



Biodiversity & Ecological Forecasting Team Meeting

**NASA Earth Science
and Applications**

*Lawrence Friedl
Applied Sciences Program
Earth Science Division
NASA Headquarters*

23.April.2013

*Discovering the Earth,
Delivering it Home*



The NASA Earth Science Division supports basic and applied research on the Earth system and its processes.

Primary efforts are to characterize, understand, and improve predictions of the Earth system.

In parallel with research, NASA pursues innovative and practical uses of Earth science data and results to improve government, business, and civil society decision-making activities.

Technology

Flight Missions

Research

Data Systems

Education

Applications

Operating & Planned Satellites (through 2023)



■	Formulation
■	Implementation
■	Primary Ops
■	Extended Ops



Terra

QuikSCAT*

Aquarius

Suomi NPP

SAGE III (on ISS)

CYGNSS

TRMM

SORCE

Aqua

CloudSat

CALIPSO

Aura

GRACE (2)

Jason

OSTM/Jason 2 (NOAA)

SAGE III (on ISS)

CYGNSS

TRMM

ACRIMSAT

Landsat-7 (USGS)

ICESat-2

EO-1

GRACE-FO (2)

SMAP

OCO-2

LDCM

GPM

Discovering and demonstrating innovative and practical uses of Earth Science in organizations' policy, business, and management decisions.

Applications

Capacity Building

***Satellite
Mission Planning***

Applications Themes



Health



Water



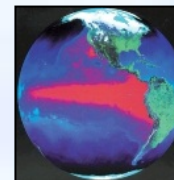
Disasters



Ecosystems



Agriculture



Climate



Energy



Oceans



Weather



Applications Readiness Level (ARL)

Nine-stage metric to track the maturity of applications projects – from initial idea, through development, to the transition to operational use.

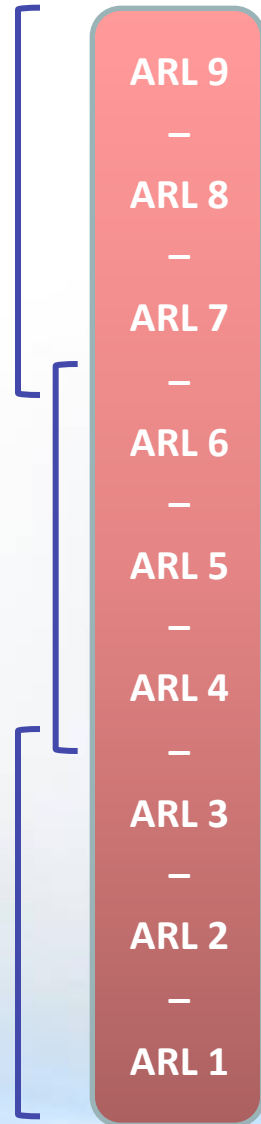
ARL as a tool:

- » Communication Tool to convey expected advancement to PIs & project teams.
- » Analysis Tool to assess progress of a project or state of entire project portfolio.
- » Reporting Tool for performance goals.
- » Diagnostic Tool to identify where projects tend to break down in development.

ARL 7-9:
*Partner
Demonstration
and Transition*

ARL 4-6:
*Development,
Test, and
Validation*

ARL 1-3:
*Discovery and
Feasibility*





Feasibility-to-Decision Support Projects – New in 2012

A two-stage approach to identify more high-reward projects with strong commitment by partner organizations. **Start with multiple feasibility studies** of possible applications ideas. After a year, **the Program selects a subset** of successful studies to pursue as **in-depth applications projects**.

Approach generates numerous applications ideas and focuses investments on those with high-reward potential.

Approach prioritizes partners’ “skin-in-the-game” to increase their involvement in project and commitment to adopting the project results.

Year	Stage	Activity	NASA Share		Partner Share	
Year 1	Feasibility	Prove out application potential		100%	Optional	
Year 2	Decision Support	Develop application		~80%	~20%	
Year 3	Decision Support	Continue development		~60-70%	~30-40%	
Year 4	Decision Support	Complete application and transition		~30-40%	~60-70%	

Earth Science Missions – Early Adopters



Early Adopters: *New with SMAP, a Soil Moisture Mission in 2014*

Purpose is to conduct pre-launch applications research to accelerate use of data after launch.

Organizations with clearly-defined needs for *SMAP*-like data products evaluate & demonstrate the utility of *SMAP* data for their application and decision making.

Early Adopters:

- » Use data products prior to launch (simulated data and cal/val data from field campaigns)
- » Provide feedback on products and formats to increase applications value of mission
- » Streamline and accelerate use of data soon after launch and check-out
- » Supply own resources to do these activities

**** ICESat-2 starting Early Adopters in 2013 ****

20 organizations are currently EAs from public & private-sector, domestic & foreign





House Authorization

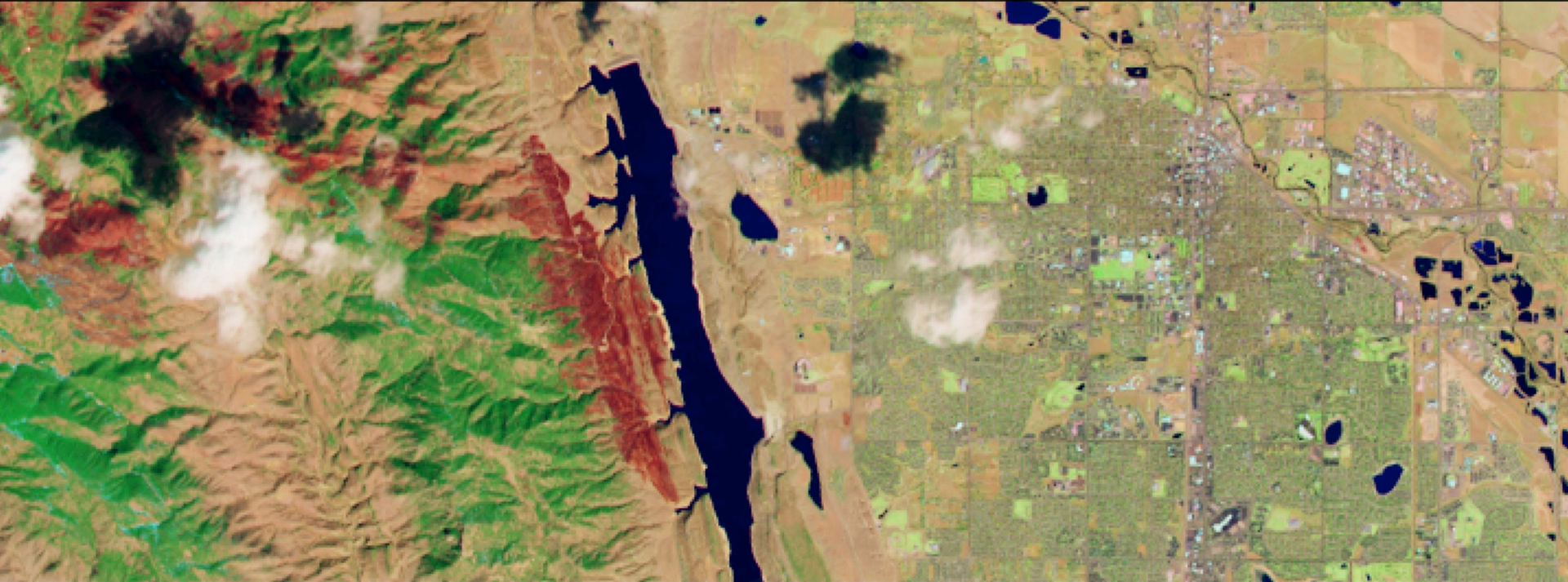
NASA Earth Science was moved under a new oversight subcommittee within the House Committee on Science, Space, and Technology.

While most of NASA is under the Subcommittee on Space, NASA Earth Science is under the Subcommittee on Environment, which also does oversight of NOAA, EPA.

Subcommittee on Environment:

Rep. Chris Stewart (R-Utah), Chair

Rep. Suzanne Bonamici (D-Oregon), Ranking Minority Member



**Human Dimensions in
Earth System Science:
*Social, Behavioral, and Economic***

Integration of Natural and Social Sciences

Restructuring Federal Climate Research (NRC/BASC, 2009)

“Reorganize ... to facilitate crosscutting research focused on understanding the interaction among the climate, human, and environmental systems ...”

“Such a re-structuring around scientific-social issues is required to help the program become more cross disciplinary, more fully embrace the human dimensions component, and encourage an end-to-end approach (from basic science to decision support).”



Belmont Forum (ICSU Report, 2010)

“The physical-climate, climate-impact and resilience-adaptation-vulnerability research communities – which, historically, have been separate – must expand their coordination and collaboration. Funding agencies must be encouraged to establish strategic visions that draw these three communities closer together.”

Human Dimensions in Earth System Science: Social, Behavioral, and Economic



Integration of Natural and Social Sciences

USGCRP Strategic Plan, 2012-2021

Numerous references to the integration of physical, chemical, biological, and social sciences;

to collaborations among researchers in natural and social sciences;

to a workforce capable of bridging the natural and social sciences.

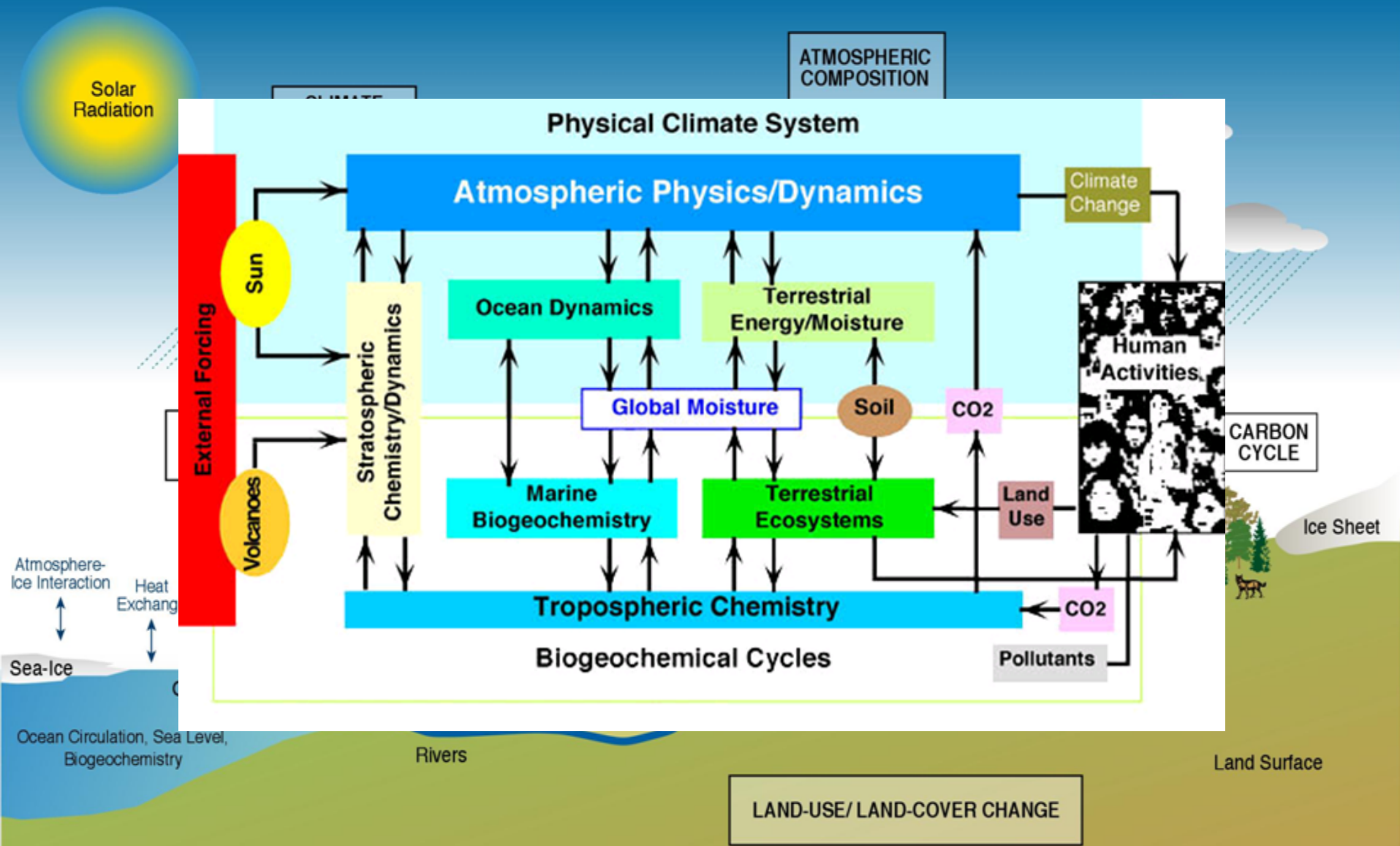


Planet Under Pressure Meeting: *State of the Planet Declaration (2012)*

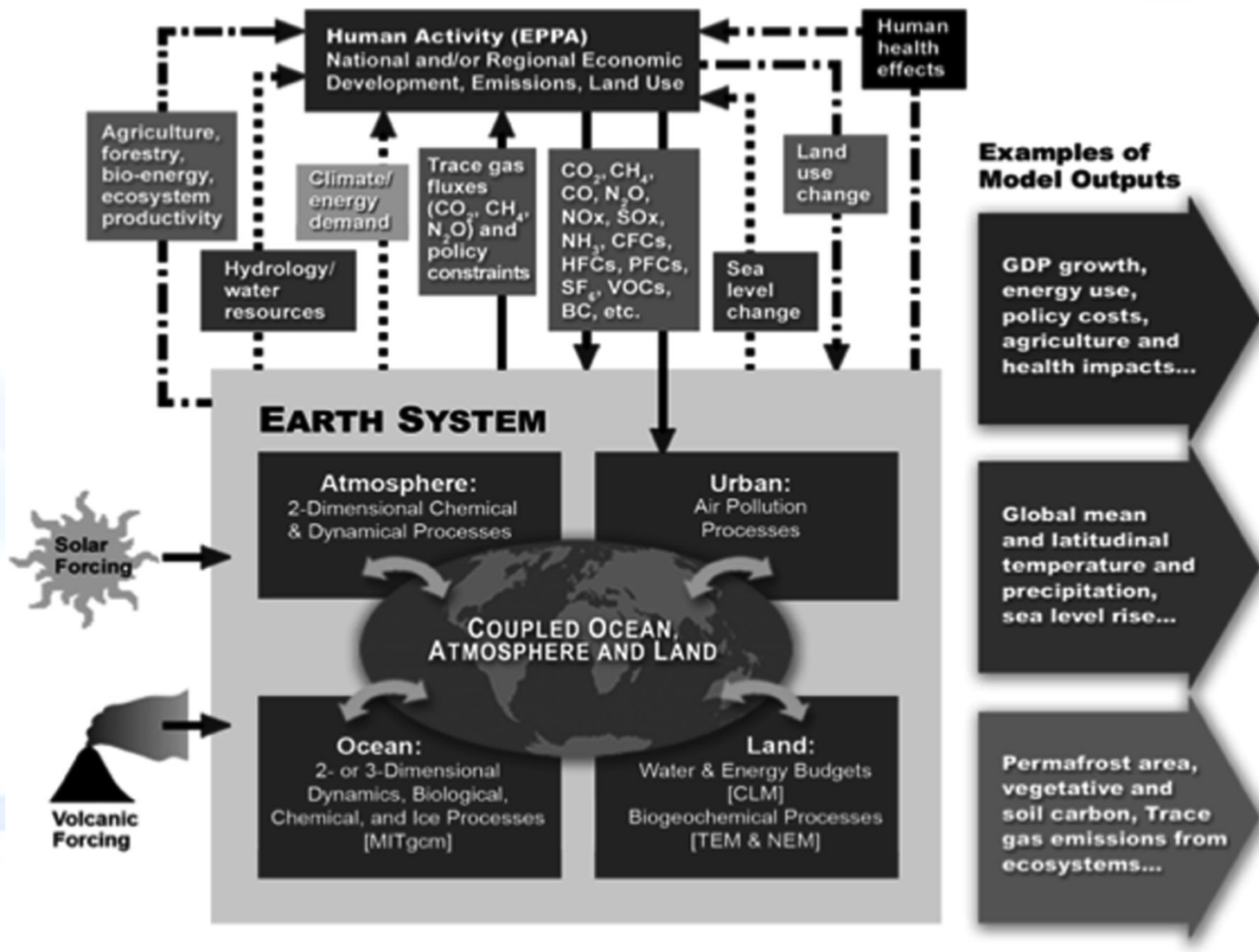
“The international global-change research community proposes a new contract between science and society in recognition that science must inform policy to make more wise and timely decisions ...”

Proposed a major research initiative,
Future Earth: research for global sustainability

Earth as a Complex Inter-related System



Integrated Global Systems Model (MIT)



Elinor Ostrom, 2009 Nobel Prize



2009 Nobel Prize in Economic Sciences
(shared with O. Williamson) for "her analysis of economic governance, especially the commons."

Study of common pool resources (CPR)

Work emphasizes how humans interact with ecosystems to maintain long-term sustainable resource yields. Common pool resources include many forests, fisheries, oil fields, grazing lands, and irrigation systems.

Ostrom's work has considered how societies have developed diverse institutional arrangements for managing natural resources and avoiding ecosystem collapse in many cases.

Source: Wikipedia



Elinor Ostrom

Integration of Natural & Social Sciences on Global Change



“The IHDP is now working on developing a social sciences conceptual framework, which could be easily integrated with the natural sciences frameworks to provide a deeper **understanding of the principle indirect drivers**, such as population demographics, inequality, world beliefs, and values among others, that might be the **causal factor for the direct drivers of change**, such as climate change, water and land use, etc.”



“Recent studies by behavioral scientists show the use of their research in gaining a better understanding of **why societies are reluctant to act even with the wealth of scientific knowledge**. ... Understanding these underlying values, beliefs, or fears is crucial for understanding and managing these behaviors in addressing climate change.”

Evolution of natural and social science interactions in global change research programs (PNAS, 2013)

- H. Mooney, A. Duraiappah, A. Larigauderie

Emphases added.

Source: Mooney et al.

www.pnas.org/cgi/doi/10.1073/pnas.1107484110

Terminology Transfer in Interdisciplinary Work

Economics & Policy Analysis

- » Shadow Price
- » Discount Rate
- » Contingent Valuation
- » Cobb Douglas Function
- » Revealed Preference
- » Marginal Utility
- » Price Elasticity
- » Net Present Value

Earth Science & Remote Sensing

- » Spectroradiometer
- » Synthetic Aperture
- » Normalized Difference Vegetation Index
- » Kriging
- » Supervised Classification
- » Passive Microwave
- » Climate Envelope
- » Orthorectification

Terms shared by both (though meanings may differ)

- » Productivity
- » Probability Density Functions
- » Markov Processes
- » Sensitivity Analysis
- » Monte Carlo
- » Lagrangian Function

Socioeconomic Impacts: A Primer



Purpose:

Inform the Earth observations community and project teams about the language, key principles, techniques, and applications of socioeconomic impact analyses.

Released March 2013

NASA Earth Science: Integral to Geospatial Industry Growth

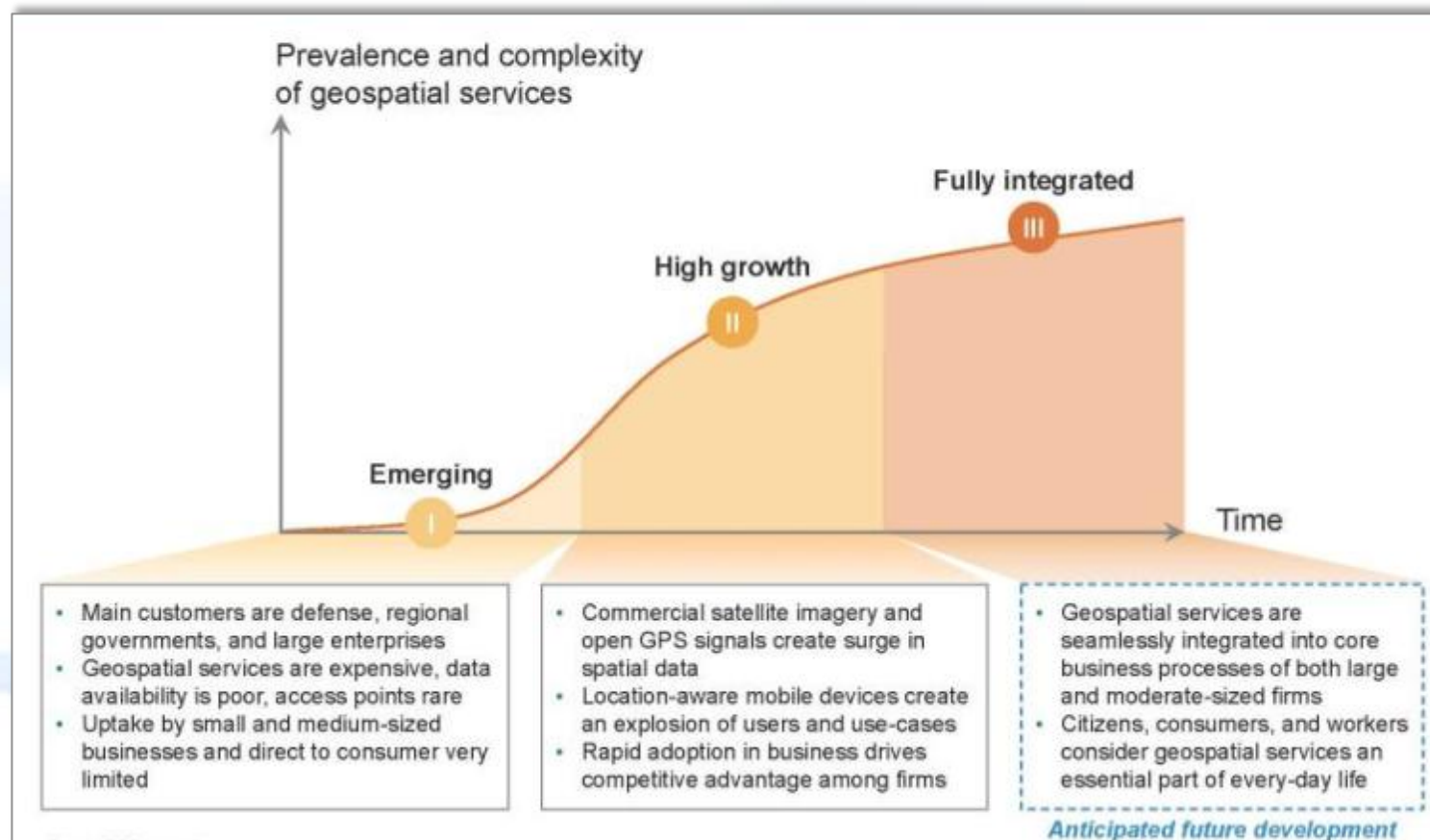


Geospatial services in the U.S. are in a high-growth phase, headed toward market maturity.

– Boston Consulting Group

Key success factors:

Government investment and policy support of geo-data collection; Clear open data policies and effective geo-infrastructure; Strong support for geospatial education, training, and innovation.



Environmental Situational Awareness



Know the field, know the weather.

– Sun Tzu, *The Art of War*



Observations

Scientific Knowledge

Modeling

Applications Knowledge

Crowd-sourcing

Hosted payloads

Mobile apps

Social media

Citizen observations

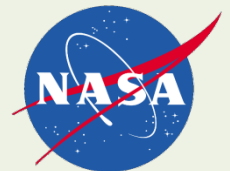
Competitions

NASA Science Mission Directorate Earth Science Division



Biodiversity & Ecological Forecasting Team Meeting

Questions • Discussion



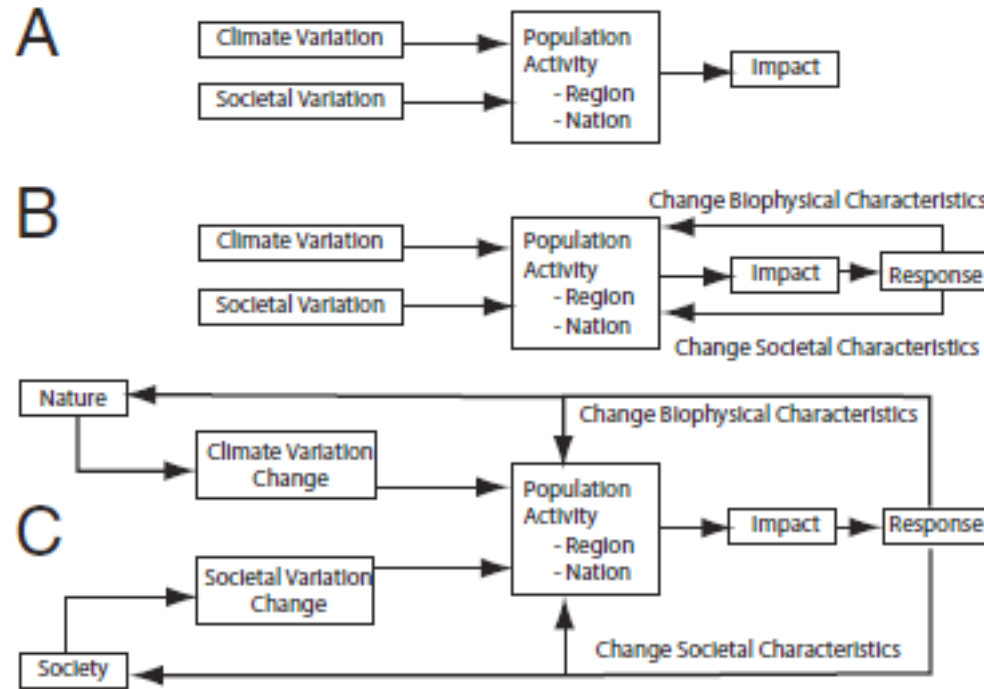


Fig. 2. Conceptual diagrams of the interactions between society and nature in response to climate change impacts (53). (A) Basic model structure, (B) interactive model with some feedback, and (C) interactive model with feedbacks to populations as well as driving variables. Modified from ref. 53.

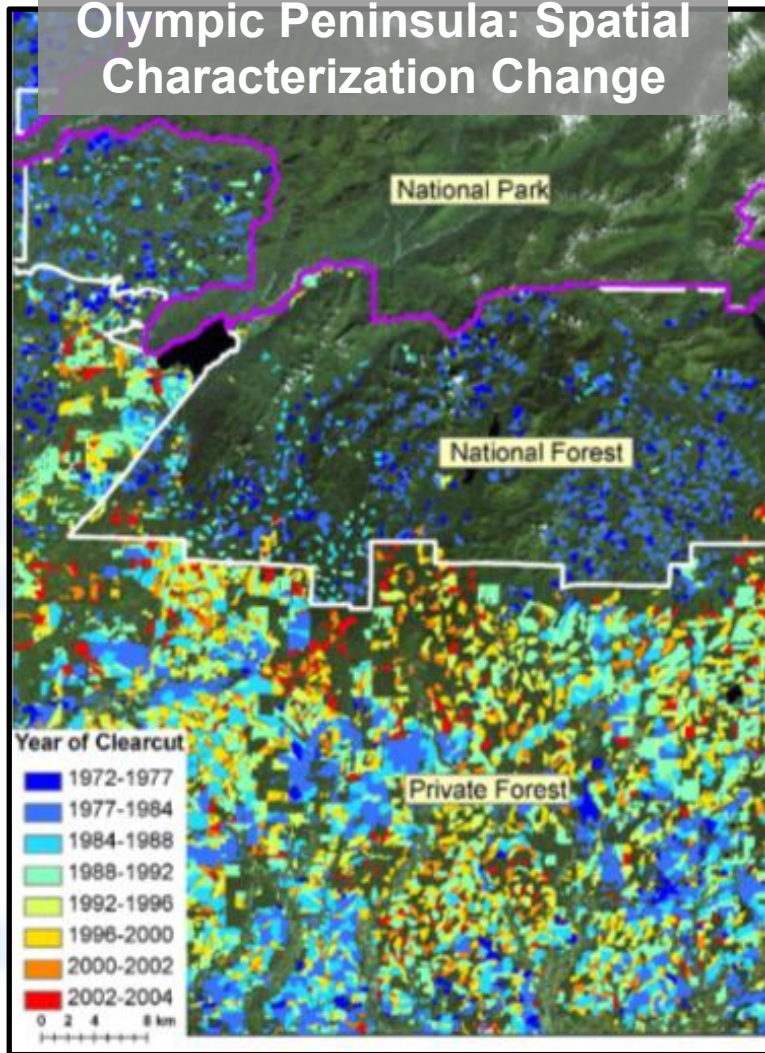
Forest Carbon Storage Assessments



Research → Applied Sciences → USFS

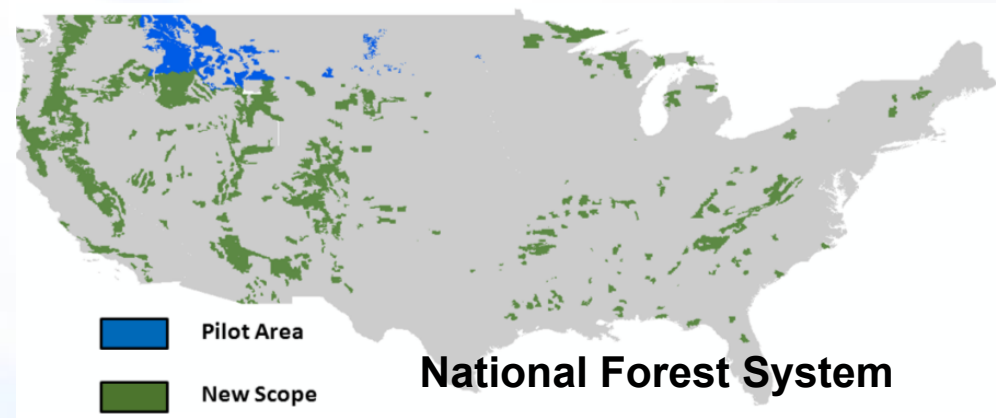


Olympic Peninsula: Spatial Characterization Change



Forest management and natural disturbances effect carbon storage

USFS adopted an ESD-developed forest carbon tool based on Landsat imagery in a comprehensive approach to carbon-storage assessments and forest management. Supports USFS implementation of E.O. [TBS]



USFS funded the expansion of the application from the pilot areas to the entire National Forest System.

SMD/ESD Applied Sciences Program



Applications Themes



Health



Water



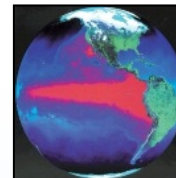
Disasters



Ecosystems



Agriculture



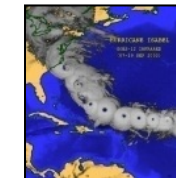
Climate



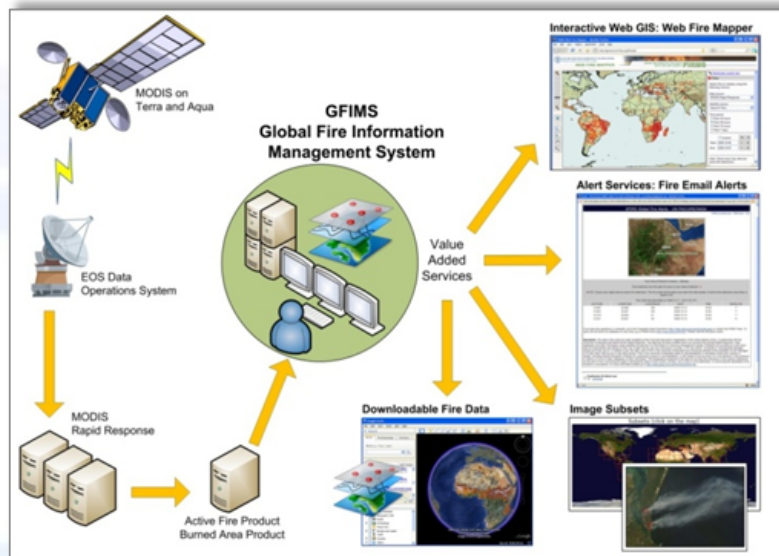
Energy



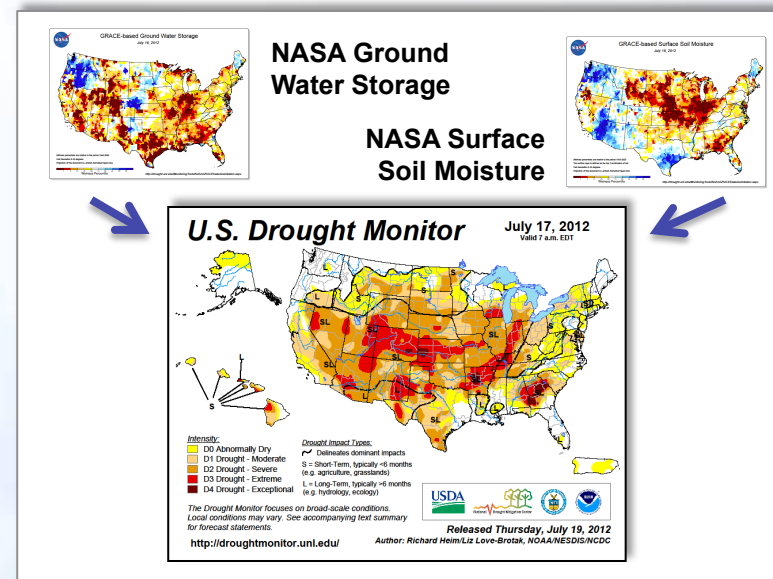
Oceans



Weather



United Nation's system now using data from NASA's Terra and Aqua satellites to identify fires and send alerts to remote areas via SMS and text messages.



USDA/NOAA-managed U.S. Drought Monitor now using NASA's GRACE data as part of analysis in creation of weekly national and state-level maps.

SERVIR: Earth Science for development challenges



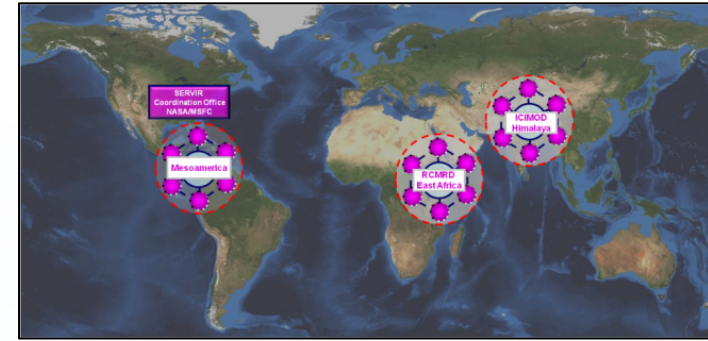
NASA/USAID Capacity Building

Partnership to improve environmental management, resilience to climate change, and solve pressing development challenges

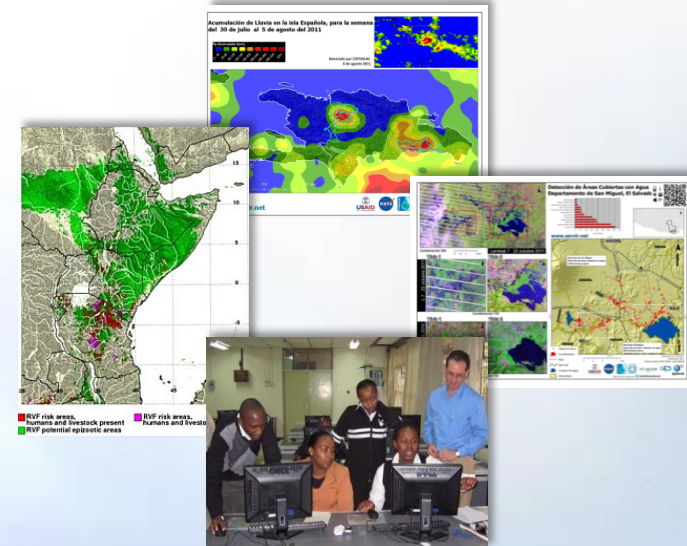
- » Integrates Earth science data and models in practice of development for societal benefits
- » Supports USAID's pursuit of improved decisions on climate change and sustainable landscapes
- » Expands uses and users of NASA data and identifies new applications ideas

SERVIR Applied Science Team (New 2012)

- » Team of 11 Earth scientists. Each member has an individual project and is part of *ad hoc* teams to address immediate apps. or emerging needs.



Access to Data, Models, Online Maps, Visualizations, Decision Support Tools, Training, Needs Assessments, ...



“The biggest problem we have is lack of data. When someone like SERVIR-Africa comes along to help us out it is very good because we have been missing floods.”

– Simintei Kooke, Kenya Ministry of Water and Irrigation

