Description of the NOAA S-band Profiler
Data Collected during the
Mid-latitude Continental Convective Cloud Experiment (MC3E)
22 April – 6 June 2011

Introduction

The S-band Profiler data are available as 4 different data sets:

- GPM Ground Validation NOAA S-Band Profiler Minute Data MC3E
- GPM Ground Validation NOAA S-Band Profiler Original Dwell Data MC3E
- GPM Ground Validation NOAA S-Band Profiler Raw Data netCDF format MC3E
- GPM Ground Validation NOAA S-Band Profiler Raw Data SPC format MC3E.

The Minute dwell data set has data processed from the precipitation mode, and the Original dwell data set has data processed in both the precipitation and attenuation modes. Both of these data sets are in the netCDF format with browse images available. The Raw data is available in the netCDF format and the SPC format in both the precipitation and attenuation modes. The SPC formatted data requires special software available by the Vaisala Company. The details of the instrument, the modes and each data set are further in subsequent sections.

S-band Profiler

1. Installation

A profiler operating at 2.835 GHz (in the S frequency band) was deployed in Northern Oklahoma at the DOE Atmospheric Radiation Mission (ARM) Southern Great Plains (SGP) Central Facility from 8 April through 7 June 2011. The S-band profiler was deployed by NOAA (http://www.esrl.noaa.gov/psd/ data/obs/instruments/WindProfilerDescription.html). The purpose of the S-band profiler was to measure the vertical structure of precipitation from approximately 200 meters to 16 km above the ground when precipitation passed over the profiler site. The profiler used a dish antenna that can be seen in the background in Figure 1 and in the foreground in Figure 2.
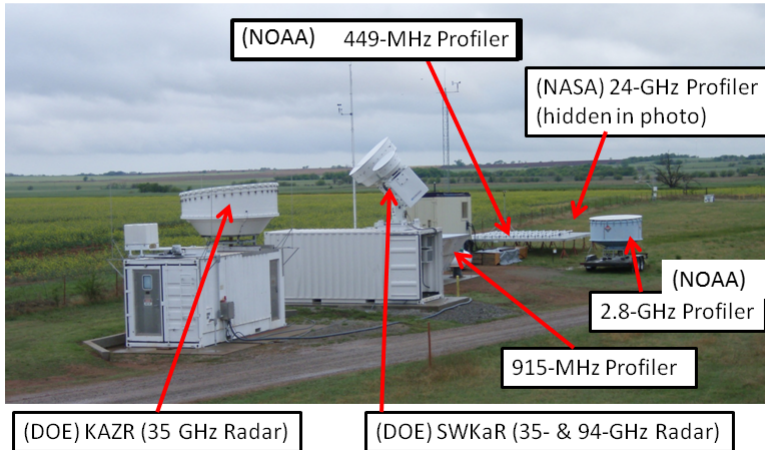
Figure 1. Radars deployed at the Department of Energy (DOE) Atmospheric Radiation Mission (ARM) Southern Great Plans (SGP) Central Facility during MC3E. Photo was taken looking toward the West.
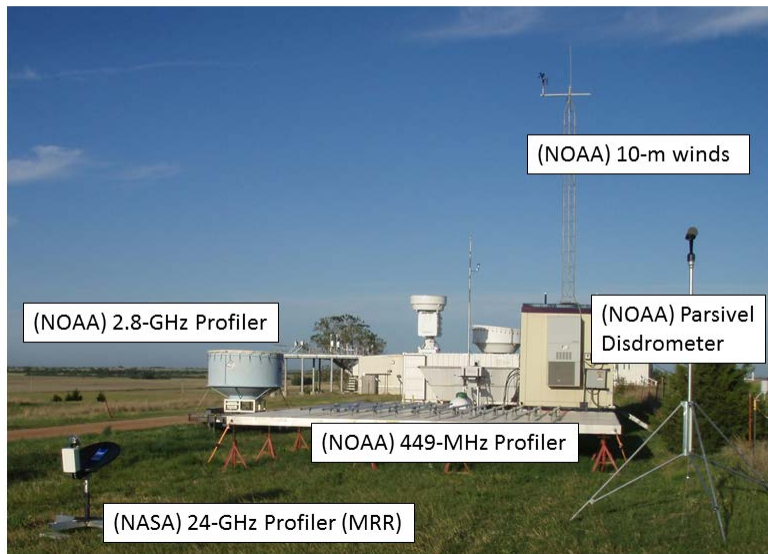

Figure 2. Radars deployed at SGP Central Facility during MC3E. Photo was taken looking toward the East.

2. S-band Profiler Raw Spectra Data Sets
GPM Ground Validation NOAA S-Band Profiler Raw Data netCDF format MC3E
GPM Ground Validation NOAA S-Band Profiler Raw Data SPC format MC3E.

The Raw Spectra Data sets are available in two formats: the netCDF and the SPC format. The netCDF format has a one-to-one correspondence with the SPC formatted data, The S-band profiler operated in two modes: a precipitation mode and an attenuated mode. The modes are exactly the same except that the power return from the attenuated mode is approximately 30 dB less than the precipitation mode (the actual calibration procedure determined the attenuation had a mean of 29.2 dB with a 2 dB standard deviation). The attenuation mode is designed to observe precipitation at close ranges when the precipitation is so intense that the precipitation mode saturates. In examining the calibrated data, the precipitation mode saturated for only a few minutes during the whole campaign.

The raw S-band profiler data consists of uncalibrated Doppler velocity spectra data in units of relative power return. The S-band profiler operated with a 7-second dwell. Nine consecutive 7-second precipitation mode dwells were collected followed by one 7-second attenuated mode dwell. This 10 profile sequence was repeated throughout the field campaign. (Prior to 25 April, the 10 profile sequence consisted of seven precipitation mode profiles followed by three attenuation mode profiles.) The raw spectra were saved in netCDF format. The profiler operating parameters are shown in Table 1.

Table 1. S-band Operating Parameters

Radar Parameter	Value
Operating Frequency (GHz)	2.835
Wavelength (cm)	10.4
Peak Power (W)	380
Antenna Type	1.2-m shrouded dish
Beamwidth	2.5˚
Interpulse Period (µs)	110
Unambiguous Range (km)	16.5
Pulse Width (ns)	416
Range Resolution (m)	62.4
Range Spacing (m)	62.4
Number of Range Gates	250
Maximum Height Sampled (km)	15.7
Height of First Range Gate (km)	0.16
Number of Coherent Integrations	15
Nyquist Velocity (m s^{-1})	15.8
Number of points in Spectrum	256
Spectral Resolution (m s^{-1})	0.125
Number of Spectra Averaged Together	16
Dwell Time (s)	7
Number of Consecutive profiles w/out Attenuation	7 (pre-25 April) and 9 post-25 April
Attenuation Added During Attenuated Mode	30 dB

3. S-band Profiler Raw Spectra Filename Conventions

The precipitation and attenuated mode spectra are saved in separate hourly files. The precipitation mode and attenuated raw spectra data files have the following naming convention for the netCDF format:

       precipitation: sgpsbdC1.00.YYYYNNDD.hhmmss.lmc_YYDDDhhmmssP_SM.nc
       attenuated: sgpsbdC1.00.YYYYMMDD.hhmmss.lmc_YYDDDhhmmssA_SM.nc

Each precipitation hourly data file size varies and can be up to 170 MB. The attenuated mode raw spectra data files hourly files are about 56 MB.

See Section 6 to learn more about the netCDF file format.

The file name structure is:

sgp	- site identifier – Southern Great Plains
sbd	- instrument identifier – S-band Profiler
C1	- facility designation – Central Facility
00	- data level – raw data
YYYY	- year
MM	- month
DD	- day of month
hhmmss	- hour, minute, second of first profile
lmt	-raw data source from Lamont, Oklahoma
YY	-2 digit year
DDD	-julian date
P/A	- operating mode – either precipitation or attenuation mode
SM	file contains spectra (S) and moments (M)
nc	- netCDF data format

The SPC formatted data is available as a tar gzip aggregation of hourly files in both the attenuated and precipitation mode. These are saved as "H" and "D" files with the following file naming convention and structure:

   "D" files:
       precipitation: sgpsbdC1.00.YYYYMMDD.000000.raw.Dlmc0000000P.SPC.tar.gz
       attenuated: sgpsbdC1.00.YYYYMMDD.000000.raw.Dlmc0000000A.SPC.tar.gz

and
   "H" files:
       precipitation: sgpsbdC1.00.YYYYMMDD.000000.raw.Hlmc0000000P.SPC.tar.gz
       attenuated: sgpsbdC1.00.YYYYMMDD.000000.raw.Hlmc0000000A.SPC.tar.gz

where

sgp	- site identifier – Southern Great Plains	
sbd	- instrument identifier – S-band Profiler	
C1	- facility designation – Central Facility	
00	- data level – raw data	
YYYY	- year	
MM	- month	
DD	- day of month	
000000	- hour, minute, second of first profile of day	
D/H	- D refers to the Data file and H refers to the Header file	
lmc	-raw data source from Lamont, Oklahoma	
000000	- hour, minute, second of first profile of day	
SPC	-POP/SPC raw format; (read software required)	
tar	-Tape archive file aggregation (UNIX)	
gz	-gzip compression	

Multiple files are contained in the aggregated "tar.gz" daily "H" and "D" files.   When uncompressed and untarred, multiple files with a similar file naming conventions above. The dates following the "Dlmc" and "Hlmc" are the julian date (YYDDDhh) of the source attenuated or precipitation files.

       sgpsbdC1.00.20110408.230000.raw.Dlmc1109823A.SPC
       sgpsbdC1.00.20110408.230000.raw.Hlmc1109823P.SPC

See Section 6 for more information about the special software needed to read the SPC data files.

4. Calibrated S-band Profiler Spectra Data Sets, 7-sec Dwell
GPM Ground Validation NOAA S-Band Profiler Original Dwell Data MC3E netCDF format

The S-band profiler observations are available at the original temporal resolution with three levels of signal processing: uncalibrated spectra, calibrated spectra, and calibrated moments. The uncalibrated spectra are the raw spectra and are needed to reprocess the radar observations in the future. The S-band spectra were calibrated against the surface disdrometer to determine a radar calibration constant. Calibrated spectra were constructed for each profile and are expressed as reflectivity spectral density (units of reflectivity per m s^{-1}, or units of mm^6 m^{-3} (m s^{-1})$^{-1}$). The reflectivity, mean Doppler velocity and spectrum width were also estimated for each spectra and saved along with the calibrated spectra. And the third data set consists of calibrated moments in separate data files so that the user can have the moments without processing the spectra.

The S-band observations are saved in the hourly data files with the following filename convention:

Precipitation Mode:

      Uncalibrated spectra:

            sgpsbdprecippopC1.a1.YYYYMMDD.hh0000.nc.mc3e

      Calibrated spectra:

            sgpsbdprecipspcC1.a1.YYYYMMDD.hh0000.nc.mc3e

      Calibrated moments:

            sgpsbdprecipmomC1.a1.YYYYMMDD.hh0000.nc.mc3e

Attenuation Mode:

      Uncalibrated spectra:

            sgpsbdattenpopC1.a1.YYYYMMDD.hh0000.nc.mc3e

      Calibrated spectra:

            sgpsbdattenspcC1.a1.YYYYMMDD.hh0000.nc.mc3e

      Calibrated moments:

            sgpsbdattenmomC1.a1.YYYYMMDD.hh0000.nc.mc3e

where

sgp	- site identifier – Southern Great Plains
sbd	- instrument identifier – S-band Profiler
precip/atten	- operating mode – precipitation or attenuation mode
C1	- facility designation – Central Facility
a1	- data level – derived geophysical variabmes
YYYY	- year
MM	- month
DD	- day of month
hh0000	- hour, minute, second of first profile of day
nc	- netCDF format
mc3e	- MC3E field campaign

The hourly data files are about 100 MB in size. Since the many profiles do not have valid signals are high ranges, the zipped daily files are typically less than 20 MB in size.

Browse files are available for both precipitation and attenuated modes as hourly and daily files respectively online through [the Global Hydrology Resource Center](#) and have the following naming convention:

    precipitation: sgpsbdprecipmomC1.a1.YYYYMMDD.hh0000.hourly.mc3e.tif

    attenuated: sgpsbdattenmomC1.a1.YYYYMMDD.000000.daily.mc3e.tif

where

    sgp   - site identifier – Southern Great Plains
    sbd   - instrument identifier – S-band Profiler
    precipmom/attenmom   - precipitation or attenuated moment files
    C1   - facility designation – Central Facility
    YYYY   - year
    MM   - month
    DD   - day of month
    hh0000   - hour, minute, second of first profile of day or hour
    hourly/daily   - time frame for image
    mc3e   - MC3E project desginator
    tif   - tagged image file extension

5. Calibrated S-band Profiler Spectra Data Sets, 60-sec Dwell
GPM Ground Validation NOAA S-Band Profiler Minute Data MC3E

The original 7-sec dwell raw spectra were aggregated into 1-minute dwells and then calibrated to yield 1-minute calibrated spectra. The reflectivity, mean Doppler velocity and spectrum width were estimated from the minute spectra. Since there is approximately one attenuated mode every minute, the attenuated mode was not averaged into 1-minute dwells. Only the precipitation mode was processed into 1-minute data sets.

The 1-minute calibrated spectra are available in one data set and the 1-minute calibrated moments are available in another data set. The minute spectra and moments were saved in hourly data files with the following filename convention (note the '1' in the fourth position indicating the data have 1 minute resolution):

    sgp1sbdprecipspcC1.a1.20110416.hh0000.mc3e.nc

The hourly files have been zipped into daily files following the filename convention:

    sgp1sbdprecipmomC1.a1.YYYYMMDD.000000.mc3e.nc

The hourly data files are about 15 MB in size. The profiles contain many heights that don't have valid signals.

The file name structure is:

sgp	- site identifier – Southern Great Plains
1	- Averaging interval in minutes – 1 minute average data
sbd	- instrument identifier – S-band Profiler
precip	- operating mode -precipitation mode
spc/mom	- spc are hourly files; mom indicate a daily file
C1	- facility designation – Central Facility
a1	- data level – converting from raw counts to geophysical units
YYYY	- year
MM	- month
DD	- day of month
hh0000	- hour with minute and second listed as 00 and 00; daily has 00 as hh
mc3e	- field experiment name
nc	- netCDF data format

6. Read Software

Three S-band data sets are available in the netCDF format**:**

- GPM Ground Validation NOAA S-Band Profiler Minute Data MC3E
- GPM Ground Validation NOAA S-Band Profiler Original Dwell Data MC3E
- GPM Ground Validation NOAA S-Band Profiler Raw Data netCDF format MC3E

The Network Common Data Format (netCDF) is a set of software libraries and self-describing machine-independent data format which supports the creation, access and sharing of scientific data. The software is available as a free download from Unidata; more information about this can be found at http://www.unidata.ucar.edu/software/netcdf/.

The GPM Ground Validation NOAA S-Band Profiler Raw Data SPC format MC3E data set requires special software.   The SPC formatted data if formatted as Profiler Online Program, POP and was originally developed by NOAA. An updated software called Lap-XM was developed by Vaisala Corporation and may be purchased from them. Alternatively an individual can develop their own code using the Lap-XM online manual which has file structures (page 61 for the H files, and page 66 for the D files). The manual can be found at ftp://ftp.etl.noaa.gov/users/tayers/tars/TARS%20Profiler%20System%20documentation/LapXM%20Manual.pdf .