Evolution and Priorities for NASA Land Cover and Land Use Change Program

NASA LCLUC Science Team Meeting
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Anthony C. Janetos, Director
Joint Global Change Research Institute
Former Program Manager: NASA LCLUC Program

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Critical Issues

- How does our scientific understanding inform decision-making in a wide variety of domains?
- We are now the dominant force affecting many environmental conditions – land-cover, air quality, and increasingly, the climate system itself
- So it is critically important to understand how human decisions and resource use interact with natural processes to shape landscapes and the Earth system itself

The State of the Near Future Defines Important Scientific Issues

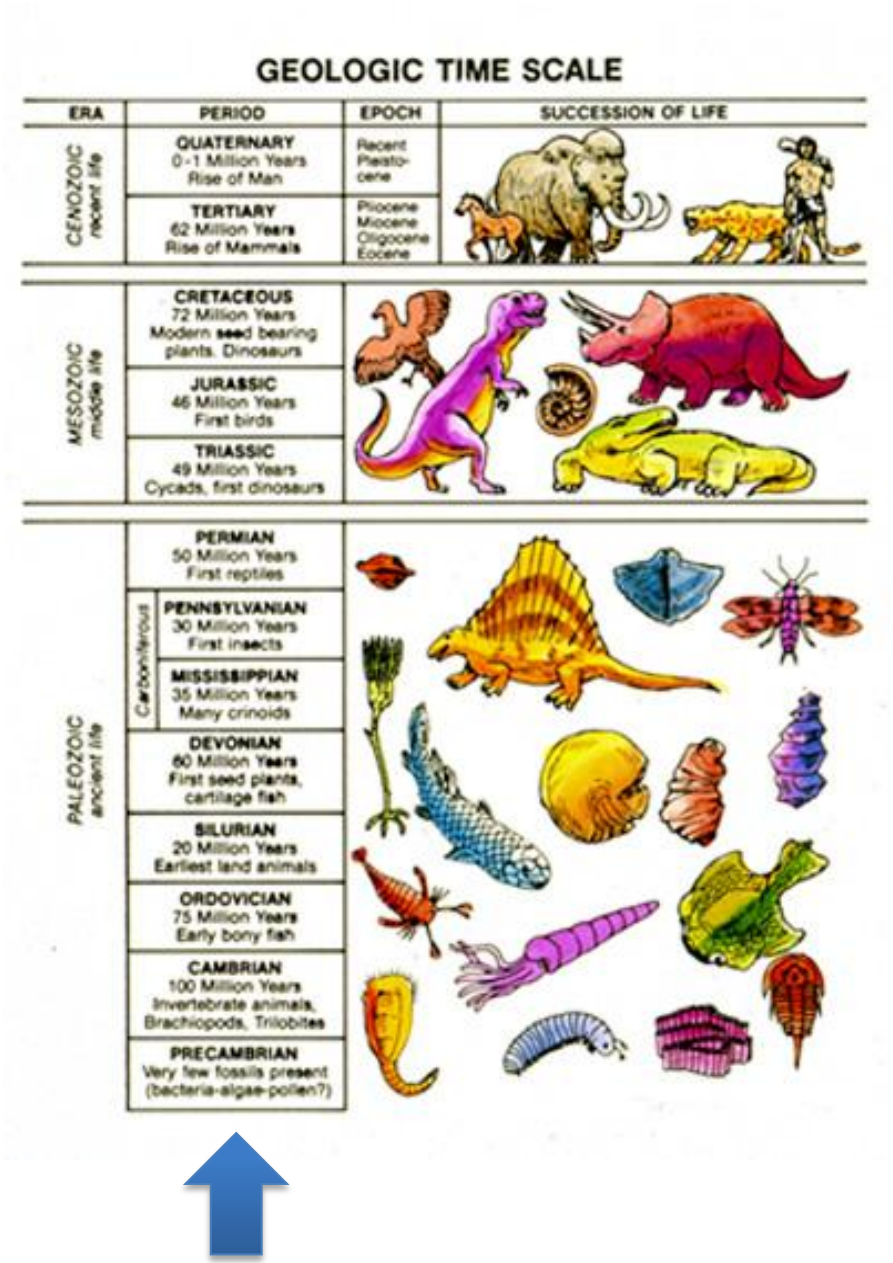
- A planet with 6.5 billion people headed towards 9 or 10 billion in the next several decades
- Most of those new people will be in the developing world
- Food demand will approximately double, and energy demand likely to roughly triple in the same time period, as people seek to raise standards of living
- Implications for water, habitat, natural ecosystems
- And the physical climate system is also changing, and impacts of that are being felt more rapidly than we had originally thought
- Enormous challenges for long-term sustainability

My Four Principles about Interdisciplinary Science and the Environment

- We should study the world we have, not the world we wished or imagine we have
- Science should be interesting AND useful
- There is no bright line between “basic” or “fundamental” and “applied” research
- All the really interesting, important, and challenging problems in the environment are intrinsically interdisciplinary

Evolving Over 15 Years

- Review the original goals and structure of the program
- Did we succeed?
- What challenges remain from the original set?
- What new challenges have emerged that should be pursued?



Where my history starts

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The View from 1999

Land-Cover and Land-Use Change: Program Vision

- Capability to perform repeated global inventories from space
- Evaluate consequences of observed change

Land-Cover and Land-Use Change: Program Goals

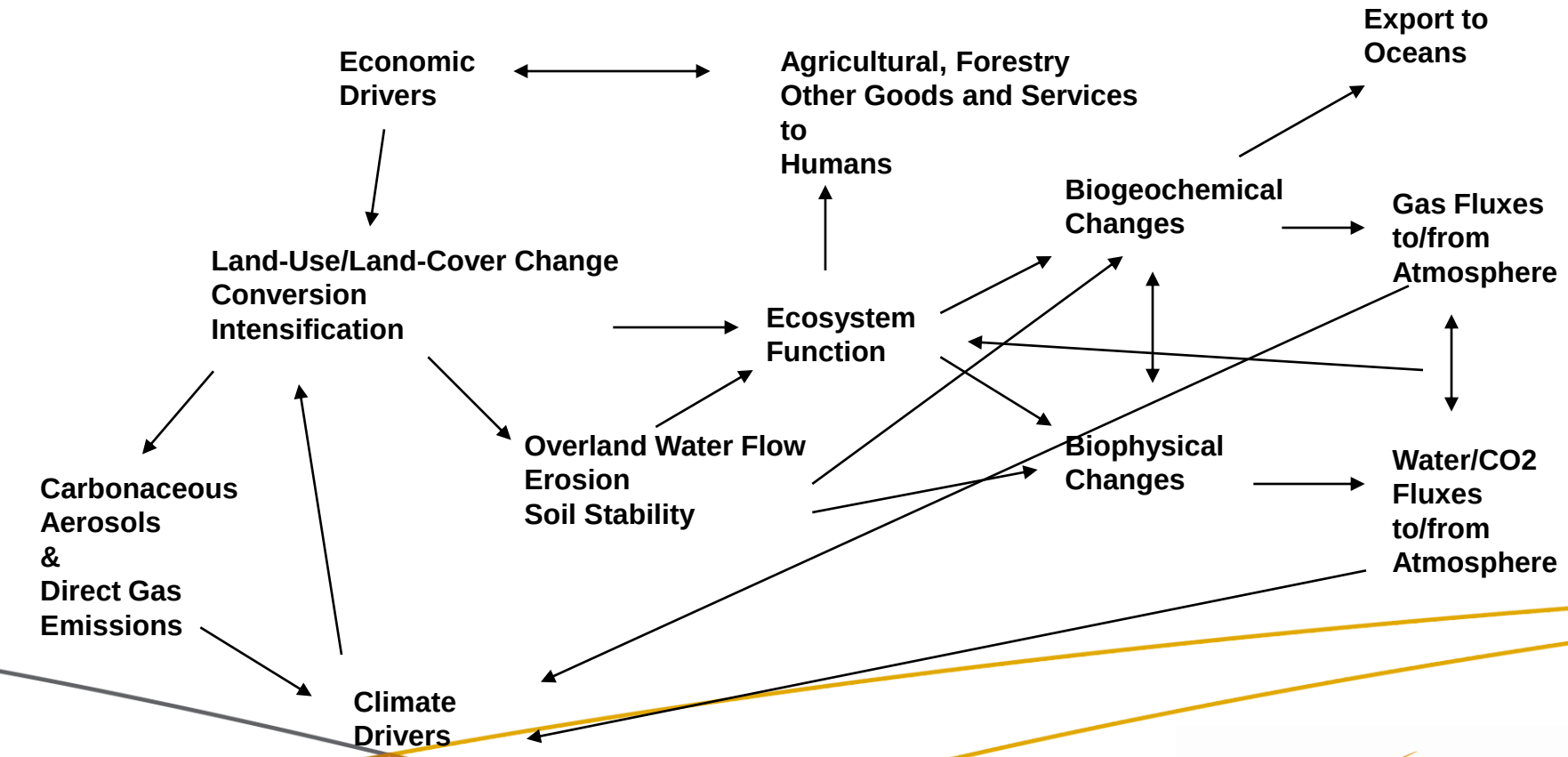
- Land-cover conversion
  - Identify current distribution of land-cover types
  - Track conversion to other land-cover types
  - Primary interest in conversion of forest ecosystems to other types
- Land-use intensification
  - Understand consequences of intensified management of agricultural and agroforestry systems in tropics and sub-tropics
  - Measure the long-term *in situ* degradation of forest ecosystems

Land-Cover and Land-Use Change: Program Goals

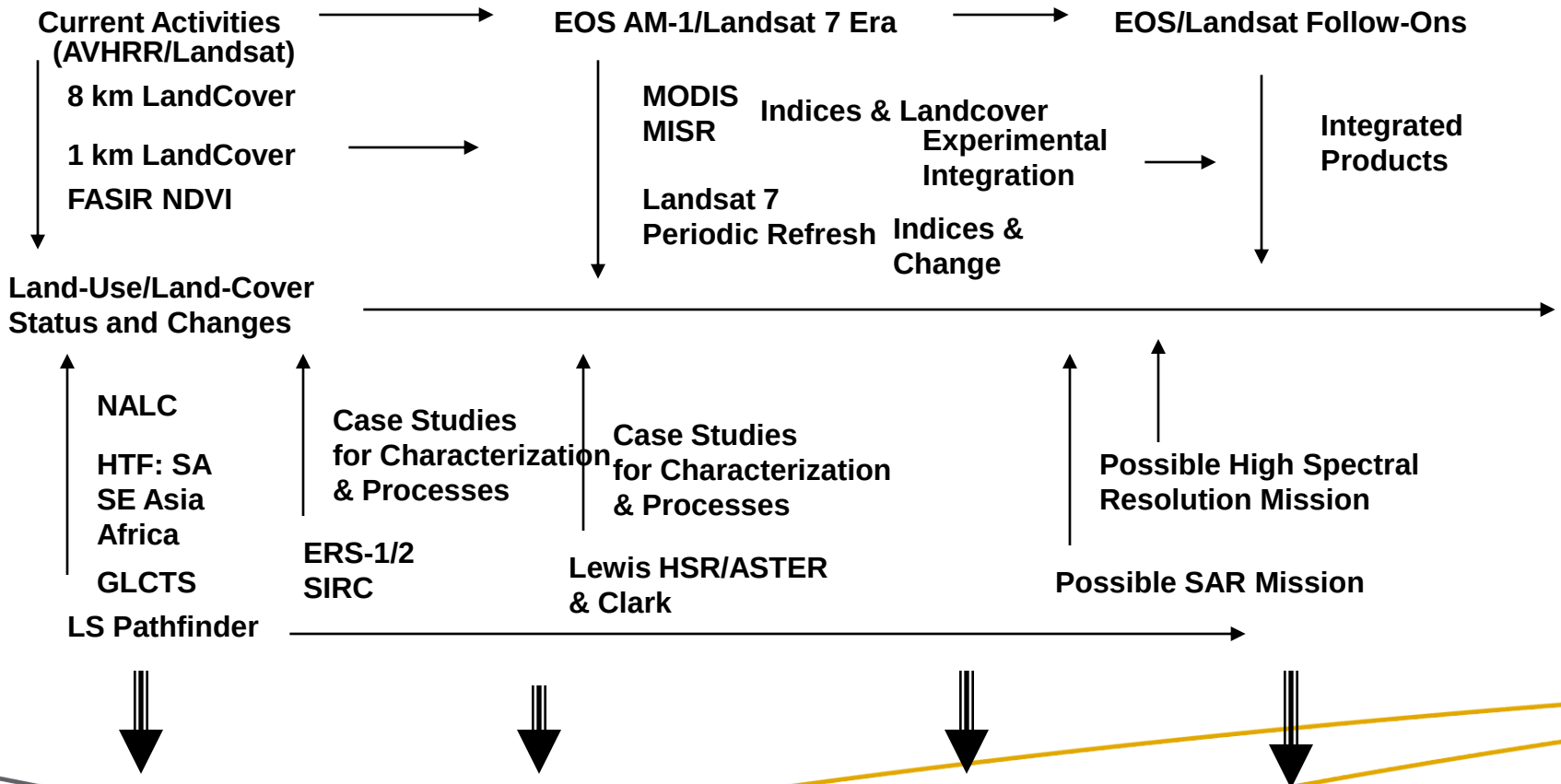
- Verification
  - Understand consequences of international agreements
  - Investigate forestry and agriculture in temperate and boreal climates
- Modeling
  - Develop techniques to incorporate actual land-cover

Fig. 1

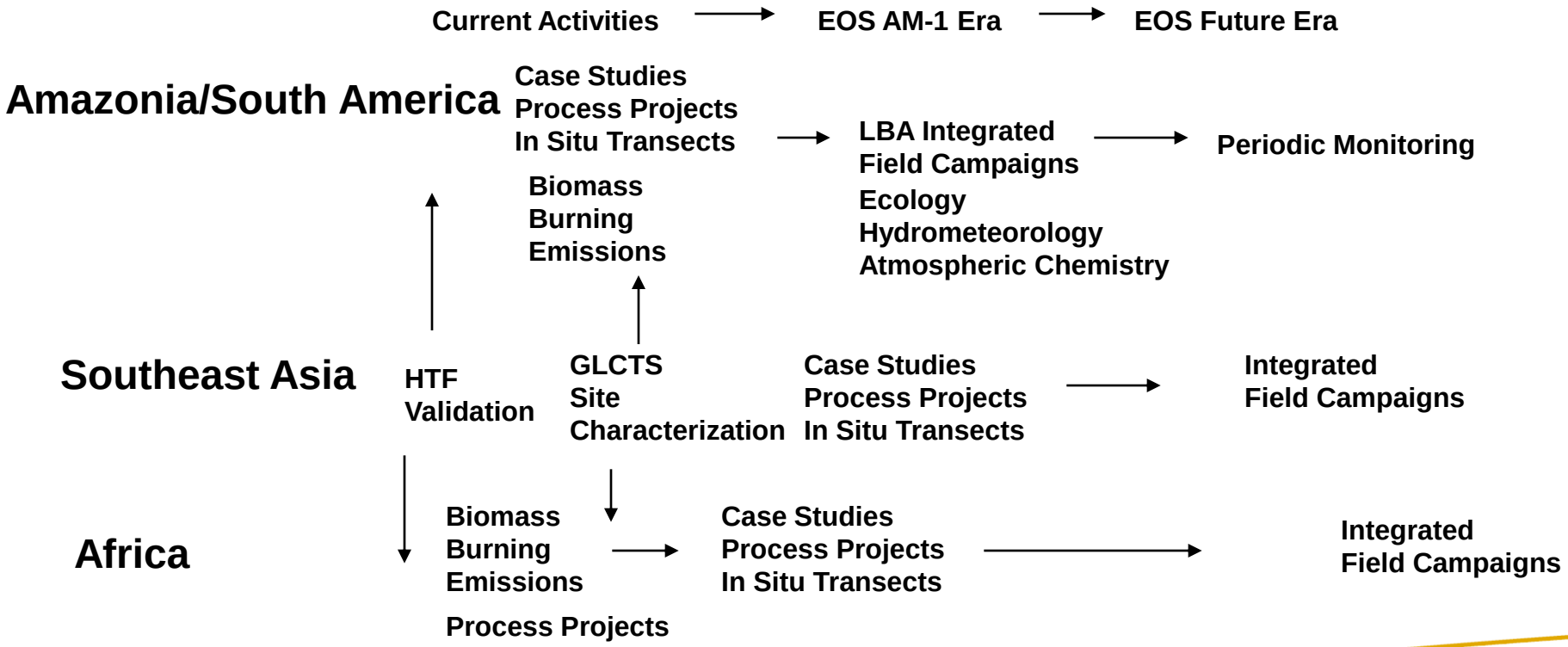
Interactions of Land-Cover/Land-Use Change



Satellite Studies & Assessments



Land-Cover/Land-Use Change: Field Studies & Campaigns



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Land-Cover and Land-Use Change: Selected Accomplishments

- Deforestation rates for Brazilian Amazon quantified for late 1970's-1980's
- Estimates of regrowth in Amazon as high as 30% of the area
- Satellite observations of distribution and frequency of fires in southern African savannas
- Increases in boreal fire frequencies could potentially contribute another 0.3-0.8 GtC/yr to the atmosphere as a consequence of increased greenhouse warming

Land-Cover and Land-Use Change: A View Ahead

- Premier example of interdisciplinary study of land-use in the USGCRP
- Important contributor to US National Assessment of Potential Consequences of Climate Variability and Change
- Important contributor to international scientific assessments related to land-cover and land-use
- Must now incorporate new measurement and modeling capabilities
- Must now become major contributor to policy-relevant issues internationally and domestically

Did We Succeed?

- Premier example of interdisciplinary study of land-use in the USGCRP
  - Yes, no question about it
- Important contributor to US National Assessment of Potential Consequences of Climate Variability and Change
  - One of many programs
- Important contributor to international scientific assessments related to land-cover and land-use
  - Yes, through contributions in the broader literature and also through the MA and IPCC
- Must now incorporate new measurement and modeling capabilities
  - Continually…
- Must now become major contributor to policy-relevant issues internationally and domestically
  - Partially…

So What is Next?

- Enhancing operational capabilities
- Synthesis of individual case studies for broader perspective
- Land science at the interfaces
- Towards prospective, process-based modeling of land-use

Possibilities for Advancement

- The first bullet is really the province of GEO, GOFC-GOLD, National and International Space Agencies, etc.
- The second is an outgrowth of various scientific assessment and synthesis processes, e.g. the synthesis phase of IGBP
- The others are at the cutting edge of what we are capable of in research, and here is where I think we can make significant progress in the coming years

Fig. 1

Interface with Human Needs and Ecosystem Services

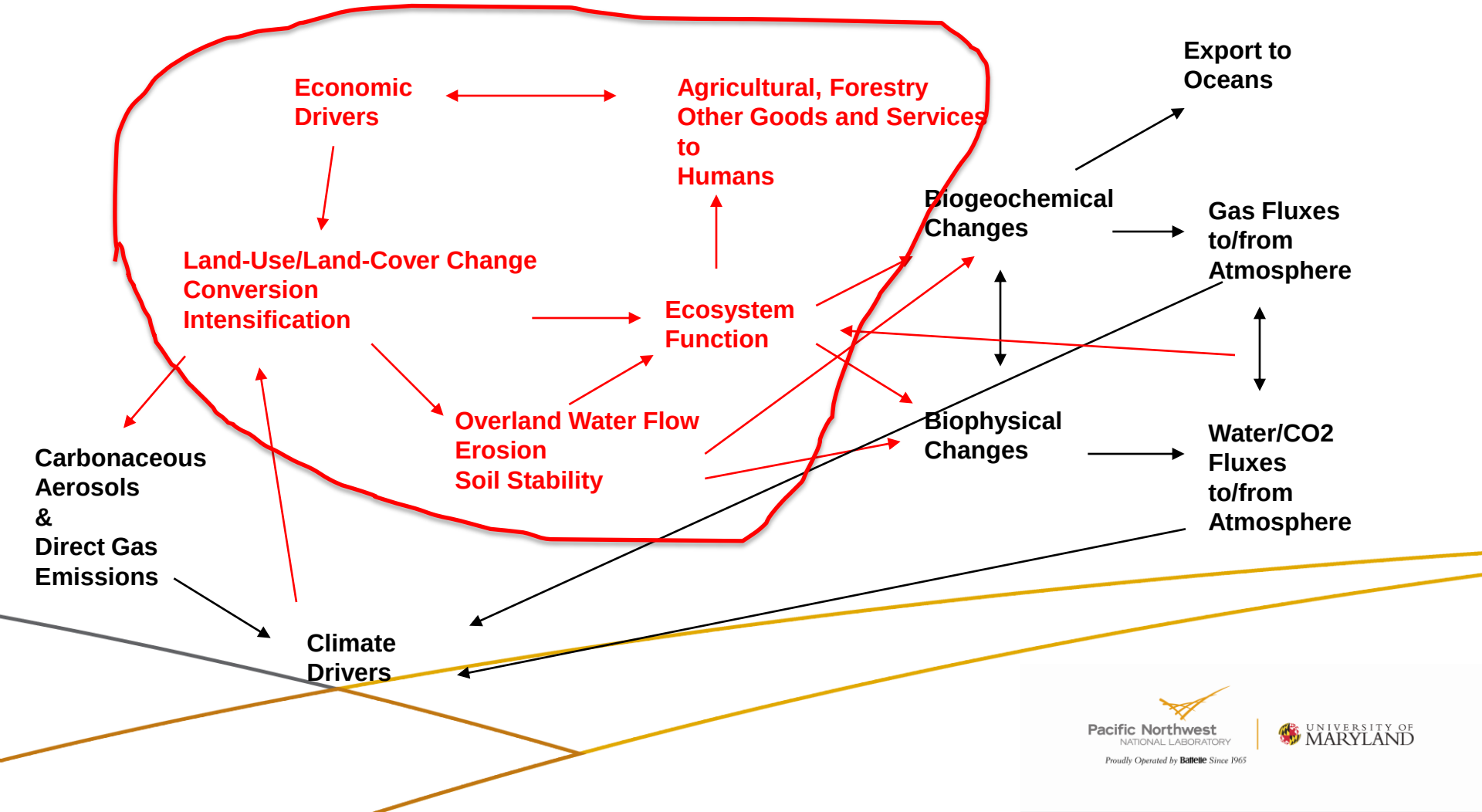

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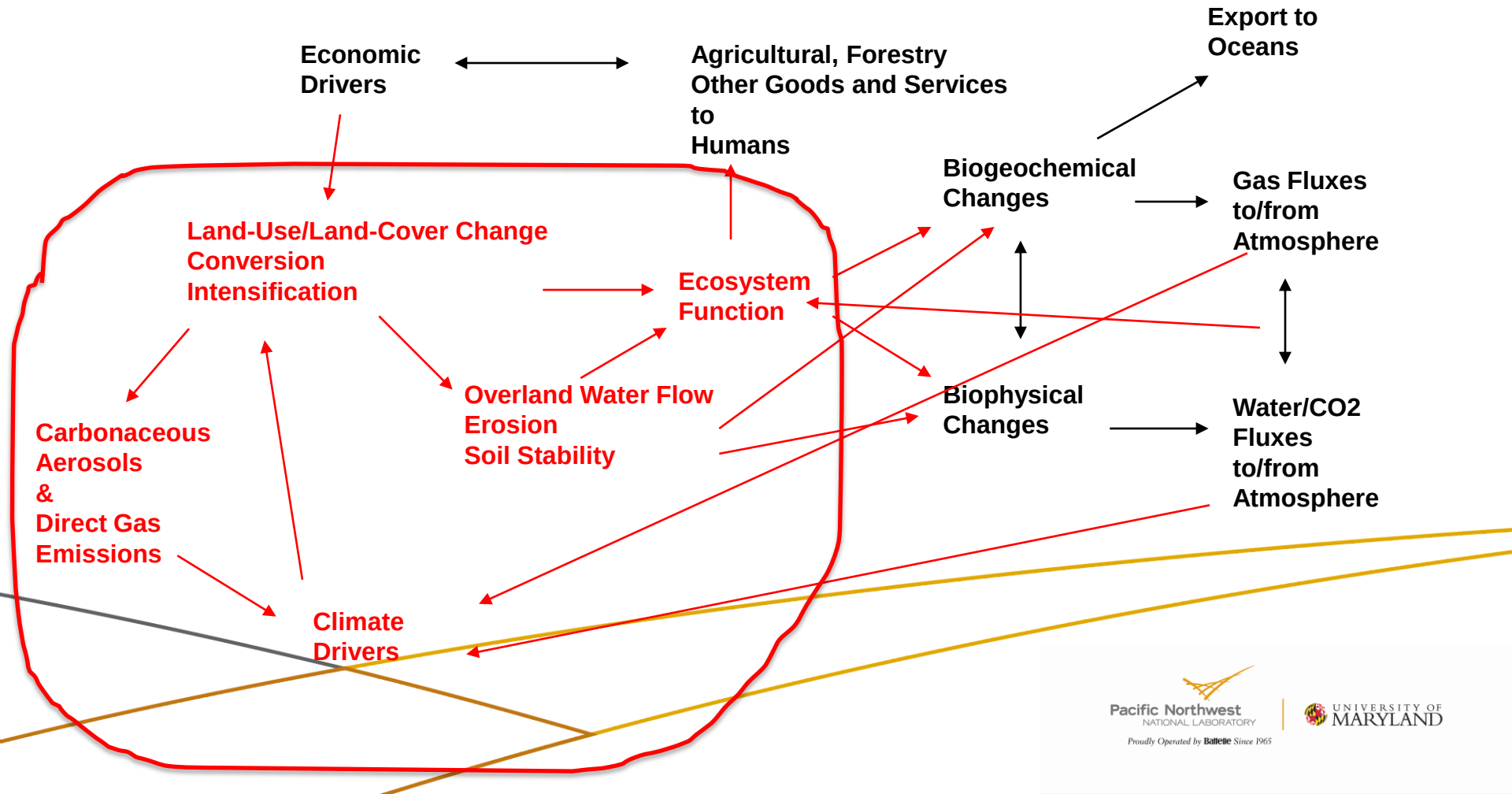
Fig. 1

Interface with a Changing Climate System



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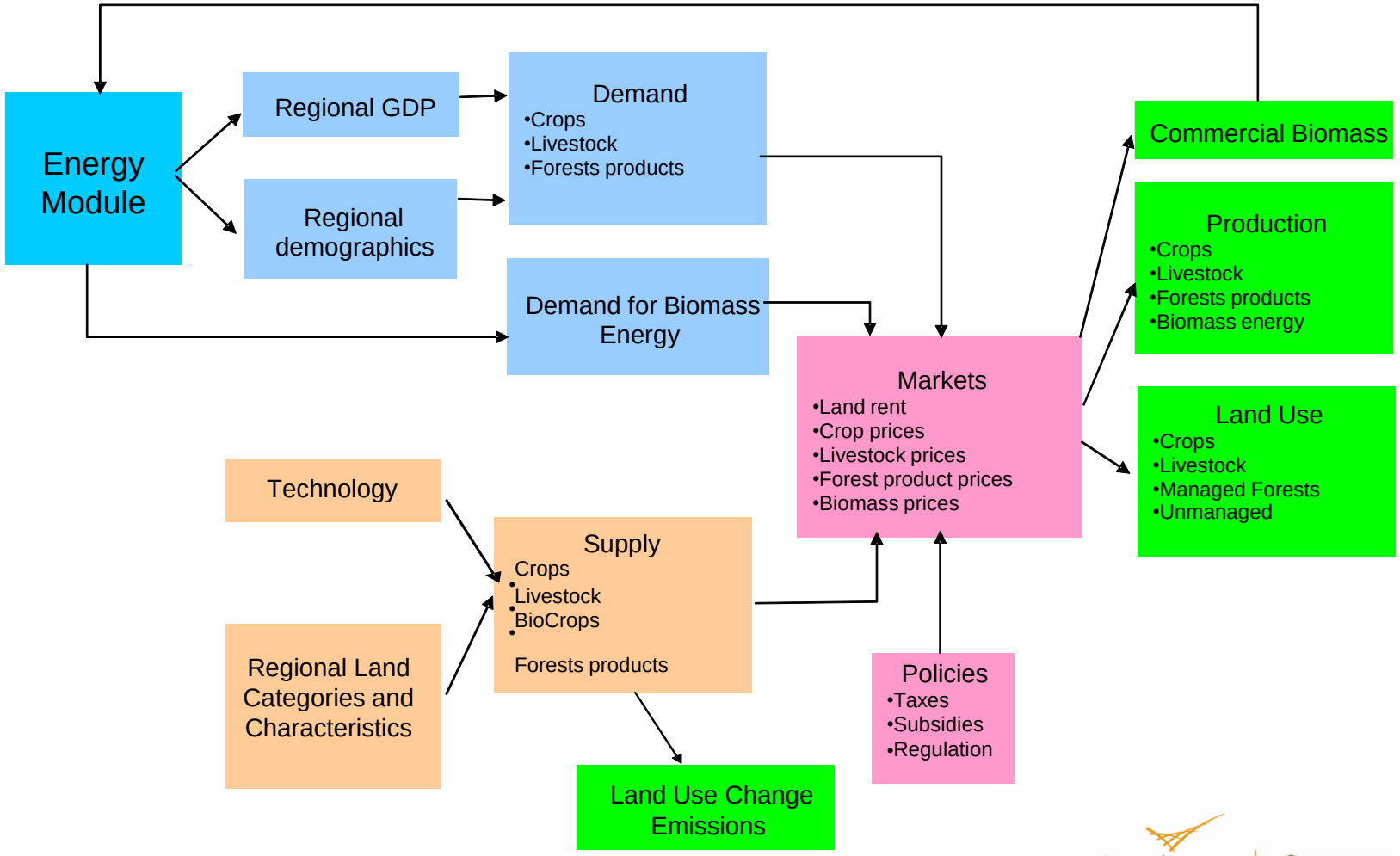
What Could be Done?

- Need to interact with modeling communities which already simulate changing human demands for agricultural productivity, energy, and water
- Begin to adapt those models to deal with other human factors affecting land-use
- Confront those models with observational data on land-cover and land-use
- Experiment with modeling interactions with the physical climate system
- Explore alternative futures in a way that illustrates the joint effects of meeting societal demands, sustaining ecosystem services, and interacting with a changing climate system
- Understand the consequences of those potential futures from the standpoint of adaptive capacity and vulnerability – these are very different worlds from today

Could We Be Successful?

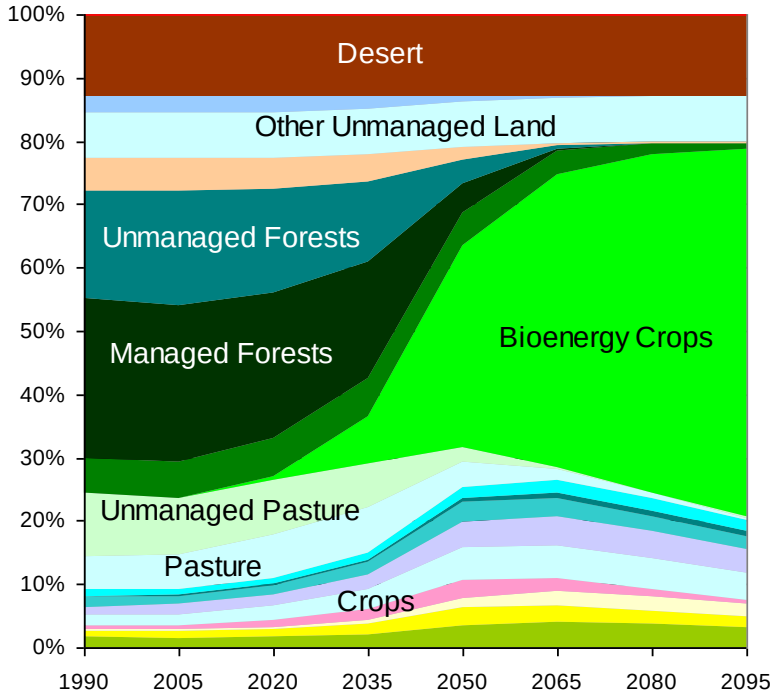
- There are many reasons to think we can
- Collaborations are beginning to emerge

Agriculture, Land-use and Energy in GCAM

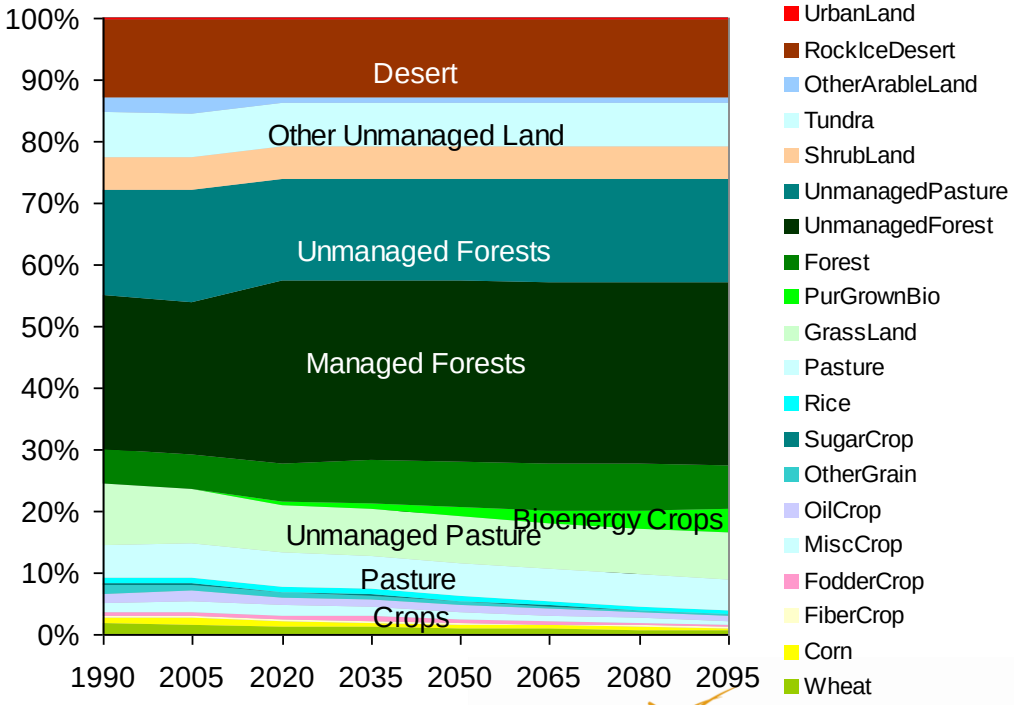


The Land Use Implications of Stabilizing at 450 ppm When Terrestrial Carbon is Valued

450 ppm Stabilization Scenario When Terrestrial Carbon is NOT Valued (FFICT)



450 ppm Stabilization Scenario When ALL Carbon is Valued (UCT)



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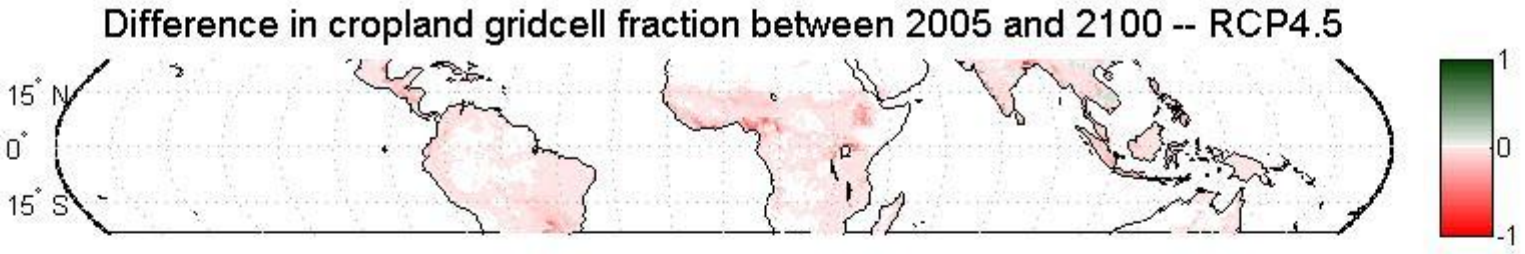
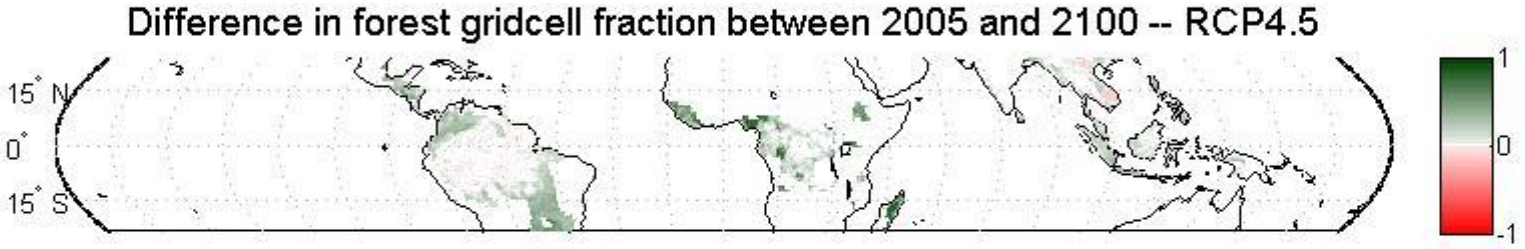
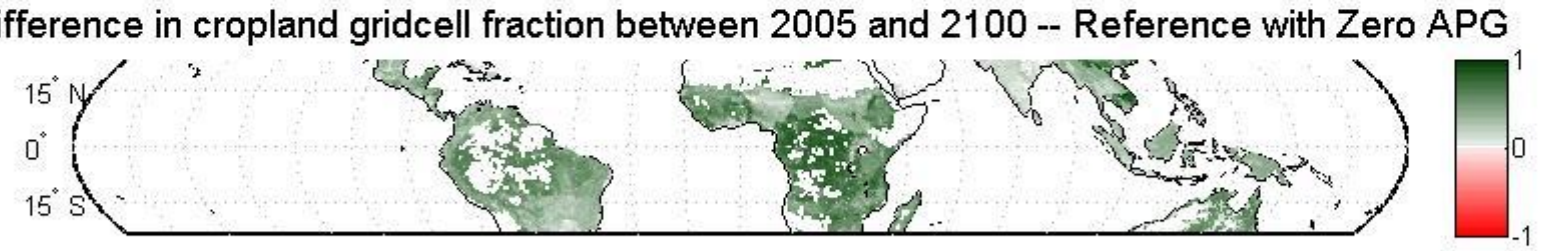
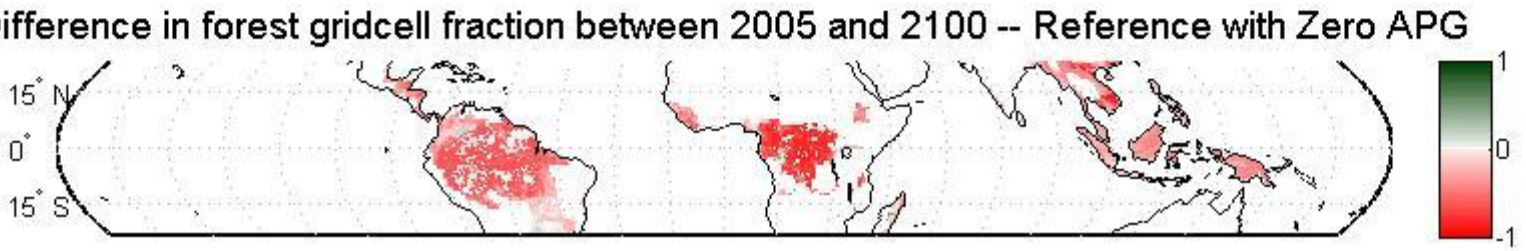
Develop down-scaling algorithms for land cover







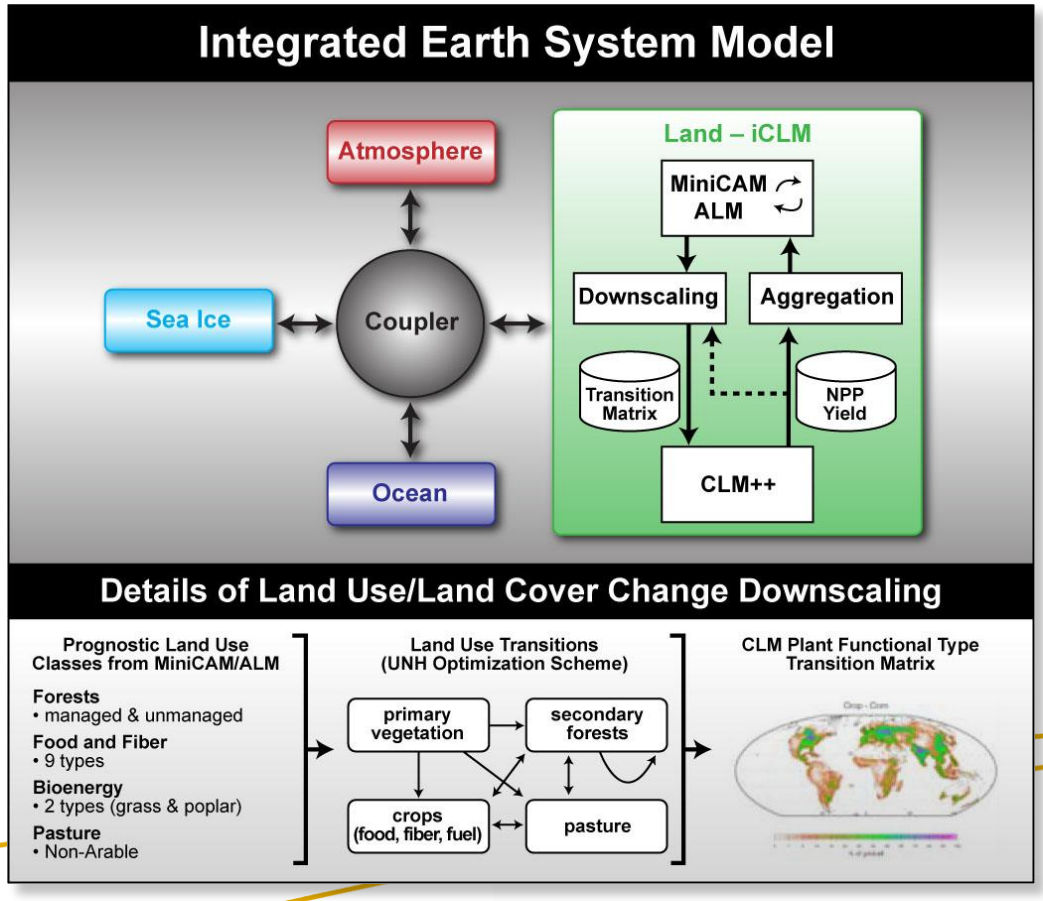


Thomson et al., 2010 *PNAS*

Integrated modeling biofuels and feedbacks

Objectives of iESM team:

- Investigate biofuel sustainability under future climate change.
- Study feedbacks from climate and CO_2 to the energy markets (phases 2 and 3)
- Quantify irrigation demand/costs for biofuels and energy markets.



Conclusion

- Even though early efforts are still experimental, have the capability to expand to other forcing factors
- Observational record for land-cover is good, but of course its sustainability must be secured
- Starting to think about what a similar record for land-use would look like
- We should be optimistic
- NASA LCLUC Program can and should still be one of the places where really new ideas and approaches are incubated and tested