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SMOS Level-4 SMAP Compatible Brightness Temperatures

1 Introduction

Building climate data records of soil moisture (SM) requires computing long time series by merging retrievals from sensors on-board different satellites, which implies to perform a bias-correction or scaling on the original time series. Nowadays, two satellite missions specifically designed to measure SM frequently and globally are operating: the Soil Moisture and Ocean Salinity (SMOS, Kerr et al., 2010), launched by the ESA (European Space Agency) in 2009, and the Soil Moisture Active and Passive (SMAP, Entekhabi et al., 2014), launched by the National Administration Space Agency (NASA) in 2015. These two satellites carry onboard a passive radiometer operating at L-band that provides measurements of brightness temperatures (BT). These measurements are then used as inputs to different retrieval algorithms to estimate SM on a daily basis at global scale.

The main aim of this document is to present a modified version of the SMOS Level-3 BT product in which the SMOS BT were scaled against the SMAP Level-3 Enhanced BT. The underlying ideas are to provide to the scientific community

- an unbiased SMOS BT dataset (with respect to SMAP) to be used along with the SMAP Enhanced BT for applications for which spatial coverage and revisit frequency of the BT measurements are crucials.
- an unbiased SMOS BT dataset (with respect to SMAP) to be used along with the SMAP Enhanced BT as inputs to a retrieval algorithm to produce a SM dataset with increased spatial coverage and revisit frequency.

The content of the SMOS Level-4 SMAP Compatible BT product and how it was derived is described below. For additional information concerning the scaling, please refer to the technical report Madelon et al. (2023).

2 Input products

2.1 SMOS Level-3 Brightness Temperatures

The SMOS L3 V7 BT product (Al Bitar et al., 2017) provided BT measurements in horizontal (H), vertical (V), and Stokes 3 and 4 polarisations for 15 angle bins (each bin 5-degrees wide), centered on angles 2.5° to 62.5°, in a grid resolution of 25 km. Note that bin 9 is centered on 40° and has a width of 2 degrees rather than 5°. This product is available on the Centre Aval de Traitement des Données (CATDS).

2.2 SMAP Enhanced Level-3 Brightness Temperatures

The SMAP Enhanced L3 V5 SM product (O'Neill et al., 2021) provides BT measurements in H and V polarisations for a fixed incidence angle of 40° degrees in a grid resolution of 9 km. This product is available on the National Snow and Ice Data Center (NSIDC).

3 Method

The scaling of the SMOS BT was performed as follows.

- The SMAP and SMOS BT were filtered by using the flags described in the technical report **?**.
- The SMAP BT without water body correction were interpolated, using the closest neighbor approach, from the 9-km to the 25-km grid.
- For each polarisation and orbit independently, a multi-linear regression was performed on a per pixel basis, using the SMOS BT at 32.5, 37.5 and 42.5 incidence angles as inputs and the SMAP BT as targets:

$$a_{i,j,k}.SMOSBT^{32.5}_{i,j,k} + b_{i,j,k}.SMOSBT^{37.5}_{i,j,k} + c_{i,j,k}.SMOSBT^{42.5}_{i,j,k} + d_{i,j,k} = SMAPBT^{40}_{i,j,k} \quad (1)$$

  In equation 1, the upper exponent refers to the incidence angle. The lower exponents *i, j, k* respectively refer to the current orbit, polarisation and pixel. Only the BT from February 2015 to December 2020 were taken into account to perform the multi-linear regression (see technical report **?** for additional information).

- The scaling coefficients *a, b, c, d* from equation 1 were then used to scale the SMOS BT from November 2010 to December 2022.

4 Output product

4.1 Description

The SMOS Level-4 SMAP Compatible Brightness Temperatures (BT) product provides an unbiased version of the SMOS Level-3 BT with respect to the SMAP Enhanced Level-3 BT. The data are available in both H and V polarisations, at a fixed incidence angle of 40° degrees, and in a grid resolution of 25 km. Ascending and descending overpasses are processed separately, from November 2010 to December 2022 on a daily basis.

4.2 Content

File type: MIR_L4SBTX

Description: SMOS Level-4 SMAP Compatible Brightness Temperatures

Name Format: $SM\_SCIE\_MIR\_L4SBTX\_yyyymmddThhmmss\_YYYYMMDDTHHMMSS\_vvv\_ccc\_8$

Format: NetCDF4

Frequency: Daily

Variables:

lat: Latitude

lon: Longitude

$Days$: Number of days since 2000/01/01.

$UTC\_Seconds$: Number of seconds.

BT_H: Multi-linear combination of the SMOS L3 brightness temperatures at 32.5, 37.5 and 42.5 degrees in H-pol to mimic the SMAP Enhanced L3 brightness temperatures.

BT_V: Multi-linear combination of the SMOS L3 brightness temperatures at 32.5, 37.5 and 42.5 degrees in V-pol to mimic the SMAP Enhanced L3 brightness temperatures.

$Pixel\_Radiometric\_Accuracy\_H$: Error accuracy measurement of the brightness temperatures in H polarisation.

$Pixel\_Radiometric\_Accuracy\_V$: Error accuracy measurement of the brightness temperatures in V polarisation.

4.3 Naming convention

Name	Description
SM	It specifically stands for SMOS mission
SCIE	File class: represents data in science mode (SCIE)
MIR	File category: MIR represents the MIRAS (SMOS instrument)
L4SBTX	L: "Land" product 4: Level-4 SBT: SMAP Compatible Brightness Temperatures X: Ascending (A)/Descending (D)
yyyymmddThhmmss	Sensing start time of the data contained in the product yyyy: year mm: month dd: day of the month hh: hour mm: minute ss: second
YYYYMMDDTHHMMSS	Sensing stop time of the data contained in the product YYYY: year MM: month DD: day of the month HH: hour MM: minute SS: second
vvv	Version number of the processor generating product
ccc	File counter; higher the file counter number recent, the more recent product
n	processing site (C-PDC=7, C-EC SM=8, C-EC OS=9)

Bibliography

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