# User Guide
# Pioneer Venus Special Events Data Bundle
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## NSSDCA
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# 1  OVERVIEW

This archive contains Pioneer Venus (PV) Special Events Data (SED). The SED products, which are derived data, consist of separate files for a number of instruments on the Pioneer Venus Orbiter (PVO) and the four atmospheric probes:  Large; Small Day; Small Night; and Small North, collectively known as the Multiprobes. The SED comprise atmospheric data from the Multiprobes during descent through the atmosphere of Venus on 9 December 1978;  PVO atmospheric drag and model data from 9 December 1978 (orbit 5) through 7 August 1979 (orbit 246); and PVO solar wind data from 5 December 1978 (orbit 1) and continue through 21 October 1981 (orbit 1050). For this archive, we extracted PV SED data from NSSDCA dataset PSPA-00034 and reformatted as ASCII comma-delimited (CSV) products.

# 2  PV SED Bundle

The SED data products divided into eight Data collections by type of instrument in the PV SED Bundle. The logical identifier (LID) for this bundle is *urn:nasa:pds:pv_sed*.

| Instrument(s) | *Collection LID*, Directory Name | Start Date | Stop Date | Brief Description |
|---|---|---|---|---|
| Multiprobes Atmospheric Structure (LAS/SAS) | *urn:nasa:pds:pv_sed:data_atm_struct* data_atm_struct/ | 1978-12-09 (orbit 5) | 1978-12-09 (orbit 5) | Pressure, temperature data during entry and descent of the four probes |
| Large Probe Gas Chromatograph (LGC) | *urn:nasa:pds:pv_sed:data_lgc* data_lgc/ | 1978-12-09 (orbit 5) | 1978-12-09 (orbit 5) | Lower atmospheric composition data |
| Large Probe Infrared Radiometer (LIR) | *urn:nasa:pds:pv_sed:data_lir* data_lir/ | 1978-12-09 (orbit 5) | 1978-12-09 (orbit 5) | Pre-entry, descent data |
| Large Probe Solar Flux Radiometer (LSFR) | *urn:nasa:pds:pv_sed:data_lsfr* data_lsfr/ | 1978-12-09 (orbit 5) | 1978-12-09 (orbit 5) | Lower atmospheric data |
| Multiprobes Nephelometer (LN/SN) | *urn:nasa:pds:pv_sed: data_neph* data_ neph / | 1978-12-09 (orbit 5) | 1978-12-09 (orbit 5) | Atmospheric backscatter, temperature, and UV and VIS background data |
| Small Probes Net Flux Radiometers (SNFR) | urn:nasa:pds:pv_sed: data_lsfr data_lsf/ | 1978-12-09 (orbit 5) | 1978-12-09 (orbit 5) | Lower atmospheric data (13-66 km) |
| Orbiter Atmospheric Drag Experiment (OAD) | *urn:nasa:pds:pv_sed: data_oad* data_oad/ | 1978-12-09 (orbit 5) | 1979-08-07 (orbit 246) | Atmospheric model and density data (140-190 km) |
| Orbiter Solar Wind Plasma Analyzer (OPA) | *urn:nasa:pds:pv_sed: data_opa* data_opa/ | 1978-12-05 (orbit 1) | 1981-10-21 (orbit 1050) | Proton parameters outside the bow shock |

The bundle includes three additional collections:

| *Collection LID*, Directory Name | Brief Description |
|---|---|
| urn:nasa:pds:pv_sed:document document/ | Contains this user guide and the NSSDCA's data description document for PSPA-00034 which is necessary for interpreting the SED data products |
| urn:nasa:pds:pv_sed:context context/ | Identifies PDS spacecraft and instrument context products referenced by this bundle; required by PDS for operational purposes and completeness |
| urn:nasa:pds:pv_sed:xml_schema xml_schema/ | Identifies PDS schema products used in this bundle; required by PDS for operational purposes and completeness |

The following sections describe the contents of the Data and Document collections. For information about context and schema collections, see *PDS4 Standards Reference* (2023).

# 3   Reformatting NSSDCA PV SED to PDS CSV Data Products

## 3.1   *About PSPA-00034, The Source Data*

The PV SED were originally produced by the Unified Abstract Data System for the PV mission and submitted to the NSSDCA as EBCDIC records generated on an IBM 360 computer. They were translated into ASCII stream data files without any control characters for line endings (e.g., no carriage return or line feed characters) and archived as NSSDCA dataset PSPA-00034.  The NSSDCA holds this dataset on tape.

The NSSDCA also maintains a PDF document (hereafter pspa00034.pdf, found in the Document collection) that identifies the data files contained in PSPA-00034 and provides the details and formats of the different types of instrument data files. It also includes discussions composed by the data providers for the data from some of the instruments. The NSSDCA designation for this document is Dataset Catalog #627.

We note pspa00034.pdf identifies 70 original data files. However, only 66 of those files were archived in PSPA-00034.  Four of the original files were not archived at the NSSDCA because they did not contain useful data or were never submitted.

## 3.2   *Reformatting to CSV Data Products*

After downloading the 66 source files from tape, we reformatted them accordingly:

1) Wrapped each ASCII stream file into 78-character records and appended carriage return and line feed characters (CR+LF) as the line ending. This resulted in most of the data contained in these files to be displayed in tabular format for easier manipulation.

2) Transformed tabular data into CSV-formatted files, *.csv.

   a) When the instrument data spanned more than one source file, we merged all the data into one CSV file (product), e.g., we merged source files 012-015, 034-052, and 062-070 into opa_proton_params.csv in the Orbiter Solar Wind Plasma Analyzer Data Collection.

   b) When a source file contained more than one type of tabulated data, we created a separate CSV file (product) for each type, e.g., we separated the six different types of data is source file 027 into the six different sn_day*.csv files (products) contained in the Multiprobes Nephelometer Data Collection.

3) Cleaned the data when necessary, such as:

   a) Fixed obvious typos.

   b) Replaced blanks in time stamps with zeros, e.g., changed the value "19: 1: .7" to "19:01:00.7" to confirm to PDS standards.

4) Captured any explanatory text and headings contained in the source files in separate ASCII text decryption files, *_descr.txt, e.g., las_low_atm_state_descr.txt in the

Multiprobes Atmospheric Structure Data Collection captures explanatory text and headings from source files 001 and 002.

5) For each CSV-formatted file, *.csv, and when applicable its associated descriptive text file, *_descr.txt, generated a PDS data product label, *.xml.

6) Organized the resulting data products into separate PDS data collections by instrument.

For a list of the source files in PSPA-00034 cross-referenced to the data files in this bundle, see pspa00034_vs_pds_file_list.pdf in the Document Collection.

# 4  Large Probe Gas Chromatograph (LGC) Data Collection

## 4.1  Instrument Overview

The objective of LGC was to determine the composition of the lower atmosphere of Venus. From these measurements, deductions were made of the gaseous sources of infrared opacity, the degree of differentiation of Venus' interior, the degree of similarity between the solid bodies of Earth and Venus, and evolution of Venus' atmosphere. Two gas chromatograph columns were used to analyze samples of the atmosphere during probe descent. The Gas Chromatograph sampled the lower atmosphere three times during the Large Probe's descent.

## 4.2  Data Products

This collection contains one data product, consisting of one CSV data file and a metadata label.  Although pspa00034.pdf states file 028 in PSPA-00034 contains the LGC data, file 028 only exists as a digitized printout included in pspa00034.pdf.  To generate this product, we manually typed the values from that printout into the CSV data file.

| Product LID | Product files in collection directory data_lgc/ | Brief Description |
|---|---|---|
| urn:nasa:pds:pv_sed:data_lgc:lgc_low_atm_comp | lgc_low_atm_comp.csv lgc_low_atm_comp.xml | Lower atmospheric composition from 3 samples |

The CSV data file contains one record for each sample. Each record contains 57 columns: sample number, ground received time (GRT) in UT hours, minutes, and seconds; altitude in kilometers; atmospheric pressure including 3-sigma and 1-sigma intervals in bars; concentration including 3-sigma and 1-sigma intervals  as percentages for the following gases: $CO_2$, N, $H_2O$, O, Ar, CO, Ne, and $SO_2$; and the upper limit in parts per million for the following undetected gases: H, $CH_4$, Kr, ethylene, ethane, hydrogen sulfide, carbonyl sulfide, propane, and nitrous oxide.

## 4.3  Notes, including findings from reformatting

The PSPA-00034 dataset includes this comment about the LGC data:  Carbon dioxide and the seven neutral minor constituents were determined from individual and direct measurement of peak areas by computerized curve fitting.

### 4.4    References

Oyama, V. I., et al., Pioneer Venus sounder probe gas chromatograph, IEEE Trans. Geosci. Rem. Sens., GE-18, No. 1, 85-92, doi:10.1109/TGRS.1980.350287, Jan. 1980.

Oyama, V. I., et al., Venus lower atmosphere composition: Analysis by gas chromatography, Science, 203, No. 4382, 802-805, doi:10.1126/science.203.4382.802, Feb. 1979.

Oyama, V. I., et al., Pioneer Venus gas chromatography of the lower atmosphere of Venus, J. Geophys. Res., 85, No. A13, 7891-7902, doi:10.1029/JA085iA13p07891, Dec. 1980.

# 5   Large Probe Infrared Radiometer (LIR) Data Collection

### 5.1    Instrument Overview

The objectives of the LIR were to measure the atmosphere thermal flux profile, detect cloud layers and infer their composition, and estimate the atmospheric water vapor content as it descended through the atmosphere. This experiment used a 4-channel infrared radiometer looking down from the probe. Two internal blackbodies were used to allow absolute measurements of the flux in each channel. The primary measurement was the difference in upward and downward infrared flux at different wavelengths.

### 5.2    Data Products

This collection contains four data products, each consisting of a CSV data file, a descriptive text file, if applicable, and a metadata label.  The products are the reformatted contents of files 003 - 006, 029, and 030 in PSPA-00034.

| Product LID | Product files in collection directory data_lir/ | Brief Description |
|---|---|---|
| urn:nasa:pds:pv_sed:data_lir:lir_calibration | lir_calibration.csv<br>lir_calibration_descr.txt<br>lir_calibration.xml | On-board calibration flux measurements |
| urn:nasa:pds:pv_sed:data_lir:lir_pre-entry_checkout | lir_pre-entry_checkout.csv<br>lir_pre-entry_checkout_descr.txt<br>lir_pre-entry_checkout.xml | Pre-Entry atmospheric flux measurements for checkout purposes |
| urn:nasa:pds:pv_sed:data_lir:lir_pre-entry | lir_pre-entry.csv<br>lir_pre-entry_descr.txt<br>lir_pre-entry.xml | Pre-entry atmospheric flux measurements and calibrations, interleaved |
| urn:nasa:pds:pv_sed:data_lir:lir_descent | lir_descent.csv<br>lir_descent_descr.txt<br>lir_descent.xml | Atmospheric flux measurements during descent |

Each CSV data file contains five columns. First is the ground received time (GRT) in hours, minutes, and seconds. The other four columns contain the derived flux measurements in watts per square meter for the following spectral band passes in microns: 3-250 (3-150 for pre-entry checkout data), 6-7, 7-8, and 8-9.

All four lir_*.csv files:  Each record contains five columns as follows:
- ground received time (GRT) in hours, minutes, and seconds UT.
- Derived flux in watts per square meter in the spectral bandpass at 3-250 micron (3-150 micron for pre-entry checkout data),

- Derived flux in watts per square meter in the spectral bandpass at 6-7 micron,
- Derived flux in watts per square meter in the spectral bandpass at 7-8 micron, and
- Derived flux in watts per square meter in the spectral bandpass at 8-9 micron.

### 5.3   Notes, including findings from reformatting

The PSPA-00034 dataset includes this comment about the LIR data: The on-board calibration data indicate an increasing signal during the descent phase of the mission. This was due to increasing probe bus voltage; the calibration system was not on regular power. This type of change was observed during calibration of the instrument. The last calibration cycle ended 2 minutes, 18 seconds prior to impact on the surface of Venus.

The ground received time (GRT) is the earth received time given in UT and is about 3 minutes later than the spacecraft time (Table 5-2, Fimmel et al., 1995). These times used to relate the altitude, pressure, temperature contained in the Large Probe Atmospheric Structure (LAS) data products in the Multiprobe Atmospheric Structure Data Collection.

### 5.4   References

Fimmel, R.O., L. Colin, and E. Burgess, Pioneering Venus A Planet Unveiled, Technical Report, NASA Ames Research Center, Moffett Field, CA, 1995.

Boese, R. W., et al., The infrared radiometer on the sounder probe of the Pioneer Venus mission, IEEE Trans. Geosci. Rem. Sens., GE-18, No. 1, 97-99, doi:10.1109/TGRS.1980.350289, Jan. 1980.

Boese, R. W., et al., First results from the large probe infrared radiometer experiment, Science, 203, No. 4382, 797-800, doi:10.1126/science.203.4382.797, Feb. 1979.

Colin, L., Ed., and D. M., Ed. Hunten, Pioneer Venus experiment descriptions, Space Sci. Rev., 20, No. 4, 451-525, doi:10.1007/BF02186463, June 1977.

# 6   Large Probe Solar Flux Radiometer (LSFR) Data Collection

### 6.1   Instrument Overview

The objective of the LSFR was to determine the regions in the atmosphere where solar energy is deposited. The narrow field-of-view detectors measured the intensity of scattered solar light. As the probe descended through the atmosphere, the difference between upward-looking and downward-looking detectors indicated the net downward flux. The data were used to determine the deposition of solar energy in the atmosphere of Venus between 67 km and the surface along with upward and downward fluxes and radiances. The LSFR continuously measured the difference in atmospheric radiance above and below the horizon of the probe as a function of altitude, to determine how much sunlight was absorbed by the clouds and how much reached the surface. The results allow for more accurate modelling of the radiation balance of the atmosphere than previously possible, to help determine the role of the greenhouse effect on the heating of the Venus atmosphere.

## 6.2 Data Products

This collection contains one data product, consisting of one CSV data file, a descriptive text file, and a metadata label. The product is the reformatted contents of files 007 and 008 in PSPA-00034.

| Product LID | Product files in collection directory data_lsfr/ | Brief Description |
|---|---|---|
| *urn:nasa:pds:pv_sed:data_lsfr:lsfr_solar_flux* | lsfr_solar_flux.csv<br>lsfr_solar_flux_descr.txt<br>lsfr_solar_flux.xml | Lower atmospheric solar up, down, and net flux measurements below 65 km |

The CSV file contains 12 columns as follows: ground received time (GRT) in hours, minutes, and decimal seconds, corresponding to when the data sample was taken; atmospheric pressure in earth atmospheres; altitude in kilometers; the upward, downward, and net (downward minus upward) fluxes in watts per square meter for the visible channel at approximately 0.40-0.96 microns; the upward, downward, and combined fluxes in watts per square meter for the combined channel, which is a synthesis of both the visible and infrared channels into a single broad-band at approximately 0.41-1.78 microns; and the upward, downward, and net fluxes in watts per square meter for the narrow-band channel at approximately 0.59-0.67 microns.

lsfr_solar_flux.csv: Each record contains 12 columns as follows:
- ground received time (GRT) in hours, minutes, and seconds, corresponding to when the data sample was taken,
- atmospheric pressure (earth atmosphere),
- altitude (km),
- upward, downward, and net (downward minus upward) fluxes in watts per square meter for the visible channel at approximately 0.40-0.96 micron,
- upward, downward, and combined fluxes in watts per square meter for the combined channel, which is a synthesis of both the visible and infrared channels into a single broad-band at approximately 0.41-1.78 micron, and
- upward, downward, and net fluxes in watts per square meter for the narrow-band channel at approximately 0.59-0.67 micron.

## 6.3 Notes, including findings from reformatting

An empty field in lsfr_solar_flux.csv means that data value was blank in the source file.

## 6.4 References

Tomasko, M. G., et al., Preliminary results of the solar flux radiometer experiment aboard the Pioneer Venus multiprobe mission, Science, 203, No. 4382, 795-797, doi:10.1126/science.203.4382.795, Feb. 1979.

Tomasko, M. G., et al., Pioneer Venus sounder probe solar flux radiometer, IEEE Trans. Geosci. Rem. Sens., GE-18, No. 1, 93-96, doi:10.1109/TGRS.1980.350288, Jan. 1980.

Pollack, J. B., et al., Distribution and source of the UV absorption in Venus' atmosphere, J. Geophys. Res., 85, No. A13, 8141-8150, doi:10.1029/JA085iA13p08141, Dec. 1980.

Tomasko, M. G., et al., Measurements of the flux of sunlight in the atmosphere of Venus, J. Geophys. Res., 85, No. A13, 8167-8186, doi:10.1029/JA085iA13p08167, Dec. 1980.

# 7 Orbiter Atmospheric Drag (OAD) Observations and Model Data Collection

## 7.1 Instrument Overview

The OAD experiment made use of the spacecraft S-band and X-band radio signals for data measurements. The objectives were (1) to establish the diurnal variation of thermospheric density and density scale height (2) to determine the relationship of solar wind variations to variations in atmospheric density, (3) to determine the relationship of long and short term variation in solar extreme UV radiation to density variations, (4) to search for phenomena such as a semi-annual variation and super rotation of the thermosphere, and (5) to formulate a thermospheric model for the atmosphere of Venus. The OAD experiment worked by measuring the Doppler shift in X and S band transmissions to the Deep Space Network which would give the spacecraft acceleration along a line-of-sight from the spacecraft to the receiver.

## 7.2 Data Products

This collection contains two data products, each consisting of a CSV data file and a metadata label.  The products are the reformatted contents of files 054 and 055 in PSPA-00034.

| Product LID | Product files in collection directory data_oad/ | Brief Description |
|---|---|---|
| urn:nasa:pds:pv_sed:data_oad:oad_atm_density | oad_atm_density.csv<br>oad_atm_density.xml | Atmospheric drag observations for 1978-12-09 to 1979-08-07 (orbits 5-246) |
| urn:nasa:pds:pv_sed:data_oad:oad_atm_drag_model | oad_atm_drag_model.csv<br>oad_atm_drag_model.xml | Pioneer Venus atmospheric drag model (140-190 km) output |

oad_atm_density.csv:  There is one record for each orbit. Each record contains nine columns as follows:
- observing date as Greenwich Mean Time (GMT) in year, month, and day,
- orbit number,
- altitude (km),
- density (g/cc),
- error in density/density,
- scale height (km),
- exospheric temperature (K),
- local solar time (decimal hours), and
- Venus longitude (deg).

oad_atm_drag_model.csv:  Each record contains six columns as follows:
- local solar time in integer hours,

- altitude (km,)
- density (g/cc),
- number density of atomic oxygen (particles/cc),
- ratio of number densities of O/CO2, and
- temperature (K).

### 7.3   Notes, including findings from reformatting

These data, the measurements and model output, are discussed and tabulated in Keating, et al. (1980).

Although the source file for oad_atm_density.csv defines the observing date in the first column as Greenwich Mean Time, the section in pspa00034.pdf about the OAD data describes this date as the Ground Received Time.

During reformatting, we forced all instances of ":  " to ":00" and ": " to ":0" in the GMT column in oad_atm_density.csv.

### 7.4   References

Keating, G. M., et al., Venus thermosphere and exosphere: First satellite drag measurements of an extraterrestrial atmosphere, Science, 203, No. 4382, 772-774, doi:10.1126/science.203.4382.772, Feb. 1979.

Keating, G. M., et al., Short-term cyclic variations and diurnal variations of the Venus upper atmosphere, Science, 205, No. 4401, 62-64, doi:10.1126/science.205.4401.62, July 1979.

Keating, G. M., et al., Venus upper atmosphere structure, J. Geophys. Res., 85, No. A13, 7941-7956, doi:10.1029/JA085iA13p07941, Dec. 1980.

Colin, L., Ed., and D. M., Ed. Hunten, Pioneer Venus experiment descriptions, Space Sci. Rev., 20, No. 4, 451-525, doi:10.1007/BF02186463, June 1977.

# 8   Orbiter Solar Wind Plasma Analyzer (OPA) Data Collection

### 8.1   Instrument Overview

The OPA instrument was a quadrispherical electrostatic analyzer, similar to the plasma instrument on Pioneers 10 and 11, with five current collectors and electrometers. The objectives were to measure solar wind conditions (velocity, density, flow direction, and temperature) both outside the Venusian bow shock and inside the magnetosheath flow field, and to study the ionopausal structure.

### 8.2   Data Products

This collection contains two data products, each consisting of a CSV data file and a metadata label.  The products are the reformatted contents of files 012-015, 034-052, 062-070, and 033 in PSPA-00034.

| Product LID | Product files in collection directory data_opa/ | Brief Description |
| --- | --- | --- |

| | | |
|---|---|---|
| *urn:nasa:pds:pv_sed:data_opa:opa_ proton_params* | opa_proton_params.csv opa_proton_params.xml | Proton parameters outside the bow shock for orbits 1-1050 |
| *urn:nasa:pds:pv_sed:data_opa:opa_ orbit7_9min_bulk_velocities* | opa_orbit7_9min_bulk_velocities.csv opa_orbit7_9min_bulk_velocities.xml | 9-minute solar wind proton bulk velocities for orbit 7 |

opa_proton_params.csv:  There is one record for each orbit. Each record contains 10 columns as follows:
- orbit number,
- time in hours and minutes UT at the spacecraft, reduced solar wind flow speed (km/s), and reduced proton number density (per cc) observed just before the (first) inbound crossing of the bow shock of Venus,
- time in hours and minutes UT at the spacecraft, reduced solar wind flow speed (km/s), and reduced proton number density (per cc) observed just after the (last) outbound crossing of the bow shock of Venus,
- data processing date, and
- source filename in PSPA-00034, e.g., 012.

opa_orbit7_9min_bulk_velocities.csv:  Each record contains two columns as follows:
- time of the measurement in hours, minutes, and seconds UT at the spacecraft
- bulk velocity (km/s).

### 8.3    Notes, including findings from reformatting

The PSPA-00034 dataset includes this comment about the OPA data:  The proton parameters were obtained by a least squares fit of a convecting isotropic Maxwellian proton velocity distribution, convolved through the instrument response function obtained from laboratory calibration, to the raw currents. The flow speed obtained by this procedure should normally be accurate (conservative error bars would be +/-10%). The proton number density is generally less accurate (conservatively +/-50%). The precise time of measurement refers to the completion of the measurement cycle (approximately 9 minutes) of 45 spin periods. The time is always within two measurement cycles of the inferred shock crossing.

opa_proton_params.csv:
- An empty field means that value was blank in the source file.
- During reformatting, we forced one instance of ":" to "." in the outbound density value in the record for orbit number 118.

We did not reformat source files 011 and 061 in PSPA-00034 as data products for this archive because they are bulletins issued by the data providers about OPA data processing and do not contain any data.  However, we included the contents of the files in Appendices A and B for completeness.

### 8.4    References

Intriligator, D. S., et al., The Pioneer Venus Orbiter plasma analyzer experiment, IEEE Trans. Geosci. Rem. Sens., GE-18, No. 1, 39-43, doi:10.1109/TGRS.1980.350258, Jan. 1980.

Wolfe, J., et al., Initial observations of the Pioneer Venus Orbiter solar wind plasma experiment, Science, 203, No. 4382, 750-752, doi:10.1126/science.203.4382.750, Feb. 1979.

Intriligator, D. S., et al., Electron observations and ion flows from the Pioneer Venus Orbiter plasma analyzer experiment, Science, 205, No. 4401, 116-119, doi:10.1126/science.205.4401.116, July 1979.

# 9 Small Probes Net Flux Radiometers (SNFR) Data Collection

### 9.1 Instrument Overview

The objectives of the three SNFR instruments were to locate regions of radiative convergence and divergence as a function of altitude and to indicate the height at which solar energy is absorbed by the atmosphere. The North and Night Probes, both entering the nightside of Venus, measured net infrared flux only, while the Day Probe also measured net solar flux. The instrument was designed to cover the spectral band from 0.2 to 50 microns with a resolution of 1 km.

### 9.2 Data Products

This collection contains three data products, each consisting of a CSV data file, a descriptive text file, and a metadata label.  The products are the reformatted contents of files 022-025 in PSPA-00034.

| Product LID | Product files in collection directory data_snfr/ | Brief Description |
|---|---|---|
| urn:nasa:pds:pv_sed:data_snfr: snfr_day_net_flux | snfr_day_net_flux.csv snfr_day_net_flux_descr.txt snfr_day_net_flux.xml | Day Probe net solar flux measurements (13-66 km) |
| urn:nasa:pds:pv_sed:data_snfr: snfr_night_net_flux | snfr_night_net_flux.csv snfr_night_net_flux_descr.txt snfr_night_net_flux.xml | Night Probe atmospheric  net infrared flux measurements (66-13 km) |
| urn:nasa:pds:pv_sed:data_snfr: snfr_night_net_flux | snfr_north_net_flux.csv snfr_north_net_flux_descr.txt snfr_north_net_flux.xml | North Probe atmospheric net infrared flux measurements (66-13 km) |

All three snfr_*_net_flux.csv files:  Each record contains seven columns as follows:
- ground received time (GRT) in decimal minutes after 1900 Greenwich Mean Time (GMT), with negative signs indicating minutes before GMT,
- altitude (km) above 90.3 bars surface pressure,
- pressure (bars),
- atmospheric temperature (K),
- external sensor temperature (K),
- net total radiance flux density in watts per square meter as measured, with positive signs indicating upward flux exceeds downward flux, and
- net flux in watts per square meter corrected for estimated effects of deployment transient, rate of change of offset, and non-vertical attitude.

### 9.3 Notes, including findings from reformatting

snfr_night_net_flux.csv and snfr_north_net_flux.csv:

- In the source files some values for sensor temperature, measured net flux, and corrected net flux are given as 9999.0 or 9999.00, indicating a missing or not available value. During reformatting, we preserved these values except for 9999.0 which we forced to 9999.00 for consistency.

### 9.4 References

Sromovsky, L. A., et al., Pioneer Venus small probes net flux radiometer experiment, IEEE Trans. Geosci. Rem. Sens., GE-18, No. 1, 117-121, doi:10.1109/TGRS.1980.350293, Jan. 1980.

Suomi, V. E., et al., Preliminary results of the Pioneer Venus small probe net flux radiometer experiment, Science, 205, No. 4401, 82-85, doi:10.1126/science.205.4401.82, July 1979.

Suomi, V. E., et al., Net radiation in the atmosphere of Venus: Measurements and interpretation, J. Geophys. Res., 85, No. A13, 8200-8218, doi:10.1029/JA085iA13p08200, Dec. 1980.

Colin, L., Ed., and D. M., Ed. Hunten, Pioneer Venus experiment descriptions, Space Sci. Rev., 20, No. 4, 451-525, doi:10.1007/BF02186463, June 1977.

# 10 Multiprobes Nephelometer (LN/SN) Data Collection

### 10.1 Instrument Overview

The four nephelometer experiments (designated LN on the Large Probe and SN on the Small Probes) measured the energy backscattered from cloud particles. They used a solid state pulsed focused light beam emitter (at about 9000 A) to illuminate the clouds. The objectives were to simultaneously investigate the vertical structure of the clouds of Venus at four widely separated locations, and to attempt to vertically document the source of atmospheric ultraviolet absorption. The nephelometers were designed to search for cloud particles in the atmosphere outside the region that was aerodynamically disturbed by the probe, over a distance from approximately 20 cm from the lens plane to beyond 2 meters. The nephelometers were automatically deployed when the heat shield jettisoned at about 65 km altitude for the Large Probe, about 66 km for the Day Probe, about 64 km for the Night Probe, and about 61 km for the North Probe.

### 10.2 Data Products

This collection contains 24 data products, each consisting of a CSV data file, a descriptive text file, and a metadata label. The products are the reformatted contents of files 027, 031, 032, and 053 in PSPA-00034.

| Product LID | Product files in collection directory data_neph/ | Brief Description |
|---|---|---|
| urn:nasa:pds:pv_sed:data_neph :ln_background_uv_vis_h_units | ln_background_uv_vis_h_units.csv ln_background_uv_vis_h_units.xml | LN ambient background radiation readings for UV and VIS channels in 'H' units vs. time |

| | | |
|---|---|---|
| *urn:nasa:pds:pv_sed:data_neph :ln_background_uv* | ln_background_uv.csv<br>ln_background_uv.xml | LN ambient background radiation for UV channel, spectral functions |
| *urn:nasa:pds:pv_sed:data_neph :ln_background_vis* | ln_background_vis.csv<br>ln_background_vis.xml | LN ambient background radiation for VIS channel, spectral functions |
| *urn:nasa:pds:pv_sed:data_neph :ln_backscatter_angular_weighti ng* | ln_backscatter_angular_weighting.csv<br>ln_backscatter_angular_weighting.xml | LN backscatter channel angular weighting functions |
| *urn:nasa:pds:pv_sed:data_neph :ln_backscatter* | ln_backscatter.csv<br>ln_backscatter.xml | LN backscatter channel data vs. time |
| *urn:nasa:pds:pv_sed:data_neph :ln_temperature* | ln_temperature.csv<br>ln_temperature.xml | LN instrument temperature vs. time |
| *urn:nasa:pds:pv_sed:data_neph :sn_day_background_uv_vis_h_u nits* | sn_day_background_uv_vis_h_units.csv<br>sn_day_background_uv_vis_h_units.xml | SN Day Probe ambient background radiation readings for UV and VIS channels in 'H' units vs. time |
| *urn:nasa:pds:pv_sed:data_neph :sn_day_background_uv* | sn_day_background_uv.csv<br>sn_day_background_uv.xml | SN Day Probe ambient background radiation for UV channel, spectral functions |
| *urn:nasa:pds:pv_sed:data_neph :sn_day_background_vis* | sn_day_background_vis.csv<br>sn_day_background_vis.xml | SN Day Probe ambient background radiation for VIS channel, spectral functions |
| *urn:nasa:pds:pv_sed:data_neph :sn_day_backscatter_angular_w eighting* | sn_day_backscatter_angular_weighting.csv<br>sn_day_backscatter_angular_weighting.xml | SN Day Probe backscatter channel angular weighting functions |
| *urn:nasa:pds:pv_sed:data_neph :sn_day_backscatter* | sn_day_backscatter.csv<br>sn_day_backscatter.xml | SN Day Probe backscatter channel data vs. time |
| *urn:nasa:pds:pv_sed:data_neph :sn_day_temperature* | sn_day_temperature.csv<br>sn_day_temperature.xml | SN Day Probe instrument temperature vs. time |
| *urn:nasa:pds:pv_sed:data_neph :sn_night_background_uv_vis_h_ units* | sn_night_background_uv_vis_h_units.csv<br>sn_night_background_uv_vis_h_units.xml | SN Night Probe ambient background radiation readings for UV and VIS channels in 'H' units vs. time |
| *urn:nasa:pds:pv_sed:data_neph :sn_night_background_uv* | sn_night_background_uv.csv<br>sn_night_background_uv.xml | SN Night Probe ambient background radiation for UV channel, spectral functions |
| *urn:nasa:pds:pv_sed:data_neph :sn_night_background_vis* | sn_night_background_vis.csv<br>sn_night_background_vis.xml | SN Night Probe ambient background radiation for VIS channel, spectral functions |
| *urn:nasa:pds:pv_sed:data_neph :sn_night_backscatter_angular_ weighting* | sn_night_backscatter_angular_weighting.csv<br>sn_night_backscatter_angular_weighting.xml | SN Night Probe backscatter channel angular weighting functions |
| *urn:nasa:pds:pv_sed:data_neph :sn_night_backscatter* | sn_night_backscatter.csv<br>sn_night_backscatter.xml | SN Night Probe backscatter channel data vs. time |
| *urn:nasa:pds:pv_sed:data_neph :sn_night_temperature* | sn_night_temperature.csv<br>sn_night_temperature.xml | SN Night Probe instrument temperature vs. time |
| *urn:nasa:pds:pv_sed:data_neph :sn_north_background_uv_vis_h _units* | sn_north_background_uv_vis_h_units.csv<br>sn_north_background_uv_vis_h_units.xml | SN North Probe ambient background radiation readings for UV and VIS |

| | | channels in 'H' units vs. time |
|---|---|---|
| *urn:nasa:pds:pv_sed:data_neph :sn_north_background_uv* | sn_north_background_uv.csv<br>sn_north_background_uv.xml | SN North Probe ambient background radiation for UV channel, spectral functions |
| *urn:nasa:pds:pv_sed:data_neph :sn_north_background_vis* | sn_north_background_vis.csv<br>sn_north_background_vis.xml | SN North Probe ambient background radiation for VIS channel, spectral functions |
| *urn:nasa:pds:pv_sed:data_neph :sn_north_backscatter_angular_ weighting* | sn_north_backscatter_angular_weighting.csv<br>sn_north_backscatter_angular_weighting.xml | SN North Probe backscatter channel angular weighting functions |
| *urn:nasa:pds:pv_sed:data_neph :sn_north_backscatter* | sn_north_backscatter.csv<br>sn_north_backscatter.xml | SN North Probe backscatter channel data vs. time |
| *urn:nasa:pds:pv_sed:data_neph :sn_north_temperature* | sn_north_temperature.csv<br>sn_north_temperature.xml | SN North Probe instrument temperature vs. time |

All four *_background_uv_vis_h_units.csv files:  Each record contains four columns as follows:

- ground received time (GRT) in hours, minutes, and seconds GMT,
- background ultraviolet channel reading ('H' units),
- background visible channel reading ('H' units), and
- spacecraft or instrument event or a note contained in the original source file.

All four *_background_uv.csv files:  Each record contains two columns as follows:

- wavelength (nm), and
- spectral function R ('H' units/(microwatt*m^2*sr)).

All four *_background_vis.csv files:  Each record contains NNN columns as follows:
The backscatter channel data consist first of a tabulation of the angular weighting or sensitivity function, f (theta), for the nephelometer as a function of
scattering angle with respect to the direction of propagation of a nearby monochromatic incident light beam at a wavelength of approximately 900 nanometers

- time of the measurement in hours, minutes, and seconds UT at the spacecraft
- bulk velocity (km/s).

All four *_backscatter_angular_weighting.csv files:  Each record contains three columns as follows:

- scattering angle (deg)
- angular weighting or sensitivity function, f(theta), for the nephelometer backscatter channel as a function of scattering angle with respect to the direction of propagation of a nearby monochromatic incident light beam at a wavelength of approximately 900 nanometers. The f (theta) function is normalized so that the integral of f(theta) *d*_theta = 1, and
- errata for capturing value(s) contained in the source file but not explained in the documentation.

All four *backscatter.csv files:  Each record contains three columns as follows:
- Ground-received time (GRT) in hours, minutes, and seconds GMT,
- measured backscatter cross section (1/(m*sr)),
- spacecraft or instrument event or a note contained in the original source file.

All four *temperature.csv files:  Each record contains two columns as follows:
- Ground-received time (GRT) in hours, minutes, and seconds GMT, and
- Instrument temperature (degrees Celsius), measured at the location of the light emitting diode.

### 10.3  Notes, including findings from reformatting

The user should refer to the Nephelometer section in pspa00034.pdf, which provides a detailed discussion of these data.

The PSPA-00034 source files include this user note for the LN/SN backscatter channel data:  Please see data of Atmospheric Structure experiments (LAS/SAS) to obtain altitude vs. time profiles.

The PSPA-00034 source files label the observation times as GMT but pspa00034.pdf states those values are GRT. We assumed the observation times are GRT as GMT.

In the four *_backscatter_angular_weighting.csv files, the first column is simply defined as "angle" in the documentation and literature. We assume it is the scattering angle referenced by the angular weighting or sensitivity function, f(theta), in the second column.

ln_background_uv_vis_h_units.csv:
- We forced blank values, which indicate saturated values, to 9.99E+09.
- During reformatting, we forced one instance of ":" to "." in the outbound density value in the record for orbit number 118.

sn_background_uv_vis_h_units.csv:
- We forced blank values, which indicate saturated values, to 9.99E+09.

We did not include reformat files 011 and 061 from PSPA-00034 as data products for this archive because they are bulletins issued by the data providers about the OPA data processing and are not useful.  However, we included the contents of the files in Appendices A and B for completeness.

### 10.4  References

Ragent, B., et al., Pioneer Venus sounder and small probes nephelometer instrument, IEEE Trans. Geosci. Rem. Sens., GE-18, No. 1, 111-116, doi:10.1109/TGRS.1980.350292, Jan. 1980.

Ragent, B., and J. Blamont, Preliminary results of the Pioneer Venus nephelometer experiment, Science, 203, No. 4382, 790-792, doi:10.1126/science.203.4382.790, Feb. 1979.

Blamont, J., and B. Ragent, Further results of the Pioneer Venus nephelometer experiment, Science, 205, No. 4401, 67-70, doi:10.1126/science.205.4401.67, July 1979.

Ragent, B., and J. Blamont, The structure of the clouds of Venus: Results of the Pioneer Venus nephelometer experiment, J. Geophys. Res., 85, No. A13, 8089-8015, doi:10.1029/JA085iA13p08089, Dec. 1980.

# 11 Multiprobes Atmospheric Structure (LAS/SAS) Data Collection

### 11.1  Instrument Overview

The objective of the four Atmospheric Structure experiments (designated LAS on the Large Probe and SAS on the Small Probes) was to characterize the atmosphere of Venus down to the surface at the four different entry sites. LAS was a slightly different version that SAS on the three small probes. LAS instruments included four-axis accelerometers, pressure sensors, and temperature sensors. SAS instruments included one single-axis accelerometer, pressure sensors, and temperature sensors, The measurements were used to construct a profile of atmosphere state properties for the probe trajectory from the surface to approximately 140 km altitude; and to determine vertical wind velocity, horizontal wind velocity, and turbulence.

### 11.2  Data Products

This collection contains eight data products, each consisting of a CSV data file, a descriptive text file, and a metadata label.  The products are the reformatted contents of files 001, 002, 016-021, 056-060 in PSPA-00034.

| Product LID | Product files in collection subdirectory data_atm_struct/descent_low_atm/ | Brief Description |
|---|---|---|
| urn:nasa:pds:pv_sed:data_atm_struct:las_low_atm_state | las_low_atm_state.csv<br>las_low_atm_state_descr.txt<br>las_low_atm_state.xml | Large Probe lower atmospheric state properties during descent, below 62 km< |
| urn:nasa:pds:pv_sed:data_atm_struct:sas_day_low_atm_state | sas_day_low_atm_state.csv<br>sas_day_low_atm_state_descr.txt<br>sas_day_low_atm_state.xml | Day Probe lower atmospheric state properties during descent, below 67 k |
| urn:nasa:pds:pv_sed:data_atm_struct:sas_night_low_atm_state | sas_night_low_atm_state.csv<br>sas_night_low_atm_state_descr.txt<br>sas_night_low_atm_state.xml | Night Probe lower atmospheric state properties during descent, below 65 k |
| urn:nasa:pds:pv_sed:data_atm_struct:sas_north_low_atm_state | sas_north_low_atm_state.csv<br>sas_north_low_atm_state_descr.txt<br>sas_north_low_atm_state.xml | North Probe lower atmospheric state properties during descent, below 62 k |

| Product LID | Product files in collection subdirectory data_atm_struct/entry_mid_atm / | Brief Description |
|---|---|---|
| urn:nasa:pds:pv_sed:data_atm_struct: sas_day_mid_atm_state | sas_day_mid_atm_state.csv<br>sas_day_mid_atm_state_descr.txt<br>sas_day_mid_atm_state.xml | Day Probe middle atmospheric state properties and trajectory parameters during entry, 137-70 km |
| urn:nasa:pds:pv_sed:data_atm_struct: sas_night_mid_atm_state | sas_night_mid_atm_state.csv<br>sas_night_mid_atm_state_descr.txt<br>sas_night_mid_atm_state.xml | Night Probe middle atmospheric state properties and trajectory parameters during entry, 137-70 km |
| urn:nasa:pds:pv_sed:data_atm_struct: sas_north_mid_atm_state | sas_north_mid_atm_state.csv<br>sas_north_mid_atm_state descr.txt<br>sas_north_mid_atm_state.xml | North Probe middle atmospheric state properties and trajectory parameters during entry, 119-66 km |
| Product LID | Product files in collection subdirectory data_atm_struct/entry_high_atm/ | Brief Description |
| urn:nasa:pds:pv_sed:data_atm_struct: sas_night_high_atm_state | sas_night_high_atm_state.csv<br>sas_night_high_atm_state_descr.txt<br>sas_night_high_atm_state.xml | Night Probe high atmospheric state properties during entry, 170-142 km, derived from PVO drag data |

All four *_low_atm_state.csv files:  Each record contains six columns as follows:
- ground received time (GRT) in hours and decimal minutes UT,
- ground received time (GRT) in seconds UT.
- altitude (km),
- atmospheric pressure (bar),
- temperature (K),
- derived density (kg/m^3), and
- gas compressibility factor "zeta".

All four *_mid_atm_state.csv files:  Each record contains seven columns as follows:
- ground received time (GRT) in hours and decimal minutes UT,
- ground received time (GRT) in seconds UT.
- altitude (km),
- velocity (km/s),
- probe path angle below horizon "gamma" (deg),
- derived density (kg/m^3),
- atmospheric pressure (bar),
- temperature (K), and
- comment, contained in the original source file, about interpolated data.

sas_night_high_atm_state.csv file:  Each record contains four columns as follows:
- altitude (km),
- derived density (kg/m^3),
- atmospheric pressure (millibar), and
- temperature (K).

### 11.3  Notes, including findings from reformatting

The user should refer to the Atmosphere Structure Experiment section in pspa00034.pdf, which provides a detailed discussion of these data.

The ground received time (GRT) is the earth received time given in UT and is about 3 minutes later than the spacecraft time (Table 5-2, Fimmel et al., 1995).  The GRT given in hours and minutes is correct to the nearest 0.06 sec. The GRT given in seconds is rounded to nearest second.

The PSPA-00034 dataset includes these comments about the LAS/SAS data:
- Altitudes are referenced to 6052.0 km, which is the observed radius in the vicinity of the Large Probe landing site as determined by the Orbiter Radar Altimeter Experiment.
- For the Large Probe, data entries are at 4-s intervals above 13 km, and at 32-s intervals thereafter. For the small probes, data intervals are 8 s in upper descent, 16 s in lower descent, and 32 s below 12-14 km. Below about 13 km the temperature data were faulty, so in this region extrapolated values are given.

During reformatting, we forced all instances of ":  " to ":00" and ": " to ":0" for hours in the GMT column in the *_low_atm_state.csv and *_mid_atm_state.csv files.

### 11.4  References

Fimmel, R.O., L. Colin, and E. Burgess, Pioneering Venus A Planet Unveiled, Technical Report, NASA Ames Research Center, Moffett Field, CA, 1995.

Seiff, A., et al., Structure of the atmosphere of Venus up to 110 kilometers: Preliminary results from the four Pioneer Venus entry probes, Science, 203, No. 4382, 787-790, doi:10.1126/science.203.4382.787, Feb. 1979.

Seiff, A., et al., Atmosphere structure instruments on the four Pioneer Venus entry probes, IEEE Trans. Geosci. Rem. Sens., GE-18, No. 1, 105-110, doi:10.1109/TGRS.1980.350291, Jan. 1980.

Seiff, A., et al., Measurements of thermal structure and thermal contrasts in the atmosphere of Venus and related dynamical observations: Results from the four Pioneer Venus probes, J. Geophys. Res., 85, No. A13, 7903-7933, doi:10.1029/JA085iA13p07903, Dec. 1980.

Seiiff, A., and D. B. Kirk, Structure of the Venus mesosphere and lower thermosphere from measurements during entry of the pioneer Venus probes, Icarus, 49, No. 1, 49-70, doi:10.1016/0019-1035(82)90056-2, Jan. 1982.

Hoffman, J. H., et al., Composition and structure of the atmosphere of Venus, Space Sci. Rev., 20, No. 3, 307-327, doi:10.1007/BF02186468, May 1977.

# 12 Document Collection

## 12.1 Data Products

This collection contains three document products in PDF/A format.

| Product LID | Product files in collection directory data_lir/ | Brief Description |
|---|---|---|
| urn:nasa:pds:pv_sed:document: pspa00034 | pspa00034.pdf pspa00034_errata.txt pspa00034.xml | NSSDCA dataset description of PV SED PSPA-00034; known errata in that document |
| urn:nasa:pds:pv_sed:document: pspa00034_vs_pds_file_list | pspa00034_vs_pds_file_list.pdf pspa00034_vs_pds_file_list.xml | List of NSSDCA PSPA-00034 data file names correlated with PDS data files in this bundle |
| urn:nasa:pds:pv_sed:document: bundle_user_guide | bundle_user_guide.pdf bundle_user_guide.xml | User guide for the PV SED Bundle |

# 13 General PV References

Colin, L., Ed., and D. M., Ed. Hunten, Pioneer Venus experiment descriptions, Space Sci. Rev., 20, No. 4, 451-525, doi:10.1007/BF02186463, June 1977. Colin, L., Encounter with Venus, Science, 203, No. 4382, 743-745, doi:10.1126/science.203.4382.743, Feb. 1979.

Colin, L., Pioneer Venus overview, IEEE Trans. Geosci. Rem. Sens., GE-18, No. 1, 3-4, doi:10.1109/TGRS.1980.350250, Jan. 1980.

Colin, L., The Pioneer Venus program, J. Geophys. Res., 85, No. A13, 7575-7598, doi:10.1029/JA085iA13p07575, Dec. 1980.

Donahue, T. M., Pioneer Venus results: An overview, Science, 205, No. 4401, 41-44, doi:10.1126/science.205.4401.41, July 1979.

Fimmel, Richard O., et al., Pioneer Venus, NASA ARC, SP-461, Moffett Field, CA, 1983.

Nothwang, G. J., Pioneer Venus spacecraft design and operation, IEEE Trans. Geosci. Rem. Sens., GE-18, No. 1, 5-10, doi:10.1109/TGRS.1980.350251, Jan. 1980.

Planetary Data System, *PDS4 Standards Reference, Version 1.20.0.0*, JPL D-7669, Part 2, Jet Propulsion Laboratory, doi:10.17189/gqaa-fw86, March 2023.

# 14 Terminology and Definitions

- Bundle        A set of PDS4 collections
- Collection    A set of PDS4 basic products
- CSV           Comma separated values file
- EBCDIC        Extended Binary Coded Decimal Interchange Code
- GMT           Greenwich Mean Time
- GRT           Ground Received Time
- IBM           International Business Machines Corporation
- LID           PDS Logical Identifier for a bundle, collection, or basic product
- NSSDCA        NASA Space Science Data Coordinated Archive
- PDF           Portable Document Format

- PDF/A          Version of PDF specialized for archiving and long term preservation
- PDS            Planetary Data System
- PDS4           Version 4 of the PDS Data Model, XML-based
- UT             Universal Time
- XML            eXtensible Markup Language

# 15 Appendix A

Contents of Source File 011, OPA Bulletin:

```
******** ******** ******** ******** ******** *******
BULLETIN OPAPARAM CREATED: 04/25/80 12:34:21 BY ARCALL
******** ******** ******** ******** ******** ********
*
SINCE FILE NAME AND DESCR DO NOT REFLECT ORBITS IN EACH DATA SET NOW
IN UADS/SED, THE FOLLOWING LIST WILL DESCRIBE THE DATA.  FUTURE ENTRIES
WILL INDICATE THE FIRST ORBIT NO. OF THE SET.  APPROXIMATELY 30 ORBITS
WILL BE ENTERED AT A TIME.
       OPA ORBITS 001/031
      OPA2 ORBITS 032/062
       OPA3 ORBITS 063/093
       OPA4 ORBITS 094/124
```

# 16 Appendix B

The contents of PSPA-00034 file 061 are captured here.  This is a historical bulletin for users of the OPA data.  It essentially states all orbit numbers in OPA data file 065 were corrected and archived in the PV SED dataset.  While producing this bundle, we confirmed that file 065 (named OPA896 in the bulletin) archived in NSSDCA collection PSPA-00034 contains the stepped down orbit numbers.

```
******** ******** ******** ******** ******** *******
BULLETIN OPAERR CREATED: 08/28/81 15:44:07 BY ARCALL
******** ******** ******** ******** ******** ********
*
THIS BULLETIN CONCERNS ONLY THOSE USERS WHO EXTRACTED THE SED FILE OPA897
(PV PROTON PARAMS OUTSIDE BOW SHOCK) BETWEEN 8/25 AND 8/28, 1981.

OPA897 HAS BEEN REPLACED BY A NEW CORRECTED FILE OPA896.  ALL ORBIT NUMBERS
IN OPA897 WERE INCORRECT AND HAVE BEEN STEPPED DOWN BY ONE.  FOR EXAMPLE,
ORBIT 899 HAS BEEN CORRECTED TO 898.  PLEASE REPLACE YOUR RECORDS OF OPA897
WITH OPA896.
                        THANK-YOU
```