'*Tree-Grass*': Proposal for a NASA Terrestrial Ecology Field Activity in Savannas and Mixed Tree-Grass Ecosystems

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INTRODUCTION

We describe a proposal for a NASA Terrestrial Ecology field activity that will enhance remote sensing and earth system modelling capabilities in ecosystems characterized by mixtures of woody and herbaceous species ('tree-grass' systems). The proposed "*Tree-Grass*" (*TG*) program will transform our ability to use satellite data and earth system models to assess the current and future role of tree-grass systems in the earth system, and their future in the face of changing climate, changing land use and human population growth. In so doing we will enhance our ability to manage tree-grass ecosystems for sustainability, food security and economic wellbeing.

Draft white paper and more information available at:
http://www.nrel.colostate.edu/projects/srs/

(1) The Global Importance of Tree-Grass Mixtures

Conventional biome-based vegetation maps tend to *under-emphasize* tree-grass mixtures. Structurally-based analysis indicates that more than 35% of global land area can be considered "tree-grass".

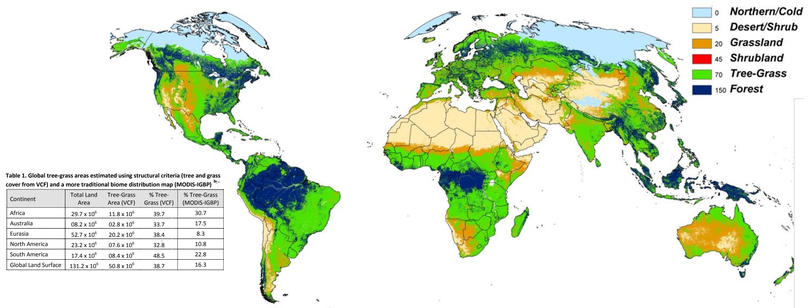


Table 1. Global tree-grass areas estimated using structural criteria (tree and grass cover from VCF) and a more traditional biome distribution map (MODIS-IGBP)[3]

Continent	Total Land Area	Tree-Grass Area (VCF)	% Tree-Grass (VCF)	% Tree-Grass (MODIS-IGBP)
Africa	29.7×10^6	11.8×10^6	39.7	30.7
Australia	08.2×10^6	02.8×10^6	33.7	17.5
Eurasia	52.7×10^6	20.2×10^6	38.4	8.3
North America	23.2×10^6	07.6×10^6	32.8	10.8
South America	17.4×10^6	08.4×10^6	48.5	22.8
Global Land Surface	131.2×10^6	50.8×10^6	38.7	16.3

Figure 1. Global distribution of tree-grass mixtures based on classification of MODIS VCF data

The 2005 VCF product (Hansen et al., 2005) provides relative cover estimates for 'trees', herbaceous' &'bare soil' components. Tree-grass mixtures were assessed using fixed structural criteria (satisfying 1% < tree cover < 50% and grass cover > 25%). We screened for arctic, taiga, northern boreal, and high mountain regions using a mean annual temperature threshold of -5C (Woodward et al., 2004). The temperature threshold is necessary because, in these colder regions, under-story communities are dominated by perennial forbs and sub-shrubs, not grasses, but VCF recognizes them as woody and herbaceous mixtures. Because VCF does not resolve small trees and shrubs, tree-grass mixtures are underestimated in some areas (e.g. Sahelian Africa and central Australia).

TREE-GRASS KEY QUESTIONS

- How are climate change and land-use altering the structure, function and productivity of tree-grass systems at landscape, regional and global scales? ("Global Change Processes")
- How will changes in tree-grass structure, function and productivity interact in the earth system and feed-back on the major cycles of carbon, water and nutrients and energy flows? ("Biophysical and Ecological Interactions")
- How will global change and biophysical interactions in tree-grass systems impact human wellbeing, food security and sustainability into the future? Conversely, what is the potential for global change mitigation, and can human populations in tree-grass regions benefit from this potential? ("Goods and Services")

(2) *Tree-Grass* Concepts

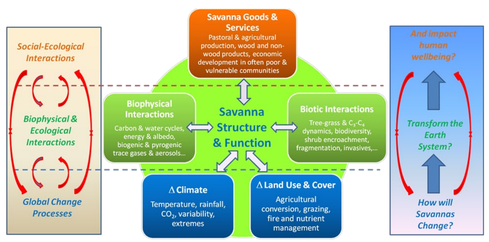


Figure 2: Conceptual diagram for tree-grass and savanna systems, showing drivers of change, ecosystem processes and provision of goods and services (center), interactions between global change, biophysical and social-ecological domains (left), and key science questions for the *Tree-Grass* activity (right).

(3) *Tree-Grass* Science Framework

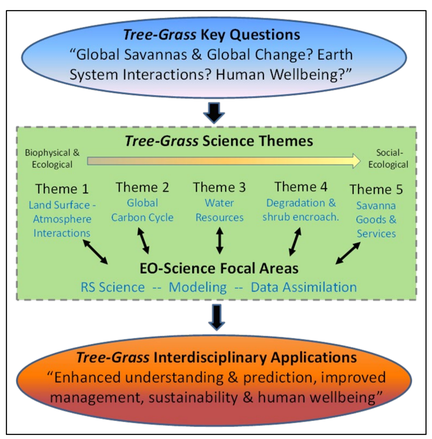
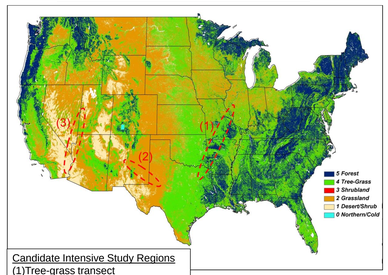


Figure 3: *Tree-Grass* science framework showing key science questions, *TG* Science Themes, Earth Observation (EO)-Science Focal Areas and emergent *Tree-Grass* applications

(4) *Tree-Grass* Strategies

TG Intensive Field Sites



Candidate Intensive Study Regions
(1)Tree-grass transect
(2)Shrub-grass transect
(3)Hot-cold desert-shrublands

TG Distributed Field Sites

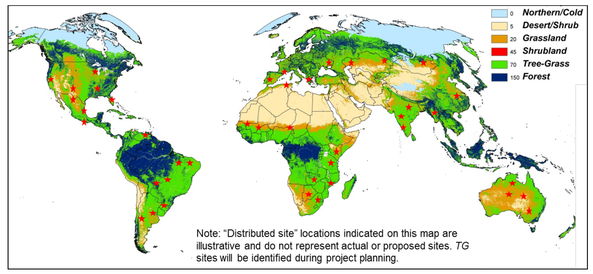


Figure 4: *TG Intensive* and *Distributed* field sites provide opportunities for detailed process-based studies with global sampling of diverse tree-grass systems

Intensive Site Strategy: Intensive sites with detailed process studies will address *TG* Science Themes and EO Focal Areas. NASA concentration in North America, with possible additional *Intensive Sites* supported in collaboration with international partners (major logistical/financial investment)

Distributed Site Strategy: Globally distributed, low intensity measurement sites, will sample climatic, biotic and anthropogenic diversity for parameterization, calibration and validation of *TG* technologies and models in global tree-grass systems (modest logistical/financial investment)

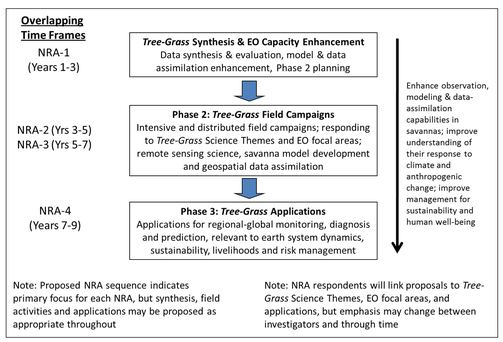


Figure 5: Proposed implementation strategy for the *Tree-Grass* research program

Acknowledgements
The NASA Terrestrial Ecology Program supported a Scoping Study entitled "**Challenges and Opportunities in Remote Sensing of Global Savannas: A Scoping Study for a New TE Field Campaign**". We thank a broad community of savanna and tree-grass enthusiasts who attended the Savanna Remote Sensing Workshop (Fort Collins, March 2010) and provided comments and feedback in drafting of the *Tree-Grass* White Paper.

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(5) *Tree-Grass* Education & Outreach

Tree-Grass Phase	Year	Graduate Student	K-12	Under-graduate	General Public	Practitioners	Managers
Phase 1	1	X					
	2	X					
Phase 2	3	X	X	X	X		
	4	X	X	X	X		
	5	X	X	X	X		
	6	X	X	X	X		
Phase 3	7	X	X	X	X	X	X
	8	X				X	X
	9	X				X	X
		GRFP		E4S		TTAP	

Figure 6. *Tree-grass* education and outreach programs
GRFP = Graduate Research Fellowship Program
E4S = Earth System Science Summer Schools
TTAP = Technology Transfer & Adoption Program

TG IMPACTS

TG seeks to revolutionize earth observation science through improved consideration of woody and herbaceous functional groups in remote sensing and modeling of terrestrial ecosystems. The *TG* program will further entrain and inspire the next generation of earth system scientists and enhance public appreciation of the crucial role NASA remote sensing technologies can play in understanding and managing the earth system.

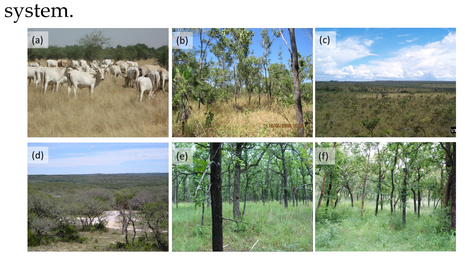

Figure 7. Globally diverse tree-grass vegetation associations, with regions typically classified as "savanna" in the upper row, and regions typically not classified as savanna in the lower row.
(a) Sahel of Mali, West Africa (Photo: F Dembele); (b) Northern Territory savannas, Australia (Photo: A Marks); (c) Cerrado, Brazil (Photo: M Bustamante); (d) Edwards plateau shrublands, Texas (Photo: MJ Hill); (e) Oklahoma oak woodlands (Photo: J Burton); (f) Dry deciduous woodlands of southern Western Ghats, India (Photo: J Ratnam).