IPAB Antarctic Drifting Buoy Data, Version 1

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

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National Snow and Ice Data Center

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1 DATA DESCRIPTION

The World Climate Research Programme (WCRP) International Programme for Antarctic Buoys (IPAB), through participating research organizations in various countries, maintains a network of drifting buoys in the Antarctic sea ice zone to support a better understanding of sea ice motion, meteorology, and oceanography. The IPAB Antarctic Drifting Buoy Data archive, presently spanning the years 1995 to 1998, includes measurements of buoy position, atmospheric pressure, air temperature, and sea surface temperature. Data are organized by daily and three-hour averages; and the raw, instantaneous, non-interpolated data values. Data were collected from buoys initially deployed in three study regions: East Antarctica; the Weddell Sea; and the Bellingshausen, Amundsen, and Ross Seas. Data are in ASCII text format and are available by ftp. Data updates will become available as data are processed and new buoys are deployed.

1.1 Parameters

1.1.1 Parameter Description

The primary IPAB data set parameters are buoy position, atmospheric pressure, air temperature, and sea surface temperature. Other variables (for example, wind speed, sea surface salinity, sub-surface salinity, wave period and height, and ice motion) are often measured by buoy platforms, but IPAB did not have access to calibrations for these variables.

Table 1. Units of Measure

Parameter	Units
Buoy position	latitude, longitude [decimal degrees]
Surface atmospheric pressure	hectopascals [hPa]
Surface air temperature	degrees Celsius [°C]
Sea surface temperatures	degrees Celsius [°C]

1.1.2 Parameter Range

Table 2. Table modified from Data Buoy Cooperation Panel (DBCP), 1995.

Parameter	Approximate range
Buoy position	-76° to -57 ° latitude -180° to +180° longitude
Surface atmospheric pressure	800 to 1050 hPa
Surface air temperature	-50 to +45 degrees Celsius
Sea surface temperature	-2 to +35 degrees Celsius

1.1.3 Sample Data Record

Table 3. Following is sample output from the file "aad18_24h.a_97".

#PTT	Year	Day of Year	Longitude	Latitude	Air Pressure	Air Temperature	Sea Surface Temperature
4471	1997	1.000	112.9654	-60.5241	995.1	3.43	99.99
4471	1997	2.000	113.1589	-60.5793	998.0	2.30	99.99
4471	1997	3.000	113.3499	-60.7142	983.6	2.29	99.99
4471	1997	4.000	113.7715	-60.5270	963.6	0.92	99.99
4471	1997	5.000	114.2524	-60.3807	956.6	0.82	99.99

Columns represent Argos transmitter number (#PTT), year, day of year, longitude and latitude (decimal degrees), air pressure (hPa), air temperature (degrees Celsius), and sea surface temperature (degrees Celsius). A value of 99.99 indicates that data are not available.

1.2 File Information

1.2.1 Format

Data are in fixed-width, space-delimited, ASCII text format.

Data are available in the following forms:

All: Raw, instantaneous, non-interpolated data values for buoy position, air pressure, air temperature, and sea surface temperature.

Daily: 24-hour spline-interpolated buoy position, air pressure, air temperature, sea surface temperature, and zonal, meridional, and total daily drift components.

Three-Hour: Three-hourly interpolated buoy position, air pressure, air temperature, and sea surface temperature.

Files range in size from approximately 574 bytes to 421,120 bytes.

Data is available here: https://daacdata.apps.nsidc.org/pub/DATASETS/IPAB_BUOYS/

1.2.2 Naming Convention

File naming convention is as follows:

aaacc_ttt.a_yy or aaacc_ttt.v_yy

Where

aaa = participating agency

Example:

awi = Alfred Wegener Institute, Germany

aad = Australian Antarctic Division

crc = Antarctic Cooperative Research Centre, Australia

fin = Finnish Institute of Marine Research & Dept. of Geophysics, University of Helsinki

gia = Geophysical Institute, University of Alaska, USA

ldo = Lamont-Doherty Earth Observatory, Columbia University, USA

spi = Scott Polar Research Institute, United Kingdom

cc = unique identifier given to each IPAB buoy (values range from 01 to 99)

ttt = temporal resolution

Example:

24h: 24-hour spline-interpolated measurements at 00:00 GMT each day. Columns represent Argos PTT#, year, day of year and fractional hour/minute, longitude, latitude, air pressure, air temperature, and ice/water (hull) temperature.

File names with a "v" instead of an "a" (example: aad15_24h.v_95) contain the same information plus total daily velocity components (Ve = east, Vn = north, and Vt = total) and an ice flag (0 = no ice, 1 = 1-30% concentration, 2 = 40-100% concentration). Columns represent Argos PTT#, year, day of year and fractional hour/minute, longitude, latitude, ice flag, Ve, Vn, Vt, air pressure, air temperature, and ice/water (hull temperature).

3h: three-hourly interpolated measurements. Columns represent Argos PTT#, year, day of year and fractional hour/minute, longitude, latitude, ice flag, air pressure, air temperature, and ice/water (hull) temperature.

all: raw, instantaneous, non-interpolated data. Columns represent Argos PTT#, year, day of year and fractional hour/minute, longitude, latitude, Argos position accuracy classification (0 = greater than 1000 m, 1 = between 350 m and 1000 m, 2 = between 150 m and 350 m, 3 = less than 150 m, 9 = GPS-derived position), ice flag, air pressure, air temperature, and ice/water (hull temperature).

Bad or missing data have dummy values of 9999.9, 99.9, etc. Not all buoys report fractional hour and minute along with day of year. Some only report day of year.

yy = year (values range from 94 to 98)

1.3 Spatial Information

1.3.1 Coverage

Data were collected from buoys initially positioned in three primary regions:

- East Antarctica
- Weddell Sea
- Bellingshausen, Amundsen and Ross Sea

1.3.2 Resolution

Drifting buoy positions are variable. The World Weather Watch (WWW) set a goal for atmospheric pressure, air temperature, and wind vector measurements to have a horizontal resolution of 250 km. For ocean areas, the minimum target for horizontal resolution of surface data is 500 km. The parameters for the IPAB Antarctic Drifting Buoy Data meet this resolution requirement.

Southernmost Latitude: -76
Northernmost Latitude: -57
Westernmost Longitude: -180
Easternmost Longitude: 180
Maximum Depth: 600 m

1.4 Temporal Information

1.4.1 Coverage

The current set of data range from January 1995 to July 1998. Data collection is ongoing, and data beyond 1998 will be available in the future.

1.4.2 Resolution

Data are provided as instantaneous raw values, daily averages, (every 24 hours), and three-hour averages. Buoy data logging systems typically collect and average the sensor data (usually over ten minutes) and transmit them to two polar-orbiting satellites every 60 or 90 seconds. Depending on latitude and area of coverage during the satellite overpass, only about 16 to 22 independent data transmissions are available for each platform per day.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

Atmospheric pressure is measured with various buoy devices, including aneroid cells, beam balance quartz crystal transducers, and piezo-resistive transducers. The inlet or pressure port allows the ambient pressure to be transmitted freely into the sensing element. The error or pressure change is related to the shape and configuration of the inlet. In most cases, the pressure error is related to the square of the wind velocity. Atmospheric pressure measurements from a small drifting buoy in the open ocean are difficult to obtain due to natural atmospheric pressure variation, wind interaction with the sensor, sensor error, sensor calibration and long-term drift, telemetry bit errors, and other factors (DBCP 1995).

A common approach for measuring wind is to measure the drag force on a sphere that is proportional to wind speed. The most conventional method is to use cup or vane anemometers. Wind direction is usually determined with a vane to point the buoy into the wind and a compass to compute direction. The Argos Global Telecommunications System (GTS) is capable of making an automatic geomagnetic variation correction (using the 1985 World Chart Model) on wind direction data to compensate for the bias due to the difference between true North and magnetic North. This correction depends on the buoy location and time of observation (DBCP 1995).

Air temperature measurements are typically conducted with a thermistor contained within a radiation-shielded housing about one meter above the ocean surface. Thermistors also measure sea surface temperature (SST). A source of error is the heating effect produced when solar and infrared radiation strike the air temperature transducer. Therefore, radiation shields are often implemented. Sub-surface temperature measurements are conducted with a thermistor chain to a depth of 600 m.

2.2 Acquisition

2.2.1 Source or Platform Collection Environment

Data were collected in the Antarctic sea ice zone. Buoys can be in the open ocean or within a sea ice pack. An ice flag, determined from Special Sensor Microwave/Imager (SSM/I) passive microwave data, is provided with all data and indicates the amount of sea ice present (0 = no ice, 1 = 1-30% concentration, 2 = 40-100% concentration).

2.2.2 Source or Platform Mission Objectives

Real time data from the IPAB drifting buoys are collected and sent to the GTS by the Collecte, Localization, Satellites (CLS) Services Argos. Atmospheric pressure measurement and buoy position are the minimum data requirements. Other various surface and upper ocean parameters and sea ice properties would be valuable (WCRP 1993), but are generally not provided.

For global climate research applications, the WCRP suggests a network of drifting buoys with a spacing of 500 km to obtain surface pressure and sea ice drift data over the Antarctic sea ice zone. A network of 50 drifting buoys would provide adequate sampling of the ice-covered zone of the Southern Ocean (WCRP 1993) but this goal has yet to be met.

The World Weather Watch (WWW) has also set processing requirements for data ingested by numeric weather prediction models. For basic surface variables (atmospheric pressure, air temperature, and wind vector), a horizontal resolution of 250 km is desired, with four observations per day. For ocean areas, the minimum target for horizontal resolution of surface data is 500 km. In the Antarctic region, the WWW requirements would be satisfied by a network of about 50 instrumented buoys, together with a corresponding network of meteorological stations on the Antarctic continent. (WCRP 1993).

All buoys in the basic network are to be equipped with transmitters to enable basic meteorological data to be transmitted in real time mode. Data are coded in a form suitable for extraction of basic meteorological parameters.

2.2.3 Source or Platform Program Management

The Argos system was developed to locate fixed and mobile buoy platforms and collect data from them. The system is a cooperative effort between the French Space Agency, the National Aeronautics and Space Administration (NASA), and the National Oceanic and Atmospheric Administration (NOAA). Its purpose is to provide an operational service for the duration of the Polar-orbiting Operational Environmental Satellites (POES) beyond the year 2000 (DBCP 1995).

2.2.4 Coverage Information

Satellite coverage is approximately 5200 km in diameter at any given moment, assuming that the line of sight to the NOAA Television Infrared Observation Satellite (TIROS)-N satellite is at least 5 degrees above the horizon. As the satellite orbits, the ground track of this circle produces a swath of 5200 km in width encompassing the earth. At each orbit, this swath covers both north and south poles. A satellite pass directly over a transmitting Platform Transmitter Terminal (PTT) will be within view of that antenna for about 13 minutes. The average satellite pass is approximately 10 minutes, independent of the PTT latitude. The number of satellite passes per day, however, is dependent on the PTT latitude (DBCP 1995).

2.2.5 Data Collection System

The Argos Data Collection and Location System (DCLS) receives messages transmitted by buoy platforms within satellite coverage. Messages are separated in time through the asynchronization of transmissions and the use of different repetition periods. Messages are separated by frequency according to Doppler shifts in carrier frequencies received from various PTTs. Up to eight simultaneous messages can be acquired by the DCLS. The DCLS records time of acquisition, measures the received carrier frequency, and demodulates and records the PDD identification code and sensor data. Data are formatted and transmitted to the TIROS Information Processor (TIP) (DBCP 1995).

2.2.6 Communication Links

All platforms used in conjunction with the Argos system carry an electronic transmitter called a PTT. A PTT includes an antenna, a Radio Frequency (RF) modulator and power amplifier, message generation logic, a sensor interface unit, an ultra-stable oscillator, and a power supply.

Since the NOAA-K satellite launch in 1996, all PTTs transmit on the same frequency band, from 401.620 to 401.680 MHz. Each PTT transmits at regular intervals. The period ranges from 90 to 120 seconds for platforms that utilize a Global Positioning System (GPS), and 200 seconds for platforms that collect data only. The duration of a single transmission burst depends on the data message length, but is usually less than one second (360 to 920 ms). The peak radiated power is less than 5 W (DBCP 1995).

2.2.7 Ground Segment Information: Data Acquisition and Processing

The NOAA TIROS-N satellites receive and record buoy data and transmit them to the NOAA National Environmental Satellite, Data, and Information Service (NESDIS) in Suitland, Maryland; or Météorologie National in Lannion, France; where they are separated from other satellite instrument data. They are then forwarded to the Argos Global Processing Centers (GPCs) in Toulouse, France, and Landover, Maryland, USA. The data are processed to calculate transmitter locations and interpret sensor outputs.

When data are sent to the GPCs, the following processing tasks are performed:

1. Decoding of the PTT messages and processing of the sensor data
2. Computation of PTT locations from Doppler shifts and orbital data
3. Storage of these processing outputs on computer files

Technical details of sensor data processing and platform location are provided in DBCP 1995.

2.3 Quality, Errors, and Limitations

2.3.1 Error Sources

Error sources for atmospheric pressure measurements include natural atmospheric pressure variation, wind interaction with the sensor, sensor error, sensor calibration and long-term drift, and telemetry bit errors. Errors in air temperature measurements result from the heating effect produced when solar and infrared radiation strike the air temperature transducer.

The accuracy of buoy positions depends on the oscillator stability of the buoy transmitter, the geometry of the NOAA satellite pass for ARGOS Doppler locations or the GPS constellation (for buoys with GPS receivers), the movement of the buoy, and inaccuracies of the satellite orbit ephemeris. In general, the accuracy of the Argos positioning is estimated to be about 350 m. Accuracy of GPS position is about 100 m prior to 1 May 2000, and about 10 to 15 m after 1 May 2000, when selective availability was discontinued. Factors that can reduce Argos location accuracy include: orbit prediction errors, medium-term oscillator drift that produces a location bias, and short-term oscillator instability that produces a random location error (DBCP 1995).

2.3.2 Measurement Error for Parameters

The World Weather Watch (WWW) set accuracy requirements for parameters measured by buoys:

Parameter	Observational Error (RMS)
Buoy position	± 1 km
Surface atmospheric pressure	± 0.2 to 1 hPa
Surface air temperature	± 0.5 degrees Celsius
Sea surface temperature	± 0.5 degrees Celsius (ship) ± 0.2 degrees Celsius (buoy)

The RMS error reflects the total system accuracy of the buoy system. A buoy position accuracy of ± 1 km is required for meteorological data. Calculations of ice drift require much greater accuracy. A position accuracy flag is provided with all instantaneous, raw data. Individual contributors are expected to allocate system component error sources to archive the required system accuracy. The parameters measured by the buoys are averaged onboard the buoys to minimize errors resulting from buoy motion and environmental variability (DBCP 1995).

2.3.3 Additional Quality Assessments

In January 1992, the Data Buoy Cooperation Panel (DBCP) implemented quality control guidelines for buoy data distributed on the GTS. It set up an electronic bulletin board for exchanging quality information on buoy data. The DBCP Technical Coordinator is typically the point of contact for ensuring data problems are resolved (DBCP 1995). See DBCP Quality Control Guidelines for GTS buoy data for more information.

2.4 Instrumentation

2.4.1 Description

Key Variables: See Parameters section.

2.4.2 Principles of Operation

Buoys collect and average sensor data and transmit them to two polar-orbiting satellites every 60 or 90 seconds. The buoy locations are determined from the Doppler shifts of the transmitter signals observed at different satellite positions. Data transmission and localization are conducted through the Collecte, Localisation, Satellites (CLS) Services Argos. Most buoys are equipped with GPS receivers for improved location accuracy. ARGOS maintains a monthly record of all platforms. Only the data with the largest number of identical transmissions within a satellite pass are saved. Approximately 25 independent transmissions are available for each platform per day. Data are transmitted in binary or hexadecimal format, and are converted to physical units based on the specifications of the sensors and on additional calibrations and buoy comparisons. All data are checked for permitted sensor tolerances, and a replacement value is assigned to erroneous data. Data are rearranged in chronological order. Outliers are found by objective methods and visual editing. Components of ice drift velocity are derived from the changes of positions. Using a smoothing cubic spline interpolation, regularly spaced time series are generated, which have a time resolution of three hours or one day. Long gaps are filled by linear interpolation (WCRP 1993).

2.4.3 Manufacturer of Sensor or Instrument

Buoys are built by several manufacturers who employ different mechanical and electronic designs. A chart summarizes buoy manufacturers used by each participating IPAB agency member. A complete list of buoy manufacturers is available from the DBCP web site. Further information on sensor specifications may be available from participating agencies:

- Alfred Wegener Institute, Germany
- Australian Antarctic Division, Australia
- Antarctic Cooperative Research Centre, Australia

- Finnish Institute of Marine Research and Dept. of Geophysics, University of Helsinki
- Geophysical Institute, University of Alaska, USA
- Lamont-Doherty Earth Observatory, Columbia University, USA
- Scott Polar Research Institute, United Kingdom

3 USAGE

Drifting buoy data are used to study physical characteristics and climatology of sea ice within the Antarctic sea ice zone. Atmospheric pressure, air temperature, and sea surface temperature data are distributed in near real time for use in operational meteorological analyses. The ice drift and other parameters are also used in various scientific studies, including ice and snow cover thickness; structural, chemical, and thermal properties of snow and ice; upper ocean hydrography; floe size; processes of ice formation; water mass modification; and ice edges.

3.1 Future Modifications and Plans

Data beyond 1998 will be available in the future. Processing is ongoing. All registered users of the IPAB Antarctic Drifting Buoy Data will automatically be notified of updates to the data set.

4 RELATED DATA SETS

- Arctic Climatology Project - EWG Arctic Meteorology and Climate Atlas
- International Arctic Buoy Programme (IABP) Drifting Buoy Gridded Pressure, Temperature, Position, and Interpolated Ice Velocity

For a list of other related sea ice products, please visit Sea Ice Products at NSIDC. This site offers a complete summary of sea ice data derived from passive microwave sensors and other sources, and is useful for users who want to compare characteristics of various sea ice products to understand their similarities and differences. This site also provides links to tools for passive microwave data and a list of other sea ice resources.

5 CONTACTS AND ACKNOWLEDGMENTS

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6 REFERENFCES

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7 DOCUMENT INFORMATION

7.1 Publication Date

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7.2 Date Last Updated

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