AmandaSchwantes_week3

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1 Activity for week 3: How to plot and examine metadata for a NEON RGB Camera Image

created on 6/27/2018 by Amanda M. Schwantes

Check to confirm that Python 3.5 is running and change my working directory

```
In [1]: import sys
        print(sys.version)

        path1 = "C:\\Users\\Amanda Schwantes\\Documents\\workshopNEON2018\\week3prior\\"
        import os
        os.chdir(path1)
        print(os.getcwd())
```

```
3.5.5 |Anaconda custom (64-bit)| (default, Apr  7 2018, 04:52:34) [MSC v.1900 64 bit (AMD64)]
C:\Users\Amanda Schwantes\Documents\workshopNEON2018\week3prior
```

Import the libaries and functions needed for the analysis

```
In [2]: import gdal
        import numpy as np
        import matplotlib.pyplot as plt
        %matplotlib inline
        import warnings
        warnings.filterwarnings('ignore')
```

```
In [3]: def RGBraster2array(RGB_geotif):
            """RGBraster2array reads in a NEON AOP geotif file and returns
            a numpy array, and header containing associated metadata with spatial information.
            --------
            Parameters
                RGB_geotif -- full or relative path and name of reflectance hdf5 file
            --------
            Returns
            --------
```

```
array:
    numpy array of geotif values
metadata:
    dictionary containing the following metadata (all strings):
        array_rows
        array_cols
        bands
        driver
        projection
        geotransform
        pixelWidth
        pixelHeight
        extent
        noDataValue
        scaleFactor
--------
Example Execution:
--------
RGB_geotif = '2017_SERC_2_368000_4306000_image.tif'
RGBcam_array, RGBcam_metadata = RGBraster2array(RGB_geotif) """

metadata = {}
dataset = gdal.Open(RGB_geotif)
metadata['array_rows'] = dataset.RasterYSize
metadata['array_cols'] = dataset.RasterXSize
metadata['bands'] = dataset.RasterCount
metadata['driver'] = dataset.GetDriver().LongName
metadata['projection'] = dataset.GetProjection()
metadata['geotransform'] = dataset.GetGeoTransform()

mapinfo = dataset.GetGeoTransform()
metadata['pixelWidth'] = mapinfo[1]
metadata['pixelHeight'] = mapinfo[5]

metadata['ext_dict'] = {}
metadata['ext_dict']['xMin'] = mapinfo[0]
metadata['ext_dict']['xMax'] = mapinfo[0] + dataset.RasterXSize/mapinfo[1]
metadata['ext_dict']['yMin'] = mapinfo[3] + dataset.RasterYSize/mapinfo[5]
metadata['ext_dict']['yMax'] = mapinfo[3]

metadata['extent'] = (metadata['ext_dict']['xMin'],metadata['ext_dict']['xMax'],
                      metadata['ext_dict']['yMin'],metadata['ext_dict']['yMax'])

raster = dataset.GetRasterBand(1)
array_shape = raster.ReadAsArray(0,0,metadata['array_cols'],metadata['array_rows']
metadata['noDataValue'] = raster.GetNoDataValue()
metadata['scaleFactor'] = raster.GetScale()
```

```
            array = np.zeros((array_shape[0],array_shape[1],dataset.RasterCount),'uint8') #pre
            for i in range(1, dataset.RasterCount+1):
                band = dataset.GetRasterBand(i).ReadAsArray(0,0,metadata['array_cols'],metadata
                band[band==metadata['noDataValue']]=np.nan
                band = band/metadata['scaleFactor']
                array[...,i-1] = band

            return array, metadata
```

Load the image from our working directory and run the function that converts our raster file to an array

```
In [4]: RGB_geotif = './2017_SERC_2_368000_4306000_image.tif'
        SERC_RGBcam_array, SERC_RGBcam_metadata = RGBraster2array(RGB_geotif)
```

Prints the dimensions of the array

```
In [5]: SERC_RGBcam_array.shape
```

```
Out[5]: (10000, 10000, 3)
```

prints the metadata (information that is stored in the header)

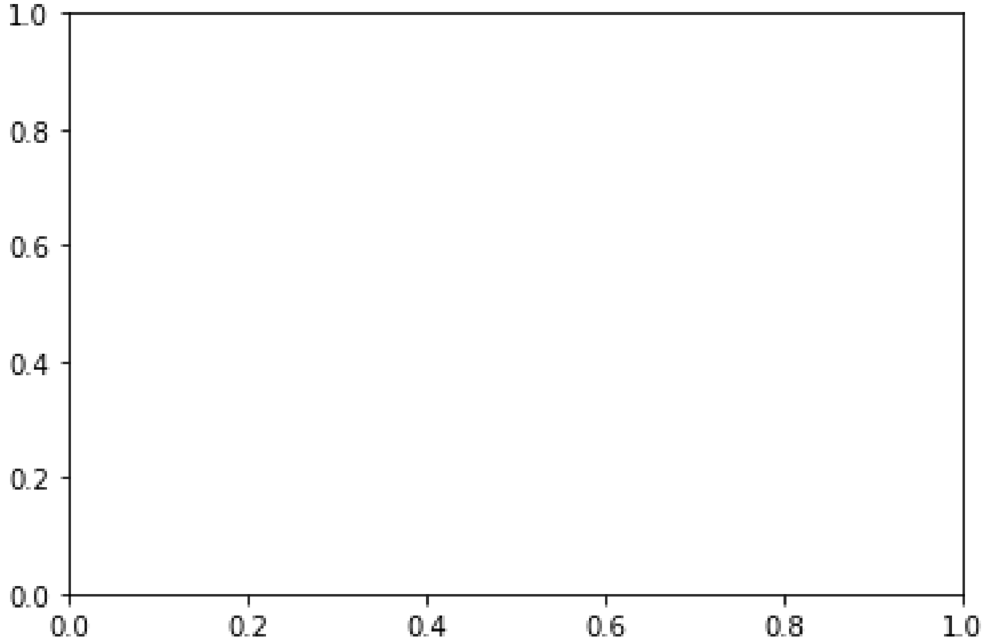
```
In [6]: for key in sorted(SERC_RGBcam_metadata.keys()):
          print(key)
```

```
array_cols
array_rows
bands
driver
ext_dict
extent
geotransform
noDataValue
pixelHeight
pixelWidth
projection
scaleFactor
```

The function below plots a RGB image when a 3-band image is provided

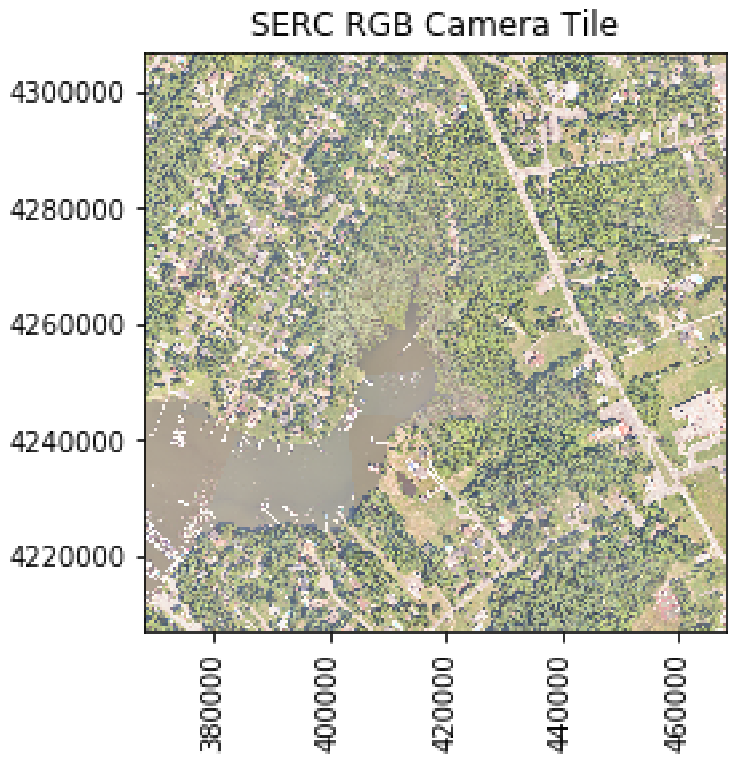
```
In [7]: def plot_band_array(band_array,
                            refl_extent,
                            colorlimit,
                            ax=plt.gca(),
                            title='',
                            cbar ='on',
                            cmap_title='',
```

```python
                colormap='spectral'):

'''plot_band_array reads in and plots a single band or an rgb band combination of
--------
Parameters
--------
    band_array: flightline array of reflectance values, created from h5refl2array
    refl_extent: extent of reflectance data to be plotted (xMin, xMax, yMin, yMax)
    colorlimit: range of values to plot (min,max). Best to look at the histogram o
    ax: optional, default = current axis
    title: string, optional; plot title
    cmap_title: string, optional; colorbar title
    colormap: string, optional; see https://matplotlib.org/examples/color/colormap
--------
Returns
    plots array of single band or RGB if given a 3-band
--------
Example:
--------
plot_band_array(SERC_RGBcam_array,
                SERC_RGBcam_metadata['extent'],
                (1,255),
                title='SERC RGB Camera Tile',
                cbar='off')'''

plot = plt.imshow(band_array,extent=refl_extent,clim=colorlimit);
if cbar == 'on':
    cbar = plt.colorbar(plot,aspect=40); plt.set_cmap(colormap);
    cbar.set_label(cmap_title,rotation=90,labelpad=20)
plt.title(title); ax = plt.gca();
ax.ticklabel_format(useOffset=False, style='plain'); #do not use scientific notati
rotatexlabels = plt.setp(ax.get_xticklabels(),rotation=90); #rotate x tick labels
```



We then plot our RGB image

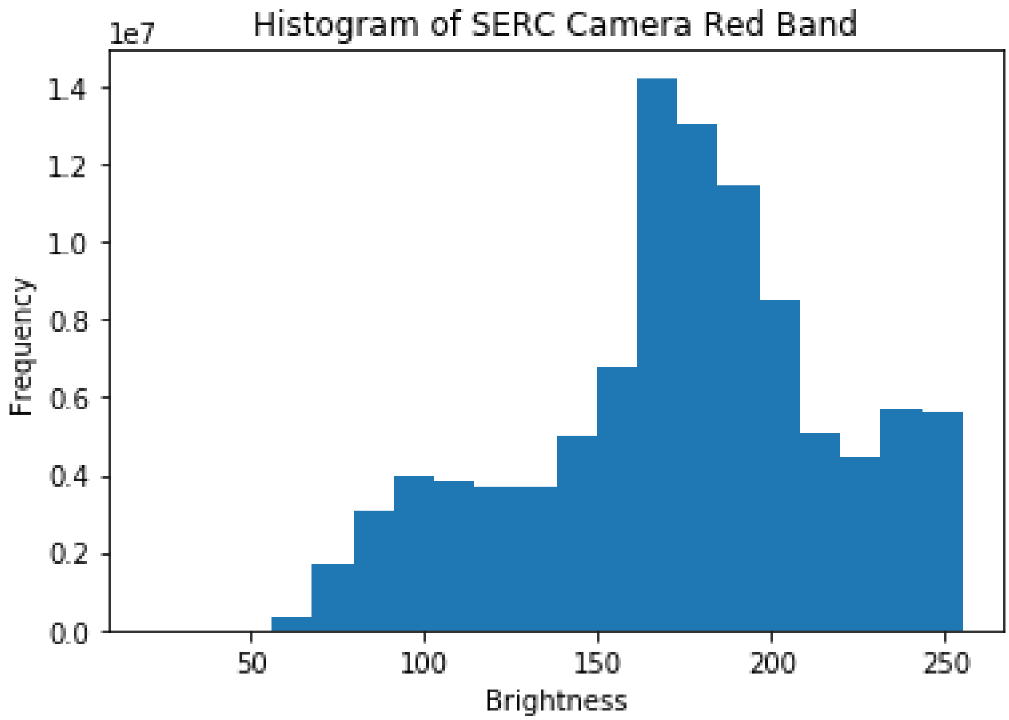
```
In [8]: plot_band_array(SERC_RGBcam_array,
                        SERC_RGBcam_metadata['extent'],
                        (1,255),
                        title='SERC RGB Camera Tile',
                        cbar='off')
```



Lastly, we plot a histogram of the first band: red

In [9]:
```
plt.hist(np.ravel(SERC_RGBcam_array[:,:,0]),20);
plt.title('Histogram of SERC Camera Red Band')
plt.xlabel('Brightness'); plt.ylabel('Frequency')
```

Out[9]:
```
Text(0,0.5,'Frequency')
```

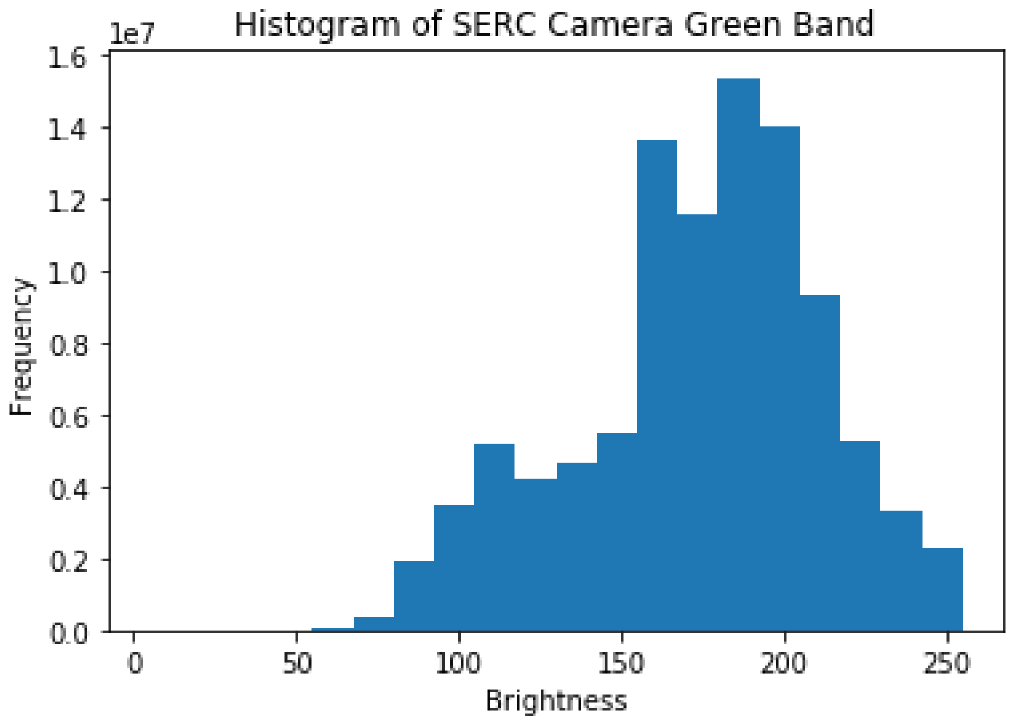


---

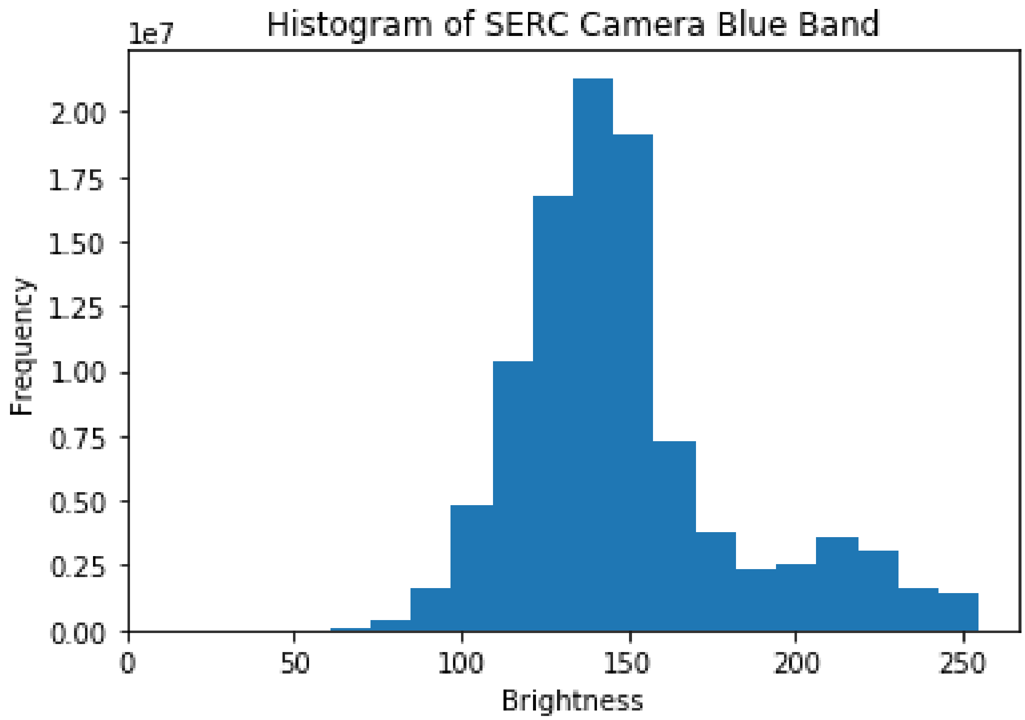
2 Now for the challenge questions

(1) Green and Blue band histograms **Asumptions** are that the second band is green, and the third band is blue, based on the name of the file. This also seems to be the case based on the outputs of the plots below.

```
In [10]: plt.hist(np.ravel(SERC_RGBcam_array[:,:,1]),20);
         plt.title('Histogram of SERC Camera Green Band')
         plt.xlabel('Brightness'); plt.ylabel('Frequency')

Out[10]: Text(0,0.5,'Frequency')
```




```
In [11]: plt.hist(np.ravel(SERC_RGBcam_array[:,:,2]),20);
         plt.title('Histogram of SERC Camera Blue Band')
         plt.xlabel('Brightness'); plt.ylabel('Frequency')

Out[11]: Text(0,0.5,'Frequency')
```



(2a) Min and Max reflectance for each band To calculate the min and max reflectance for each band we can use the np.amin() and np.amax() functions.

```
In [12]: B1min = np.amin(SERC_RGBcam_array[:,:,0])
         B2min = np.amin(SERC_RGBcam_array[:,:,1])
         B3min = np.amin(SERC_RGBcam_array[:,:,2])

         B1max = np.amax(SERC_RGBcam_array[:,:,0])
         B2max = np.amax(SERC_RGBcam_array[:,:,1])
         B3max = np.amax(SERC_RGBcam_array[:,:,2])

         print("Band 1: reflectance ranges from " + str(B1min) + " to " + str(B1max))
         print("Band 2: reflectance ranges from " + str(B2min) + " to " + str(B2max))
         print("Band 3: reflectance ranges from " + str(B3min) + " to " + str(B3max))
```

```
Band 1: reflectance ranges from 21 to 255
Band 2: reflectance ranges from 5 to 255
Band 3: reflectance ranges from 12 to 255
```

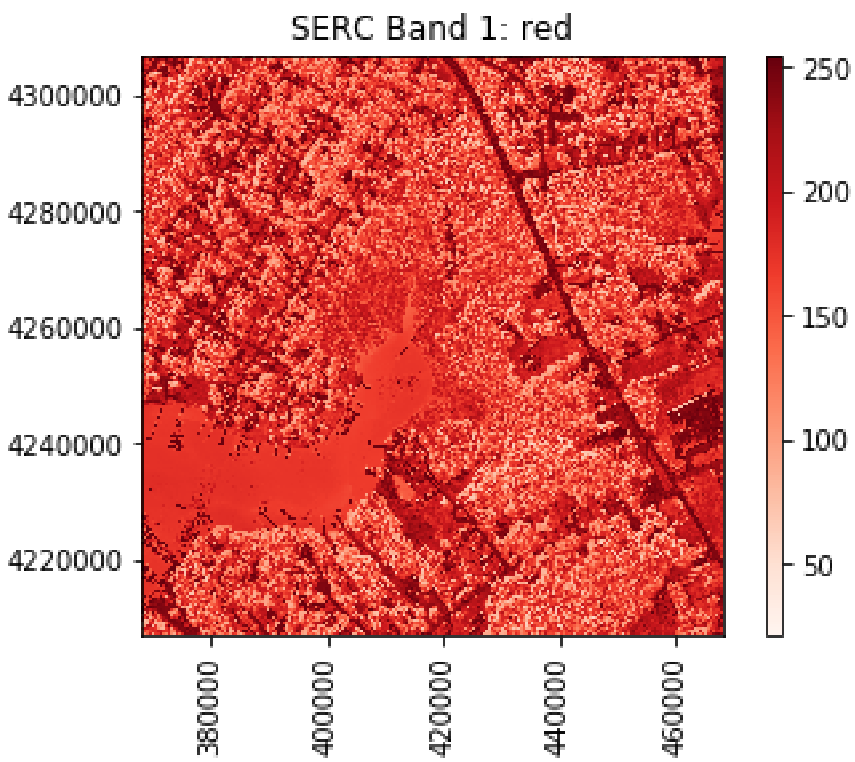
(2b) Projection Looking at the metadata the projection seems to be "WGS 84 / UTM zone 18N". Therefore, the UTM zone of the data is "18N".

```
In [13]: print(SERC_RGBcam_metadata['projection'])
```

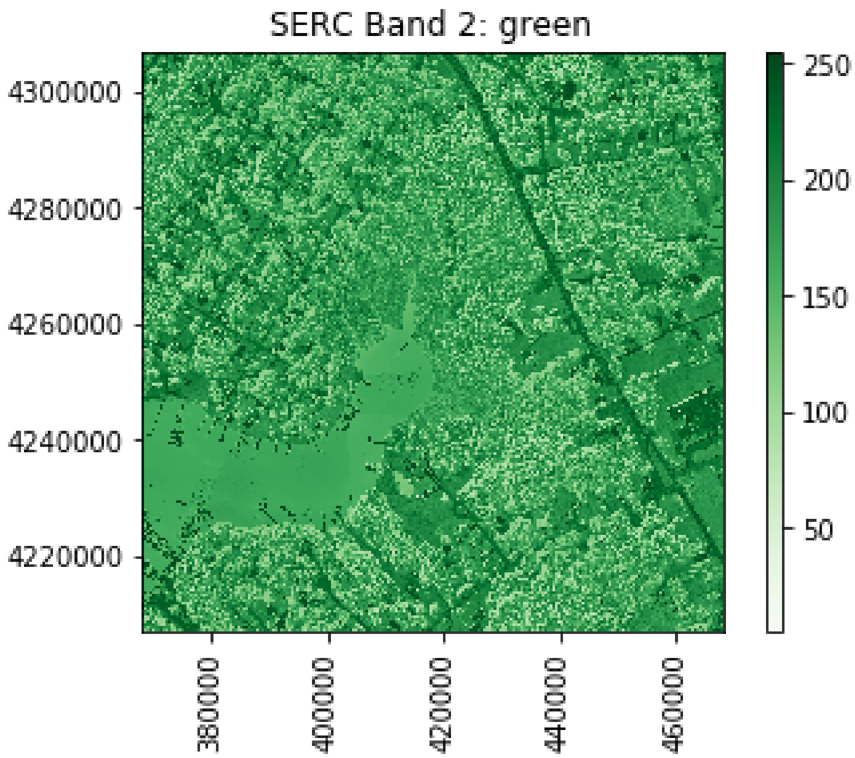
PROJCS["WGS 84 / UTM zone 18N",GEOGCS["WGS 84",DATUM["WGS_1984",SPHEROID["WGS 84",6378137,298.2

(2c) Plot each band seperately We can use the min and max values we calculate above as inputs into the SERC_RGBcam_array() function. I also turned on the color bar and changed the color legends to reflect which band was being mapped.

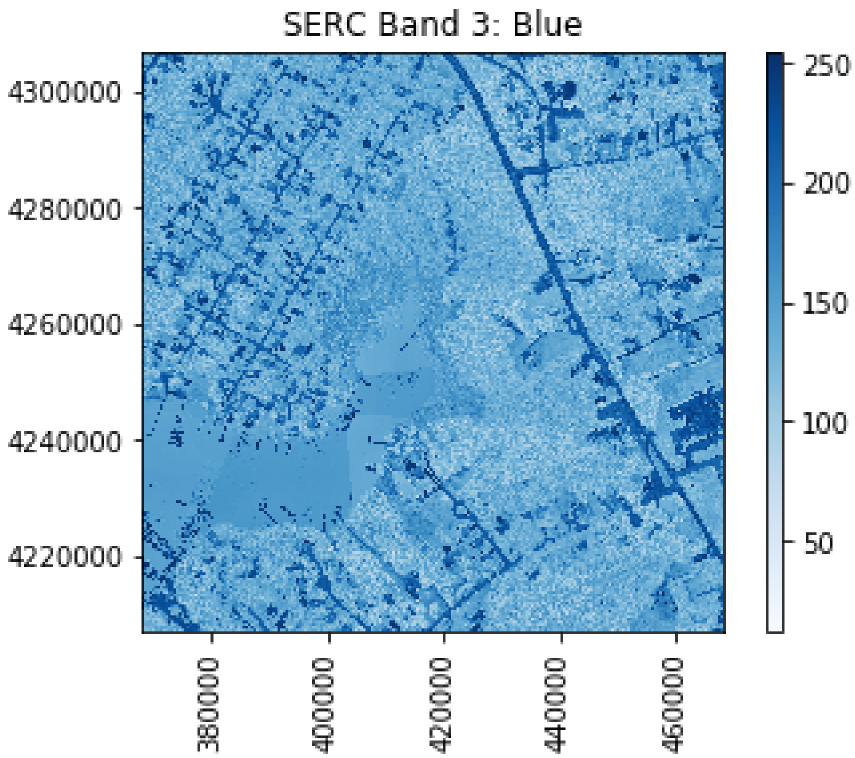
```
In [14]: plot_band_array(SERC_RGBcam_array[:,:,0],
                         SERC_RGBcam_metadata['extent'],
                         (B1min,B1max),
                         title='SERC Band 1: red',
                         cbar='on',
                         colormap='Reds')
```




```
In [15]: plot_band_array(SERC_RGBcam_array[:,:,1],
                         SERC_RGBcam_metadata['extent'],
                         (B2min,B2max),
                         title='SERC Band 2: green',
                         cbar='on',
                         colormap='Greens')
```




```
In [16]: plot_band_array(SERC_RGBcam_array[:,:,2],
                         SERC_RGBcam_metadata['extent'],
                         (B3min,B3max),
                         title='SERC Band 3: Blue',
                         cbar='on',
                         colormap='Blues')
```


SERC Band 3: Blue
4300000
4280000
4260000
4240000
4220000
380000
400000
420000
440000
460000
250
200
150
100
50