SHADOWS ON AERIAL PHOTOGRAPHS

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Introduction

AERIAL photographs showing clouds, cloudshadows or a hazy spot are usually rejected under clauses inserted in most survey contracts.

This is probably the main reason why the attention of interpreters is seldom drawn to the relation between the images of an object and its shadow, and likewise to the cause of a specific hazy spot. On photographs showing clouds this relation may be presented quite clearly.

Fundamentals

In Figure 1 let O be the position of the survey camera, C' and C'' clouds floating above flat country, P, S' and S'' the shadows of the survey plane and of the clouds respectively, OP, $C'S'$ and $C''S''$ being parallel. A photograph taken at this moment will show C' as situated at T', C'' at T''.

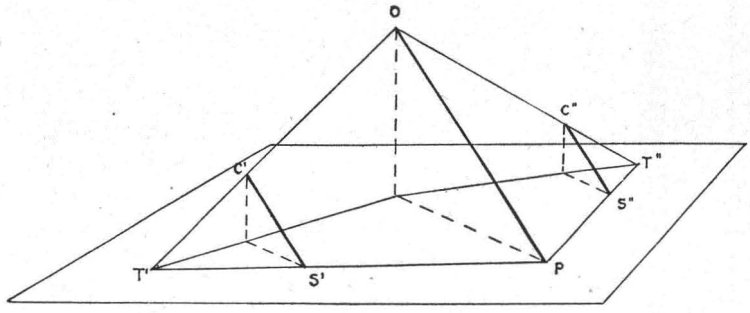

Fig. 1

It can be shown that T', S' and P, and also T'', S'' and P are on straight lines intersecting at P. In other words, on a photograph of flat country the straight lines connecting the images of objects and the shadows thereof have one point in common.

Apparently it depends upon the position of the sun, the field of view of the camera and the course flown, whether or not this point will appear on the untilted photograph.

In general this point will appear up to a latitude of $23\frac{1}{2} + \frac{1}{2}\psi$ degrees, where ψ is the camera angle.

On a photograph of wooded country, only the crown of a tree situated at P will be visible, but not its shadow. As one progresses away from P the tree-shadows, all pointing toward P, will gradually become visible. Due to a shortage of shadow this area has a less dark aspect, which is enhanced by the reflection of light straight to the camera. In Figure 2, A represents the area (around point P) under discussion, while at B the reflected image of the sun is visible in a swampy region near a river.

This reflected image may be accompanied by light streaks of various form and size, caused by reflection of sunlight in the lens-elements.

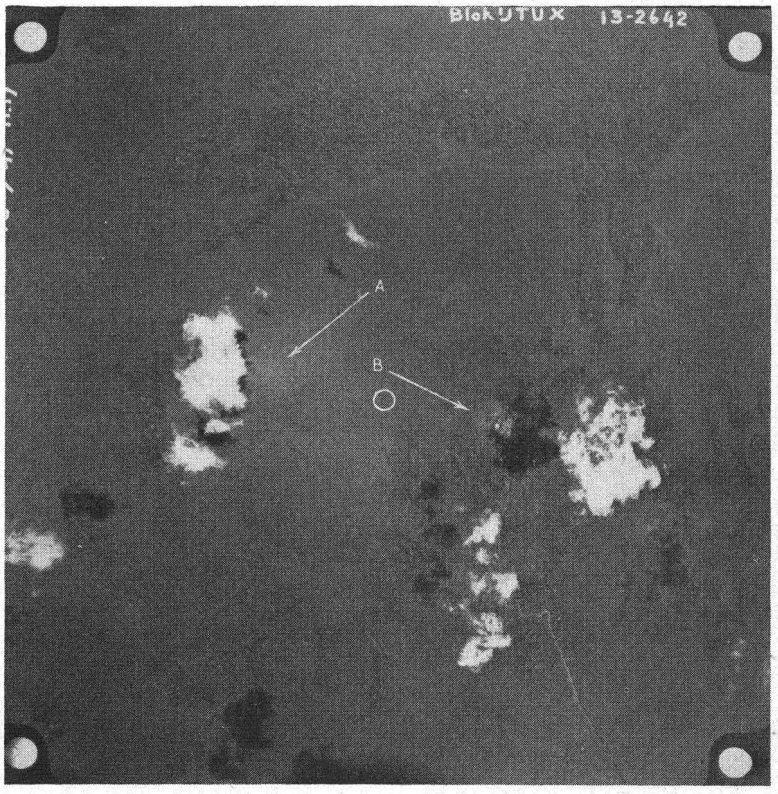

FIG. 2. Photograph, taken September 18, 1947 at 11:19 local time, showing the light area around the shadow of the plane (*A*) and the reflection of the sun in a swamp (*B*). Lines connecting clouds and their shadows point toward *A*. Photo K.L.M. Copyright C.B.L.

CONCLUSIONS

a. Stereoscopic observation is seriously hampered by phenomena like *A* and *B*. As far as economically possible this should be taken into account when planning a survey.

b. For the calculation of the angle of elevation of the sun or for the orientation of the photograph with respect to true north, Spurr* gives the formula:

$$\sin x = \frac{(\cos b)(\cos N)\sqrt{(\cos^2 a) - (\cos^2 b)(\sin^2 N)} \pm (\sin^2 a)(\sin b)}{1 - (\cos^2 b)(\sin^2 N)}$$

where N is the angle between the direction of the shadow and true north measured on the photograph.

It seems that this formula is based on the assumption that shadows on a photograph are parallel to each other. From Figure 1 it will be clear that the formula may be applied only when the direction of the shadow is measured in the centerpoint (principal point); with tilted photographs the plumbpoint (nadir) should be used.

c. Sometimes excessive tilt is diagnosed from the convergence of lines normally parallel. Care should be taken not to use shadows for this purpose.

* S. H. Spurr, "Aerial Photographs in Forestry," p. 232.