Skyline Extraction

Skylines are being extracted separately to help create “points of interest” useful as additional points for correspondence (point matching between images), or for example as gps markers (see the Yosemite half dome and peak finder notes).

Two intermediate image products while creating Canny Edge filters are a theta image and a combined gradientXY image created from the x and y gradients of the main color image. The theta image’s largest contiguous zero value pixels appears to be a good way to locate the sky for most cases. Those sky points can then be used with the gradientXY and color images to further grow the region to the apparent skyline using color and contrast filters.

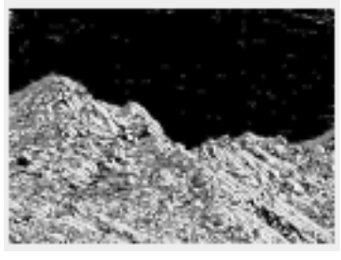
Note that the results may need to be combined w/ multiple aligned images for ambiguous patches due to optically thick clouds.

These are notes while implementing the skyline extraction.

The contiguous zero values are found with a depth first traversal of image pixels. With the default stack size of the java jvm (the architecture is my laptop) the stack is small for the method frame of the dfs method when the number of pixels in the image is larger than about 870,000. Beyond that number of pixels, the runtime of the method dramatically increases. Image binning is performed to reduce the number of pixels to make a reasonable runtime. The image is down sized to a factor of a factor of 2 to result in nPixels < 870,000. Then the largest group of contiguous zero value pixels is found. The zero value points’ coordinates are then transformed back to the reference of the full size theta image and corrections for lower resolution are made.

This appears to result in a stable location of the sky for most images.

scaled theta

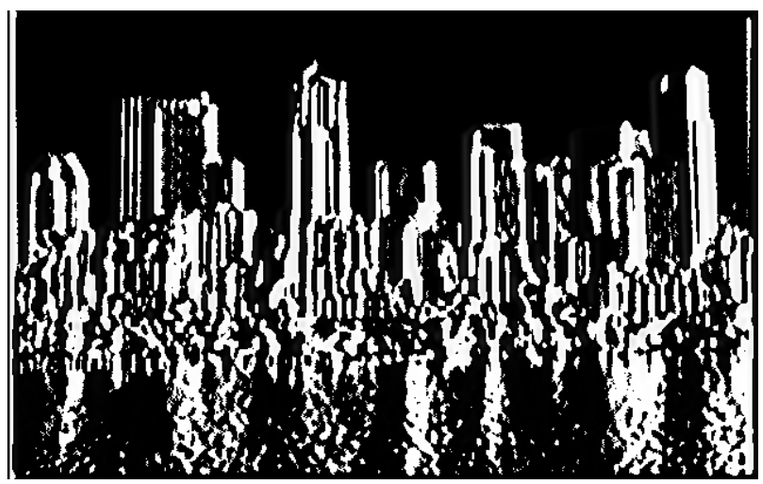


zero points from down scaled image upscaled in blue

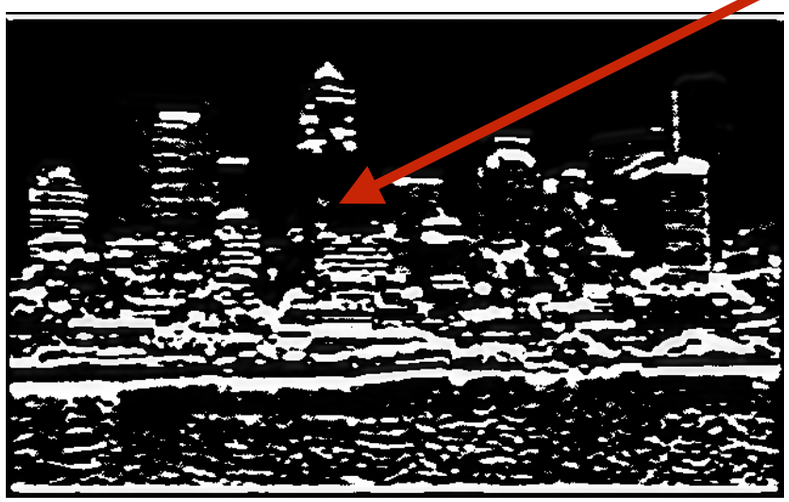
Note that skyscrapers with repetitive structure on the scale of combined convolution (approx the FWHM = 2.355 * sqrt(2*2 + 0.5*0.5) = 6 pixels) or any object w/such repetition can result in “blind spots” in the theta image and so they need to be removed from the sky points set using the color image before the sky point set is grown to larger boundaries.

Skyline Extraction

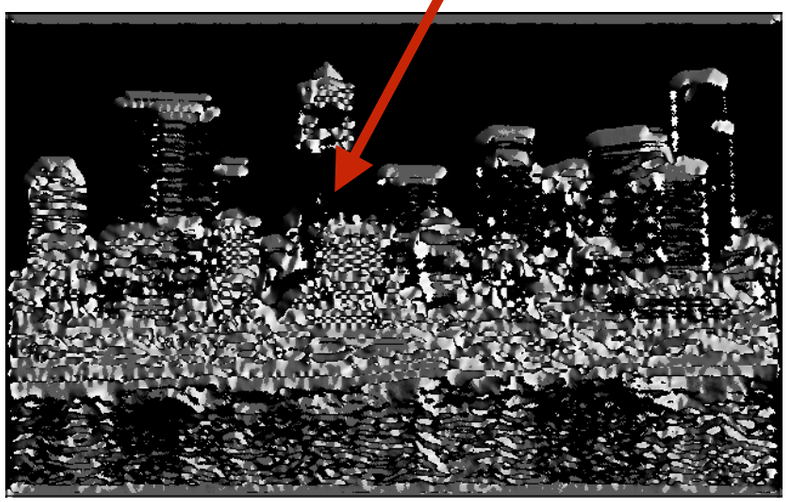
Here is an example of repetitive structure on the scale of combined convolution (approx the FWHM = 2.355 * sqrt(2*2 + 0.5*0.5) = 6 pixels in a skyscraper that results in a gap in the y gradient image where there is an object in the color image.



gradient X



gradient Y



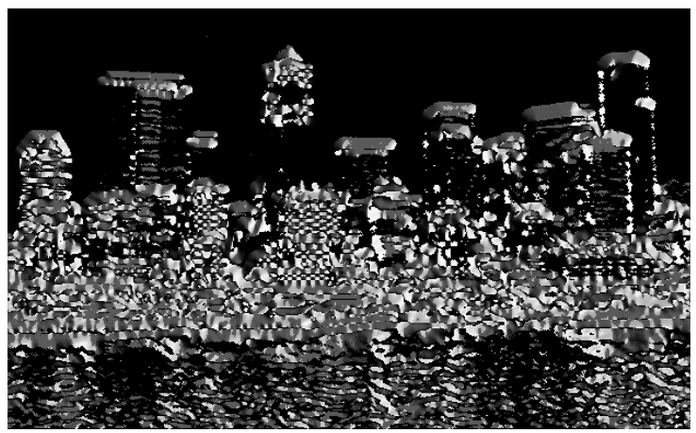
theta

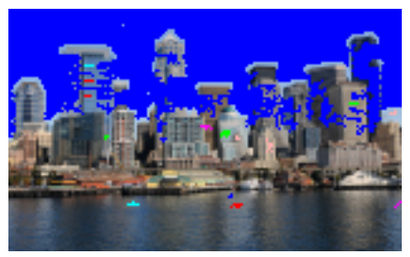
Skyline Extraction

(1) Seattle image:.summary of stages so far

https://www.flickr.com/photos/tdlucas5000/14177059903

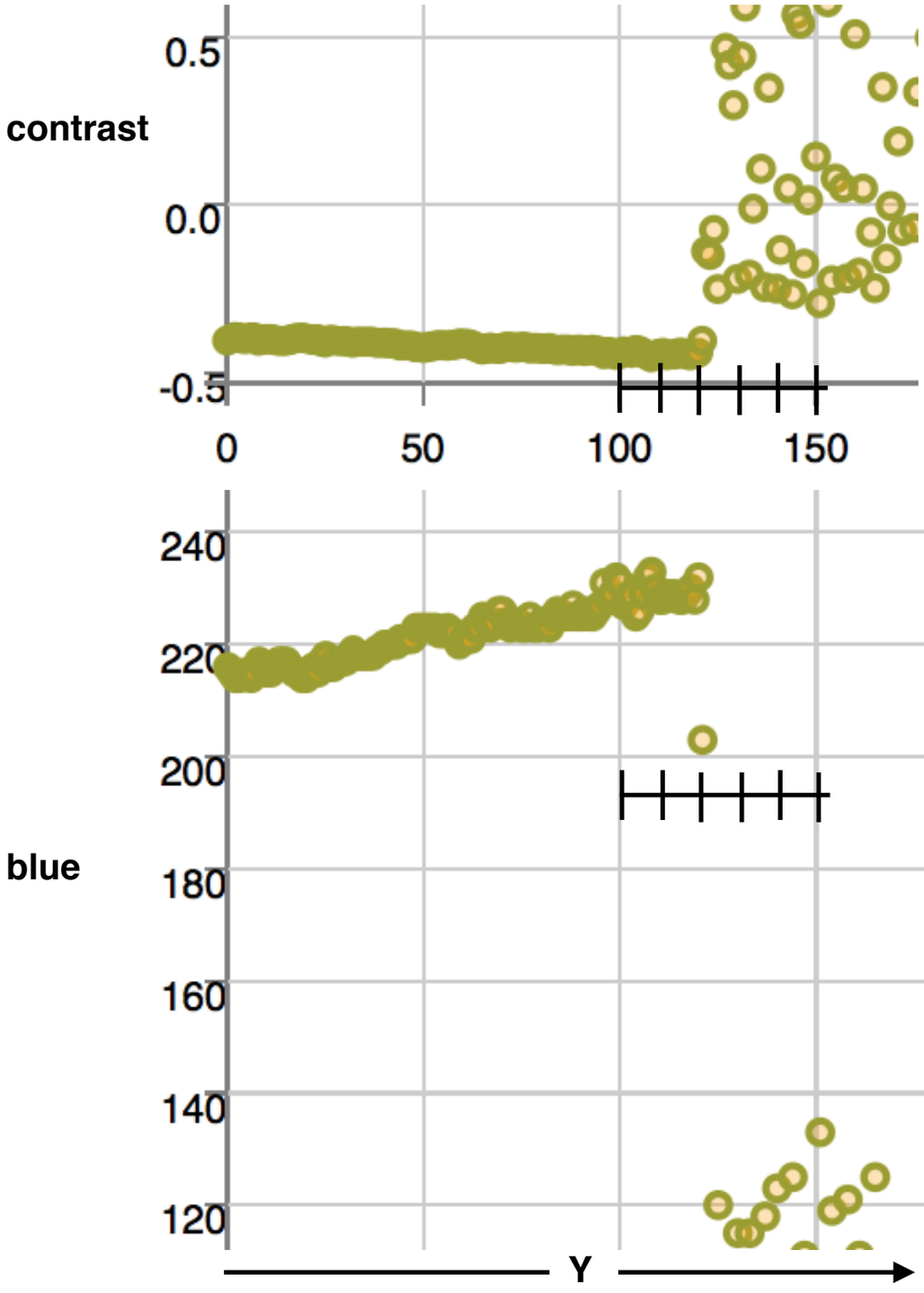
Y

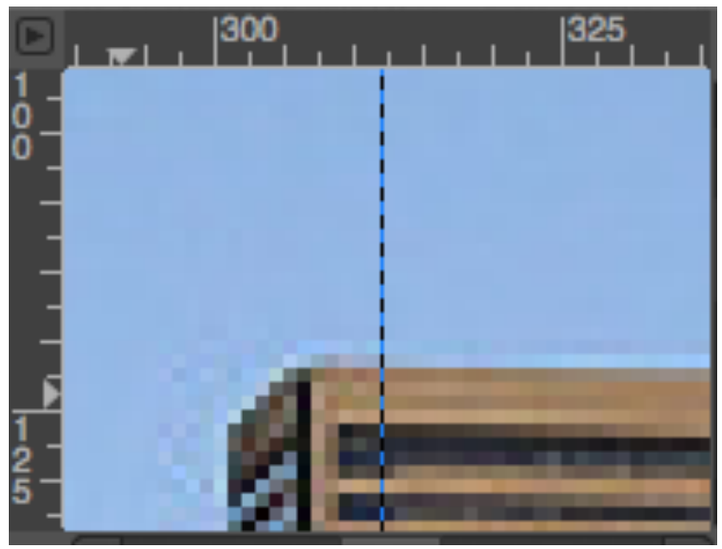




Skyline Extraction

(3) Growing the sky region to the skyline.





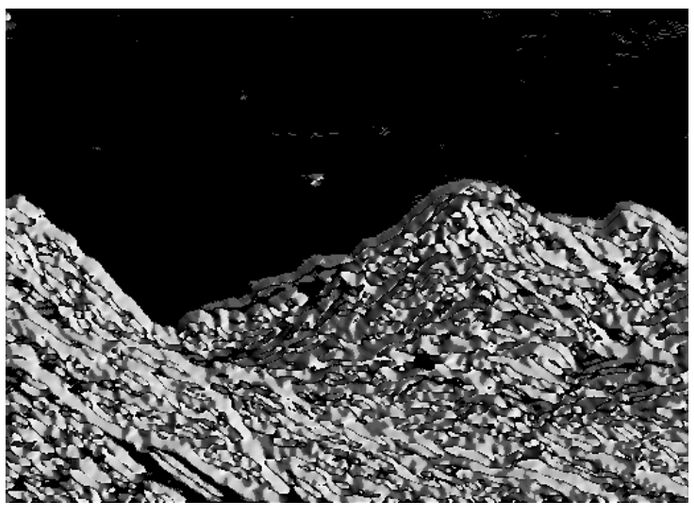
Y is approx 122

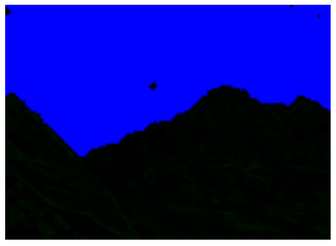
Looks like the distinguishing characteristic is: for pixel to 8 neighbors the avg change in contrast and blue.

boundary pixel has dContrast > factor*dContrastAvg and dBlue < factor*dBlueAvg, the candidate should not be added.

Skyline Extraction

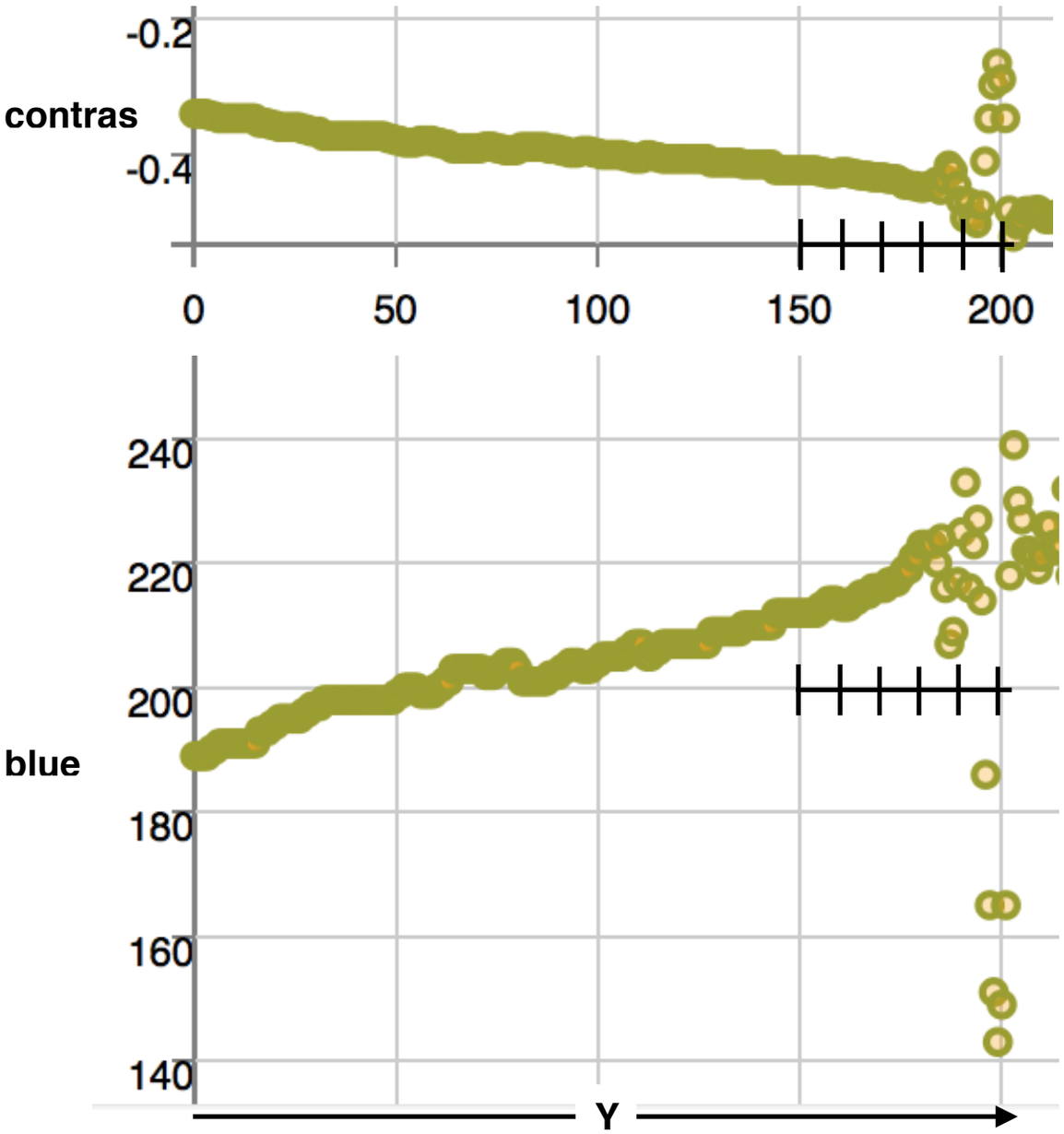
(1) Brown & Lowe 2003 image:.summary of stages so far

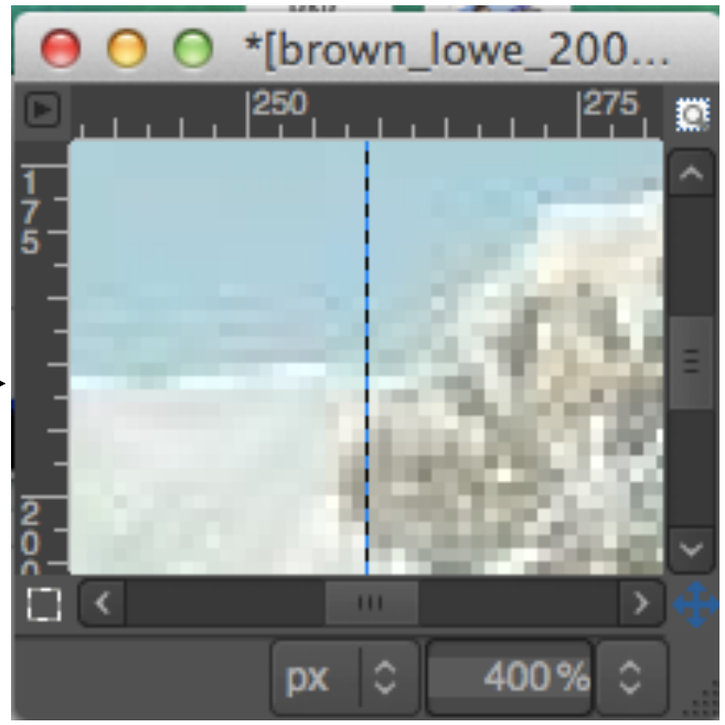




Skyline Extraction

(3) Growing the sky region to the skyline.





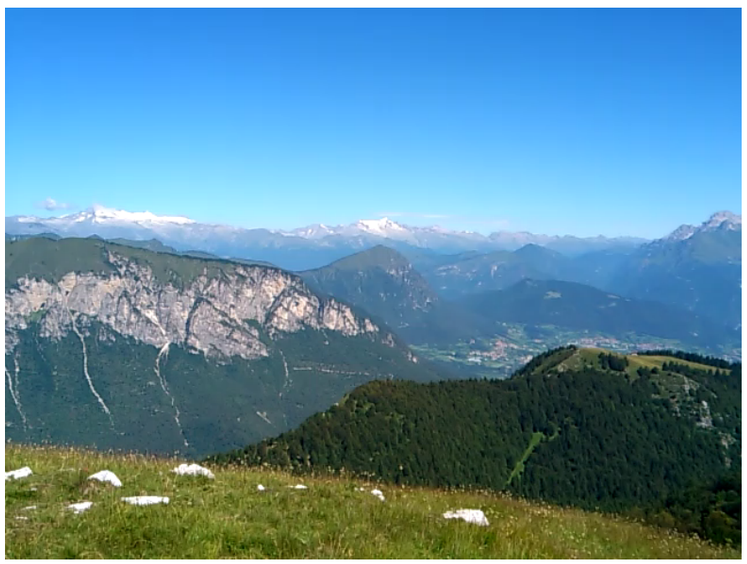
Y is approx 190

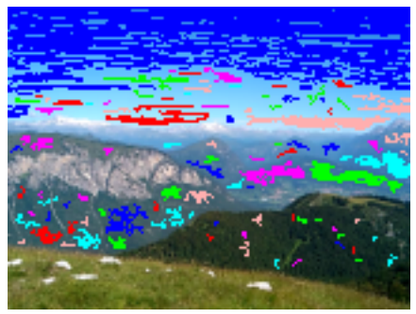
boundary pixel has dContrast > factor*dContrastAvg and dBlue < factor*dBlueAvg, the candidate should not be added.

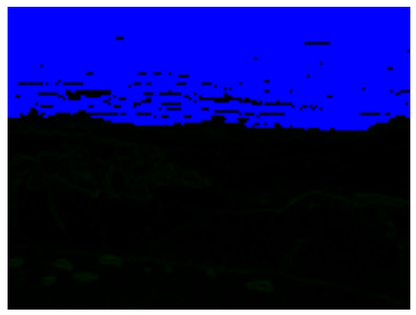
Skyline Extraction

(1) Venturi mountain image:.summary of stages so far

`https://venturi.fbk.eu/results/public-datasets/mountain-dataset/`

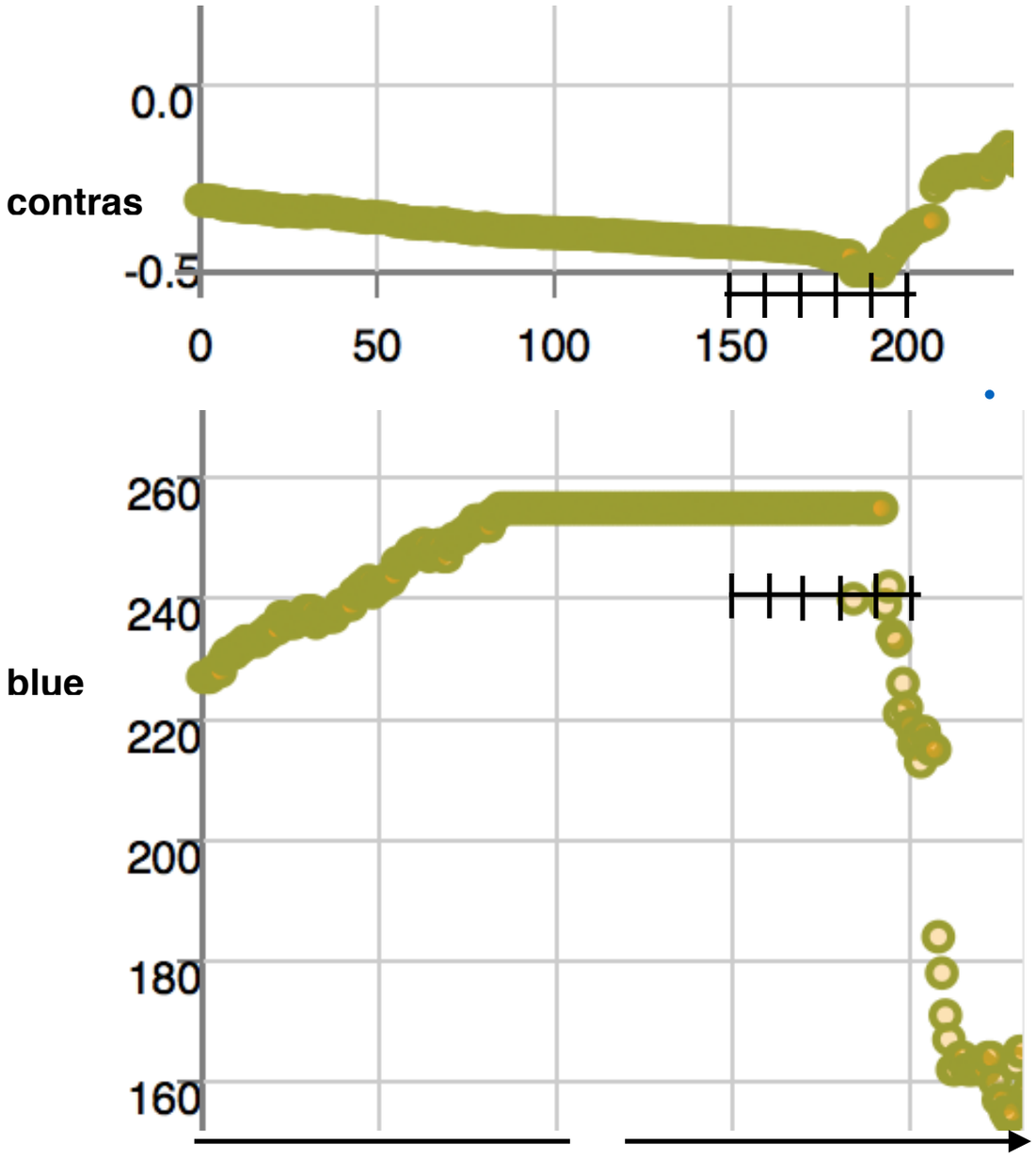


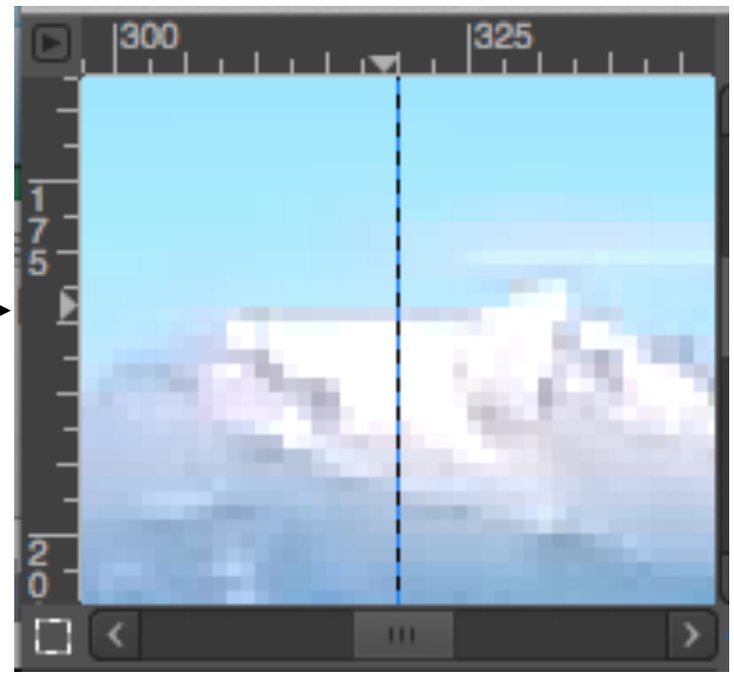




Skyline Extraction

(3) Growing the sky region to the skyline.





Y is approx 184

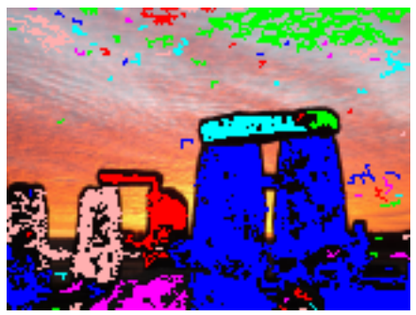
boundary pixel has dContrast > factor*dContrastAvg and dBlue < factor*dBlueAvg, the candidate should not be added.

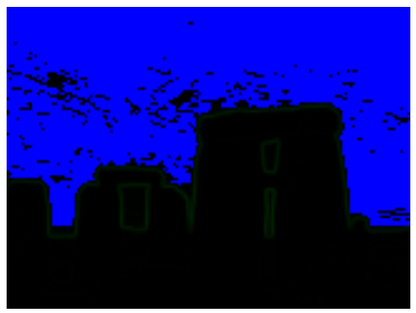
Skyline Extraction

(1):.summary of stages so far

https://www.flickr.com/photos/stonehenge-stone-circle/11774684414/

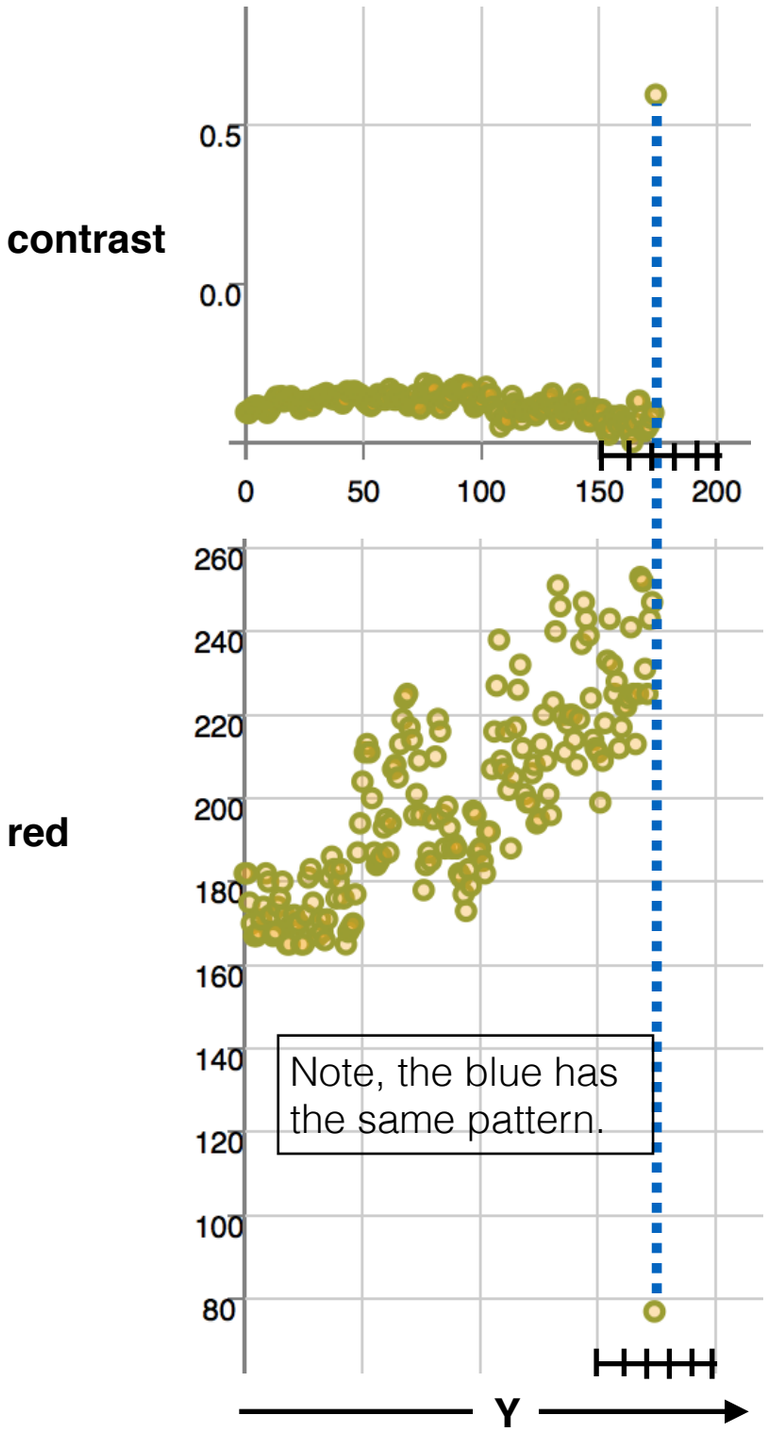
Y

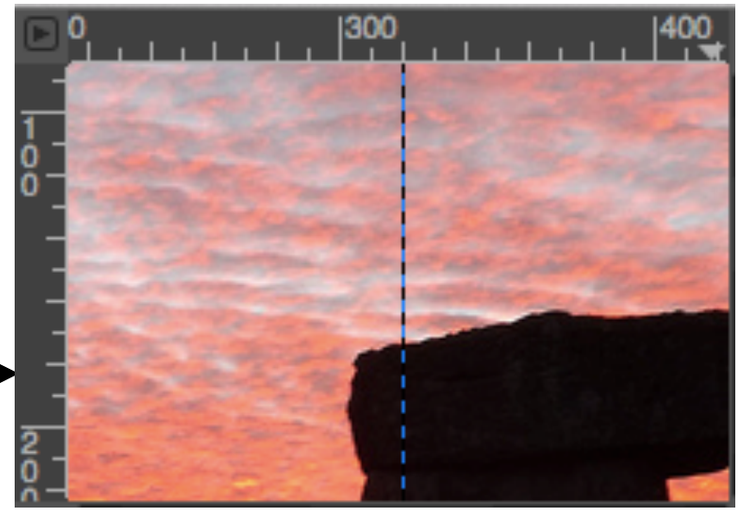




Skyline Extraction

(3) Growing the sky region to the skyline.





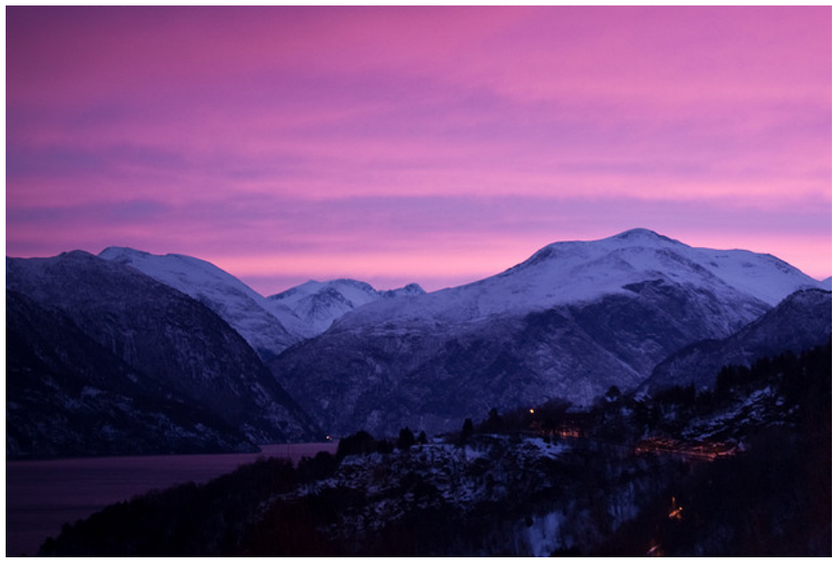
Y is approx 172

boundary pixel has dContrast > factor*dContrastAvg and dRed < factor*dRedAvg, the candidate should not be added.

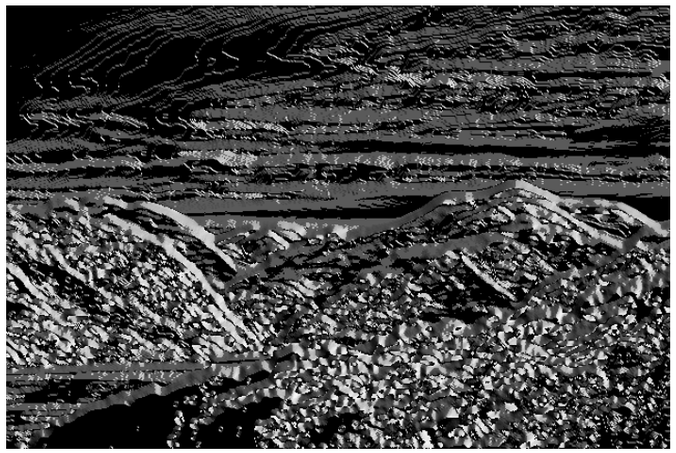
Skyline Extraction

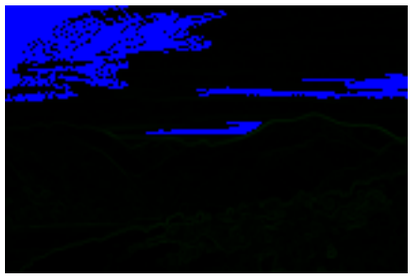
(1) :.summary of stages so far

https://www.flickr.com/photos/jvikphoto/4305855415



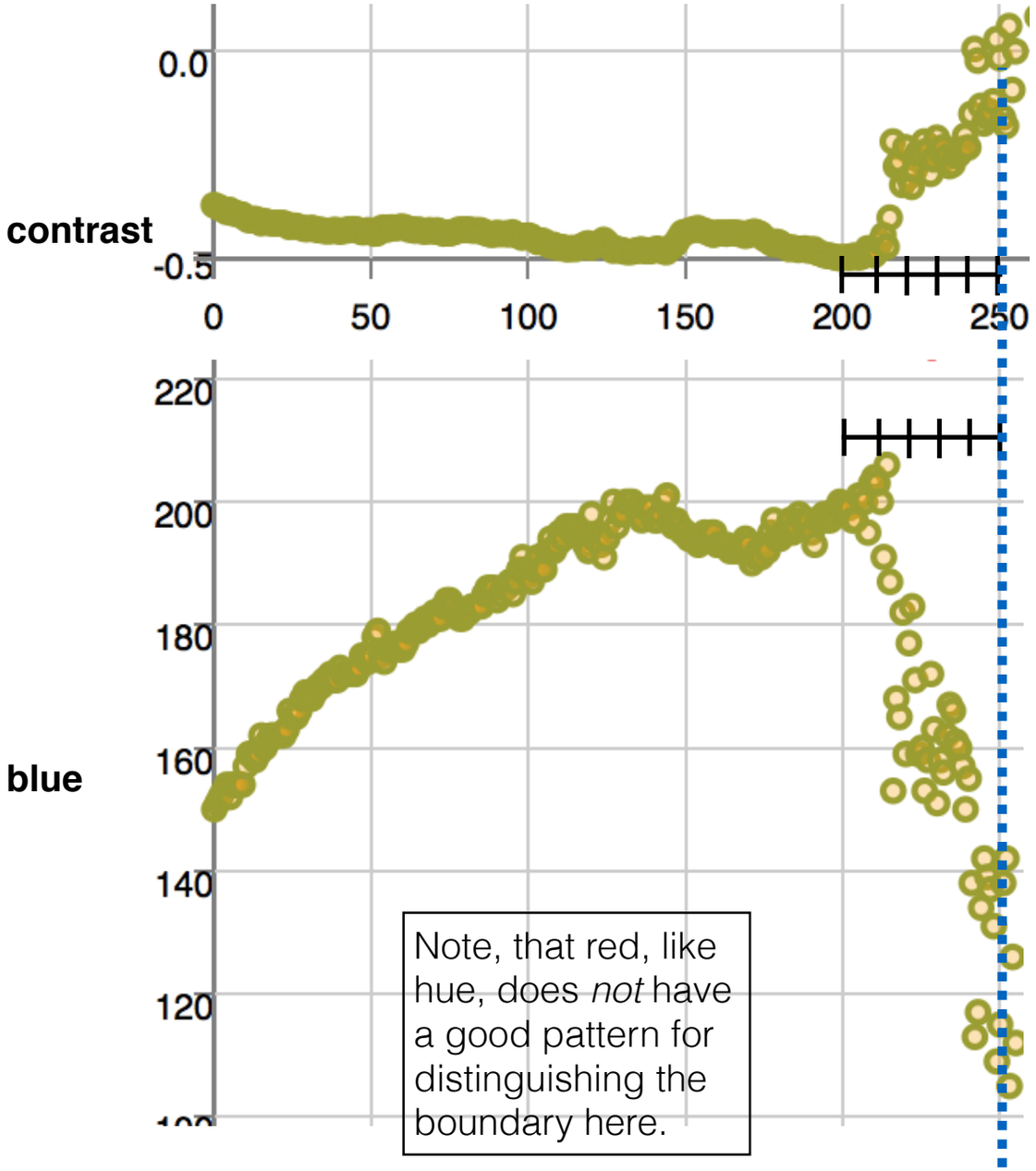
Y

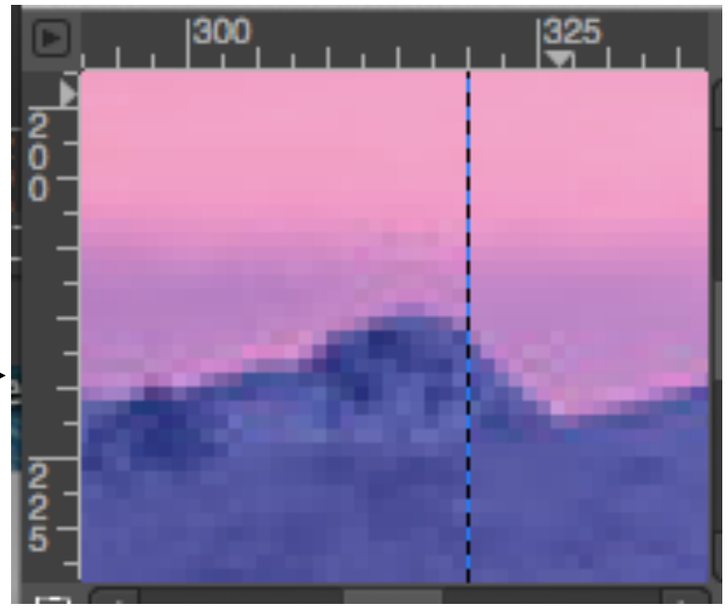




Skyline Extraction

(3) Growing the sky region to the skyline.





Y is approx 216

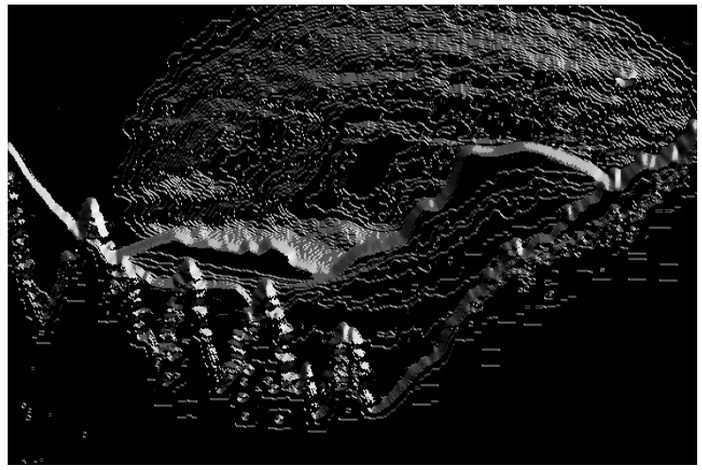
boundary pixel has dContrast > factor*dContrastAvg and dBlue < factor*dBlueAvg, the candidate should not be added.

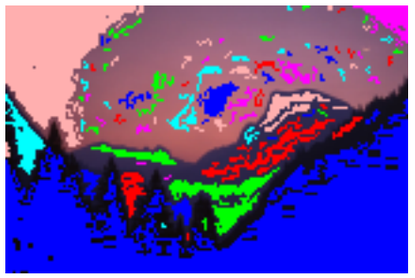
Skyline Extraction

(1) :.summary of stages so far

https://www.flickr.com/photos/7147684@N03/919374354

Y

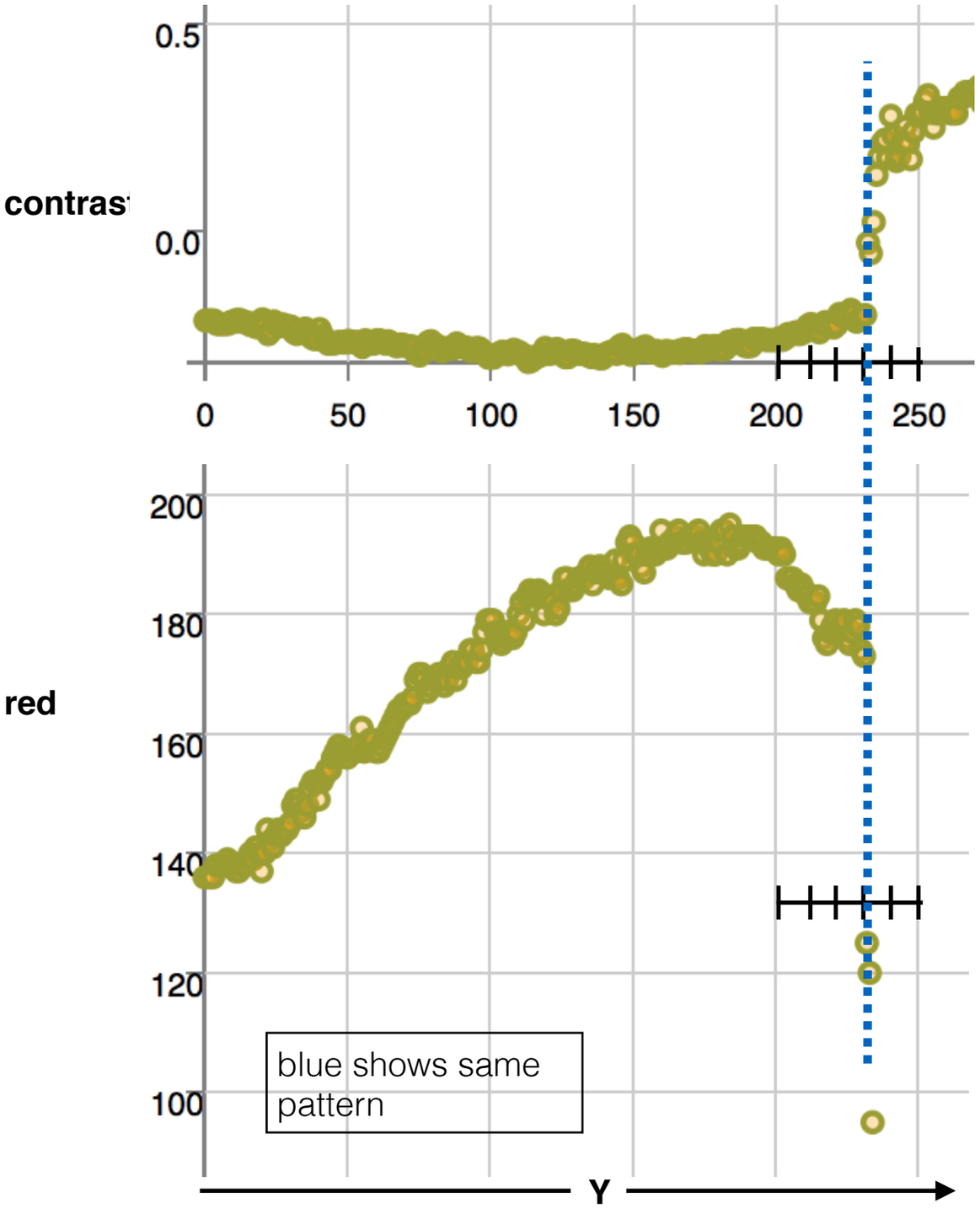


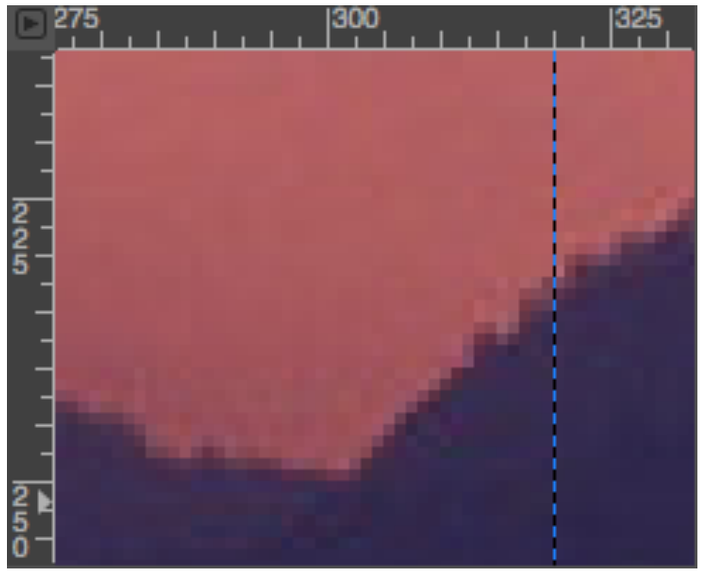


also, see PeakFinder http://www.peakfinder.org/?lat=37.7511&lng=-119.5215&ele=2365&name=37°45'N%20119°32'W

Skyline Extraction

(3) Growing the sky region to the skyline.





Y is approx 232

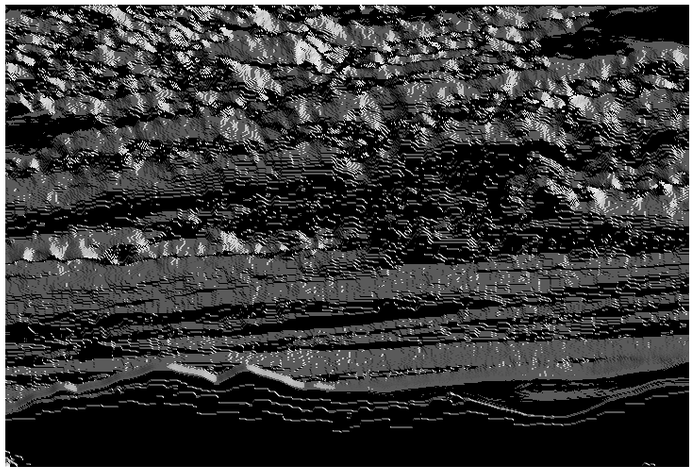
boundary pixel has dContrast > factor*dContrastAvg and dRed < factor*dRedAvg, the candidate should not be added.

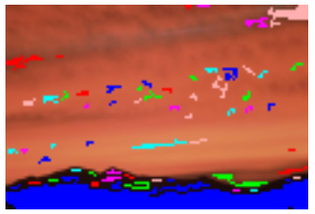
Skyline Extraction

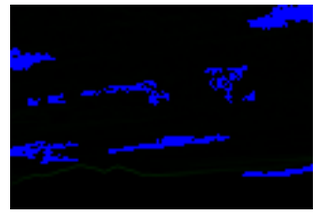
(1) :.summary of stages so far

http://www.public-domain-image.com/nature-landscapes-public-domain-images-pictures/sunrise-public-domain-images-pictures/new-mexico-sunrise.jpg.html

Y



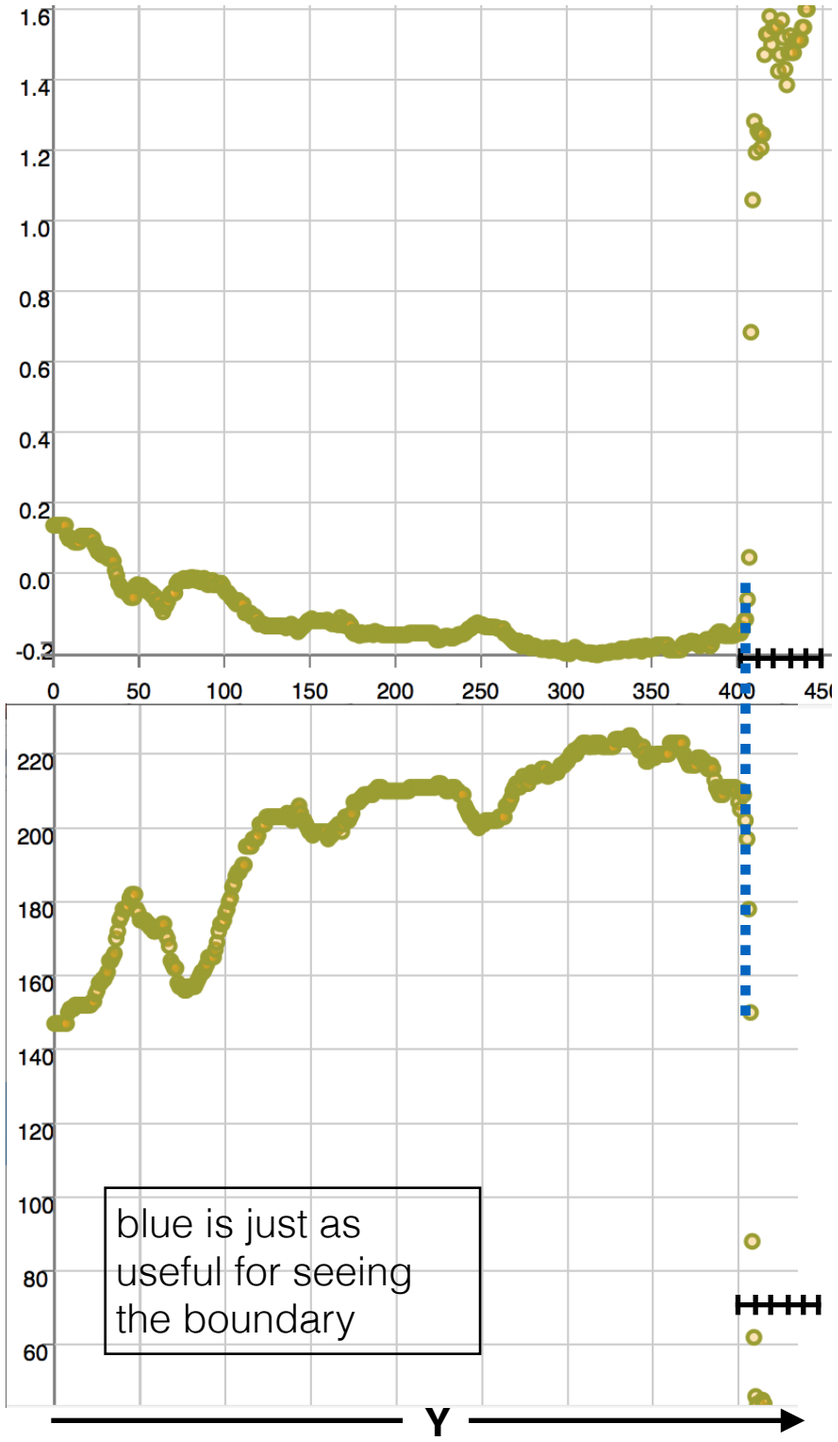




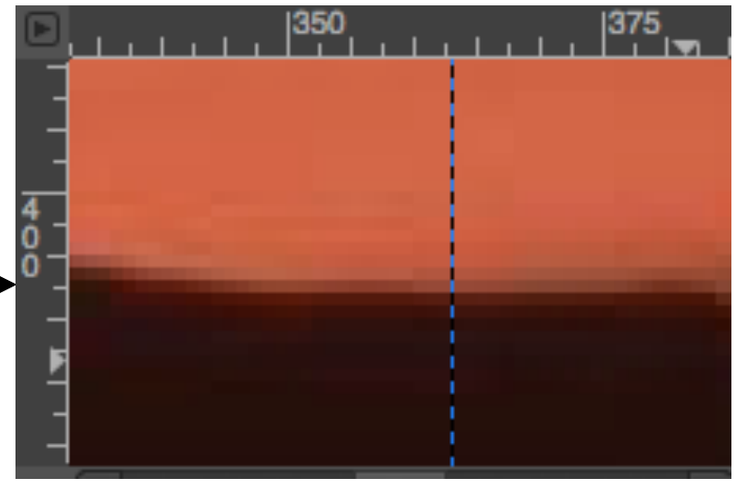
Skyline Extraction

(3) Growing the sky region to the skyline.

contrast



red

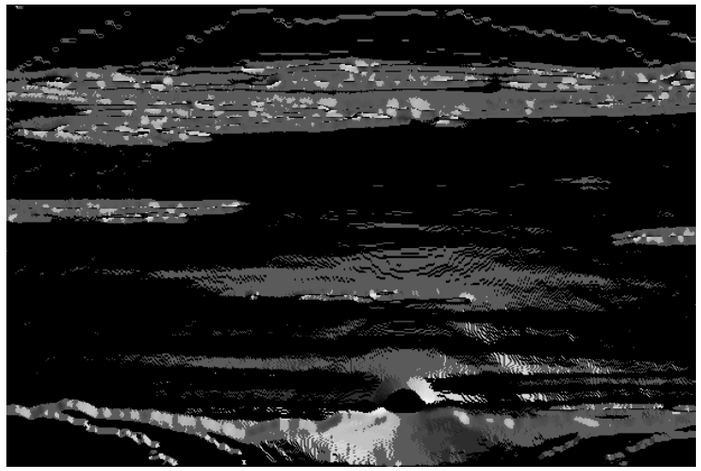


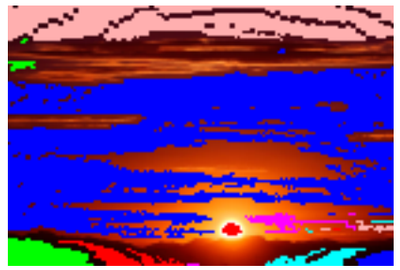
Y is approx 406

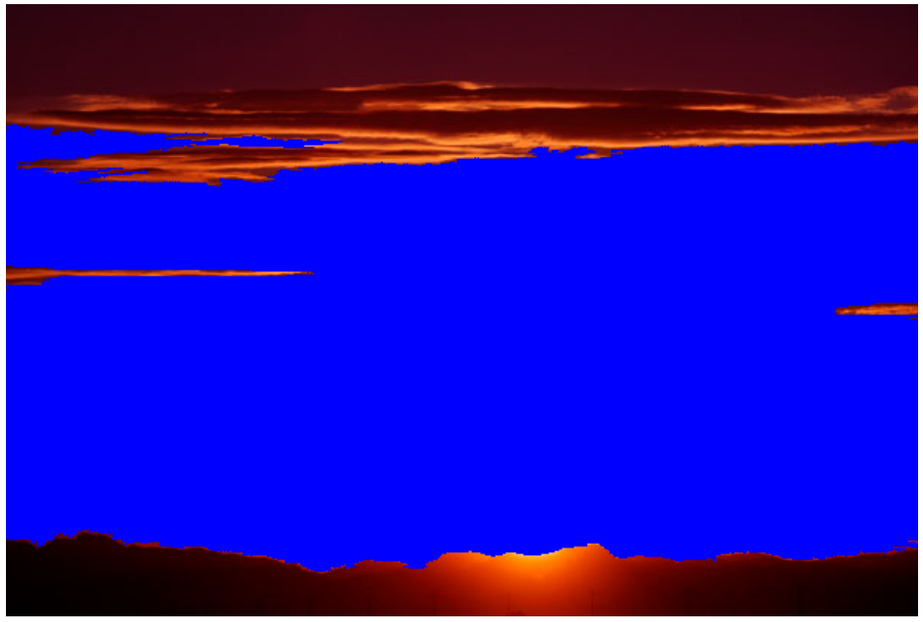
boundary pixel has dContrast > factor*dContrastAvg and dRed < factor*dRedAvg, the candidate should not be added.

Skyline Extraction

(1) :.summary of stages so far



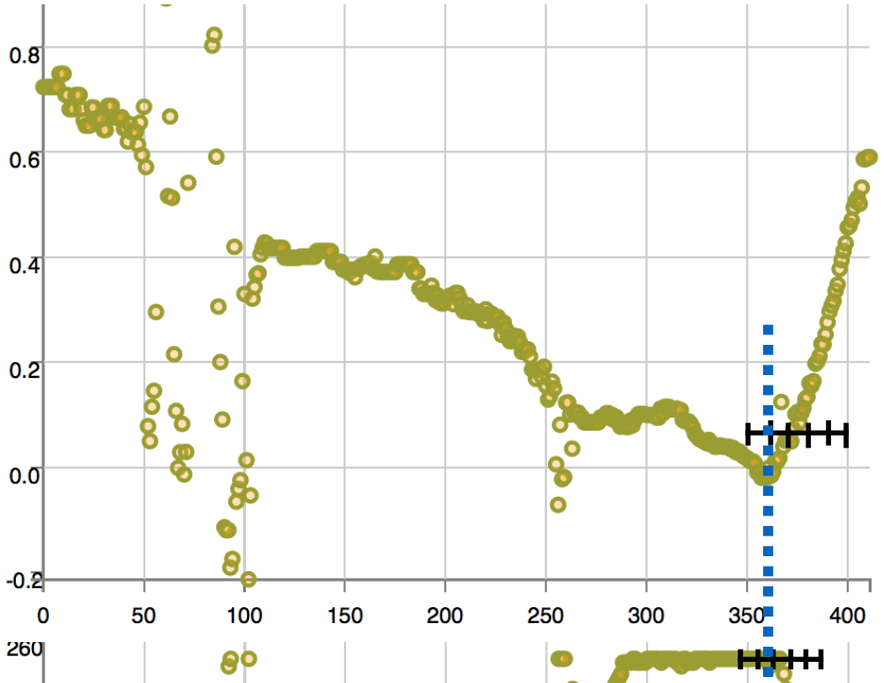




Skyline Extraction

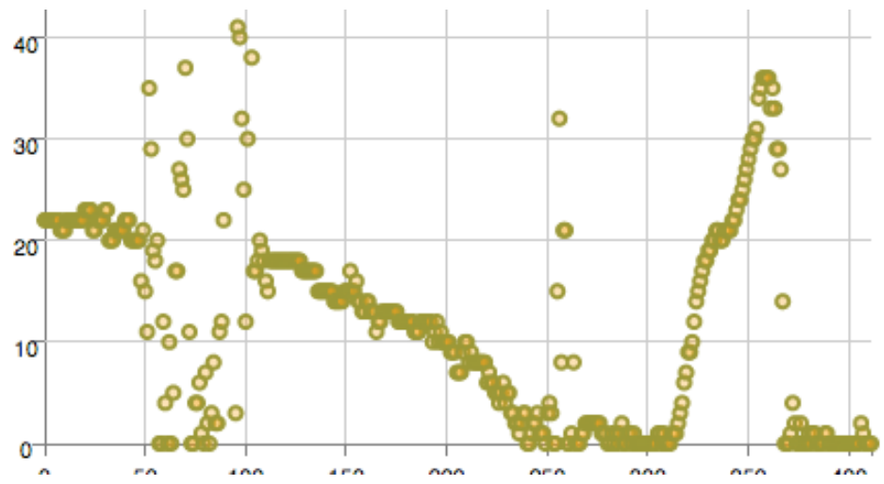
(3) Growing the sky region to the skyline.

contrast

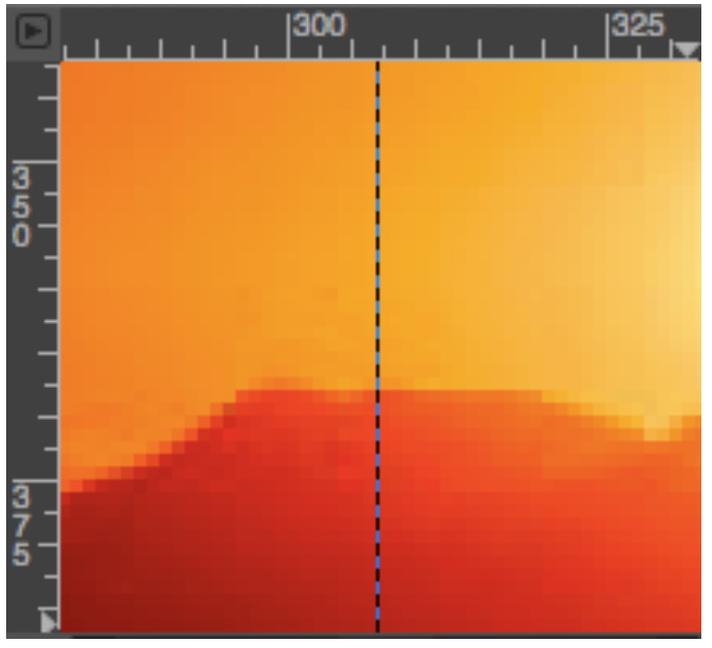


red

blue



Y



Y is approx 368

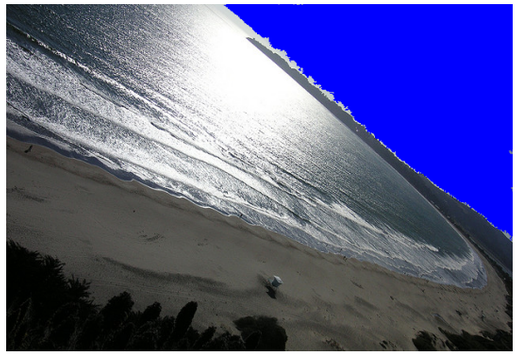
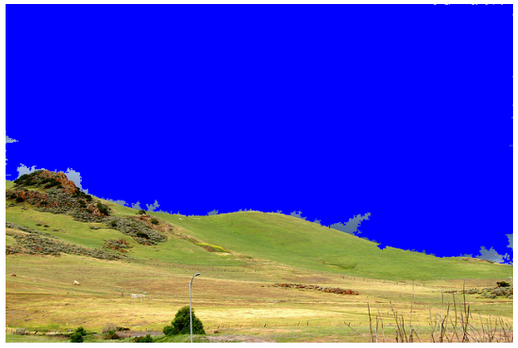
boundary pixel has dContrast > factor*dContrastAvg and dRed < factor*dRedAvg, the candidate should not be added.

Skyline Extraction

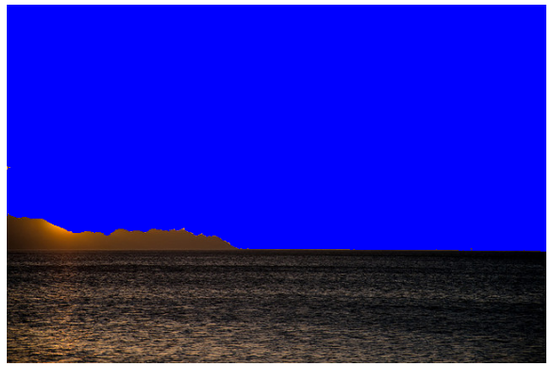
(5) **continued** find clouds and grow sky (*only implemented for red sky so far, and not finished for that yet*)





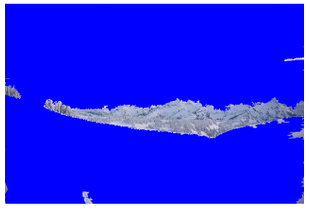
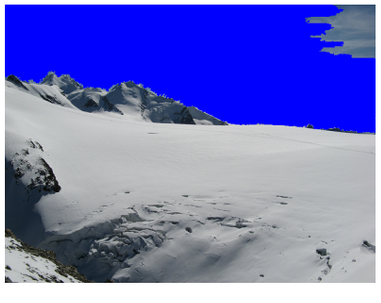











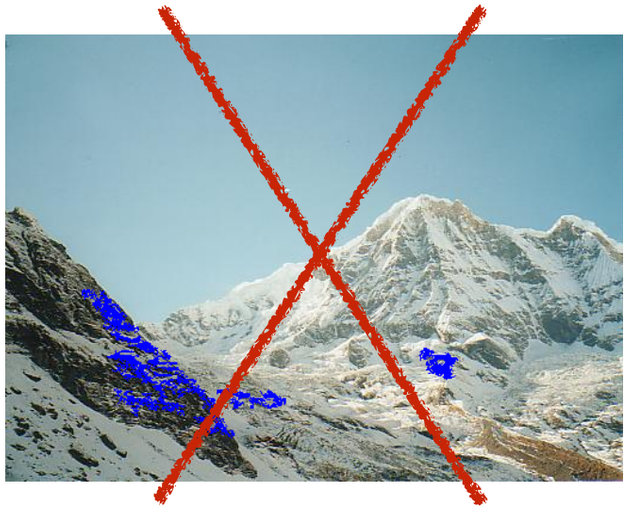



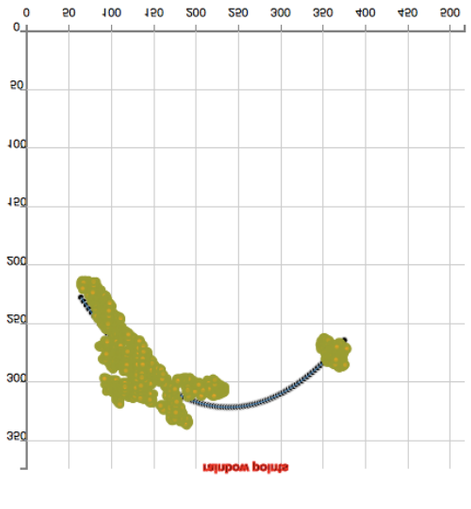
Skyline Extraction

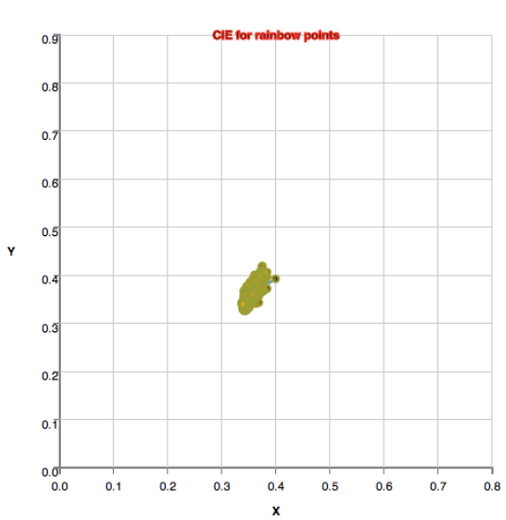
(6) **find sun photosphere**

Skyline Extraction

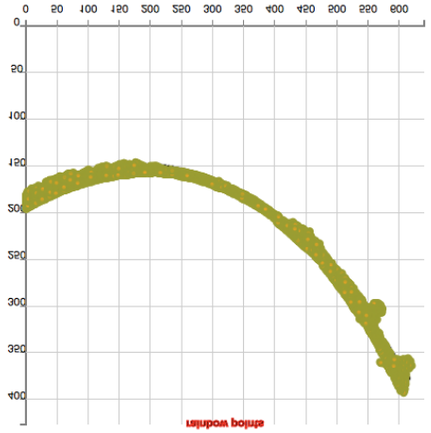
(6.b) **find rainbows,** but only if sun is not found. Finds points within color polygons of the CIE 1931 xy chromaticity, then uses 2nd order polynomial fits to filter points spatially, then further filters by missing colors.

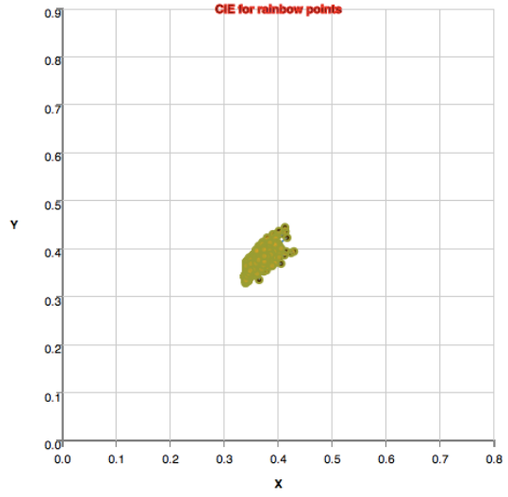


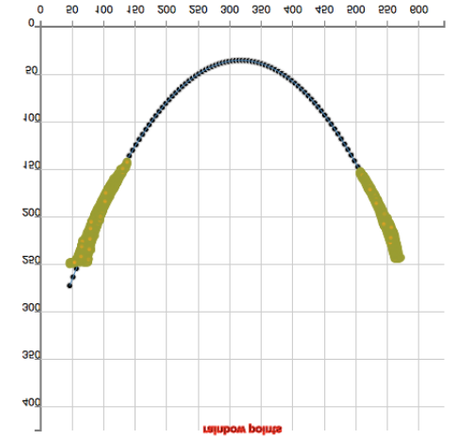


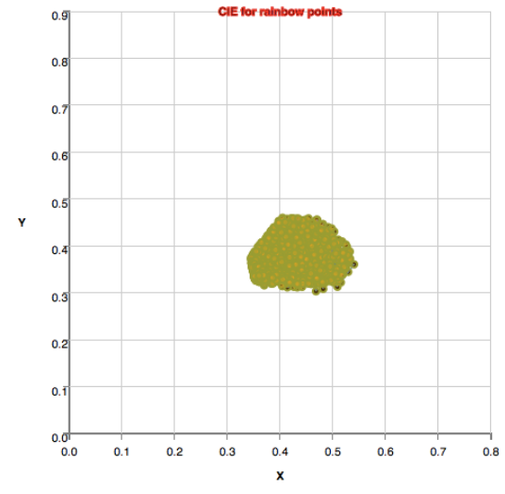


missing some of the expected rainbow colors, so not a rainbow









Skyline Extraction

(7) **create smoothed edges and calculate corners in the skyline edges**