GaoFen Soil Moisture Experiment in Heihe River Basin: Towards Validation of High-Resolution Soil Moisture Retrievals and Monitoring of Irrigation at Agricultural Field Scale

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Background

A research project entitled "Key Technology Research and Standard Specifications for the Validation of High-Resolution Remote Sensing Products" was launched in 2020, which aimed to carry out comprehensive satellite-airborne-ground remote sensing experiments to support drafting the specifications for the validation of high-resolution satellite remote sensing products. Under the framework of the project, a series of comprehensive experiments were conducted in several typical climate regions of China. The soil moisture observation experiment was one of the most critical components of the experiments conducted in the middle stream of the Heihe River Basin (HRB, Figure 1a) in northwestern China in the summer of 2021.

Experiment composition

☐ Ground observation system

a) **Long-term ground stations and measurements**

Two permanent automatic weather stations were established during the HiWATER and have been operating for over 10 years (Figure 1b).

b)Temporary ground stations and measurements

From early August before the airborne experiment, eight temporary soil moisture observing stations were set up in the core region of the Zhangye Oasis, seven of which were located at maize fields and the other was located at an orchard where pear trees were planted (Figure 1c).

c) Ground sampling campaign

Concurrent with the airborne campaign or satellite passing the area, three ground sampling campaigns were conducted to collect soil moisture measurements at the south border of the oasis (Figure 1d).

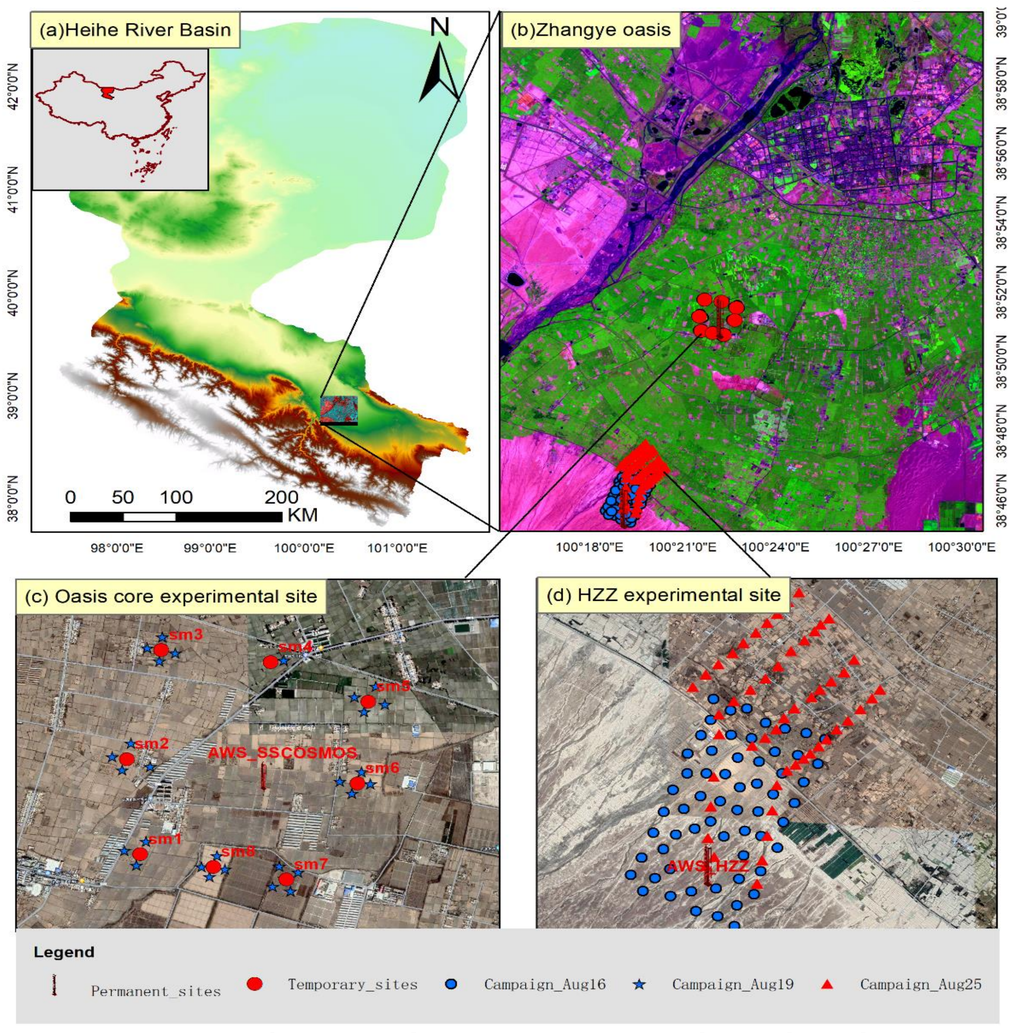

Figure 1. Location of GaoFen soil moisture experiment and ground sampling sites.

Results: Evaluation of ground-based sensors against soil cores

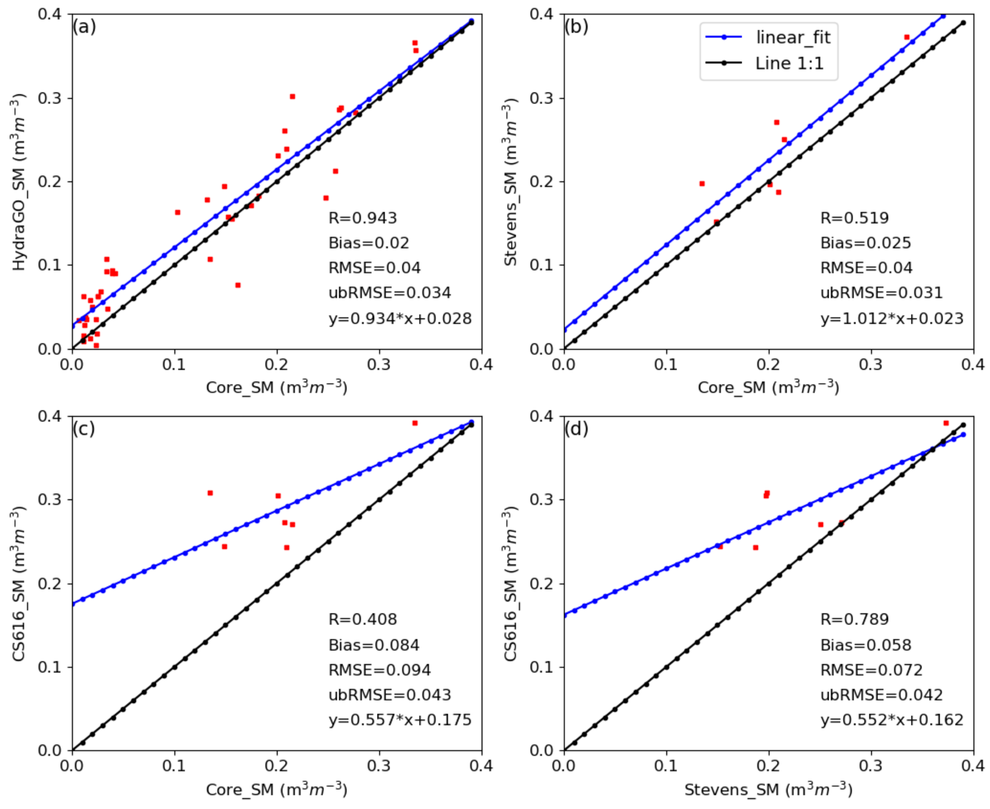

Figure 2. Comparison of soil moisture measurements from soil cores and multiple sensors: (a) HydraGO vs. soil cores, (b) in-situ Stevens probes vs. soil cores, (c) CS616 vs. soil cores, (d) CS616 vs. in-situ Stevens probes at the same soil layers of the same sites. The HydraGO measurements are well consistent with the soil core measurements, with an RMSE=0.040 m3m-3 (ubRMSE=0.034 m3m-3) and R=0.943, while the CS616 measurements show a large discrepancy with the Stevens measurements

Results: Evaluation of SMAP soil moisture products

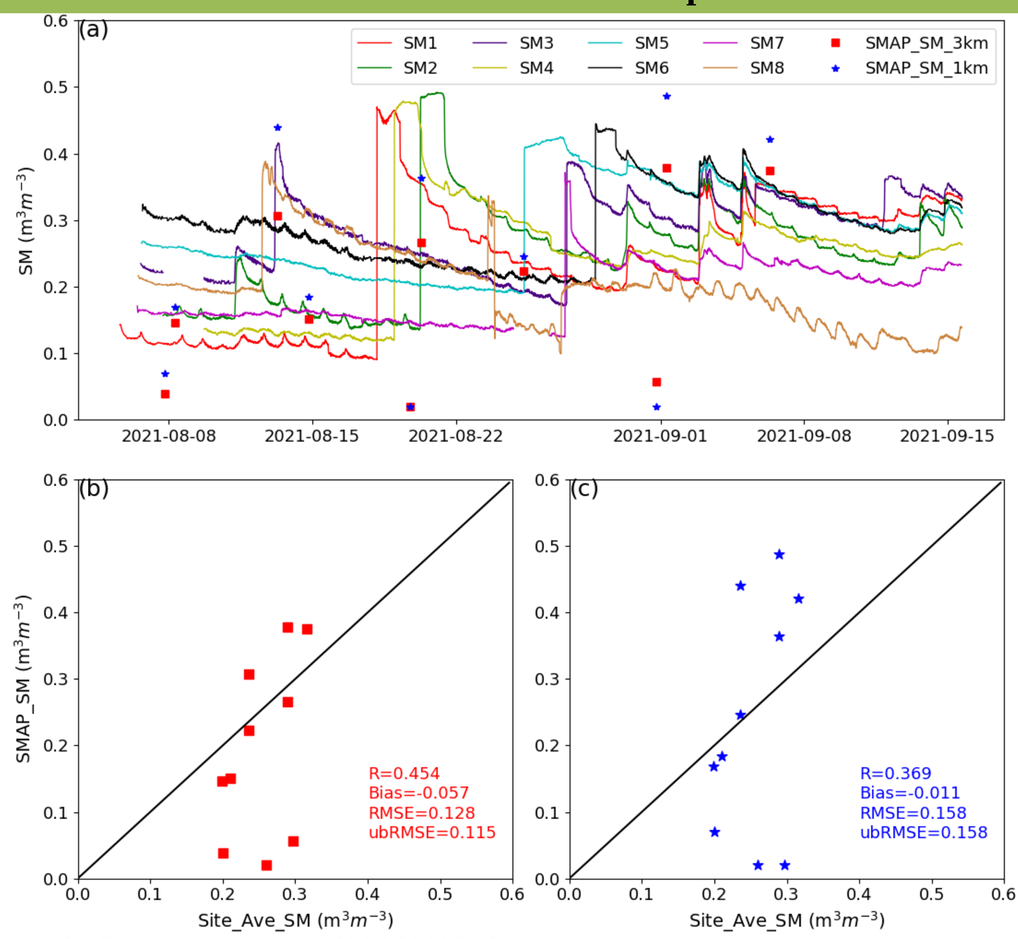

Figure 3. Evaluation of the SPL2SMAP_S product against the average values of the Stevens measurements at the 8 sites. Both the products at 3 km and 1 km resolution show a certain extent of correlation with the ground measurements, with R being 0.454 and 0.369, respectively.

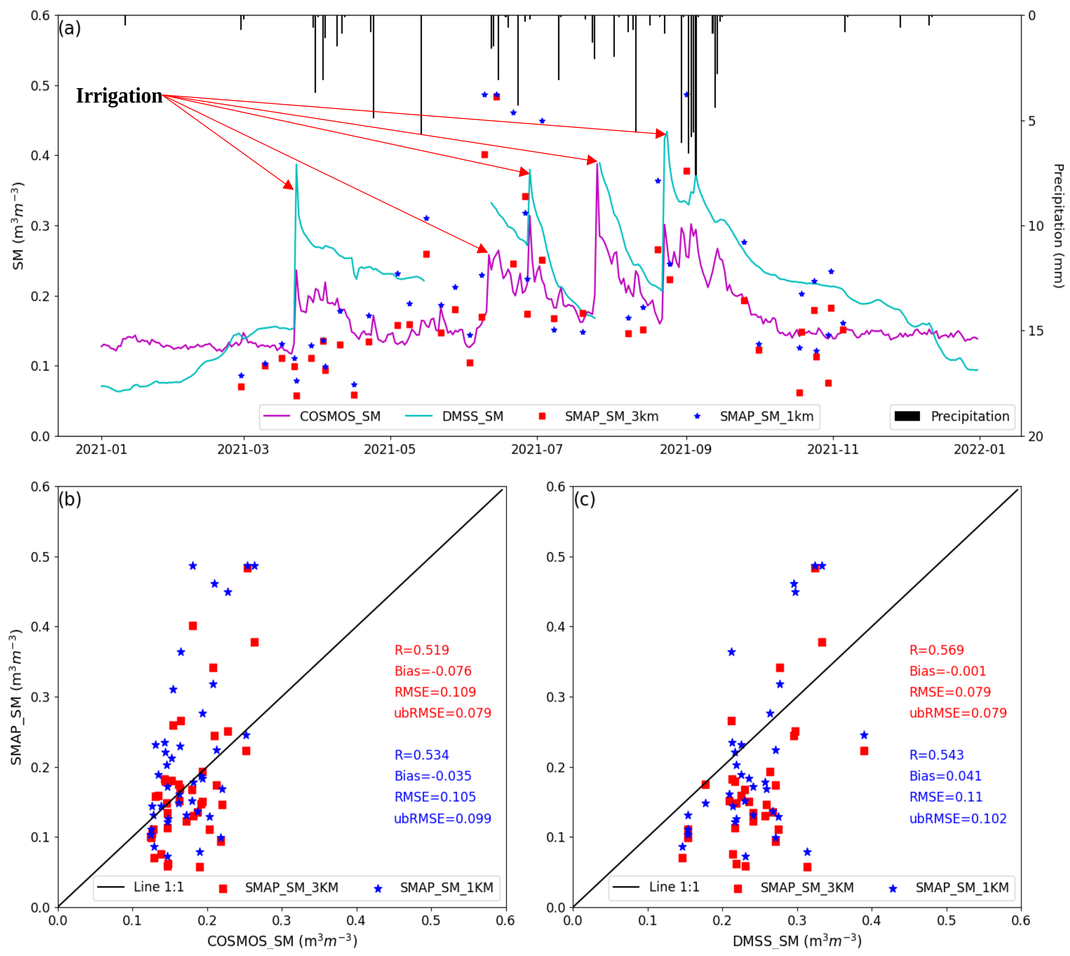

Figure 4. Evaluation of the SPL2SMAP_S product against COSMOS. Both the ground measurements and the SMAP product can reflect the seasonal variation of soil moisture, especially they can identify the irrigation-caused increase in soil moisture.

Results: Evaluation of Sentinel-2 soil moisture retrievals for irrigation

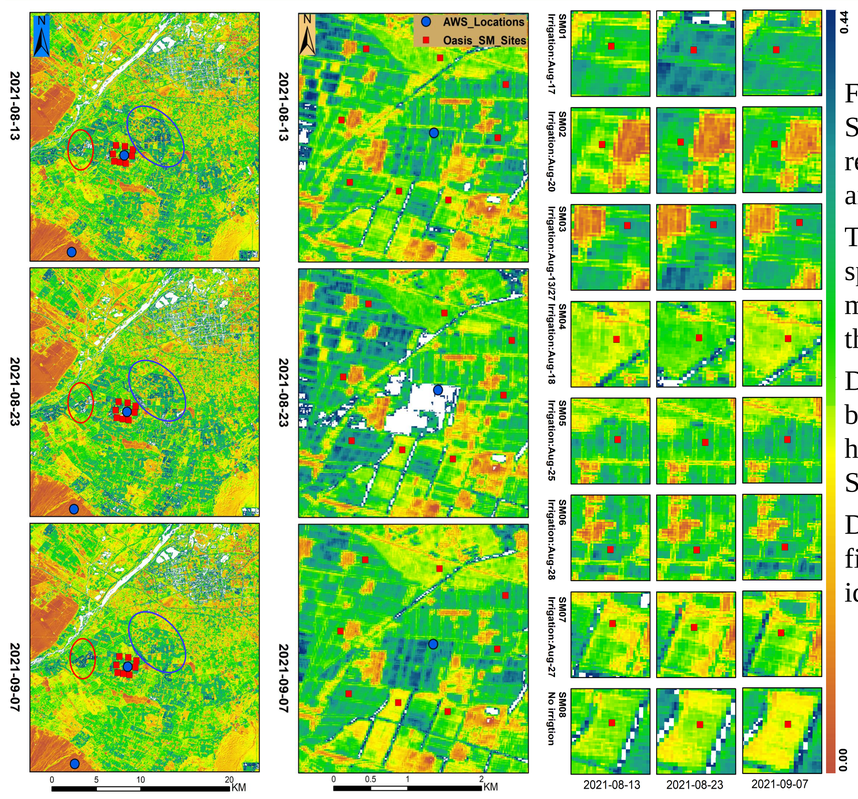

Figure 5. Spatial distribution of Sentinel-2-based soil moisture retrievals on August 13, 23, and September 7, respectively.

The retrievals can reflect the spatial distribution of soil moisture and irrigated area at the agricultural field scale

Details of irrigated areas can be well revealed due to the high spatial resolution of the Sentinel-2 data.

Drying or wetting of the same fields on different days is also identified by the retrievals.