

# Using Neural Networks for Two -Dimensional Scientific Data Compression

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*SIParCS Research Intern*

JULY 29, 2020



# Indigenous Lands Acknowledgement

Today, I give this presentation on the traditional territory of the following nations:

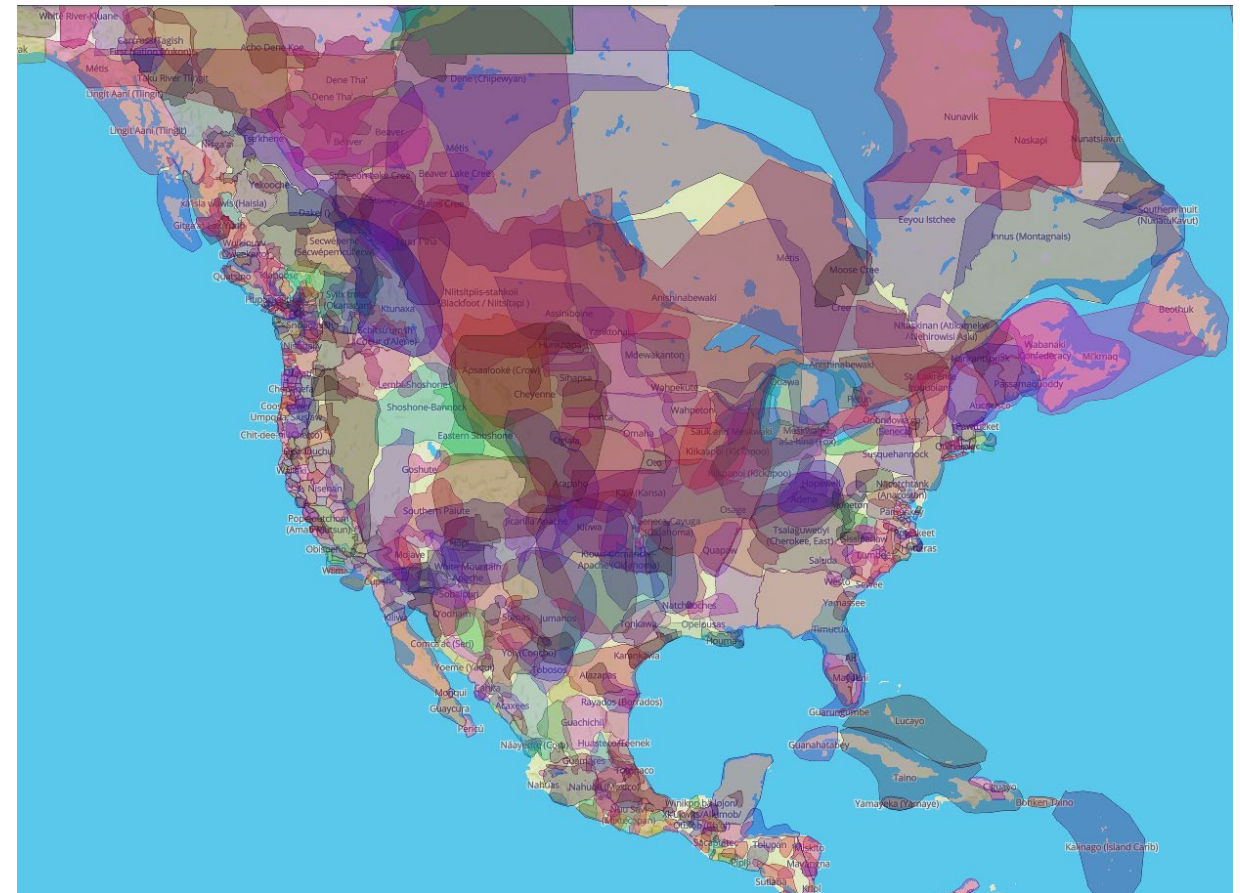
Arapaho

Cheyenne

Ute

Sioux

Colorado's Front Range is a contemporary and traditional site of trade and gathering for many Indigenous peoples.

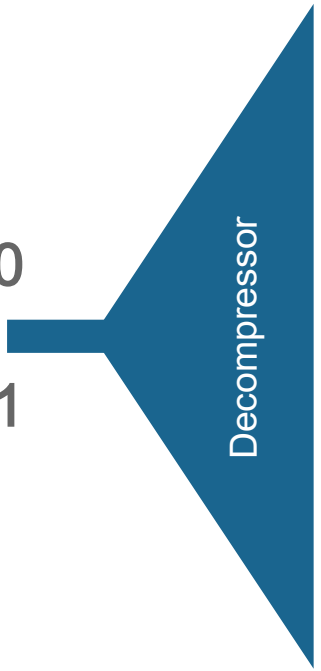


<https://native-land.ca/territory-acknowledgement/>

# What is compression?



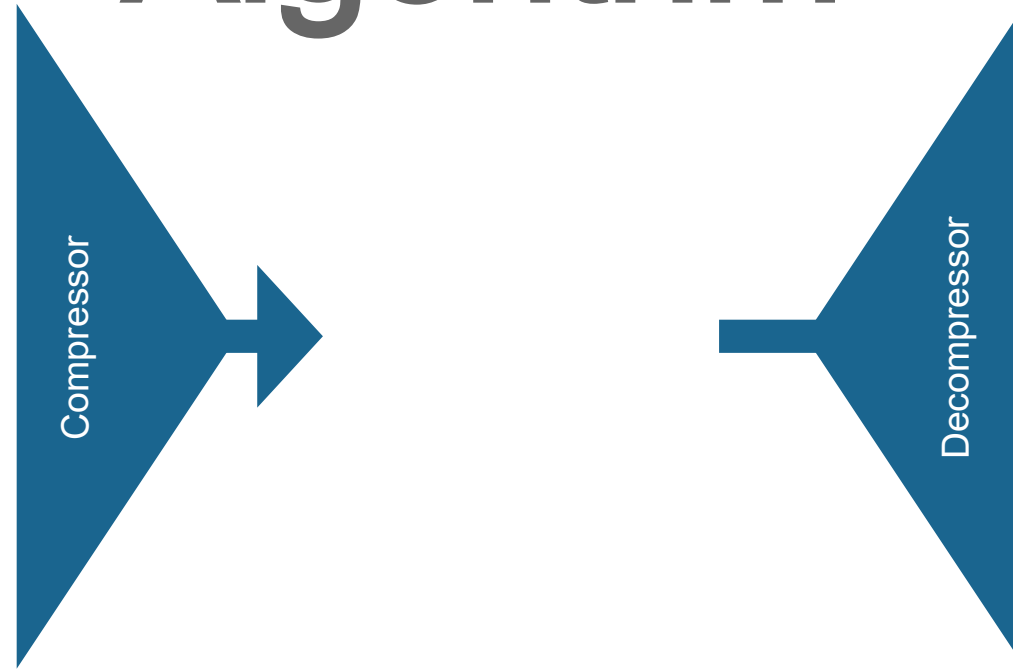
...  
10101000010  
0100111  
10011000101



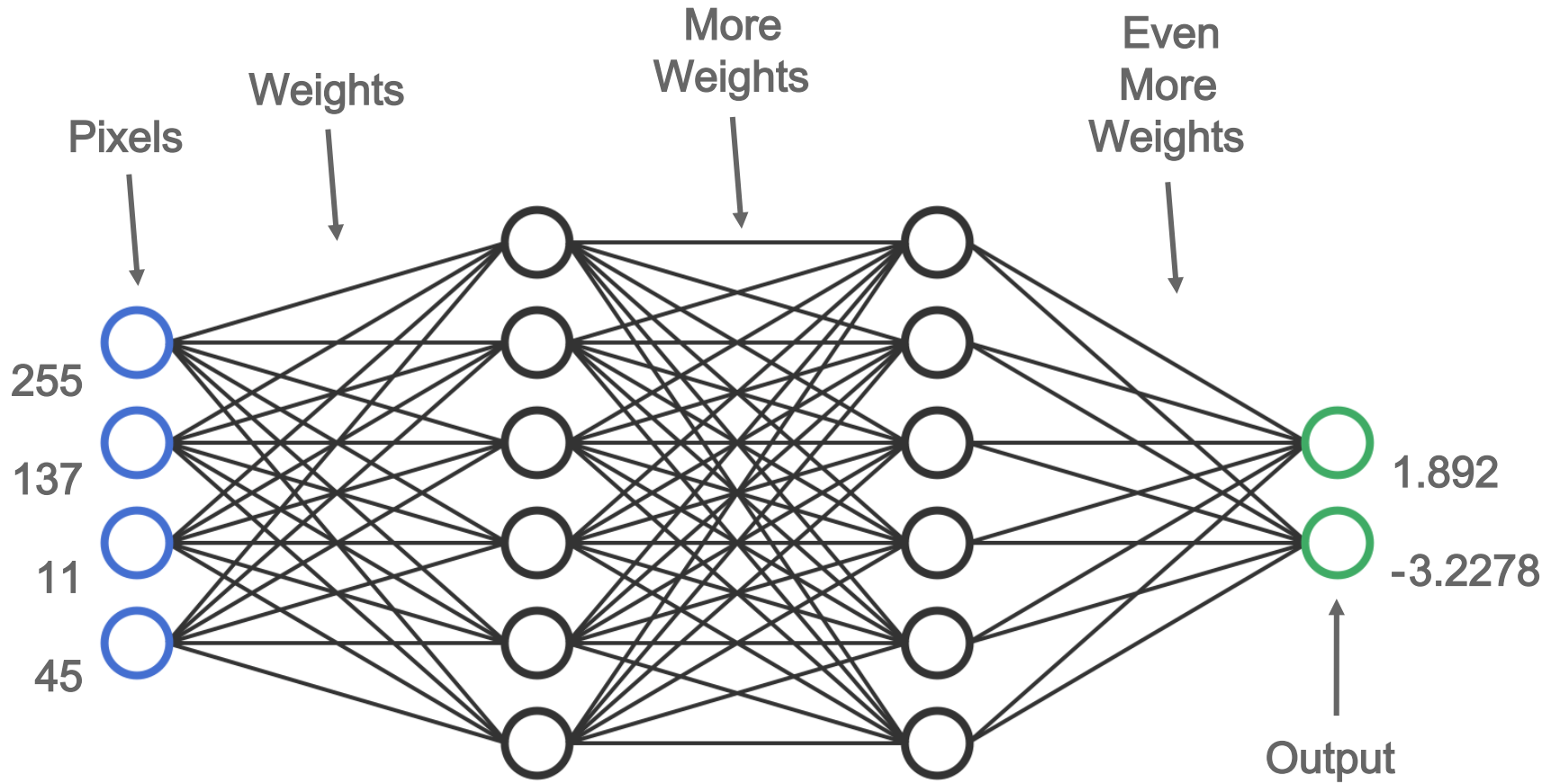
Rate

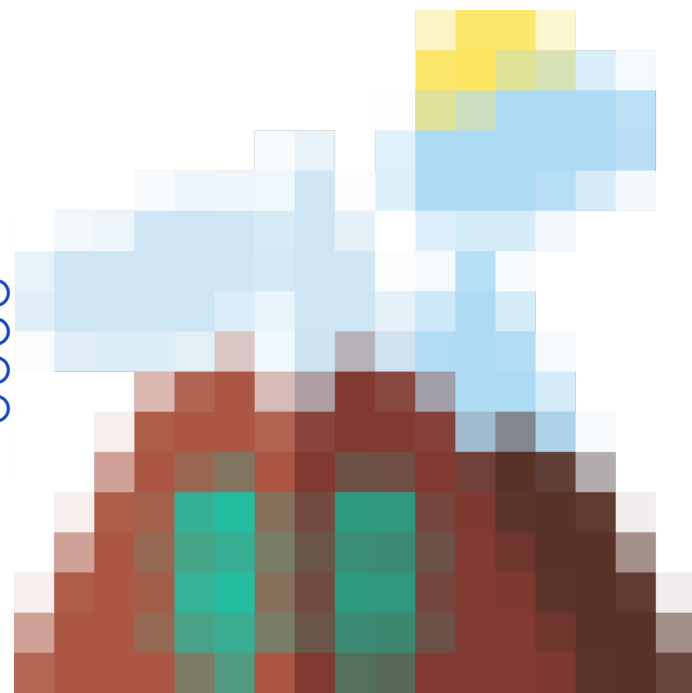
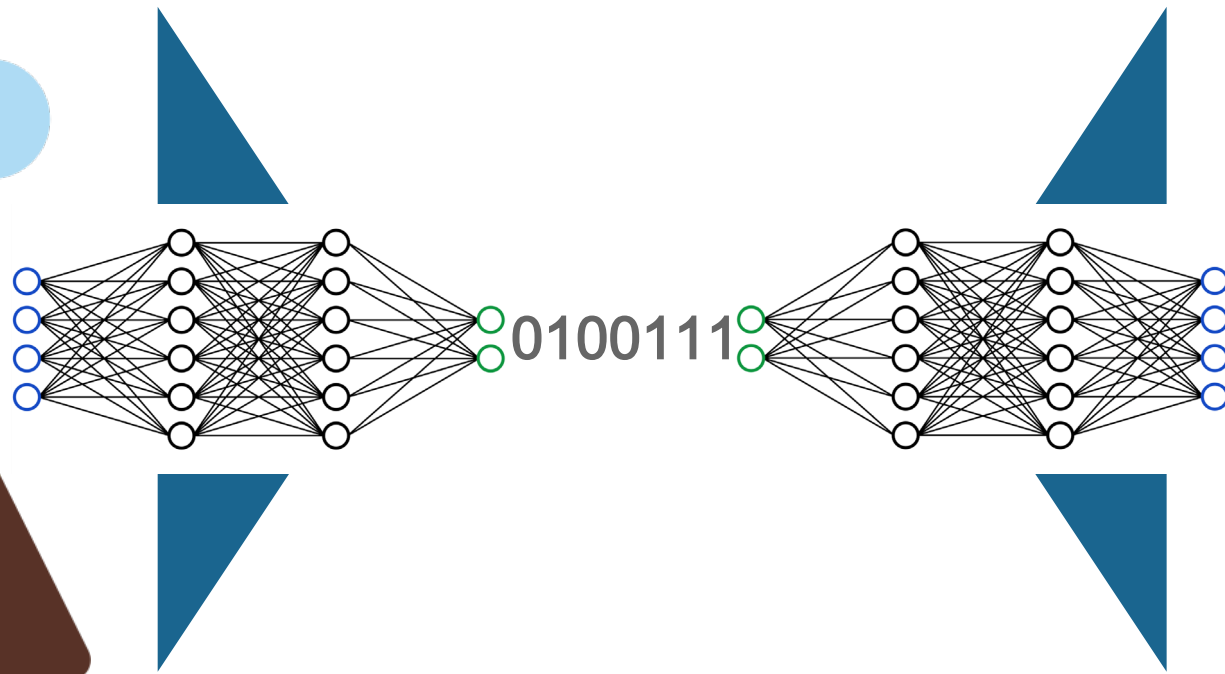
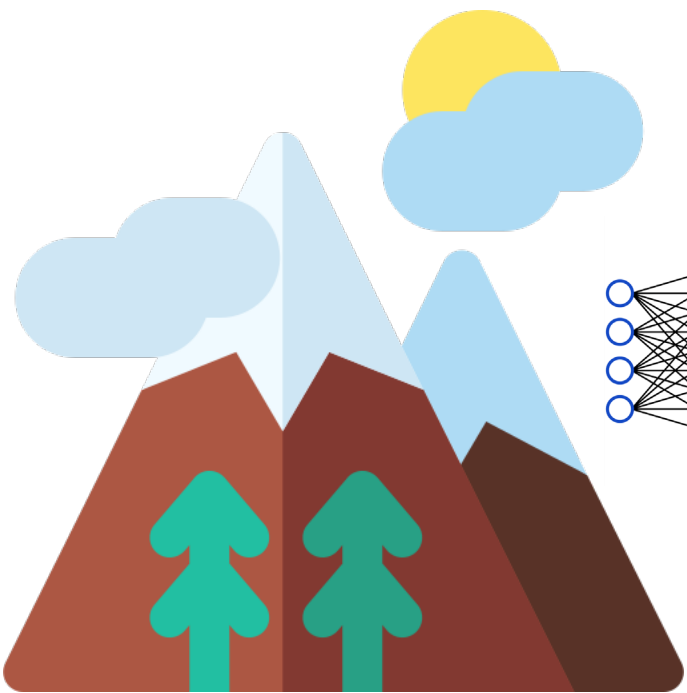
Distortion

# The Compression Algorithm



# Neural Networks





# VARIATIONAL IMAGE COMPRESSION WITH A SCALE HYPERPRIOR

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`jballe@google.com`

**David Minnen\***

`dminnen@google.com`

**Saurabh Singh\***

`saurabhsingh@google.com`

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`sjhwang@google.com`

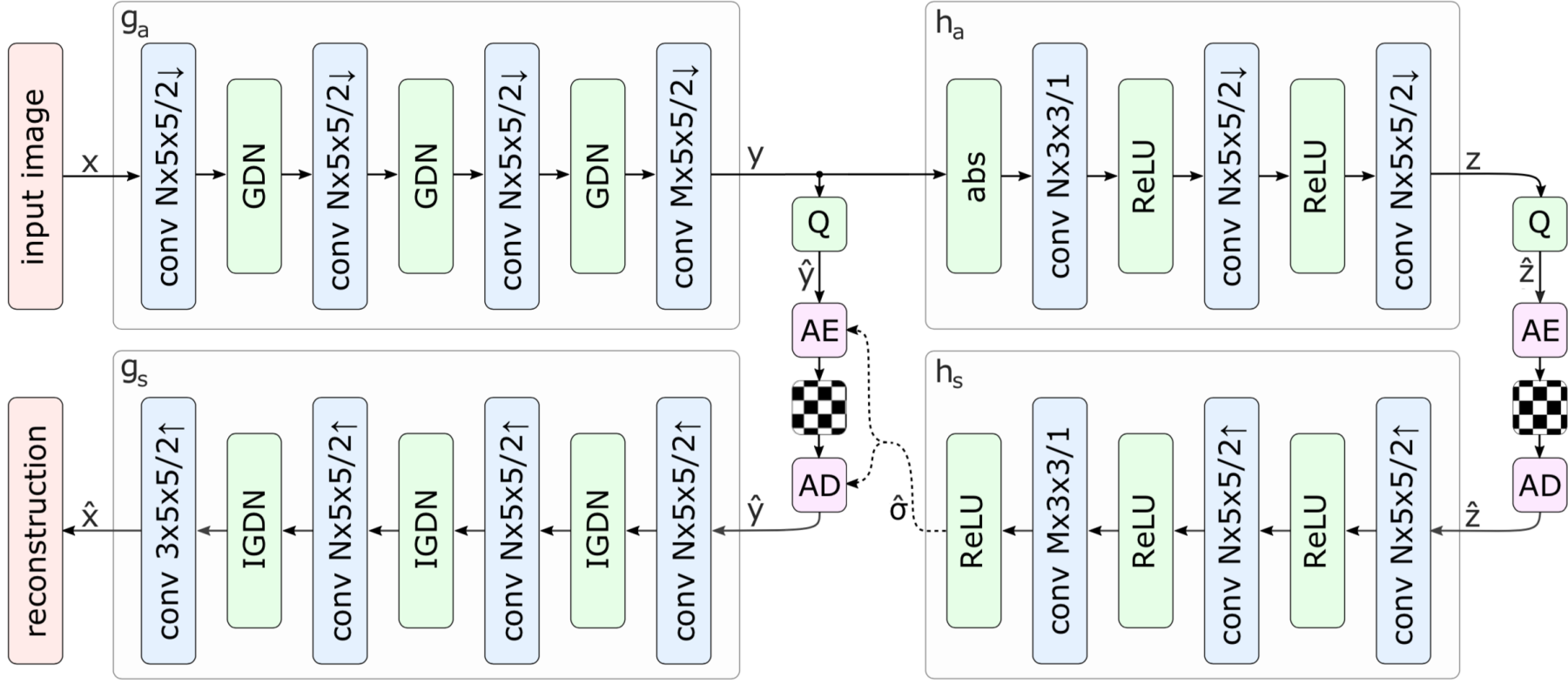
**Nick Johnston\***

`nickj@google.com`

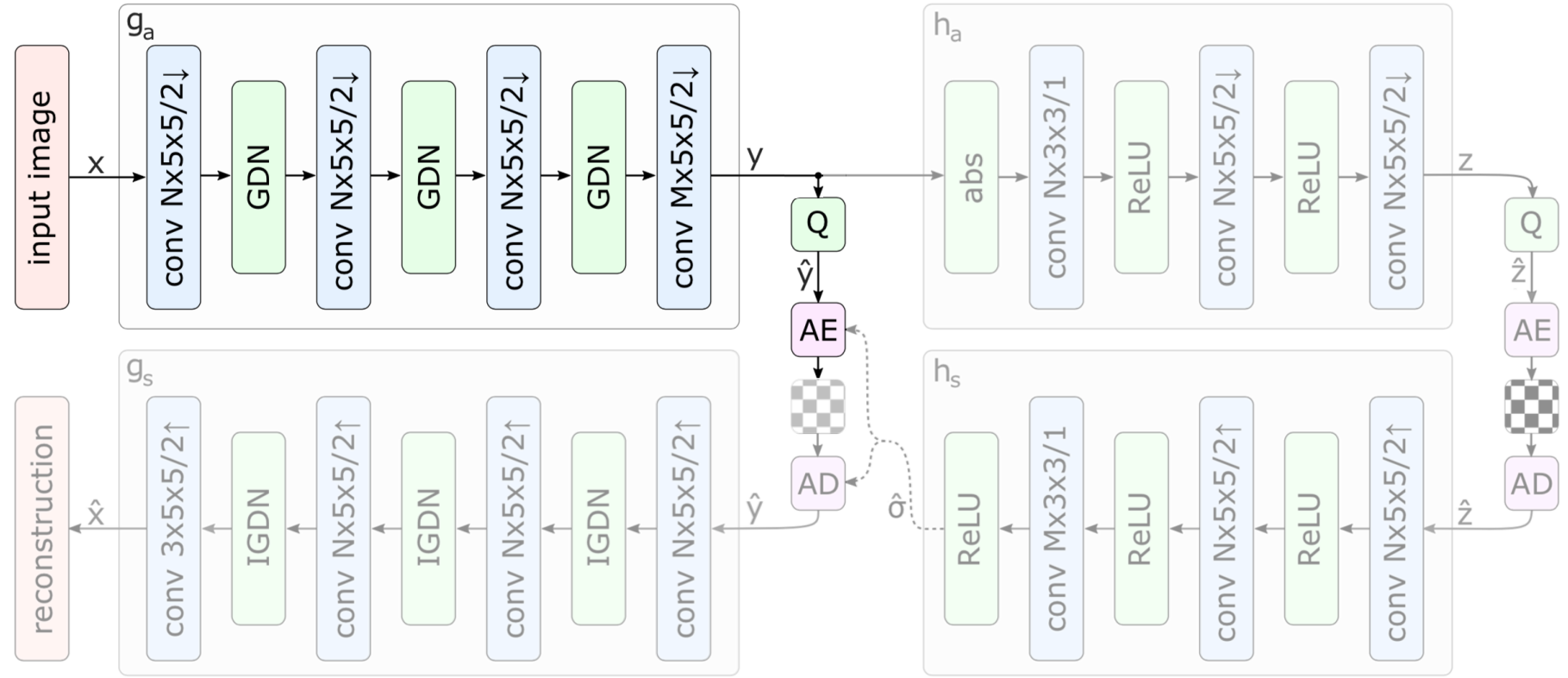
\*Google

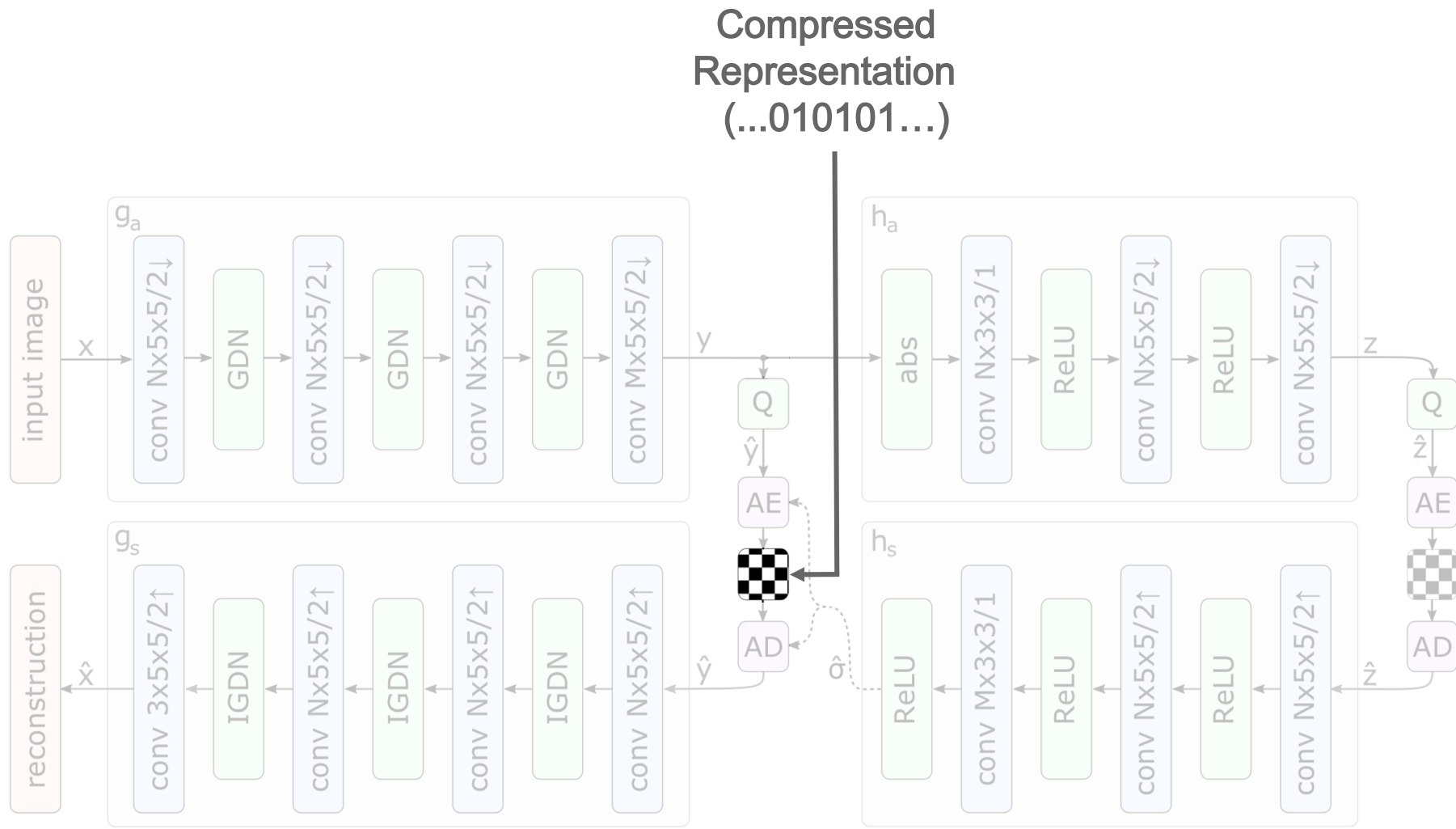
Mountain View, CA 94043, USA

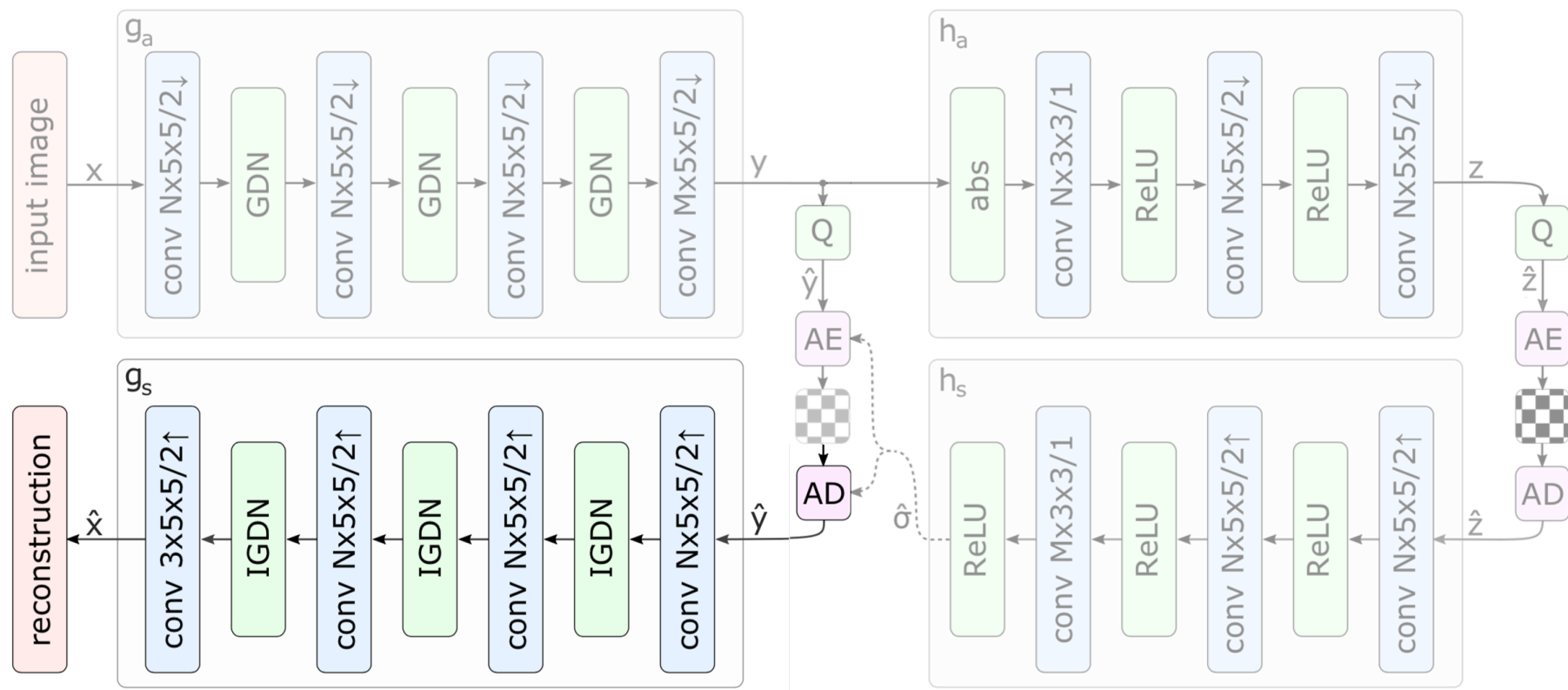




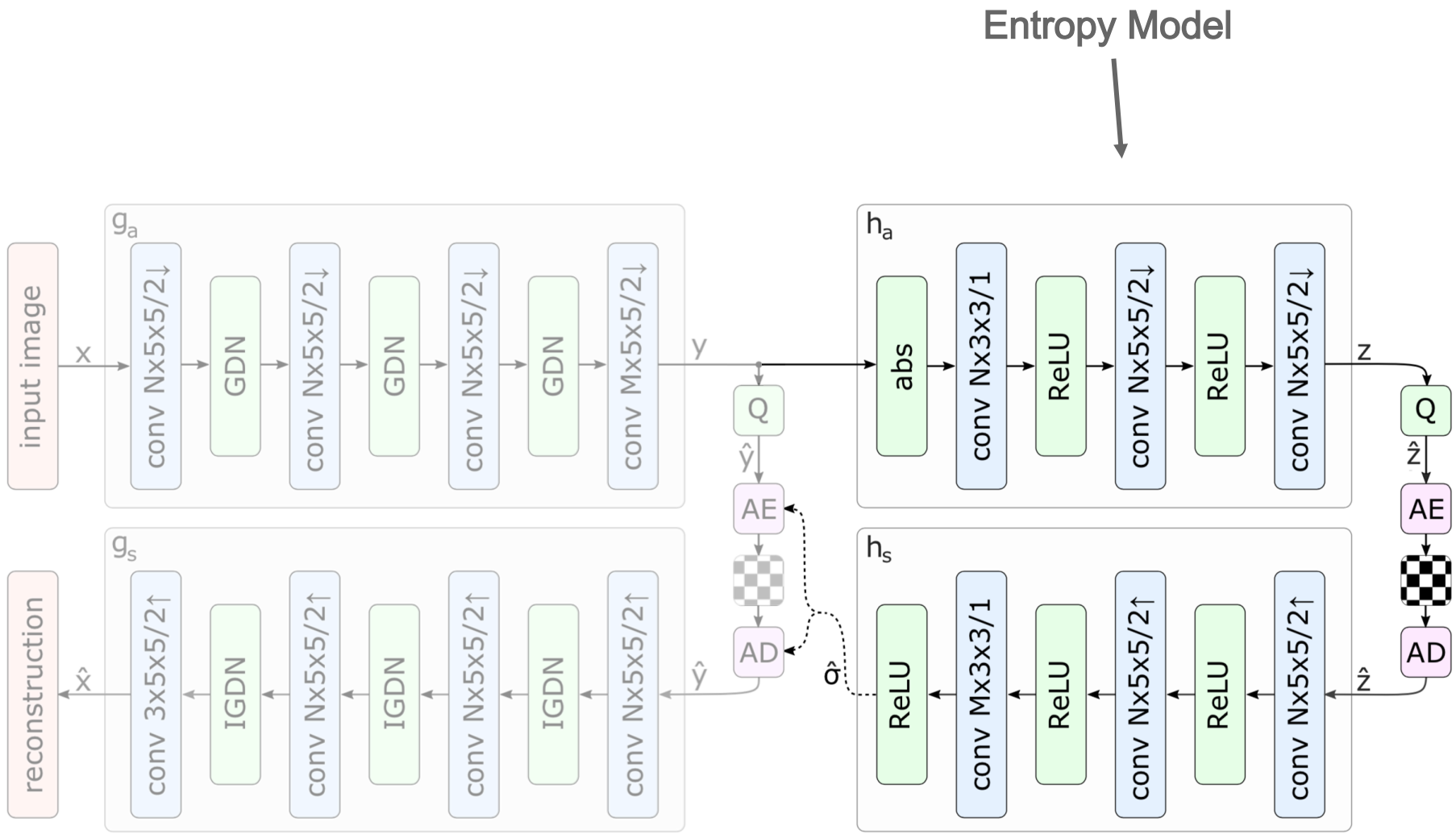
# Compressor

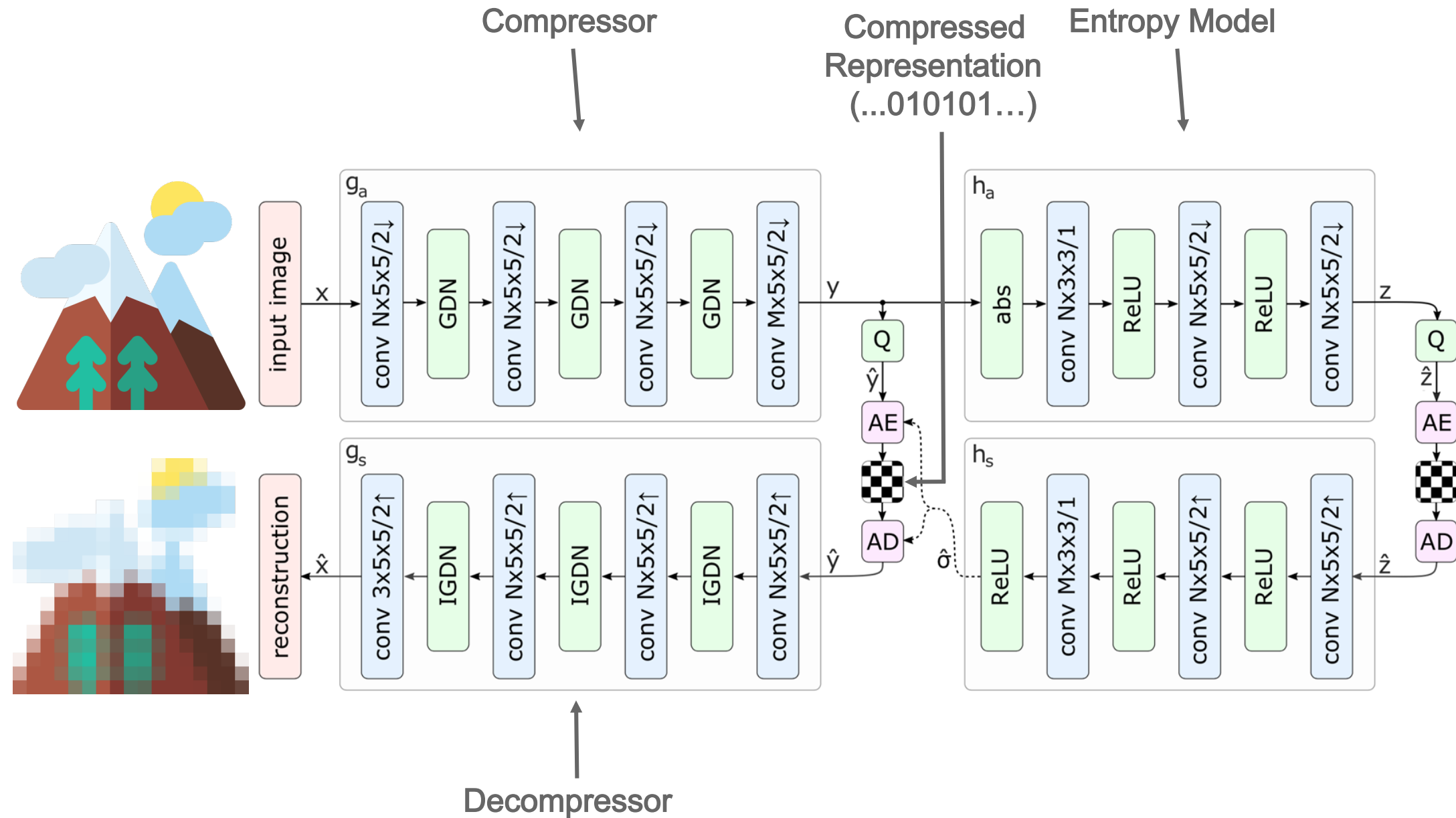




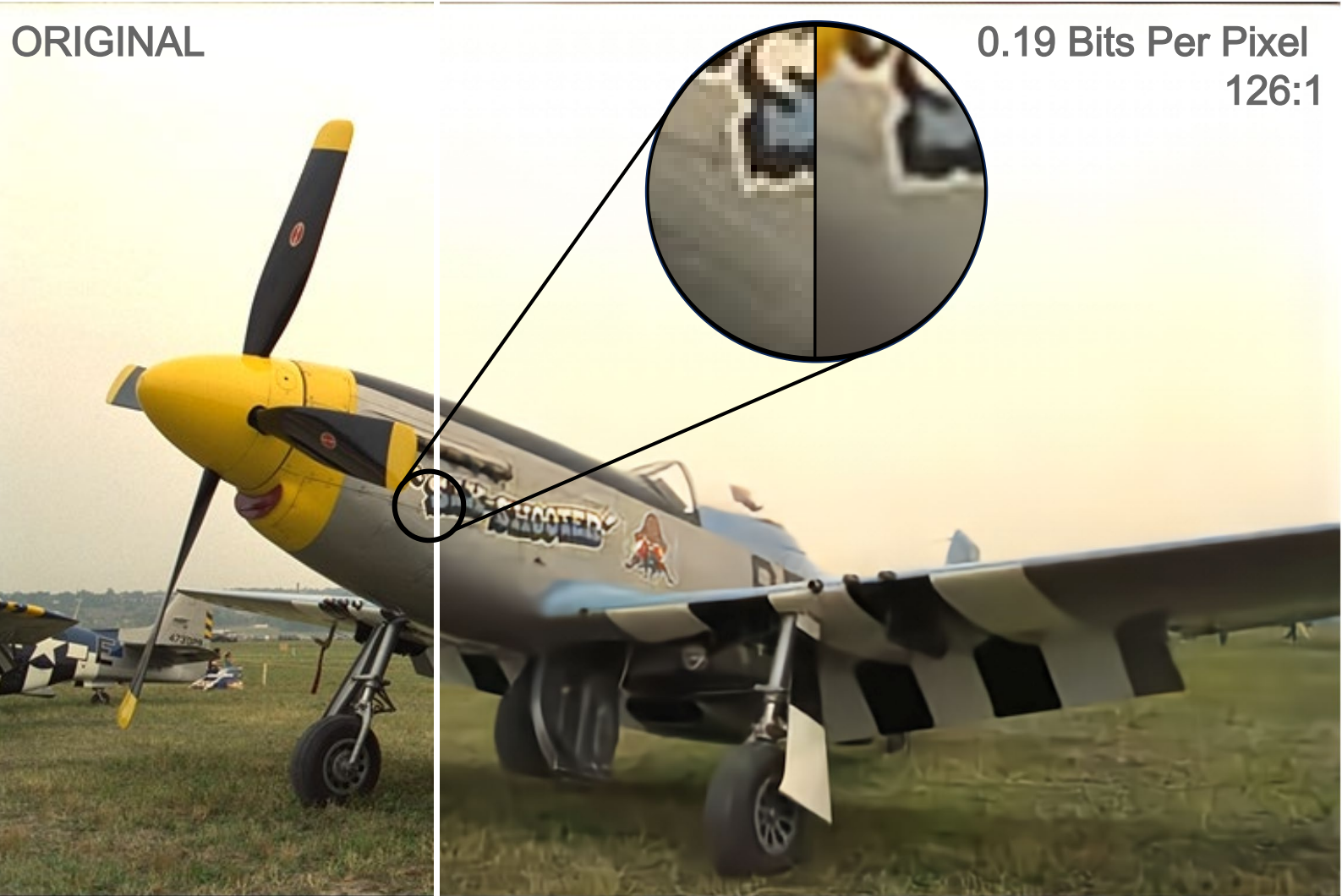


Decompressor



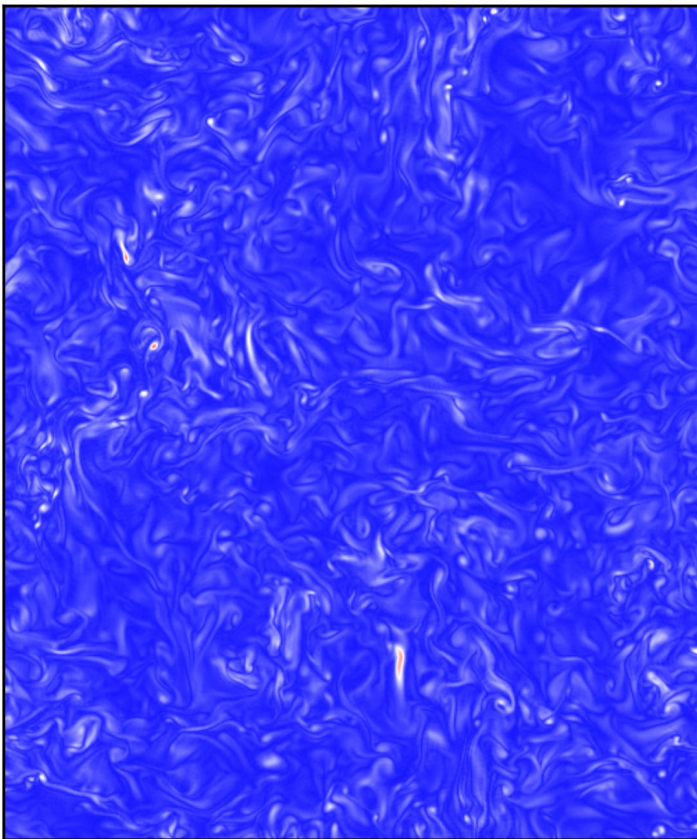


# VARIATIONAL IMAGE COMPRESSION WITH A SCALE HYPERPRIOR

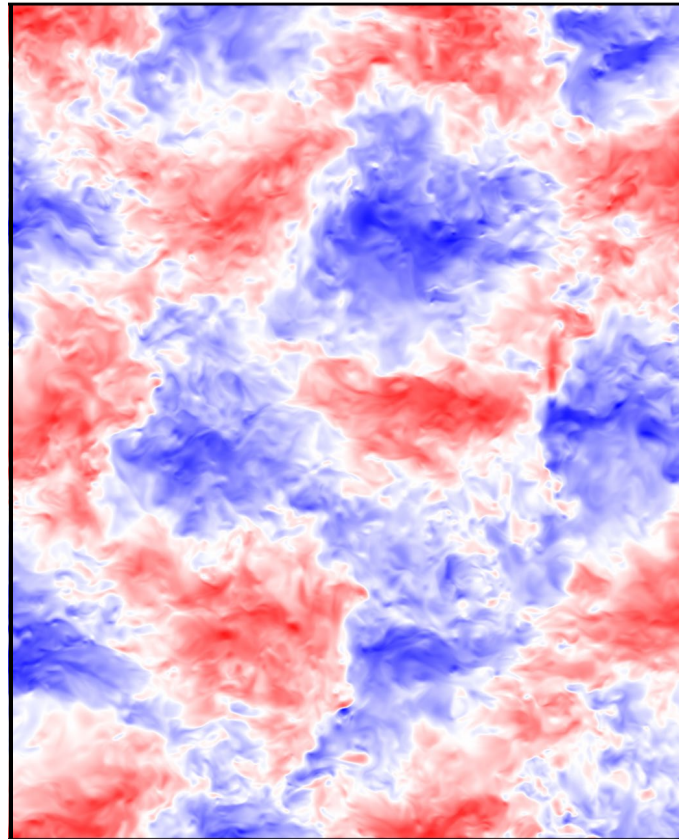


# What does this have to do with Scientific Data?

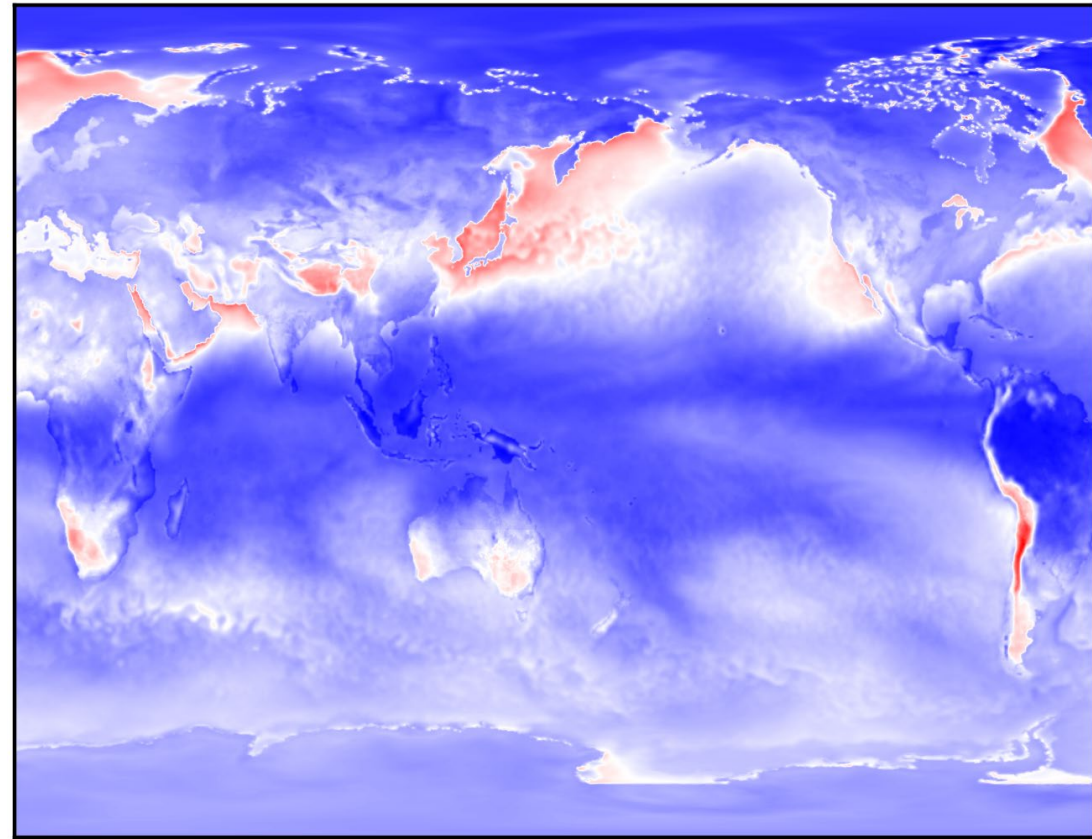




Vorticity



Velocity



Climate Data

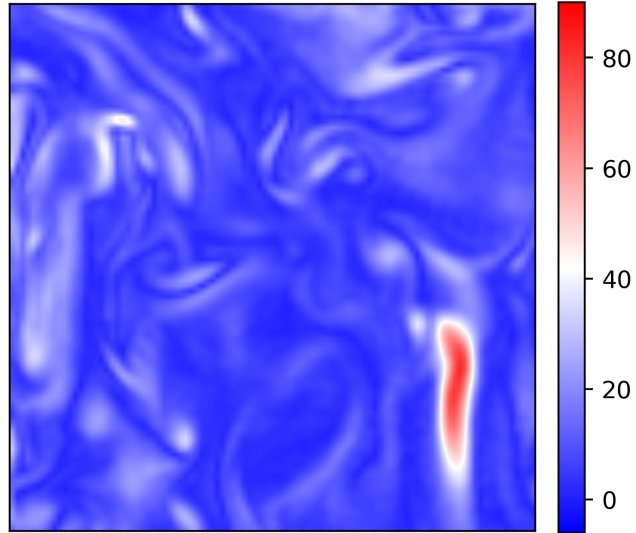


# Out-of-the-Box Results

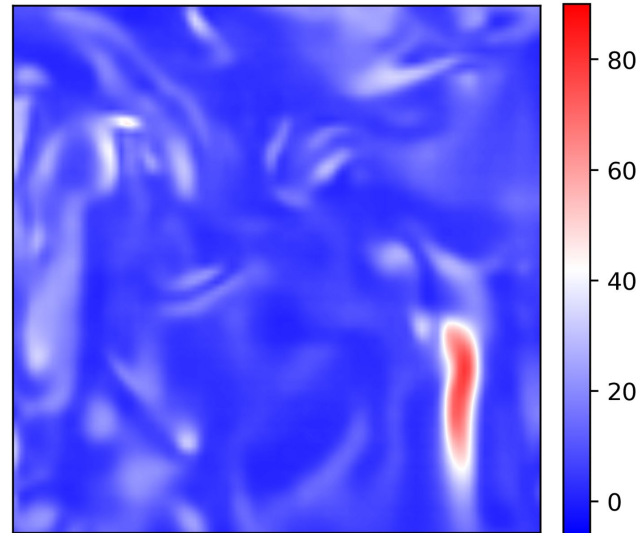
# Vorticity



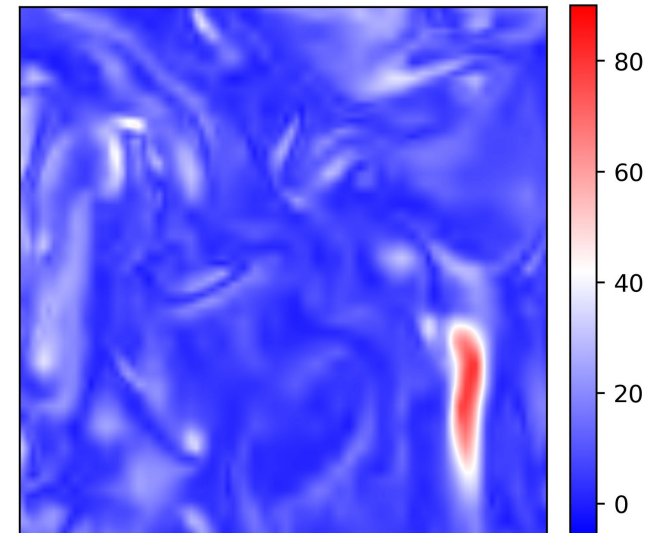
Original (32 BPP)



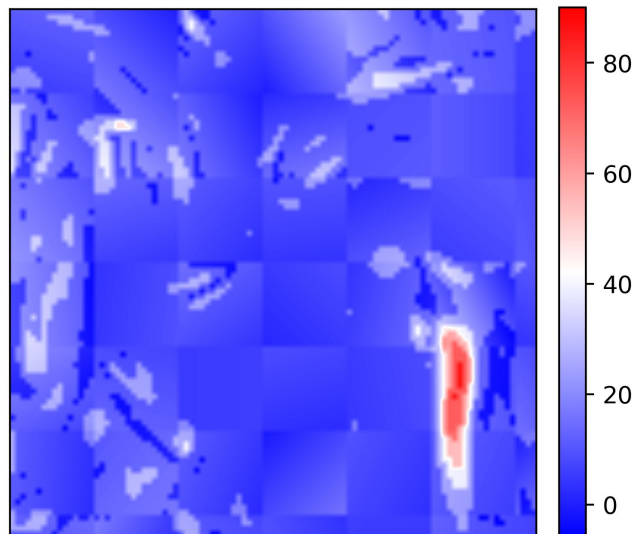
Neural Network ( BPP 0.55)



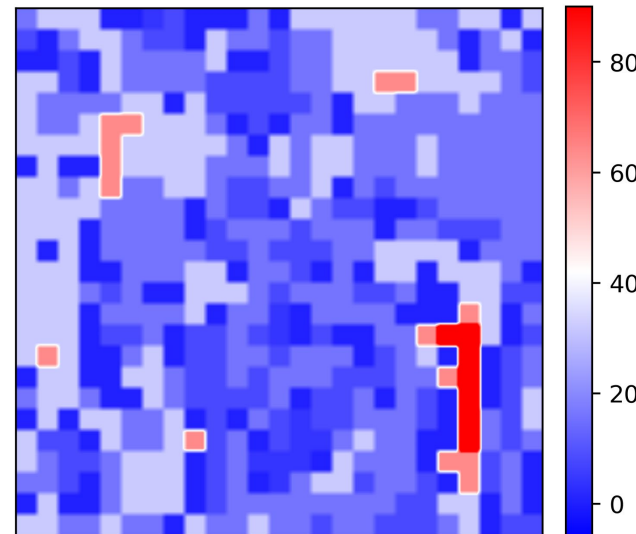
Speck (0.60 BPP)



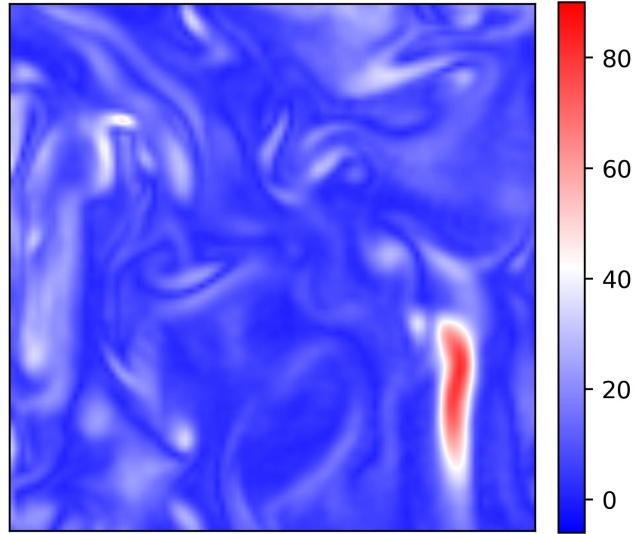
SZ (0.62 BPP)



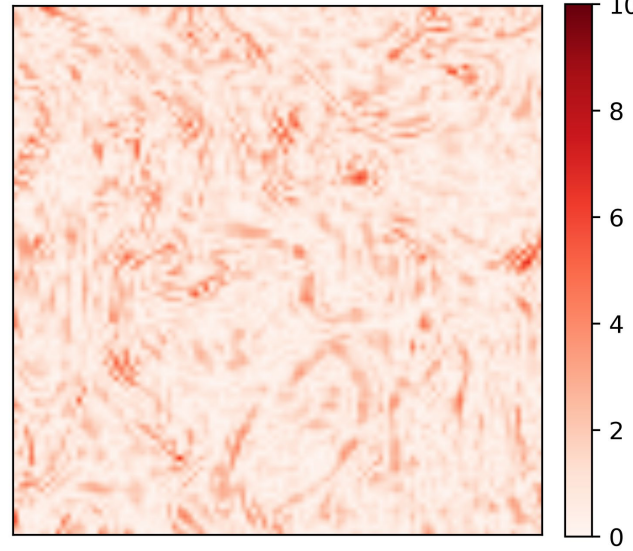
ZFP (0.69 BPP)



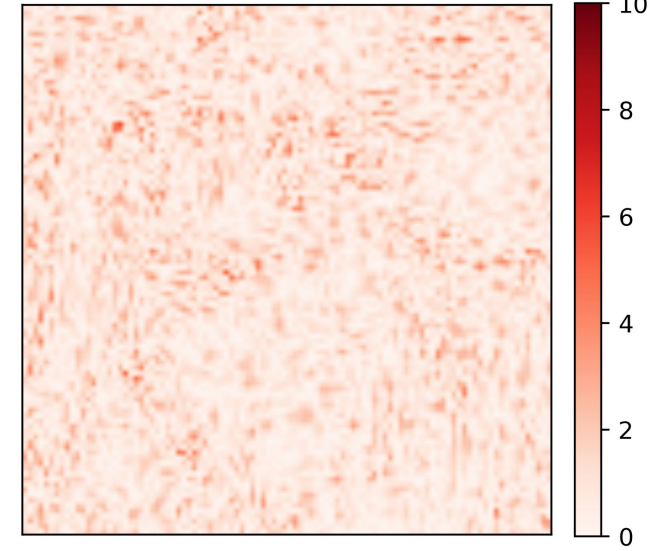
Original (32 BPP)



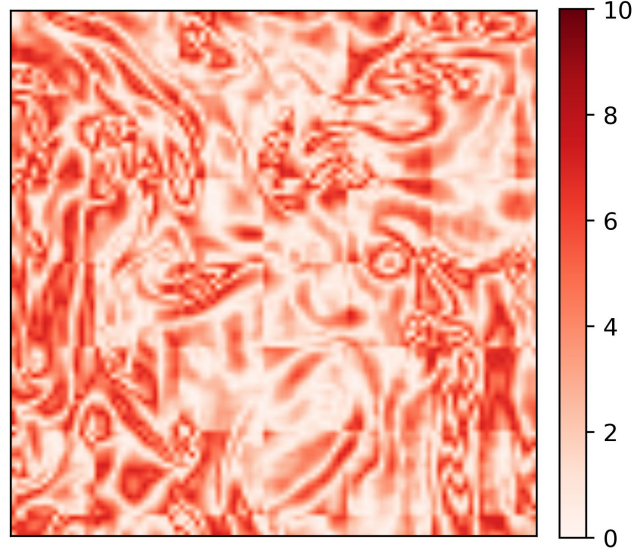
Neural Network ( BPP 0.55)



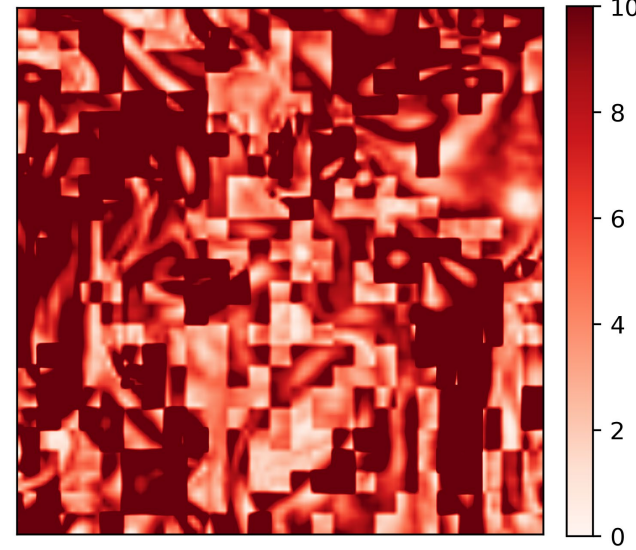
Speck (0.60 BPP)



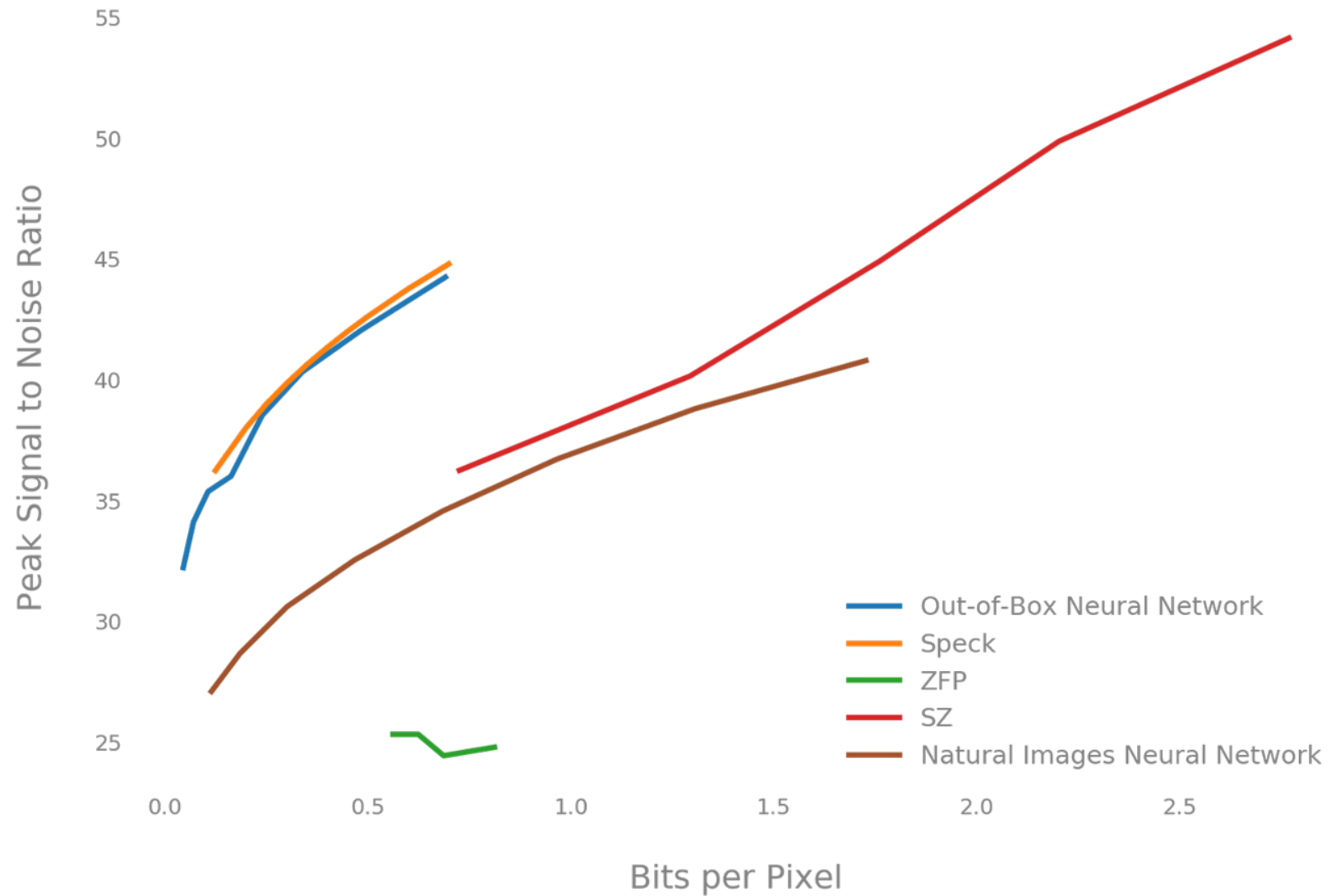
SZ (0.62 BPP)



ZFP (0.69 BPP)



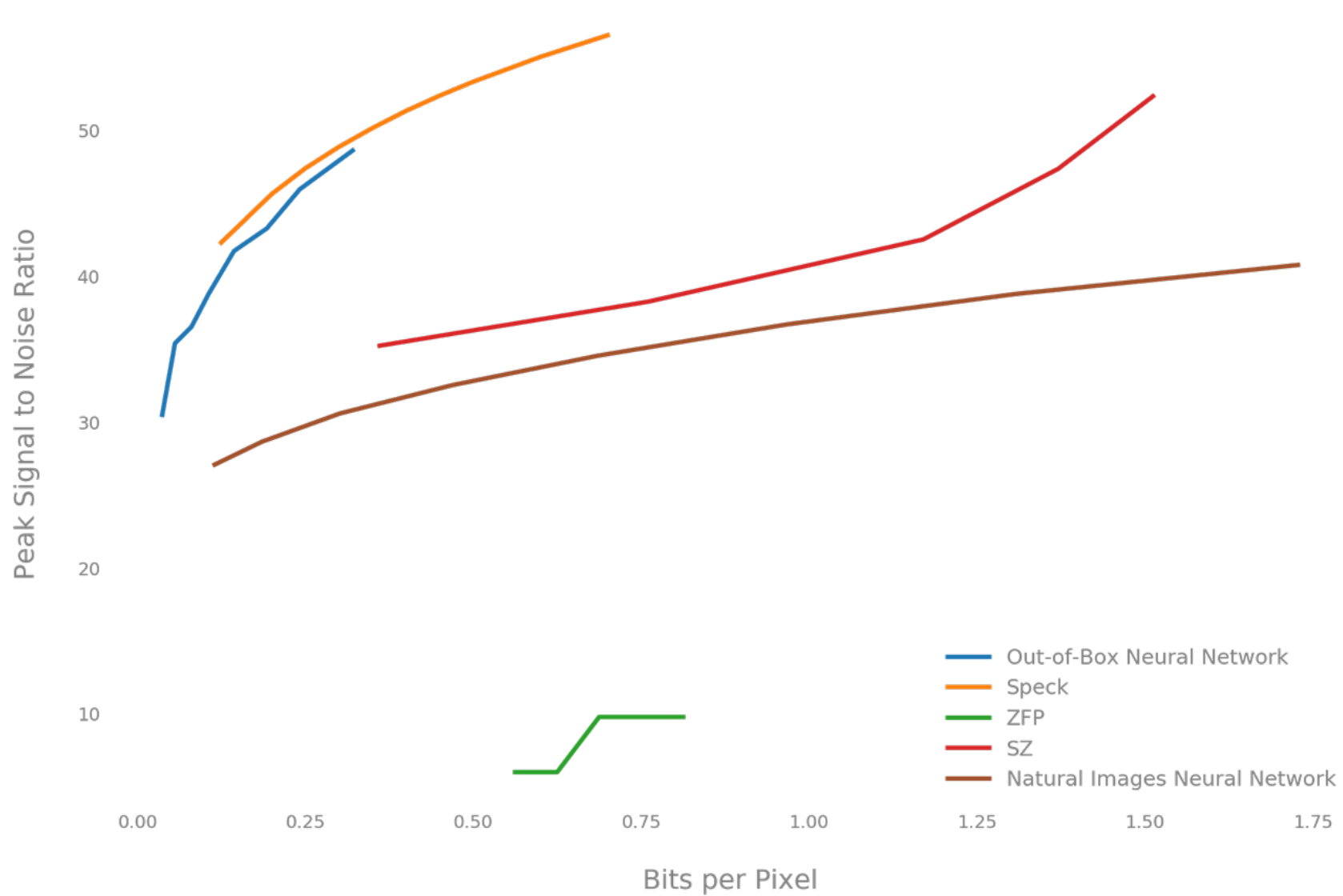
# Vorticity Peak Signal to Noise Ratio



# Velocity



# Velocity Peak Signal to Noise Ratio

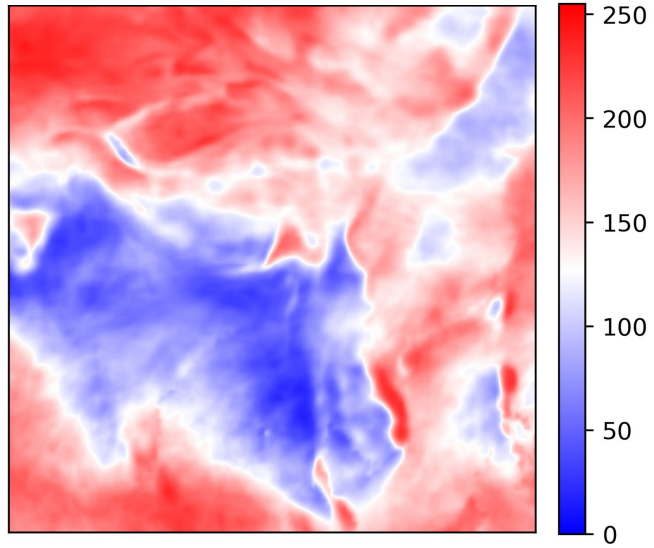




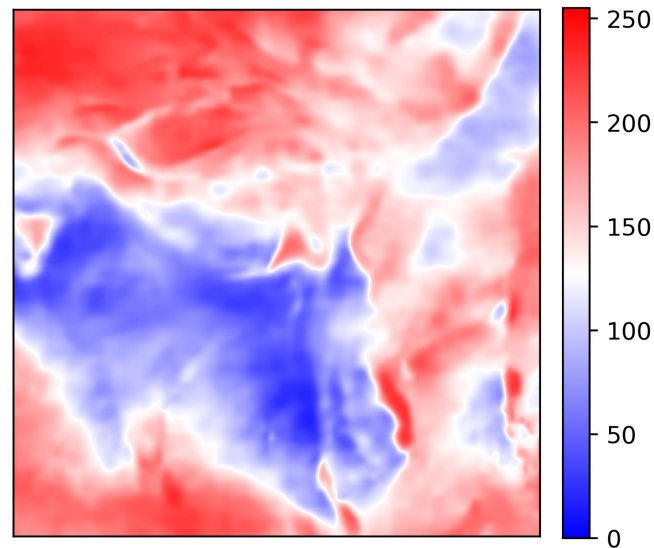
# Climate Data



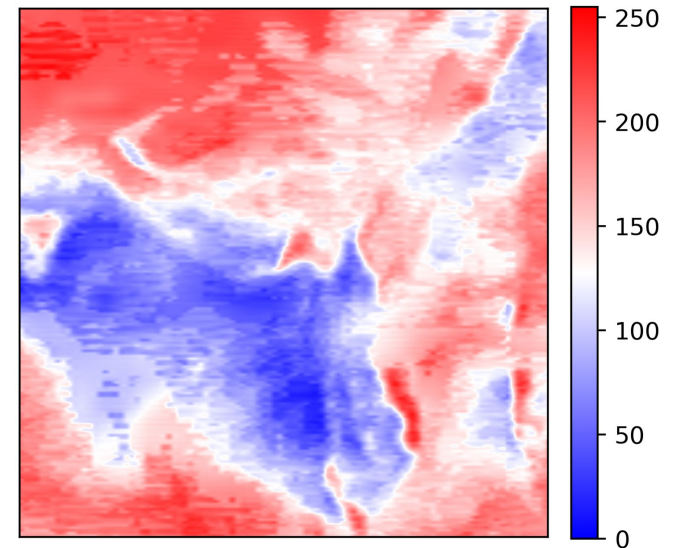
Original (32 BPP)



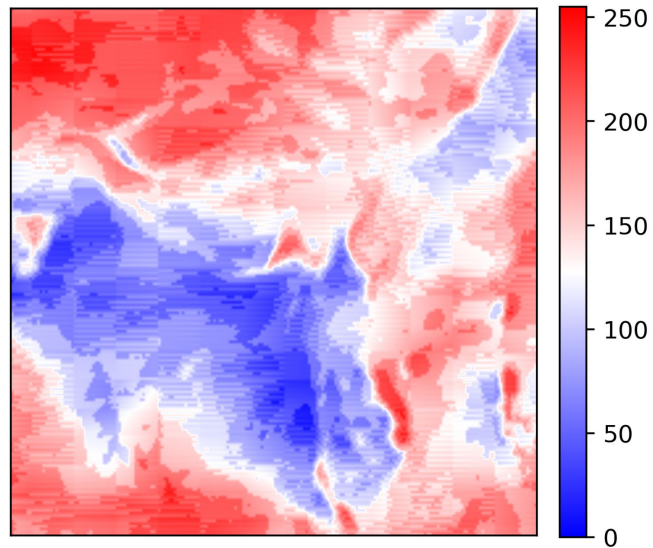
Neural Network ( BPP 0.41)



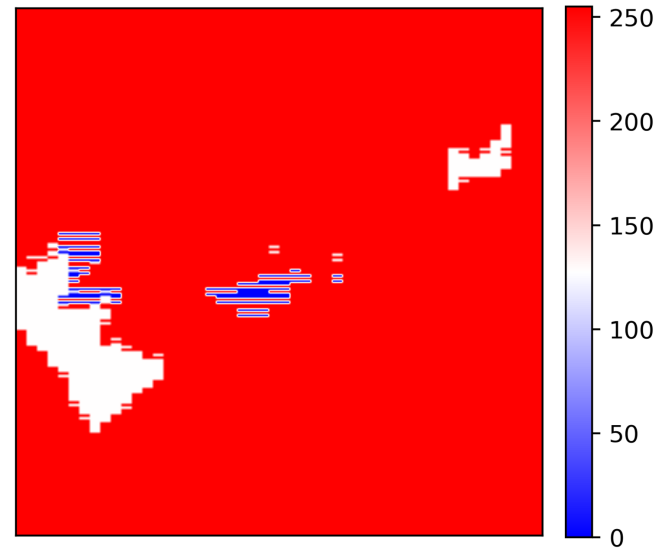
Speck (0.70 BPP)



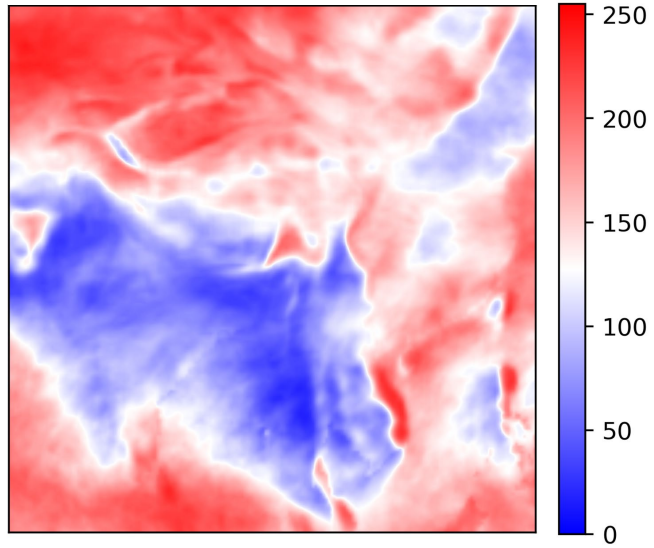
SZ (0.87 BPP)



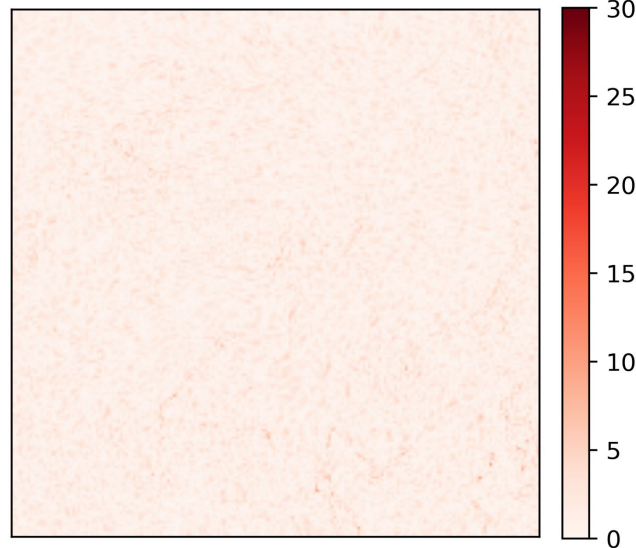
ZFP (0.7 BPP)



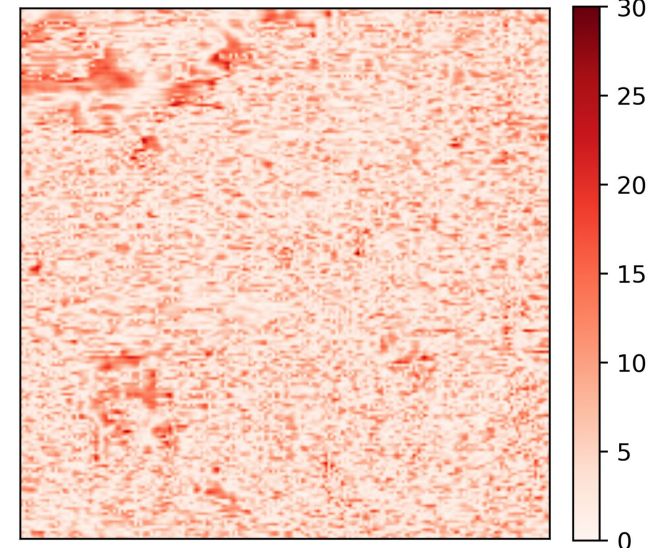
Original (32 BPP)



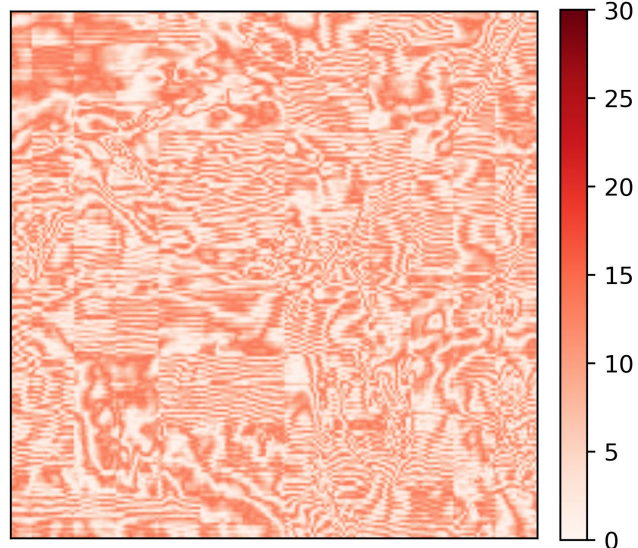
Neural Network ( BPP 0.41)



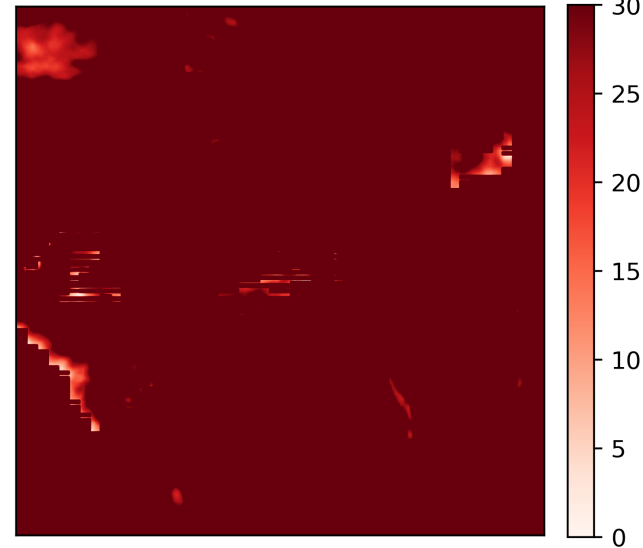
Speck (0.70 BPP)



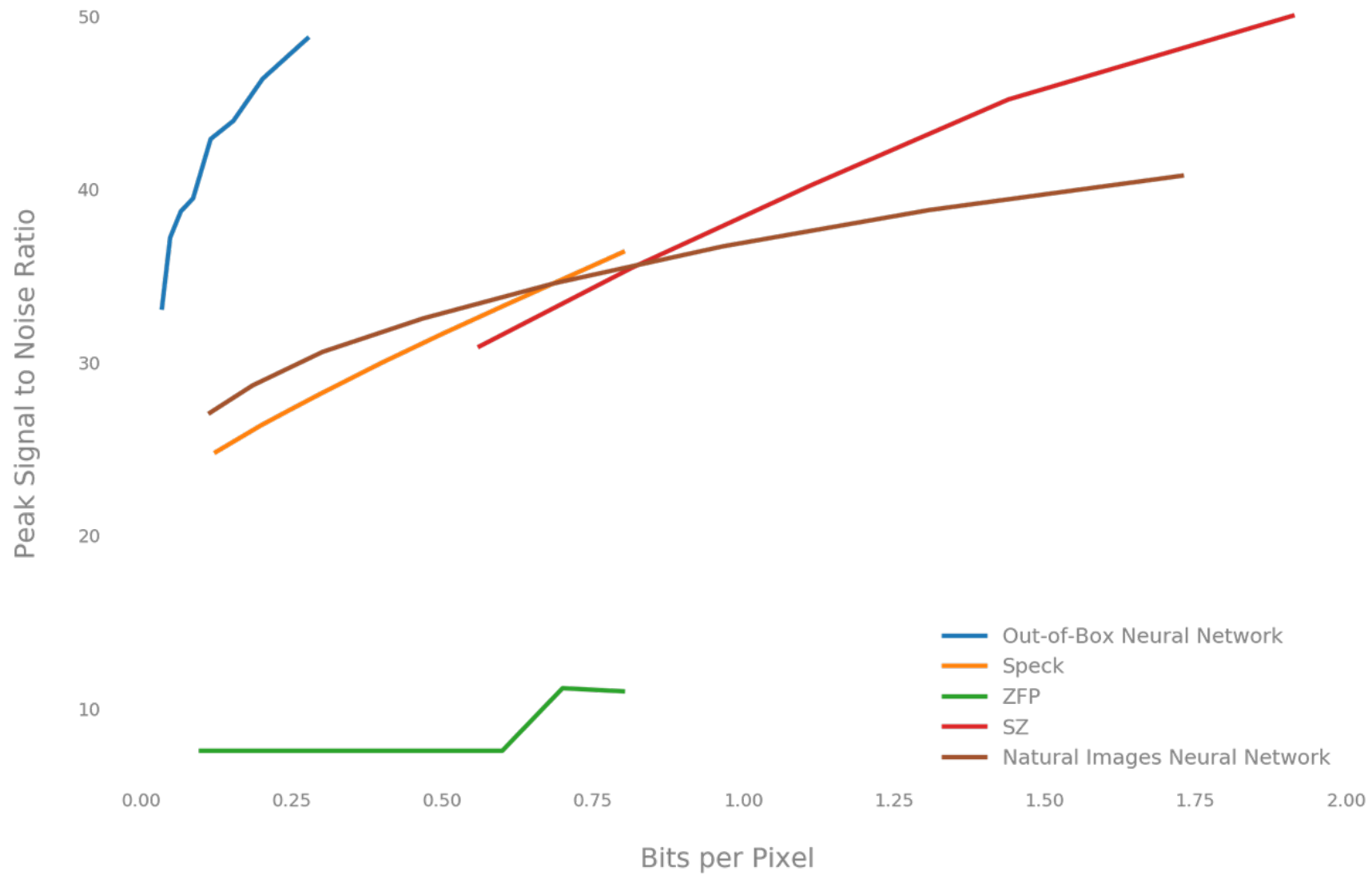
SZ (0.87 BPP)



ZFP (0.7 BPP)



# Climate Data Peak Signal to Noise Ratio

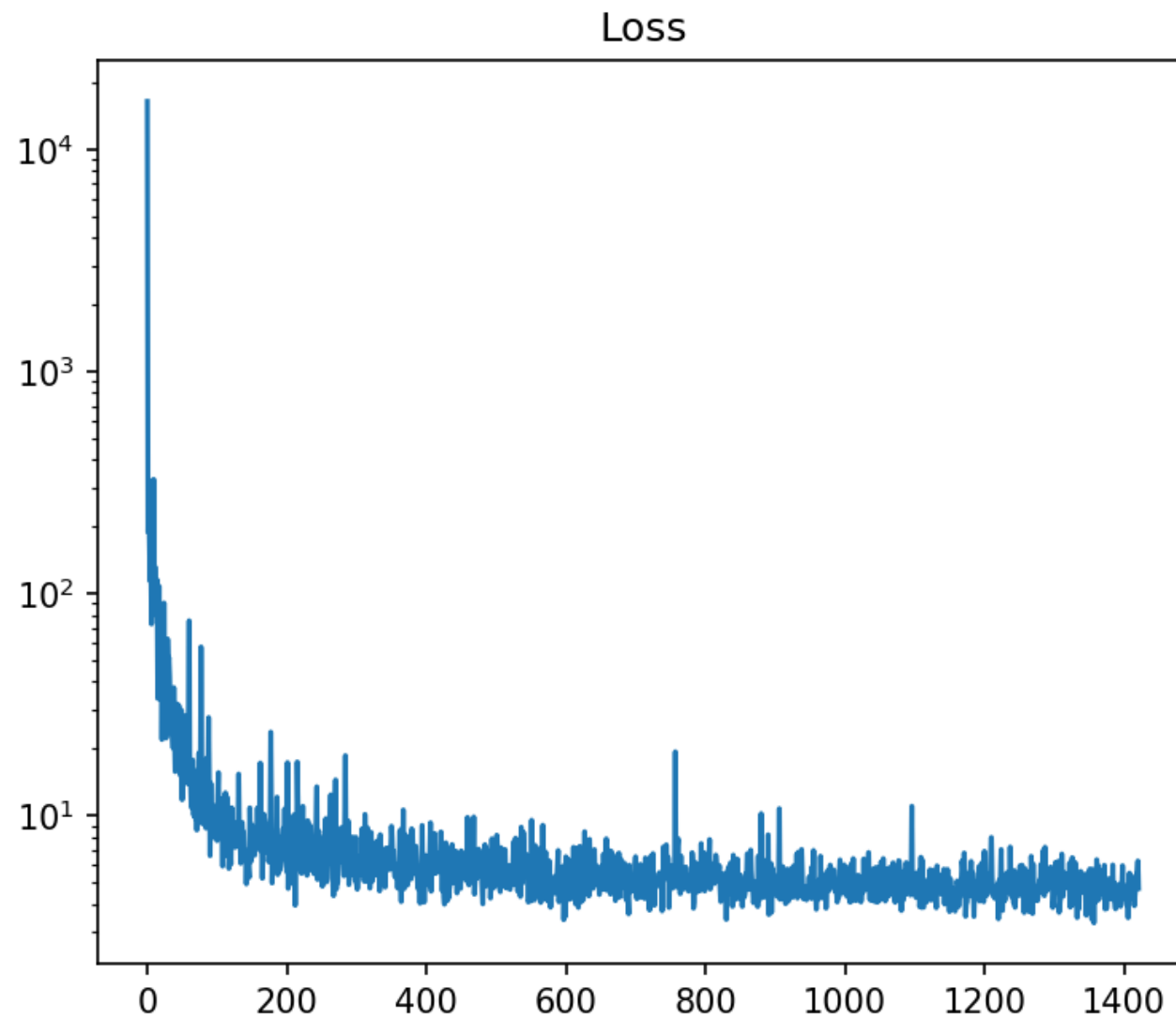


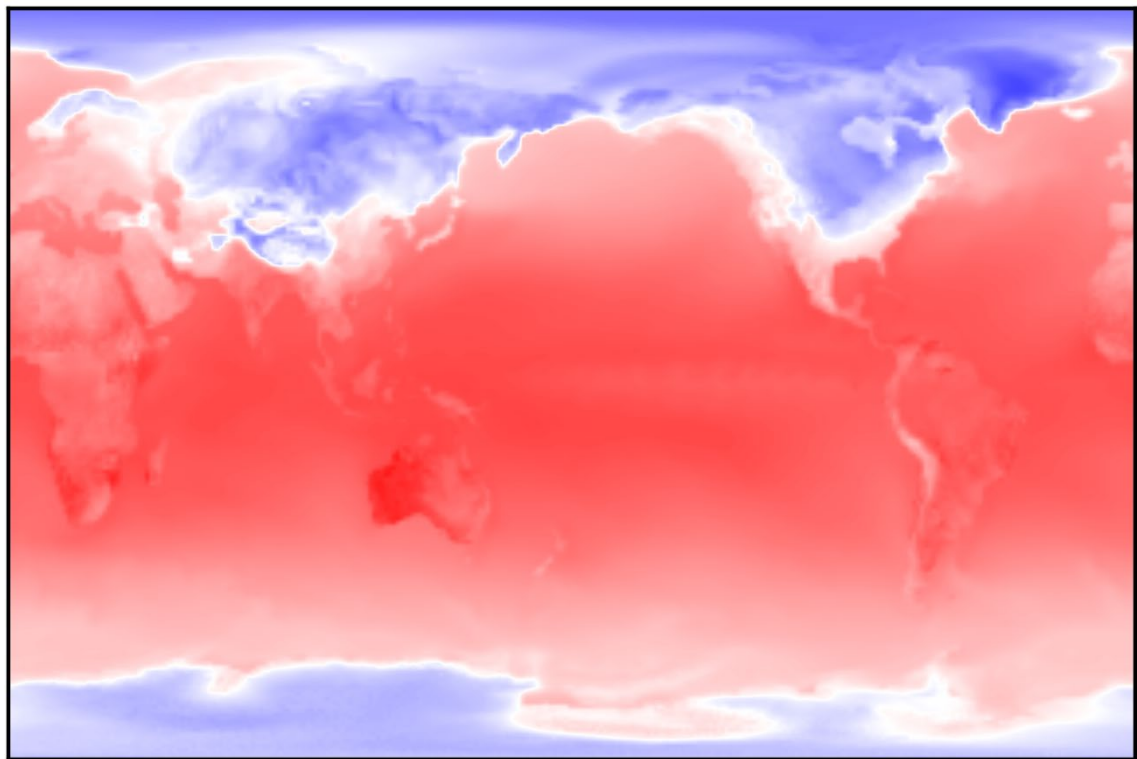
# Retraining

- I. Customize Bits Per Pixel
- II. Improve Climate Data Performance

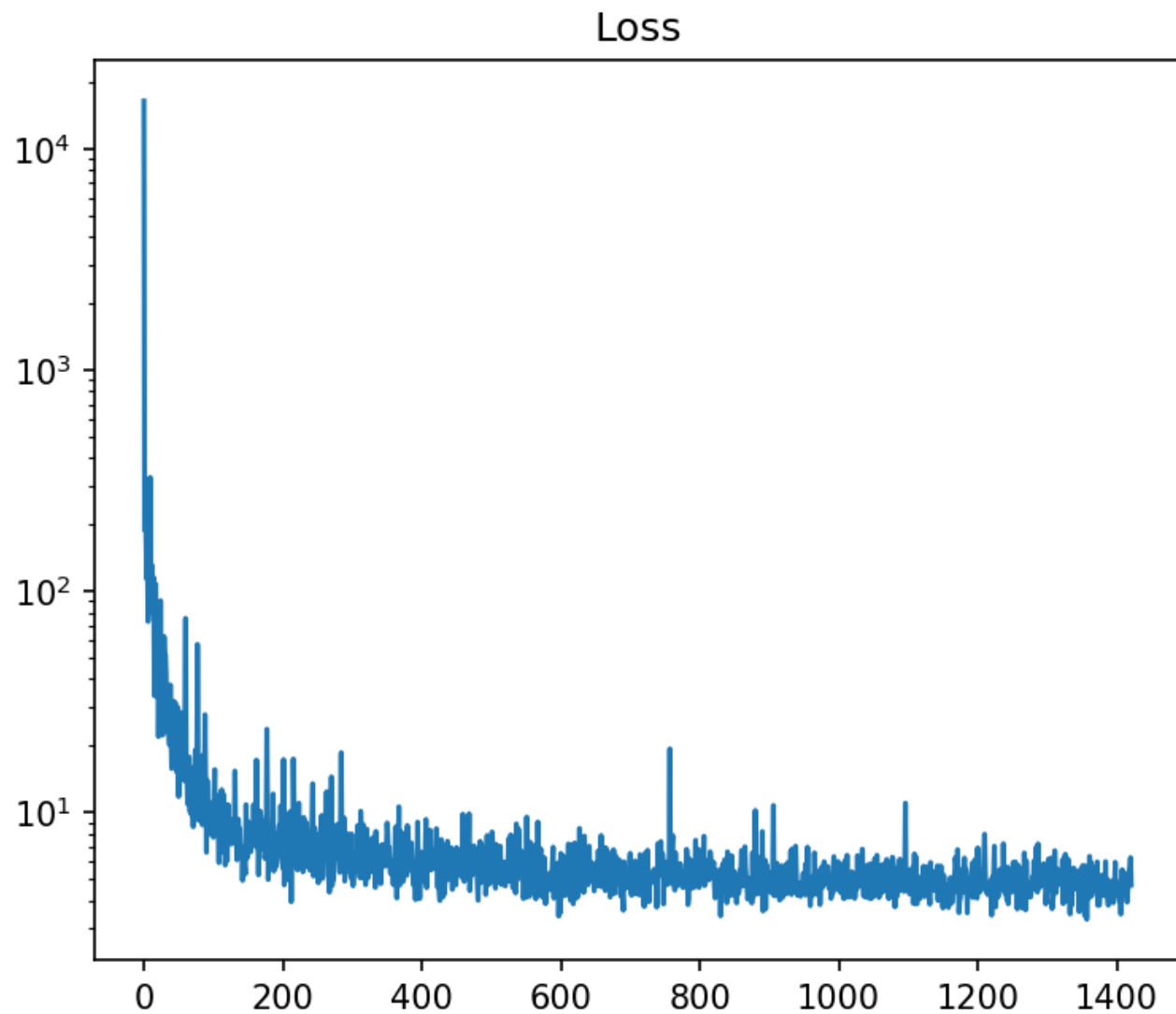


2 Million Steps





500 Thousand Steps

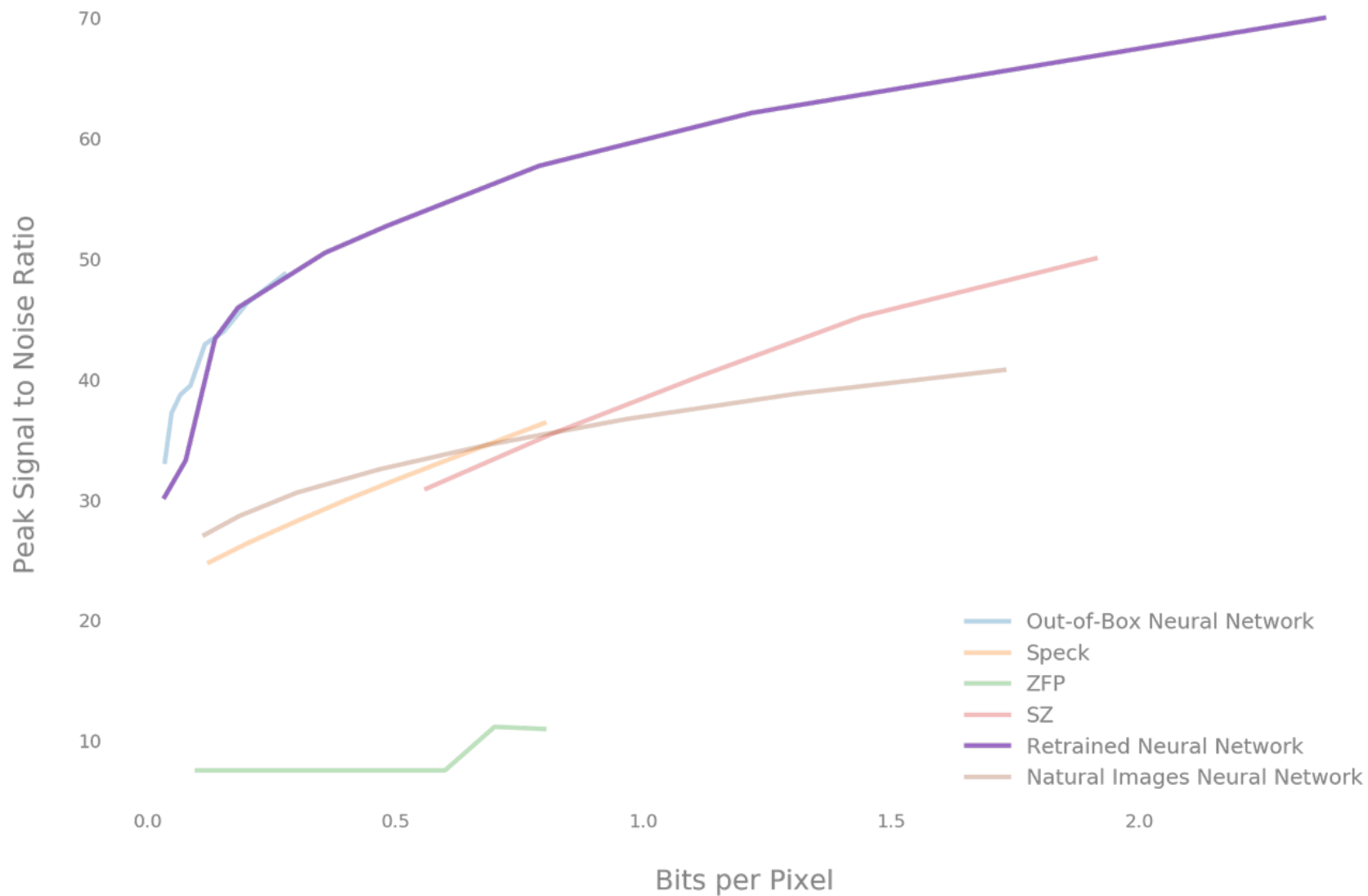


# Climate Data

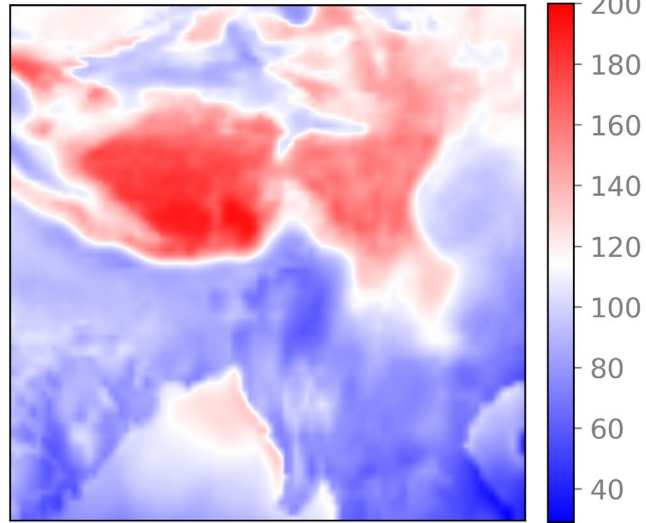




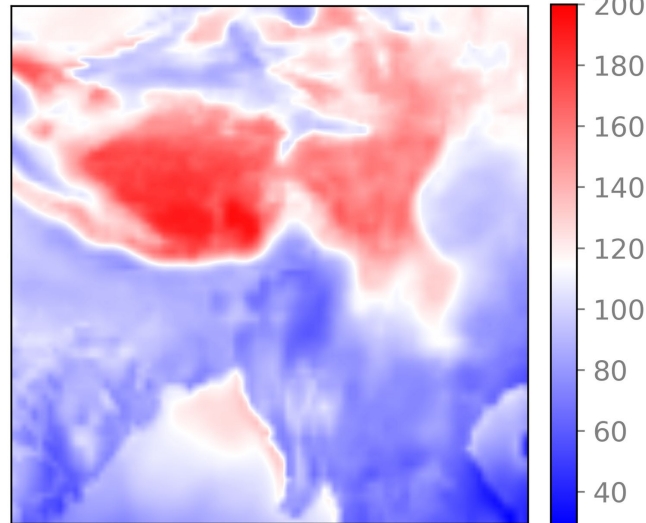
# Climate Data Peak Signal to Noise Ratio



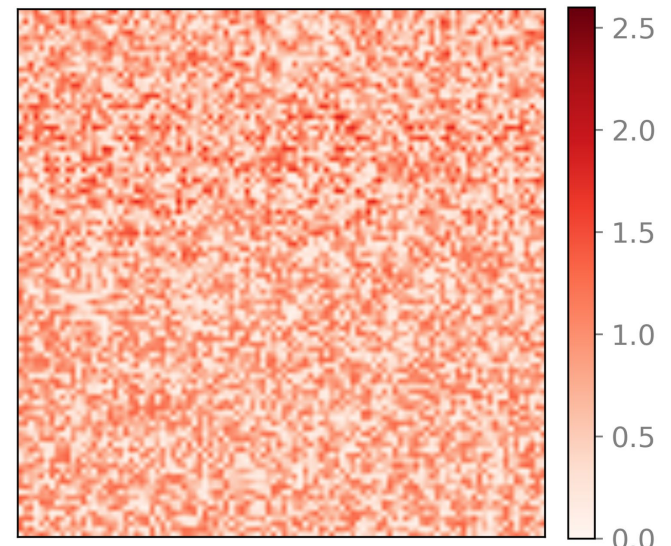
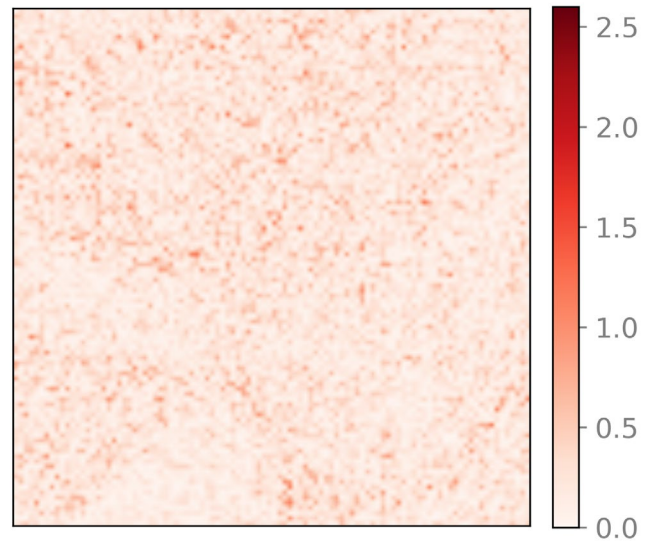
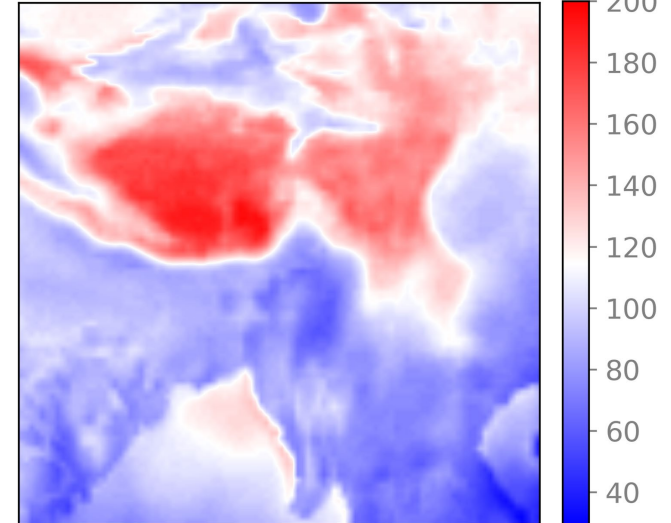
Original (32 BPP)



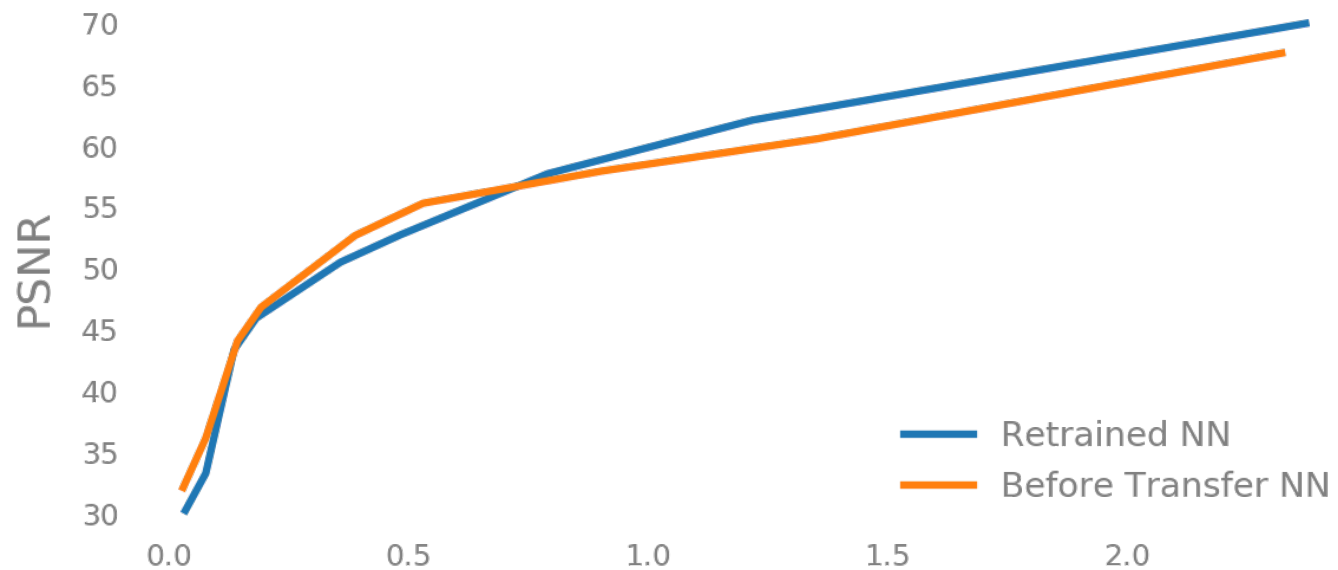
Retrained NN (1.5 BPP)



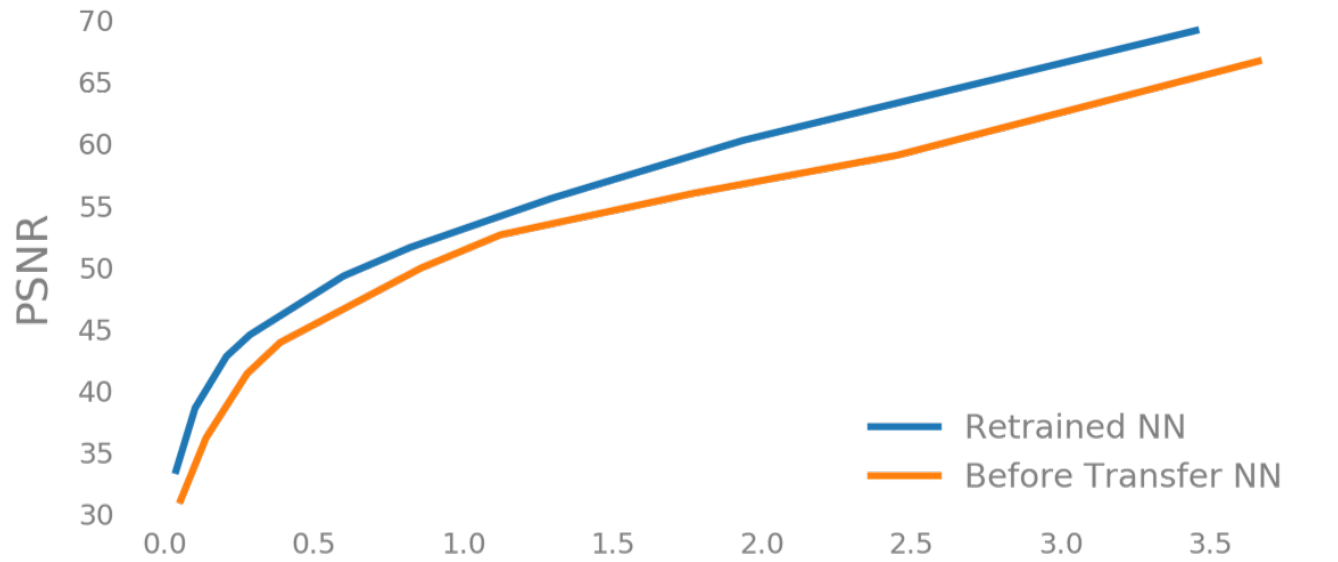
SZ (2.3 BPP)



# Climate Data PSNR



# Training Data (PRECT + TS) PSNR



# Special Thanks



## Mentors

Samuel Li  
John Clyne



## SIParCS Team

AJ Lauer  
Virginia Do  
Jess Hoopengardner  
Jerry Cyccone

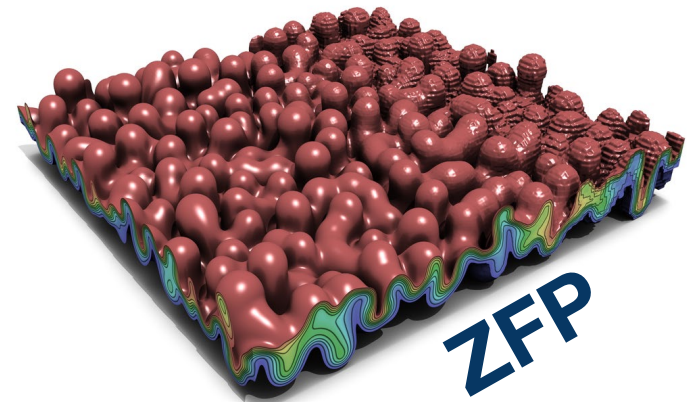
# Questions







Squeeze (SZ)





# VARIATIONAL IMAGE COMPRESSION WITH A SCALE HYPERPRIOR

ORIGINAL



# VARIATIONAL IMAGE COMPRESSION WITH A SCALE HYPERPRIOR

0.1932 Bits Per Pixel  
And compression ratio



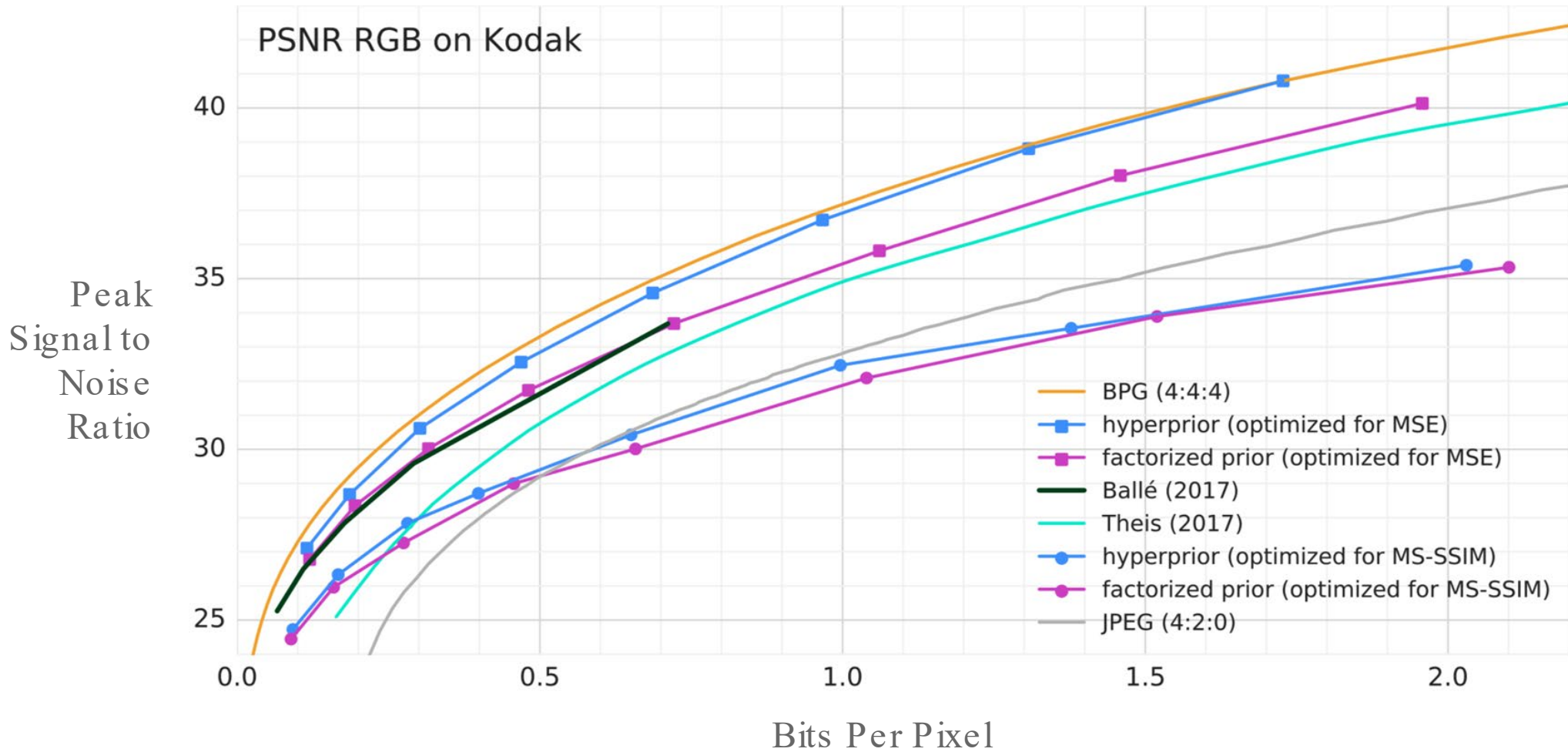
# VARIATIONAL IMAGE COMPRESSION WITH A SCALE HYPERPRIOR

ORIGINAL

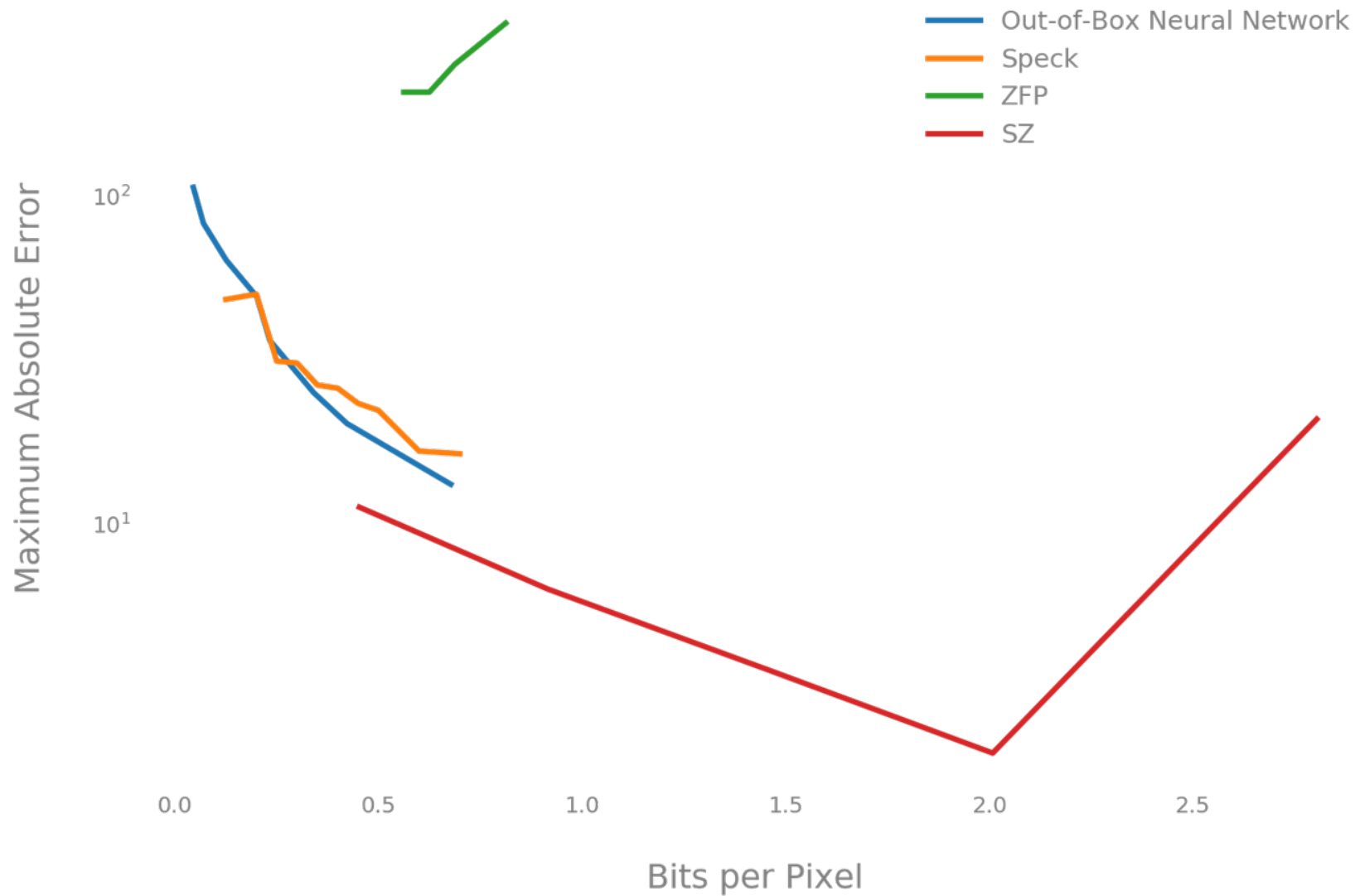
0.1932 BPP



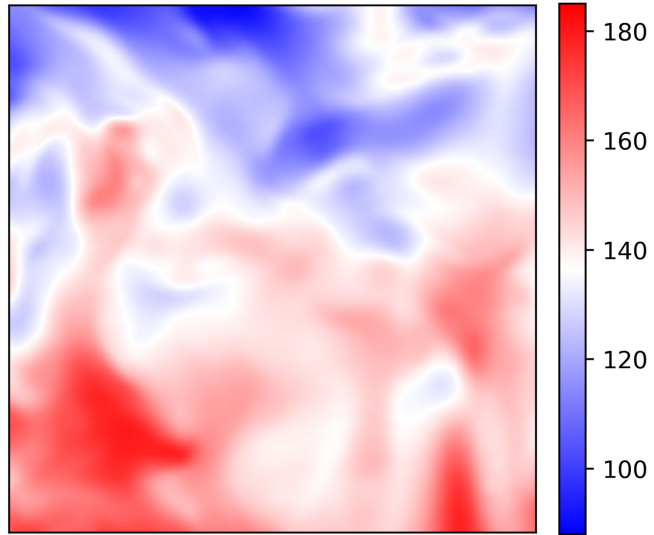
# VARIATIONAL IMAGE COMPRESSION WITH A SCALE HYPERPRIOR



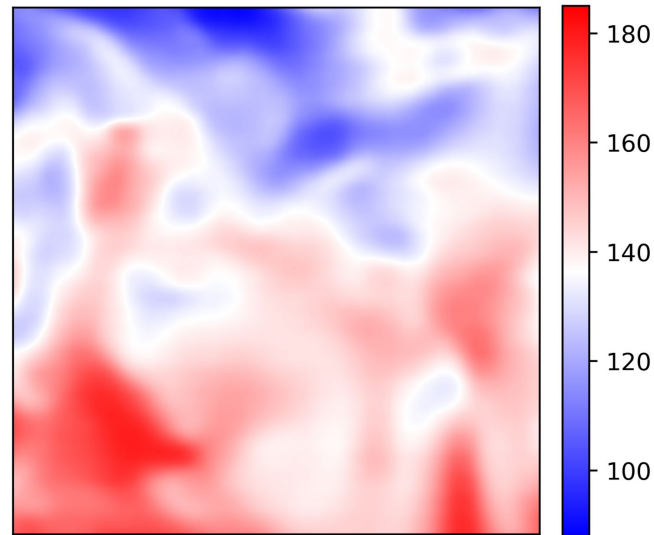
# Vorticity Maximum Error



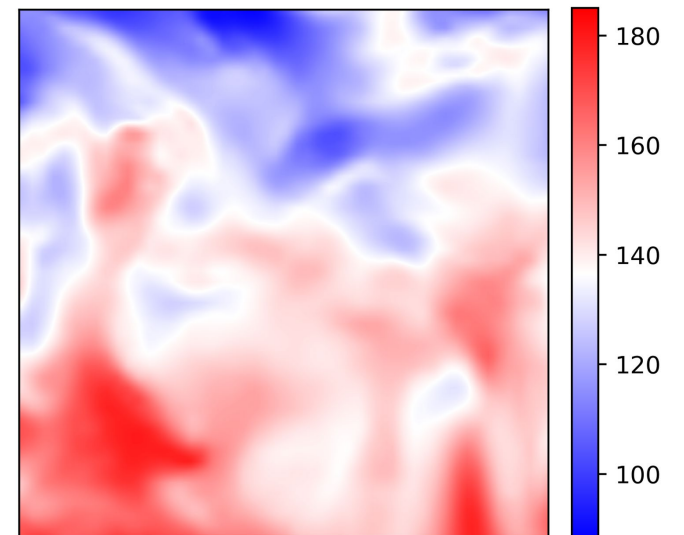
Original (32 BPP)



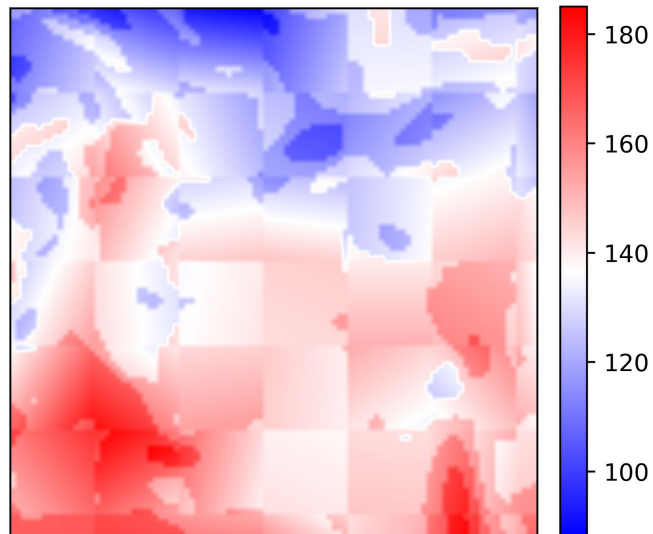
Neural Network (BPP 0.27)



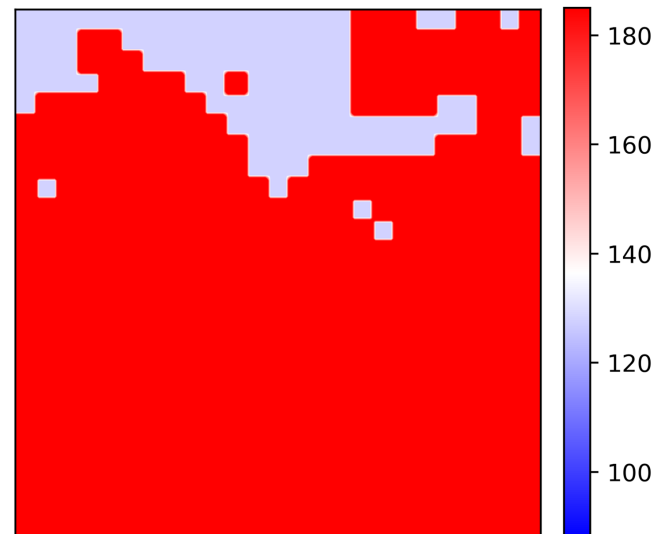
Speck (0.60 BPP)



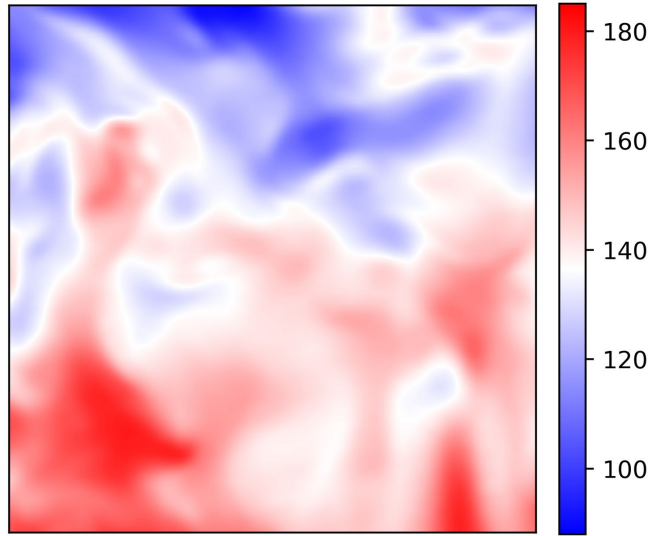
SZ (0.70 BPP)



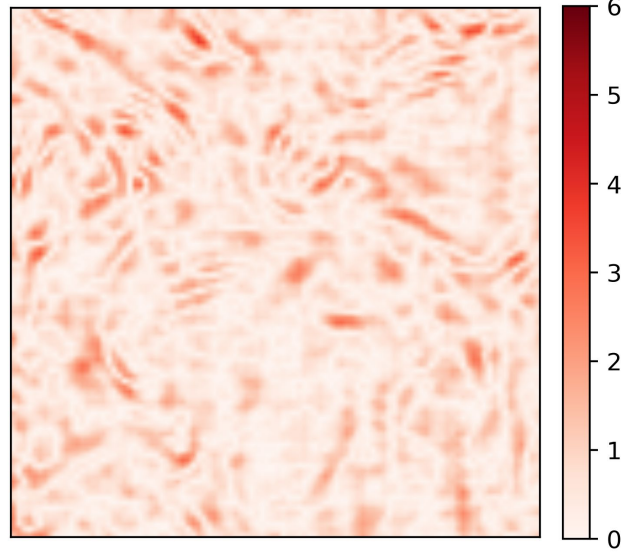
ZFP (0.69 BPP)



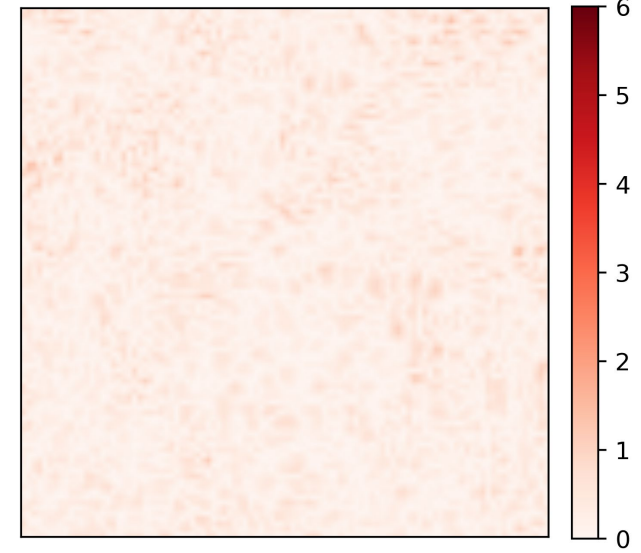
Original (32 BPP)



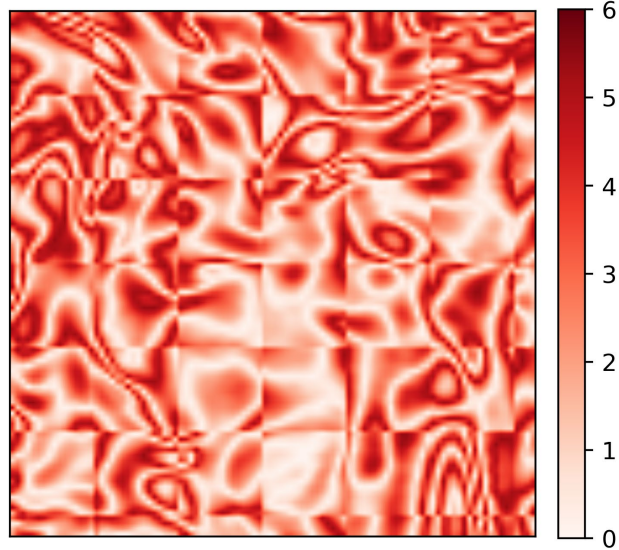
Neural Network (BPP 0.27)



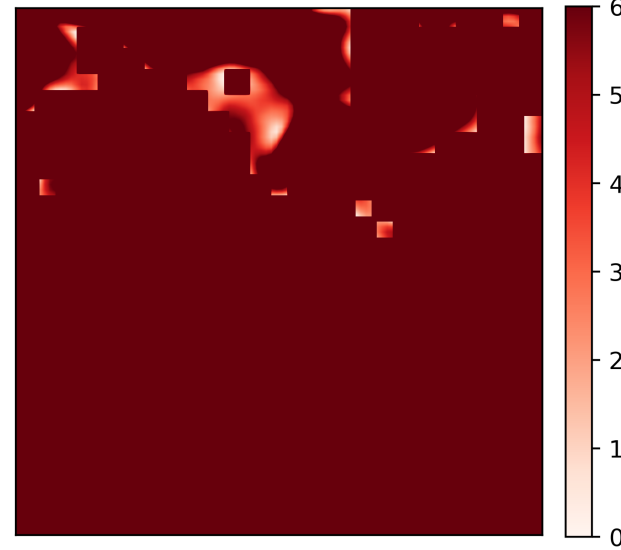
Speck (0.60 BPP)



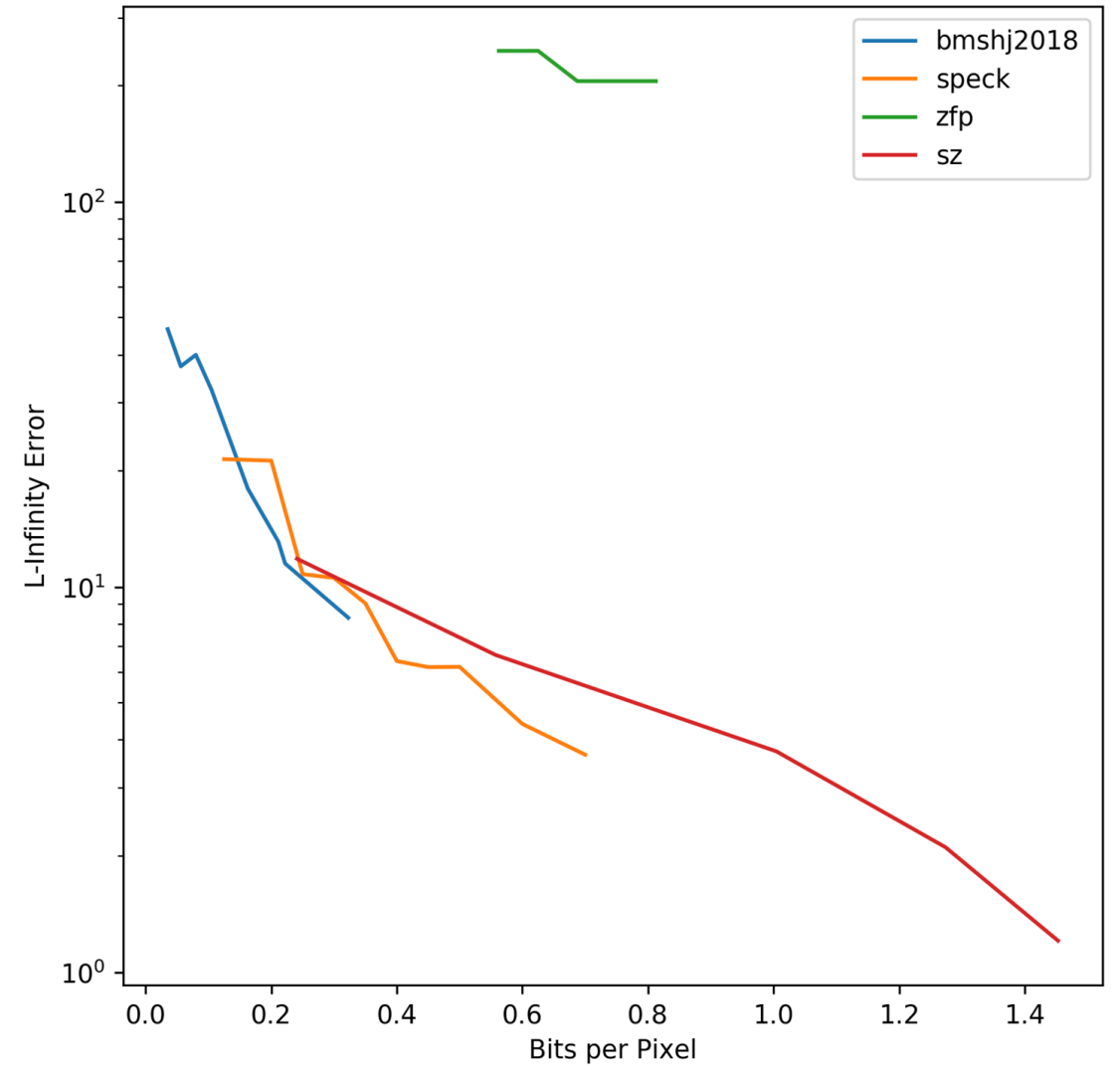
SZ (0.70 BPP)



ZFP (0.69 BPP)



Velocity X L-Infinity





Real World Data L-Infinity

