Estimation of Soil Moisture in Bare Soils of the Northern Dry Zone of the Deccan Plateau, Karnataka, using Sentinel-1 Band C imagery

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Introduction

Soil moisture information is a critical input to water resource allocation, irrigation scheduling and climate risk management. The date of sowing is an important decision farmers take after initial rainfall occurs based on traditional knowledge and physical estimation of soil moisture. The present study was conducted on bare agriculture fields of Siruguppa sub-district in Karnataka state in India to estimate surface soil moisture using radar remote sensing with the aim of developing an accurate and scalable methodology.

Hypothesis

VV(σ°) dB and VH(σ°) dB together can improve the accuracy of soil moisture in bare soil based on the fact that VV(σ°) dB has more contribution from soils and VH(σ°) dB has more contribution from vegetation and surface roughness.

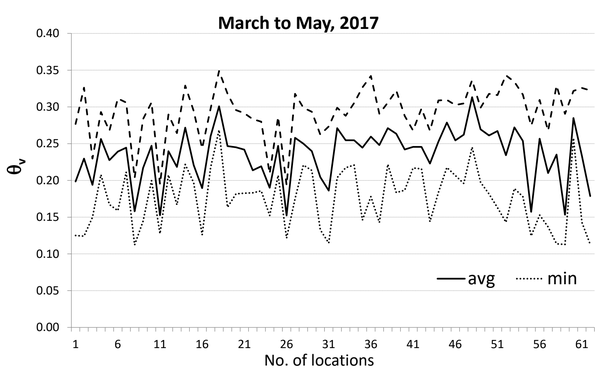
Objective

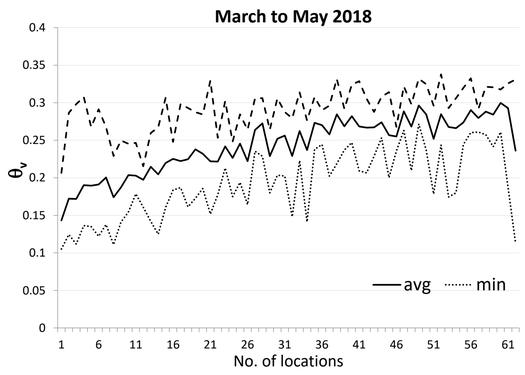
- The major goal of this study is to estimate soil moisture over bare soils using both VV and VH polarization at 10cm depth.
- A semi-empirical model is proposed for retrieval of soil moisture using VV, VH polarization and surface roughness of soil over a large area (1024 sq.km) with minimum *in-situ* samples.
- Proposed soil moisture model is validated at same locations during the year 2018.

Data

Volumetric soil moisture (θ_v)

- Volumetric soil moisture (θ_v) at 10cm depth, surface roughness (*hrms*) was collected during satellite overpass.
- Soil samples were stratified random sampled during 2017 and 2018 at the same locations in the study area to develop the model and validate.





Semi-empirical model

- A semi-empirical model was proposed to estimate θ_v over bare soils in agriculture areas from σ° based on theoretical relationships.
- The contribution of VV(σ°) is more than from VH(σ°) to soil moisture.
- Modeled VH(σ°) in addition to VV(σ°) to improve the soil moisture estimate.

$$F(\theta_v) = T + H(\sigma^\circ)VV + G(\sigma^\circ)VH + P\ (HRMS)$$

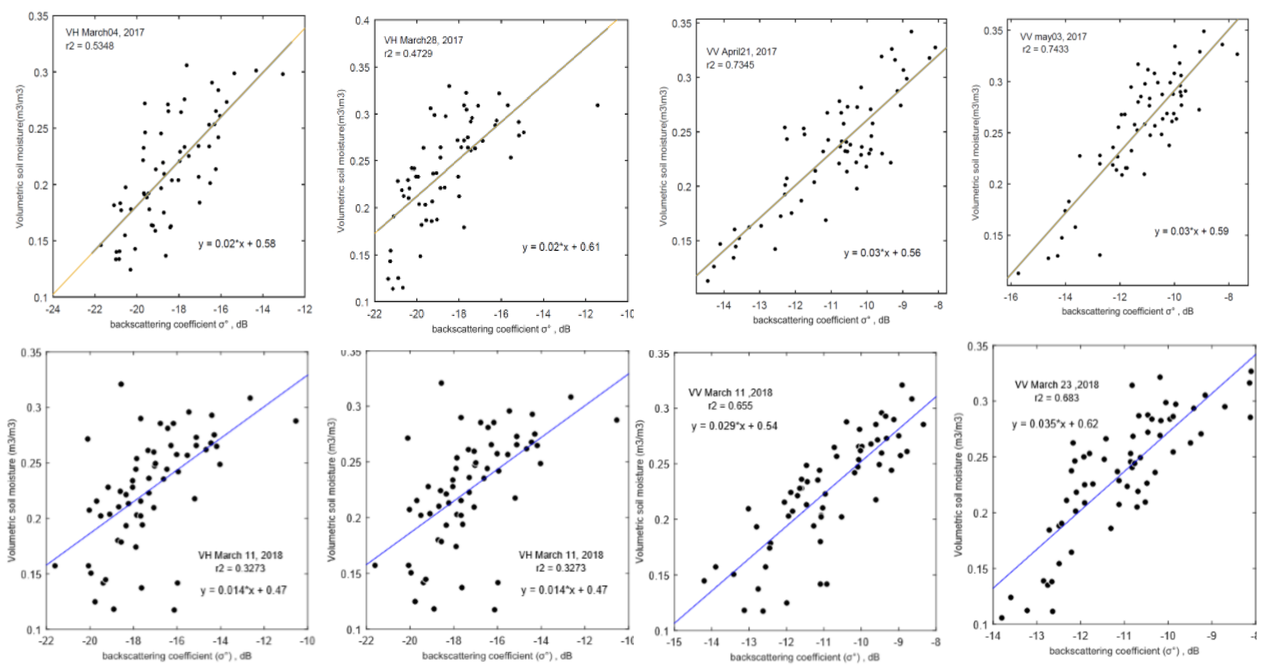
Where *mv* is the volumetric soil moisture, *hrms* surface roughness, T, G, H and P are empirical constants which depend on radar wave length, polarization, frequency, incidence angle and soil texture

Summary

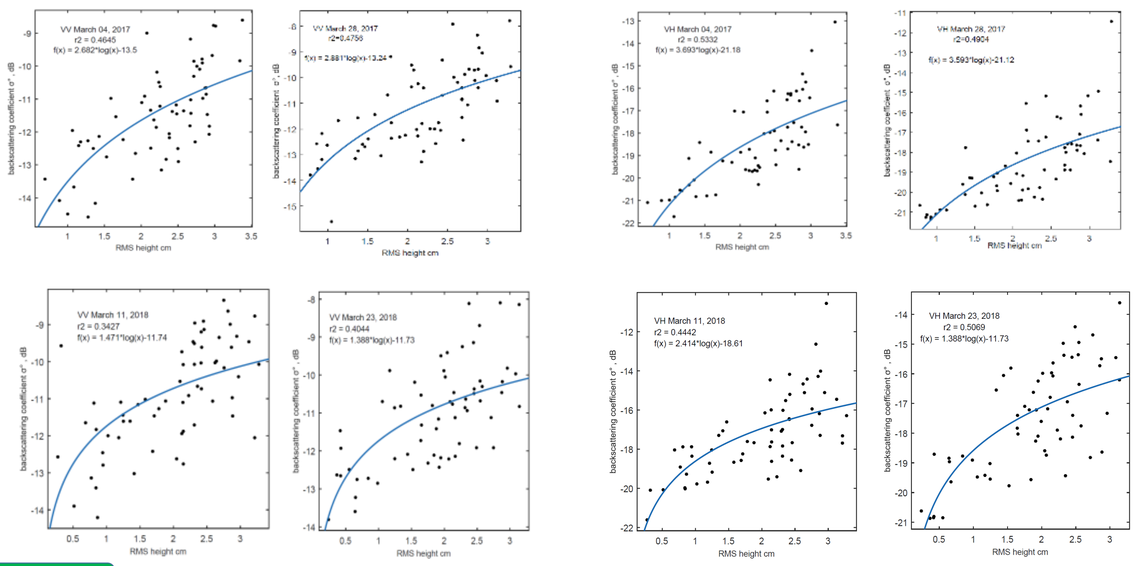
- The scatter plots, clearly indicate that inter-year variation in the backscatter values behave almost similar for both polarization, except for the energy response indicating a bare soil condition and the importance of VV polarization along with VH in increasing the accuracy of *mv* estimate
- VV polarization is more sensitive to soil moisture at 30°-35° incidence angle and a depth of 10cm during March 4, 2017 to May 22, 2018 than VH σ° for same period
- For surface roughness VH polarization is more sensitive than from VV
- The model validation r^2 ranged from 0.72 to 0.84 and the rmse value was mostly 0.02 m^3/m^3 for all the dates except 16th April which was 0.03 m^3/m^3
- Soil moisture maps generated from 4 March, 2017 to 27 May, 2017 clearly shows that the model is able to capture the weather variability in precipitation, directly influencing the soil moisture

Results

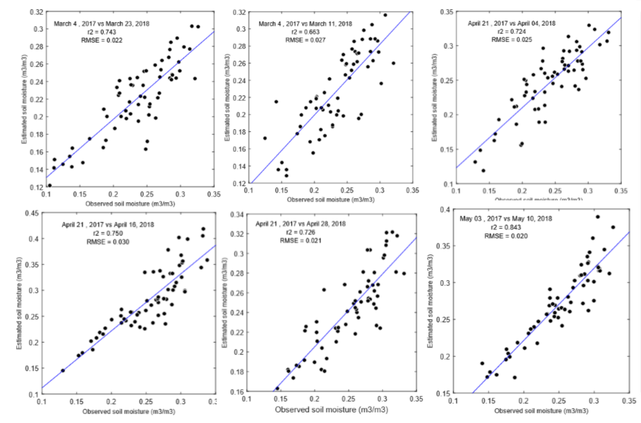
Relationship between θ_v and σ° during 2017 to 2018



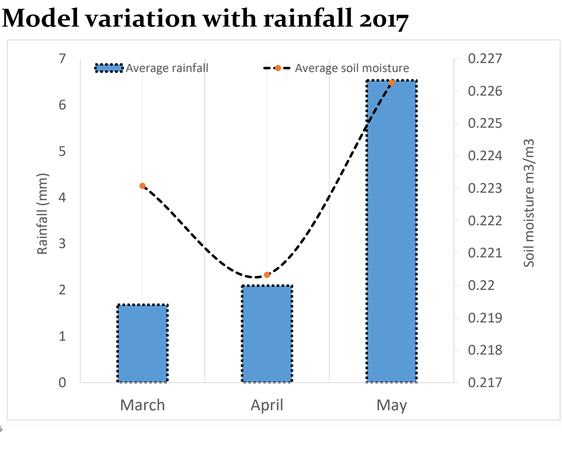
Relationship between *hrms* and σ° during 2017, 2018



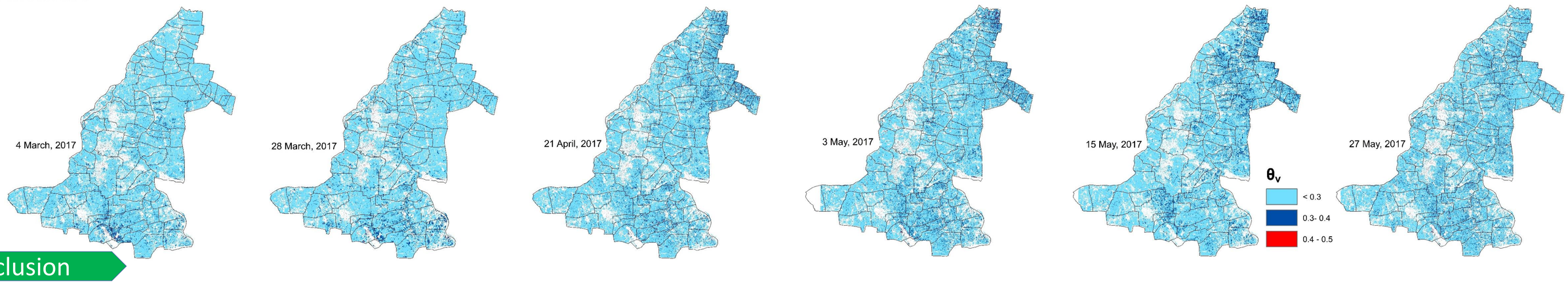
Validation



Model variation with rainfall 2017



Spatial variability of soil moisture estimated using semi-empirical model during 2017



Conclusion

- VV polarization along with VH in the model improved accuracy from (previous studies) 3-6% to 2-3%.
- More accurate and scalable estimates of spatial variation of surface soil moisture can be used to trigger sowing date advisories or parametrize crop models for prediction

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