Poster # NH45D-0619

Expanding the Spatiotemporal Range of Soil Moisture Analysis using NASA Earth Observations and In-Situ Measurements

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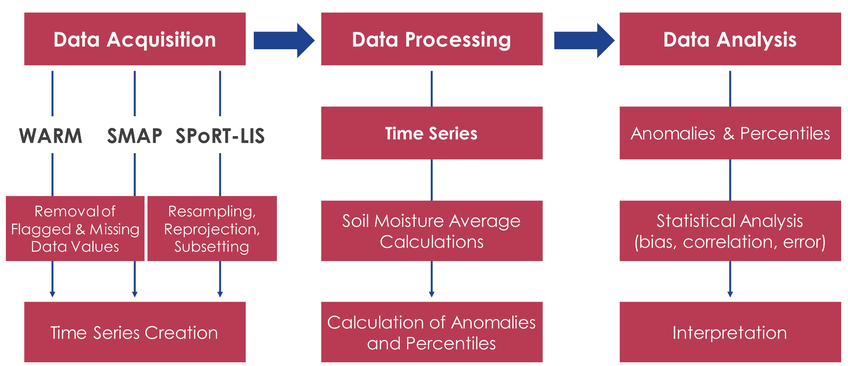
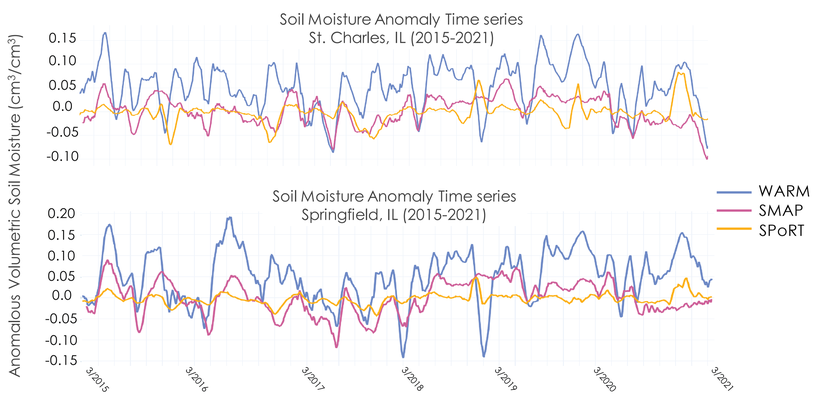
ABSTRACT

Drought can cause immense agricultural and ecological damage resulting in high mitigation and compensation costs. Climate variability in future decades is expected to cause severe drought conditions and threaten necessary water resources. Stakeholders seek to implement effective drought assessments in preparation for potential economic and environmental damage invoked by drought. Although *in-situ* measurements are accurate, the current infrastructure is spatially limited and costly to maintain. A framework was created to compare modeled, satellite and *in-situ* data in drought monitoring. Here we show that the comparison of *in-situ* and remotely sensed soil moisture (SM) measurements can increase the spatiotemporal range of SM assessments. Data collected between 2003 and 2021 by NASA's SPoRT Land Information System (SPoRT-LIS) and Soil Moisture Active Passive (SMAP) mission were standardized and compared with *in-situ* data provided through the Illinois Climate Network (WARM). Statistical analysis results including the Pearson correlation coefficient (r), root mean squared error, mean absolute error and others were calculated to compare the WARM measurements to the SMAP and SPoRT-LIS products. Results indicate that both satellite products demonstrate seasonally variable bias that is not present in the *in-situ* measurements. Bias was highest in the winter months and lowest in the late summer and early fall months in both satellite datasets. Overall, WARM-SPoRT comparisons resulted in lower seasonal variability. However, on average, the SMAP comparison demonstrated higher correlation values and lower error values. The WARM-SMAP average correlation (r) was 0.61 compared to the WARM-SPoRT average correlation (r) value of 0.54. Average mean absolute error values calculated for the SMAP and SPoRT comparisons were 0.07 and 0.08 percent soil moisture by volume, respectively. These analyses suggest integrating *in-situ* measurements and those provided by NASA Earth observations can be utilized in a multi-faceted SM evaluation, a valuable contribution to drought monitoring and water resource decision making.

METHODOLOGY



TIME SERIES RESULTS



Figures 2-3: Anomaly time series are show values at two climate data collection stations. In-situ and remotely sensed products are shown on the same plot to allow for comparison of datasets.

STUDY AREA & PERIOD

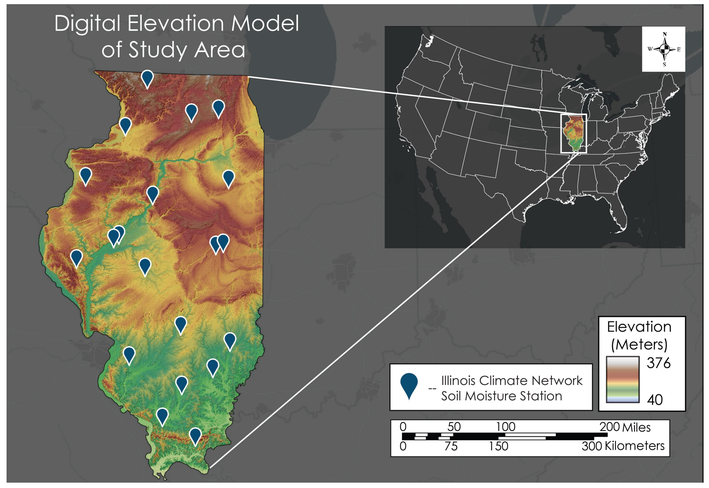


Figure 1

PROJECT PARTNERS

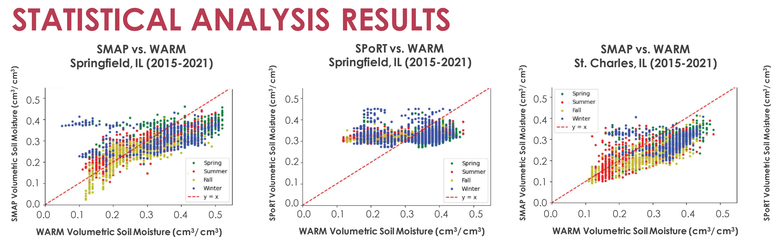
- Illinois State Water Survey
- USDA Midwest Climate Hub
- NOAA Regional Climate Services Central Region
- NOAA National Integrated Drought System, Midwest Drought Early Warning System
- NOAA Central River Forecasting Center

COMMUNITY CONCERNS & PROJECT OBJECTIVES

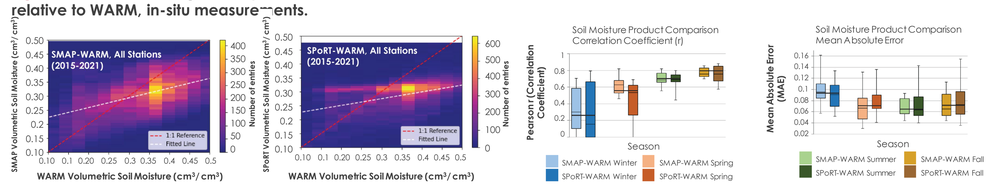
- Stakeholders seek to **reduce** the **economic** and **ecological damage** incurred by drought
- Illinois has a productive **agricultural industry** and is especially **vulnerable to drought** as a Midwestern state
- In-situ data networks have **high accuracy**, but are **spatially limited** and **costly** to maintain
- A **comprehensive drought assessment** is necessary to fully understanding the scope of soil moisture in this study area

- Expand the spatiotemporal range of soil moisture analysis by evaluating the feasibility of incorporating NASA EO data with existing in-situ data
- **Enhance** current decision-making processes surrounding **drought monitoring** and water resource management in the state of **Illinois**

STATISTICAL ANALYSIS RESULTS



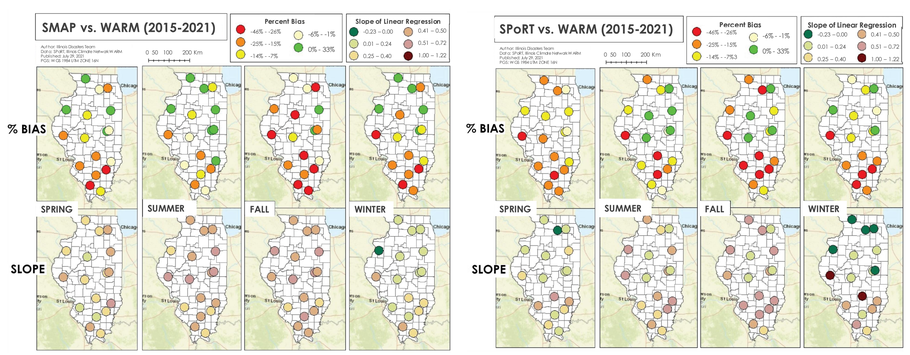
Figures 4-7: The following scatterplots allow us to visualize the distribution and deviation of SMAP and SPoRT measurements relative to WARM, in-situ measurements.



Figures 8-9: Density plots show SMAP vs. WARM and Sport vs. WARM comparisons at all stations.

Figures 10-11: Plots show average correlation coefficient and mean absolute error values by season.

STATISTICAL MAPPING RESULTS



Figures 12-13: Spatial distribution of percent bias and slope of the least linear squares line across 17 climate network stations. Left: SMAP vs. WARM soil moisture data comparison Right: SPoRT vs. WARM soil moisture data comparison

CONCLUSIONS & DISCUSSION

- **Multi-scale** analysis can enhance a comprehensive soil moisture assessment
- Statistical analysis shows seasonal variability in both in-situ networks and satellite data
  - **WARM-SMAP** correlation **≥ WARM-SPoRT** correlation
  - WARM-SMAP **Mean Absolute Error ≤ WARM-SPoRT** correlation
  - **SPoRT** values are closer in range with WARM values during wet conditions – **WARM-SPoRT RMSE ≤ WARM-SMAP RMSE** when WARM percentiles are > 80

Previous research suggests:

↑ Climate variability = ↑ drought = ↑ H_2O budgeting

- This 10-week feasibility analysis suggests that remotely sensed data can be incorporated with existing in-situ infrastructure to **improve drought monitoring** through **soil moisture research**

FUTURE WORK & LIMITATIONS

- **Quantify uncertainty** of remotely sensed datasets
- **Apply framework** to other satellite products:
  - **AirMOSS**
  - **GRACE**
  - **SMOS**

- Differences in **time of day and depth** of data collection
- Seasonally **variable crop cover**
- **Temporal limitations** of **SMAP** data availability

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ILLINOIS Disaster

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