Iowa State University

Soil Moisture Dynamics: A Comparison of the SMOS Satellite to the South Fork in-situ Soil Moisture Network

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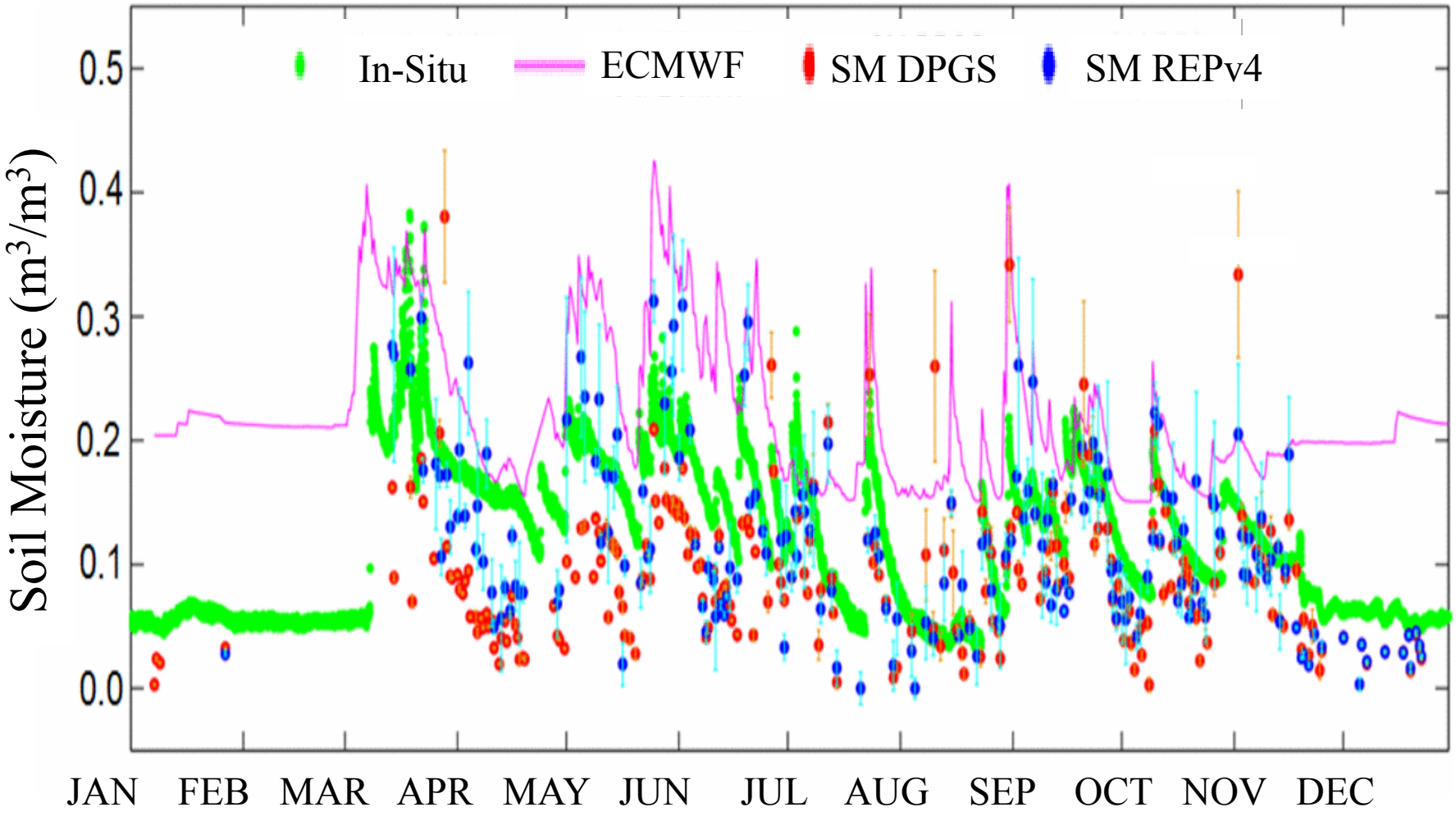
Symposium on Undergraduate Research and Creative Expression

- Introduction
- Hypothesis
- Methods
- Results
- Analysis
- Conclusion

Why Study Soil Moisture



Why Study Soil Moisture

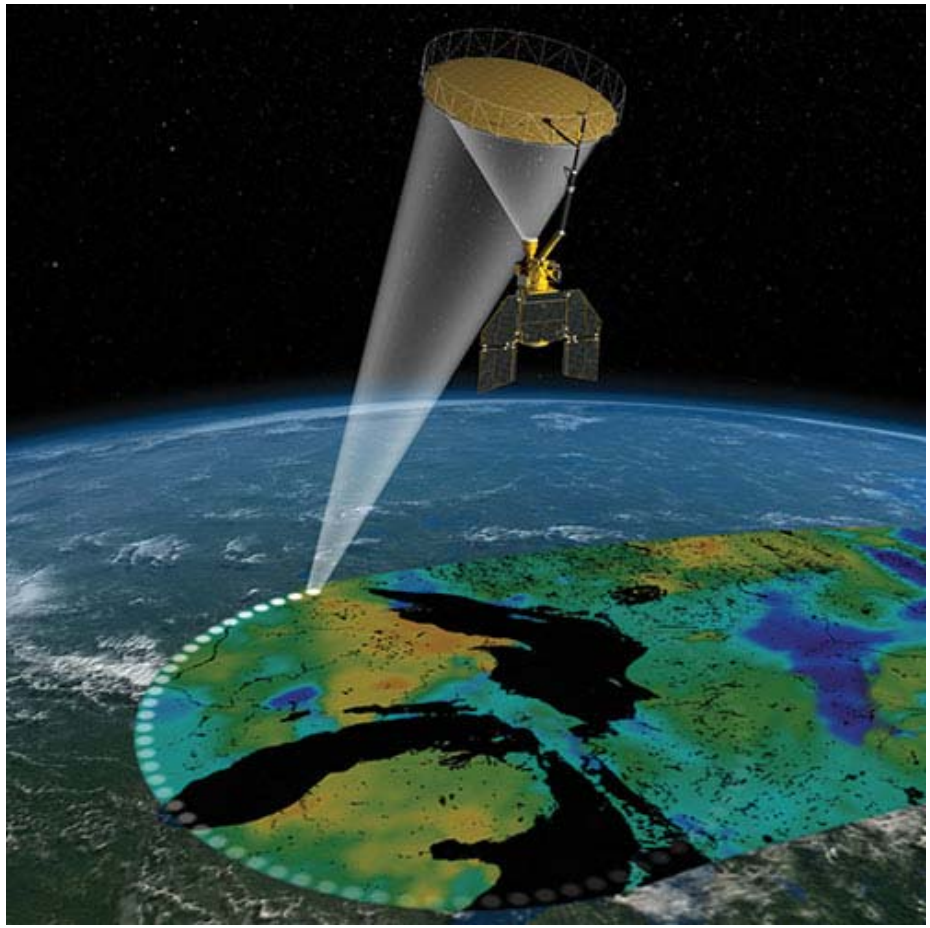
- Lack of Accuracy in Weather Models
- Hydrological Cycle
- Crop Forecasts
- Drought Monitoring
- Flood Control

Soil Moisture and Oceanic Salinity (SMOS) Satellite

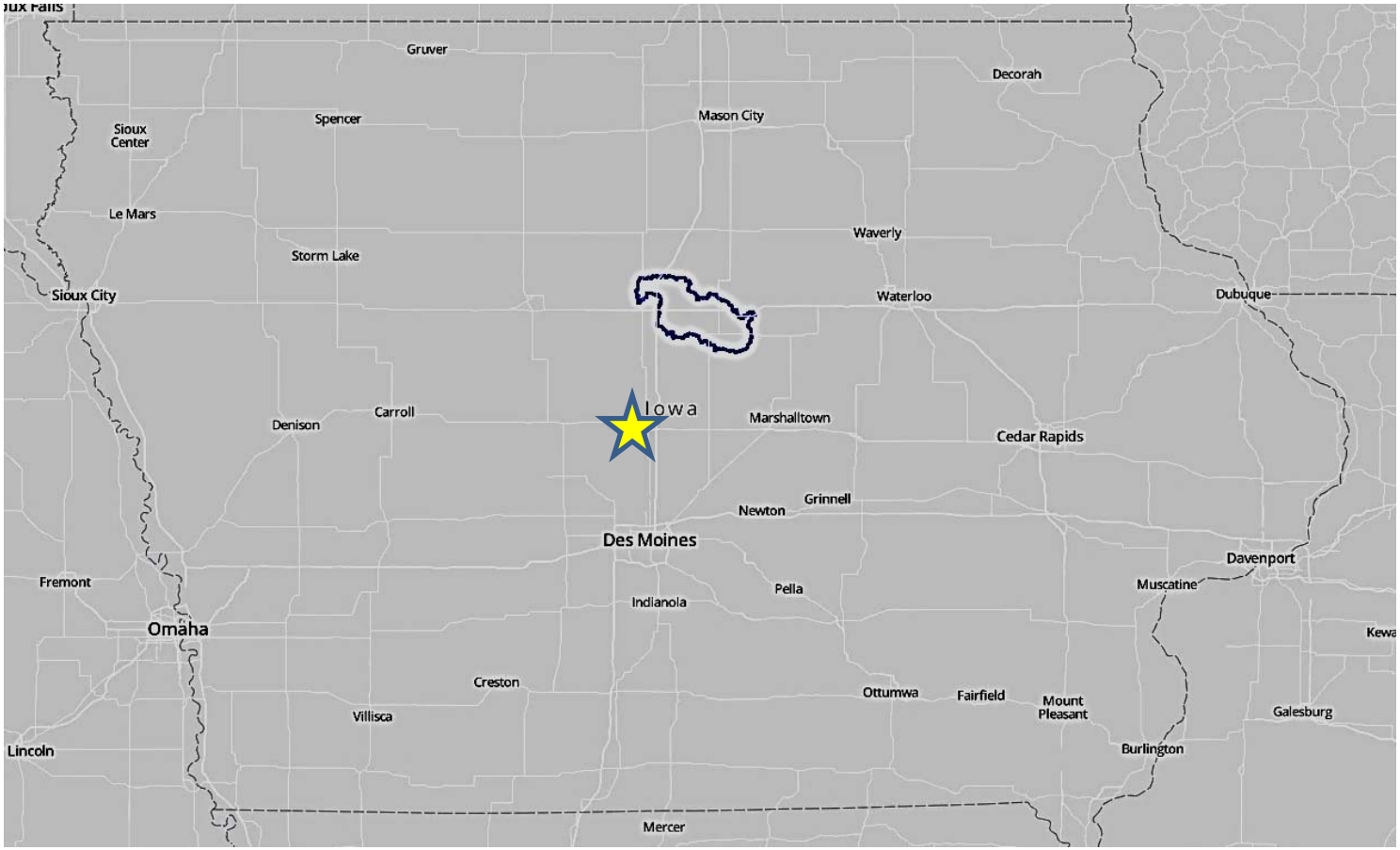
- Soil Moisture from Surface to Approximately 3-5 cm
- Average 1-3 Day Cycle
- Passive Sensor
- 40 km Grid
- European Space Agency

Soil Moisture Active Passive (SMAP)

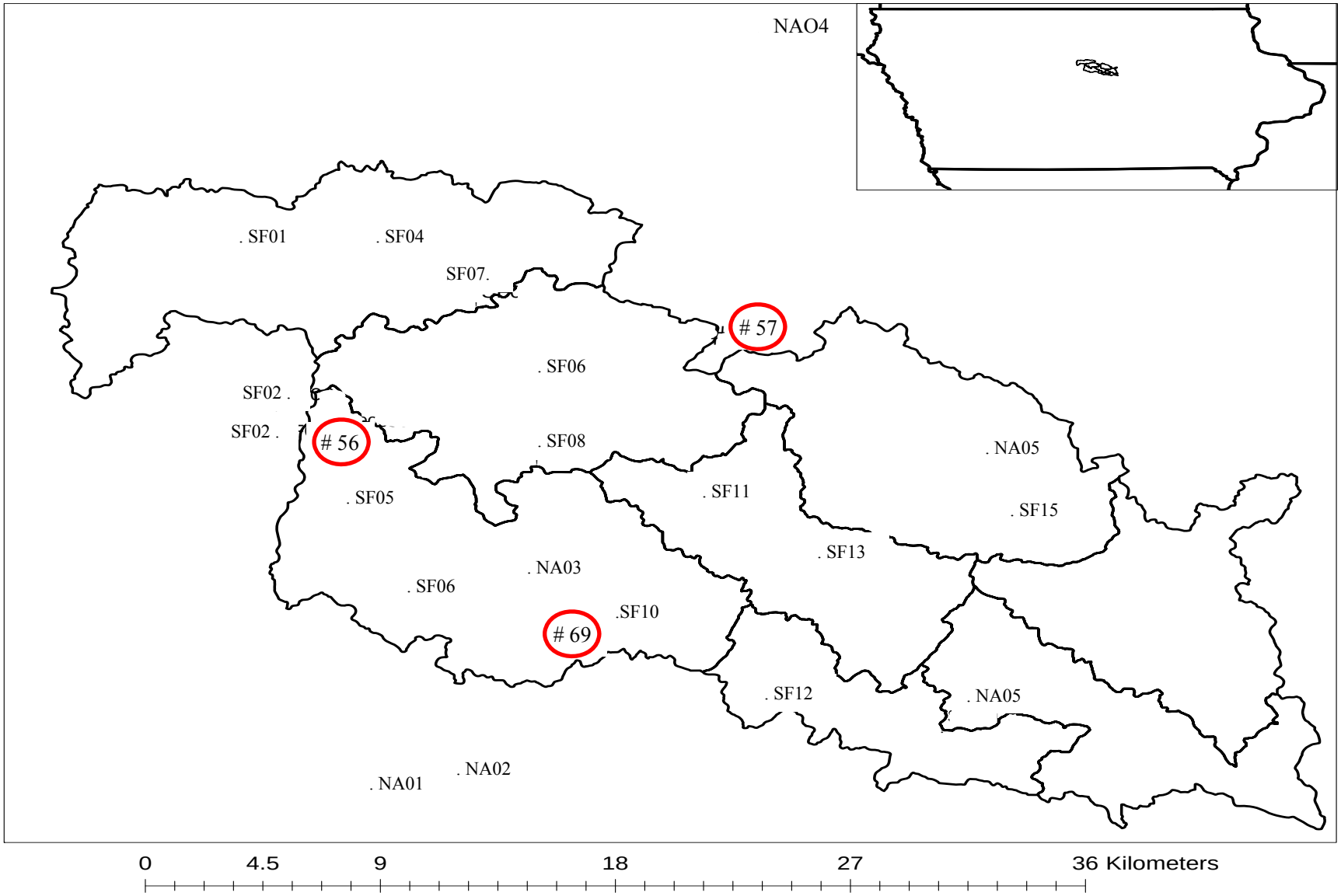
- November 2014
- NASA
- 2-3 Day Cycle
- Passive and Active



South Fork Watershed of the Iowa River



http://hrsl.arsusda.gov/awhite/crop_map.html


NAO4
. SF01
. SF04
SF07.
57
. SF06
SF02 .
SF02 .
56
. SF08
. NA05
. SF05
. SF11
. SF15
. SF13
. NA03
. SF06
.SF10
69
. SF12
. NA05
. NA02
. NA01
0
4.5
9
18
27
36 Kilometers

South Fork Stations

- 20 sites
- USDA and NASA
- Soil Moisture and Precipitation

Comparison of Current Instruments

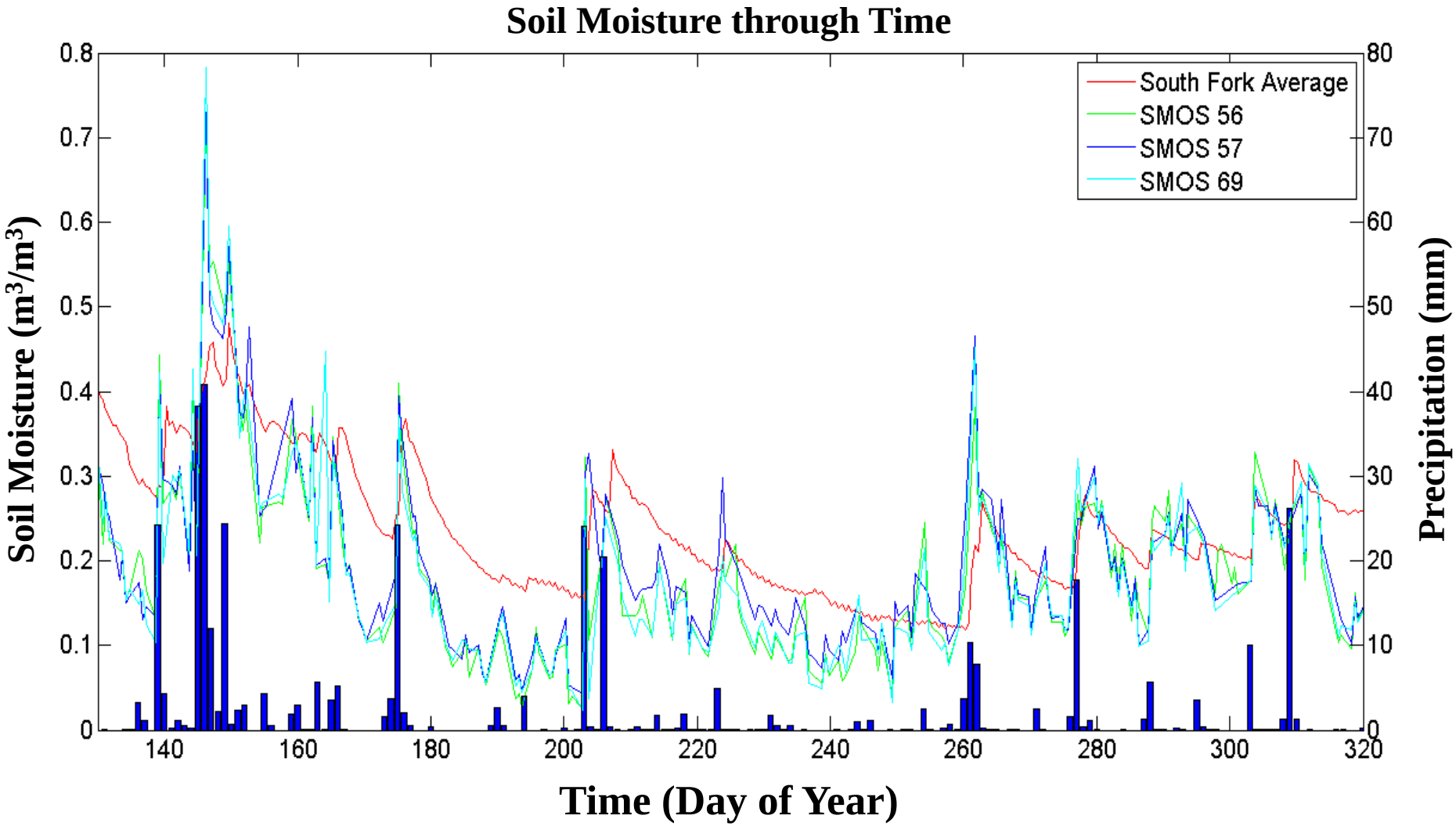
- Soil Moisture and Ocean Salinity (SMOS) Satellite
- South Fork In-Situ Soil Moisture Network
- Characterize the Values

Hypothesis

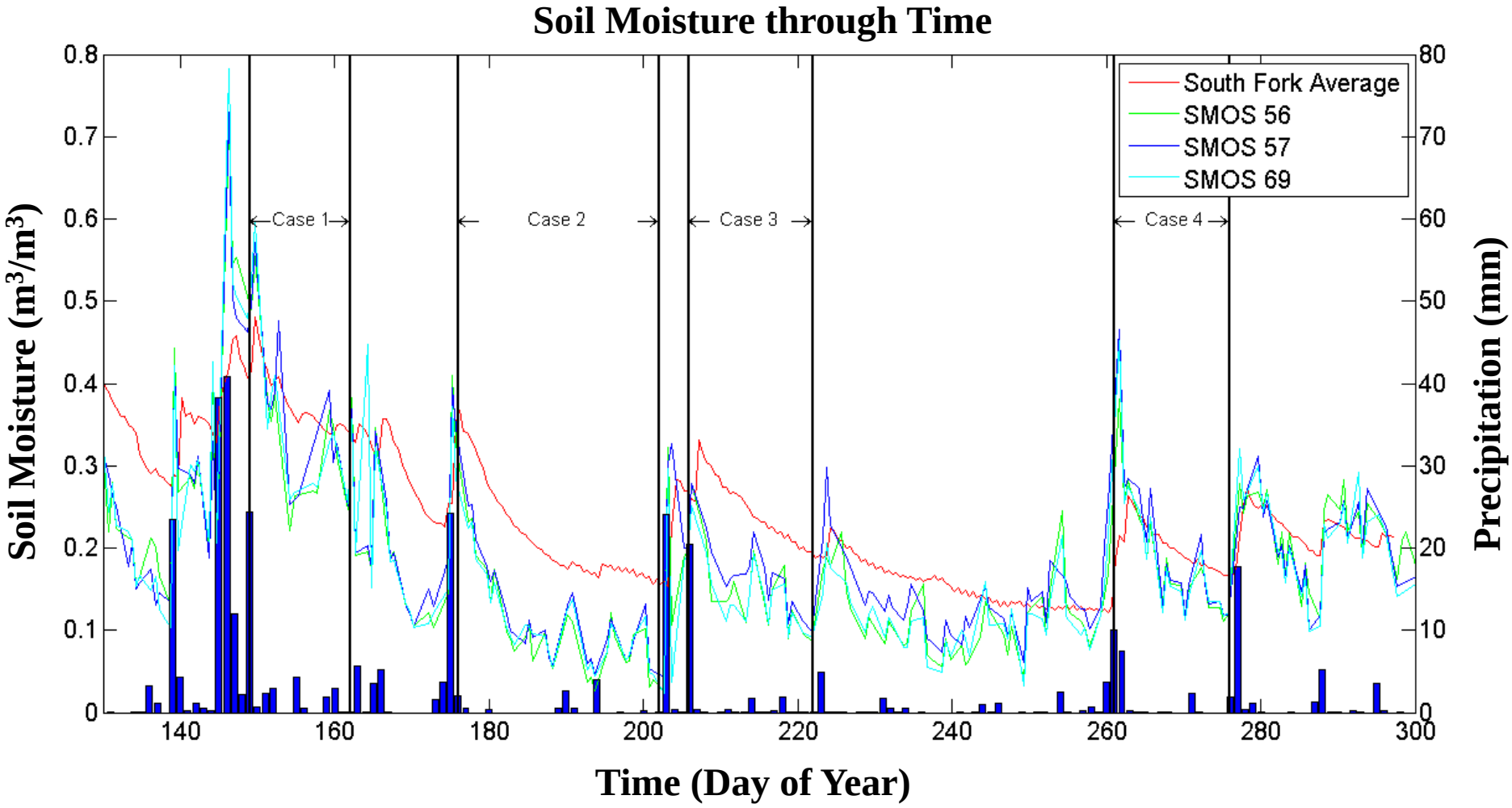
- Soil Moisture Changes Observed by the SMOS Satellite Will be Different than the Soil Moisture Changes of the South Fork Soil Moisture Network.

- The SMOS Satellite Measurements Will Have More Variability than the South Fork Soil Moisture Network.

Methods


Soil Moisture through Time
South Fork Average
SMOS 56
SMOS 57
SMOS 69
Soil Moisture (m3/m3)
Precipitation (mm)
Time (Day of Year)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
10
20
30
40
50
60
70
80
140
160
180
200
220
240
260
280
300
320

Methods


Soil Moisture through Time
Soil Moisture (m3/m3)
Precipitation (mm)
Time (Day of Year)
South Fork Average
SMOS 56
SMOS 57
SMOS 69
Case 1
Case 2
Case 3
Case 4
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
10
20
30
40
50
60
70
80
140
160
180
200
220
240
260
280
300

Numerical Analysis

- Exponential Fit

$$\hat{y} = Ae^{Bx} + C$$

- Rate of Soil Moisture Change

$$\frac{d\hat{y}}{dx} \approx ABe^{Bx}$$

- Residuals

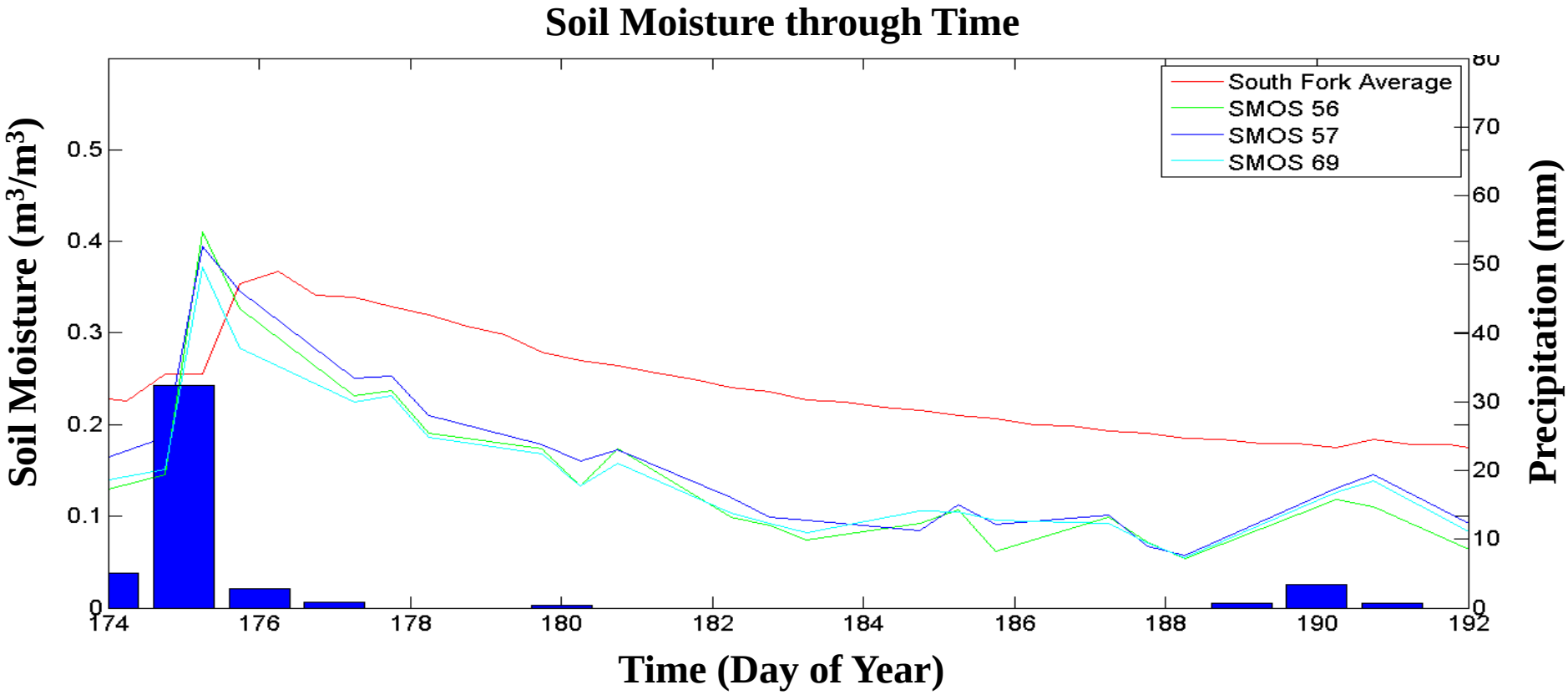
$$residuals = y - \hat{y}$$

y = Observed Values

$\hat{y}$ = Exponential Fit Values

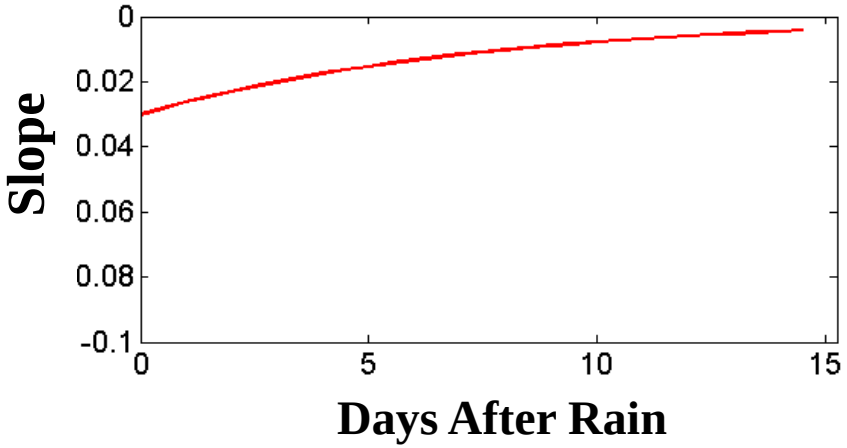
Results

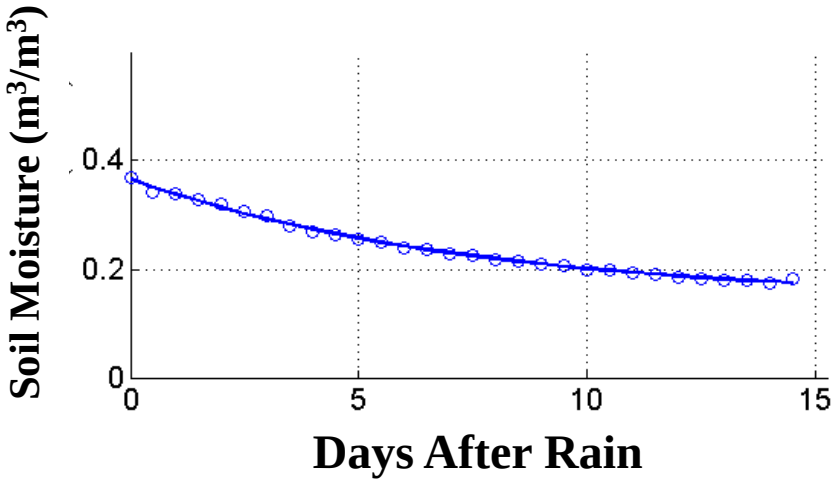
Case 2 (June 24th – July 10th)

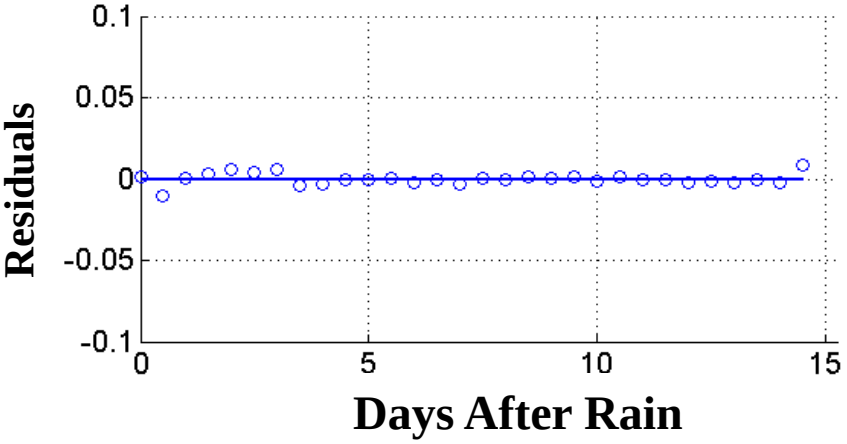


Case 2 (June 24th – July 10th)

South Fork

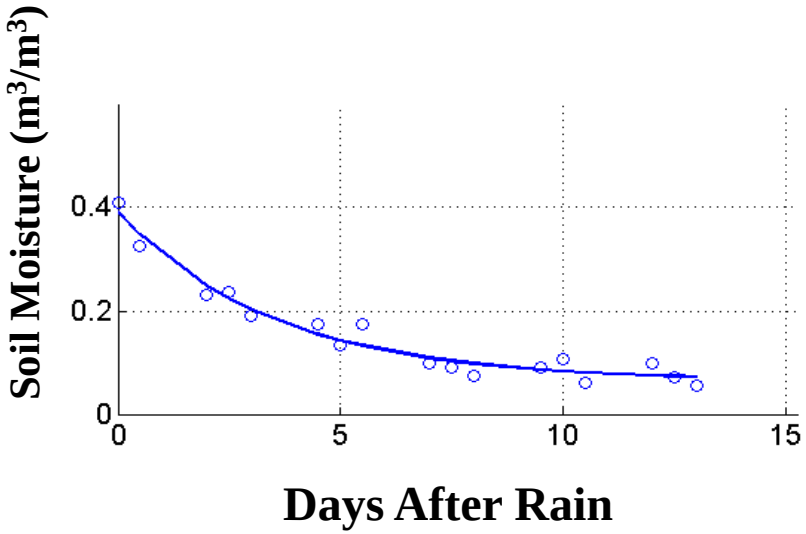


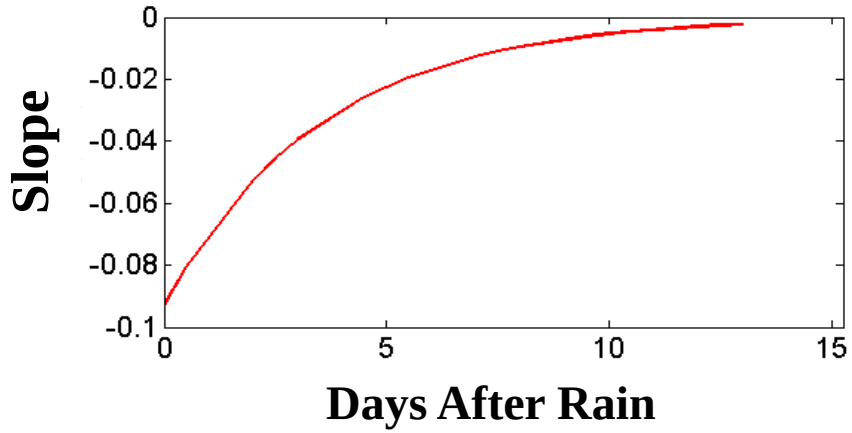


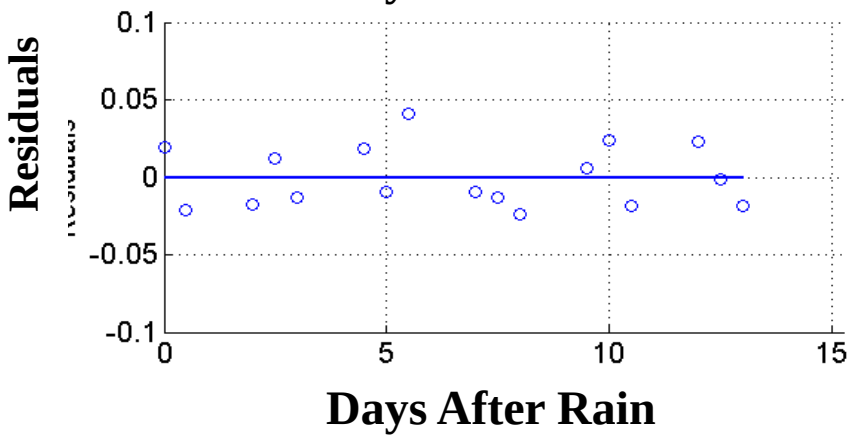


Case 2 (June 24th – July 10th)

Satellite







Numerical Analysis

Case 1	Slope (t=0)	Noise
Satellite	-0.121	0.028
South Fork	-0.042	0.008
Case 2	Slope (t=0)	Noise
Satellite	-0.093	0.019
South Fork	-0.030	0.003
Case 3	Slope (t=0)	Noise
Satellite	-0.074	0.021
South Fork	-0.020	0.004
Case 4	Slope (t=0)	Noise
Satellite	-0.040	0.020
South Fork	-0.018	0.002

Numerical Analysis

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Satellite	-0.040	0.020
South Fork	-0.018	0.002

Conclusion

- Satellite Observed Faster Rates of Soil Drying than South Fork Sites
- Satellite Values More Variable

Special Thank You

- Dr. Brian Hornbuckle
- Dr. Michael Cosh
- Jason Patton
- George Vardaxis