

How will we know if we are on track?

Challenges and Opportunities for Measuring, Reporting and Verification (Evaluation)

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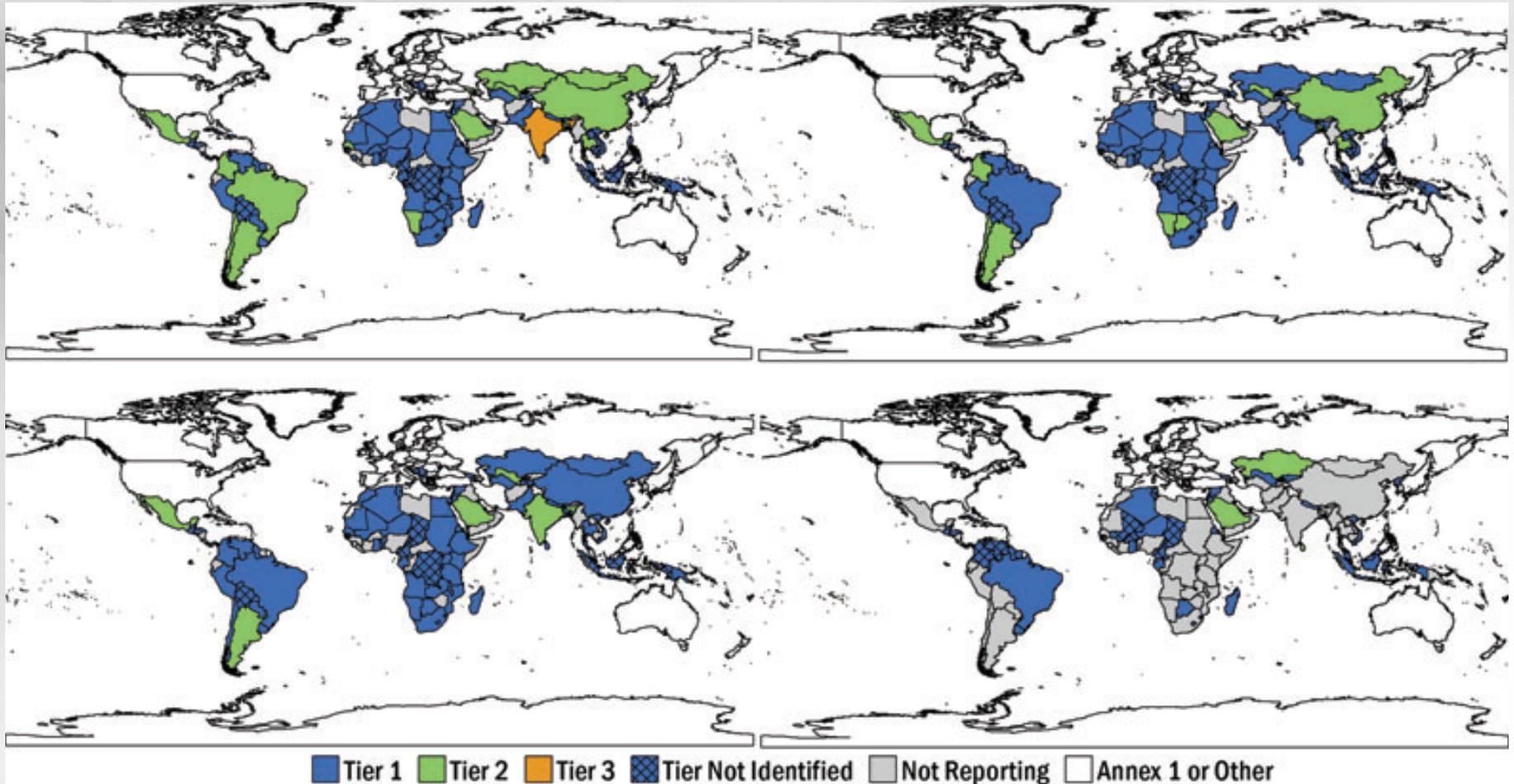
Introduction

- ▶ Measuring, Reporting and Verification (MRV)
 - The need to keep track of national and global emissions was recognized in the UN Framework Convention on Climate Change (UNFCCC), as early as 1970s!
 - MRV definition according to UN system **“all measures which states take to collect data on emissions, mitigation actions and support, to compile this information in reports and inventories, and to subject these to some form of international review or analysis.”**
- ▶ Part of the challenge of creating a well functioning MRV system is institutional.
 - Getting all Parties to adopt the same methods and conventions, and to share data.
- ▶ Part of the challenge is due to uncertainty in underlying factors contributing to emissions.
 - Uncertainties associated with processes, measurements, models and analyses.
- ▶ Given the approach adopted for NDCs is a “bottom-up” and relies on self reporting process.
 - What is/are the best national and international measures and indicators of progress?
- ▶ **How Can Research Community Support MRV Process?**
 - **Implementing effectively current commitments (i.e. NDCs)**
 - **Identifying opportunities for greater ambitions**

How Can Science Contribute to Effective Implementation of NDCs?

- ▶ For example, the Agreement makes specific reference to land use, reaffirming and anchoring the complete forest-related legal framework adopted under the Convention.
- ▶ Vast majority of the NDCs -117 out of 160 Parties that submitted their potential contributions by end of December 2015- had included land use REDD+ -relevant contributions.
- ▶ Assuming that detailed mitigation strategies will be developed in the context of NDCs.
- ▶ The rules on accounting for NDCs, which emphasize the importance of complete coverage, also highlight the role of forests and land use under the Agreement, both in mitigation and adaptation.
- ▶ However, the Agreement is less specific from an agricultural perspective, there is no explicit reference to agriculture and 'food production'.
- ▶ The implied challenge is to reconcile food production/security with mitigation/adaptation efforts in/by the agricultural sector.
- ▶ Does this present an opportunity or a challenge for the Parties in fulfilling their current commitments, and perhaps greater ambitions? t

Example: Agricultural Systems Role in GHG Management



National GHG Inventory methods used in developing countries for estimating methane emissions (a), manure management (b), agricultural soil N₂O (c), and soil carbon stock changes (d). The data are based on national reporting to the UNFCCC (http://unfccc.int/national_reports/items/1408.php). (Ogle et al, 2014, GCB)

Different Tiers of UNFCCC Carbon Inventory Approach



Tier 3 – Using multiple measurements over certain time period in different land categories, and country specific high resolution gridded data of annual biomass growth, and land use and land cover change.

Tier 2 – Uses country specific data of land cover type, reference C stocks (soil survey) and emission/removal factors (from long term experiment plots).

Tier 1 – C accounting approach that uses default global reference C stocks (croplands, grasslands, forest, and organic soils) and emission/removal factors that can be used to account for net changes in SOC storage.

Complexity & Accuracy Criteria

Used by Different Nations
(Ogle et al., 2014, GCB).

Biogenic Carbon Fluxes from Global Agricultural Production and Consumption

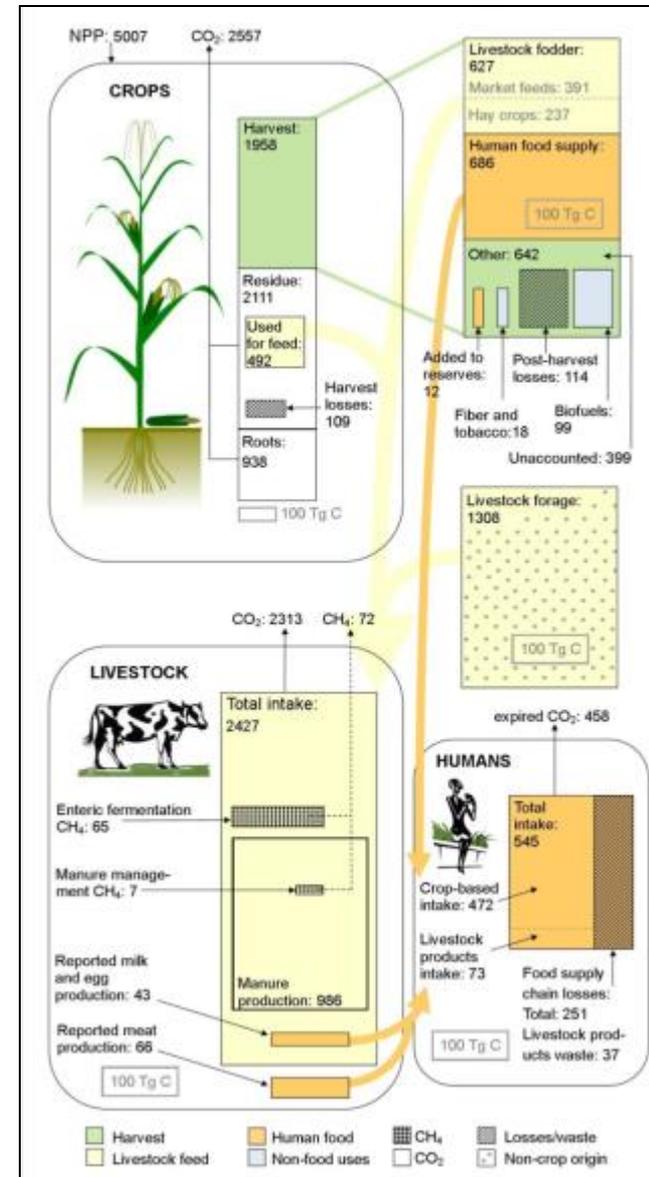
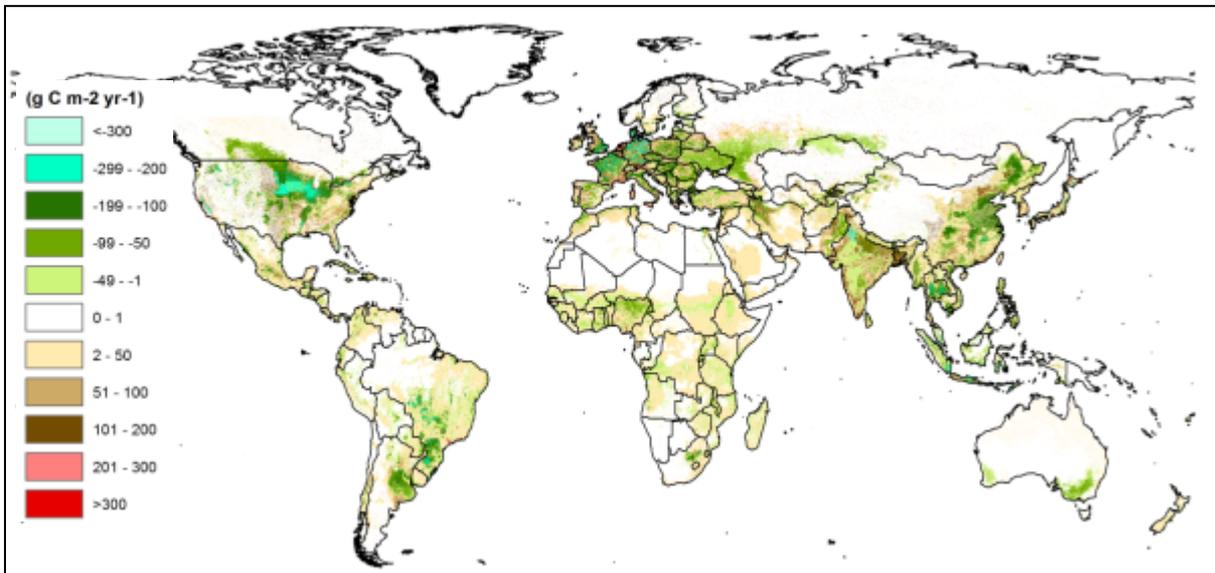
Combine multiple data sources:

- crop/livestock inventory
- human population
- remote sensing data

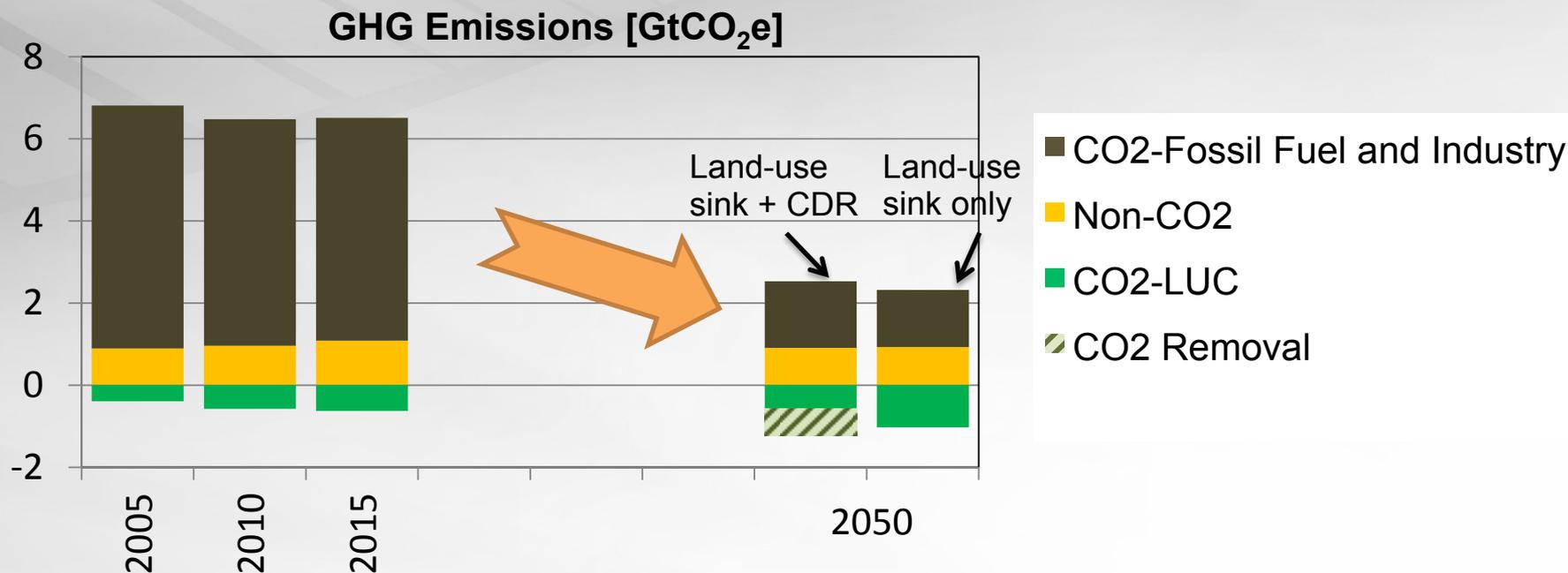
to produce:

- gridded, annual estimates of net agricultural carbon exchange (below, year 2009 shown)
- global agricultural carbon budgets (right, year 2009 shown)
- uncertainty estimates with Monte Carlo (not shown)

Wolf et al., 2015



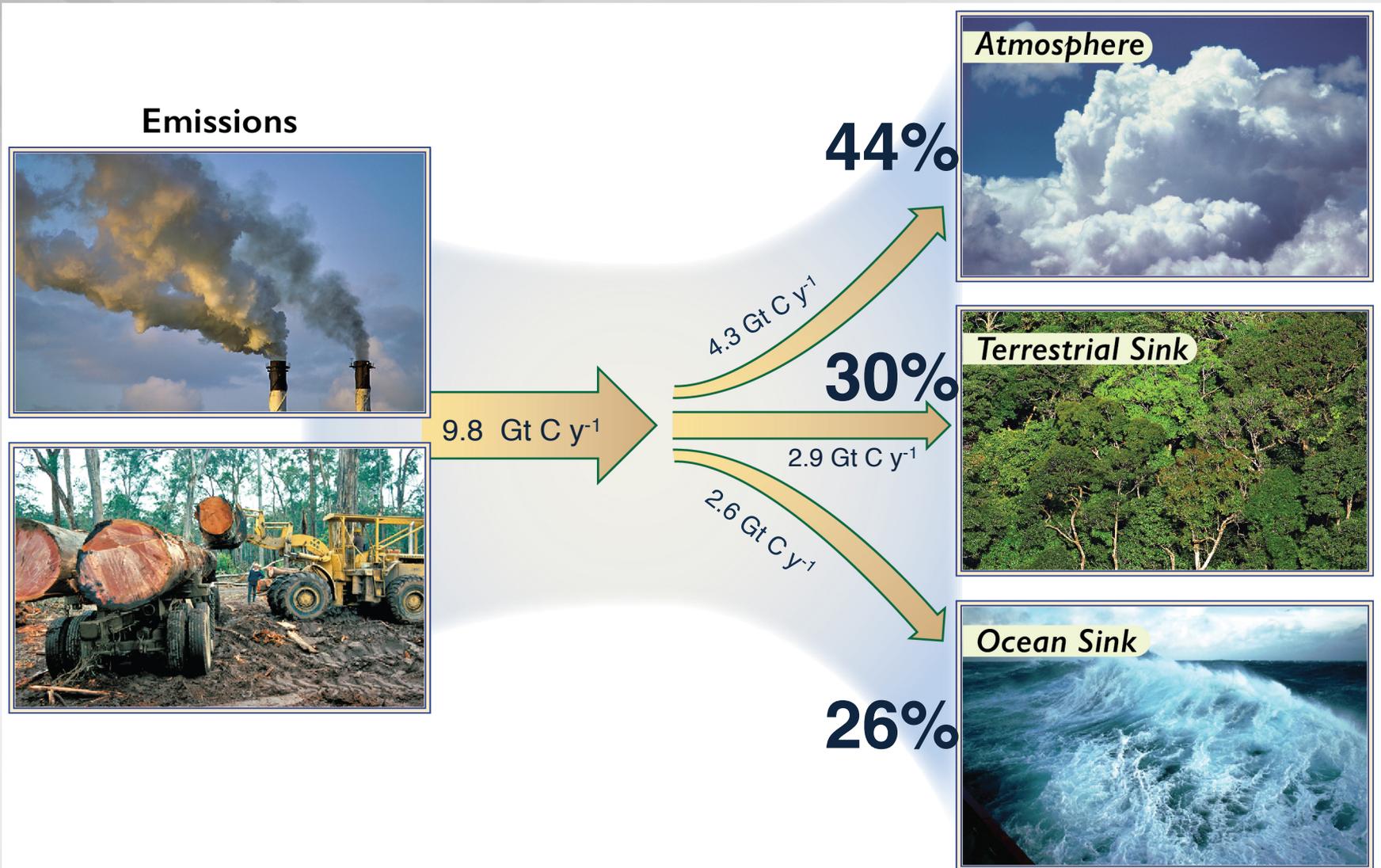
Terrestrial emissions become increasingly important as emission from industrial sources decline



- ▶ Scenario 1, sinks are achieved by a combination of terrestrial sinks and deployment of CDR technologies;
- ▶ Scenario 2, sinks comprise of terrestrial CO₂ uptake alone
- ▶ Both assume optimistic technological advances, almost complete decarbonization of the electricity sector and increased electrification of end-uses!

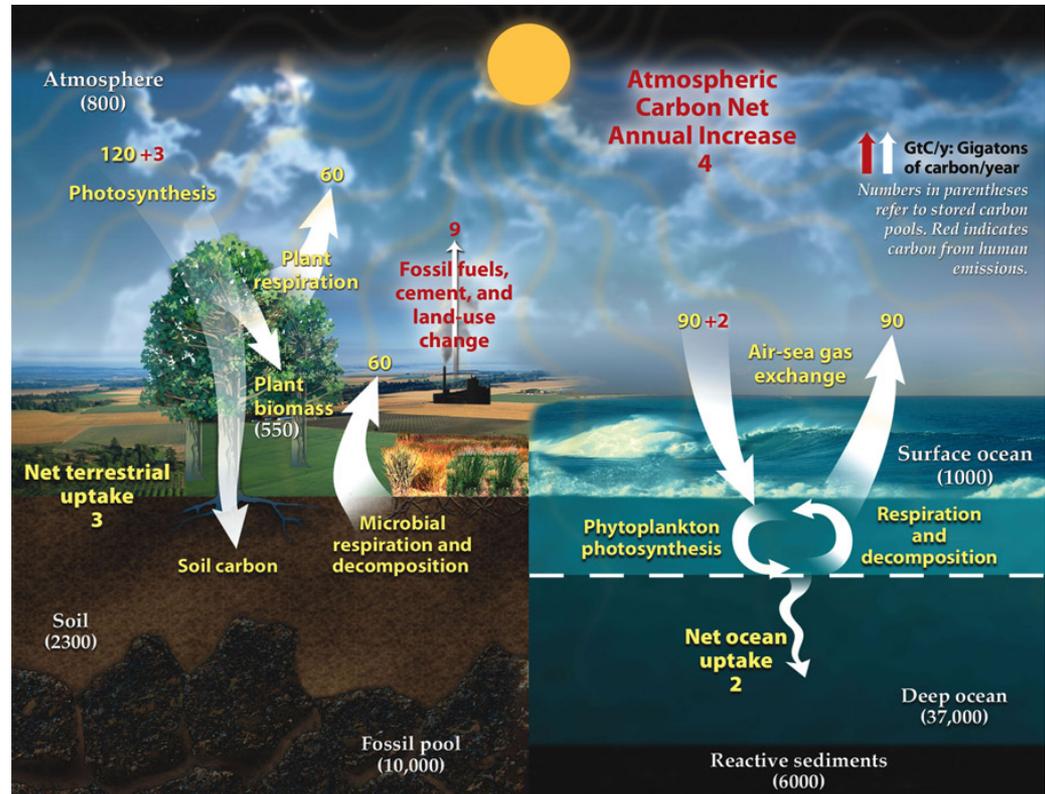
Iyer et al., work in progress

The Sink for Global CO₂ Emissions (2005-2015)



Terrestrial Systems Emissions Uncertainty

- ▶ Uncertainty in net emissions of carbon from terrestrial systems has been a long-standing challenge because the annual net fluxes are small compared with total fluxes.
- ▶ Emphasis on emissions has focused on fossil fuel sources because this component of the carbon cycle is large and growing.
- ▶ But, as emissions are reduced the net fluxes from land surface become more significant.



Relative Contribution of Five Eco-regions to Total Global GPP and its Variability, 2001-2010.

Inter-Annual Variability

MODIS: 42.4%

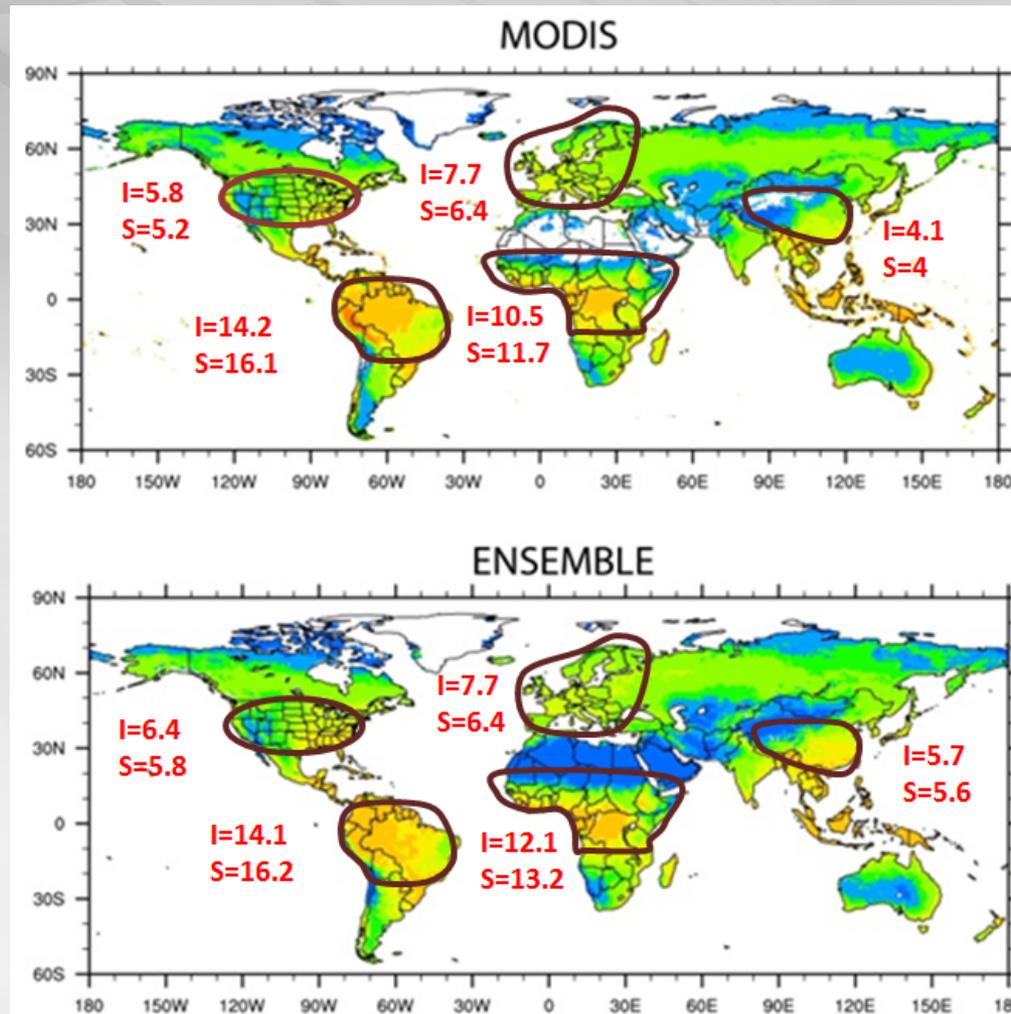
Eight Models Ensemble: 46.3%

Seasonal Variability

MODIS: 43.3%

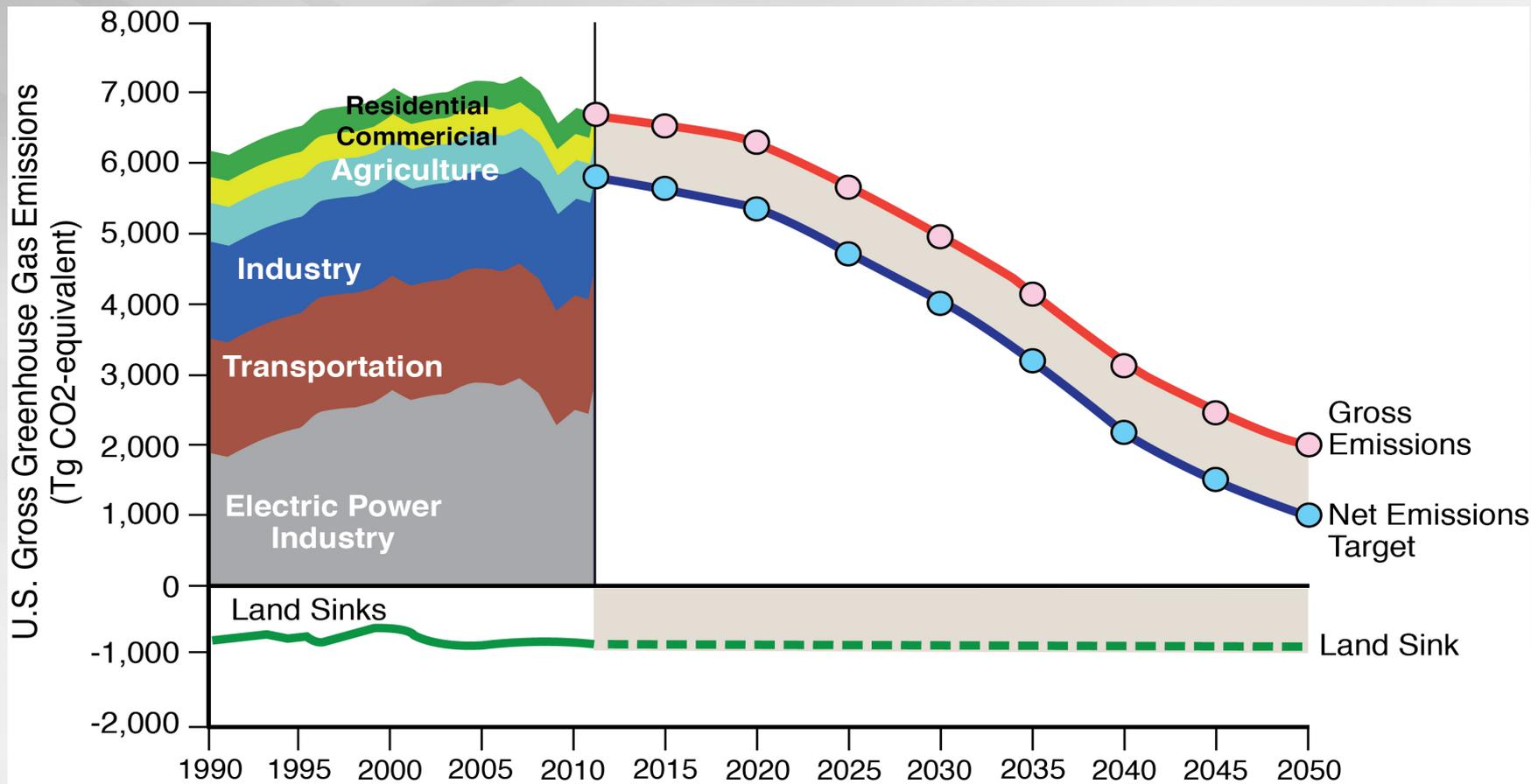
Eight Models Ensemble: 47.3%

Rafiq et al., in review.

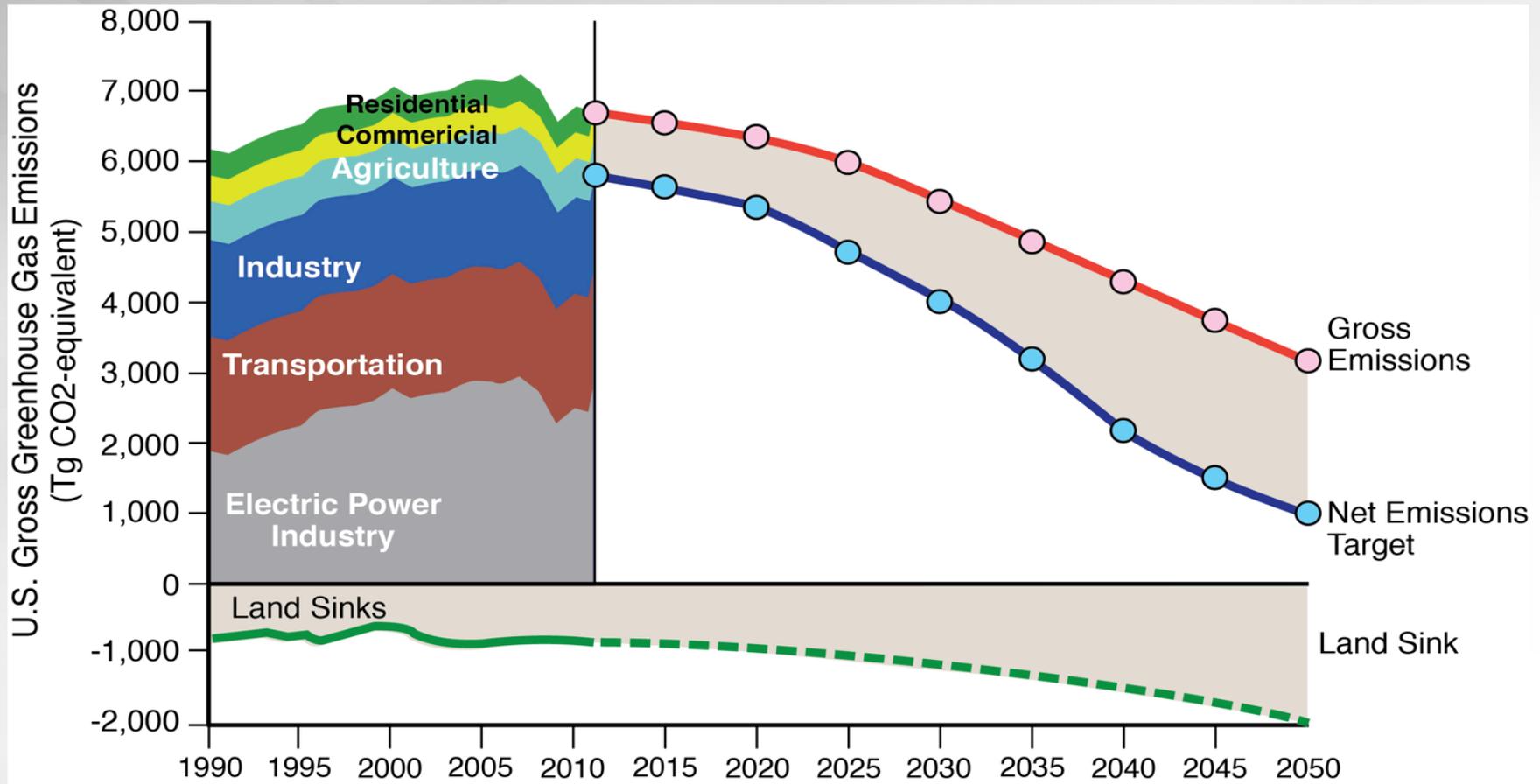


The inter-annual (I) and seasonal (S) variability of the global GPP (in %), based on observations and simulations from 8 land-atmosphere models, 2001-2010.

The U.S. land carbon sink is critical to U.S. carbon reduction pathways and future energy costs



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How Can Science Contribute to Effective Implementation of NDCs?

- ▶ Tracking emissions is necessary, but not sufficient to ensure success in implementing NDCs!
- ▶ What is/are the best indicators of progress given the diversity of sectors and factors contributing to emission?
- ▶ Is there a need for specific indicators for different sources and sectors, or composite indicators?
- ▶ How about the role of co-benefits, i.e. food security, energy security, air quality,.....?
- ▶ What is the role of technology and non-energy emissions in achieving NDCs and the long-term goals?
- ▶ How can near-term actions be designed/influenced to facilitate long-term goals?

How will we know if we are on track to final destination?

- ▶ Terrestrial ecosystems undoubtedly play a major role in management of carbon to achieve current and future ambitions, especially when paired with technology and policy options.
- ▶ Science community can certainly play a key role in helping the nations, and the world, to navigate the path(s) to the final destination.
- ▶ We will certainly know when we get there, but the road will be bumpy with unexpected detours?!

Thank you