

H SAF Soil Moisture Products

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CDOP3 Surface Soil Moisture (SSM) Products

- **ASCAT SSM Near Real-Time (NRT) products**

- Metop-A

- 25 km spatial sampling - H102
 - 12.5 km spatial sampling - H101

- Metop-B

- 25 km spatial sampling - H103
 - 12.5 km spatial sampling - H16
 - 0.5 km spatial sampling - H08 (Europe only)

- Metop-C

- 25 km spatial sampling - H105
 - 12.5 km spatial sampling - H104

- Metop-A, Metop-B, Metop-C

- 6.25 km spatial sampling - H122
 - 1 km spatial sampling - H28

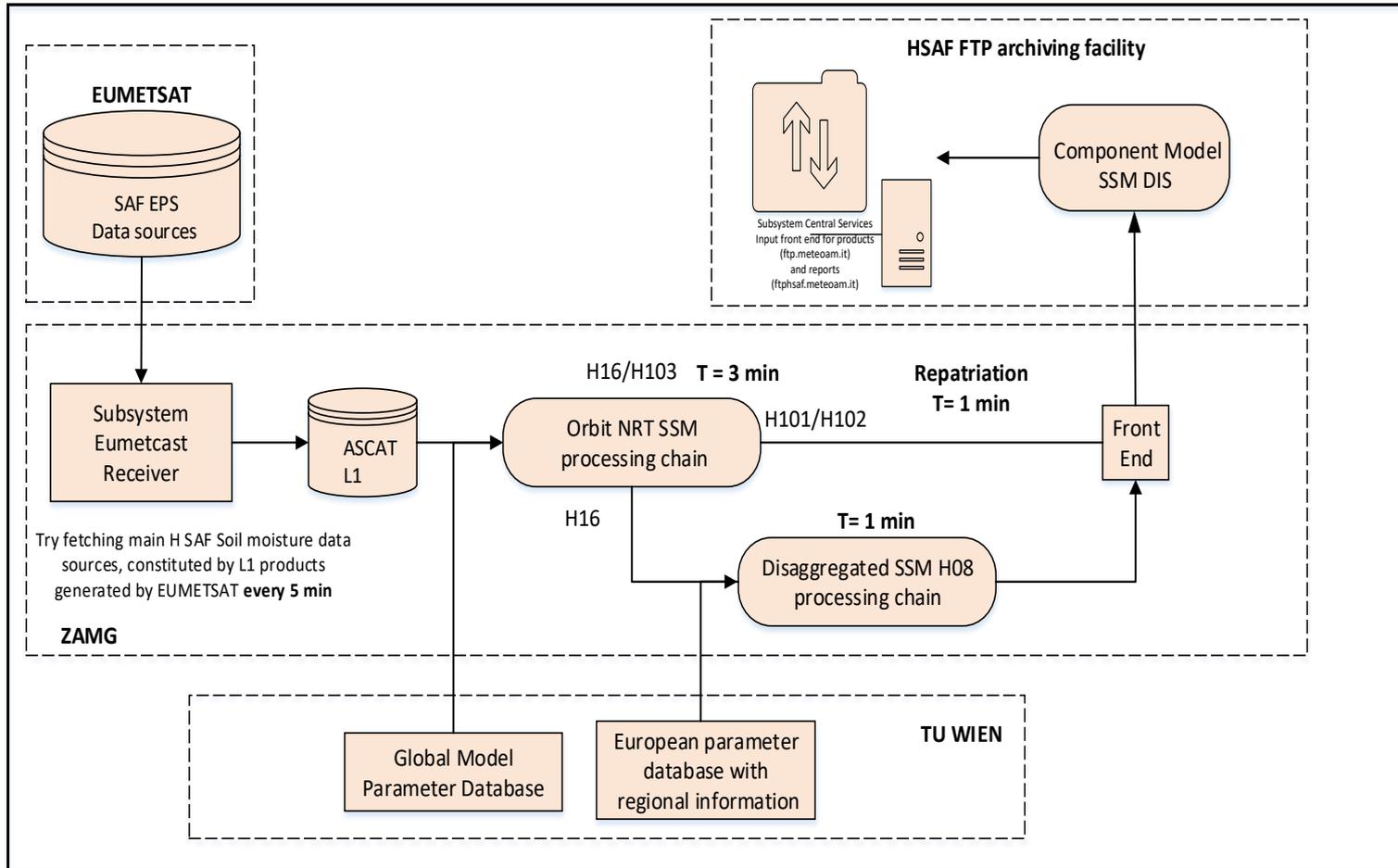
- **ASCAT SSM Climate Data Record (CDR) and Offline (CDR Extension) products**

- Metop ASCAT DR2015 SSM time series 12.5 km sampling - H25 (Extension H108)
 - Metop ASCAT DR2016 SSM time series 12.5 km sampling - H109 (Extension H110)
 - Metop ASCAT DR2017 SSM time series 12.5 km sampling - H111 (Extension H112)
 - Metop ASCAT DR2018 SSM time series 12.5 km sampling - H113 (Extension H114)
 - Metop ASCAT SSM CDR v5 12.5 km sampling - H115 (Extension H116)
 - Metop ASCAT SSM CDR v6 12.5 km sampling - H117 (Extension H118)

CDOP3 Root Zone Soil Moisture (RZSM) Products

- **RZSM Near Real-Time (NRT) products**
 - Root Zone Soil wetness Index by scatterometer data assimilation - H14
 - 25 km resolution
 - Metop ASCAT-A/B assimilation
 - Timeliness < 36 hours after 00 UTC analysis time
 - Root Zone Soil wetness Index by scatterometer data assimilation – H26
 - 10 km resolution
 - Metop ASCAT-A/B/C assimilation
 - Timeliness < 12 hours after 00 UTC analysis time
- **RZSM Climate Data Record (CDR) and Offline (CDR Extension) products**
 - 25 km resolution RZSM CDR - H27 (1992-2014)
 - 25 km resolution RZSM CDR - H140 (2015-2016)
 - 10 km resolution RZSM CDR - H141 (1992-2018) and extension - H142 (2019-2021)

Architecture of SSM NRT Production Chain



Chain Performance Status

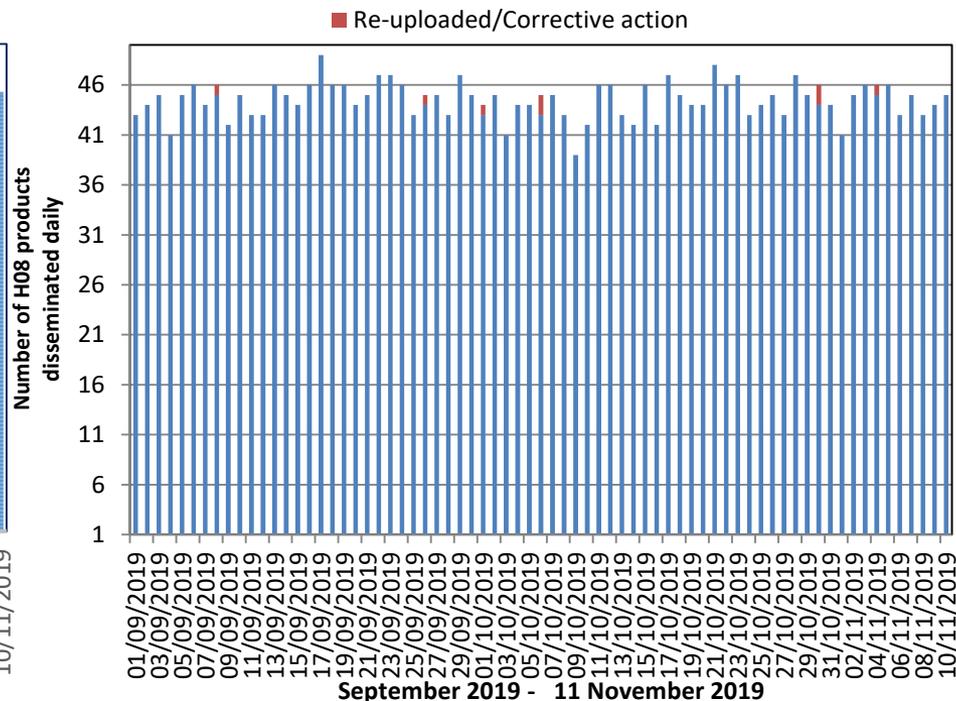
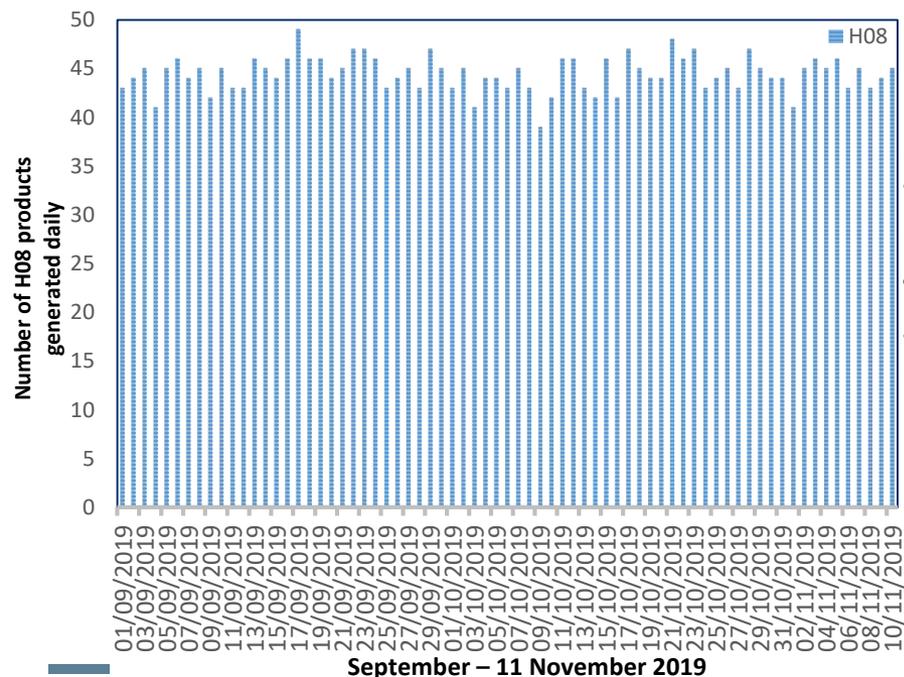
SSM ASCAT NRT O (H16, H101-H103)

- During September – 11 November 2019, SSM ASCAT A/B NRT product generation follows **nominal** status

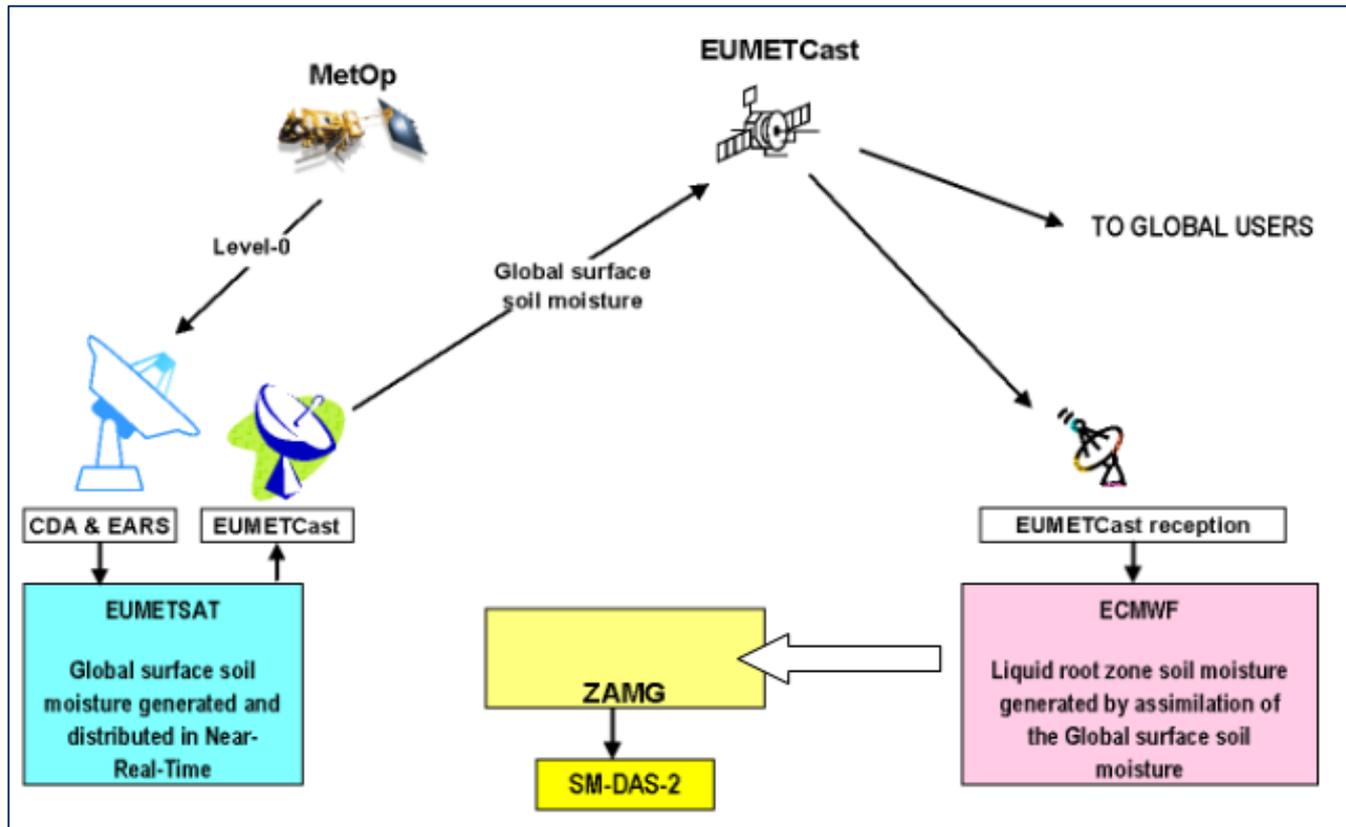
SSM ASCAT NRT DIS (H08)

- ZAMG production chain **consistently produced** the expected **H08** data (**100% success rate**)
- H08** products dissemination to the HSAF FTP server distribution facility had a **88,7% success rate**

H08



Architecture of RZSM NRT Production Chain

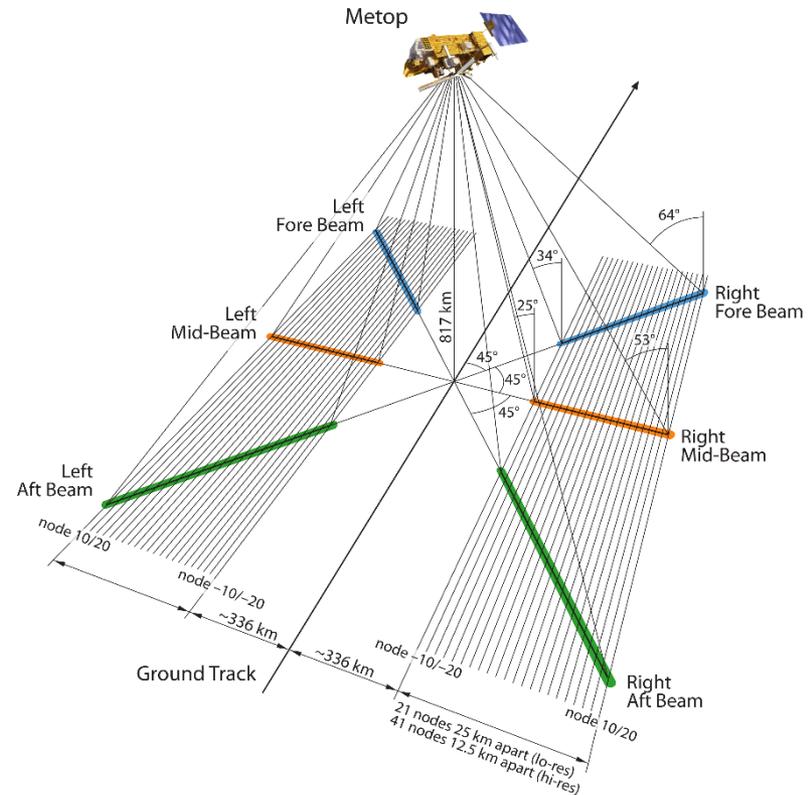


SURFACE SOIL MOISTURE



Advanced Scatterometer (ASCAT) on board Metop

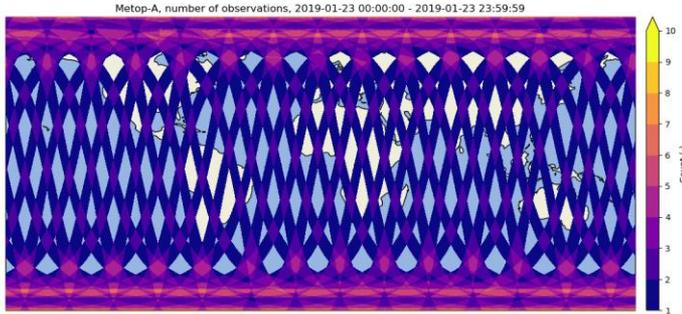
- Sensor characteristics
 - Active microwave scatterometer
 - Frequency: C-band, 5.255 GHz
 - Polarisation: VV
 - Spatial Resolution: 25 km/ 50 km
 - Antennas: 2 x 3
 - Swath: 2 x 500 km
 - Multi-incidence: 25-65°
 - Daily global coverage: 82 %
- Metop-A (Oct. 2006 – ongoing)
- Metop-B (Sep. 2012 – ongoing)
- Metop-C (Nov. 2018 – ongoing)



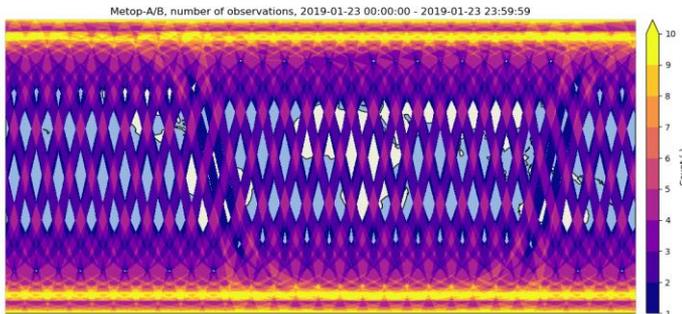
Figa-Saldana, et al., The advanced scatterometer (ASCAT) on the meteorological operational (MetOp) platform: A follow on for European wind scatterometers, Canadian Journal of Remote Sensing, 28(3), 404–412 (2002). <http://dx.doi.org/10.5589/m02-035>

Spatial coverage of ASCAT

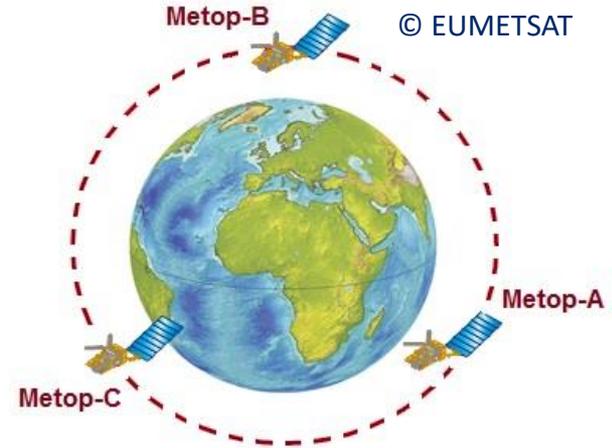
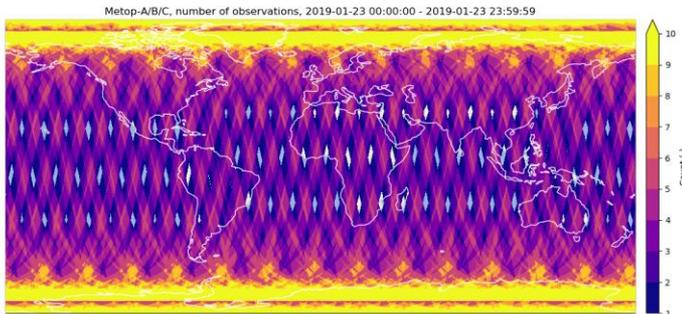
Metop-A



Metop-A
Metop-B



Metop-A
Metop-B
Metop-C

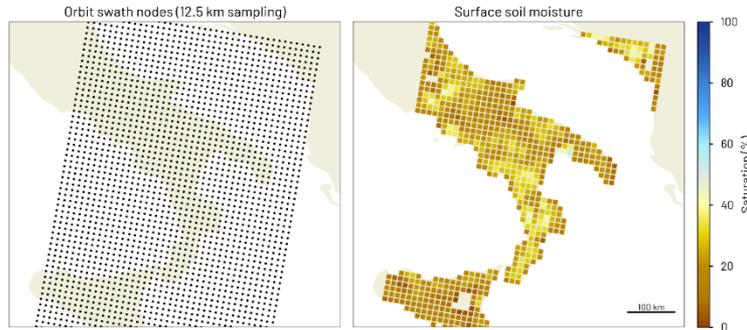


- The series of Metop satellites fly in a “tri-star” constellation
- Metop-A will be put in a drift-orbit and presumably remain operational until 2021

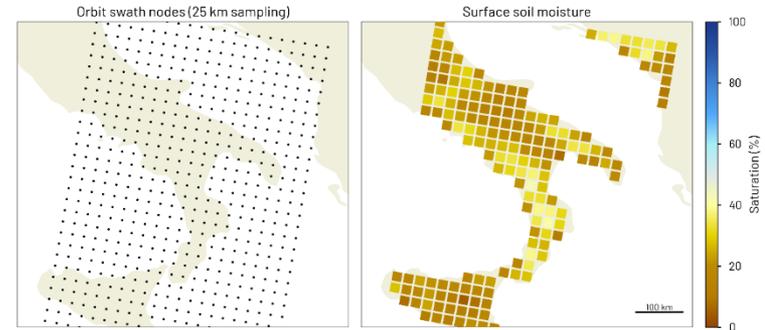
H SAF ASCAT Surface Soil Moisture

- **ASCAT SSM Near Real-Time (NRT) products**

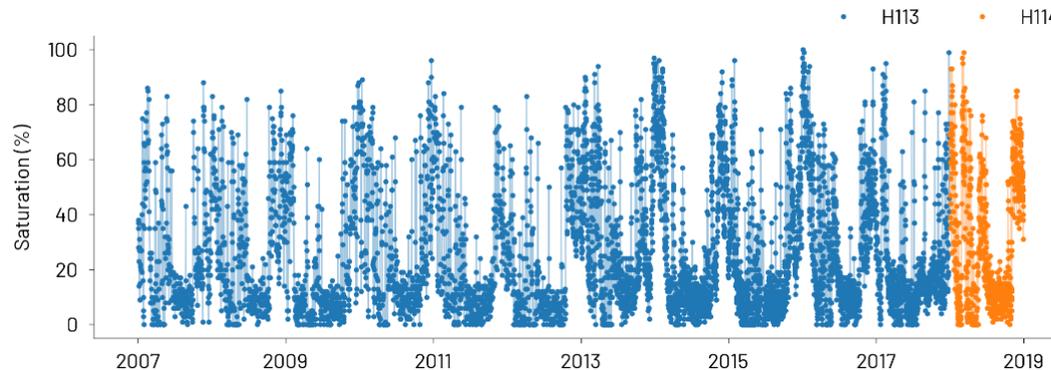
Metop-B ASCAT Surface Soil Moisture Near Real Time 12.5 km sampling (H16): 2019-07-01 08:23:00 - 2019-07-01 08:24:59



Metop-B ASCAT Surface Soil Moisture Near Real Time 25 km sampling (H103): 2019-07-01 08:23:00 - 2019-07-01 08:24:59

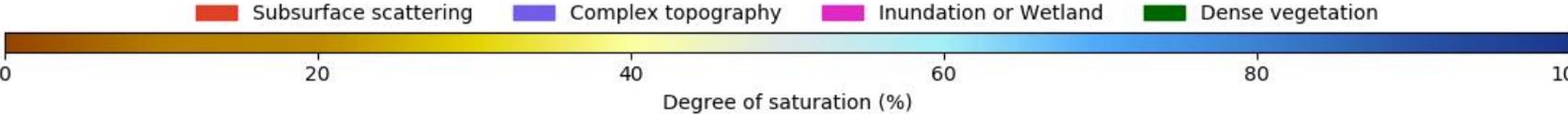
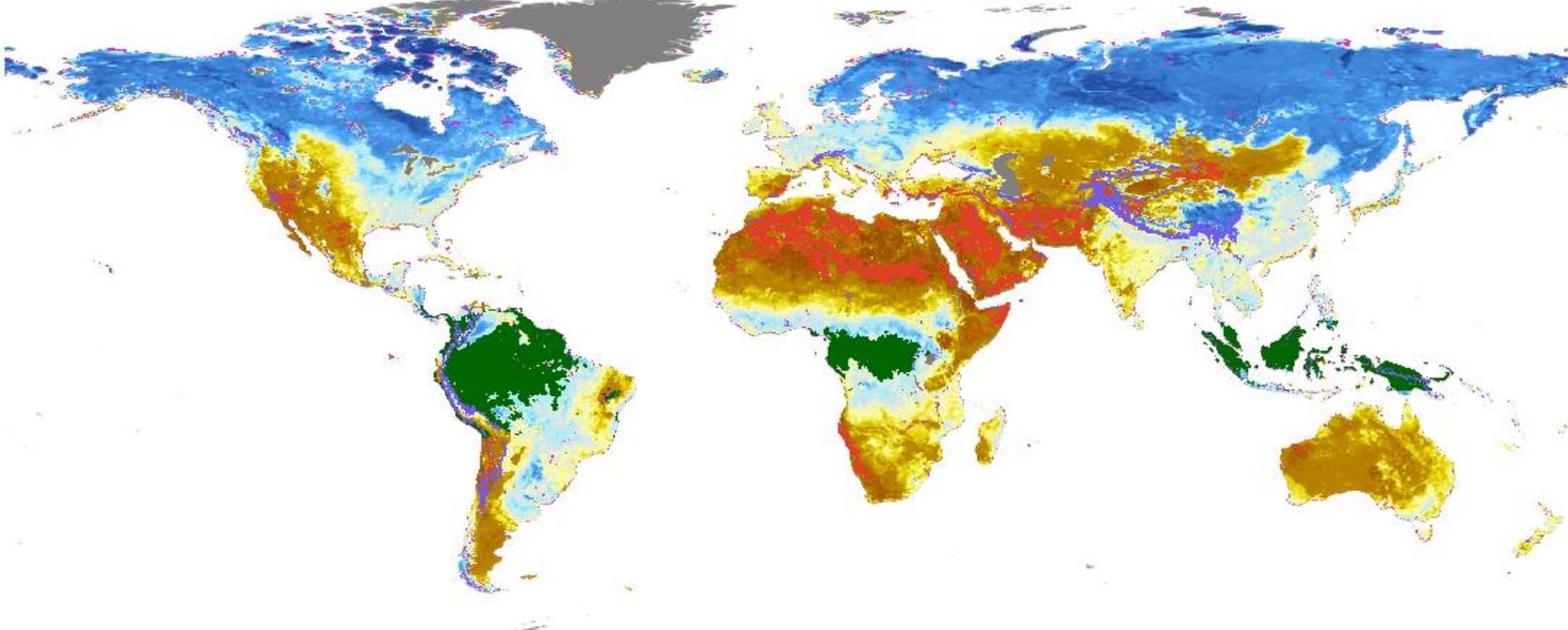


- **ASCAT SSM Climate Data Record (CDR) and Offline (CDR Extension) products**



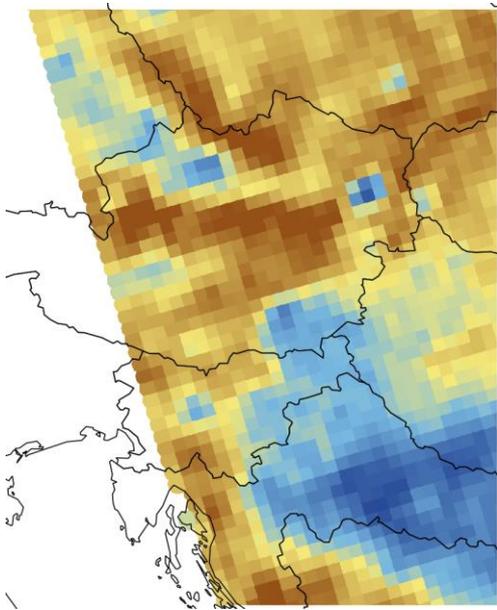
Metop ASCAT Surface Soil Moisture DR2018 (H113)

H113 Metop ASCAT Surface Soil Moisture CDR - Mean 2007-2017

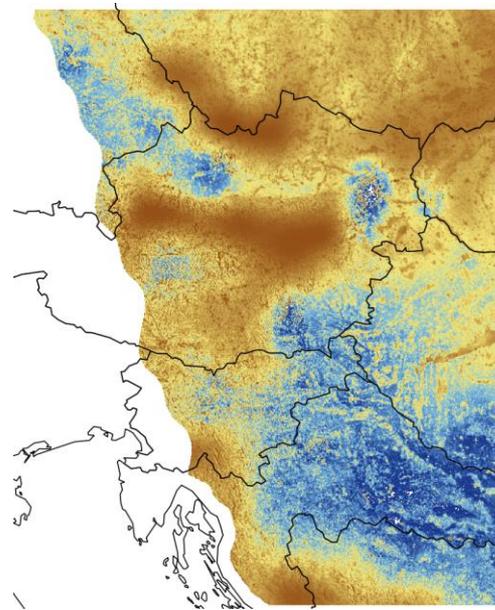


Disaggregated Metop ASCAT NRT SSM

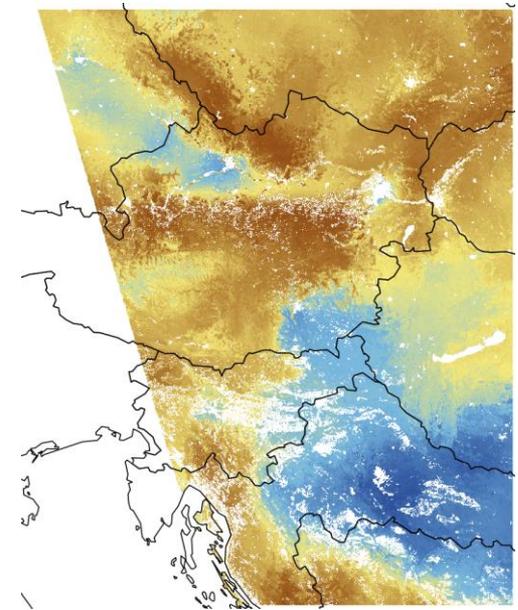
- H08 - 0.5 km spatial sampling (BUFR, NetCDF) based on Metop-B
- H28 - 1 km spatial sampling (NetCDF) based on Metop-A/B/C



H16 - 12.5 km sampling



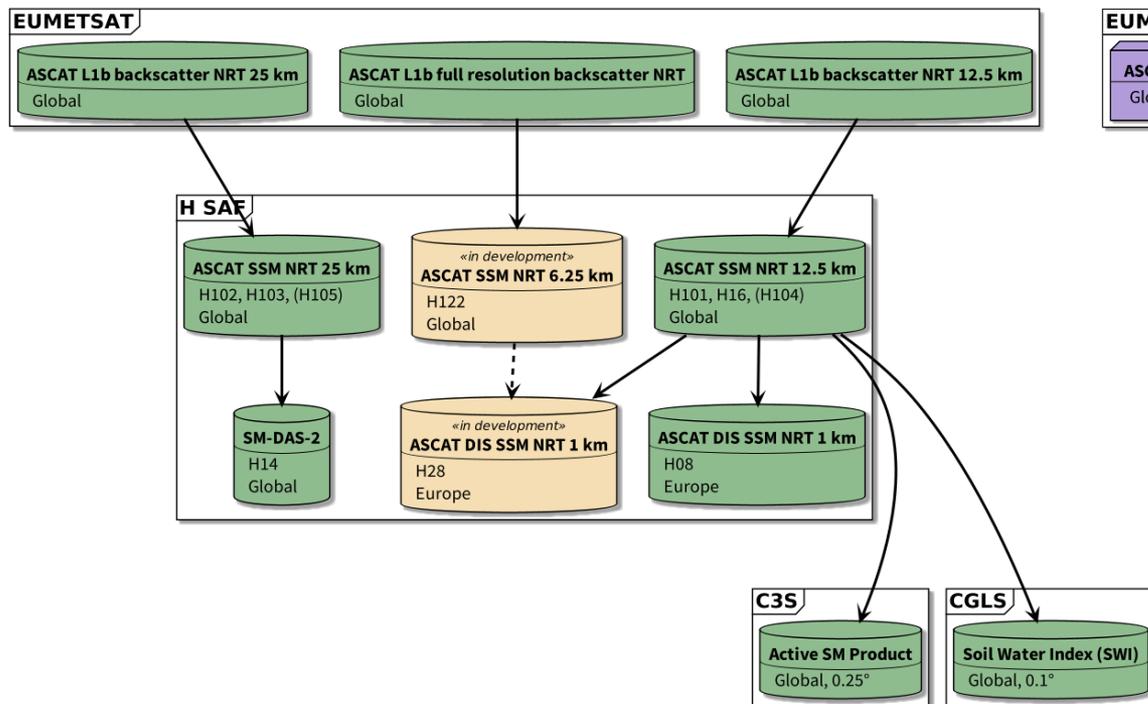
H08 - 0.5 km sampling



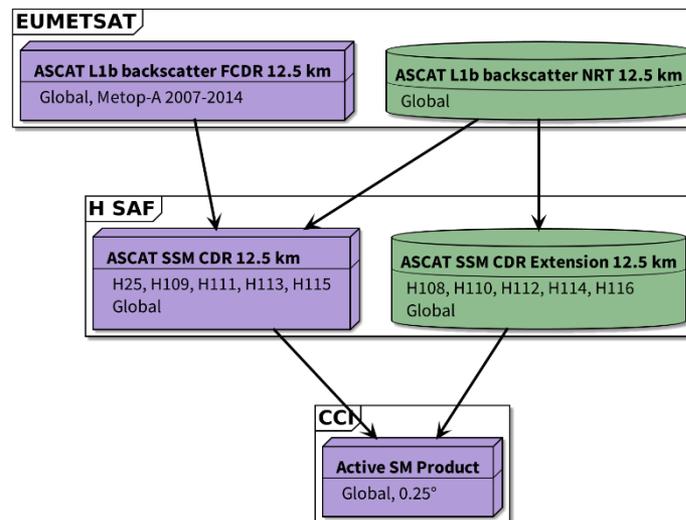
H28 - 1 km sampling

H SAF SSM Downstream Services

Near Real-Time



Climate Data Record

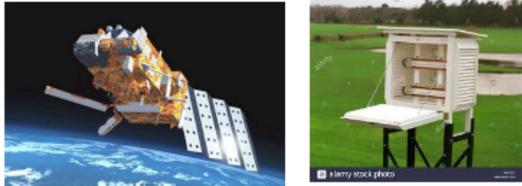


ROOT ZONE SOIL MOISTURE

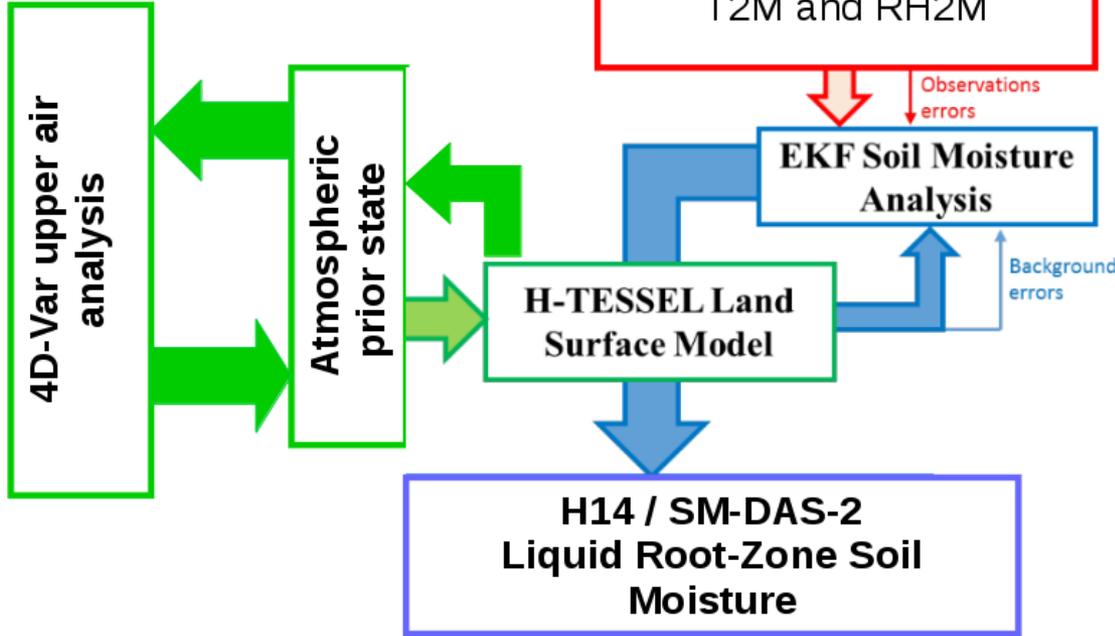


H14 near-real-time

Quality control
 Use data when:
 - Topographic complexity ≤ 20
 - Wetland fraction ≤ 15
 - Noise level ≤ 8
 - Snow-free conditions
 - Unfrozen soil



Observations: ASCAT, T2M and RH2M



Simplified EKF analysis

$$\mathbf{x}^a(t_i) = \mathbf{x}^b(t_i) + \mathbf{K}_i \left[y^o(t_i) - \mathcal{H}_i(\mathbf{x}^b) \right],$$

$$\mathbf{K}_i = \left[\mathbf{B}^{-1} + \mathbf{H}_i^T \mathbf{R}^{-1} \mathbf{H}_i \right]^{-1} \mathbf{H}_i^T \mathbf{R}^{-1},$$

$$\mathbf{H}_{mm,i} = \frac{\mathcal{H}_{m,i}(\mathbf{x}^b + \delta \mathbf{x}_n^b) - \mathcal{H}_{m,i}(\mathbf{x}^b)}{\delta x_n}.$$

SM analysed over first 3 layers in H-TESSSEL:
 Layer 1: 0-7 cm
 Layer 2: 7-28 cm
 Layer 3: 28-100 cm
 Layer 4 (not analysed): 100-289 cm

- ASCAT observations bias-corrected using seasonal linear rescaling (Scipal *et al.*, (2008), Draper *et al.*, 2009)
- 25 km resolution, available at 00 UTC with 12-36 hour latency

H14 Data assimilation

Simplified EKF analysis

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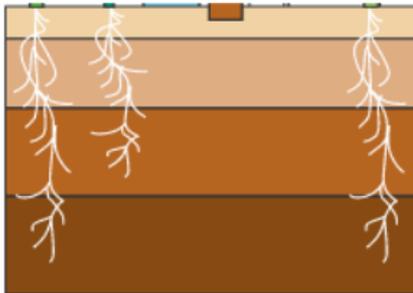
**SM analysed over first 3 layers
in H-TESEL:**

Layer 1: 0-7 cm

Layer 2: 7-28 cm

Layer 3: 28-100 cm

Layer 4 (not analysed): 100-289
cm



- SEKF based on de Rosnay *et al.*, (2013);
- **B** is diagonal, with background-error standard deviation $0.01 \text{ m}^3\text{m}^{-3}$ for each layer;
- **R** is diagonal, with observation-error standard deviation $0.05 \text{ m}^3\text{m}^{-3}$ for ASCAT-derived SSM, 1 K for 2m temperature and 4% for relative humidity.

H14 Data assimilation

Simplified EKF analysis

$$\mathbf{x}^a(t_i) = \mathbf{x}^b(t_i) + \mathbf{K}_i [\mathbf{y}^o(t_i) - \mathcal{H}_i(\mathbf{x}^b)],$$

$$\mathbf{K}_i = [\mathbf{B}^{-1} + \mathbf{H}_i^T \mathbf{R}^{-1} \mathbf{H}_i]^{-1} \mathbf{H}_i^T \mathbf{R}^{-1},$$

$$\mathbf{H}_{mn,i} = \frac{\mathcal{H}_{m,i}(\mathbf{x}^b + \delta x_n) - \mathcal{H}_{m,i}(\mathbf{x}^b)}{\delta x_n}.$$

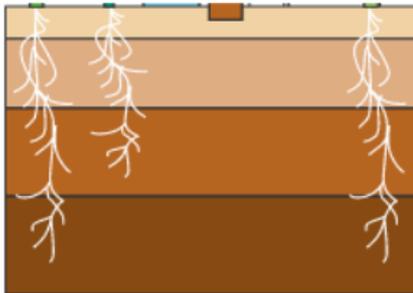
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- Jacobian elements \mathbf{H}_{mn} for analysis variable n and observation m calculated using finite differences:



H14 Data assimilation

Simplified EKF analysis

$$\mathbf{x}^a(t_i) = \mathbf{x}^b(t_i) + \mathbf{K}_i [\mathbf{y}^o(t_i) - \mathcal{H}_i(\mathbf{x}^b)],$$

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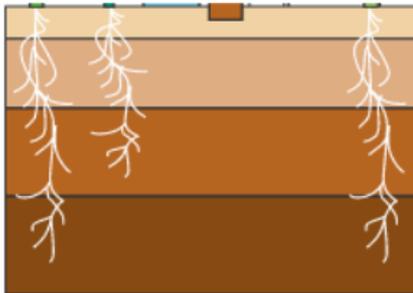
SM analysed over first 3 layers in H-TESEL:

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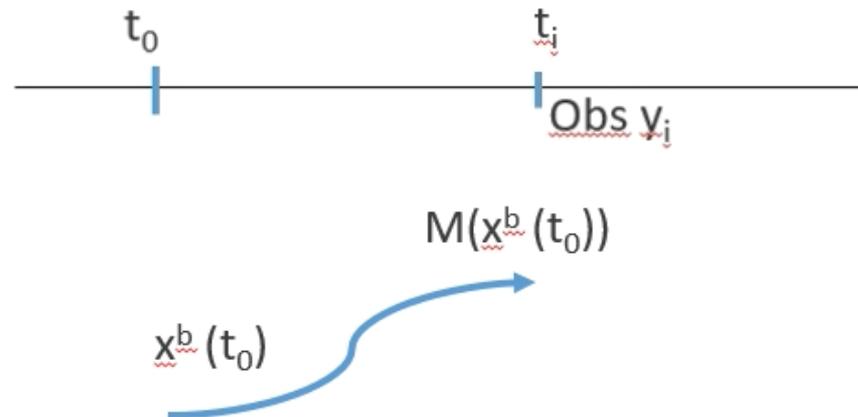
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Layer 3: 28-100 cm

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H14 Data assimilation

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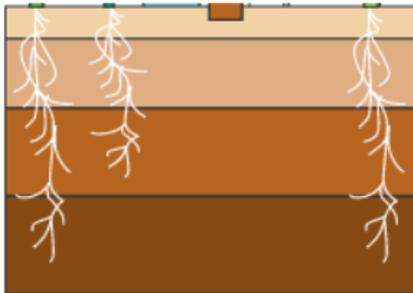
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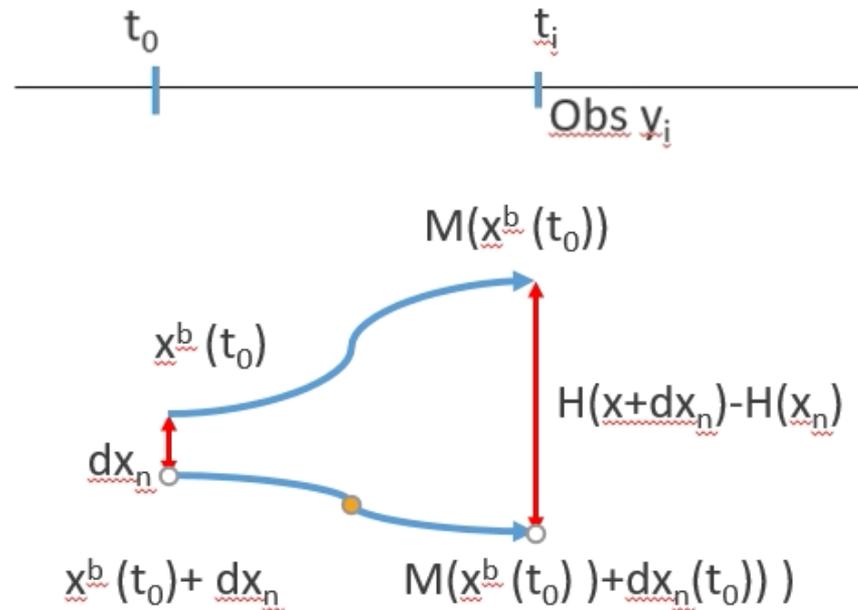
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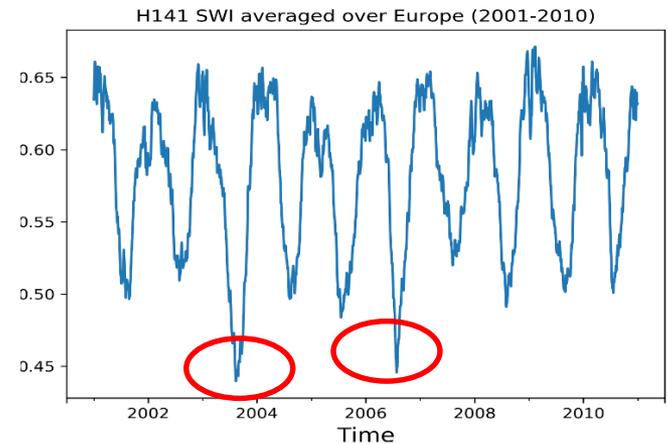
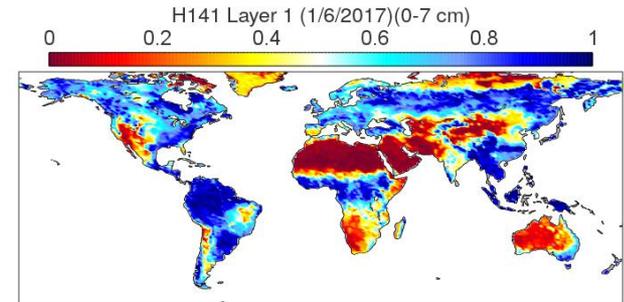
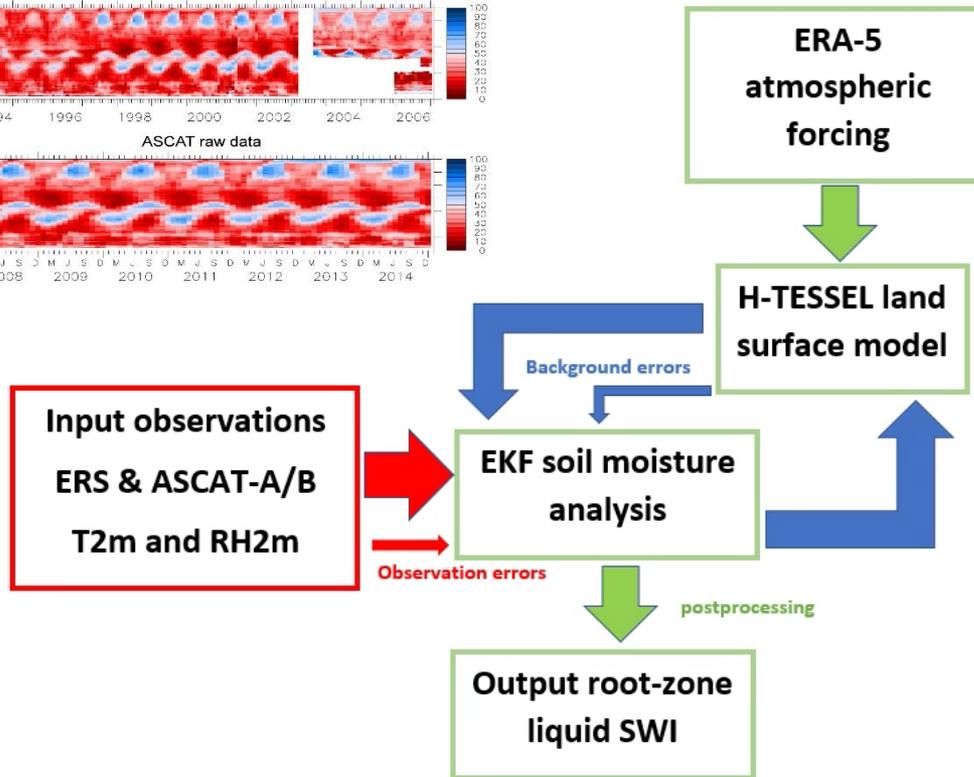
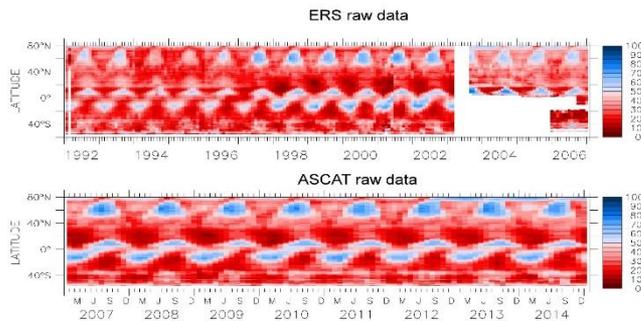
Layer 4 (not analysed): 100-289 cm



- Jacobian elements H_{mn} for analysis variable n and observation m calculated using finite differences:



New H SAF RZSM climate data record (1992-2018)



- H141: Global liquid soil wetness index available daily from 1992-2018 (available daily at 00 UTC);
- 10 km resolution in netCDF/grib formats
- Produced using offline version of IFS land data assimilation forced by ERA-5;
- Assimilates pre-processed scatterometer observations (1992-2018);
- Soon to be released (available as demonstration product)

Summary

H SAF Surface Soil Moisture Products

- New Metop ASCAT SSM CDR v5 12.5 km sampling - H115 (Extension H116)
- Metop ASCAT SSM CDR v6 (H117) processed in 2020, including Metop-C
- Metop-C NRT SSM operational review in 2020

H SAF Root Zone Soil Wetness Index Products

- 25 km resolution NRT RZSM (H14) assimilates Metop ASCAT-A/B with SEKF
- New 10 km resolution RZSM CDR (1992-2018) under review (H141)
- 10 km NRT RZSM (H26) operational review in 2020

User documentation/training

- Products freely available: <http://hsaf.meteoam.it/user-registration.php>
- Training: <http://hsaf.meteoam.it/training-courses.php>
- Demonstration session to follow the workshop (Thursday afternoon)
- GitHub examples: https://github.com/H-SAF/hsaf_hepex_workshop_2019

References

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