AN EARLY ACCOUNT OF A FLIGHT TO MODIFY LIGHTNING STORMS

by

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On February 4, 1948, Mr. Harry T. Gisborne visited me at the General Electric Research Laboratory in Schenectady to discuss our cloud modification studies. During this visit he pointed out that fires started by cloud to ground lightning comprised at least 75% of the causes of fire in the northern Rockies, and that in 1940 nearly 1500 fires occurred from lightning in a ten day period.

This was such an intriguing situation, entirely different than anything which happens in the Northeast, that I told Mr. Gisborne that I would like to visit the area to see if I could understand the mechanisms which produce such unusual effects.

I went to Priest River that summer, arriving at the Priest River Experiment Station in the Kaniksu Forest, and spent much of the period between July 17 and August 4 on the summit of Looking Glass (now Gisborne) Mountain whenever storm developments could be observed.

While at Priest River I observed one of the unique lightning storms that causes much of the forest fire ignition problems. It occurred on August 4, 1948 and was observed to move 20 miles in 45 minutes, during which time it produced 77 cloud to ground lightning strikes. One of the interesting features of such storms is that they produce very little rain, have cloud bases as high as 20,000 feet, originate as towering alto cumulus, and in some manner are associated with a jet stream.[1] On the other hand, while at Priest River I also observed a number of lightning storms of the air mass type which contained much supercooled cloud low bases and which could be easily modified by dry ice or silver iodide seeding.

At the end of my visit to Priest River, I prepared a report for the U.S. Forest Service entitled "The Possibilities of Modifying Lightning Storms in the Northern Rockies,"[2] which contained my recommendations for a field research program.

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[1] Schaefer, V.J. The Relationship of Jet Streams to Forest Wildfires. J. of Forestry 55, 419-425 (1957)

[2] _____. The Possibilities of Modifying Lightning Storms in the Northern Rockies. Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Mont., Station Paper No. 19, 17 pp, Jan. 1949. U.S. Department of Agriculture Forest Service.

The following year I was involved in field studies at Albuquerque, New Mexico with Project Cirrus and thus was not able to return to the Kaniksu Forest to continue my collaboration with Harry Gisborne. We remained in touch, however, and I urged him to attempt to carry out some of my recommendations.

It is one thing to make plans within the calm of the office or the laboratory and quite a different thing to carry them out as planned. The (to me at least) hilarious account of the first seeding attempt conducted by "Gis" (as he was affectionately called by all who knew him) is a "landmark" operation and one that should be in the annals of the pioneering efforts of weather modification. While it is unlikely that such primitive procedures as described by Gis would be possible with our present sophistication in aircraft, delivery systems, and advanced electronics, his account clearly conveys some of the problems that were an inherent part of the early "state of the art."

On November 9, 1949, while returning from a field reconnaissance of the disastrous Mann Gulch fire, he was fatally stricken with a heart attack. This was his last project as Chief of the Division of Fire Research of Region 1. He died with his boots on.

This calamity put a "hold" on further research of the lightning problem by the Forest Service. In 1952, when I left the General Electric Research Laboratory to become Director of Research of the Munitalp Foundation, I had a discussion with Jack Barrows regarding the possibility of continuing the field research that Gisborne had initiated. Jack was a young protege of Harry Gisborne who was heading fire research at Missoula, Montana.

These plans culminated in the development with Paul MacCready, Donald Fuquay and Jack Barrows of Project Skyfire.[3] But that is another story. The interesting account prepared by Harry Gisborne "for the files" of his dry ice cloud seeding experiment follows:--

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[3]Barrows, J.S., Schaefer, V.J. and MacCready, P.B. A Progress Report on Lightning Fire and Atmospheric Research. Intermountain Forest and Range Experiment Station, Ogden, Utah, Research Paper No. 35, 47 pp, Nov. 1964. U.S. Department of Agriculture Forest Service.

June 21, 1949

TO: Files

FROM: H. T. Gisborne, Chief, Division of Fire Research

SUBJECT: RF-NRM, PREVENTION, Lightning

In his report on "The Possibilities of Modifying Lightning Storms..." Schaefer recommended that we make a trial run or "shake-down cruise" on a cumulus cloud -- almost any cumulus cloud -- before commencing real tests of dissipating incipient lightning storms with dry ice. A small increase in funds for fire research, made in late May by our Washington office, permitted us to do this. The shake-down proved to be highly beneficial because it uncovered numerous, and some serious, difficulties.

This first trial was made near Missoula on June 16 while A. A. Brown was here and able to participate. Elmer Bloom was present with his movie and still cameras. I made the third member of the Forest Service crew. Ormund LaVoie was pilot of the C-47 plane. Bob Johnson, (Johnson Flying Service) went along as co-pilot.

Meteorological conditions were not at all satisfactory for a good test. Although small cumuli were numerous over the mountains north of town from 1000 to noon, they were evaporating fast between noon and 1400, while two big storm centers were building up, one to the east and one to the southwest. However, by 1500 the orographic cumuli were increasing, and at take-off time, at 1541, there was one distinct cumulus over Evaro Hill (15 miles northwest) whose top was at 16,000 to 18,000 feet m.s.l. by abney measurement. Its base was later found to be at 11,000 feet. As we took off I asked LaVoie to get on top of this particular cloud. Due to the later cold, lack of oxygen, mental loginess, and circling flight path I lost all sense of direction and I do not know for sure that this was the cloud which we finally almost topped. By the time we topped out, at 25,000 feet m.s.l., the other clouds around us had closed in until there was no possibility of flying off to one side and determining what effect, if any, resulted from the one bag of dry ice which we dropped.

It should be recorded that the widespread rain which began in Missoula about two hours after we scattered our ice, and the snow which stopped traffic on Evaro Hill that evening, occurred elsewhere throughout this section of Montana, and were the products of a general meteorological condition. It should also be recorded that this condition was not foreseen by the local Weather Bureau. At 1030 on June 16, Bill Krumm phoned me that the air was stable aloft and that the chances of good cumulus clouds to work on were poor for that afternoon. Actually, he was 100% wrong. There was a lapse rate from 60° to -30° F between ground and 25,000 feet, and there were too many clouds instead of not enough.

There were four features of this shake-down cruise of most importance. These are: (1) The use of the oxygen apparatus by Ross Angle and by us, (2) the dry-ice supply and handling, (3) the airplane and its facilities, and (4) the organization and positioning in the plane of the three Forest Service men required for this job.

(1) Oxygen apparatus. On the day we planned our test we found that Ross Angle had one of the two oxygen apparatuses with him, over in eastern Montana on an aerial photographic job. Thanks to some long-distance telephoning by Cullen Waldo and to some good flying by Ross and his pilot, the apparatus was back at Hale Field at 1:00 p.m., in time for our use.

In the future Ross should let us know when he takes the oxygen and we must let him know when we plan to use it. As we will want it on cumulus cloudy days in north Idaho whereas he needs it on clear days in eastern Montana, there may be some conflicts.

(2) Dry Ice. On June 13 I ordered three 70# cakes, for delivery at the Gold Medal Dairy on the morning of June 15. The Dairy gets it by night train from Spokane. It did not arrive until the morning of the 16th. That trouble should not bother us if we operate out of Sandpoint or Spokane because we can go directly to the dry-ice manufacturer for our supply.

Dry ice comes in 70# cakes about 12" x 12" x 18". I had it sawed into slabs 12" x 12" x 3/4". The Dairy charged 10¢ per pound, sawed. The slabs fit very well into the insulated bags used by the Forest Service in dropping hot and cold food containers from airplanes. A big stock of bags is available at both the Missoula and Spokane warehouses. By putting one bag inside another there is little loss between sawing and breaking into 1/2-inch or smaller pieces.

Two men with ordinary hammers can break the slabs from one 70# cake into fragments of under 1/2-inch diameter in 10 minutes or less. After a little practice it is easy to produce these sizes with very little powder. The powder is separated out by use of the sieve which I built. The insulated bags will hold up to 50 or 55 pounds of the broken ice. For ease of handling in the plane, at low temperatures, it is best not to put more than 30 pounds in each bag.

These bags cannot be dumped out the door of the plane and get good distribution of the ice. The 100-m.p.h. wind blowing across the door of the plane closes the mouth of the bag and holds it shut too tightly. A box and chute will be built to remedy this trouble.

(3) The C-47 and its facilities. This plane proved to have a good rate of climb. We made 10,000 feet above take-off in 13 minutes, the next 10,000 feet in 17 minutes more, and the last 2,000 feet in 15 minutes more.

Air temperatures as recorded by Brown were:

Time	Altitude	Temperature
3.42	3,400	60°
3.43	4,000	55
3.44	6,000	50
3.45	7,000	45
3.46	8,000	40
3.47	9,000	33
3.48	10,000	26
3.50	11,000	20
3.51	12,000	20
3.55	14,000	10
4.00	?	0
4.07	?	-15
4.08	?	-20
4.10	?	-20
4.27	25,000	-30

The C-47 which we used did not have two-way communication on Forest Service frequencies. For the final tests, on the Kaniksu, we must have plane-to-ground and ground-to-plane communication. If the plane transmits on 3250 and can receive 3155 we can get what we want. If FM sets are available at Looking Glass Lookout, at the Experiment Station, and in the plane, that would be even better. I will see Apgar and Morton about this.

(4) Organization. The failure to get temperatures at all elevations above 14,000 feet was due to our lack of organization of the work. Brown had an aneroid barometer good up to 14,000 feet. I was supposed to get elevations from there on up from the pilot, via the inter-communicating system on the plane, tell Brown, and he would read the temperature. I got fouled up with the oxygen supply and when I finally called the pilot on the intercom he was not listening. So Brown recorded only as above.

It is important to note that Brown's handwriting became worse in direct proportion to the decreasing temperature. In fact he could not hold a pencil in his hand at 30° below zero, hence he did not record that figure until we were back on the ground. Taking notes at 30° below zero is not easy.

To dump ice from the C-47 it is necessary to remove the inner part of the door, a part about 2' x 4'. This lets a blast of air into the rear end of the ship. When that blast is at 30° below zero it is impossible to keep warm, make notes, or operate a camera without warm clothing, especially gloves and mittens. After we returned to ground we found that the Forest Service has several sheepskin-lined suits stored at the "Loft" here in Missoula. We will use those next time.

Although this open door seems to be a bad feature of the C-47, I

do not think it will be as bad in the future. For one thing we never have intended to go to 25,000 feet. For another, the temperatures upstairs probably will not be as low, even at 25,000 feet from now on. Third, the open door is necessary for picture taking as well as dumping the ice.

The intercom system available in the C-47 provides a microphone and receiving headset for the pilot and the same for one man at the rear of the ship. We decided, after the confusion on this flight, that in the future the co-pilot should wear the mike and earphones up front while the man in the rear of the plane reading temperatures and making other observations and notes should wear the second headset, if only two are available.

I had expected to "direct operations" and to dump the ice, hence I wore the set on this first flight. As a result I had a 6-foot telephone wire tying my head to one place, a 4-foot rope around my waist tying my middle to a chair in another place, and a 10-foot plastic tube from my mouth to the oxygen tanks on the floor. The confusion was troublesome. Next time I will have only the rope and an oxygen tube.

The oxygen apparatus and its arrangement were poor in three respects. The oxygen tanks and the controls of supply lay on the floor. Our tubes got stepped on, kinked, and snarled. The tanks should be strapped upright against the wall with the tubes threaded through the plane framework and coming down from overhead.

No oxygen masks were available and it is exceedingly difficult to hold a slippery, very cold end of a plastic tube in your mouth while taking pictures or dumping ice. Furthermore, that blast of oxygen coming out of a tube and directly into your mouth at 30^{0} below zero freezes your adenoids to your tonsils, if you have any. Four masks should be provided. Two of these should have microphones built in, for reasons to be given.

Perhaps our greatest difficulty came from the fact that there were four oxygen outlets and four controls of the supply of oxygen, one for each outlet. I am quite sure that Bloom, Brown and I became confused at times, and when attempting to adjust our own control we sometimes turned the wrong knob, not our own, thereby giving one of the other men more or less oxygen. That can be prevented by labeling each knob with the man's name. As it was, we three novices undoubtedly wasted half the oxygen supply.

At about 12,000 or 14,000 feet elevation all three of us began to feel the effect of insufficient oxygen. Although we began then to use the emergency knob, which forces oxygen into your mouth, instead of making you suck for it, I think we all had difficulty from then on. The effects of insufficient oxygen are not painful or even troublesome.

I simply became logy both mentally and physically. I am told that with decidedly insufficient oxygen a man cannot perform a simple addition in arithmetic. I believe it. I know that by the time we reached 25,000 feet my head was as sluggish as my hands, which were so cold that I could barely hold on to the canvas bag full of ice and dump it out the door. I have never experienced such a feeling of absolute carelessness. I was weak, faint, and maybe suffocating but it didn't hurt and I didn't give a damn. I couldn't think and I didn't care if I didn't think.

Before leaving the ground the pilot, LaVoie, had told Bloom and me that when the oxygen pressure gauge dropped to 150 pounds that was the danger point, and time to start down. He also told us to watch each other for blue faces and lips -- the sign of insufficient oxygen. As we were all blue with the 30 below temperature long before we reached 25,000 feet, none of us paid any attention to the "blues." But just as we were almost at the top of our cloud, which had been growing almost as fast as our plane could climb, Bloom called my attention to the oxygen pressure gauge. It was down to 150 pounds. I therefore tried to call the pilot on the intercom to tell him. I tried three times but got no answer. He was listening on another frequency -- perhaps to the Missoula CAA beam -- and did not hear my call. He had not showed me how to use a knob on the intercom and cut in on him. So I took a couple of deep swigs of pure oxygen, dropped my tube, walked up front, told him our oxygen was down to 150 pounds, and came back to my tube. After reaching my tube and a seat I was rather weak and when Bob Johnson looked back at me I was just senseless enough to give him the signal to go down. Although this disgusted Bob, I think he told LaVoie to start down right then even though he knew we were almost on top of our cloud and had not yet dumped any ice. Personally I didn't know, or care.

After a couple minutes of pure oxygen I perked up and realized that we had not dumped any ice. So I sat on the floor -- our shoe soles were frozen and were slippery on the smooth metal floor -- and with Brown's help dumped the one bag of ice which was ready. I didn't even see whether it fell in the cloud or down through clear air. We learned, however, that the air rushing in the door held the mouth of the bag shut tight. It was all we could do to pound and kick the contents out of the bag.

By that time we were probably down to 20,000 feet and there was a little more air. Also we managed somehow to keep those ice-cold and slippery plastic tubes in our mouths, so we were getting oxygen. Consequently I wanted to dump another bag. But when I tried to unfasten the snap hook which kept the bag from flying out the door I could not manipulate it. My fingers were so cold I could niether bend them nor feel with them. As a result we did not use 3 of the 4 bags of ice which we had with us.

So we came down.