Applications of ECOSTRESS Data

1. TVA water temperature monitoring
2. Nature Conservancy of Canada Norfolk & Long Point 500 ha+ Oak Woodland restoration project
3. GeoHealth Project - A geospatial surveillance and response system resource for vector borne disease in the Americas
4. Improving Malaria Decision Support with Earth Observations

Jeffrey C. Luvall
NASA Marshall Space Flight Center
Huntsville, AL
jluvall@nasa.gov

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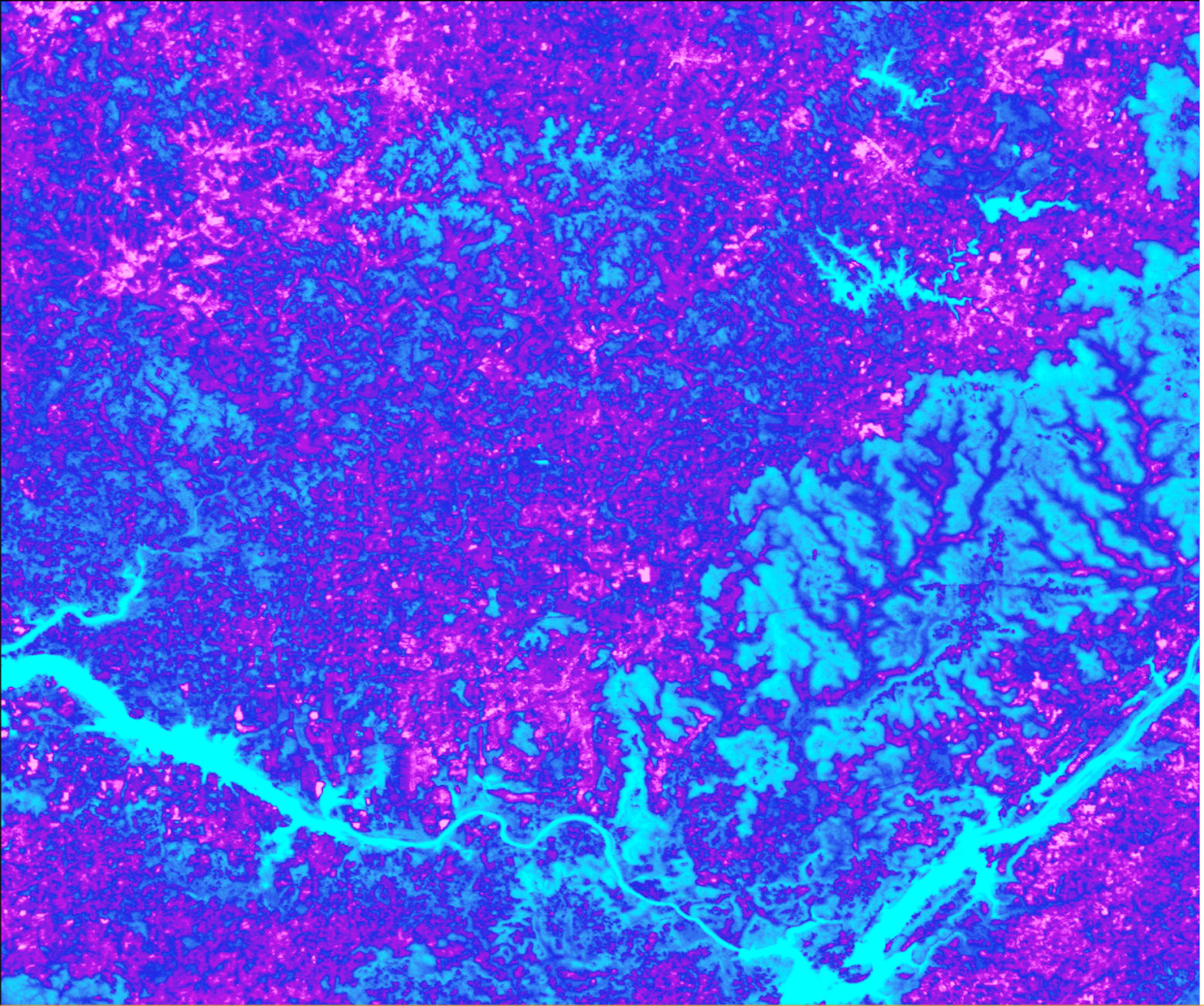


National Aeronautics and Space Administration

TENNESSEE VALLEY ENERGY

Assessing the Hydrothermal Outputs of Nuclear Power Plants Along the Tennessee River with NASA Earth Observations

Jessica Ding

Samuel Tatum

Rachel Smith

Lisa Dong

BFNP: EXTENDED POWER UPRATE

- Completed in **2019**
- **Increased power** output of each unit by **120%**
- Uprate coincides with **predicted increase in surrounding water temperature** of the Tennessee River

Image source: Google

PROJECT OBJECTIVES

- Visualize **yearly** and **seasonal** water surface temperatures through time-series maps to identify surface temperature spatial variation over time
- Compare **satellite performance** between **BFNP** and **SNP**
- Analyze **river flow rate, air surface temperature**, and **power output** impacts on water surface temperatures through statistical analyses
- Improve the **TVA's Delft3D model** by showing spatial variation in river surface temperature
- Illustrate the feasibility of using NASA Earth observations to monitor water surface temperatures through a **tutorial**
- Wrap up project through **a story map**

TEMPERATURE THRESHOLDS

93 °F

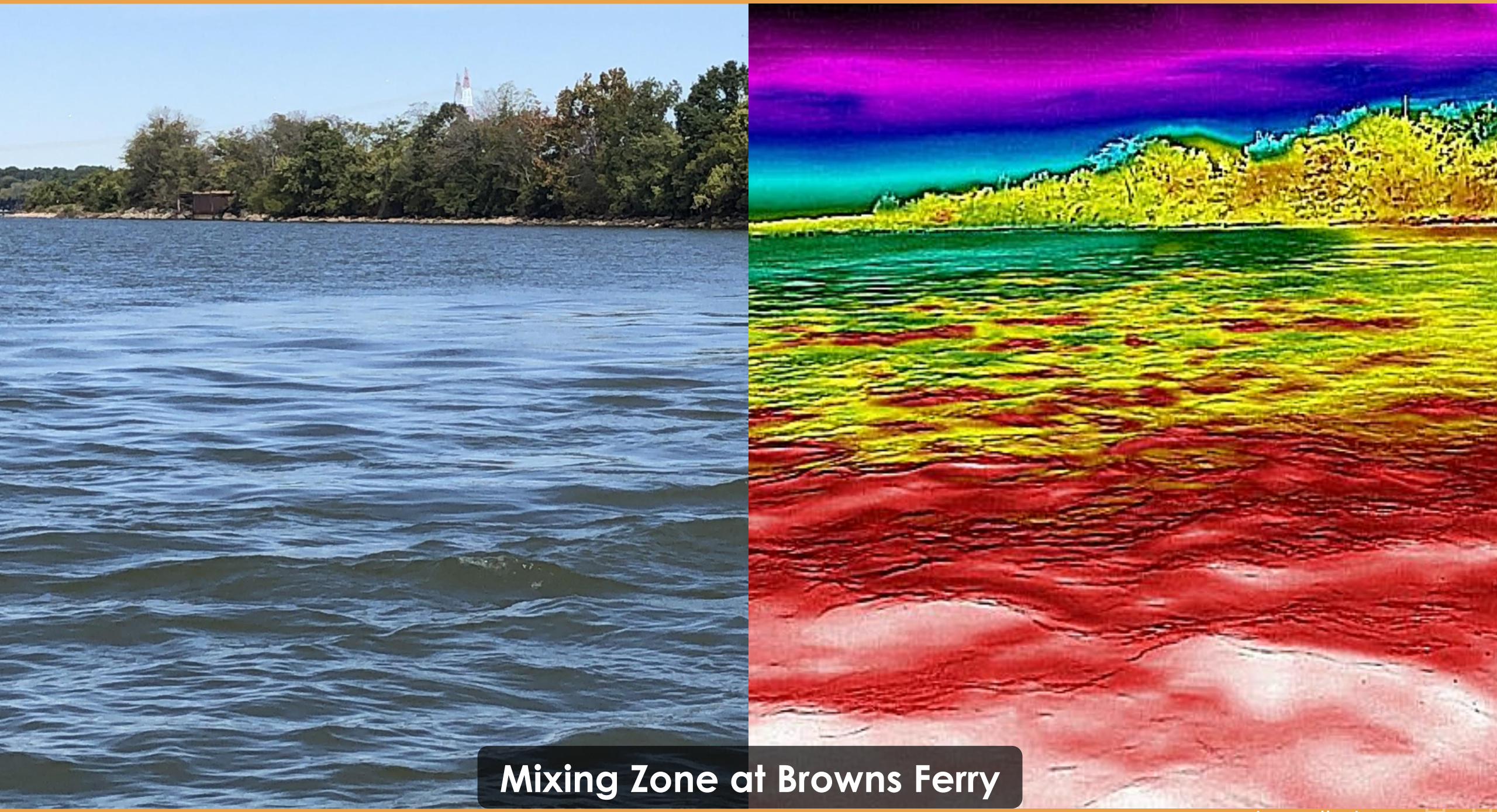
- 1- Hour average threshold

90 °F

- Daily Average threshold

10 °F

- Daily average limit relative to ambient



Mixing Zone at Browns Ferry

Image Source: Ding Li Luvall

IN SITU MONITORING

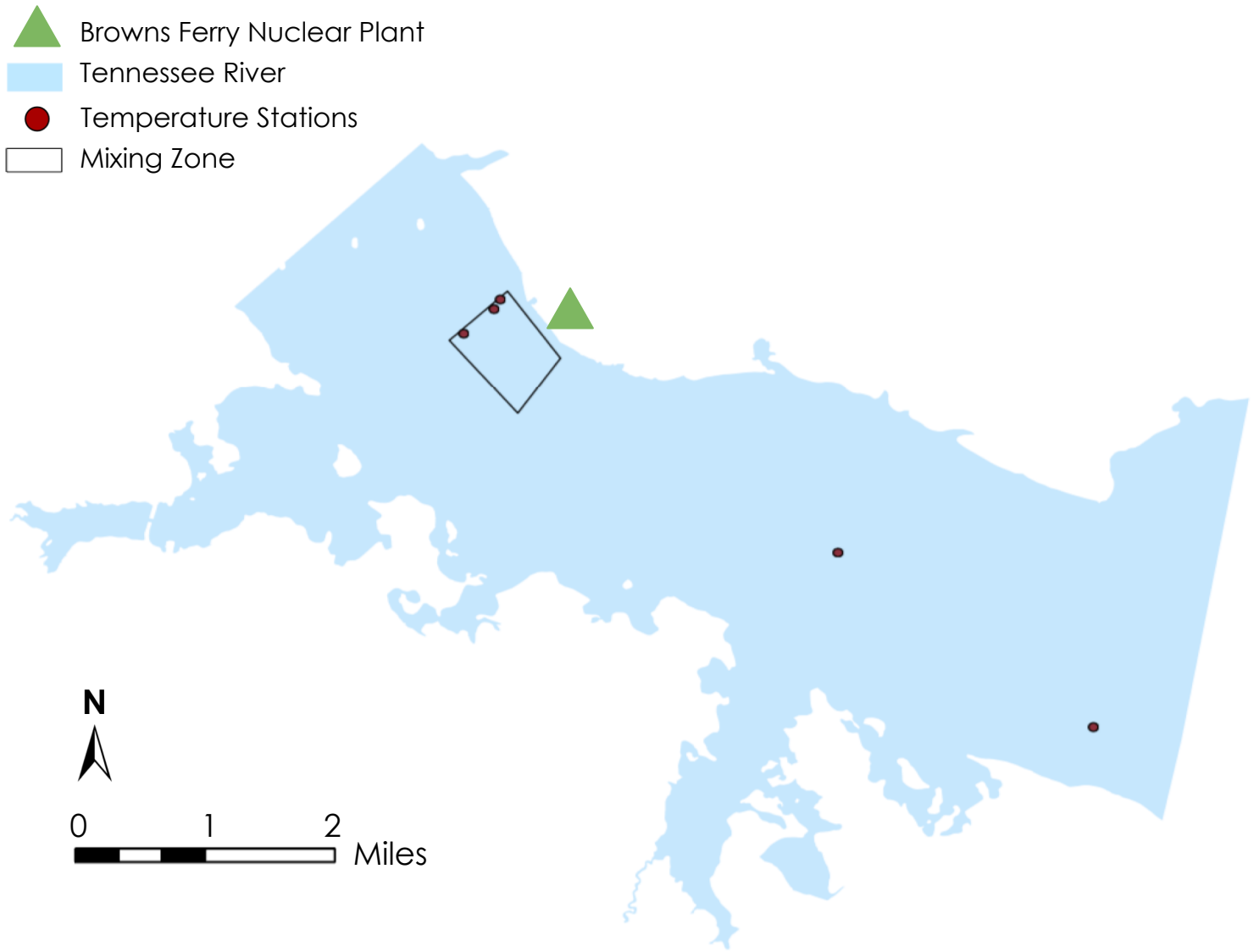
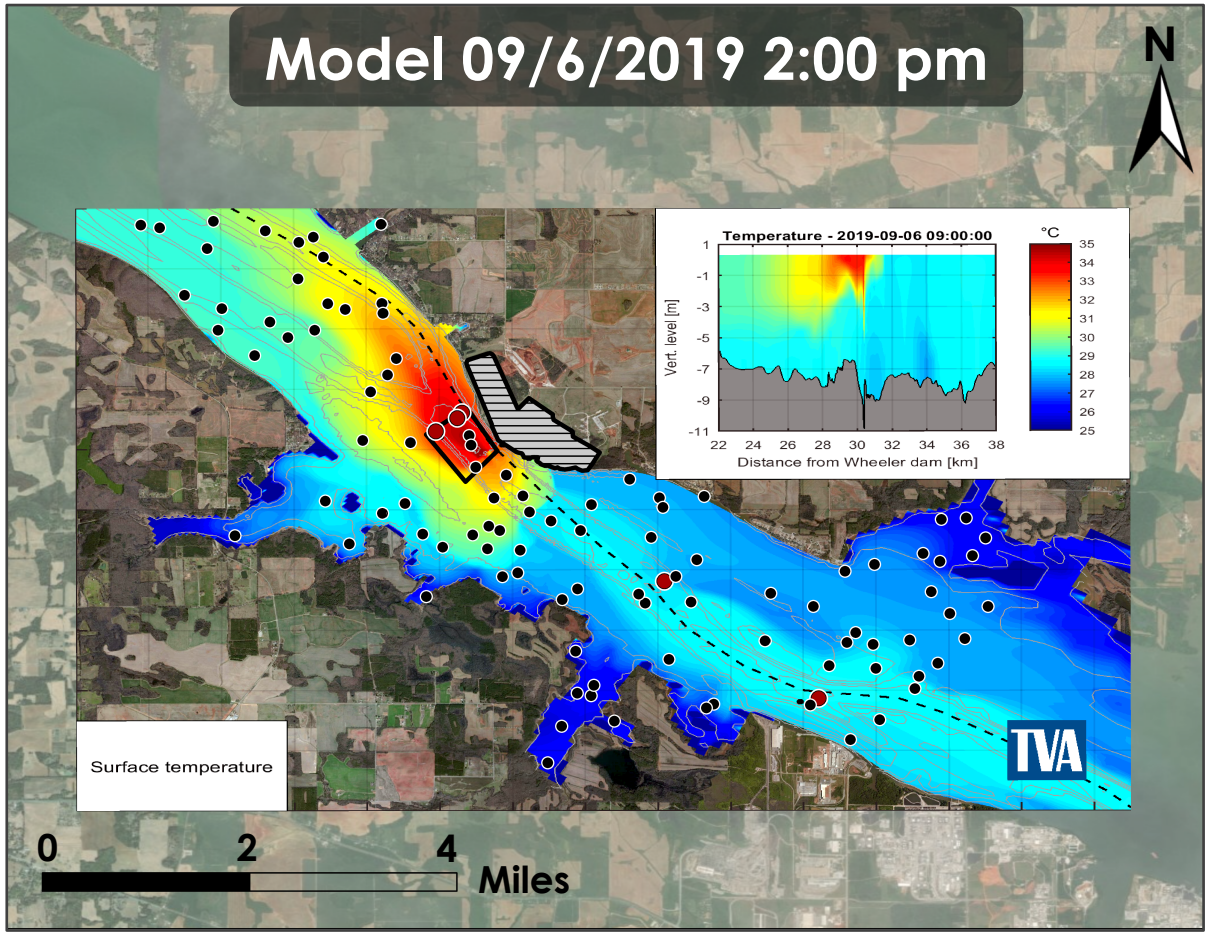


Image source: Dong, L.; Ding, J.

ECOSTRESS: MODEL COMPARISON



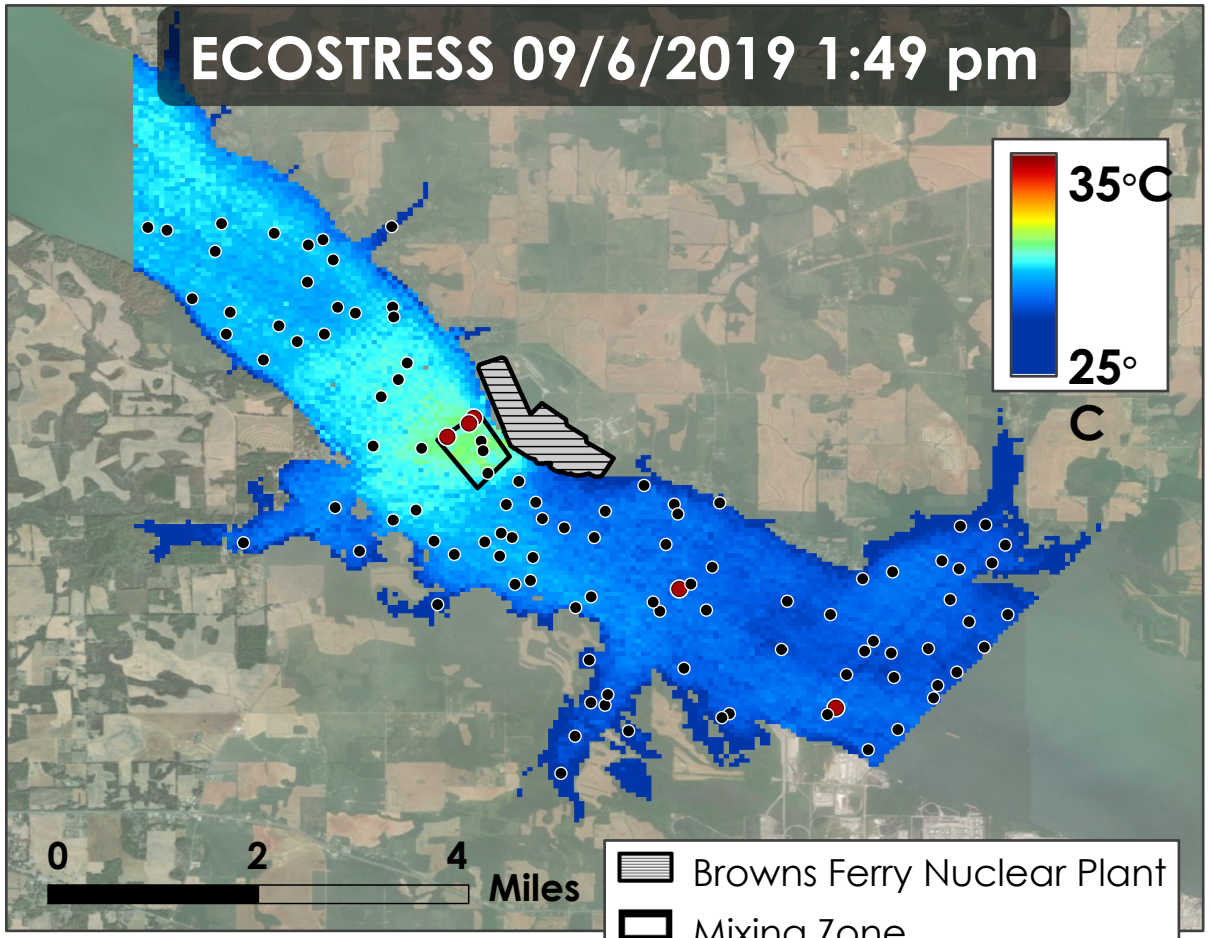
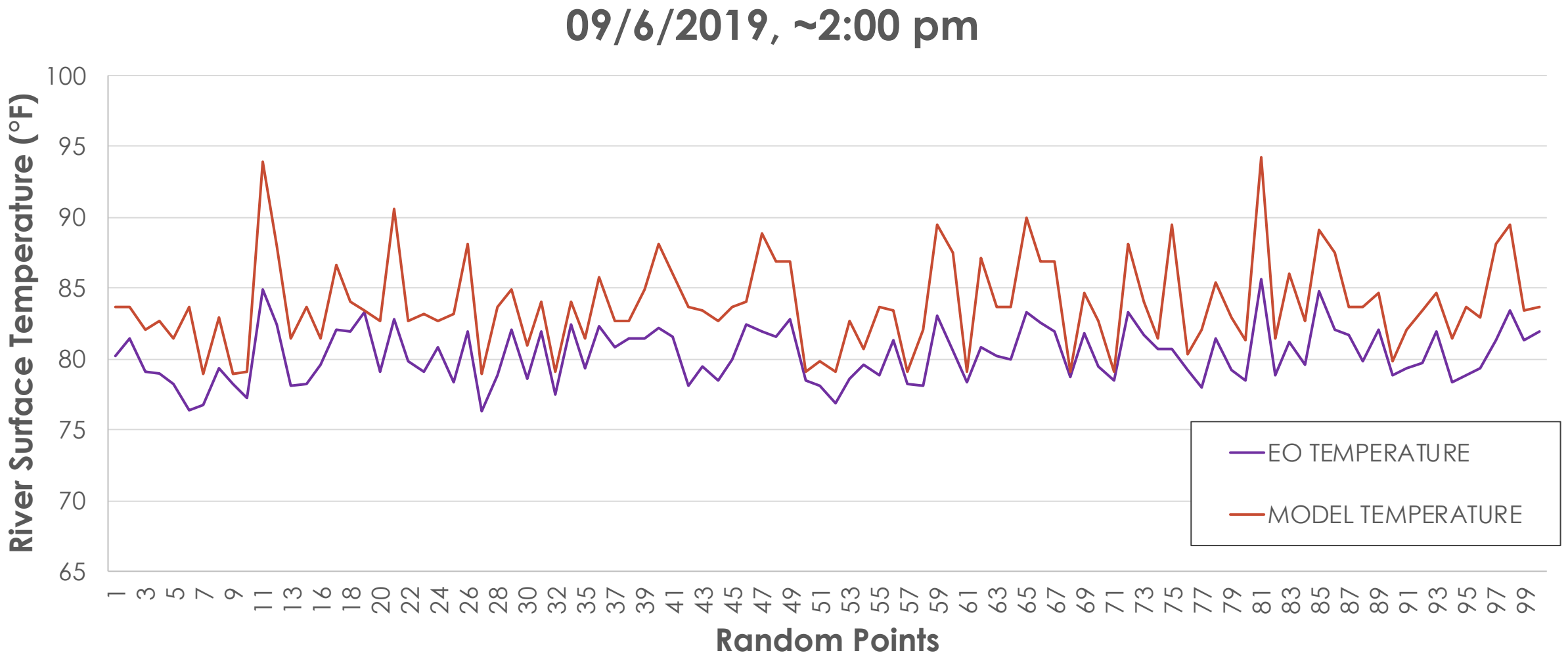
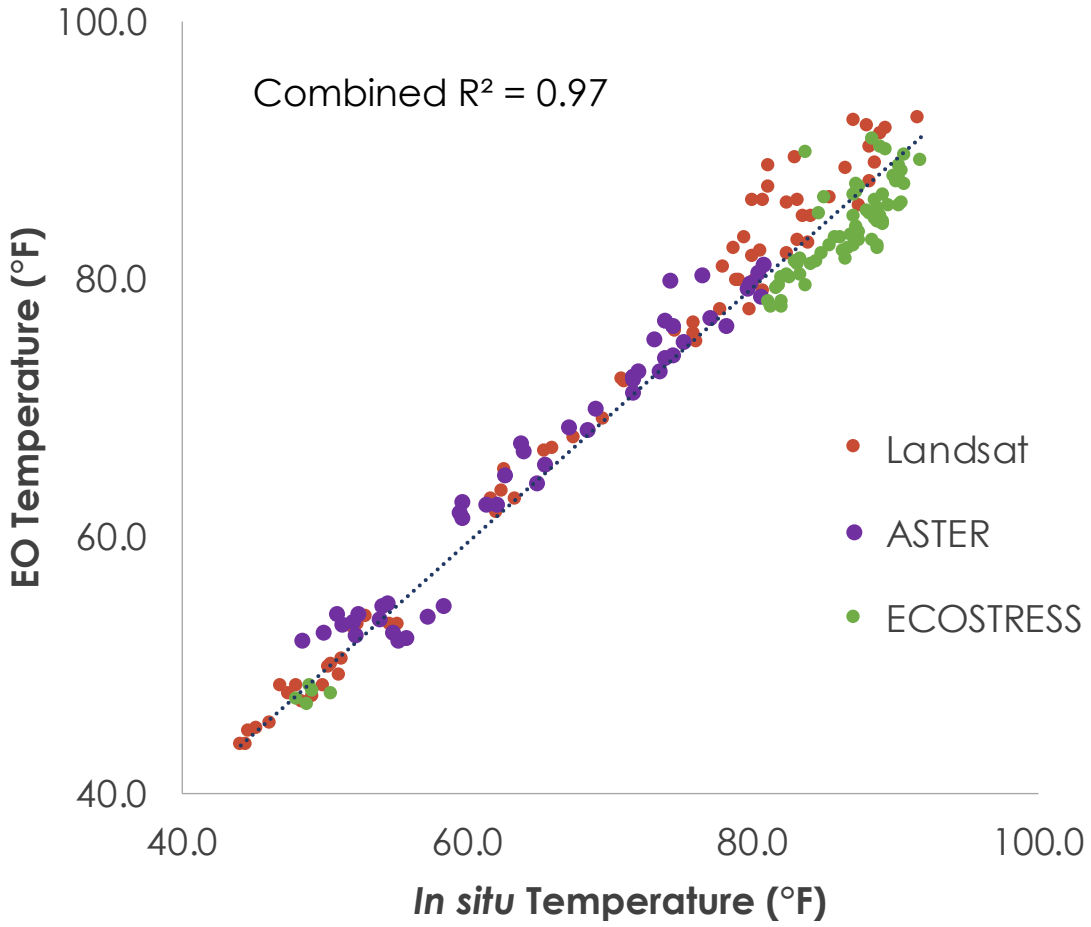


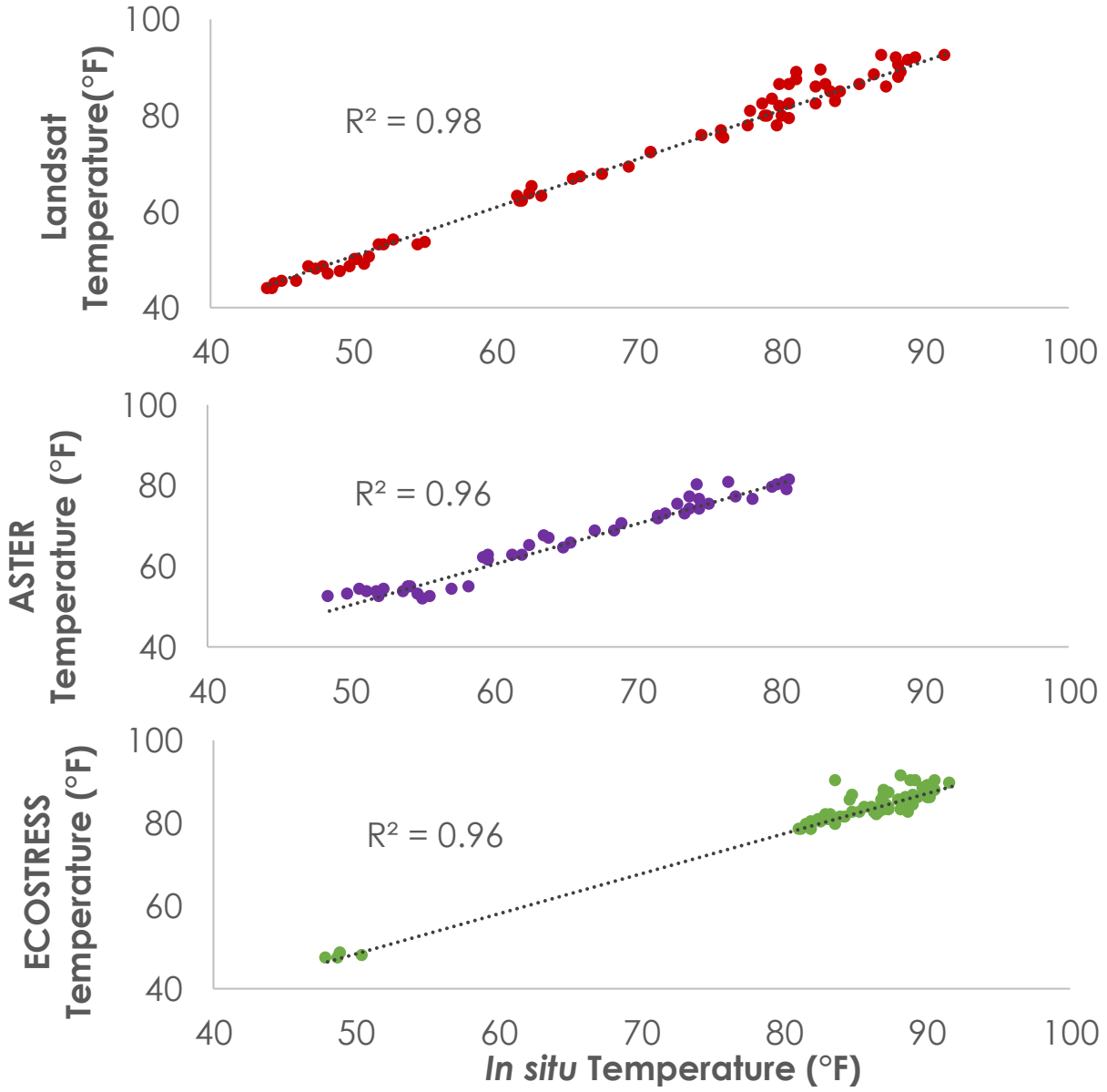
Image source: Lisa Dong

ECOSTRESS: MODEL VS. SATELLITE

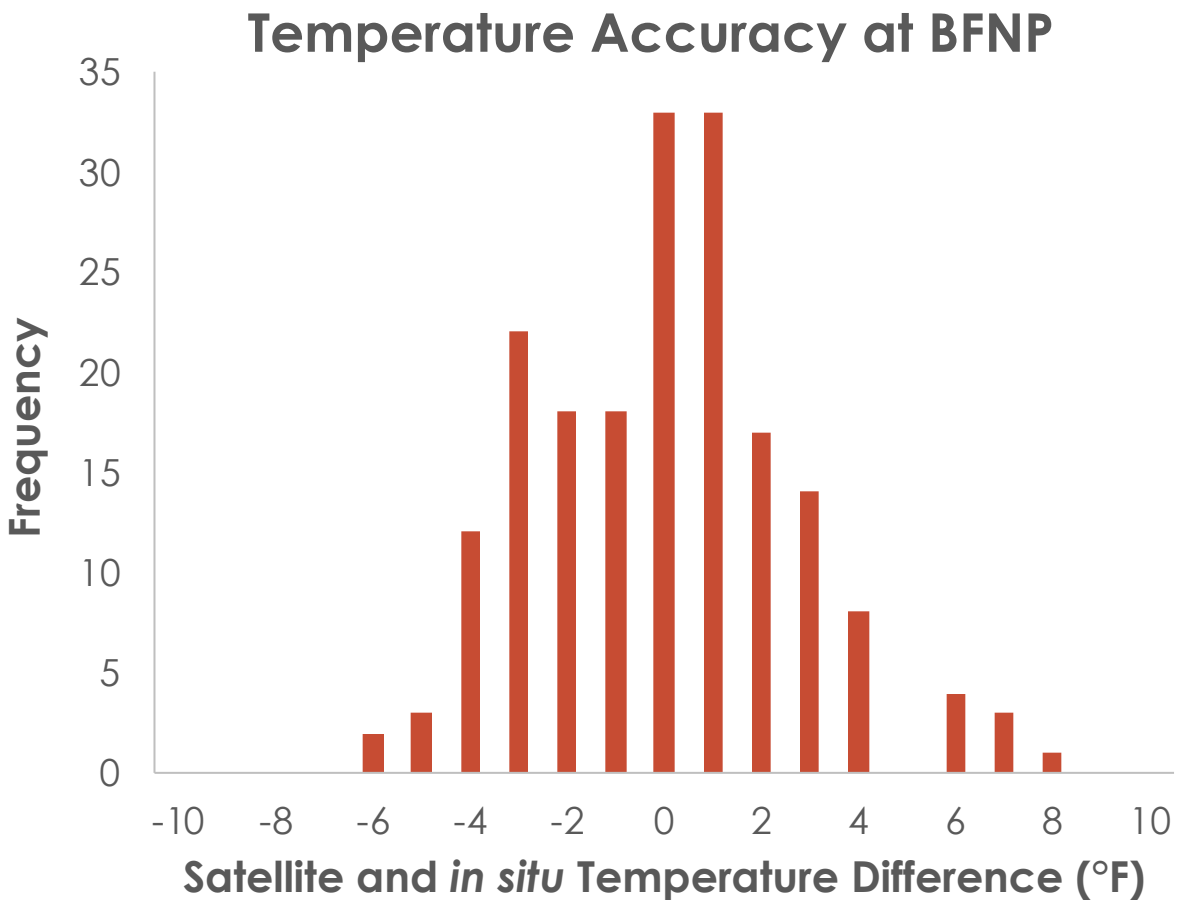


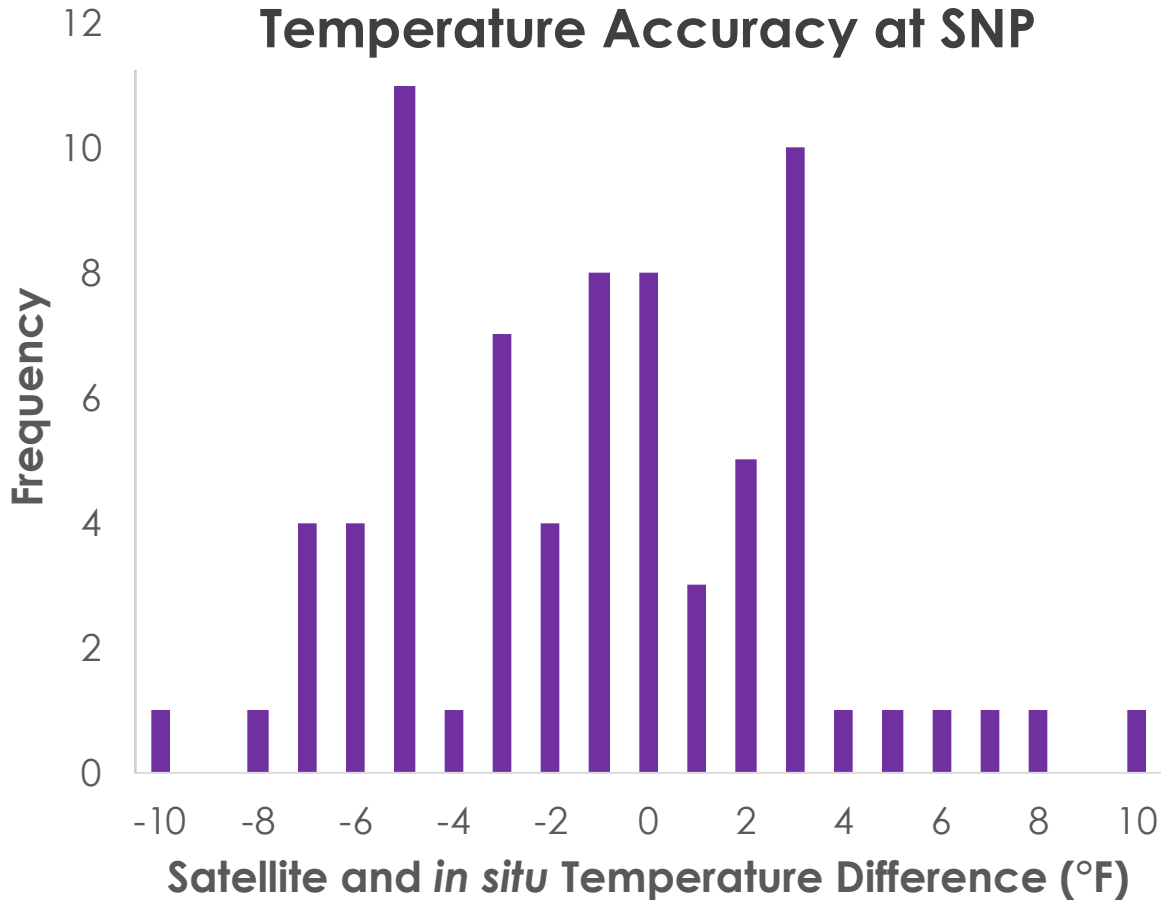
EARTH OBSERVATIONS VS. *IN SITU*





FACILITY COMPARISON





CONCLUSIONS

- **River flow rate** has a **significant impact** on water surface temperature. **Earth observations can demonstrate spatial trends** at varying flow rates.
- NASA Earth Observations can **benefit thermal effluent model calibration.**
- Satellite imagery cannot replace *in situ* temperature reporting for compliance due to **low temporal & spatial resolutions.**

Nature Conservancy of Canada Norfolk & Long Point 500 ha+ Oak Woodland restoration project

We compared 12 years of vegetation data with thermal data from Landsat 5, 7, 8 and ECOSTRESS

Jonas Hamberg
lhamberg@uwaterloo.ca / hamberg.jonas@gmail.com

UNIVERSITY OF WATERLOO
FACULTY OF ENVIRONMENT

Nonequilibrium thermodynamic hypotheses concerning ecosystem development

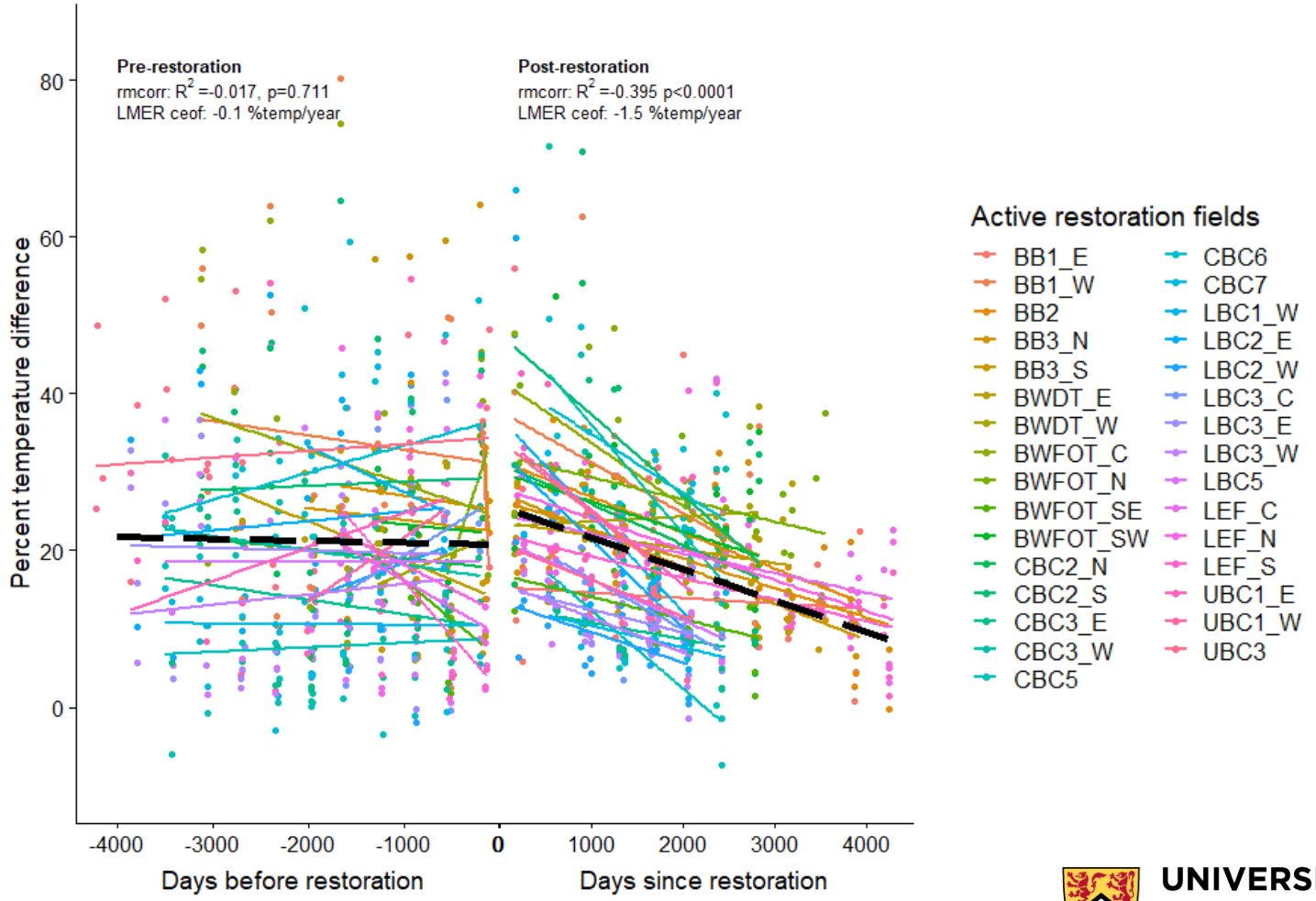
- Exergy utilization will increase
  - Rn/K* will increase
  - Surface temperature will decrease
- Internal equilibrium will increase
  - Spatial variation in surface temperature will decrease (Beta index increases)
  - Temporal variation in surface temperature will decrease (TRN increases)

Kay, Schneider, Luvall, Fraser various articles 1989-2005

Restoration cooled the land by about 4.5 °C in 12 years (summer day-time temperatures)

Each line is a field before and after restoration. Before restoration there is no significant pattern. After restoration 30 out of 31 fields get colder.

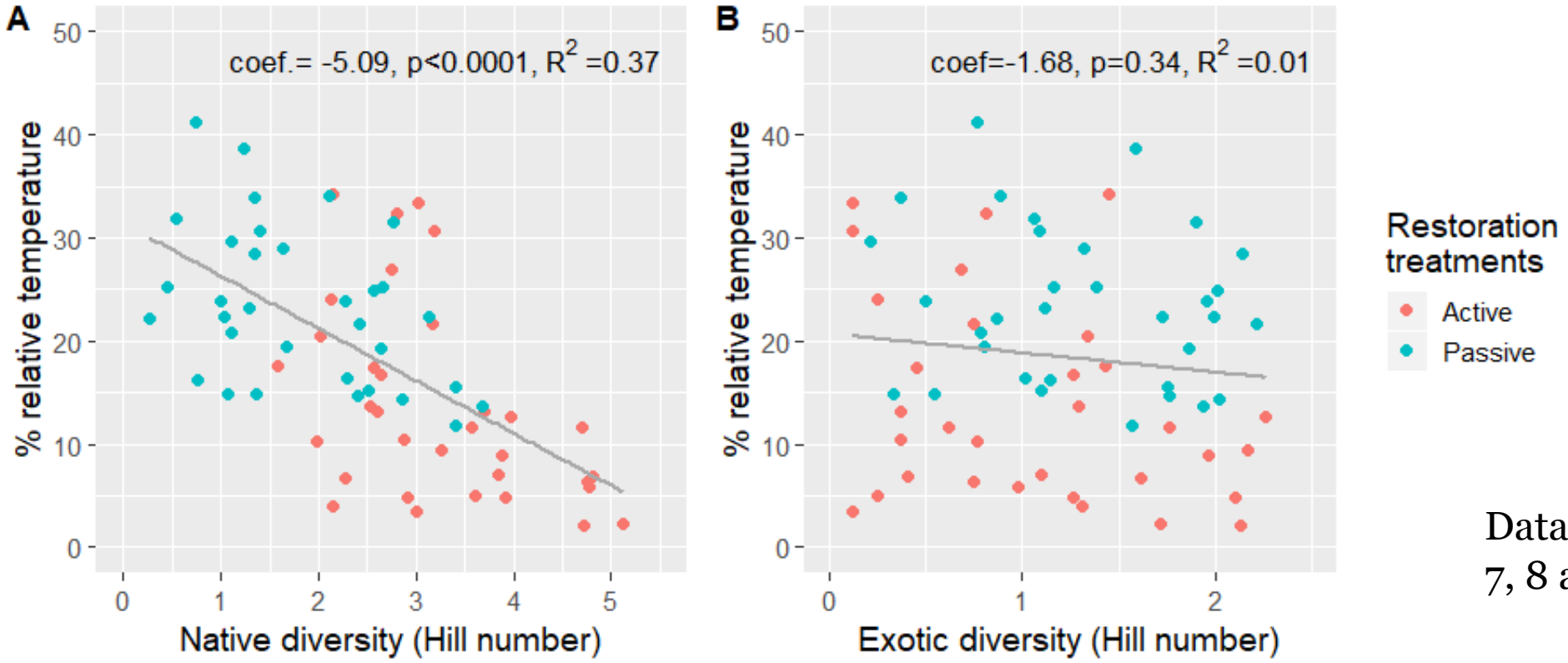
Data from Landsat 5, 7, 8 and ECOSTRESS



Jonas Hamberg
lhamberg@uwaterloo.ca / hamberg.jonas@gmail.com

UNIVERSITY OF WATERLOO
FACULTY OF ENVIRONMENT

Controlling for biomass and shade, an increase in native vegetation biodiversity decreased temperatures more than an increase in exotic species diversity.



Data from Landsat 5, 7, 8 and ECOSTRESS

Jonas Hamberg
lhamberg@uwaterloo.ca / hamberg.jonas@gmail.com

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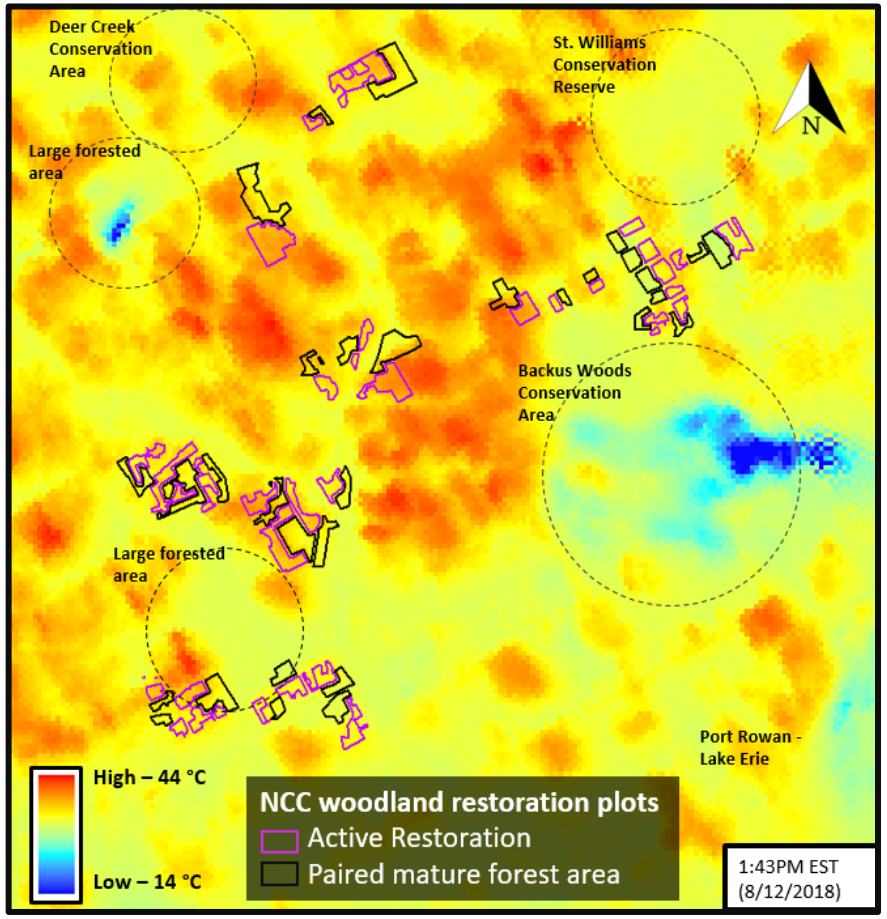
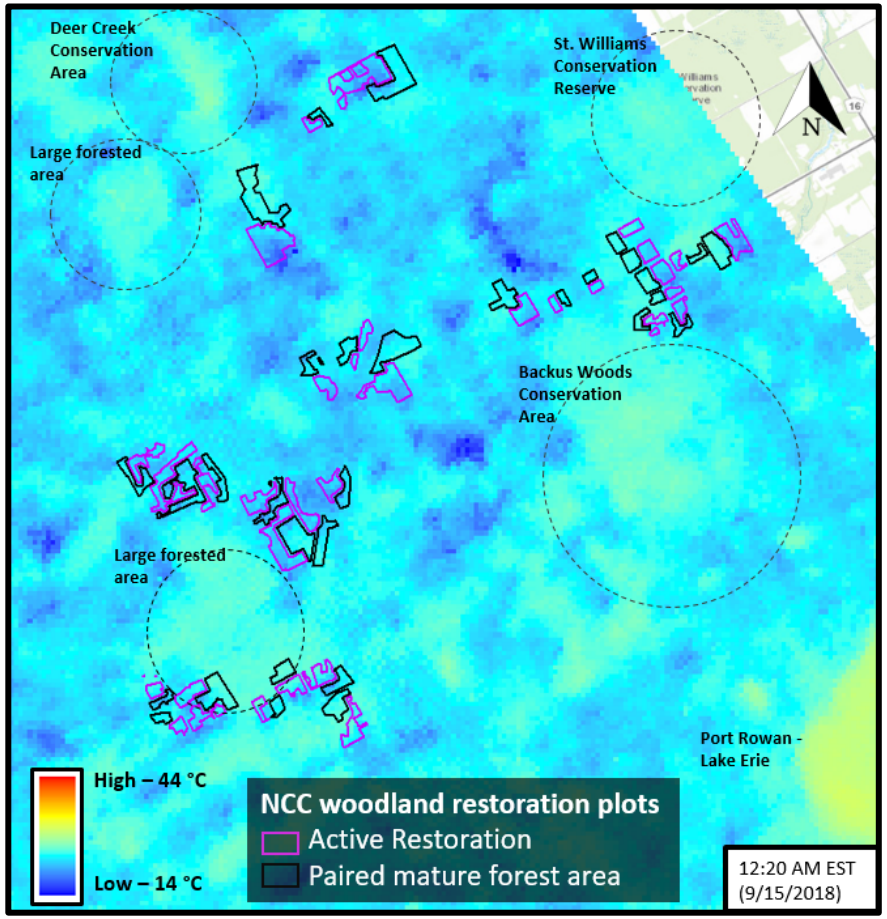
Night-time temperatures increases with restoration



ECOSTRESS – daytime imagery



ECOSTRESS – night-time imagery

Jonas Hamberg
lhamberg@uwaterloo.ca / hamberg.jonas@gmail.com

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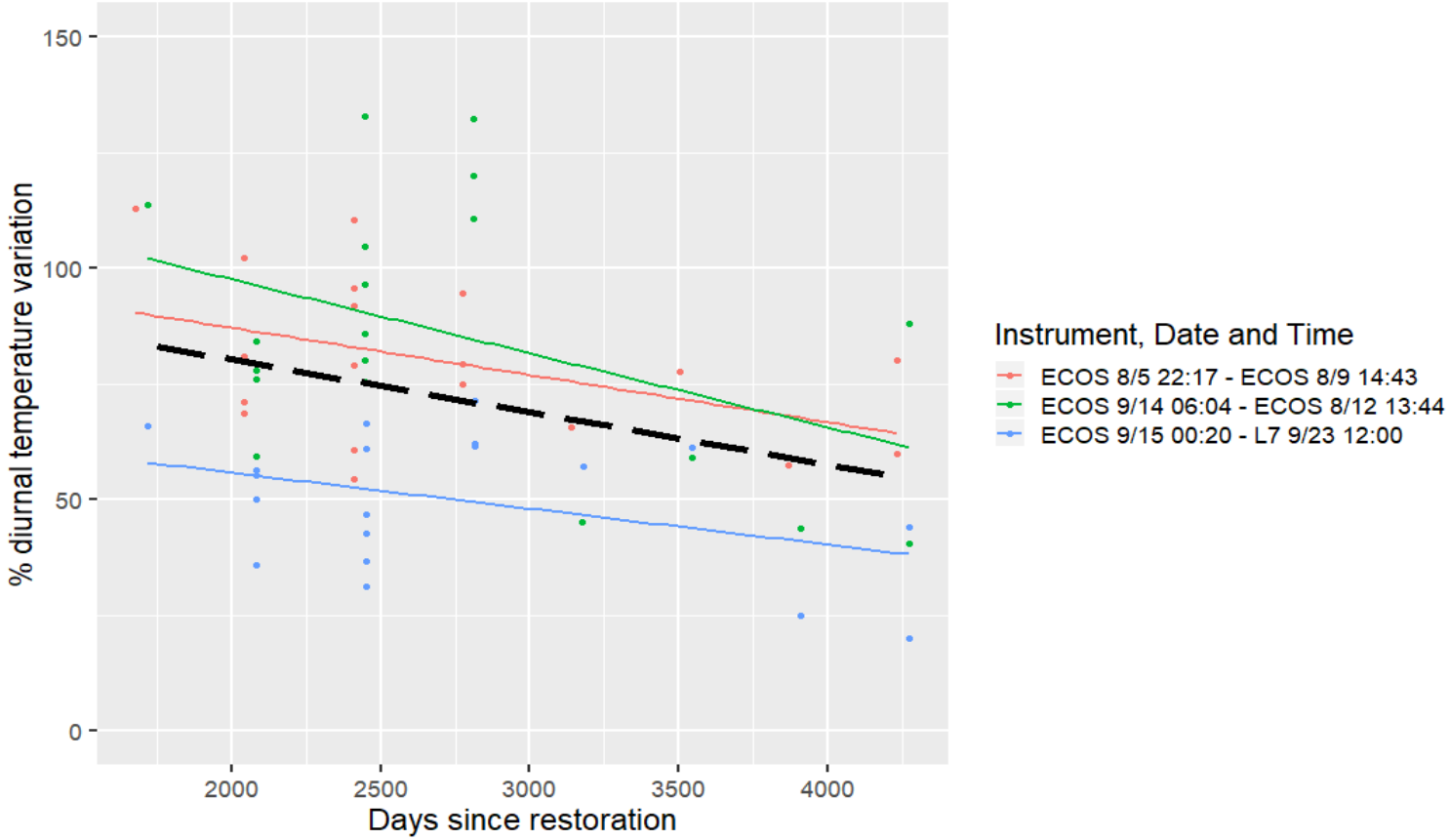
Variation between day-time and night-time temperatures decreases by 5 °C over 8 years as more, and more diverse vegetation holds energy



This comparison would have been impossible without ECOSTRESS, as Landsat returns around noon every day. Night time measurements are very interesting from an a perspective of energy flow in ecosystems.

Jonas Hamberg
lhamberg@uwaterloo.ca / hamberg.jonas@gmail.com

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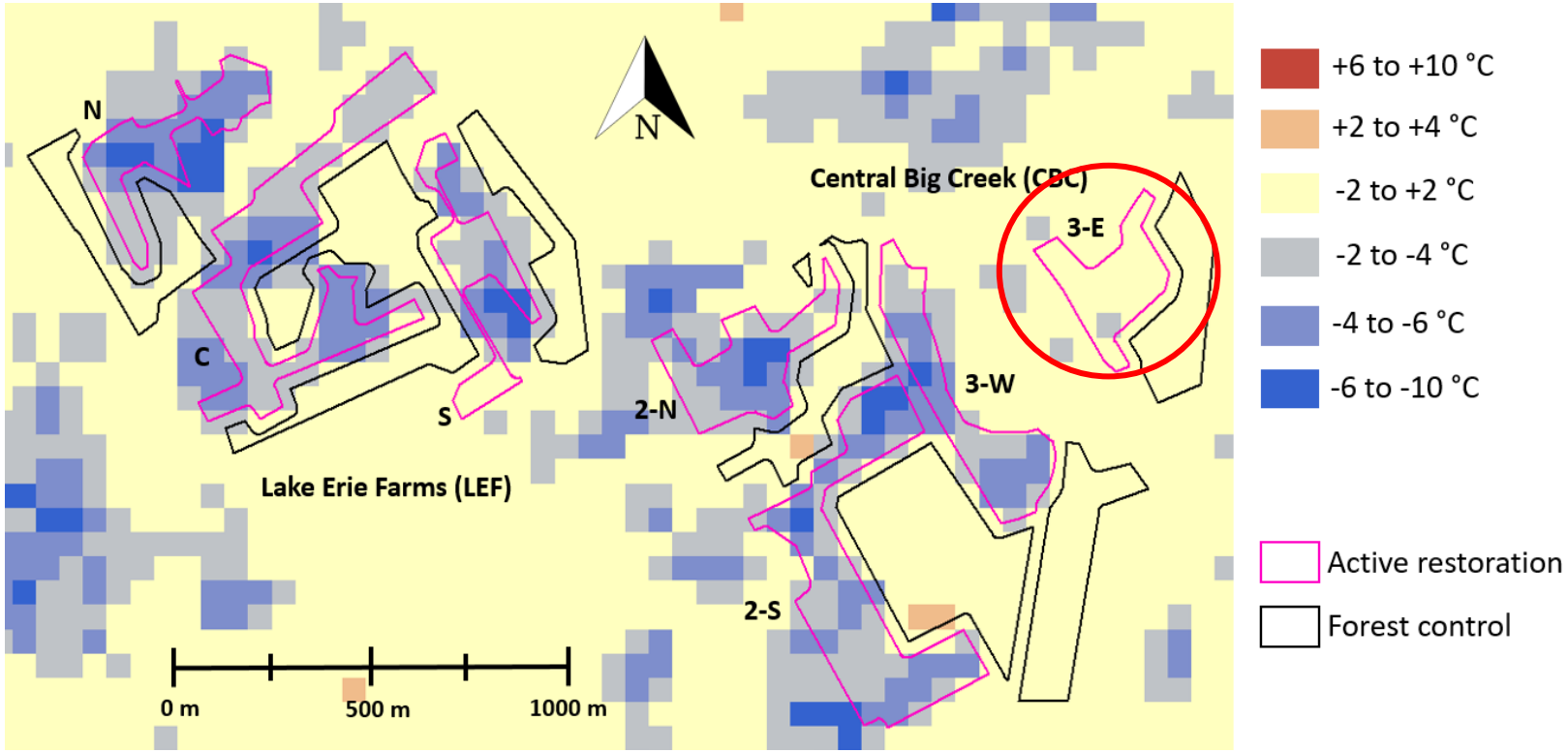
Combining ECOSTRESS and Landsat imagery can provide cost-effective monitoring of large-scale and fragmented restoration areas



Map of mean day-time summer temperature change between 2014 and 2018 imagery. Most restoration areas (magenta) have decreased in temperature, except area 3-E, this area may require further management to increase vegetation cover and diversity.

Jonas Hamberg
lhamberg@uwaterloo.ca / hamberg.jonas@gmail.com

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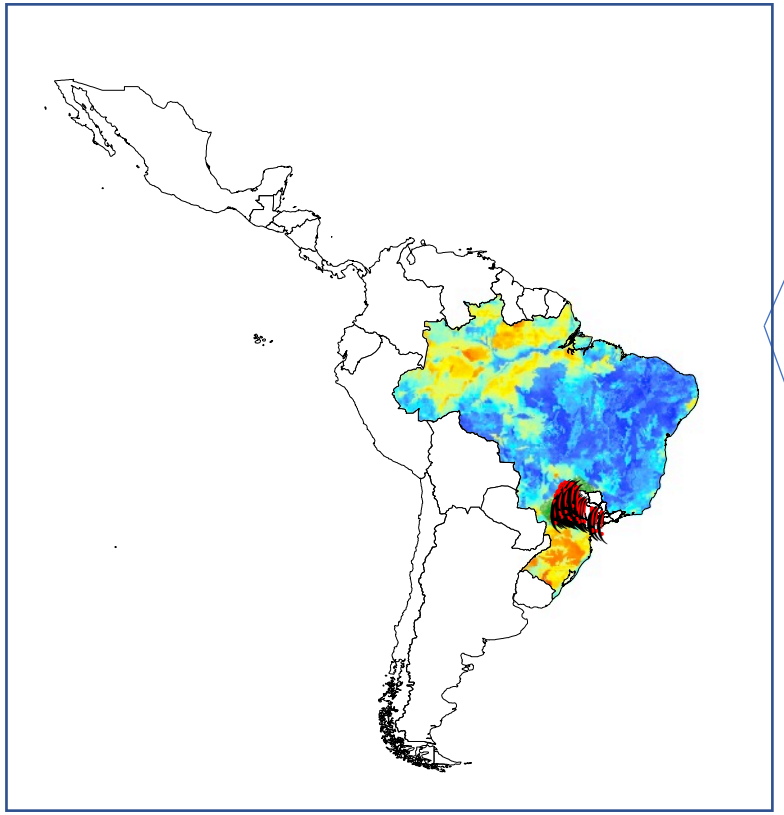
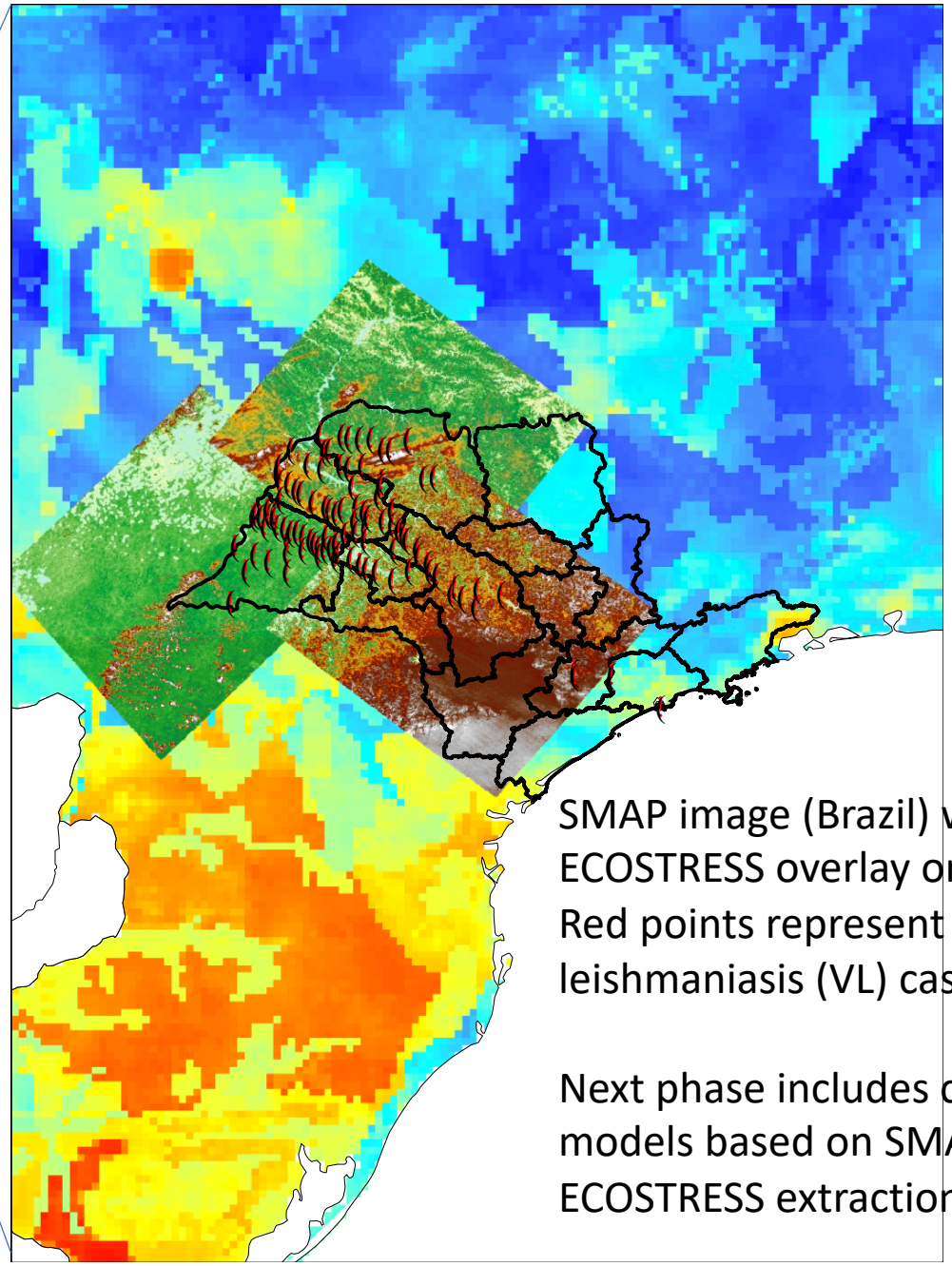
GEOHEALTH PROJECT

A geospatial surveillance and response system resource for vector borne disease in the Americas



John Malone[1], Rebecca Christofferson[1], Jeffrey Luvall[2], SJ Park[3], Mara Bavia[4], Elivelton Fonseca[5], Prixia del Mar Nieto[1] Moara Rodgers[1], Raul Guimaraes[5]

[1]Pathobiological Sciences, LSU School of Veterinary Medicine;
[2] NASA Marshall Space Flight Center, Huntsville AL,
[3] Electrical Engineering and Computer Science, LSU
[4] Federal University of Bahia, Salvador, Brazil
[5] Federal University of Uberlandia, Brazil



SMAP image (Brazil) with ECOSTRESS overlay on Sao Paulo. Red points represent visceral leishmaniasis (VL) cases.

Next phase includes creating VL risk models based on SMAP and ECOSTRESS extractions.

Improving Malaria Decision Support with Earth Observations

John Beck, PI, UAH, John Painter, Co-I CDC, Udaysankar Nair and Todd Berendes, Co-I, UAH, Jeffrey Luvall (Co-I)
& Walter Petersen, MSFC unfunded collaborator

District Health Information Software 2 (DHIS2)

- DHIS2 is the preferred health management information system in 60 countries across four continents worldwide including all sub-Saharan African countries with whom CDC works.
- DHIS2 is used by the CDC, the European Union (EU), and other health facilities and government organizations to monitor diseases, provide vital health data, and support disease-control decision making.
- Malaria has been selected for the case study because of the well-established impacts of environmental factors on transmission of the disease.

Improving Malaria Decision Support with Earth Observations
PI John Beck / The University of Alabama in Huntsville (UAH)

Highlight:

- MoSqUITO aims **to improve malaria control decision making** in sub-Saharan Africa by developing and deploying technology for **incorporating the latest NASA Earth observations** for surface temperatures, precipitation, and vegetation health into the District Health Information Software 2 (DHIS2) used worldwide, including all sub-Saharan African countries.
- Objectives include:
  1. Enhanced health decision making for malaria control by integrating the latest relevant NASA Earth observations into an existing decision-making activity
  2. Developing and deploying technology solutions that will provide a path to long-term sustainability for the use of NASA Earth observations to end-user health decision makers.

Relevance:

- Incorporating environmental data into the most frequently used geo-referenced disease surveillance platform, District Health Information System (DHIS2)
- Making information from Earth Observations available to countries to improve malaria intervention evaluation, assessment of malaria burden and trends, and resource allocation
- Malaria decision-makers will be better able to assess malaria trends in the context of environmental factors that drive malaria risk in their area.

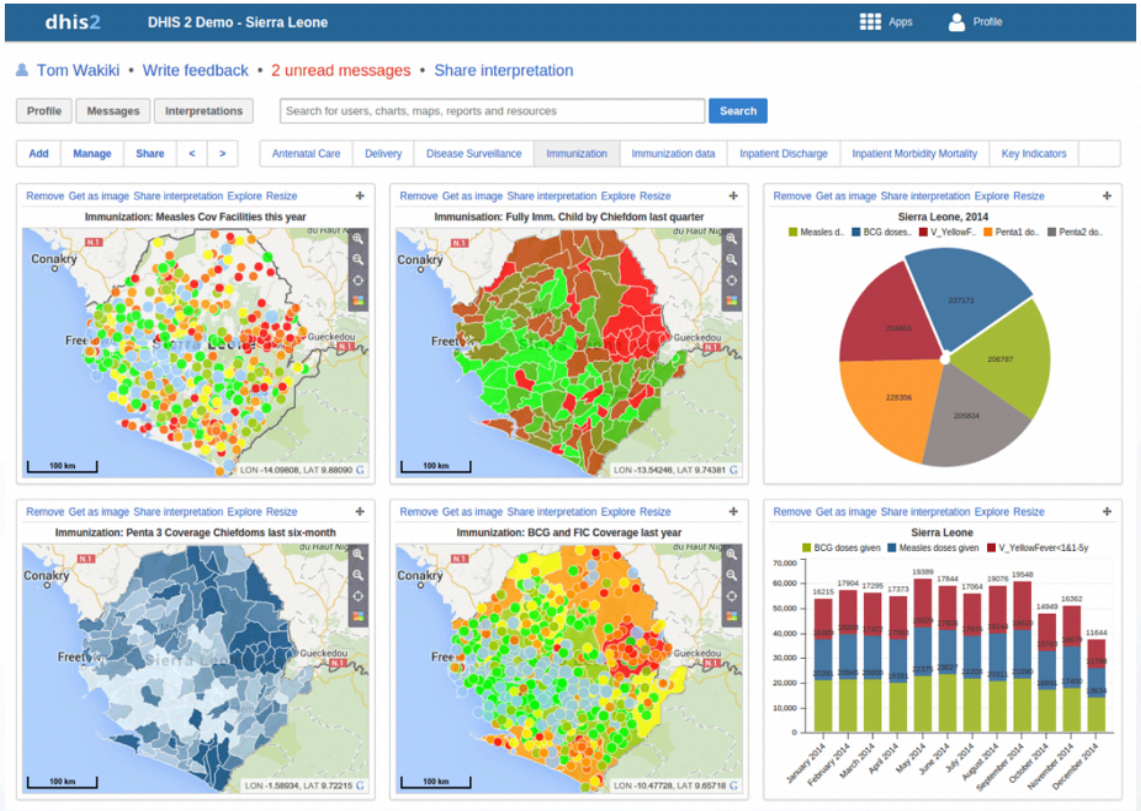
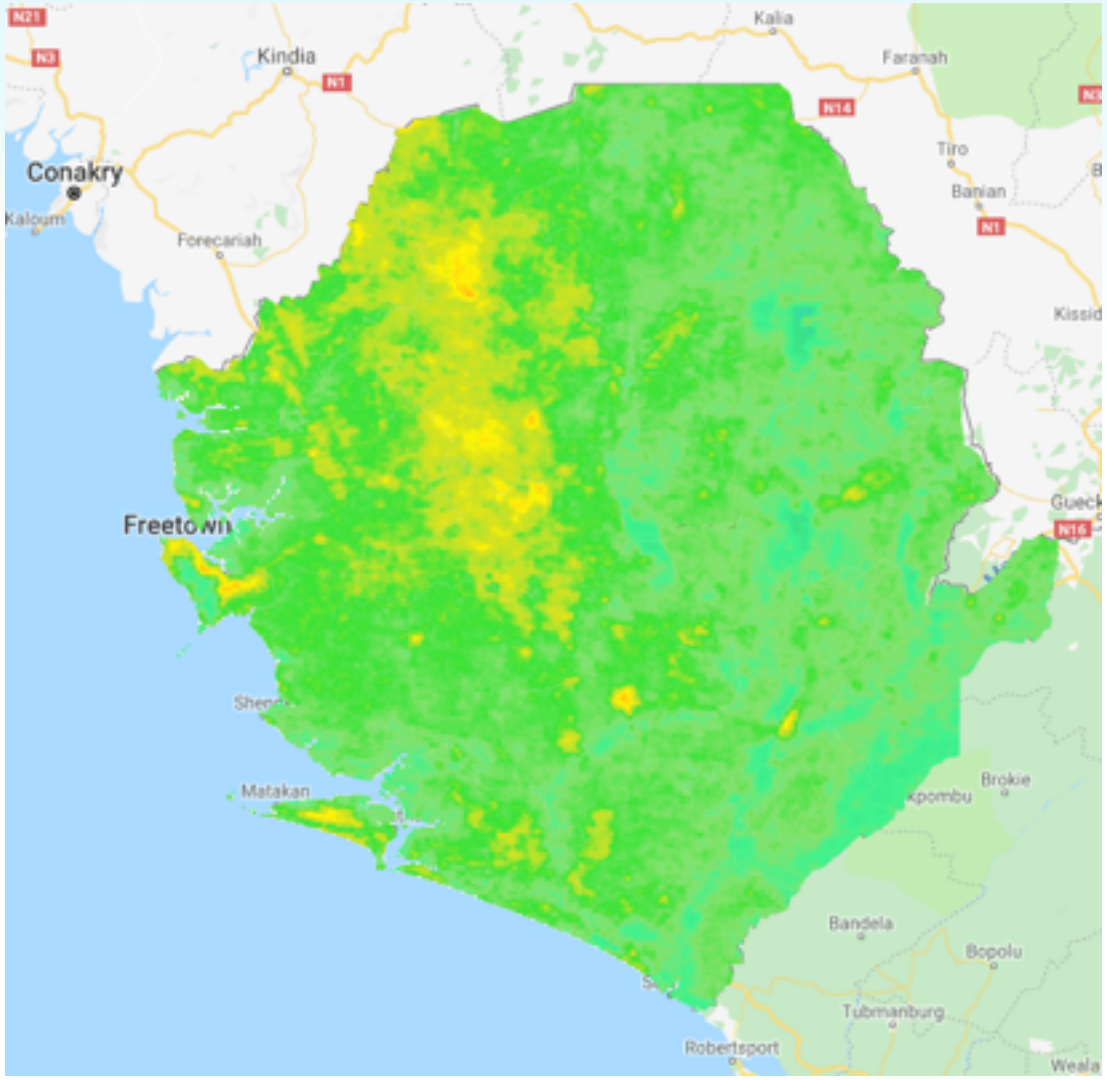


Figure 1: Example DHIS2 Interface illustrating health information from Sierra Leone, likely one of the MoSqUITO project collaborating countries.

MODIS Temperature Datasets

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

MOD11A2 – 1km MODIS derived Land Surface Temperature (LST), 2017 average



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