Dataset of direct measured downward global solar radiation in the Western Pacific Ocean

1. IDENTIFICATION INFORMATION

Name	Dataset of direct measured downward global solar radiation in the Western Pacific Ocean
Edition	1.0
Abbreviation	SRWP dataset
DOI	doi:10.20783/DIAS.673 [https://doi.org/10.20783/DIAS.673]
Metadata Identifier	SOLAR_RADIATION_WP20250911003125-DIAS20221121113753-en

2. CONTACT

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5. DATE OF THIS DOCUMENT

2025-09-11

6. DATE OF DATASET

creation : 2010-06-10

7. DATASET OVERVIEW

7.1 Abstract

This dataset provides downward, global solar radiation flux observed mainly in the Western Pacific Ocean from 1990 to 1995. Twenty Japanese voluntary merchant ships participated the observation project. The observation project is described in Iwasaka et al. (1994) and Iwasaka et al. (2000).

10-minute average downward global solar radiation with the observation time (UT), position, cloudiness if available, the ship direction, the solar azimuth relative to the ship direction and the solar altitude at the observation time are given in each record in the dataset. 500,050 records are contained in the file.

The observation project was conducted by the researchers from Tokyo University of Mercantile Marine, The Ocean Research Institute, the University of Tokyo, and Graduate School of Science, Tohoku University.

7.2 Topic Category(ISO19139)

climatologyMeteorologyAtmosphere

environment

geoscientificInformation

oceans

7.3 Temporal Extent

Begin Date	1990-09-01
End Date	1995-02-12
Temporal Characteristics	10minute

7.4 Geographic Bounding Box

North bound latitude	60
West bound longitude	-180
Eastbound longitude	180

South bound latitude	-45

7.5 Grid

7.6 Geographic Description

7.7 Keywords

7.7.1 Keywords on Dataset

Keyword Type	Keyword	Keyword thesaurus Name
theme	Oceans > Ocean Heat Budget > Shortwave Radiation	GCMD_science

7.7.2 Keywords on Project

7.7.2.1 Data Integration and Analysis System

Keyword Type	Keyword	Keyword thesaurus Name
theme	DIAS > Data Integration and Analysis System	No_Dictionary

7.8 Online Resource

file download : https://data.diasjp.net/dl/storages/filelist/dataset:673

7.9 Data Environmental Information

1. Dataset File name: SR_WESTERN_PACIFIC.dat Type: Text file Format: One line contains one record. One record contains 18 items and consists of 77 characters. Space characters are used as the field separator. Sorting order: Ship code, and observation time. Note: The solar radiation values are given for daytime, i.e., from sun rise to sun set, only. See Table 1 for details of the format. 2. Flags (1) Position flag The flag is "1" when the observation position was recorded by crew, usually at 0800, 1200 and 1600 ship's time. The flag is "0" when the position was inferred. The inferred position was estimated every 10 minutes between the recorded positions via a Mercator sailing with a constant ship speed. (2) Shade flag The solar altitude and the solar azimuth are estimated from the recorded/inferred observation position and observation time. The ship direction is evaluated from the two successive observation positions. They are used to judge whether the pyranometer is in the sun (the flag is "1") or shade ("-1"). If the ship direction is not available, the flag is "99". When one of the following conditions was satisfied, the pyranometer was judged to be in the sun. (i) Single sensor observation Absolute value of the relative solar azimuth angle from the ship direction is less than 90° (ii) Double sensor observation (a) Only the sensor on the port side is available. The sun is on the port side. (b) Only the sensor on the starboard side is available. The sun is on the starboard side. (c) The sensors on the both sides are available. Larger value at each observation time is chosen as the observation in the sun when the two simultaneous observations are available. Table 1: Record format No. Variables Type Length Unit Description 1 year I 4 year Observation time (UT) 2 month I 2 month 3 date I 2 date 4 hour I 2 hour 5 minute I 2 minute 6 latitude I 3 degree Latitude of the ship position at the observation time. Positive value indicates the Northern Hemisphere. 7 latitude I 3 minute 8 longitude I 4 degree Longitude of the ship position

at the observation time. Positive indicates the Eastern Hemisphere. 9 longitude I 3 minute 10 position flag I 1 ”1” indicates the position recorded by crew. ”0” implies the inferred position. 11 downward global solar radiation flux F 7.1 Wm^(-2) Downward global solar radiation flux averaged during 10 minutes just before the observation time. 12 cloudiness I 3 Visual observation of the cloudiness (0~10). ”999” indicates the observation was not available. 13 ship direction F 7.1 degree Ship direction was defined as the moving direction of the ship. The direction is expressed as the angle measured from the north. Positive angle means the direction is on the eastern side and the negative on the western side. ”999” indicates the direction is not available. 14 relative solar azimuth F 7.1 degree Solar azimuth angle relative to the ship direction. The angle is measured from the direction and positive angle means the sun is on the starboard side and negative on the port side. 15 solar altitude F 7.1 degree Solar altitude from the horizon 16 shade flag I 2 When the pyranometer is in the sun, the flag is ”1”, and when in the shade the flag is ”-1”. ”99” means unknown. 17 sensor arrangement A 1 ”N” indicates the single-sensor observation. ”M” implies the double-sensor observation. ”P” indicates only the data obtained from the sensor on the port side was available, and ”S” means that from the starboard side was available during the double sensor observation. 18 ship code A 3 See Table 2. *1: Symbols of the data type are as follows: ”I” means integer type, ”F” means real type and ”A” indicates character type, respectively. *2: Length of the real type ”7.1” indicates that the total length is 7, the length of the integer part is 5 including the sign and the length of decimal point is 1, and the length of decimal part is 1, following FORTRAN. Table 2: Ship code code ship name ATA Atagosan maru AUS Australian Endurance GOD Godwit GRA Mizukawa maru, later Gracious Spirit HAK Hakuba maru HEI Heiryu maru HYU HYUGA KEN Kenryu maru KII Kiimaru, later Kinokawa maru KUN Kunisaki maru code ship name KYO Kyokuksho maru NIC Nichigo maru ONO Onoe maru OYA Ooyashima maru SHI Shirotae maru SIN Shinwa maru SOU Southern Cross maru TSU Tsukuba maru WEL Welington maru YAS Yashirokawa maru

7.10 Distribution Information

name	version	specification

8. DATA PROCESSING

8.1 Data Processing (1)

8.1.1 General Explanation of the data producer’s knowledge about the lineage of a dataset

1. Introduction

The observation project was designed to make direct measurement of downward global solar radiation at the sea surface in the Western Pacific. In order to monitor short wave radiation, we installed instruments on the voluntary merchant ships that plied on the lanes between Japan and Indonesia, New Caledonia, Australia or New Zealand. The observation was designed to obtain statistically significant monthly mean, 5-degree-latitude by 5-degree longitude average of the downward solar radiation in the objective area only based on direct measurements.

The sea-lanes were chosen because they covered both tropics and extratropical latitudes and because they were seldom changed by weather conditions.

There are a few insolation data obtained in other oceans and high latitude regions because some of the ships rarely went to other continents due to customer’s request.

2. Instrument

(1) Composition

The instrument consisted of a pyranometer, gimbals, and a data recorder.

(2) Pyranometer

The pyranometer was the Ishikawa Sangyo K.K., model S-185 black and white thermopile sensor.

Sensitivity: 7mV/(kWm^(-2)) for the spectral range of 300-2800 nm

E-folding response time: 6 seconds.

Accuracy: 2%.

(3) Record

The output of the pyranometer, i.e., voltage, was recorded every 10 minutes as a 10-minute average value.

(4) Calibration

Before installing and after unloading, the pyranometers were calibrated against the Eiko Seki, type MS41 pyranometer that had been calibrated by the Japan Meteorological Agency. The calibration revealed that the sensitivity of each pyranometer had changed by no more than 1% during the field observations. Comparing the change of the sensitivity of each sensor, that was no more than 1% with the accuracy of the sensor, we concluded that the deterioration of the sensors was not significant. Thus, we apply calibration coefficients obtained before loading of sensors on the ships.

3. Post-processing

About 6 months later, the recorder was unloaded. The recorded values (mV) were calibrated using the calibration coefficient for each sensor and converted to short wave radiation flux values (Wm^(-2)) using the sensitivity coefficient of the pyranometer.

4. Observation history

We started the observation in the Western Pacific in autumn 1990 and continued until 1995. We installed the instruments on the voluntary merchant ships that plied on the lanes between Japan and Indonesia, New Caledonia, Australia or New Zealand. The sea-lanes were chosen because they covered both tropics and extratopical latitudes and because they were seldom changed by weather conditions.

The observation began in autumn 1990 and ended in autumn 1995. During the first half of the period, i.e., from 1990 through early 1993, we put one set of the instrument on each voluntary ship (single-sensor observation). Although we had been aware of the possibility that the sensor might be shadowed by superstructures of the ship during the voyages, we installed only one set of the instrument on a handrail in front of the highest deck, on the center line of the ship. This was because we intended to have voluntary ships as many as possible so that we would be able to make observation frequent enough to collect data to compute monthly mean, 5-degree-latitude by 5-degree-longitude averaged values in the objective area. We had planned to correct the effect of the shadow on the observation in a statistical way. As many as 20 ships joined the observation during this period.

In 1993, however, the second set of the instrument was loaded on each voluntary ship because we needed to reduce the risk of failure in obtaining data due to troubles in recording system under sever sea conditions in open ocean. One set of the instrument was put on the starboard and the other on the port side of the highest deck of each ship (double-sensor observation), so that at least one of them was always outside of shadow of the superstructure. At the same time, we were forced to reduce the number of the voluntary ships into half, i.e., 10, because of limited number of the instruments. See Iwasaka et al. (2000) for the details of the observation.

8.1.2 Data Source

Data Source Citation Name	Description of derived parameters and processing techniques used

9. DATA REMARKS

Uncertainty in the observations

(1) Observed solar radiation

The accuracy of the pyranometer used in the observation project is ±2%. We do not care possible bias errors due to dried spray on the glass dome of the pyranometer because we had asked the ship's officer and crew to clean the glass dome with freshwater every morning.

(2) Underestimation by shade

Iwasaka et al. (2000) have evaluated the underestimation rate of the daily mean solar radiation is 6.7% in average when the observation suffered from shading.

For individual 10-minute average, the underestimation rate is less than 5.0% when the global solar radiation is less than 400Wm^(-2), and less than 6.0% for the solar radiation less than 1200Wm^(-2). The underestimation rates were evaluated using complete sets of double-sensor observations. The underestimation rate is defined as the rate that 68% of the observation suffered from shading are less or equal to the rate, which is evaluated for every 10Wm^(-2) bin of the observed solar radiation in the sun. There is about 32% chance that the observation suffered from the shade is underestimated more than the rate.

These underestimation rates, 5.0% or 6.0%, are applicable for 10-minute average values obtained from single-sensor observations, which possibly suffered from shading, when the shading flag is "1". If one of the two sensors was fail to measure the solar radiation in a certain double-sensor observation, the underestimation rates are also applicable when the flag is "1".

Double-sensor observations give the solar radiation values free from the effect of shading when observations from both of the sensors are available.

(3) Position

Combination of a celestial navigation, a hyperbolic navigation system, and the navy navigation satellite system was generally used to determine the ship's position until the middle of 1990s because it was too early to use the GPS system on the merchant ships. Therefore, the uncertainty in the recorded position must be larger than that of the recent GPS positioning.

We applied a Mercator sailing to infer the ship's positions between the recorded positions. In the calculation, we assumed the Earth was complete sphere, rather than a spheroid because of simplicity in calculation.

It is difficult to evaluate uncertainty in the positioning quantitatively but it must be subject to at least a few hundred meters in open ocean.

(4) Time

The time stamp was issued by the clock in the data recorder, KADEC-UP from KONA System Co. Ltd. The time of the clock was correctly adjusted just before the observation started. However, the time stamp sometimes showed a small difference from the correct time when the recorder was unloaded about 6 months later. Since the time differences were generally less than 10 minutes, we did not make any correction on the time stamps in the record.

10. DATA POLICY

10.1 Data Policy by the Data Provider

The reference (Iwasaka et al., 2000) should be cited when the dataset is used.

10.2 Data Policy by the Project

10.2.1 Data Integration and Analysis System

If data provider does not have data policy, DIAS Terms of Service (https://diasjp.net/en/terms/) and DIAS Privacy Policy (https://diasjp.net/en/privacy/) apply.

If there is a conflict between DIAS Terms of Service and data provider's policy, the data provider's policy shall prevail.

11. LICENSE

12. DATA SOURCE ACKNOWLEDGEMENT

12.1 Acknowledge the Data Provider

12.2 Acknowledge the Project

12.2.1 Data Integration and Analysis System

If you plan to use this dataset for a conference presentation, paper, journal article, or report etc., please include acknowledgments referred to following examples. If the data provider describes examples of acknowledgments, include them as well.

" In this study, [Name of Dataset] provided by [Name of Data Provider] was utilized. This dataset was also collected and provided under the Data Integration and Analysis System (DIAS), which was developed and operated by a project supported by the Ministry of Education, Culture, Sports, Science and Technology. "

13. REFERENCES

Iwasaka, N., S. Kuwashima, H. Otobe, K. Hanawa, H. Hagiwara and R. Suzuki, 1994: In situ measurement of incoming solar radiation by voluntary ships in the Western Pacific, J. Oceanogr., 50, 713-723.

Iwasaka, N., Y. Isozaki, S. Kuwashima, H. Otobe and K. Hanawa, 2000: Observational study on the downward solar radiation at the sea surface in the Western Pacific. J. Oceanogr., 56, 717-726.