How to work with SSM products From Download to Visualization

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Topics

- Overview
- ASCAT SSM NRT Products
- ASCAT SSM CDR Products
- Read and plot ASCAT SSM NRT Products
- Read and plot ASCAT SSM CDR Products
- Summary

H SAF ASCAT Surface Soil Moisture Products

- ASCAT SSM Near Real-Time (NRT) products
  - NRT products for ASCAT on-board Metop-A, Metop-B, Metop-C
  - Swath orbit geometry
  - Available 130 minutes after sensing
  - Various spatial resolutions
    - 25 km spatial sampling (50 km spatial resolution)
    - 12.5 km spatial sampling (25-34 km spatial resolution)
    - 0.5 km spatial sampling (1 km spatial resolution)

- ASCAT SSM Climate Data Record (CDR) products
  - ASCAT data merged for all Metop (A, B, C) satellites
  - Time series format located on an Earth fixed DGG (WARP5 Grid)
  - 12.5 km spatial sampling (25-34 km spatial resolution)
  - Re-processed every year (in January)
  - Extensions computed throughout the year until new release

Outlook: Near real-time surface soil moisture products

CDOP3

H08 - SSM ASCAT NRT DIS Disaggregated Metop ASCAT NRT SSM at 1 km (pre-operational)*

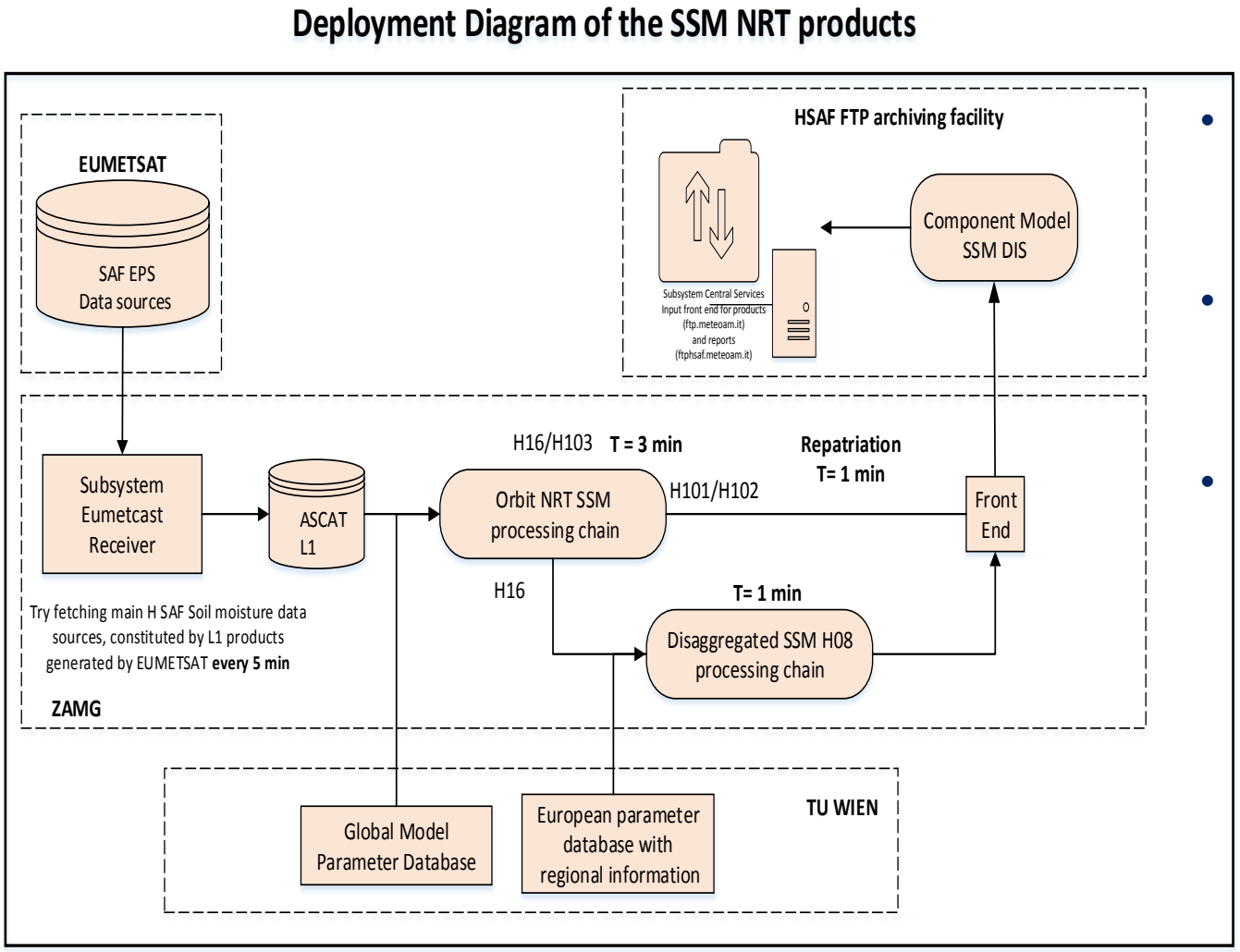
H101 - SSM ASCAT-A NRT O12.5 Metop-A ASCAT NRT SSM orbit 12.5 km sampling (operational)

H102 - SSM ASCAT-A NRT O25 Metop-A ASCAT NRT SSM orbit 25 km sampling (operational)

H16 - SSM ASCAT-B NT O12.5 Metop-B ASCAT NRT SSM orbit 12.5 km sampling (operational)

H103 - SSM ASCAT-B NRT O25 Metop-B ASCAT NRT SSM orbit 25 km sampling (operational)

Architecture of ASCAT SSM Data Services



- Operational processing environment (NRT)
  - ZAMG
- Research & Development, Re-processing activities
  - TU Wien
- Software and Data interfaces

Central Services – Archiving

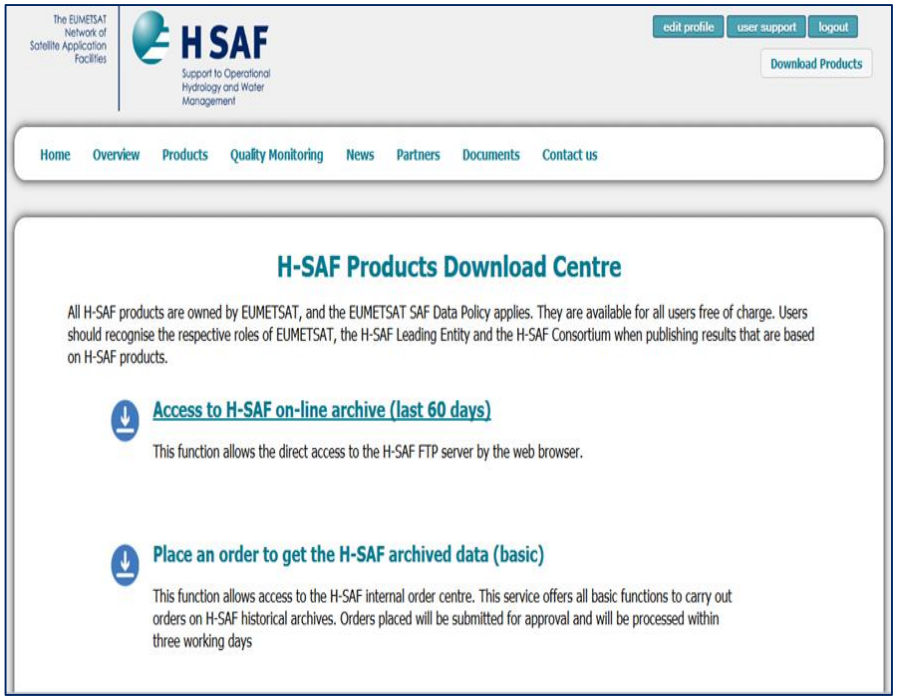
H SAF products NRT availability requirement guaranteed to end users

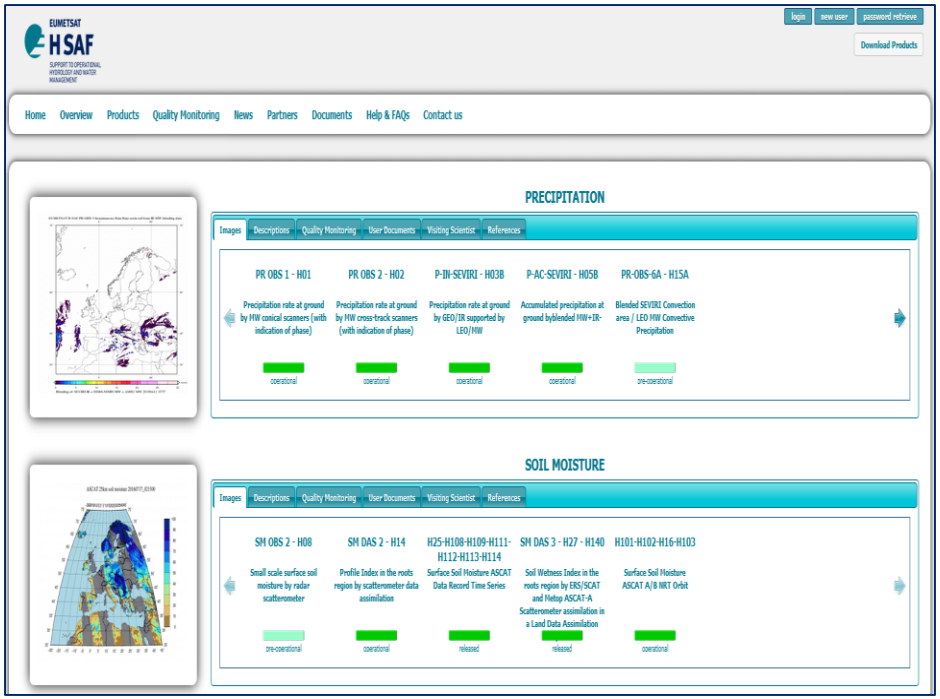
Products are maintained in two separate storage areas:

- **On-line Archive:** Latest 60 days of production constantly available (24/7) Immediate access to selected items for registered users
- **Off-line Archive:** Entire production since the beginning of H SAF operations. Items available through Order Management System, made available on demand in a FTP area for a limited temporal window

```
Connected to ftphsaf.meteoam.it.
220 Welcome to Italian Air Force Meteorological Service H-SAF FTP service.
331 Please specify the password.
Password:
230 Login successful.
Remote system type is UNIX.
Using binary mode to transfer files.
ftp> ls
229 Entering Extended Passive Mode (|||20485|).
150 Here comes the directory listing.
drwxr-xr-x   31 ftp      ftp          4096 Sep 20 03:14 hsaf_archive
dr-xr-xr-x   15 ftp      ftp          4096 Jun 11 08:25 hsaf_doc
dr-xr-xr-x    9 ftp      ftp          4096 Jul 02 12:41 hsaf_share
dr-xr-xr-x   48 ftp      ftp          4096 Oct 30 13:52 products
226 Directory send OK.
```

User Services – Website





Outlook: Near real-time products

➢ Surface soil moisture products

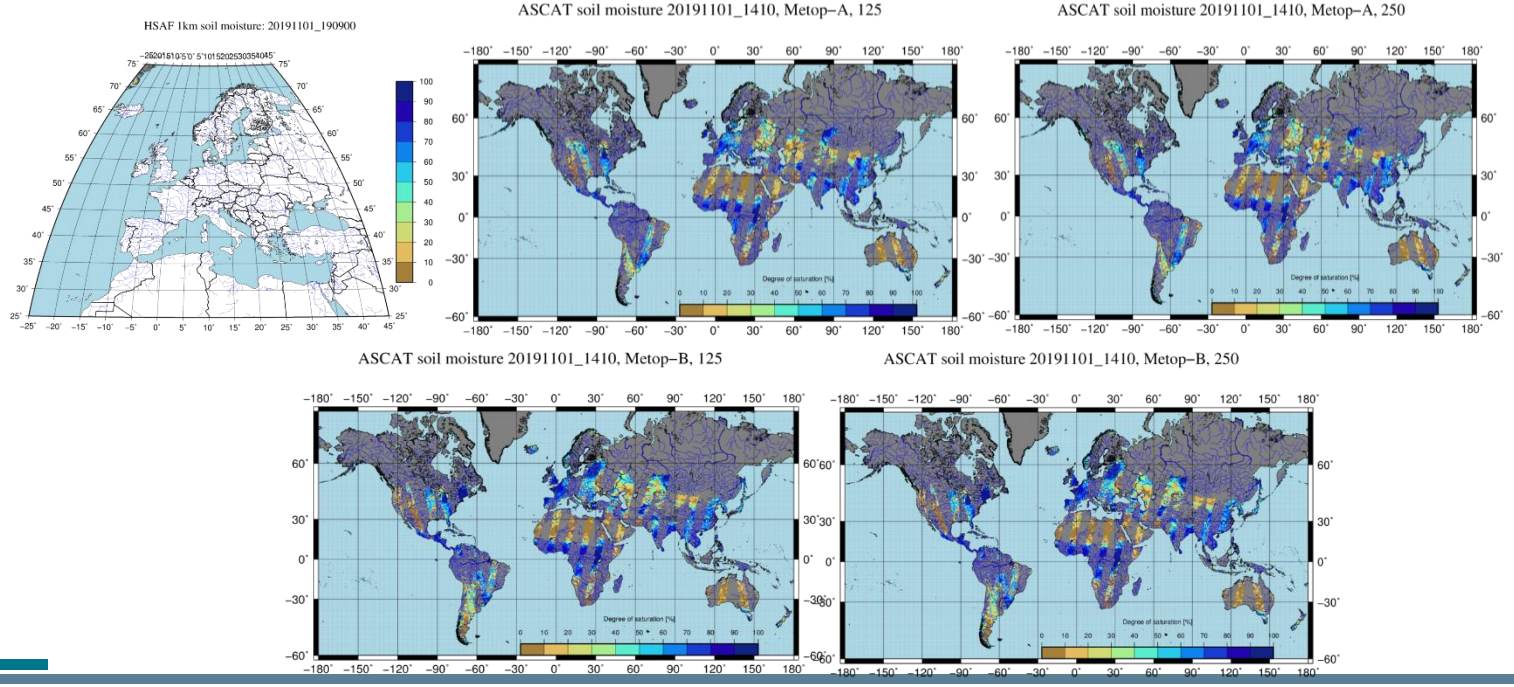
H08 - SSM ASCAT NRT DIS Disaggregated Metop ASCAT NRT SSM at 1 km (pre-operational)

H101 - SSM ASCAT-A NRT O12.5 Metop-A ASCAT NRT SSM orbit 12.5 km sampling (operational)

H102 - SSM ASCAT-A NRT O25 Metop-A ASCAT NRT SSM orbit 25 km sampling (operational)

H16 - SSM ASCAT-B NRT O12.5 Metop-B ASCAT NRT SSM orbit 12.5 km sampling (operational)

H103 - SSM ASCAT-B NRT O25 Metop-B ASCAT NRT SSM orbit 25 km sampling (operational)



ASCAT NRT SSM Products

- Metop-A ASCAT NRT SSM
  - H102 - 25 km spatial sampling (50 km spatial resolution)
  - H101 - 12.5 km spatial sampling (25-34 km spatial resolution)
- Metop-B ASCAT NRT SSM
  - H103 - 25 km spatial sampling (50 km spatial resolution)
  - H16 - 12.5 km spatial sampling (25-34 km spatial resolution)
  - H08 - 0.5 km spatial sampling (1 km spatial resolution)

ASCAT NRT SSM Variables and Flags

- Main variables
  - Surface soil moisture (degree of saturation, %)
  - Surface soil moisture noise (degree of saturation, %)
- Flags
  - Processing flags
  - Correction flags
  - Advisory flags

Table 5.2: Processing and correction field.

Name	Scaling factor	Units	Type	Byte size
PROCESSING_FLAGS	-	-	uint8	1
CORRECTION_FLAGS	-	-	uint8	1

Table 5.3: Advisory flag fields.

Name	Scaling factor	Units	Type	Byte size
SNOW_COVER_PROBABILITY	-	-	uint8	1
FROZEN_SOIL_PROBABILITY	-	-	uint8	1
INUNDATION_OR_WETLAND	-	-	uint8	1
TOPOGRAPHICAL_COMPLEXITY	-	-	uint8	1
AGGREGATED_QUALITY_FLAG	-	-	uint8	1

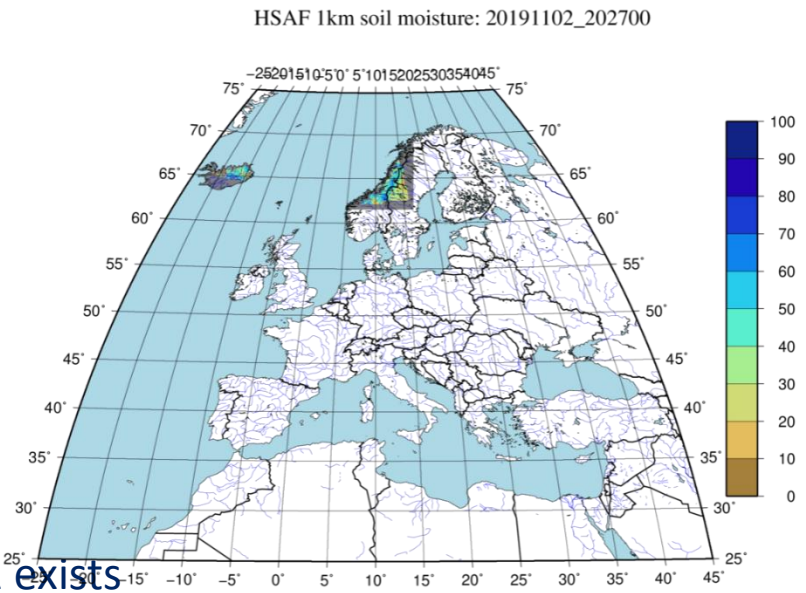
Table 5.1: Overview of Level 2 parameters.

Name	Scaling factor	Units	Type	Byte size
SOIL_MOISTURE	10^2	%	uint16	2
SOIL_MOISTURE_ERROR	10^2	%	uint16	2
MEAN_SURF_SOIL_MOISTURE	10^2	%	uint16	2
SIGMA40	10^6	dB	int32	4
SIGMA40_ERROR	10^6	dB	int32	4
SLOPE40	10^6	$\frac{dB}{deg}$	int32	4
SLOPE40_ERROR	10^6	$\frac{dB}{deg}$	int32	4
SOIL_MOISTURE_SENSITIVITY	10^6	dB	uint32	4
DRY_BACKSCATTER	10^6	dB	int32	4
WET_BACKSCATTER	10^6	dB	int32	4
RAINFALL_FLAG	-	-	uint8	1
WARP_NRT_VERSION	-	-	uint16	2
PARAM_DB_VERSION	-	-	uint16	2

ASCAT DIS NRT SSM data distribution & archive

- NRT distribution
  - EUMETCast
  - H SAF FTP (last 60 days)
- (NRT) Archive
  - H SAF FTP

- File format
  - EUMETCast/H SAF FTP
    - BUFR, NetCDF
- H08: At the moment no re-processed CDR exists
- Available only over Europe



ASCAT DIS NRT SSM Variables and Flags

- Main variables
  - Surface soil moisture (degree of saturation, %)
  - Surface soil moisture noise (degree of saturation, %)
- Flags
  - Correction flags

Table 6.1: Overview of Level 2 parameters.

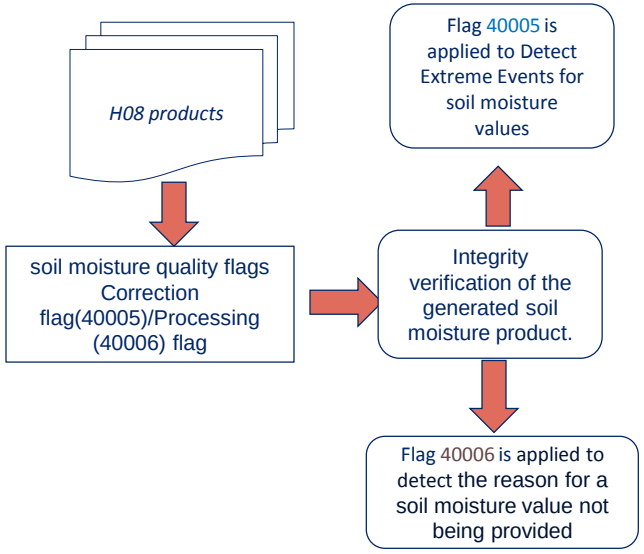
Name	Scaling factor	Units	Type	Byte size	NaN
SM	-	%	int8	1	127
SM_NOISE	-	%	int8	1	127

Table 6.2: Overview of geo-location and satellite parameters.

Name	Scaling factor	Units	Type	Byte size
LATITUDE	-	Degrees North	float32	4
LONGITUDE	-	Degrees East	float32	4
TIME	-	Days since 1900-01-01 00:00:00 UTC	float64	8

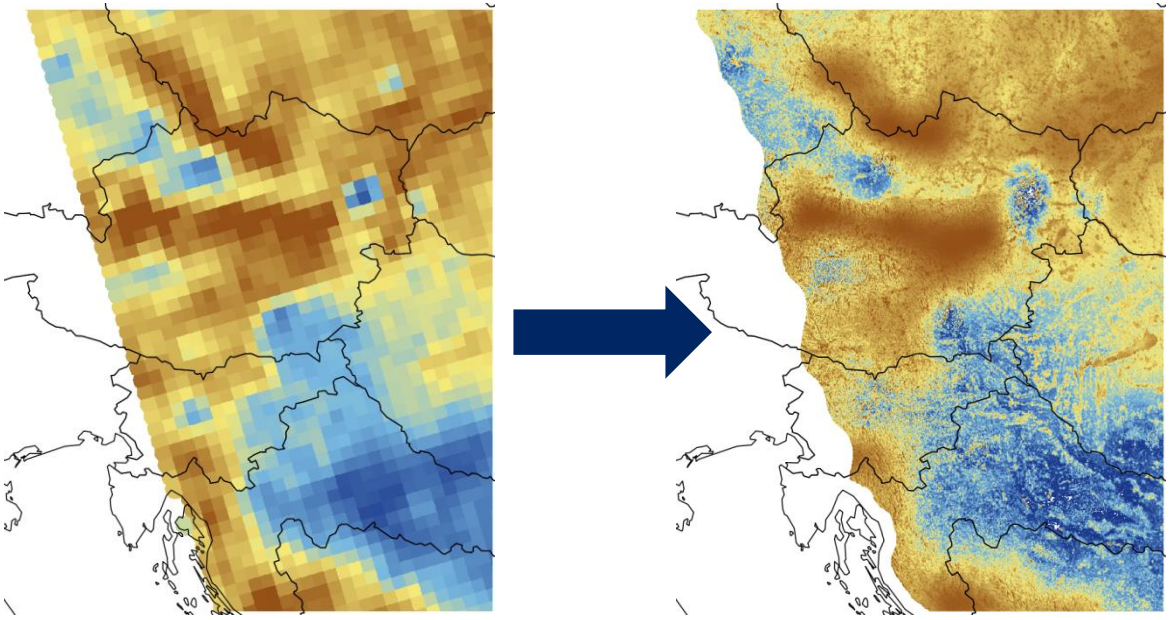
Table 6.3: Correction flags.

Name	Scaling factor	Units	Type	Byte size
CORR_FLAG	-	-	uint8	1



Disaggregated Metop ASCAT NRT SSM

- H08 - 0.5 km spatial sampling (BUFR, NetCDF) based on Metop-B



H16 - 12.5 km sampling

H08 - 0.5 km sampling

CDOP3 Outlook: SM CDR and SM CDR-EXT products

H<id> CDR product name	H<id> CDR-EXT product name
H111 Metop ASCAT SSM CDR2016	H112 Metop ASCAT SSM CDR2016-EXT
H113 Metop ASCAT SSM CDR2017	H114 Metop ASCAT SSM CDR2017-EXT
H115 Metop ASCAT SSM CDR2018	H116 Metop ASCAT SSM CDR2018-EXT
H117 Metop ASCAT SSM CDR2019	H118 Metop ASCAT SSM CDR2019-EXT
H119 Metop ASCAT SSM CDR2020	H120 Metop ASCAT SSM CDR2020-EXT
H121 Metop ASCAT SSM CDR2021	-

Table 1. List of Soil Moisture Climate Data Records (SM CDR) and their extensions (SM CDR-EXT)

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ASCAT CDR SSM Products

- Metop ASCAT CDR SSM
  - H25 - Metop ASCAT CDR2015 SSM (2007-2014)
  - H109 - Metop ASCAT CDR2016 SSM (2007-2015)
  - H111 - Metop ASCAT CDR2017 SSM (2007-2016)
  - H113 - Metop ASCAT CDR2018 SSM (2007-2017)
  - H115 - Metop ASCAT CDR2019 SSM (2007-2018)
- Metop ASCAT CDR SSM Extension
  - H108 - Metop ASCAT CDR2015 SSM (2015+)
  - H110 - Metop ASCAT CDR2016 SSM (2016+)
  - H112 - Metop ASCAT CDR2017 SSM (2017+)
  - H114 - Metop ASCAT CDR2018 SSM (2018+)
  - H116 - Metop ASCAT CDR2019 SSM (2019+)

ASCAT CDR SSM Variables and Flags

- Main variables
  - Surface soil moisture (degree of saturation, %)
  - Surface soil moisture noise (degree of saturation, %)
- Flags
  - Processing flags
  - Correction flags
  - Confidence flags
  - Surface state flag

Table 4.3: Product flags.

Name	Scaling factor	Units	Type	Byte size	NaN value
SSF	-	-	int8	1	127
CONF_FLAG	-	-	uint8	1	255
CORR_FLAG	-	-	uint8	1	255
PROC_FLAG	-	-	uint8	1	255

Table 4.1: Overview of soil moisture parameters.

Name	Scaling factor	Units	Type	Byte size	NaN value
SM	-	%	int8	1	127
SM_NOISE	-	%	int8	1	127

Table 4.2: Overview of geo-location and satellite parameters.

Name	Scaling factor	Units	Type	Byte size	NaN value
LOCATION_ID	-	-	int64	8	-
ROW_SIZE	-	-	int64	8	-
LATITUDE	-	Degrees North	float32	4	-
LONGITUDE	-	Degrees East	float32	4	-
TIME	-	Fraction of days	float64	8	-
DIR	-	-	int8	1	127
SAT_ID	-	-	int8	1	127

Read and plot ASCAT

SSM Products

With Jupyter

Create virtual environment for python with conda

Conda is an open source package management system and environment management system that runs on Windows, macOS and Linux. Conda quickly installs, runs and updates packages and their dependencies. It was created for Python programs, but it can package and distribute software for any language. https://conda.io/en/latest/index.html

➢ How to set up a virtual environment using miniconda

Mac:

```
curl https://repo.anaconda.com/miniconda/Miniconda3-4.7.10-MacOSX-x86_64.sh -o miniconda.sh
bash miniconda.sh -b -p $HOME/miniconda
export PATH="$HOME/miniconda/bin:$PATH"
conda create -n sm_env
conda install -n sm_env -c conda-forge numpy scipy pandas matplotlib rasterio geopandas netCDF4 pyflakes
statsmodels cartopy basemap basemap-data-hires cython h5py jupyter gdal python=3.6 metview pybufr-ecmwf
pykdtree pygrib pyresample
source activate sm_env
pip install --upgrade pip
pip install ascat pytesmo metview
```

Linux:

```
wget https://repo.anaconda.com/miniconda/Miniconda3-4.7.10-Linux-x86_64.sh -O miniconda.sh
bash miniconda.sh -b -p $HOME/miniconda
export PATH="$HOME/miniconda/bin:$PATH"
conda create -n sm_env
conda install -n sm_env -c conda-forge numpy scipy pandas matplotlib rasterio geopandas netCDF4 pyflakes
statsmodels cartopy basemap basemap-data-hires cython h5py jupyter gdal python=3.6 metview pybufr-ecmwf
pykdtree pygrib pyresample
source activate sm_env
pip install --upgrade pip
pip install ascat pytesmo metview
```

https://docs.conda.io/en/latest/miniconda.html

ASCAT SSM Products and Software

- **Two product families**
  - ASCAT SSM Near Real-Time (NRT) products
    - Each ASCAT sensor, 12.5 and 25 km sampling, swath orbit geometry
    - Metop-B ASCAT, 0.5 km sampling, swath orbit geometry
    - Re-processed versions of NRT products, product type becomes CDR
  - ASCAT SSM Climate Data Record (CDR) products
    - Combined ASCAT data, time series format
- Python Package ascat – Read/process ASCAT L1b and L2 data
  - https://github.com/TUW-GEO/ascat
  - https://pypi.org/project/ascat/
- Python Package pytesmo – Soil Moisture Validation Toolbox
  - https://github.com/TUW-GEO/pytesmo
  - https://pypi.org/project/pytesmo/
- H SAF SM EW https://github.com/H-SAF/eumetrain_sm_week_2019

Website and Helpdesk

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  - http://h-saf.eumetsat.int/
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