AN APPROXIMATION

Posted on the message board by Clifford E Carnicom
AUGUST 22 2000

The following is a first pass at an approximation to the logistics of a seed or spray operation, with at least an initial consideration given to the factors of volume of air involved, seeding concentration, particle size, weight and size limitations of aircraft, number of aircraft required, and the amount of time involved. As any errors of significance are found, please do not hesitate to note them and the subsequent revisions and re-considerations can be made. All figures are given in approximate forms. The primary objective here is to determine the feasibility of an operation as commonly is observed across the country, and initial results indicate the logistics of such an operation are quite feasible.

1. Assume a volume of the sky is to be seeded with micron size hygroscopic (water-seeking) nuclei. This example picks a volume of 200 miles long by 200 miles wide by 1 mile thick. Lets' also assume the job needs to be done in a couple of hours.

2. The volume of air involved is then 200*5280*200*5280*5280 = 5.8879E15 cu.ft.

3. Assume that we wish to seed this volume at a concentration of 30 particles per liter. Vincent Schaefer, in references to early cloud seeding projects, mentions an introductory range of 10-50 particles per liter are desirable. Let us use the average of this range.

4. So the number of particles that need to be introduced is 5.8879E15 cu.ft. * (28.3168 liters/cu.ft) * (30 particles/liter) = 5.00E18 particles at the micron size.

5. Let's assume a plane travels at 500mph (733ft./sec.) Next question is how wide a swath of air would a plane have to seed to finish the job in 2 hours. This can be set up as:

5.8879E15cu.ft / (n * X * (733ft./sec) * 5280ft.) = 7200 sec. (2hours)

where n would be the number of aircraft, and X the width of seeding by an individual aircraft.

6. X here solves at 211295ft, or approx. 40 miles wide, assuming n=1 for the time being. So if one aircraft could seed an area 40 miles wide, the job would be done with one aircraft. But as this does not seem reasonable, and also does not fit the observations which are commonly reported, let's assume an equivalent configuration of 8 aircraft seeding spaced 5 miles apart horizontally . Or 10 aircraft at 4 miles apart horizontally, etc., could be used.
The set of 8 aircraft will satisfy reasonable conditions of conformance to observations for the time being.

7. At this point we have a configuration which will seed the volume of atmosphere under consideration by a reasonable number of aircraft in a specified time at a certain concentration of a certain size.

8. We can verify the number of particles being delivered by each aircraft by the following:

9. Each plane needs to seed : (211295 ft. / 8 aircraft) * 733ft. * 5280ft./sec. = 1.022E11 cu.ft./sec with (5.00E18 particles / 8 aircraft) = 6.25E17 particles per aircraft and 6.25E17 particles / 7200sec. = 8.68E13 particles/sec. per aircraft.

10. And for the final concentration of seeding, (8.68E13 particles/sec.) / (1.022E11cu.ft./sec) = 850 particles / cu. ft. / sec. and 850 particles/cu.ft./sec with 28.32 liters/cu.ft = 30 particles / liter as is desired.

11. Steps 8, 9, 10 only serve to verify the seeding concentration is in order.

12. Now we need to give consideration to the weight of the material being carried, and whether it also remains feasible. If we have a system that is capable of transforming solid material to micron size seeding material, we will need: 5.00E18 particles / (1E18 particles/cu.meter) = 5.00 cu. meters.

13. With 8 aircraft, this is 5.00 cu. meters / 8 aircraft = .625 cu. meters /aircraft. or .625 cu. meters * (35.31 cu. ft. /cu. meter) = 22.1 cu. ft. of material per plane. This is equal to a block of material 2.81 ft. on a side. Feasible for size.

14. For weight, let's pick the element of barium to work with. Reasons for this choice are under consideration and will be discussed further at a later time. The density of barium is 3.5gm/cu.cm or 3500kg/cu.meter.

So in our example, .625cu.meter * (3500kg/cu.meter) = 2188 kg. Since 1 kg. = 2.2lbs, the weight in a familiar system is 4812 lbs. of barium.

15. And now since Barium occurs naturally in a couple of forms, and since I currently have a greater interest in barium carbonate, and since the elemental barium is 70% of the atomic weight of barium carbonate, lets jump the weight of material required to 4812 / .7 = 6875 lbs. of barium carbonate or, 3.44 tons per plane. Since aircraft easily are carrying 150 folks at 160lbs/folk = 24000lbs = 12 tons, weight requirements also do not seem to be a major problem.

In summary, an operation that seeds the sky with micron sized hygroscopic (water-seeking) nuclei involving 8 aircraft within a 200 mile by 200 mile by 1 mile high volume of our skies in a 2 hour period at a concentration of 30 particles /liter seems quite feasible, and is in accordance with repeated observations of same over the past 1 1/2 years across the country. Although not intended at this stage to be an exhaustive study, reasonable consideration has been given to constraints of air volume, concentration levels, particle size, weight and size limitations of aircraft, number of aircraft employed, and the amount of time required to conduct the operation. Any significant errors discovered will be corrected as this scenario is reviewed by the readership.

Clifford E Carnicom
August 22 2000

Note: The following exchange between a user by the name of Skylooker and myself subsequently occurred on the message board on August 23 2000, and may be useful in regards to the statements above:

“Are you on the level???????

“You can’t squeeze rain from a cirrus cloud cover”, especially if it is an artificial,water,absorbent,expanding,aerosol cloud cover. Seeding is most effective within the cummulus cloud context and is predisposed towards precipitation, not towards the opposite end of the spectrum.>>>>>>>CHIEF SKYLOOKER”

Re: An Approximation

Skylooker,

I appreciate the distinction, and this may be an issue of semantics more than reality. There is no mention of precipitation or the intent of creating it within this scenario, and all indications are that exactly the opposite phenomenon of extraction of moisture is taking place. Hence the repeated emphasis upon the use of hygroscopic. The term seeding is used only in the generic sense of a “source or germ” – for a catalytic process. Extraction and diverting of moisture may well be germane, but there is no assumption or mention of an intent to induce immediate precipitation in the model above. I will assume that the point and question at this time is one of semantics.. regards,

Clifford E Carnicom