



*National Aeronautics and Space
Administration Goddard Earth Science Data
Information and Services Center (GES DISC)*

README Document for Cloud Absorption Radiometer (CAR) Data Products

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Goddard Earth Sciences Data and Information Services Center (GES DISC)

<http://disc.gsfc.nasa.gov>

NASA Goddard Space Flight Center

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Revision History

<i>Revision Date</i>	<i>Changes</i>	<i>Author</i>
02/12/2018	updated SRF_XXXXnm units from 'nm' to '1/nm'.	Elliot Sherman
06/13/2018	fixed grammatical typos and updated Python script	Elliot Sherman

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1.0 Introduction

This document provides basic information for using Cloud Absorptive Radiometer (CAR) products. These products include:

1. CAR Arctic Research of the Composition of the Troposphere from Aircraft and Satellites Level 1C (CAR_ARCTAS_L1C)
2. CAR Arctic Radiation Measurement in Column: Atmosphere-surface System Level 1C (CAR_ARMCAS_L1C)
3. CAR Chesapeake Lighthouse and Aircraft Measurements for Satellites Level 1C (CAR_CLAMS_L1C)
4. CAR Cloud and Land Surface Interaction Campaign Level 1C (CAR_CLASIC_L1C)
5. CAR Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality Level 1C (CAR_DISCOVERAQ_L1C)
6. CAR Vegetation Structure and Biomass Estimation Level 1C (CAR_ECO3D_L1C)
7. CAR the First ISCCP (International Satellite Cloud Climatology Project) Regional Experiment Arctic Cloud Experiment Level 1C (CAR_FIREACE_L1C)
8. CAR Intercontinental Chemical Transport Experiment–Phase B Level 1C (CAR_INTEXB_L1C)
9. CAR Kuwait Oil Fire Smoke Experiment Level 1C (CAR_KOFSE_L1C)
10. CAR Arctic Lead Experiment Level 1C (CAR_LEADEX_L1C)
11. CAR Southern African Regional Science Initiative-2000 Level 1C (CAR_SAFARI2000_L1C)
12. CAR Smoke/Sulfates, Clouds and Radiation – America Level 1C (CAR_SCARA_L1C)
13. CAR Smoke/Sulfates, Clouds and Radiation – Brazil Level 1C (CAR_SCARB_L1C)
14. CAR Skukuza Savanna Experiment Level 1C (CAR_SKUKUZA_L1C)
15. CAR Snow Experiment in 2017 Level 1C (CAR_SNOWEX17_L1C)
16. CAR Tropospheric Aerosol Radiative Forcing Observational Experiment Level 1C (CAR_TARFOX_L1C)

1.1 Dataset/Mission Instrument Description

The CAR project consists of many missions spanning the globe. The versatility of the CAR measurements has allowed for multiple missions investigating snow melt and albedo, air quality, ocean reflectance anisotropy and implications in ocean color remote-sensing problems, radiative characteristics of clouds embedded in smoke, and changes in vegetation. Although the applications of the instrument and data have expanded over time, primary applications were for cloud diffusion domain studies and measurements of bidirectional reflectance.

The CAR instrument is an airborne multi-wavelength scanning radiometer. It is mounted on an aircraft and deployed in the field to make measurements including: bidirectional reflectance, angular distributions of scattered radiation, determining single scattering albedo, and collecting imagery. These datasets consist of measurements of spectral radiance for numerous environments. The CAR instrument was developed at NASA Goddard Space Flight Center by Dr. Michael King. The current principal investigator is Dr. Charles Gatebe.

For further information about the instrument see: <https://car.gsfc.nasa.gov/instrument>

Although the datasets consist of measurements of reflected/scattered solar radiation within cloud layers and/or reflected solar radiation over natural ecosystems, the intent of each mission was different. Below is a description of each CAR mission.

CAR SnowEx17 Level 1C Snow Mass and Energy Measurements

SnowEx is a multi-year airborne project to help advance snow remote sensing capabilities, and plan for a near-future space mission to monitor global seasonal snow water equivalent — currently an inconsistently collected and difficult-to-obtain data point that scientists say is critical to understanding the world’s water resources.

During the SnowEx mission in 2017, the CAR instrument was flown aboard the Naval Research Lab (NRL) P-3 Orion research aircraft and obtained measurements of bidirectional reflectance distribution function (BRDF) of snow covered forests for a variety of conditions including snow grain size or age, snow liquid water content, solar zenith angle, cloud cover, and snowpack thickness at Grand Mesa, Colorado – one of the largest flat-topped mountain in the world.

CAR Discover-AQ Level 1C Air Quality

DISCOVER-AQ, a NASA Earth Venture program funded mission, stands for Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality.

In recent years, progress in reaching air quality goals has begun to plateau for many locations. Furthermore, near-surface pollution is one of the most challenging problems for Earth observations from space. However, with an improved ability to monitor pollution from satellites DISCOVER-AQ seeks to improve the interpretation of satellite observations to diagnose near-surface conditions relating to air quality.

During the DISCOVER-AQ mission in 2014, the CAR instrument was flown aboard NASA P-3 aircraft and obtained measurements of bidirectional reflectance distribution function (BRDF) at different scales over agricultural and urban areas in Colorado, USA.

CAR Eco-3D Level 1C Vegetation Response to Changing Forcing Factors

This study provides critical measurements on 3-dimensional structure of vegetation, which is important for quantifying the amount of carbon stored in biomass.

During the ECO-3D mission in 2011, the CAR instrument was flown aboard the NASA P-3 and obtained measurements of bidirectional reflectance distribution function (BRDF) over forests ranging from Boreal to tropical wetlands covering sites from Quebec to Southern Florida.

CAR ARCTAS Level 1C Arctic Atmospheric Composition and Climate

ARCTAS was a major science field campaign in 2008 that was designed to study the atmosphere in the Arctic and high northern latitudes as part of the International Polar Year. The first phase of ARCTAS was based in Fairbanks and Barrow, Alaska with some flights to Thule, Greenland in April and focused on thick aerosol layers known as “arctic haze.” The second phase followed in July based from Cold Lake, Alberta and the Northwest Territories focusing on the emissions from large boreal forest fires in northwest Canada.

During the ARCTAS mission, the CAR instrument was flown aboard the NASA P-3 and obtained measurements of bidirectional reflectance distribution function (BRDF) over snow, ice, clouds, smoke and ocean. In addition, the CAR instrument obtained solar radiation measurements inside very thick forest fire smoke.

CAR CLASIC Level 1C Cloud and Land Surface Measurements

CLASIC (Cloud and Land Surface Interaction Campaign) focuses on advancing the understanding of how land surface processes influence cumulus convection. CLASIC was conducted in the Southern Great Plains (SGP – a region comprising Kansas, Oklahoma, and Texas) of the United States during June 2007. The SGP site consists of in situ and remote-sensing instrument clusters arrayed across approximately 55,000 square miles (143,000 square kilometers) in north-central Oklahoma, making it the largest and most extensive climate research field site in the world. The CAR flew aboard Sky Research Jetstream-31 and measured spectral and angular distribution of scattered light by clouds and aerosols, and provided bidirectional reflectance of various surfaces, and imagery of cloud and Earth surface features over covering many locations within the SGP. By making such diverse measurements, our goal is to widen the audience of potential end-users and to foster collaborations among campaign participants and with outside users.

CAR INTEX-B Level 1C Long-range Pollution Transportation

INTEX-B (Intercontinental Chemical Transport Experiment-Phase B) focuses on the long-range transport of pollution, global atmospheric photochemistry, and the effects of aerosols and clouds on radiation and climate. It has two phases: phase 1 of the study was performed in Mexico from March 1-20, 2006, and phase 2 was performed in April and May and focused on Asian City pollution outflow over the western Pacific. The CAR flew aboard Sky Research Jetstream-31 (March 2006) and measured spectral and angular distribution of scattered light by clouds and aerosols, and provided bidirectional reflectance of various surfaces including Gulf of Mexico and Mexico City.

CAR Skukuza Level 1C South African Ecosystems

Southern Africa interact with a persistent high pressure (anticyclonic circulation) system that remains in place about 80% of the time, especially during the winter months (April to October). The large-scale subsidence resulting from the presence of the continental high pressure in turn creates multiple persistent layers of stability that occur throughout the atmosphere at nearly the same pressure levels (~850, 700, 500, and 300 hPa) and with a high degree of frequency throughout the year. These persistent continental high pressure system enhances concentrations of aerosols and trace gases by inhibiting vertical mixing.

CAR mission Skukuza measured bidirectional reflection functions at different altitudes over the savanna ecosystem in southern Africa to study the vertical distribution of optical characteristics of atmospheric aerosol in southern Africa. The measurements were conducted to characterize surface anisotropy in support of the NASA's Earth Observing System satellites validation program and provided an opportunity to develop and test new algorithms for retrieving profiles of aerosol properties.

CAR CLAMS Level 1C Chesapeake Lighthouse Aircraft Ocean Measurements

CLAMS is the Chesapeake Lighthouse and Aircraft Measurements for Satellites field campaign sponsored by CERES, MISR, MODIS-Atmospheres and the NASA/GEWEX Global Aerosol Climatology Project (GACP). The centerpiece of CLAMS is the Chesapeake Lighthouse sea platform 20 km east of Virginia Beach, at which NASA and NOAA make continuous, long-term measurements of radiation, meteorology, and ocean waves. Members of the CERES, MISR and MODIS instrument teams are collaborating to accomplish a common set of objectives tied to

the validation of EOS data products. The CLAMS campaign took place in July-August 2001 to validate Terra data products from a shortwave closure experiment targeting clear (cloud-free) sky conditions and focused on obtaining:

1. more accurate spectral and broadband radiative fluxes at the surface and within the atmosphere,
2. characterization of ocean optics in the vicinity of the lighthouse.
3. description of the atmospheric aerosol amounts, micro-physical and optical properties, and their variability.

The CAR was flown aboard the University of Washington Convair 580 (CV-580) research aircraft during the CLAMS field campaign and obtained measurements of bidirectional reflectance distribution function (BRDF) of the ocean under different illumination conditions with solar zenith angles ranging from 15° to 46° and under different environmental conditions, where the ocean wind speed ranges from 1-11 m/s.

CAR Safari Level 1C South African Biogeophysics and Biogeochemistry

The Southern African Regional Science Initiative (SAFARI) 2000 is an international science field campaign aimed at developing a better understanding of the southern Africa earth-atmosphere-human system. The goal of SAFARI 2000 is to identify and understand the relationship between the physical, chemical, biological, and anthropogenic processes that underlie the biogeophysical and biogeochemical systems of southern Africa. Particular emphasis will be placed upon biogenic, pyrogenic, and anthropogenic emissions - their characterization and quantification, their transport and transformations in the atmosphere, their influence on regional climate and meteorology, their eventual deposition, and the effects of this deposition on ecosystems.

Between 12 August and 16 September 2000, the CAR onboard the University of Washington Convair CV- 580 research aircraft obtained measurements of surface bidirectional reflectance of savanna, salt pans, and strato- cumulus clouds throughout southern Africa as part of SAFARI 2000.

CAR FIREACE Level 1C Arctic Ice and Cloud Radiation

The scientific objectives of FIRE/ACE are to study impact of Arctic clouds on radiation exchange between surface, atmosphere, and space, and the influence of surface characteristics of sea ice, leads, and ice melt ponds on these clouds. It was conducted over the Beaufort Sea, Alaska in the summer of 1997. FIRE/ACE will attempt to document, understand, and predict the Arctic cloud-radiation feedbacks, including changes in cloud fraction and vertical distribution, water vapor cloud content, cloud particle concentration and size, and cloud phase as atmospheric

temperature and chemical composition change. FIRE/ACE uses the data to focus on improving current climate model simulations of the Arctic climate, especially with respect to clouds and their effects on the surface energy budget. In addition, FIRE/ACE addresses a number of scientific questions dealing with radiation, cloud microphysics, and atmospheric chemistry.

CAR SCAR-B Level 1C Smoke, Clouds, and Radiation-Brazil

The SCAR-B campaign was conducted in August-September 1995 in selected areas of central Brazil. The objectives for the SCAR-B mission are to collect measurements of the properties of smoke from biomass burning and the microphysical properties of clouds embedded in the smoke (emission rates of trace gases, properties of smoke particles, light scattering efficiency, interaction processes of smoke particles, effect of biomass burning on surface vegetation, etc). Comparison and validation with data from other SCAR campaign was another important goal. The campaign will advance our knowledge of how the physical, chemical and radiative processes in our atmosphere are affected by sulfate aerosol and smoke from biomass burning; to improve our expertise at remotely sensing smoke, water vapor, clouds, vegetation and fires; and to assess the effects of deforestation and biomass burning on tropical landscapes. The SCAR-B campaign occurred in Brazil

CAR SCAR-A 1C Sulfates, Clouds, and Radiation-Atlantic

The campaign was completed in July 1993. The objectives for the SCAR-A mission was to collect information on the properties and effects of radiation on clouds and sulfite particles --- compared with those for aerosol particles and biomass burning. The SCAR-A campaign occurred in western Atlantic Ocean.

During a two-week period In July 1993, the University of Washington C-131A aircraft took off from its base at Wallops Flight Facility on Wallops Island, Virginia, and flew over several regions, including Hog Island, the Great Dismal Swamp in southern Virginia, the Pine Barrens in New Jersey, Atlantic City, and over parts of the Atlantic Ocean.

CAR ARMICAS Level 1C Arctic Cloud Radiation Measurements

The Arctic Radiation Measurement in Column Atmosphere-surface System (ARMICAS) was a collaborative research effort funded by NASA, NSF and ONR and conducted from June 1-15, 1995 in the North Slope of Alaska and the Beaufort Sea area. The objectives were collect cloud mask data for MODIS algorithm development, perform scale analysis for varying spatial resolutions, retrieve cloud properties over highly reflecting surfaces, obtain in-situ

measurements for cloud retrieval validation, measure droplet spectral absorption with microphysics, measure aerosol light scattering and CCN (Cloud Condensation Nuclei) properties, study statistical properties of cloud microphysics, measure bidirectional reflectance of various surface types, serve as pilot study for FIRE-III and SHEBA campaigns.

The CAR onboard the University of Washington Convair C-131A research aircraft obtained measurements of surface bidirectional reflectance of the melt-season sea ice and tundra. Coordinated flights with ER-2 aircraft took place over the tundra of the North Slope and over the partially ice-covered Beaufort Sea. Several of these flights were closely coordinated in order to provide simultaneous in situ and remote sensing measurements of arctic clouds.

CAR LEADDEX Level 1C Arctic Sea Ice and Tundra Radiation Measurements

CAR LEADDEX mission measured bidirectional reflectance functions for four common arctic surfaces: snow covered sea ice, melt season sea ice, snow covered tundra, and tundra shortly after snowmelt. The measurements show how the reflectance differs amongst the mentioned arctic surfaces and provides insights into the variability of albedo in the arctic.

CAR Kuwait Oil Fire Level 1C Kuwait Oil Fire Spectral Reflectance

This experiment was a part of an international research effort in response to an environmental crisis, when over 600 oil wells in Kuwait were ignited by Iraqi forces in 1991. The resulting fires produced large plumes of smoke that had significant effects on the Persian Gulf region but limited global effects. Between May 16 and June 12, 1991, the Kuwait Oil Fire Smoke Experiment (KOFSE) was conducted in the Persian Gulf Region. The purpose of KOFSE was to determine the chemical and physical nature of the smoke and to investigate its potential effects on air quality, weather, and climate.

During the experiment, CAR aboard the University of Washington C-131A aircraft flew over Kuwait, Saudi Arabia, and the Persian Gulf, and obtained bidirectional reflectance function of smoke from Kuwait oil fires. Measurements were also taken over the Saudi Arabian desert with overlying desert dust, and Persian Gulf waters with some overlying aerosols.

CAR TARFOX Level 1C Tropospheric Aerosol Radiative Forcing Observational Experiment

TARFOX was conducted to reduce uncertainties in the effects of tropospheric aerosols on climate by determining the direct radiative impacts on regional radiation budgets in cloud-free skies, as well as the chemical, physical, and optical properties of the aerosols carried over the western Atlantic Ocean from the United States. In July 1996, CAR data were collected aboard the University of Washington C-131A aircraft over the forested Great Dismal Swamp wetlands south of Norfolk, Virginia and the Atlantic Ocean approximately 340 km offshore of Richmond, Virginia.

1.2 Algorithm Background

CAR data post processing involves first separating the various data types: header (navigation), the science, housekeeping, and dark current (read data cycle section on our CAR website: <https://car.gsfc.nasa.gov/instrument/schematics>). Secondly, the science data is corrected for aircraft roll so that the reference pixel in each scan corresponds to a known geophysical feature (e.g. first pixel corresponds to 5° before zenith and the last one 5° after nadir for starboard imaging). Also, in each scan an average of dark current signal is subtracted from each value of the science data signal of the subsequent scan. Thirdly, the resulting product is converted to radiance units using the calibration constants computed during the pre-and post-flight calibrations. Finally, data are geographically and time referenced before they are archived for use by the scientific community.

1.3 Data Disclaimer

The CAR data is provided as a public service by the National Aeronautics and Space Administration (NASA). We make every effort to provide complete and accurate information. However, we do not guarantee accuracy, completeness, timeliness or correct sequencing of the information. We will do our best to correct errors brought to our attention.

Reference herein to any specific commercial products, processes, or services by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement or recommendation by NASA or the United States Government.

1.3.1 Acknowledgement

NASA promotes the full and open sharing of all data with the research and applications communities, private industry, academia, and the general public (Read the [NASA and Information Policy](#)). The Cloud Absorption Radiometer (CAR) data is a public domain data. We

request that end users who make use of CAR data or imagery for subsequent distribution, deriving value added products, or using or referencing CAR products in written or oral presentations to add the following acknowledgment:

We acknowledge the use of CAR data products or imagery archived by the NASA/GSFC/Earth Science Data and Information System (ESDIS) with funding provided by NASA.

If the CAR data is a principal component of a scientific paper, please work with principal investigator and offer co-authorship.

1.3.2 Contact Information

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2.0 Data Organization

The CAR data is level 1 aircraft data as defined by NASA ESDIS. However due to the uniqueness of this dataset, the data provider identifies this data as level 1C. Each file corresponds to an aircraft flight for that mission. Each file contains observations of reflectance and spectral response function as measured by the CAR instrument. The timespan and spatial coverage for the files can differ from one another. The 'AircraftLatitude', 'AircraftLongitude', and 'Time' variables describe the changes in space and time for the aircraft.

The CAR data consist of views of Earth-atmosphere scenes through 190° defined by observations of both local zenith and nadir around the starboard horizon, or 190° views of the Earth scene from horizon to horizon, or 190° views of the sky above the aircraft from horizon to horizon. Data are always sampled simultaneously and continuously for eight spectral bands 0.34 to 1.27 μm (or seven bands for missions prior to 2000), plus one of the six bands on the filter wheel (1.55–2.30 μm). Data from the filter wheel either include all six spectral bands at a prescribed interval (usually changing filter every fifth scan line), or one of the six spectral bands, usually 1.66, 2.10, or 2.21 μm, sampled continuously.

2.1 File Naming Convention

ZZZZ-car_AAA_yyyymmdd_XXXX_Level1C_productionDate.nc

Where:

ZZZZ = CAR mission name (short_name)

AAA = Aircraft

yyymmdd = mission date

yyyy = 4 digit year number

mm = 2 digit month [01-12]

dd = 2 digit day [01-31]

XXXX = flight number

productionDate = 4 digit year, 2 digit month, 2 digit day

Filename example: discoverAQ-car_p3b_20140708_2037_Level1C_20171105.nc

2.2 File Format and Structure

CAR dataset files are in NetCDF4 (network Common Data Form) format. NetCDF is a self-describing, hierarchical, and machine independent data format for array oriented scientific data. For more information visit: <https://www.unidata.ucar.edu/software/netcdf/>

3.0 Data Contents

These datasets contain radiance and spectral response functions at given wavelengths for multiple environments (see mission descriptions Section 1.1).

3.1 Dimensions

CAR data set dimensions are listed below. The 'Scans', 'CAR_Viewing_Angles', and 'CentralWavelength' dimension names are consistent across data sets. However, the values may not be the same across data sets and are dependent on the mission and instrument. The Scans

- a. The ‘Scans’ dimension refers to the scans performed by the CAR instrument.
- CAR_Viewing_Angles
 - a. The ‘CAR_Viewing_Angles’ dimensions provides the viewing angles of the CAR instrument.
- CentralWavelength
 - a. The ‘CentralWavelength’ dimension provides the wavelength for each channel of the CAR instrument.

‘SRF_XXXXnm’, and ‘SpectralRange_XXXXnm’ dimensions differ across data sets and are dependent on the mission and instrument.

The ‘XXXX’ in ‘SRF_XXXXnm’, and ‘SpectralRange_XXXXnm’ refer to the central wavelength for the CAR instrument’s channels.

Earlier CAR missions did not measure the spectral range or spectral response function. CAR missions that made these measurements are: Arctas, CLAMS, CLASIC, Discover-AQ, Eco-3D, INTExB, Safari, Skukuza, and SnowEx17.

- SpectralRange_XXXXnm
 - a. The ‘SpectralRange_XXXXnm’ dimension provides the spectral range for the central wavelength which is denoted with XXXX.
- SRF_XXXXnm
 - a. The ‘SRF_XXXXnm’ dimension provides the spectral response function for the spectral range denoted by XXXX.

3.2 Products/Parameters

Variables that are left blank are unitless. Incidents of ‘XXXX’ denote the central wavelength which can vary across missions.

Table 1. CAR level 1C variables

Short Name	Long Name	Unit
Date	Data Acquisition Date in the format of YYYYMMDDhhmmss.s	
CoordinatedUniversalTime	UTC time in the format of HHMMSS.s	
Scan_Start_Angle	Scan start angle relative to the local sky-earth normal	degrees
Time	seconds since 2017-02-16 00:00:00.0 UTC	seconds since 2017-02-16 00:00:00.0 UTC

AircraftAltitude	GPS height in Meters above the mean sea level	m
AircraftLatitude	Aircraft Latitude Degrees	degrees_north
AircraftLongitude	Aircraft Longitude Degrees	degrees_east
AircraftHeading	Aircraft Heading Degrees relative to the local geodetic north	degrees
AircraftPitch	Aircraft Pitch Degrees relative to the local sky-earth normal	degrees
Scans	Scan line count from data start	
CAR_Viewing_Angles	CAR viewing angles	degrees
radiance_XXXXnm	XXXX nm radiance	W m-2 sr-1
ViewingAzimuthAngle	CAR pixel viewing azimuth angle relative to the local geodetic north	degree
ViewingZenithAngle	CAR pixel viewing zenith angle relative to the local sky-earth normal	degree
SolarZenithAngle	Solar Zenith Angle relative to the local sky-earth normal	degree
SolarAzimuthAngle	Solar Azimuth Angle relative to the local geodetic north	degree
CentralWavelength	CAR Central Wavelength	nm
SolarIrradiance	Solar Spectral Irradiance	W m-2
SRF_XXXXnm	Spectral Response Function at XXXXnm	1/nm
SpectralRange_XXXXnm	SpectralRange for CAR chIY XXXXnm	nm

Table 1. A list of the variables' "Short Name", "Long Name" and "Unit" attributes across all CAR data sets described in section 1.1.

4.0 Options for Reading the Data

The CAR data are stored in NetCDF-4 format. There are many software packages that can be used for manipulating or displaying NetCDF data. This Unidata site provides references about these packages.

How to work with NetCDF Files from the command line:

http://www.unidata.ucar.edu/software/netcdf/docs/netcdf_working_with_netcdf_files.html

The NetCDF-4 Tutorial Documentation:

<http://www.unidata.ucar.edu/software/netcdf/netcdf-4/newdocs/netcdf-tutorial.html>

4.1 Command Line Utilities

ncdump

The ncdump tool can be used as a simple browser for NetCDF and HDF data files, to display the dimension names and sizes; variable names, types, and shapes; attribute names and values; and optionally, the values of data for all variables or selected variables in a NetCDF file. The most common use of ncdump is with the `-h` option, in which only the header information is displayed.

```
ncdump [-c|-h] [-v ...] [[-b|-f] [c|f]] [-l len] [-n name] [-d n[,n]] filename
```

Options/Arguments:

`[-c]` Coordinate variable data and header information

`[-h]` Header information only, no data

`[-v var1[,...]]` Data for variable(s) `<var1>`,... only data

`[-f [c|f]]` Full annotations for C or Fortran indices in data

`[-l len]` Line length maximum in data section (default 80)

`[-n name]` Name for NetCDF (default derived from file name)

`[-d n[,n]]` Approximate floating-point values with less precision filename File name of input NetCDF file

4.2 Tools/Programming

Panoply

Panoply is a visualization tool developed at the Goddard Institute for Space Studies (GISS). It is compliant with NetCDF Climate and Forecast (CF) Metadata Conventions. A strength of the tool is that data can be previewed “remotely” over the network – i.e. user can preview file content of HDF or NetCDF files stored on a remote site, without downloading them. Panoply is available from GISS:

<http://www.giss.nasa.gov/tools/panoply/>

Python

Python is a versatile open source programming language that can be used to subset, process, analyze, and visualize data. To download and learn more about Python visit: <https://www.python.org/>

Below is a Python 2.7 script that will read-in and plot CAR data.

```
#===== Begin Python CAR script =====  
from netCDF4 import Dataset  
import matplotlib.pyplot as plt
```

```

# Read in NetCDF4 file. Assign directory path if necessary.
data = Dataset('C:\Users\esherman\Desktop\CAR 1C data prep\data FINAL\Eco3D\Eco3d-
car_p3b_20110819_2024_Level1C_20171202.nc', mode='r')

# prints header information
print data

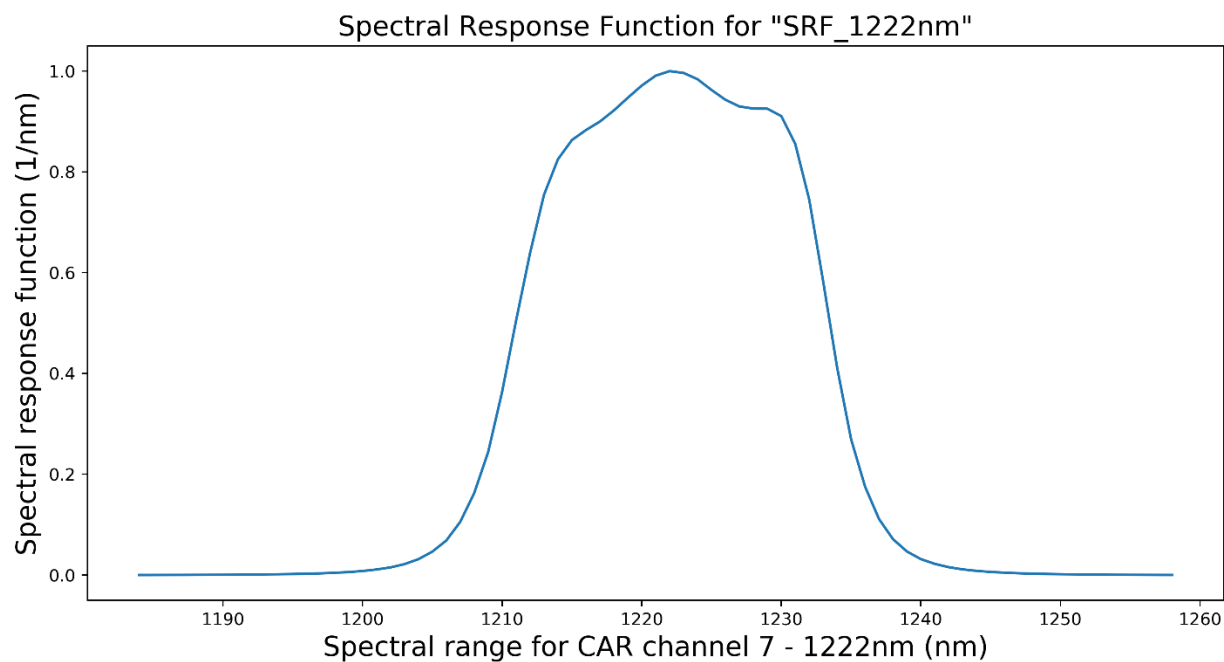
# read variables
srf1222=data.variables['SRF_1222nm']
sr1222=data.variables['SpectralRange_1222nm']

# plot spectral response function
plt.figure(figsize=(12,6))
plt.plot(sr1222,srf1222)
plt.title('Spectral Response Function for "SRF_1222nm"', fontsize=16)
plt.xlabel('Spectral range for CAR channel 7 - 1222nm (nm)', fontsize=16)
plt.ylabel('Spectral response function (1/nm)', fontsize=16)

plt.savefig('%s_SRF_1222nm.png'%str(data.experiment_name), format='png', dpi=360)
#===== End Python Car script =====

```

Example image produced by Python CAR script:



5.0 Data Services

5.1 NASA Earthdata Login System

Starting August 1st, 2016, access to GES DISC data requires all users to be registered with the Earthdata Login system. Data continue to be free of charge and accessible via HTTPS. Access to data via FTP will no longer be available on or after October 3rd, 2016. Detailed instructions on how to register and receive authorization to access GES DISC data are provided at <https://disc.sci.gsfc.nasa.gov/data-access>.

GES DISC users who deploy scripting methods to list and download data in bulk via anonymous FTP are advised to review the How to Download Data Files from HTTP Service with wget recipe that provides examples of GNU wget commands for listing and downloading data via HTTPS.

If you need assistance or wish to report a problem:

Email: gsfc-help-disc@lists.nasa.gov

Voice: 301-614-5224

Fax: 301-614-5268

Address: Goddard Earth Sciences Data and Information Services Center NASA Goddard Space Flight Center Code 610.2 Greenbelt, MD 20771 USA

5.2 Data Services

5.2.1 Landing Pages

Below is a list of landing pages for each CAR mission. These landing pages provide product summary, data citation, documentation, data access and services for each mission.

https://disc.gsfc.nasa.gov/datasets/CAR_SNOWEX17_L1C_V1/summary
https://disc.gsfc.nasa.gov/datasets/CAR_DISCOVERAQ_L1C_V1/summary
https://disc.gsfc.nasa.gov/datasets/CAR_ECO3D_L1C_V1/summary
https://disc.gsfc.nasa.gov/datasets/CAR_ARCTAS_L1C_V1/summary
https://disc.gsfc.nasa.gov/datasets/CAR_CLASIC_L1C_V1/summary
https://disc.gsfc.nasa.gov/datasets/CAR_INTEXB_L1C_V1/summary
https://disc.gsfc.nasa.gov/datasets/CAR_SKUKUZA_L1C_V1/summary
https://disc.gsfc.nasa.gov/datasets/CAR_CLAMS_L1C_V1/summary
https://disc.gsfc.nasa.gov/datasets/CAR_SAFARI_L1C_V1/summary
https://disc.gsfc.nasa.gov/datasets/CAR_FIREACE_L1C_V1/summary
https://disc.gsfc.nasa.gov/datasets/CAR_SCARB_L1C_V1/summary
https://disc.gsfc.nasa.gov/datasets/CAR_SCARA_L1C_V1/summary

https://disc.gsfc.nasa.gov/datasets/CAR_ARMCAS_L1C_V1/summary
https://disc.gsfc.nasa.gov/datasets/CAR_LEADDEX_L1C_V1/summary
https://disc.gsfc.nasa.gov/datasets/CAR_KUWAITOILFIRE_L1C_V1/summary
https://disc.gsfc.nasa.gov/datasets/CAR_TARFOX_L1C_V1/summary

6.0 More Information

Additional information can be found at the Cloud Absorption Radiometer (CAR) website:
<https://car.gsfc.nasa.gov/>

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