



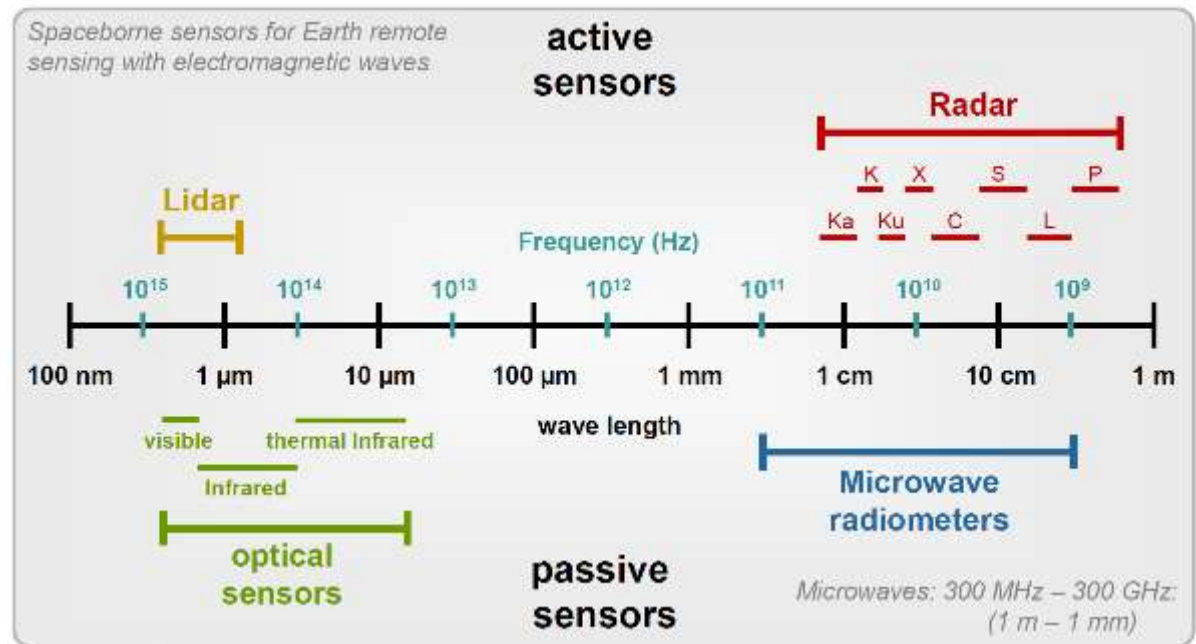
H SAF Soil Moisture Data Services

Wolfgang Wagner

Department of Geodesy and Geoinformation (GEO)
Vienna University of Technology (TU Wien)
<http://www.geo.tuwien.ac.at/>

Active and Passive Microwave Remote Sensing

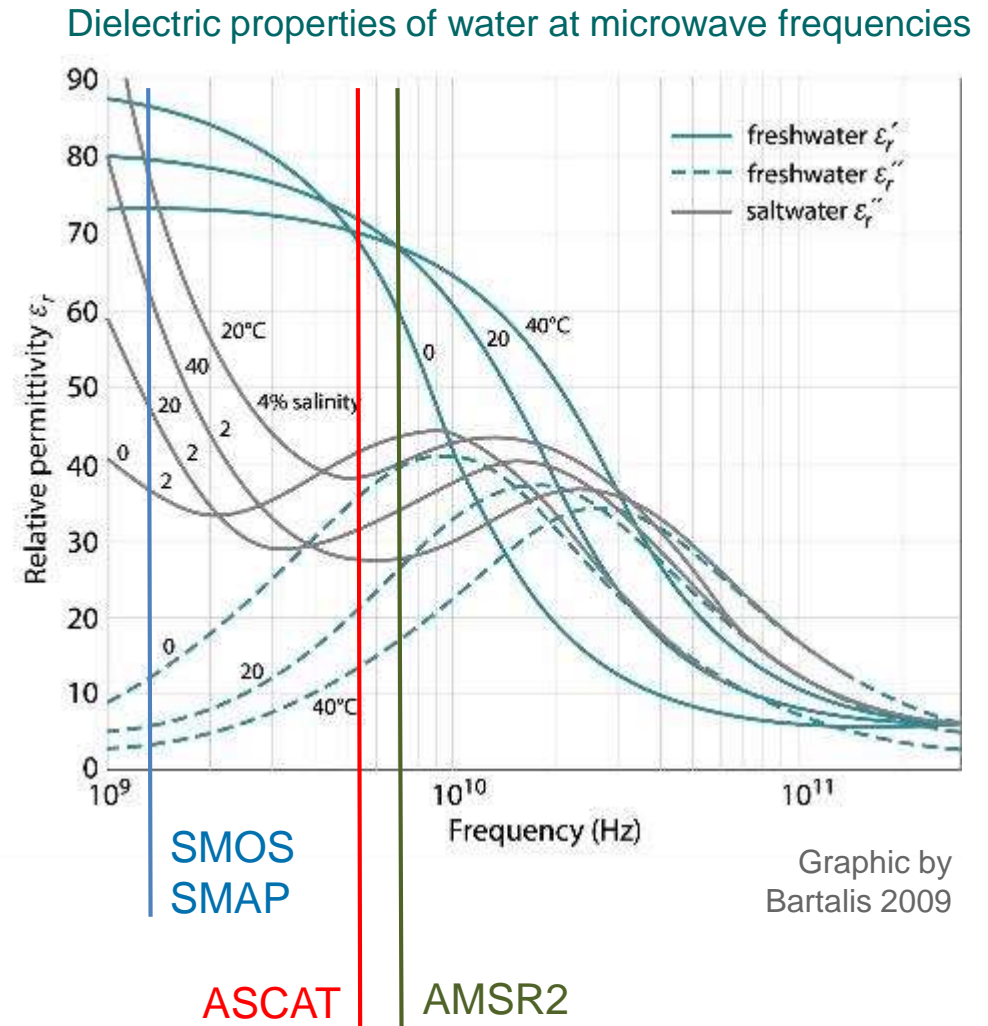
- Passive microwave sensors record electromagnetic energy that is reflected or emitted from the surface of the Earth
 - Microwave radiometers
- Active microwave sensors create their own electromagnetic energy and record the backscattered radiation
 - Altimeters
 - Scatterometers
 - SAR



<https://earth.esa.int/documents/10174/642943/6-LTC2013-SAR-Moreira.pdf>

Measurement Capabilities

- Microwave measurements are sensitive to
 - Geometric structure
 - Roughness
 - Dielectric properties
 - Water
- High penetration into vegetation and soils
 - Longer wavelengths beneficial
- Target quantities
 - Soil moisture
 - Vegetation water
 - Freeze/thawing
 - Surface water
 - Etc.



Global Soil Moisture Satellites & Sensors

Passive
 $\lambda = 21 \text{ cm}$
~36 km



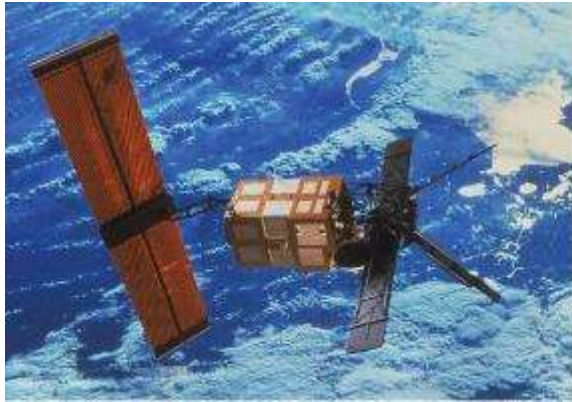
Passive
& Active
 $\lambda = 21 \text{ cm}$
~40 km

Passive
 $\lambda = 4.3 \text{ cm}$
~60 km



Active
 $\lambda = 5.6 \text{ cm}$
~25 km

European C-Band Scatterometer Series



AMI Scatterometer

Frequency: 5.3 GHz
Polarisation: VV

Resolution: 50 km
Daily coverage: <40%

Satellites

ERS-1: 1991-2000
ERS-2: 1995-2011



METOP ASCAT

Frequency: 5.255 GHz
Polarisation: VV

Resolution: 25 km
Daily coverage: 82%

Satellites

METOP-A: 2006 ongoing
METOP-B: 2012 ongoing
METOP-C: 2018 ongoing



METOP-SG SCA

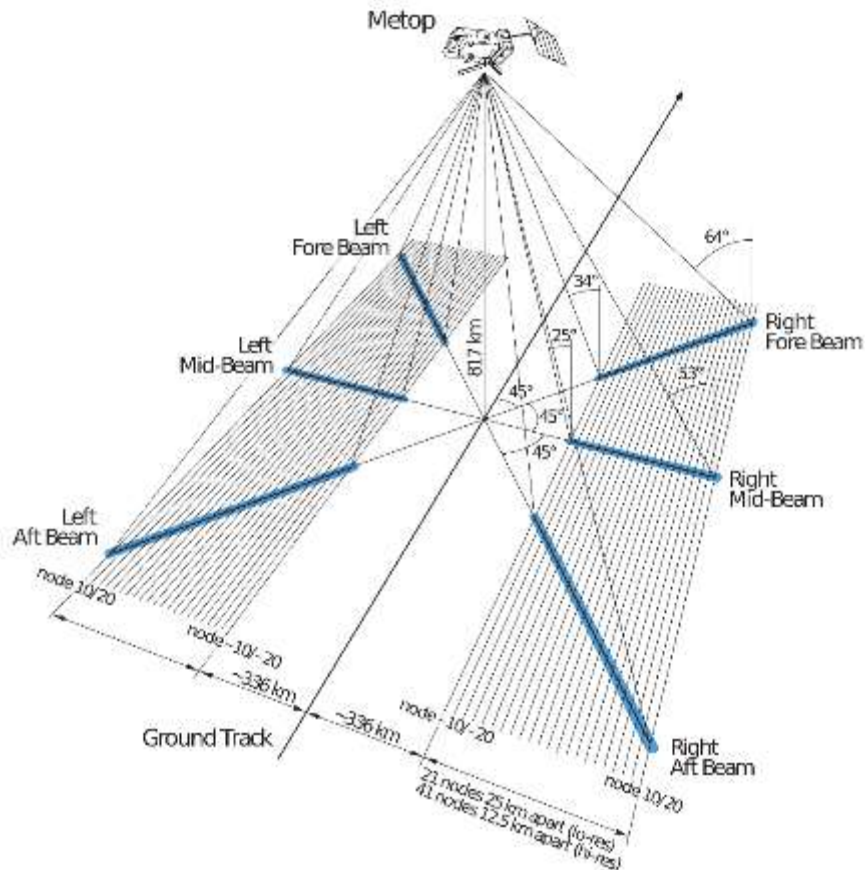
Frequency: 5.355 GHz
Polarisation: VV + VH + HH

Resolution: ~12.5 km
Daily coverage: ~88%

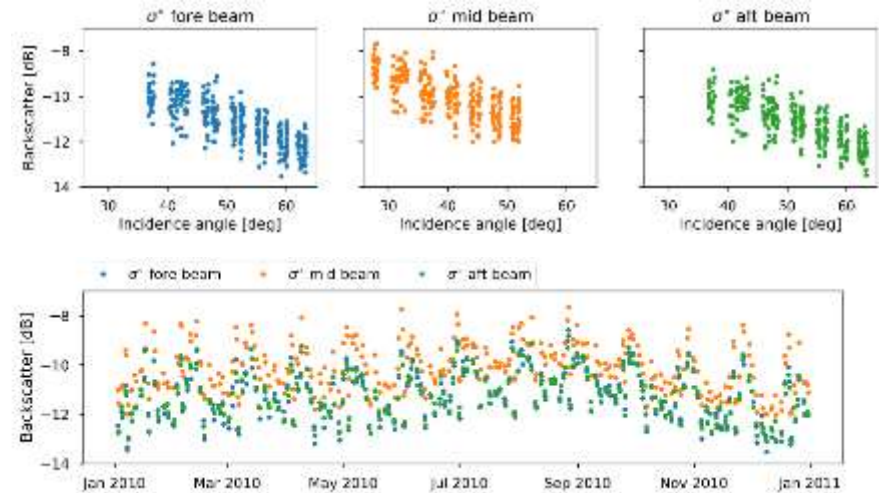
Satellites

METOP-SG-B1: 2022
METOP-SG-B2: 2030

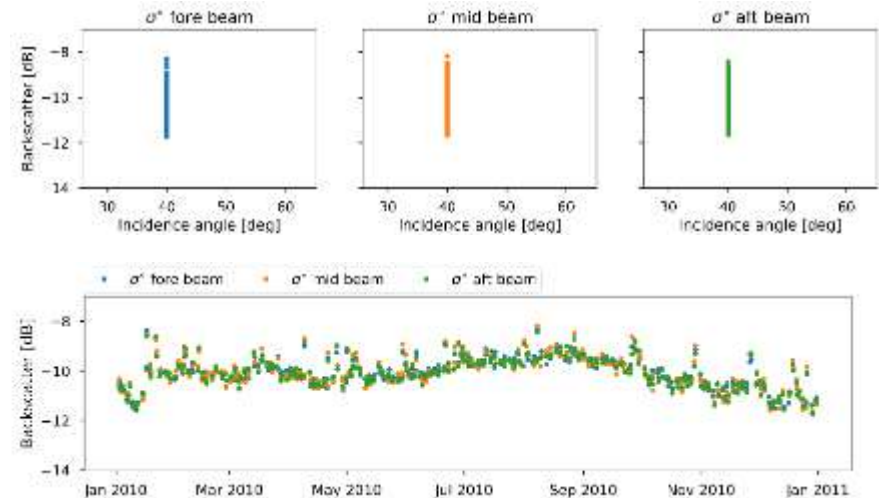
Incidence Angle Dependency of ASCAT Backscatter



Original ASCAT Measurements



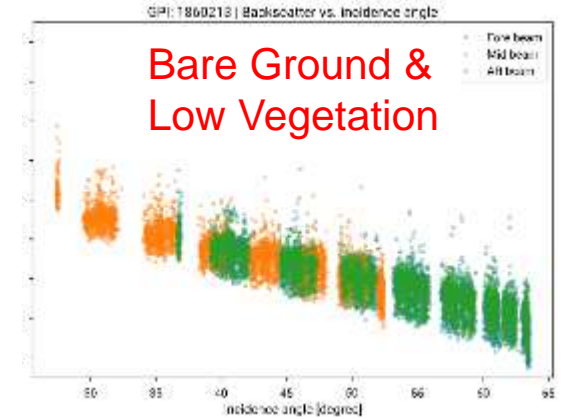
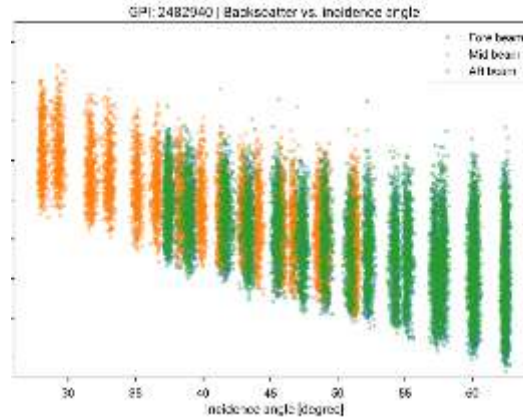
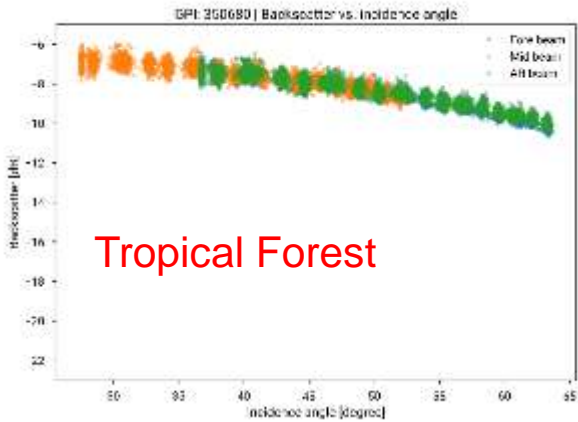
After Normalisation to 40° Incidence Angle



Changes in Backscatter with Land Cover and Season

- Land cover

Agriculture/Grassland

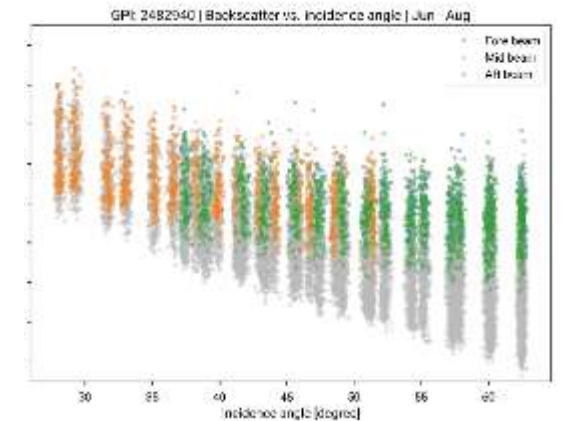
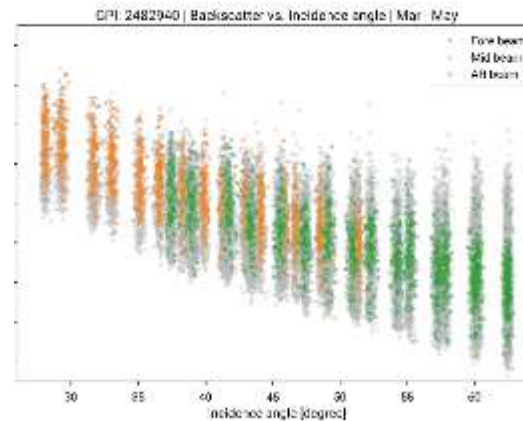
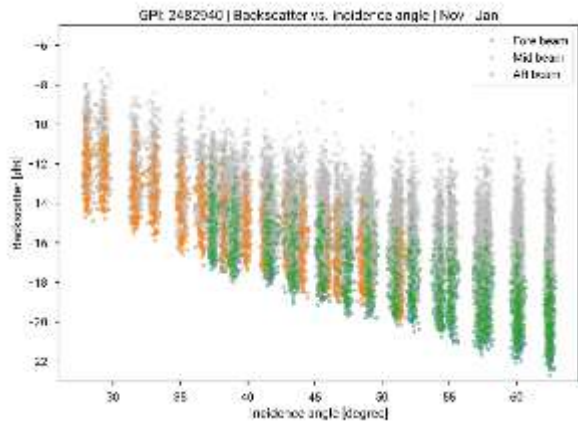


- Season

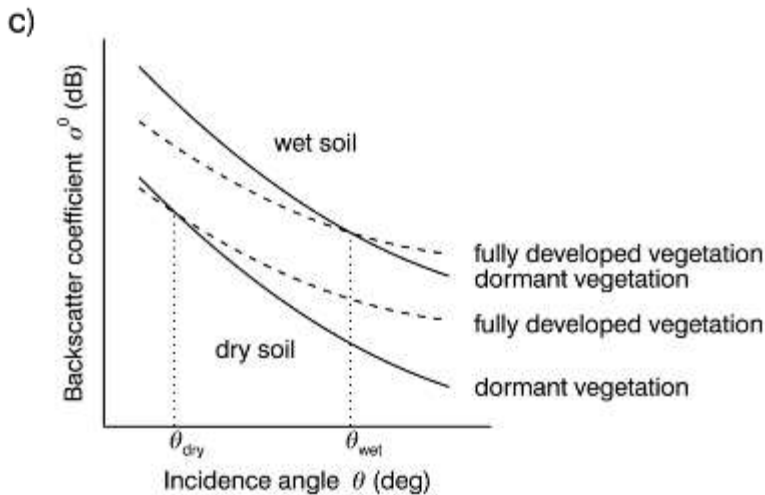
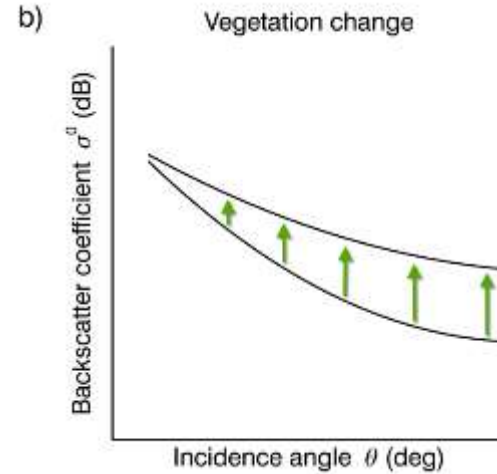
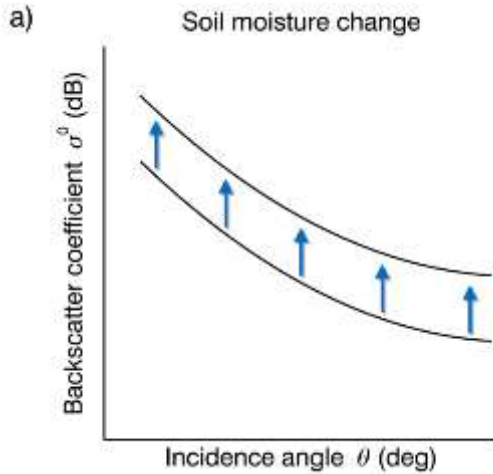
Winter

Spring

Summer



TU Wien Backscatter Model

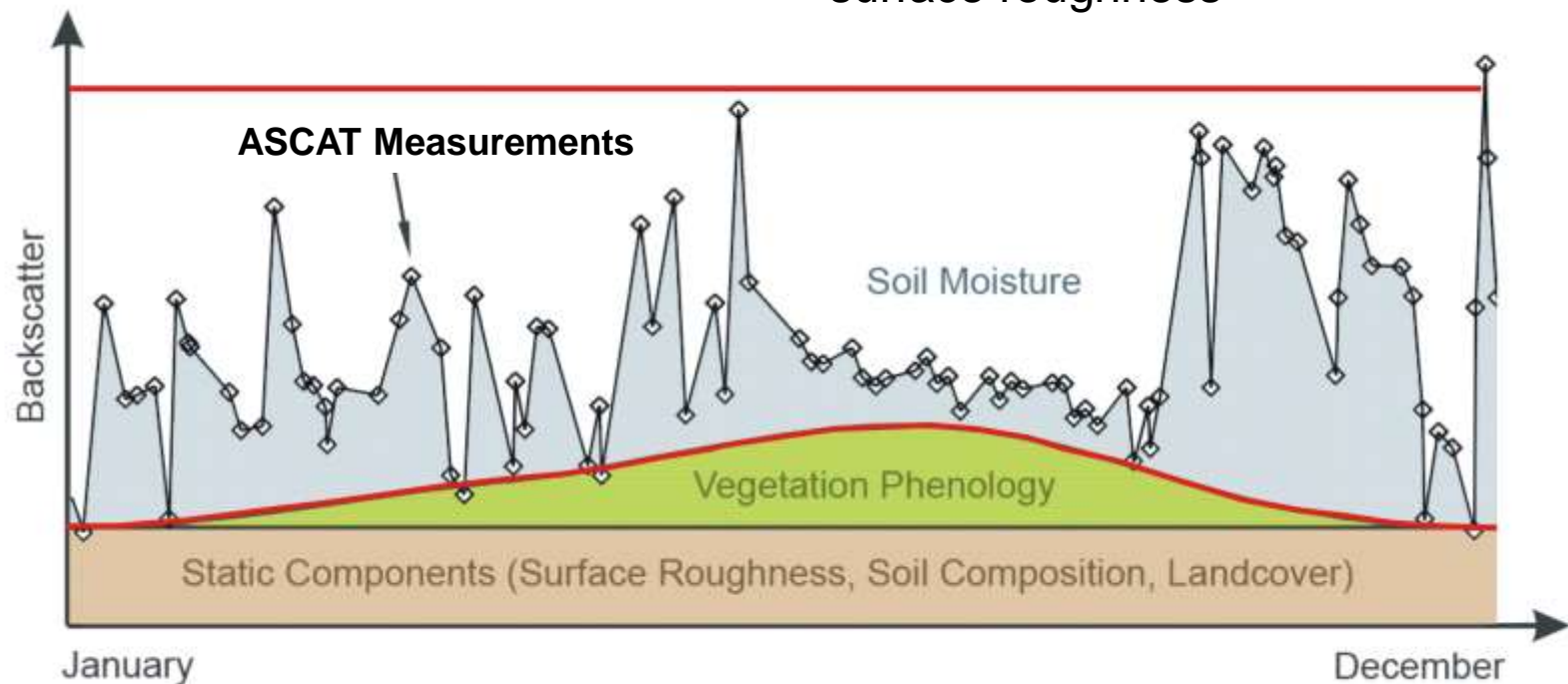


- Linear relationship between backscatter (in dB) and soil moisture
- Seasonal vegetation effects cancel each other out at the "cross-over angles"
 - dependent on soil moisture
- Functional behavior similar to "Water Cloud" model

Change Detection

$$m_s(t) = \frac{\sigma^0(t) - \sigma_{dry}^0(t)}{\sigma_{wet}^0(t) - \sigma_{dry}^0(t)}$$

- Calibration of model parameters σ_{dry}^0 and σ_{wet}^0 by analysing historic time series
 - Accounts indirectly for land cover and surface roughness



ASCAT Soil Moisture Data Services

■ Hydrology SAF

- 25 km ASCAT SSM in near-real-time and swath geometry
- 25 km ASCAT SSM data record time series
- Disaggregated 1 km ASCAT SSM maps
- Root zone soil moisture index based on ECMWF Land Data Assimilation System



■ Copernicus Global Land

- Daily 25 km Soil Water Index (SWI) product based on H SAF soil moisture data
- 1 km Sentinel-1 SSM for Europe
- 1 km ASCAT/Sentinel-1 SWI data for Europe



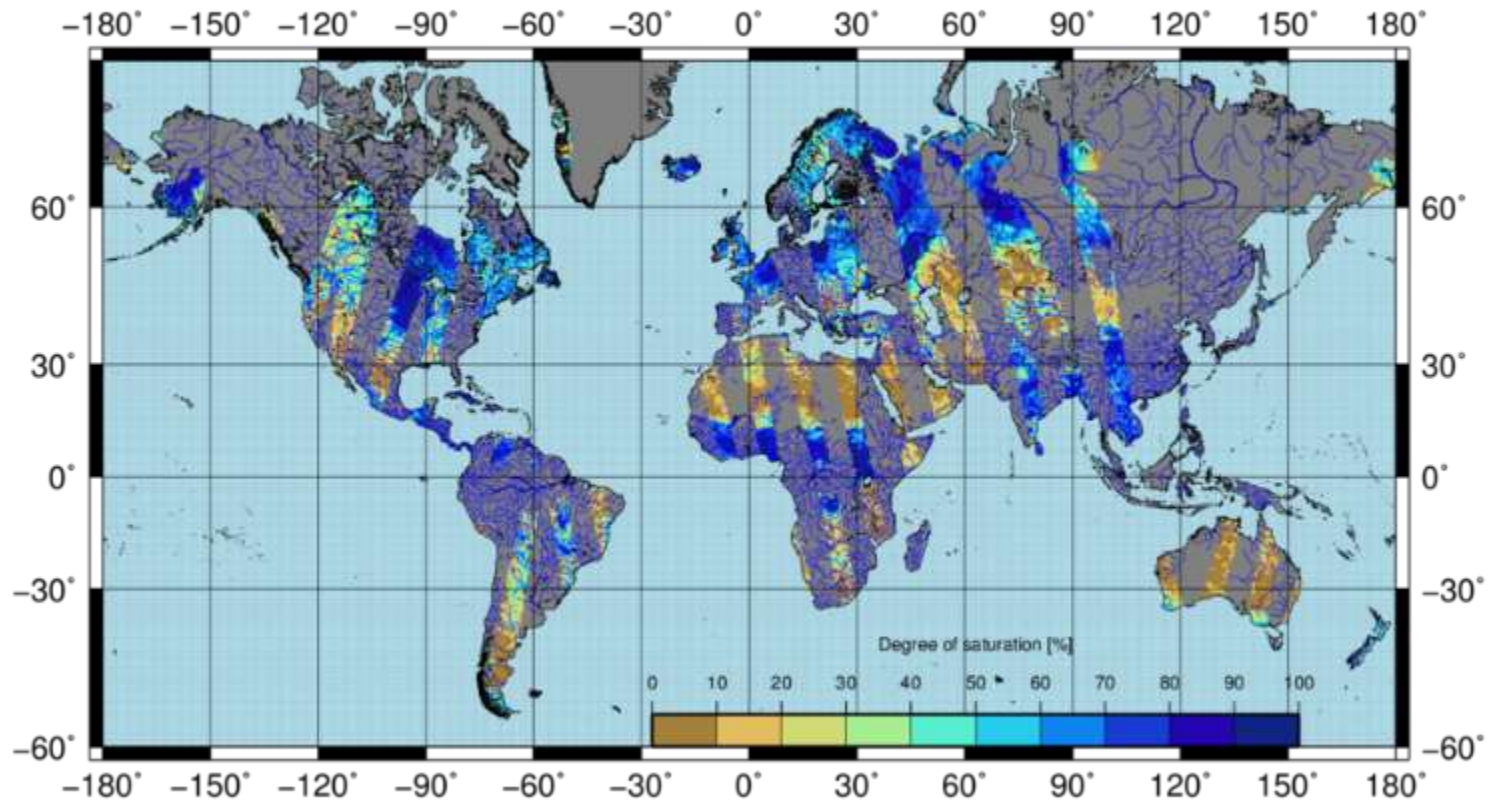
■ Copernicus Climate Change Service

- Climate data records (CDR) and Intermediate CDRS (ICDR) for
 - 0.25° active microwave soil moisture
 - 0.25° passive microwave soil moisture
 - 0.25° merged active/passive microwave soil moisture



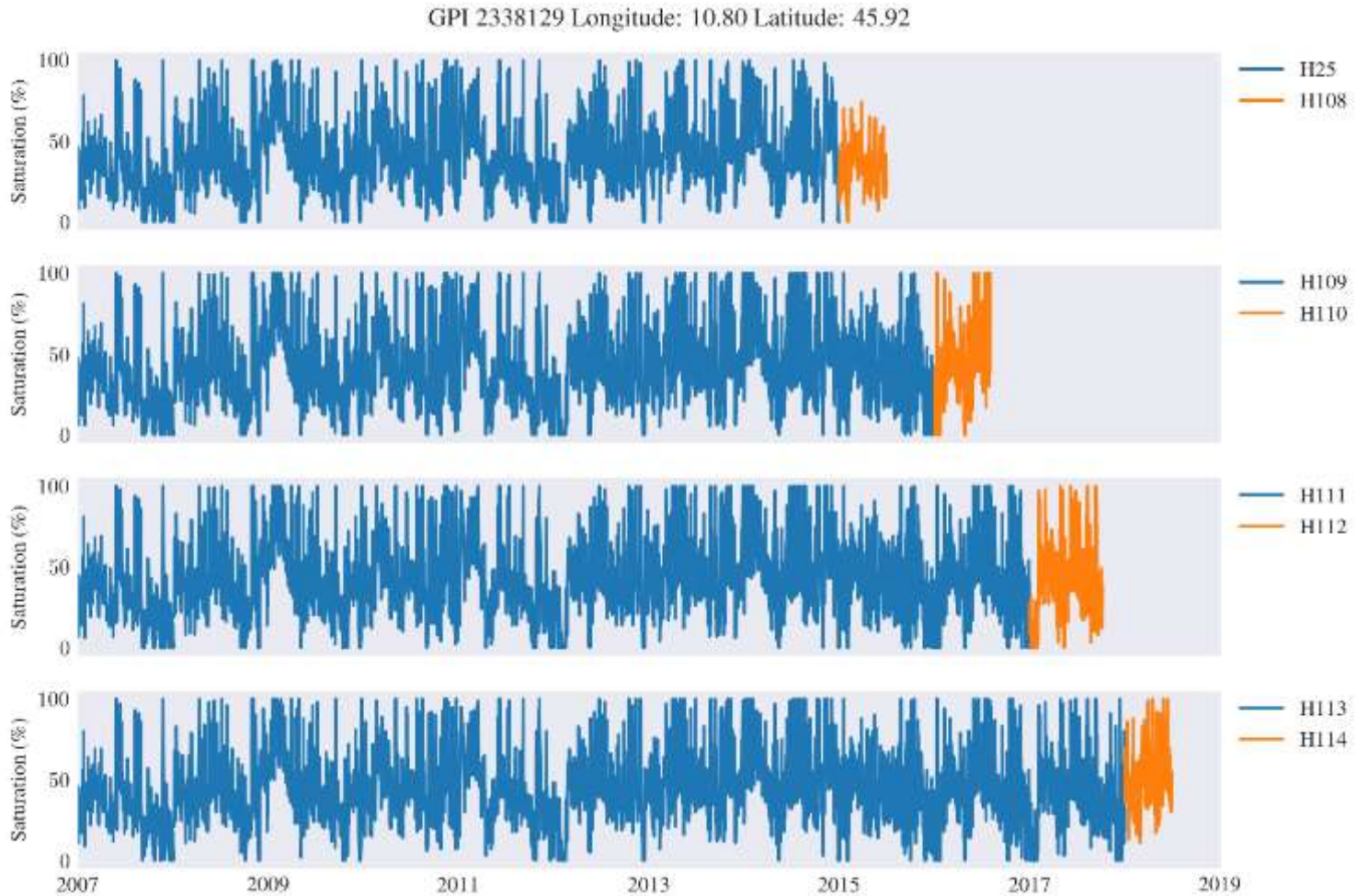
ASCAT Surface Soil Moisture

ASCAT soil moisture 20191009_0210, Metop-A, 125



<http://hsaf.meteoam.it/soil-moisture.php?tab=5>

ASCAT Data Record Time Series

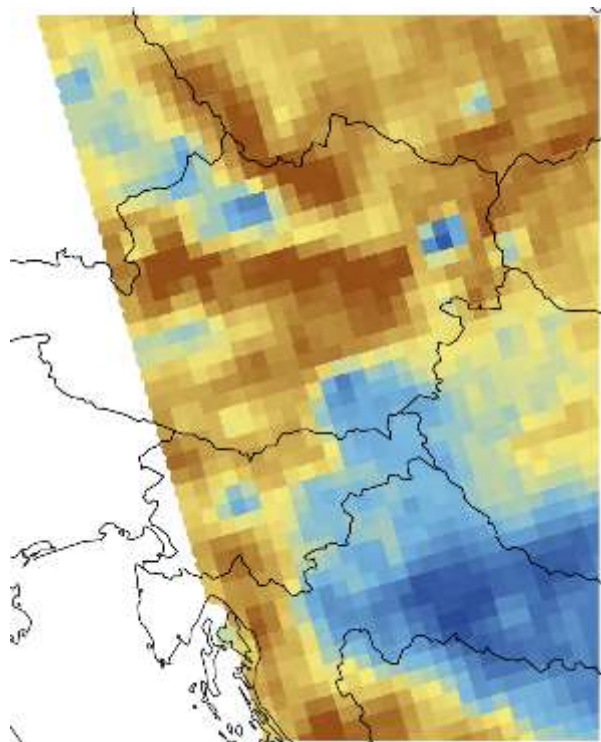


For grid point location see: <https://www.geo.tuwien.ac.at/dgg/index.php>

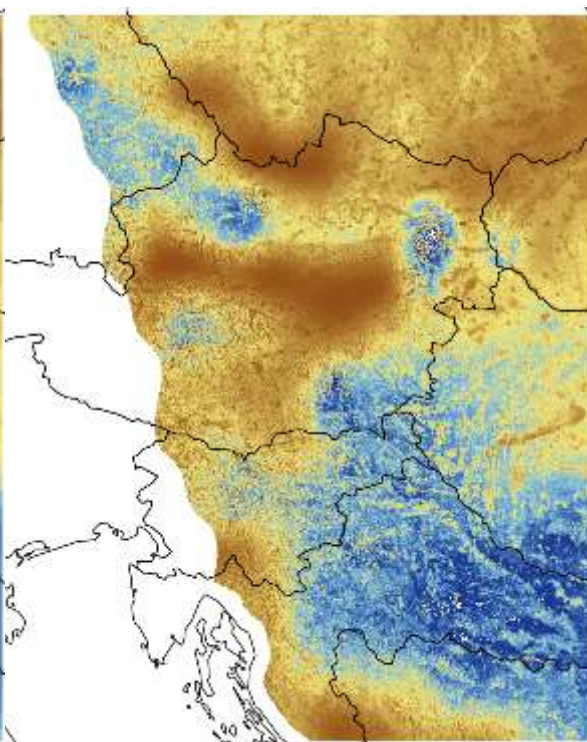


Disaggregating ASCAT SSM based on Sentinel-1

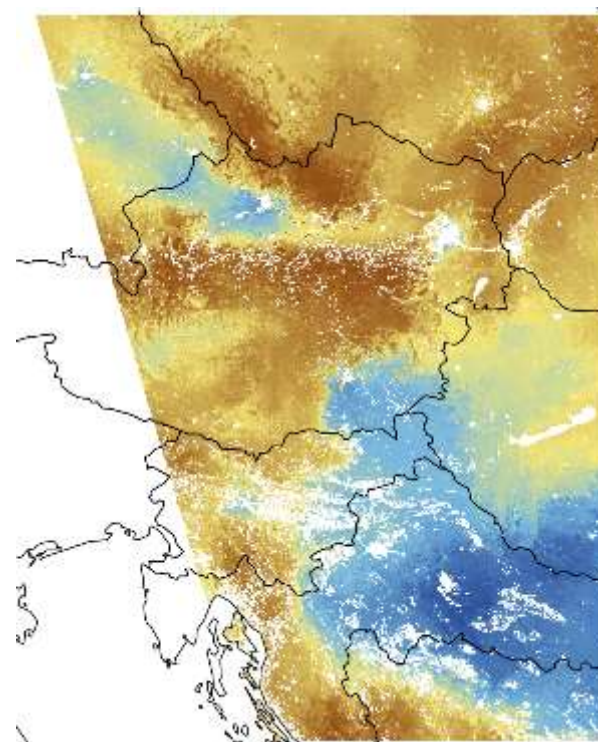
2018-03-21 19:09:00 METOP-B



H SAF H16



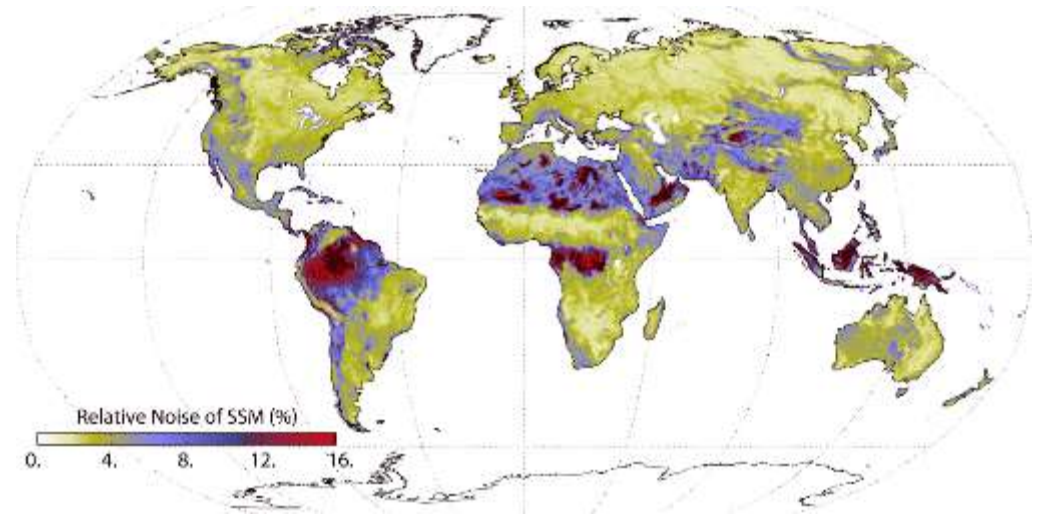
H SAF H08



New directional
resampling approach

Where does the Retrieval Go Wrong?

- Low signal-to-noise ratio (known from **error propagation**)
 - Vegetation
 - Mountainous regions
 - Urban areas
- Where does the model fail?
 - Frozen ground
 - Snow cover
 - Water surfaces
- Known issues
 - Changes in land cover (urban sprawl, deforestation, etc.)
 - Radio frequency interference
 - Sub-surface soil scattering



Conclusions

- ASCAT surface soil moisture data
 - carry the same information as SMAP, SMOS and AMSR2 data and are competitive in terms of their accuracy
 - are fully operational
 - near-real-time
 - long-term data records
 - long-term prospects
 - are based on mature algorithms
 - very hard to improve them

Yet, due to their very nature, ASCAT surface soil moisture data are challenging to use! → See my next presentation

Acknowledgements

EUMETSAT: H-SAF CDOP2

