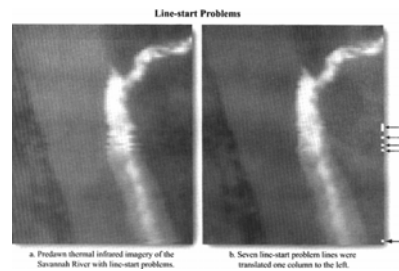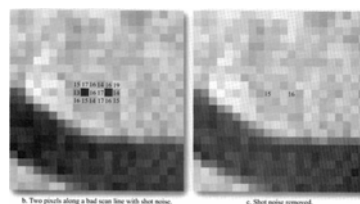# Preprocessing

- Pre what?
- Prepreocessing
  - Correcting sensor errors
  - Geometric corrections & registration
  - Atmospheric corrections
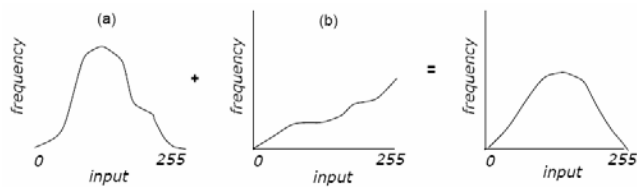 - Radiometric corrections

Correcting Sensor Errors

- Random bad pixels
- Line or column drop-outs (Fig 4.1)

- Striping (MSS & TM) (Fig 4.2)

- Line-start problems

b. Two pixels along a bad scan line with shot noise.   c. Shot noise removed.

Line-start Problems

a. Predawn thermal infrared imagery of the Savannah River with line-start problems.   b. Seven line-start problem lines were translated one column to the left.

Correcting Methods

- Random bad pixels & line (column) drop-outs
  - Line (pixel) replacement
  - Line (pixel) average
  - Adjusted line average
- Striping
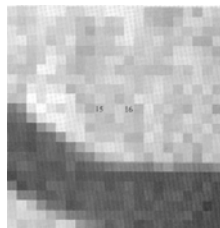 - Frequency domain correction (Week 7)
  - Histogram matching

Source histogram (a), mapped through the lookup table (b), approximates model histogram (c).

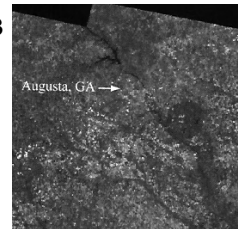# Histogram
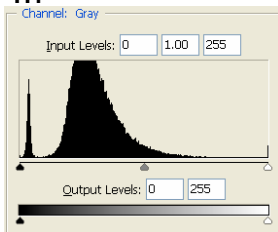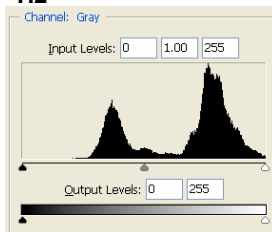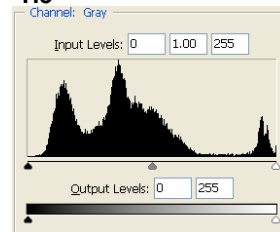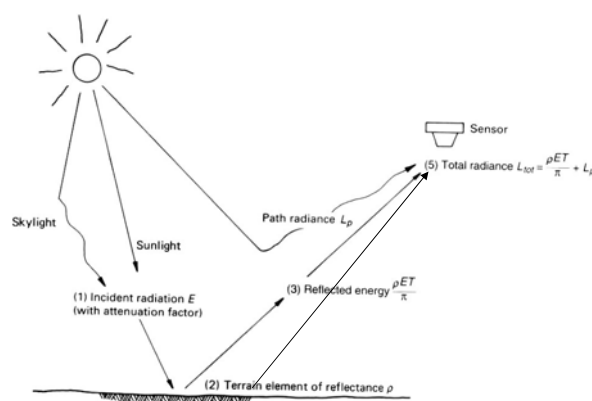(Connect the histograms to their images)

Correcting Atmospheric Attenuation/Scattering

- Absolute atmospheric correction
  - Convert BV (i.e., radiance) to reflectance

- Relative atmospheric correction
  - De-hazing (Week 5: Tasselled Cap)
  - Radiometric normalization (within scene and between dates)

Radiometric Preprocessing

- Scattering
- Refraction
- Absorption

Skylight

Sunlight

Path radiance L_p

Sensor

(5) Total radiance $L_{tot} = \frac{\rho ET}{\pi} + L_p$

(3) Reflected energy $\frac{\rho ET}{\pi}$

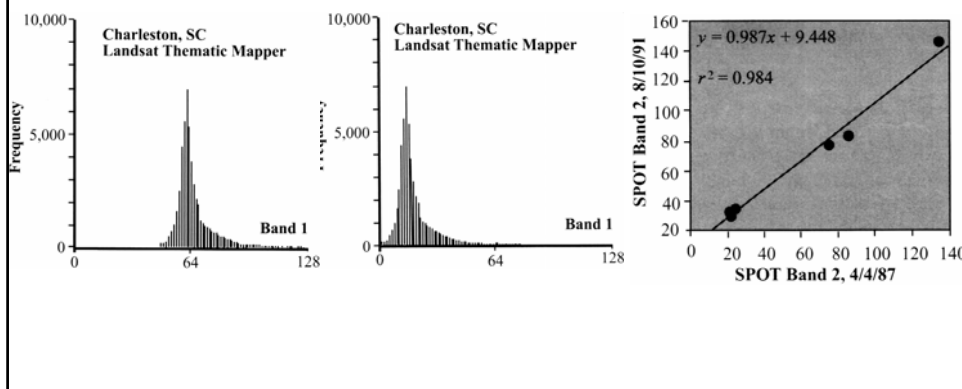(1) Incident radiation E (with attenuation factor)

(2) Terrain element of reflectance ρ

See Fig 4.11 in text

Radiometric Correction Methods

- Histogram minimum method
- Scatter-gram controlled regression

Quiz

- What does GCP stand for in this week's readings?
- The text mentions three resampling methods commonly used in geometric correction. Name one of them.

Sources of Geometric Error/Distortion

- Sources
  - Instrument error
  - Panoramic/earth curvature distortion
  - Earth rotation
  - Platform instability
  - Relief displacement
- Correction approaches
  - Orbital geometry model (system correction)
  - Photogrammetry
  - Registration

Geometric Correction

- Rectification
  - Registration (register one image to another)
  - Georeferencing (assign map coord. to image)
- Orthorectification (correct for terrain relief displacement)
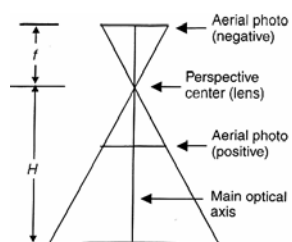- Trueorthorectification (correct for relief displacements of both terrain and landscape objects)
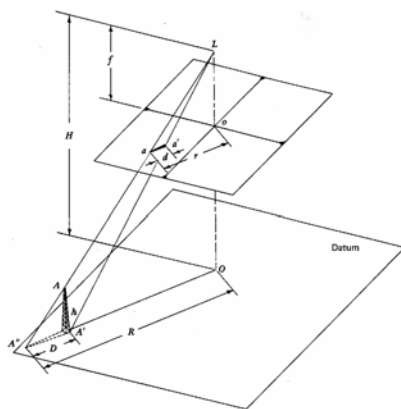

Photo with radial distortion.   Ture orthophoto
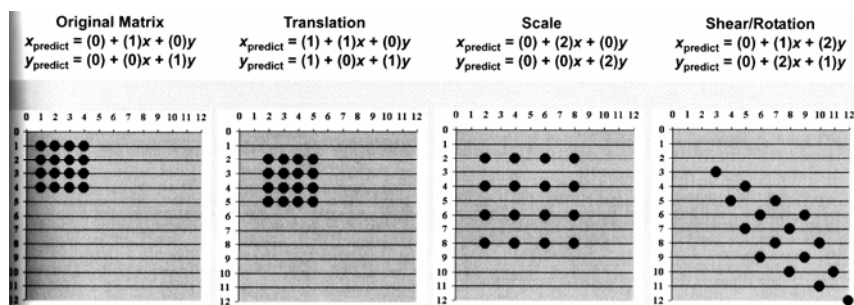
Photogrammetry

$$d = \frac{rh}{H}$$

$$h = \frac{dH}{r}$$

$$\frac{1}{S} = \frac{f}{H}$$

d = relief displacement
h = object height
r = radial distance between location and PP on photo
H = flying height

Affine Transformation

- aka linear or first-order transformation

Original Matrix	Translation	Scale	Shear/Rotation
$x_{predict} = (0) + (1)x + (0)y$	$x_{predict} = (1) + (1)x + (0)y$	$x_{predict} = (0) + (2)x + (0)y$	$x_{predict} = (0) + (1)x + (2)y$
$y_{predict} = (0) + (0)x + (1)y$	$y_{predict} = (1) + (0)x + (1)y$	$y_{predict} = (0) + (0)x + (2)y$	$y_{predict} = (0) + (2)x + (1)y$

$$x_o = a_1 + a_2 x_i + a_3 y_i$$
$$y_o = b_1 + b_2 x_i + b_3 y_i$$

x_i and y_i = source coordinates
$+x_o$ and y_o = rectified coordinates

$$\begin{bmatrix} x_0 \\ y_0 \end{bmatrix} = \begin{bmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{bmatrix} \begin{bmatrix} 1 \\ x_i \\ y_1 \end{bmatrix}$$

Rectification Steps

- Locate GCPs
- Calculate and evaluate a transformation
- Apply the transformation. Pixels must be resampled to conform to the grid.

Locate GCPs

- Ideal location: road intersections, corners of landscape objects, or single pixel objects dispersed evenly on the image.
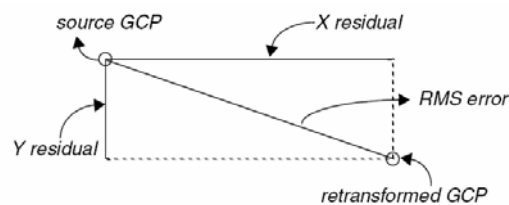- Source and reference coordinates.

of GCPs

- The more the better.
- 16 (Bernstein et al. 1983)

$$\frac{((t+1)(t+2))}{2}$$

Order of Transformation	Minimum GCPs Required
1	3
2	6
3	10
4	15
5	21
6	28
7	36
8	45
9	55
10	66

GCP Evaluation

- Residual
- Error per GCP (R)
- RMSE (T)
- Error contribution by point (R/T)

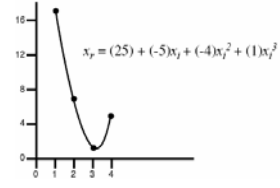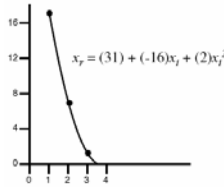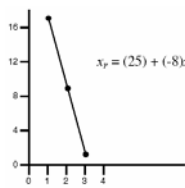# Transformation equations and coefficients

1st-order polynomial equations

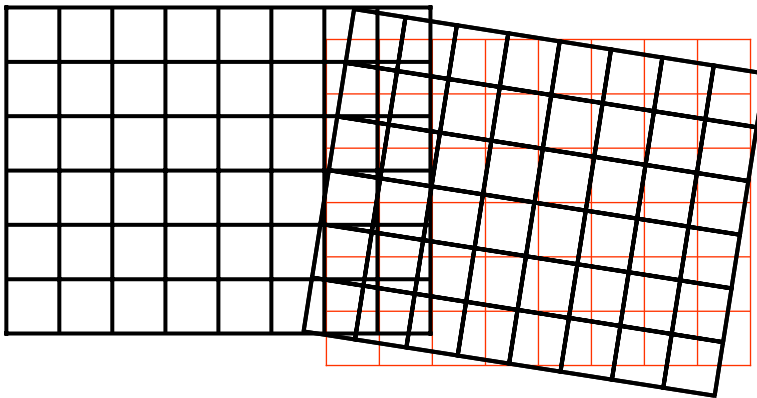$$x' = a_0 + a_1x + a_2y$$

$$y' = b_0 + b_1x + b_2y$$

2nd-order polynomial equations

$$x' = c_0 + c_1x + c_2y + c_3xy + c_4x^2 + c_5y^2$$

$$y' = d_0 + d_1x + d_2y + d_3xy + d_4x^2 + d_5y^2$$

$x_r = (25) + (-8)x_i$

$x_r = (31) + (-16)x_i + (2)x_i^2$

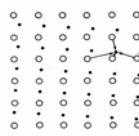$x_r = (25) + (-5)x_i + (-4)x_i^2 + (1)x_i^3$

Transformation & Resampling

Nearest neighbor   Bilinear interpolation   Cubic convolution