Ross Sea

The Last Ocean

Presentation by Group 4
URL to code repo: https://github.com/Aufuray/ross-sea-project

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The last ocean?

The Ross Sea ecosystem is the **last** intact marine ecosystem left on Earth!

Unlike many other areas of the world's oceans, the Ross Sea's top predators are still abundant.

Random Fact: *The heart of the Antarctic toothfish beats once every six seconds.*

The last ocean?

Penguin

The Ross sea is home to species found **nowhere** else in the world - **uninterrupted** by humans.

Commercial fishing now threatens survival in the Ross Sea.

You can help save the Last Ocean by donating and working with the New Zealand government. lastocean.org/Take-Action

Yes. We care about the planet.

But that’s not our assignment today 

Random Fact: *Visibility under the Antarctic ice is 10 times clearer than anywhere else in the world.*

Our Dataset:

Date: December 2nd, 2015

(Julian Date: 336)

Time: 00:41 am to 20:25 pm

Sensors: VIRS and MODIS

(8 VIRS, 12 MODIS snaps)

Our Stack:

Python: Scripting Language

NumPy: To work with np arrays

SciPy: Load matfiles

To Compute Empirical CDF

Histogram matching

K-means clustering

Pandas: To create Time series

Matplot: Plot Graphs and charts

Game Plan

- Work with Sea Ice Concentration (mw_sic) data
  - Determine where the sea ice is located
  - Try to use histogram matching to normalize images from different sensors
- Visualising independent components
  - Determine where land, water, cloud, ice components overlap
  - See if any element(s) encroached more into the other over time
- Use K-means Algorithm
  - Separate the individual components into clusters
  - See if the clusters validate the analysis of the ICA in step 2

Working with Sea Ice data

Random Fact: *The surface area of Antarctic Sea ice increases dramatically during the winter.*

Working with Sea Ice data

Challenge:

Analysing the data from the [mw_sic] in our images, we found some irregularities between the VIIRS and MODIS sensors. 60% of our data files are from MODIS instrument, so we decided not to use VIIRS images alone.

Solution: Histogram Matching and Linear Interpolation.

We used the VIIRS images as reference and MODIS images as source of our histogram match computation.

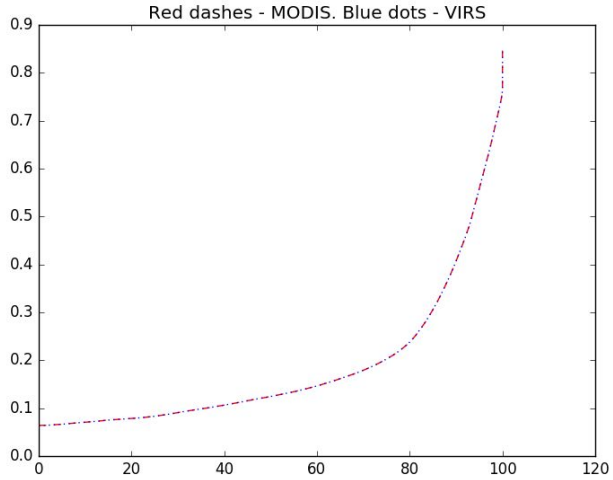
We used images that were taken approx. 20mins apart from each other.

This is because images with large time produced very different histograms.

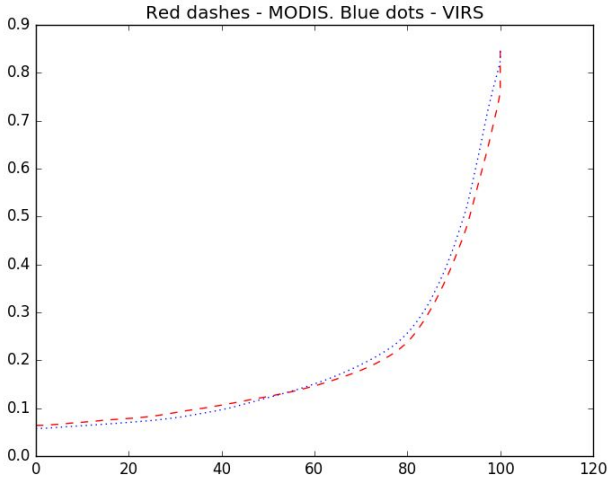
Working with Sea Ice data

Before Histogram Matching

Sample Sea Ice discrepancy between VIIRS and MODIS sensors



Images from MODIS and VIIRS sensors taken **4 mins** apart

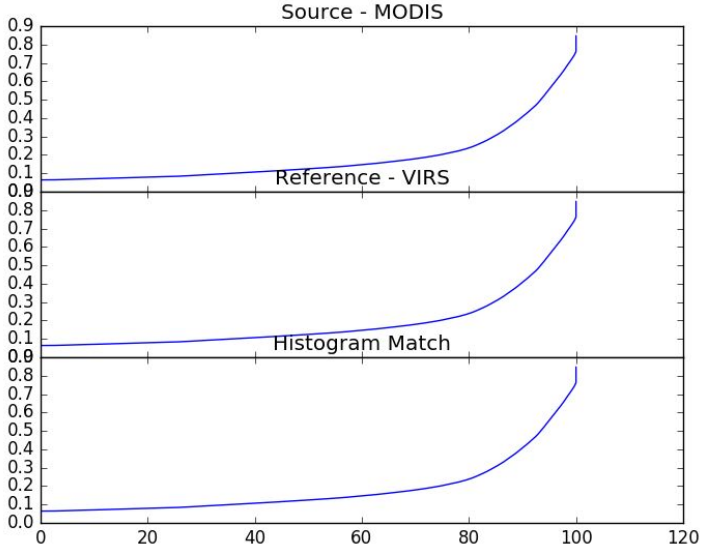


Images from MODIS and VIIRS sensors taken **16 hours** apart

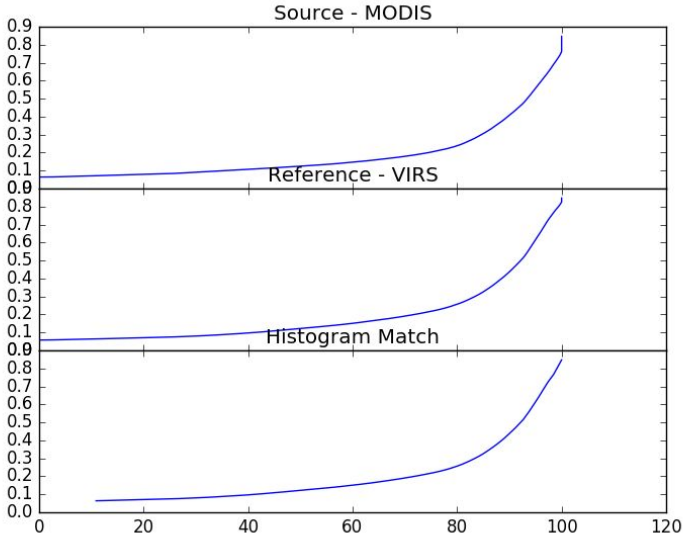
Working with Sea Ice data

After Histogram Matching

Sample Sea Ice discrepancy between VIIRS and MODIS sensors

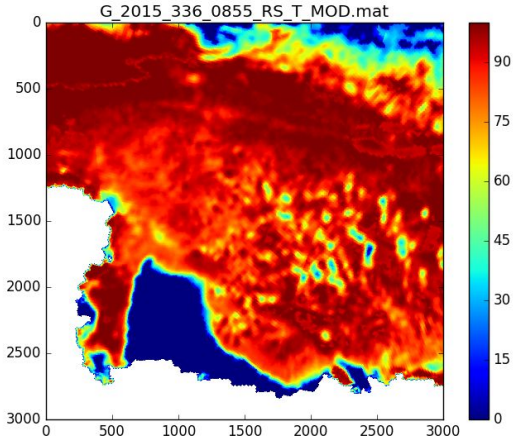


Using images from MODIS and VIIRS sensors taken **4 mins** apart

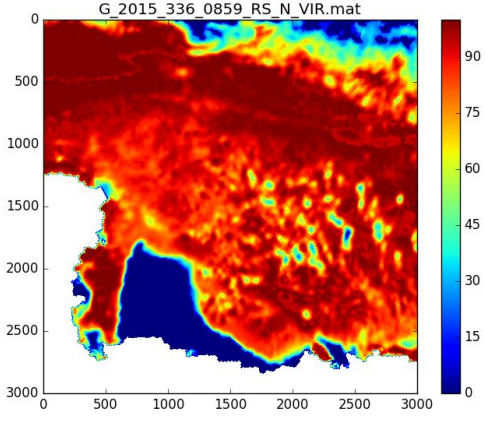


Using images from MODIS and VIIRS sensors taken **16 hours** apart

Working with Sea Ice data



MODIS image taken at time: **0855**



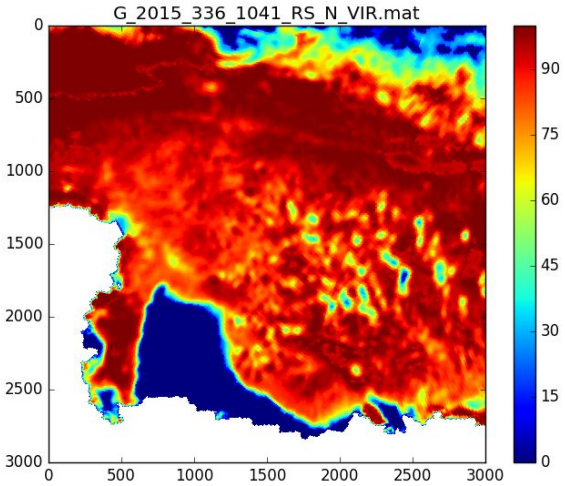
VIIRS image taken at time: **0859**

Histogram Match of images taken approx. 20 mins apart

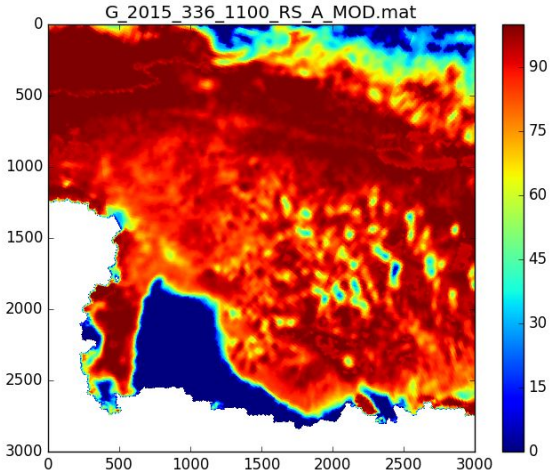
VIIRS image used as reference.
MODIS used as source.

Conclusion:
The closer the images were taken to each other, the more similar the resulting histogram matched image was.

Working with Sea Ice data



VIIRS image taken at time: **1041**



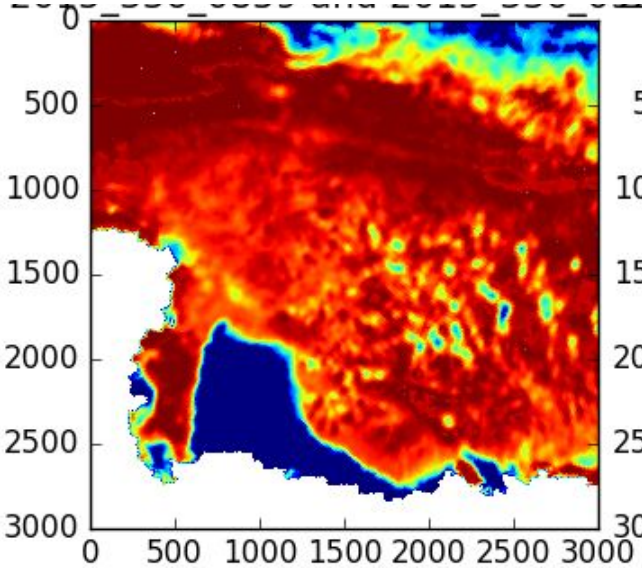
MODIS image taken at time: **1100**

Histogram Match of images taken approx. 20 mins apart

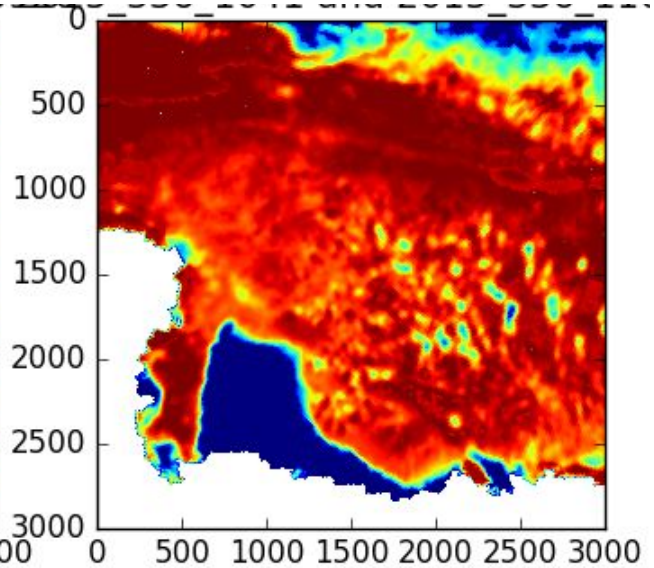
VIIRS image used as reference.
MODIS used as source.

Conclusion:
The closer the images were taken to each other, the more similar the resulting histogram matched image was.

Working with Sea Ice data



Hist Match between Images taken at time: **0859** and **0900**



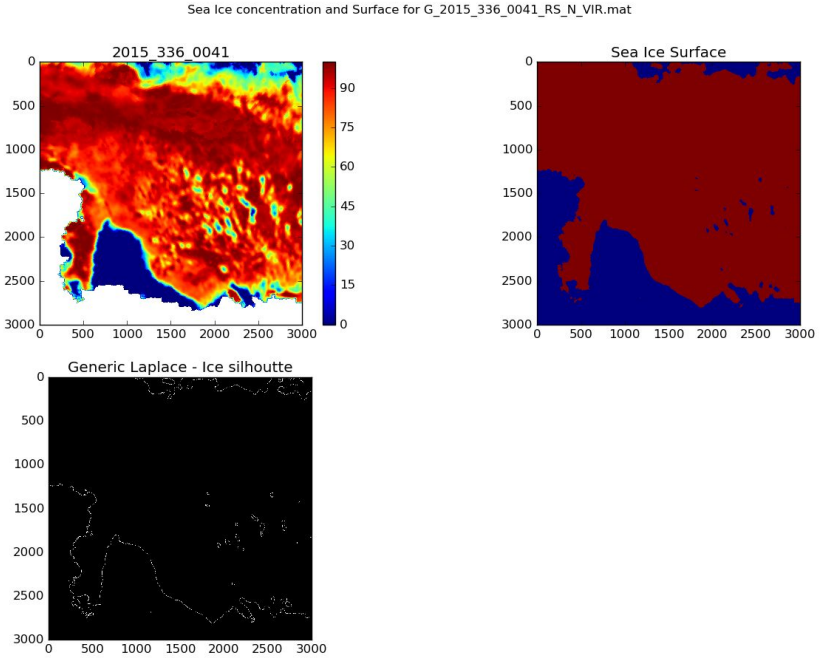
Hist Match between Images taken at time: **1041** and **1100**

Histogram Match of images taken approx. 20 mins apart basically looks very similar to the individual images.

Working with Sea Ice data

Sea Ice

Others



In the microwave sea ice readings, we set a threshold:

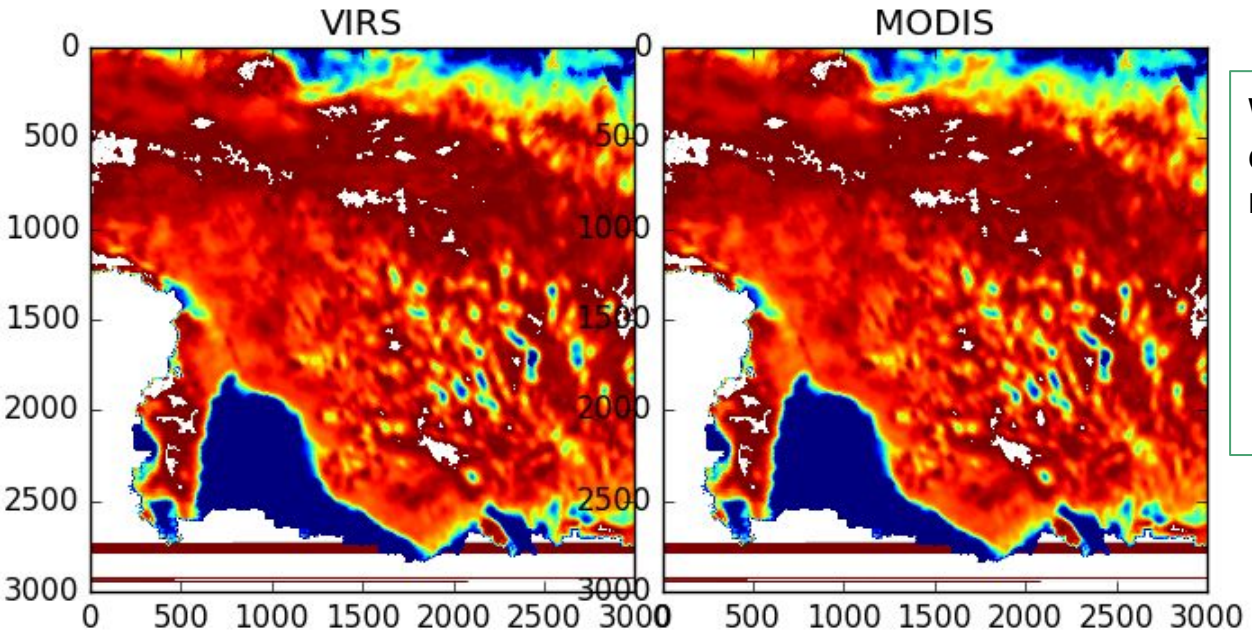
<= 40 for other components,

> 40 for sea ice.

Hence we were able to classify and separate the image into two portions.

We also applied a **Generic Laplace filter** on the image to create a silhouette that highlights the edges.

Cumulative histogram match of sea ice images by sensors



We built a sensor-wise cumulative histogram of all mw_sic images.

Visualising independent components over time

Random Fact: *We humans have pushed marine ecosystem to the brink of collapse worldwide.*

Visualising independent components over time

Challenge:

Plot a component-wise analysis of each image and build a Time Series.
See how the Time Series changes over time.

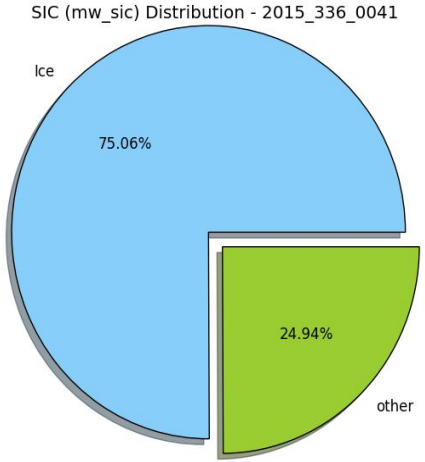
Solution:

Use the Land mask and Sea ice array values.
Plot percentage of components in a pie chart and translate that to bar graph of time series.

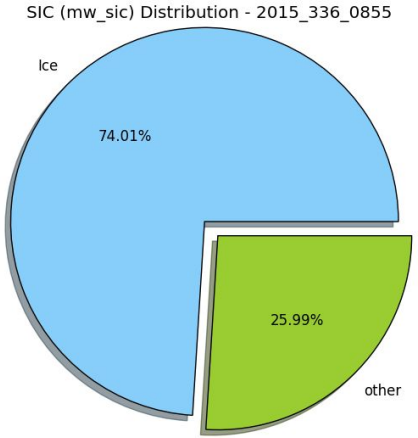
Visualising components over time

Sea Ice

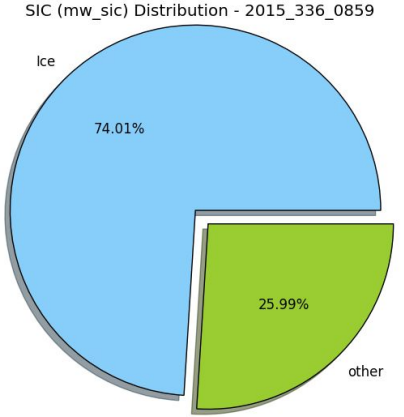
Land and water



From VIIRS snap taken at **0041**

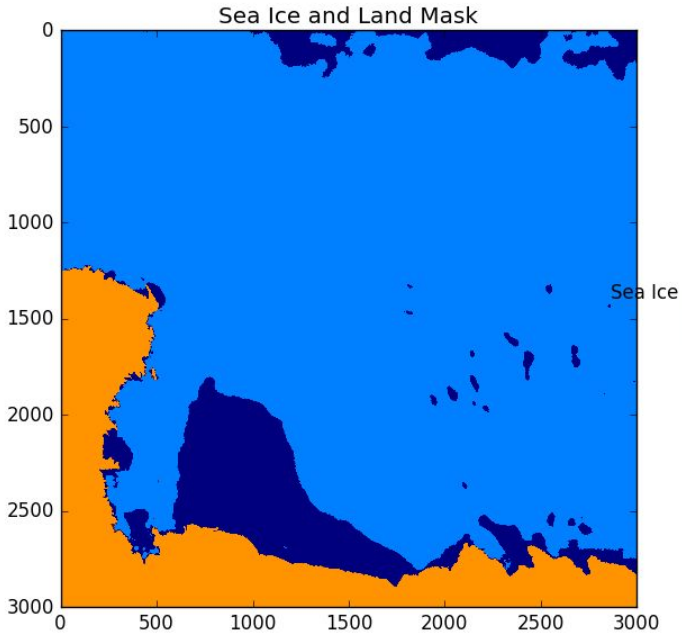


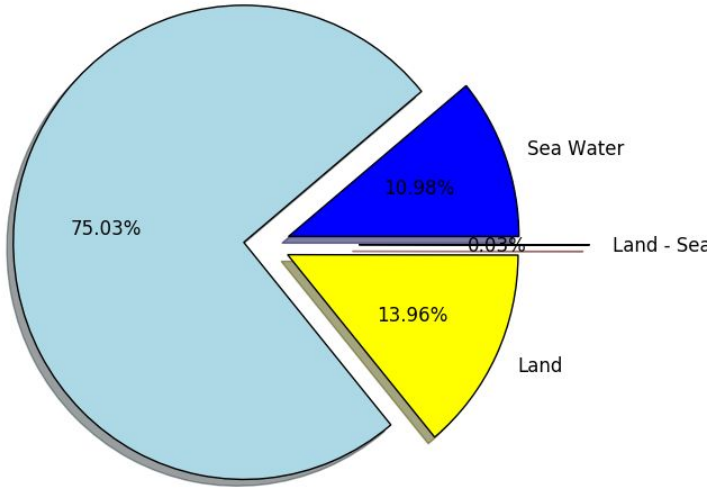
From MODIS snap taken at **0855**



From VIIRS snap taken at **0859**

Visualising components in single image

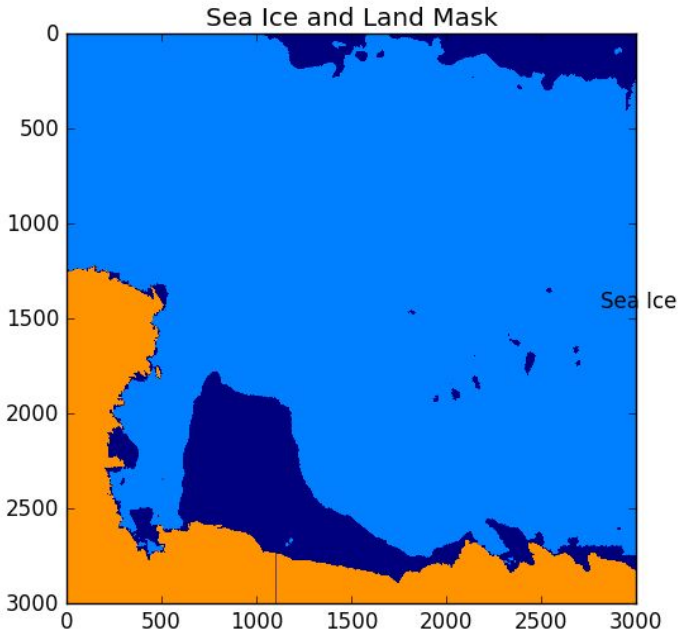


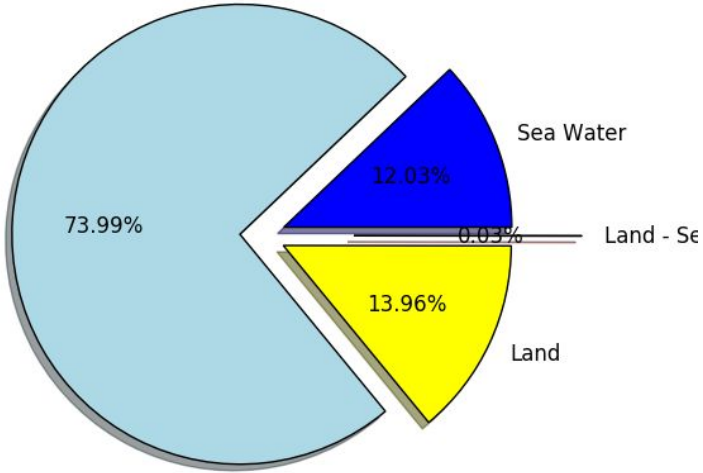


0.03% of this image is an overlap between sea ice and land.

From VIIRS snap taken at **0041**

Visualising components in single image

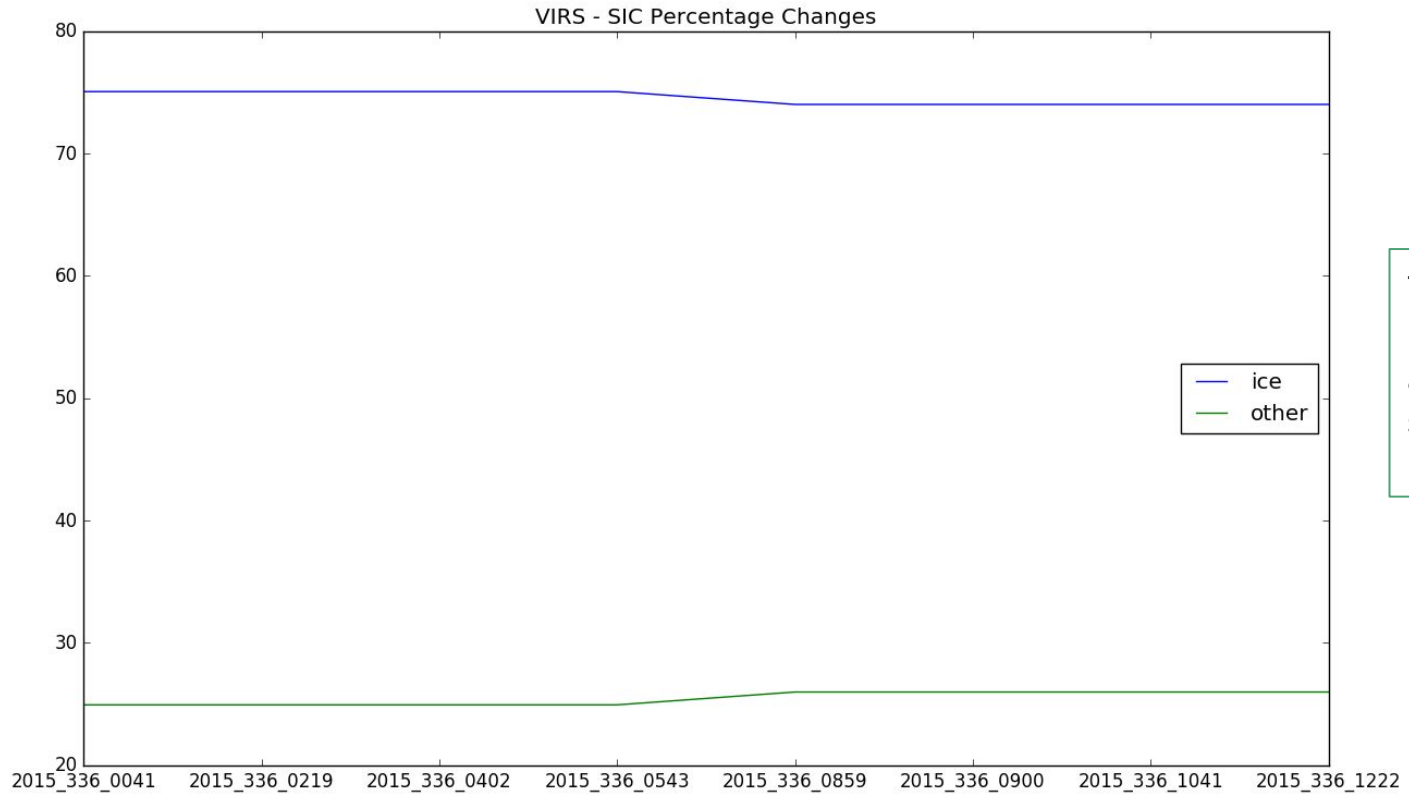




0.03% of this image is an overlap between sea ice and land.

From MODIS snap taken at **0855**

Time series of Sea Ice percentage (VIIRS Sensor)

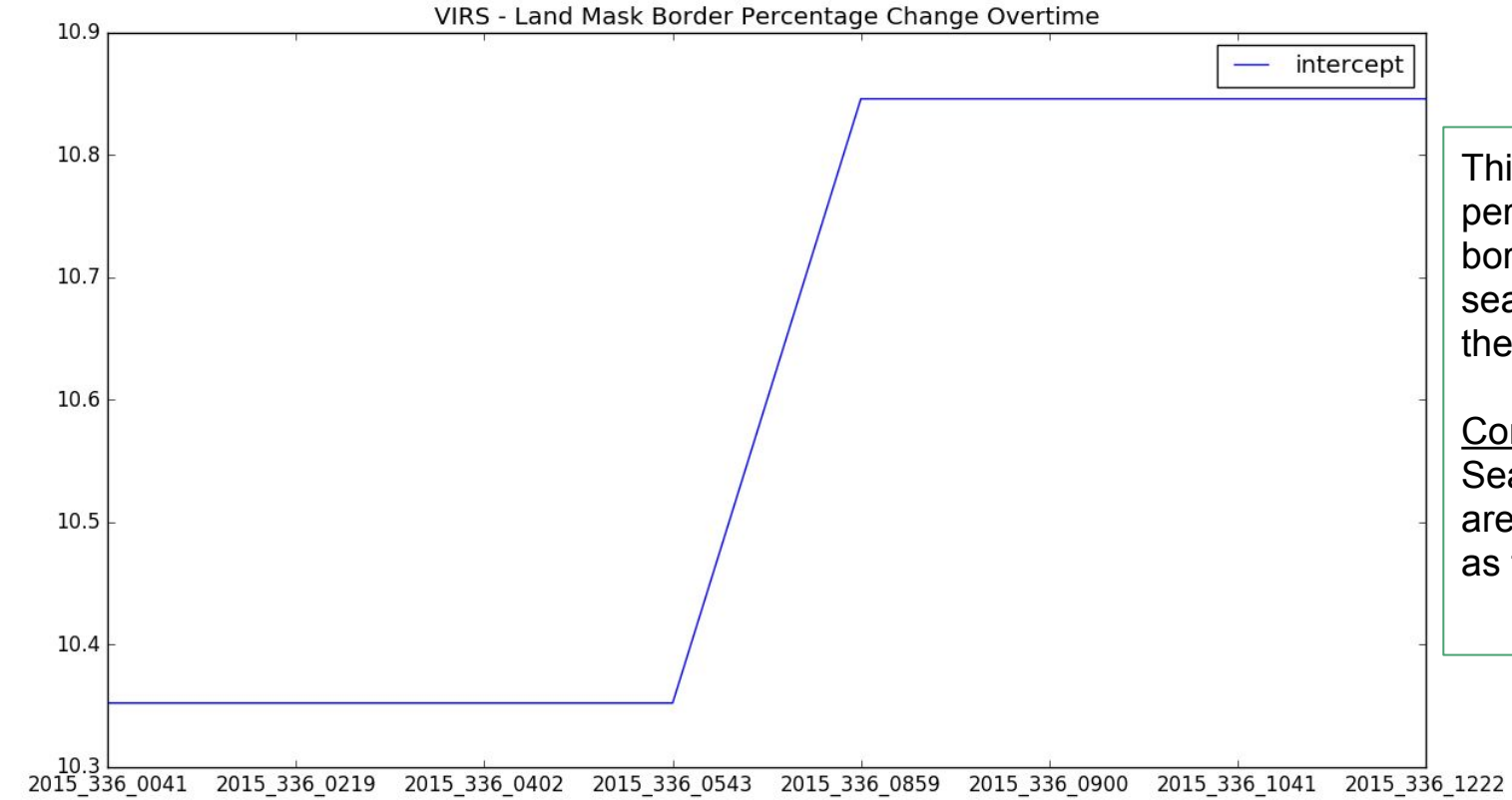


Sea Ice

Others

The sea ice percentage reduces slightly over time - as shown in this time series from VIIRS sensors.

Time series of Sea Ice at land border (VIIRS Sensor)



This graph shows the percentage of the land border being covered by sea ice over time - from the VIiRS sensors.

<u>Conclusion:</u>
Sea ice touched more of area of the land border as time progressed.

Using K-means

Solving a classification problem

Random Fact: *Commercial fishing now threatens natural dynamic balance of the Ross sea.*

Using K-Means

Challenge:

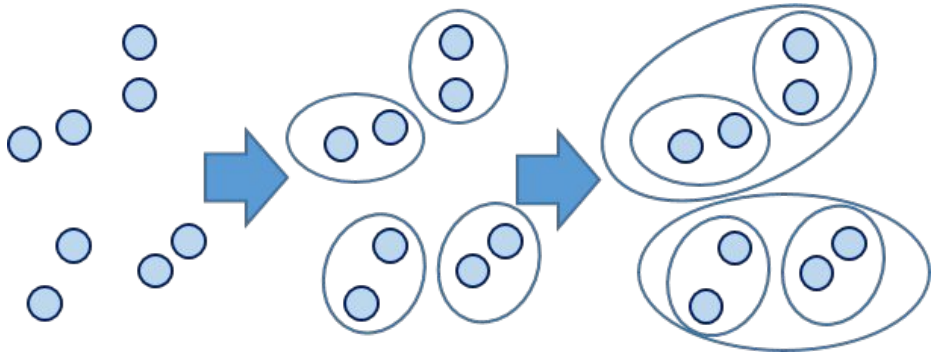
Group the data into clusters of individual components (cloud, ice, water, land). By far the toughest challenge we had.

Solution:

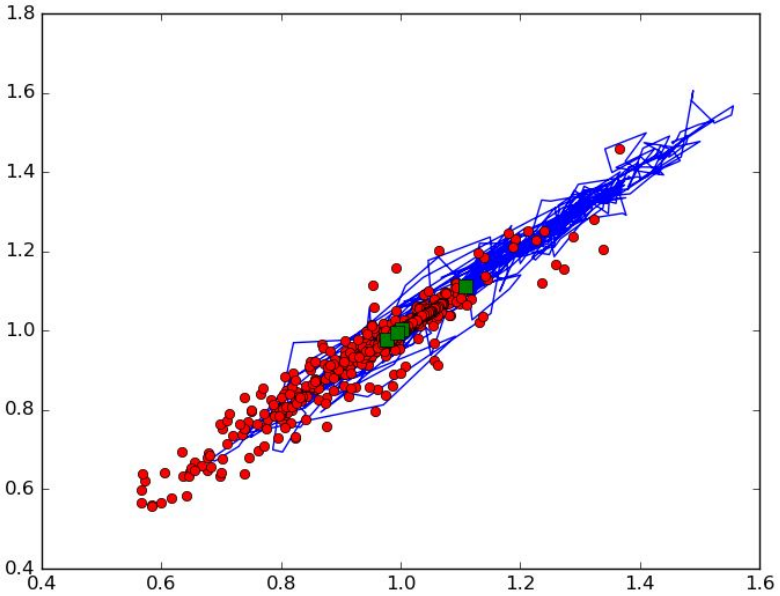
K-means clustering algorithm from Scipy.

How K-Means works ?

- K-Means clustering is a technique in which the algorithm groups the data entities into a specified number of clusters (***k***).
- K-Means algorithm selects ***k*** random *centroid* points, and assigns each data entity to a cluster based on the shortest distance to a centroid.



Using K-Means - wrong implementation



Ice

Centroids

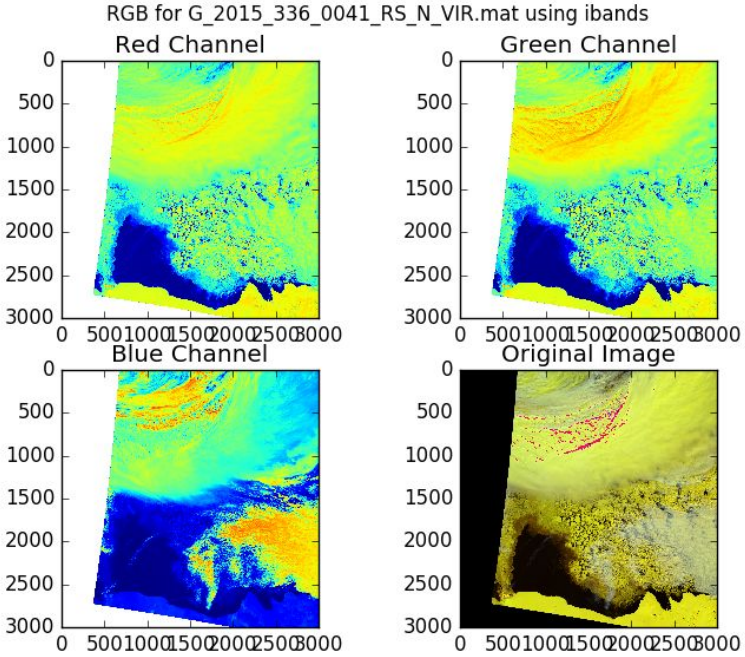
Water

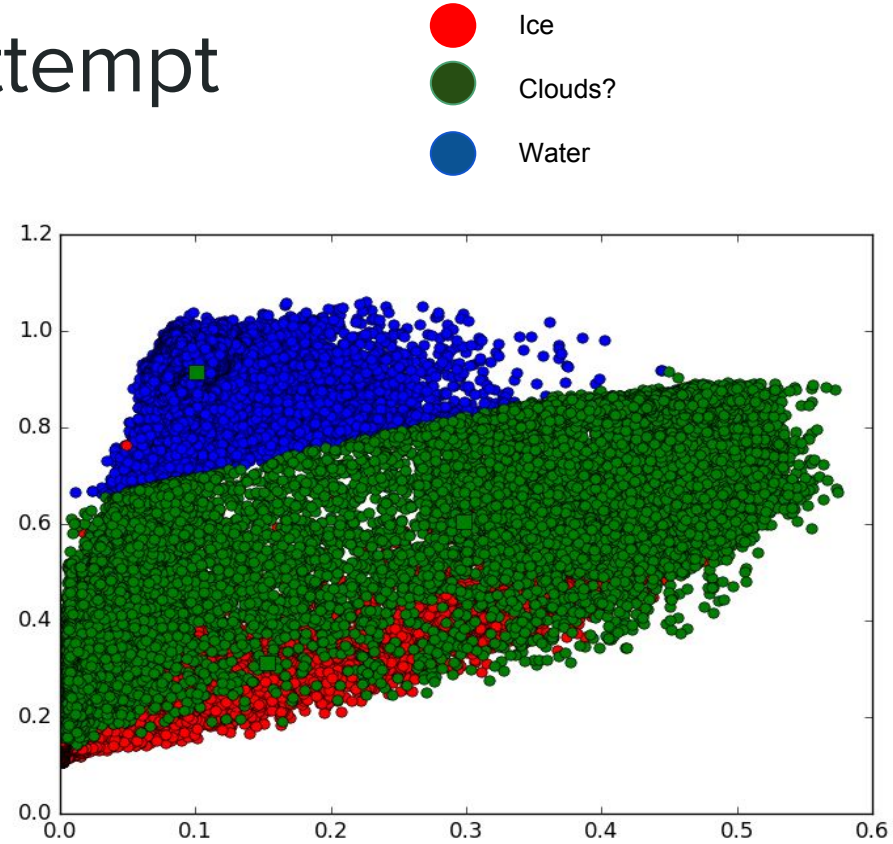
Result was highly skewed and irregular, Because the data insufficient - too small to tell components apart.

Basically, we were using one dimension. Also, were using wrong RGB slices from the data set.

Using VIIRS image taken at time: **0041**

Using K-Means - 2nd attempt





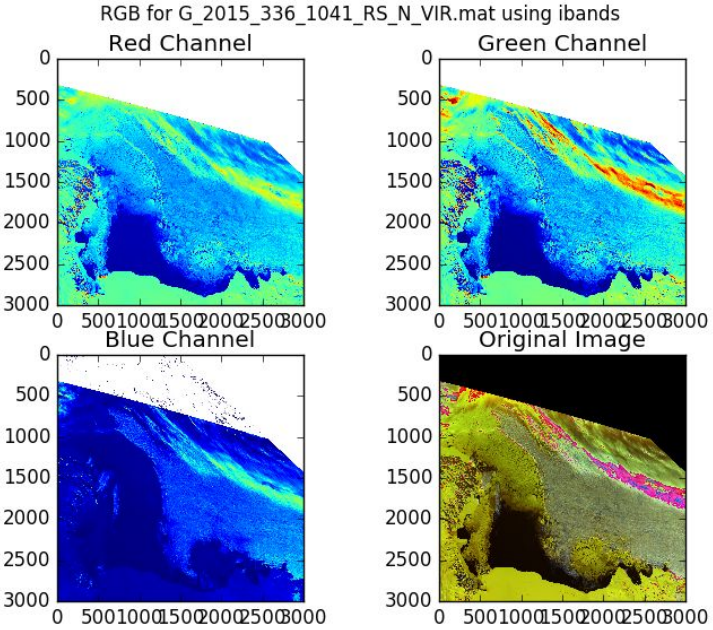
Using VIIRS image taken at time: **0041**

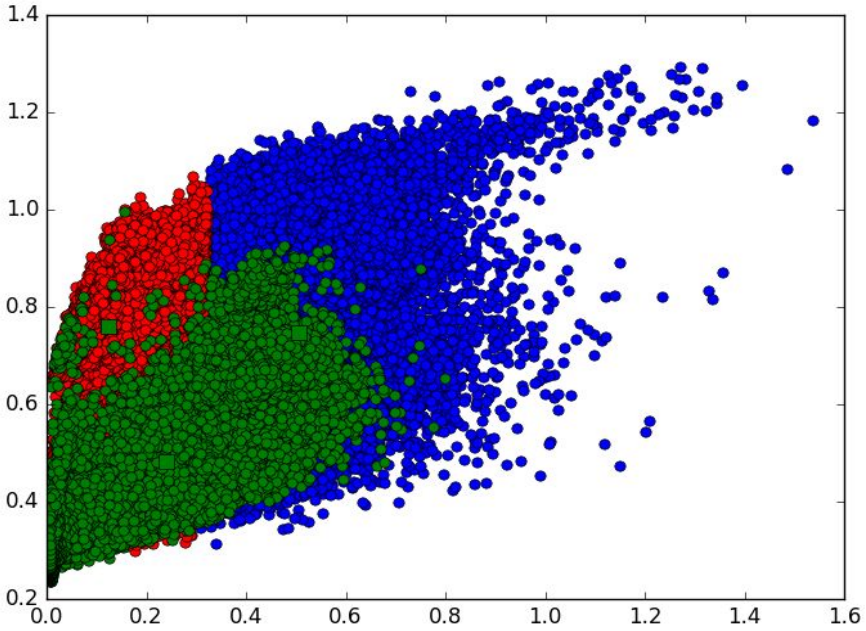
Using K-Means - 2nd attempt

Ice

Clouds?

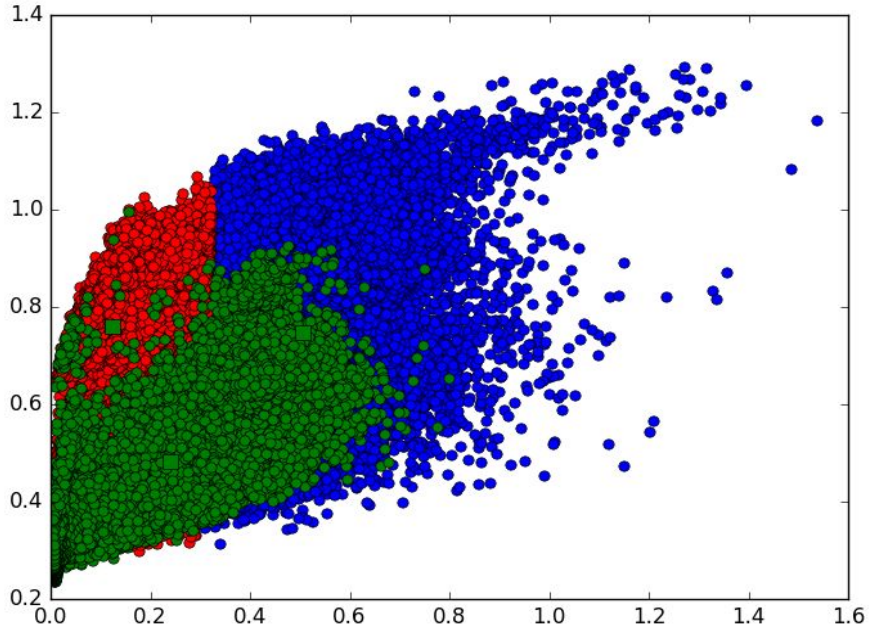
Water





Using VIIRS image taken at time: **1041**

Using K-Means

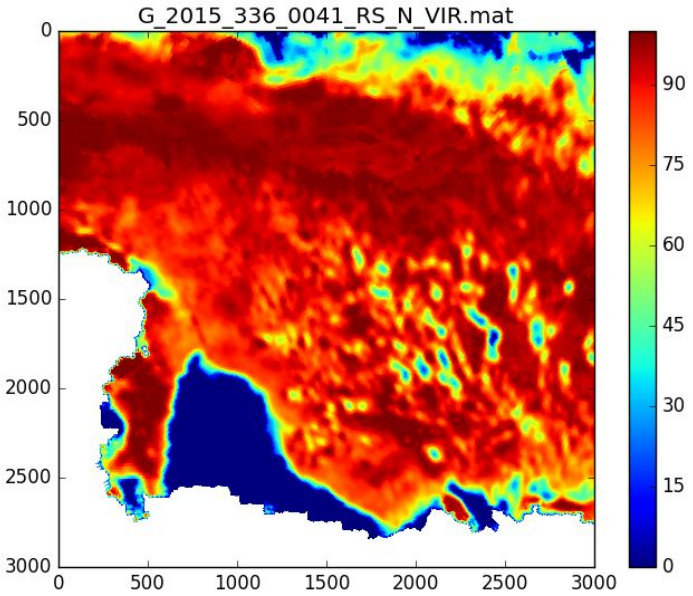


We basically wanted our k-means output to validate the analysis of our time series and graph visualisations.

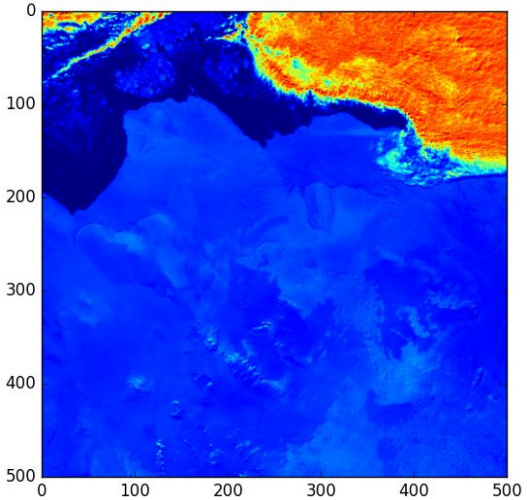
To verify that the sea ice clusters truly encroach more into land over time.

Using K-Means with 2 centroids

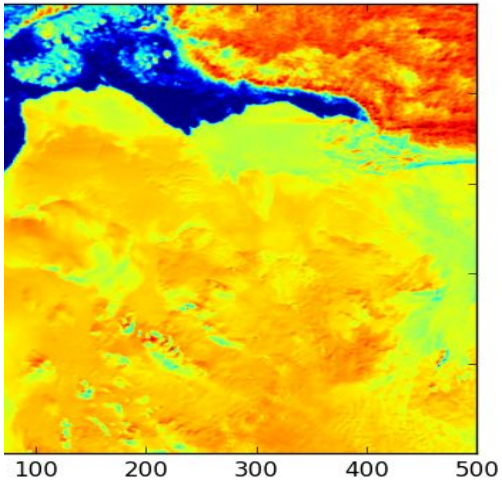
Using ibands and mbands on Lower right 500 X 500 slice



Full image mw_sic

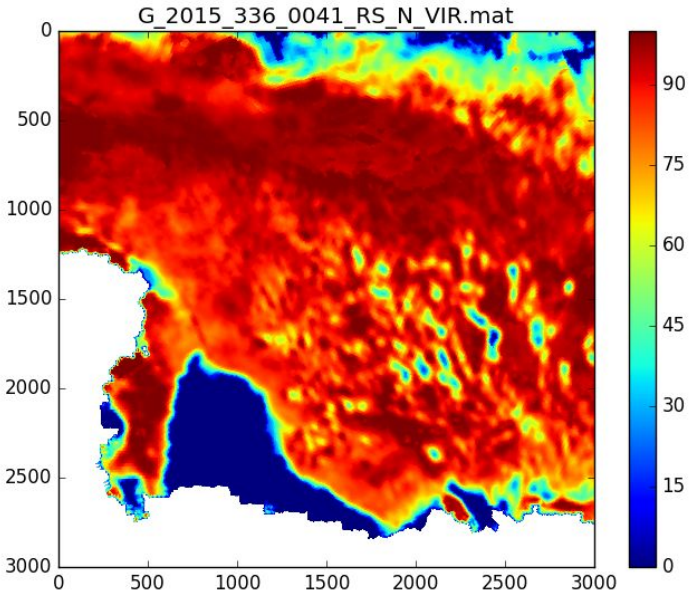


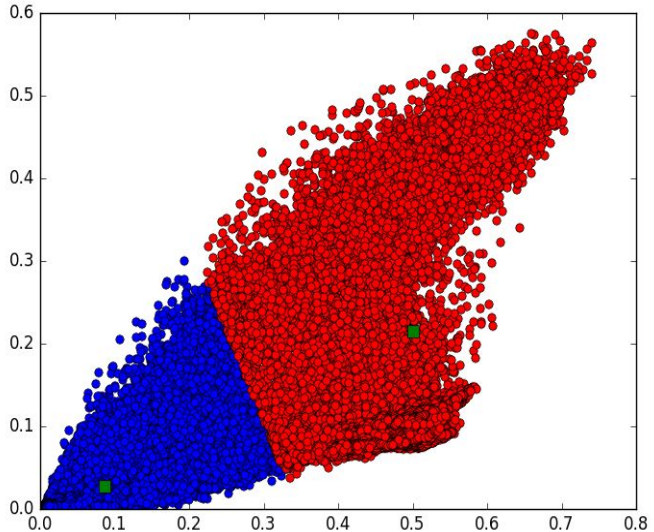
ibands



mbands

Using K-Means with 2 centroids





Ice

Water

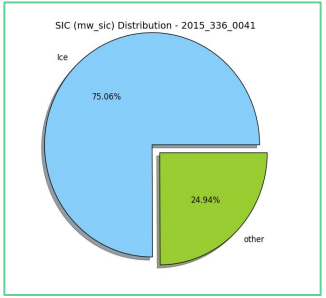
Using ibands and mbands

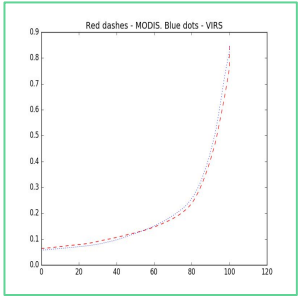
From clustering the data into sea ice and other components.

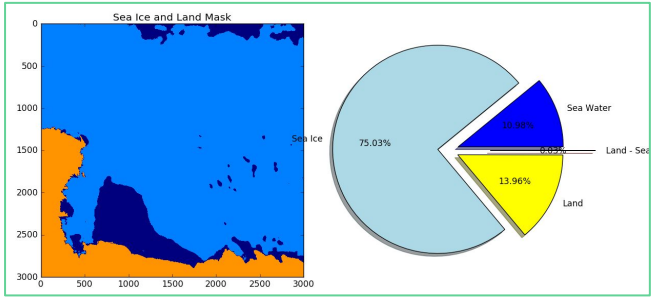
The clusters are clearly divided as our original mw_sic image plot.

In conclusion ...

1. Going forward, it is possible to build a prediction model using the movement of ice and see observing how it spreads in and out of the land over time.
2. Before applying histogram matching, difference in time between images should be taken into consideration because of the moving components.
3. K-means clustering can be used to validate inferences from the ICA.
   We worked with 2 centroids for this project, we can improve to work with 3 centroids.







Random Fact: *The Last Ocean campaign runs on donations … You should consider donating.*

Thank You!

URL to Code Repo:
https://github.com/Aufuray/ross-sea-project

References:
Images: Group 4, Wikipedia
Random Facts: Lastocean.org
scikit-learn.org

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