6.3A INCREASE OF ANTENNA AREA INSTEAD OF TRANSMITTER POWER

J. Rottger*

EISCAT Scientific Association
S-981 27 Kiruna, Sweden

In this short note attention shall be drawn to the fact that an extension of the antenna area may be preferred to an increase of transmitter power, if one takes into account that reflection often dominates the scatter contribution at near zenith angles. We can write the radar equation (e.g. ROTTGER, 1984):

$$P = P_a \cdot A \cdot \Delta r \, (C_r^2 + C_s^2) \cdot r^{-2}$$

with the contribution due to

reflection $\quad C_r^2 = A \cdot (F \cdot \overline{M})^2 \cdot \lambda^{-2}$

and the contribution due to

scattering $\quad C_s^2 = 0.03 \; C_n^2 \cdot \lambda^{-1/3}$,

where

- P = received echo power,
- P_a = average transmitter power,
- A = antenna area,
- r = range,
- Δr = transmitter pulse length,
- λ = radar wavelength,
- M = mean generalized refractive index gradient,
- F = calibration factor,
- C_n^2 = turbulence refractive index.

It is noticed that an increase of the antenna area A linearly increases the contribution of reflection. This is most likely to occur at vertical incidence, since M is largest in the vertical direction (leading also to the well-known aspect sensitivity). If $C_r^2 > C_s^2$, the received power P increases quadratically with the antenna area; e.g. doubling the area yields a four-fold increase of echo power, whereas a doubling of transmitter power (e.g. doubling the number of transmitters) only doubles the received power (see Figure 1). However, one has to bear in mind that these considerations hold only in the far field r_m of the antenna, i.e. $r_m > D^2/\lambda$, where D is the diameter of the antenna array. The altitude ranges at which the echo power gets weak and we have to consider improvements of sensitivity are mostly larger than 5-8 km. It follows that our considerations are valid up to antenna diameters close to 200 m for wavelengths of 6 m. On the other hand one has to bear in mind that the reflected component has to be larger than the scattered component which only holds for near zenith angles.

REFERENCE:

Rottger, J. (1984), the MST Radar Technique, Handbook for MAP, Vol. 13, 187-232, SCOSTEP Secretariat, Dep. Elec. Eng., Univ. Il, Urbana.

---

*presently at Arecibo Observatory, Arecibo, Puerto Rico, on leave from Max-Planck-Institut fur Aeronomie, Lindau, W. Germany.

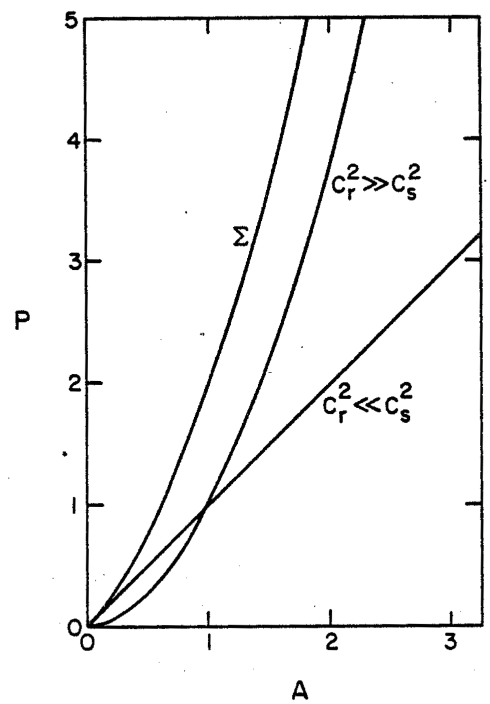

Figure 1. Dependence of power P (arbitrary units) and antenna area A (arbitrary units) for dominating scattering ($C_r^2 << C_s^2$) and dominating reflection ($C_r^2 >> C_s^2$).