Stony Brook University Mobile X-band Phased Array Radar (SKYLER II) Data During ESCAPE

Authors

(Lead) Pavlos Kollias
Stony Brook University, Stony Brook, New York, USA
Brookhaven National Laboratory, Upton, New York, USA
(pavlos.kollias@stonybrook.edu)

Bernat Puigdom,nech Treserras
McGill University, Montreal, Quebec, Canada
(bernat.puigdomenech-treserras@mcgill.ca)

Edward P. Luke
Brookhaven National Laboratory, Upton, New York, USA
(eluke@bnl.gov)

Mariko Oue
Stony Brook University, Stony Brook, New York, USA
(mariko.oue@stonybrook.edu)

Corresponding author:
Pavlos Kollias
School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, NY 11794-5000.
Phone: 631-632-8691
Email: pavlos.kollias@stonybrook.edu
http://radarscience.weebly.com
Professor, Stony Brook University
Scientist, Brookhaven National Laboratory

1. Data Set Description

1.1 Abstract

One of the challenges to analyze the convective cell properties is quick evolution of the individual convective cells. While the operational radar data provide great dataset to analyze of evolution of radar observables of convective precipitation clouds statistically, the previous studies also suggested the quick evolution of cell lifecycle that the conventional radar volume scan strategies taking ~5-7 minutes might not capture the detailed evolutions. During the Experiment of Sea Breeze Convection,
Aerosols, Precipitation and Environment (ESCAPE) field campaign in Houston (Jensen et al.,2022), the Stony Brook University Mobile Radar Truck installed an X-band dual polarization phased array radar named SKYLER II and was deployed closely coordinated with the University of Oklahoma mobile X-band radars (RaxPol and PX-1000). SKYLER II was operated for 13 deep convection days between May 31, 2022 to June 22, 2022. SKYLER II performed a rapid volume scan of a 90 degree azimuth sector approximately every 12 seconds for each deployment.

1.2 Data version and data

Version 1.0, published on March 16, 2023

1.3 Data Status

Preliminary

1.4 Time period covered by the data

May 31 to June 22, 2022.

1.5 Physical locations of the measurements

SKYLER II was installed on the SBU Mobile Radar Truck. The truck was deployed at the following sites during the ESCAPE field campaign.
* May 31, 2022
Wallisville, TX (29.830N, -94.750E, 3 m ASL), Southeast of Houston site
* June 1, 2022
Brazoria National Wildlife Refuge (29.125N, -95.245E, 2 m ASL), South site
* June 2, 2022
Damon, TX (29.336N, -95.688E, 14 m ASL), Southwest site
* June 3, 2022
Damon, TX (29.336N, -95.688E, 16 m ASL), Southwest site
* June 4 ? 5, 2022
Brazoria National Wildlife Refuge (29.124N, -95.250E, 1 m ASL), South site
* June 8, 2022
Wallisville, TX (29.833N, -94.750E, 2 m ASL), Southeast site
* June 9, 2022
Wallisville, TX (29.836N, -94.750E, 2 m ASL), Southeast site
* June 16, 2022
Deatonville, LA (30.064N, -93.267E, 0.5 m ASL), Louisiana site
* June 17, 2022
Deatonville, LA (30.064N, -93.267E, 0.5 m ASL), Louisiana site
* June 20, 2022
Damon, TX (29.336N, -95.719E, 15 m ASL), Southwest site
* June 21, 2022
Damon, TX (29.336N, -95.719E, 15 m ASL), Southwest site
* June 22, 2022
Cedar Lane, TX (28.938N, -95.724E, 6 m ASL), South site

1.6 Data frequency

Data were collected every less than 1 minute, generally, every 30 sec.

1.7 Web address references

Please see our web site for quick description of SKYLER II available at http://radarscience.weebly.com/skyler.html

1.8 Dataset restrictions

The data set should be restricted by password. The data set should be available for the ESCAPE PIs for one year after the ESCAPE field campaign completed and be available for beyond PIs after one year.

2. Instrument Description

The Radar Science group at Stony Brook University in collaboration with Raytheon Technologies has been experimenting with the use of X-band phased array radars (SKYLER radars) for weather research. During the summer of 2021, Raytheon Technologies provided a second-generation system, SKYLER-II, which uses a 2D phased array, a single channel transmit/receive module, and a dual polarization antenna operating in alternating transmit, alternating receive mode (ATAR). The software defined transceiver uses long duty cycle pulses and pulse compression to increase sensitivity and can employ phase coding to suppress multi trip echoes. The weather data processor (WDP) utilizes spectrum-based methods for noise estimation and clutter filtering and provides the following polarimetric moments: reflectivity, differential reflectivity, radial velocity, spectrum width, specific differential phase and co-polar correlation coefficient, as well as several quality control parameters (http://radarscience.weebly.com/skyler.html).

Table 1. Technical characteristics of SKYLER II (Kollias et al. 2022).

Parameter	Range
Operational frequency band	9.0-9.6 GHz
Tx power	< 250 W
Antenna size	~1 m x 1 m
Antenna beamwidth	~2deg x ~2deg
Maximum duty cycle	25%
Pulse repetition frequency	Selectable, typically 1.2 - 4.0 kHz
Pulse width	Selectable, typically 1 - 55 us
Wave pulse modulation	CW, LFM, NLFM
Tx/Rx polarization modes	HH, HV, VV, VH
Angular coverage	+-45 degrees in azimuth, by +-15 degrees in elevation
Instrumented range	40 km

3. Data Collection and Processing

SKYLER II performed rapid scans of a volume of approximately 90 degree (70 to 90 degrees) azimuth sector covering elevation angles from 0 to 30 degrees by Plan Position Indicator (PPI) at a few elevation angles every 12 - 30 seconds for each deployment. Each volumetric scan was generally composed of PPI with 1 - 10 degree azimuth spacings covering elevation angles from 0 to 30 degrees with 1 degree increment preceded by 90-degree azimuth sector PPI scans with ~0.5 degree azimuth spacing at a few elevation angles (e.g., 3 and 15 degrees).

The collected data for each cycle were bungled in 1) a volume data file which includes volumetric scan data generally composed of PPI with 1 - 10 degree azimuth spacing covering elevation angles from 0 to 30 degrees with 1-degree increment, 2) PPI files each of which includes data from a 90-degree azimuth sector PPI scan with ~0.5-degree azimuth spacing, and 3) Range Height Indicator (RHI) files each of which includes data resampled from the volume data and reformatted as RHI at a single azimuth angle.

The radar variables included in the data files are listed in Table 2.

Table 2: Radar variables included in the data files.

Variable	Unit	Description
reflectivity	dBZ	Reflectivity
corrected_reflectivity	dBZ	Reflectivity corrected for attenuation using specific differential phase
differential_reflectivity	dB	Differential reflectivity
corrected_differential_reflectivity	dB	Differential reflectivity corrected for attenuation using specific differential phase
cross_pol_correlation	-	Correlation coefficient between H and V returns
differential_phase	degrees	Differential phase
specific_differential_phase	degrees/km	Specific differential phase
signal_to_noise_ratio	dB	Signal to noise ratio for H
normalized_coherent_power	-	Normalized coherent power
measured_differential_phase	degrees	Measured differential phase
unfolded_differential_phase	degrees	Differential phase corrected for folding
velocity	m/s	Doppler velocity
ahv_velocity	m/s	Doppler velocity H & V alternative reception
spectral_width	m/s	Doppler spectrum width

4. Data Format

The data files are NetCDF 4.0. The file name convention follows:

skyler2_hou_[scan type]_[yyyymmdd]_[hhnnss]_[microsec].nc where [scan type] can be “vol” for volumetric data, “ppi” for PPI data, and “rhi” for RHI data, and [yyyymmdd], [hhnnss], and [microsec] are date, time (hh:nn:ss), and micro seconds in UTC for the scan start time.

The data are stored in a radar-coordinate having dimensions of gates and radial and/or elevation (gates and radial for ppi, gates and elevation for rhi, and gates, radial, and elevation for vol). The data files are stored in subdirectories separated by date.

5. References

Jensen, M.P., Flynn, J.H., Judd, L.M., Kollias, P., Kuang, C., Mcfarquhar, G., Nadkarni, R., Powers, H., and Sullivan, J.:A Succession of Cloud, Precipitation, Aerosol, and Air Quality Field Experiments in the Coastal Urban Environment, B. Am. Meteorol. Soc.,103,103?105,2022.

Kollias, P., Luke, E. P., Tuftedal, K., Dubois, M. and Knapp, E. J.: Agile Weather Observations using a Dual-Polarization X-band Phased Array Radar, 2022 IEEE Radar Conference (RadarConf22), New York City, NY, USA, 2022, pp. 1-6, doi: 10.1109/RadarConf2248738.2022.9764308.

6. Appendix

GCMD Science Keywords:
Convective cloud systems (observed)
Precipitating convective cloud systems
Deep convective cloud systems
Atmospheric wind
Cloud dynamics