Data User Guide

SBU Ka-band Scanning Polarimetric Radar (KASPR) IMPACTS

Introduction

The SBU Ka-band Scanning Polarimetric Radar (KASPR) IMPACTS dataset consists of polarimetric radar data collected by the Stony Brook University (SBU) Ka-band Scanning Polarimetric Radar (KASPR) 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. KASPR 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 6, 2020 through February 26, 2020 in netCDF-4 format.

Citation

Kollias, Pavlos and Mariko Oue. 2020. SBU Ka-band Scanning Polarimetric Radar (KASPR) IMPACTS [indicate subset used]. Dataset available online from the NASA Global Hydrometeorology Resource Center DAAC, Huntsville, Alabama, U.S.A. doi: http://dx.doi.org/10.5067/IMPACTS/RADAR/DATA101

Keywords:

GHRC, NASA, IMPACTS, SBU SoMAS, KASPR, Ka-band, polarimetric radar, reflectivity, mean velocity, spectrum width, linear depolarization ratio, differential reflectivity, differential phase, specific differential phase, co-polarized correlation coefficient, signal-to-noise ratio

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.

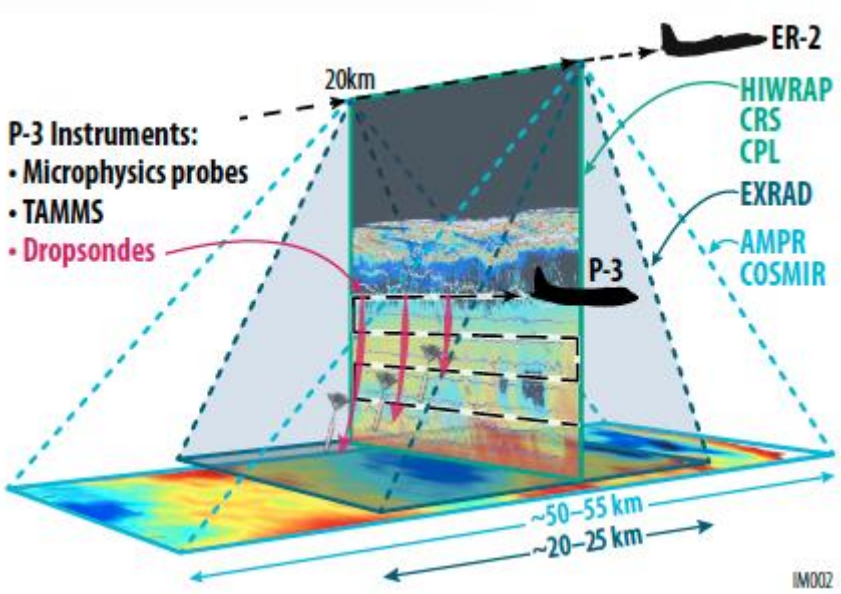

Figure 1: IMPACTS airborne instrument suite
(Image source: NASA IMPACTS ESPO)

Instrument Description

The Stony Brook University (SBU) Ka-band Scanning Polarimetric Radar (KASPR) is a 35.29 GHz 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 instrument was designed to capture detailed observations of clouds and precipitation. KASPR's polarimetric capabilities allow it to transmit radiation in both the horizontal and the vertical. Its polarimetric data products include reflectivity, mean velocity, spectrum width, linear depolarization ratio (LDR), differential reflectivity (ZDR), differential phase, specific differential phase, co-polarized correlation coefficient, and signal-to-noise ratio (SNR). These data provide detailed information about the microphysics and dynamics of liquid water and ice clouds. KASPR has five operation modes: standard pulse pair, staggered PRI pulse-pair, polarimetric pulse-pair, standard FFT mode, and polarimetric FFT mode. It can also perform three types of scans: Plan Position Indicator (PPI) where a 360 degree sweep of the antenna is made, Range-Height Indicator (RHI) in which scans are pointed at a specific azimuth and the antenna tilts upward to get vertical profile information, and Vertically-Pointing (VPT) where the antenna is pointed directly upward toward zenith. The specifications of KASPR are listed in Table 1 below. More information about SBU KASPR is available on the SBU SoMAS KASPR webpage.

Table 1: SBU KASPR Specifications

Variable	Description
Peak transmit power	2.2 kW typical
Pulse repetition frequency	staggered prf: max 15 KHz
Pulse width	100 ns - 13000 ns
Range resolution	15 m - 200 m
Antenna diameter	1.8 m
Antenna gain	53.3 dBi
Antenna beamwidth	0.32 degrees

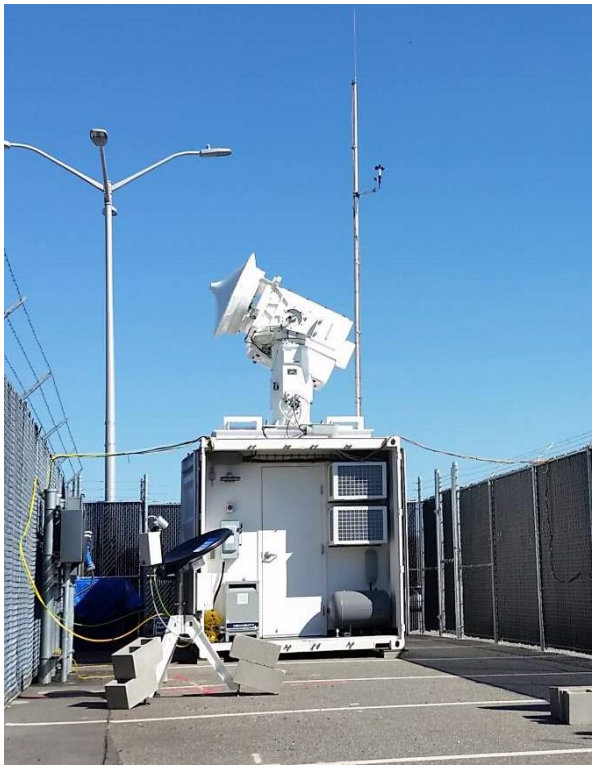

Figure 2: KASPR in the SBU Radar Observatory
(Image source: SBU SoMAS KASPR webpage)

Investigators

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Data Characteristics

The SBU Ka-band Scanning Polarimetric Radar (KASPR) 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 are available on the EOSDIS Data Processing Levels webpage. The characteristics of this dataset are listed in Table 2 below.

Table 2: Data Characteristics

Characteristic	Description
Platform	Ground-based
Instrument	Ka-band Scanning Polarimetric Radar (KASPR)
Spatial Coverage	N: 40.891 , S: 40.900, E: -73.128, W: -73.128 (U. S. Northeast Coast)
Spatial Resolution	15 - 200 m
Temporal Coverage	January 6, 2020 - February 26, 2020
Temporal Resolution	Varies: minute -< hour
Sampling Frequency	Variable based on scan mode and ranges from 30 s to several minutes
Parameter	Reflectivity, mean velocity, spectrum width, linear depolarization ratio, differential reflectivity, differential phase, specific differential phase, co-polarized correlation coefficient, signal-to-noise ratio
Version	1
Processing Level	1A

File Naming Convention

The SBU Ka-band Scanning Polarimetric Radar (KASPR) IMPACTS dataset files are organized by radar scan type: PPI, RHI, and VPT. The files are available in netCDF-4 format and named using the following convention:

PPI Data files:
IMPACTS_SBU_kaspr_YYYYMMDD_hhmmss_ppi.nc

RHI Data files:
IMPACTS_SBU_kaspr_YYYYMMDD_hhmmss_[rhi_aw|rhi_cw|rhicomp].nc

VPT Data files:
IMPACTS_SBU_kaspr_YYYYMMDD_hhmmss_vpt.nc

Table 3: File naming convention variables

Variable	Description
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_aw|rhi_cw|rhicomp]	rhi_aw: along-wind range-height indicator scan rhi_cw: cross-wind range-height indicator scan rhicomp: composite range-height indicator scan

vpt	Vertically-pointing scan
.nc	netCDF-4 format

Data Format and Parameters

The SBU Ka-band Scanning Polarimetric Radar (KASPR) IMPACTS dataset files are stored in netCDF-4 format. The files are organized into three main groups based on the KASPR scan type: PPI, RHI, and VPT. The data fields included in each file type are listed in Tables 4 and 5 below.

Table 4: PPI and RHI File Data Fields

Field Name	Description	Unit
range*	Distance from radar	m
time*	Time (seconds since 1970-01-01 00:00:00 0:00)	-
altitude	Altitude	m
azimuth	Azimuth	Degrees from north
correlation_coefficient	Copolar correlation coefficient	-
cross_polar_correlation_coefficients_htx	Co-to-crosspolar correlation coefficient horiz. transmission	-
cross_polar_coefficients_vtx	Co-to-crosspolar correlation coefficient vert. transmission	-
cross_polar_differential_phase_htx	Cross-polar differential phase horiz. transmission	degrees
cross_polar_differential_phase_vtx	Cross-polar differential phase vertical transmission	degrees
differential_phase	Differential phase	degrees
differential_reflectivity	Differential reflectivity	dB
elevation	Elevation	degrees
fixed_angle	Ray target fixed angle	degrees
latitude	Latitude	Degrees north
linear_depolarization_ratio	Linear depolarization ratio	dB
linear_depolarization_ratio_hv_hh	Linear depolarization ratio vh	dB
longitude	Longitude	Degrees east
mean_doppler_velocity	Unfolded doppler velocity	m/s
mean_doppler_velocity_folded	Doppler velocity	m/s
reflectivity	Reflectivity h copolar	dBZ
reflectivity_v	Reflectivity v copolar	dBZ
reflectivity_xpol_htx	Reflectivity xpol horiz. transmission	dBZ
reflectivity_xpol_vtx	Reflectivity xpol vert. transmission	dBZ
snr	Signal-to-noise ratio	dB
snr_xpol_htx	Signal-to-noise ratio xpol horiz. transmission	dB

snr_xpol_vtx	Signal-to-noise ratio xpol vert. transmission	dB
spectrum_width	Doppler spectrum width	m/s
sweep_end_ray_index	Sweep end ray index	-
sweep_mode	Scan mode for sweep	-
sweep_number	Sweep index number 0 based	-
sweep_start_ray_index	Sweep start ray index	-
time_offset	Seconds from scan start	sec
kdp	Specific differential phase	deg/km

*Note: The 'range' and 'time' fields are coordinate fields.

Table 5: VPT File Data Fields

Field Name	Description	Unit
range*	Distance from radar	m
time*	Time (seconds since 1970-01-01 00:00:00 0:00)	-
altitude	Altitude	m
azimuth	Azimuth	Degrees from north
elevation	Elevation	degrees
fixed_angle	Ray target fixed angle	degrees
latitude	Latitude	Degrees north
linear_depolarization_ratio	Linear depolarization ratio vh	dB
longitude	Longitude	Degrees east
mean_doppler_velocity	Doppler velocity	m/s
reflectivity	reflectivity	dBZ
reflectivity_xpol_htx	Reflectivity xpol horiz. transmission	dBZ
snr	Signal-to-noise ratio	dB
snr_xpol_htx	Signal-to-noise ratio xpol horiz. transmission	dB
spectrum_width	Doppler spectrum width	m/s
sweep_end_ray_index	Sweep end ray index	-
sweep_mode	Scan mode for sweep	-
sweep_number	Sweep index number 0 based	-
sweep_start_ray_index	Sweep start ray index	-
time_offset	Seconds from scan start	sec

*Note: The 'range' and 'time' fields are coordinate fields.

Algorithm

Polarimetric radars like KASPR have the ability to transmit electromagnetic radiation with both a horizontal and vertical orientation. It can therefore measure the horizontal and vertical dimensions of cloud and precipitation particles, revealing cloud microphysical properties and processes. For example, if the power received in the horizontal is greater than the power received in the vertical, this indicates that more oblate particles are being detected by the radar. Additional information on polarimetric radars is available on the National Severe Storms Laboratory (NSSL) Dual Polarized Radar webpage.

Quality Assessment

The KASPR system software data processing includes pulse compression, clutter filtering, noise estimation, power spectra computation, among other processes. There are also quality control measures taken with the radar hardware to ensure temperature/moisture control inside the system and protection for the instrument's electronic components. More information about quality control measures taken for KASPR is available on the SBU SoMAS KASPR webpage.

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. The data can also be displayed using a Python plotting routine.

Known Issues or Missing Data

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

References

Stony Brook University SoMAS. (2019). KASPR.
https://www.somas.stonybrook.edu/about/facilities/radaryard/kaspr/

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:

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