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# INITIAL DEPLOYMENT OF THE TERMINAL DOPPLER WEATHER RADAR SUPPLEMENTAL PRODUCT GENERATOR FOR NWS OPERATIONS

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## 1. INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) Systems Engineering Center (SEC) has been developing capabilities to ingest, process and integrate complimentary weather radar data and products into its warning and forecast operations. Several radars operated by the Federal Aviation Administration (FAA) were found to contain weather channels that could be exploited to complement the existing network of NWS Doppler radars, the Weather Surveillance Radar – 1988 Doppler (WSR-88D) (Stern, 2003).

Since Saffle (2001) and Istok (2005) described the many advantages of utilizing complementary radar data, significant progress has been made in creating and deploying a proof-of-concept and a fully integrated radar processing system. The FAA's Terminal Doppler Weather Radar (TDWR) was selected as the first system to be supported due to its optimization for hydro-meteorological surveillance. This paper will describe progress made in completing the first build of the Supplemental Product Generator (SPG), its initial deployment and plans for future builds and capabilities.

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## 2. SPG OVERVIEW

The design of the SPG is based on the proven technology of the NWS open systems Radar Product Generator (RPG) which was developed to ingest, process and execute scientific algorithms on data from the WSR-88D (Istok, 2003). The SPG has been customized to ingest the TDWR data stream and to create products that could be directly integrated and displayed on the Advanced Weather Interactive Processing System (AWIPS) within NWS Weather and Forecast Offices (WFOs) and national centers. Stern (2005) provided detailed descriptions and attributes of the SPG system design and data flow.

## 3. DEPLOYMENT PHASES

### *3.1 TDWR Web Server*

Initial development of the SPG involved creating a proof-of-concept system called the TDWR Web Server (Stern, 2004). The TDWR Web Server was built on a PC with a Linux operating system. The Web Server simply generates GIF images of TDWR base radar moments (reflectivity, unconditioned velocity and dealiased velocity). A Web interface was provided to allow forecasters to interrogate the data. Capabilities included:

- Image pan and zoom
- Radar elevation selection
- Pixel interrogation via mouse that provided azimuth, range and beam height
- Fixed and manually generated loops

- A one month archive and playback tool.

The objective of the Web Server was to get TDWR data into the hands of field forecasters and assess its value for the NWS forecast and warning program. Web Server systems were deployed to Sterling, VA, Las Vegas, NV, Phoenix, AZ, Salt Lake City, UT and Greer, SC. The success of the Web Server and the value of the data provided the impetus to develop the SPG.

### *3.2 SPG Build 1*

SPG Build 1 was designed to take advantage of many of the infrastructure capabilities that are inherent within the RPG. Some of these capabilities include using the same linear buffers that the RPG uses for data storage, algorithm queuing and product transmission.

The main difference between the SPG and the RPG can be found in its front end design. The base data communications manager had to be replaced to accept the TDWR data stream (which consists of a UDP broadcast). Also, a special component called the pre-processor module (PPM) had to be created and placed between the communications manager and the system's base data processor. The PPM acts as a data translator (to convert TDWR radials into the RPG base data format), handles radar data quality and TDWR system exceptions. The PPM also takes the place of the Radar Data Acquisition (RDA) component of the WSR-88D by providing TDWR status messages to the infrastructure when requested.

SPG Build 1 contains algorithms to generate only base data products. Specifically, the products include:

| **Product Type** | **Data Resolution** | **Range** |
|---|---|---|
| Long Range Reflectivity | 4-bit | 276 km |
| | 8-bit | 276 km |
| Short Range Reflectivity | 4 bit | 90 km |
| | 8-bit | 90 km |
| Base Velocity | 4-bit | 90 km |
| | 8-bit | 90 km |
| Base Spectrum Width | 4-bit | 90 km |

Range resolution of the long range reflectivity data is 600 m. Range resolution of the short range reflectivity data is 300 m. Range resolution of the Doppler moments (velocity and spectrum width) is 150 m. The beam width is 1 degree.

TDWRs have already proven to be a valuable tool as a complementary technology for the NWS warning program. Figure 1 shows a long range reflectivity image (276 km range) of Hurricane Katrina as the storm approached southeast Louisiana during the early morning hours of August 28, 2005.

Figure 2 shows a long range reflectivity image of Hurricane Rita skirting by southern Louisiana at 1235 UTC, September 23, 2005. Figure 3 captured Hurricane Wilma just 12 minutes prior to its official landfall time. The image, from the West Palm Beach TDWR was from 1018 UTC, October 24, 2005.

Figure 4 shows how NWS forecasters are able to mosaic TDWR scans. In this case, long range reflectivity data from the Orlando and West Palm Beach systems have been mosaicked on an AWIPS display.

### *3.3 SPG Build 2*

SPG Build 1 began deployment to field sites in August 2005. Developmental work immediately began on the second deployment build. Build 2 will provide TDWR reflectivity data at its highest resolution and with a longer range:

| **Product Type** | **Resolution** | **Range** |
|---|---|---|
| Long Range Reflectivity | 300 m | 416 km |
| Short Range Reflectivity | 150 m | 90 km |
| Base Velocity | 150 m | 90 km |
| Base Spectrum Width | 150 m | 90 km |

SPG Build 2 will also include several WSR-88D algorithms that have been translated and customized for use with TDWR data. In addition to the Build 1 base products, Build 2 will include:

- User Selectable Layer Composite Reflectivity (Maximum) (Figure 5)
- Velocity Azimuth Display (Figure 6)
- VAD Wind Profile (Figure 7)

Additional capabilities include the ability to use the WSR-88D velocity dealiasing algorithm with TDWR data. Product playback and one time request capability will also be enabled.

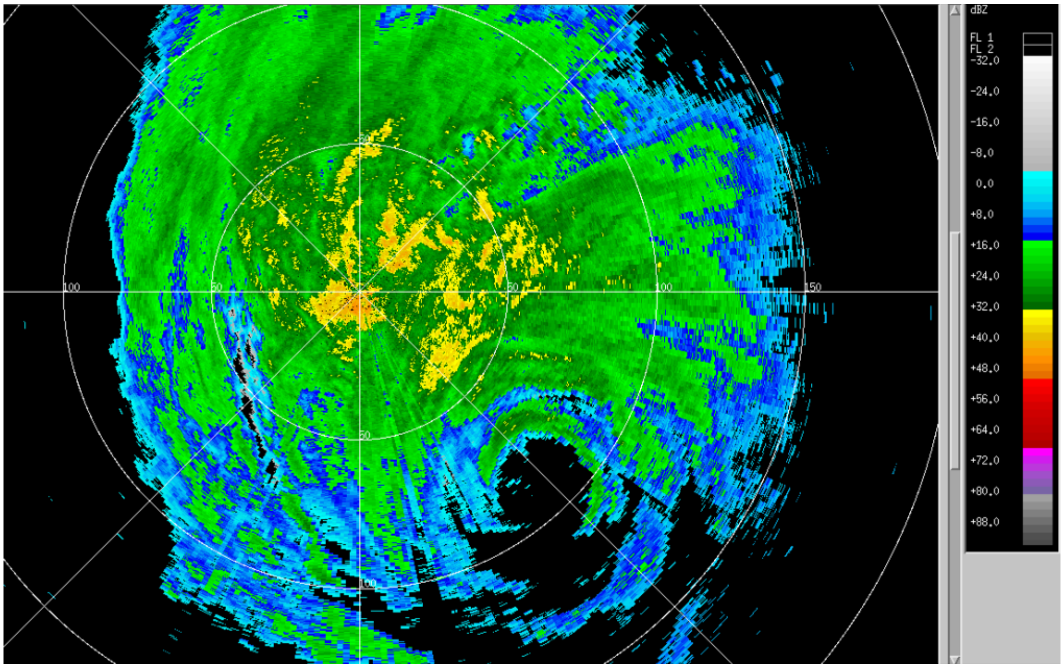


**Figure 1** Long range reflectivity image of Hurricane Katrina as captured by the New Orleans TDWR 0905 UTC, August 29, 2005.

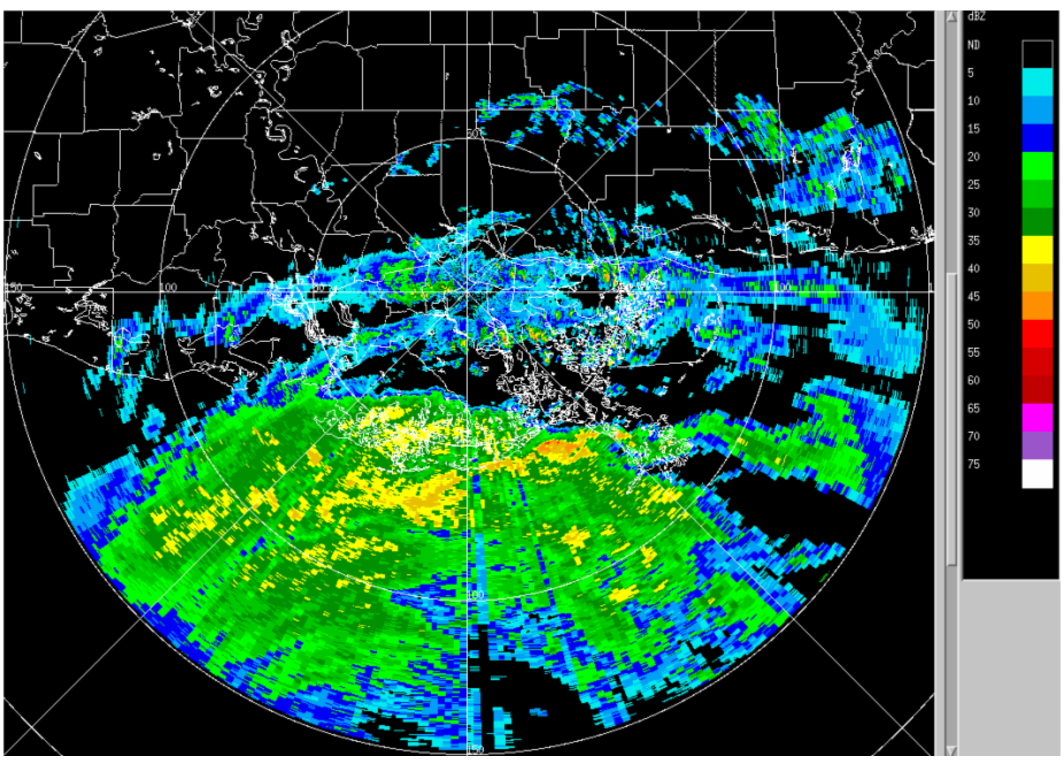


**Figure 2** Long range reflectivity image of Hurricane Rita as seen by the New Orleans TDWR 1235 UTC, September 23, 2005.

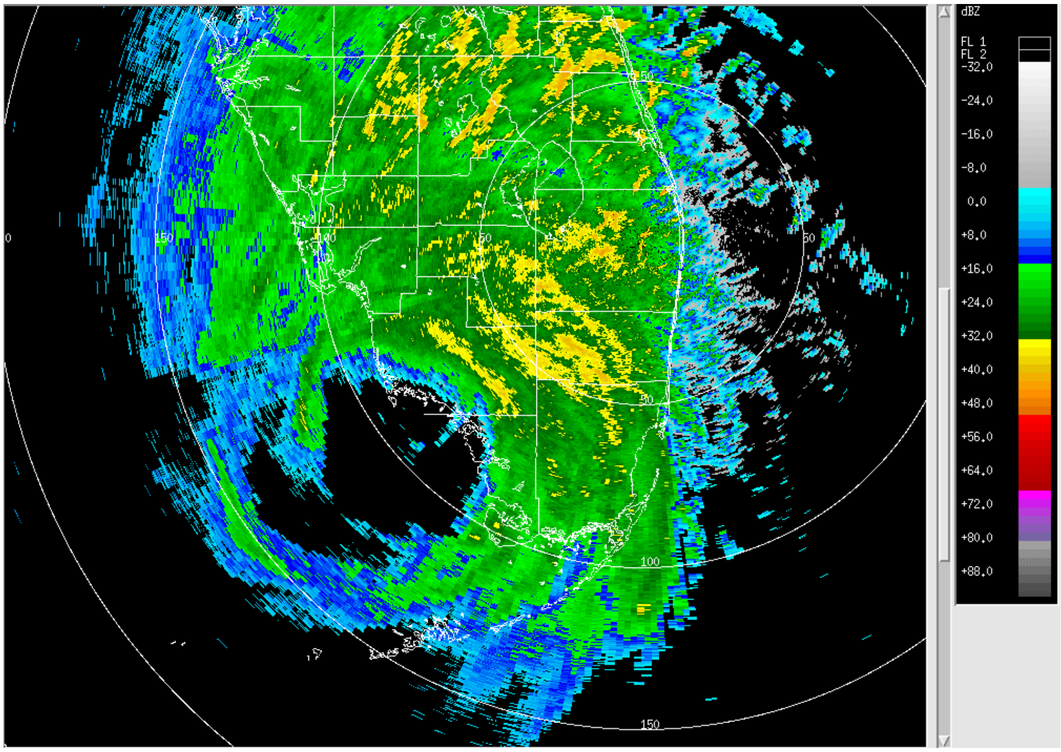


**Figure 3** Long range reflectivity image of Hurricane Wilma as seen by the West Palm Beach TDWR 12 minutes before official landfall in southwest Florida. Image time was 1018 UTC October 24, 2005.

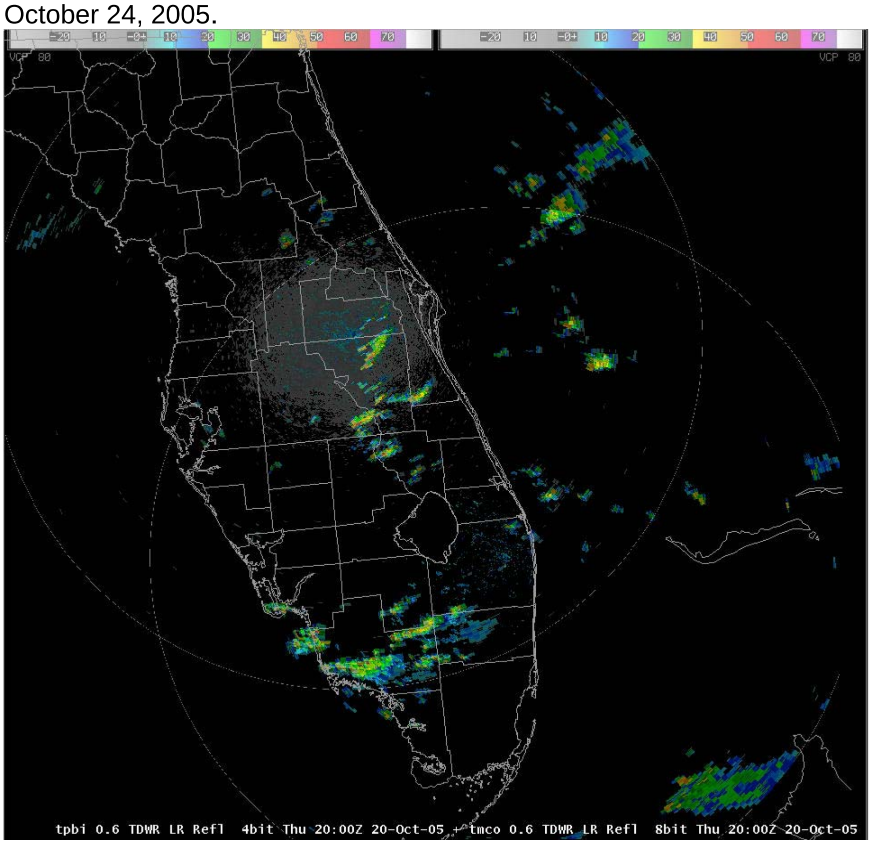


**Figure 4** A mosaic of TDWR data from the Orlando and West Palm Beach radars as compiled on a NWS AWIPS display.

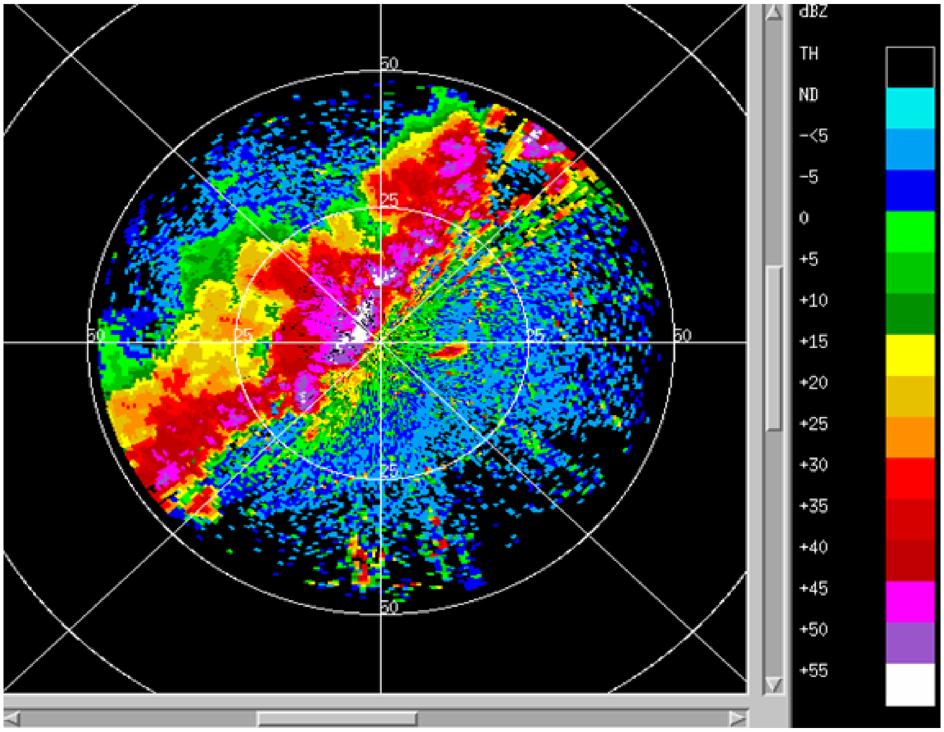


**Figure 5** User Selectable Layer Composite Reflectivity (Maximum) for the layer from 0-3000 feet from 2233 UTC, July 27, 2005

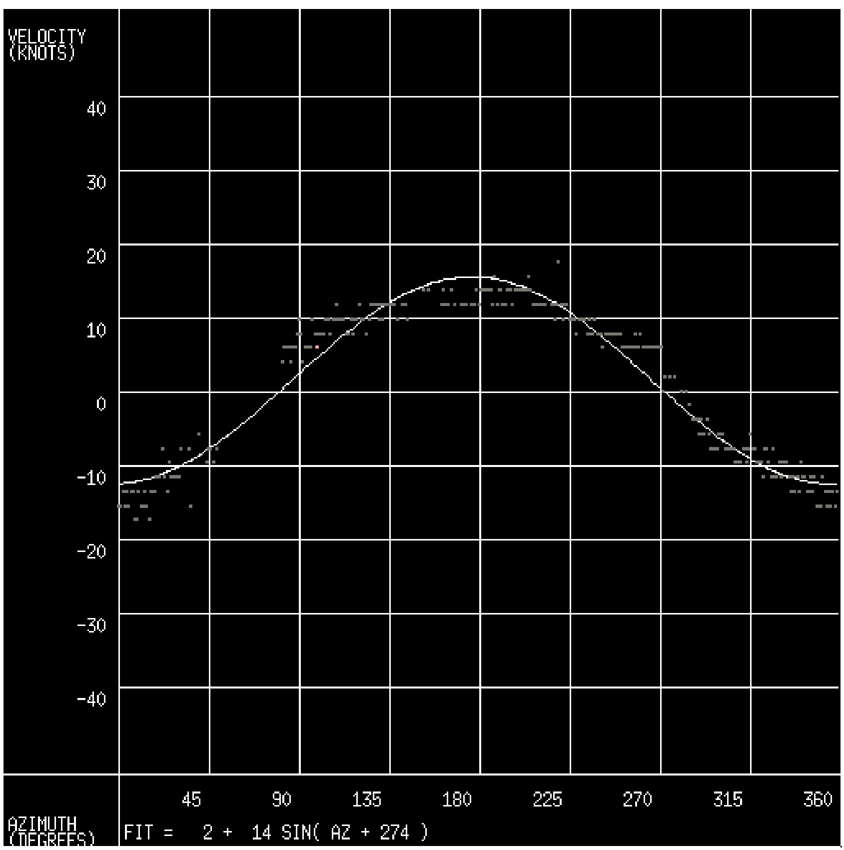


**Figure 6** Example of a Velocity Azimuth Display product for 3000 feet

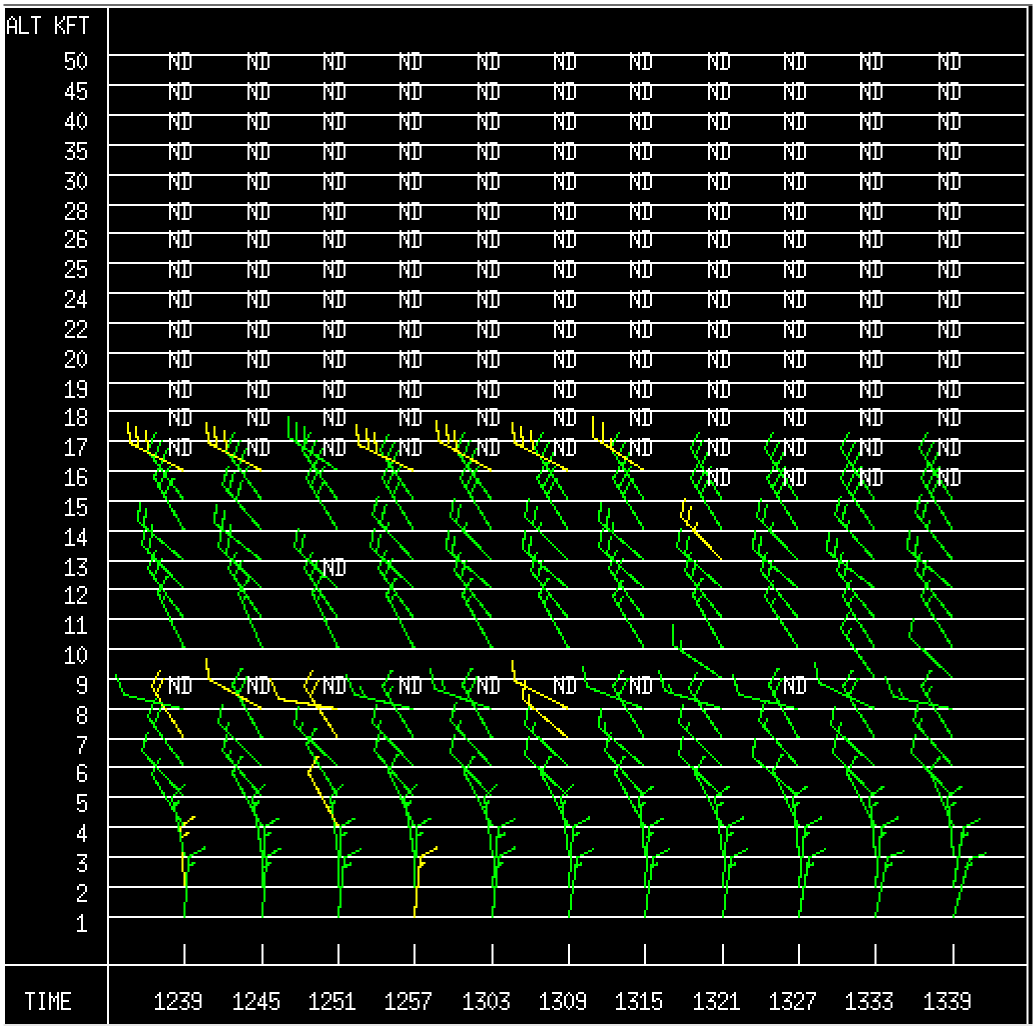

**Figure 7** Example of a VAD Wind Profile product

### *3.4 SPG Build 3*

Build 3 of the SPG is scheduled for development during 2006 with deployment in early 2007. This version will have all of the functionality of Build 2, but will also have more sophisticated severe weather and hydrologic algorithms translated from the WSR-88D RPG.

Anticipated new capabilities for SPG Build 3 include:

- Vertically Integrated Liquid (VIL)
- Mesocyclone Detection Algorithm (MDA)
- Tornado Vortex Signature (TVS)
- Storm Cell Identification and Tracking (SCIT)
- Precipitation Preprocessing System (PPS)

## 4. SPG DEPLOYMENT

There are 45 operational TDWR systems deployed across the country. Figure 8 shows both where the radars are located and their potential associations with NWS WFOs. If all TDWRs were integrated into WFO operations, then several offices would have access to multiple radars within their forecast area.

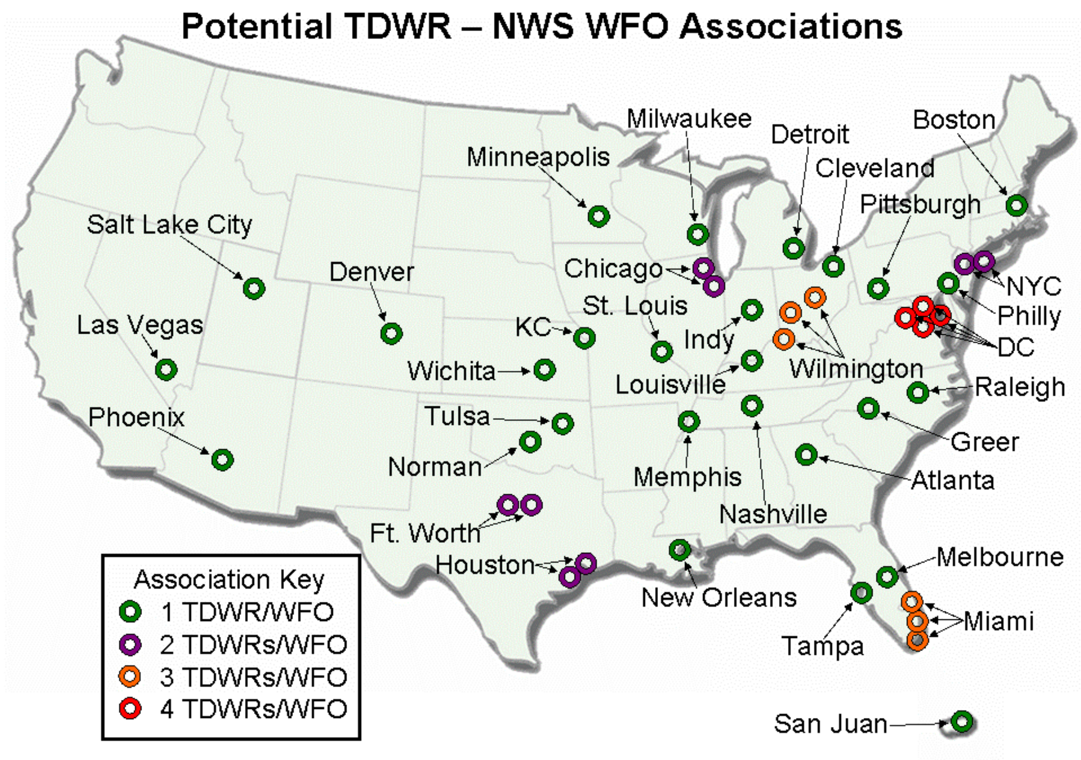


**Figure 8** TDWR locations and their associated NWS WFO

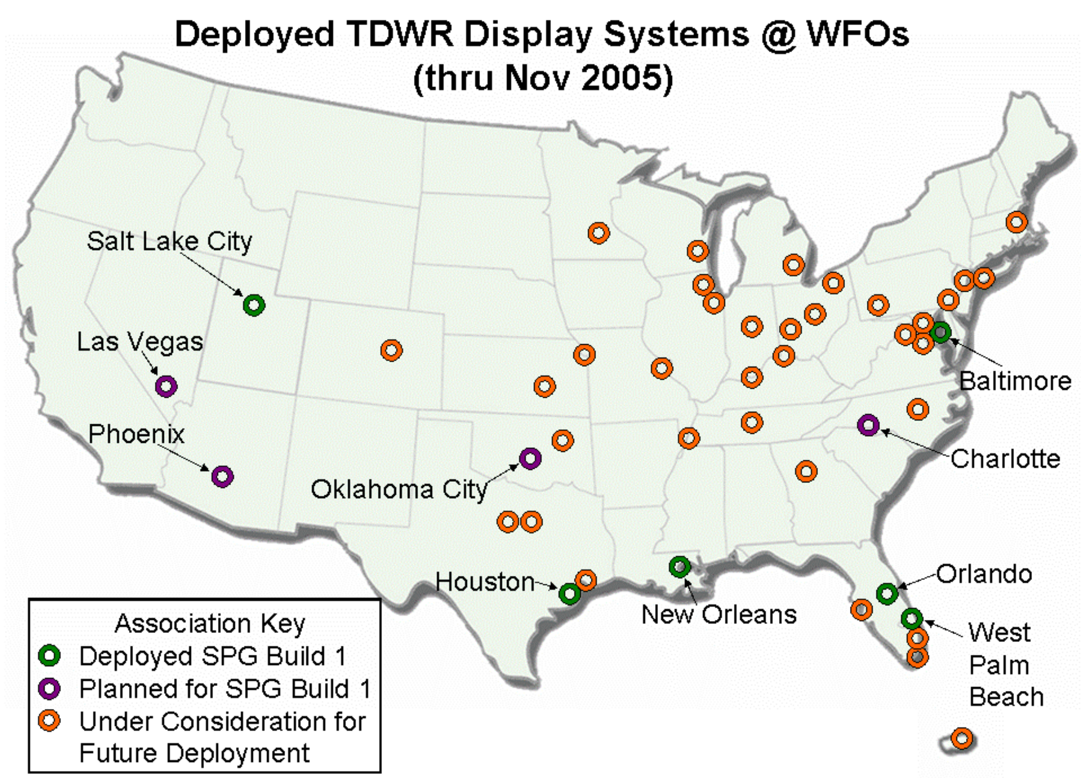


**Figure 9** Deployed TDWR SPG systems at NWS WFOs (through mid fall 2005)

At the time of this writing (mid fall 2005) deployment of SPG Build 1 systems was underway. The initial deployment thrust was focused along the southern Atlantic and Gulf coasts due to the frequency of land falling tropical systems (Figure 9). This included installation of Build 1 systems at WFO Melbourne (TDWR Orlando), WFO Miami (TDWR West Palm Beach), WFO Slidell (TDWR New Orleans), and WFO Houston/Galveston (TDWR Houston/Hobby).

Other sites with early Build 1 deployments included WFO Sterling (TDWR Baltimore) and WFO Salt Lake City (TDWR Salt Lake City). The remaining TDWR prototype Web Server locations (Las Vegas, Phoenix and Greer, SC) are expected to be upgraded to SPG systems by the end of 2005. The TDWR serving Oklahoma City will also likely get an upgrade due to its proximity to the NWS Radar Operations Center and the National Severe Storms Laboratory.

Full scale deployment to many of the remaining associated WFOs is scheduled to occur between April 2006 and September 2007, dependant on available budgets.

## 5. SUMMARY

The National Weather Service Systems Engineering Center has developed capabilities to ingest, process and integrate weather radar data from the Federal Aviation Administration's Terminal Doppler Weather Radar (TDWR) within a system called the Supplemental Product Generator (SPG). The SPG is based on the well proven infrastructure of the NWS Radar Product Generator (RPG).

The NWS began deployment of a proof-of-concept TDWR display system to a group of NWS Weather Forecast Offices during 2003 enabling forecasters to gain an understanding of the use of TDWR data. Since then, the NWS has developed and began deployment of Build 1 SPG systems to a number of NWS field offices.

Descriptions of the capabilities of the different builds of SPG were presented as well as providing an approximate schedule for system deployment.

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