# Relationships between snow pack, soil moisture, and forest greenness: Implications for SMAP

By Jordan Anderson

Mentors: Dr. Noah Molotch[1] and Dr. Bin Guan[1]

CSU STAR

1: Jet Propulsion Laboratory, California Institute of Technology

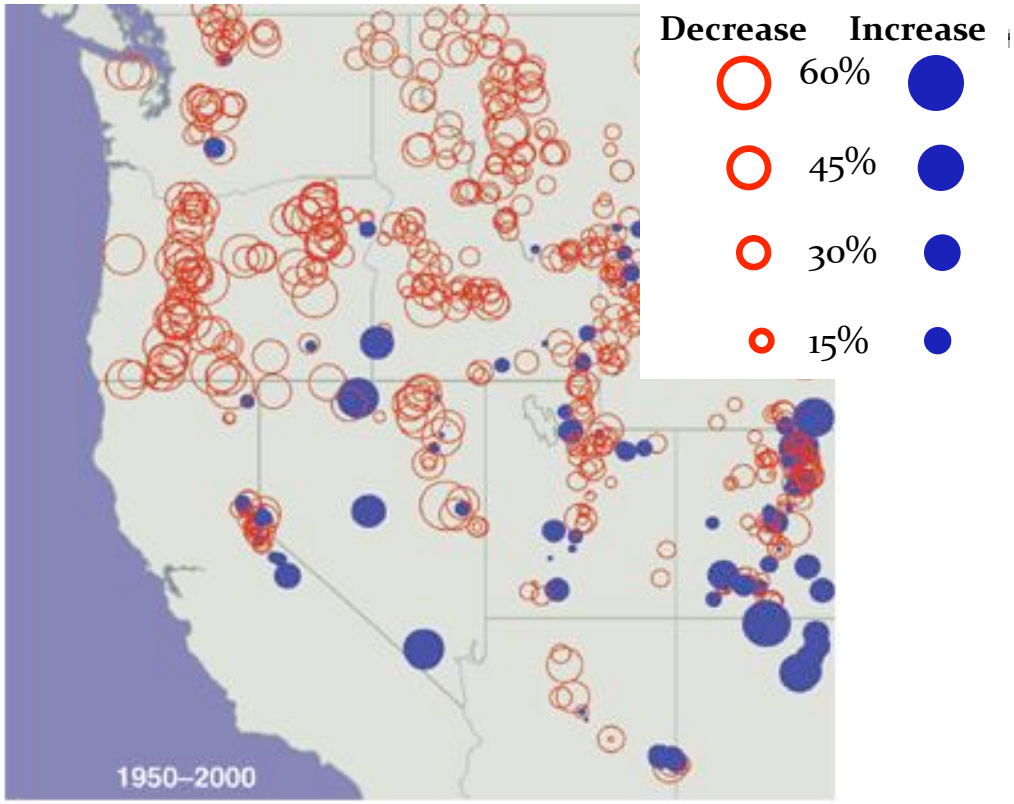
The SMAP mission has not been formally approved by NASA. The decision to proceed with the mission will not occur until the completion of the National Environmental Policy Act (NEPA) process. Material in this document related to SMAP is for information purposes only.

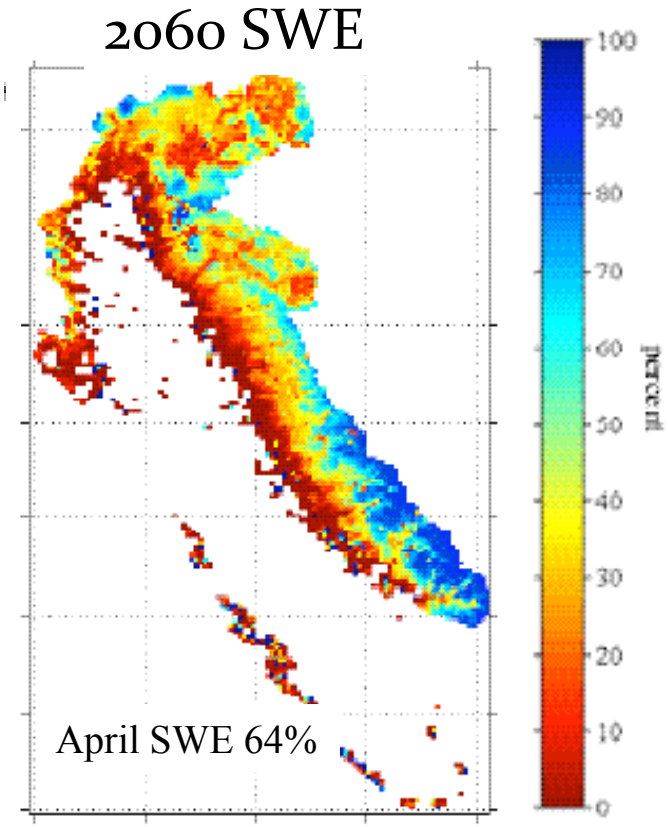
# Overview

- Background Information
- Motivation
- Investigations: Remotely Sensed and *In Situ*
- Regression Analysis of Remotely Sensed data
- *In Situ* Results (2)
- Conclusions
- Acknowledgements
- Disclaimer
- References


Source: P. Mote via Service, 2004

# Climate Variability: Impact on the Snowpack




Source: P. Mote via Service, 2004

Source: *Knowles and Cayan, 2002*

# Snow-Vegetation Interactions

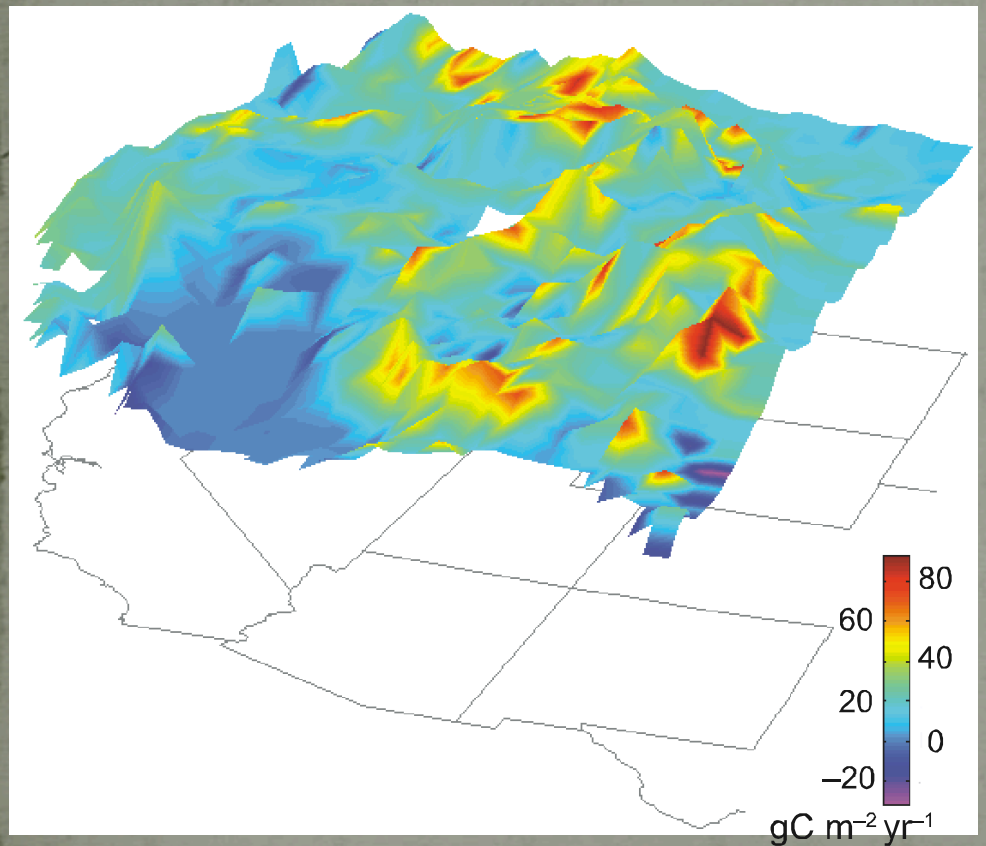



Image depicts net ecosystem exchange of grams of carbon per year

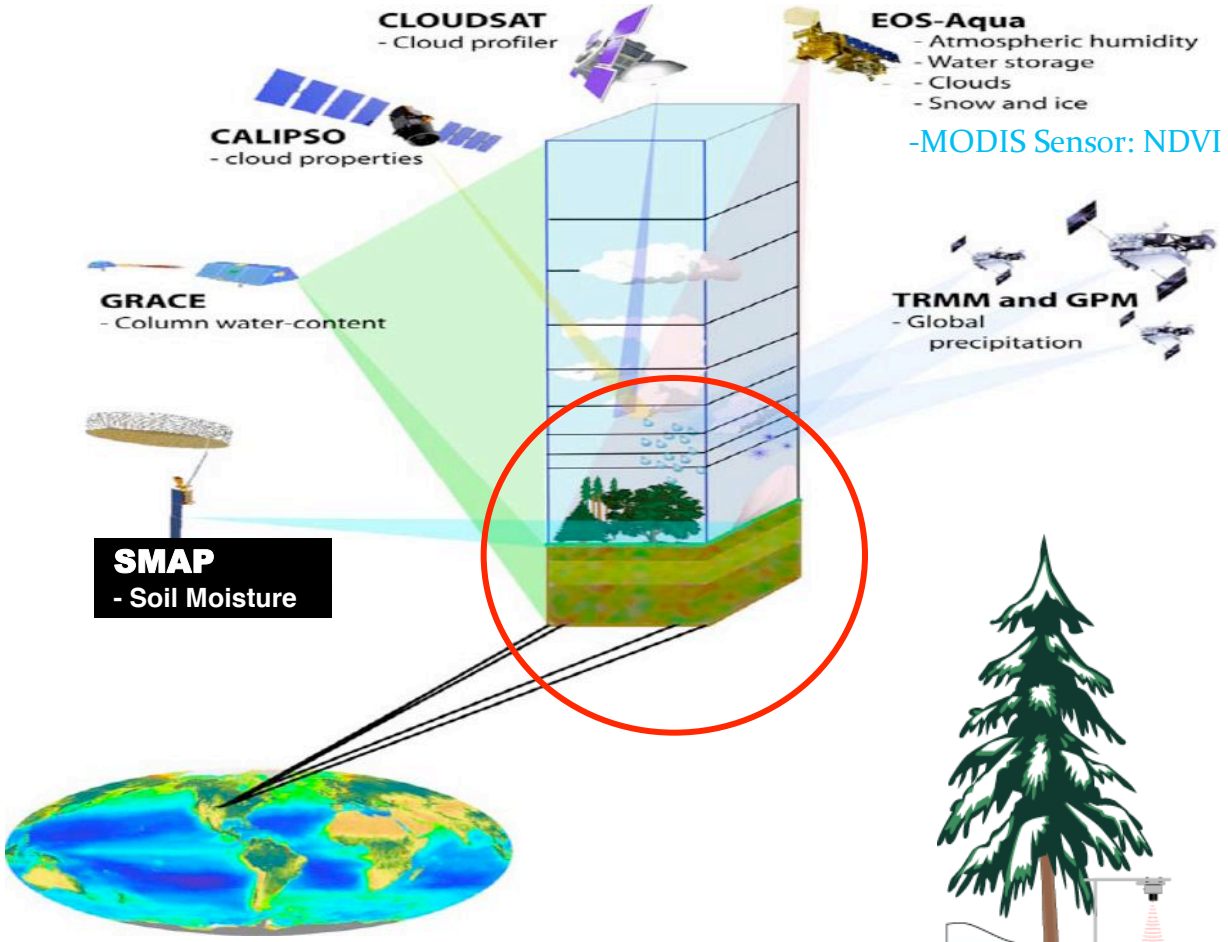
High Elevation = High Carbon Density

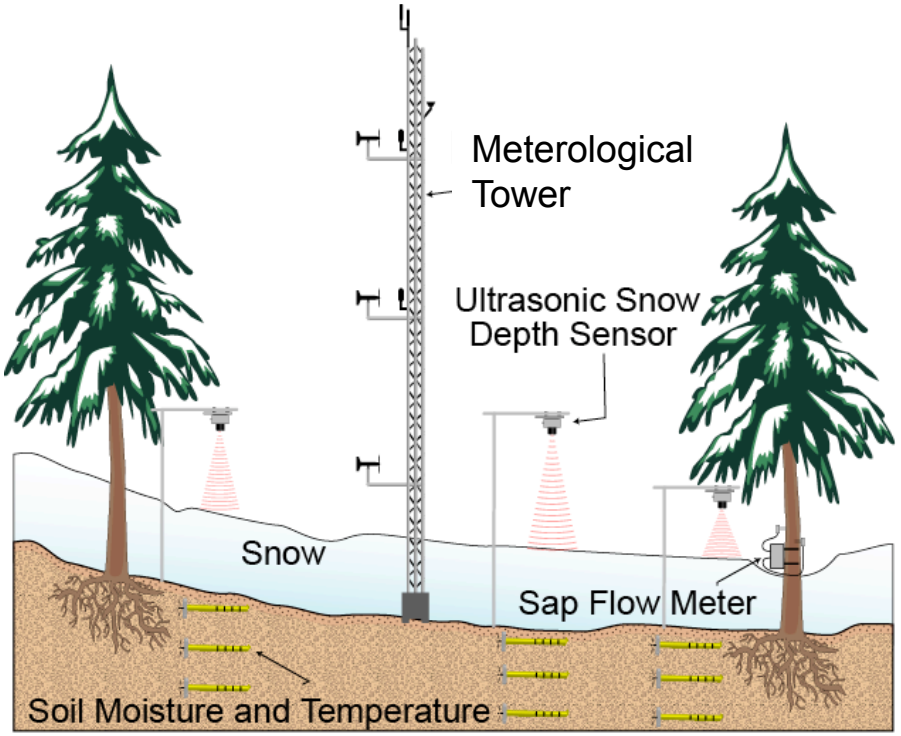
Schimel et al., 2002

# Motivation

- Snowpack in the arid/semi-arid western United States is a critical element of the hydrologic cycle as water is stored in the winter and released in the spring and summer
- The warmer seasons rely heavily on this water source for various purposes
- Low and mid-elevation forests are most sensitive to climate change

# Investigations

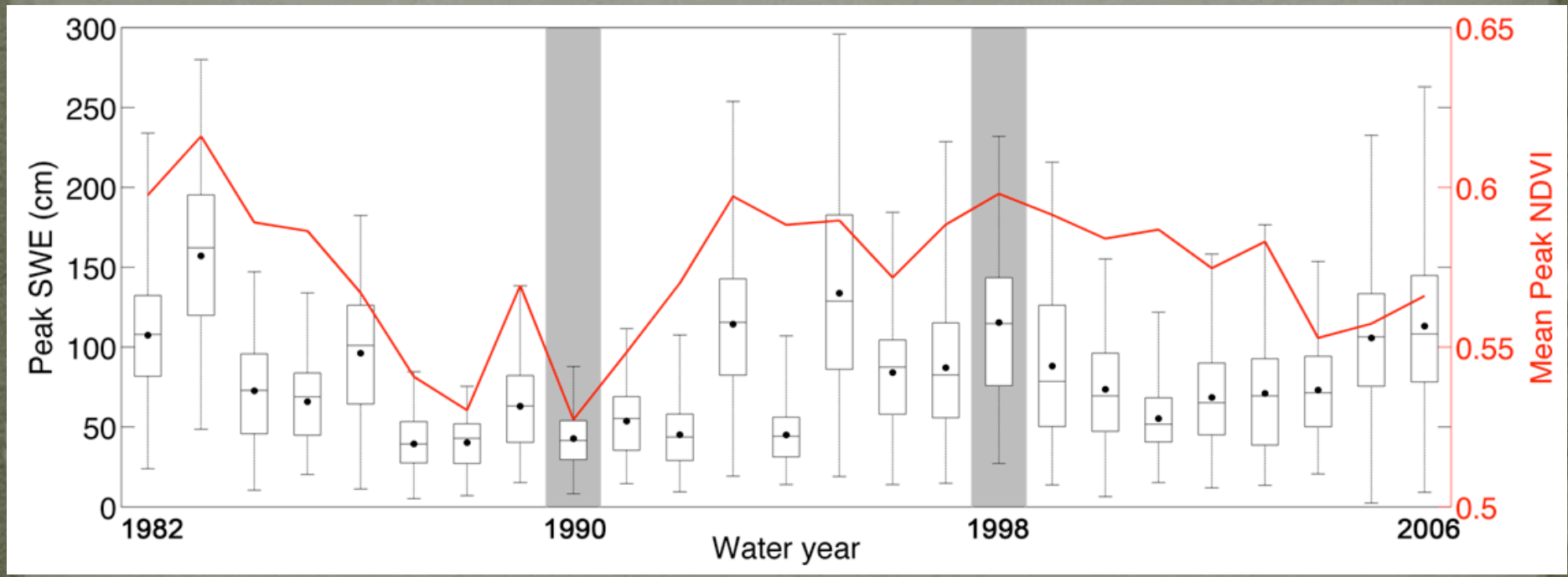


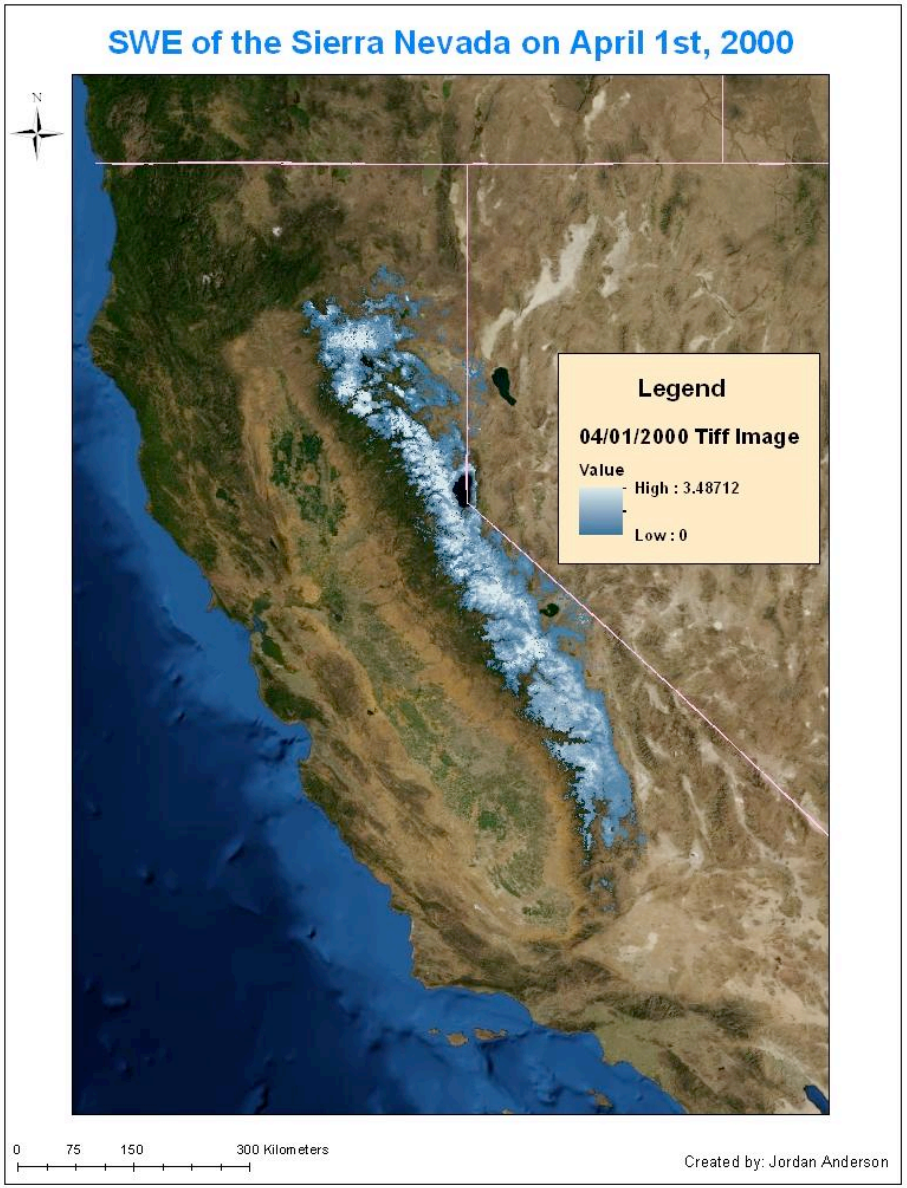

Source: JPL/NASA

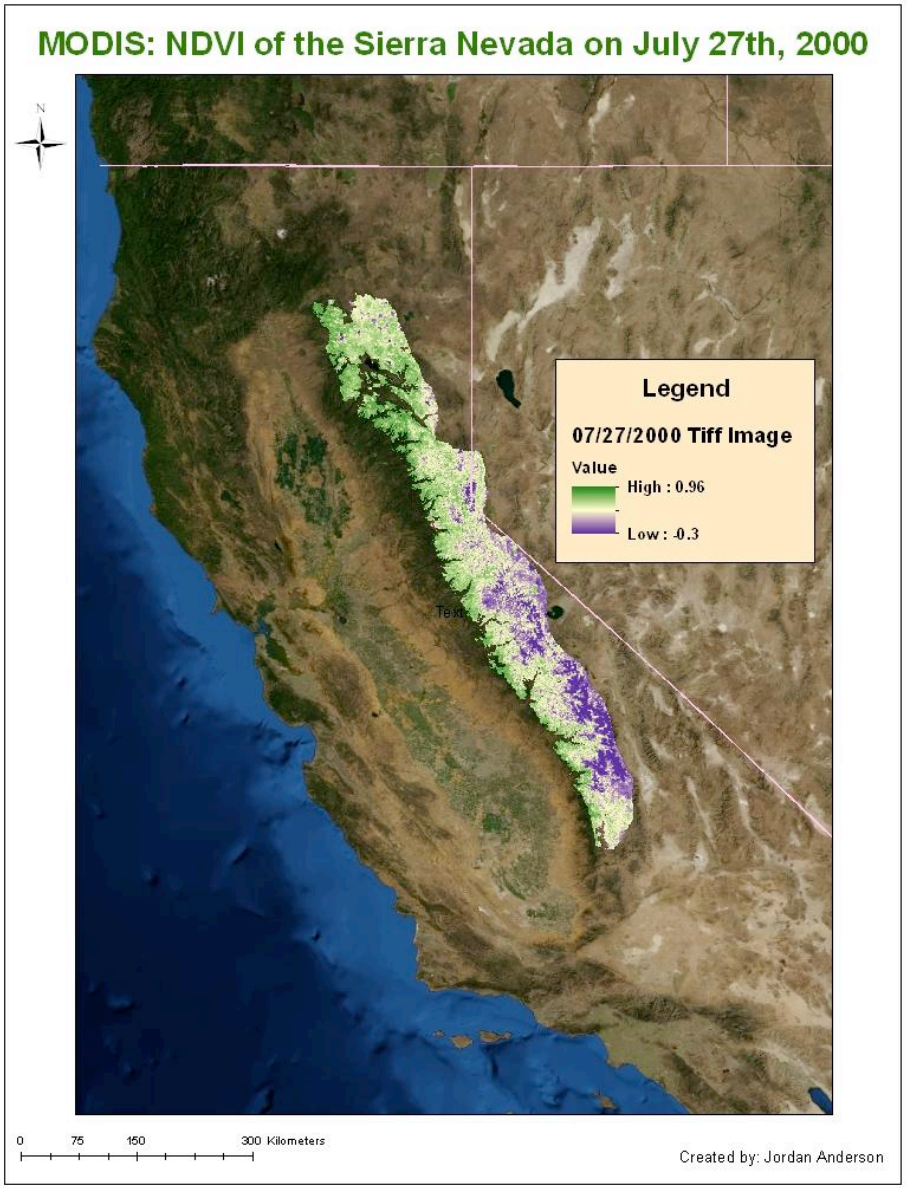
# Ordinary Least Squares Regression Hypothesis

- We expect a correspondence between winter snowpack with spring greenness.



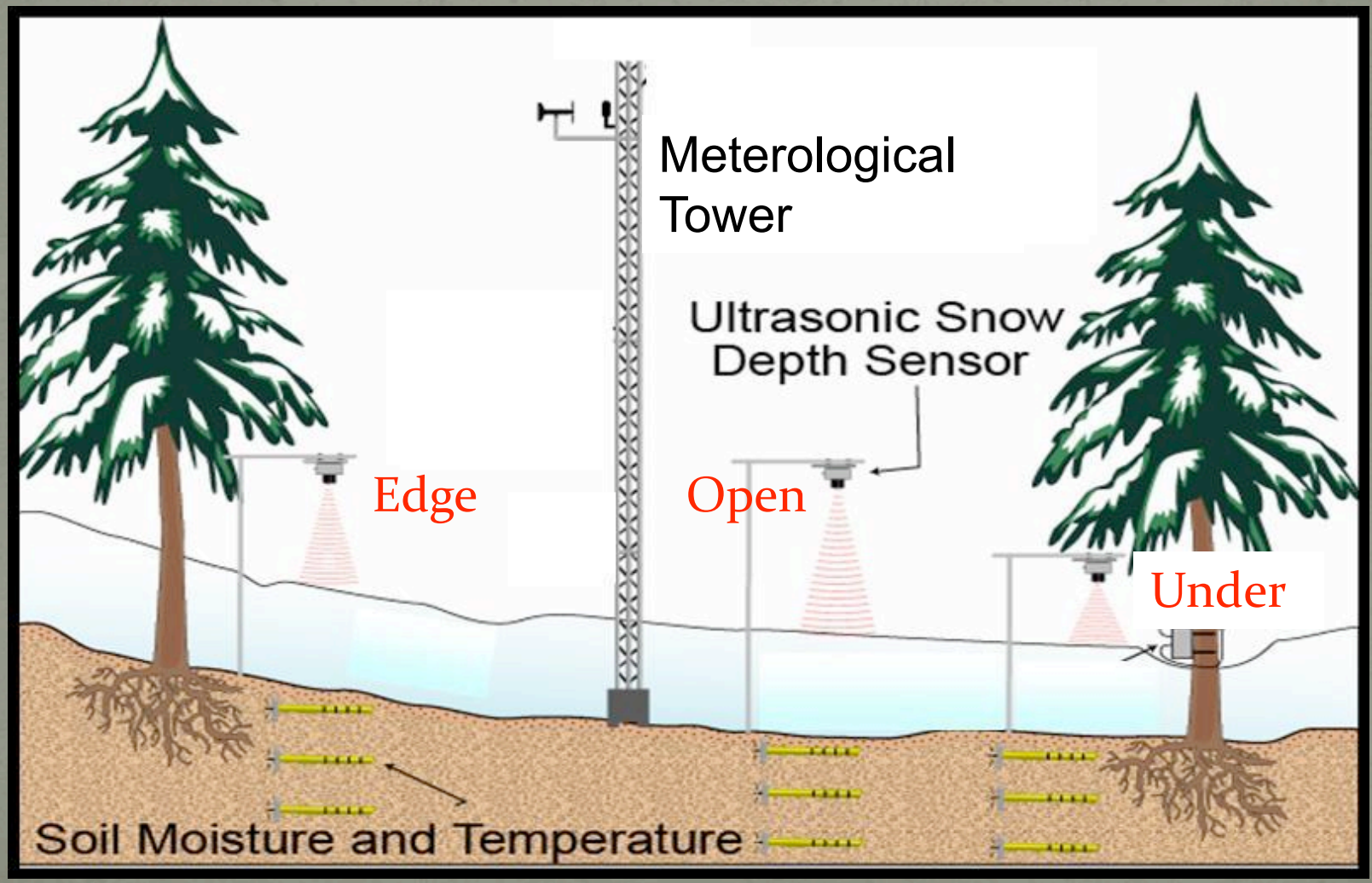

Source: Trujillo et al., in revision – Nature Geoscience




Result: Adjusted R-Squared of 29.67

# *In Situ* Investigation



# *In Situ* Hypotheses

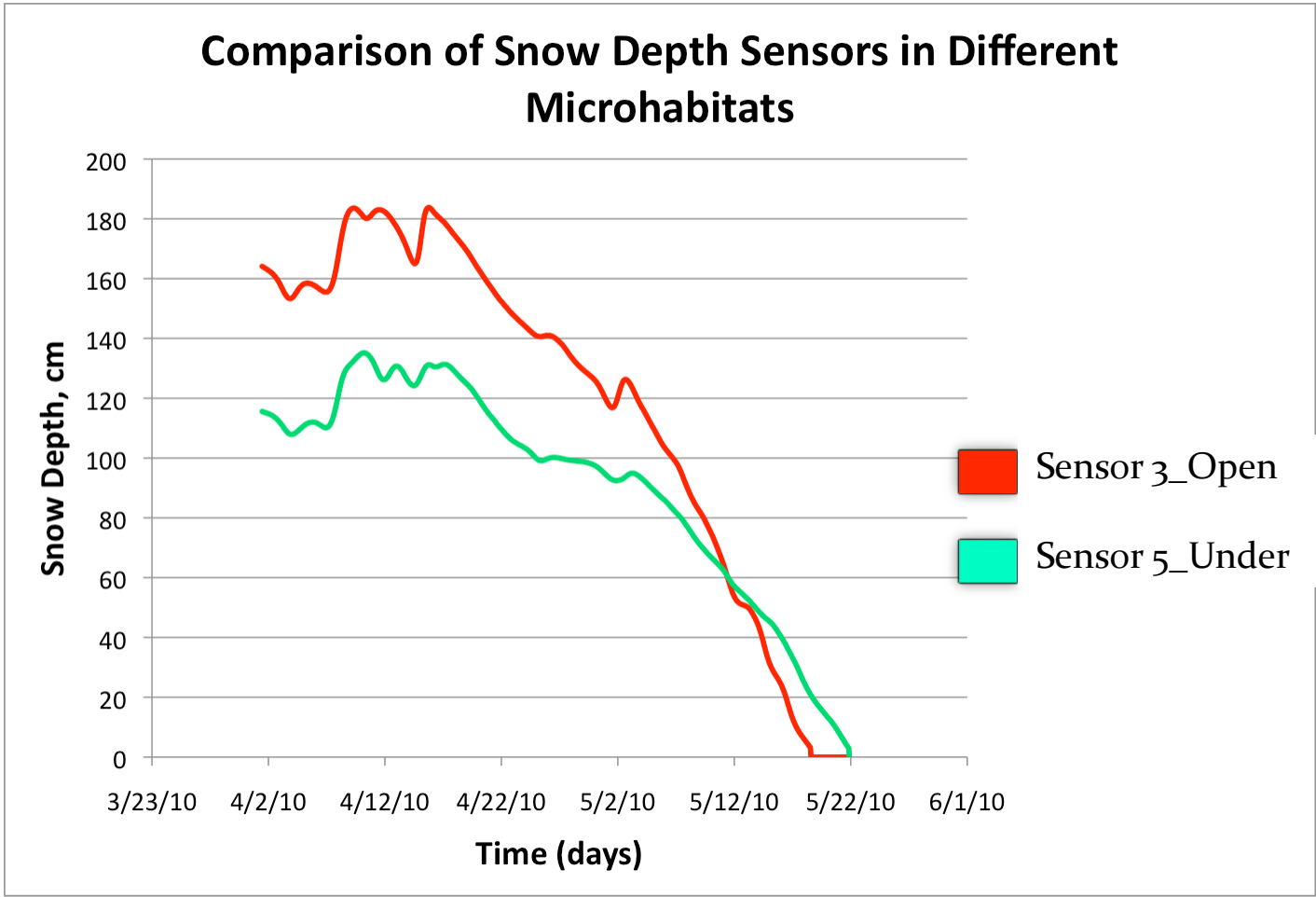
- 1) The snow “open” microhabitat (mh) will have a steeper slope than the “under” snow mh.

- 2) Snow ablation will occur earlier in the year than soil moisture ablation.

# *In situ* Hypothesis

1) The snow “open” microhabitat (mh) will have a steeper slope than the “under” snow mh.

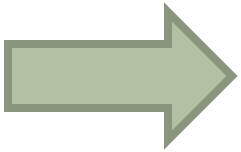
## Result

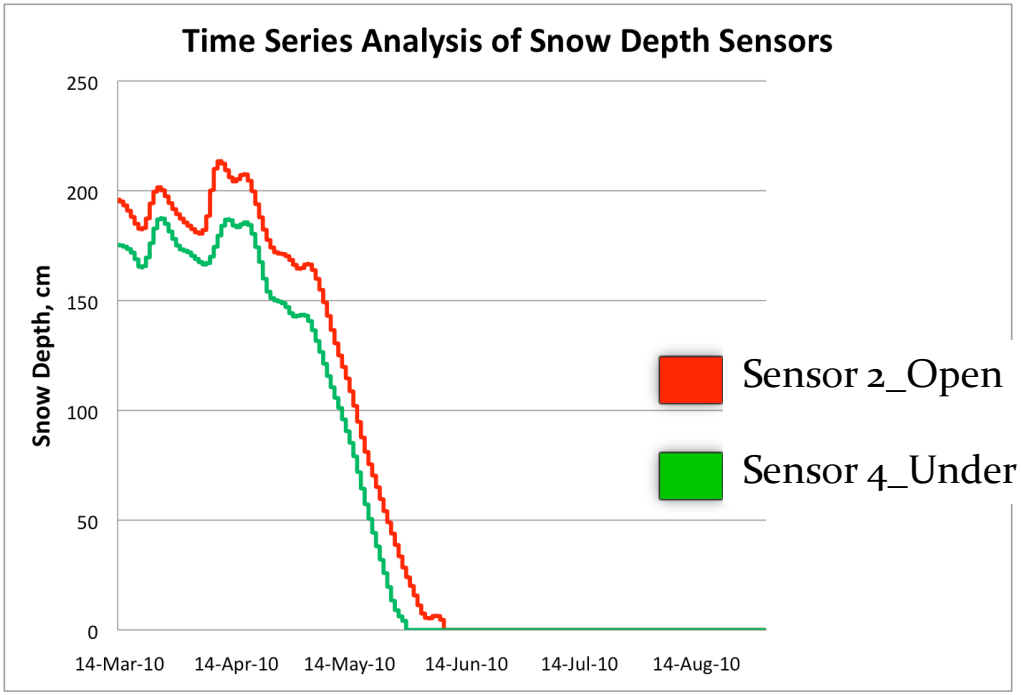


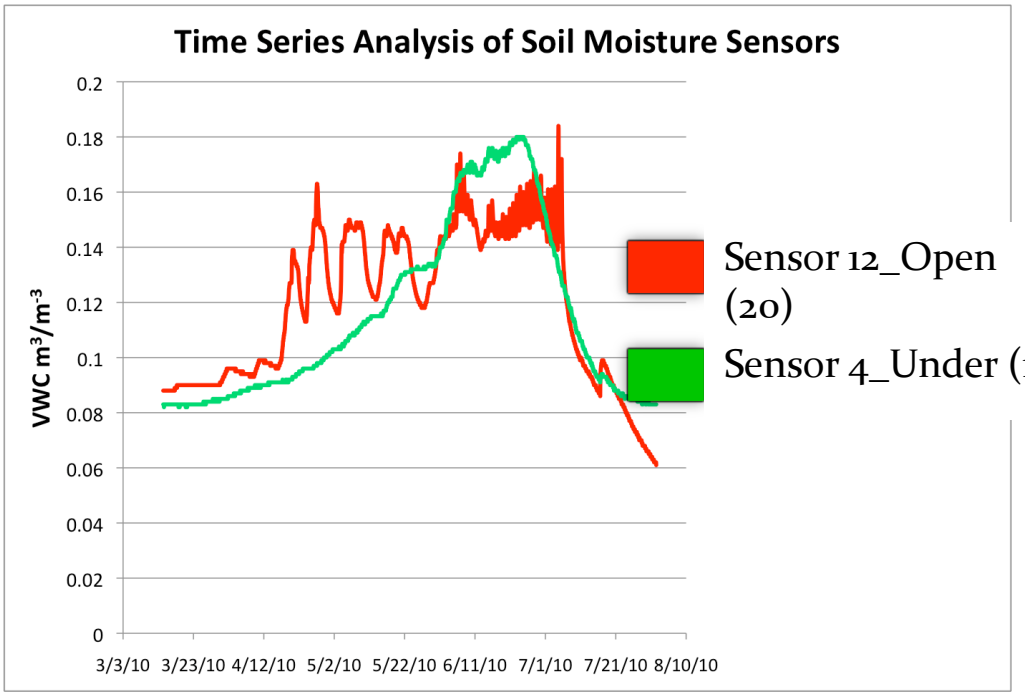
# *In situ* Hypothesis

- 2) Snow ablation will occur earlier in the year than soil moisture ablation.

# Result: Comparison of time trajectory

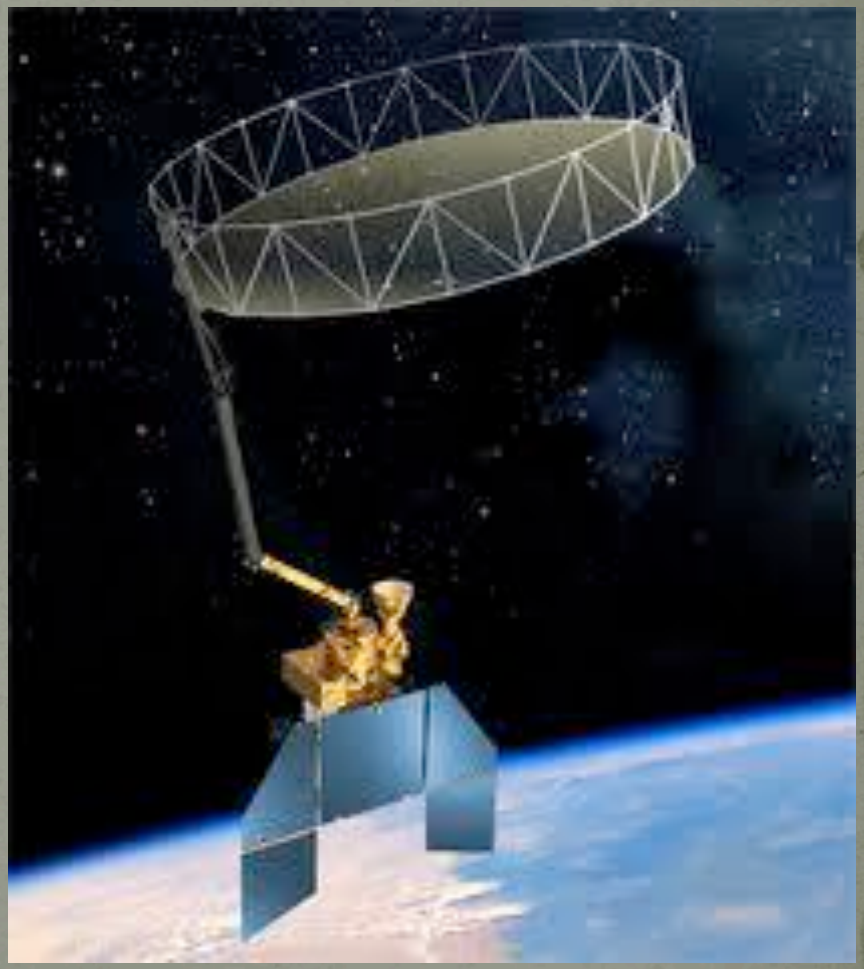




# Conclusions

- Snow depth and soil moisture are affected by changes in microhabitat
- Snow and soil moisture ablation are synchronized
- *In situ* analysis is needed to add utility to SMAP

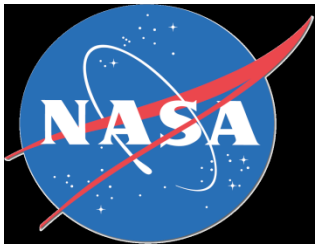


Source: JPL/NASA

# Acknowledgments


- Dr. Noah Molotch
- Dr. Bin Guan
- Martin Mathews
- Dr. Gerry Simila
- Petra Kneissl-Milanian
- JPL Education Office
- Dr. Bryan Rebar
- STAR Program & Staff
- NASA and JPL
- SMAP
- National Science Foundation
- Bechtel Foundation
- California State University Fresno
- SMEC Office at Fresno State










# Disclaimer


- This material is based upon work supported by the S.D. Bechtel, Jr. Foundation and by the National Science Foundation under Grant No. 0952013 and Grant No. 0934967. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the S.D. Bechtel, Jr. Foundation or the National Science Foundation.

# References


- Knowles, N. and D. R. Cayan. 2002. Potential effects of global warming on the Sacramento/San Joaquin watershed and the San Francisco estuary. Geophysical Research Letters **29**:38-31.
- Schimel, D., T. Kittel, S. Running, R. Monson, A. Turnispeed, and D. Anderson. 2002. Carbon sequestration studied in western US mountains. EOS Transactions **83**:445.
- Service, R. F. 2004. Water resources: As the West goes dry. science **303**:1124-1127.
- Trujillo et al., in revision – Nature Geoscience


- Image References:
- Farming image:
  http://www.google.com/imgres?q=farming&hl=en&biw=2560&bih=1457&gbv=2&tbm=isch&tbnid=Dm2QsUssCgPe8M:&imgrefurl=http://www.matternetwork.com/2008/10/week3.cfm&docid=WoHSKBSR9v1qBM&w=474&h=480&ei=Td1CTpW8BoneiAKG3uTFBQ&zoom=1&iact=rc&dur=367&page=1&tbnh=133&tbnw=132&start=0&ndsp=122&ved=1t:429,r:15,s:0&tx=79&ty=84
- Mountain Stream Image:
  http://www.google.com/imgres?q=mountain+stream&hl=en&gbv=2&biw=2560&bih=1457&tbm=isch&tbnid=gHVLo9mWueeq1M:&imgrefurl=http://www.mlewallpapers.com/view/4x3-Standard-Screen-2/High-Country-Mountain-Stream-I-161.html&docid=LNBg_hKvxIKbAM&w=1601&h=1200&ei=wt1CTuqXOujkiAKwq4CUBQ&zoom=1&iact=rc&dur=161&page=1&tbnh=129&tbnw=172&start=0&ndsp=125&ved=1t:429,r:21,s:0&tx=74&ty=81
- Lake recreation Image:
  http://www.google.com/imgres?q=lake+recreation&hl=en&gbv=2&biw=2560&bih=1457&tbm=isch&tbnid=tV4T7bVMfUhvtM:&imgrefurl=http://www.mikewochner.com/Big_Bear_Lake_Recreation/page_1980711.html&docid=P8wAZVdbJ3pOiM&w=271&h=217&ei=9d1CTvOEAsTfiAKz06XCBQ&zoom=1&iact=hc&vpx=396&vpy=267&dur=385&hovh=169&hovw=211&tx=127&ty=61&page=1&tbnh=142&tbnw=181&start=0&ndsp=117&ved=1t:429,r:13,s:0