ESS4137:
Earth Observation Satellite
Data Science and Laboratory

Radar EOS Data (MLC-I)

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SLC vs MLC

Single Look Complex (SLC) Data:
1. SLC data is the raw, complex radar data received by the SAR sensor.
2. It is called "single look" because it represents a single radar pulse reflection from the Earth's surface. This means that each pixel in the SLC image corresponds to a single radar echo.
3. SLC data is represented in a complex format, which means it includes both amplitude and phase information. This complex format allows for more advanced processing and interferometric applications.

Multi Look Data:
1. Multi-look data is generated by averaging or combining information from neighboring pixels in the SLC image. Instead of each pixel representing a single radar echo, each pixel in the multi-look image represents the information from multiple radar echoes.
2. Multi-look processing helps reduce the noise and speckle in the image, which can improve the quality of the SAR data.
3. The number of looks (the amount of averaging) can vary depending on the desired image quality and application. More looks result in smoother images with reduced noise but may sacrifice some spatial resolution.

Multi-looking

The process of multi-looking improve the SAR image quality by reducing the speckle and allows us to obtain a square pixel on the output image. Either in range or azimuth direction or in both the directions, subsequent lines are averaged to get a better image.

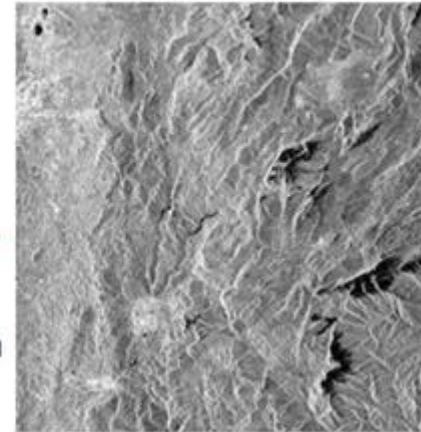Single Look Complex
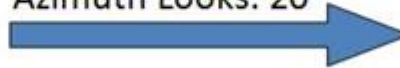
Range Looks: 1
Azimuth Looks: 1

Range Spacing: 7.8 m
Azimuth Spacing: 4.0 m

Multilooked

Range Looks: 4
Azimuth Looks: 20

Range Spacing: 31.2 m
Azimuth Spacing: 80.0 m

Multi-looking

```
>> A
A =
   2.0 + 3.0i   3.0 - 1.0i  -2.0 + 3.0i   1.0 + 2.0i
   2.0 - 1.0i   3.0 + 2.0i   8.0 - 2.0i   2.0 + 3.0i

>> real(A)
ans =
    2    3   -2    1
    2    3    8    2

>> imag(A)
ans =
    3   -1    3    2
   -1    2   -2    3

>> ml=sum(A(:))
ml =
  19.0000 + 9.0000i

>> real(ml)^2+imag(ml)^2
ans =
   442
```

Matlab (Radar Data-Multilook)

```matlab
%% MLC (multi look complex) intensity
rl=4; % number_of_range_looks
al=1; % number_of_azimuth_looks

samples2=samples/rl;
lines2=lines/al;

mlc=zeros(lines2,samples2);
Intensity_mlc=zeros(lines2,samples2);

for ii=1:lines2,
    for jj=1:samples2,

        temp_i=iData(al*(ii-1)+1:al*ii,rl*(jj-1)+1:rl*jj);
        temp_q=qData(al*(ii-1)+1:al*ii,rl*(jj-1)+1:rl*jj).*j;

        mlc(ii,jj)=sum(temp_i + temp_q)/(rl*al);
        Intensity_mlc(ii,jj)= real(mlc(ii,jj)).^2 + imag(mlc(ii,jj)).^2;

    end
end

figure,imagesc(Intensity_mlc,[0 1]);
axis image;
colorbar;colormap(gray);
title('MLC-Intensity')
```
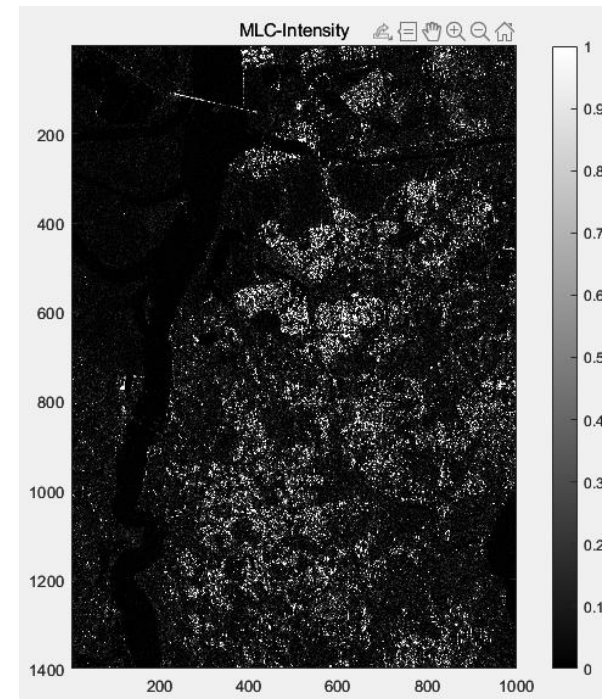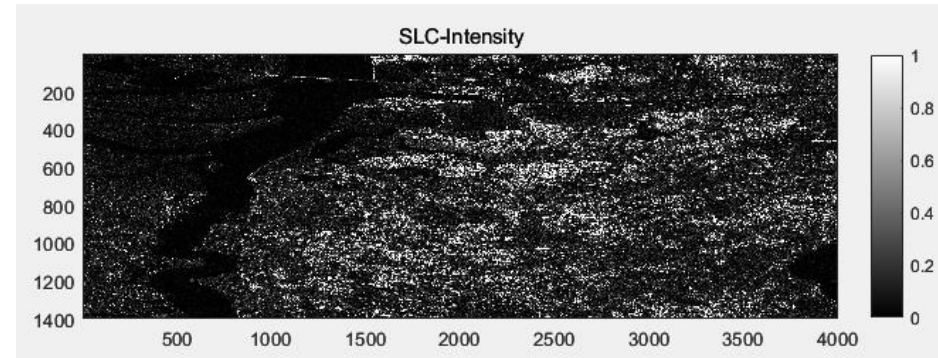
Matlab (median filter 3by3)

```
%% filtering (median 3by3)
Intensity_mlc_med3by3=zeros(lines2,samples2);

for ii=2:lines2-1,
  for jj=2:samples2-1,
    temp=Intensity_mlc(ii-1:ii+1,jj-1:jj+1);
    Intensity_mlc_med3by3(ii,jj)=median(temp(:));
  end
end

figure,imagesc(Intensity_mlc_med3by3,[0 1]);
axis image;
colorbar;colormap(gray);
title('MLC-Intensity(median 3by3)')
```