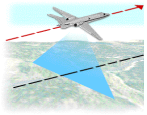
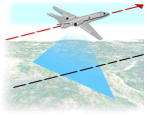


FRST121 Maps & Photos

Air photo geometry and scale

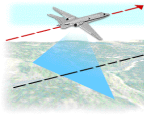
Instructors: Doug Corrin
Bill Beese

VANCOUVER ISLAND UNIVERSITY
Enjoy the journey.

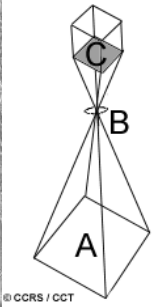


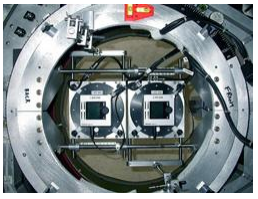
Outline

1. How photos and maps differ
2. Geometry: similar triangles
3. Scale: ratios, variation
4. Examples

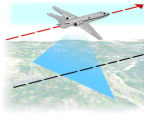


Aerial photo equipment

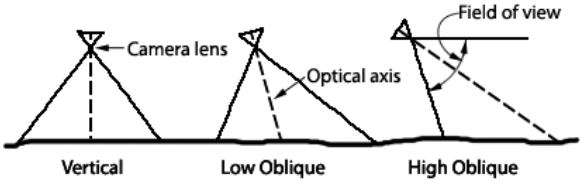




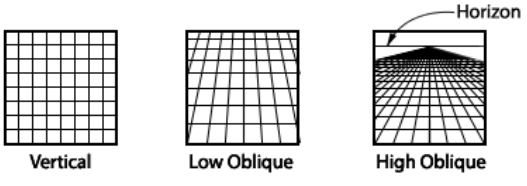
Images from
Selkirk Remote Sensing



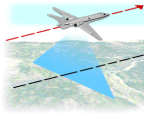
Photos: different perspectives



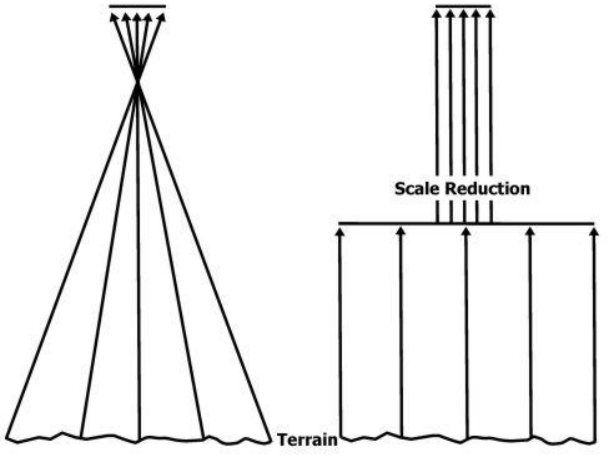
Camera orientation for various types of aerial photographs



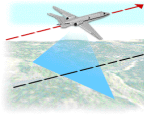
How a grid of section lines appears on various types of photos.



How aerial photos and maps differ

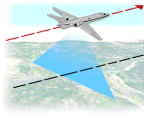


Perspective vs orthographic projection

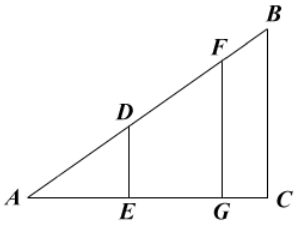


Except…Ortho-photos

A photo-map made from images that have been corrected for distortion and digitally ‘glued’ together



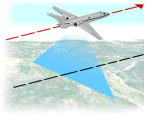
Geometry: similar triangles



$$\frac{AB}{AC} = \frac{AD}{AE}$$

"Similar" if respective angles are equal.
Example: *ABC*, *ADE* and *AFG* are similar

So…
ratios of the lengths of corresponding sides are equal.



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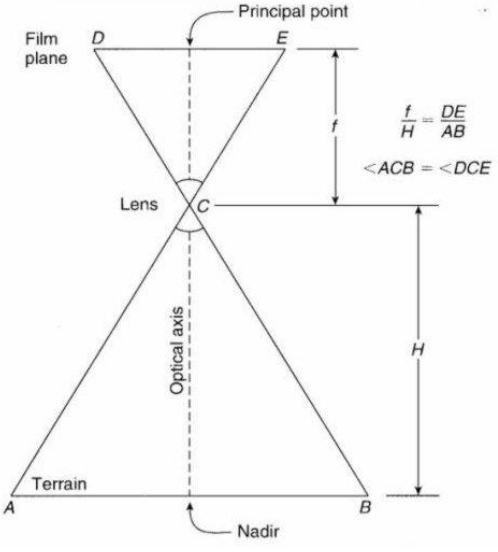
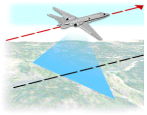




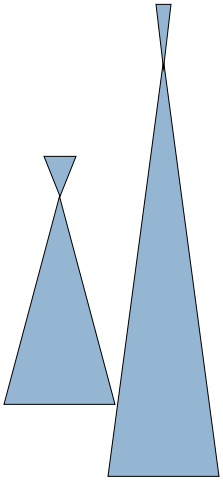
Scale calculation

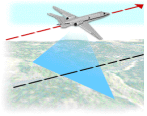
PD Photo Distance / GD Ground Distance = 1/x

f focal distance / H Ht above ground = 1/x

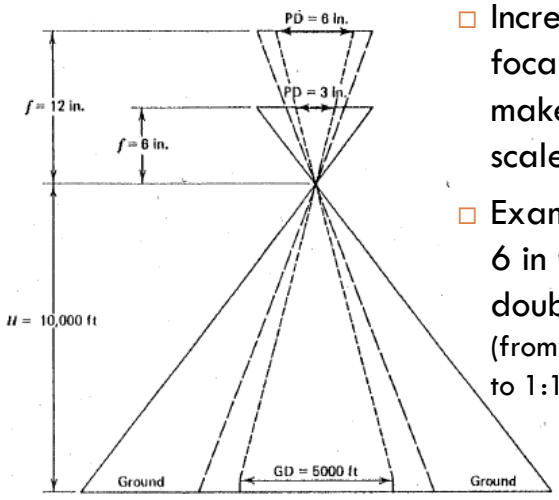
Scale varies with both f and H

(distance from lens)

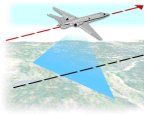




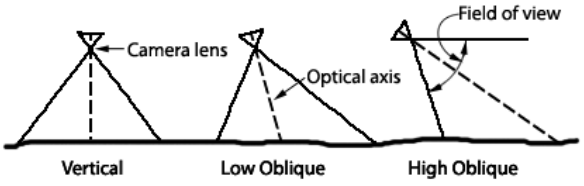
Effect of focal length on scale



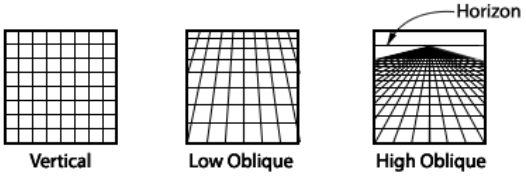
- Increasing the focal length makes the scale larger
- Example: 6 in to 12 in doubles scale (from 1:20000 to 1:10000)



Scale also varies with tilt

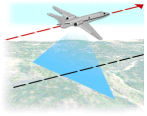


Camera orientation for various types of aerial photographs



How a grid of section lines appears on various types of photos.

Can ignore if < 3 degrees



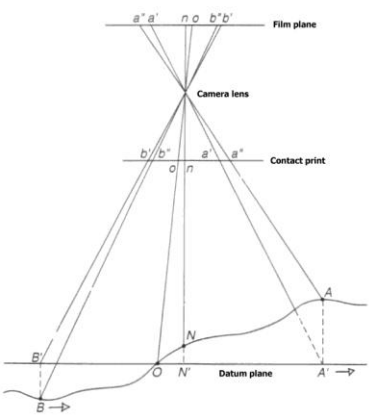
Scale changes with relief

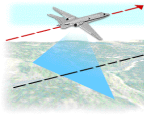
Scale at point A
will be different than B

How? A > B

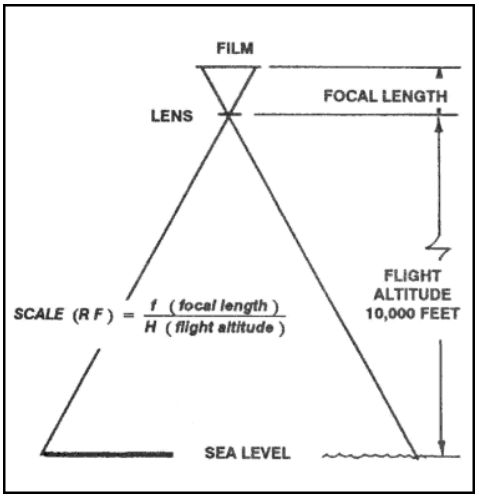
(higher elevation areas
will appear larger on
the photo)

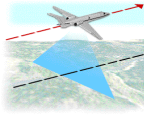
Average photo elevation
vs. point elevations





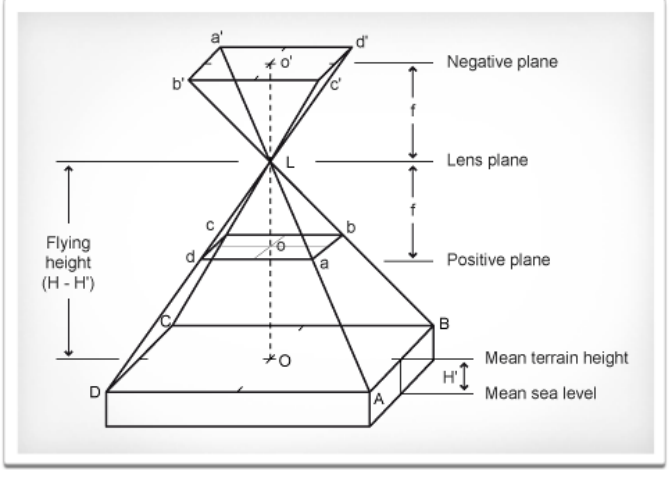
Simple at the seashore

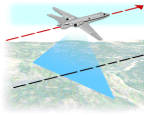




Adjust "H" for terrain height

H = Altitude (of camera lens) – Elevation (ground)





Example scale calculations

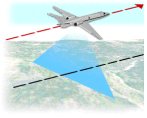
- What if the distance on a photo between two points is 10cm, and the ground distance is 1000m. What is the scale?

  10cm / 1000m x 100cm (per m) = 1:10,000

- What if the focal distance (f) for a photo is 6 inches, and the scale is 1:15,000. How high was the plane flying (in feet)?

f/H = 1/15000 So…0.5 ft / H ft = 1/15000
15000 x 0.5 = 7500 ft (if we're talking sea level)

If the ground elevation was 2000 ft, then how would we figure this out??



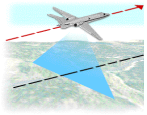
Example scale calculations

- What if the focal distance (f) for a photo is 6 inches, and the scale is 1:15,000, and the ground elevation is 2,000 ft. How high was the plane flying (in feet)?

First, H = Flying Altitude – Elevation
So… H = Alt – 2000 ft, or
H + 2000 = Altitude

f/H = 1/15000 So…0.5 ft / H ft = 1/15000
15000 x 0.5 = 7500 ft (same H as before)

7500 + 2000 = 9500 ft (Altitude of the plane)

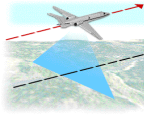


Example scale calculations

- What if we know the flying altitude (23,000 ft), the focal length (305mm) and the photo scale (1:20000). How would we get the avg elevation of the photo in meters?

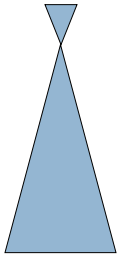
First, f/H = 1/20000 So…30.5cm / H cm = 1/20000
20000 x 30.5 = 610,000 cm / 2.54cm/in / 12in/ft = 20,013 ft

Next, H = Flying Altitude – Elevation
So… H = 23000 – Elev (ft)
So…20,013 = 23,000 – Elev (ft)
That's 2987 ft / 3.28 ft/m = 911m



All you need to know is…

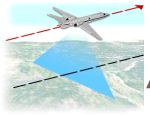
1. $\frac{\text{PD Photo Distance}}{\text{GD Ground Distance}} = \frac{1}{x}$



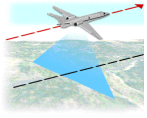
2. $\frac{f \text{ focal distance}}{H \text{ Ht above ground}} = \frac{1}{x}$

3. H = Altitude (of camera lens) – Elevation (ground)

Remember: same units!



A scale we won't be talking about



Another example…

$$SCALE\ (RF) = \frac{f\ (focal\ length)}{H\ (flight\ altitude) - h\ (average\ ground\ elevation)}$$

Example:

f = 6 inches	or	15.2 centimeters
H =10,000 feet	or	3,048 meters
f =850 feet	or	259.08 metprs

With metric measures:

$$\frac{15.2}{(3{,}048 - 259.08) \times 100} = \frac{15.2}{278{,}900} = \frac{1}{18{,}300}\ (approximately)$$

or 1:18,300

With English measurements:

$$\frac{0.5}{10{,}000\ feet - 850\ feet} = \frac{0.5}{9150} = \frac{1}{18{,}300}$$

or 1:18,300