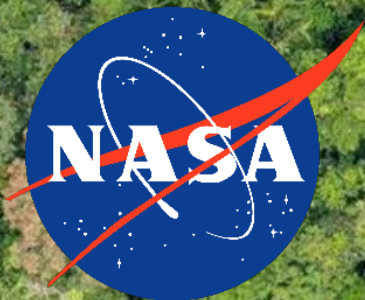


PANGEA

PAN tropical investigation of bioGeochemistry and Ecological Adaptation

Scoping a NASA Terrestrial Ecology Field Campaign

April 2, 2024 – LCLUC Meeting



PANGEA Leadership Team



Isaac Aguilar
UCLA



Dana Chadwick
JPL



Lola Fatoyinbo
NASA Goddard



António Ferraz
UCLA / JPL



Peter Griffith
NASA Goddard



Michael Keller
USFS



Junjie Liu
JPL



Chip Miller
JPL



Elsa Ordway (PI)
UCLA



Fabian Schneider
JPL



Bonaventure Sonké
Univ. of Yaoundé I



Hannah Stouter
UCLA



Xiangming Xiao
Univ. of Oklahoma



Funding Support

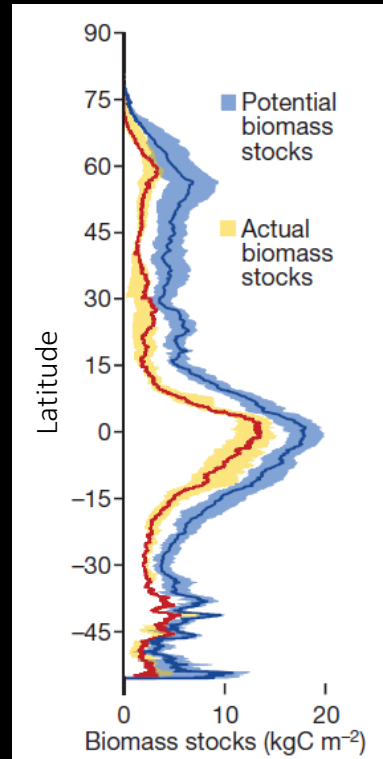
Institutional Partners



NGEE-TROPICS
NEXT-GENERATION ECOSYSTEM EXPERIMENTS



Tropical forests - critically important ecosystems



Erb et al 2018 *Nature*

Tropical ecosystems:

- Cover 10% land surface
- Maintain 66-80% of all species
- Home to over 3 billion people
- Constitute major water and heat pumps, contributing to regional and global climate
- Account for >30% of terrestrial NPP
- Store 25-40% of total terrestrial biomass

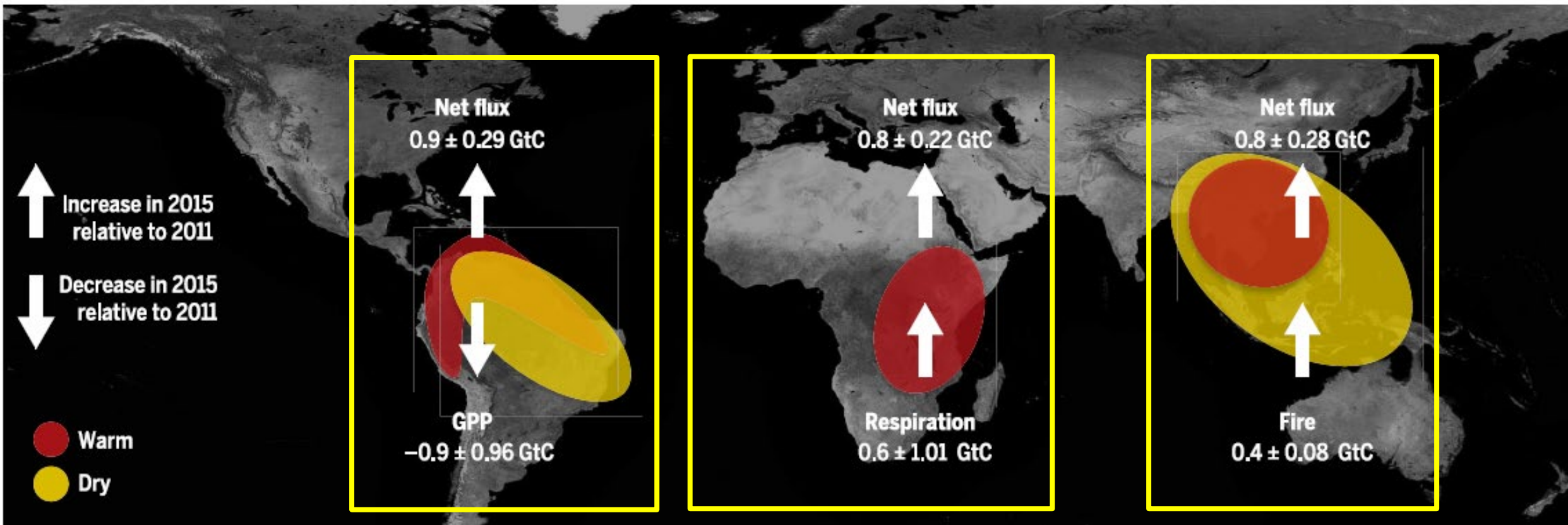
Tropical forest regions are changing rapidly

- Entering a no-analog state – compositionally different than anything found today
- Temperatures will soon be hotter than most tropical ecosystems have experienced in their evolutionary history → range shifts, adaptation, acclimation??
- Cropland and pastureland expansion in the tropics is the single greatest driver of deforestation, causing ~80% of forest conversion globally
- Agricultural production will be directly influenced by changing temperatures and rainfall patterns
- Tropical structure and function could be greatly diminished by the end of the century, resulting in critical climate feedbacks



Pan-tropical C source following 2015 El Niño

Distinct regional pathways resulted in net C emissions across tropics



Liu et al. & Eldering et al. 2017 *Science*

Drier land surface →
 Less plant growth →
 More CO₂

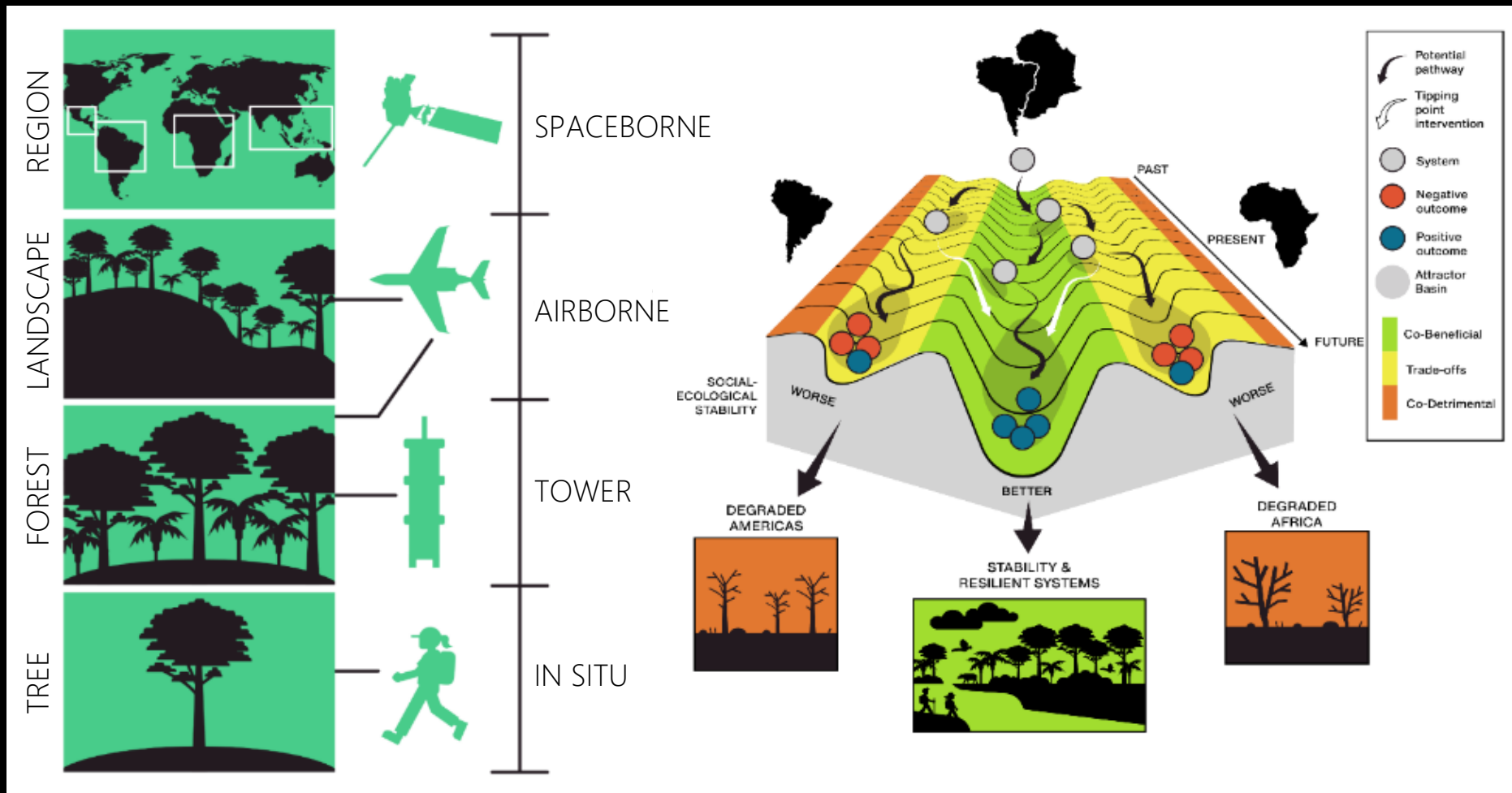
Higher temperatures →
 Increased respiration →
 More CO₂

Hotter and drier →
 More fire →
 More CO₂



PANGEA

PAN tropical investigation of bioGeochemistry and Ecological Adaptation



PANGEA

*How are climate change and
land-use change impacting the
vulnerability and resilience of
tropical forests across time
and space?*





NASA Terrestrial Ecology field campaigns are meant to:

- a) Answer big science questions targeted on important regions or biomes;
- b) Enable more effective interpretation and analysis of space-based measurements;
- c) Foster collaborative interactions and building new relationships within the scientific community;
- d) Provide valuable opportunities for training and educating the next generation of scientists; and
- e) Leave a legacy data set of great value for future research



What does it mean to scope a TE field campaign?

- A one-year effort to engage with the research community to:
 - Identify scientific research priorities and opportunities
 - Build relationships and define shared goals
 - Determine the geographic scope
 - Evaluate campaign feasibility
- Only 2 scoping proposals funded – [PANGEA](#) and [ARID](#)
- **Deliver white paper reporting findings by November / December 2024**
- If campaign funded, 6- to 9-year campaign



Past NASA TE Field Campaigns

- FIFE: First International Satellite Land Surface Climatology Project (ISLSCP) Field Experiment (1987-1989)
- BOREAS: Boreal Ecosystem-Atmosphere Study (1992-1999)
- LBA: Large-scale Biosphere-Atmosphere Experiment in Amazonia (1998-2011)
- ABOVE: Arctic Boreal Vulnerability Experiment (2015-2024)



ABOVE

ARCTIC BOREAL VULNERABILITY EXPERIMENT

Vulnerability and Resilience Framework



CAUSES OF CHANGE

Many factors from the local, to regional, to global scales drive changes to ecosystems. Examples include: natural disturbances such as fires and insects; and increasing temperature and CO₂.



CHANGES TO ECOSYSTEMS

Ecosystem structure and function are impacted by drivers that are both external (e.g., climate, invasive species) and internal (e.g., fire, animal disease, mining, infrastructure).



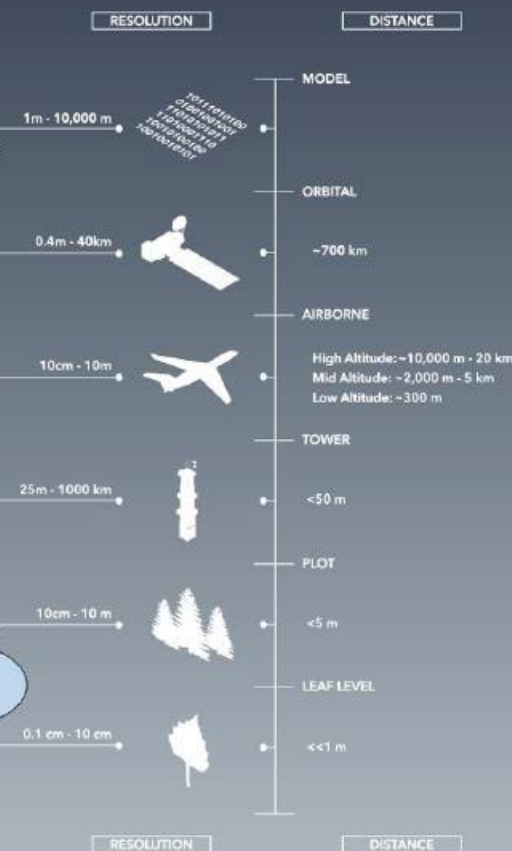
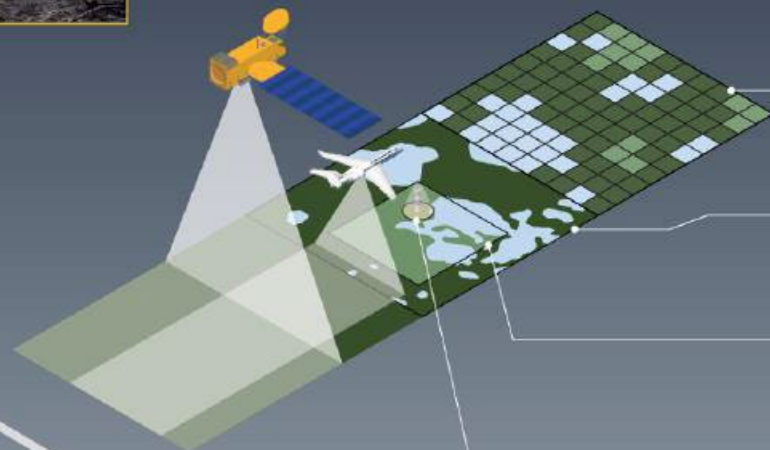
ECOSYSTEM SERVICES

Ecosystem services are the benefits and value that people derive from the environment that sustains us. Examples include: food and freshwater production and indigenous wildlife harvest.



SOCIAL SYSTEMS

People respond to these changes in many ways. Individuals and households may change their behavior, for example relying more heavily on store-bought food than subsistence hunting.



Scaling Observations from Leaf to Orbit

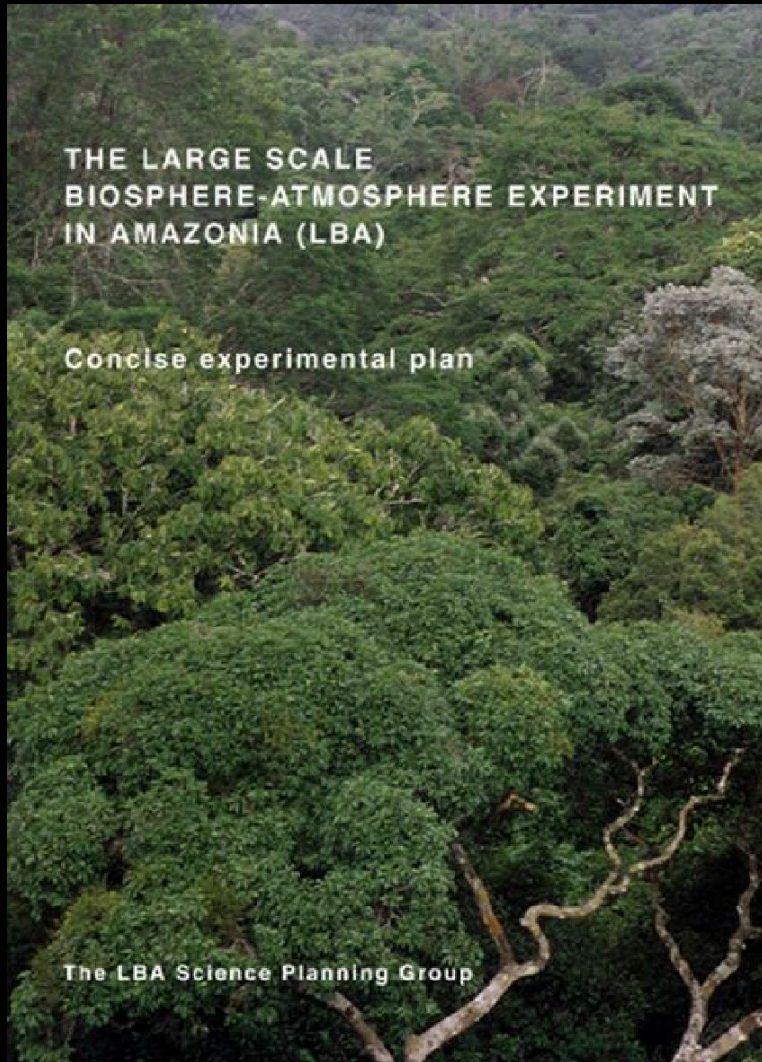


LBA Large-Scale Biosphere-Atmosphere Experiment in Amazonia



- An international program led by Brazil (Brazilian Ministry of Science and Technology)
- Initiated in 1998 and still active in Brazil
- NASA's Terrestrial Ecology and Land Use-Land Cover Change Programs participated in LBA through their sponsorship of LBA projects called LBA-ECO
- The largest, coordinated, regional Earth system science study





Overarching LBA science questions:

1. How does Amazonia function as a regional entity?
2. How will changes in land use and climate affect the biological, chemical, and physical functions of Amazonia, including the sustainability of the region and the influence of Amazonia on regional and global climate?

The LBA-ECO (NASA) Question:

1. How do tropical forest conversion, regrowth, and selective logging influence carbon storage, nutrient dynamics, trace gas fluxes, and the prospect for sustainable land use in Amazonia?



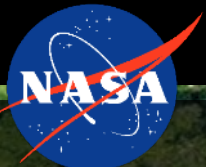
LBA: a monumental effort and a large legacy

- >1000 students trained (>500 PhD and MSc)
- Nearly 2000 scientists
- >2000 scientific papers



PANGEA Overarching Questions

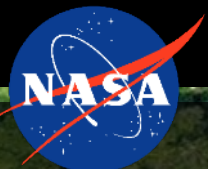
1. What are the similarities and differences within and between each tropical regions?
2. How are the vulnerability and resilience of tropical forest ecosystems changing with global change?
3. How can this information be used to guide decision making for climate adaptation & mitigation and biodiversity conservation?



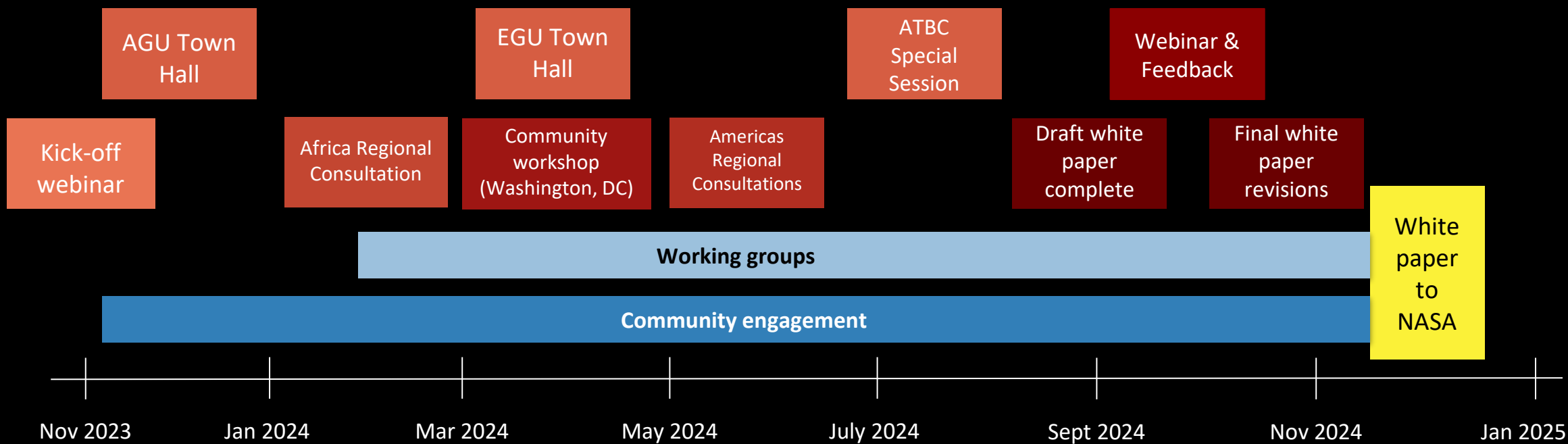
Community Engagement & Next Steps

PANGEA will work with people across disciplines, career stages and continents to:

- Determine scientific priorities across the tropical research community
- Articulate the most pressing and feasible science questions
- Define the geographic scope and identify field sites
- Create a research environment that supports historically marginalized voices, researchers and communities
- Guide societal responses to land cover change and climate change



PANGEA Scoping Timeline



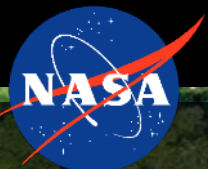
Questions?

Get involved



Click here to get involved
with PANGEA:

Get Involved!



Why we need PANGEA

- LBA started 25 years ago. The world has changed. The climate has changed.
- When LBA started, we asked how tropical forests are changing. We now ask whether and how tropical forest regions will survive the changes.
- Science and technology have advanced.
- We are in a data rich era for satellite observation compared to when LBA began in the 1990s.
- We need a PAN-tropical campaign → PANGEA



What is a PANGEA?

- A 1-year effort to scope a large-scale research and capacity building campaign to better understand how Earth's tropical terrestrial ecosystems are responding to global change.
 - Interdisciplinary
 - Ecology, Biogeochemistry, Hydrology, Atmospheric Sciences, Socio-Ecological systems, and more
 - Multi-scalar
 - Surface, airborne and spaceborne observations
 - Local to global ramifications & engagement

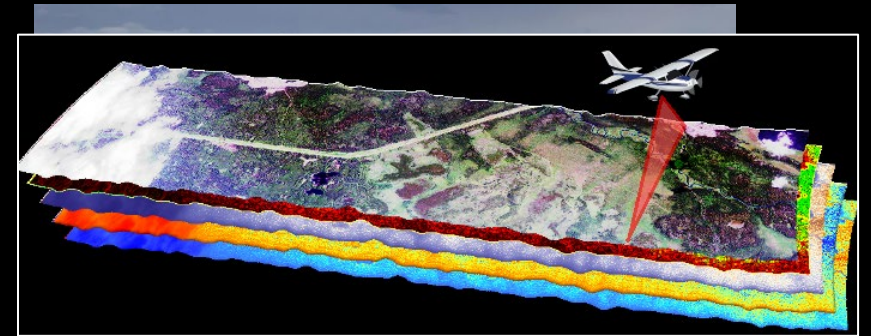


Image credits: C. Boyd, CongoFlux, AVIRIS-NG



PANGEA Working Groups

Science
Themes

- Biogeochemical cycles & carbon dynamics
- Ecosystem structure, function, and biodiversity
- Climate feedbacks and interactions
- Socio-ecological systems
- Modeling & Data Assimilation
- Feasibility
- Community Engagement
- Research and Applications Output

Cross-
Cutting

