H SAF Surface Soil Moisture Products

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Topics

- Overview
- ASCAT SSM NRT Products
- ASCAT Disaggregated NRT Products
- ASCAT SSM CDR Products
- WARP5 Grid
- Summary
OVERVIEW
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)
    • 6.25 km spatial sampling (15-20 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
Architecture of ASCAT SSM Data Services

- Operational processing environment (NRT)
  - EUMETSAT
  - ZAMG

- Research & Development, Re-processing activities
  - TU Wien

- Software and Data interfaces
ASCAT NRT SURFACE SOIL MOISTURE
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)
  – H122 - 6.25 km spatial sampling (15-20 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)
  – H123 - 6.25 km spatial sampling (15-20 km spatial resolution)
  – H08 - 0.5 km spatial sampling (1 km spatial resolution)
  – H28 - 1 km spatial sampling

• Metop-C ASCAT NRT SSM
  – H105 - 25 km spatial sampling (50 km spatial resolution)
  – H104 - 12.5 km spatial sampling (25-34 km spatial resolution)
  – H124 - 6.25 km spatial sampling (15-20 km spatial resolution)
ASCAT NRT SSM data distribution and archive

- **NRT data distribution**
  - EUMETCast System, EUMETSAT’s near real-time delivery of satellite data and products
  - H SAF FTP

- **(NRT) Data archive**
  - EUMETSAT Data Centre
  - H SAF FTP (last 60 days, but more can be ordered, only PDU format!)

PDU (3 min)  
Full orbit (101 min)
ASCAT NRT SSM data distribution and archive

• **File formats**
  - **EUMETCast** - Product Dissemination Unit (PDU) (3 minutes)
    • BUFR (also re-distributed via H SAF FTP, last 60 days)
  - **EUMSAF Data Centre** - full orbit (101 minutes)
    • EPS Native, BUFR, NetCDF

• **Re-processed H101/H102 available on request (EPS Native)**
  - H106 – Metop-A ASCAT SSM DR1 12.5 km sampling
  - H107 – Metop-A ASCAT SSM DR1 25 km sampling

• **Important:** H SAF FTP re-distributes NRT SSM from EUMETCast using a different product/file names
  - SMR – Soil Moisture Research
    • H101 ASCAT NRT 12.5 km sampling = Metop-A ASCAT Level 2 SMR
    • H16 ASCAT NRT 12.5 km sampling = Metop-B ASCAT Level 2 SMR
  - SMO – Soil Moisture Operational
    • H102 ASCAT NRT 25 km sampling = Metop-A ASCAT Level 2 SMO
    • H103 ASCAT NRT 25 km sampling = Metop-B ASCAT Level 2 SMO
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.

<table>
<thead>
<tr>
<th>Name</th>
<th>Scaling factor</th>
<th>Units</th>
<th>Type</th>
<th>Byte size</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROCESSING_FLAGS</td>
<td>-</td>
<td>-</td>
<td>uint8</td>
<td>1</td>
</tr>
<tr>
<td>CORRECTION_FLAGS</td>
<td>-</td>
<td>-</td>
<td>uint8</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5.3: Advisory flag fields.

<table>
<thead>
<tr>
<th>Name</th>
<th>Scaling factor</th>
<th>Units</th>
<th>Type</th>
<th>Byte size</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNOW_COVER_PROBABILITY</td>
<td>-</td>
<td>-</td>
<td>uint8</td>
<td>1</td>
</tr>
<tr>
<td>FROZEN_SOIL_PROBABILITY</td>
<td>-</td>
<td>-</td>
<td>uint8</td>
<td>1</td>
</tr>
<tr>
<td>INUNDATION_OR_WETLAND</td>
<td>-</td>
<td>-</td>
<td>uint8</td>
<td>1</td>
</tr>
<tr>
<td>TOPOGRAPHICAL_COMPLEXITY</td>
<td>-</td>
<td>-</td>
<td>uint8</td>
<td>1</td>
</tr>
<tr>
<td>AGGREGATED_QUALITY_FLAG</td>
<td>-</td>
<td>-</td>
<td>uint8</td>
<td>1</td>
</tr>
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</table>

Table 5.1: Overview of Level 2 parameters.

<table>
<thead>
<tr>
<th>Name</th>
<th>Scaling factor</th>
<th>Units</th>
<th>Type</th>
<th>Byte size</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOIL_MOISTURE</td>
<td>10^2</td>
<td>%</td>
<td>uint16</td>
<td>2</td>
</tr>
<tr>
<td>SOIL_MOISTURE_ERROR</td>
<td>10^2</td>
<td>%</td>
<td>uint16</td>
<td>2</td>
</tr>
<tr>
<td>MEAN_SURF_SOIL_MOISTURE</td>
<td>10^2</td>
<td>%</td>
<td>uint16</td>
<td>2</td>
</tr>
<tr>
<td>SIGMA40</td>
<td>10^6</td>
<td>dB</td>
<td>int32</td>
<td>4</td>
</tr>
<tr>
<td>SIGMA40_ERROR</td>
<td>10^6</td>
<td>dB</td>
<td>int32</td>
<td>4</td>
</tr>
<tr>
<td>SLOPE40</td>
<td>10^6</td>
<td>dB</td>
<td>int32</td>
<td>4</td>
</tr>
<tr>
<td>SLOPE40_ERROR</td>
<td>10^6</td>
<td>dB</td>
<td>int32</td>
<td>4</td>
</tr>
<tr>
<td>SOIL_MOISTURE_SENSITIVITY</td>
<td>10^6</td>
<td>dB</td>
<td>int32</td>
<td>4</td>
</tr>
<tr>
<td>DRY_BACKSCATTER</td>
<td>10^6</td>
<td>dB</td>
<td>int32</td>
<td>4</td>
</tr>
<tr>
<td>WET_BACKSCATTER</td>
<td>10^6</td>
<td>dB</td>
<td>int32</td>
<td>4</td>
</tr>
<tr>
<td>RAINFALL_FLAG</td>
<td>-</td>
<td>-</td>
<td>uint8</td>
<td>1</td>
</tr>
<tr>
<td>WARP_NRT_VERSION</td>
<td>-</td>
<td>-</td>
<td>uint16</td>
<td>2</td>
</tr>
<tr>
<td>PARAM_DB_VERSION</td>
<td>-</td>
<td>-</td>
<td>uint16</td>
<td>2</td>
</tr>
</tbody>
</table>
ASCAT DISAGGREGATED NRT SURFACE SOIL MOISTURE
ASCAT Disaggregated NRT SSM Products

- Metop-B ASCAT DIS NRT SSM
  - H08 - 0.5 km spatial sampling (BUFR, NetCDF)
  - H28 - 1 km spatial sampling (NetCDF)

H16 - 12.5 km sampling
H08 - 0.5 km sampling
H28 - 1 km sampling
Directional downscaling using Sentinel-1

- Comparing local and regional scale backscatter from Sentinel-1
- Calculation of directional downscaling parameters
- Computationally demanding

Directional downscaling parameter based on Sentinel-1
ASCAT DIS NRT SSM data distribution & archive

• Data distribution only in PDU format (3 min)
  – 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.

<table>
<thead>
<tr>
<th>Name</th>
<th>Scaling factor</th>
<th>Units</th>
<th>Type</th>
<th>Byte size</th>
<th>NaN</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM</td>
<td>-</td>
<td>%</td>
<td>int8</td>
<td>1</td>
<td>127</td>
</tr>
<tr>
<td>SM_NOISE</td>
<td>-</td>
<td>%</td>
<td>int8</td>
<td>1</td>
<td>127</td>
</tr>
</tbody>
</table>

Table 6.2: Overview of geolocation and satellite parameters.

<table>
<thead>
<tr>
<th>Name</th>
<th>Scaling factor</th>
<th>Units</th>
<th>Type</th>
<th>Byte size</th>
</tr>
</thead>
<tbody>
<tr>
<td>LATITUDE</td>
<td>-</td>
<td>Degrees North</td>
<td>float32</td>
<td>4</td>
</tr>
<tr>
<td>LONGITUDE</td>
<td>-</td>
<td>Degrees East</td>
<td>float32</td>
<td>4</td>
</tr>
<tr>
<td>TIME</td>
<td>-</td>
<td>Days since 1900-01-01 00:00:00 UTC</td>
<td>float64</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 6.3: Correction flags.

<table>
<thead>
<tr>
<th>Name</th>
<th>Scaling factor</th>
<th>Units</th>
<th>Type</th>
<th>Byte size</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORR_FLAG</td>
<td>-</td>
<td></td>
<td>uint8</td>
<td>1</td>
</tr>
</tbody>
</table>
ASCAT CDR SURFACE SOIL MOISTURE
ASCAT CDR SSM Products

- Metop ASCAT CDR SSM
  - ...

- Metop ASCAT CDR SSM Extension
  - H110 - Metop ASCAT CDR2016 SSM (2016+)
  - H112 - Metop ASCAT CDR2017 SSM (2017+)
  - ...

ASCAT CDR SSM Products

• Evolution
  – Longest “product” of TU Wien, first released in 2001
  – Brought into H SAF during CDOP2 (2012-2017)
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

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### Table 4.1: Overview of soil moisture parameters.

<table>
<thead>
<tr>
<th>Name</th>
<th>Scaling factor</th>
<th>Units</th>
<th>Type</th>
<th>Byte size</th>
<th>NaN value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM</td>
<td>-</td>
<td>%</td>
<td>int8</td>
<td>1</td>
<td>127</td>
</tr>
<tr>
<td>SM_NOISE</td>
<td>-</td>
<td>%</td>
<td>int8</td>
<td>1</td>
<td>127</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Scaling factor</th>
<th>Units</th>
<th>Type</th>
<th>Byte size</th>
<th>NaN value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCATION_ID</td>
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<td></td>
<td>int64</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>ROW_SIZE</td>
<td>-</td>
<td></td>
<td>int64</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>LATITUDE</td>
<td>-</td>
<td>Degrees N</td>
<td>float32</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>LONGITUDE</td>
<td>-</td>
<td>Degrees E</td>
<td>float32</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>TIME</td>
<td>-</td>
<td>Fraction of days</td>
<td>float64</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>DIR</td>
<td>-</td>
<td></td>
<td>int8</td>
<td>1</td>
<td>127</td>
</tr>
<tr>
<td>SAT_ID</td>
<td>-</td>
<td></td>
<td>int8</td>
<td>1</td>
<td>127</td>
</tr>
</tbody>
</table>
ASCAT CDR SSM data distribution

- **Distribution**
  - H SAF FTP

- **File format**
  - 5x5 degree cell files, NetCDF

- **NetCDF Climate and Forecast (CF) Metadata Conventions**
  - [Contiguous ragged array representation](#)

<table>
<thead>
<tr>
<th>Location ID</th>
<th>Row size</th>
<th>Variable</th>
<th>Cell file</th>
</tr>
</thead>
<tbody>
<tr>
<td>412401</td>
<td>500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>542221</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35121</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>445121</td>
<td>250</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
WARP5 DGG

- Discrete Global Grid (DGG) with 12.5 km sampling
- Ellipsoid: GEM 6
- Number of grid points: 3,264,391 (839,826 over land)
Grid Point Locator

http://rs.geo.tuwien.ac.at/dv/dgg/
ASCAT CDR SSM Validation Metrics

- Evolution of validation standard
  - Until 2012: RMSE as for SMOS and SMAP
  - 2012-2016: Correlation to external model data set
  - From 2016: SNR applied to committed areas only
International Soil Moisture Network (ISMN)

46 networks with >1600 stations

http://ismn.geo.tuwien.ac.at/
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/
Website and Helpdesk

• **EUMETSAT**
  - [http://www.eumetsat.int/](http://www.eumetsat.int/)
  - ops@eumetsat.int

• **H SAF**
  - [http://hsaf.meteoam.it/](http://hsaf.meteoam.it/)
  - us_hsaf@meteoam.it

• **TU Wien**
  - [http://rs.geo.tuwien.ac.at/](http://rs.geo.tuwien.ac.at/)
  - remote.sensing@geo.tuwien.ac.at
References - Technical Reports

References - Articles

References - Articles


• W. Wagner, G. Lemoine, M. Borgeaud, and H. Rott, A study of vegetation cover effects on ERS scatterometer data, vol. 37, no. 2II, pp. 938–948.