National Aeronautics and Space Administration

OPERA

Observational Products for End-Users from Remote Sensing Analysis

Product Specification Document for Dynamic Surface Water Extent from Sentinel-1

www.nasa.gov

Observational Products for End-Users from Remote Sensing Analysis (OPERA) Project

OPERA Level-3 Dynamic Surface Water Extent from Sentinel-1A/B Product Specification

Version 0.2.1

JPL D-108761, Rev - Preliminary

October 5, 2023

Paper copies of this document may not be current and should not be relied on for official purposes.

Key Authors

Jung, Jungkyo. *Jet Propulsion Laboratory, California Institute of Technology*

Part of the research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration (80NM0018D0004).

SIGNATURE PAGE

Prepared by:

Jungkyo Jung
OPERA Algorithm Development Team
DSWx-S1 Cognizant Engineer

Date

Approved by:

David Bekaert
OPERA Project Manager

Date

Heresh Fattahi
OPERA Algorithm Development Team Lead
Algorithms

Date

Steven K. Chan
OPERA Project Scientist

Date

Steven Lewis
OPERA Project System Engineer

Date

Concurred by:

Luca Cinquini
OPERA Science Data System Manager

Date

DOCUMENT CHANGE LOG

Revision	Cover Date	Sections Changed	ECR #	Reason, ECR Title, LRS #*
Preliminary	Mar 17, 2023	All	N/A	New document
v0.2	Aug 31, 2023	All	N/A	Beta delivery
v0.2.1	Oct 5, 2023	All	N/A	Update for beta point release 2.1 (R2.1)

TABLE OF CONTENTS

LIST OF TBC ITEMS

These items are to be completed when the document is ready to enter configuration control.

Page	Section

LIST OF TBD ITEMS

These items are to be completed when the document is ready to enter configuration control.

Page	Section
4	Sec. 2. 1 Define reference water map
4	Sec. 2.1 Define if coastal margin mask is needed
10	Sec. 4.2. The metadata field may change in future due to the OPERA RTC S1 under development
14-15	Sec. 5.1 Define color table for WTR and BWTR products

1 INTRODUCTION

1.1 Document Purpose

The primary purpose of this document is to convey product specifications of the OPERA (Observational Products for End-users from Remote-sensing Analysis) Level-3 Dynamic Surface Water Extent (DSWx) product that uses Sentinel-1A/B as the primary image-based inputs. This product, referred to by the short name DSWx-S1, will be generated by the OPERA Data System (SDS). It will be openly distributed by NASA's Physical Oceanography Distributed Active Archive Center (PO.DAAC).

1.2 Document Organization

Section 2 provides an overview of the product, including its purpose.

Section 3 provides the structure of the product, including tile definition, file organization, spatial resolution, and temporal and spatial organization of the content, as well as the typical file size and total data volume.

Section 4 provides a detailed description of DSWx-S1 product layers and corresponding metadata.

Appendix A provides a list of the acronyms used in this document.

1.3 Applicable and Reference Documents

The product described in this document responds to requirements imposed by applicable documents indicated below. In case of conflict between the applicable documents and this one, the OPERA Project shall review the conflict to find the most effective resolution.

Applicable Documents

[AD1] NASA SNWG Cycle 2 – OPERA Program Level (Level 1) Requirements Document, Oct. 15, 2021

[AD2] OPERA Level 2 Requirements, JPL D-107391, Rev A, Dec. 16, 2021

[AD3] Level-3 Algorithm Requirements Document, JPL D-107406, Jan 25, 2022

[AD4] OPERA Product Description, JPL D-107389, Rev A, Dec. 14, 2021

Reference Documents

[RD1] Product Specification Document for the OPERA Radiometric Terrain-Corrected SAR Backscatter from Sentinel-1, JPL D-108758, Rev Preliminary, December 15, 2022

[RD2] OPERA Algorithm Theoretical Basis Document for Dynamic Surface Water Extent from Sentinel-1 A/B data, JPL D-108763, Initial Revision, June 15, 2023

[RD3] *Cloud Optimized GeoTIFF: An imagery format for cloud-native geospatial processing.* www.cogeo.org/. Accessed 14 Oct. 2021.

[RD4] Earth Science Data and Information System (ESDIS) Standards Office (ESO). "GeoTIFF File Format, ESDS-RFC-040v1.1." Earthdata, 16 Sept. 2019. earthdata.nasa.gov/esdis/eso/standards-and-references/geotiff. Accessed 14 Oct. 2021.

[RD5] "TIFF/IT for Image Technology." *The National Digital Information Infrastructure and Preservation Program at the Library of Congress*, 3 Oct. 2006, www.loc.gov/preservation/digital/formats/fdd/fdd000072.shtml. Accessed 21 June 2022.

[RD6] "Coordinate Systems." National Geospatial-Intelligence Agency (NGA), 1 Mar. 2022, earth-info.nga.mil/index.php?dir=coordsys&action=coordsys#mgrs. Accessed 15 Oct. 2021.

The latest official versions of OPERA documents should be obtained from https://www.jpl.nasa.gov/go/opera/about-opera. This document is a 'live' one with the primary purpose of developing and describing the DSWx-S1 product for the OPERA Algorithm Development Team's (ADT) Beta point delivery R2.1 to the OPERA SDS.

1.4 Applicable Software

This document is being released for the Beta point release R2.1 of the DSWx-S1 Science Application Software (SAS) at this GitHub repository: opera-adt/DSWX-SAR. Version 0.2.1 (v0.2.1). This Beta point release updates the repository to be the official repository supported by the OPERA Project. The products generated by this version of the SAS are consistent with this document.

2 PRODUCT OVERVIEW

2.1 Product Background

DSWx-S1 product maps the extent of surface water features on a near-global basis, i.e., all land masses excluding Antarctica from Sentinel-1A/B data.

The theoretical basis and processing sequence used to generate DSWx-S1 are described in [RD1]. Figure 2-1 conceptually summarizes the DSWx-S1 product workflow. Currently, the input dataset for generating each DSWx-S1 product is the OPERA Level-2 Radiometric Terrain-Corrected (RTC) Product from S1A/B data [RD2]. The OPERA RTC-S1 products provide the radiometric terrain corrected γ0 (gamma naught) backscatter coefficient in geocoded burst domain, approximately every 6 to 12 days. The OPERA RTC-S1 products are produced and distributed in the Universal Transverse Mercator (UTM) coordinate System for each single burst [RD2].

The current DSWx-S1 algorithm requires multiple RTC S1 bursts to correctly delineate the boundary between the water and non-water as well as to avoid the discontinuity between the DSWx-S1 products. Thus, the input for DSWx-S1 includes multiple OPERA RTC S1 products within the collection of MGRS tiles. The number of OPERA RTC S1 bursts are variable depending on the size of the collections of MGRS tiles.

The DSWx-S1 products will be produced over MGRS tiles that each cover an area of 109.8 km × 109.8 km with 3660 x 3660 pixels.

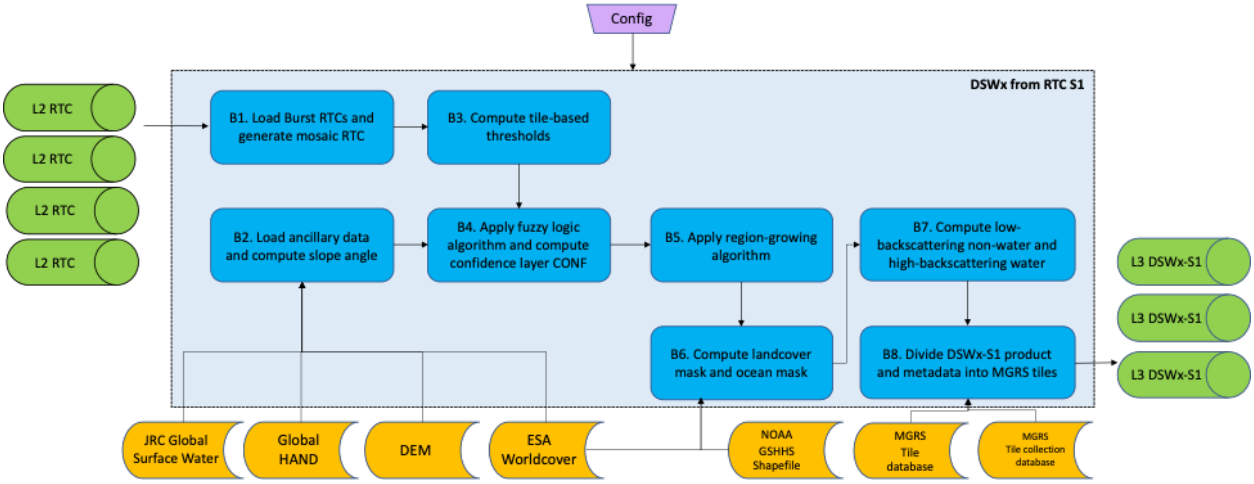

Figure 2-1. OPERA DSWx-S1 workflow diagram.

Table 2-1. Product Dependency Diagram.

Product	Scope	Description	Granule Size
OPERA RTC-S1	Global	The input RTC-S1 products	Variable
Copernicus DEM	Global	Copernicus Digital Elevation Model (DEM) 30-m GLO-30	Variable from 360 × 3600 to 3600 × 3600 (x, y)
JRC Global Surface Water	Global	Water Seasonality or Occurrence map [TBD], 30-m spatial resolution	Variable
ESA Worldcover	Global	ESA Land-cover classes with 10-m spatial resolution	Variable
ASF HAND	Global	ASF Height Above Nearest Drainage (HAND), 30-m spatial resolution	Variable
NOAA GSHHS shapefile [TBD]	Global	Global Self-consistent, Hierarchical, High-resolution Geography Database (GSHHG) to be used for ocean masking	Vector
MGRS tile database	Global	MGRS tile to define output bounding box	SQLite
MGRS tile collection database	Global	MGRS tile collections consisting of MGRS tile	SQLite

2.2 DSWx-S1 Product Overview

Each DSWx-S1 product is distributed as a set of 3 GeoTIFF (Geographic Tagged Image File Format) files corresponding to each DSWx-S1 layer (see Section 4.1). The GeoTIFF files are saved as Cloud-Optimized GeoTIFFs (COGs) [RD3] to make retrieval of GeoTIFF data from web storage, including Distributed Active Archive Centers (DAACs), more efficient.

The pixel spacings of the DSWx-S1 product in east and north directions are consistent with the input OPERA RTC-S1 product (Table 2-2).

Table 2-2. Posting of DSWx-S1 product.

Product	Posting in Northing (m)	Posting in Easting (m)
DSWx-S1	30	30

3 PRODUCT ORGANIZATION

In this section, we describe the DSWx-S1 file format and naming convention, as well as tile definition, labeling scheme, and spatial organization.

3.1 File Format – GeoTIFF

Each OPERA DSWx-S1 product is distributed as a set of 3 Cloud Optimized GeoTIFF [RD4] files containing additional metadata.

The GeoTIFF is a format to store georeferenced raster images and is widely used by remote-sensing communities. The GeoTIFF format is defined in the public domain as Tagged Image File Format (TIFF) [RD5]. It enables the storage of compressed images with associated metadata that can be easily read by Geographic Information System (GIS) software, including the open Geospatial Data Abstraction Library (GDAL) and Quantum GIS (QGIS).

3.2 File-Naming Convention [TBD]

OPERA DSWx-S1 granule names are designed to ensure unique and descriptive identification for the OPERA DSWx_S1 products. The following file-naming convention is used:

Project_**L**evel_**P**roduct**S**hort**N**ame-
Source_**T**ile**ID**_**D**ate**T**ime_**P**roduct**G**eneration**D**ate**T**ime_**S**ensor_**P**ixel**S**pacing_**P**roduct**V**ersion
**L**ayer**N**umber**L**ayer**N**ame.**E**xt

- **P**roject: “OPERA”
- **L**evel: “L3”
- **P**roduct**S**hort**N**ame: “DSWx”
- **S**ource: The input source of the product (“S1” in this case)
- **T**ile**ID**: Specific MGRS tile ID of the product.
- **D**ate**T**ime: The acquisition date and time (Greenwich Mean Time or GMT) of the input RTC-S1 burst imagery (format: YYYYMMDDTHHMMSSZ). The earliest acquisition time is extracted from the RTC-S1 bursts overlapped with the MGRS tile.
- **P**roduct**G**eneration**D**ate**T**ime: The date and time (GMT) at which the product was generated by OPERA (format: YYYYMMDDTHHMMSSZ)
- **S**ensor: The image input sensor “S1A” (Sentinel-1A) or “S1B” (Sentinel-1B)
- **P**ixel**S**pacing: Pixel spacing in meters
- **P**roduct**V**ersion: OPERA DSWx-S1 product version number with four characters, including the letter “v” and two digits indicating the major and minor versions, which are delimited by a period
- **L**ayer**N**umber: Three characters corresponding to the letter “B,” followed by a two-digit integer indicating the DSWx-S1 layer number, starting with 01 for the WTR layer
- **L**ayer**N**ame: Name of the DSWx-S1 layer (see Table 4-1)

- **E**xt: File extension (“tif” in this case)

Example:
OPERA_L3_DSWx-S1_T15SXR_20210205T163901Z_20220101T140222Z_S1A_30_v0.1_B01_WTR.tif

3.3 Tile Definition

OPERA DSWx-S1 products conform to the tiling scheme of OPERA DSWx-HLS products to optimize the integration of surface water-related OPERA products. Each tile spans a ground area of 109.8 km x 109.8 km, structured into 3,660 rows and 3,660 columns with a pixel spacing of 30 m in both horizontal and vertical directions. To facilitate seamless mosaicking, both DSWx-S1 and DSWx-HLS products feature a 4,900 m overlap in every direction, aligning with the MGRS 100,000-m square tiling system, thus preventing gaps between contiguous DSWx-S1 product tiles. Additionally, DSWx-S1 tiles are aligned with projected map coordinates consistent with MGRS [RD6].

MGRS is a geographic grid reference system defined using the Universal Transverse Mercator (UTM) for most latitudes and the Universal Polar Stereographic (UPS) coordinate systems for polar regions (North of 84°N and South of 80°S). The OPERA DSWx-S1 products are defined over the UTM coordinate system with a 100 km-by-100 km tiling scheme with 9.8 km buffer in vertical and horizontal directions. At this precision level, MGRS tiles are labeled using the grid zone designation followed by the 100,000-m square identification.

The grid zone designation is defined by the UTM zone number followed by the latitude band. Each longitude section has a width of 6°, resulting in 60 UTM zones. Each zone is divided into 20 latitude bands of 8° in the latitude direction and each band (tile) is identified by a letter starting from “C” at 80°S to “X” at 80°N, omitting letters “I” and “O” because of their similarity to numerals 1 and 0. Both latitude bands “C” and “X” are extended 4° towards the Poles, i.e., the latitude band “C” comprises the latitude range from −84° to −72° and the latitude band “X” identifies the latitude range from 72° to 84°. The 100,000-m square identification, or 100_SID, consists of a 100_SID column letter “A” to “Z” followed by a 100_SID row letter from “A” to “V.” Similar to latitude bands, 100_SID column and row letters also omit letters “I” and “O.” The resulting MGRS tiling scheme DSWx-S1 has the following format:

UTM_ZONE_NUMBER**L**ATITUDE_BAND100_SID_**C**OLUMN_LETTER100_SID_**R**OW_LETTER>

For instance, the Louisiana example that is shown in Section 5 is located at the tile identified as “15SXR,” where “15” is the UTM zone number, “S” is the latitude band, “X” is the 100_SID column letter, and “R” is the 100_SID row letter.

3.4 Spatial Organization

Salient features of the output grid for the DSWx-S1 product are as follows:

1. The output grid is common to all layers in each product.
2. The DSWx-S1 data are arranged on a uniformly spaced, north-up and west-left grid – i.e., decreasing north or Y coordinate in the row direction and increasing east or X coordinate in the column direction following the row-major order convention of representing 2D raster arrays.

3.5 Grid Alignment

OPERA DSWx-S1 products will use a “pixel is area” convention. The “pixel is area” convention, uses northing and easting coordinates Y and X, with (0,0) denoting the upper-left corner of the image, and increasing X to the east, increasing Y to the south. The first pixel value fills the grid cell with the top-left position (0,0) and bottom-right position (1,1).

4 PRODUCT SPECIFICATION

In this section, we describe the DSWX-S1 product layers and associated metadata.

4.1 Product Raster Layers

Each DSWX-S1 product contains 3 GeoTIFF files (layers), each with 3,660 rows and 3,660 columns. Layers are provided as Unsigned Integers of 8 bits (UInt8), or floating-point number 32 (Float32). It also contains a single browse image in Portable Network Graphic format, as noted by its '.png' file name extension. Specifics regarding GeoTiff layer names and content are shown in Table 4-1.

Table 4-1. DSWx-S1 raster layers.

Product Variables	
Layer: 1	**Binary water (BWTR)**
Type: UInt8	**Shape (x, y): (3660 × 3660)**
Description: The binary water map is derived from the WTR layer as a union of water classes (open water and high-backscattering water) and a union of non-water classes (not water and low-backscattering non-water) into a binary map indicating areas with and without water. Invalid data classes (landcover masked, hand masked, layover/shadow masked, ocean masked and fill value) are also provided to indicate areas in which the binary classification does not provide water/no-water classification.	
Layer classes: 0: Not water – an area with valid data that is not water (class 1) and not HAND masked (class 252), layover or shadow (class 253), or ocean masked (class 254). 1: water – an area classified as “open water” or “high-backscattering water” (see WTR layer). 5: Height Above Nearest Drainage (HAND) masked - an area where topographic height is higher than the HAND threshold. 6: Layover/shadow masked - an area identified as layover or shadow computed from the geometry of the digital elevation model and sensor. The area is directly copied from input burst RTC products. 7: Inundated vegetation - an area where vegetation is submerged or covered by water. 120: Fill value (no data). 254: Ocean Masked - an area identified as ocean using a shoreline database with an added margin	
Layer: 2	**Water classification (WTR)**
Type: UInt8	**Shape (x, y): (3660 × 3660)**
Description: Masked interpreted water classification layer. This represents pixel-wise classification into one of two water classes (low- and high-backscattering water), landcover mask, low-backscattering non-water, hand mask, layover/shadow class, or no data classes.	
Layer classes: 0: Not water – an area with valid data that is not open water (class 1), high-backscattering water (class 2), low-backscattering non-water (class 3), landcover masked (class 4), height above nearest drainage masked (class 5), layover/shadow masked (class 6), inundated vegetation (class 7) or ocean masked (class 254). Masking can result in “not water” (class 0) where land cover masking is applied. 1: Open water – an area that is entirely water and unobstructed to the sensor, including obstructions by vegetation, terrain, and buildings. 2: High-backscattering water – an area that is entirely water and has higher backscattering than thresholds. 3: Low-backscattering non-water - an area that is not water and lower backscattering than thresholds 4: Landcover masked - an area identified from the land-cover masking step 5: Height Above Nearest Drainage (HAND) masked - an area where topographic height is higher than the HAND threshold. 6: Layover/shadow masked - an area identified as layover or shadow computed from the geometry of the digital elevation model and sensor. The area is directly copied from input burst RTC products. 7: Inundated vegetation - an area where vegetation is submerged or covered by water. 120: Fill value (no data) 254: Ocean masked - an area identified as ocean using a shoreline database with an added margin	

Layer: 3	Confidence (CONF)
Type: Float32 [TBD]	Shape (x, y): (3660 × 3660)
Description: A metric of the confidence associated with the WTR classification that is commuted from ancillary data including HAND, terrain slope angle, reference water and RTC backscattering with thresholds. Values in this band range between 0 and 100. Specific interpretation of this metric is [TBD], but will be documented in future ATBD documents.	
Layer classes: 0-100: Confidence associated with the WTR classification that is computed from backscattering intensity, reference water, slope angle, and HAND values. 120: Fill value (no data). 252: Height Above Nearest Drainage (HAND) masked - an area where topographic height is higher than the HAND threshold. 253: Layover/shadow masked - an area identified as layover or shadow computed from the geometry of the digital elevation model and sensor. The area is directly copied from input burst RTC products. 254: Ocean Masked - an area identified as ocean using a shoreline database with an added margin	

4.2 GeoTIFF Metadata

All DSWx-S1 product layers (GeoTIFF files) are saved with the same metadata. The DSWx-S1 metadata is divided into three sections: 1) Product Identification and Processing Information, 2) input datasets, and 3) Sentinel-1 A/B product metadata.

4.2.1 Product Identification and Processing Information

Table 4-2 lists the product identification fields of the GeoTIFF metadata. The attribute PRODUCT_VERSION informs the version of the DSWx-S1 product (structure and metadata), whereas the attribute SOFTWARE_VERSION describes the version of the software that generated the DSWx-S1 product.

Table 4-2. GeoTIFF metadata: product identification.

Attribute	Description
DSWX_PRODUCT_VERSION	The DSWx-S1 product version
SOFTWARE_VERSION	The software version used to generate the DSWx-S1 product
PROJECT	OPERA
PRODUCT_LEVEL	3
PRODUCT_TYPE	DSWx-S1
PRODUCT_SOURCE	OPERA RTC S1
INSTITUTION	NASA JPL
PROCESSING_DATETIME	DSWx-S1 product processing date. Format: YYYY-MM-DDTHH:MM:SSZ.
SPACECRAFT_NAME	Name of the sensor platform (e.g., Sentinel-1A/B)
SENSOR	Name of the sensor instrument (e.g., IW)

4.2.2 Sentinel-1 product Metadata

Table 4-4 lists the metadata copied or derived from the OPERA RTC product metadata to the DSWx-S1 GeoTIFF metadata.

Table 4-3. GeoTIFF metadata: OPERA RTC-S1 product metadata.

Attribute	Description
SENSING_START	Sensing start time. Earliest acquisition time of OPERA burst RTC set. Format: YYYY-MM-DDTHH:MM:SSZ
SENSING_END	Sensing start time. Latest acquisition time of OPERA burst RTC set. Format: YYYY-MM-DDTHH:MM:SSZ
SPATIAL_COVERAGE	The area percentage of the tile with data
LAYOVER_SHADOW_COVERAGE	The percentage of layover and shadow in the DSWx-S1 product based on OPERA RTC-S1 product
RTC_PRODUCT_VERSION	The version of OPERA RTC algorithm used for RTC products. Copied directly from OPERA RTC metadata.
POLARIZATION	Polarizations (e.g. VV, VH)
BURST_ID	List of the burst id. format: TrackNumber_BurstID_Swathnumber
ABSOLUTE_ORBIT_NUMBER	Absolute orbit number. Copied from OPERA burst RTC products.

ORBIT_PASS_DIRECTION	Orbit direction (e.g. Ascending or Descending). Copied from OPERA RTC.
TRACK_NUMBER	Track number. Copied from OPERA RTC.

4.2.3 Input Ancillary datasets

Table 4-3 lists the input dataset fields of GeoTIFF metadata.

Table 4-4. GeoTIFF metadata: input datasets.

Attribute	Description
INPUT_SHORELINE_SOURCE [TBD]	Description of input shoreline shapefile to be used ocean masking
INPUT_DEM_SOURCE	Description of the input DEM
INPUT_REFERENCE_WATER_SOURCE	Description of the input reference water file
INPUT_WORLDCOVER_SOURCE	Description of the input ESA WorldCover 10-m file
INPUT_HAND_SOURCE	Description of the input ASF GLO-30 HAND 30-m file

4.2.4 DSWx-S1 Processing and Product Parameters

Table 4-4 lists the metadata copied or derived from the OPERA RTC product metadata to the DSWx-S1 GeoTIFF metadata.

Table 4-5. GeoTIFF metadata: S1 product metadata.

Attribute	Description
PROCESSING_INFORMATION_WORKFLOW	Indicate workflow for DSWx-S1; either ”DSWx-S1-open_water " or “DSWx-S1-inundated_vegetation”
PROCESSING_INFORMATION_THRESHOLDING	initial thresholding algorithm, either “Kittler-Illingworth” or “OTSU”
PROCESSING_INFORMATION_MULTI_THRESHOLD	Boolean if trimodal distribution is assumed
PROCESSING_INFORMATION_TILE_SELECTION	Tile selection method (e.g. Tweles, Chini, Bimodality or combined)
PROCESSING_INFORMATION_FILTER	Filter name (e.g. Enhanced Lee Filter)
PROCESSING_INFORMATION_INUNDATED_VEGETATION	Boolean if inundated vegetation is involved.

PROCESSING_INFORMATION_FUZZY_SEED	seed value for fuzzy-logic classification
PROCESSING_INFORMATION_FUZZY_TOLERANCE	tolerance value for fuzzy-logic classification

5 DSWx-S1 Sample Product

To visually present the product, a randomly selected OPERA RTC S1 input was used to generate the following graphics, as shown in Figure 5-1 (left). This collection consists of 40 OPERA RTC S1 products acquired over the Amazon Forest on July 21, 2020, covering 8 MGRS tile IDs; 18MVU, 18MVV, 18MWU, 18MWV, 18MXU, 18MXV, 18MYU, and 18MYV. The OPERA DSWx-S1 requires the collection of RTC S1 data, and these data were processed to produce the DSWx-S1 water (WTR) layer, which is displayed in Figure 5-1 (right). The resulting output products include DSWx-S1 sets that cover the 8 MGRS tiles. Each product covers a single MGRS tile.

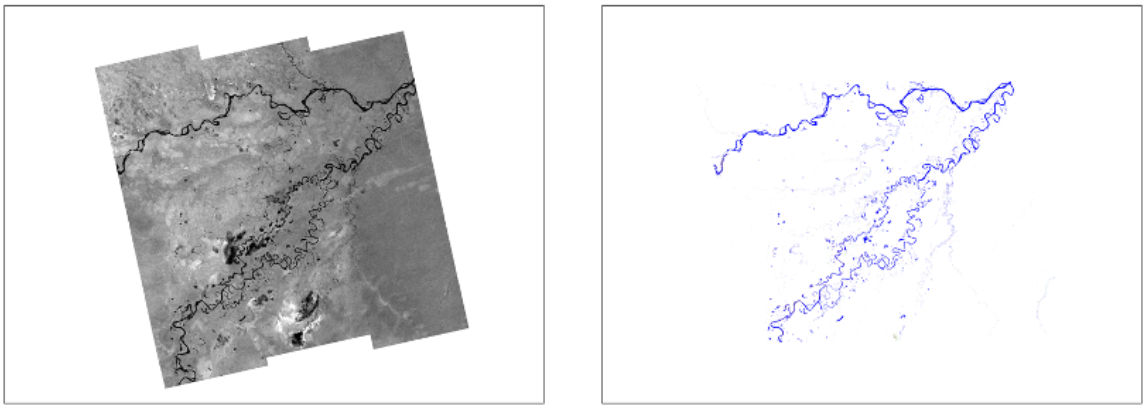

Figure 5-21. Input OPERA RTC-S1 [polarization: VV] layers (left) and DSWx-S1 water classification layer WTR (right) for 8 MGRS tiles.

Individual DSWx-S1 products consist of three layers; WTR, BWTR and CONF as described in the Layer 1 section of table 4-1. The individual WTR layer contains nine values as shown in figure 5-2 (right): not water (0, shown in white); open water (1, shown as dark blue); high-backscattering water (2, shown in red [TBD]); low-backscattering non-water (3, shown in light blue [TBD]); landcover masked (4, shown in yellow[TBD]); HAND masked (5, shown in dark gray); layover/shadow masked (6, shown in light gray); ocean masked(254, shown in [TBD]); and fill or no data value (255, transparent, although not present in this example).

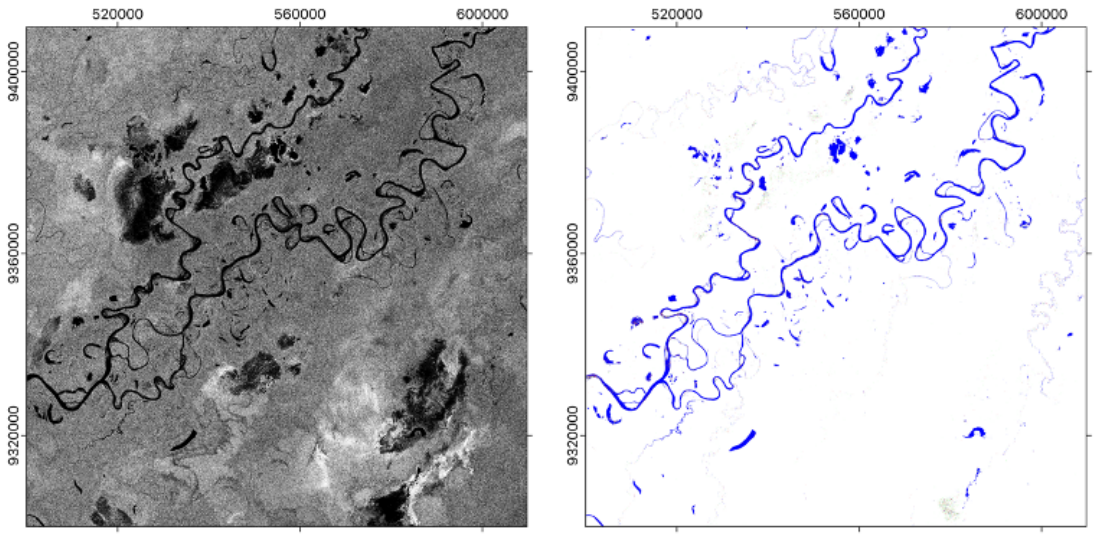

Figure 5-2. Input OPERA RTC-S1 [polarization: VV] layers (left) and DSWx-S1 water classification layer WTR (right) in 18MWU MGRS tile.

Figure 5-3 (left) shows the BWTR layer, which is a binary water map (0, not water in white, 1, water in blue, and masked and invalid classes 252-255 following the WTR layer. The single water class is a union of all water classes in the WTR layer. Figure 5-2 (right) shows the CONF layer, which is a representation of the confidence associated with the WTR classification that is computed from backscattering intensity, reference water, slope angle, and HAND values. A complete description of the confidence values can be found in Table 4-1.

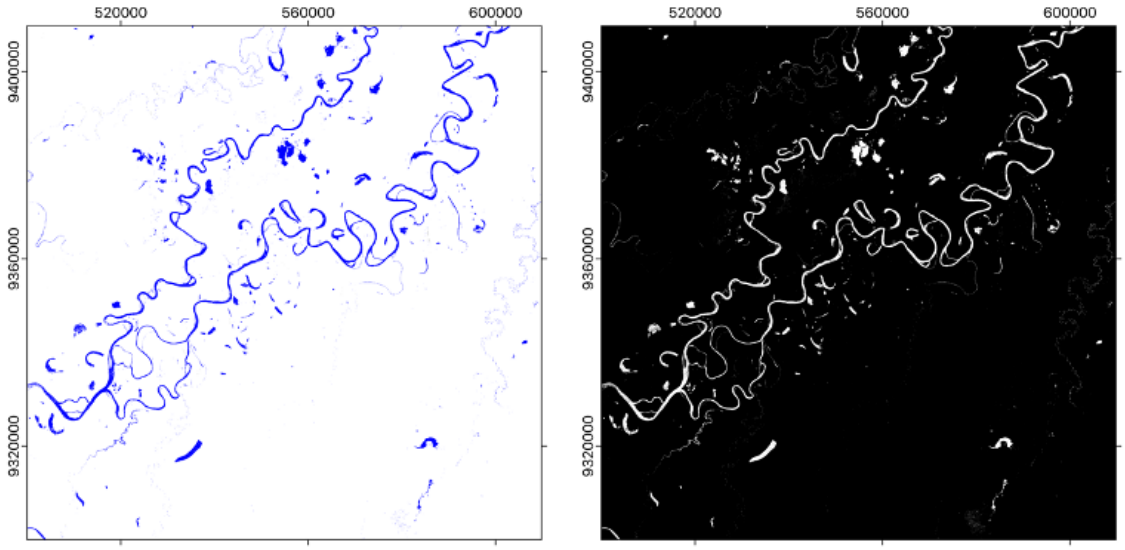

Figure 5-3. DSWx-S1 Binary water layer BWTR (left) and Confidence layer CONF (right) in 18MWU MGRS tile.

[RD7] APPENDIX A: ACRONYMS

ADT	Algorithm Development Team
COG	Cloud-Optimized GeoTIFF
DAAC	Distributed Active Archive Center
DEM	Digital Elevation Model
DOI	Digital Object Identifier
DSWx	Dynamic Surface Water Extent
ESA	European Space Agency
ESDIS	Earth Science Data and Information System
ESO	ESDIS Standards Office
Float32	Floating-point number of 32 bits
GDAL	Geospatial Data Abstraction Library
GeoTIFF	Georeferenced Tagged Image File Format
GIS	Geographic Information System
HAND	Height Above Nearest Drainage
HLS	Harmonized Landsat and Sentinel-2
IF	Interface (delivery)
MGRS	Military Grid Reference System
NGA	National Geospatial-Intelligence Agency
NISAR	NASA-ISRO Synthetic Aperture Radar
OPERA	Observational Products for End-users from Remote-sensing Analysis
PO.DAAC	NASA's Physical Oceanography Distributed Active Archive Center
QA	Quality Assurance
QGIS	Quantum Geographic Information System
S1	Sentinel-1 A/B
SAR	Synthetic Aperture Radar
SAS	Science Application Software
SDS	Science Data System
SR	Surface Reflectance
SWOT	Surface Water and Ocean Topography
TIFF	Tagged Image File Format
UInt8	Unsigned Integers of 8 bits
UInt16	Unsigned Integers of 16 bits
UPS	Universal Polar Stereographic
URI	Uniform Resource Identifier
UTM	Universal Transverse Mercator
WRS	World Reference System