PANGEA White Paper Outline

[NASA Tropical Ecology Scoping Solicitation](https://nspires.nasaprs.com/external/viewrepositorydocument/cmdocumentid=860588/solicitationId=%7BEB63A640-7CE0-70F6-BE80-C12541C56B5F%7D/viewSolicitationDocument=1/A.4%20Terrestrial%20Ecology%20Amend%2036.pdf)

***From Solicitation:***

The main deliverable will be a scoping report that lays out the scientific issues at stake, the logistical framework, and one or more paths forward toward implementation. Scoping studies will be required to address the following elements:

1. The science questions and issues
2. The current state-of-the-science
3. The potential for a major, significant scientific advancement
4. The central, critical role of NASA remote sensing
5. The essential scientific components of the study and why coordinated teamwork is required in their implementation
6. An overall study design identifying the required observational (e.g., spaceborne, airborne, and/or supporting in situ observations) and analytical (e.g., models, data, and information system) infrastructure
7. The feasibility of the proposed project, both technical and logistical
8. The engagement of the broader research community to seek feedback on the ideas, to assess interest, and to foster diversity and inclusion
9. The disciplinary skills needed to conduct the study and engage potential partners in their planning activities
10. Potential use of results for applications and decision support.

Scoping studies must produce a written report that **provides the scientific rationale and an initial study design concept** for a new field campaign or related team project. While this report need not be lengthy, it **must include a thorough presentation of science questions, goals, and objectives; the underlying rationale in terms of state-of-the-art, relevance, and expected advances; implementation concepts**; and other information to enable NASA to fully evaluate the project.

**[LOGO]**

**The PAN tropical investigation of bioGeochemistry and Ecological Adaptation (PANGEA): A Concise Plan for a NASA-Sponsored Field Campaign**

**Final Report**

**December 2024**

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**Foreword**

NASA’s Research Opportunities in Space and Earth Sciences released in 2022 called for proposals to conduct scoping studies to identify the scientific questions and develop the initial study design and implementation concept for a new NASA Terrestrial Ecology field campaign. In the spring of 2023, NASA selected two projects for funding, including a project entitled: “*A Scoping Study for the NASA Tropical Terrestrial Ecology Campaign”* (NASA Grant 80NSSC23K1019 to the University of California, Los Angeles). This report contains the recommendations from this scoping study, which presents the **PAN tropical investigation of bioGeochemistry and Ecological Adaptation (PANGEA).** NASA outlined ten expectations to be identified for each scoping study:

1. The science questions and issues.
2. The current state-of-the-science.
3. The potential for a major, significant scientific advancement.
4. The central, critical role of NASA remote sensing.
5. The essential scientific components of the study and why coordinated teamwork is required in their implementation.
6. An overall study design identifying the required observational (e.g., spaceborne, airborne, and/or supporting in situ observations) and analytical (e.g., models, data, and information system) infrastructure.
7. The feasibility of the proposed project, both technical and logistical.
8. The engagement of the broader research community to seek feedback on the ideas, to assess interest, and to foster diversity and inclusion.
9. The disciplinary skills needed to conduct the study and engage potential partners in their planning activities.
10. Potential use of results for applications and decision support.

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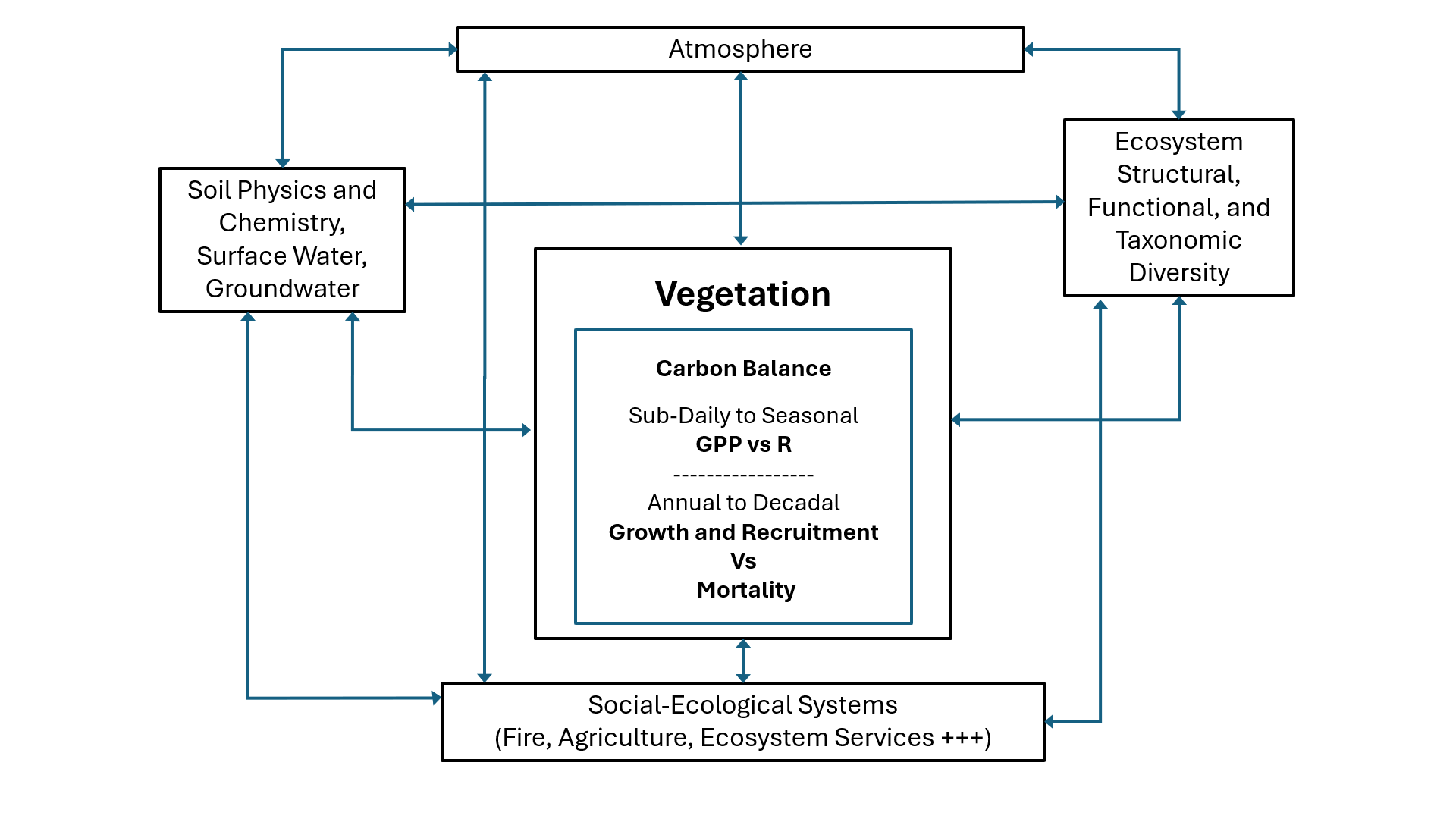
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## 1. Introduction and Motivation

In recent decades, tropical forest regions have been a strong and persistent carbon sink. As a result of climate change and land-use change, the tropical carbon sink is now fragile, at times reversing to become a source of carbon emissions to the atmosphere in response to extreme events. Critically, tropical forests appear to differ in their sensitivity to extreme events and future climate and land-use change feedbacks. We do not currently know how sensitive tropical forest regions are, how much that sensitivity differs across continents, or the mechanisms that account for those differences.

The global carbon cycle and tropical forest function are tightly linked to the water cycle (e.g., rainfall recycling), increasing temperatures and changes in seasonality, the biodiversity that underpins these systems, and feedbacks with the people that live in and depend on these landscapes. A coordinated multiscale campaign is required to advance our understanding of the sensitivity of these systems to future change. This campaign will simultaneously advance global-scale understanding of tropical ecosystem processes, accelerate progress in modeling tropical ecosystems, and in our data-rich era of new dimensionality effectively utilize current and forthcoming satellite missions to diagnose the current state of tropical forests.



### 1.1 Science Questions and Objectives/Issues

### 1.2 PANGEA Science Themes

### 1.3 Role of Remote Sensing Observations

### 1.4 PANGEA Study Domain

## 2. PANGEA Science Themes

### 2.1 Biogeochemical Cycles and Carbon Dynamics

### 2.2 Ecosystem Structure, Function, and Biodiversity

### 2.3 Climate Interactions and Feedbacks

### 2.4 Social-Ecological Systems

### 2.5 Potential use of results for applications and decision support

## 3. Research Strategy and Study Design Critical role of NASA remote sensing

### 3.1 Overall Design / Approach

### 3.2 Candidate Study Sites / Regions

### 3.3 Modeling and Integrative Analyses

### 3.4 Remote Sensing Observations

### 3.5 Field Observations, Studies, Experiments

### 3.6 Technical and Logistical Feasibility / Issues

## 4. Organization and Management

### 4.1 Scientific Leadership

### 4.2 Project Organization

### 4.3 Field Operations

### 4.4 Data Management and Sharing

### 4.5 Timetable

## 5. Required Resources and Coordinated Teamwork

### 5.1 Engagement of the broader research community

### 5.2 Disciplinary skills needed

### 5.3 Field Infrastructure

### 5.4 Suborbital Platforms and Sensors

### 5.5 Satellite Data Availability, Access, and/or Purchase

### 5.6 International and Other Agreements

### 5.7 Training and Education

### 5.8 Cost Estimates

## 6. Summary of Broad Research Community Involvement and Interests

## 7. Issues to be Resolved

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### A - Planned and Ongoing Research and Monitoring Activities

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