Global maps of the soil roughness effect using L-band SMOS data

Maria Parrens, Jean-Pierre Wigneron, Philippe Richaume, Ahmad Al Bitar, Arnaud Mialon, Shu Wang, Roberto Fernandez-Moran, Amen AliAaari, Yann Kerr

INTRODUCTION

At L-band the signal mainly depends on soil moisture (SM) and vegetation but it is significantly affected by the effects of surface soil roughness. Quantifying this latter effect is a key issue to improve the quality of passive microwave large-scale SM products.

In this model, surface soil roughness is modeled with empirical parameters \( Q_r \), \( H_r \), and \( N_r \), with \( p = H \) or \( V \) polarizations. These parameters have been estimated by numerous studies but only at local scale from in situ measurements or airborne campaigns [1–3]. However, these local estimations are not representative of measurement conditions of the large scale of satellite data. Moreover, the main surface roughness parameters \( H_r \) and \( Q_r \) are assumed to be constant globally in the operational SMOS algorithm. This assumption is not consistent with the actual surface roughness conditions, especially in agricultural areas where surface roughness may vary significantly over the season and can lead to important errors in the SM inversion process.

In this study, a method had been develop to make a global map of the roughness parameter \( H_r \) at L-band.

RADIATIVE TRANSFER MODEL

The radiative transfer model implemented in the SMOS operational surface soil moisture retrieval algorithm [4] is the L-MEB model [5]. The L-MEB model is based on the \( \tau - \omega \) model and the brightness temperature \( T_B(p, \omega) \) can be expressed as:

\[
T_B(p, \omega) = (1 - \omega_p)(1 - \gamma(p, \omega)) \left[ 1 + \gamma(p, \omega) T_C(p, \omega)T_G + (1 - \gamma(p, \omega)) \gamma(p, \omega) T_G \right]
\]

According to previous studies [6–8], the vegetation and roughness effects can be combined in only one parameter called TR:

\[
TR = \tau_{rad} + H_r \frac{T_G}{2}
\]

This combination required some assumptions:

1. \( N_r \approx 1 \), \( Q_r \approx N_r H_r \), \( \omega \approx 0 \), \( T_C \approx T_r \), and \( T_G = T_B \).

In this way, the TR modeling (Eq.1) becomes:

\[
TR(p, \omega) = T[1 - \gamma(p, \omega) \exp(-2TR \cos(\theta))] \]  

In the 2-P retrieval process, SM and TR are retrieved (instead of SM and \( \tau_{rad} \) in the SMOS operational retrieval algorithm).

FIRST GLOBAL MAP OF THE ROUGHNESS EFFECT \( H_r \) AT L-BAND

MEANING OF THE \( H_r \) MAP?

⇒ Is \( H_r \) correlated with the altitude map?

⇒ Is \( H_r \) correlated with the standard deviation of the altitude map?

FIRST GLOBAL MAP OF THE ROUGHNESS EFFECT \( H_r \) AT L-BAND

CONCLUSION

⇒ Setting \( N_r = -1 \): very good results in terms of SM and TR retrievals

⇒ To our knowledge, the first map of the roughness effect at L-band (\( H_r \) parameter) was produced

⇒ For low vegetation, \( H_r \) is mostly correlated with the standard deviation of the altitude

⇒ For dense vegetation, \( H_r \) is mostly correlated with the vegetation

⇒ Important errors on \( H_r \) parameter in aeras where strong RFI are present

⇒ SM retrievals from SMOS, two choices:

- Calibrate carefully \( H_r \) and \( N_r \) values (site dependent)
- Inversion of SM and \( \tau_{rad} \)

⇒ Set \( N_r = -1 \) ⇒ inversion of SM and TR

⇒ No need to calibrate roughness effects which are implicitly accounted for in TR

REFERENCES


