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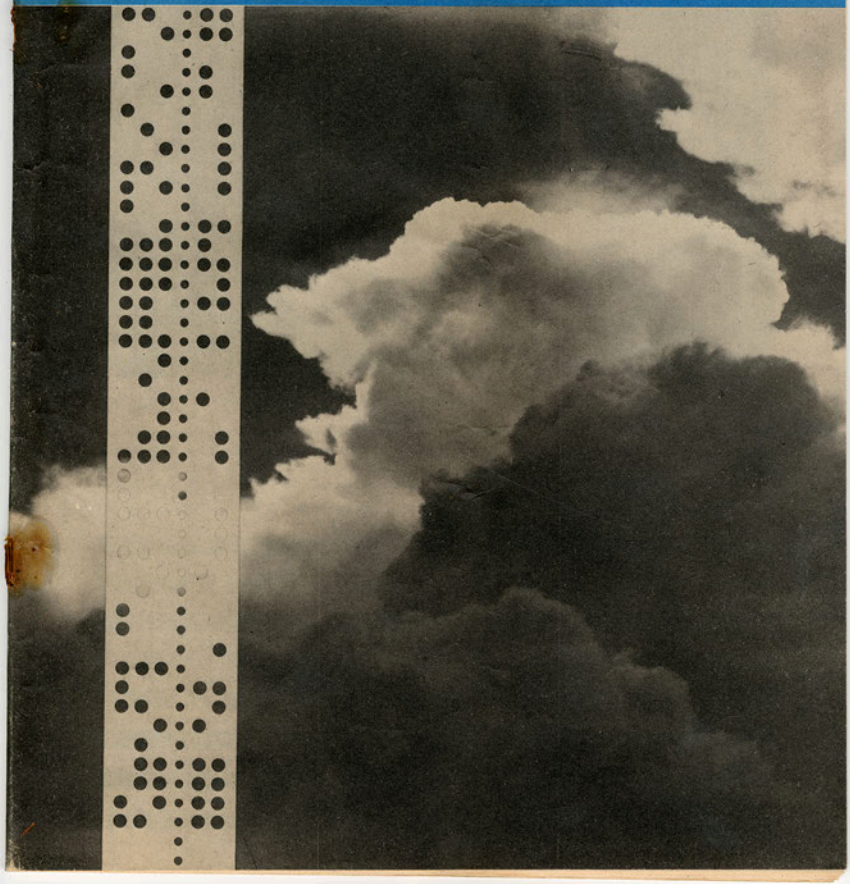


NOTES AND COMMENTS

CAN'T WE CHANGE THE WEATHER?

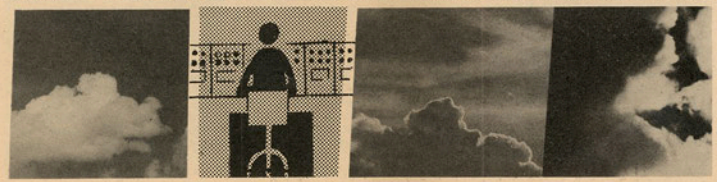
Control of the weather has been an age-long ambition of men, and a motive for much magic. Today we begin to see dimly how it might indeed be possible, by scientific means, so to tamper with the great engine of the atmosphere as to produce noticeable changes either locally or over a wide area. In a report published by the National Academy of Sciences-National Research Council in Washington this week, entitled *Weather and Climate Modification: Problems and Prospects* (2 vols, $5), a panel of American scientists reports most optimistically on the "further outlook" in this line of endeavour. The possibility that soon the computer will give meteorologists sufficient of a grasp of atmospheric processes to enable them to make confident proposals about weather modification, is something that should be taken very seriously indeed. Tricky questions of social and international policy, not to mention the hazards of gross climatic error, would follow immediately in the train of such a technical advance.

So convinced is the panel that weather modification "presents some of the most pressing scientific problems facing our society" that it recommends that one Federal agency should be given overall responsibility for pursuing the necessary research, and that the funds should be increased at least six-fold (from $5 million to $30 million) within five years.

In his preface to the report, the panel's chairman, George J. F. MacDonald, observes that when the panel was appointed in November 1963 "the complexion of the field had changed subtly" since 1957, when an advisory committee had reported to President Eisenhower on weather control. In many fundamental respects, the panel says, an earlier era of speculation was gradually superseded by the present period, "in which rational and systematic exploration of modification potentialities has become possible". Three factors are singled out as having caused the shift. In the first place, "moderately realistic" mathematical models can now be constructed for atmospheric systems ranging from the small-scale to the global. Secondly, the computer makes possible numerical simulations as a "primitive first step" towards understanding the interdependent workings of the atmosphere. The third factor is the availability of meteorological satellites and other advanced observation techniques required for monitoring the atmospheric systems one may seek to modify.

After this brave preamble, it is more than disappointing to discover that the panel is unable to answer the straightforward technical question which has awaited an answer for twenty years—namely, whether rainfall from clouds can be increased to any significant extent by "seeding" them with suitable smoke (usually of silver iodide or solid carbon dioxide). All the panel can say is that there is "increasing but still somewhat ambiguous statistical evidence" that precipitation from some types of cloud and storm systems can be modestly increased or redistributed by seeding techniques. By "modestly increased" the panel means about 10 per cent addition to the rain that would otherwise have fallen on the target area. But the panel repeats the somewhat plaintive rigmarole, familiar to anyone who has followed evaluations of cloud seeding since experiments began in 1946: that it is difficult to distinguish between seedable and unseedable clouds under field conditions, that lack of randomization in the trials precludes the drawing of decisive conclusions, and so on. Similarly, there is no agreement on whether silver iodide can mitigate hail damage. On the other hand, there are favourable reports from the US Forest Service that seeding tends to suppress lightning from a thundercloud, while from the US Air Force, some US airlines, and the USSR, comes conviction that cold fogs can be dispersed by seeding over a limited area. There has been little progress against warm fogs, and although cloud changes in hurricanes have been reported following seeding experiments, these unfortunately fall within the range of natural variability of such storms.

It is a not unfamiliar paradox of discussions of weather modification that it may be easier to bring about large-scale, long-lasting changes of climate than local cloud-by-cloud adjustments. The panel reviews the possibility that men are already unintentionally altering the climate by burning fossil fuels, building cities, flying aircraft and launching rockets. It stresses the immediate need for greatly improved methods of detecting man-made alterations in the chemical composition and energy budget of the atmosphere. "It is generally agreed," the panel reports, "that the total amount of carbon dioxide in the atmosphere has increased by 10 to 15 per cent in this century"—due to the burning of fossil fuels. The most recent calculations suggest that surface temperatures may have risen by 0.2 deg C as a result of this carbon dioxide, but that the stratosphere may have cooled by 2 deg C. The panel thinks that meteorological effects of afforestation, deforestation, irrigation and other alterations of the rural landscape are small and localized compared with the effects of large-scale city building and pollutants in the atmosphere. In drawing a similar distinction, the panel doubts whether supersonic trans-



NOTES AND COMMENTS *continued*

port aircraft will disturb the stratosphere appreciably, but is more perplexed and worried by the rocket exhaust in the higher atmosphere and by the dispersal of "exotic" materials in space research, such as atomic sodium. Vigorous investigation is called for, to settle the issue.

For deliberate modification of local, regional and continental areas, the panel notes that much more research must first be directed towards the exchanges of energy across the boundaries between the air and the land and the air and the sea. By altering the thermal properties of limited ground areas it is theoretically feasible to increase cloudiness and rainfall in deserts, by reducing or increasing the reflectivity of coastal desert strips, in order to generate convection currents. J. F. Black has proposed to test the principle by blackening strips in the coastal desert of Western Australia with asphalt.

For modification on a larger scale, present ideas are of necessity more speculative and bizarre; they provide useful talking points. Examples include the proposals for spreading coal dust over Greenland, for erecting a dense network of advertising hoardings over the Great Plains to increase the coefficient of friction for the air, and oiling the oceans to reduce the friction. Even if such procedures were feasible (e.g. there were enough advertisers to pay for the billboards) it would not be a good idea to try. Writing of the present impossibility of predicting the consequences of massive interference with the atmosphere, the panel remarks: "As long as our understanding is thus limited, to embark on any vast experiment in the atmosphere would amount to gross irresponsibility."

Present mathematical models of the atmosphere, using available computers, are said to be capable of predicting reliably the qualitative influence of, say, removing the Rocky Mountains, but not the subtler changes more accessible to human intervention. Accordingly, the panel wants computers ten to one hundred times more powerful than those at present available.

The report is a curious document. It adds little to previous speculation or experimental information about weather modification and yet it makes recommendations as if a new day had dawned; it speaks of the wonders now possible with computers and complains that the machines are quite inadequate. Nevertheless it is hard to deny the long-term plausibility of the idea that men will control the weather, and if the experts have to assume a kind of desperate enthusiasm in putting their case for greater facilities, that may be merely a reflection of how science policy is formed these days. It is certainly not too early to ponder the legal, social and international implications of weather and climate modification (which are the subject of a parallel report by the National Science Foundation in Washington).

LITTLE THINGS WRONG IN POWER SOURCES

Few things could do more to spread gloom if not despondency among those responsible for Britain's power supplies than a long-range forecast that predicts cold weather for the next month. Simultaneously, the gas and electricity industries, vying boisterously for business, appear to have stumbled. The obstacle in each case has been the difficulty of getting advanced technology into service.

In the case of the electricity supply industry, the technical troubles are rooted in the pace at which individual generating plant itself has grown. Post-war Britain could boast nothing larger than 60 MW electrical generators. They were supplanted by generators of 100-120 MW capacity, an advance achieved by the normal engineering process of extrapolating from the experience of proven designs.

Then came a great leap forward, to generators of 300-350 MW, several of which are now installed and running but not without their troubles. Technically these new machines are much more advanced and far more complex. Inevitably they are much more sensitive to trouble. They are justified economically, for Britain sorely needs the immense "chunks" of power they can raise so cheaply, but the price of cheap power quickly includes a premium exacted by a turbulent commissioning period, sometimes lasting many months, before the power station is delivering its design output.

It is the generating sets in the 300-350 MW range that are causing the troubles today: not systematic trouble but all manner of trivialities—in lubrication, in control systems, even in leaky valves—associated with the ancillary plant. Such troubles seem to arise only too readily when technological boundaries are being pushed out.

But within a couple of months the first of the 500 MW sets should come "on-line" at Ferrybridge in Yorkshire. This is the machine that will form the backbone of Britain's electricity supply system in a few years. Can we expect a whole new crop of troubles in bringing them up to full load? With luck, no, for these machines are less of a technological advance than those now in difficulties; they use the same steam conditions, so the metallurgy, the layout, the operating conditions all remain much the same.

Once through the present troubles, the engineers foresee a smooth passage, at least until the next size of set, which will probably be 660 MW. Sets of this size are already at an advanced stage of discussion, but one crucial point has still to be decided: whether or not they shall use a more advanced boiler technology.

The gas industry has been advancing its own technical frontiers. Chemical engineers are familiar enough with high pressure and high temperatures—but not with both at once, which is what the new gas-making processes require. Pressures of hundreds of lb-force per square inch at bright-red heat are handled at the new gasworks like Tipton in Staffordshire.

But difficult though the engineering can be in plants of this sort, the trouble at Tipton seems to be nothing more exciting than a leak in a six-inch pipe. At Coleshill last autumn the trouble was probably equally trivial: a small fire, again unconnected with the hub of the new technology. The West Midlands gas board, one of a dozen area boards, must count itself exceptionally unlucky to be involved in two big doses of trouble in one winter.

But these troubles, far from exonerating the suppliers of the two power industries, indicate that although they are to be congratulated on the way they have mastered the new technologies, they should nevertheless be taxed with failing to give commensurate attention to the more conventional aspects of their engineering. Nowhere is this more obvious than in the construction of nuclear power stations.

Reactor engineering has achieved a remarkably high standard, simply because nothing less was acceptable in a piece of engineering which, once working, is almost impossible of access. Not so the ancillary engineering, where equipment as mundane as the blowers used for gas cooling has caused long and costly delays, in almost every nuclear station. Are Britain's great engineering companies still unaware that they can lose their reputations no less surely over conventional equipment than over advanced technology?

HOW CLIMBERS CAN SAVE THEMSELVES

Men have climbed to the top of the highest mountain in the world and returned unharmed, yet every year an increasing number of mostly young, fit people suffer acute illness and even death as a result of exposure during the course of modest expeditions over Britain's little hills and vales. Now Dr Lewis Pugh, a Medical Research Council physiologist, and a member of the 1953 Mount Everest expedition, has made a report to the Medical Commission on Accident Prevention in which he analyses 23 exposure incidents which have occurred in this country during recent years (*British Medical Journal*, 1966, Vol. 1, p. 123). He has pinpointed some of the causes of disaster, and suggested a number of practical precautions.

In fatal cases, the two principal factors involved were wet clothing and walking to the point of collapse. Sometimes the victims had set out in bad weather. At other times, high winds and icy rains had overtaken them. When somebody wet-through is exposed to wind, body cooling can be very rapid, and wet-cold conditions are more dangerous than dry-cold. Once