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Method Article

A method for soil moisture probes calibration and validation of satellite estimates

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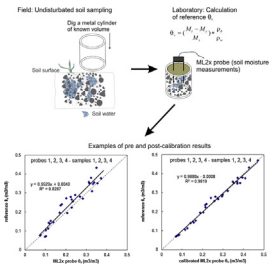
GRAPHICAL ABSTRACT



ABSTRACT

Optimization of field techniques is crucial to ensure high quality soil moisture data. The aim of the work is to present a sampling method for undisturbed soil and soil water content to calibrated soil moisture probes, in a context of the SMOS (Soil Moisture and Ocean Salinity) mission MIRAS Level 2 soil moisture product validation in Pampean Region of Argentina. The method avoids soil alteration and is recommended to calibrated probes based on soil type under a freely drying process at ambient temperature. A detailed explanation of field and laboratory procedures to obtain reference soil moisture is shown. The calibration results reflected accurate operation for the Delta-T thetaProbe ML2x probes in most of analyzed cases (RMSE and bias $\leq 0.05\ m^3/m^3$). Post-calibration results indicated that the accuracy improves significantly applying the adjustments of the calibration based on soil types (RMSE $\leq 0.022\ m^3/m^3$, bias $\leq -0.010\ m^3/m^3$).

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- A sampling method that provides high quality data of soil water content for calibration of probes is described.
- Importance of calibration based on soil types.
- A calibration process for similar soil types could be suitable in practical terms, depending on the required accuracy level.

ARTICLE INFO
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Method details

The United Nations recognize the critical role of soils in sustainable development, given that soils contribute to ecosystem services related to several of the United Stations Sustainable Development Goals (e.g. food security in developing countries, health, water security/resources, biodiversity) [1]. Soil moisture is an essential component of the soil-vegetation-atmosphere system determining physical processes (e.g. water cycle and energy balance, land-atmosphere interactions) and the functioning of plants and other soil biota [2]. The interdisciplinary study of soil moisture is crucial to understand links between soils and climate and to improve climate models and agricultural production, given the impact on crop yield and food security [2,3]. It can show a high spatial variability due to diverse factors like topography, ground water level, soil type or vegetation cover [4,5] and these variations produce significant changes in regional runoff, crop productivity or groundwater recharge, among others. In [3,4] we showed the spatial impact of soil water deficit and excess on the main crops of Pampean Region of Argentina, one of the major grain producers of the world.

On the other hand, in the last decades the pressure on water resources managers has been increasing to maintain soil water and to maximize the productivity of natural and agricultural systems. In this sense, diverse satellite missions have been designed to monitor spatially surface soil moisture (e.g. Soil Moisture and Ocean Salinity-SMOS, Soil Moisture Active Passive −SMAP). Besides, significant efforts have been done to validate the retrieved soil moisture data, including expensive field campaigns. In this context, measured data are assumed to represent the truth and are used for adjusting models and decisions [1]. However, efforts should be done to optimize field techniques to ensure high quality data. In [6] a campaign for a SMOS soil moisture product validation in Pampean Region of Argentina was carried out. The field/laboratory techniques were briefly described and the more detailed process included in this work should be useful for different studies to understand soil-vegetation-atmosphere processes. These aspects should be determining in a context of climate change and the growing world population and its food needs.

The aim of the work is to present a sampling method for undisturbed soil and soil water content to calibrate soil moisture probes (in this case, Delta-T thetaProbe ML2x probes) and validation of satellite estimates. The calibration process for specific soil types was carried out. The method is highly recommended to calibrated soil moisture probes based on soil type under a freely drying process at ambient temperature.

Materials and methods

Field sampling procedure

The Pampean Region covers the most productive area of Argentina whose dominant soil order is Mollisol, characterized by a fertile mollic epipedon (see www.soils.org/publications/soils-glossary#) [7]. Also, Argiudoll is the main soil great group of the humid and sub-humid area of the region, and the organic matter content of the A horizon varies approximately between 2% (Córdoba province) and 5% (South of Buenos Aires province) [8]. The campaign was designed to cover representative soils at