Space-Based Monitoring of Temporal Water Level Variations in the South Florida Everglades Ecosystem Using Sentinel-1 SAR Observations

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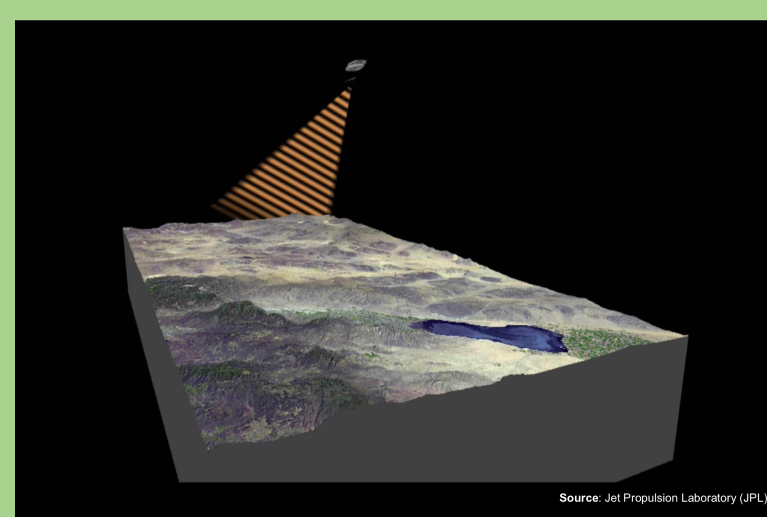
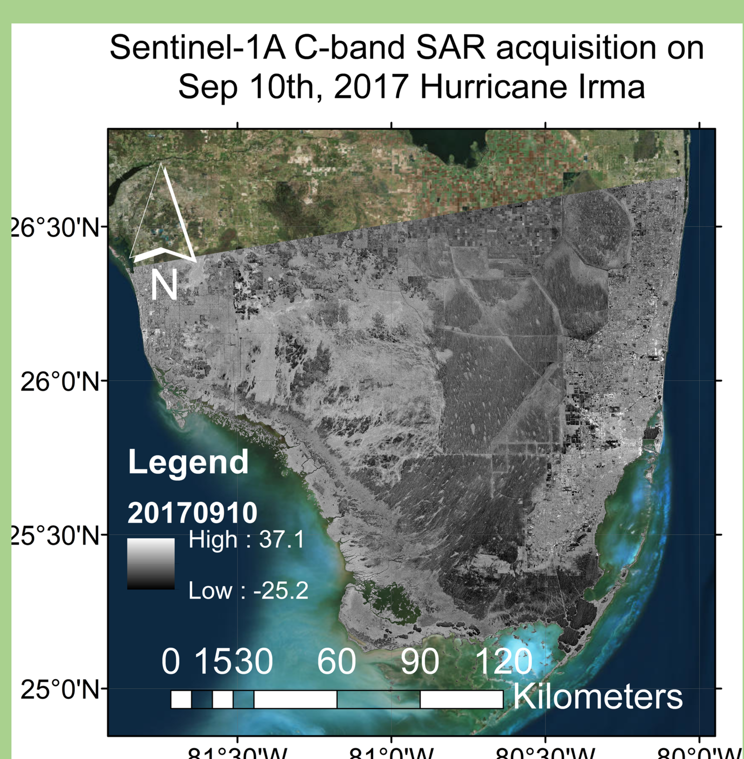
Introduction

The Synthetic Aperture Radar (SAR) satellite is able to transmit microwave signal to the Earth surface. The signal has interaction with objects on the ground (e.g. scattering) and bounce back to the satellite. So radar image represents backscattering intensity.

We use SAR data from Sentinel-1A constellation, which has high temporal resolution, 12 days and high spatial resolution 10m.





The figure on the left hand side show the SAR image acquired on Sep 10th, 2017, 5 hours after Hurricane Irma left south Florida.

The vast extent of marshes in the middle of the image appears to be very dark, which is because of water level rise.

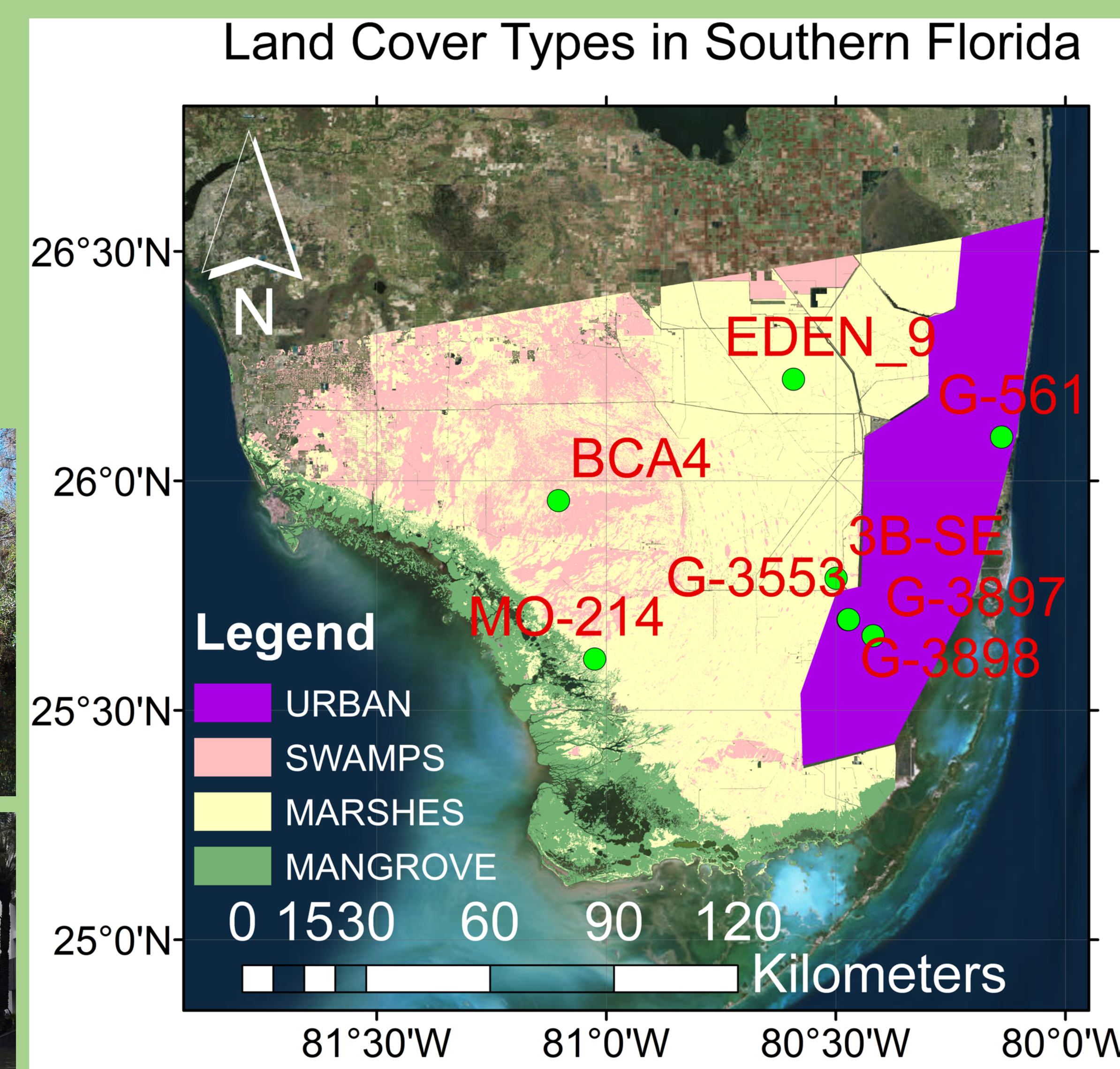
This study focuses on exploring the relationship between the SAR signal intensity and temporal water level variation in South Florida.

Since different land covers have different response towards SAR signal, we split the study areas in four classifications (on the right hand side).

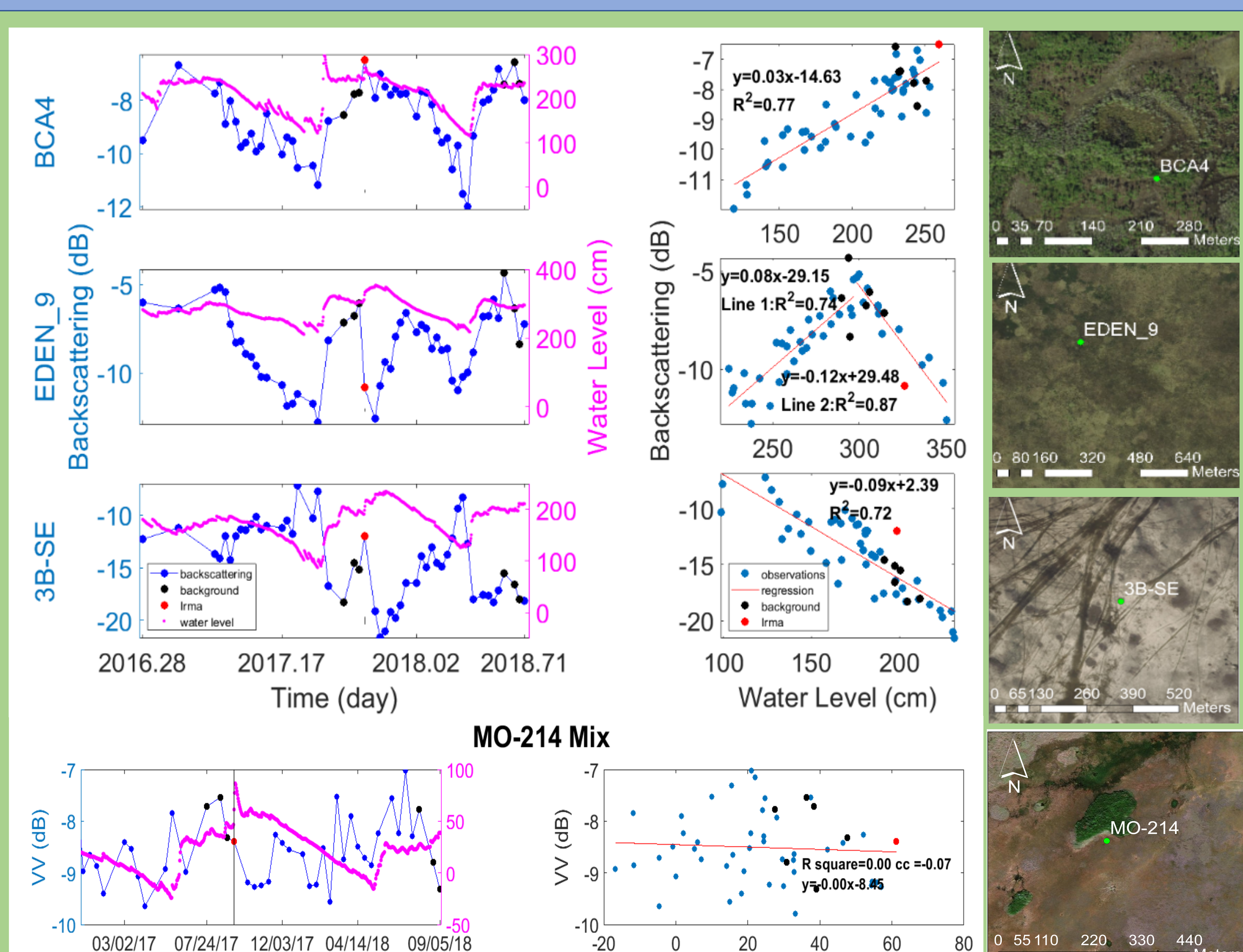
Study Area

The figure below shows four types of land cover classifications, and the figure on the right hand side is the distribution of four land cover types.

The green dots are water gauges from EDEN, with daily water level measurements. Each gauge represents a land cover type in rural and urban respectively.

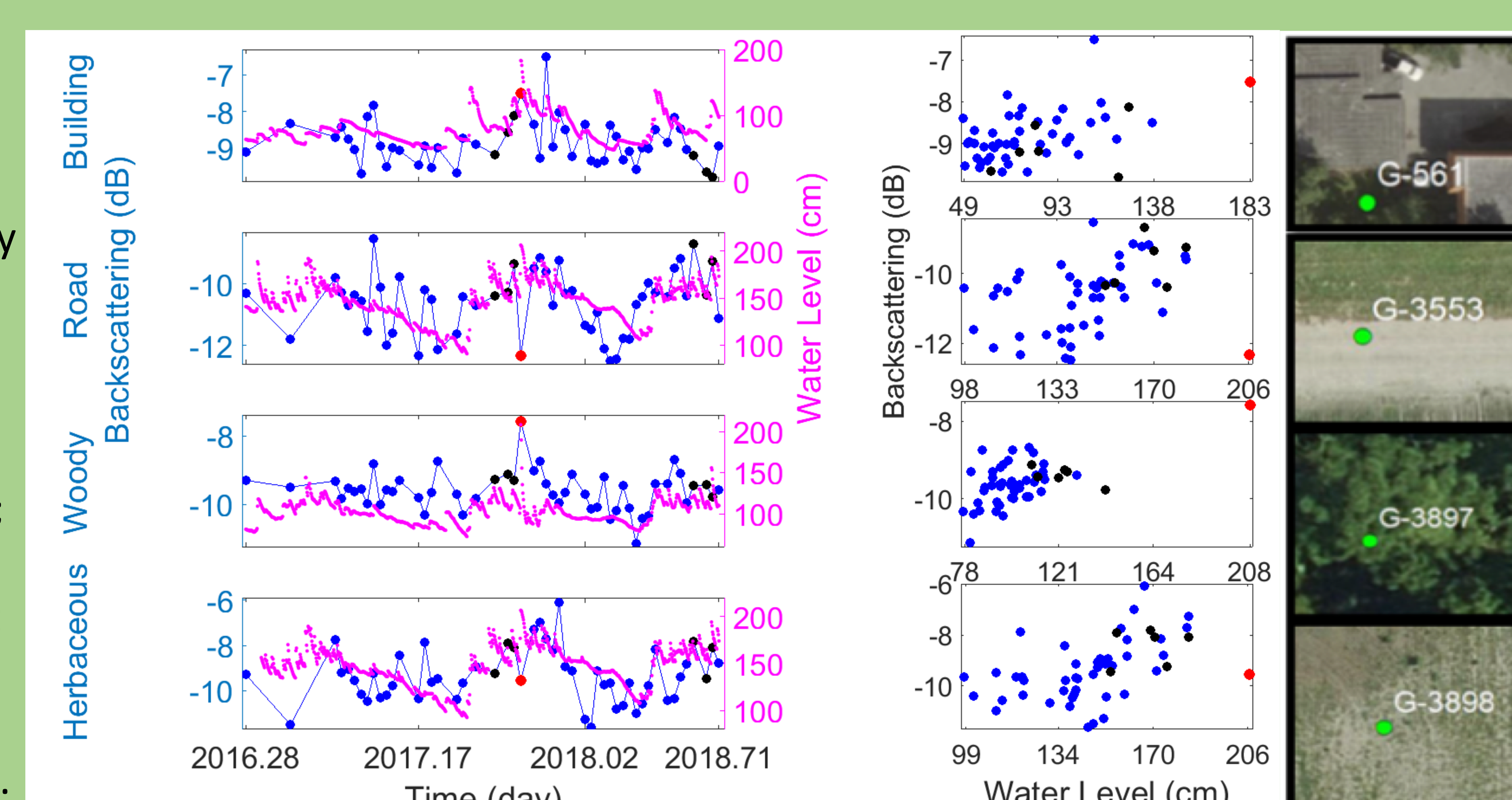


Results



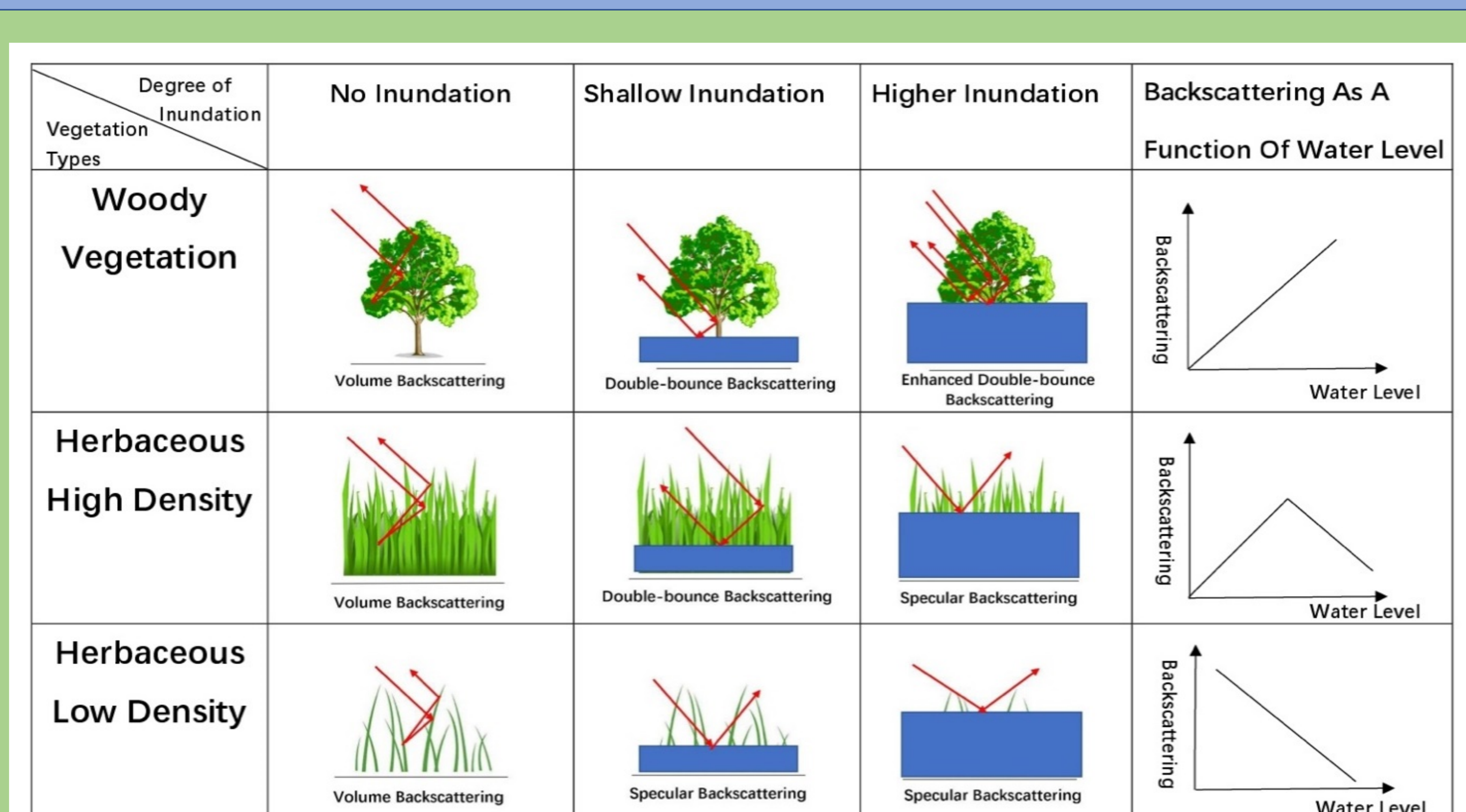
Left figure shows the relation between signal backscattering intensity and water level variations of woody, high-density herbaceous, low-density herbaceous and finally mix vegetation respectively.

Woody vegetation has monotonically increasing trend; high-density herbaceous has increasing in the beginning, but then decreasing. Low-density has decreasing trend, and mix type does not fit a linear model.



Backscattering and water variation model in urban areas. Water gauges are in the proximity of building, road, woody and herbaceous vegetation environments. There is less water level variations, compared with rural area situation.

Conclusion



Based on the observations above, we conclude with these backscattering-water level models.

On the left shows the model in rural areas. Woody, high-density and low-density herbaceous vegetation has different trends. It is consistent with the scattering mechanisms which are shown in the figure.

The right figure is the model for urban areas. Instead of gradual change of backscattering, there is a abrupt change.