Data User Guide

SBU X-band Phased Array Radar (SKYLER) IMPACTS

Introduction

The SBU X-band Phased Array Radar (SKYLER) IMPACTS dataset consists of polarimetric radar data collected by the Stony Brook University (SBU) X-band Phased Array Radar (SKYLER) during the Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS) field campaign. IMPACTS was a three-year sequence of winter season deployments conducted to study snowstorms over the U.S. Atlantic Coast (2020-2023). The campaign aimed to (1) Provide observations critical to understanding the mechanisms of snowband formation, organization, and evolution; (2) Examine how the microphysical characteristics and likely growth mechanisms of snow particles vary across snowbands; and (3) Improve snowfall remote sensing interpretation and modeling to significantly advance prediction capabilities. SKYLER provided detailed observations of cloud and precipitation microphysics, specifically ice and snow processes. These data include reflectivity, mean velocity, spectrum width, linear depolarization ratio, differential reflectivity, differential phase, specific differential phase, co-polarized correlation coefficient, and signal-to-noise ratio. The dataset files are available from January 17, 2022, through February 28, 2023, in netCDF-4 format.

Citation

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Keywords:

GHRC, NASA, IMPACTS, SBU, SKYLER, X-band, phased array radar, reflectivity, differential reflectivity, radial velocity, spectrum width, specific differential phase, co-polar correlation coefficient

Campaign

The Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS), funded by NASA's Earth Venture program, is the first comprehensive study of East Coast snowstorms in 30 years. IMPACTS will fly a complementary suite of remote sensing and in-situ instruments for three 6-week deployments (2020-2023) on NASA's ER-2 high-altitude aircraft and P-3 cloud-sampling aircraft. The first deployment began on January 17, 2020, and ended on March 1, 2020. IMPACTS samples U.S. East Coast winter storms using advanced radar, LiDAR, and microwave radiometer remote sensing instruments on the ER-2 and state-of-the-art microphysics probes and dropsonde capabilities on the P-3, augmented by ground-based radar and rawinsonde data, multiple NASA and NOAA satellites (including GPM, GOES-16, and other polar-orbiting satellite systems), and computer simulations. IMPACTS addressed three specific objectives: (1) Provide observations critical to understanding the mechanisms of snowband formation, organization, and evolution; (2) Examine how the microphysical characteristics and likely growth mechanisms of snow particles vary across snowbands; and (3) Improve snowfall remote sensing interpretation and modeling to significantly advance prediction capabilities. More information is available from NASA's Earth Science Project Office's IMPACTS field campaign webpage.

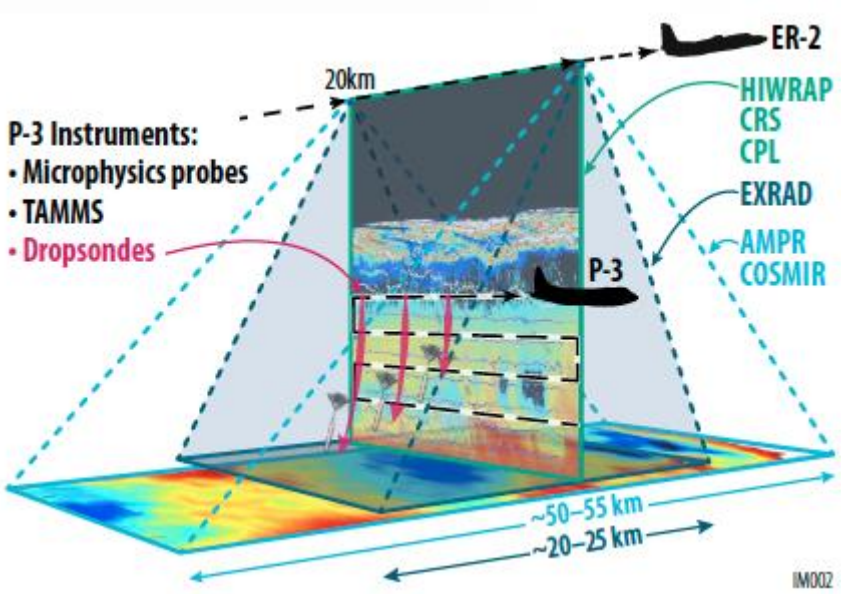

Figure 1: IMPACTS airborne instrument suite
(Image source: NASA IMPACTS ESPO)

Instrument Description

The Stony Brook University (SBU) X-band Phased Array Radar (SKYLER) is a polarimetric Doppler radar stationed within the SBU Radar Observatory on the university's campus (Figure 2) and operated by the SBU School of Marine and Atmospheric Sciences (SoMAS). The Radar Science group at Stony Brook University in collaboration with Raytheon Technologies has been experimenting with the use of SKYLER radars for weather research. In 2019, a SKYLER-I system was integrated into a mobile platform for weather observations (Fig. 1a). The SKYLER-I radar has an antenna beamwidth of 1.98° in azimuth and 2.1° in elevation at boresight. The beam is electronically scanned in the horizontal plane by +/- 45° and in the vertical plane +/- 15° relative to the boresight. The radar transmits H- and V-polarization pulses (alternating) and provides estimates of dual-polarization measurements in addition to the standard power and Doppler measurements. 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. More information about SBU SKYLER is available on the SBU Radar Science SKYLER webpage.

Figure 2: (a) SKYLER-I and (b) SKYLER-II on the SBU weather mobile platform.
(Image source: Radar Science SKYLER webpage)

Investigators

Pavlos Kollias
Stony Brook University, SoMAS
Stony Brook, NY

Mariko Oue
Stony Brook University, SoMAS
Stony Brook, NY

Data Characteristics

The SBU X-band Phased Array Radar (SKYLER) IMPACTS dataset consists of polarimetric radar data collected during the IMPACTS field campaign. The dataset contains various polarimetric radar parameters stored in netCDF-4 format. These data are available at a Level 1A processing level. More information about the NASA data processing levels is available on the EOSDIS Data Processing Levels webpage. The characteristics of this dataset are listed in Table 2 below.

Table 1: Data Characteristics

Characteristic	Description
Platform	Ground-based, mobile radar
Instrument	X-band Phased Array Radar (SKYLER)
Spatial Coverage	N: 43.695, S: 40.150, E: -71.266, W: -77.487 (Northeast U.S.)
Spatial Resolution	5 - 10 m
Temporal Coverage	January 17, 2022 - February 28, 2023
Temporal Resolution	minute -< hour
Sampling Frequency	30 seconds - minutes
Parameter	reflectivity, differential reflectivity, radial velocity, spectrum width, specific differential phase, co-polar correlation coefficient
Version	1
Processing Level	1A

File Naming Convention

The SBU X-band Phased Array Radar (SKYLER) IMPACTS dataset files are organized by platform and then by radar scan type: PPI and RHI. The files are available in netCDF-4 format and named using the following convention:

PPI Data files:
IMPACTS_SBU_skyler1_YYYYMMDD_hhmmss_ppi.nc
IMPACTS_SBU_skyler2_YYYYMMDD_hhmmss_ppi_[]deg.nc

RHI Data files:
IMPACTS_SBU_skyler1_YYYYMMDD_hhmmss_rhi.nc
IMPACTS_SBU_skyler2_YYYYMMDD_hhmmss_rhi_[]deg.nc

Table 2: File naming convention variables

Variable	Description
skyler1	Ground-based
skyler2	Mobile radar
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
hh	Two-digit hour in UTC
mm	Two-digit minute in UTC
ss	Two-digit second in UTC
ppi	Plan position indicator scan
rhi	Range-height indicator scan
[]deg	SKYLER2 degree on mobile radar
.nc	netCDF-4 format

Data Format and Parameters

The SBU X-band Phased Array Radar (SKYLER) IMPACTS dataset files are stored in netCDF-4 format. The files are organized by ground-based radar and mobile radar and then based on the SKYLER scan type: PPI and RHI. The data fields included in each file type are listed in Tables 4 and 5 below.

Table 3: Ground-based Radar Data Fields

Field Name	Description	Unit
altitude	Altitude above sea level	m
altitude_agl	Altitude above ground level	m
azimuth	Azimuth angle from true north	deg
CorrectedReflectivity	Equivalent reflectivity factor at horizontal polarization	dBZ
elevation	Elevation angle from horizontal plane	deg
fixed_angle	Ray target fixed angle	deg
follow_mode	Follow mode for scan strategy	-
frequency	Transmission frequency	s^-1
instrument_type	Type of instrument	-
latitude	Latitude	deg N
longitude	Longitude	deg E
n_samples	Number of samples used to compute moments	-
nyquist_velocity	Unambiguous doppler velocity	m/s
platform_type	Platform type	-
primary_axis	Primary axis of rotation	-

prt	Pulse repetition time	s
prt_ratio	Pulse repetition frequency ratio	s
pulse_width	Transmitter pulse width	s
range	Range to measurement volume	m
ray_gate_spacing	Gate spacing for ray	m
ray_start_range	Start range for ray	m
RecievedPower	Received power at horizontal polarization	dBm
SignalToNoiseRatio	Signal to noise ratio at horizontal polarization	dB
sweep_end_ray_index	Index of last ray in sweep	-
sweep_mode	Scan made for sweep	-
sweep_number	Sweep index number 0 based	-
sweep_start_ray_index	Index of first ray in sweep	-
time	Time in seconds since volume start	s
time_coverage_end	Data volume end time utc	-
time_coverage_start	Data volume start time utc	-
unambiguous_range	Unambiguous range	m
Velocity	Radial velocity	m/s
volume_number	Data volume index number	-

Table 4: Mobile Radar Data Fields

Field Name	Description	Unit
altitude	Altitude above sea level	m
altitude_agl	Altitude above ground level	m
azimuth	Azimuth angle from true north	deg
DBMHC	Received power at horizontal polarization	dBm
elevation	Elevation angle from horizontal plane	deg
fixed_angle	Ray target fixed angle	deg
follow_mode	Follow mode for scan strategy	-
frequency	Transmission frequency	s^-1
instrument_type	Type of instrument	-
KDP	Specific differential phase	deg/km
latitude	Latitude	deg N
longitude	Longitude	deg E
n_samples	Number of samples used to compute moments	-
nyquist_velocity	Unambiguous doppler velocity	m/s
PHI	Differential phase	deg
platform_type	Platform type	-
primary_axis	Primary axis of rotation	-
prt	Pulse repetition time	s
pulse_width	Transmitter pulse width	s
range	Range to measurement volume	m
ray_gate_spacing	Gate spacing for ray	m
ray_start_range	Start range for ray	m
REF	Equivalent relectivity factor at horizontal polarization	dBZ

RHO	Copolar cross correlation coefficient at lag zero	-
scan_rate	Antenna angle scan rate	deg/s
SNRHC	Signal to noise ratio at horizontal polarization	dB
sweep_end_ray_index	Index of last ray in sweep	-
sweep_mode	Scan made for sweep	-
sweep_number	Sweep index number 0 based	-
sweep_start_ray_index	Index of first ray in sweep	-
time	Time in seconds since volume start	s
time_coverage_end	Data volume end time utc	-
time_coverage_start	Data volume start time utc	-
unambiguous_range	Unambiguous range	m
VEL	Radial velocity	m/s
volume_number	Data volume index number	-
WIDTH	Spectrum width	m/s
ZDR	Differential reflectivity	dB

Software

This dataset is in netCDF-4 format and does not require any specific software to read. However, the data are easily readable and viewed in Panoply.

Known Issues or Missing Data

There are no known issues with these data or any known gaps in the dataset.

References

Radar Science - SKYLER. (2021).
http://radarscience.weebly.com/skyler.html

Stony Brook University - Radar Science. (2018). SKYLER
https://you.stonybrook.edu/radar/observatory/skyler/

Related Data

All other datasets collected as part of the IMPACTS campaign are considered related and can be located by searching the term “IMPACTS” in the Earthdata Search.

Contact Information

To order these data or for further information, please contact:

NASA Global Hydrometeorology Resource Center DAAC
User Services
320 Sparkman Drive
Huntsville, AL 35805

Phone: 256-961-7932
E-mail: support-ghrc@earthdata.nasa.gov
Web: https://ghrc.nsstc.nasa.gov/

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