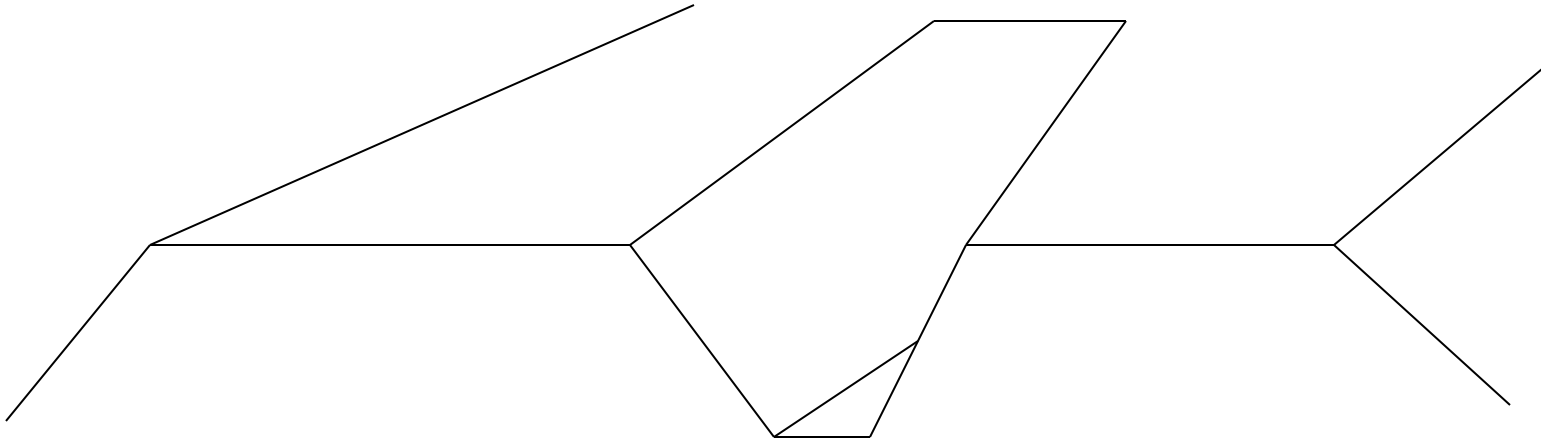


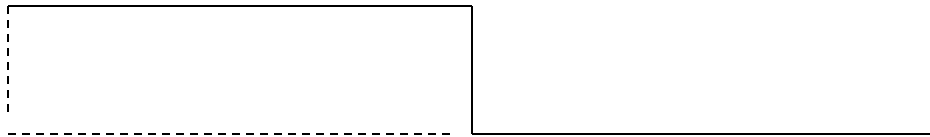
Mountain-Valley winds (or mountain-plain winds)

Discussed in McNider and Pielke
(1984) in J. Appl. Meteo.

- Mountain-valley winds are related to slope flows and owe their existence to slope flows.
- However, there are some important distinctions between slope flows and mountain-valley winds
- Consider the case of an idealized valley that is cut into a plateau:



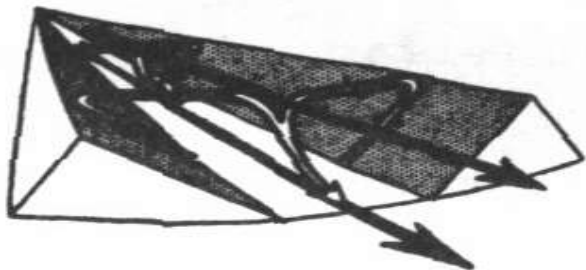
Front, oblique view



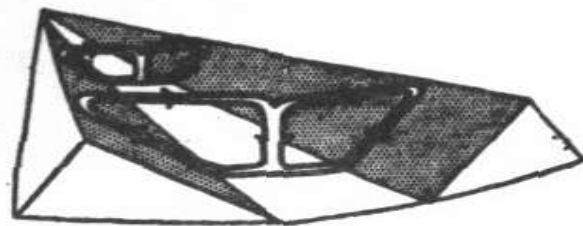
Side view

- Now let us suppose that we have thermally-forced slope flows along the valley sidewalls:
 - during the night, cold air flows down the slopes and collects in the valley. The net cooling of the air in the valley results in a pressure increase in the valley, which eventually becomes large enough to drive a circulation along the valley axis from the valley to the plains

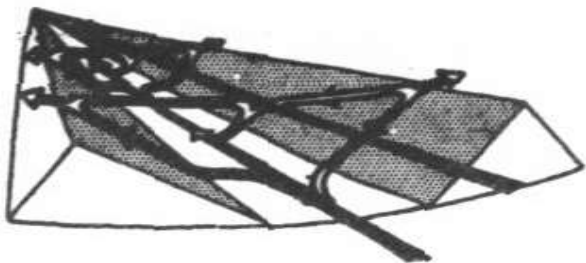
- during the day, warm air flows upslope along the valley sidewalls, and the reverse arguments will apply. A pressure decrease in the valley drives a circulation along the valley axis from the plains to the valley.
- The classic explanation of the mountain-plains wind was given by Defant (1951). This explanation remains unsurpassed for its clarity and completeness.



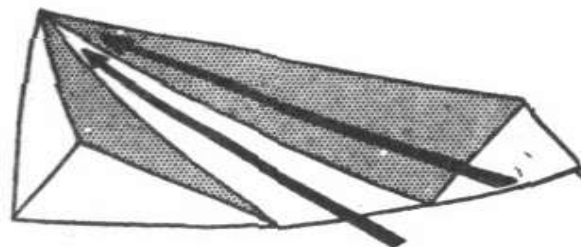
(a)



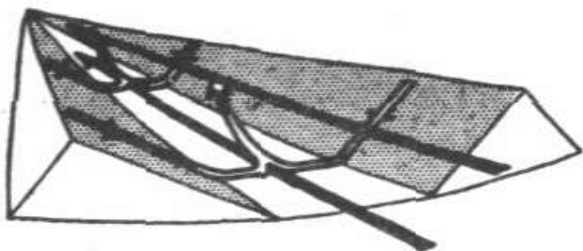
(b)



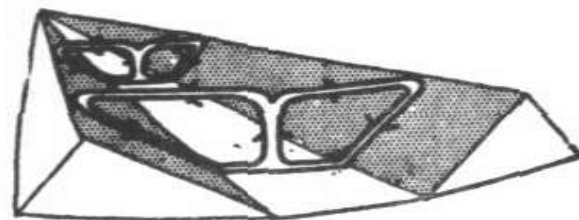
(c)



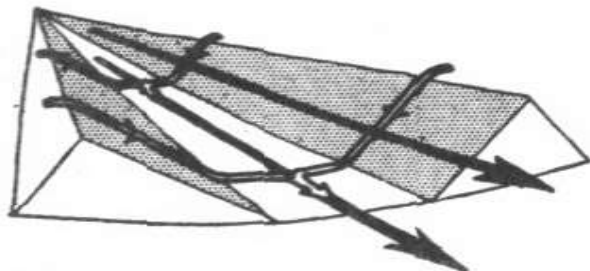
(d)



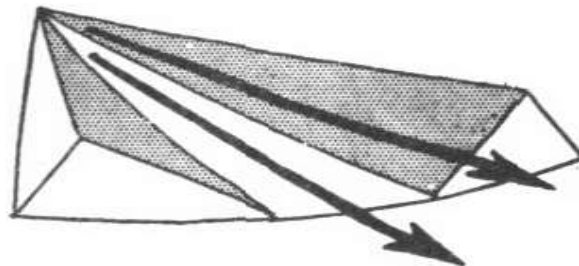
(e)



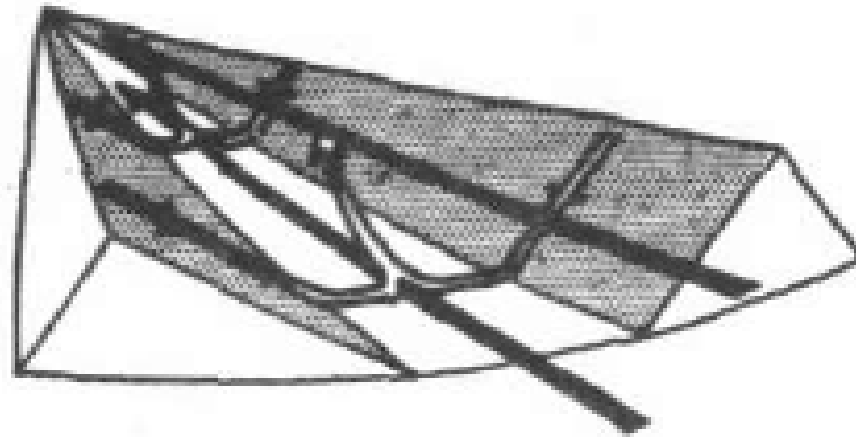
(f)



(g)

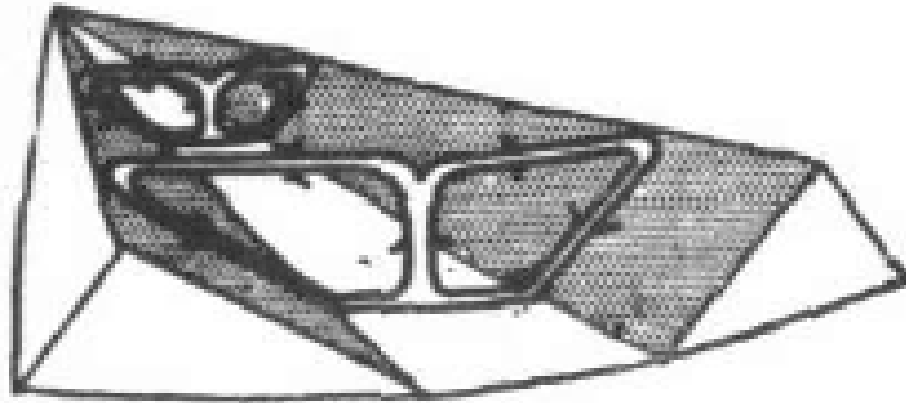


(h)



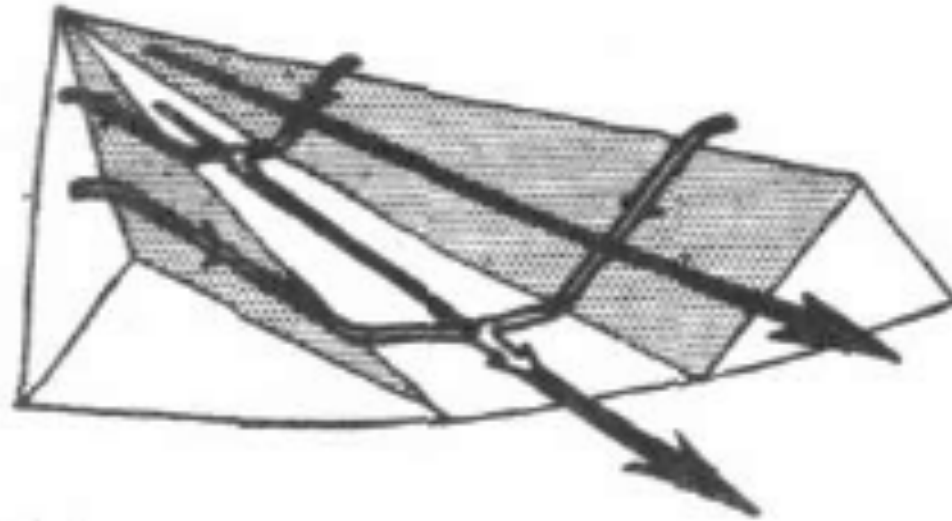
(e)

Air flow at beginning of evening. The downslope winds are beginning. The valley wind is decreasing (it has been blowing up from the plains up the valley). The pressure drop is still in the up-valley direction. Temperature: It is slightly warmer in the valley than it is over the plain. Changes in temperature (until the situation in the next picture) – the valley is cooling rapidly; the plain is cooling only slightly.



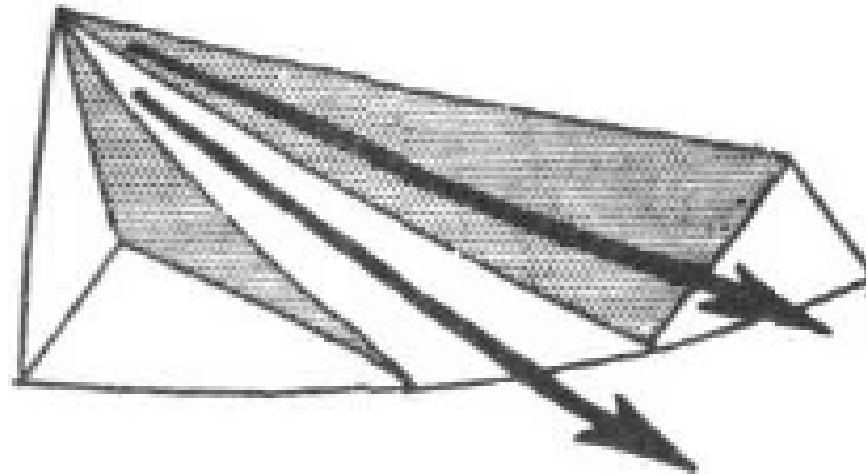
(f)

Air flow from late evening through the first half of the night. Downslope winds are present. The system is in a state of transition from valley wind to mountain wind. Pressure drop is zero. Temperature until the next picture – valley continues to cool rapidly.



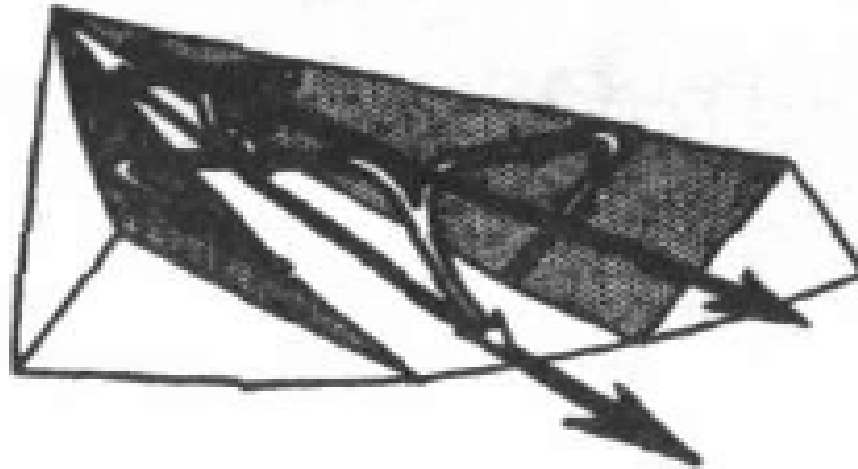
(g)

Air flow at night. Mountain wind is present along with downslope winds. Pressure drop is in the down-valley direction. Valley is cold, plains are relatively warm. Changes in temperature until next picture – valley is cooling, plain is cooling slightly but is still warm relative to the valley.



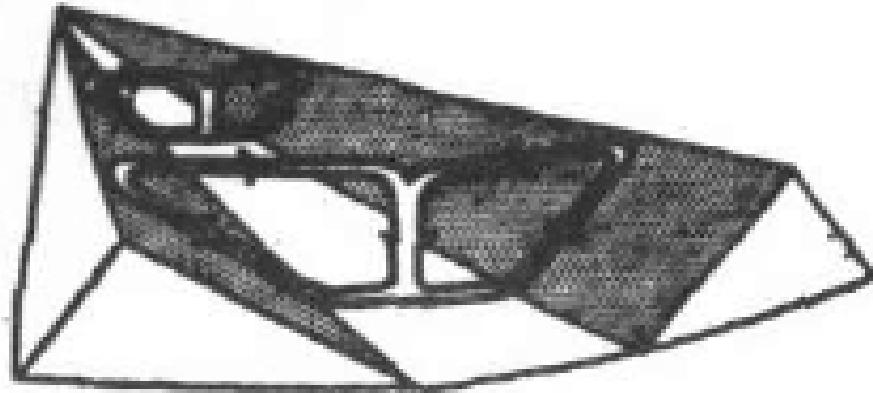
(h)

Air flow late at night until morning. The downslope winds have died out. The mountain wind extends to the sides of the slopes, with a pressure drop in the down-valley direction. Temperature: Cold in valley, warmer over plains. Only slight changes in temperature in valley and plains around this time.



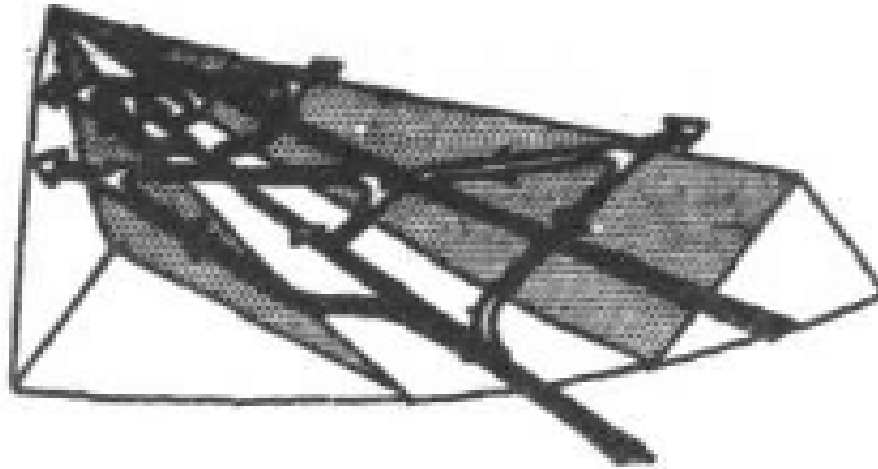
(a)

Air flow in the morning at sunrise. Upslope winds are beginning (up slopes of sidewalls). Mountain wind (black arrows) is still present in valley. Pressure drop is in the down-valley direction. Temperatures are cold in valley with plains relatively warm. Change in temperature – valley is becoming warmer, plains still getting cooler.



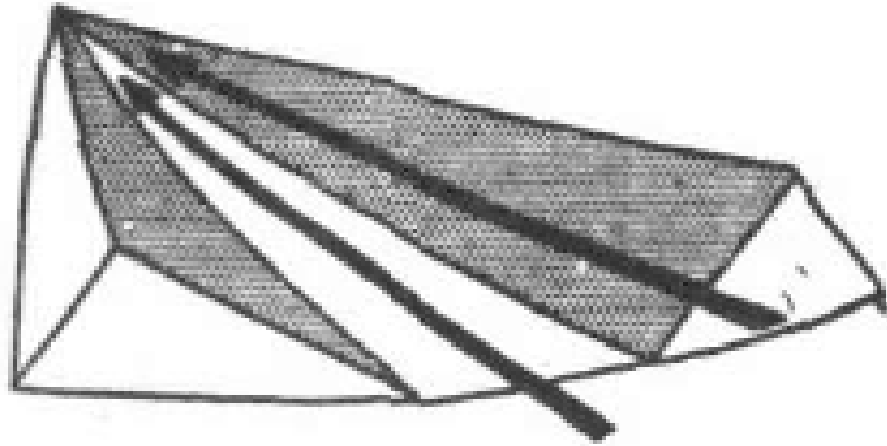
(b)

Air flow in the morning (about 9 am). Upslope winds are strong. System is in a state of transition from mountain wind to valley wind. Pressure drop is zero. Temperature is equalized. Changes in temperature: valley is rapidly becoming warmer, temperature over plain is changing slightly.



(c)

Air flow from noon until early afternoon. Upslope winds are decreasing. Valley wind is fully developed. Pressure drop is in up-valley direction. Valley is warm and plains relatively cold. Changes in temperature are essentially none.



(d)

Air flow in the late afternoon. The upslope winds are gone. The strength of the valley wind is the same as last picture. Valley wind extends to the sides of the slopes. The pressure drop is in the up-valley direction. Temperatures are warm in valley, relatively cool in plains. Changes in temperature: valley is slowly cooling.

- Notice that the mountain-plains wind does not require a slope to the valley floor. That is, pressure gradient that produces the mountain-plains wind is caused by the pooling (or evacuation) of air by the buoyancy-driven slope flows; but the mountain-plains wind itself is not dependent on buoyant accelerations.

- Mountain-valley winds are especially important in determining the dispersion of atmospheric pollutants. This is true not only for the obvious case of pollution sources in the valley; the mountain-valley flows create complicated flow patterns over the plains that make it difficult to evaluate where pollutants will be transported. An example is the Denver area where the boundary-layer flow indicates the presence of different flow systems related to canyons along the Front Range (this is most pronounced in winter when the valley-plains winds are especially well developed).

- Note: Valley warming/cooling is proportional to its shape.