PROTECTING PEOPLE AND ASSETS

Enhancing Weather Surveillance with EEC 3.5GHz Dual-Pol Weather Radar for Local Weather Service

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Introduction

Weather radar systems typically operate at one of three frequency bands: S-band, C-band, or X-band. In general, S-band weather radars have the longest surveillance range, the least Doppler velocity ambiguity, and the best performance in observing severe weather (hail, tornadoes, hurricanes, etc.). Therefore, the National Weather Service (NWS) has chosen the S-band frequency (2.7-3.0 GHz) for its nationwide Next-Generation Weather Radar (NEXRAD) network. A major disadvantage for S-band radars is the large antenna required to achieve a comparable (<1.0°) angular resolution with C-band/X-band radars. Given such a large antenna, the system complexity and cost, both up-front and life-cycle, are considerably higher than comparable C-band and X-band systems.

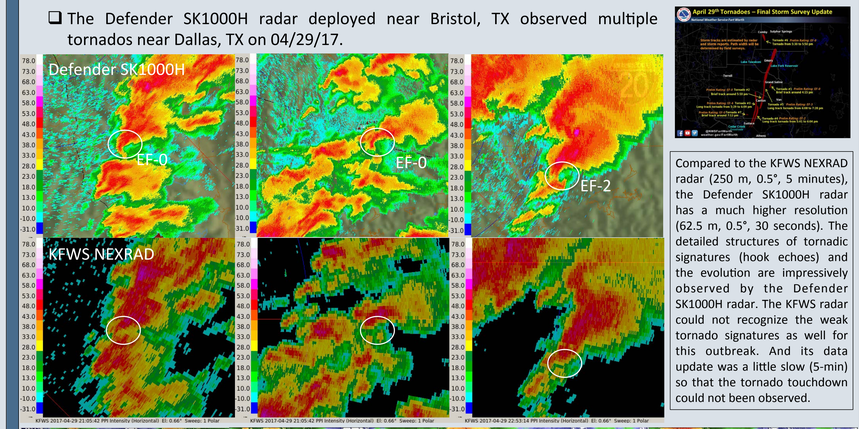
Recently, Enterprise Electronics Corporation (EEC) in Alabama, United States, developed a new type of "high-frequency" (3.5-3.6 GHz) S-band dual-pol weather radar—the Defender SK1000H series. Compared to NEXRAD systems, EEC's "high-frequency" systems apply a much smaller antenna (20-foot), while maintaining a similar beam width (0.95°) to that of more traditional S-band radars with a 28-foot dish. Therefore, its size, cost, and complexity are effectively reduced. In addition, due to the frequency increase (from 2.7-3.0GHz to 3.5-3.6GHz), the radar performance is improved for radar sensitivity, measurement accuracy, and clutter filtering. It is noted that the attenuation @3.5 GHz is only slightly increased and does not affect data quality.

EEC's "high-frequency" Defender SK1000H systems have been delivered to several TV stations across the US to provide local weather analysis. These systems are generally operated with a very high spatial-temporal resolution configuration (0.25° and 125 meters azimuth-range resolution, updating every 0.5-1 minute). Compared to NEXRAD data (0.5-1.0°, 250-1000 meters, updating roughly every 5 minutes), the high-resolution Defender SK1000H data presents surprisingly in-depth details of storm features and evolution. With EEC's advanced radar analysis software, EDGE, the local TV stations are capable of providing high quality weather services such as quantitative precipitation estimation, flash flood forecasts and warnings, and severe weather detection, nowcasting, and alerting. The current study presents several cases of high-quality weather surveillance taken from operational EEC Defender SK1000H "high-frequency" S-band radar systems, including several tornadoes and hailstorms in the southern plains of United States.

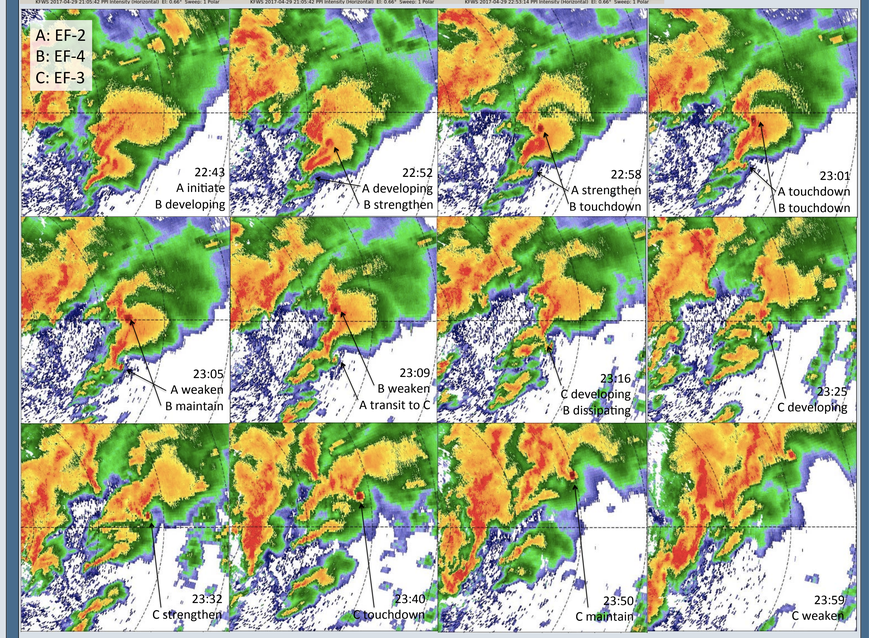
SYSTEM	DEFENDER SK1000H
Operating Frequency	3.5-3.6 GHz
Pulse Width	0.4-4.5 μs
Pulse Repetition Frequency	200Hz-2400Hz
Range Resolution	Minimum 16 m
Range	> 600 km (~250 km operational)
Antenna Size (Diameter)	20 feet
Antenna Gain	> 45 dBi
3-dB Beam Width	0.95°
Polarization	Linear Horizontal/Vertical
Transmitter Type	Klystron
Peak Power	1000 kW
Minimum Discernable Signal	-114 dBm
Linear Dynamic Range	up to 105 dB
Sensitivity	-20 dBZ @ 30km
Clutter Suppression	≥ 55 dB

High Resolution Observations of Tornado

- The Defender SK1000H radar deployed near Bristol, TX observed multiple tornadoes near Dallas, TX on 04/29/17.



Compared to the KFWS NEXRAD radar (250 m, 0.5°, 5 minutes), the Defender SK1000H radar has a much higher resolution (62.5 m, 0.5°, 30 seconds). The detailed structures of tornadic signatures (hook echoes) and the evolution are impressively observed by the Defender SK1000H radar. The KFWS radar could not recognize the weak tornado signatures as well for this outbreak. And its data update was a little slow (5-min) so that the tornado touchdown could not been observed.



Summary

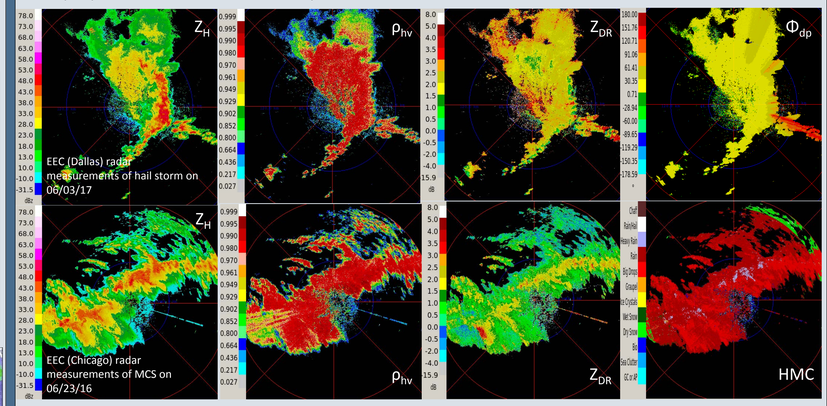
- EEC's Defender SK1000H system with the dual-pol capability is a powerful tool for weather surveillance
- Compared to NEXRAD, this unique S-band (3.5 GHz) system has advantages in reliability, maintainability, size, cost, complexity, radar sensitivity, etc.
- The high-resolution measurements of severe weather can substantially improve the weather service provided by local TV stations

Acknowledgment

The authors would like to thank all the meteorologists and engineers who have made the Defender systems well operational and provided the radar data for this presentation.

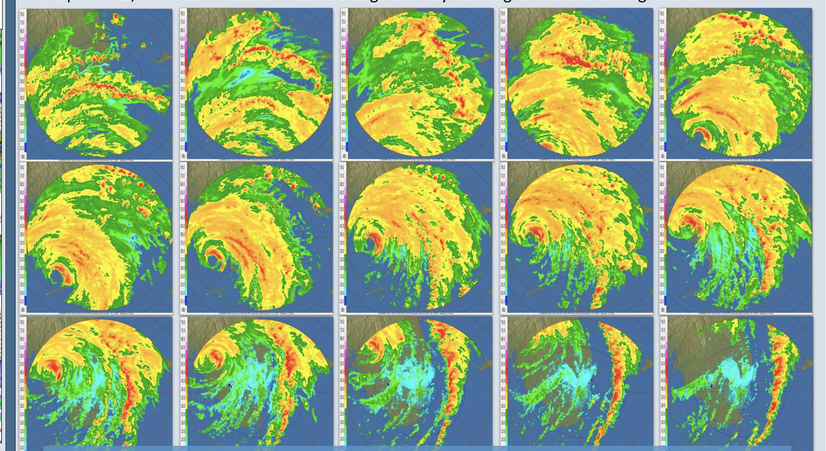
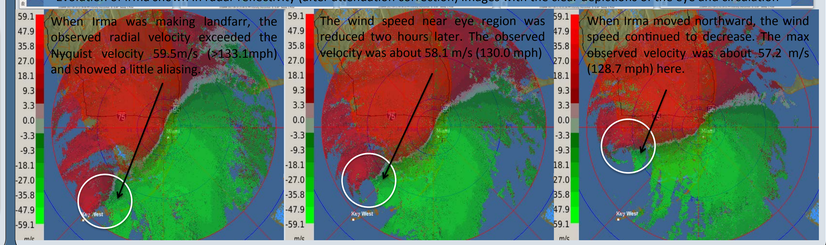
Useful Dual-Pol Observations of Defender

The Defender SK1000H systems operationally provide dual-pol radar measurements, which can improve the accuracy of attenuation correction, hydrometeor classification, and quantitative estimation of rainfall, snowfall, and hail. The dual-pol radar algorithms are realized in EEC's radar software, EDGE. The dual-pol products make Defender a helpful tool for users.



High Resolution Observation of Hurricane Irma

The Defender SK1000H radar deployed in Miami, FL measured Hurricane Irma with a high temporal-spatial resolution (~0.5 minute update interval, 62.5m~250m gate width, 0.86° azimuth interval). The evolution of Irma was well observed by Defender SK1000H radar with great details. Using radar QPE and wind products, the local TV station was able to give timely warning of weather during landfall.



Evolution of Irma shown in radar reflectivity (after attenuation correction) images with the clear depictions of the eye and circulation