JOHN FINDLAY

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65 METER RADIOTELESCOPE PROJECT

PHOTOMETRIC QUALITY AS A SITE SELECTION CRITERION

Victor Herrero

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Introduction

Kellermann's memo of July 30, 1970 brings up the discussion of several important criteria for site selection, and emphasizes the importance of the photometric quality of the site.

It is apparent that at short wavelengths, requirements for a radio observatory site approach those for optical observatories. However, at this early stage, I do not share his reservations on mountain sites. I believe mountain observatories can be quite good in relation to cloud cover conditions. For example, at Cerro Tololo in Chile (7250 feet), from September through April, 70% of the nights are normally of photometric quality (photometric night is one with more than 6 hours of continuous cloudless sky).

Temperature variations are of the order of 3 to 6 °C throughout the year. Temperature variations during the day are much higher but it should be emphasized that we have recognized for some time, that observations at the shorter wavelengths, with good performance, will be possible only at night, probably for any location that is chosen.

The observation concerning the frequent appearance of heavy clouds over Kitt Peak is well taken. However, one should recognize the systematic nature of orographic and regional effects in the micro-climate

Orographic effect

A mountain chain causes an uplift of low altitude moist air which condenses and often gives the chain a characteristic cloud cap. A spectacular example is provided by the Sierra Nevada lens shaped

clouds, caused by westerly winds producing a gigantic air wave over the mountain tops. Associated with the wave flow is severe turbulence, with strong up and down drafts, excellent for sailplane flying but bad for astronomical observing.

Temperature inversion effect

At night, however, the orographic effect is replaced by the favourable downdraft due to radiation cooling of the mountain. Under normal circumstances, the temperature of the air decreases with increasing elevation. In arid mountainous regions, on account of the lack of water vapour, little of the energy radiated by the ground is retained by the atmosphere. The air itself does not radiate well and stays at nearly constant temperature during the night. However, the air close to the ground is cooled by contact with the cold surface. The layer of inverted cold air over the ground may have a thickness as large as 100 meters over a plain.

The effect is quite pronounced in mountainous areas. The air cooled on the slopes of the mountain flows downhill continuously replacing the air at the mountain top with warmer dry air from above. As an example of the power of this effect, Kuiper notes that in studying the air flow around Mauna Loa in 1963 (13700 ft.). a strong downdraft at the 11200 ft. level was noted on the north slope, strong enough to overcome the 15-20 mph Trade Wind blowing from the NE.

The Southwest Monsoon

Special consideration should be given to the regional climato-

logy. For example, the southwest of the U.S. has a pronounced wet season extending through the summer. The influx of wet Gulf air gives a rainy season that overrides all other considerations. This is an undesirable effect since the limitation to night observing due to thermal considerations will tend to systematically disfavour observation of the important galactic center region. Hawaii, for example, does not display this wet summer effect (the low latitude adds to the advantage)

Conclusion

By the orographic effect, high mountains are frequently enveloped in cloud during the day. During the night, the temperature inversion effect tends to make the peak completely clear.

Isolated peaks are much better than a plateau and it is generally the height above surrounding terrain what really counts.

References

Jurgen Stock, Site survey for the Inter-American Observatory in Chile, Science, 148, 1054, 1965.

Gerard Kuiper, High altitude sites and IR astronomy, Communications of the Lunar and Planetary Laboratory, N° 142, 1970.