Product Guide

Product Specification Guide: MEaSUREs Wetlands Summary

Guide available in PDF format.

The Alaska Satellite Facility (ASF) DAAC acquired the MEaSUREs (Making Earth System Data Records for Use in Research Environments) Wetlands dataset from the Jet Propulsion Laboratory in 2012. The dataset contains the first level-2, derived synthetic aperture radar (SAR) products available from ASF. The dataset includes a global-scale Earth System Data Record (ESDR) of inundated wetlands to facilitate investigations on their role in climate, biogeochemistry, hydrology, and biodiversity. This ESDR provides an accurate, consistent, and comprehensive global-scale dataset of wetland inundation and vegetation, including continental-scale, multi-temporal, and multi-year monthly inundation dynamics at varying scales.

ASF DAAC's MEaSUREs Wetlands holdings are available through ASF here.

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1) Data Set Overview

MEaSUREs Wetlands data were gathered from these SAR sensors and satellites:

- **PALSAR** (Phased Array type L-Band Synthetic Aperture Radar)/ **ALOS** (Advance Land Observing Satellite)
- **QuikScat**-EOS (AMSR-E)(Advanced Microwave Scanning Radiometer) (AMSR-E)/**Aqua**
- **SeaWinds/Quick Scatterometer**

Introduction
The MEaSUREs Wetlands project used data from three sources:

1. **PALSAR** was one of the three remote-sensing instruments onboard **ALOS**. ALOS was launched on January 2006 by JAXA for the purpose of acquiring highly precise observations of land coverage. The satellite, which lost power in 2011, used advanced technology to accurately determine spacecraft position and altitude. It was also capable of handling large capacity mission data at high speeds.

2. **Aqua** is a NASA Earth Science satellite mission, which launched in 2002 and is named for the large amount of information that the mission is collecting about the Earth's water cycle—including evaporation from the oceans, water vapor in the atmosphere, clouds, precipitation, soil moisture, sea ice, land ice, and snow cover on land and ice. Additional variables also being measured by Aqua include radiative energy fluxes, aerosols, vegetation cover on land, phytoplankton, and dissolved organic matter in the oceans, as well as air, land, and water temperatures.

3. NASA's ocean-observing satellite, **QuikScat**, was launched in 1999 and was operational for 9.5 months. It carried a **SeaWinds** scatterometer, and the mission objectives were to:

- Acquire all-weather, high-resolution measurements of near-surface winds over global oceans.
- Determine atmospheric forcing, ocean response, and air-sea interaction mechanisms on various spatial and temporal scales.

- Combine wind data with measurements from scientific instruments in other disciplines to help researchers better understand the mechanisms of global climate change and weather patterns.
- Study both annual and semi-annual rainforest vegetation changes.
- Study daily/seasonal sea ice edge movement and Arctic/Antarctic ice pack changes.

The mission's operational objectives were to:

- Improve weather forecasts near coastlines by using wind data in numerical weather- and wave-prediction models.
- Improve storm warning and monitoring.

Program Management

MEaSUREs Wetlands is a NASA/Jet Propulsion Laboratory Earth observation project.

Mission Objectives

MEaSUREs is a NASA-funded program to support research scientists and groups in data product creation, using a multitude of data sources and robust algorithms. These projects generate coherent time series and facilitate the synthesis of datasets in the development of comprehensive Earth system models. The MEaSUREs Wetlands purpose was to construct a global-scale ESDR of inundated wetlands to facilitate investigations on their role in climate, biogeochemistry, hydrology, and biodiversity.

Parameters

1. **ALOS was the largest satellite developed in Japan** and carried three remote sensing instruments: the along-track 2.5-m resolution Panchromatic Remote-sensing Instrument for Stereo Mapping (PRISM), the 10-m resolution Advanced Visible and Near-Infrared Radiometer type 2 (AVNIR-2), and the polarimetric PALSAR.

ALOS was launched from JAXA's Tanegashima Space Center in southern Japan in January 2006. With a total weight of 4,000 kg, ALOS was launched with an H-IIA rocket vehicle, and placed in a sun-synchronous orbit at 691 km, with an orbital revisit period of 46 days.

Fifteen minutes after lift-off, ALOS reached its nominal orbit and separated from the rocket. It established its 3-axis attitude and initiated ground station contact. Communications for tracking and control with local ground stations were performed through the X-band antenna mounted at the nadir side of the satellite body. During nominal operations, this antenna was also used for direct (120-140 Mbps) downlink of Earth observation data.

Additional ALOS parameters are available here. A summary table is provided below.

Table 1. ALOS Orbit and Equipment Parameters

Item	Characteristics
Orbit	Sun synchronous, Sub recurrent
Equator pass time	~10.30 (desc.); ~22.30 (asc.)
Altitude	691.65 km
Inclination	98.16 deg.
Recurrence cycle	46 days
Orbital control	+/- 2.5 km (at equator)
GPS orbital position accuracy	1 m (off-line)
Star Tracker attitude determination accuracy	0.0002 deg (off-line) (~2.5 m on the ground)
Attitude stability	1 ms
High-speed Solid State Recorder (HSSR)	Capacity: 96 Gbytes Data rate (max): 360 Mbps (recording) 240 Mbps (playback)
Data transmission: Ka-band antenna	240 Mbps (via DRTS)
X-band antenna	120 Mbps (direct GS down-link)
Solar Array Paddle	3 m x 22 m, 9 segments
Generated power	> 7 kW at EOL
Total weight	4000 kg

2. **The Aqua mission** is a part of the NASA-centered, international Earth Observing System (EOS). Aqua was formerly named EOS PM, signifying its afternoon equatorial crossing time. A timeline of Aqua on-orbit progress through the initial 120-day check-out period can be found here.

Aqua was launched on May 4, 2002, and has six Earth-observing instruments on board, collecting a variety of global datasets. Aqua was the first member launched of a group of satellites termed the Afternoon Constellation, or sometimes the A-Train. Additional Aqua parameters are available here.

3. **NASA's QuikScat** was lofted into space at 7:15 p.m. Pacific Daylight Time on June 19, 1999, atop a U.S. Air Force Titan II launch vehicle from Space Launch Complex 4 West at California's Vandenberg Air Force Base. The satellite was launched in a south-southwesterly direction, soaring over the Pacific Ocean at sunset as it ascended into space to achieve an initial elliptical orbit with a maximum altitude of about 800 km (500 mi) above Earth's surface. QuikScat operates in a near polar orbit. It flies in a circular orbit and completes a full orbit in about 101 minutes, which translates to a little more than 14 orbits per day. Additional QuikScat parameters are available here.

SAR (Synthetic Aperture Radar) Sensors

1. **PALSAR** is an enhanced version of the SAR on JERS-1 (L-band; HH-polarization; 35°off-nadir angle). Like its predecessor, PALSAR was developed jointly by JAXA and the Japan Resources Observation Systems Organization (JAROS).

PALSAR is a fully polarimetric instrument, operating in fine-beam mode with single polarization (HH or VV), dual polarization (HH+HV or VV+VH), or full polarimetry (HH+HV+VH+VV). It also features wide-swath ScanSAR mode, with single polarization (HH or VV). The center frequency is 1270 Mhz (23.6 cm), with a 28 MHz bandwidth in fine beam single polarization mode, and 14 MHz in the dual-, quad-pol and ScanSAR modes. The off-nadir angle is variable between 9.9° and 50.8° (at mid-swath), corresponding to a 7.9-60.0° incidence angle range. In 5-beam ScanSAR mode, the incidence angle range varies from 18.0° to 43.0°.

The antenna PALSAR consists of 80 T/R modules on 4 segments, with a total size of 3.1 by 8.9 m when deployed. As a result of the relatively small antenna size, orbit altitude, and large Doppler bandwidth, the pulse repetition frequency varies (1500-2500 Hz) along the orbit.

Table 2. PALSAR Specifications

Item	Specifications
Center frequency	1270 MHz / 23.6 cm
Chirp band width	28 MHz (single polarization),â€ 14 MHz (dual, quad-pol., ScanSAR)
Transmission power	2 kW (peak power)
Pulse Repetition Frequency	1500 – 2500 Hz (discrete stepping)
Image modes	Single polarization (HH or VV), Dual pol. (HH+HV or VV+VH), Quad-pol. (HH+HV+VH+VV), ScanSAR (HH or VV; 3/4/5-beam)
Bit quantization	3 or 5 bits (5 bits standard)
Off-nadir angle	Variable: 9.9 – 50.8 deg.â€ (inc. angle range: 7.9 - 60.0), ScanSAR: 20.1-36.5 (inc. 18.0-43.3)
Look direction	Right
Yaw steering	ON
Swath width	70 km (single/dual pol.@41.5°), 30 km (quad-pol.@21.5°)â€ 350 km (ScanSAR 5-beam)
Ground resolution Rg (1 look) x Az (2 looks)	~ 9 m x 10 m (single pol.@41.5°)â€ , ~ 19 m x 10 m (dual pol.@41.5°)â€¨, ~ 30 x 10 m (quad-pol.@21.5°)â€¨, ~ 71-157m (4 look) x 100m (2 look) (ScanSAR 5-beam)
Data rates	240 Mbps (single/dual/quad-pol) 120 or 240 Mbps (ScanSAR)

2. **AMSR-E** is a 12-channel, six-frequency, total power passive microwave radiometer at all channels. The Earth-emitted microwave radiation is collected by an offset parabolic reflector 1.6 meters in diameter that scans across the Earth along an imaginary conical surface, maintaining a constant Earth incidence angle of 55° and providing a swath width array of six feedhorns, which then carry the radiation to radiometers for measurement. Calibration is accomplished with observations of cosmic background radiation and an on-board warm target. Spatial resolution of the individual measurements varies from 5.4 km at 89.0 GHz to 56 km at 6.9 GHz.

AMSR-E Instrument Characteristics

- Passive microwave radiometer, 12 channels, 6 frequencies, dual polarization, conically scanning.
- Measures precipitation rate, cloud water, water vapor, sea surface winds, sea surface temperature, ice, snow and soil moisture.
- All-weather measurements of geophysical parameters supporting several global change science and monitoring efforts.
- External cold load reflector and a warm load for calibration.
- Offset parabolic reflector, 1.6 m in diameter, and rotating drum at 40 rpm.
- Multiple feedhorns (6) to cover six bands from 6.9 to 89 GHz with 0.3 to 1.1 K radiometric sensitivity; vertical and horizontal polarization.

3. The **SeaWinds on QuikScat** mission is a "quick recovery" mission to fill the gap created by the loss of data from the NASA Scatterometer (NSCAT), when the satellite carrying it lost power in June 1997. The SeaWinds instrument on the QuikScat satellite is a specialized microwave radar that measures near-surface wind speed and direction over Earth's oceans under all weather and cloud conditions.

SeaWinds uses a rotating dish antenna with two spot beams that sweep in a circular pattern. The antenna radiates microwave pulses at a frequency of 13.4 GHz across broad regions on Earth's surface. The instrument will collect data over ocean, land, and ice in a continuous, 1,800-km-wide band, making approximately 400,000 measurements and covering 90 percent of Earth's surface in one day.

SeaWinds Instrument Characteristics

- Radar: 13.4 GHz; 110-watt pulse at 189-Hz pulse repetition frequency (PRF)
- Antenna: 1-m diameter rotating dish that produces two spot beams, sweeping in a circular pattern
- Mass: 200 km
- Power: 220 watts
- Average Data Rate: 40 KB per second

2) Data Acquisition and Processing

Data were collected using the following SAR sensors and satellite missions:

- PALSAR/ALOS
- AMSR-E/Aqua
- SeaWinds/QuikScat.

Data were processed by the MEaSUREs Wetlands team:

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3) Data Description

Spatial Characteristics
The ESDR is comprised of two complementary components:
1. Fine-resolution, 100-m maps of wetland extent, vegetation type, and seasonal inundation dynamics, derived from SAR for continental-scale areas covering crucial wetland regions.

2. The second component is comprised of global monthly mappings of inundation extent at ~25 km resolution.

Data Naming Convention
ASF's MEaSUREs Wetlands data products do not follow a strict naming convention. Examples of common naming schema are below:

- alaska_wetlands_map.tif
- 20070104_430_HH_003_19M.cls
- south-america-alos-scansar.gif

GeoTIFF Product (.tif)

GeoTIFF is a public domain metadata standard that allows georeferencing information to be embedded within a TIFF file. The GeoTIFF data products are geocoded to the Universal Transverse Mercator (UTM) map projection, using the zone that best represents the data's geolocation. The ASF MEaSUREs Wetlands GeoTIFF products have the file extension .tif.

GIF Product (.gif)
The Graphics Interchange Format is a bitmap image format supports animations and allows a separate palette of up to 256 colors for each frame. GIF images are compressed using the Lempel-Ziv-Welch (LZW) lossless data compression technique to reduce the file size without degrading the visual quality.

4) Data Quality Issues

Please refer to the following publication for a detailed description of data quality issues associated with the Alaska Wetlands Map:

Alaska Wetlands Map derived from JERS-1 data. Whitcomb, J., M. Moghaddam, K. McDonald, J. Kellndorfer, and E. Podest, "Mapping wetlands of Alaska from L-band SAR imagery," C. J. Remote Sensing, vol. 35, no. 1, pp. 54-72, February 2009.

For other data quality questions, please contact:

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5) Using MEaSUREs Wetlands Products

The MEaSUREs Wetlands data products are currently supported to varying degrees by a number of software tools and packages that can be used to investigate and visualize the data.

Data exploration through the ASF Wetlands data portal

1. ASF's **time series animation tool** allows users to easily visualize wetland inundation dynamics across the globe. To use this tool, navigate to https://www.asf.alaska.edu/wetlands/time_series_data.

2. ASF's time-series tool allows users to select a point on a map interface and generate a graph of wetlands inundation and/or snow cover. To use this tool, navigate to https://www.asf.alaska.edu/wetlands/select_data.

Data exploration through other software packages

1. **ENVI** is a commercial geospatial software that processes and analyzes imagery. It integrates with ArcGIS® from Esri. It is available at the following link: https://www.harris.com/solution/envi
2. **Google Earth**
3. **GDAL**
4. **ArcGIS® from Esri** is a commercial geography platform enabling users to create, organize, and share geographic information and tools with anyone by using intelligent online maps and useful apps. It is available at the following link: http://www.esri.com/software/arcgis/platform
5. **MapReady**

6) Data Access

To Obtain ASF MEaSUREs Wetlands Data:

Data are available to users under NASA's open-access data policy.
View and download holdings at https://www.asf.alaska.edu/wetlands.

For more information, visit the Alaska Satellite Facility website **www.asf.alaska.edu**.

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7) References

http://www.eorc.jaxa.jp/ALOS/kyoto/ref/ALOS_BioGeo-04.pdf
https://nsidc.org/data/amsre/amsre-instrument
https://winds.jpl.nasa.gov/missions/quikscat/
http://wetlands.jpl.nasa.gov/index.html

8) Acronyms and Abbreviations

The following acronyms and abbreviations are used in this document:

ALOS	Advanced Land Observation Satellite
AMSR-E	Advanced Microwave Scanning Radiometer — EOS
ASF	Alaska Satellite Facility
AVNIR-2	Advanced Visible and Near-Infrared Radiometer type 2
Az	Azimuth
CCRS	Canada Centre for Remote Sensing
EORC-JAXA	Earth Observation Research Center-Japan Aerospace Exploration Agency
EOS	Earth Observing System
ESDR	Earth System Data Record
GPS	Global Positioning System
GHz	GigaHertz
HSSR	High-speed Solid State Recorder
JAROS	Japan Resources Observation Systems Organization
JAXA	Japan Aerospace Exploration Agency
JPL	Jet Propulsion Laboratory
JRC	Joint Research Centre, European Commission
MEaSUREs	Making Earth System Data Records for Use in Research Environments
NASA	National Aeronautics and Space Administration
NSCAT	NASA Scatterometer
PALSAR	Phased Array L-Band Synthetic Aperture Radar
PRF	Pulse Repetition Frequency
PRISM	Panchromatic Remote-sensing Instrument for Stereo Mapping
QuikScat	Quick Scatterometer
Rg	Range
SAR	Synthetic Aperture Radar
TIFF	Tagged Image File Format
UTM	Universal Transverse Mercator

9) Document Information

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https://www-wp.asf.alaska.edu/sar-information/wetlands-measures-time-series-data/