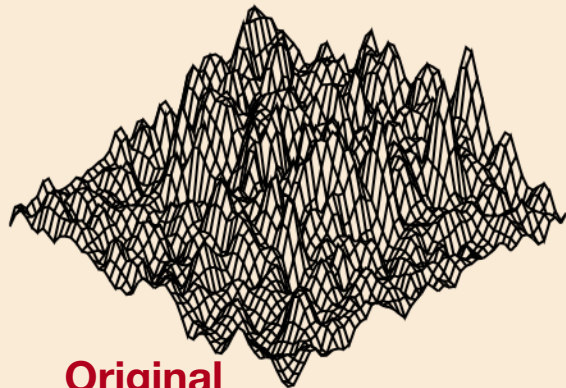


**Gamma**

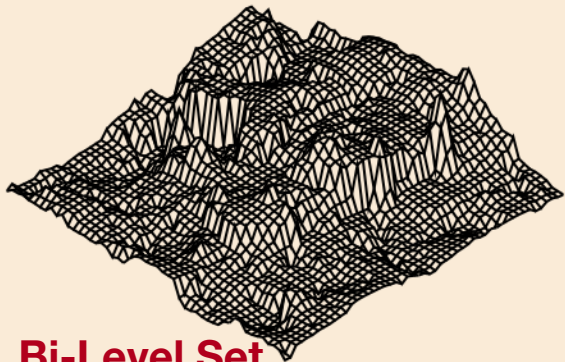


**Refined Lee**





**Original**



**Bi-Level Set**



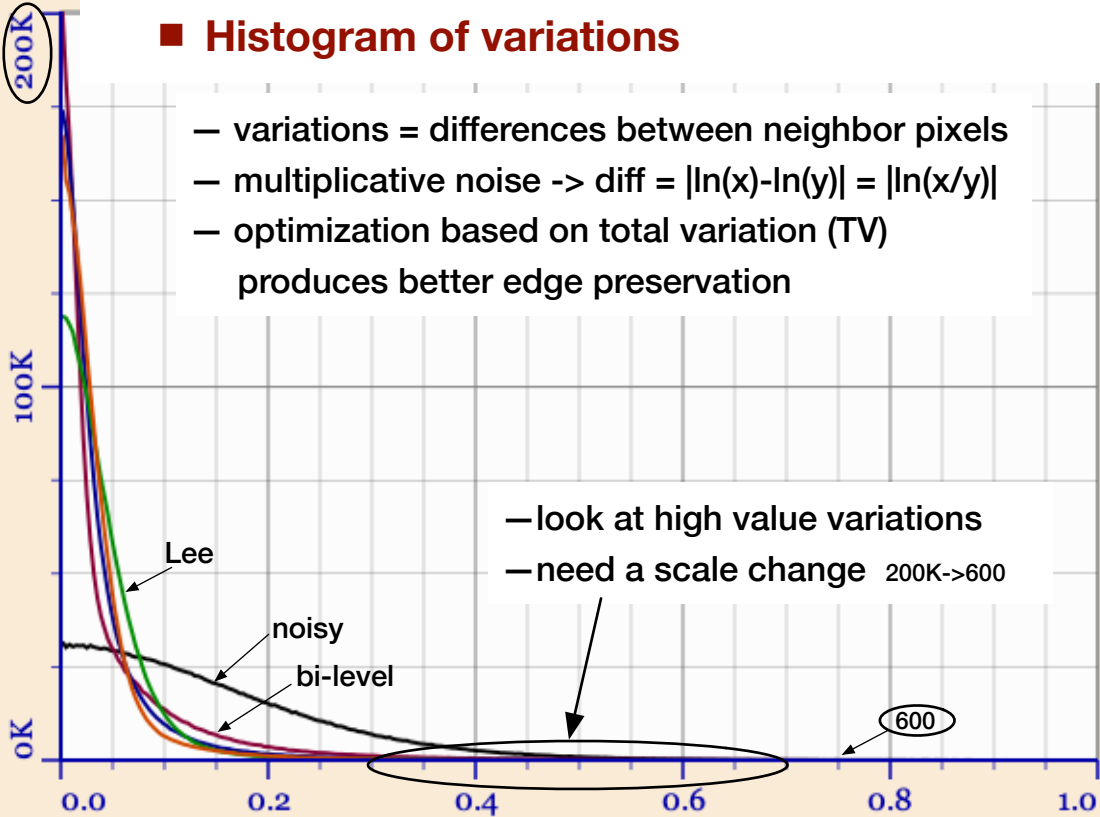
**Refined Lee**

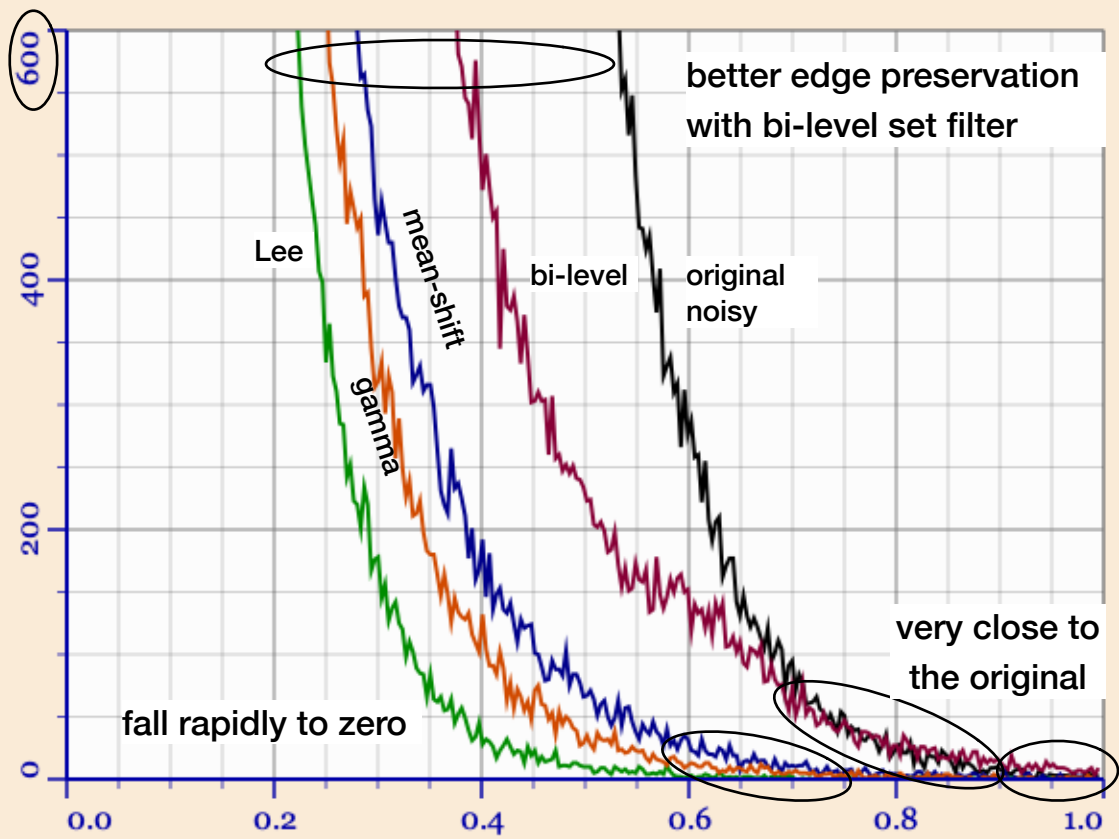


**Mean Shift**

## ■ Histogram of variations

- variations = differences between neighbor pixels
- multiplicative noise  $\rightarrow$  diff =  $|\ln(x) - \ln(y)| = |\ln(x/y)|$
- optimization based on total variation (TV) produces better edge preservation

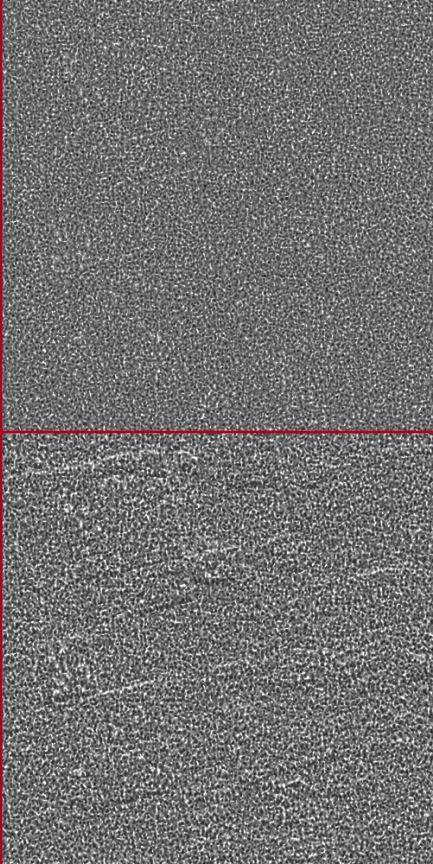
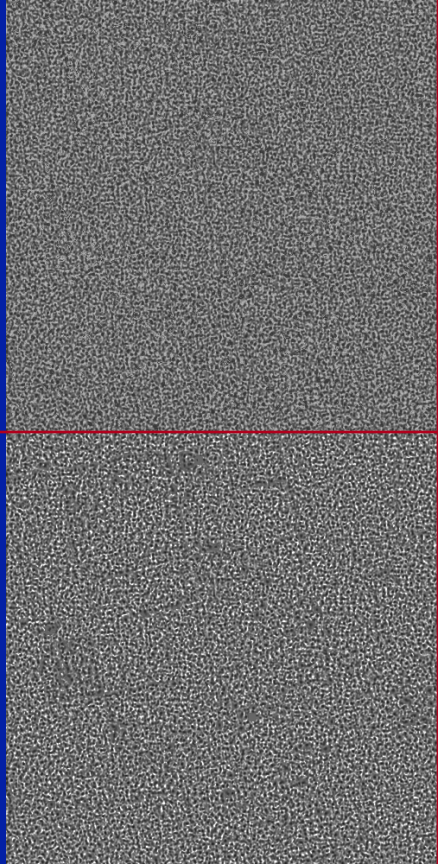




# Ratio Images

**Gamma**

**Bi-Level Set**

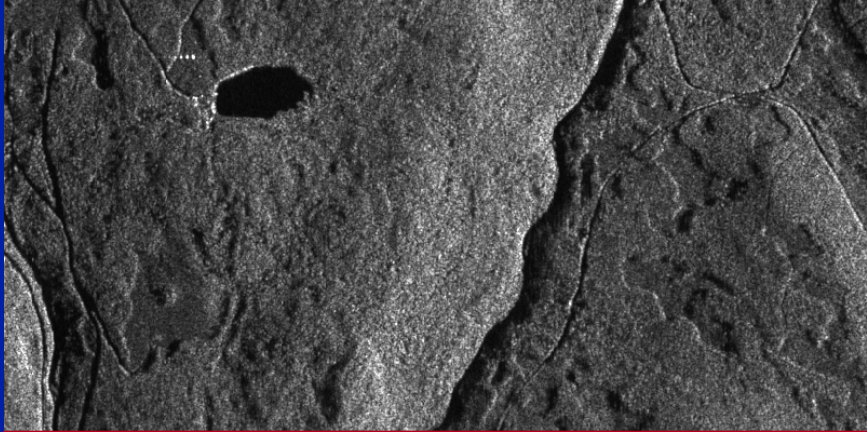


**Refined Lee**

**Mean Shift**



# Forêt Montmorency



# Conclusion

Bi-level set filter produces good edge preservation.

Histogram of between pixel variations show edge preservation.