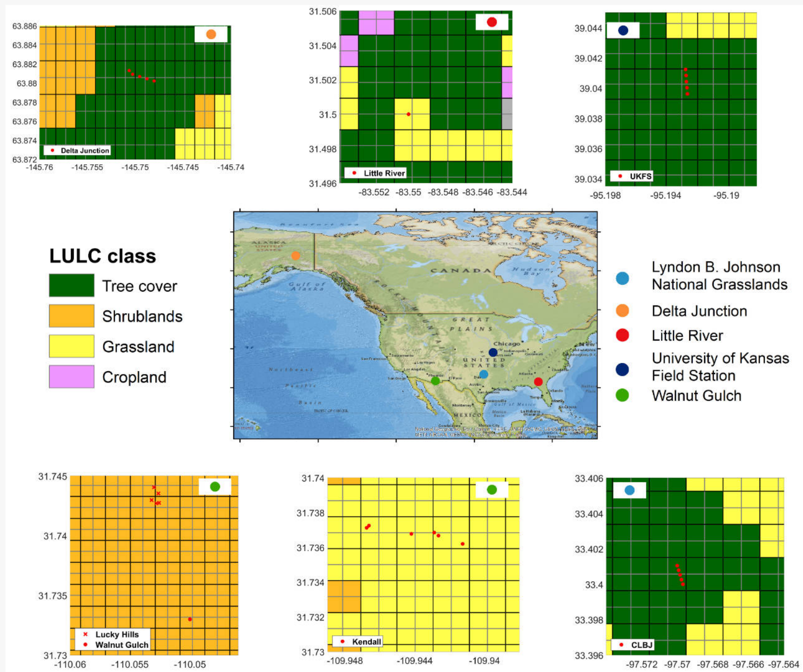
Unlocking detailed soil moisture insights with NISAR's multi-scale algorithm

GA, UNITED STATES, September 5, 2025 /EINPresswire.com/ -- The ability to monitor soil moisture at high resolutions is crucial for improving agricultural productivity, water resource management, and environmental forecasting. The upcoming NASA-ISRO SAR (NISAR) mission, with its innovative multi-scale soil moisture retrieval algorithm, promises to address the limitations of existing global soil moisture products, which are often hindered by coarse spatial resolutions. This study validates the NISAR algorithm using data from ALOS-2 SAR, demonstrating its capacity to retrieve soil moisture at resolutions as fine as 100 meters, a significant improvement over traditional satellite measurements.



Overview of the test site showing the EASE-2 grid cells at a spatial resolution of 200[m] (black line) and 100 [m] (grey line), along with land cover class and the locations of in-situ measurements of soil moisture.

Soil moisture is a critical variable for understanding and managing water resources, especially in the context of climate change. Existing satellite soil moisture products typically offer spatial resolutions of around 30-50 km, which are insufficient for applications that require fine-scale information, such as precision agriculture and hydrological modeling. The NASA-ISRO SAR (NISAR) mission, set to launch in 2025, seeks to overcome this limitation by using advanced radar technology to provide high-resolution soil moisture data at 200 meters, with the potential to achieve even finer resolutions. However, the performance of the multi-scale algorithm across various land covers and climates has not been fully explored, necessitating further validation.

A recent study (DOI: 10.34133/remotesensing.0729), published in Journal of Remote Sensing, explores the validation of the NISAR mission's multi-scale soil moisture retrieval algorithm, which is capable of producing soil moisture data at high spatial resolutions. The research, conducted by Michigan State University and Cornell University, utilizes ALOS-2 SAR data as a proxy for the upcoming NISAR satellite. The study focuses on validating the algorithm’s performance across five test sites, including forest, shrubland, cropland, and grassland environments, in varying hydrometeorological conditions.

The multi-scale algorithm works by enhancing coarse-resolution soil moisture data (9 km) using fine-scale synthetic aperture radar (SAR) backscatter measurements. This approach allows for high-resolution retrievals, achieving soil moisture data at 100 m and 200 m resolutions. The study demonstrated the algorithm's effectiveness at multiple test sites, ranging from arid regions like Walnut Gulch to polar sites such as Delta Junction, where permafrost dynamics are critical for ecosystem monitoring. Results showed that the 100 m resolution provided more detailed moisture patterns, which were particularly beneficial in agricultural regions, where small-scale moisture variations significantly impact irrigation planning. Validation against in-situ measurements indicated that the algorithm met NISAR's accuracy goals, with a root mean square error (RMSE) of less than 0.06 m^3/m^3 in most cases.

Professor Narendra N. Das, a key researcher from Michigan State University, stated, "The successful validation of the multi-scale algorithm at high resolutions is a significant step forward in soil moisture monitoring. It not only enhances our understanding of fine-scale moisture variability but also supports critical applications in water resource management and agriculture, especially in regions with limited access to ground-based measurements."

The validation of this high-resolution soil moisture retrieval algorithm marks a crucial milestone in the development of the NISAR mission's operational capabilities. The ability to monitor soil moisture at 100 m and 200 m resolutions has profound implications for fields such as precision agriculture, where detailed soil moisture data can optimize irrigation practices and improve crop yield predictions. Furthermore, the algorithm's success in capturing fine-scale moisture variations strengthens its potential for enhancing climate modeling and disaster preparedness, particularly in regions prone to floods or droughts. As the NISAR mission progresses, the deployment of such high-resolution data will offer a new era of more accurate, timely, and actionable environmental monitoring.

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