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COMMENTS ON HIGH-POWER HIGH-RESOLUTION RADARS

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For observing precipitation, in terms of its intensity, increases in power and resolution could make good tools better. For precipitation intensity, however, it is not these changes that are vital, but rather a departure from use of a single attenuating wavelength (without lessening existing standards of resolution and sensitivity).

Angels: For angels, the situation is different. To move one step at a time, the situation was different when the Wallops Island Observations were undertaken by Atlas, et al. Let us define angels, for now at any rate, as targets yielding radar returns from a clear sky, distinguishing between true angels (inhomogeneities in the dielectric constant of the gaseous atmosphere, usually in the water-vapour concentration) and pseudo-angels (usually one or more birds or insects). True angels are related to the inhomogeneities that make possible radio scatter-propagation, and to those that are measured by "microwave refractometers", although distributions with frequency and gradient tend to differ for the three cases: radar, radio, refractometer. The situation, then, was that several scientists had a proper interest in true angels, and were busily engaged in observing angels, and interpreting them as true angels, even though this required some ingenuity. It was recognized, at the same time, that birds and insects could serve as radar targets; indeed, radar was being used by some to observe birds per se, and as hazards to aircraft. There had been fifteen years of debate as to the fraction of apparent angels that were biological rather than ethereal.

That was the state of affairs when Atlas designed and led in the execution of the Wallops Island experiment, using three radars having roughly the same beamwidth but differing in wavelength, and having enough power to see angels of one sort or another out to a good range. Some angels reflected better at a longer wavelength, so it was possible to remove the ambiguity between true and pseudo-angels, or to do so within those observations at any rate.

The experiment demonstrated the use of a "biological filter", based principally on variation of reflectivity with wavelength. It demonstrated the great field of observation available to radar installations several times larger than those assigned to meteorological studies in the past. At the same time, it made possible, by the new insights it provided, the more effective use of smaller, traditional installations.

The Wallops Island experiment was a perfect example of the opportune use for a scientific purpose of short-term-available scientific equipment. It does not follow that the equipment used then was the ideal establishment, either for solving the particular problem or for a continuing more general programme. One question that would arise, for example, is whether continued use of three wavelengths (rather than two) would be justified. Such questions can be raised usefully for conference discussion, but it could be unwise to base decisions directly on immediate answers.

Doppler radar gives the velocity of precipitation particles in a storm (or of any other point targets). More specifically, Doppler radar gives the radial component of such velocity, toward the radar, and usually quite reasonable and plausible assumptions can be made to convert radial component to vector velocity. Dr. Lhermitte would remove the need for these assumptions, by installing three radars at the points of a large triangle. The new tool thus created would be a powerful one. It would surely be complex.

I hope that Dr. Lhermitte's proposal can be supported, and I believe that it would be an excellent investment in major equipment. I hope at the same time that those of us who use radar without Doppler can carry on in our conservative habits with clear consciences. These hopes both have logical basis. Perhaps I may be permitted to use personalities and anecdotes to support them.

For myself, Lord Rayleigh's 1870 paper "on the light from the sky, its polarization and colour" is inspired gospel. It was written not only before the Lord was a Lord, but before Clerk Maxwell's equations. Thus, as I see it, weather radar was brought into the world to exploit Rayleigh scattering, with its simple relationship to particle size, and wavelength, and why the sky is blue. For me, the thing to measure is target intensity, as far out as storms can be seen over a curved earth. Suggestions that every radar should have a Doppler capability I resist, because I always suspect that with Doppler the radar is no longer optimal for intensity, or is reduced in the range to which it reaches. My opinion will change with enlightenment, but give me time.

For Roger Lhermitte, Doppler is a different matter. Doppler has been put to good use in weather radar by several scientists, and much credit goes

in particular to the unswerving interest in this technique of Dr. Lhermitte. Existing use, though, does tend to depend on assumptions, usually quite reasonable ones. Dr. Lhermitte sees a technical breakthrough that makes those assumptions unnecessary. This would make a world of difference in the case of the severe storm, where assumptions cannot be given great trust. The technical breakthrough involves one of those major jumps in the size of installation involved. This jump to a major installation is justified. In support of which claim, I recall an anecdote from the thirties, involving Queen Mary and the Chairman of the Board.

Actually, it is the ship Queen Mary that comes into the story. She was a much larger ship than anything before, and considerably faster. Her construction was complicated and delayed by the depression, and there was a need to justify her completion. The Chairman of Cunard made this justification, at the launching I believe it was. The Queen Mary, he said, was simply the smallest and slowest ship that, with just one sister, could maintain a weekly service between European ports and New York. Now, this comment could be put down to understatement for effect (and British understatement tends to be for effect, rather than self-effacement). But Sir Percy had a good point, worth remembering: is the proposed system the slowest and smallest that will do the job to a reasonable schedule; then is it worth the cost to get the job done?

Examples of this "Cunard criterion" can be found closer to home. Dr. Atlas has demonstrated in the Wallops Island experiment how one major experiment was just large enough in its capability to settle an arguement that had continued through years of smaller-scale experimentation. Dr. Pierce, in another context and on a more modest scale, has indicated how a national sferics facility, somewhat larger than we are used to, might make a major increase in the effective use of sferics techniques. Dr. Lhermitte's proposal for a Doppler triangle impresses one as an economical solution to the problem of measuring vector velocities in a storm. Experience to date can give us confidence, on the one hand, that the proposal is the smallest and simplest that will do the job to a reasonable schedule, and on the other, that the state of the art is now quite ready for the undertaking.

SESSION 5

Radio Tropospheric Scatter