CRH SSD
NOVEMBER 1993

CENTRAL REGION TECHNICAL ATTACHMENT 93-28

ALERT GRID APPLICATION TO SKYWARN

Douglas M. Dubrish
National Weather Service Office
Muskegon, Michigan

1. Introduction

SKYWARN is the severe weather spotter program sponsored by the National Weather Service (NWS). This national volunteer program began in January of 1969 in response to the need for rapidly and accurately reporting the occurrence of tornadoes. Through the decades, the SKYWARN observers have saved countless lives by alerting authorities to potentially dangerous weather situations.

In recent years, the Alert Grid concept has been applied to the development and maintenance of the SKYWARN network serving the Weather Service Office at Muskegon, Michigan. It was foreseen that the processing of critical weather variables, e.g. precipitation, would continue to take place in the future as the NWS improves remote sensing, as well as communication systems. The input from an established all-seasons SKYWARN spotter network would prove helpful in calibrating the rainfall estimation by remote sensing devices, i.e. satellite and Weather Service Radar 74C (WSR-74C), as well as improving hydrometeorological warnings.

The Alert Grid, a systematic method of describing locations of SKYWARN spotters, has improved the efficiency of data collection and warning preparation. The Muskegon office discovered that having each county coded, and subdivided into sections, allowed geographical particularities and irregularities to be readily placed in a database. It was envisioned that this database could be a reference source for future manual and automatic product warning and statement preparation. Additional elements could be included, such as regional soil type, drainage, frost depth, river tributaries, terrain and seasonal climatology along with rainfall, snow water equivalency, and evaporation rates.

The results of the Alert Grid network initiative also suggested that the program would have future benefits during the transition period of the modernization of the National Weather Service.

2. Methodology

2.1 Background

In SKYWARN, performance comes in the form of reports that are evaluated to fine-tune the overall achievement of the SKYWARN program. In this manner, inconsistencies can be addressed which will advance the efficiency of the system. As applied to the conventional SKYWARN network, quality performance is difficult to achieve. In a large part, this is due to the vast geographical area the SKYWARN program covers. Although the SKYWARN program does have collective resources, its spotter locations are not ordinarily cataloged systematically. Reports are therefore of a hit-or-miss nature. Topographical differences may also result in inclement weather occurring where a spotter is not in place; with misrepresentation occurring at many locations. Therefore, a SKYWARN program should be defined further to allow proper feedback in fine-tuning the warning process. Effectively, this must begin at the county level using an "inter-linking" strategy.

An Alert Grid network in each county of an office's county warning area assures that there is a minimum number of weather spotters strategically located to view and report weather phenomena across the entire county. An Alert Grid network also allows attention to be given to areas void of spotters.

2.2 Partitioning of Counties

The development of an Alert Grid begins with a county map. The map should show primary roads; unimproved primary roads; and paved, gravel, and earth roads. This type of map is generally printed by the county road commission. The next step is to divide the county map into nine sections, which would resemble a tic-tac-toe crosshatch. Each of the sections should be nearly equal in areal dimension. However, natural divisions such as main roads, township divisions, etc., should be considered as valid boundaries when deciding partitions. There are nine basic spotter identification numbers listed per county. There may be more than one spotter per section, but still nine basic numbers. Whenever possible, avoid having major cities, towns, dams, or other significant points on a border. Rectangular symmetry should be maintained even with unusual county contours. At times this might result in a county not having the full nine subdivisions.

The next step is to number each of the nine divisions as illustrated in Example 1.

1	2	3
4	5	6
7	8	9

Example 1. Alert Grid

Regardless of county, each number relates to a geographic direction (Example 2) with 5 as the central location. Where 1 = Northwest, 2 = North central, 3 = Northeast, etc..

001/NW	002/NC	003/NE
004/WC	005/C	006/EC
007/SW	008/SC	009/SE

Example 2.

2.3 Spotter Identification - FIPS Codes and the Alert Grid

Every county is represented by a Federal Information Processing Standards (FIPS) number issued by the Census Bureau. Each county within a state has a unique FIPS number, although the numbers are repeated from state to state. Therefore, a prefix to the spotter identification number of MIC - for Michigan (MI) counties (C) might be added where WFO county warning areas overlap state boundaries. Then the first three digits of a spotter's identification number would be the FIPS code for that particular county. The second three digits represent the location of that spotter within the county, i.e. MIC-005-004.

The identification number identifies that the spotter is in Michigan, the county is Muskegon County (005), and that the spotter is in the West Central portion of that county (004). The next number of the identification tells you which spotter in the west central portion of the county it is, i.e. MIC-005-004-1. A minimum of one fully trained spotter should be required for each of the nine sections of the county.

Finally, a suffix (Example 3) would provide any notable comment that might be distinctive about the spotter, i.e. MIC-005-004-1A.

A= Amateur Radio Member
C= Cooperative Observer
R= River Stage Observer
S= Snowfall Observer
W= Water Temperature Observer
X= Radar System Available

Example 3.

2.4 Alert Grid Relationship to GWARN/SRWarn Software

By providing nine subdivisions per county, the Alert Grid also offers a direct relationship with the nine sub-divided areas used in warning software (SRWarn Users Manual Version 6.00 pg. 3.10 screen 6). With the spotter identification number designating which county and portion of a county, even a new staff member can focus immediately on the area to warn without delay.

3. Scenario

3.1 Hypothetical Synopsis

A deepening low pressure area over central Illinois created a moderately strong flow with increasing moisture into the Great Lakes region (Figure 1). Based on the forecasted track of the system, the 6-hour quantitative precipitation forecast, as seen in Figure 2, indicated the area of concern for flooding. The river forecast office issued the Flash Flood Guidance product, MSPFFGMI (Figure 3), which alerted the field offices that the stage was being set for activation of the SKYWARN Spotter Network.

Based on the unfolding events, a Flood Watch was issued late Wednesday afternoon. The watch was broadcasted on NOAA Weather Radio with a short SKYWARN call-to-action appended, "During the Watch, SKYWARN members should check rain gages and review related reporting plans." The members of the SKYWARN network have been trained to respond to such an activation by reporting observed precipitation amounts. The Flood Watch was also disseminated over the NOAA Weather Wire, and the Michigan Law Enforcement Information Network (LEIN).

There were four counties in the WSO Muskegon county warning area that were involved in this scenario. They were Oceana, Newaygo, Mecosta, and Muskegon as seen in Figure 4. Based on the FIPS Code Identification, the county numbers were 006, 014, 017, and 005, respectively. There were a minimum of nine spotters in each county, for a total of 36 spotters (that coincide with the Alert Grid points) in the Flood Watch area. Focusing on the Muskegon River Basin, there was a minor to moderate flood potential. The Alert Grid offered at least 18 locations where rainfall accumulations of 0.50 inch or more were reported.

The local area warning radars indicated a large area of light rain entering the southwest lower Michigan peninsula. It was moving to the northeast at 20 mph, and would reach Muskegon county just prior to midnight. At 2 am, the WSO Muskegon synoptic (0600Z) observation reported a 0.04 inches of precipitation for the previous 6-hour period.

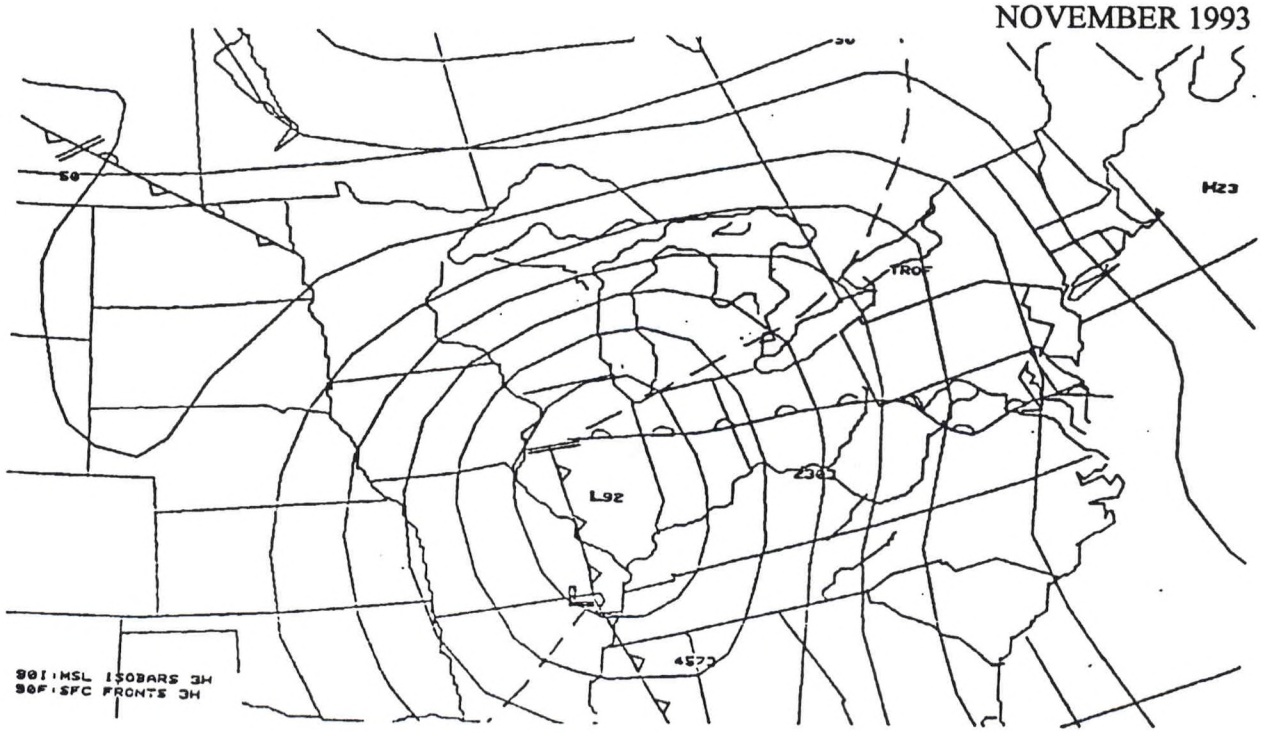

Figure 1. Surface map depicting isobars of sea-level pressure.

Figure 2. Six-hour quantitative precipitation forecast. Amounts in inches.

```
MSPFFGMI
TTAA00 KMSR
     ANN ARBOR HYDROLOGIC SERVICE AREA
AVERAGE 3-HOUR FLASH FLOOD RAINFALL GUIDANCE BY COUNTIES
GENERAL FLASH FLOOD GUIDANCE FOR STEEP TERRAIN AND URBAN AREAS ARE
ONE TO TWO INCHES OR MORE IN ONE TO TWO HOURS OR LESS RESPECTIVELY.
REFERENCE ROFL C-15-90 FILED WITH CHAPTER E-28
RELEASE DATE... WED APR
.B MSR 0415 DH00/PPTCF
```

ALCONA	MIC001	1.3		ALGER	MIC083	1.8
ALLEGAN	MIC005	1.2		ALPENA	MIC007	1.6
ANTRIM	MIC009	1.8		ARENAC	MIC011	1.3
BARAGA	MIC013	1.8		BARRY	MIC015	1.8
BAY	MIC017	1.3		BENZIE	MIC019	1.6
BERRIEN	MIC021	1.5		BRANCH	MIC023	1.2
CALHOUN	MIC025	1.2		CASS	MIC027	1.5
CHARLEVOIX	MIC029	1.8		CHEBOYGAN	MIC031	1.1
CHIPPEWA	MIC033	1.8		CLARE	MIC035	1.1
CLINTON	MIC037	1.1		CRAWFORD	MIC039	1.2
DELTA	MIC041	2.1		DICKINSON	MIC043	1.7
EATON	MIC045	1.2		EMMET	MIC047	1.8
GENESEE	MIC049	1.5		GLADWIN	MIC051	1.1
GOGEBIC	MIC053	1.6		GRAND TRAVERS	MIC055	1.7
GRATIOT	MIC057	1.1		HILLSDALE	MIC059	1.2
HOUGHTON	MIC061	1.4		HURON	MIC063	1.1
INGHAM	MIC065	1.3		IONIA	MIC067	1.8
IOSCO	MIC069	1.3		IRON	MIC071	2.8
ISABELLA	MIC073	1.1		JACKSON	MIC075	1.3
KALAMAZOO	MIC077	1.2		KALKASKA	MIC079	1.8
KENT	MIC081	1.1		KEWEENAW	MIC083	1.1
LAKE	MIC085	1.1		LAPEER	MIC087	1.7
LEELANAU	MIC089	1.4		LENAWEE	MIC091	1.1
LIVINGSTON	MIC093	1.4		LUCE	MIC095	1.8
MACKINAC	MIC097	1.8		MACOMB	MIC099	1.2
MANISTEE	MIC101	1.2		MARQUETTE	MIC103	1.8
MASON	MIC105	1.2		MECOSTA	MIC107	1.8
MENOMINEE	MIC109	1.9		MIDLAND	MIC111	1.1
MISSAUKEE	MIC113	1.8		MONROE	MIC115	1.2
MONTCALM	MIC117	1.8		MONTMORENCY	MIC119	1.2
MUSKEGON	MIC121	1.1		NEWAYGO	MIC123	1.8
OAKLAND	MIC125	1.1		OCEANA	MIC127	1.8
OGEMAW	MIC129	1.2		ONTONAGON	MIC131	1.5
OSCEOLA	MIC133	1.8		OSCODA	MIC135	1.2
OTSEGO	MIC137	1.2		OTTAWA	MIC139	1.2
PRESQUE ISLE	MIC141	1.4		ROSCOMMON	MIC143	1.2
SAGINAW	MIC145	1.3		ST CLAIR	MIC147	1.5
ST JOSEPH	MIC149	1.3		SANILAC	MIC151	1.3
SCHOOLCRAFT	MIC153	1.8		SHIAWASSEE	MIC155	1.8
TUSCOLA	MIC157	1.5		VAN BUREN	MIC159	1.7
WASHTENAW	MIC161	1.2		WAYNE	MIC163	1.1
WEXFORD	MIC165	1.3				

```
.END MCRFC
```

Figure 3.

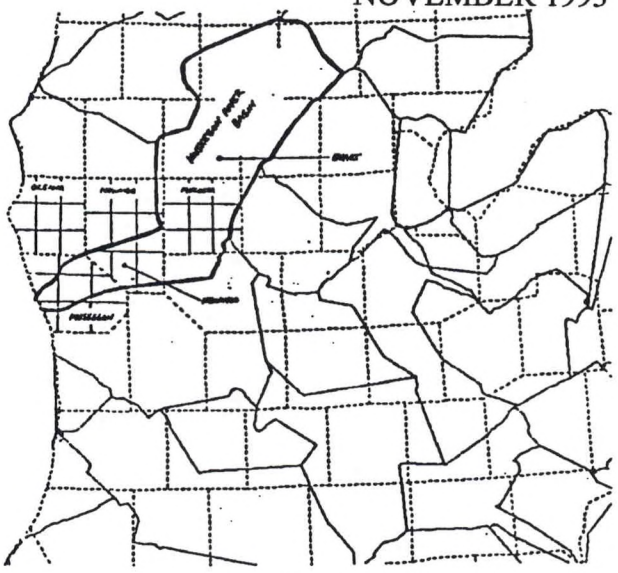

Figure 4.

Spotter Network Report Form

SKYWARN

Date	Spotter ID Number	County	Report
9	006-001-0	OCEANA	8A-8A .21
9	018-002-0	NEWAYGO	8A-8A .63
9	014-008-0	NEWAYGO	8A-8A .78
9	005-005-0	MUSKEGON	8A-8A .37
9	017-006-0	MECOSTA	9A-8A .39
9	005-004-0	MUSKEGON	8A-8A .23
9	014-005-0	NEWAYGO	7:30A-7:30A .48
9	005-001-0	MUSKEGON	8:15A-8:15A .17
9	006-006-0	OCEANA	8A-8A .52
9	017-004-0	MECOSTA	8A-8A .51
9	006-004-0	OCEANA	8A-8A .18
9	005-002-0	MUSKEGON	8A-8A .43
9	014-004-0	NEWAYGO	8:15A-7:30A .73

Figure 5.

SHEF.IDS REV. 4 Oct 92
Page 1 of 7

Standard Hydrologic Exchange Format (SHEF) for
Northwest and West Central Lower Michigan

Muskegon County

Spotter ID#	SHEF Code	Location
005-001-0	X4320862	Whitehall 17NW MKG
-001-1C	MTGM4	Montague
005-002-0	X4340861	Twin Lake 16NE MKG
005-003-0	--------	No grid due to county shape
005-004-0	X4330863	North Muskegon 11NW WSO MKG
005-005-0	X4320861	NE Muskegon 6N WSO MKG
005-006-0		
005-007-0	X4310862	E. Muskegon 1NW WSO MKG
005-008-0		
005-009-0		

Oceana County

006-001-0	X4350862	Pentwater 45NW MKG
006-002-0		
006-003-0		
006-004-0A	X4340863	Little Sable Pt. 35NW MKG
-004-1	X4340862	Shelby 30NW MKG
-004-2	X4340863	Silver Lake 33NW MKG
006-005-0		
006-006-0A	X4340860	Hesperia 30NE MKG
-006-1C	HSPM4	Hesperia
-006-2C	WALM4	Walkerville
006-007-0		
006-008-0		
006-009-0		

Figure 6.

Through the early morning hours the rain slowly spread over the entire Muskegon River Basin. At the next 6-hourly report (8 am Thursday), WSO Muskegon reported 0.34 inch precipitation. It was at this time, that the spotters having rainfall were encouraged to phone in their 24-hour rainfall totals regardless of amounts.

The reports were collected (Figure 5) from the spotter network via the "800" telephone recorder system. Then the reports were converted to "stranger stations" in the SHEF code format. This is accomplished by referring to a conversion list given in Figure 6. The River and Rainfall Report (ARBRR1MKG) was then composed using the coded data and sent to the River Forecast Center and other users (Figure 7).

Over the next 12 hours, ending at 8 pm, 0.62 of an inch fell at WSO Muskegon. No further reports from spotters were received.
The Flood Watch had been canceled at 5 pm due to the lack of additional precipitation in the river basin. The NWS's telephone calls to the river gages indicated only minor rises at Evart and Newaygo, Michigan. The next river stage guidance (MSPRVFSMW) indicated the 3-Day Forecast for Evart and Newaygo as:
SLOW RISE..REMAIN BLO FS.

4. Conclusion

The hypothetical scenario depicted the flow of information during operational conditions. The information exchanged has the fundamental elements of Total Quality Management since the exchange of real-time information from the Alert Grid spotter improved the river forecast product.

As WSR-88D service becomes widespread, quantitative precipitation estimates in one hour, three hours, and storm total will be available. The WSR-88D precipitation estimates are designed to be adjusted with real time reports from SKYWARN rain gages or automated rain gages. The Alert Grid concept will help the forecaster gauge the accuracy of what is seen on the WSR-88D by providing information to help fine tune some of the nearly 12,000 adaptable parameters in each WSR-88D.

With an Alert Grid in place, both the quantity and quality of information should increase. This would lend to more lives and property being saved and improve the credibility of service with fewer false alarm warnings.

```
NNNN: ##.A
:ZCZC ARBRR1MKG
TTAA00 KMKG 091331

RIVER AND RAINFALL REPORT
NATIONAL WEATHER SERVICE MUSKEGON MI
848 AM EDT WED APR 9 1993

.B MKG 0409 E DH0800/PP

:MUSKEGON COUNTY
X4320862 0.17 :PCPN 08 AM TO 08 AM WHITEHALL 17NW MKG
X4340861 0.45 :PCPN 08 AM TO 08 AM TWIN LAKE 16NE MKG
X4330863 0.23 :PCPM 08 AM TO 08 AM NORTH MUSKEGON 11NW WSO MKG
X4320861 0.37 :PCPN 08 AM TO 08 AM NE MUSKEGON 6N WSO MKG
X4310862 X.XX :PCPN XX AM TO XX AM E MUSKEGON 1NW WSO MKG
:
:OCEANA COUNTY
X4350862 0.21 :PCPN 08 AM TO 08 AM FENTWATER 45NW MKG
X4340863 0.13 :PCPN XX AM TO XX AM LITTLE SABLE PT. 35NW MKG
X4340862 X.XX :PCPN XX AM TO XX AM SHELBY 30NW MKG
X4340863 X.XX :PCPN XX AM TO XX AM SILVER LAKE 33NW MKG
X4340860 0.52 :PCPN 08 AM TO 08 AM HESPERIA 30NE MKG
:
:NEWAYGO COUNTY
X4330860 0.73 :PCPN 08 AM TO 08 AM HESPERIA 34NNE MKG
X4330854 0.48 :PCPN 08 AM TO 08 AM WHITE CLOUD 35NE MKG
X4340855 0.63 :PCPN 08 AM TO 08 AM BITELY 44 NNE MKG
X4320855 0.78 :PCPN 08 AM TO 08 AM NEWAYGO 28NE MKG
:
:MECOSTA COUNTY
X4340851 0.39 :PCPN 08 AM TO 08 AM MECOSTA 58ENE MKG
X4340853 0.51 :PCPN 08 AM TO 08 AM BIG RAPIDS 52NE MKG
:

.END
```

Figure 7.