PRECIP: NCAR S-Pol radar moments data, Version 2.0

Changes from Version 1.0

The following changes were made for V2.0:

- Improved clutter detection.
- Improved dual-polarization moments computations in regions where clutter filtering was applied.

Overview

This dataset contains radar moments data in CfRadial format, collected by the S-Pol radar during the Prediction of Rainfall Extremes Campaign In the Pacific (PRECIP). During PRECIP, S-Pol was located at the west coast of Taiwan and collected data from May 25 to August 11, 2022. For more information on PRECIP see https://www.eol.ucar.edu/field_projects/precip.

The site details for S-Pol at Nanliao are as follows:

Closest town	**Nanliao**
Latitude	24.8191 deg N
Longitude	120.9075 deg E
Antenna altitude	10 m MSL

Instrument description

NCAR/EOL's S-Pol radar is an advanced, transportable, ground-based, dual-polarized, Doppler weather radar. S-Pol transmits at 10 cm wavelength. The dual-polarimetric capabilities of S-Pol lead to improved precipitation estimates and real-time identification of hydrometeor types. An innovative system design eliminates the need for a radome and allows for S-Pol to be packed into seven standard 20 ft shipping containers that provide a base when the radar is unpacked and set up. The radar needs only minimal surface site preparation and its relative ease of transport makes S-Pol a valuable tool for studying precipitation and cloud processes at remote sites around the world. S-Pol has been deployed on four continents. For more information on S-Pol see www.eol.ucar.edu/instrumentation/remote-sensing/s-pol.

Radar characteristic	**Value**
Transmitter frequency	2.8415 GHz
Wavelength	10.557 cm
Pulse width	1.0 and 1.5 μsec
Staggered PRT 2/3 ratio	0.0016 / 0.0024 s
Peak power	630 kW
Receivers (2)	H & V

Noise power	114.5 dBm
Minimum detectable dBZ	-42.4 dBZ at 1 km -0.24 dBZ at 100km
Polarization	H-V simultaneous
Antenna	Parabolic, center feed
Gain	~45 dB including waveguide loss
Diameter	8.5 m (28 ft.)
Beamwidth	0.92 degrees
Scan rate	10.5°/s for PPIs; 6 deg/s for RHIs
Wind limit	operations: 30 m/s survivability: 54 m/s
Number of range gates	2000
Gate spacing	150 m
Max range	300 km
Number of samples	Typically 50 per dwell
Clutter filter	Adaptive using CMD
Times series (I/Q) recording	Yes

Data description

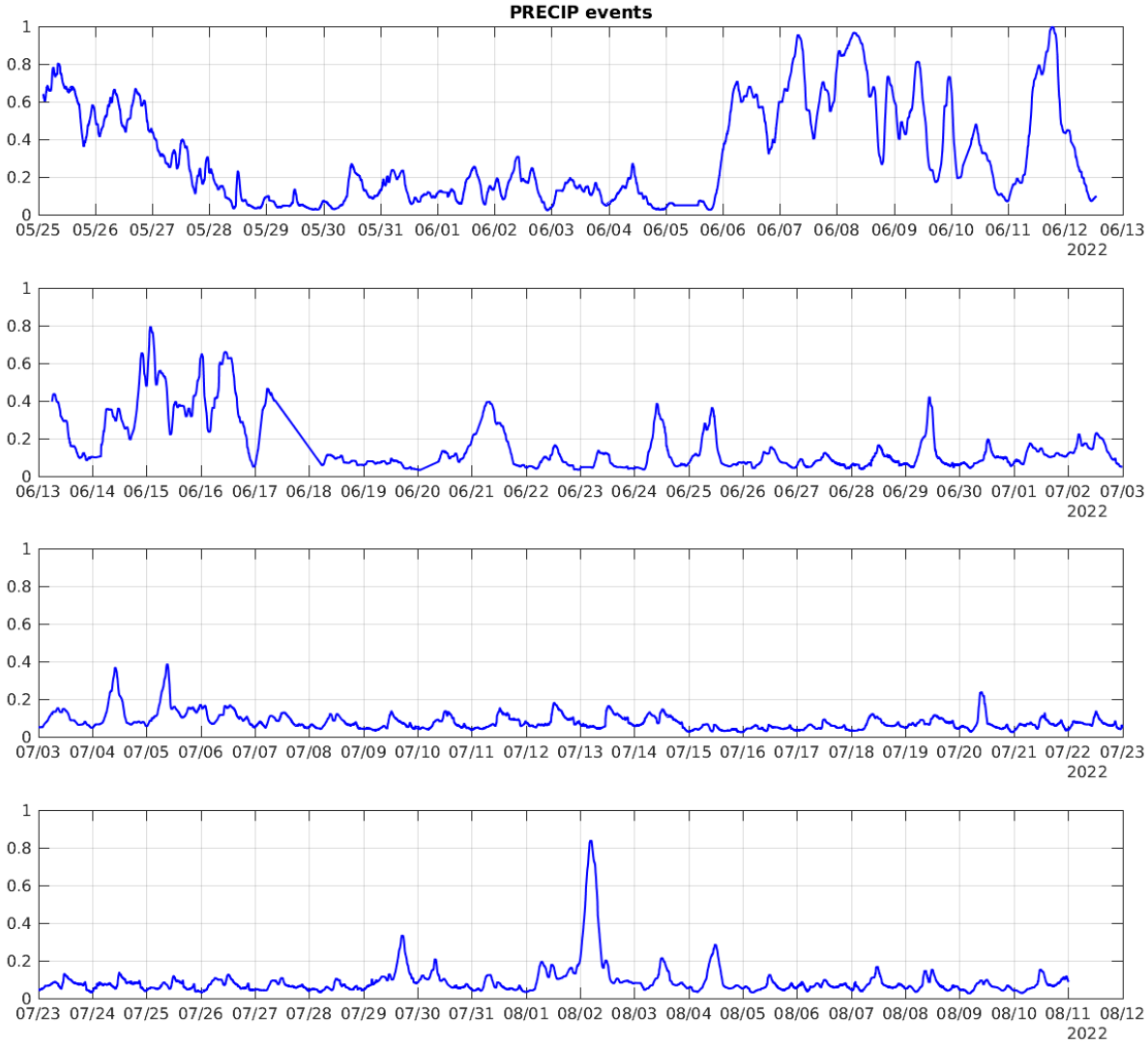
The moments data described here are available at https://data.eol.ucar.edu/dataset/621.001 in CfRadial format. For more information on CfRadial see https://github.com/NCAR/CfRadial/blob/master/docs/CfRadialDoc.v1.4.20160801.pdf.

The primary data products for scientific use are listed in the table below.

Variable	**Dimensions**	**Unit**	**Long Name**
time	time	s	Seconds since volume start
range	range	m	Range from instrument to center of gate
azimuth	time	deg	Ray azimuth angle
elevation	time	deg	Ray elevation angle
DBZ	n_points	dBZ	Reflectivity, unfiltered
DBZ_F	n_points	dBZ	Reflectivity, clutter filtered
VEL	n_points	m/s	Doppler velocity, unfiltered
VEL_F	n_points	m/s	Doppler velocity, clutter filtered
WIDTH	n_points	m/s	Doppler spectrum width, unfiltered
WIDTH_F	n_points	m/s	Doppler spectrum width, clutter filtered
NCP	n_points	none	Normalized coherent power (also SQI), unfiltered
NCP_F	n_points	none	Normalized coherent power (also SQI), clutter filtered
ZDR_F	n_points	dB	Differential reflectivity, clutter filtered
PHIDP_F	n_points	deg	Differential phase, clutter filtered
KDP_F	n_points	deg/km	Specific differential phase, clutter filtered
RHOHV_F	n_points	none	Cross correlation ratio, clutter filtered

Variable	Dimensions	Unit	Long Name
RHOHV_NNC_F	n_points	none	Same as RHOHV_F, but without noise correction
SNRHC	n_points	dB	Signal to noise ratio, H co-polar, unfiltered
SNRHC_F	n_points	dB	Signal to noise ratio, H co-polar, clutter-filtered
SNRVC	n_points	dB	Signal to noise ratio, V co-polar, unfiltered
SNRVC_F	n_points	dB	Signal to noise ratio, V co-polar, clutter-filtered
DBMHC	n_points	dB	Received power, H co-polar, unfiltered, not noise corrected
DBMHC_F	n_points	dB	Received power, H co-polar, clutter-filtered, not noise corrected
DBMVC	n_points	dB	Received power, V co-polar, unfiltered, not noise corrected
DBMVC_F	n_points	dB	Received power, V co-polar, clutter-filtered, not noise corrected
CMD_FLAG	n_points	none	Flag indicating clutter at a gate
PID	n_points	none	Hydrometeor particle ID
TEMP_FOR_PID	n_points	C	Temperature profile for PID
RATE_ZH	n_points	mm/h	Precip rate from Z
RATE_HYBRID	n_points	mm/h	Precip rate hybrid

Precipitation events sampled by S-Pol



Data processing and quality control

The following problems were noted during the operational period, and the noted procedures were carried out to correct the problems. More information can be found at https://github.com/NCAR/lrose-projects-precip/blob/main/docs/SPOL_QC1_for_PRECIP.pdf

Problem with Version 0.1 field data	Solution for QC Version 1.0
The transmit power was unstable between 2022/06/11 and 2022/06/21, with drops of up to 2 dB. This means that the v0.1 reflectivity values were low by up to 2.0 dB during this period.	The transmitter power was continuously monitored by peak power meters. The measured power was used to correct the reflectivity calibration.
The H channel receiver gain decreased after 2022/07/15, by up to 0.5 dB. As a result both Z and ZDR field values were biased negative starting	Engineering calibrations were conducted a number of times through the project. Using the time series archive, the noise power per channel was computed

Problem with Version 0.1 field data	Solution for QC Version 1.0
2022/07/15. After 2022/08/07 the gain decreased by a further 1.0 dB. at 00:00 UTC, until 2022/08/08 at 09:00 UTC.	for every 12-minute interval throughout the project. The changes in H noise value matched the change in receiver gain noted in the engineering calibrations. The noise values were then used to correct the receiver calibration, which in turn corrects the Z and ZDR fields.
The field system PHIDP values close to the radar were close to 0 deg, rather than the optimal -170 deg. This makes it more likely that PHIDP will fold in heavy precipitation.	A constant offset of 40 degrees was added to the PHIDP field to limit the folding of PHIDP in heavy precipitation. KDP was unchanged because PHIDP is unfolded before KDP is computed.
The test pulse was visible in the data at about 240 km in range.	The test pulse was censored as appropriate when there is no echo immediately before or after the test pulse. If there is an echo adjacent to the test pulse it is not censored.
The moments beyond 240 km (the short-PRT unambiguous range) were not properly processed.	The moments computation code was updated to properly compute moments beyond 240 km. The exception is velocity which is only available out to 240 km.
Noise-only gates were not properly censored.	Censoring was applied if BOTH of the following are true at a gate: (a) NCP < 0.2; (b) SNR < 0 dB.
Some surveillance and RHI volumes were not complete.	Data volumes that had too few rays to be useful were removed from the data set.

Problem with QC Version 1.0	Solution for QC Version 2.0
The dual-polarization moments calculations were not optimized for the gates at which the clutter filter was applied.	The moments computations were improved for gates at which the clutter filter was applied.
The clutter detection algorithm (CMD) did not include the latest RHOHV test for low-SNR clutter.	The RHOHV test was added to CMD. This increased the number of gates at which clutter was applied, but only by a small fraction. Generally CMD worked well for Version 1.0, and this was a minor improvement.

Operations log

The SPOL staff maintained an operations log throughout the project, to document issues that came up.

Data time-gaps

The following table lists data gaps of more than 30 minutes, based on the surveillance scan data files.

Gap start time	Gap end time	Gap secs	Gap hours	Reason
2022-05-29T00:59:38Z	2022-05-29T02:49:15Z	6577	1.827	Pedestal maintenance.
2022-05-30T04:59:32Z	2022-05-30T06:08:01Z	4109	1.141	Not logged.
2022-06-01T01:59:31Z	2022-06-01T04:00:57Z	7285	2.024	Calibration, pedestal maintenance.
2022-06-03T01:59:32Z	2022-06-03T04:03:41Z	7450	2.069	Pedestal maintenance.
2022-06-05T01:35:34Z	2022-06-05T02:25:02Z	2968	0.824	Pedestal maintenance.
2022-06-05T03:47:31Z	2022-06-05T13:38:47Z	35476	9.854	High winds at site.
2022-06-10T04:54:50Z	2022-06-10T08:07:02Z	11531	3.203	Pedestal maintenance.
2022-06-10T08:42:49Z	2022-06-10T10:07:26Z	5076	1.410	Breaker tripped.
2022-06-12T02:06:52Z	2022-06-12T04:00:50Z	6838	1.899	Install internet fiber.
2022-06-12T12:54:52Z	2022-06-13T05:55:38Z	61246	17.013	Pre-emptive shutdown because of transmitter problems, end of IOP.
2022-06-14T02:42:48Z	2022-06-14T04:01:17Z	4709	1.308	Pedestal maintenance.
2022-06-17T01:18:52Z	2022-06-17T03:13:13Z	6861	1.906	Maintenance - transmitter pulse shaper.
2022-06-17T06:42:51Z	2022-06-17T07:12:50Z	1799	0.500	Arc faults.
2022-06-17T08:54:52Z	2022-06-18T05:08:41Z	72829	20.230	Pre-emptive transmitter shutdown because of arc faults. This turned out to be a monitoring problem rather than real arcing.
2022-06-19T01:54:52Z	2022-06-19T03:58:14Z	7403	2.056	Pedestal maintenance.
2022-06-19T22:42:51Z	2022-06-20T00:12:51Z	5400	1.500	Installed CWB loaner pulse shaper.
2022-06-20T01:18:52Z	2022-06-20T09:12:57Z	28445	7.902	Tuned transmitter for CWB pulse shaper. Increased pulse width to 1.5 us. Calibration.
2022-06-21T01:42:58Z	2022-06-21T04:19:43Z	9404	2.612	Calibration. Pedestal maintenance.
2022-06-23T01:30:59Z	2022-06-23T04:40:23Z	11364	3.157	Calibration. Pedestal maintenance.
2022-06-24T01:30:59Z	2022-06-24T03:19:54Z	6535	1.815	Pedestal maintenance.
2022-06-26T01:54:52Z	2022-06-26T03:14:00Z	4749	1.319	Pedestal maintenance.
2022-06-27T09:18:52Z	2022-06-27T10:13:12Z	3260	0.906	Installed fan in pedestal for cooling.
2022-06-28T01:59:39Z	2022-06-28T03:14:08Z	4470	1.242	Oil system inspection.
2022-07-02T01:21:12Z	2022-07-02T01:54:11Z	1979	0.550	Not logged.
2022-07-04T01:18:52Z	2022-07-04T03:04:53Z	6362	1.767	Pedestal maintenance.
2022-07-05T02:11:50Z	2022-07-05T02:48:59Z	2229	0.619	Pedestal maintenance.
2022-07-08T03:11:39Z	2022-07-08T04:37:39Z	5161	1.434	Swapped CWB pulse shaper to replacement pulse shaper from the US.
2022-07-09T02:59:38Z	2022-07-09T03:40:42Z	2464	0.684	Receiver maintenance.

Gap start time	Gap end time	Gap secs	Gap hours	Reason
2022-07-10T02:23:38Z	2022-07-10T03:46:23Z	4965	1.379	Pedestal maintenance.
2022-07-11T21:59:39Z	2022-07-11T22:53:13Z	3214	0.893	Not logged.
2022-07-12T02:59:38Z	2022-07-12T04:00:56Z	3677	1.021	Solar scans.
2022-07-13T09:47:39Z	2022-07-13T10:57:48Z	4209	1.169	Solar scans, network problems.
2022-07-16T01:35:32Z	2022-07-16T03:34:16Z	7125	1.979	Calibration.
2022-07-18T01:23:34Z	2022-07-18T02:24:57Z	3683	1.023	Calibration.
2022-07-20T02:23:39Z	2022-07-20T02:45:03Z	1284	0.357	Pedestal inspection.
2022-07-20T05:42:52Z	2022-07-20T06:04:55Z	1323	0.368	Calibration.
2022-07-21T05:59:36Z	2022-07-21T06:21:54Z	1337	0.371	Pedestal maintenance.
2022-07-22T08:54:52Z	2022-07-22T09:30:35Z	2143	0.595	Not logged.
2022-07-23T02:59:39Z	2022-07-23T04:24:59Z	5120	1.422	Calibration.
2022-07-24T22:23:39Z	2022-07-24T22:57:13Z	2014	0.560	Operator error.
2022-07-25T01:59:39Z	2022-07-25T03:26:26Z	5207	1.446	Solar scans, clutter scans.
2022-07-26T23:30:52Z	2022-07-27T00:09:59Z	2347	0.652	Not logged.
2022-07-30T13:30:55Z	2022-07-30T14:53:41Z	4966	1.379	Pedestal maintenance.
2022-07-31T11:42:52Z	2022-07-31T12:25:36Z	2564	0.712	Unknown.
2022-08-02T07:42:52Z	2022-08-02T09:24:50Z	6119	1.700	Maintenance - fixed loose coax in receiver.
2022-08-02T23:54:52Z	2022-08-03T02:16:26Z	8494	2.359	AC repairs.
2022-08-06T02:11:39Z	2022-08-06T02:39:29Z	1670	0.464	Pedestal maintenance.
2022-08-08T08:30:52Z	2022-08-08T08:54:58Z	1447	0.402	Purge waveguides.
2022-08-08T22:30:52Z	2022-08-08T23:01:40Z	1849	0.514	Not logged.
2022-08-09T01:35:39Z	2022-08-09T02:00:59Z	1520	0.422	Solar scans, calibrations.
2022-08-09T03:18:52Z	2022-08-09T03:53:10Z	2059	0.572	Network problem.
2022-08-10T01:30:52Z	2022-08-10T02:57:07Z	5176	1.438	Solar scans, calibrations.
2022-08-10T09:30:51Z	2022-08-10T10:05:00Z	2048	0.569	Solar scans.
		TOTAL	116.5	hours, 6.2% total downtime.

Citation

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