

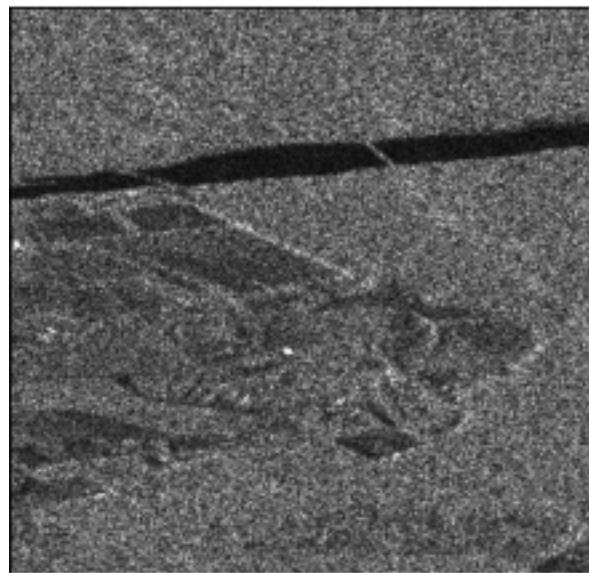
# MVA – Remote Sensing Project

**Mathieu RITA & Tristan DOT**

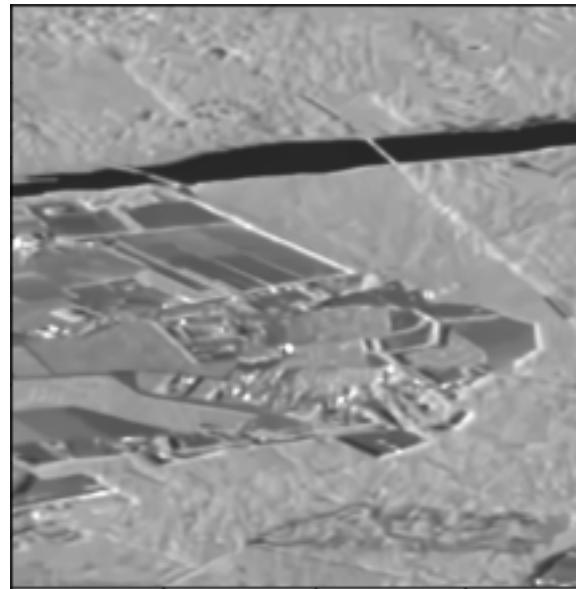
## Appendices

# **Appendix 1: pre-trained without additional training**

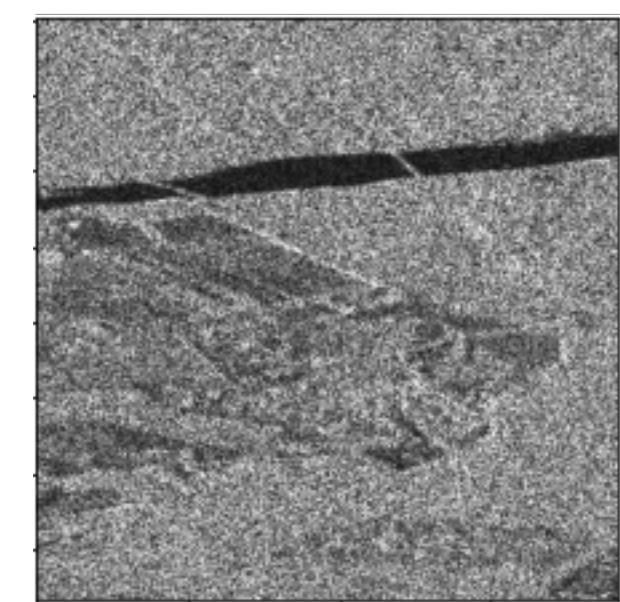
**NOISY**



**REAL IMAGE**

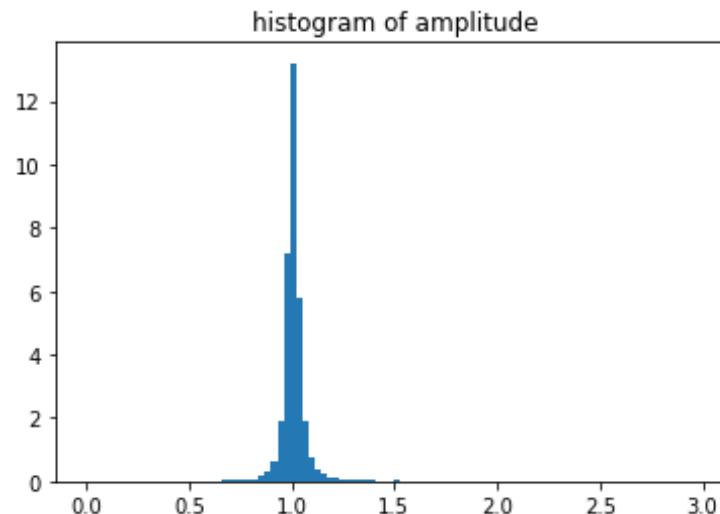


**DENOISED IMAGE**

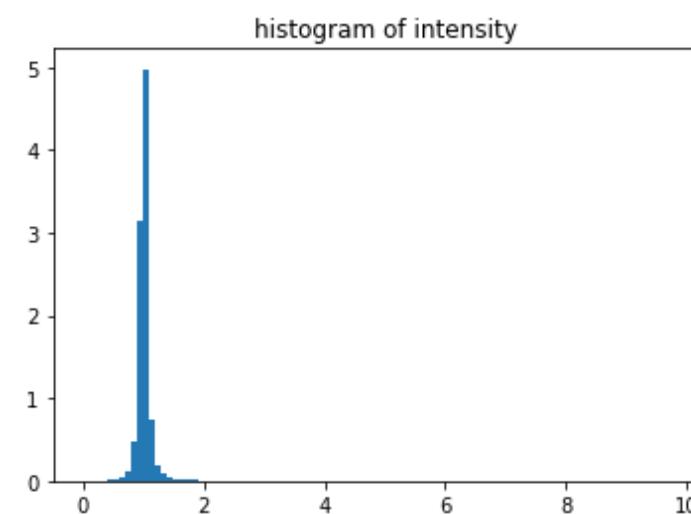


1)

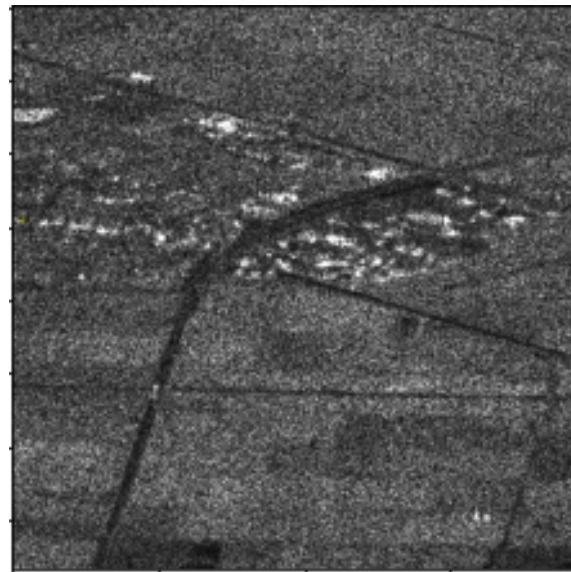
**Residual noise distribution (amplitude)**



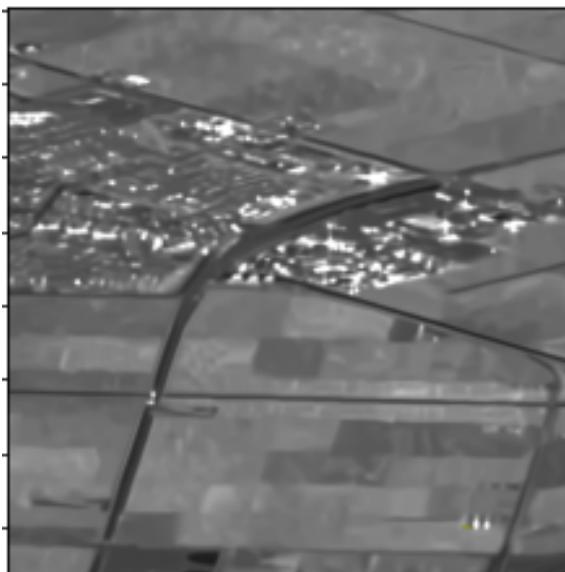
**Residual noise distribution (intensity)**



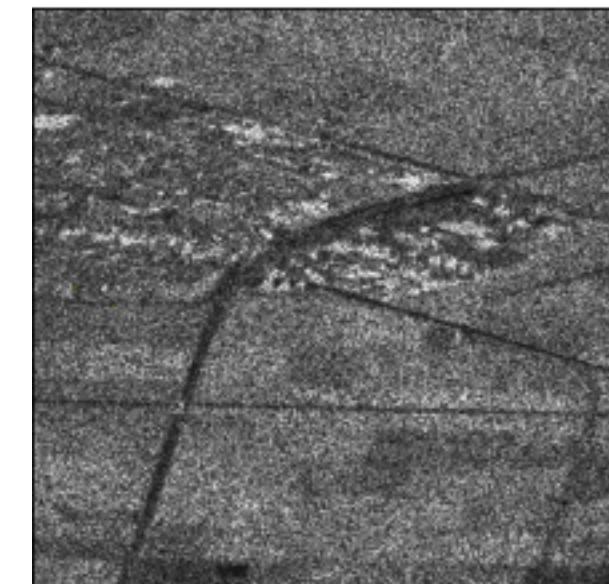
**NOISY**



**REAL IMAGE**

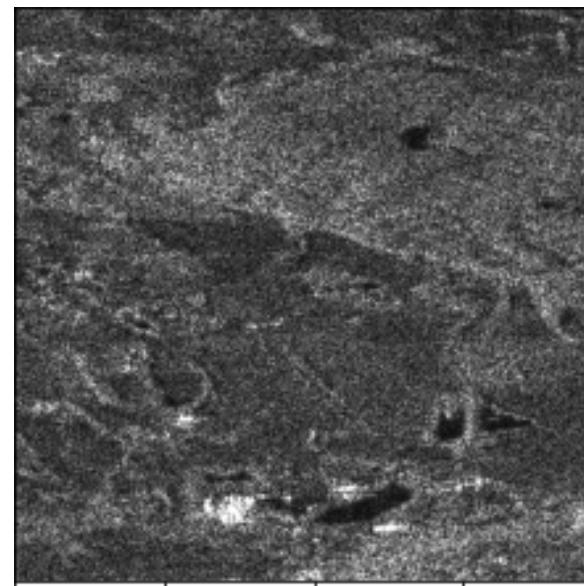


**DENOISED IMAGE**

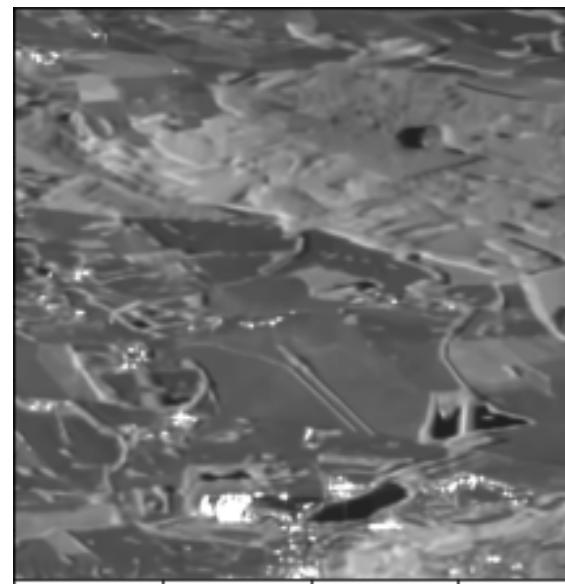


2)

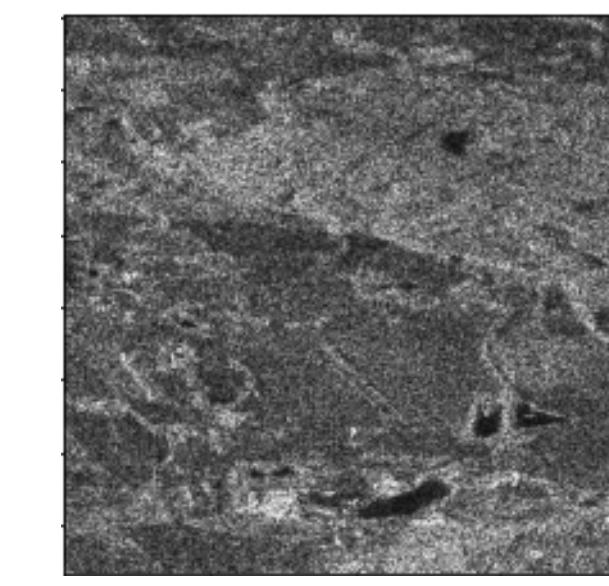
**NOISY**



**REAL IMAGE**

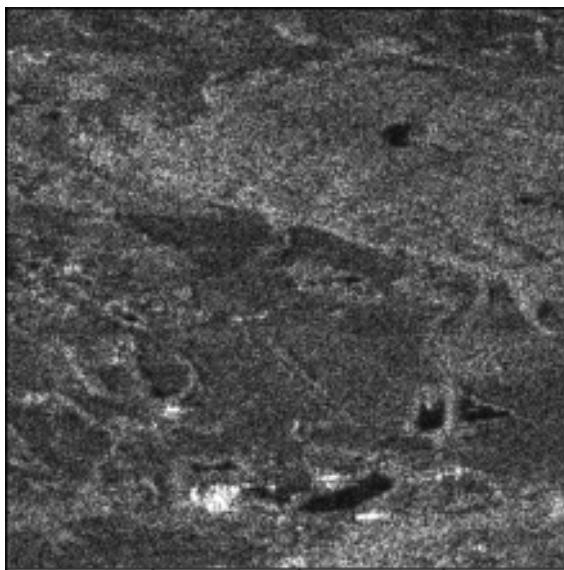


**DENOISED IMAGE**

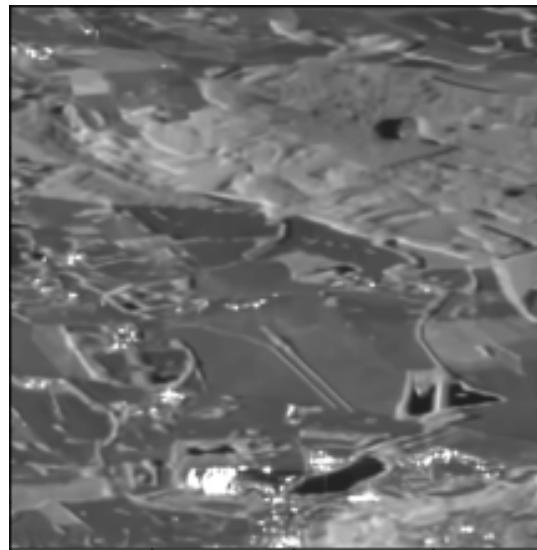


3)

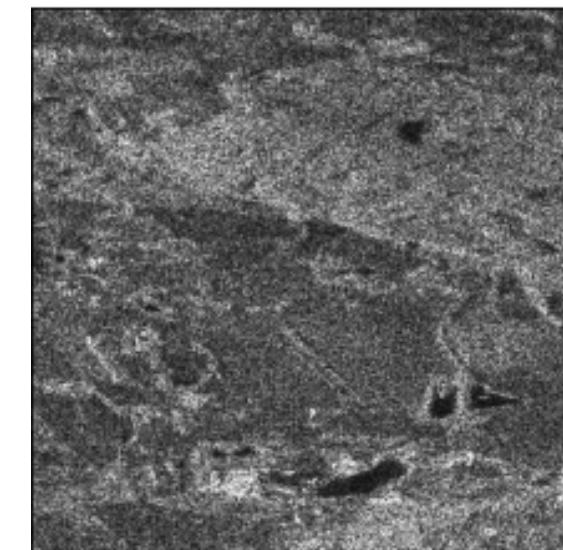
**NOISY**



**REAL IMAGE**

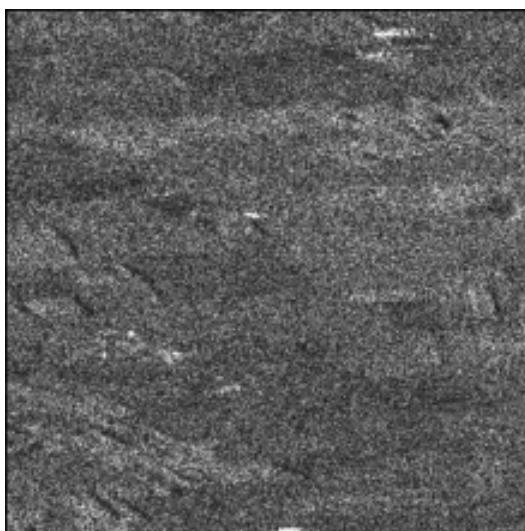


**DENOISED IMAGE**

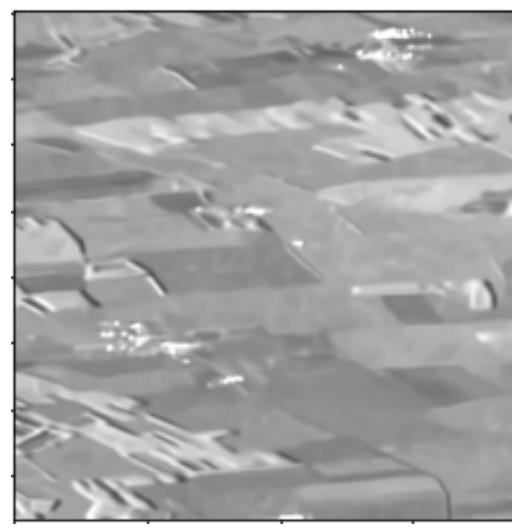


4)

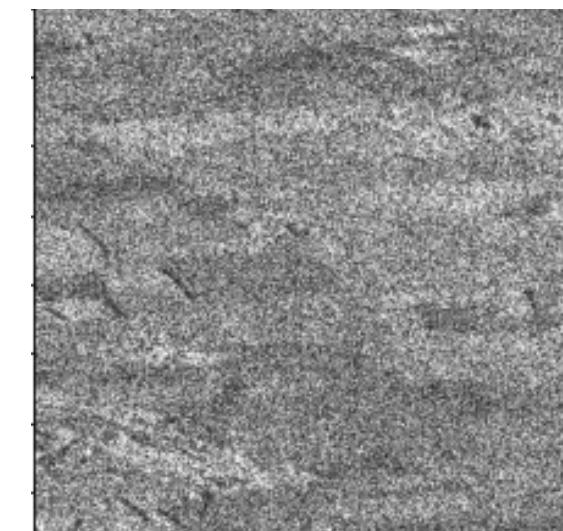
**NOISY**



**REAL IMAGE**

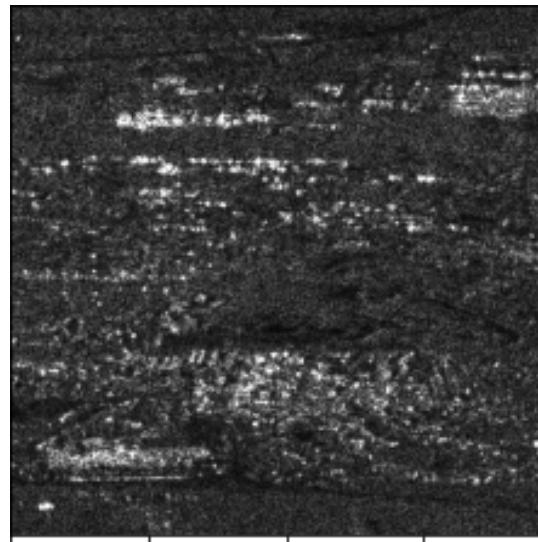


**DENOISED IMAGE**

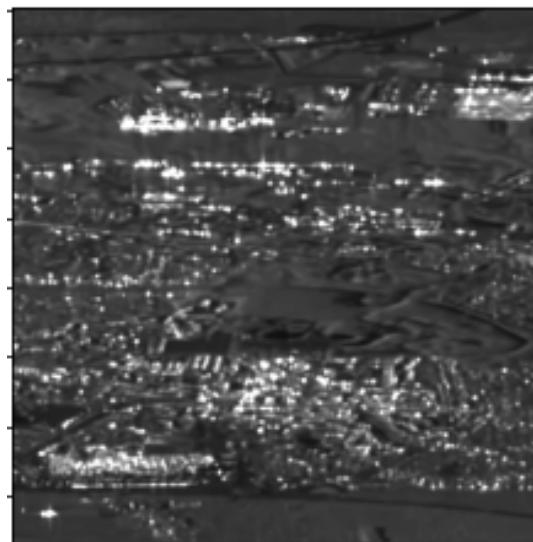


5)

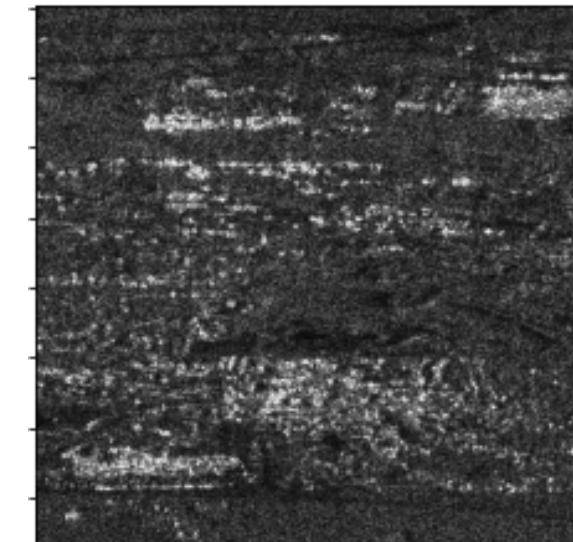
**NOISY**



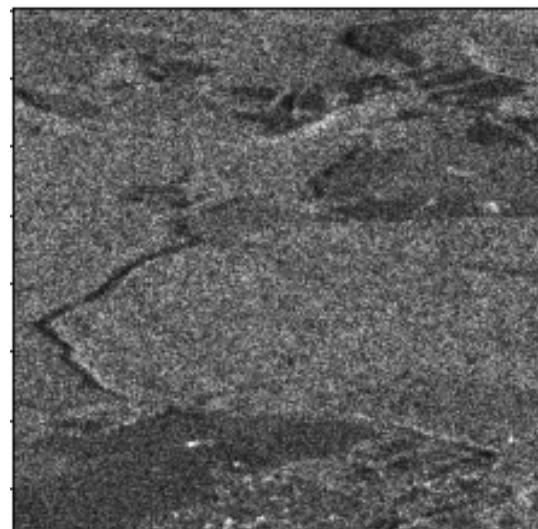
**REAL IMAGE**



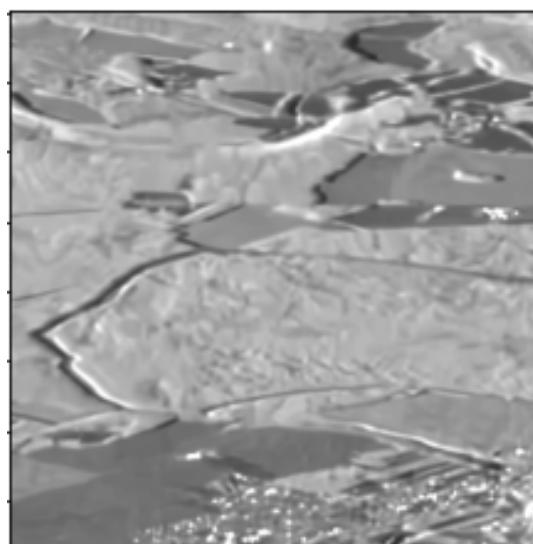
**DENOISED IMAGE**



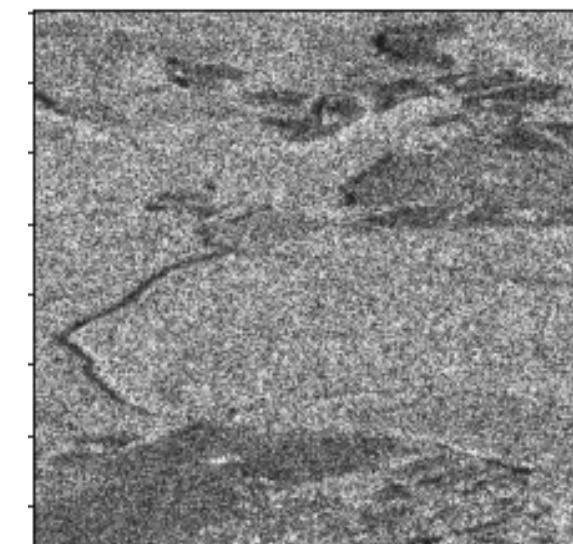
**NOISY**



**REAL IMAGE**

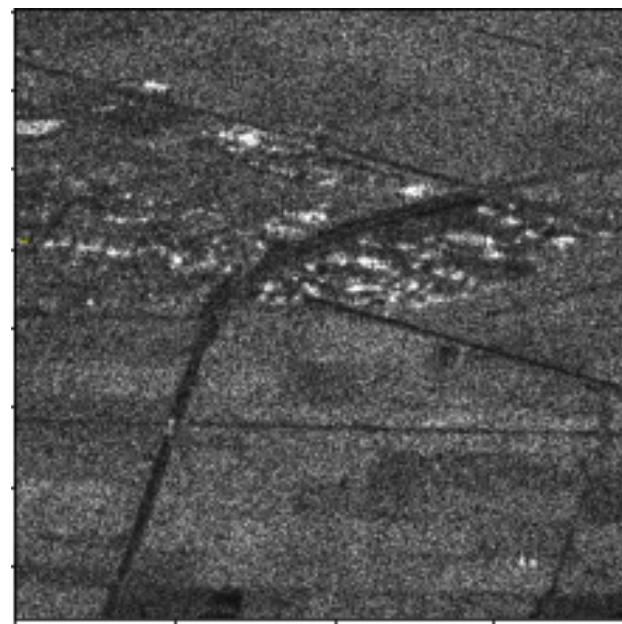


**DENOISED IMAGE**

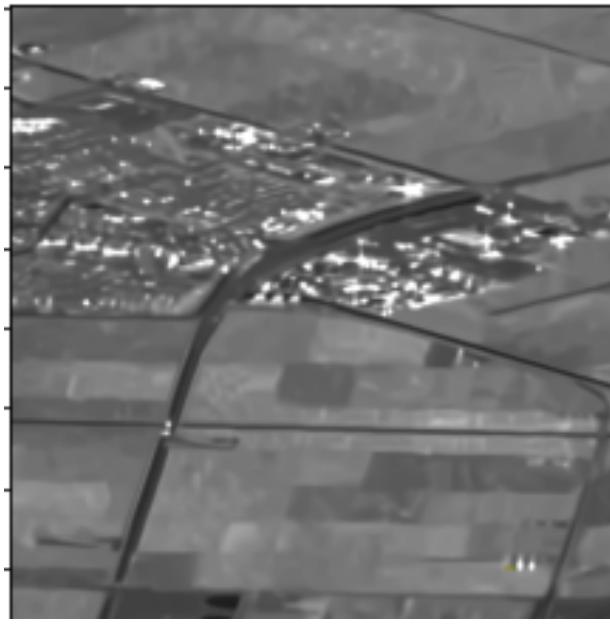


**Appendix 2:** Results of transfer learning with additional training with SAR images (L2-norm).

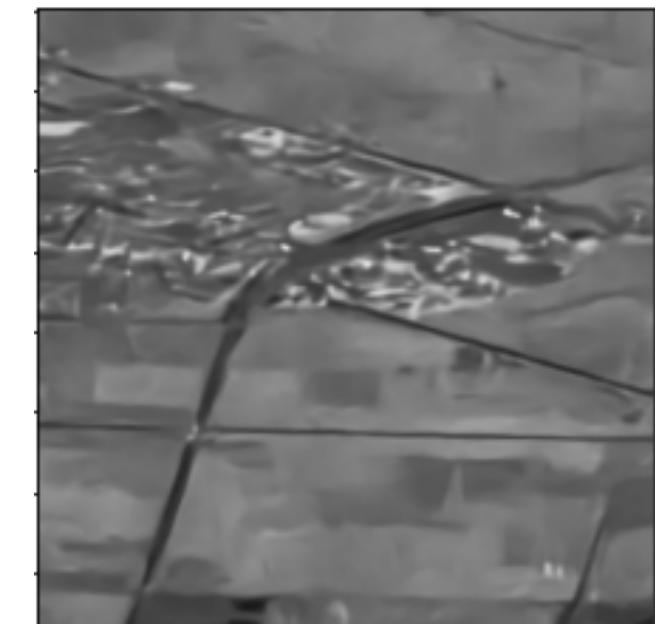
**NOISY**



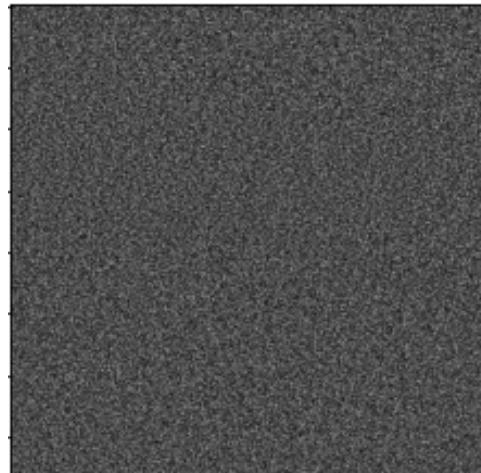
**REAL IMAGE**



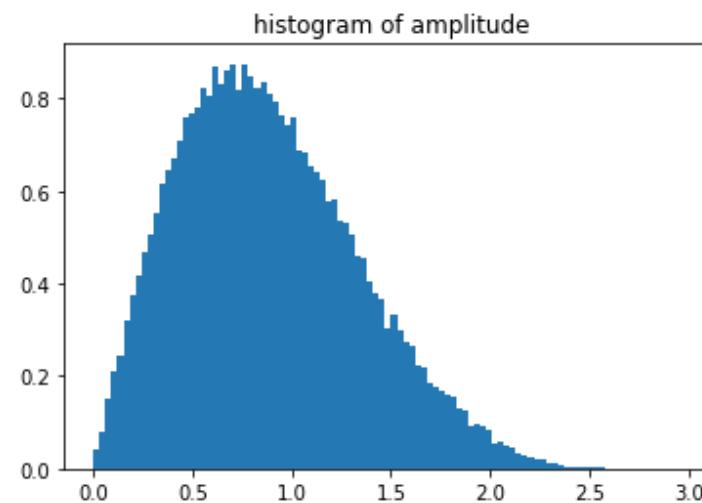
**DENOISED IMAGE**



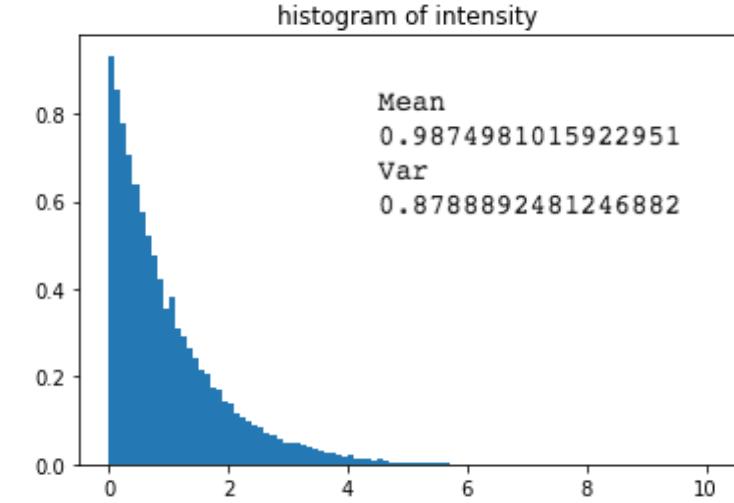
**RESIDUAL NOISE**



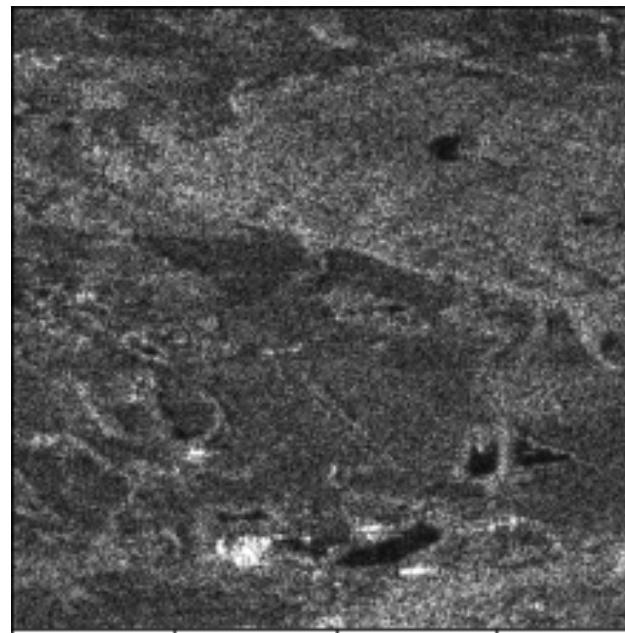
**Residual noise distribution (amplitude)**



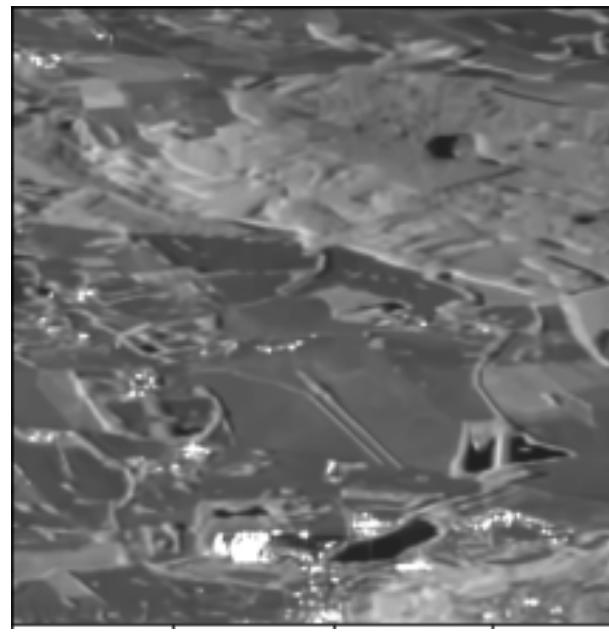
**Residual noise distribution (intensity)**



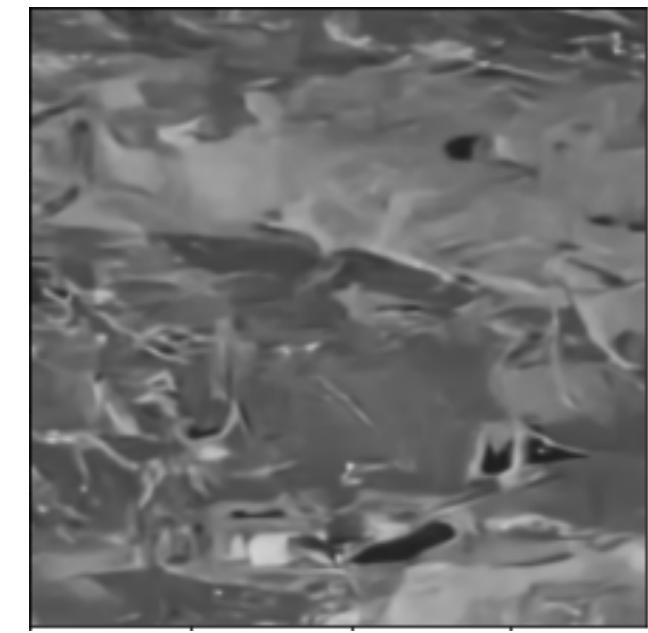
**NOISY**



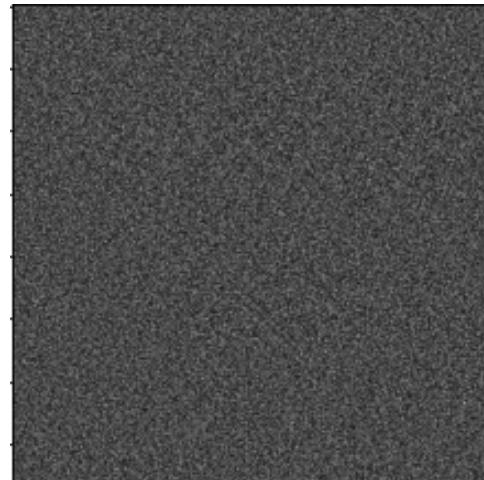
**REAL IMAGE**



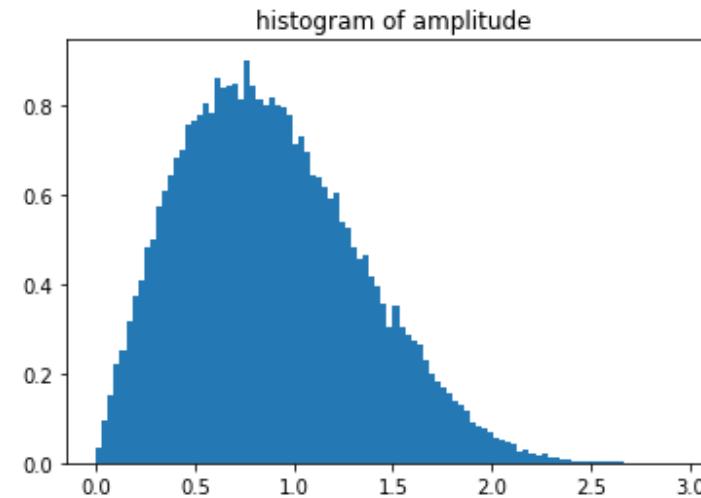
**DENOISED IMAGE**



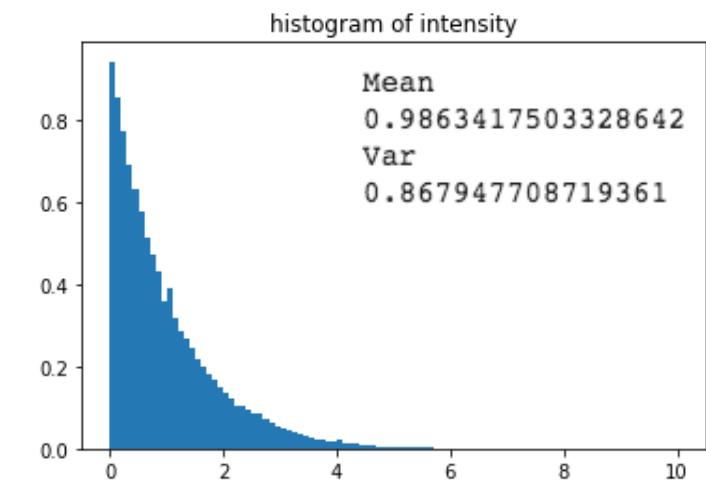
**RESIDUAL NOISE**



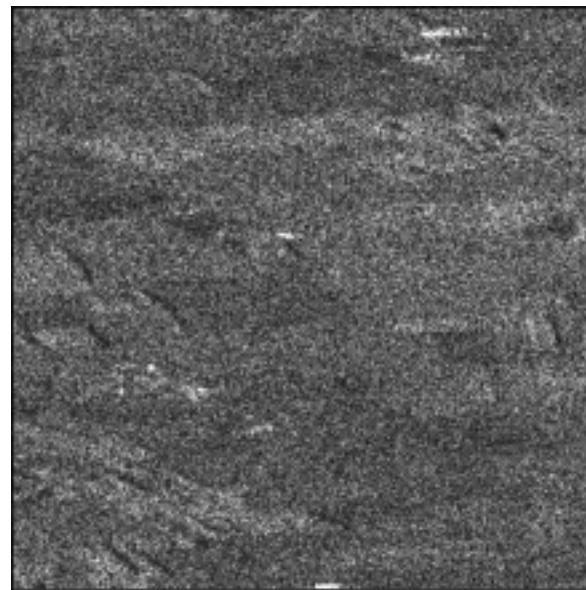
**Residual noise distribution (amplitude)**



**Residual noise distribution (intensity)**



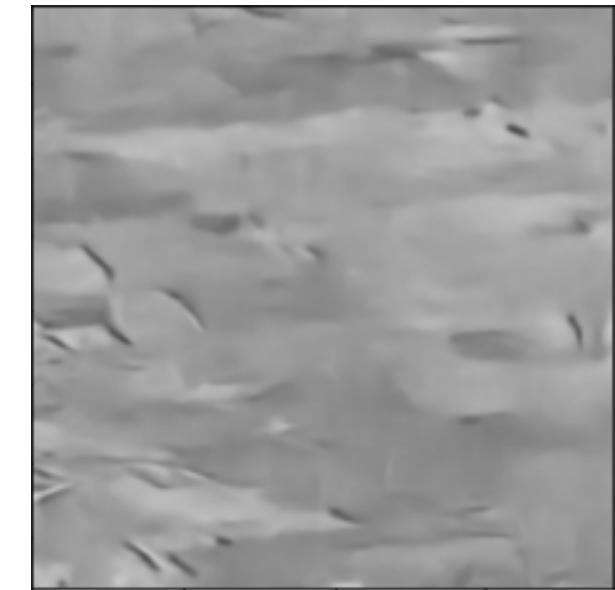
**NOISY**



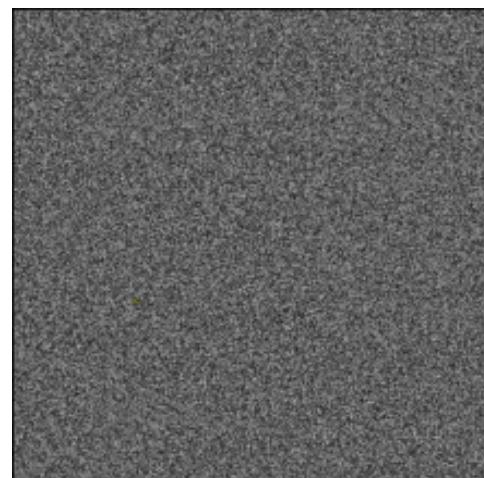
**REAL IMAGE**



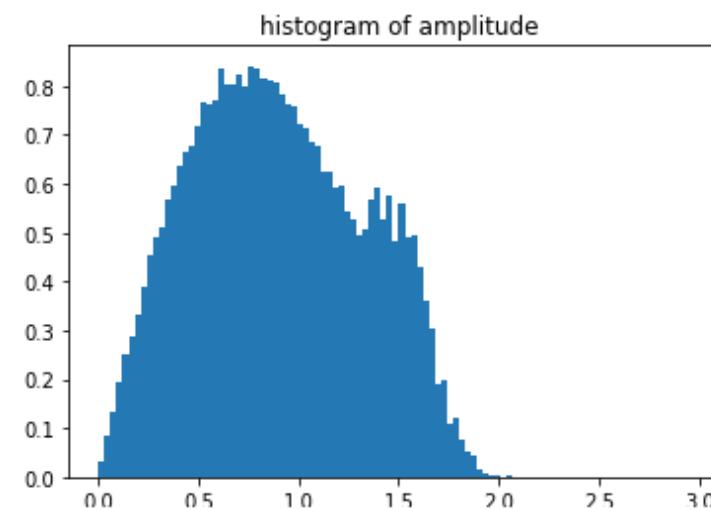
**DENOISED IMAGE**



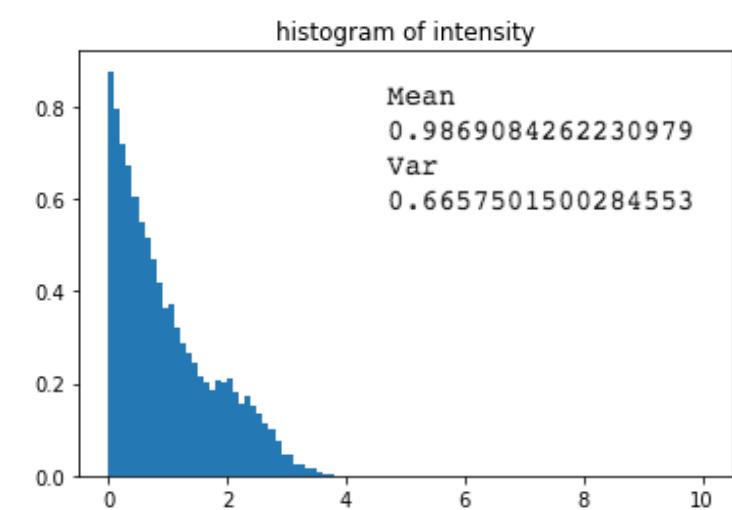
**RESIDUAL NOISE**



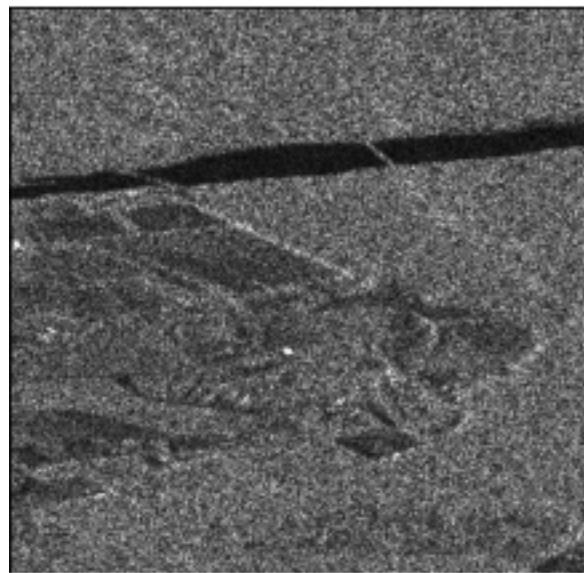
**Residual noise distribution (amplitude)**



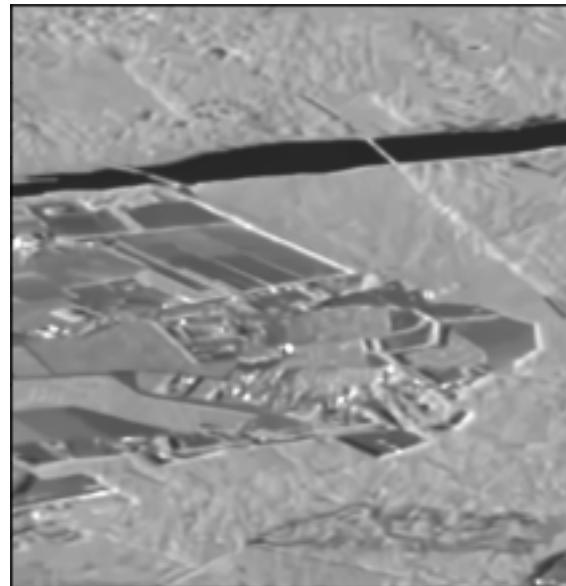
**Residual noise distribution (intensity)**



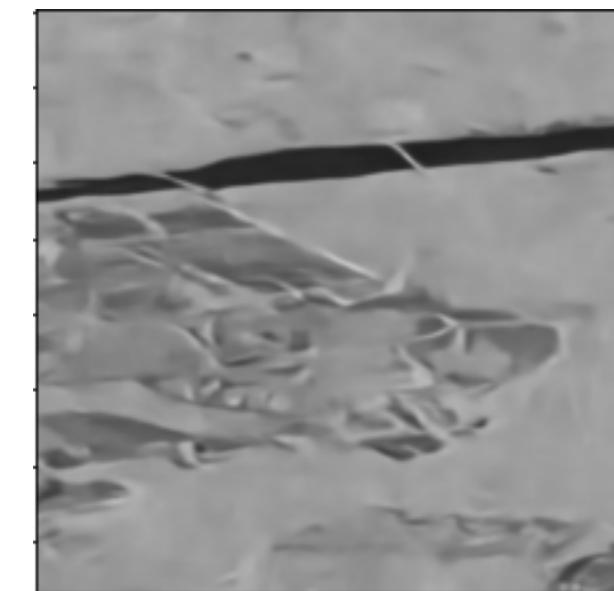
**NOISY**



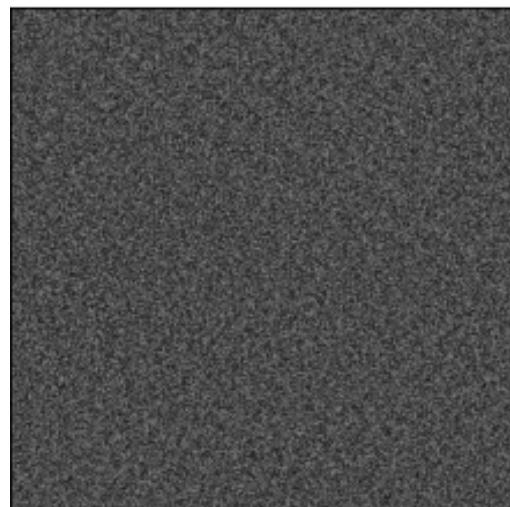
**REAL IMAGE**



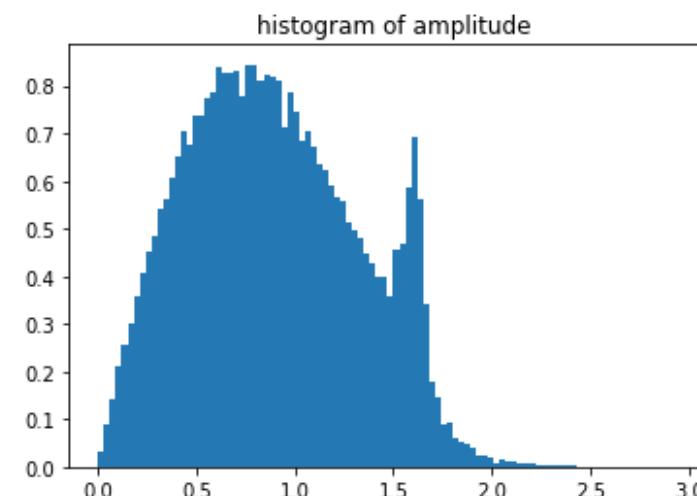
**DENOISED IMAGE**



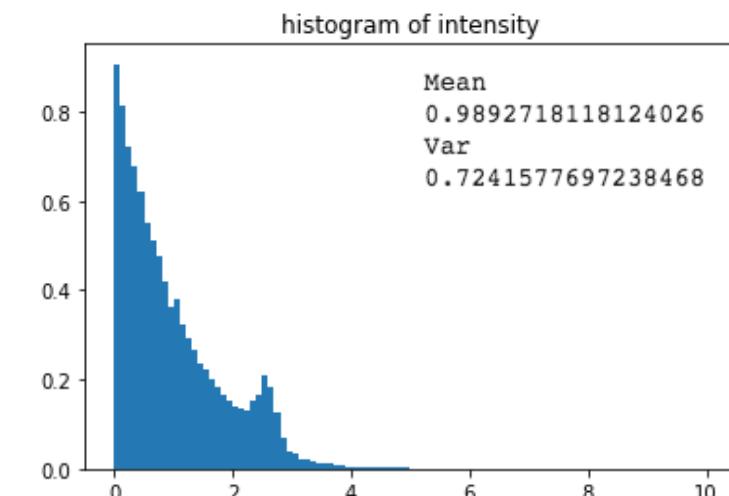
**RESIDUAL NOISE**



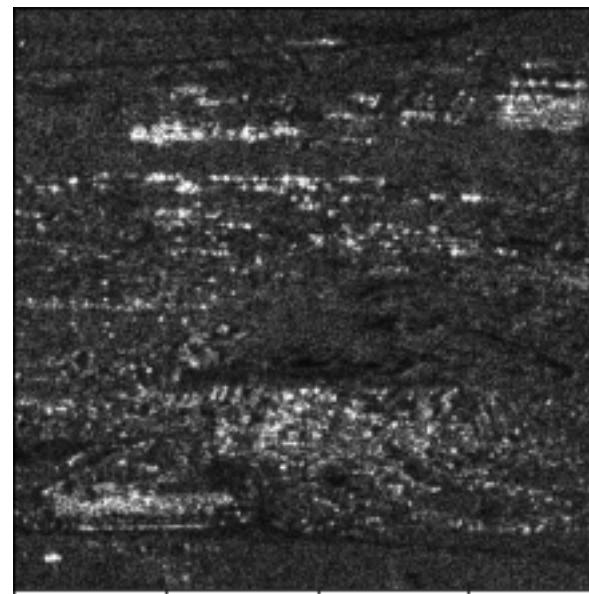
**Residual noise distribution (amplitude)**



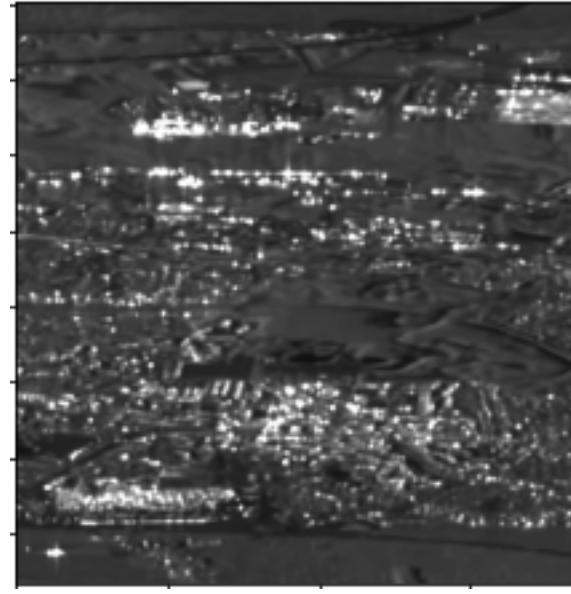
**Residual noise distribution (intensity)**



**NOISY**



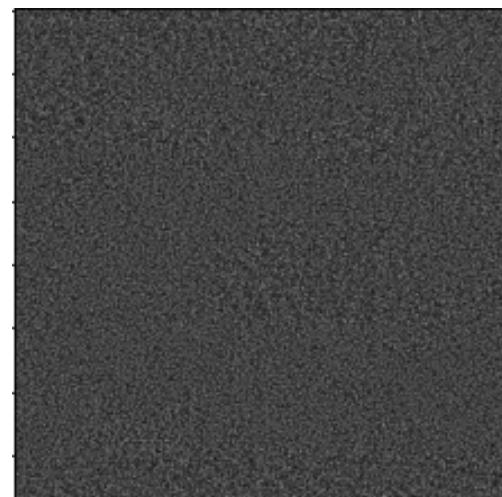
**REAL IMAGE**



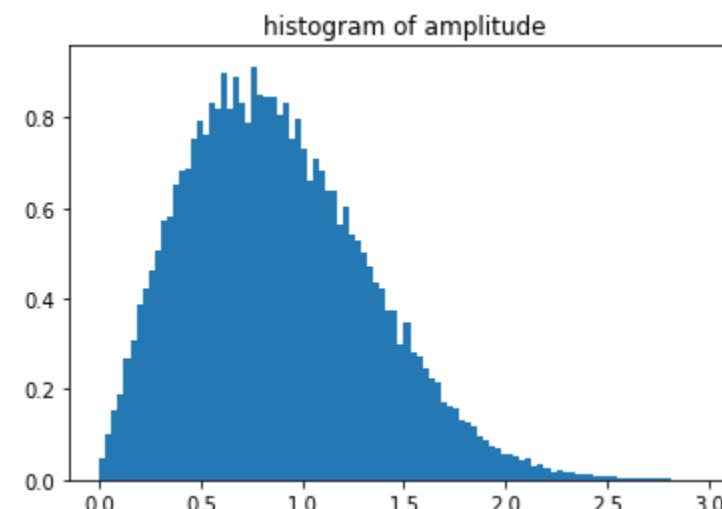
**DENOISED IMAGE**



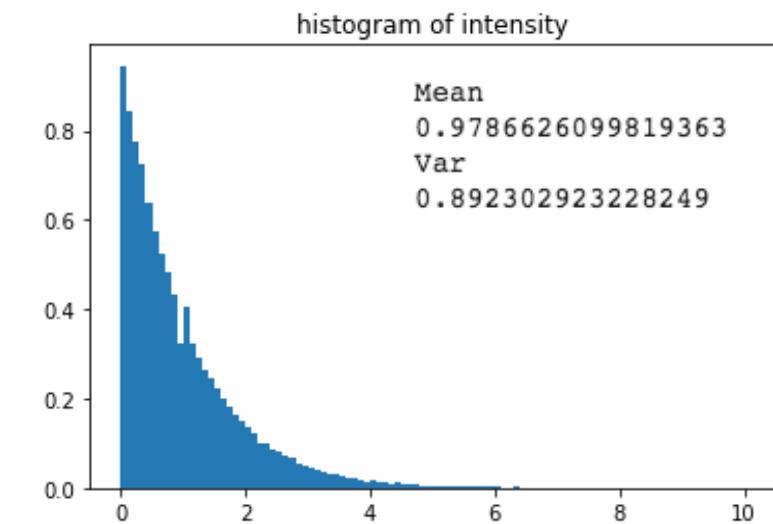
**RESIDUAL NOISE**



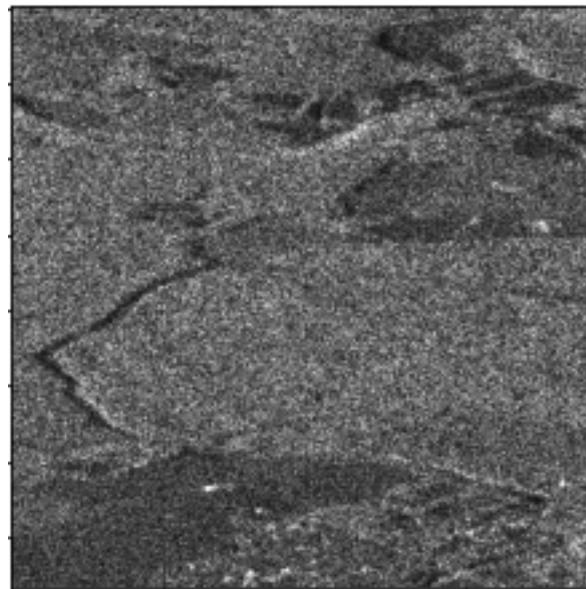
**Residual noise distribution (amplitude)**



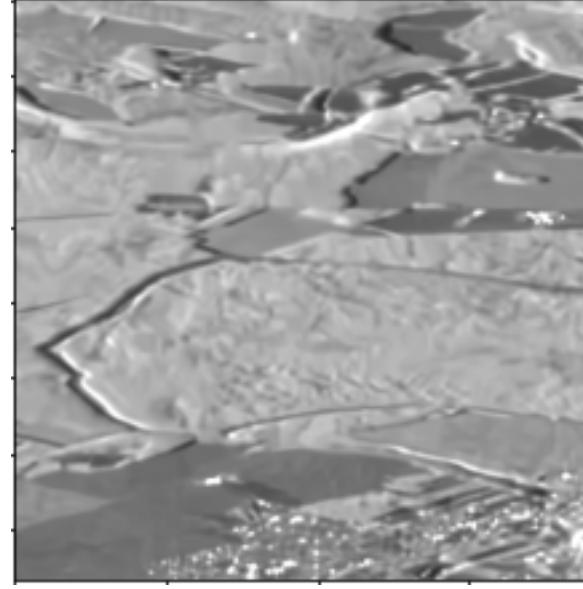
**Residual noise distribution (intensity)**



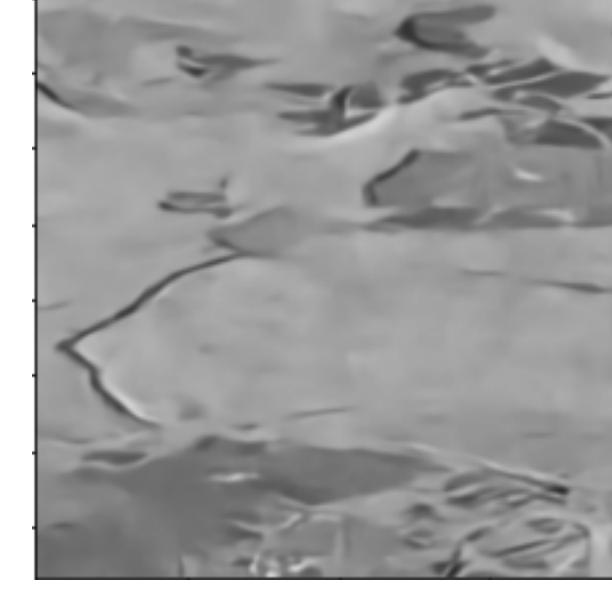
**NOISY**



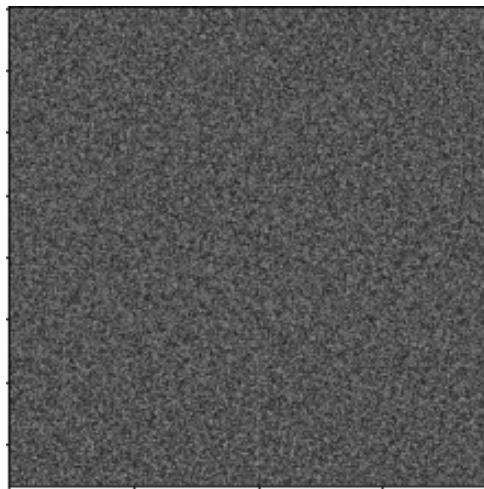
**REAL IMAGE**



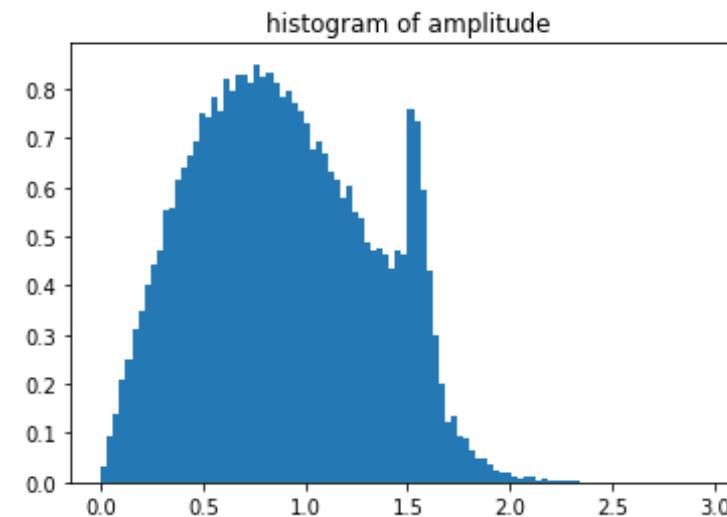
**DENOISED IMAGE**



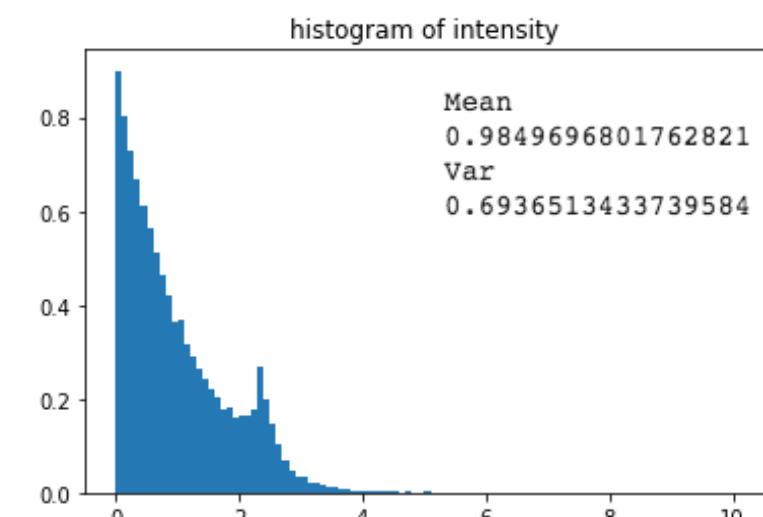
**RESIDUAL NOISE**



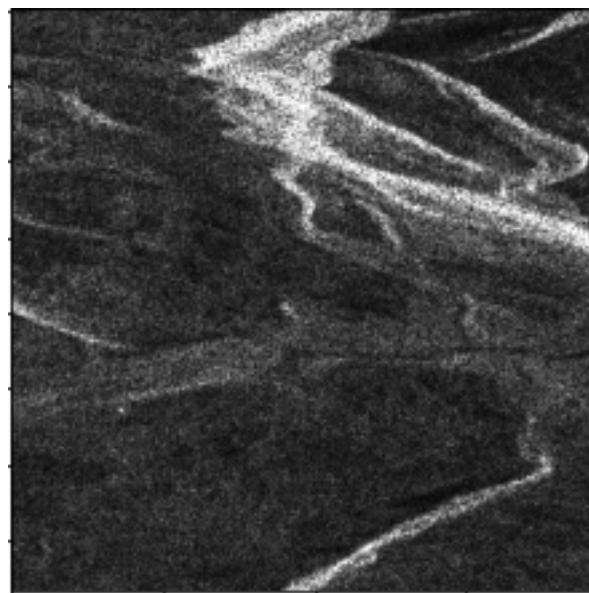
**Residual noise distribution (amplitude)**



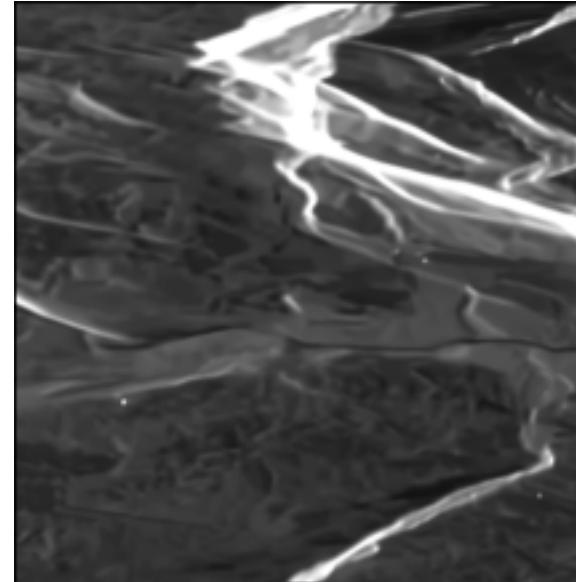
**Residual noise distribution (intensity)**



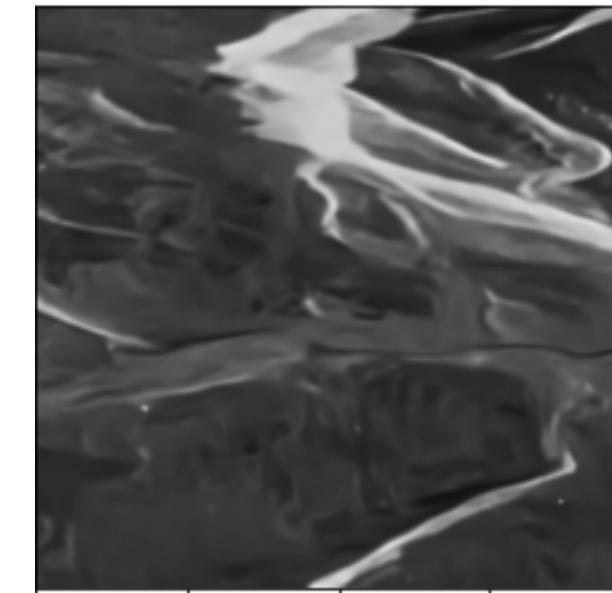
**NOISY**



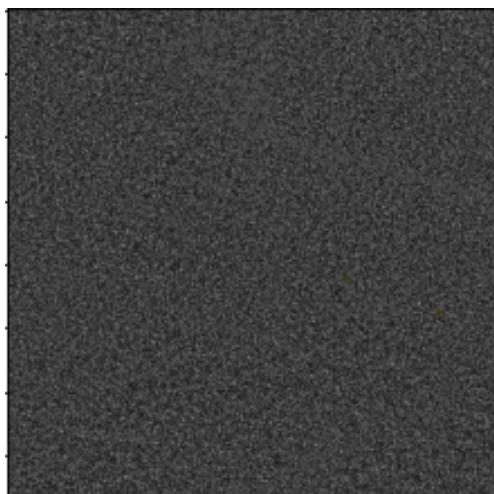
**REAL IMAGE**



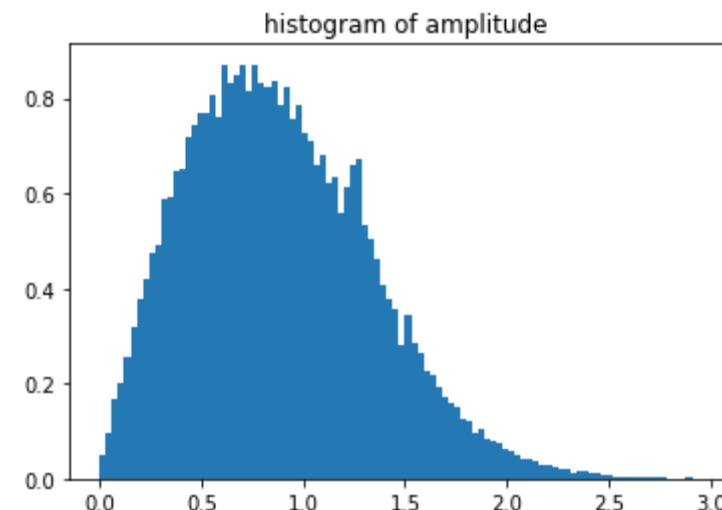
**DENOISED IMAGE**



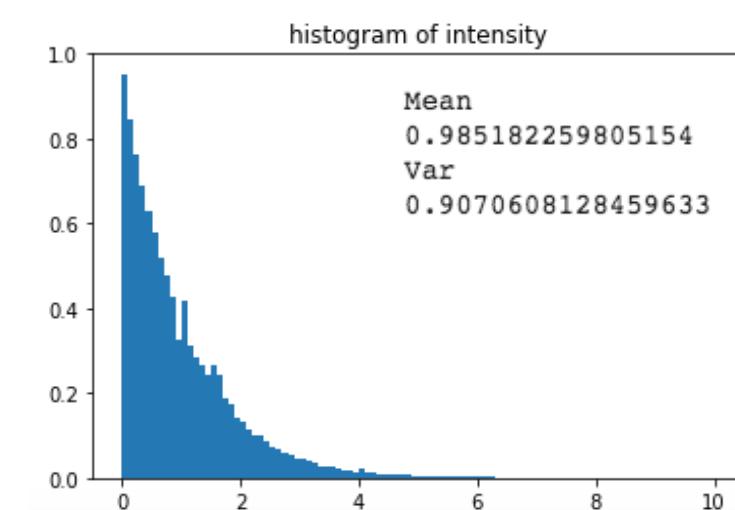
**RESIDUAL NOISE**



**Residual noise distribution (amplitude)**



**Residual noise distribution (intensity)**



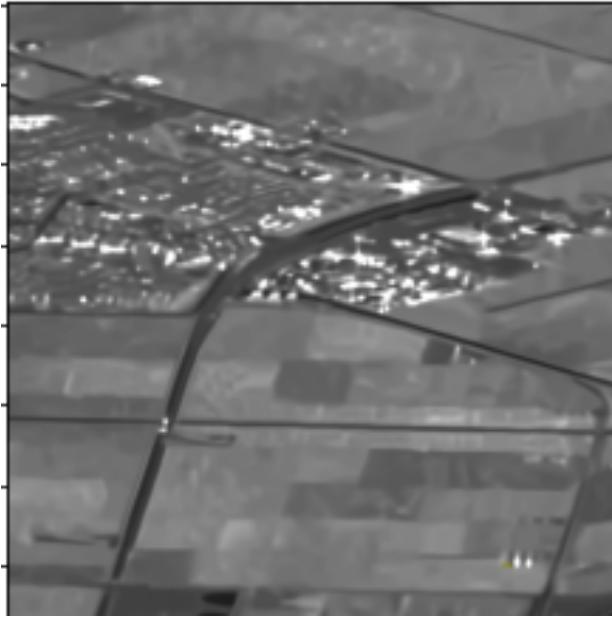
# **Appendix 3: comparison L1 VS. L2 Norm**

**L1-norm**



1)

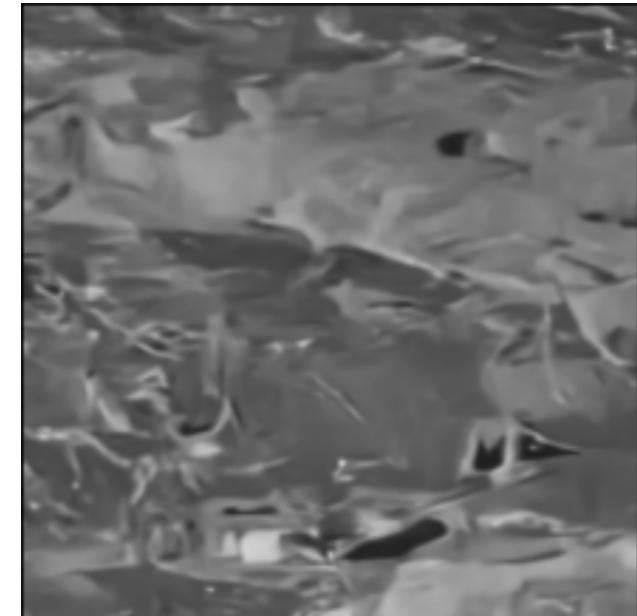
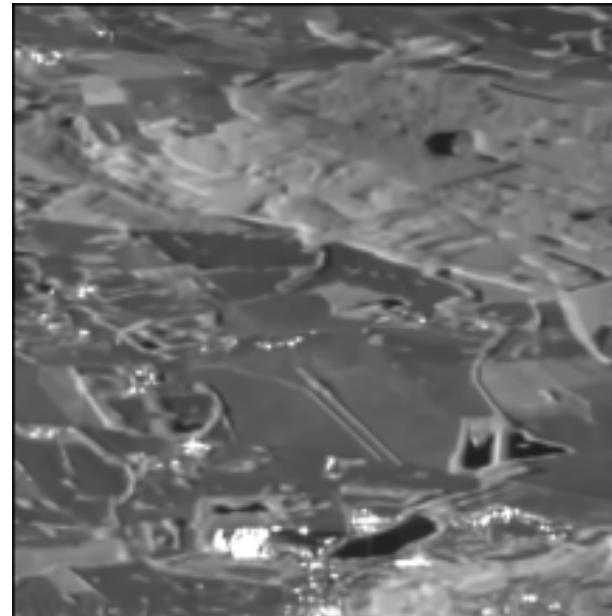
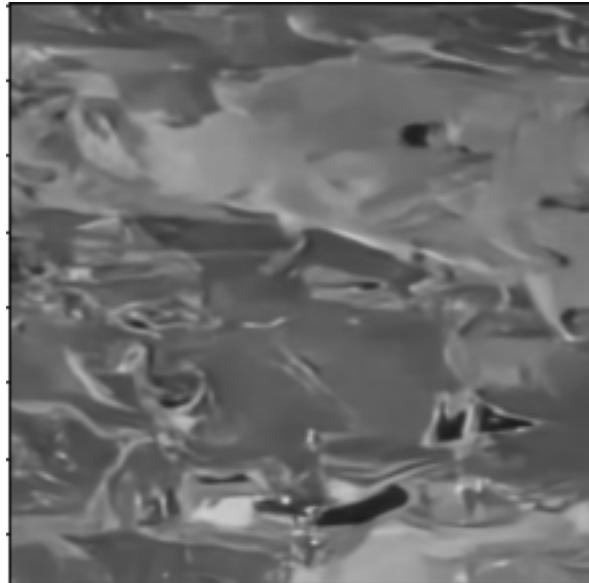
**REAL IMAGE**



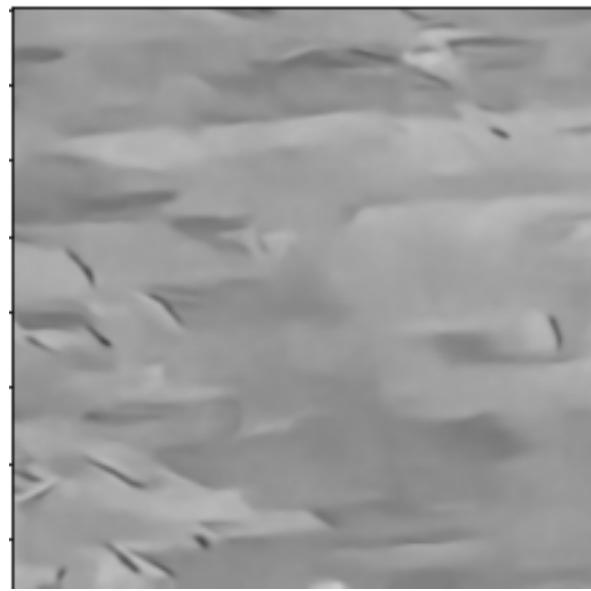
**L2-norm**



2)



**L1-norm**

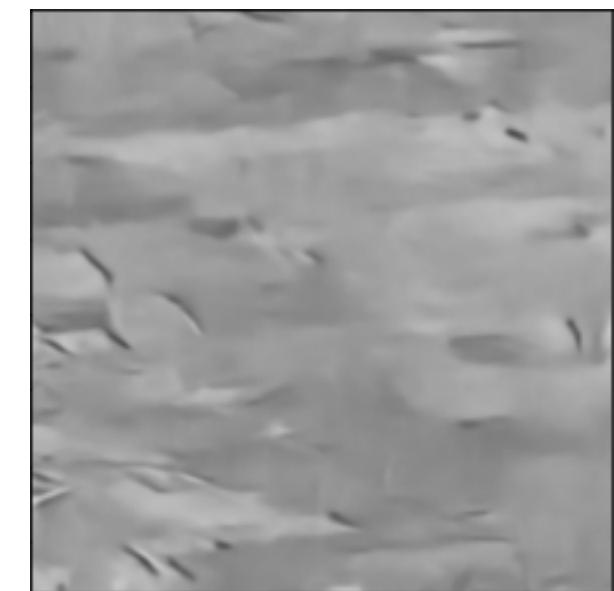


3)

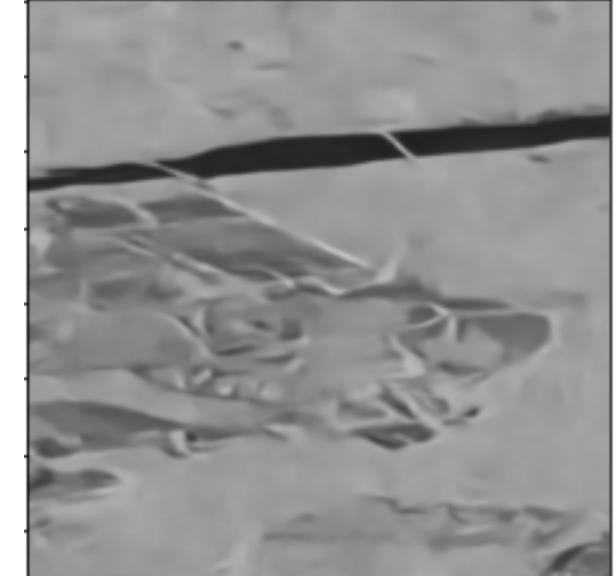
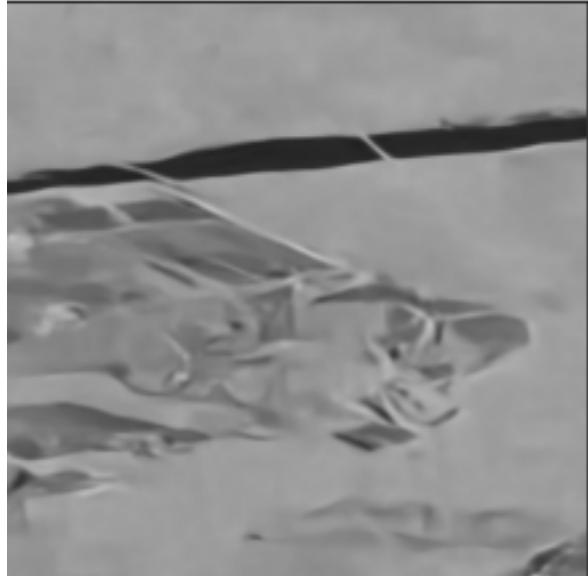
**REAL IMAGE**



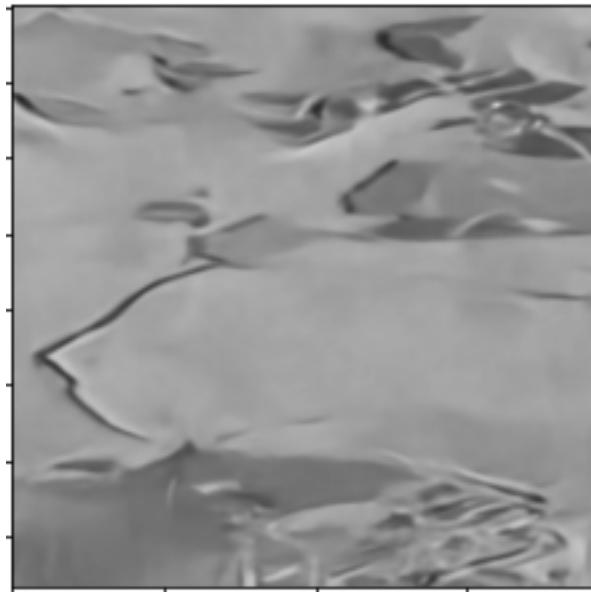
**L2-norm**



4)



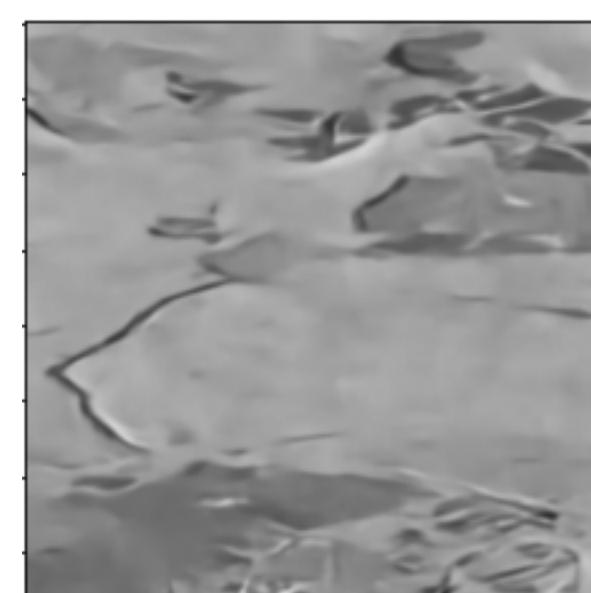
L1-norm



REAL IMAGE

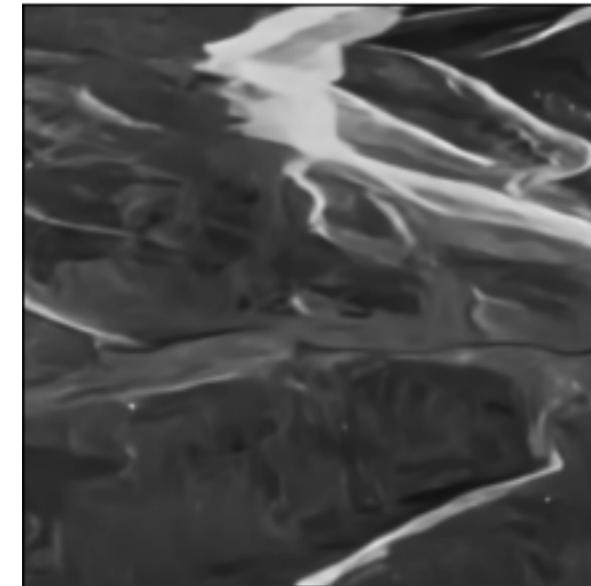
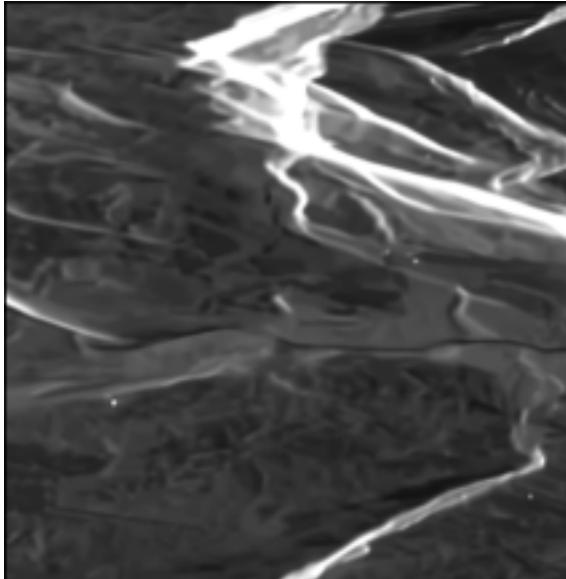
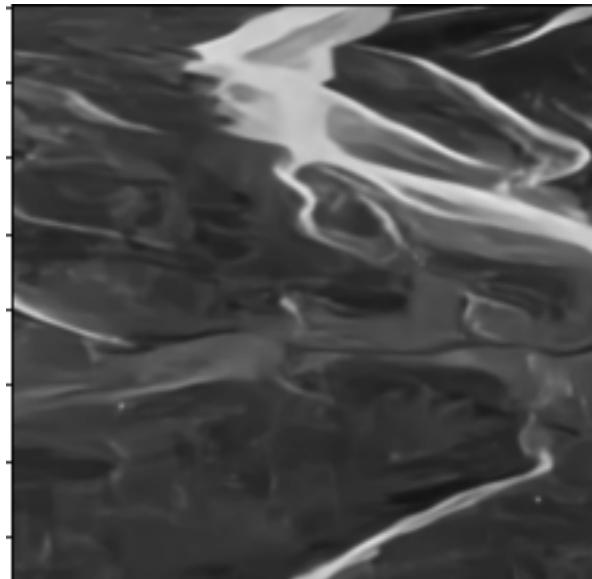


L2-norm

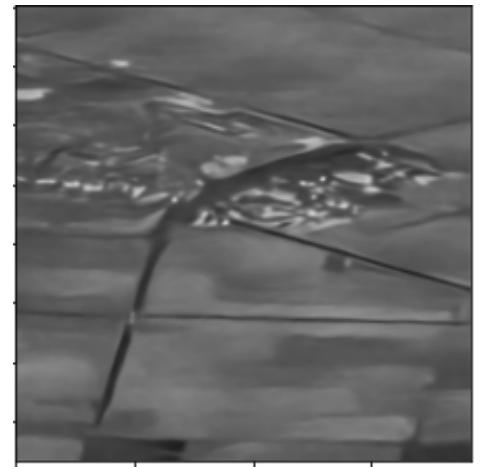
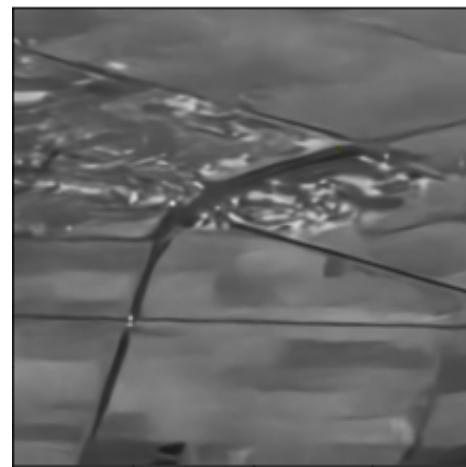
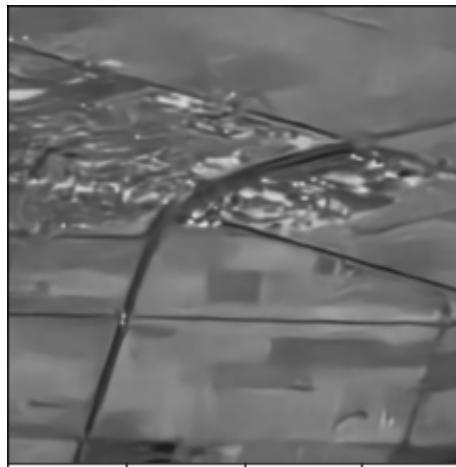
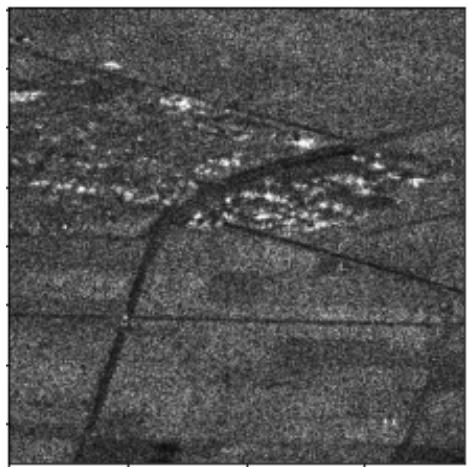


5)

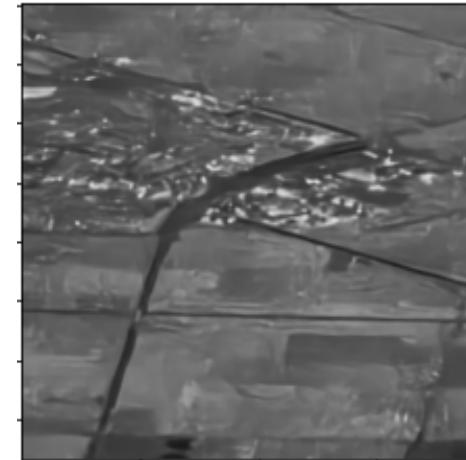
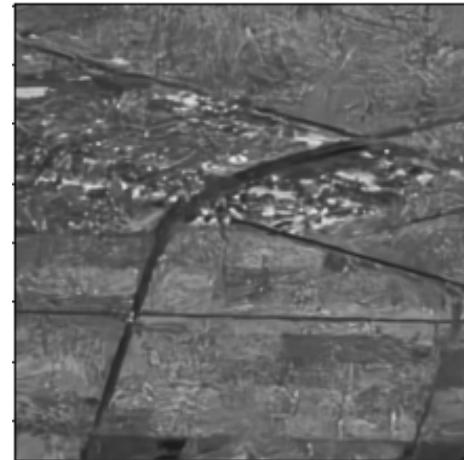
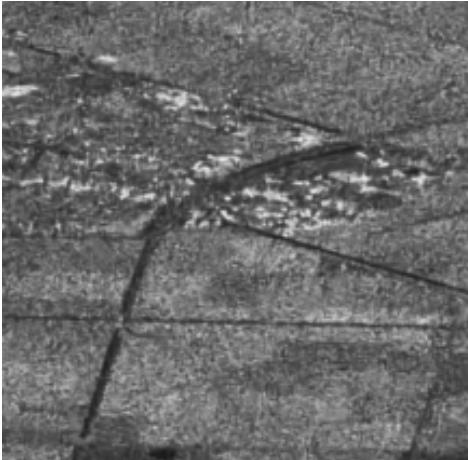
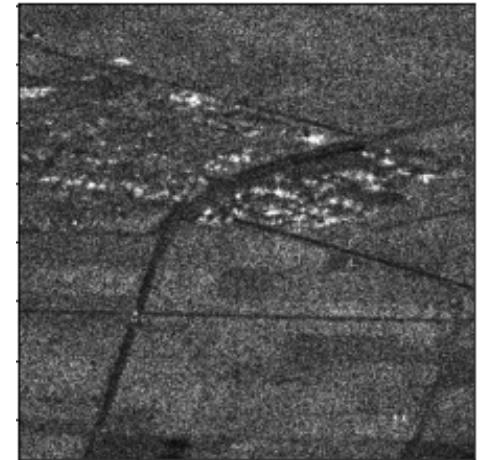
6)



**Appendix 4:** effect of the noise map on two examples (generated speckle with  $L=1$  and with  $L=5$ )

**noisy** $\sigma=0$  $\sigma=10$  $\sigma=20$ 

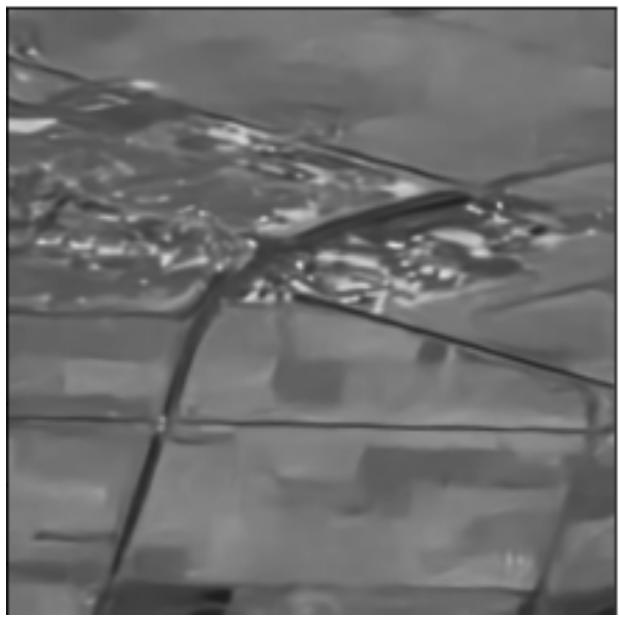
(a): Example of the influence of the noise-map with the model trained with Speckle ( $L=1$ )

**noisy** $\sigma=0$  $\sigma=10$  $\sigma=20$  $\sigma=30$ 

(b): Example of the influence of the noise-map with the model trained with Speckle ( $L=5$ )

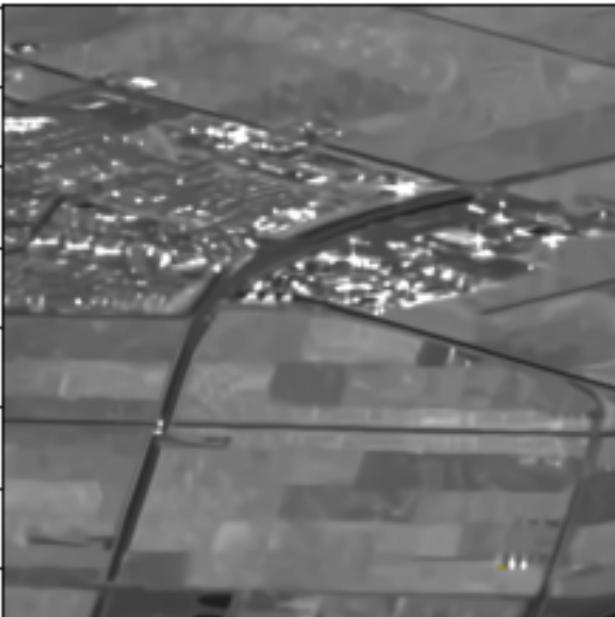
**Appendix 5:** Results of the denoising with a uniform noise map (L1-loss / noise\_level=20)

No noise-map



1)

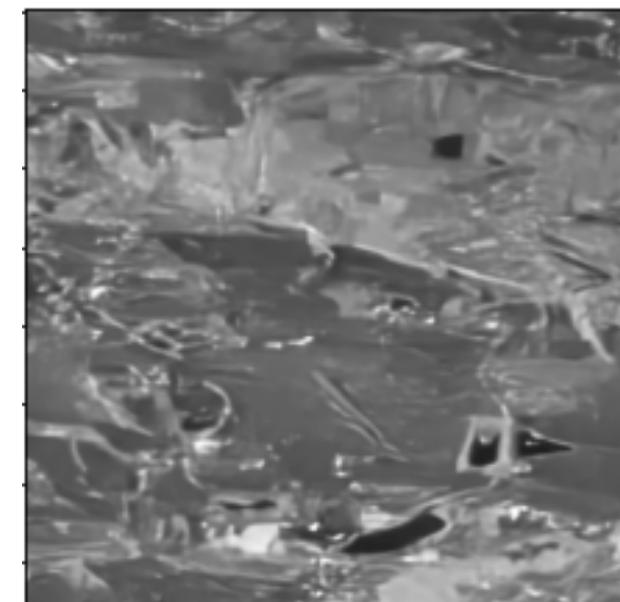
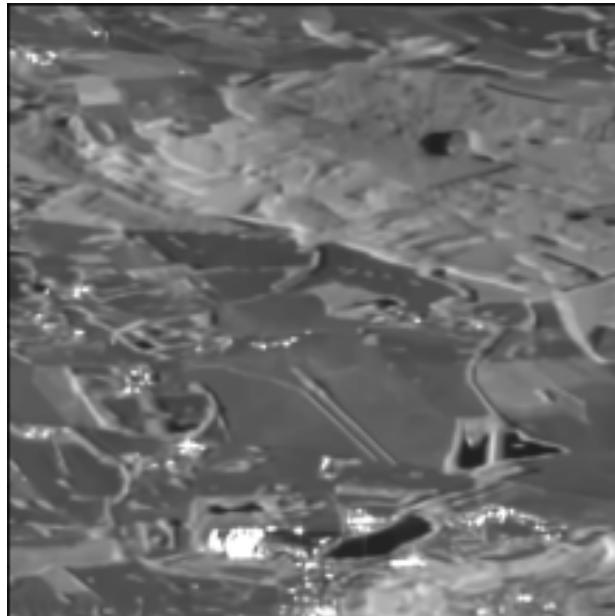
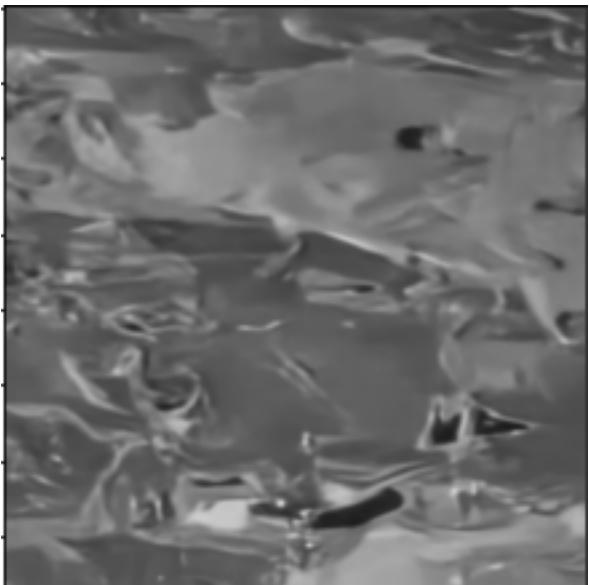
REAL IMAGE



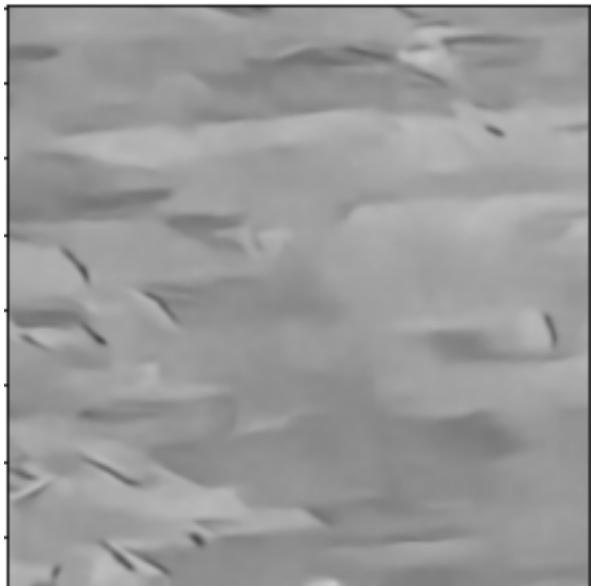
Optimal uniform noise map



2)



**No noise-map**

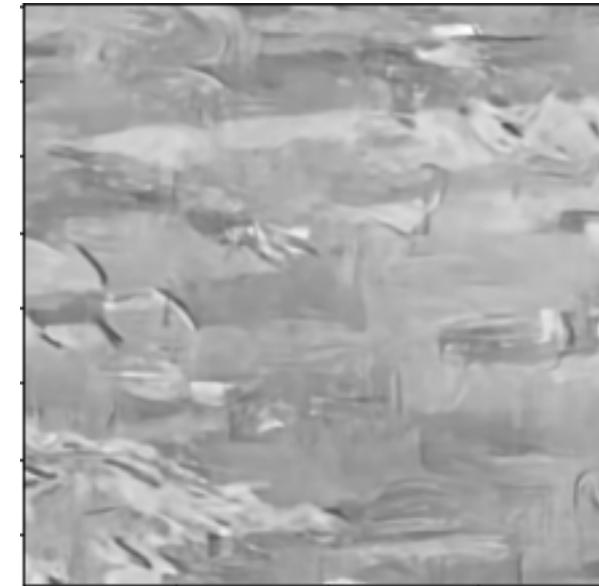


3)

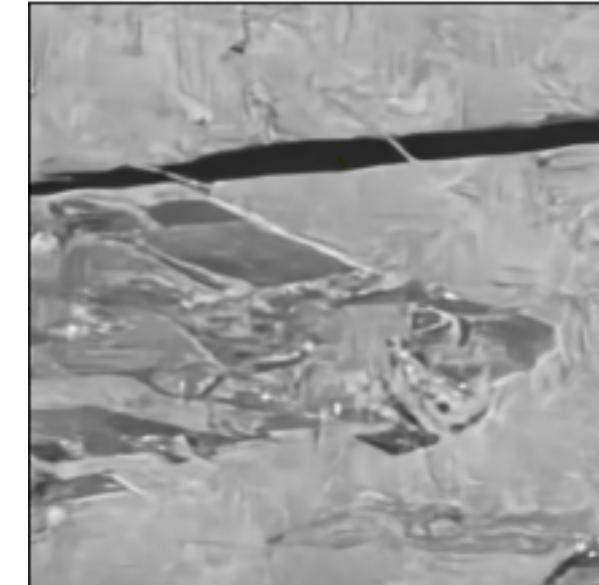
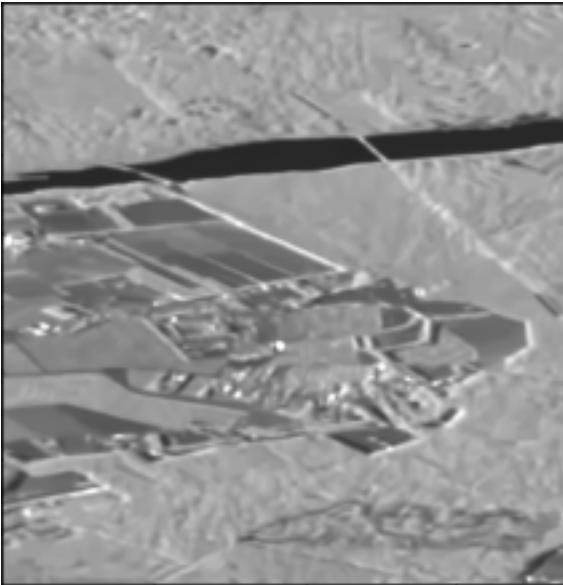
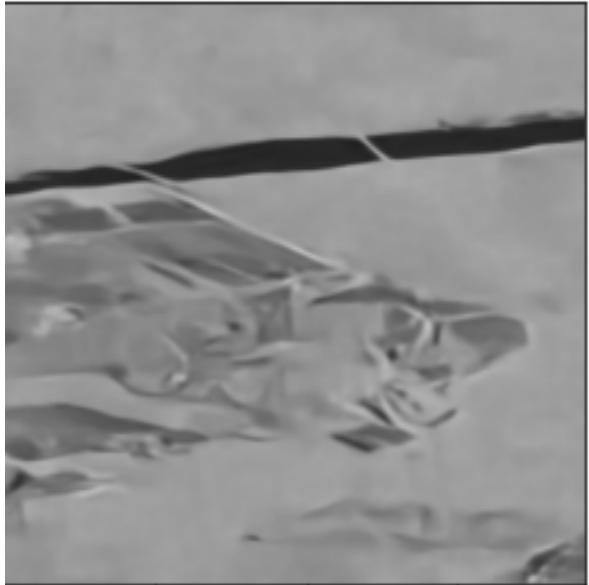
**REAL IMAGE**



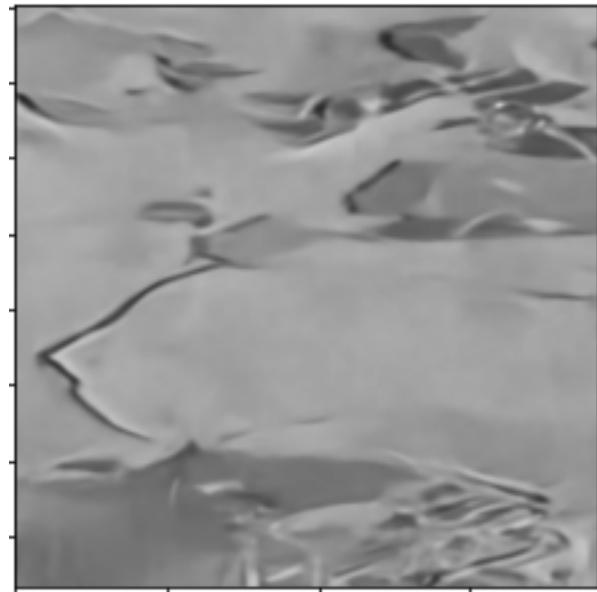
**Optimal uniform noise map**



4)



No noise-map

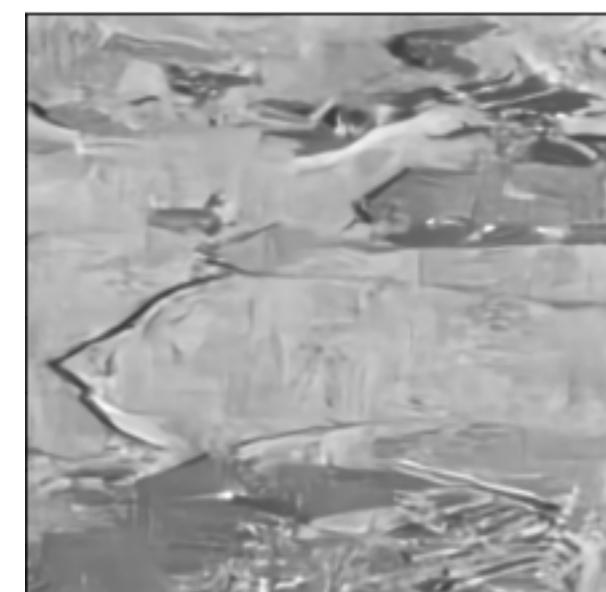


5)

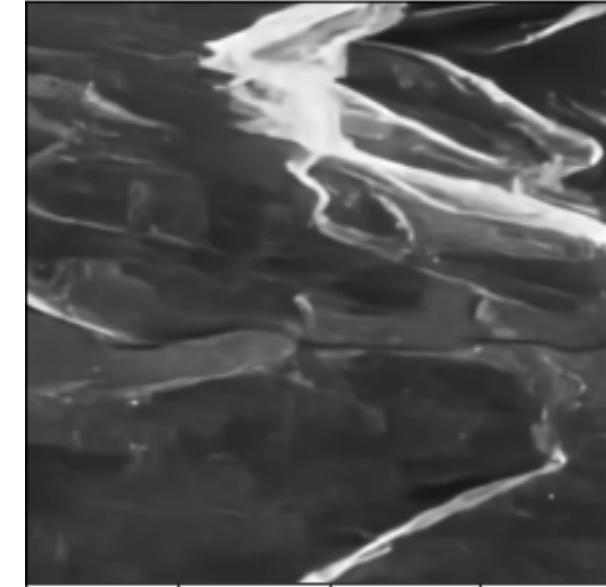
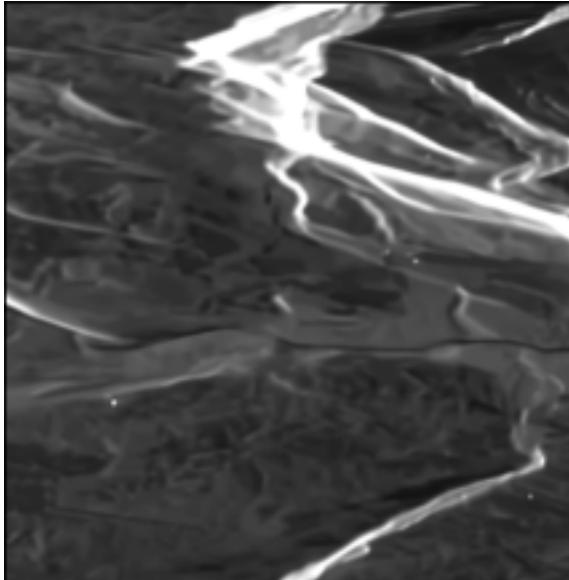
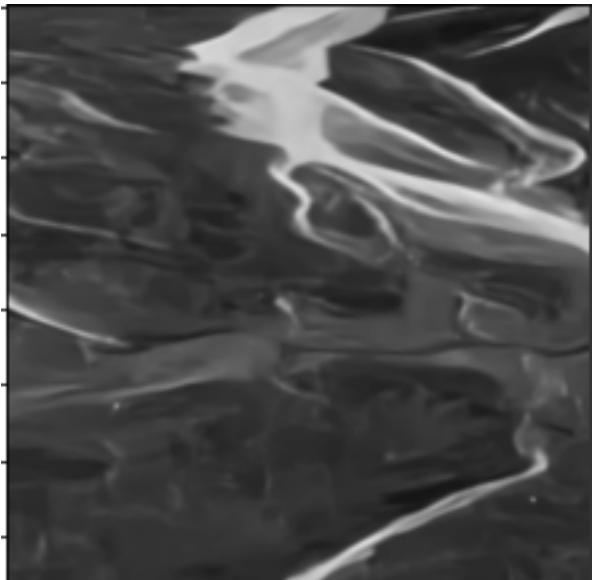
REAL IMAGE



Optimal uniform noise map

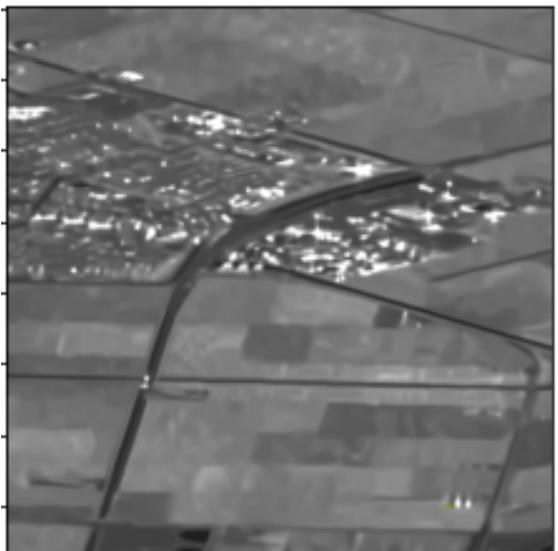


6)



**Annexe 6:** Results with a non-uniform noise map  
estimated with the local-means method and the  
oracle method (L1-loss)

**REAL IMAGE**



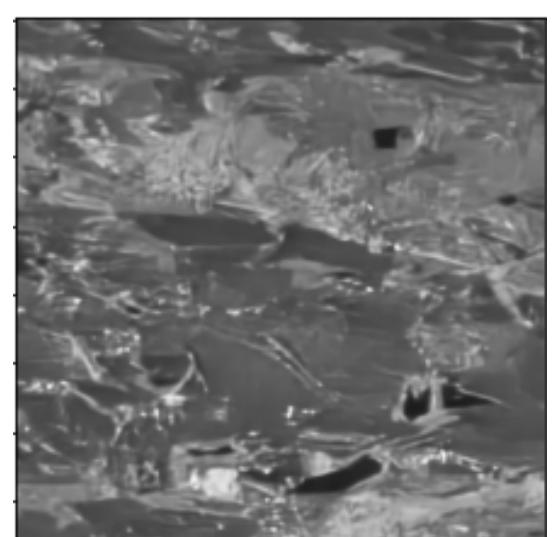
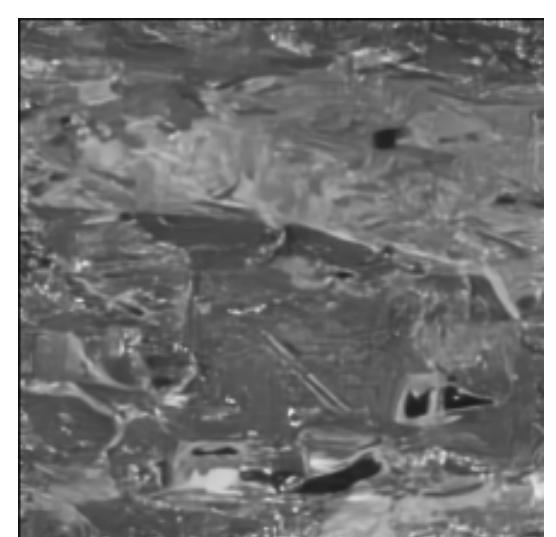
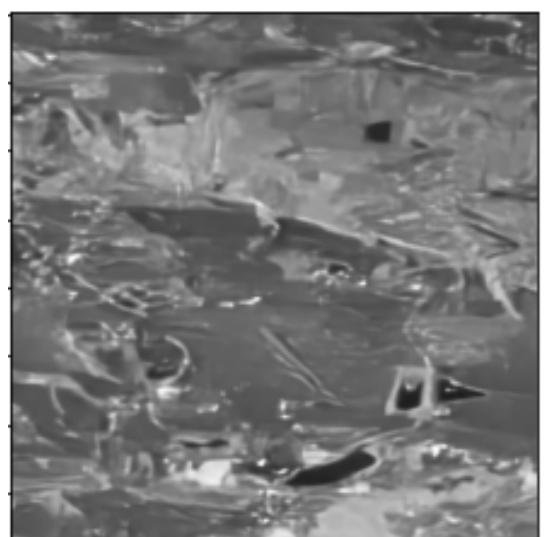
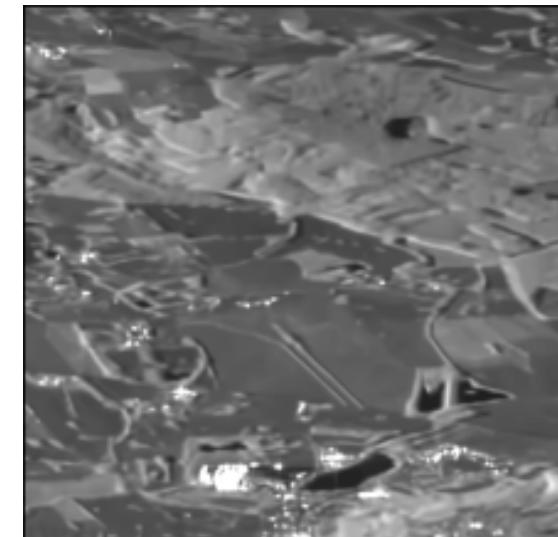
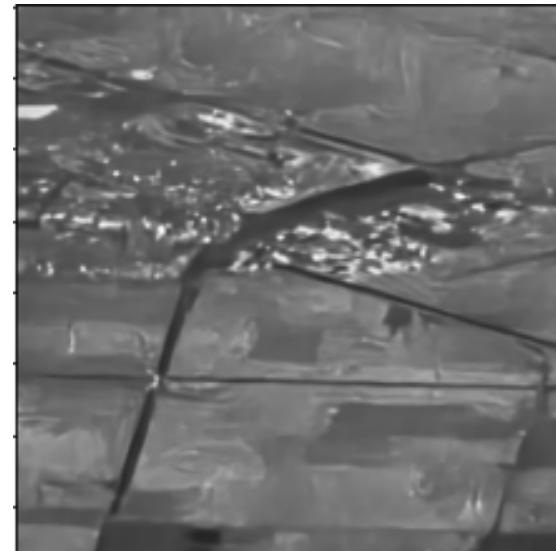
**Optimal uniform noise map**



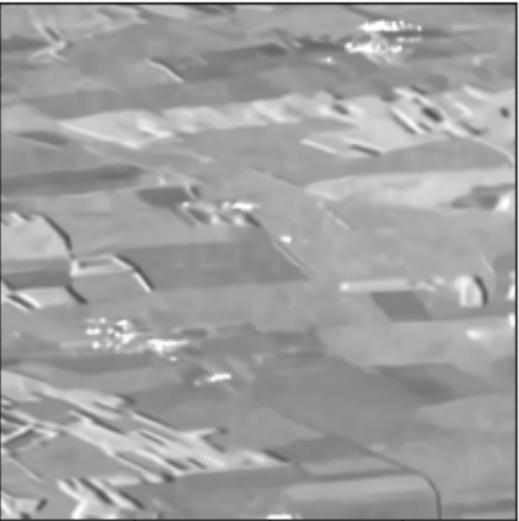
**Local means**



**Oracle**



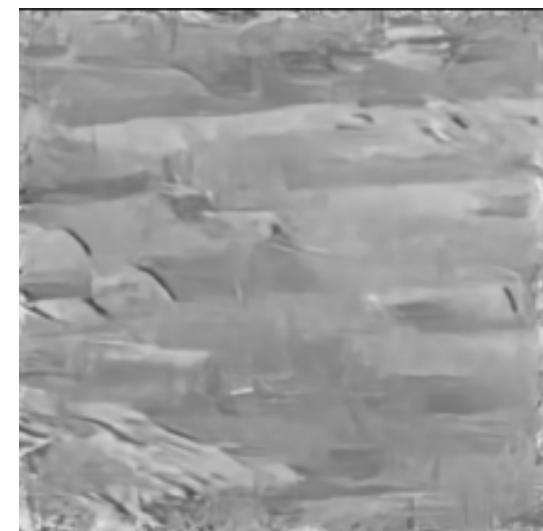
**REAL IMAGE**



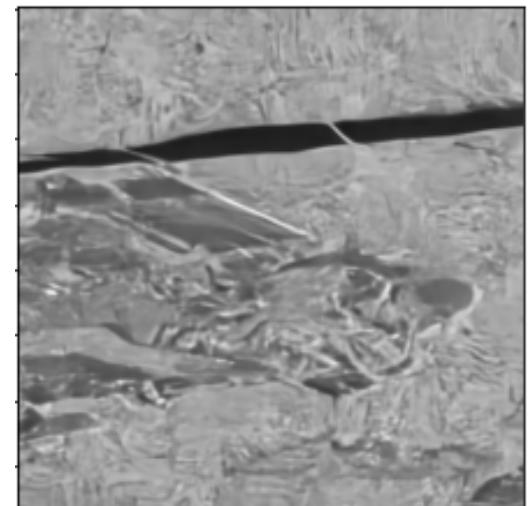
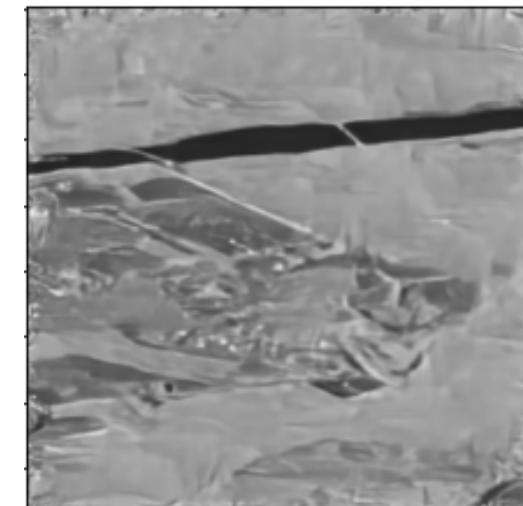
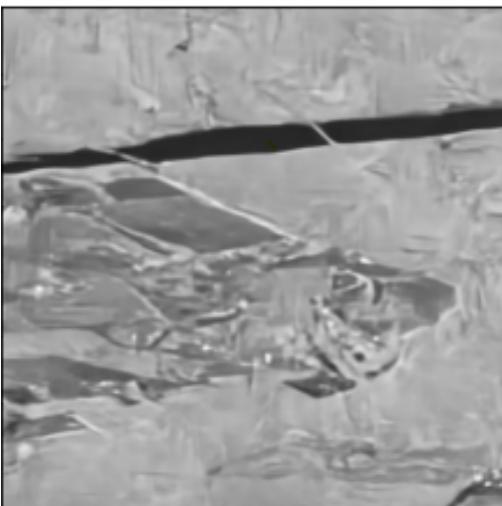
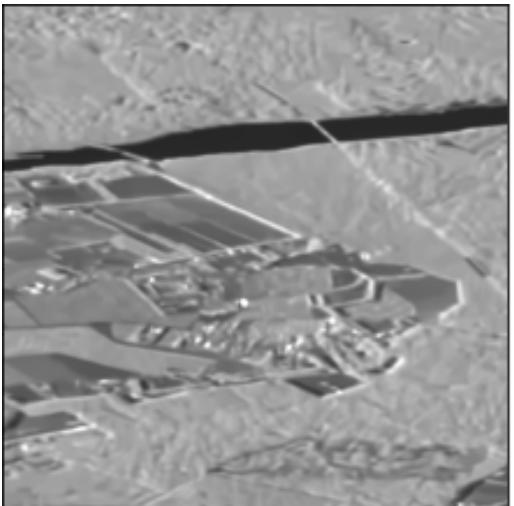
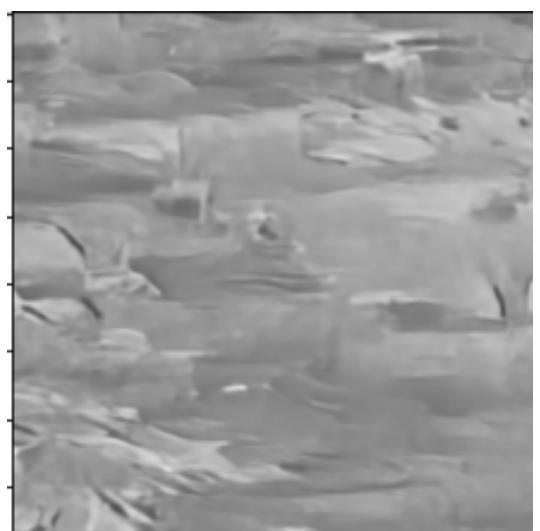
**Optimal uniform noise map**



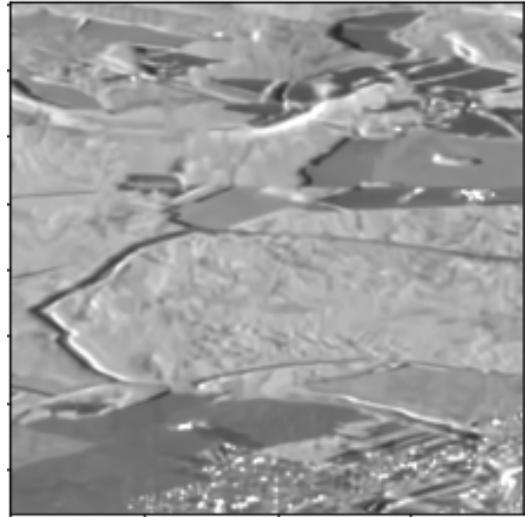
**Local means**



**Oracle**



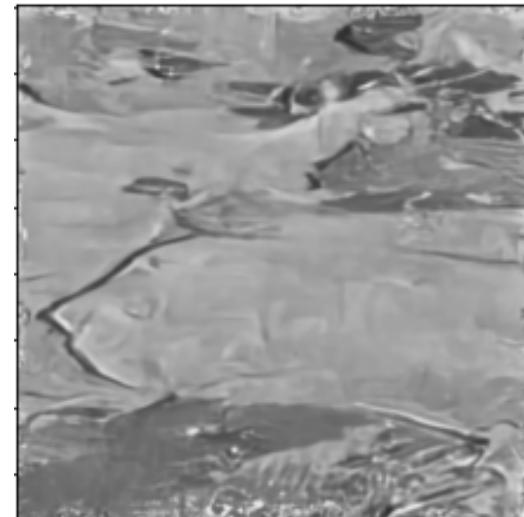
**REAL IMAGE**



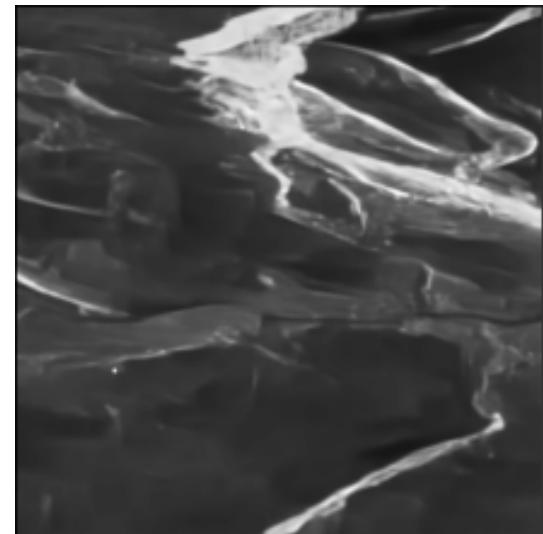
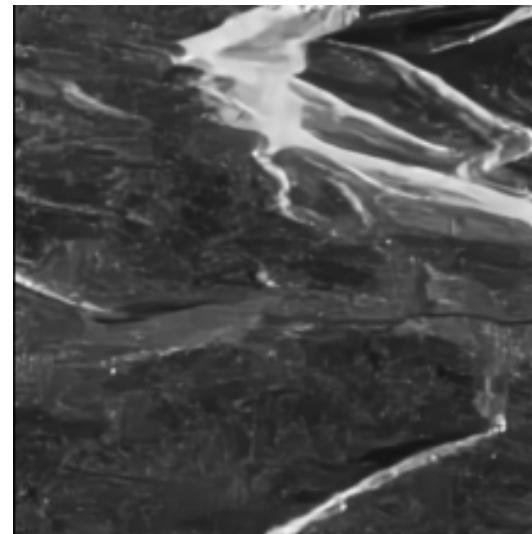
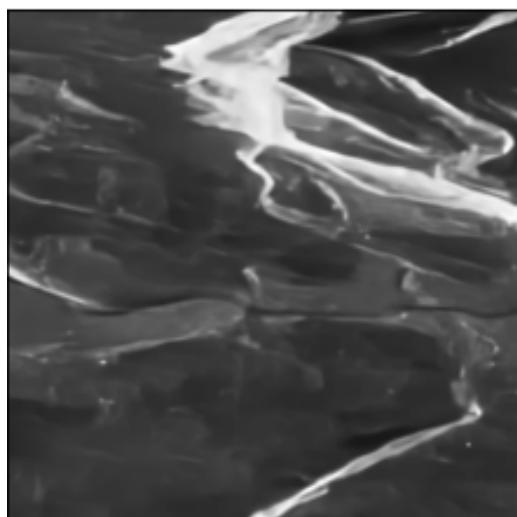
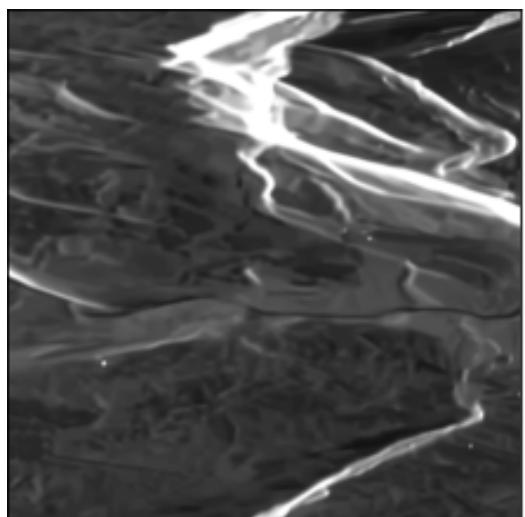
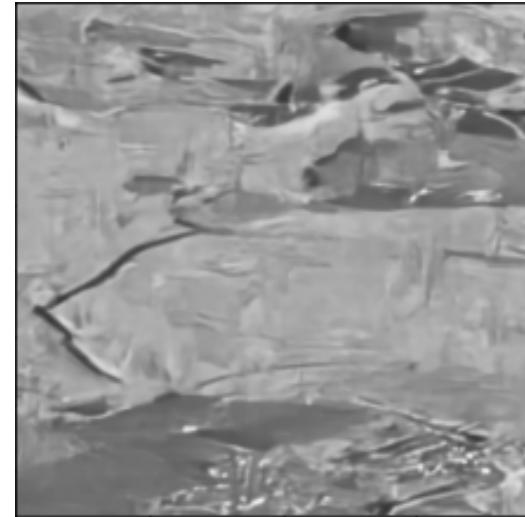
**Optimal uniform noise map**



**Local means**

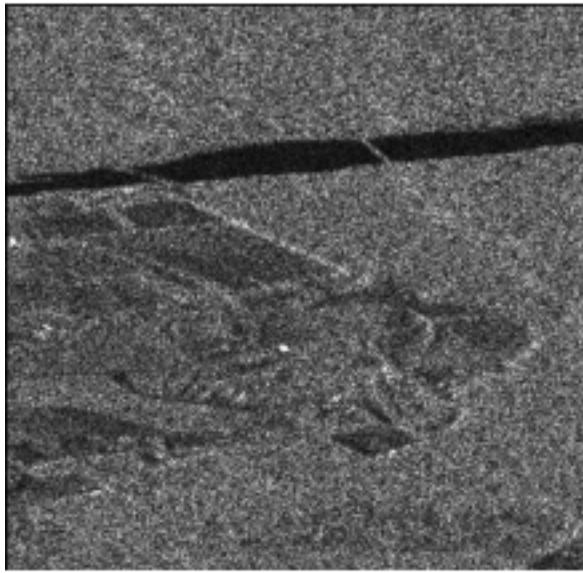


**Oracle**

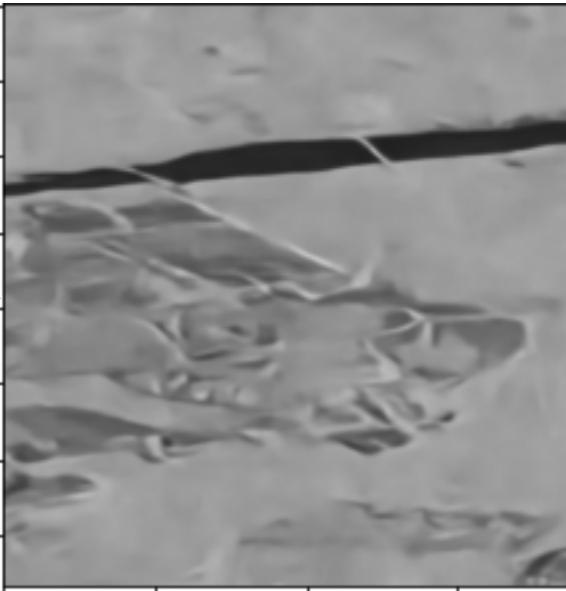


# Appendix 7: Comparison of all the methods seen in the study on an example

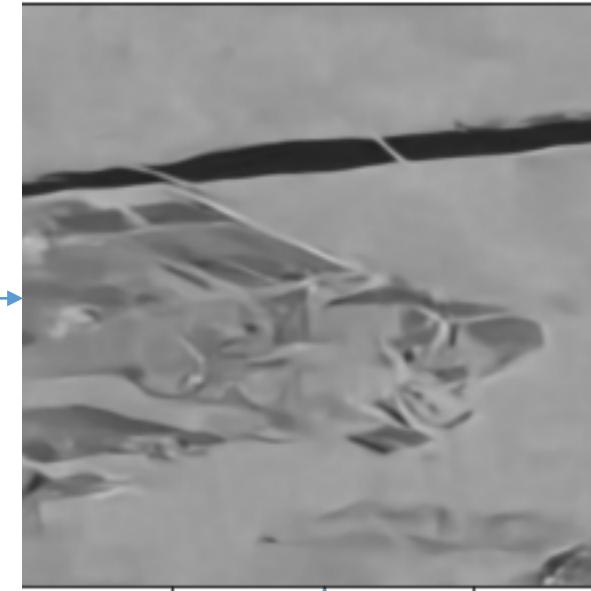
Noisy



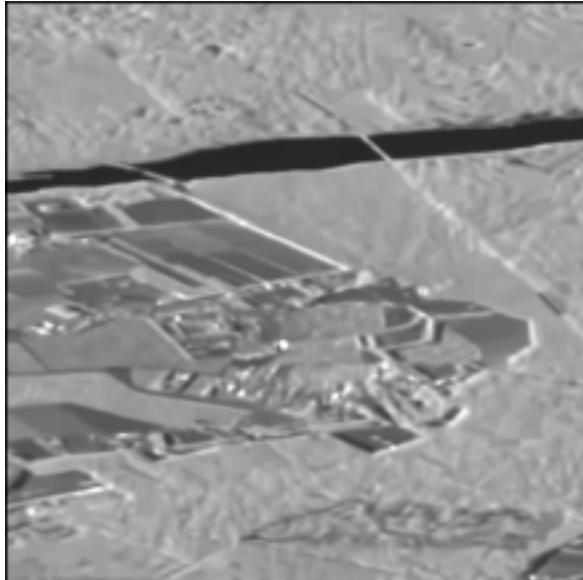
L2-norm / L=1 / no noise map



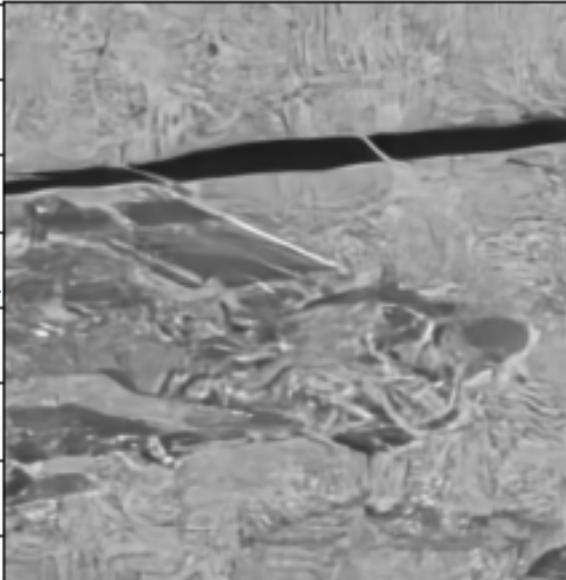
L1-norm / L=1 / no noise map



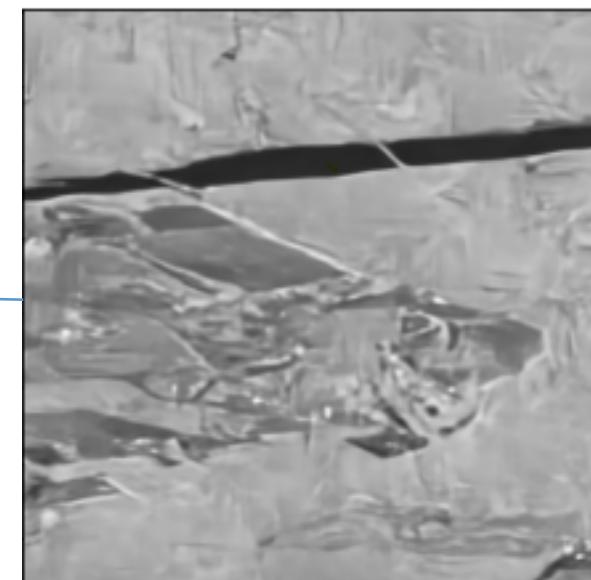
REAL IMAGE



L1-norm / L=5 / noise map=20 / oracle



L1-norm / L=5 / noise map=20



## Appendix 8: Results on real images (Sentinel1)

Real image 1



Uniform noise map





oracle

# Comparison real image /denoised



Real image 2



Uniform noise map



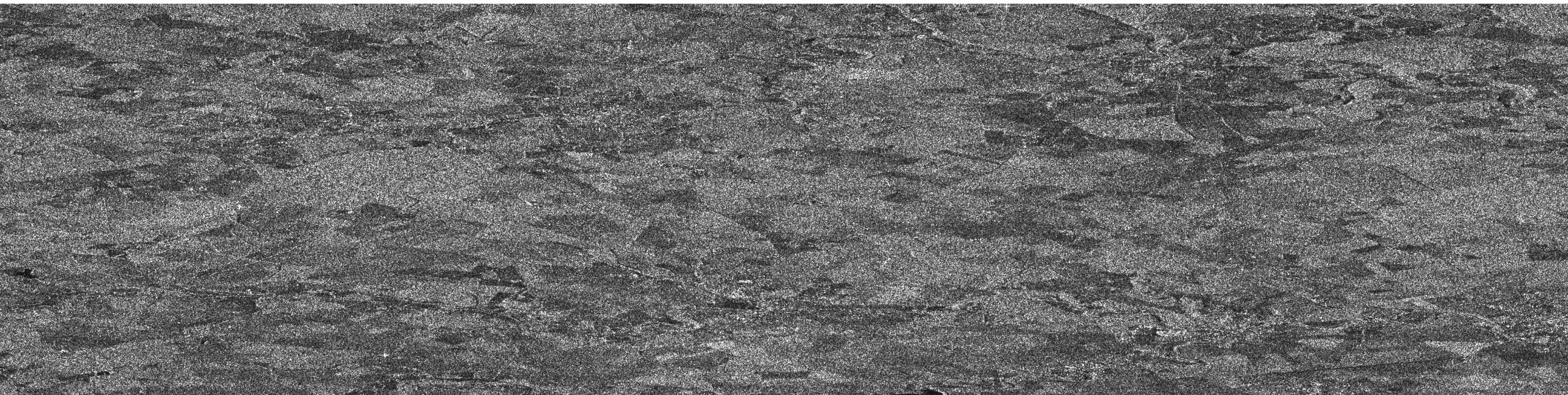


oracle

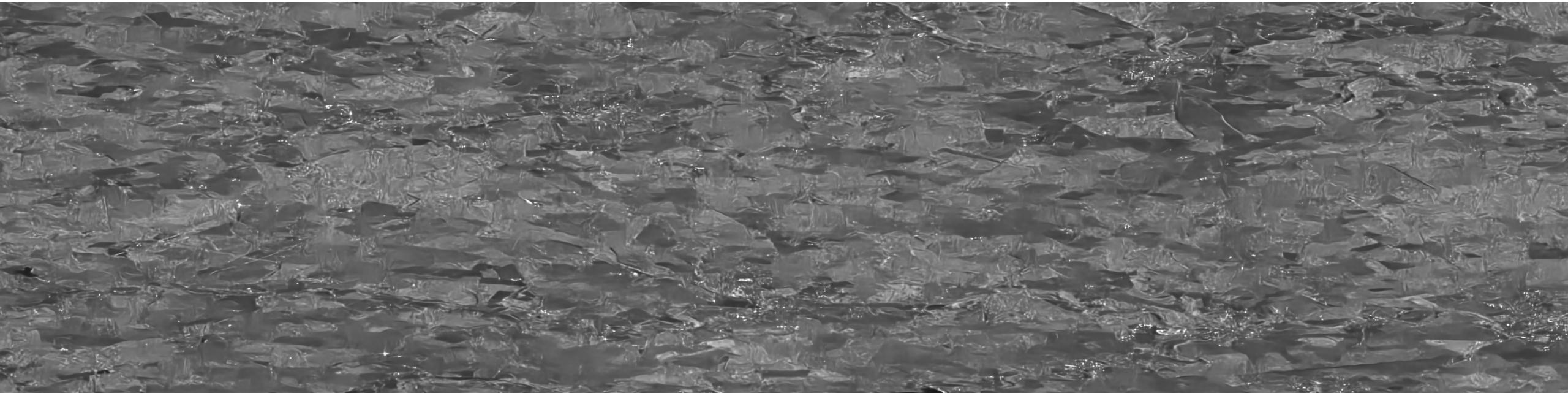
# Comparison real image /denoised



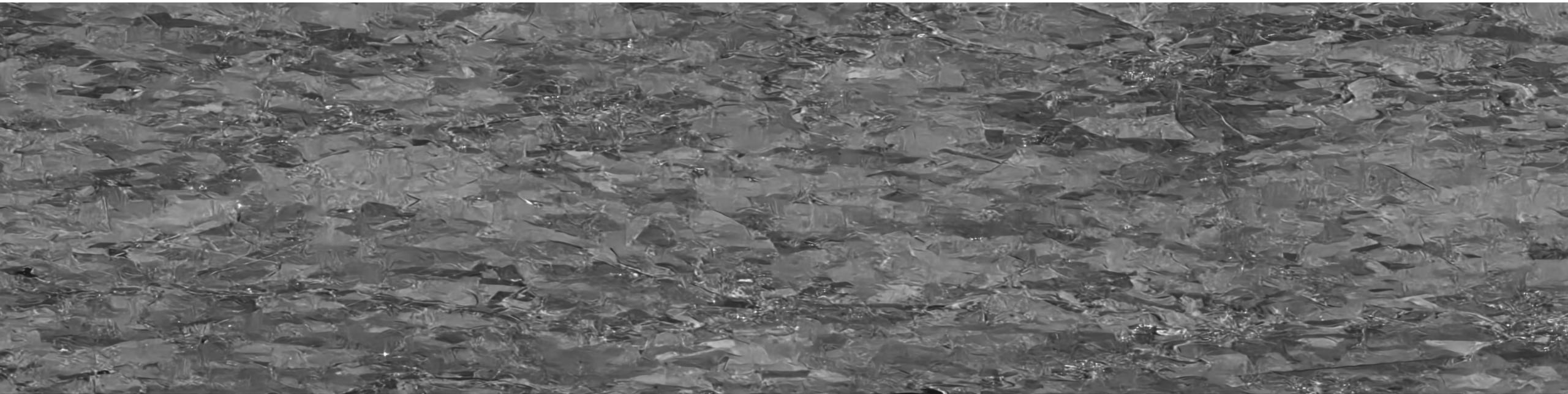
Real image 3



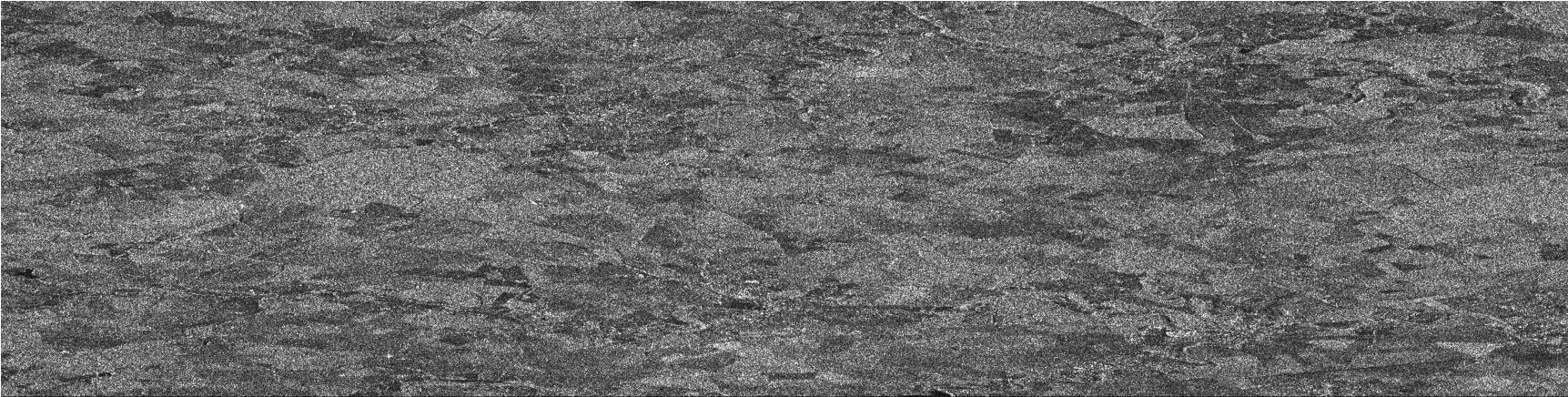
# Uniform noise map



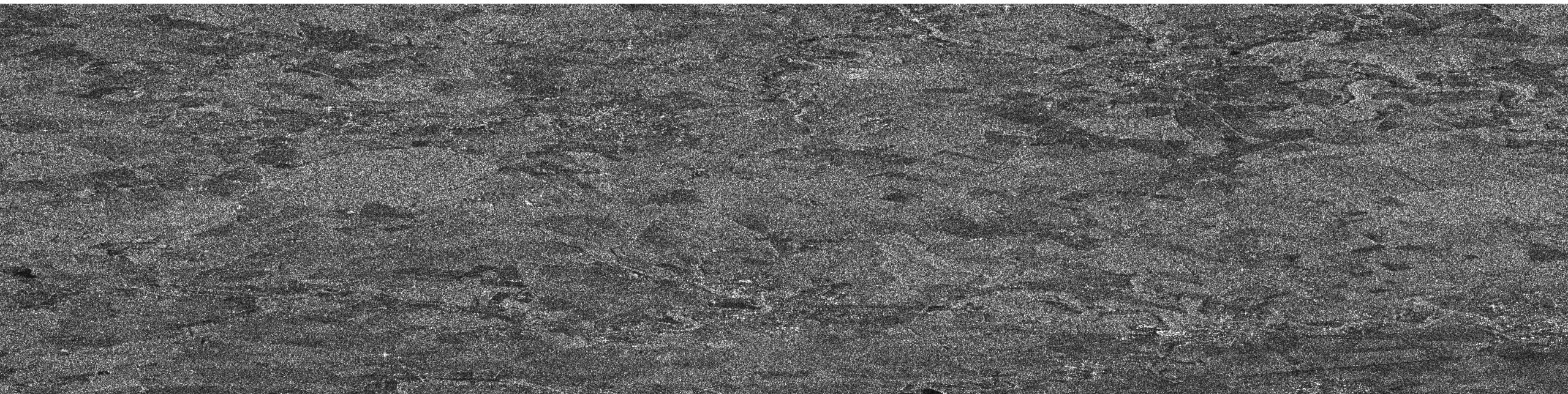
# Oracle



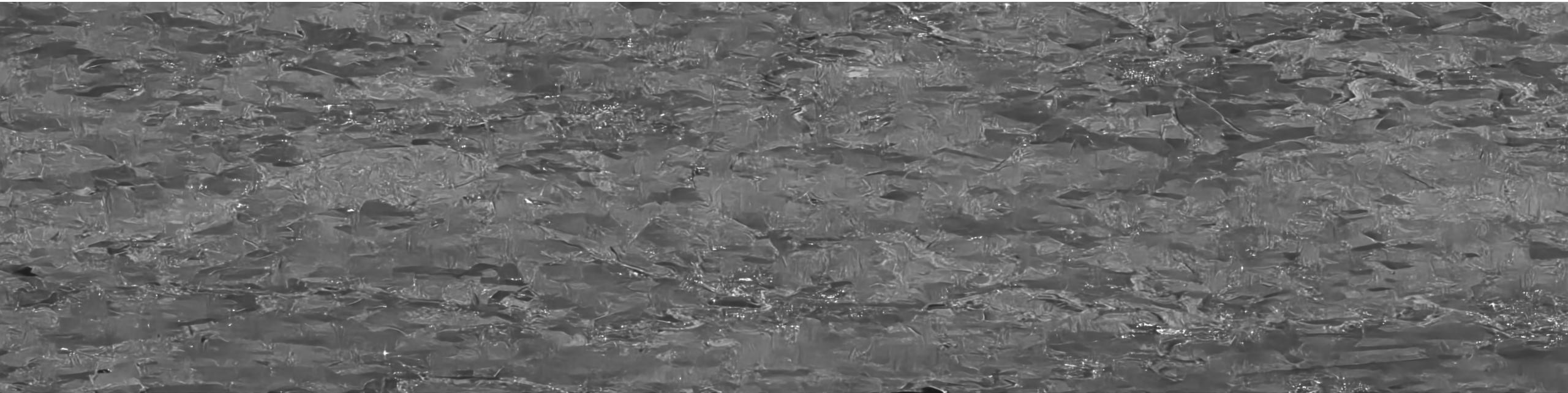
# Comparison real image /denoised



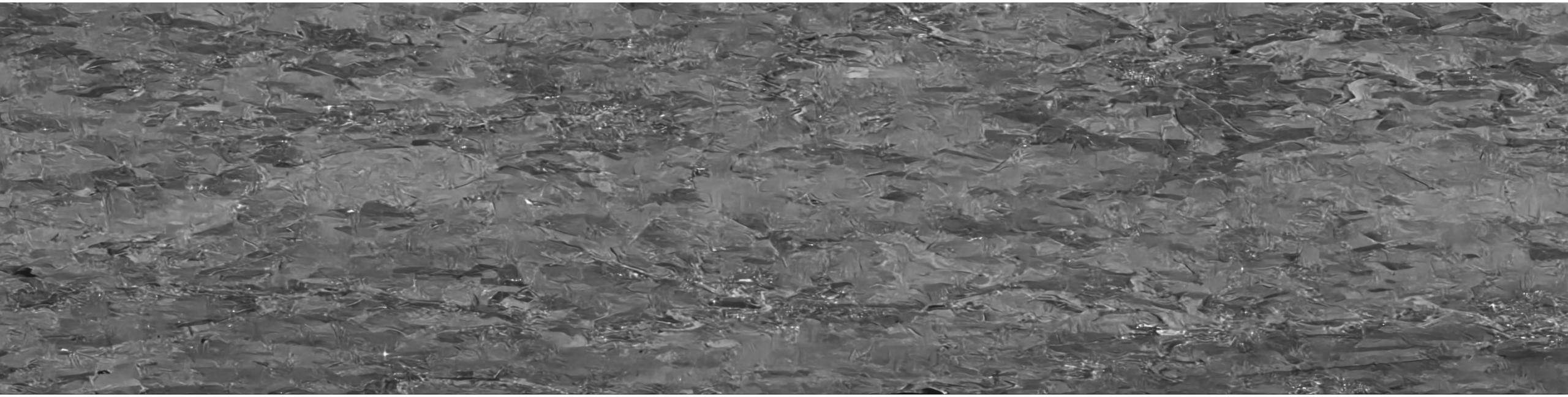
Real image 4



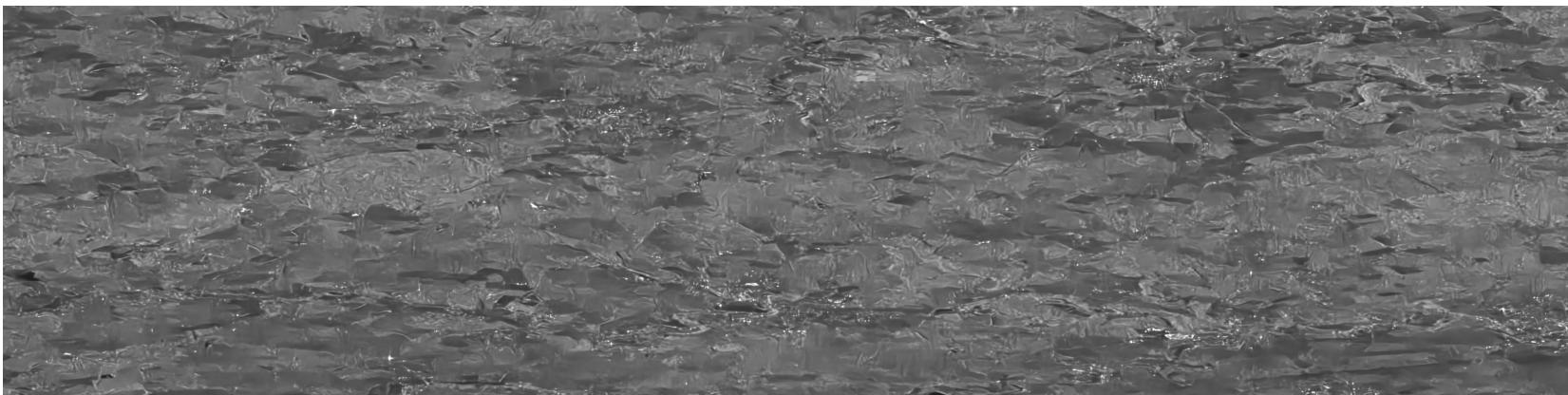
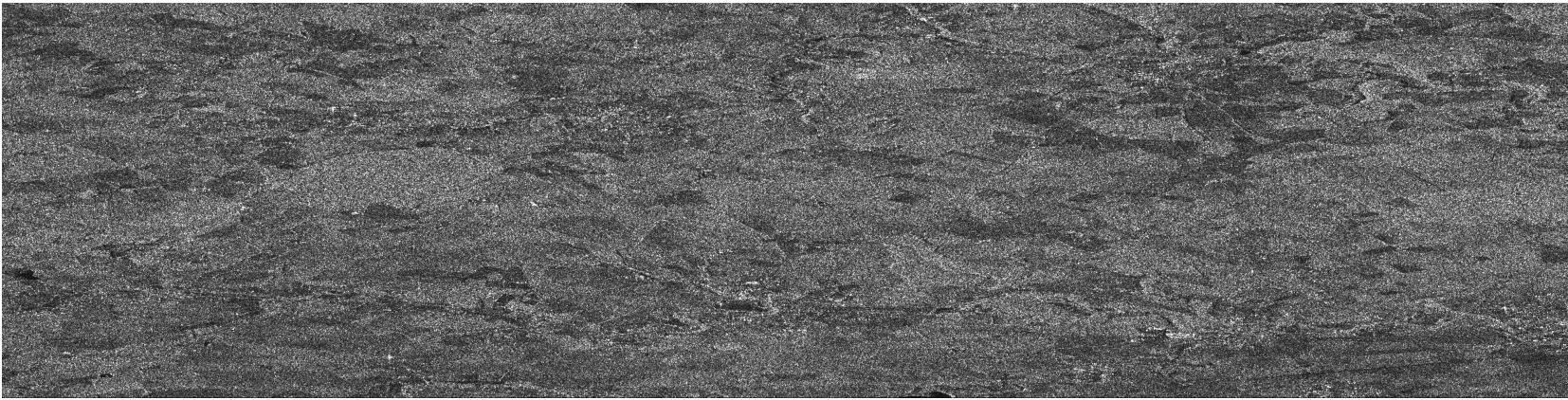
# Uniform noise map



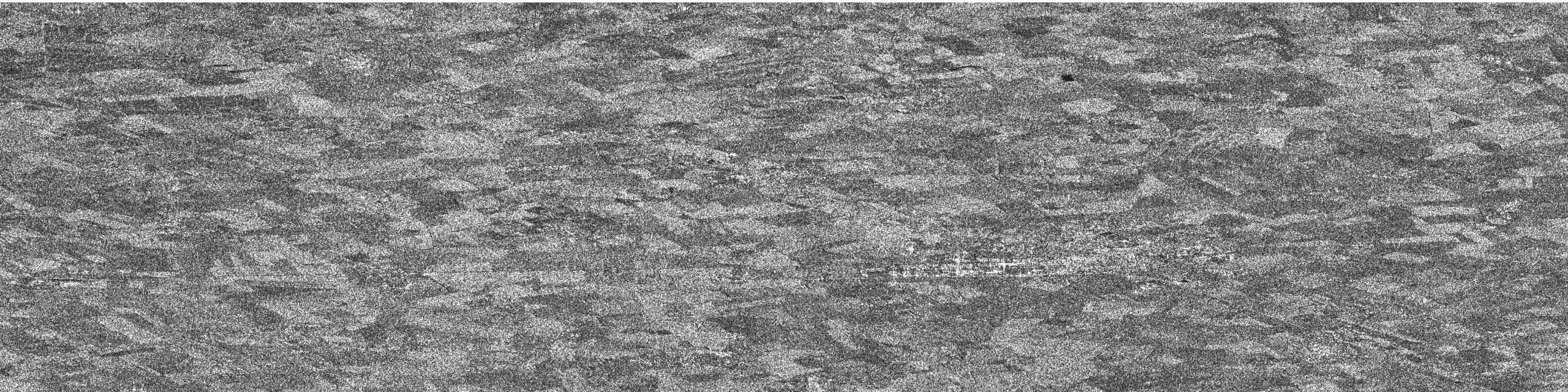
Oracle



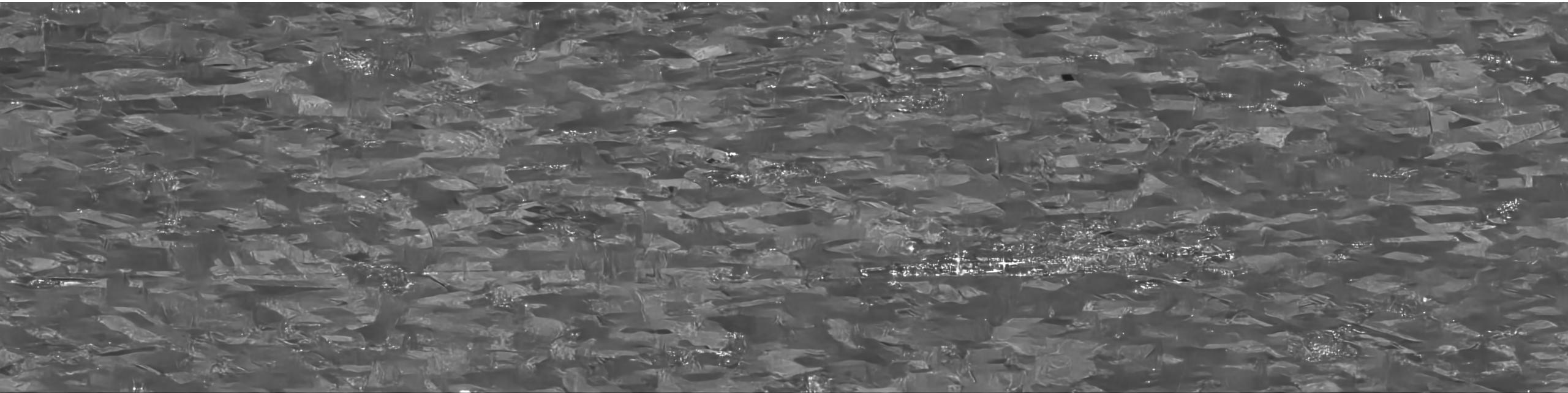
# Comparison real image /denoised



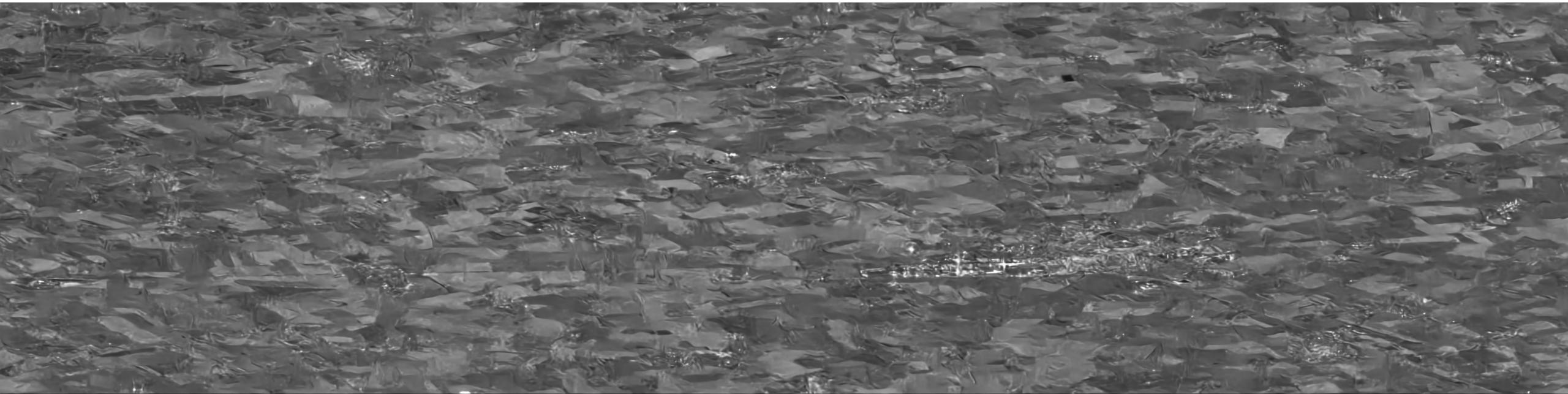
Real image 5



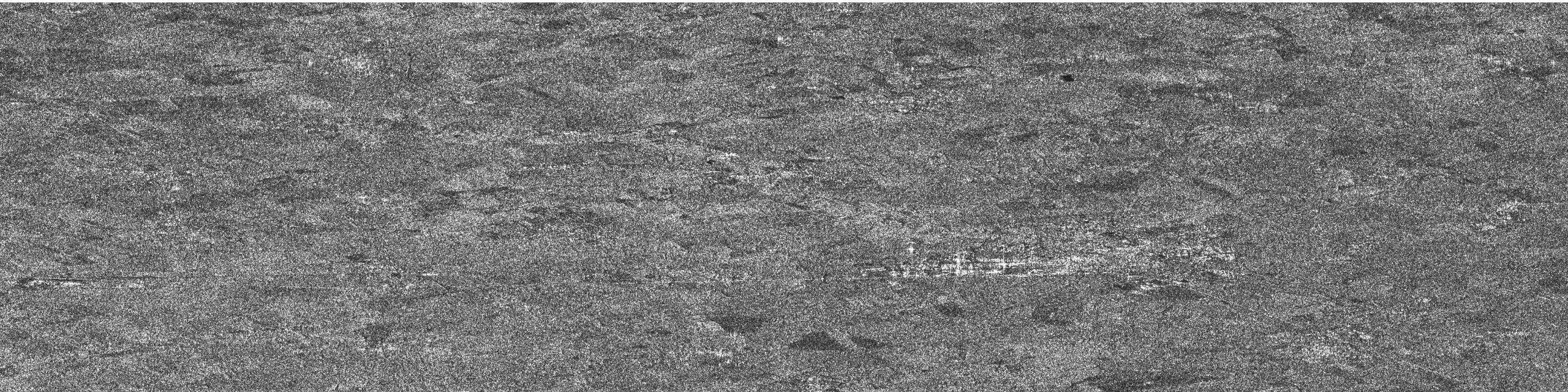
# Uniform noise map



# Oracle



Real image 6



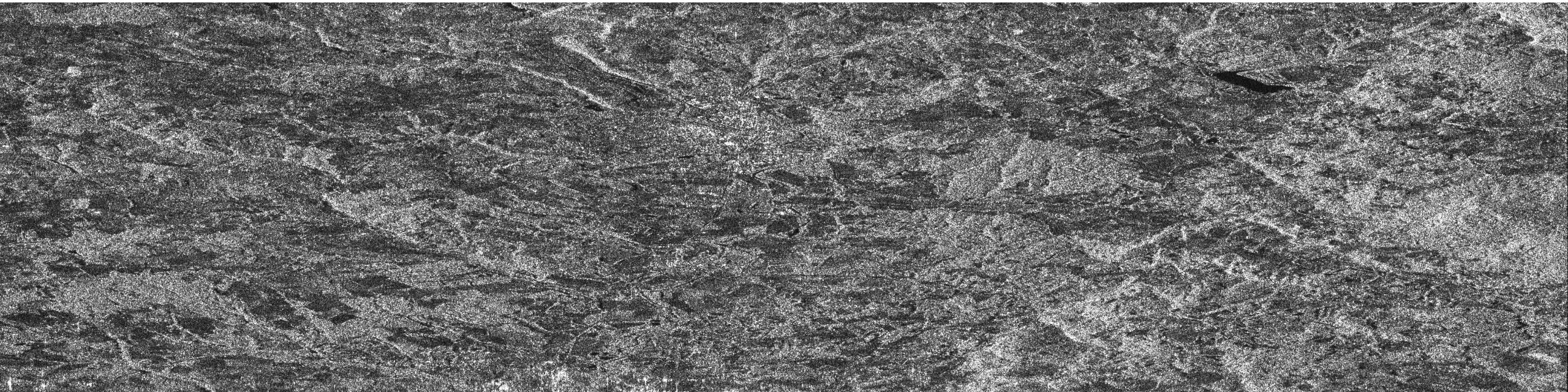
# Uniform noise map



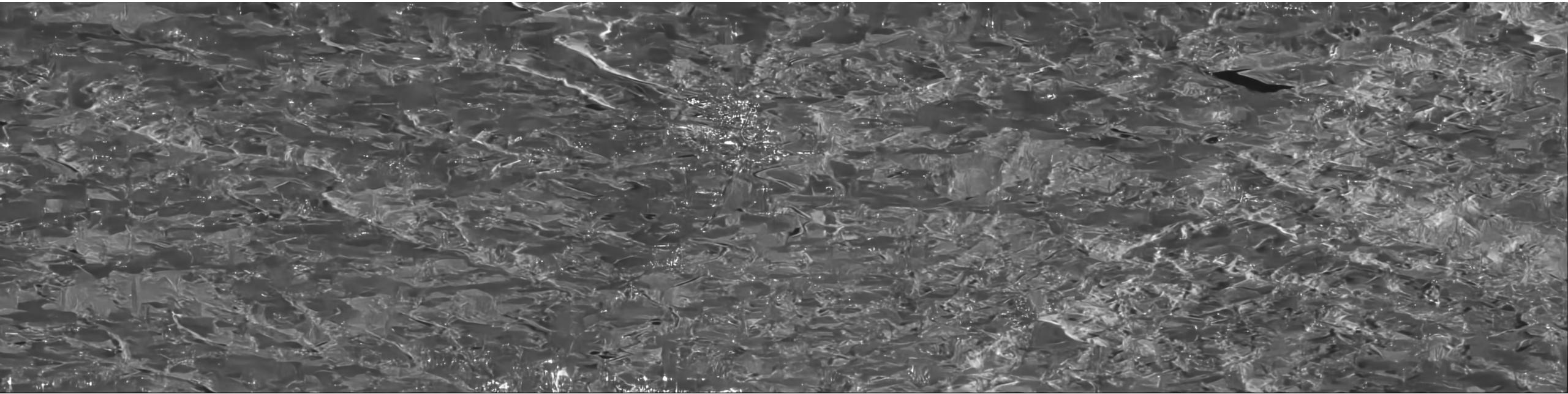
Oracle



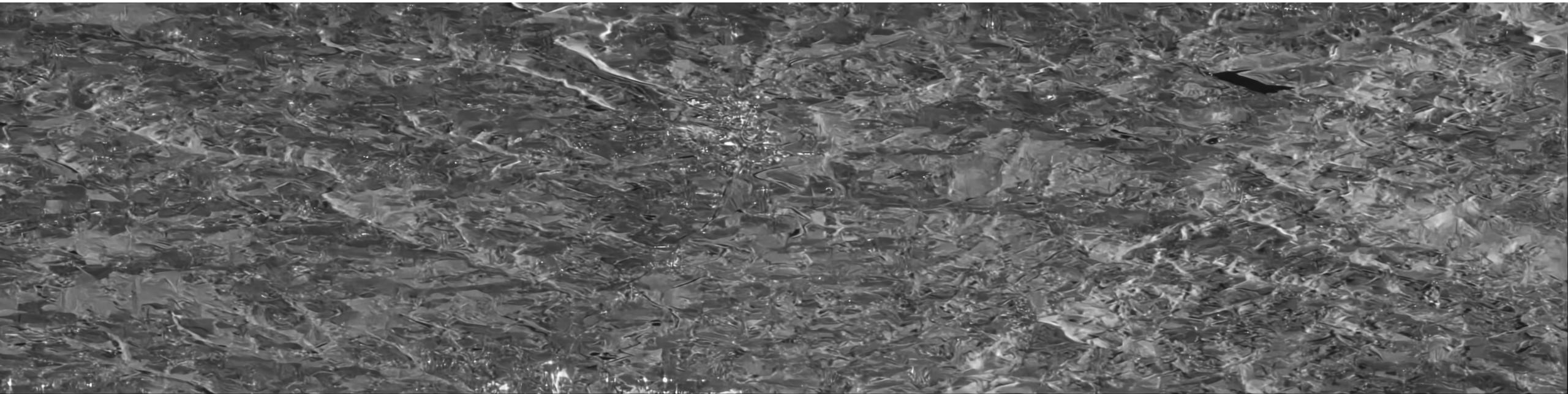
Real image 7



# Uniform noise map

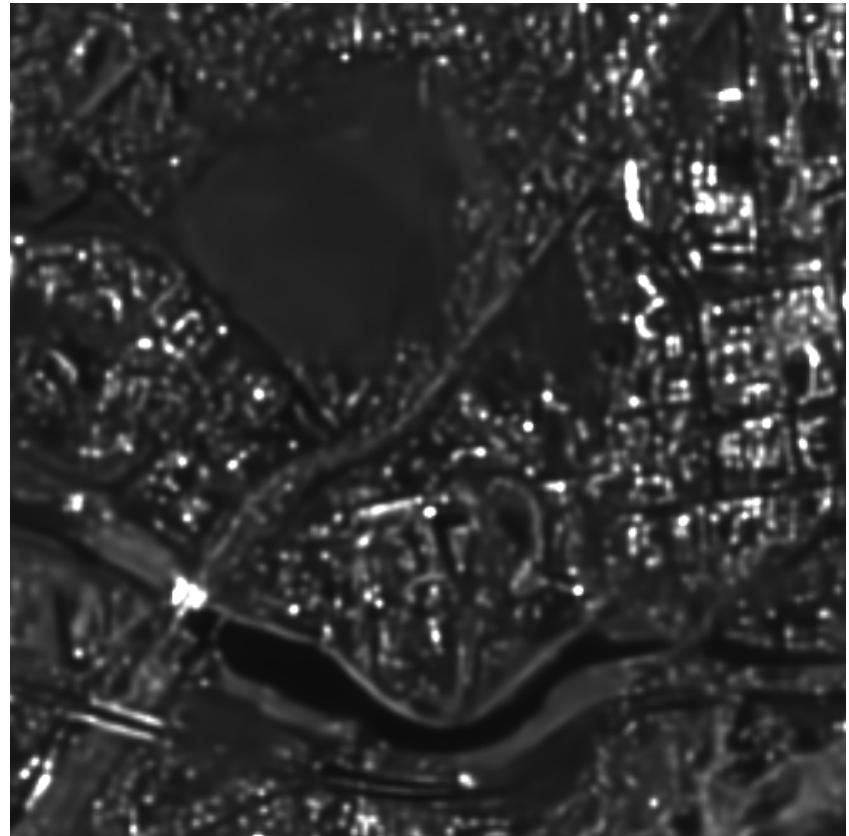


# Oracle



# Appendix 9: Results on real images (TerraSAR-X)

SAR-CNN



Noisy image



FFDNet (oracle)

