Environmental Remote Sensing
GEOG 2021

Lecture 2

Image display and enhancement

Image Display and Enhancement

Purpose

- visual enhancement to aid interpretation
- enhancement for improvement of information extraction techniques

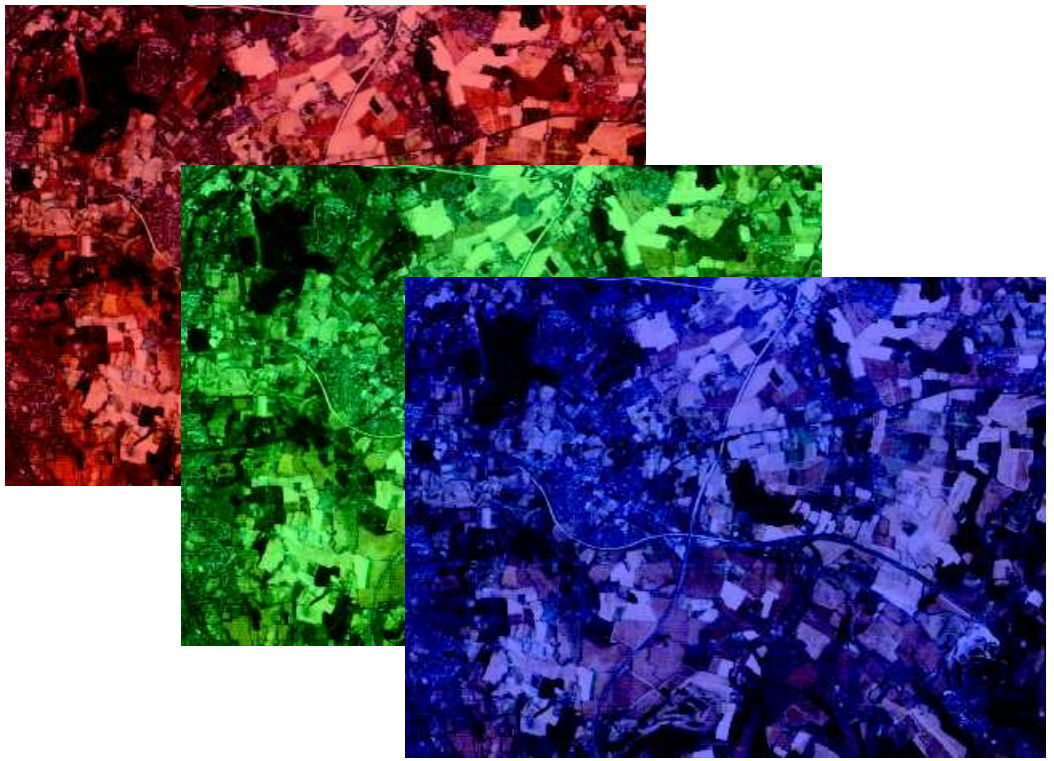
Topics

- **Display**
  - Colour composites
  - Greyscale Display
  - Pseudocoluor
- **Image arithmetic**
  - +-×÷
- **Histogram Manipulation**
  - Properties
  - Transformations
  - Density slicing

Colour Composites

‘Real Colour’ composite

red band on red
green band on green
blue band on blue



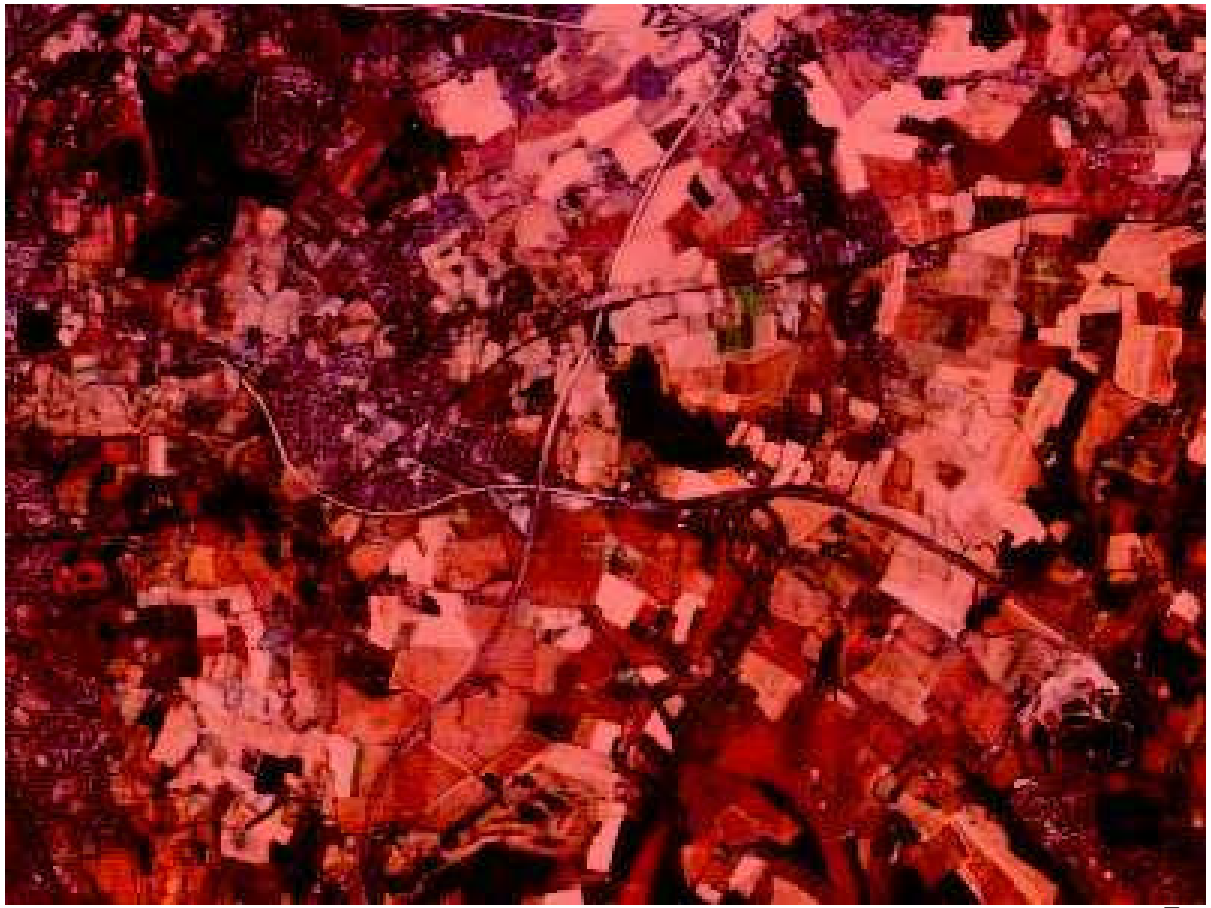
Swanley,
Landsat TM

1988

Colour Composites

‘Real Colour’ composite

red band on red



Colour Composites

‘Real Colour’ composite

red band on red

green band on green

Colour Composites

‘Real Colour’ composite

red band on red
green band on green
blue band on blue

approximation to
‘real colour’...

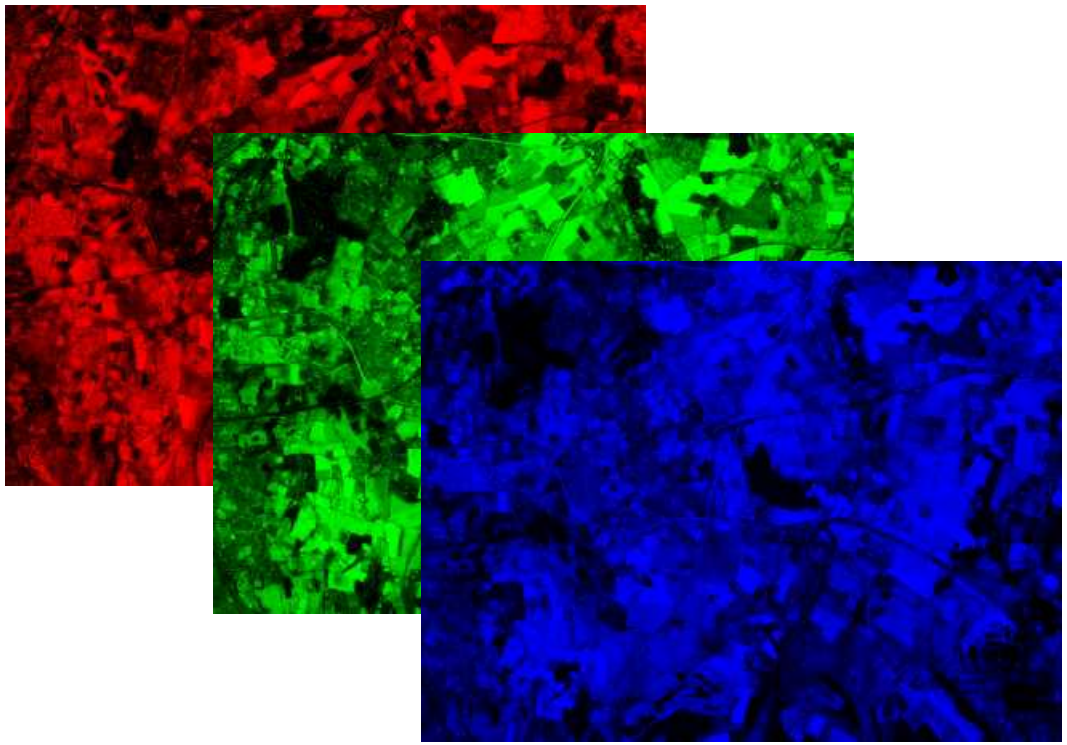
Colour Composites

‘False Colour’ composite

NIR band on red

red band on green

green band on blue



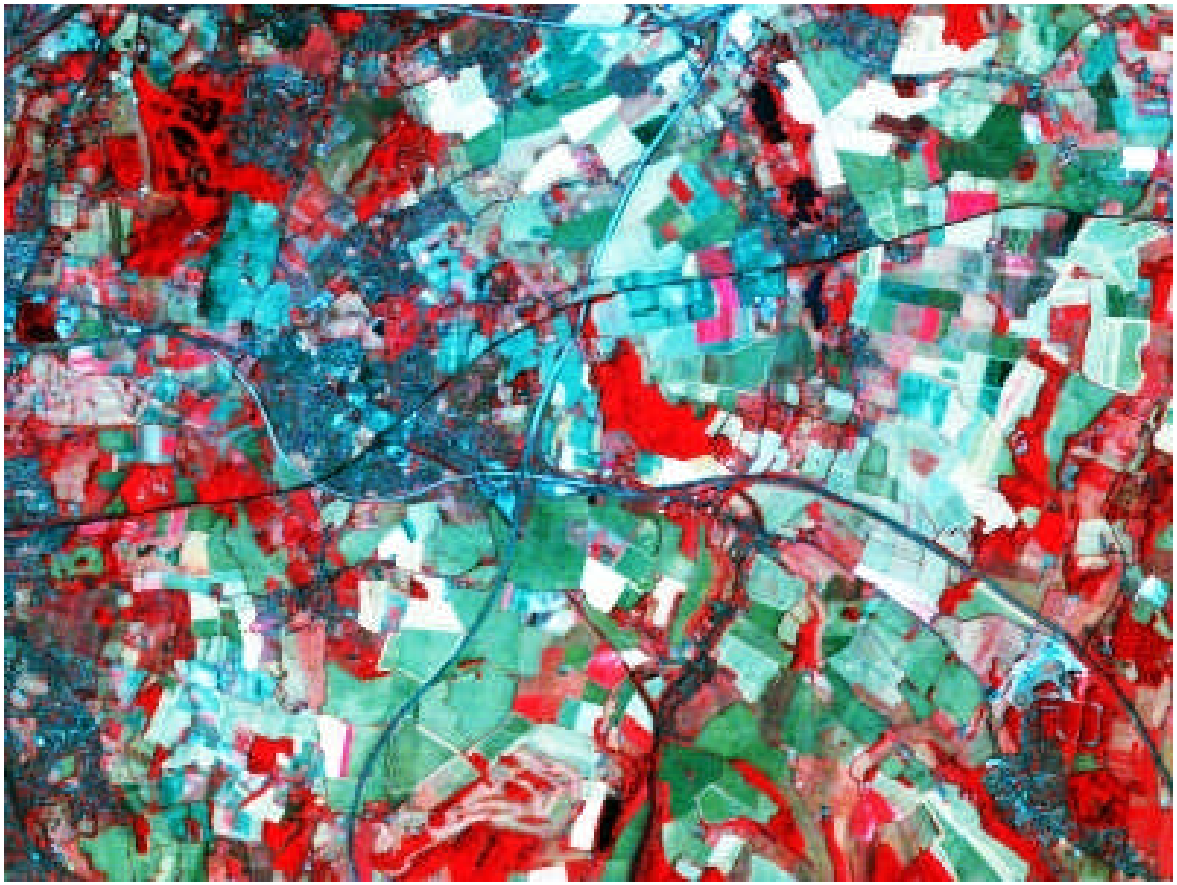
Colour Composites

‘False Colour’ composite

NIR band on red

red band on green

green band on blue



Colour Composites

‘False Colour’ composite

- many channel data, much not comparable to RGB (visible)
  - e.g. Multi-polarisation SAR

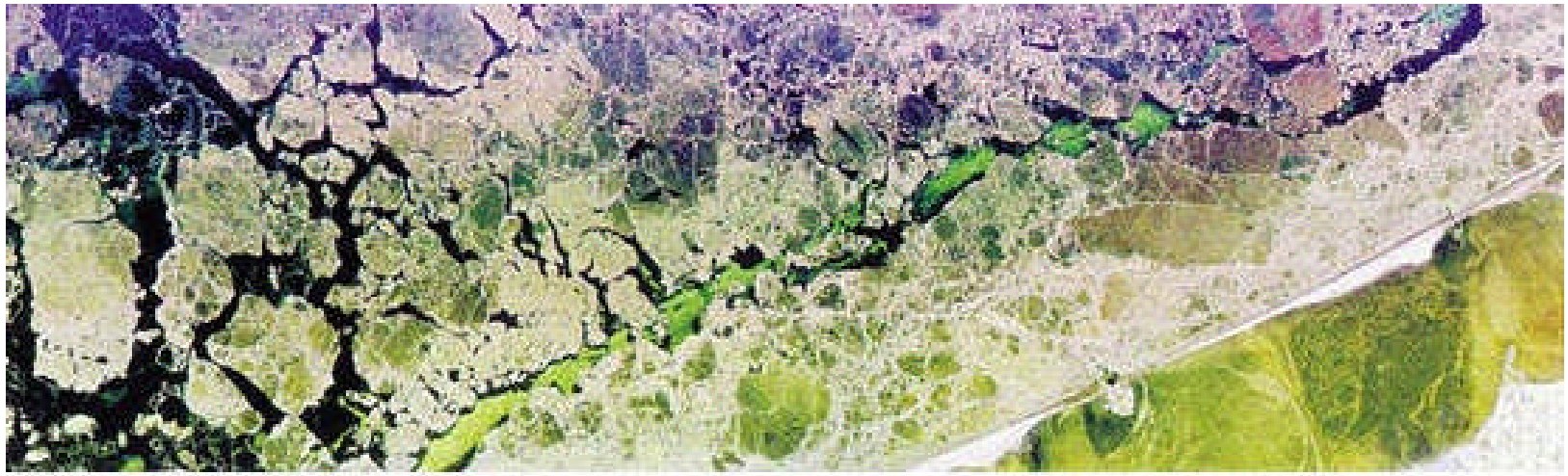


Fig. 3 L-band PI-SAR image of sea ice in southern part of the Sea of Okhotsk, February 23, 1999

HH: Horizontal transmitted polarization and Horizontal received polarization
VV: Vertical transmitted polarization and Vertical received polarization
HV: Horizontal transmitted polarization and Vertical received polarization

Colour Composites

‘False Colour’ composite

- many channel data, much not comparable to RGB (visible)
  - e.g. Multi-temporal data
  - AVHRR MVC 1995

April
August
September

Greyscale Display

Put same information on R,G,B:

August 1995

August 1995

August 1995

Pseudocolour

- use colour to enhance features in a single band
  - each DN assigned a different 'colour' in the image display

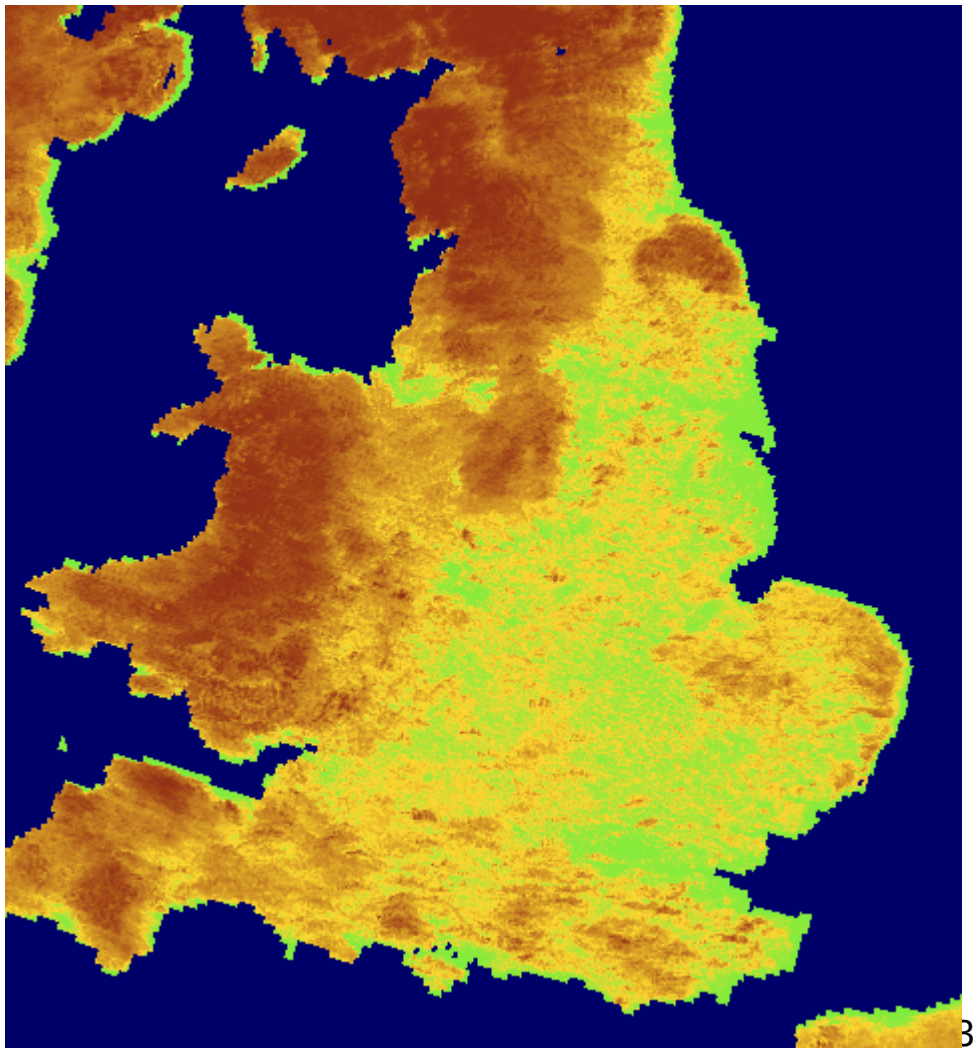


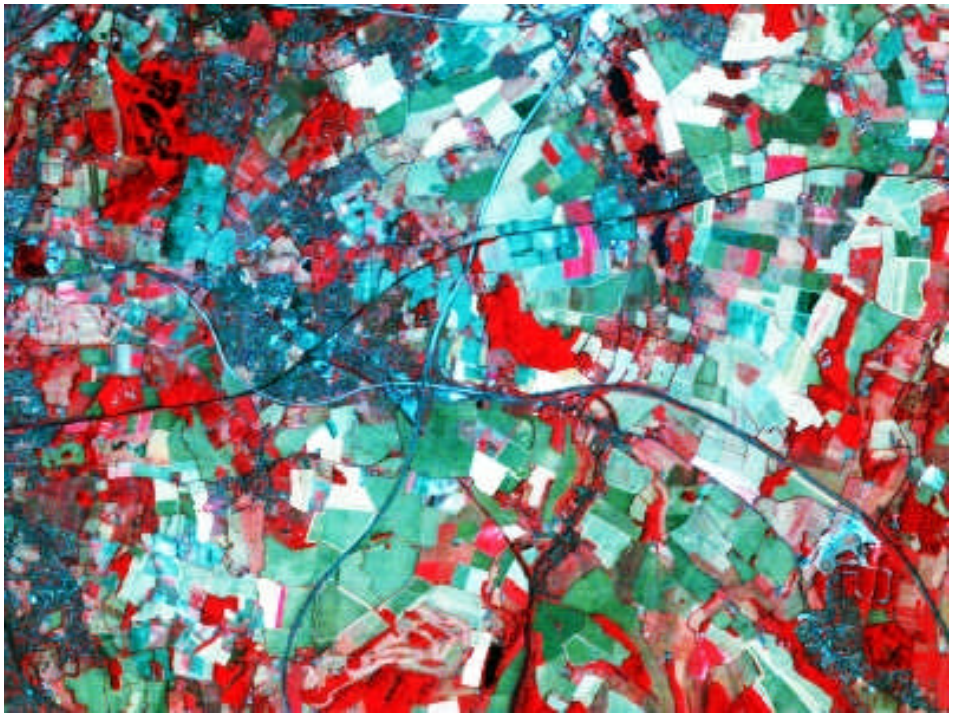
Image Arithmetic

- Combine multiple channels of information to enhance features

- e.g. NDVI

(NIR-R)/(NIR+R)

Image Arithmetic



- Combine multiple channels of information to enhance features
- e.g. NDVI

(NIR-R)/(NIR+R)

Image Arithmetic

- Common operators: **Ratio**

Landsat TM 1992

Southern Vietnam:

green band

what is the ‘shading’?

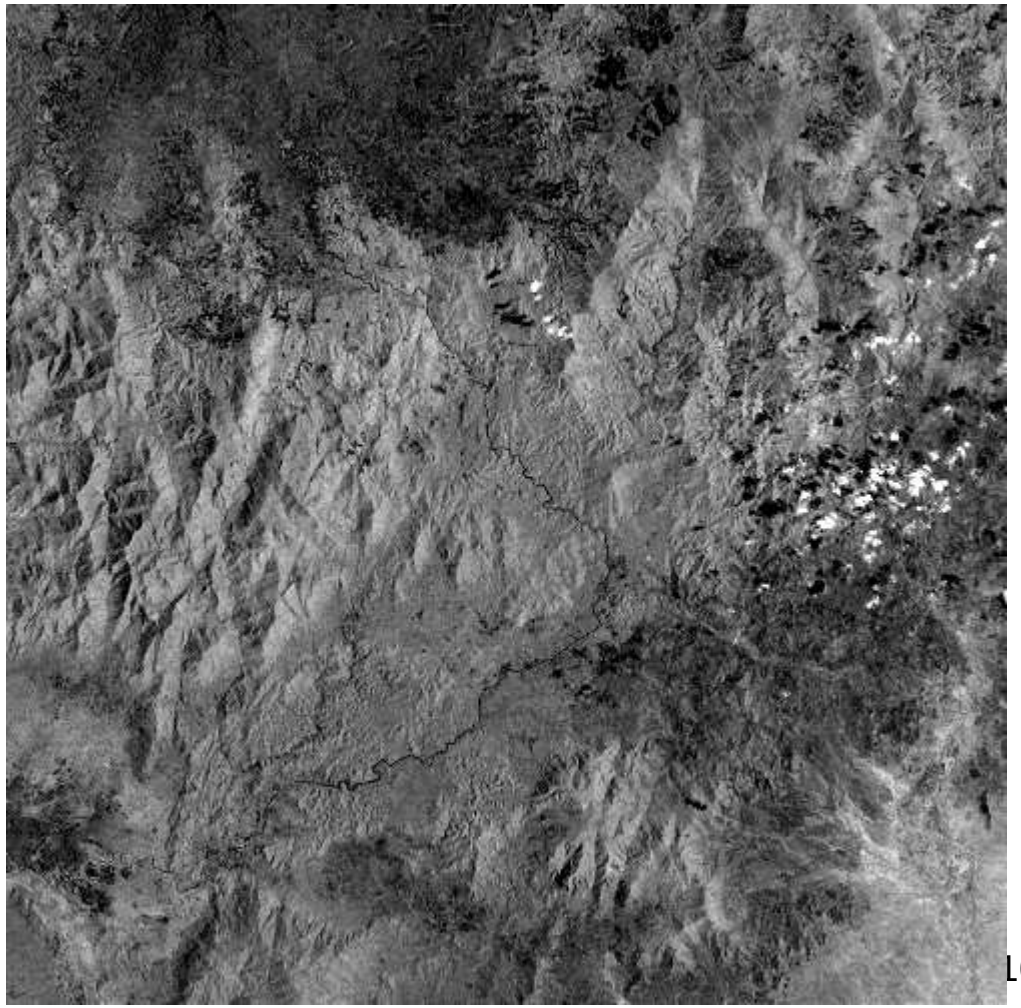


Image Arithmetic

- Common operators: **Ratio**

topographic effects

visible in all bands

FCC

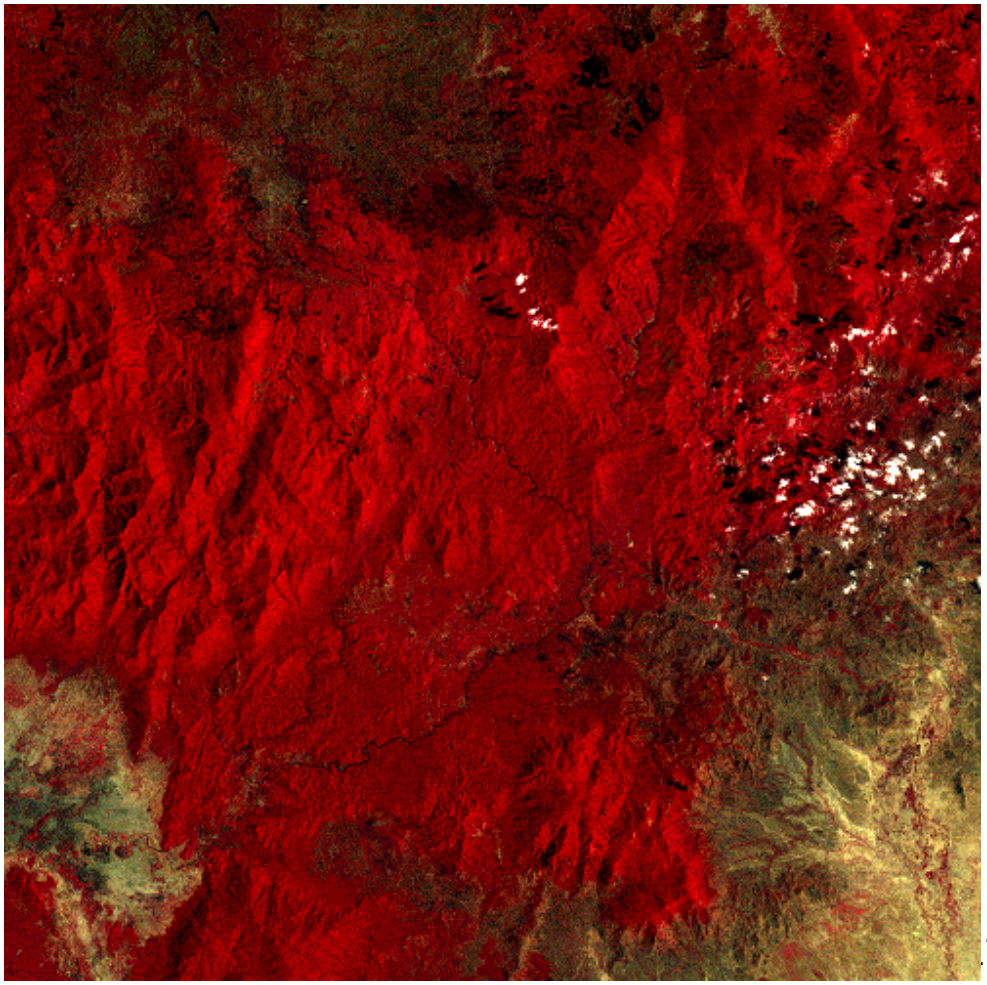


Image Arithmetic

- Common operators:

apply band ratio

= NIR/red

what effect has it had?

Ratio (ch_a/ch_b)

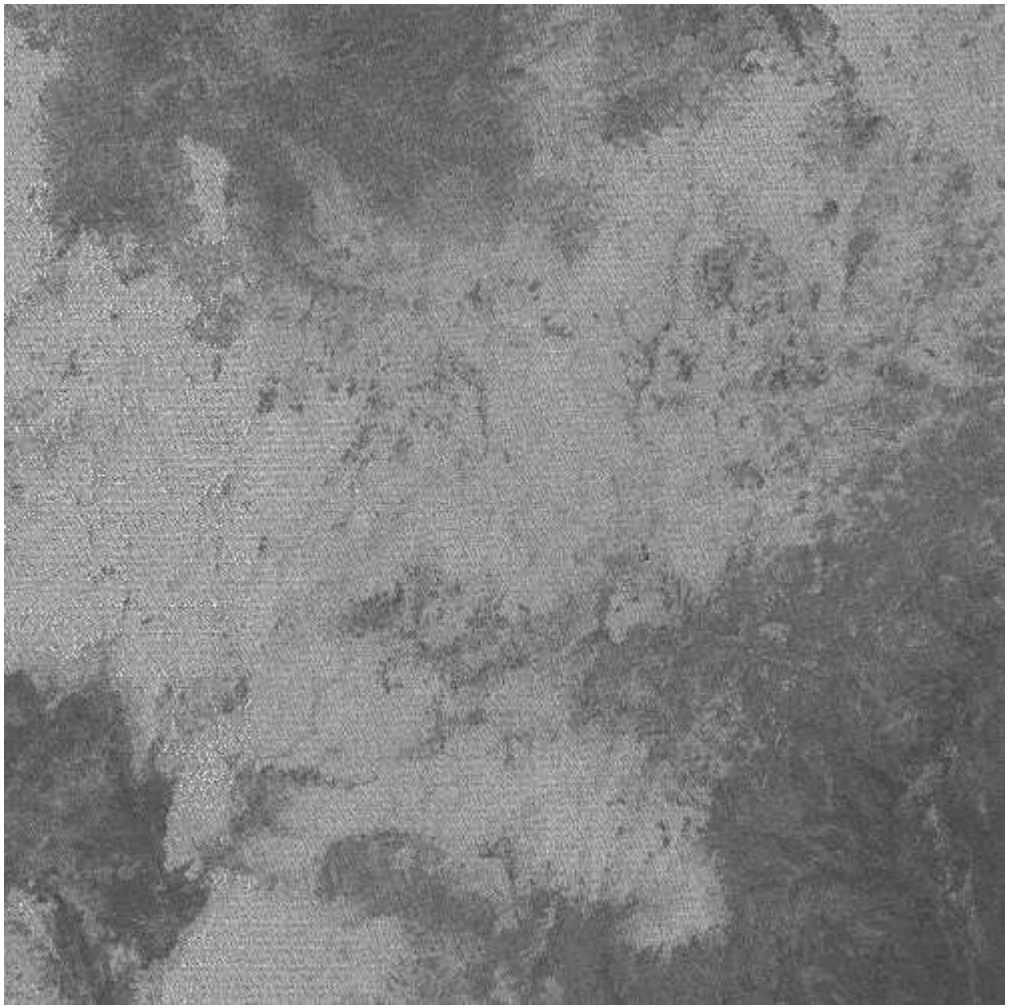
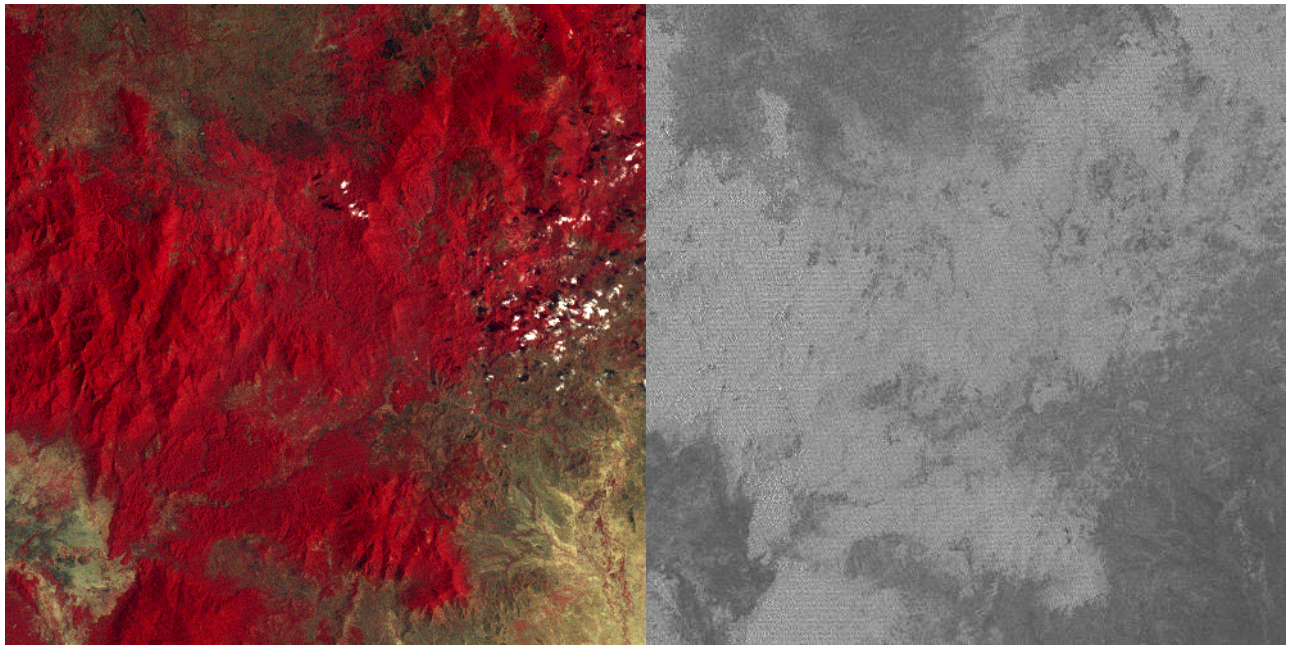


Image Arithmetic

- Common operators: **Ratio (ch_a/ch_b)**



- Reduces topographic effects
- Enhance/reduce spectral features
  - e.g. ratio vegetation indices (SAVI, NDVI++)

Image Arithmetic

- Common operators:
- **Subtraction**

MODIS NIR: Botswana Oct 2000

Predicted Reflectance

Based on tracking reflectance for previous period

- examine **CHANGE**

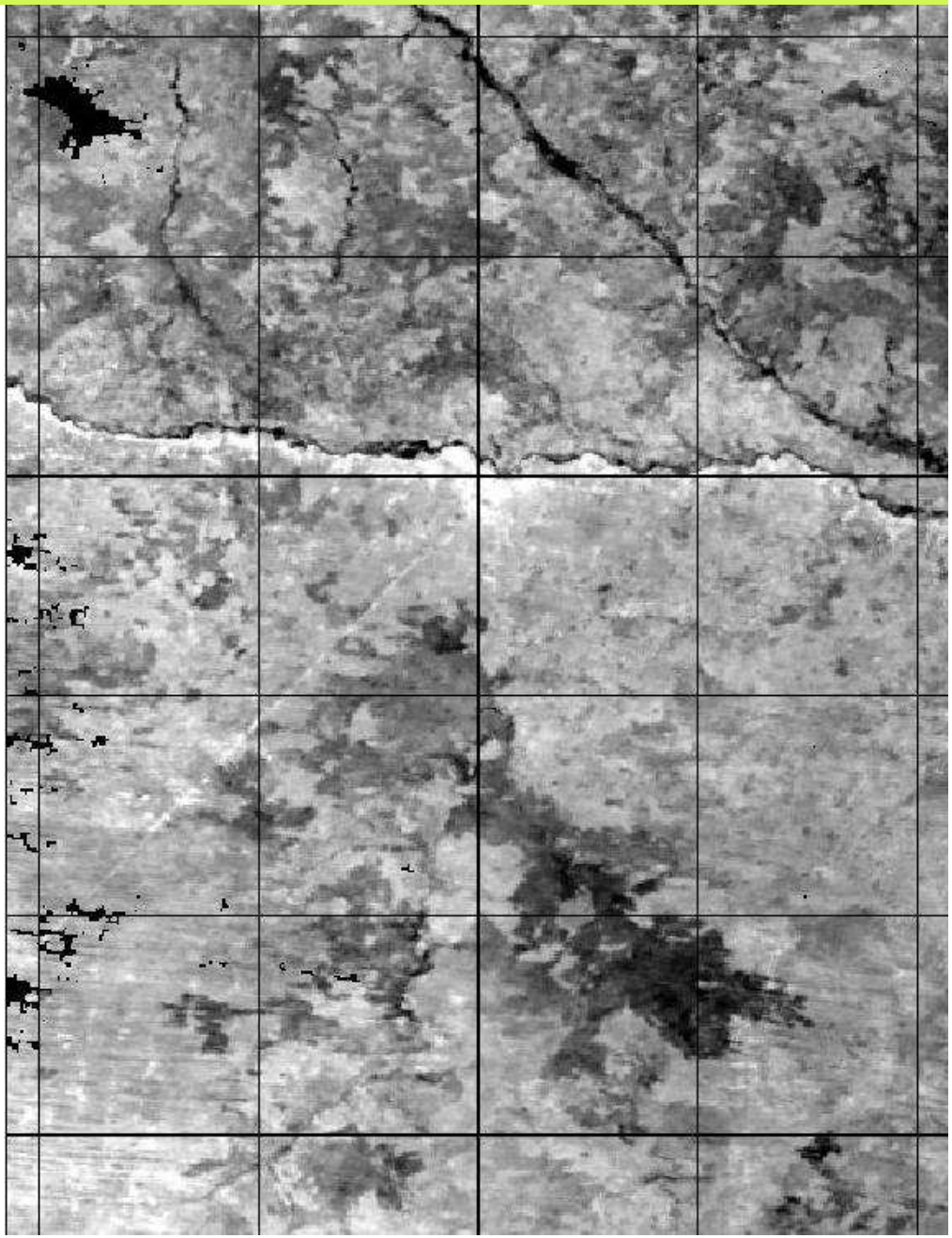


Image Arithmetic

Measured reflectance

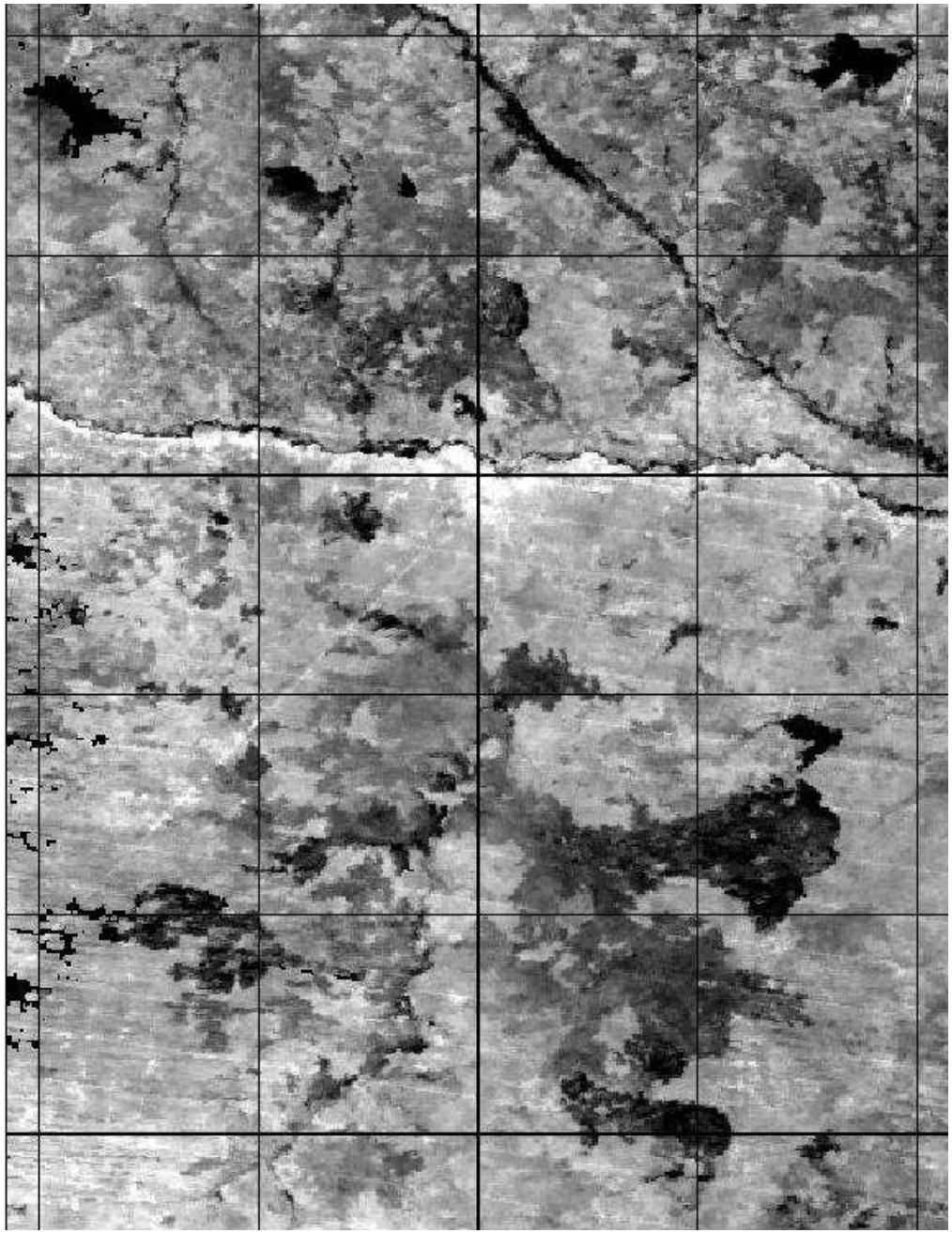


Image Arithmetic

Difference (Z score)

$$\frac{\textit{measured minus predicted}}{\textit{noise}}$$

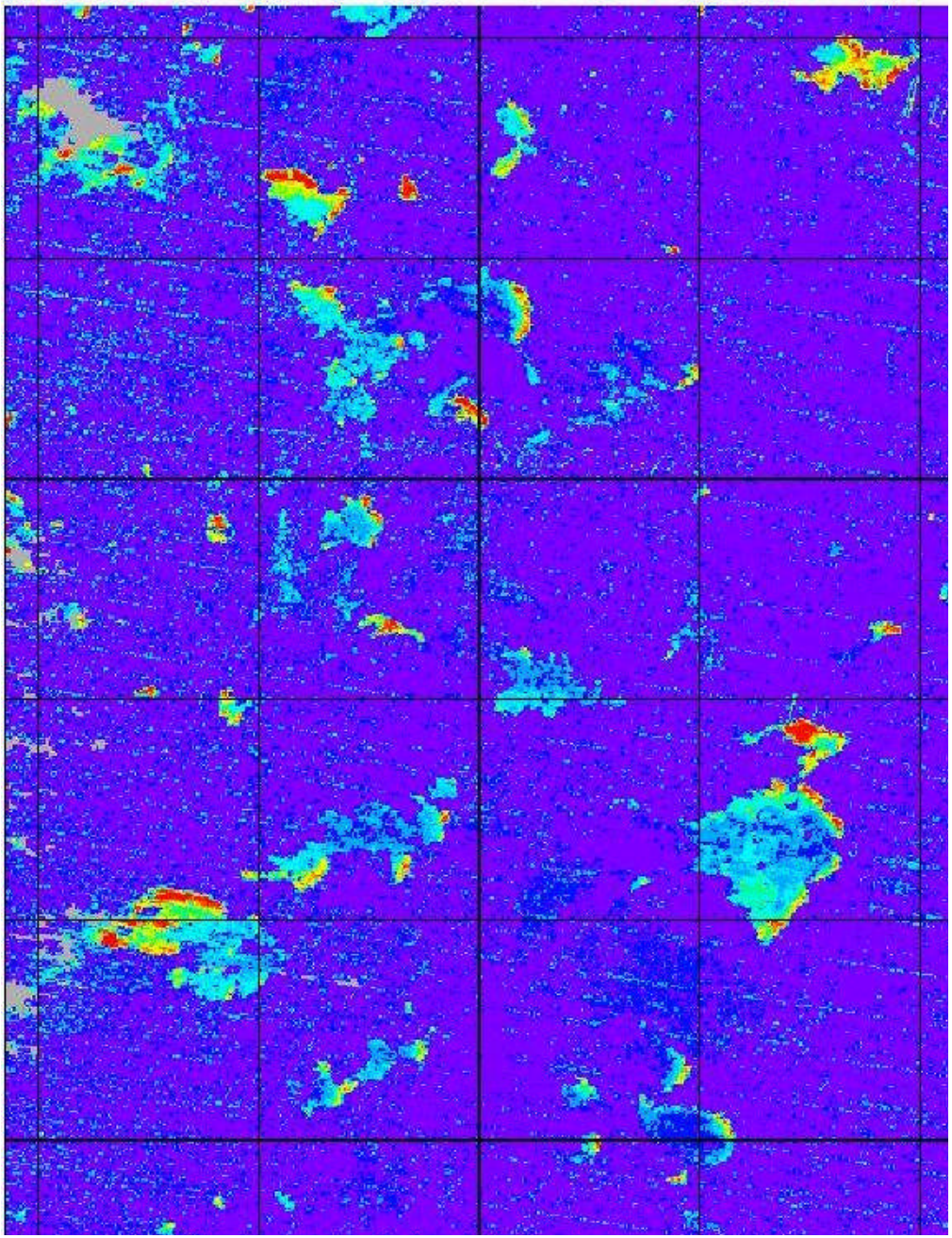
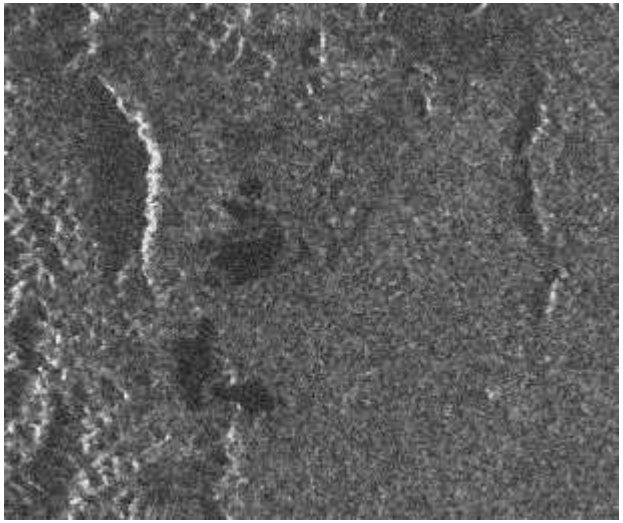
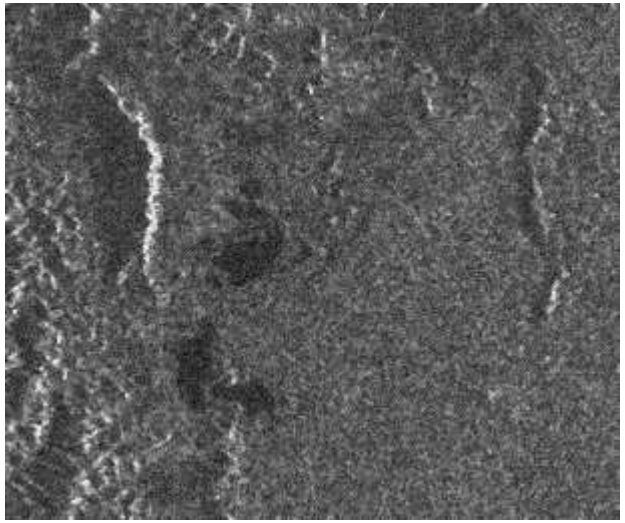


Image Arithmetic

- Common operators: **Addition**



+



  - Reduce noise (increase SNR)
    - averaging, smoothing ...
  - Normalisation (as in NDVI)

=

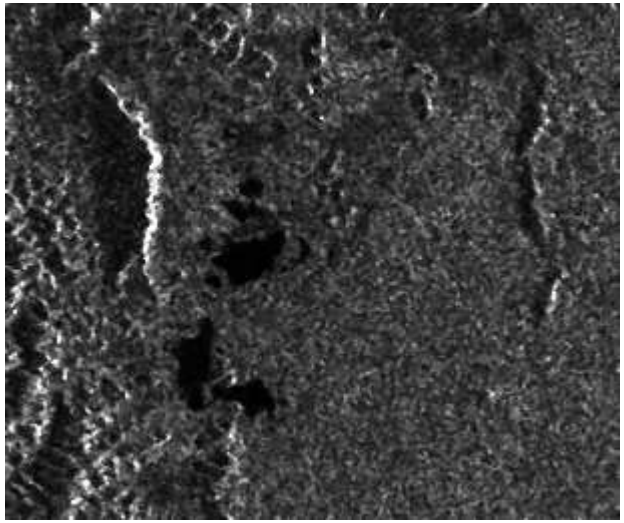
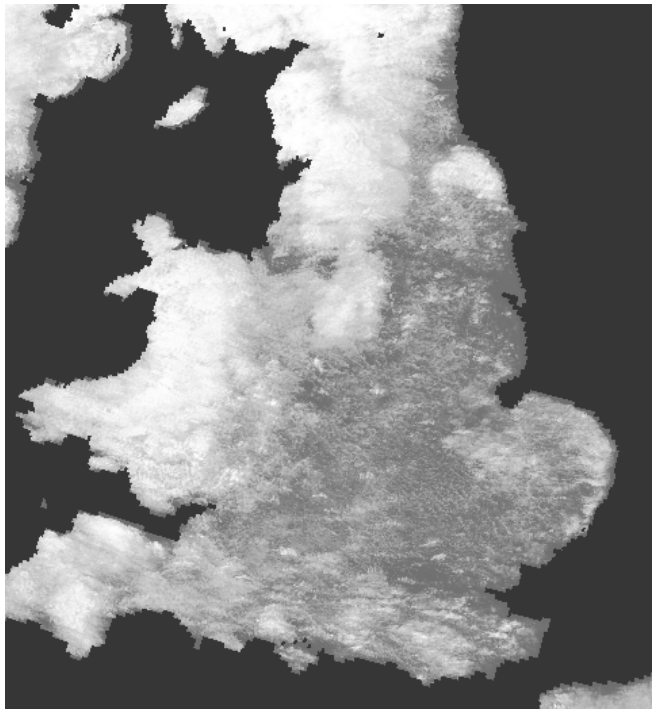


Image Arithmetic

- Common operators: **Multiplication**
- rarely used *per se:* logical operations?
  - land/sea mask



Histogram Manipluation

- **WHAT IS A HISTOGRAM?**

Histogram Manipluation

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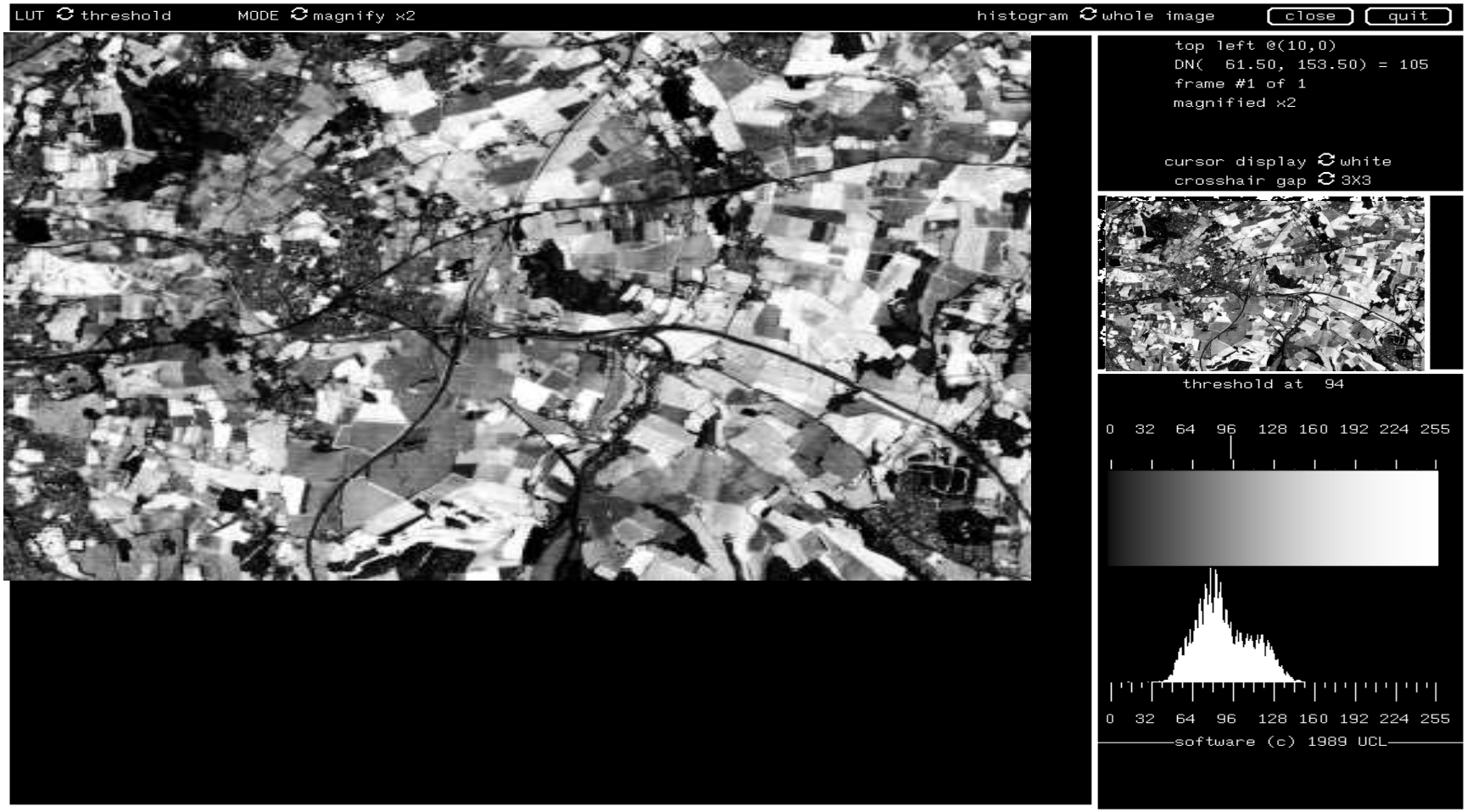
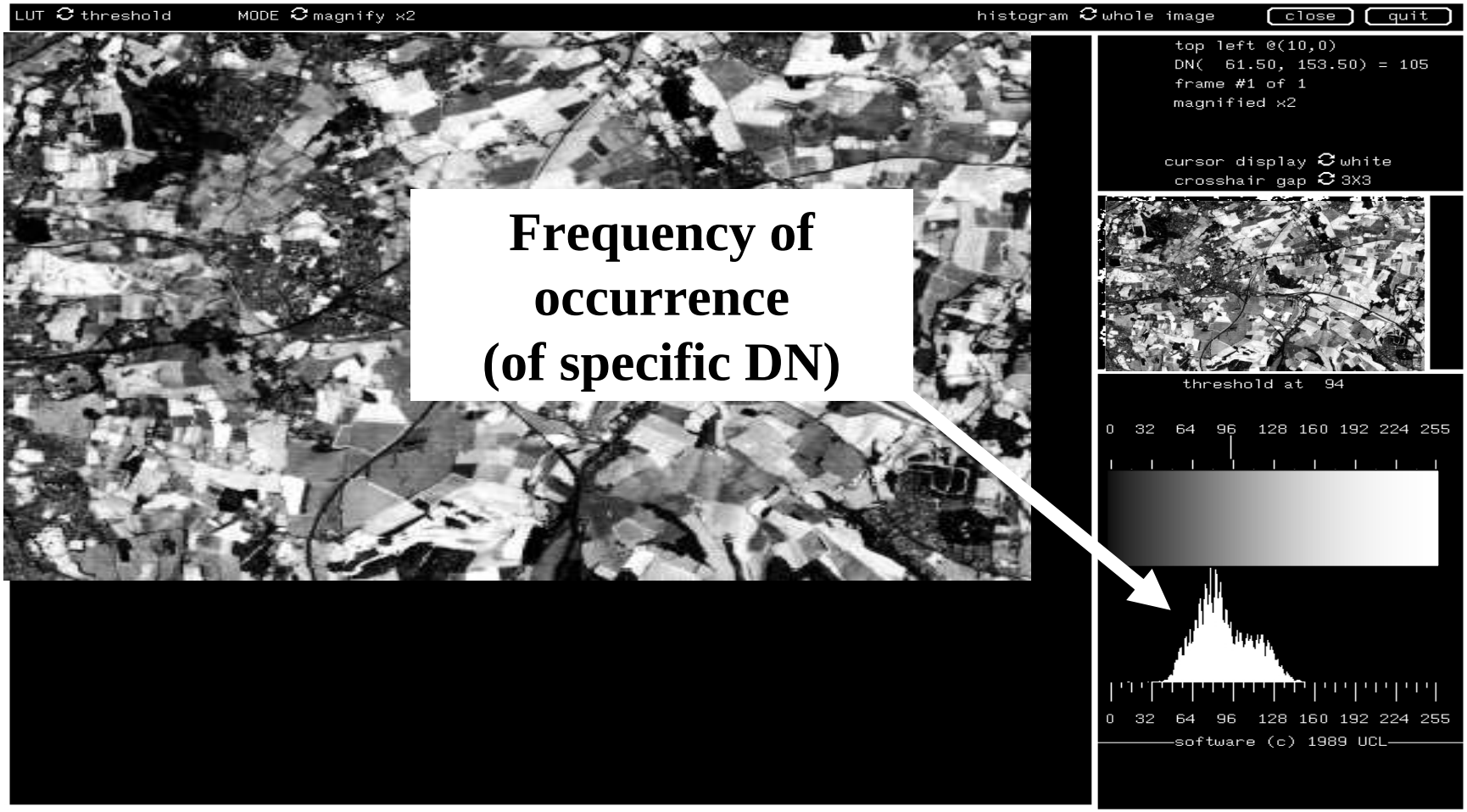
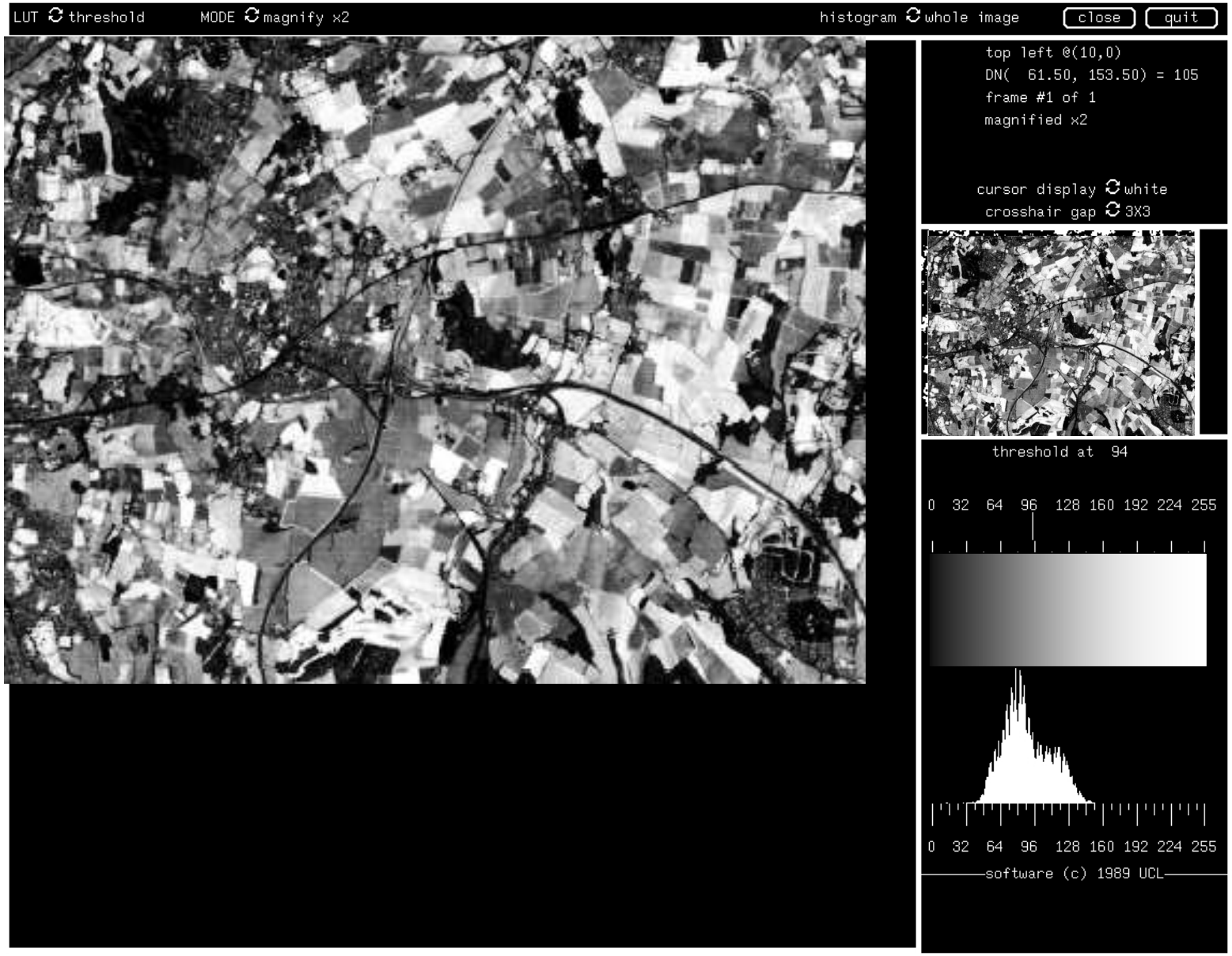


Histogram Manipluation

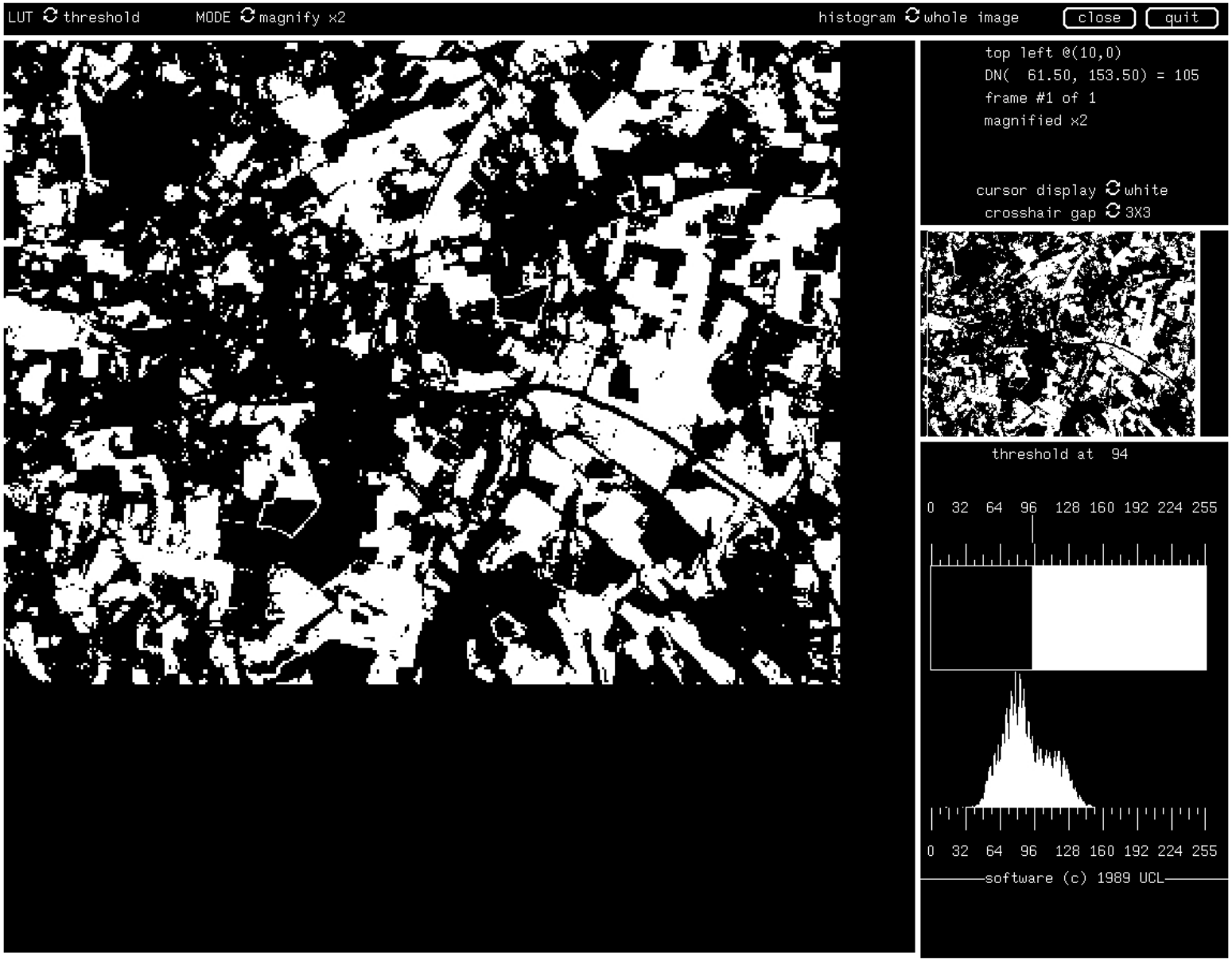
- **WHAT IS A HISTOGRAM?**



Density Slicing



Density Slicing

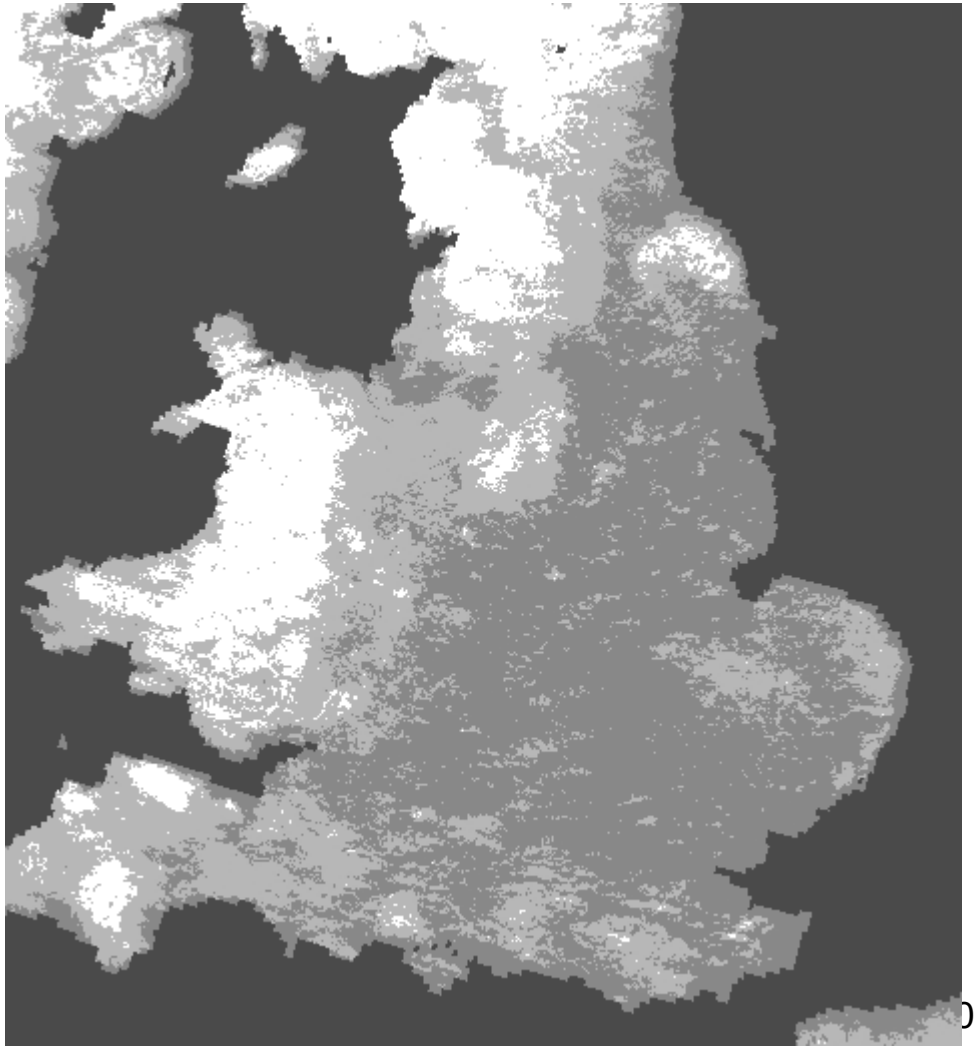


Density Slicing

Don’t always want to use full dynamic range of display

Density slicing:

- a crude form of classification



Density Slicing

Or use single cutoff

= Thresholding

Histogram Manipulation

- Analysis of histogram
  - information on the dynamic range and distribution of DN
    - attempts at visual enhancement
    - also useful for analysis, e.g. when a multimodal distribution is observed

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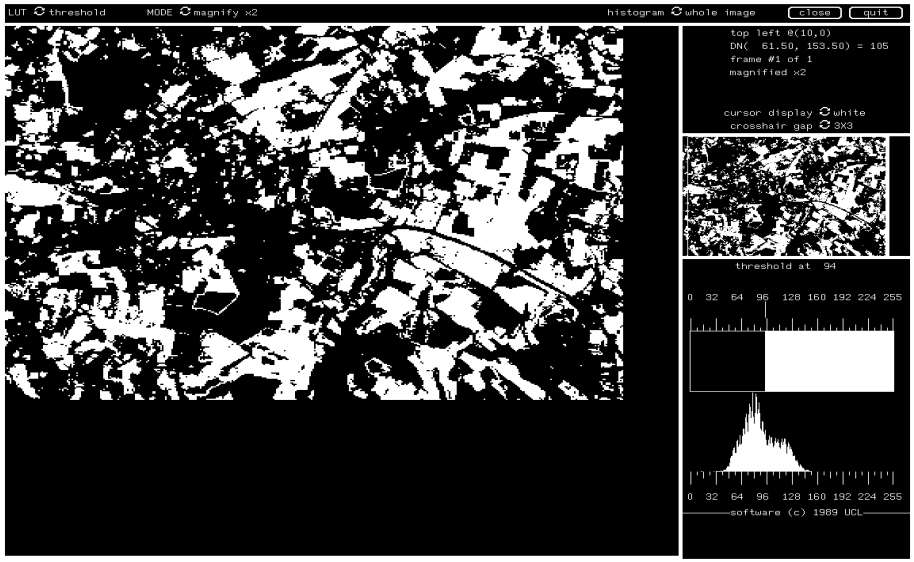
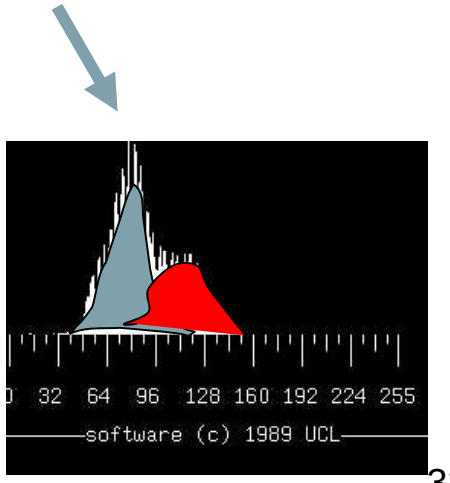
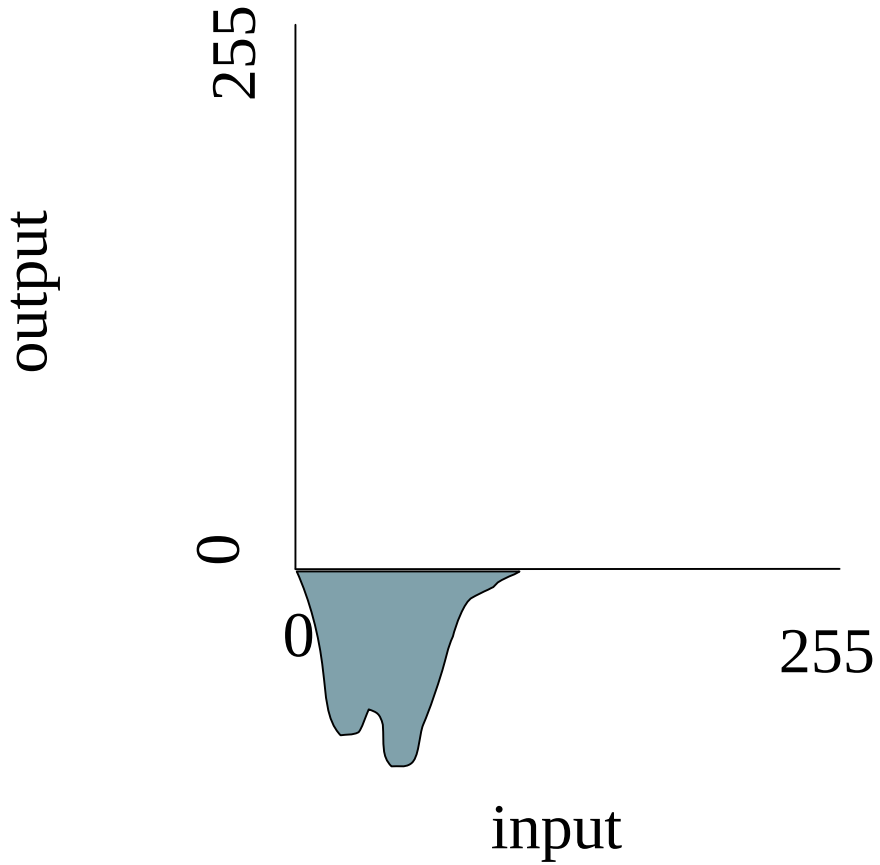


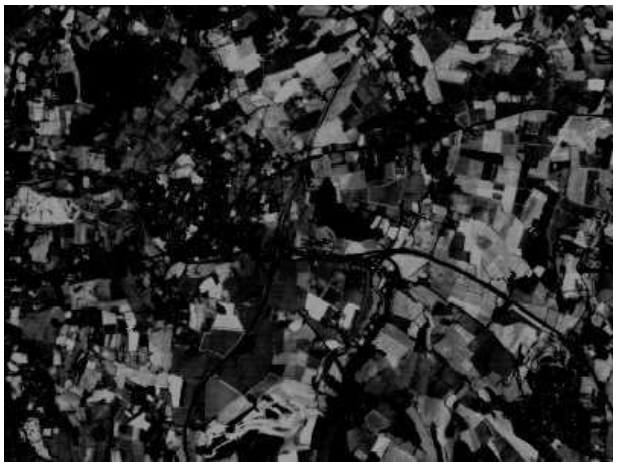


Histogram Manipulation

Typical histogram manipulation algorithms:

Linear Transformation

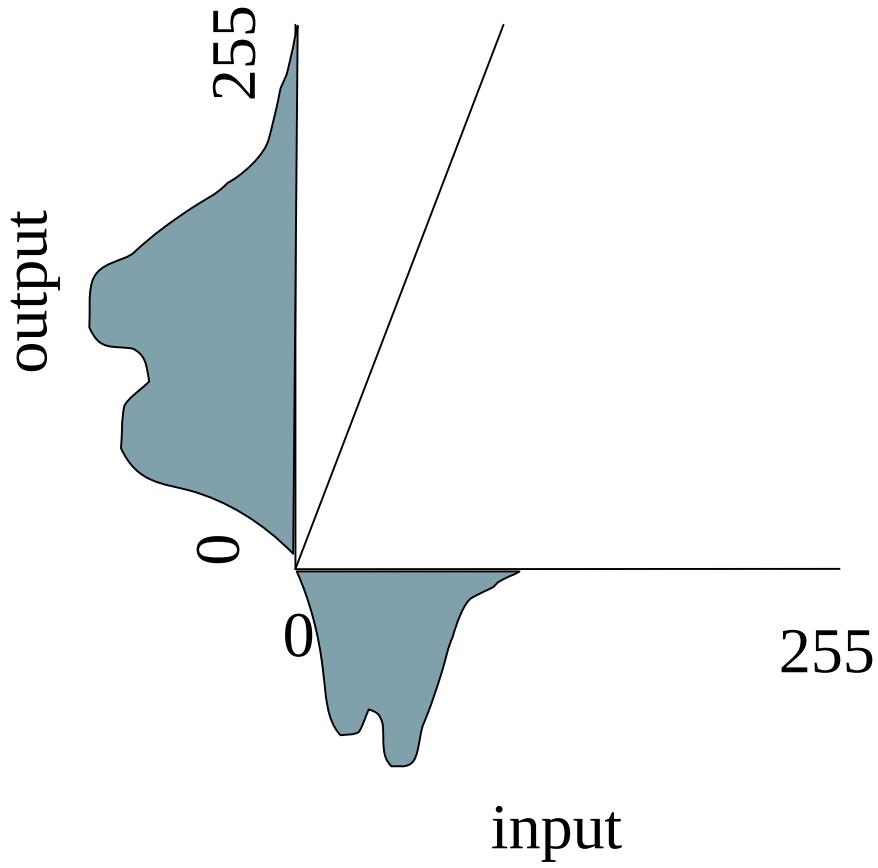




Histogram Manipulation

Typical histogram manipulation algorithms:

Linear Transformation

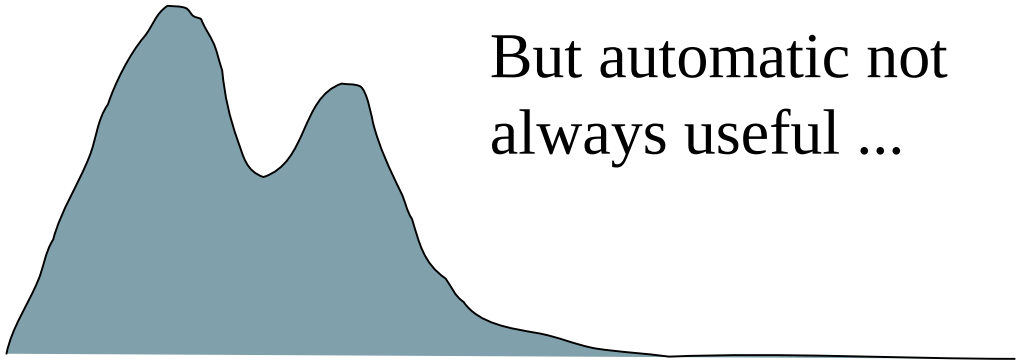


Histogram Manipulation

Typical histogram manipulation algorithms:

Linear Transformation

- Can automatically scale between upper and lower limits
  - or apply manual limits
  - or apply piecewise operator



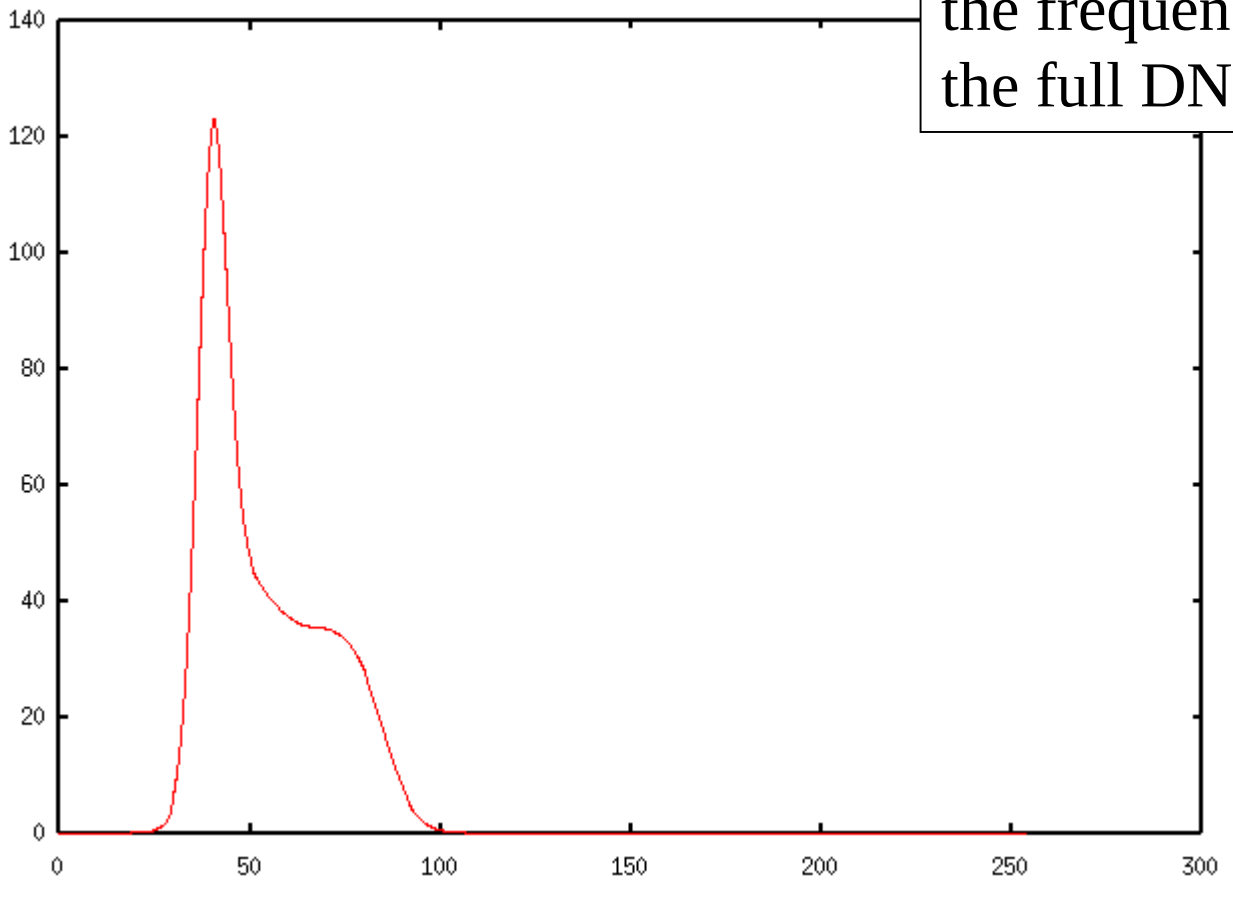
But automatic not always useful ...

Histogram Manipulation

Typical histogram manipulation algorithms:

Histogram Equalisation

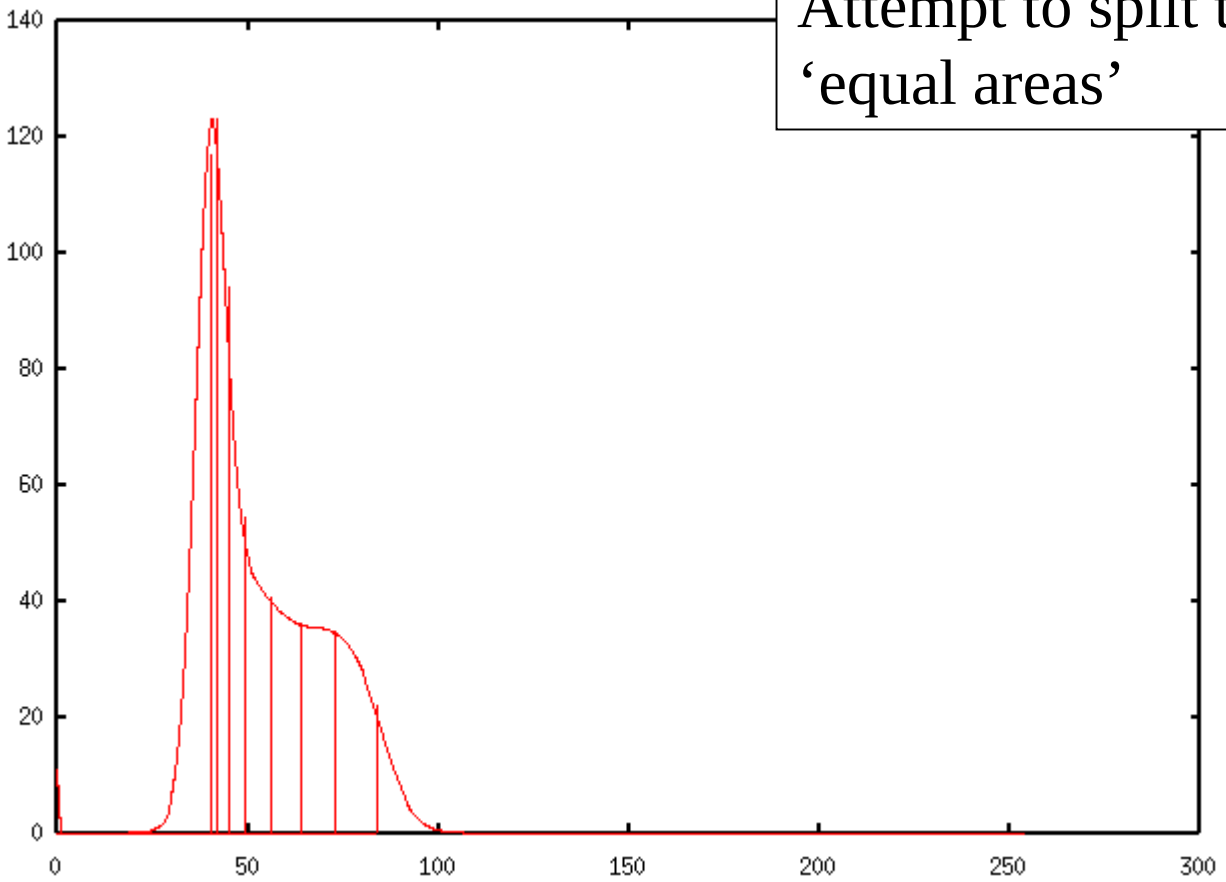
Attempt is made to ‘equalise’ the frequency distribution across the full DN range



Histogram Manipulation

Typical histogram manipulation algorithms:

Histogram Equalisation

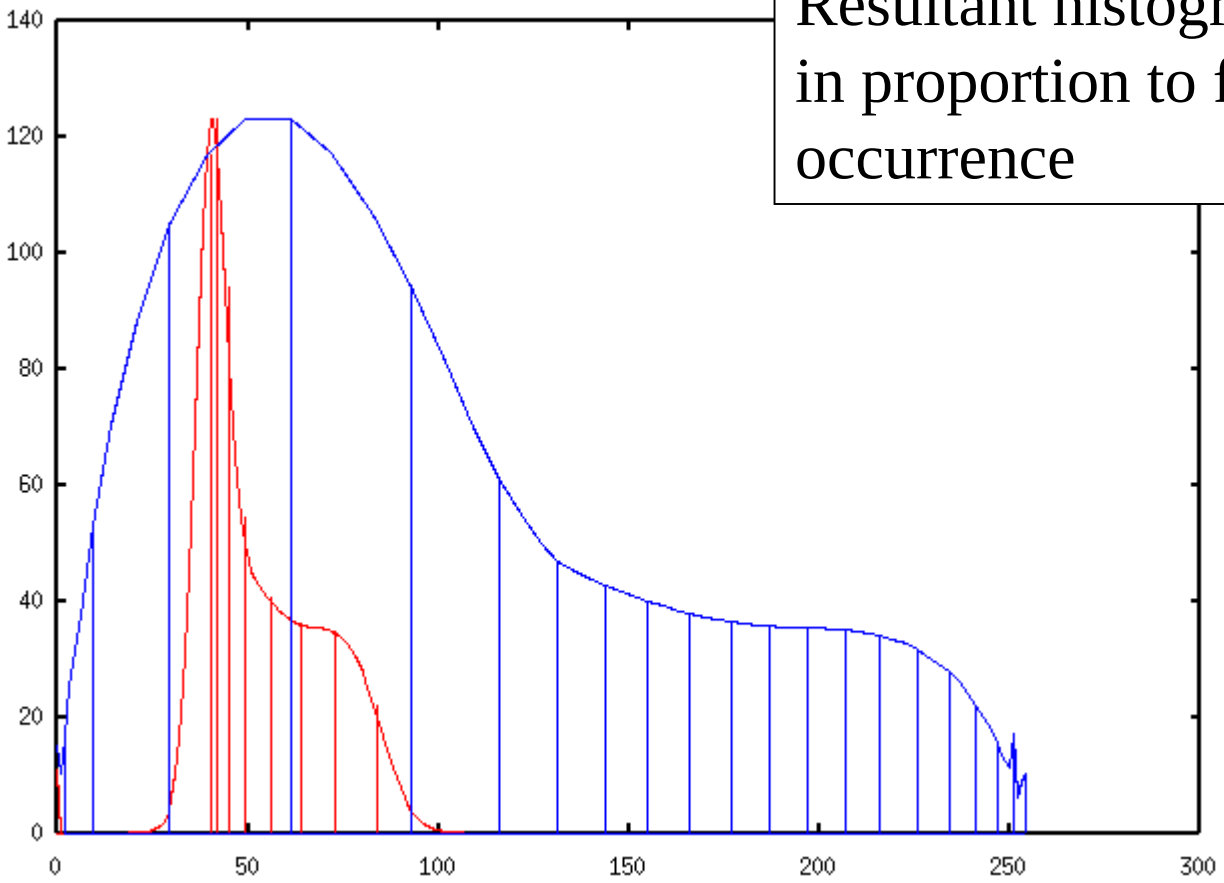


Attempt to split the histogram into ‘equal areas’

Histogram Manipulation

Typical histogram manipulation algorithms:

Histogram Equalisation



Resultant histogram uses DN range in proportion to frequency of occurrence

Histogram Manipulation

Typical histogram manipulation algorithms:

Histogram Equalisation

- Useful ‘automatic’ operation, attempting to produce ‘flat’ histogram
- Doesn’t suffer from ‘tail’ problems of linear transformation
- Like all these transforms, not always successful

- **Histogram Normalisation** is similar idea
- Attempts to produce ‘normal’ distribution in output histogram

  - both useful when a distribution is very skewed or multimodal skewed

Summary

- **Display**
  - Colour composites
  - Greyscale Display
  - Pseudocoluor
- **Image arithmetic**
  - +-×÷
- **Histogram Manipulation**
  - Properties
  - Density slicing
  - Transformations

Summary

- **Followup:**
  - web material
    - http://www.geog.ucl.ac.uk/~plewis/geog2021
    - Mather chapters
    - Follow up material on web and other RS texts
    - Access Journals