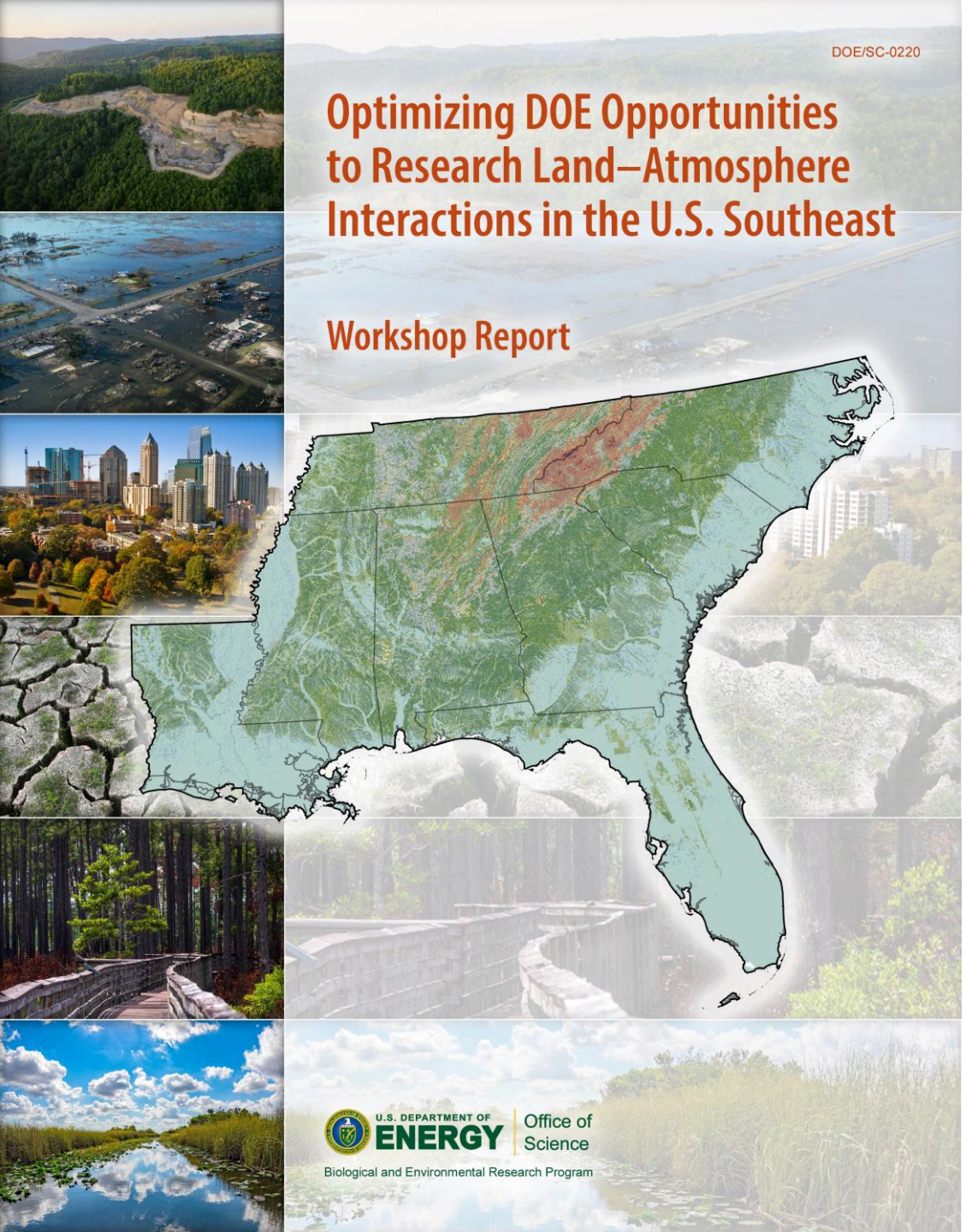


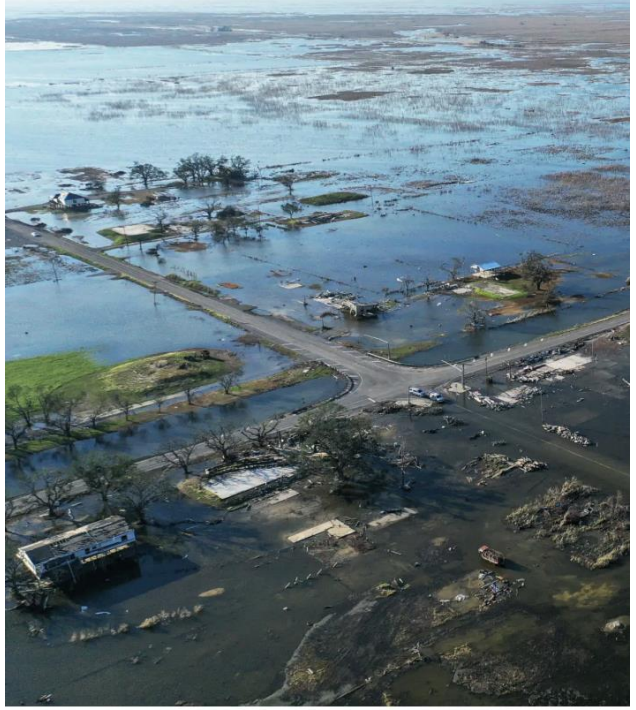
Southeast Land–Atmosphere Research Opportunities (SELARO) Workshop

August 23-24, 2023

Beth Drewniak, ESS detailee

BERAC

October 25, 2024



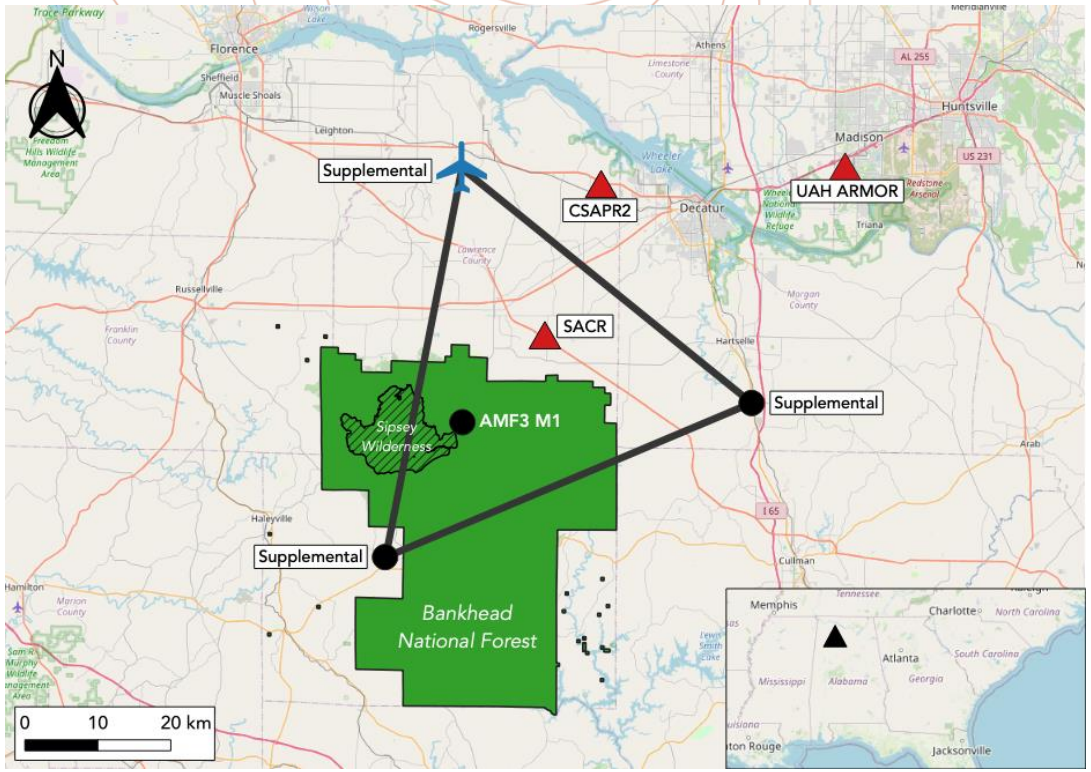
Why the Southeast U.S.?

Strong variability in land surface and vegetation cover

Subject to climate change and extreme events including hurricanes, droughts, heat waves, and wildfire

Rapid urban growth and human influence

AMF3 Deployment



AMF3 Deployment at Bankhead National Forest beginning in Fall 2024 will improve understanding and model representation of coupled land-aerosol-cloud processes.

Workshop Goal:

Identify potential research efforts to coordinate and compliment ongoing activities across the region for scientific advancement.

Organizing Committee and Participants

Nina Wurzburger
University of Georgia

Ross Hinkle
University of Central Florida (emeritus)

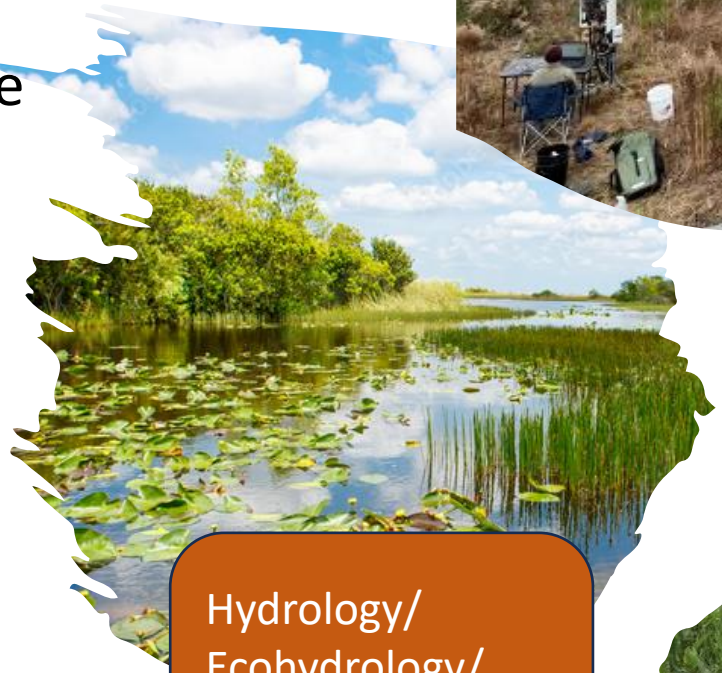
Chris Oishi
USDA Forest Service

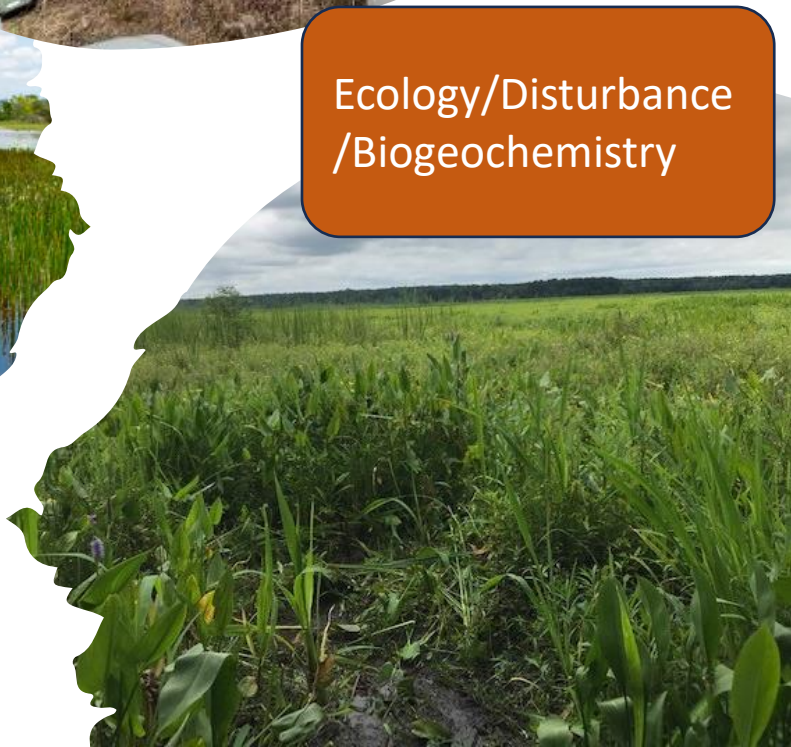
~45 participants from universities, DOE labs, other federal agencies, and ARM representatives

Expertise in Eddy Flux, land-atmosphere interactions, disturbance, ecology, ecohydrology, hydrology, boundary layer meteorology, aerosols, air quality, carbon management, soils, fire ecology, biogeochemistry, modeling, and data management

Workshop Structure

- **<u>Plenary Session Topics</u>**
- AMF3 Deployment
- ESS Strategic interests in Southeast
- Experiences with Surface Atmosphere Integrated Field Laboratory (SAIL) Campaign
- **<u>Breakout Session Topics</u>**
- Identifying Knowledge Gaps in Key Processes
- Identify Gaps for Research and Modeling to Advance Predictability
- Identify Potential ESS Relevant ModEx-Driven Opportunities





Southeast Region

Workshop participants considered the Southeast domain to include states bounded by the Gulf of Mexico to the south, the Atlantic Ocean to east, the Mississippi River to the west, and extending through Tennessee and North Carolina to the north.

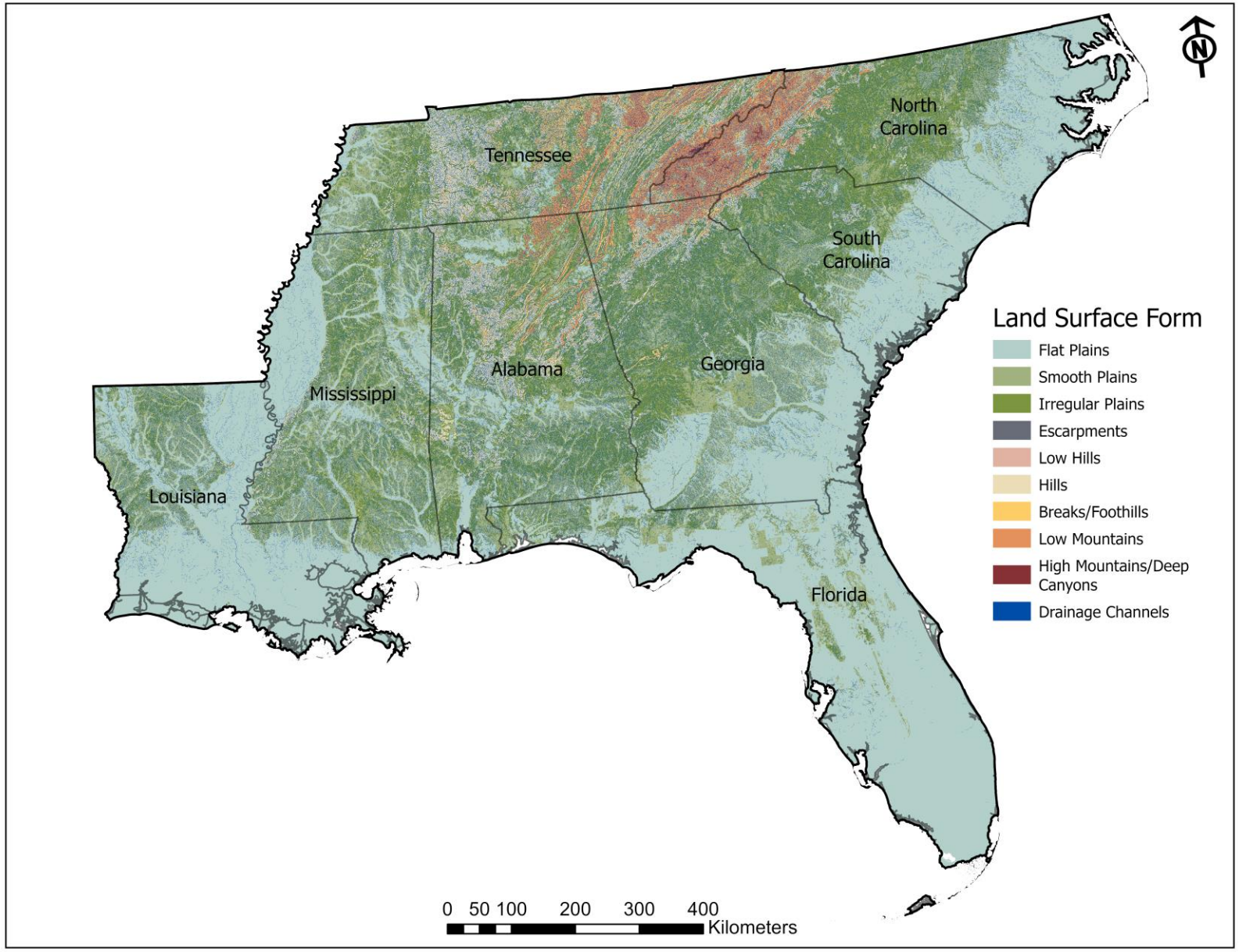


Fig. 2.1. Land Surface Forms of the Southeastern United States. [Courtesy Oak Ridge National Laboratory]

Workshop Themes

- Spatial Heterogeneity
- Climate Change
- Disturbance
- Land Management and Land Use Change
- Hydroclimatic Feedbacks
- Land-Atmosphere Coupling and Boundary Layer Dynamics

Spatial Heterogeneity

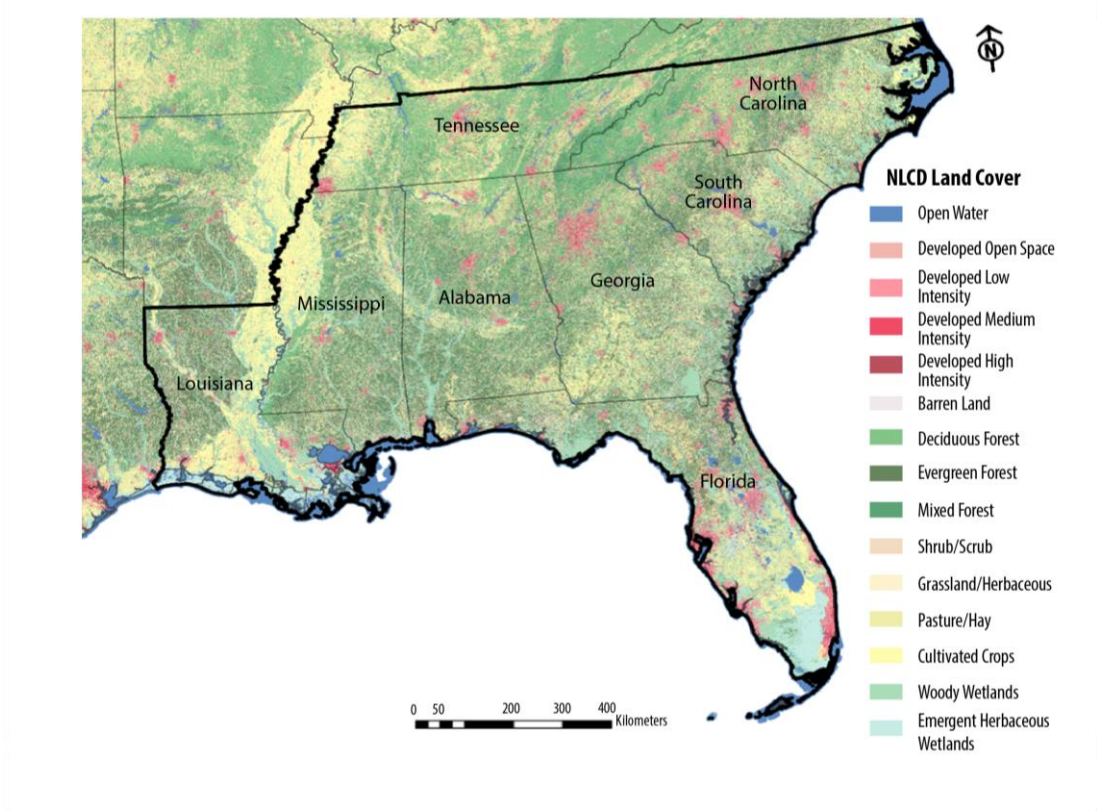


Fig. 3.1. Land Cover Types in the Southeastern United States. The targeted study area for land–atmosphere research opportunities (outlined in bold black) covers nearly 1.4 million km^2 and is characterized by heterogeneous topography, soils, ecosystems, and human land use, shown here from the National Land Cover Database. [Courtesy U.S. Geological Survey]

Key Challenges:

- ***Identify parameters that scale across diverse space and time***
  - Focus supplementary measurements at plot scale to inform how individual ecosystem components contribute to aggregated observations of AMF3-BNF
- ***Understand how landscape heterogeneity influences surface–atmosphere coupling***
  - Use the diverse characteristics of the landscape mosaic to provide key constraints to understand individual seasonal and climate contributions of different landscape types across the region

Climate Change

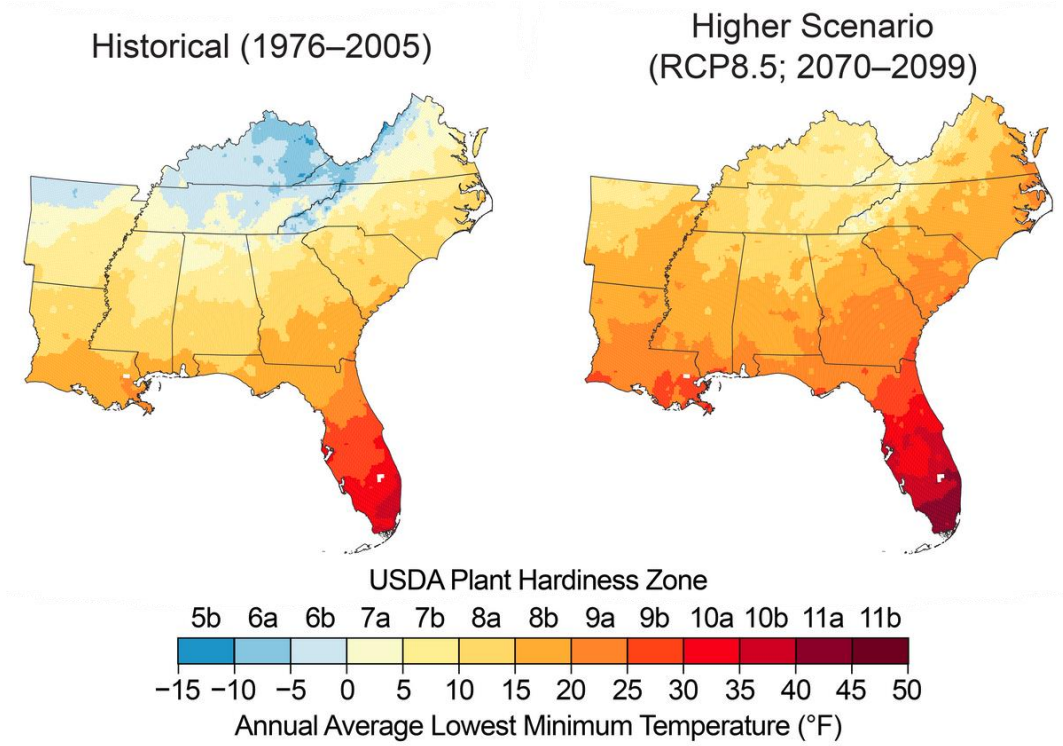


Fig. 4.2. Projected Plant Hardiness Zones for the Southeast. Drawing on U.S. Department of Agriculture plant hardiness zone data, the Fourth National Climate Assessment (NCA4) compares historical zones from 1976 to 2005 **(left)** with projected zones for 2070 to 2099 **(right)**. In this higher Representative Concentration Pathway (RCP) 8.5 scenario generated by NCA4, rising temperatures in the Southeast will cause plant hardiness zones to continue trending northward and upslope over the next 75 years. [Courtesy U.S. Department of Agriculture, National Oceanic and Atmospheric Administration, National Centers for Environmental Information, and Cooperative Institute for Climate and Satellites–North Carolina]

Key Challenges:

- ***Explore how vegetation growth and productivity respond to temperature change***
  - Establish network of common measurements across multiple sites to capture extreme temperatures, detect changes in timing of extreme events, and control of covarying factors
- ***Improve the predictability of precipitation events and ecosystem response to increased variability***
  - Leverage other measurements to improve parameterizations of land characteristics at sites with co-occurring disturbances
- ***Differentiate climate change effects from other system disturbances***
  - Leverage current and long-term data to disentangle independent and interactive effects of climate change and disturbance

Disturbance

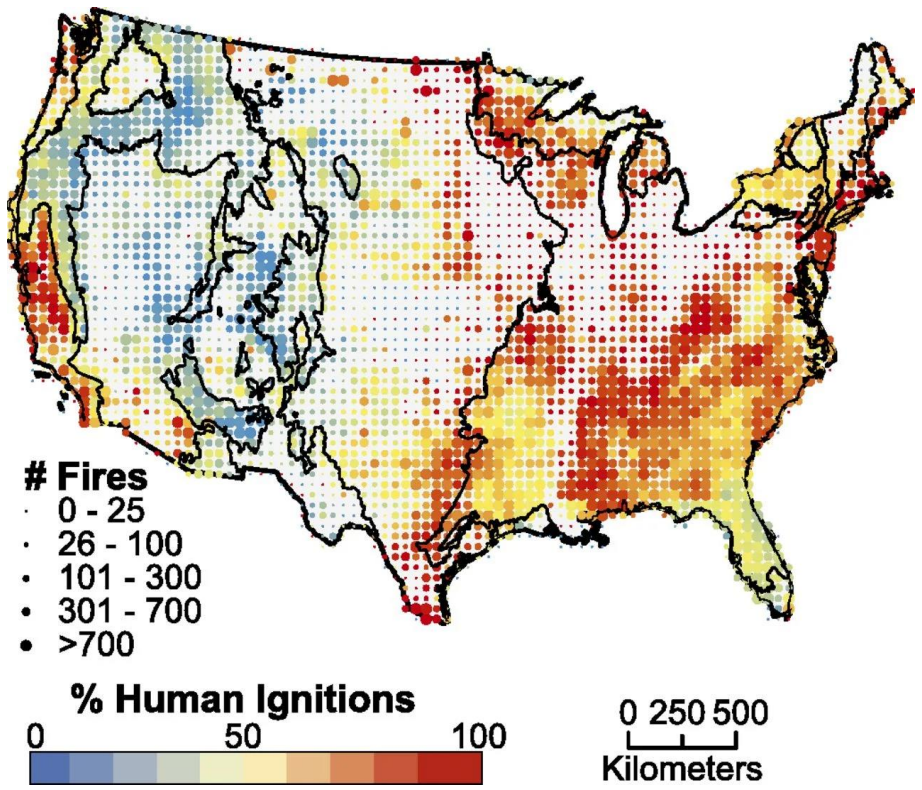


Fig. 5.1. Fires in the Southeast. The total number of wildfires (dot size) and the proportion started by humans (dot color: red indicating greater number of human-started fires) within each 50 km × 50 km grid cell across the coterminous United States from 1992 to 2012. Black lines are ecoregion boundaries. [Reprinted from Balch, J., et al., 2017. "Human-Started Wildfires Expand the Fire Niche Across the United States," *Proceedings of the National Academy of Sciences* **114**(11), 1946–51. DOI:10.1073/pnas.1617394114.]

Key Challenges:

- ***Identify how ecosystem disturbances modify surface fluxes, land–atmosphere interactions, and hydrological and biogeochemical cycles in the Southeast***
  - Leverage high spatial and temporal frequency observations of vegetation to provide a detailed understanding of cascade effects of disturbance-driven changes
- ***Compare the trajectory of ecosystem response to varying disturbance severity to other regions***
  - Integrate long term, high spatial resolution and temporal frequency observations of plant phenology, land-atmosphere flux exchange, and hydrological cycles

Land Use and Land Management

Fig. 6.1. Southeastern United States is a Hot-Spot for Land Cover Change. The geospatial distribution and magnitude of land cover change across the conterminous United States between 2001 and 2016 shows a high concentration of change in the Southeast. Forest logging, agriculture land use changes, and urban development are key factors in southeastern land cover change. Change was calculated as the proportion of 30 m change pixels in a 1 km square grid. [Courtesy U.S. Geological Survey]

Key Challenges:

- ***Identify urbanization impacts on land-atmosphere interactions and ecosystem processes***
  - Compare/contrast studies in urban, suburban, and rural environments
- ***Explore influences of forest management practices on energy, hydrology, and biogeochemistry***
  - Identify changing socioeconomic drivers of management decisions

Hydroclimatic Feedbacks

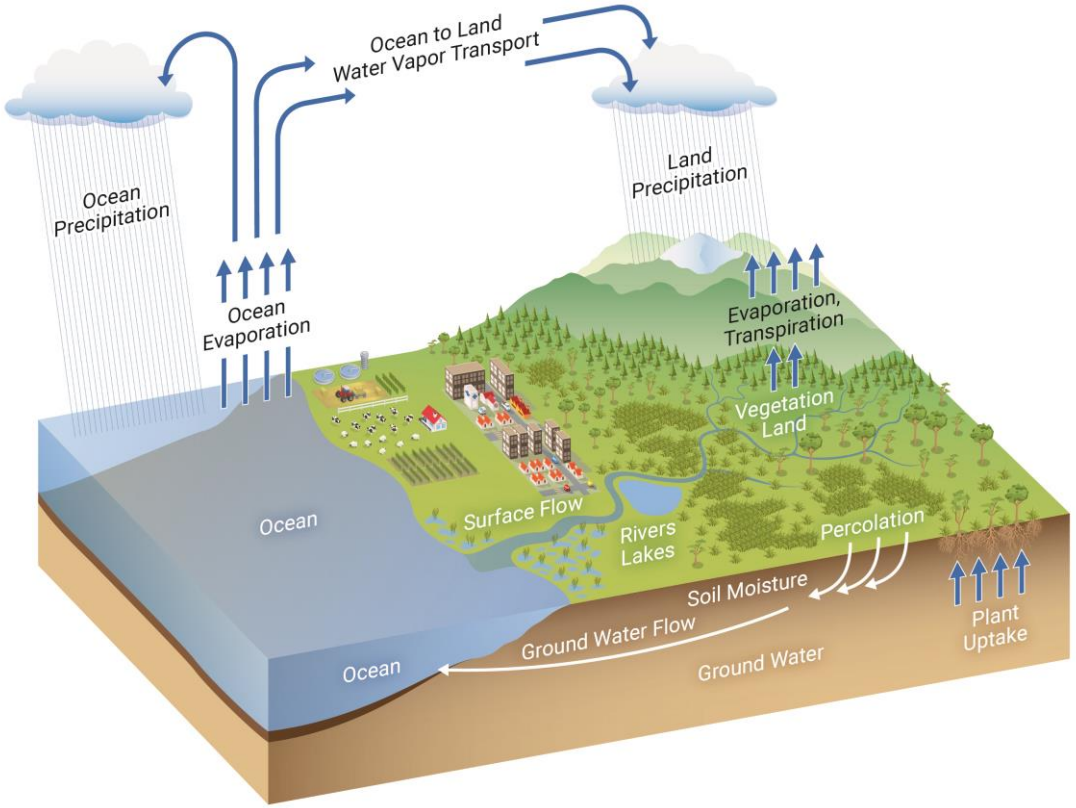


Fig. 7.2. Major Hydrologic Features of the Southeast Water Cycle. [Courtesy Oak Ridge National Laboratory]

Key Challenges:

- ***Identify ecosystem ET sensitivity to changing climatic conditions, and how compositional changes of vegetation alter these dynamics***
  - Coordinate monitoring of ET components, including substituting space for time across sites with climate variability
- ***Collect high-resolution data from AMF3-BNF to understand convective storm impacts on hydrological cycles in a watershed***
  - Leverage high-resolution data across sites spanning a range of storm intensities through a coordinated network of common measurements

Land-Atmosphere Coupling and Boundary Layer Dynamics

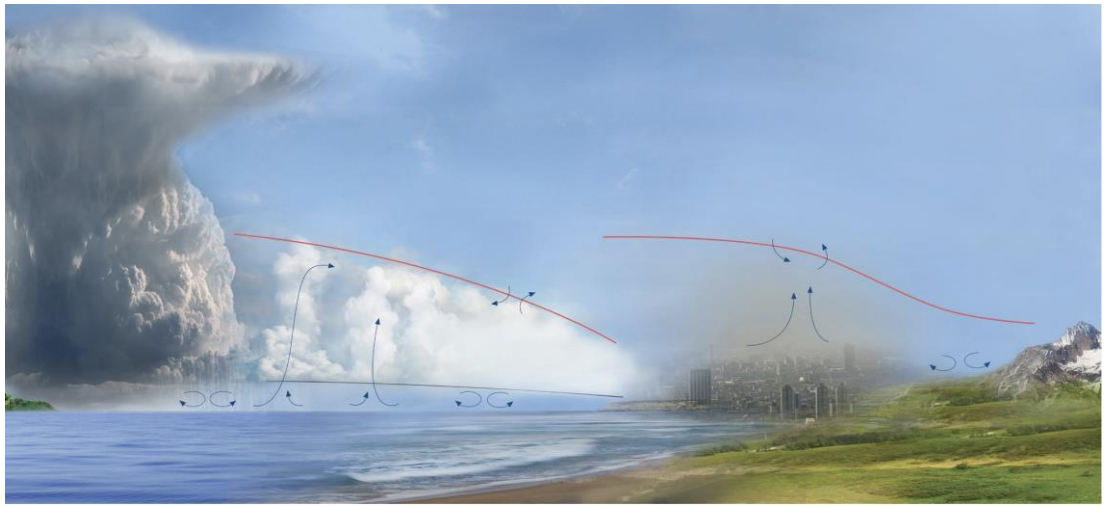


Fig. 8.1. Planetary Atmospheric Boundary Layer Schematic. Knowledge gaps exist in understanding boundary layer dynamics that in turn affect cloud processes and climate. [Reprinted with permission from Teixeira, J., et al. 2021. "Toward a Global Planetary Boundary Layer Observing System: The NASA PBL Incubation Study Team Report," NASA]

Key Challenges:

- ***Identify feedbacks between the atmospheric boundary layer and terrestrial ecosystems, and how those interactions may change in the future***
  - Couple AMF3-BNF monitoring with additional remote sensing observations across a variety of ecosystems and topography
- ***Explore controlling factors of BVOC emissions and SOA formation, and their variability across landscapes?***
  - Investigate how BVOC emissions from vegetation respond to stress and local environmental conditions

Research Opportunities to Support and Leverage AMF3 Deployment

Add Supplemental Observation Sites and Instrumentation

- Collect additional measurements within BNF and across the Southeast
- Use remote sensing platforms to complement surface observations and help bridge scales
- Gauge smaller watersheds within a larger system for scaling across a nested catchment

Include Hierarchical Observations

- Study carbon, water and energy cycling throughout the soil-plant-atmosphere continuum
- Focus measurements across gradients (e.g., urban-rural, agriculture-forest, managed-unmanaged, etc.)

Co-locate Existing Data

- Synthesize existing data in the Southeast
- Co-locate sensors at different (existing) sites to capture other land cover types
- Leverage remote sensing techniques for training, validation, or bridge to larger scales
- Integrate ecohydrology data from monitoring stations in the region where data is not available

Improve Models and Modeling Frameworks

- Leverage AI techniques
- Use linked model frameworks and model simulations to guide and inform measurements
- Allow AMF3-BNF to be a testbed for evaluating land surface models
- Explore ways to better represent disturbance and their impacts on ecosystems

SELARO Workshop Highlights

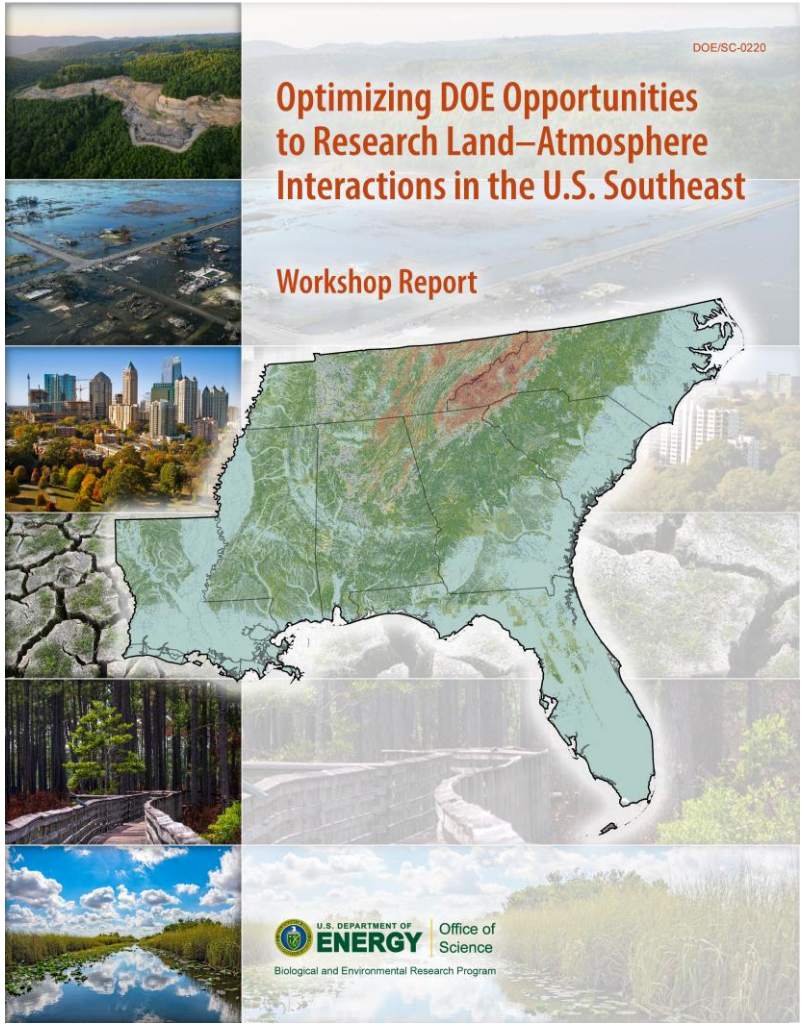
Leveraging and expanding the research focus of the AMF3-BNF deployment can:

- **Expand the types of landscapes in the domain**
- **Connect system components across spatial and temporal scales**
- **Develop new methods and techniques for simulating and understanding the Southeast**
- **Improve predictability and representation of the southeast in Earth System models**
- **Advance understanding of local and regional changes to impacts in a vulnerable, highly populated, and dynamic region**

Informed the Earth and Environmental Systems Science Research in the Southeast United States FOA

- **DE-FOA-0003420**

https://science.osti.gov/ber/-/media/grants/pdf/foas/2024/DE-FOA-0003420-000001.pdf



Questions?

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