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Operational Use of Real Time Lightning Data at a National Weather Service Forecast Office

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The National Weather Service at Albany, New York, has been using the Lightning Detection Network operated by the State University of New York at Albany (SUNYA), for four years. We have found it to be a very useful tool. It supplements our Radar network, satellite imagery, and surface observations in answering an important question...whether or not a convective cell is a thunderstorm.

This is especially important for aviation purposes. The occurrence or non-occurrence of thunderstorms is critical to aircraft operating in the vicinity of an airport. If thunderstorms are forecast and it becomes obvious that they will not occur, then an amendment is necessary. By the same token, if they develop and they weren't forecast, then an update is in order. We issue forecasts for ten airports and write four route forecasts.

Of course, on the public side of our operation, we are also interested in knowing when thunderstorms are moving through our area of responsibility. This consists of Interior Eastern New York and all of Vermont.

How does the system work? Briefly, the network consists of a number of direction finders which are activated by the electromagnetic pulse generated by lightning. Actually, the direction finders will only respond to those waveforms characteristic of a return stroke in cloud-to-ground flashes. The important thing to remember, is that only cloud-to-ground flashes are recorded. Pulses from cloud-to-cloud or cloud-to-air flashes, which may be more frequent, are screened out.

Two direction finders need to detect the same stroke in order for the position analyzer at SUNYA to pinpoint the location of the strike. This strike is then displayed on a 19-inch color monitor in our office, almost as soon as the lightning is detected. So, this is a real time system we're talking about.

We also have the capability to make a hard copy of the display.

Our microprocessor is only capable of storing about 6500 flashes. On a good thunderstorm day, we can go through the memory in 30 minutes or so.

We receive the position of each strike detected and its polarity. Positive strikes usually indicate that the storm is winding down. By using different colors for various time intervals we can get an idea of a thunderstorm's speed and direction. Alpha-numeric data at the bottom of the screen includes: the times of the first and last flashes recorded, the flash total during this interval, and the position of the last strike recorded. We generally use polar coordinates for this. The sequence of colors is also displayed. This helps in keeping track of cell movement.

As we all know, technology continues to race ahead. The display system in our office is now considered to be somewhat antiquated. A more modern and more flexible arrangement employs an IBM-PC.

To my knowledge, only three National Weather Service offices are tied into this lightning detection network. The Central Weather Service Unit (CWSU) at the Air Route Traffic Control Center (ARTCC) at Leesburg, Virginia, and our office at Albany, have been on line since 1983. The forecast office at New York City was added last year, just in time for the Statue of Liberty's birthday party. They have the more flexible IBM-PC.

Now then, what does the lightning detection system do for us that our other observational systems can't? First of all, there's a lot of empty space in upstate New York and Vermont. A lot can go on which would be missed by our observers. We might find out about it eventually but in order to issue a timely forecast or a warning, we need to know about it as soon as possible. Even in the more populated areas observers are not closely spaced. We have only 15 airports in our forecast area that take hourly observations during the day and only 12 at night.

What about Radar? That represents a big improvement but it has limitations as well. The first limitation is coverage. Only three network Radars operate in portions of our area. Their maximum reporting range is 125 nautical miles. That leaves a big hole over Northeast New York and most of Vermont. Local warning Radars at Albany and Burlington can help plug this hole but they are not operated on a regular basis. Furthermore, they are not required to transmit reports unless a severe weather watch or a flash flood watch is in effect.

We can can get some information from Canadian Radars but their reporting system is not compatible with ours. This makes their reports a bit more difficult to decode and you have to expend a little more effort to get them.

It is not uncommon for a network Radar to out-of-service for maintenance or for there to be a break in the data line between Toronto and Washington. When this happens, the Radar hole gets bigger. Even with all U.S. Radars operating and reporting, there's still a hole over the western Adirondacks and the western St. Lawrence Valley.

The second limitation is the fact that Radar cannot detect lightning. When the Radar operator reports a thunderstorm, he is only making an educated guess. He really isn't sure. Also the operator can't identify each individual cell and classify it as a thunderstorm or a shower. At best, he may identify several groups of cells, but more often than not, he will lump everything on his screen into one category.

Our last observational tool is satellite imagery. It solves the problem of coverage but again, we can only make a subjective decision about whether a convective cell is a lightning producer or not.

The SUNYA lightning detection network gives good areal coverage, even out to sea, and it does one thing very well; it can tell us objectively where cloud-to-ground lightning is occurring. It has also been highly reliable. Downtime has been at a minimum.

To my mind, the most important feature of this network, is that it is a real time system. I can supply any number of examples where the lightning system gave us the first clue that any thunderstorms were occurring.

Just last weekend we had such a case. On Saturday, May 16th, the lightning monitor began displaying a few negative strokes in south-central Tennessee (1:07 PM). The weather Radar at Nashville reported this cell as a rainshower at 1:30 PM. This particular cell appeared on the National Radar Summary Chart on AFOS shortly after 2 PM. This map would have shown up even later on the Facsimilie circuit. The previous map, for 12:30 PM, did not show any cells within 200 miles of Tennessee. That means that, unless someone had almost immediate and automatic access to Nashville's radar report, almost an hour passed by, before the existence of this cell was given widespread dissemination.

My favorite example took place just after we started using the lighting network. On July 30, 1983, the Radar at Binghamton did not indicate any thunderstorms on its 2:30 PM report. Shortly thereafter the lightning detector began going crazy between Binghamton and Williamsport. By 3:30 PM Binghamton Radar indicated a thunderstorm with tops to 51,000 feet and hail.

In a worst case senario, up to an hour and a half can go by from the time a thunderstorm is picked up by the lightning detector and the time it is finally displayed on the National Radar Summary Chart. Assuming that the thunderstorm lasted more than the usual 30 minutes or so, and assuming it was moving at a speed of 30 knots, it would have covered 45 nautical miles during this interval.

So you can see that if a forecaster had real time lightning data available, he could be much more on top of a situation such as this.

Improvements in the remoting of Radar displays to distant offices have reduced the lead time advantage somewhat. But they still only indicate the presence of precipitation. They can't tell us if the echoes are actually thunderstorms.

At Albany, we have a dedicated line to the Binghamton Radar which gives us a continuous display. However, if we want to look at what's on the Burlington Radar, we have to disconnect from Binghamton and then dial up to Burlington. What's more, on a dial line you can only stay on for two or three sweeps before the connection is automatically broken.

One of the nicest features of the lightning display monitor is the fact that you can see what's going on in the entire Northeast with just a glance. In fact, you don't even need to look at it. Each recorded strike is accompanied by a short tone or "beep". Some people find that annoying. I like it because even when I'm doing something else, I'll know right away when thunderstorm activity is beginning or picking up in frequency.

As I mentioned earlier, the lightning network has probably helped our aviation forecasters the most. But its use is certainly not limited to them. Our public forecasters use it to fine tune their zone forecasts. They have also been able to be more specific in special weather statements.

Lightning data is not used as a basis for issuing severe thunderstorm warnings but information from it has been helpful in deciding where to issue warnings.

This may surprise you...lightning data was used on one occasion as the main reason for issuing a flash flood watch. On friday evening, July 6, 1984, the lightning pattern displayed on our monitor indicated an almost continuous series of thunderstorms moving up the eastern Hudson Valley, through western Vermont, into Quebec. Because of this very obvious "freight train" effect, a flash flood watch was issued. Several hours later, the Weather Service Office at Burlington issued a flash flood warning. About 6 AM Saturday morning an Amtrack passenger train ran off the rails at Williston, in Addison County, where flooding had washed out the tracks.

Before I wind up, I would like to mention one interesting event. When Hurricane Gloria churned up the coast in September of 1985 there was a noticeable lack of cloud-to-ground, or rather cloud-to-sea, lightning as the storm moved from North Carolina to New England. The weather Radar at Cape Hatteras reported thunderstorms with tops to 54,000 feet, as did several other Radars. We were so surprised about this that we thought the lightning system had "crashed". We even dragged someone from SUNYA out of bed at 12:30 AM to reset the system. As it turned out, the network was functioning properly.

Finally, we haven't been keeping our good fortune to ourselves. We have tried to share the lightning data with other offices. Frequently if we notice that lightning activity has begun, we will call an adjacent office to alert them to what is going on.

Last year we began issuing messages on AFOS (ALBADAALB) describing in general terms what we observed on the display. We are continuing this practice again this year. These messages are put out on an irregular basis and of necessity have to be fairly broadbrush. Usually they will contain the geographic areas which have the most frequent lightning, the flash rate per unit time, and the direction of movement. Despite their lack of detailed data, they have been well received by many of our offices.

What's next? The National Weather Service and SUNYA are working together on getting lightning data into AFOS every 15 minutes. Hopefully the bugs will be worked out soon. Lightning Summary maps are already available on a 30 minute basis in our Western Region.

I know this will be a welcome product for all Weather Service offices who do not have access to lightning data now. However, and I'm sure I can speak for Leesburg and New York City as well, once you've had access to the real time system we've been using, you'll be dissatisfied with anything less.

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