EMERGE Project

Environmental Characterization of Mosquito Habitats in Florida

Connecting Libraries, Educators & Communities through Remote Sensing

Dr. Yichan Li
Dr. Di Yang, GeoDI Laboratory
Dr. Caroline Nickerson, Olivia Zhang, Ashley Hays

September 2025
Department of Geography, University of Florida

Study Objectives & Significance

Research Questions:

- What environmental conditions characterize mosquito habitats in Florida?
- How variable are these conditions across different sites?
- What patterns emerge for mosquito habitat management?

Why This Matters:

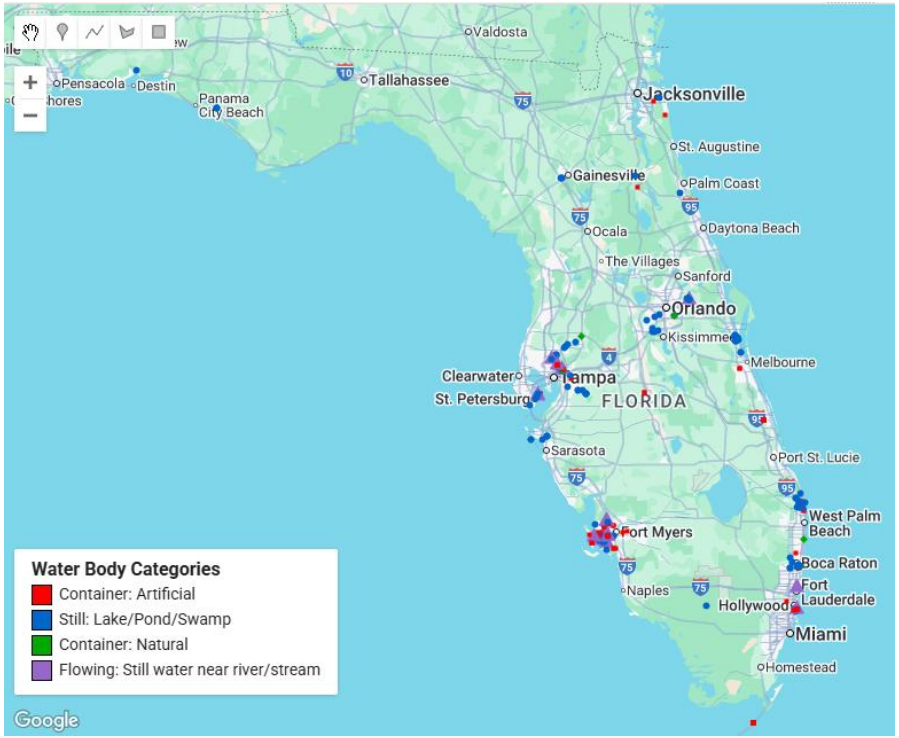
- Public Health: Understanding breeding habitat conditions for vector control
- Climate Change: Environmental variability and mosquito adaptation
- Management: Data-driven approaches to habitat

Key Innovation:

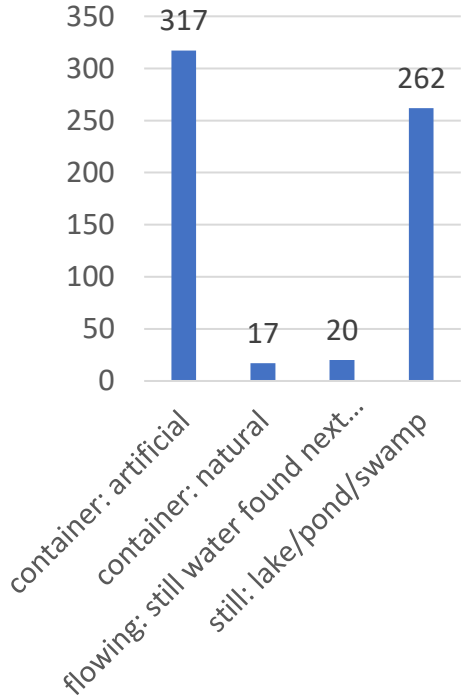
- Comprehensive multi-variable environmental analysis
- Large-scale spatial coverage (616 sites statewide)
- Integration of climate, soil, and vegetation data

Citizen Science Data – Mosquito Habitats

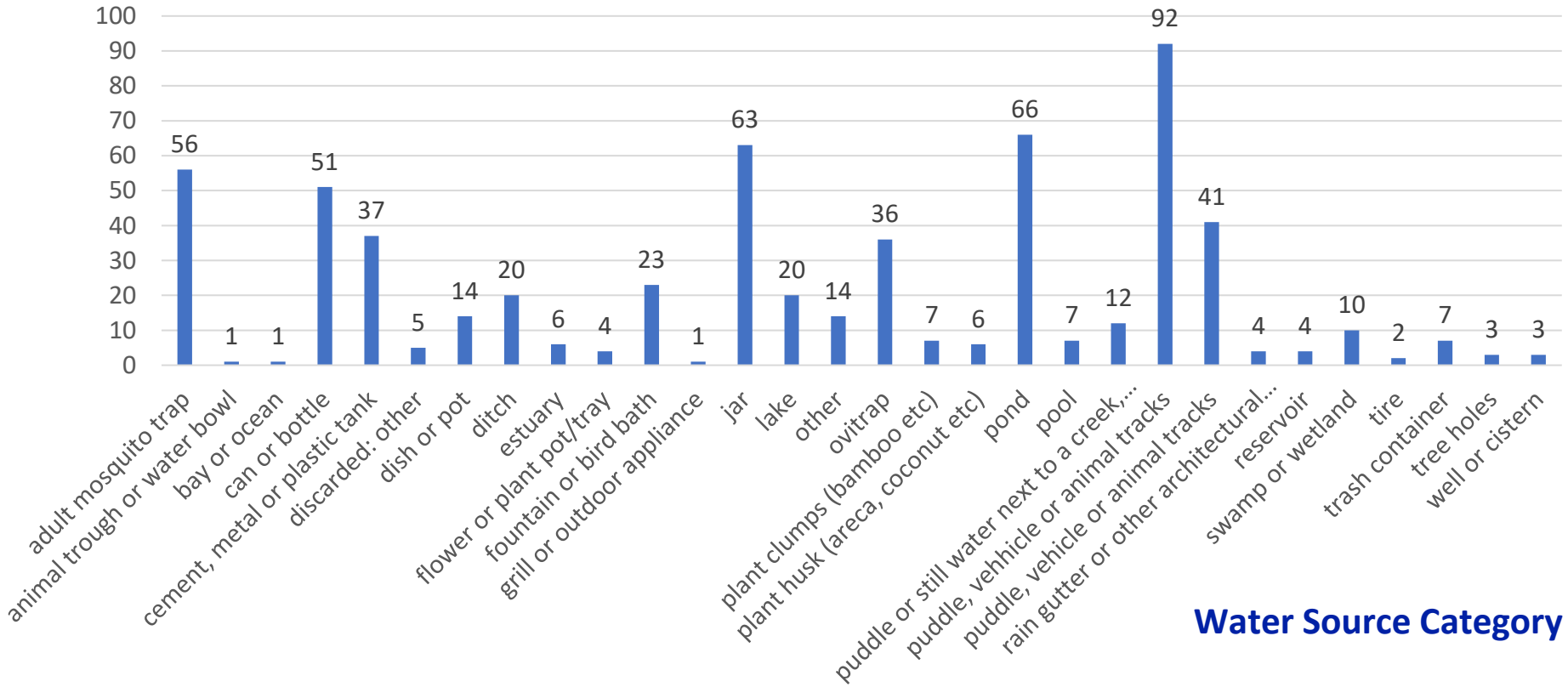
2018-2024 Sample Distribution (616 sites)



Water Source



Citizen Science Data – Mosquito Habitats



NASA Earth Observations

Earth Science Missions

Key Satellite Missions

SMAP
Soil Moisture Active Passive

GPM
Global Precipitation Measurement

MODIS
Moderate Resolution Imaging Spectroradiometer

Landsat
Land Remote-Sensing Satellite

ECOSTRESS
ECOsystem Spaceborne Thermal Radiometer

PACE
Plankton, Aerosol, Cloud, ocean Ecosystem

Key Environmental Variables

Atmospheric

- Air temperature
- Precipitation
- Humidity
- Air pressure

Source: DAYMET_V4, ERA5_LAND

Surface

- Soil moisture
- Soil temperature
- Surface temperature
- Soil pH

Source: SMAP, MODIS, OpenLandMap

Aquatic

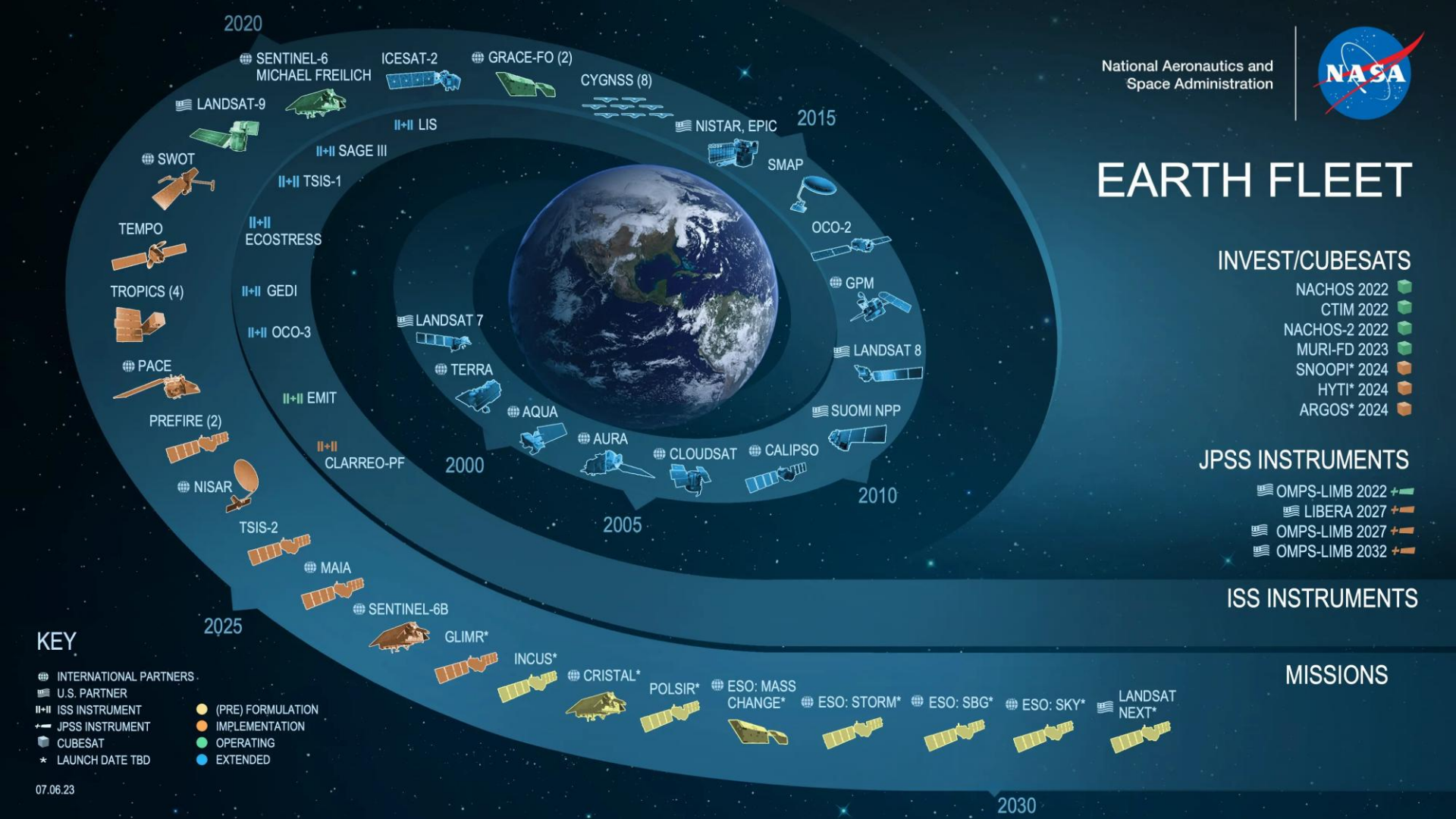
- Water temperature
- Water clarity

Source: Landsat, MODIS

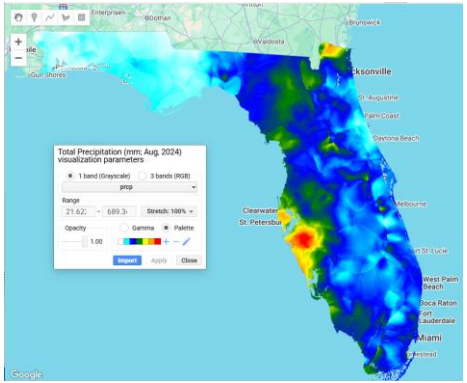
Land Cover

- Vegetation type
- Canopy coverage
- Vegetation health
- Land use changes

Source: Sentinel, MODIS

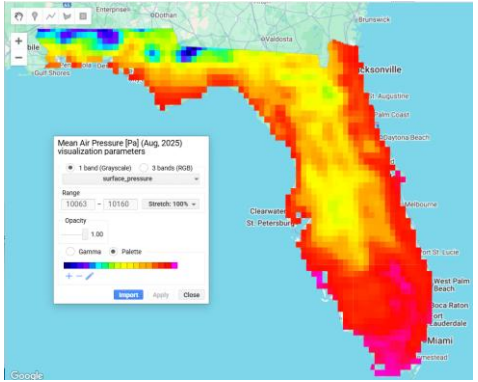

National Aeronautics and Space Administration
NASA
EARTH FLEET
2020
SENTINEL-6 MICHAEL FREILICH
ICESAT-2
GRACE-FO (2)
CYGNSS (8)
LANDSAT-9
II+II LIS
NISTAR, EPIC
2015
II+II SAGE III
SWOT
II+II TSIS-1
SMAP
TEMPO
II+II ECOSTRESS
OCO-2
TROPICS (4)
II+II GEDI
GPM
LANDSAT 7
II+II OCO-3
LANDSAT 8
PACE
TERRA
SUOMI NPP
II+II EMIT
AQUA
PREFIRE (2)
AURA
CLOUDSAT
CALIPSO
II+II CLARREO-PF
2000
2010
NISAR
TSIS-2
2005
MAIA
SENTINEL-6B
2025
GLIMR*
INCUS*
CRISTAL*
POLSIR*
ESO: MASS CHANGE*
ESO: STORM*
ESO: SBG*
ESO: SKY*
LANDSAT NEXT*
2030
INVEST/CUBESATS
NACHOS 2022
CTIM 2022
NACHOS-2 2022
MURI-FD 2023
SNOOPI* 2024
HYTI* 2024
ARGOS* 2024
JPSS INSTRUMENTS
OMPS-LIMB 2022
LIBERA 2027
OMPS-LIMB 2027
OMPS-LIMB 2032
ISS INSTRUMENTS
MISSIONS
KEY
INTERNATIONAL PARTNERS
U.S. PARTNER
II+II ISS INSTRUMENT
+ JPSS INSTRUMENT
CUBESAT
* LAUNCH DATE TBD
(PRE) FORMULATION
IMPLEMENTATION
OPERATING
EXTENDED
07.06.23

Data Source



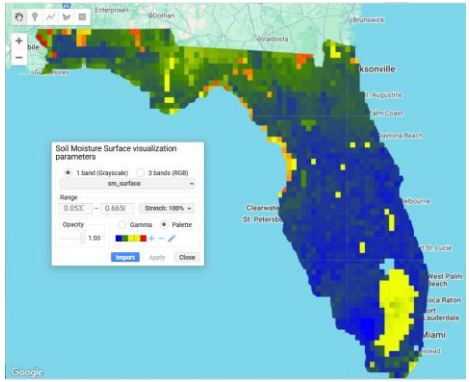
Daymet V4 (1km):

- **Precipitation**
- **Aire temperature**
- **Relative humidity**



ERA5_Land (11km):

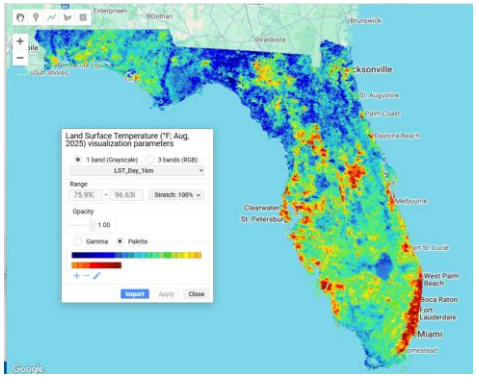
- **Air pressure**



SMAP (9km):

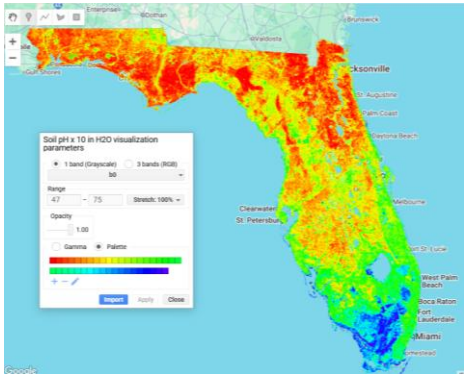
- **Surface soil moisture**

Data Source



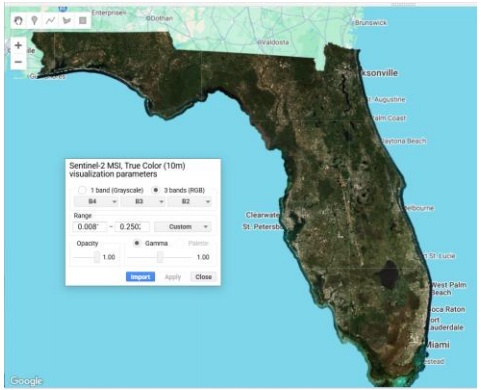
MODIS (1km):

- Land surface temperature
- Water temperature
- Water clarity



OpenLandMap (250m):

- Soil pH in H2O



Harmonized Sentinel-2 MSI (10m):

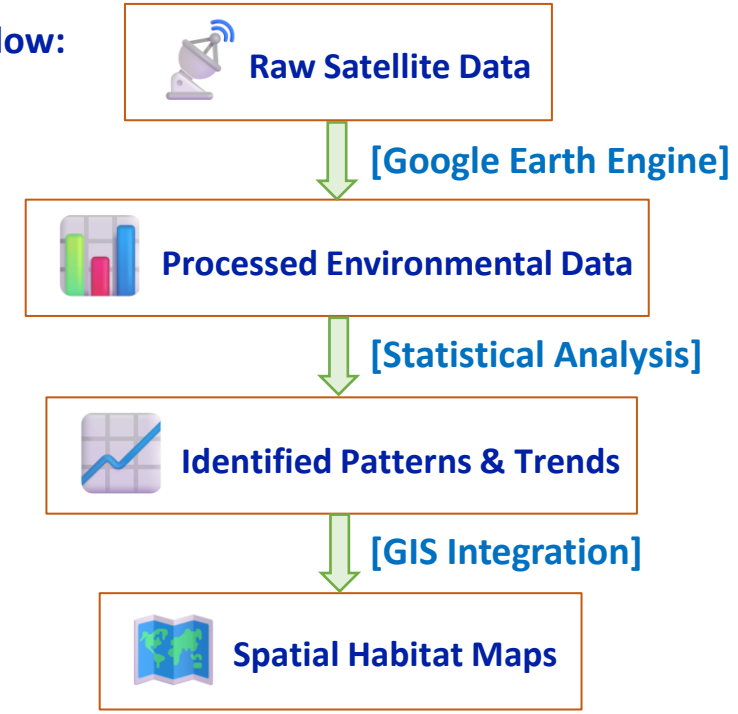
- NDVI - Normalized Difference Vegetation Index
- NDWI - Normalized Difference Water Index
- Canopy coverage percent

Research Framework & Data Quality

Study Strengths:

- Complete climate coverage enables robust temperature/humidity analysis
- High soil data completeness (>70%) supports habitat chemistry conclusions
- Large sample size (616 sites) ensures statistical power

Workflow:



Data Quality:

Variable Category	Completeness	Sample Size	Data Quality
Climate Variables	100%	616/616 sites	✅ Excellent
Vegetation Health	60-67%	368-415/616 sites	✅ Good
Soil Properties	70-97%	432-598 sites	✅ Very Good

Atmospheric Variables – Florida Mosquito Habitats (616 sites)

Key Findings:

🌡️ **Temperature Patterns:**

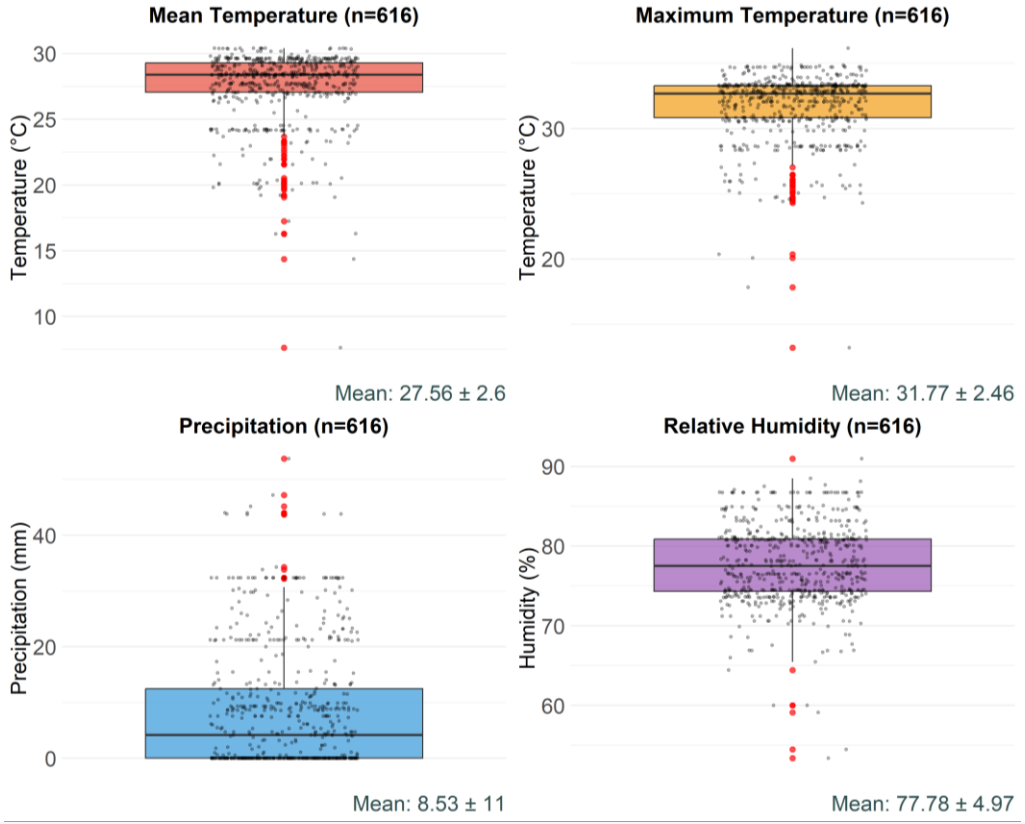
- **Mean Temperature:** 27.6°C ± 2.6
- **Range:** 7.6°C - 30.4°C (22.8°C span)
- Wide temperature tolerance indicates diverse microhabitats

☔ **Precipitation Variability:**

- **Mean:** 8.5mm ± 11.0mm
- **Range:** 0 - 53.7mm
- Seasonal and spatial breeding cycle variation

💧 **Humidity Conditions:**

- **Mean:** 77.8% ± 5.0%
- **Range:** 53.4% - 91.0%
- Consistently high humidity supports subtropical mosquito species



Surface Variables – Florida Mosquito Habitats

Key Findings:

Soil Chemistry:

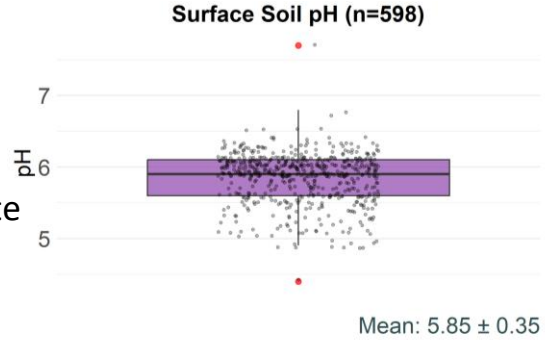
- **Surface pH:** 5.85 ± 0.34 (slightly acidic)
- **pH Range:** 4.4 - 7.7
- **Consistency:** Low variability suggests similar substrate types

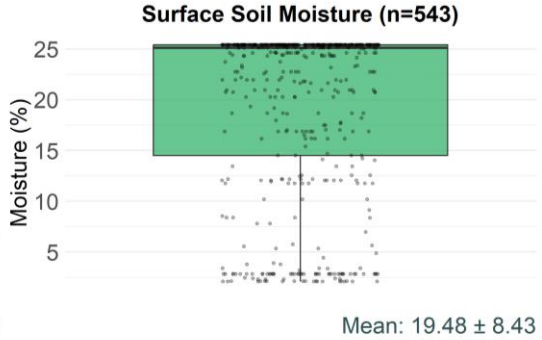
Moisture Patterns:

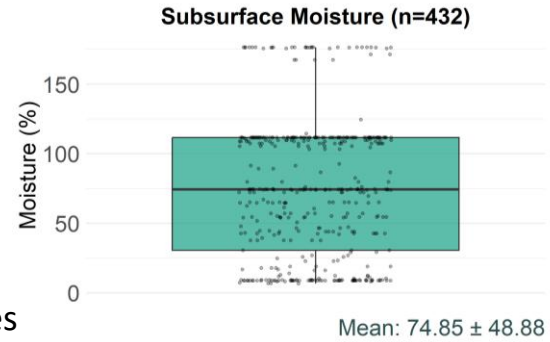
- **Surface Moisture:** 19.5% ± 8.4%
- **Subsurface Moisture:** 74.9% ± 48.8%
- **High subsurface variability:** Indicates diverse soil drainage conditions

Breeding Implications:

- Optimal pH range (5.5-6.5) for most mosquito species
- Adequate moisture for larval development
- Consistent chemistry reduces species-specific limitations







Land Cover Variables – Florida Mosquito Habitats

Key Findings:

🌿 Vegetation Health:

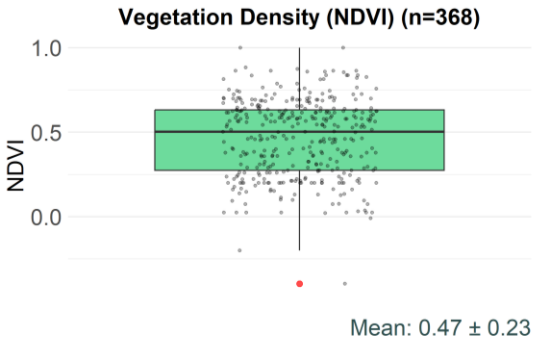
- **NDVI:** 0.49 ± 0.23 (moderate vegetation density)
- **NDWI:** -0.43 ± 0.19 (mainly terrestrial/vegetated areas with low water content)

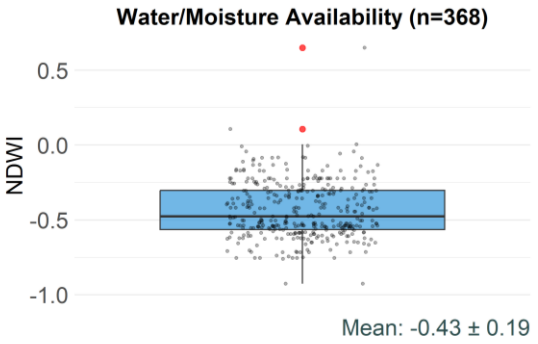
🌳 Canopy Coverage:

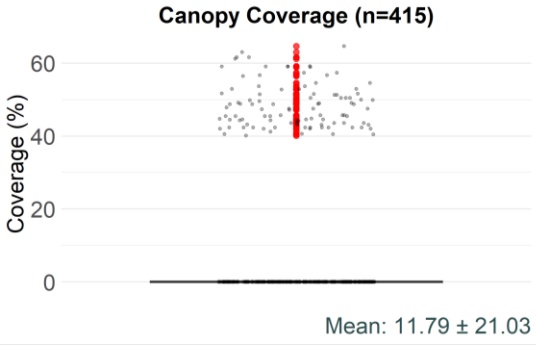
- **Mean Coverage:** 11.79% ± 21.03%
- **Range:** 0% - 60% (high variability)
- Most sites show sparse to moderate canopy cover

🌻 Microhabitat Diversity:

- Low mean canopy = sun-exposed breeding sites
- High variability = diverse shade/sun gradient
- Mixed conditions support multiple species



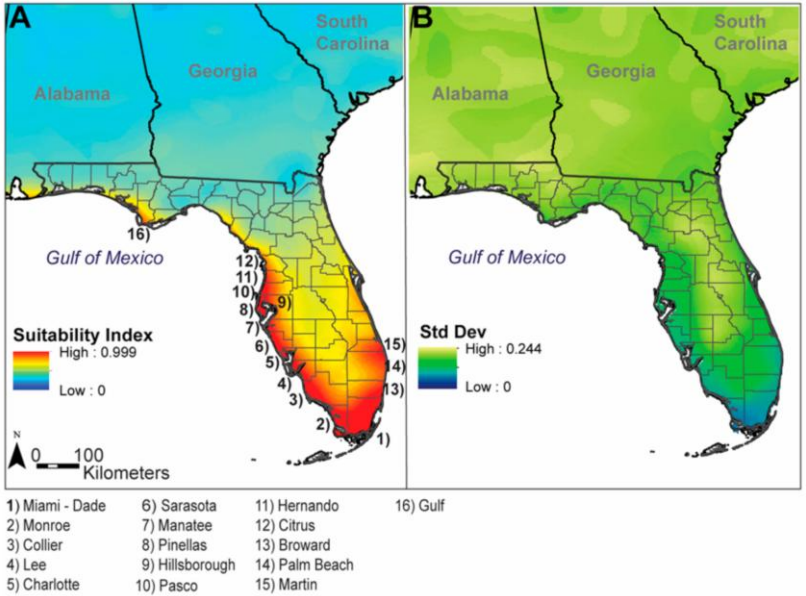




https://data.globe.gov/system/photos/2022/06/03/2886457/original.jpg
https://data.globe.gov/system/photos/2022/07/12/2949679/original.jpg

Variable Validation & Model Support

- **Temperature ranges** (27.6°C ± 2.6) fall within suitable conditions for neotropical mosquito species.
- **High humidity** (77.8% ± 5.0%) supports subtropical mosquito habitat requirements.
- **Soil moisture variability** indicates diverse microhabitats suitable for multiple species.
- **Mixed vegetation conditions** provide the environmental heterogeneity needed for vector establishment.
- 616 sample points across Florida capture the environmental gradients critical for mosquito surveillance.



Model projection of **predicted suitability** for Ae. scapularis in Florida and surrounding states (Campbell et al, 2021)

Campbell, Lindsay P., Nathan D. Burkett-Cadena, Evaristo Miqueli, Isik Unlu, Kristin E. Sloyer, Johana Medina, Chalmers Vasquez, William Petrie, and Lawrence E. Reeves. "Potential distribution of Aedes (Ochlerotatus) scapularis (Diptera: Culicidae): a vector mosquito new to the Florida peninsula." *Insects* 12, no. 3 (2021): 213.