Meteorological data from the Tudor Hill Marine Atmospheric Observatory, Bermuda in 2017, 2019, 2020, 2021 and 2022

Website: https://www.bco-dmo.org/dataset/731478
Data Type: Other Field Results
Version: 2
Version Date: 2024-03-13

Project
» Operation of a Community Marine-Atmospheric Sampling Facility at Tudor Hill, Bermuda (THMAO)

Program
» United States Surface Ocean Lower Atmosphere Study (U.S. SOLAS)

Contributors	Affiliation	Role
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Abstract
The BIOS Tudor Hill Marine Atmospheric Observatory (THMAO) has been supported by the NSF Chemical Oceanography and Atmospheric Chemistry Programs following a major refit in 2003. Since that time it has provided a unique research facility for the scientific community. The specific objectives are: 1) To operate and maintain a state-of-the-art marine atmospheric sampling and observing facility at Tudor Hill, Bermuda, available for use by the wider U.S. and international research community; 2) To continue the collection of continuous meteorological data and weekly bulk-aerosol and rainwater samples, which will be archived at BIOS and made freely available to other researchers; 3) To collect additional atmospheric samples and data for other investigators (primarily in longer-term time-series programs), and to provide for the use of the facility in person by other investigators (primarily in shorter-term intensive programs).

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Coverage

Location: Tudor Hill Marine Atmospheric Observatory in Bermuda, western North Atlantic Ocean,
Spatial Extent: **Lat**:32.2646 **Lon**:-64.8791
Temporal Extent: 2017-01-01 - 2022-12-31

Dataset Description

Meteorological data and aerosol sampling data from the Tudor Hill Marine Atmospheric Observatory, West Bermuda (32.2646,-64.8791).

Data covers the years 2017, 2019, 2020, 2021 and 2022.

Methods & Sampling

The Tudor Hill Marine Atmospheric Observatory comprises of field laboratories and a 23 m walk-up tower. The tower is equipped with a suite of meteorological instruments to measure wind speed and direction, air temperature and relative humidity, and rainfall. Barometric pressure is recorded inside one of the laboratory vans at the site. All data are recorded on a data logger, with regular data transfer and on- and off-site data archiving.

Data logger:

2017-2024: Campbell Scientific CR1000
2024-current: Campbell Scientific CR1000X

Meteorological Equipment:

Wind Speed & Direction: RM Young model 05103
3D Wind (since 2022): RM Young Sonic Anemometer model CST3
Temperature & Relative Humidity: Vaisala model 41382
Barometric Pressure: Campbell Scientific EE181
Rainfall: RM Young Tipping Bucket model 52203

Data Processing Description

Loggernet software (Campbell Scientific) was used to download data from the Campbell Scientific data logger during weekly site maintenance visits. The protocol was updated in 2024 to include better notification of invalid data.

BCO-DMO Processing Description

BCO-DMO Data Manager Processing Notes:

Version 1
* added a conventional header with dataset name, PI name, version date
* modified parameter names to conform with BCO-DMO naming conventions
* multiple codes per "Note" value changed from comma delimited to ; (e.g. "P1:MOFF, P2:MOFF, P3:MOFF" -> P1:MOFF; P2:MOFF; P3:MOFF) to support csv output. Quotation marks also removed in these cases.
* No data value "nan" in the original dataset will be displayed as "nd" for no data.

Version 2
* added data from the years 2019, 2020, 2021, 2022
* Removed columns Pump1_Status, Pump2_Status, Pump3_Status, Pump1_Runtime, Flow1, Sample_volume1, Pump2_Runtime, Flow2, Sample_volume2, Pump3_Runtime, Flow3, Sample_volume3 & Notes(unnecessary for reuse) at submitters request.
* Added instrument Temperature/Relative Humidity probe (Vaisala, model 41382)

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Data Files

File
731478_v2_meteo.csv (Comma Separated Values (.csv), 234.75 MB) MD5:1381e080b611ae59cfda021391095390 Primary data file for dataset ID 731478, version 2

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Parameters

Parameter	Description	Units
TIMESTAMP	Date and time (UTC) of measurement in format "yyyy-mm-dd HH:MM"	untiless
RECORD	Record number from logger	unitless
Mean_WS	Mean wind speed	meters per second (m/s)
ResultantMean_WS	Vector mean wind speed	meters per second (m/s)
ResultantMean_WD	Vector wind direction	degrees
StdDev_WD	Vector mean wind direction standard deviation	degrees
SonicU	3D wind speed data in the 3 axes: U	meter per second (m/sec)
SonicV	3D wind speed data in the 3 axes: V	meter per second (m/sec)
SonicW	3D wind speed data in the 3 axes: W	meter per second (m/sec)
SonicTemp_C	Air Temperature	degrees Celsius
batt_volt_Min	Minimum voltage of logger	volts direct current (VDC)
Rain_Tot	Total rainfall	millimeters (mm)
AirTempC_Avg	Air Temperature	degrees Celsius
RH_Avg	Average relative humidity	percent (%)
BP_mmHg_Avg	Average air pressure	millimeters of mercury (mmHg)

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Instruments

Dataset-specific Instrument Name	RM Young/05103
Generic Instrument Name	Anemometer
Dataset-specific Description	Wind speed and direction with 4 blade prop and vane (data parameters: Mean_WS, VectorMean_WS, and VectorMean_WD)
Generic Instrument Description	An anemometer is a device for measuring the velocity or the pressure of the wind. It is commonly used to measure wind speed. Aboard research vessels, it is often mounted with other meteorological instruments and sensors.

Dataset-specific Instrument Name	3D sonic anemometer (Campbell Scientific, model CST3)
Generic Instrument Name	Anemometer
Generic Instrument Description	An anemometer is a device for measuring the velocity or the pressure of the wind. It is commonly used to measure wind speed. Aboard research vessels, it is often mounted with other meteorological instruments and sensors.

Dataset-specific Instrument Name	Campbell Scientific/ EE181
Generic Instrument Name	Barometer
Dataset-specific Description	Barometric pressure (data parameter: BP_mmHg_Avg).
Generic Instrument Description	A barometer is an instrument used to measure atmospheric pressure. There are many types of barometers identified by make and model and method of measurement.

Dataset-specific Instrument Name	Campbell Scientific CR1000 logger
Generic Instrument Name	Data Logger
Dataset-specific Description	12V measurement and control data logger.
Generic Instrument Description	Electronic devices that record data over time or in relation to location either with a built-in instrument or sensor or via external instruments and sensors.

Dataset-specific Instrument Name	Sierra Instruments/Fast-Flo 620S
Generic Instrument Name	Flow Meter
Dataset-specific Description	Insertion air flow sensor, one for each of the 3 pumps (Flow #1,#2 & #3 data parameters).
Generic Instrument Description	General term for a sensor that quantifies the rate at which fluids (e.g. water or air) pass through sensor packages, instruments, or sampling devices. A flow meter may be mechanical, optical, electromagnetic, etc.

Dataset-specific Instrument Name	Tipping Rain Gauge (RM Young/ 52203)
Generic Instrument Name	Precipitation Gauge
Dataset-specific Description	Tipping bucket rain gauge, 0.1mm per tip (data parameter: Rain_Tot).
Generic Instrument Description	measures rain or snow precipitation

Dataset-specific Instrument Name	Temperature/Relative Humidity probe (Vaisala, model 41382)
Generic Instrument Name	Young 41382 relative humidity and temperature probe
Generic Instrument Description	The Model 41382 Relative Humidity/Temperature Probe combines high accuracy humidity and temperature sensors in a single probe. The output signal is 0-1V (standard) or 0-5V (user selected option) for both relative humidity and temperature. RH range is 0-100%, temperature range is -50 to +150 deg F. The relative humidity precision is +/- 1% while the temperature precision is +/- 0.5 deg F.

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Deployments

Tudor_Hill_Observ

Website	https://www.bco-dmo.org/deployment/731495
Platform	shoreside Bermuda
Start Date	2017-01-01
End Date	2017-12-29

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Project Information

Operation of a Community Marine-Atmospheric Sampling Facility at Tudor Hill, Bermuda (THMAO)

Website: https://tudorhill.bios.asu.edu/

Coverage: West Bermuda, 32.2646N 64.8791W

NSF Award OCE-2123053 Abstract:

This project supports the Tudor Hill Marine Atmospheric Observatory in Bermuda. Because of its location in the western North Atlantic Ocean, Bermuda has been an important location for many studies of the marine atmosphere. The observatory is well equipped for carrying out research, with field laboratories and a 23 meter tower at Tudor Hill. This allows scientists to study the chemistry and physics of the atmosphere over the oceans. This part of the atmosphere plays an important role in the transfer of moisture, chemicals, and energy between the ocean and the atmosphere. Routine work at the site includes the observation and recording of weather conditions, and sampling of rain and air. In addition, samples and data are collected for a number of research partners, including NOAA, NASA and many US and international universities. As well as supporting research, this project will provide a range of educational opportunities, including through the NSF-funded Research Experience for Undergraduates (REU) program, and through other internships and courses at the Bermuda Institute of Ocean Sciences.

The continued operation and maintenance of the Tudor Hill Marine Atmospheric Observatory facilitates research concerning the chemistry and physics of the marine troposphere and ocean-atmosphere exchange processes. The specific objectives of the project are to: 1) Operate and maintain the atmospheric sampling facility at Tudor Hill, Bermuda; 2) Continue collection of continuous meteorological data and weekly bulk-aerosol and rain samples, which will be archived at BIOS and made freely available to other researchers; and 3) Collect additional atmospheric samples and data for external investigators, and provide for the use of the facility by external investigators. Ongoing partner activities at the facility include monitoring and data acquisition for NASA

(AERONET) and NOAA programs (Ozone and greenhouse gas monitoring), and a new sampling location will be established for the US National Atmospheric Deposition Program (NADP) in 2021. The THMAO site will enable research to be undertaken that is central to international initiatives such as IGAC, SOLAS and GEOTRACES. In a regional context, the Tudor Hill facility will complement ongoing oceanographic time-series research in the Sargasso Sea, including Hydrostation S and BATS.

NSF Award OCE-1829686 Abstract:

This project provides continuing support for the Tudor Hill Marine Atmospheric Observatory in Bermuda. The marine boundary layer, the lower level of the atmosphere over the oceans, plays important roles in the global cycles of many chemical elements and this observatory provides a unique facility for the ocean and atmospheric chemistry research communities. At present, many aspects of atmospheric composition, atmospheric transport, and atmosphere-ocean exchange remain poorly understood. This limits our ability to predict and mitigate the effects of anticipated future environmental change. Central to improving our understanding of these topics is the ability to observe and sample the marine boundary layer. In this regard, oceanic island observatories have played a crucial role. By virtue of its location in the western North Atlantic Ocean, Bermuda has been a key location for numerous field studies of the marine troposphere and is well equipped for such research, with the 23 meter high atmospheric sampling tower and site laboratories at Tudor Hill. Routine facility operations include the collection of continuous meteorological data and weekly bulk aerosol and rainwater samples, which are archived at the Bermuda Institute of Ocean Sciences and made freely available to the scientific community. Additionally, samples and data are collected for a variety of external research programs funded by NSF, NOAA, NASA and other agencies. This project is expected to make significant educational contributions at a number of levels, including undergraduate education opportunities through the NSF-funded Research Experience for Undergraduates (REU) program, and through other courses taught at the Bermuda Institute of Ocean Sciences.

The continued operation and maintenance of THMAO site will facilitate research topics that are central to international research initiatives such as IGAC, SOLAS and GEOTRACES. The specific objectives of the project are to: 1) Operate and maintain the atmospheric sampling facility at Tudor Hill, Bermuda; 2) Continue collection of continuous meteorological data and weekly bulk-aerosol and rain samples, which will be archived at BIOS and made freely available to other researchers; and 3) Collect additional atmospheric samples and data for external investigators, and provide for the use of the facility by external investigators. The continued operation and maintenance of the Tudor Hill site facilitates research concerning the chemistry and physics of the marine troposphere and ocean-atmosphere exchange processes. In a regional context, the Tudor Hill facility will complement ongoing time-series research in the Sargasso Sea, including Hydrostation S and BATS.

NSF Award OCE-1735504 Abstract:

This award would provide a year of continuation funding for the Tudor Hill Marine Atmospheric Observatory in Bermuda. The lower level of the atmosphere over the oceans plays important roles in the global cycles of many chemical elements and this observatory provides a unique facility for the ocean and atmospheric chemistry research communities. At present, many aspects of atmospheric composition, atmospheric transport, and atmosphere-ocean exchange remain poorly understood. This limits our ability to predict and mitigate the effects of anticipated future environmental change. Central to improving our understanding of these topics is the ability to observe and sample the marine boundary layer. In this regard, oceanic island observatories have played a crucial role. By virtue of its location in the western North Atlantic Ocean, Bermuda has been a key location for numerous field studies of the marine troposphere and is well equipped for such research, with the 23-m high atmospheric sampling tower and site laboratories at Tudor Hill. Routine facility operations include the collection of continuous meteorological data and weekly bulk aerosol and rainwater samples, which are archived at the Bermuda Institute of Ocean Sciences and made freely available to the scientific community. Additionally, samples and data are collected for a variety of external research programs funded by NSF, NOAA, NASA and other agencies.

The specific objectives of the project are to: 1) Operate and maintain the atmospheric sampling facility at Tudor Hill, Bermuda; 2) Continue collection of continuous meteorological data and weekly bulk-aerosol and rain samples, which will be archived at BIOS and made freely available to other researchers; and 3) Collect additional atmospheric samples and data for external investigators, and provide for the use of the facility by external investigators. The continued operation and maintenance of the Tudor Hill site facilitates research concerning the chemistry and physics of the marine troposphere and ocean-atmosphere exchange processes. In a regional context, the Tudor Hill facility will complement ongoing time-series research in the Sargasso Sea, including Hydrostation S and BATS. This project is expected to make significant educational contributions at a number of levels, including undergraduate education opportunities through the NSF-funded Research Experience for Undergraduates (REU) program, and through other courses taught at BIOS.

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Program Information

United States Surface Ocean Lower Atmosphere Study (U.S. SOLAS)

Website: http://www.us-solas.org/

Coverage: Global

The Surface Ocean Lower Atmosphere Study (SOLAS) program is designed to enable researchers from different disciplines to interact and investigate the multitude of processes and interactions between the coupled ocean and atmosphere.

Oceanographers and atmospheric scientists are working together to improve understanding of the fate, transport, and feedbacks of climate relevant compounds, and also weather and hazards that are affected by processes at the surface ocean.

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Physical, chemical, and biological research near the ocean-atmosphere interface must be performed in synergy to extend our current knowledge to adequately understand and forecast changes on short and long time frames and over local and global spatial scales.

The findings obtained from SOLAS are used to improve knowledge at process scale that will lead to better quantification of fluxes of climate relevant compounds such as CO2, sulfur and nitrogen compounds, hydrocarbons and halocarbons, as well as dust, energy and momentum. This activity facilitates a fundamental understanding to assist the societal needs for climate change, environmental health, weather prediction, and national security.

The US SOLAS program is a component of the International SOLAS program where collaborations are forged with investigators around the world to examine SOLAS issues ubiquitous to the world's oceans and atmosphere.

Â» International SOLAS Web site

Science Implementation Strategy Reports

US-SOLAS (4 MB PDF file)
Other SOLAS reports are available for download from the US SOLAS Web site

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1735504
NSF Division of Ocean Sciences (NSF OCE)	OCE-1829686
NSF Division of Ocean Sciences (NSF OCE)	OCE-2123053

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