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Examining the Impact of Modeling Resolution on Soil Moisture Simulation Using Multi-Faceted Remote Sensing Data

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Sustainable irrigation practices are crucial for efficient water management, particularly as over 70% of the Earth's freshwater is dedicated to agricultural production. This study delves into the importance of optimizing modeling resolution to achieve reliable soil moisture assessments.

Here, we investigate the spatio-temporal soil moisture simulation at the root zone on the Rur catchment in western Germany (covering approximately 2300 km^2). Employing high spatial resolutions of 500 and 250 meters, our investigation utilizes CosmoRea6 atmospheric data and World Soil Information (ISRIC) soil grid and texture data to comprehensively characterize soil properties. The coupled land surface-subsurface model (CLM-ParFlow) is applied, considering intricate hydrological processes within the soil-plant-atmosphere system. Validation is conducted through a multi-faceted approach, incorporating data from the Soil Moisture Active Passive (SMAP) satellite, Cosmic-ray Neutron Sensor (CRNS) stations, and Synthetic Aperture Radar (SAR)-Sentinel-1, with a specific focus on the soil moisture assimilation using high-resolution Sentinel-1 data.

The study explores the belief that increasing the resolution of input data and employing data assimilation techniques with high-resolution remote sensing data enhance the reliability of simulated soil moisture, particularly in areas with diverse soil textures and land uses. The outcomes bear significant implications for optimized modeling resolution, considering computational costs and sustainable irrigation practices. This understanding of soil moisture dynamics empowers stakeholders in agriculture to optimize water usage, improve crop productivity, and minimize environmental impacts.