DEPARTMENT OF GEOGRAPHICAL SCIENCES OVERVIEW

AUGUST 16TH, 2017

MISSION

TO MAKE A FUNDAMENTAL CONTRIBUTION TO THE ADVANCEMENT OF GEOGRAPHIC SCIENCE BY:

- CONDUCTING DISCIPLINARY AND INTEGRATIVE RESEARCH IN THE PHYSICAL AND SOCIAL SCIENCES THAT SPAN LOCAL TO GLOBAL SCALES WITH AN EMPHASIS ON A GEOSPATIAL PERSPECTIVE OF OUR CHANGING PLANET AND ITS SUSTAINABILITY
- EQUIPPING STUDENTS TO MEET THE CHALLENGES ASSOCIATED WITH THE CONTINUING EVOLUTION OF GEOGRAPHIC SCIENCE WHILE PROVIDING THEM WITH VIBRANT AND FULFILLING EDUCATIONAL EXPERIENCES
- APPLYING GEOGRAPHIC SCIENCE TO SOCIETAL AND ENVIRONMENTAL ISSUES IN OUR STATE, NATION AND GLOBAL COMMUNITY

COMPOSITION I

FACULTY

- 31 TEACHING FACULTY
  - 16 PROFESSORS
  - 15 LECTURERS
- 39 RESEARCH PROFESSORS
- 17 ADJUNCT PROFESSORS
- 19 RESEARCH ASSOCIATES
- 27 FACULTY RESEARCH ASSISTANTS

COMPOSITION II

STUDENT BODY

- 67 PHD STUDENTS
- 3 BS/MS STUDENTS
- 116 MPS STUDENTS
- 194 CURRENTLY ENROLLED MAJOR BACHELORS STUDENTS (AS OF 8/16/17)
- 110 CURRENTLY ENROLLED MINOR BACHELORS STUDENTS (AS OF 8/16/17)

GEOG RANKED BY NRC AS #3 IN THE NATION FOR PHD GRANTING UNIVERSITIES

DEPARTMENT OF Geographical Sciences
BE GLOBAL

KEY RESEARCH THEMES

- **Human Dimensions of Global Change – Coupled Human and Natural Systems**
  - Studies of linkage between socio-economic systems and environmental systems
    - Teleconnecting local consumption to global impacts
    - Effects of Nature Tourism as a Development Strategy on Poverty and Inequality
    - Modeling and Visualizing Global Food Supply
    - Poverty alleviation and climate change
    - Social Networks
- **Land Cover – Land Use Change**
  - Studies key interface between human and natural systems
    - Global Forest Monitoring using Remote Sensing
    - Mapping of Global Urban Extent
    - Fire Monitoring and Modeling Remote using Sensing
    - Global Agricultural Production Monitoring

KEY RESEARCH THEMES

- **Carbon, Vegetation Dynamics and Landscape-Scale Processes**
  - **Studies monitoring and modeling global vegetation dynamics and carbon**
    - Modeling the Impacts of major Disturbances on the Earth's Coupled Carbon-Climate System
    - Synthesis of Forest Growth, Response to Wildfires and Carbon Storage for Russian Forests
    - Carbon modelling of boreal peatland systems
    - A Framework for High-resolution Estimation of Terrestrial Carbon
- **Geospatial-Information Science and Remote Sensing**
  - **Studies utilizing big data, geospatial data mining, analysis and visualization**
    - Geospatial Data structures and Modeling
    - Spatiotemporal mobility patterns and public health
    - Place-based data analytics and Geoprivacy
    - Lidar derived 3-D Vegetation Structure (GEDI Mission)
    - GLCF Data Archive and Distribution
    - GEO ODK Mobile Application for field data collection

RESEARCH STATISTICS

- Total Research Fund: $ 13.2Million
- NASA Awarded Fund: $ 8.7 Million (69.8%)
- Total NASA projects: 58 projects
- FY 04 to FY 13 growth: +169%
- Education: Average, 6 Fellowships/year
- **Leadership in NASA Programs:**
  - Chris Justice: Program Scientist, Land Cover Land use Change, VIIRS Land Discipline Lead, Co-Chair LANCE UWG
  - Ralph Dubayah: GEDI PI., Chair Vegetation Structure WGG
  - George Hurtt: Science Team Leader, Carbon Monitoring System
  - Eric Kasischke: Co-Chair, ABOVE Science Definition Team

RESEARCH HIGHLIGHTS (2013)

- For the first time externally funded research volume passed $13 million
- 11 department researchers recognized as University Research Leaders (>$300,000/year)
- 10 Undergraduate Honors students participate in Joint UMD-BNU
- Joint Global Change Program
- 6 papers were published in top tier journals (e.g. Science, Nature, PNAS)
- UMD ranked #4 in the world in Remote Sensing
- New GSFC-UMD Joint Global Carbon Cycle Center enters year 2
- PhD Students Don Cheng and Ana Sanchez-Rivera win awards for student paper presentations at AGU and Applied Geography Conferences

UNDERGRADUATE PROGRAM

MAJORS AND TRACKS

- **GEOGRAPHICAL SCIENCES**
  - ENVIRONMENTAL SYSTEMS AND NATURAL RESOURCES
  - DEVELOPMENT AND SUSTAINABILITY
- **GEOGRAPHIC INFORMATION SCIENCE & COMPUTER CARTOGRAPHY**
  - GIS
  - REMOTE SENSING
- **ENVIRONMENTAL SCIENCE & POLICY**
  - MARINE AND COASTAL MANAGEMENT
  - LAND USE
  - GLOBAL ENVIRONMENTAL CHANGE

UNDERGRADUATE PROGRAM

MINORS

- GEOGRAPHIC INFORMATION SCIENCE
- REMOTE SENSING OF ENVIRONMENTAL CHANGE

OTHER PROGRAMS

- INTERNSHIP PROGRAM
- STUDY ABROAD
- HONORS
- TA PROGRAM
- GEOGRAPHY CLUB & GAMMA THETA UPSILON
- GEOGRAPHICAL SCIENCES CAREER FAIR
- 5 YEAR MS/BS PROGRAM
- DOUBLE MAJOR WITH SECONDARY EDUCATION

FALL 2018 LOWER LEVEL UNDERGRADUATE COURSES

COURSE #	COURSE TITLE	REQUIREMENT
GEOG110	THE WORLD TODAY: GLOBAL PERSPECTIVES	GENERAL EDUCATION (DSHS, DVUP)
GEOG130	DEVELOPING COUNTRIES	GENERAL EDUCATION (DSHS, DSSP)
GEOG140	NATURAL DISASTERS	GENERAL EDUCATION (DSNS, SCIS)
GEOG170	INTRODUCTION TO METHODS OF GEOSPATIAL INTELLIGENCE AND ANALYSIS	GENERAL EDUCATION (DSNS)
GEOG201	GEOGRAPHY OF ENVIRONMENTAL SYSTEMS	GENERAL EDUCATION (DSNL), MAJOR, MINOR
GEOG212	CAREER PLANNING FOR GEOG, GIS, AND ENSP	MAJOR

EXAMPLES OF FALL 2018 UPPER LEVEL UNDERGRADUATE COURSES

COURSE #	COURSE TITLE	REQUIREMENT
GEOG306	INTRODUCTION TO QUANTITATIVE METHODS	GENERAL EDUCATION (FSAR), MAJOR, MINOR
GEOG330	AS THE WORLD TURNS: SOCIETY AND SUSTAINABILITY IN A TIME OF GREAT CHANGE	GENERAL EDUCATION (DSHS, DVUP, SCIS), MAJOR
GEOG332	ECONOMIC GEOGRAPHY	MAJOR
GEOG372	REMOTE SENSING	MAJOR, MINOR
GEOG373	GEOGRAPHIC INFORMATION SYSTEMS	MAJOR, MINOR
GEOG416	CONCEPTUALIZING AND MODELING HUMAN-ENVIRONMENTAL INTERACTIONS	MAJOR
GEOG418	FIELD AND LABORATORY TECHNIQUES IN ENVIRONMENTAL SCIENCE	MAJOR
GEOG422	CHANGING GEOGRAPHIES OF SUB-SAHARAN AFRICA	MAJOR
GEOG432	SPATIAL ECONOMETRICS	MAJOR
GEOG476	OBJECT ORIENTED PROGRAMMING FOR GIS	MAJOR
GEOG498K	WEB GIS	MAJOR

GRADUATE PROGRAM

PROGRAMS OFFERED

1. **MASTER PROFESSIONAL STUDIES IN GEOGRAPHIC INFORMATION SCIENCES (MPS/GIS)**
2. **DOCTORAL PROGRAM • B.A. OR B.S. IN GEOGRAPHY NOT REQUIRED**
3. **COMBINED BS/MS PROGRAM**

- **APPLICATIONS ACCEPTED SEPTEMBER 1 - DECEMBER 15 FOR FALL ENTRY**
- **FINANCIAL AID – TEACHING ASSISTANTSHIPS, RESEARCH ASSISTANTSHIPS, VARIOUS FELLOWSHIPS AVAILABLE.**
- **SALARY IS FOR 9.5 MONTHS (20 HRS/WK) + FULL TUITION REMISSION – ANNUAL RENEWAL POSSIBLE IF 3.0+ GPA IS MAINTAINED**
- **FOR MORE INFORMATION, PLEASE VISIT: HTTPS://GEOG.UMD.EDU/LANDING/GRADUATE**

MPS GIS PROGRAM

- MORE THAN JUST GIS:
  - REMOTE SENSING, COMPUTER PROGRAMMING, STATISTICS
- OFFERS BOTH MPS DEGREE AND GRADUATE CERTIFICATE
  - MPS (31 CREDITS)
  - GRADUATE CERTIFICATE (12 CREDITS)
- INTERACTIVE AND DYNAMIC
  - LECTURES TAUGHT IN A REAL CLASSROOM AND SIMULTANEOUSLY BROADCAST ONLINE IN REAL TIME
  - OPTIONAL ON-CAMPUS STUDY
- BASED ON 12-WEEK LONG QUARTERS
- DESIGNATED AS AN ESRI DEVELOPMENT CENTER
- CURRENTLY ENROLLMENT: 116 MPS STUDENTS, 20 GRADUATE CERTIFICATE STUDENTS (AS OF FALL 2017; ~85% PURSUING MASTER DEGREE)

UNIVERSITY OF MARYLAND
Master of Professional Studies in Geospatial Intelligence

Starting in Fall 2017…MPS in Geospatial Intelligence

- PROVIDES GRADUATES WITH THE SKILLS AND EXPERTISE TO LEAD NEW INITIATIVES IN THE RAPIDLY SHIFTING LANDSCAPE OF GEOINT APPLICATIONS, DATA COLLECTION SYSTEMS, ANALYTIC METHODS, AND MISSION SUPPORT
- OFFERS BOTH A MASTER'S DEGREE PROGRAM AND A GRADUATE CERTIFICATE IN GEOINT
- FULL-TIME OR PART-TIME, ONLINE OR ON-SITE
- VISIT HTTPS://GEOSPATIAL.UMD.EDU/EDUCATION/OVERVIEW (CGIS WEBSITE UNDER **EDUCATION** TAB) FOR COMPLETE DETAILS

Department of Geographical Sciences
BE GLOBAL

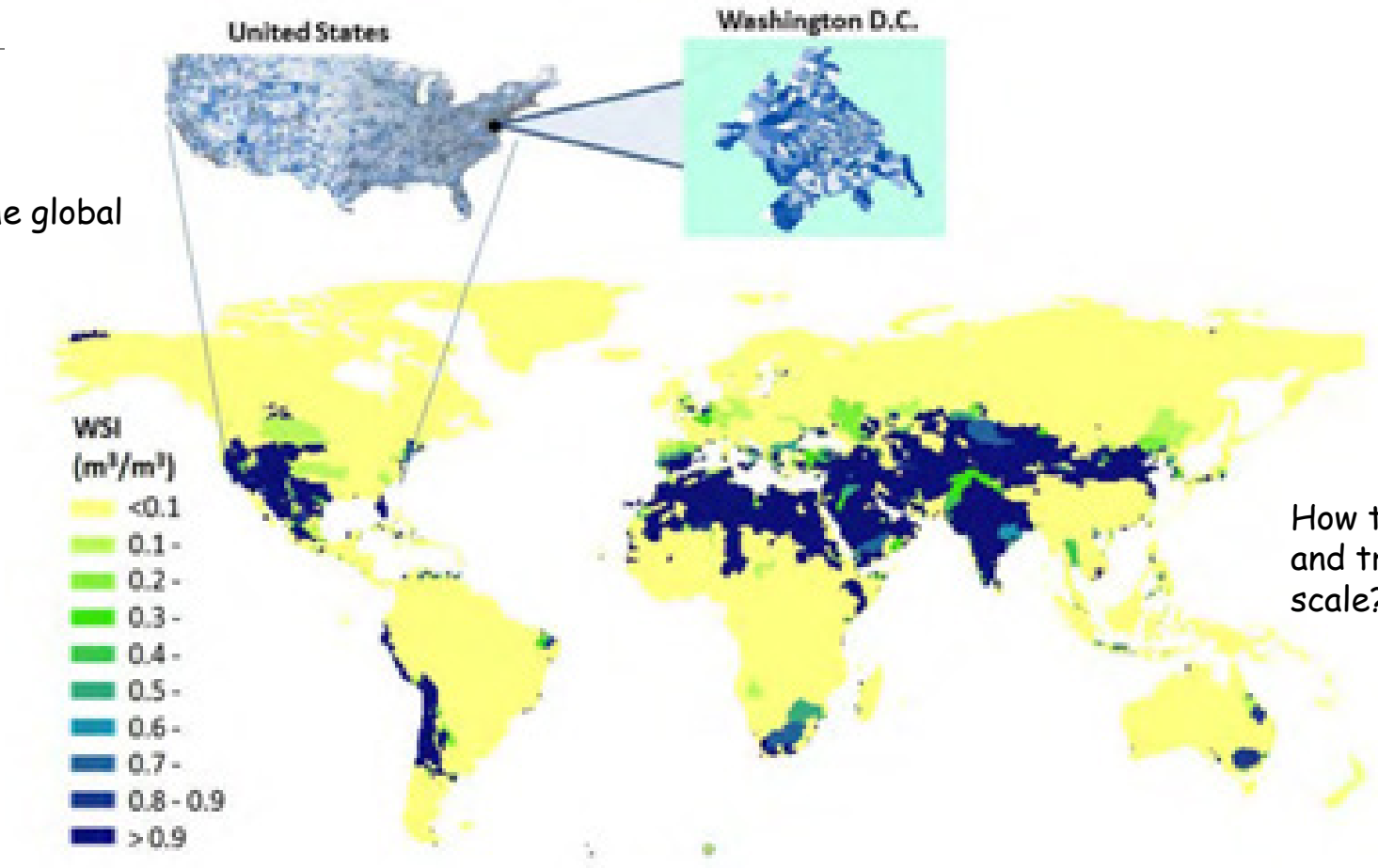
HUMAN DIMENSIONS OF GLOBAL CHANGE – COUPLED HUMAN & NATURAL SYSTEMS RESEARCH AREAS

- **STUDY OF LINKAGE BETWEEN SOCIO-ECONOMIC SYSTEMS AND CLIMATE CHANGE**
  - POPULATION, SOCIO-ECONOMIC DEVELOPMENT, CONSUMPTION AND PRODUCTION, POVERTY, CLIMATE IMPACTS AND ADAPTATION, POLICY ALTERNATIVES,, ETC.
- **EXAMPLES OF CURRENT PROJECTS:**
  - TELECONNECTING LOCAL CONSUMPTION TO GLOBAL ENVIRONMENTAL IMPACTS
  - EFFECTS OF NATURE TOURISM AS A DEVELOPMENT STRATEGY ON POVERTY AND INEQUALITY: NAMIBIA & MOZAMBIQUE TEST CASES
  - MODELLING AND VISUALIZING GLOBAL FOOD SUPPLY
  - MODELING GLOBAL TRADE NETWORK AND ENVIRONMENTAL CHANGE
  - CHINA FOOD SUPPLY PROJECTIONS
  - POVERTY ALLEVIATION AND CLIMATE CHANGE

TELECONNECTING LOCAL DECISIONS TO GLOBAL IMPACTS

How to best harness new data sets and combine approaches?

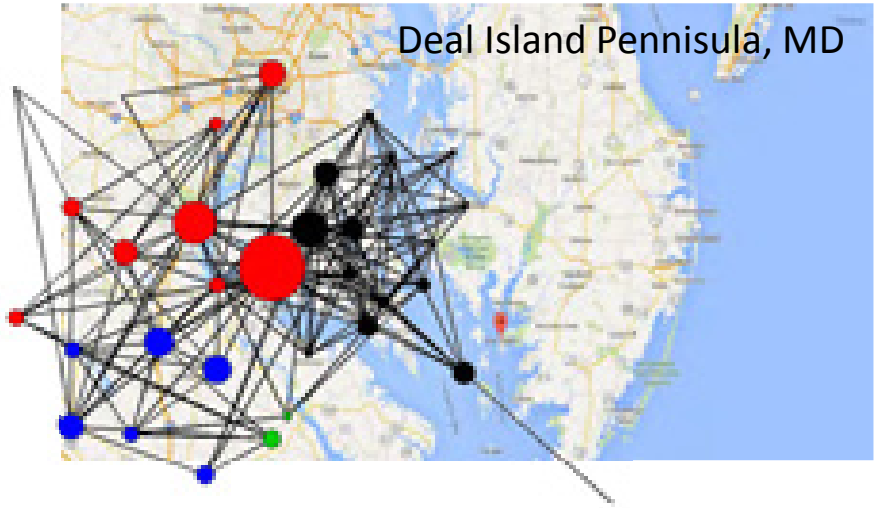
How to model the global interlinkages?

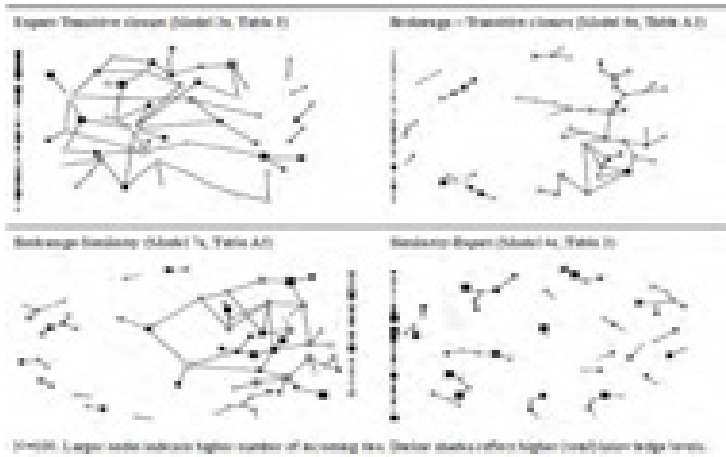


How to model impacts and trade-offs across scale?

Christina Prell's Research on Social Networks

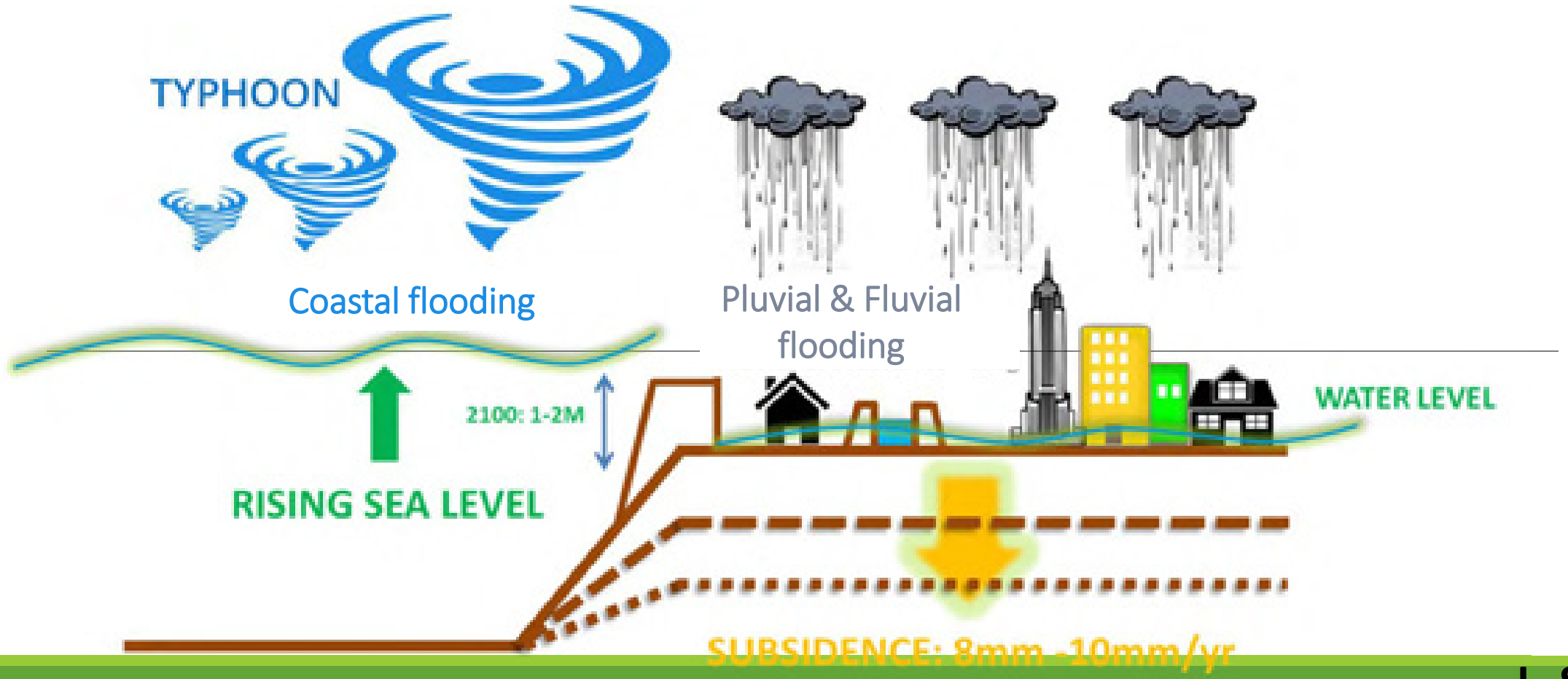
Stakeholder networks and environmental perceptions	Global trade networks and environmental change	Social network theory
Micro level – individual actors	Macro level - countries	Agent-based modelling



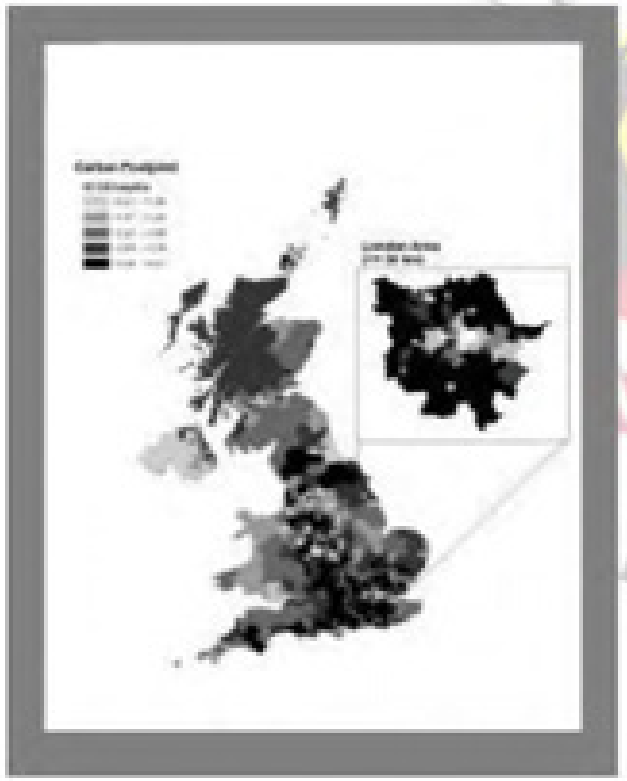


Modeling and Mitigating Compound Flood Risks in Coastal Cities

Extreme Rainstorms, Astronomical High Tides, Storm Surge, and Upstream Floods



UK URBAN CARBON FOOTPRINTS



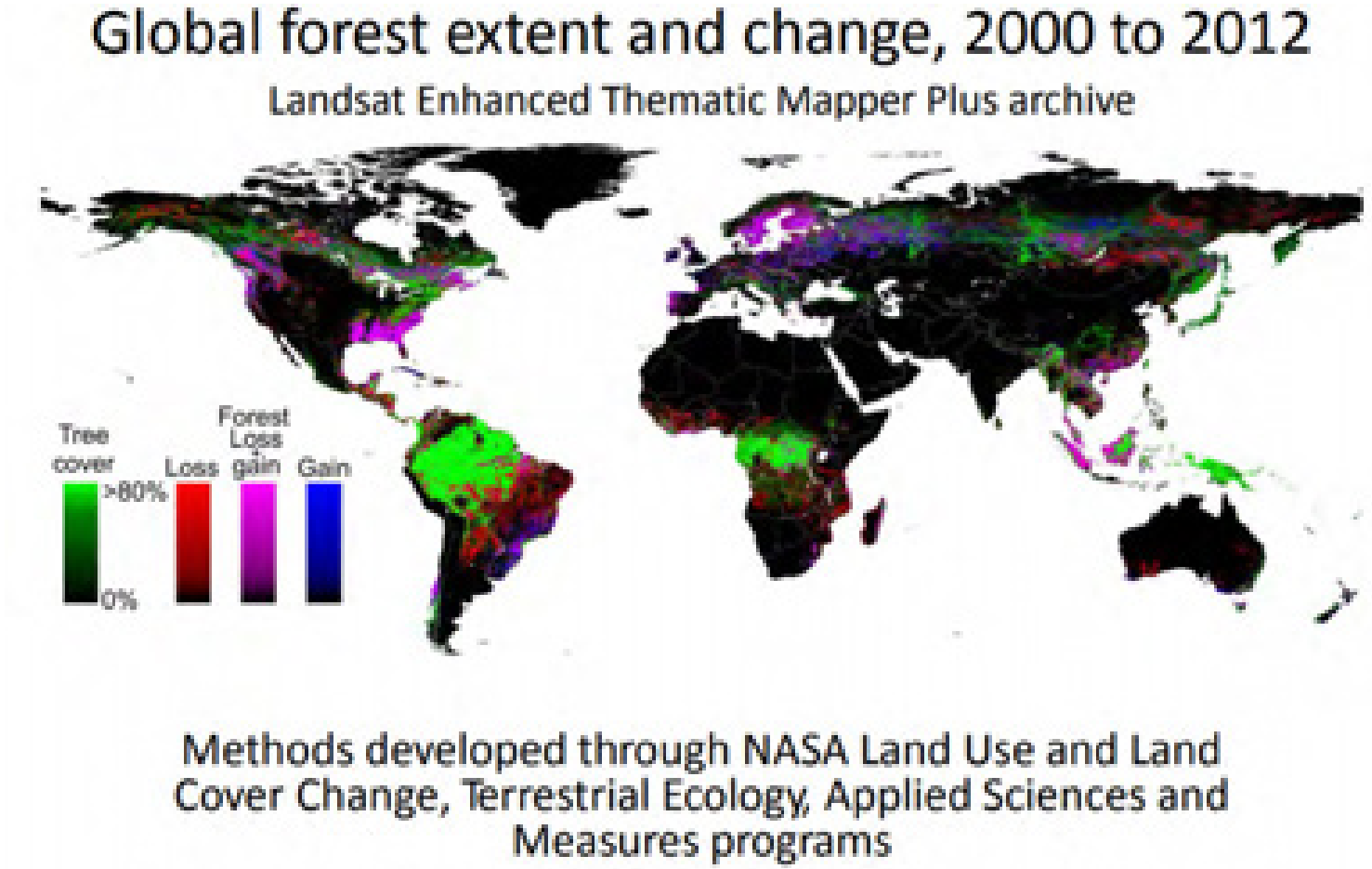
Study estimating the carbon footprints of cities and other human settlements in the United Kingdom explicitly linking global supply chains to local consumption activities and associated lifestyles.

Baiocchi et al

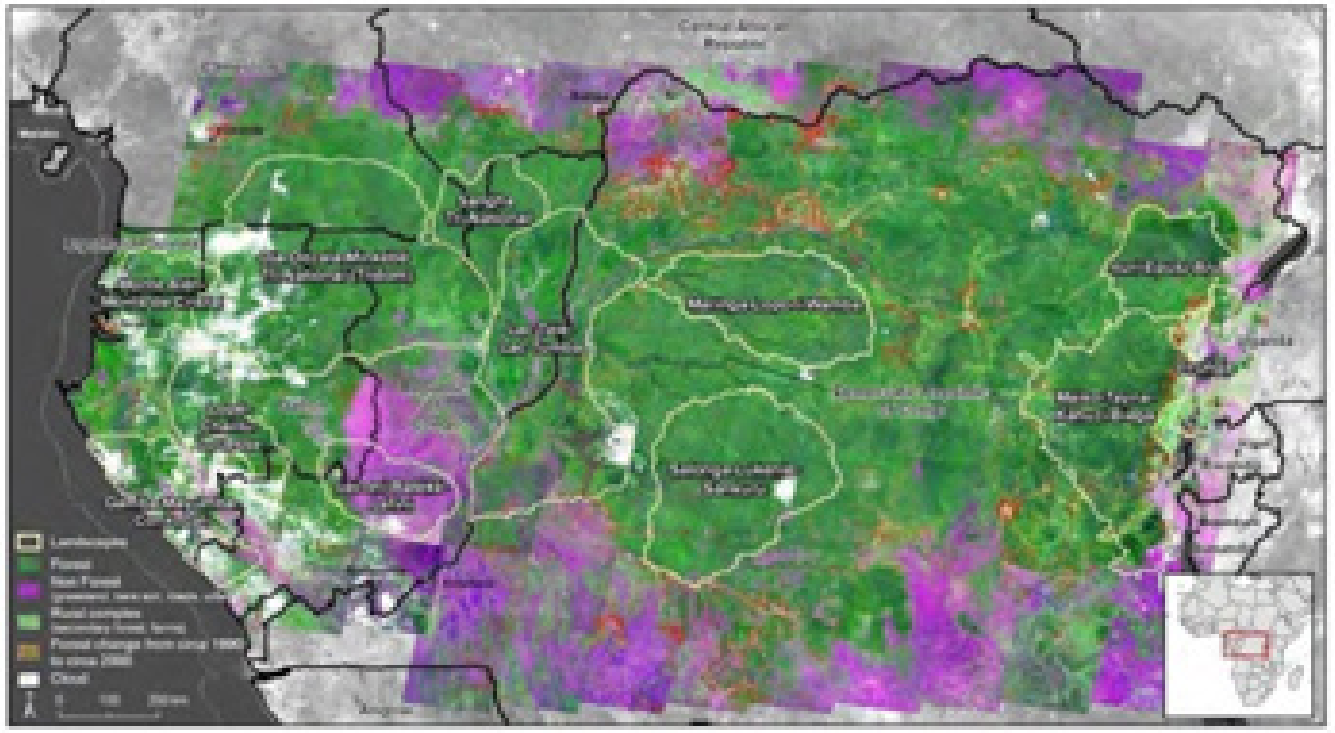
LAND COVER-LAND USE CHANGE (LCLUC) RESEARCH AREAS

- LCLUC: key interface between human and natural systems
  - Land change Information is combined with human socio-economic data to study past land cover and land use change and to inform advanced modeling of spatially-explicit future scenarios
  - Data used to address social, economic, carbon, climate, biodiversity and other aspects of land-use changes to monitor societal impacts, adaptations and vulnerability to fire, droughts, floods, desertification, and other catastrophic events
- Current Project Examples:
  - Congo Basin Forest Monitoring using Satellites for CARPE
  - Mapping of Global Urban Extent
  - Eco -System Disturbance and Fire: Patterns, Trends, and Greenhouse Gas Consequences
  - Global Drought Monitoring
  - Remote Sensing and Global Land Change Monitoring

LAND COVER/LAND-USE CHANGE



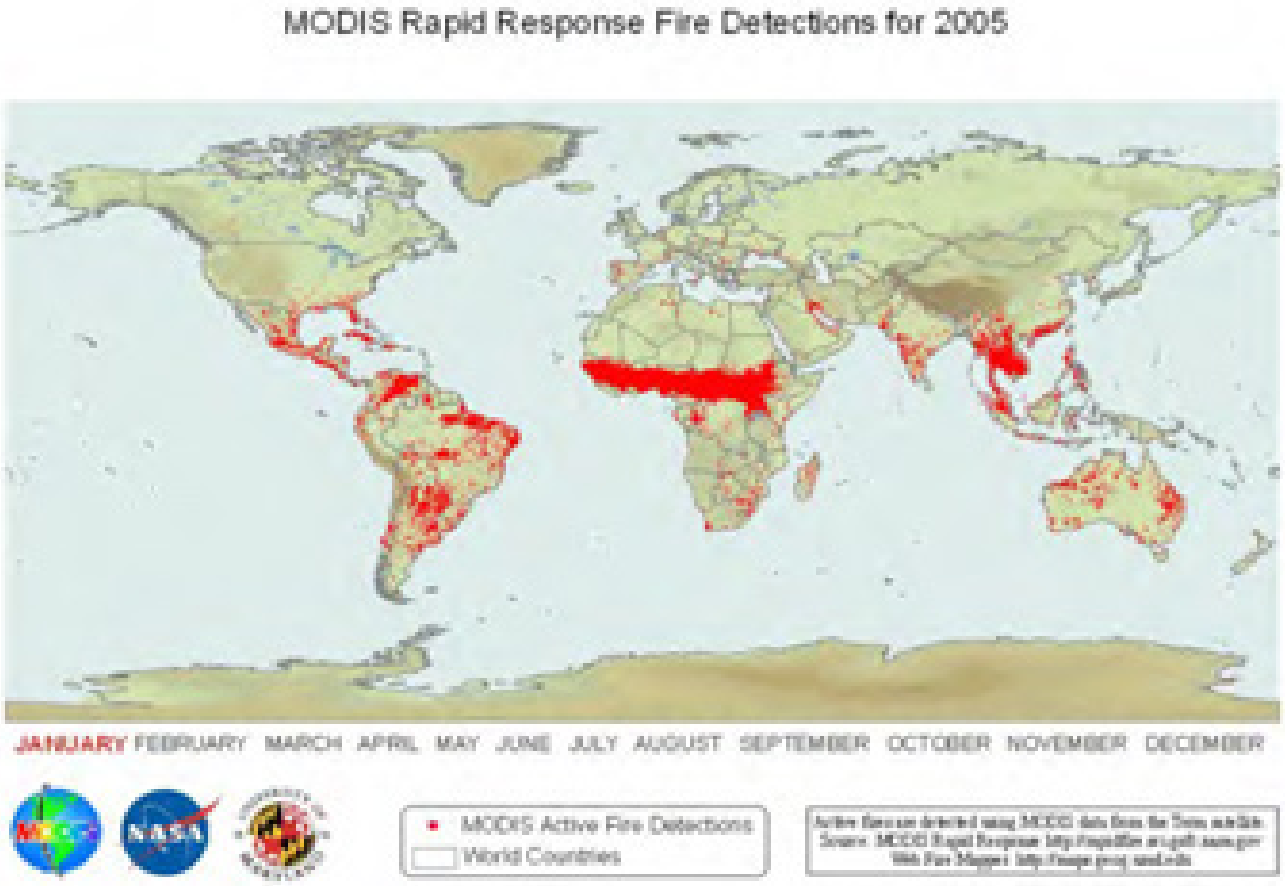
LANDSAT BASED DECADAL FOREST CHANGE MAPPING IN THE CONGO BASIN: 1990S – 2000S



Forest change and forest cover lost (in red) from circa 1990 to circa 2000 was mapped consistently at 57m across the Congo Basin via an automated procedure incorporating MODIS and Landsat. Forest loss, enhanced for visualization, is depicted in red.

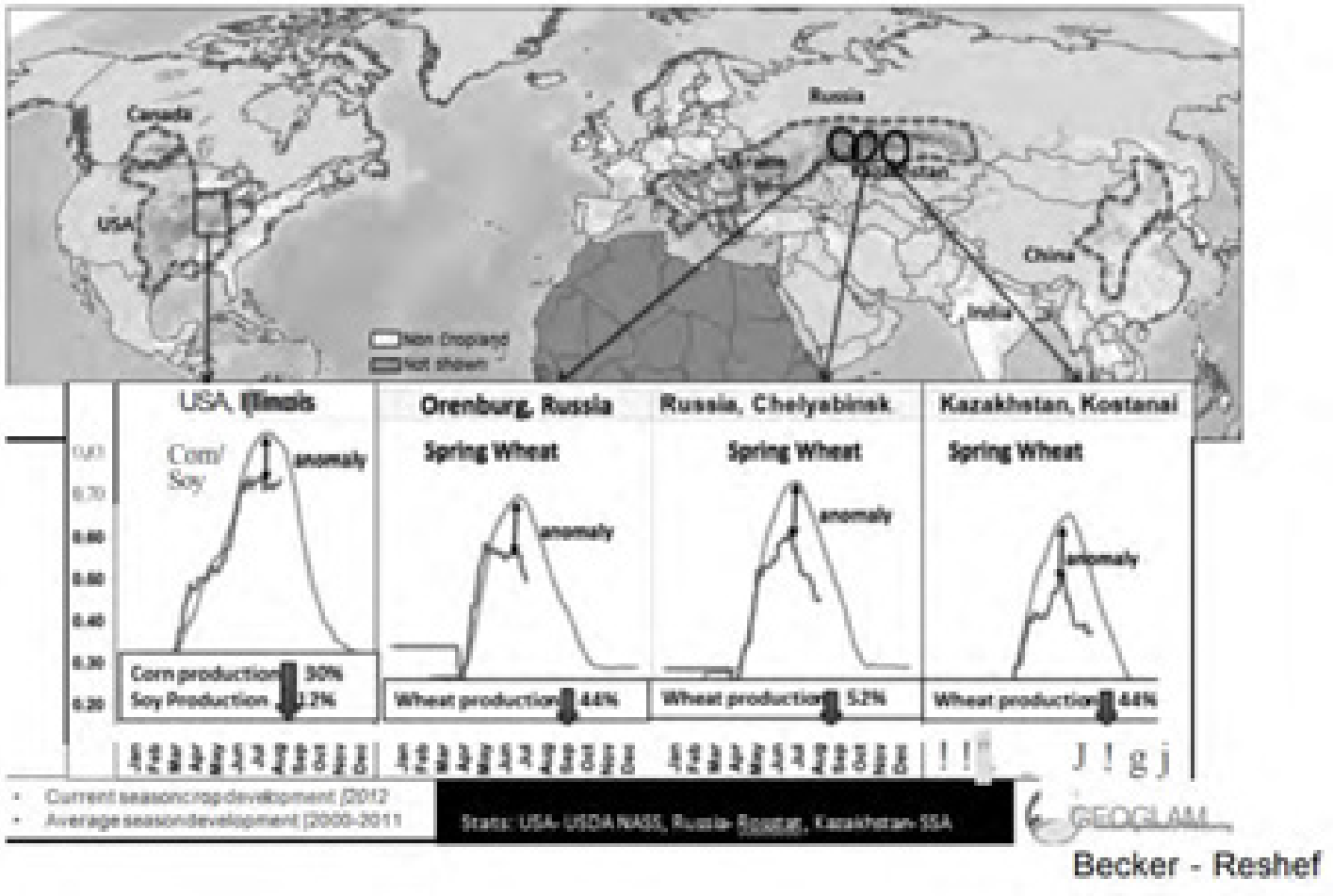
Alstatt, Wong UMD/Hansen SDSU

ACTIVE FIRES SEASONAL VARIABILITY (2005)

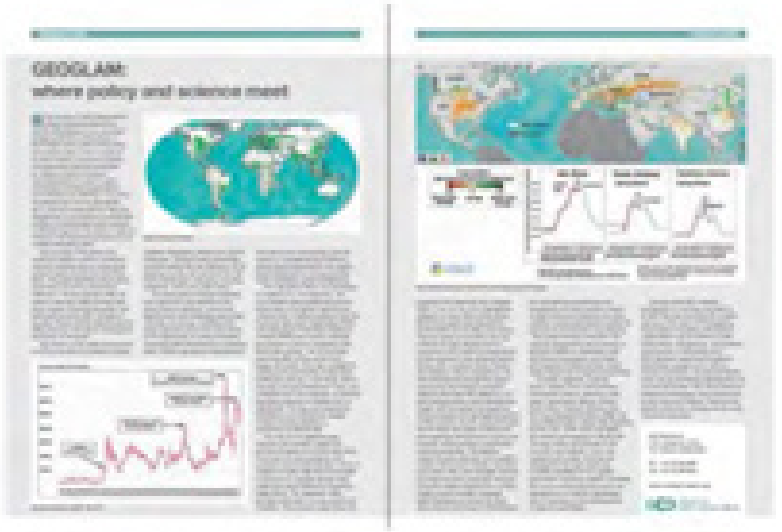


Justice, Giglio

GLOBAL AGRICULTURAL DROUGHT MONITORING



GEOGLAM
Global Agricultural Monitoring



G20 Final Declaration – Cannes, November 2011

*44. We commit to **improve market information and transparency** in order to make international markets for agricultural commodities more effective. To that end, we launched:*

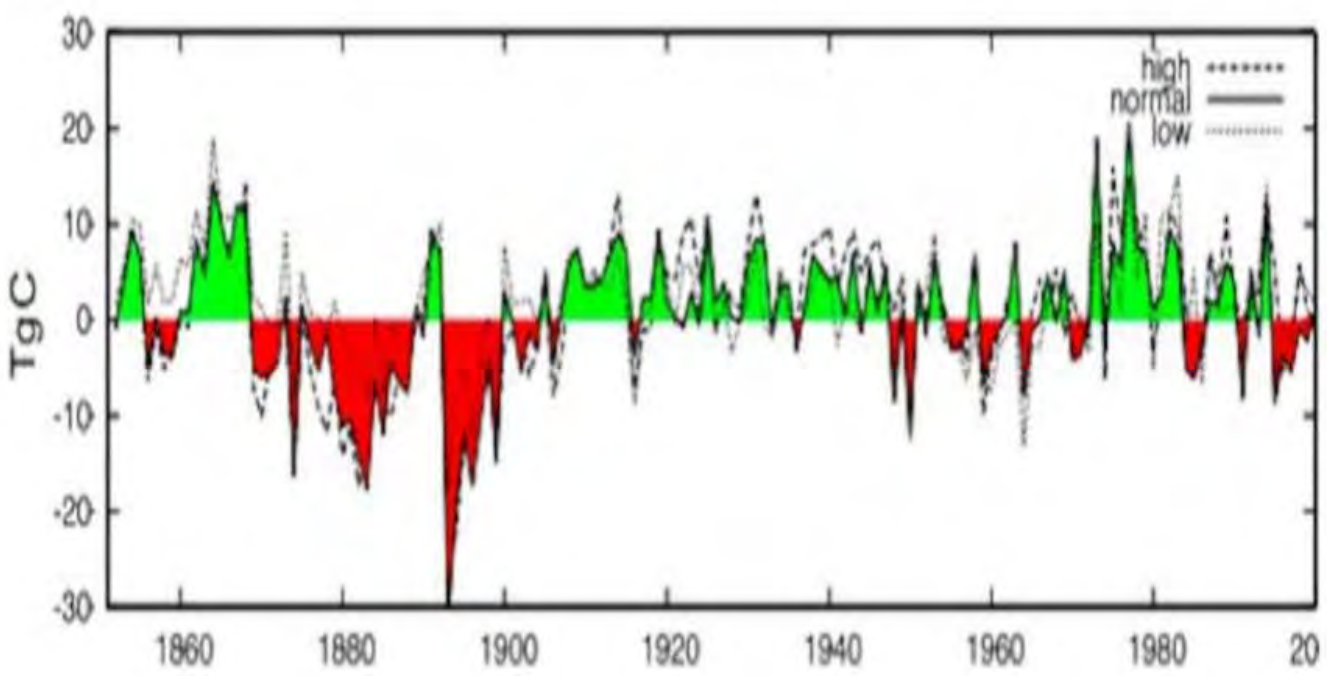
*The **"Agricultural Market Information System" (AMIS)** in Rome on September 15, 2011, to improve information on markets ...;*

*The **"Global Agricultural Geo-monitoring Initiative" (GEOGLAM)** in Geneva on September 22-23, 2011. This initiative will coordinate satellite monitoring observation systems in different regions of the world in order to enhance crop production projections and weather forecasting data.*

CARBON, VEGETATION DYNAMICS & LANDSCAPE – SCALE PROCESSES RESEARCH AREAS

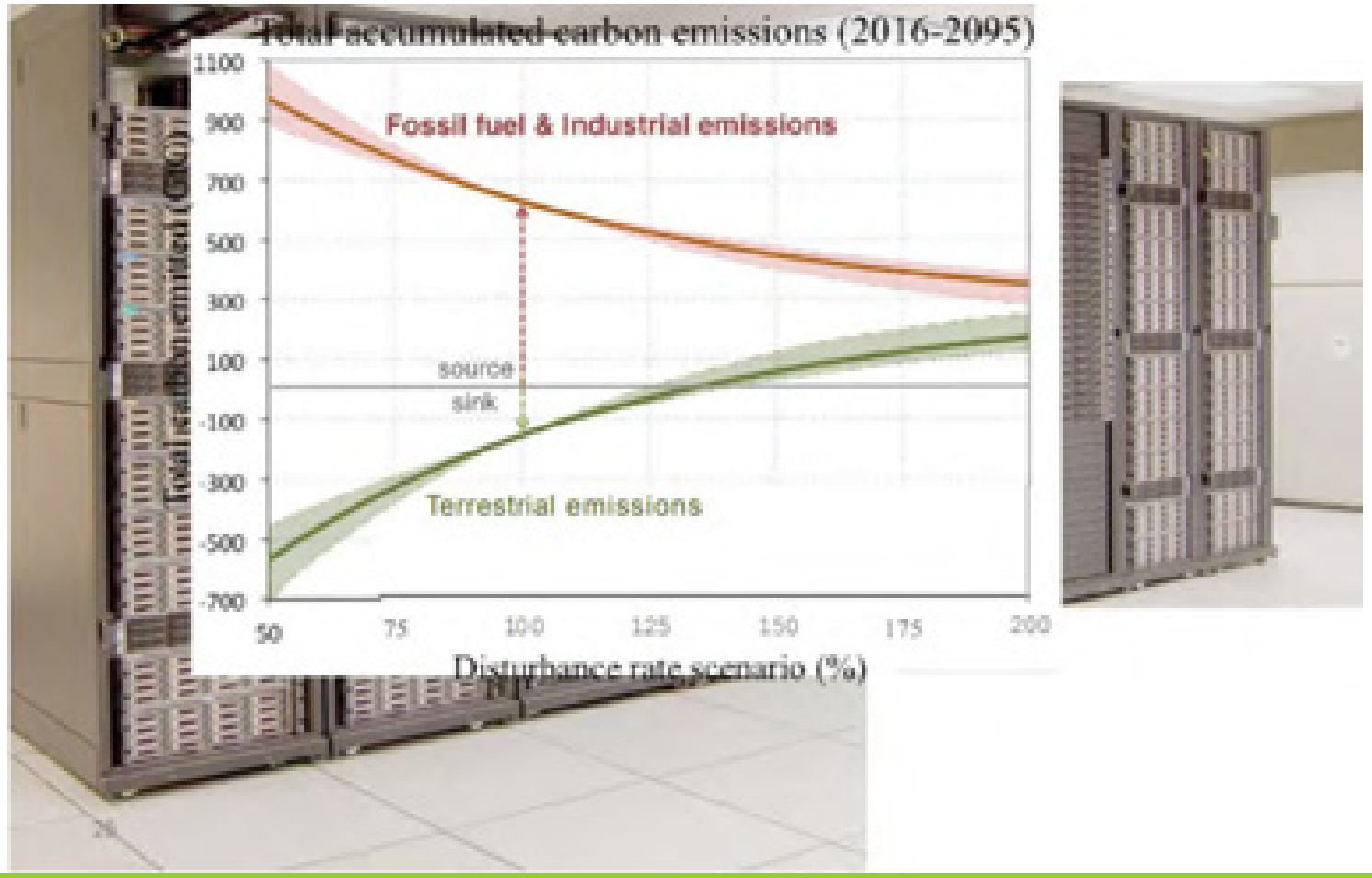
- Studies monitoring and modeling global vegetation
  - Mapping and studying human and natural disturbances and their landscape- scale impacts, as well as changes to the earth surface as a result of climate variability
  - Integration of field-based research with remotely-sensed observations to address key scientific uncertainties
  - Alterations to the global carbon cycle are changing atmospheric composition with implications for human well-being
- Current Project Examples:
  - Synthesis of Forest Growth, Response to Wildfires and Carbon Storage for Russian Forests
  - Impacts and Implications of Increased Fire in Tundra Regions of North America
  - Carbon modelling of boreal peatland systems

NET CARBON IMPACT OF TROPICAL CYCLONES



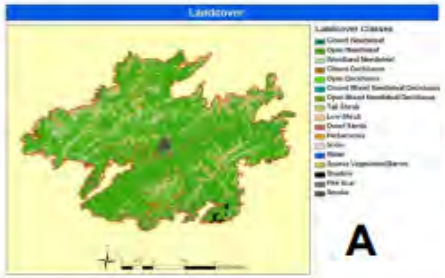
Fisk et al

INTEGRATED MODELING



Field & Airborne Campaigns

By integrating multiple data sets derived from analysis of Landsat TM and DEM data, spatial patterns of burning of 6 vegetation types on two topographic positions (uplands/ lowlands) were examined for 41 fire events from the 2004 Alaska fire season (95% of all area burned)



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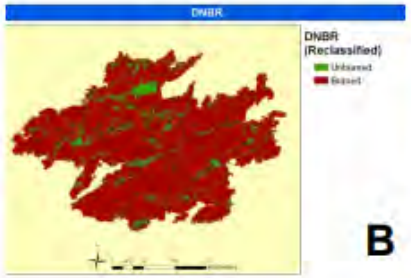

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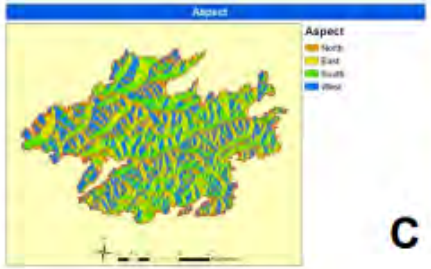

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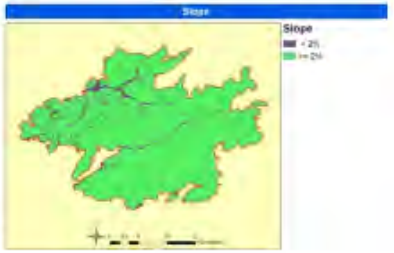
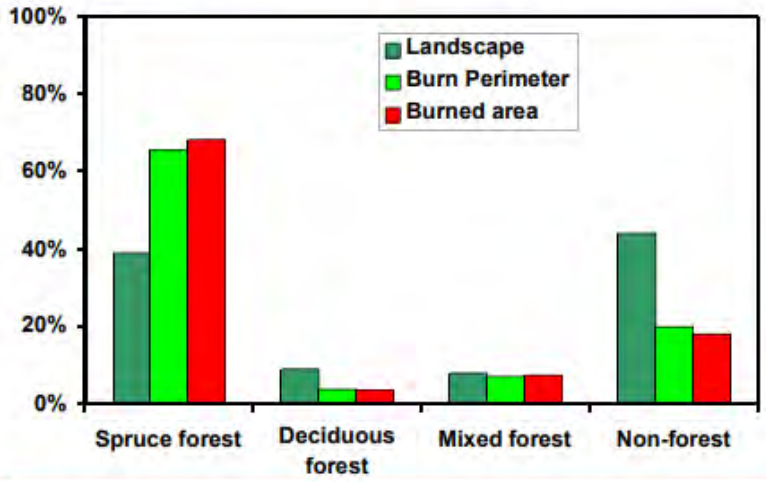
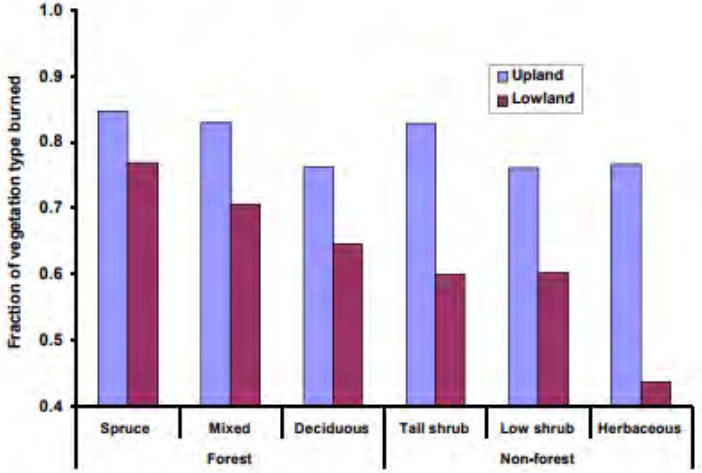






Across interior Alaska, mature spruce forests cover 40% of the landscape. However, withinthe 2004 fire perimeters, 65% of the vegetation was mature spruce. This demonstrates that fuel type controls distribution of fires at the landscape scale

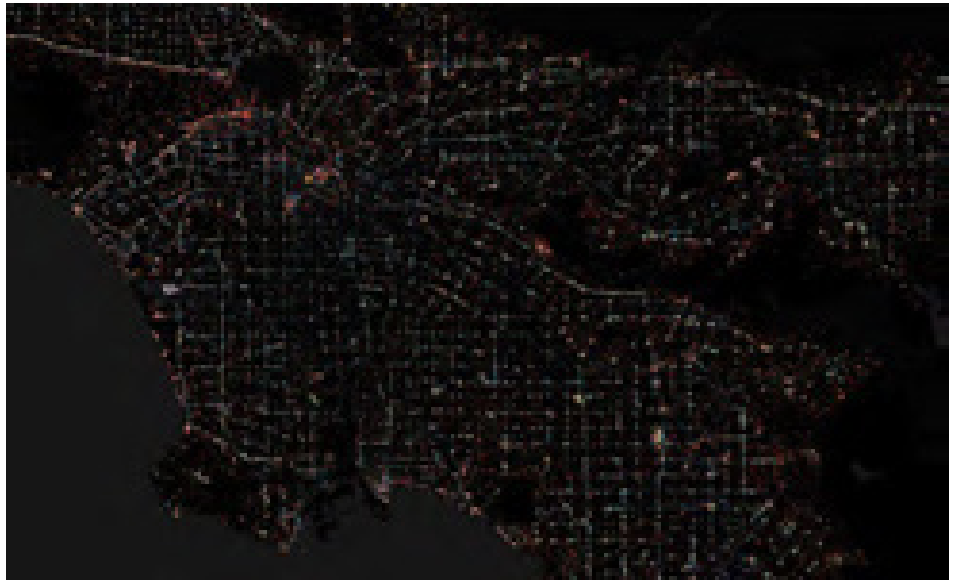
For all 2004 fires, 20% of the area within fire perimeters did not burn. Fraction burned varied as a function of vegetation type and topography

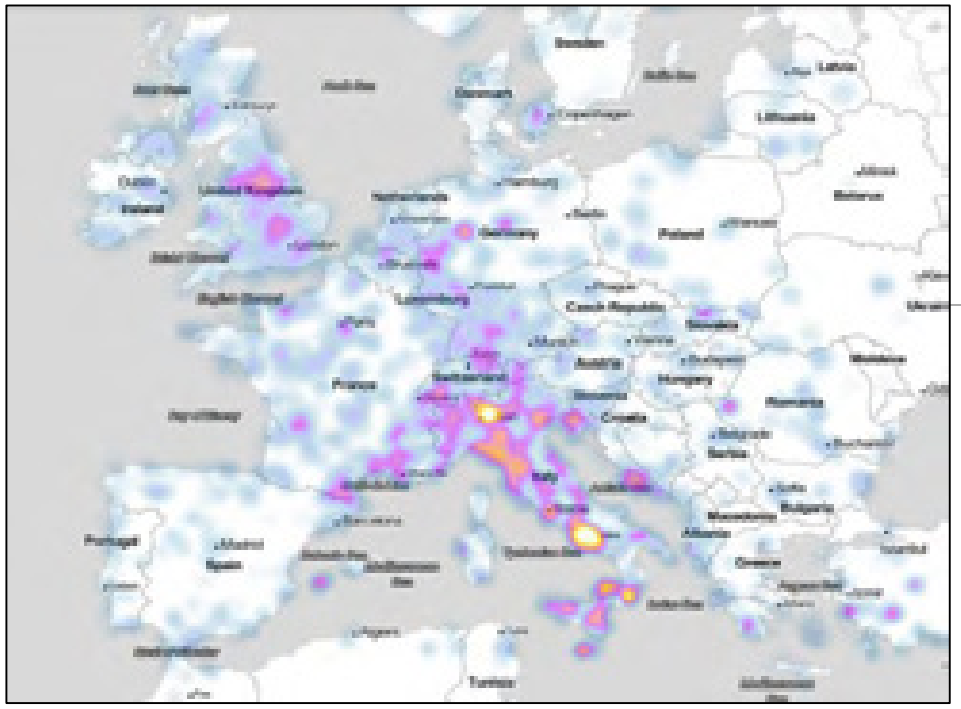
Kasischke

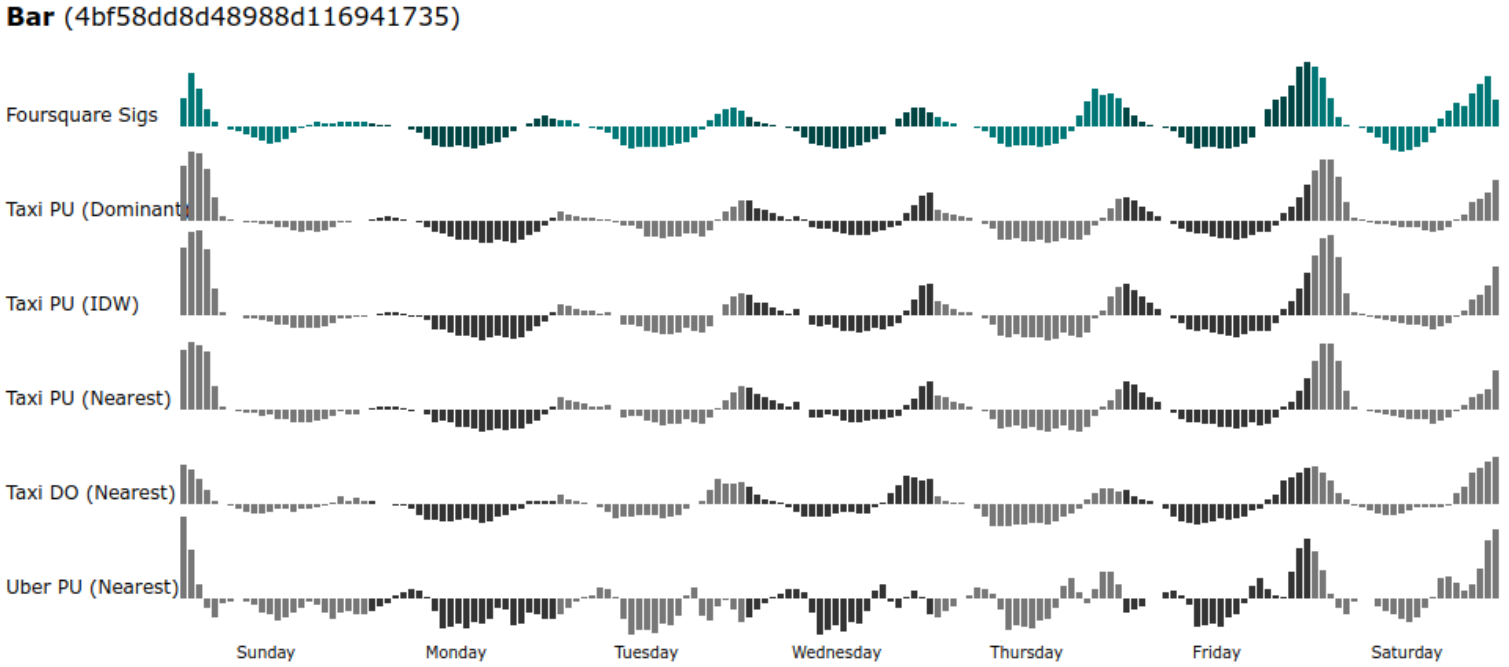
GEOSPATIAL INFORMATION SCIENCE (GISCIENCE) RESEARCH AREAS

- We are **developing** and **using** the **latest geospatial science and technologies** to address the unique challenges associated with the analysis and modeling of location-based phenomena
- **Research areas include**:
  - big geospatial data,
  - open source geospatial modeling,
  - 3D geovisualization,
  - geospatial social media analytics,
  - mobility and spatial trajectory analytics,
  - place-based analytics, and
  - geospatial visualization, among other topics

Place-based data analytics: McKenzie



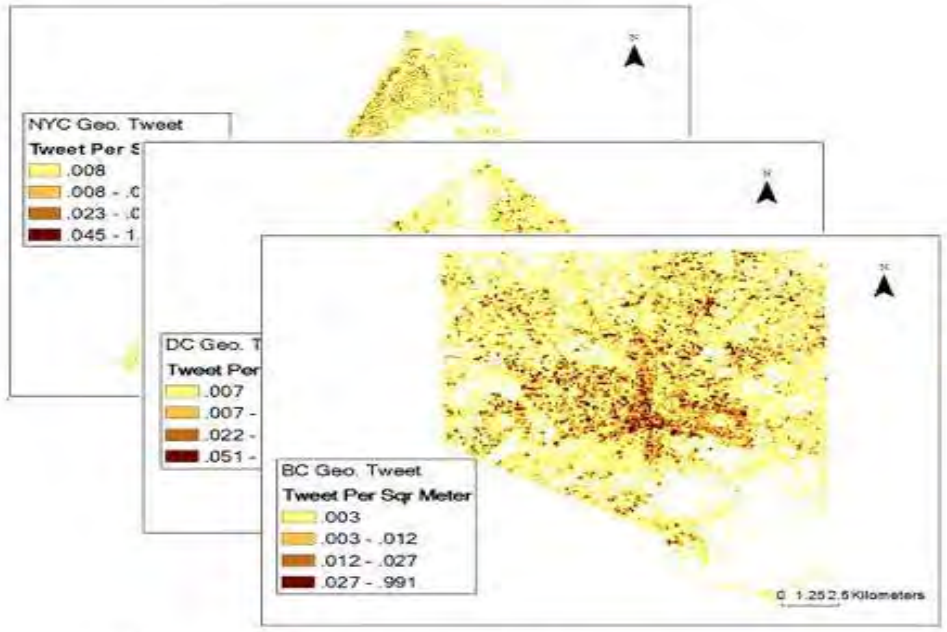




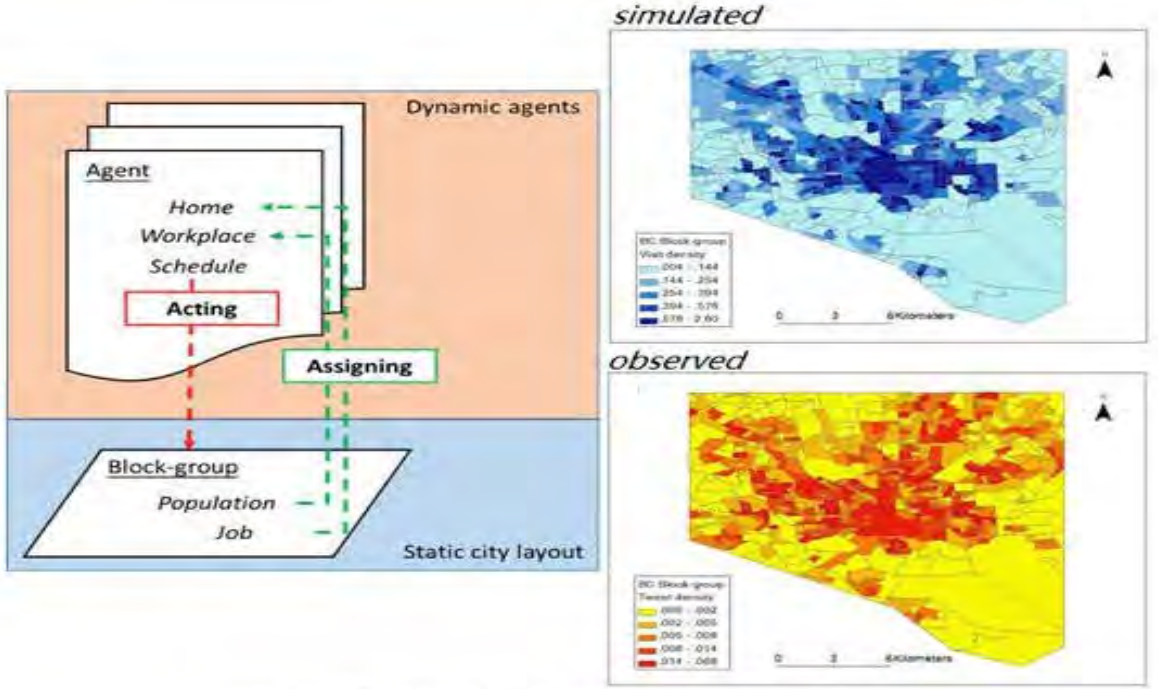
- Human Activity modeling & prediction
- Geosemantics & Knowledge representation
- Geoprivacy and location obfuscation

Augmented geospatial context analysis: Cheng Fu (Stewart)

- **Spatial activity pattern analysis** using social media data and ABM modeling

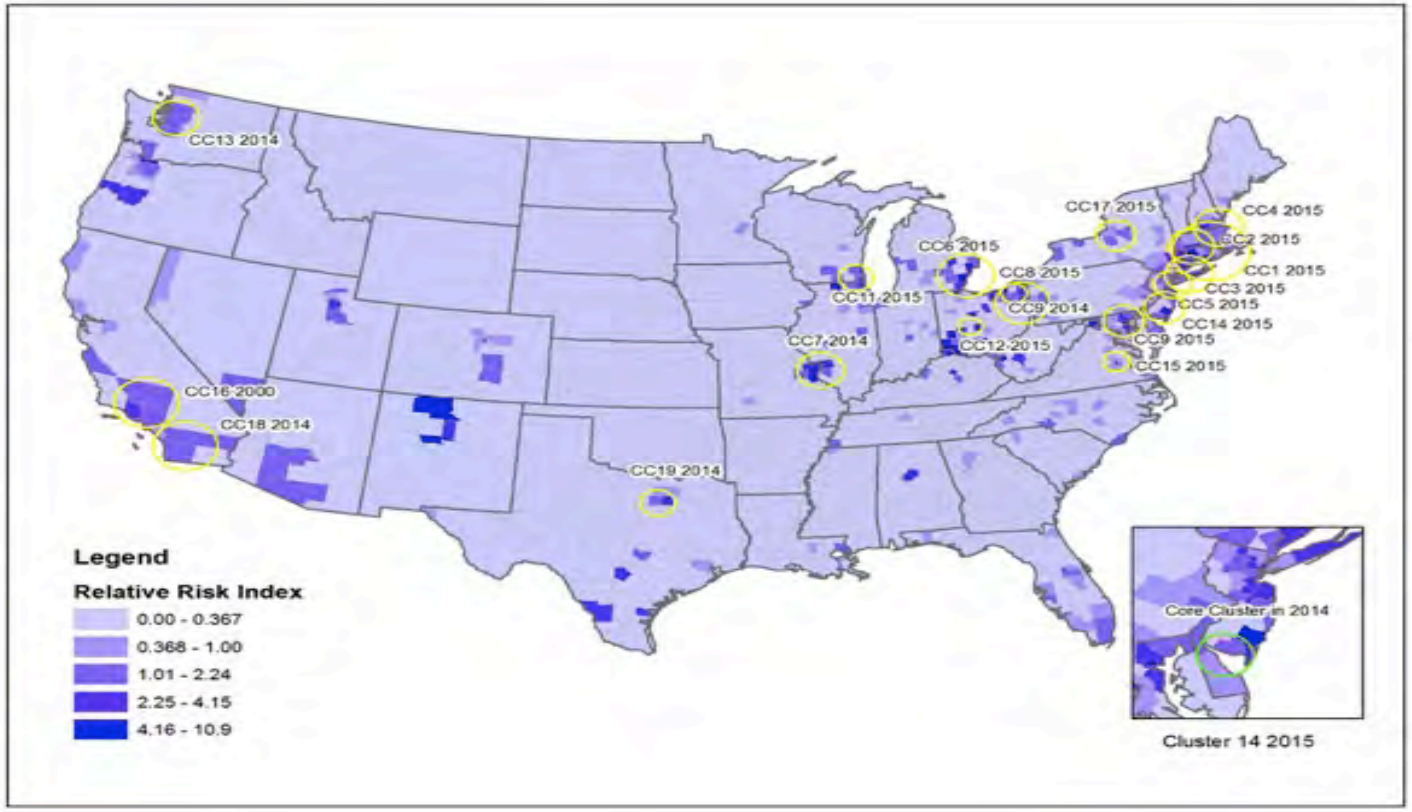


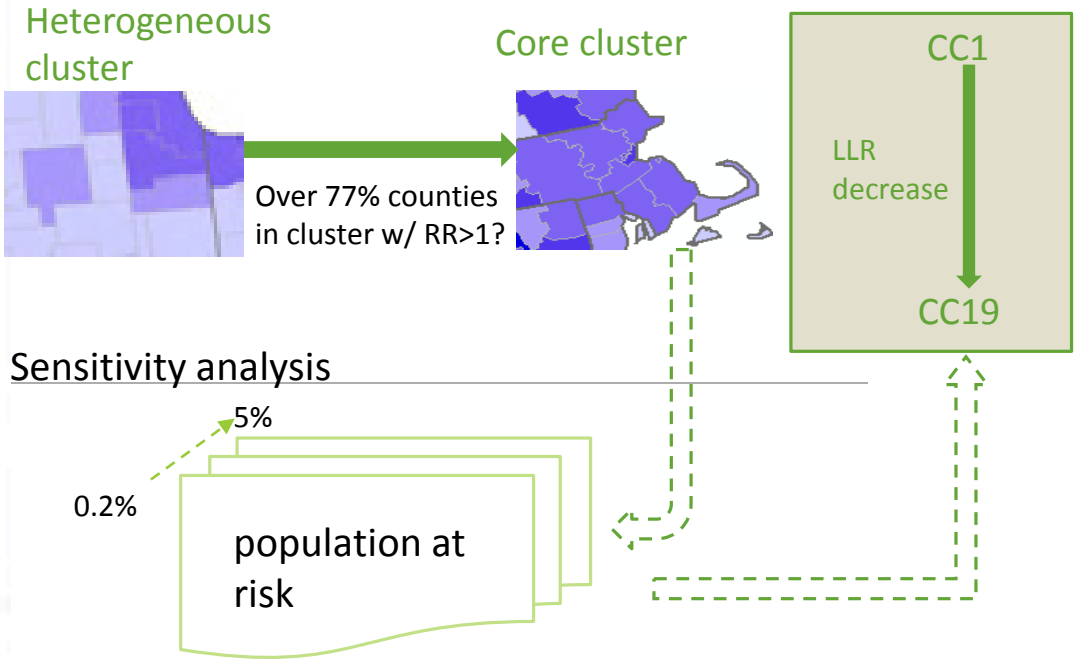
Observed intra-city activity patterns from Tweets in three US cities



Agent-based modeling is applied to validate observed activity patterns

Spatial-temporal cluster analysis of drug deaths involving heroin : Yanjia Cao (Stewart)





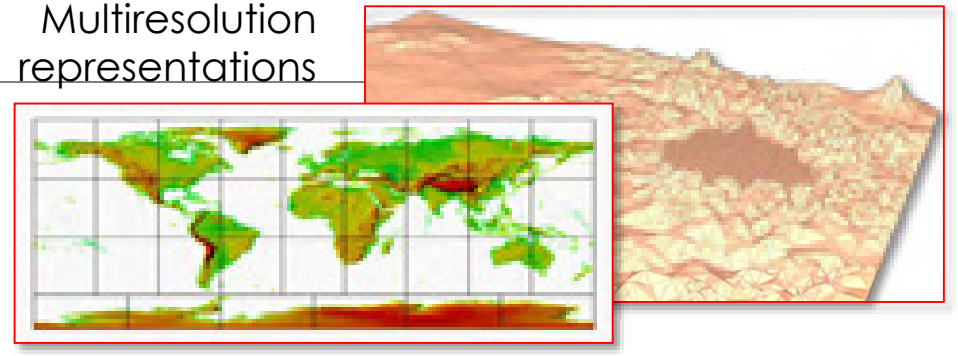
What is the spatiotemporal pattern of drug poisoning deaths involving heroin?

Spatial data analysis and representation: L. De Floriani

Visualizing and processing large sets of geospatial data

- Sparse sets of points requires ad-hoc representations
- Incomplete or redundant data requires multiresolution models

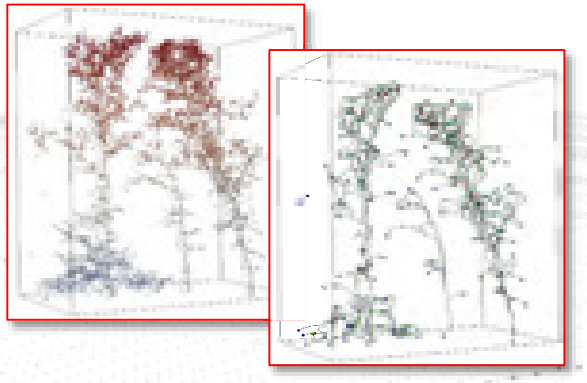
Multiresolution representations



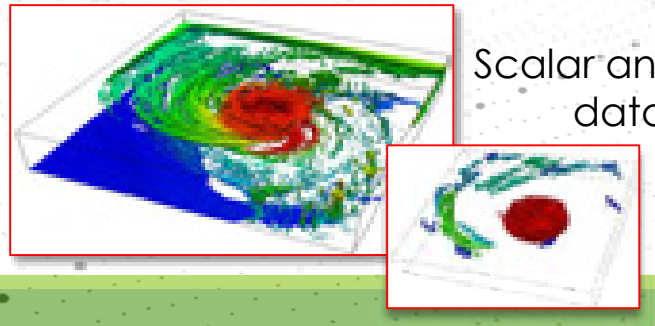
Developing analytical tools requires

- Extracting morphological features
- Incorporate simplification and noise removal techniques

Object reconstruction

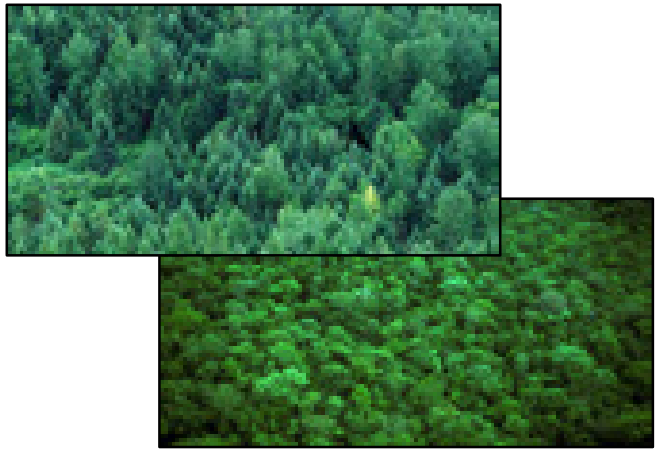


Scalar and Vector data analysis



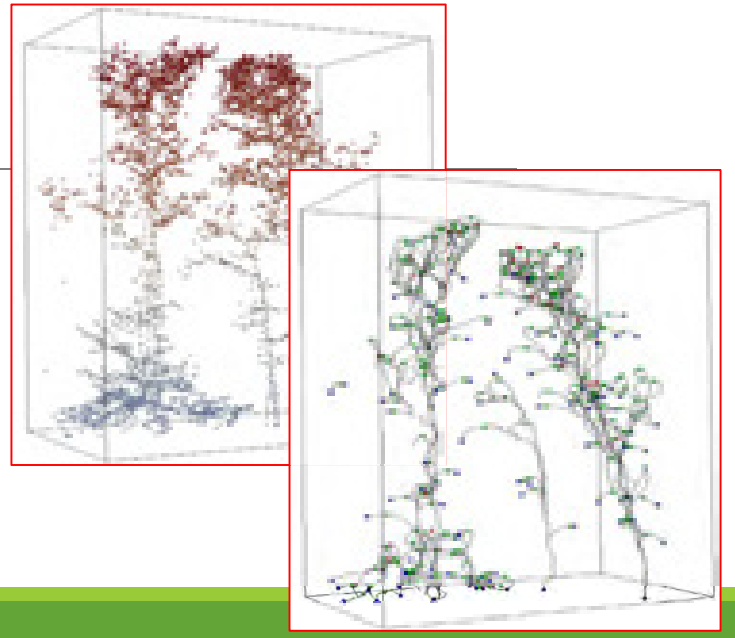
Individual Tree Mapping from LiDAR point clouds

Reconstructing the structure of each tree, starting from a point cloud describing a forest.



Challenges:

- The point cloud can be huge
- Noise and incomplete data due to occlusions
- Geometric approaches are well suited for specific kind of forests but not generalizable



Solutions:

- Multiresolution models for triangle and tetrahedral meshes are used for representing data efficiently
- A topological approach is used for studying the evolution of each single tree.
- Topological features are identified as points where the shape changes

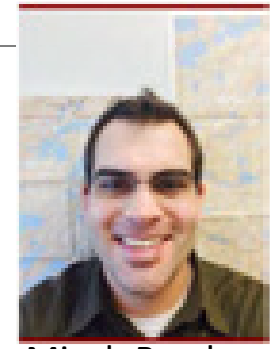
The Center for Geospatial Information Science – come meet us in 1124 LeFrak!!

Kathleen Stewart
Director

Leila De Floriani
Professor

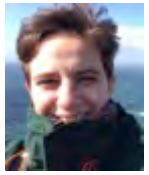
Grant McKenzie
Asst. Professor

Ruibo Han
Lecturer



Micah Brachman
Lecturer

A growing team of **postdoctoral** researchers, **graduate students**, **visiting scholars**, and **CGIS affiliates**

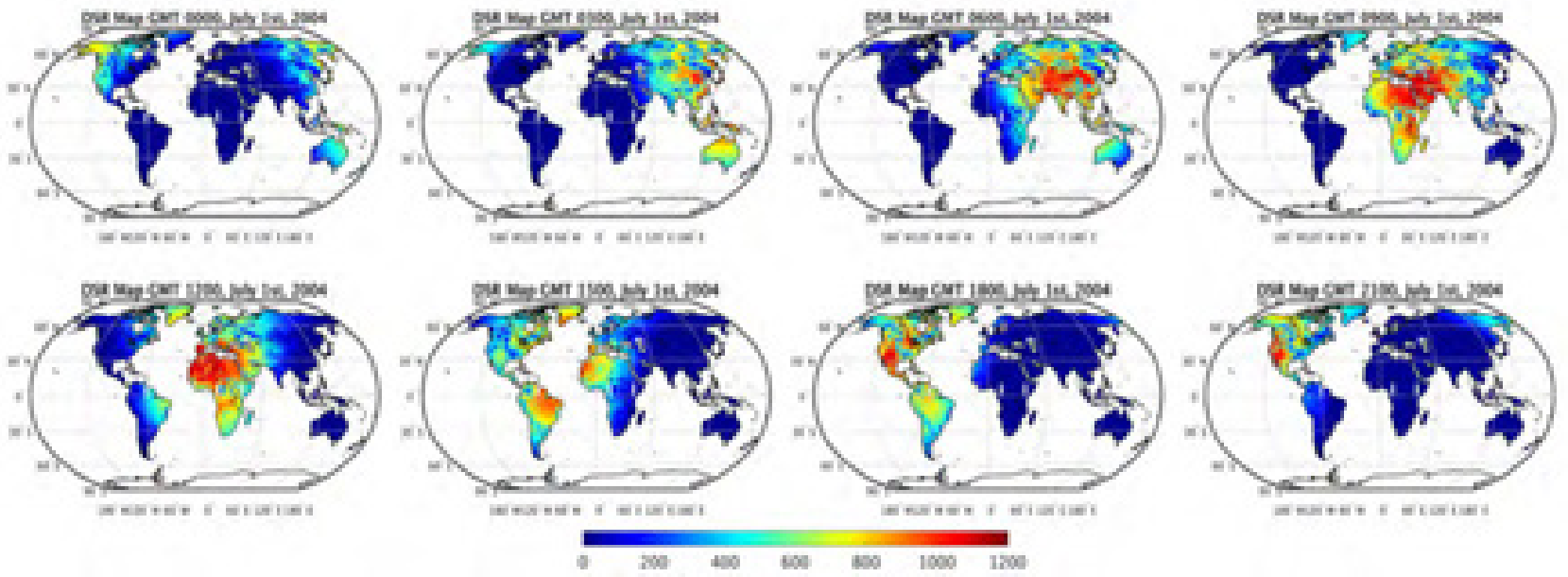


Products & Services

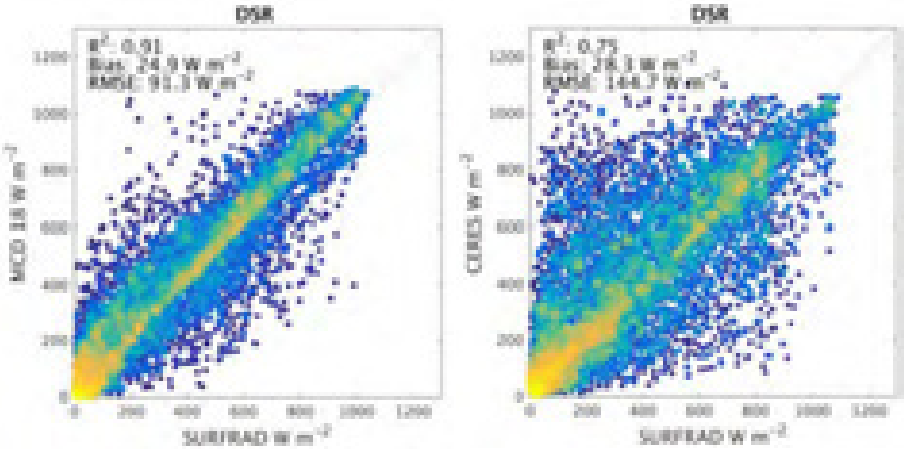
REMOTE SENSING RESEARCH AREAS

- **Remote Sensing Science**
  - Algorithm and product development
  - Collaboration on sensor specification and development (w. NASA GSFC)
  - Data and Information Delivery Systems
- **Global Observations and Data Products**
  - AVHRR>MODIS>VIIRS (NASA Science Teams) w. NASA GSFC
  - Landsat TM> ETM> LDCM (USGS Science Team) w. NASA GSFC and NASA Ames.
  - LIDAR w. NASA GSFC and NASA JPL
  - Global Urban Extent w. NASA GSFC
  - Sentinel 2 and 3 merged processing (NASA US participation)
- **Remote Sensing Applications**
  - Agricultural Monitoring w. NASA and USDA
  - Global Forest Monitoring w. NASA, Google and the Moore Foundation
  - Range Management
  - Flood Monitoring and Management
  - Fire Monitoring and Management w. USFS
- **Integration of RS observations into Earth System Models**
  - Carbon and Biogeochemical Cycling, Ecosystem Dynamics
  - Land/Atmosphere Exchanges of Energy/Water/GHG exchange
  - Emissions Estimation, Fire Regime Characterization
  - Agricultural production
  - and Degradation

Developing the first global high-resolution MODIS products of downward shortwave radiation (DSR) and photosynthetically active radiation (PAR)

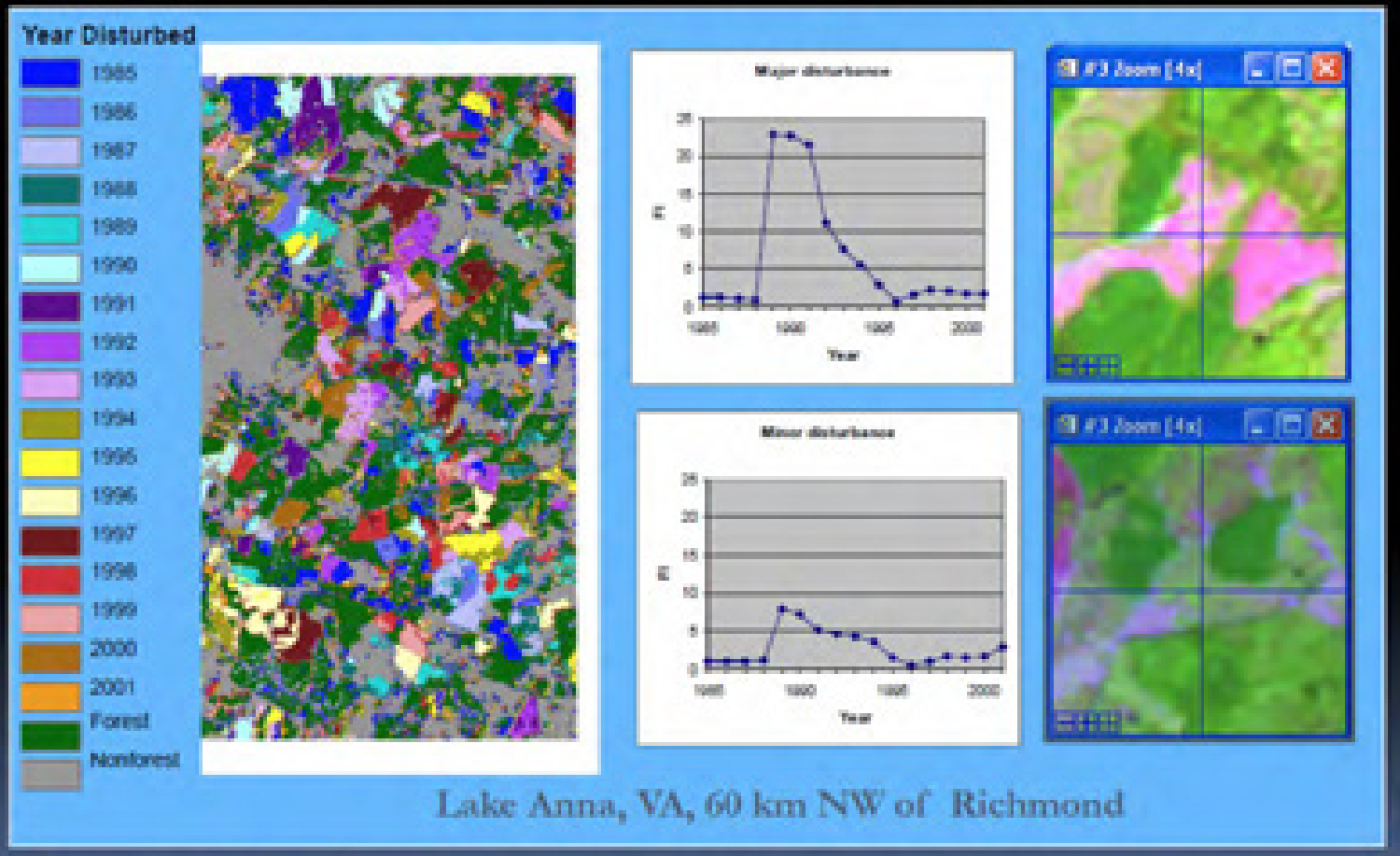


- DSR) and PAR are two key parameters required by almost all land surface models.
- We are funded by NASA to generate the DSR (MCD18A1) and PAR (MCD18A2) products from MODIS data.
- Validation shows our new products have superior accuracy and quality.



D. Wang & S. Liang, NASA, NNX14AI72G

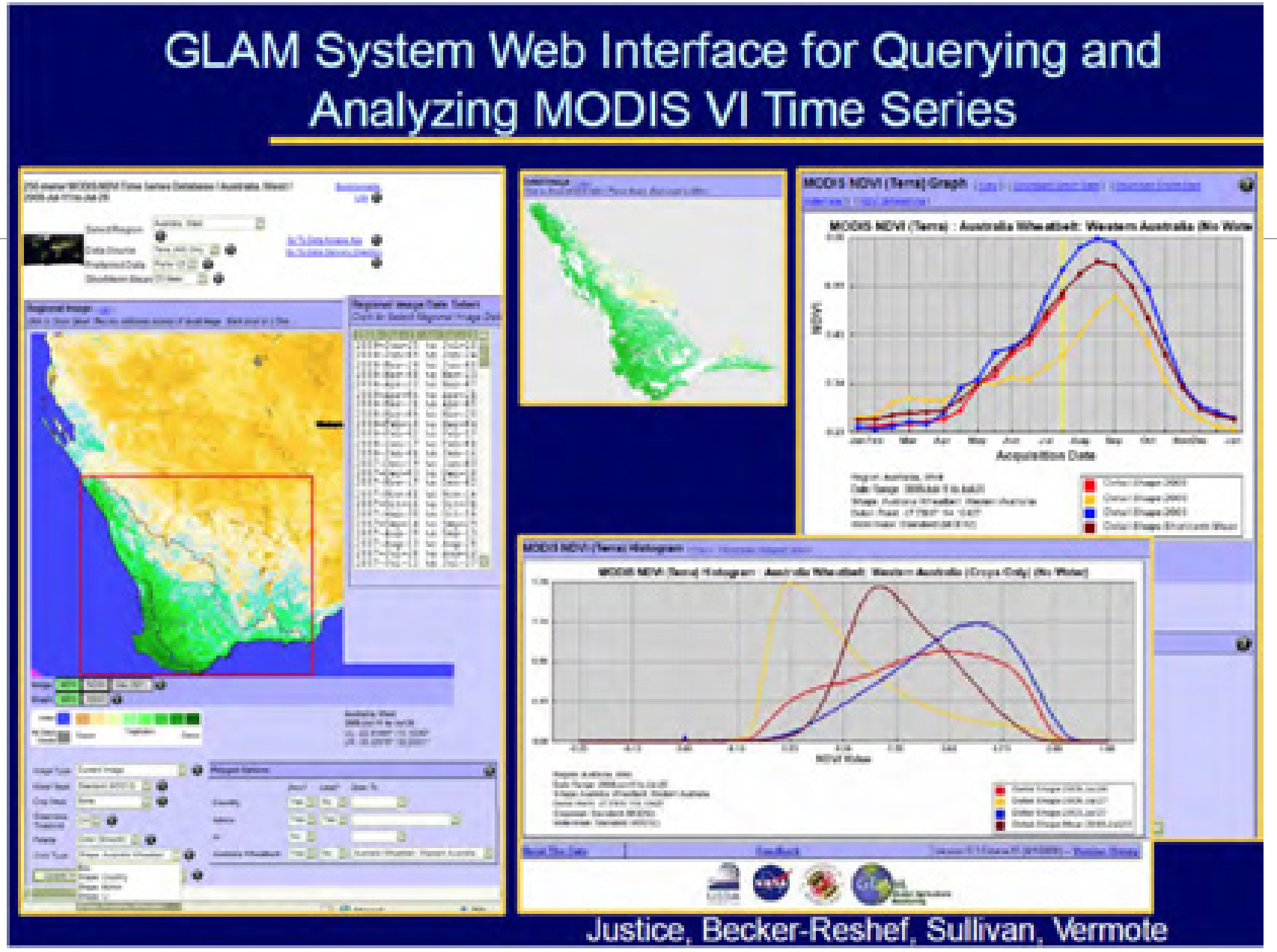
North American Forest Dynamics Vegetation Change Tracker



Lake Anna, VA, 60 km NW of Richmond

Huang et al *North American Forest Dynamics (NAFD) - A NACP Core Project*

GLAM System Web Interface for Querying and Analyzing MODIS VI Time Series



Justice, Becker-Reshef, Sullivan, Vermote