Data User Guide

Automated Surface Observing Systems (ASOS) IMPACTS

Introduction

The Automated Surface Observing Systems (ASOS) IMPACTS dataset consists of a variety of ground-based observations during the Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS) field campaign. IMPACTS was a three-year sequence of winter season deployments conducted to study snowstorms over the U.S Atlantic coast. IMPACTS aimed to (1) Provide observations critical to understanding the mechanisms of snowband formation, organization, and evolution; (2) Examine how the microphysical characteristics and likely growth mechanisms of snow particles vary across snowbands; and (3) Improve snowfall remote sensing interpretation and modeling to significantly advance prediction capabilities. This ASOS dataset consists of 176 stations within the IMPACTS domain. Each station provides observations of surface temperature, dew point, precipitation, wind direction, wind speed, wind gust, sea level pressure, and the observed weather code. The ASOS data are available from December 29, 2019 through February 29, 2020 in netCDF-4 format.

Citation

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Keywords:

NASA, GHRC, IMPACTS, ASOS, atmospheric temperature, sea level pressure, visibility, local winds, surface observations

Campaign

The Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS), funded by NASA's Earth Venture program, is the first comprehensive study of East Coast snowstorms in 30 years. IMPACTS will fly a complementary suite of remote sensing and in-situ instruments for three 6-week deployments (2020-2023) on NASA's ER-2 high-altitude aircraft and P-3 cloud-sampling aircraft. The first deployment began on January 17, 2020 and ended on March 1, 2020. IMPACTS samples U.S. East Coast winter storms using advanced radar, LiDAR, and microwave radiometer remote sensing instruments on the ER-2 and state-of-the-art microphysics probes and dropsonde capabilities on the P-3, augmented by ground-based radar and rawinsonde data, multiple NASA and NOAA satellites (including GPM, GOES-16, and other polar orbiting satellite systems), and computer simulations. IMPACTS addressed three specific objectives: (1) Provide observations critical to understanding the mechanisms of snowband formation, organization, and evolution; (2) Examine how the microphysical characteristics and likely growth mechanisms of snow particles vary across snowbands; and (3) Improve snowfall remote sensing interpretation and modeling to significantly advance prediction capabilities. More information is available from NASA's Earth Science Project Office's IMPACTS field campaign webpage.

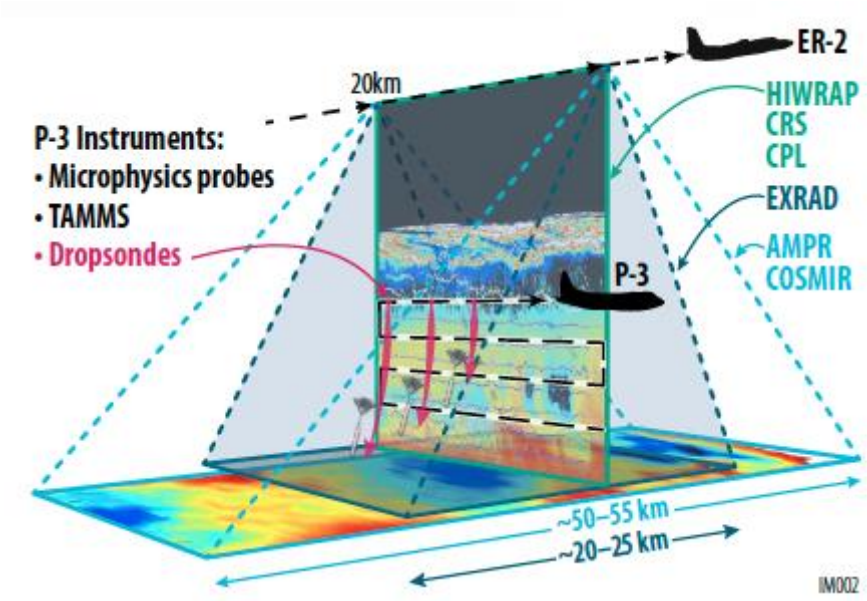

Figure 1: IMPACTS airborne instrument suite
(Image source: NASA IMPACTS ESPO)

Instrument Description

As described at Automated Surface Observing Systems (ASOS) network, the Automated Surface Observing Systems (ASOS) program is a joint effort of the National Weather Service, the Federal Aviation Administration, and the Department of Defense. The ASOS system serves as the United States' primary surface weather observing network. ASOS is designed to support weather forecast activities, aviation operations, and support the needs

of the meteorological, hydrological, and climatological research communities. The ASOS network provides basic pressure, temperature, wind, and precipitation observations, as well as sky condition, visibility, present weather information, and obstructions to vision. The details below and additional information on the ASOS network is available at the United States National Weather Service ASOS webpage, as well as the ASOS User's Guide.

Each ASOS station consists of several instruments. These include:

- Ambient temperature and dew point: This is observed by a hygrothermometer, which is a modern and fully automated version of the HO-83 hygrothermometer first used in 1985. The instrument uses a platinum Resistive Temperature Device (RTD) to measure ambient temperature and a chilled mirror to determine the dew point temperature. The RTD operates on the principle that electric resistance in a wire varies with temperature. The temper
- Wind: The rotating cup anemometer and simple wind vane are the principle instruments for observing wind speed and direction. The F420 series of instruments have become the standard for wind measurement in the United States. The instrument consists of a cup-driven Direct Current generator with the output calibrated in knots and a vane coupled to an indicator by means of a direct current synchro-system. The automated ASOS version of the F420 uses electromagnetic signals generated by the rotating cup and vane that are directly converted into reportable values. Current federal standards place the instrument at a height of 10 m (32.8 feet).
- Pressure: For pressure measurements, the ASOS instrument uses redundant digital pressure transducers, which use capacitive sensors, one side of which is permanently evacuated to a vacuum to make it a barometric pressure sensor.
- Precipitation: ASOS uses the automated heated tipping bucket to provide liquid equivalent precipitation accumulation. Advances have made the ASOS observations very capable in all but the most extreme heavy rainfall events. There do remain some limitations to fully measure precipitation accumulation during the cold season.
- Cloud height: The ASOS cloud height indicator uses a laser beam ceilometer with a reporting range of 12,000 feet. This is a vertically pointed transmitter and receiver and works similar to radar such that the time interval between pulse transmission and reflected reception from a cloud base is used to determine the cloud height. The instrument uses a gallium arsenide laser beam operating in the near infrared portion of the electromagnetic spectrum at a wavelength of ~0.9 microns. The instrument will contain only opaque clouds. Moisture layers, or thin clouds detected by the cloud height indicator that are considered to be too thin to be a cloud, are reported as a restriction to vertical visibility or not reported.
- Sky condition: The ASOS sky conditions are derived via computer algorithms to process the signal data from the cloud height indicator.
- Surface visibility: ASOS uses a forward scatter sensor which operates on the principle of light from a pulsed xenon flash lamp in the blue portion of the visible spectrum is transmitted twice a second in a cone-shaped beam over a range of angles. The detector faces north to minimize sun glare. Only the portion of the beam

that is scattered forward by the intervening medium in the sampling volume is received by the detector.

- Present weather: ASOS uses a variety of instruments to identify the current weather conditions, beyond those currently listed.
    - A single site lightning sensor is used to report thunderstorms. Three separate lightning sensors are used, with the type varying on the specific needs of the site. These include the Global Atmospherics Inc. Model 924 instrument. Service-Level D ASOS sites that do not have the Federal Aviation Administration's Automated Lightning Detection And Ranging System (ALDARS) use the ASOS Lightning Sensor (ALS). The remaining sites use the aforementioned ALDARS instrument.
    - The precipitation identification sensor, also known as a Light Emitting Diode Weather Identifier (LEDWI), differentiates rain from snow and determines the intensity of the precipitation. The LEDWI has a coherent light transmitter and a photo diode receiver.
    - A freezing rain sensor consists of a small cylindrical probe that is electrically stimulated to vibrate at its resonant frequency A feedback coil is used to measure the vibration frequency. When ice freezes on the probe, the mass of the ice and the probe increases and the resonant vibration frequency decreases.

Figure 2: A typical ASOS station setup.
(Image source: National Weather Service ASOS description webpage)

Investigators

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Data Characteristics

The Automated Surface Observing Systems (ASOS) IMPACTS dataset files contain a variety of surface-based observations from 176 sites across the IMPACTS domain including

temperature, dew point temperature, wind observations, precipitation amount, precipitation type, various visibility parameters, along with the time of observations. The data are available in netCDF-4 format at a Level 1B data processing level. More information about the NASA data processing levels are available on the EOSDIS Data Processing Levels webpage. A supporting ASOS_sites.txt document provides additional metadata for each ASOS site. The characteristics of this dataset are listed in Table 1 below.

Table 1: Data Characteristics

Characteristic	Description
Platform	Surface weather observing network
Instrument	Automated Surface Observing Systems (ASOS)
Spatial Coverage	N: 47.467 , S: 36.571, E: -67.791, W: -88.775 (United States of America)
Spatial Resolution	Multiple point observations Maximum cloud height: 12,000 feet Maximum horizontal range: 10 statute miles
Temporal Coverage	December 29, 2019 - February 29, 2020
Temporal Resolution	1 daily file per ASOS site
Parameter	Air temperature, dew point temperature, precipitation accumulated, precipitation intervals, sea level pressure, wind direction, wind gust, wind speed, weather condition code
Version	1
Processing Level	1B

File Naming Convention

The Automated Surface Observing Systems (ASOS) IMPACTS dataset files are available in netCDF-4 format. A supporting station information document is provided in text format. The dataset files are named using the following convention:

Data files: impacts_asos_YYYYMMDD_[Station_ID].nc

Table 2: File naming convention variables

Variable	Description
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
[Station_ID]	Four-character station identifier*
.nc	netCDF-4 format

*These site locations can be found in the ASOS site documentation.

Data Format and Parameters

The Automated Surface Observing Systems (ASOS) IMPACTS dataset consists of a variety of surface observations at 176 separate ASOS sites within the IMPACTS field campaign domain. These data are in netCDF-4 format. Each ASOS site has the same data format and parameters. The data field descriptions for each file are listed in Table 3 below. Please note, the latitude and longitude of each ASOS site is provided in the separate ASOS_sites.txt file and is described separately in Table 4.

Table 3: Data Fields for ASOS netCDF-4 files

Field Name	Description	Unit
Time	Seconds since January 1, 1970	seconds
drct	Wind direction	degrees
gust	Wind gust	knots
sknt	Wind speed	knots
dwpc	Dewpoint temperature	Celsius
tmpc	Temperature	Celsius
p01m	Precipitation for the last time interval (hour)	millimeters
wxcodes	Current weather codes*	-

*NOTE: The explanation for the various weather codes is available in Appendix C of the ASOS User's Guide Appendices.

The Automated Surface Observing Systems (ASOS) IMPACTS dataset includes a site information document, ASOS_sites.txt. This provides the long name of each Station_ID (Table 2) as well as geolocation information in a comma delimited format. Table 4 lists the column information.

Table 4: Data Fields for ASOS_sites.txt

Field Name	Description	Unit
Column 1	Four-character station identifier	-
Column 2	Long name of the site location	-
Column 3	Two-character state the ASOS station is located	-
Column 4	Longitude of the ASOS station	-
Column 5	Latitude of the ASOS station	-
Column 6	Elevation of the ASOS station	feet

Algorithm

Each instrument package used at an ASOS site has its own algorithm set to obtain observations for the parameters of interest. The ASOS instrumentation and algorithm design have all been developed to function autonomously. The instruments and algorithms were initially developed in the 1980s and deployed in the 1990s across the United States. ASOS uses a variety of observations and signal processing techniques to obtain the wide

array of meteorological parameters reported by the network. As listed above, this ranges from temperature, sea level pressure, to visibility. More details about the individual ASOS instrument algorithms is available with the ASOS user guide developed by the National Oceanic and Atmospheric Administration, Department of Defense, Federal Aviation Administration, and the United States Navy.

Quality Assessment

ASOS uses three levels of quality control, as described by the United States ASOS user guide (section 1.4). Level 1 quality control is conducted at the ASOS site. These are built-in, automated self-diagnostic and quality control algorithms that operate on the raw sensor data. These algorithms aim to identify a particular degree of system degradation or component failure to prevent observations from being sent and to provide a maintenance check indicator. Additionally, if sufficient raw data are unavailable, the specific element is not reported.

Level 2 quality control is conducted at an area scale in a United States National Weather Service Weather Forecast Office (WFO) county warning area. Here, WFO staff monitor observations to assess the quality of meteorological observations. Any identified issues are addressed by a variety of actions ranging from contacting co-located observers (if present) to dispatching maintenance.

Level 3 quality control is a national scale quality check conducted at the ASOS Operations and Monitoring Center (AOMC). This organization is continuously monitoring for maintenance check indicators from Level 1 quality control to missing observations and alerts the appropriate individuals to address the issue as well as alerting users of the data of the issue. The AMOC is also responsible for downloading critical operational information to the ASOS, maintaining accurate clock synchronization, and maintaining data for system reinitialization, such as field elevation. The ultimate goal of these quality control efforts is to maintain uniform system integrity.

Software

No special software is required to view these data, however, Panoply can be used to easily open and view the ASOS netCDF-4 data files.

Known Issues or Missing Data

There are no known issues with these data or any known gaps in the dataset.

References

ASOS User's Guide (1998).
https://www.weather.gov/media/asos/aum-toc.pdf

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https://www.weather.gov/asos/

Related Data

All other datasets collected as part of the IMPACTS campaign are considered related and can be located by searching the term “IMPACTS” in the GHRC Search Portal.

Contact Information

To order these data or for further information, please contact:

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