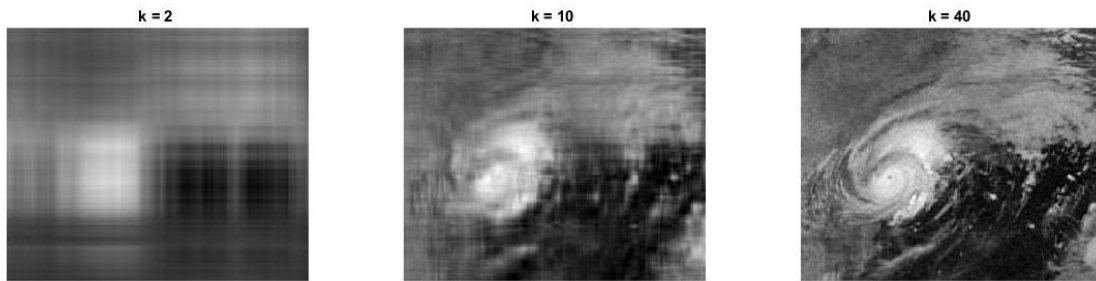


5.

(a)



For $k \in \{2, 10, 40\}$,
$$\frac{\|X - \bar{X}\|_F}{\|X\|_F} = [0.2815, 0.1587, 0.0837]$$

- Matlab Code

```
1 X = double(rgb2gray(imread('harvey-saturday-goes7am.jpg')));
2 [U,S,V] = svd(X);
3 k = [2 10 40];
4 X_approximate = zeros(size(X,1), size(X,2), size(k,2));
5 error = [];
6 for i = 1 : size(k,2)
7     X_approximate(:, :, i) = U(:, 1:k(i))*S(1:k(i), 1:k(i))*transpose(V(:, 1:k(i)));
8     error = [error norm(X - X_approximate(:, :, i), 'fro')/norm(X, 'fro')];
9     subplot(1, size(k,2), i);
10    imshow(uint8(X_approximate(:, :, i)));
11    txt = sprintf('k = %d ', k(i));
12    title(txt);
13 end
14 disp(error);
```

(b) The numbers (n) we need to describe the approximation

For $k = 2$, $n = 1296*2 + 2 + 2*1548$

For $k = 10$, $n = 1296*10 + 10 + 10*1548$

For $k = 40$, $n = 1296*40 + 40 + 40*1548$