

## PACKET RADIO AND THE NATIONAL HURRICANE CENTER

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### Abstract

Amateur radio operators in South Florida are exploring the capability of Packet Radio to provide the National Hurricane Center with high quality weather observational data, and in turn transmit timely forecast information from the Hurricane Center to effected areas.

### Preliminary Tests

On September 10, 1984, W4SS, ARRL Section Emergency Coordinator for South Florida called for a Packet Radio test between and among a number of county Emergency Operations Centers (EOC's).

On that date, a packet station was taken to the National Hurricane Center by KI4T, and an authentic weather bulletin was transmitted to the various EOC's participating in the test.

The weather bulletin text was received intact as far away as Melbourne, Florida, by N2WX, a distance of 220 miles, as well as by packet stations in Dade and Broward Counties, West Palm Beach, Stuart, and Ft. Pierce. This initial test of packet weather bulletin transmission from the Hurricane Center was in large measure responsible for some of the above mentioned municipalities purchasing packet controllers and dedicating computers to them.

Although the text was manually entered on a terminal at the Hurricane Center, it portends the day when automatic weather text transmissions become a standard service provided by the amateur radio community.

### Background

In order to better understand how packet radio might function superbly at the NHC, let's first look at how the NHC itself functions.

The Center is operated under the jurisdiction of the U. S. Department of Commerce National Oceanographic and Atmospheric Administration. Its function is to monitor the formation of hurricanes in the Atlantic, track their progress, and issue current weather information in the form of advisories, bulletins, updates, and forecasts to the effected areas and to the country at large. Incoming data, at the average rate of 4,000 pieces or "products" per 24 hour period, come from four major sources: (1) hurricane hunter aircraft, (2) weather satellites, (3) ships, (4) bouys, and (5) local land observations.

Hurricane hunter aircraft are most useful for meeting the hurricane out where it is forming, over water. The aircraft can send back many kinds of data as they fly directly into the eye of the storm and take some very sophisticated

measurements. Like all aircraft, what goes up must eventually come down. The plane can't stay indefinitely, so its observation time is limited.

Weather satellites, specifically the GEOS series, are set in geo-synchronous orbit, 23,400 miles above Earth, so that they are stationary with respect to the Earth's rotation. While these satellites have the capability of photographing a hurricane from that position on a constant basis, it is literally an "overview" and tells little about what is happening on the ground. Last hurricane season the East Coast GEOS satellite malfunctioned. NOAA must now time share one satellite between the East Coast and the West Coast of the United States.

Ships' observations are collected in Washington and are transmitted via land-line to the NHC. While it is a source of good, first hand observational data, their positioning and presence is purely random, and there is no way of knowing when or whether any ships at all will be present in a given weather area.

Buoys located in the Gulf of Mexico and along the Atlantic Coast send back weather data through satellite. Their data is exacting, but is strictly coastal. No buoys are located in international or foreign waters of the Caribbean.

Local observations are still a most important tool for forecasting movement of the storm. Local weather bureaus abound throughout the country and the Caribbean, but are far fewer in number than amateur radio stations. With minimal packet radio equipment, amateur stations can send vital weather data back to the Hurricane Center for processing.

### Amateur Radio at the NHC

For the past six years, amateur radio has played an important part in the gathering of real-time weather data for the Hurricane Center. I emphasize gathering rather than dissemination because the original and primary reason for an amateur station at the Center was to bring data into the center, rather than release information from the Center. Most are familiar with NOAA Weather Radio, broadcasting from locations throughout the country on the VHF frequencies of 162.40, 162.475, and 162.550 MHz. Fewer are familiar with the national AFOS Network. AFOS is an acronym for Automated Field Operations Services, and consists of a nationwide network of meteorological offices, connected to one another by a telco network of data lines and microwave relay stations.

While the AFOS system provides a high speed, 4800 baud link among the nation's weather facili-

ties in good weather, the system quickly degrades in severe weather, with flooded phone lines and micro-wave path loss resulting in the effected area being out of touch when they need the system most.

The Caribbean Islands are less equipped to keep in meteorological touch with the U.S., and information paths degrade even more frequently and easily than in areas of the United States proper.

It is for these reasons that the NHC has a permanent amateur radio station, donated by the Dade County Amateur Radio Public Service Corps (ARPSC). The station is manned on a 24 hour basis when the Center requests information from an effected area.

#### Operating Procedure

Amateur operators at NHC usually monitor the Hurricane Watch Net on 14.325 MHz., and two meter simplex frequency. Amateur operators in the community fan out across 40 and 80 meters, checking into emergency nets operating from the effected area such as the Gulf Coast Hurricane Emergency Net.

As many as 125 stations distributed from Mexico to the Florida Panhandle may check in during a given hurricane in the Gulf. These stations are asked to supply the Miami station with meteorological data such as rainfall amount, wind direction, and wind speed. These data, once received by the Miami station, are relayed to the NHC on the two meter simplex frequency.

The weather data is given to the forecasters who feed it into their main computer, which contains data from all previous hurricanes, as well as incoming data from the other aforementioned sources.

The computer develops a predictive behavioral model of the hurricane from the data, and produces a forecast of the future path of the storm. The forecast is sent out over the AFOS network, NOAA Weather Radio, and also 20 meters, by the amateur operator on duty.

For many Caribbean Islands, the amateur bulletin is the only forecast information they will ever receive.

In 1979, during Hurricane David, Dominica lost its entire weather station at the national airport. It blew away just five minutes after the amateur operator there announced that he was evacuating.

In 1980, during Hurricane Allen, St. Lucia was totally devastated, and the Prime Minister directed the entire relief effort from the only amateur radio station on the island.

#### The Role of Packet Radio

Packet radio has the potential to make both gathering and dissemination of timely weather information to and from the Hurricane Center infinitely more efficient, for a number of reasons.

As Bob Neben, K9BL (Rinaldo 1984: 79-82) pointed out in his paper on Packet Radio and Emergency Communications, the great advantage a packet network has over a directed phone net or C.W. net is that it can take a "bus" configuration.

This means that any station can transmit or

receive on the same channel at any time, without the necessity of a net control station and without interrupting the communications of other stations on that same channel. Packet radio will allow incoming weather information from amateur stations in an effected area to be transmitted on one frequency, essentially at the same time, with minimal interference.

#### Speed

While previous data had to be gathered laboriously on 40 and 80 meter phone through tortuous static crashes and QRM, packet promises to drastically speed up the flow of information.

Currently, the standard rate of transmission used on two meter packet frequencies is 1200 baud, or the equivalent of 1200 words per minute! This rate is nowhere as fast as current equipment allows though the FCC requires a maximum bandwidth on two meters of 20 KHz.

Still, 1200 words per minute is roughly nine times faster than normal conversational speech, and probably 18-20 times faster than passing phone traffic at writing speed; especially traffic that contains numerical statistics, passed on 80 meters, at night, through bad weather cells.

#### Accuracy

Since packet radio has built into it the ability to detect errors in reception, it is possible to send and receive perfect copy, an absolute must with weather data.

#### Man-Hour Efficiency

Since the Hurricane is manned on a 24 hour basis making manpower a premium commodity, the weather data would be much more accessible to the forecasters if received automatically. The packet station at the Hurricane Center will include a printer, allowing forecasters to access incoming data without having to disturb the amateur operator, who may be busy on a phone frequency.

If a hurricane is headed toward the South Florida area, amateur communicators are at a premium, manning shelters, municipal facilities, and other volunteer agencies. The key word here is automation.

#### Incoming Weather Data

Plans are currently in process to gather weather data by automated means, digitizing it, buffering it, and transmitting it back to the Hurricane Center. The Heathkit ID-4001 Digital Weather Center will be used in these tests, since it contains computer interface capabilities through a built-in 25 bit bus.

Data can be transmitted back on a regular basis, or upon the NHC packet station connecting to the remote weather stations on a rotational basis, and querrying them individually.

It is foreseeable that the AFOS weather network could eventually be augmented by amateur stations throughout the country, tying into it at various nodes, and adding support to other major weather offices, beside NHC.

#### Outgoing Weather Forecasts

From preliminary discussions with the tech-

nical personnel at the Hurricane Center, tests will be conducted in the near future interfacing the NHC AFOS terminal to packet radio.

The AFOS data is transmitted to a number of subscribers at a large variety of baud rates, taking into account the various types and vintages of terminals in use at the other end. Approximately 500 transmissions of weather products are made from the Center each day, to civilian, marine, and military end users.

A microprocessor will have to be able to recognize a given weather bulletin heading, in order to select out the advisories pertinent to the effected area, and destined for civilian consumption. Examples of actual weather data texts and their headings are given below in the addendum

Once these bulletins are culled from the mass, they can then be transmitted over packet radio to the amateur population at large who can then disseminate it to the appropriate authorities.

It is anticipated that these bulletins would be sent out on both HF and VHF bands, to insure that it gets to the effected areas which may be out of VHF range.

Work is currently under way to install Gator I, 9600 baud level three intercity packet link throughout Florida. High speed links of this type will facilitate the routing of weather packets.

The enclosed map indicates four major packet paths of primary concern to the Hurricane Center. These are the Atlantic Coast, the Gulf Coast, the Florida Keys, and the Caribbean. If one of these had to be singled out as being most critical it would be the Caribbean, where adequate weather communications are almost nonexistent.

The amateur radio antennas at the Hurricane Center are about 150 feet high, and offer excellent simplex two meter communications to the surrounding areas. It is anticipated that a good HF link will be needed to both the western end of the Gulf Coast, and the Caribbean, with gateway stations in those locations able to translate HF packet to VHF, and vice-versa.

#### Practical, Non-technical Considerations

The NHC is a federal agency. As such, its communications are regulated not by the FCC but by the IRAC, the Interdepartmental Radio Advisory Committee. IRAC is composed of representatives from all the federal agencies, including the military and the FCC, and would have to give its consent to the transmission of AFOS information on the Amateur Radio Service. Paragraph 97.113 of the FCC regulations prohibits the rebroadcasting of information on amateur radio frequencies, though the FCC has granted a limited number of Special Temporary Authority (STA) authorizations for the transmission of NOAA weather bulletins over two meters.

An STA application may be filed previous to conducting these tests.

It remains a grey area within the FCC amateur regulations with respect to the status of packet digipeaters as remote stations, as repeaters, or even as beacon stations. The FCC should clarify their status in the near future in response to petitions now before it.

In any case, the operation of these stations will usually occur in an emergency situation

In any case, the operation of these stations will usually occur in an emergency situation, when there exists "... the immediate safety of life... or the immediate protection of property." Under these circumstances, the operation of a packet weather network is very feasible.

#### Future Technical Considerations

Much remains to be done form a technical standpoint. While digipeaters are springing up nicely throughout South Florida, not all of them are capable of running on emergency backup power, emergency power is essential to insure reliability of pathways.

Packet stations are beginning to infiltrate the Florida Keys, a crucial communications area in times of severe weather. But as of yet we do not have an established path to Key West, the southern most key as well as the most densely populated one.

Experimentation with packet on HF SSB frequencies is proceeding along, but few stations are active on HF packet, crucial to the packet weather net.

Software command parameters have to be established on the Tucson Amateur Packet Radio Terminal Node Controller (TNC), the predominant unit used in the South Florida area, to optimize the flow of data in both directions, as well as to configure the network. And last but not least, amateur stations have to be recruited to actively participate in the collection of weather data, and its transmission to the Hurricane Center.

Packet must be introduced into the Caribbean, and gateway stations established with reliable emergency power capability.

#### Summary

We have looked at a unique application for amateur packet radio, that of supplying crucial weather information to the National Hurricane Center from severe weather areas, and reciprocally, supplying effected areas with critical forecast bulletins when traditional sources of weather information fail.

Although not every community has a Hurricane Center in the neighborhood, a comparable weather network can provide backup information to any weather bureau office, in fact all along the AFOS circuit. The sheer numbers of amateur stations potentially equipped to do so is enormous as compared with traditional sources of weather data.

Packet radio allows for this information to be transmitted error free, with little or no loss of information over multiple, simultaneous paths, and with a high degree of speed and automation.

This type of "high-tech" amateur radio participation can only strengthen our image in the community and insure the continuity of our hobby.

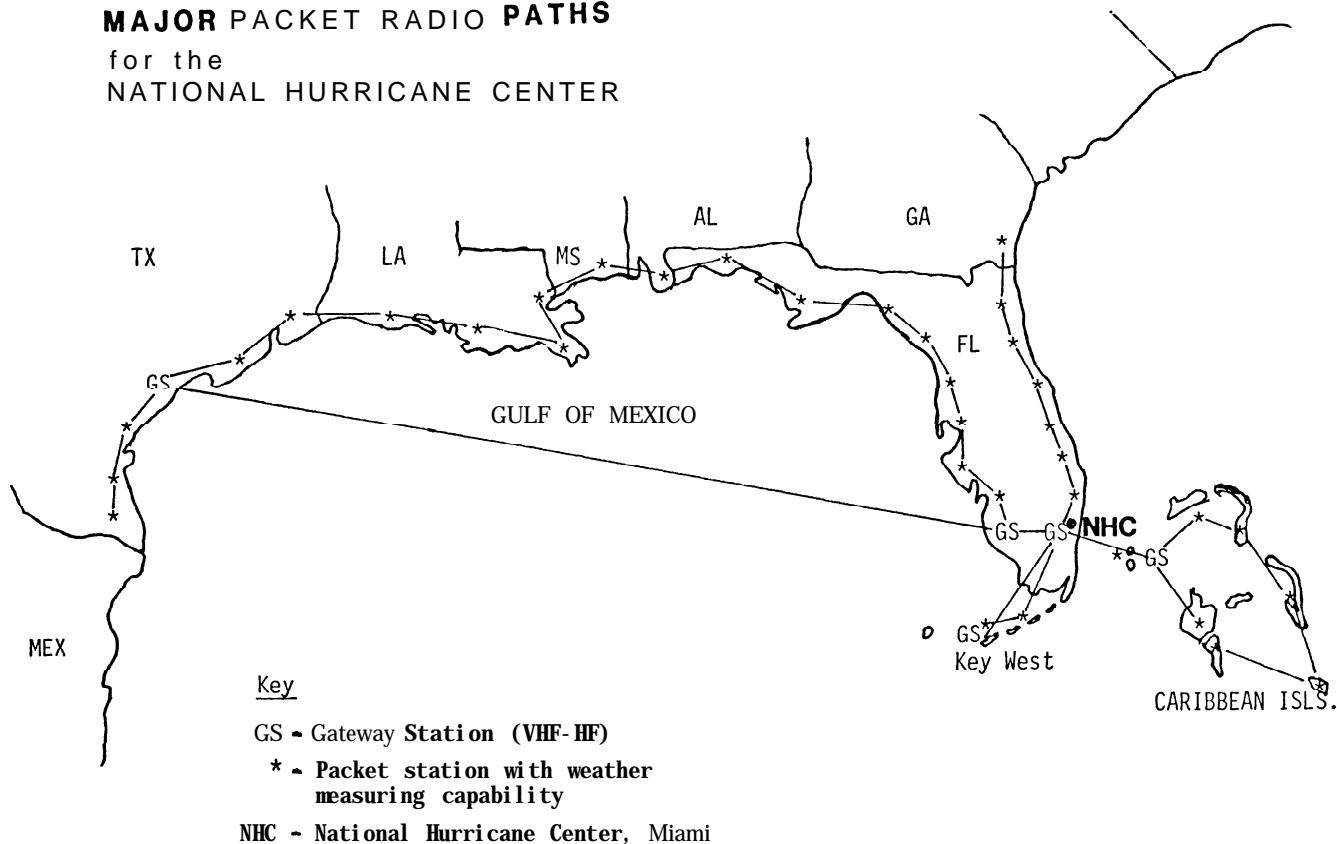
#### Acknowledgement

I wish to thank Dr. Neil Frank, Director, NHC, and William Pettyplace, NHC computer technician, for their cooperation and assistance; and KF4MI for typing this paper.

#### Reference

1984 Rinaldo, Paul L., Editor. Third ARRL Amateur Radio Networking Conference. Proceedings. Trenton.

**"WETNET"**  
**MAJOR PACKET RADIO PATHS**  
for the  
**NATIONAL HURRICANE CENTER**



**Addendum - Sample Weather Texts and Formats**

**Type 1: A Ship's Weather Report in Synoptic Code.**

ZCZC WBC656  
SMVD6 KWBC 080600 RTD  
BBXX  
VSBE9 08063 99236 70316 42308 60714 10242 20224  
40182 54000 84260 22233 00260 20101 3//// 4////

**Explanation:** Preamble contains addressee's call letters, ship's call letters, shore station's call letters, time and date of message transmission.

Five digit number groups indicate, by their position in the message sequence, date and time of reading, latitude, longitude, sky cover, wind direction, wind speed, temperature in plus or minus degrees to the tenth of a degree, dewpoint, barometric pressure, ship's directional heading and speed in knots, and wave height.

Note that the total weather report, including the heading, is approximately 128 characters long, TAPR TNC default packet length. Equivalent land-based weather observations can be sent from amateur weather stations in similar format.

**Type 2: Sample Airport Weather Report.**

SA 301300  
VRB SA 1251 60 SCT 280 - BKN7 213/51/45/1505/016  
TPA SA 1250 E50 BKN 250 OVC 10 207/55/47/1108/014

Note three letter abbreviations for indicating city (i.e., Vero Beach, Tampa), and abbreviations for cloud cover (i.e., Broken, Scattered, Overcast). Also included in information are day, time, cloud cover elevation, configuration, temperature, barometric pressure, dew point, wind (in degrees and knots), precipitous accumulation in inches, etc.

Each line is a complete weather report, and consists of only 49 characters including spaces.

**Type 3: Plain Text Reports for NOAA Distribution.**

RCV 30939 14:54 01/30/85

ZCZC MIACWFMIA  
WOUSOO KMIA 301500

MARINE FORECAST FOR FLORIDA AND GEORGIA COASTAL WATERS  
NATIONAL WEATHER SERVICE MIAMI FL  
1025 AM EST WED JAN 30 1985

SYNOPSIS  
HIGH PRESSURE RIDGE OFF THE GEORGIA AND FLORIDA ATLANTIC COAST WILL MOVE EASTWARD OVER THE NORTH PART AS THE SOUTH PART ROTATES THROUGH THE LOWER FLORIDA STRAITS.....

NNNN

Note the four N's for standard teletype printer shutdown.