Enhancing Global Forest Observations in a Changing Climate

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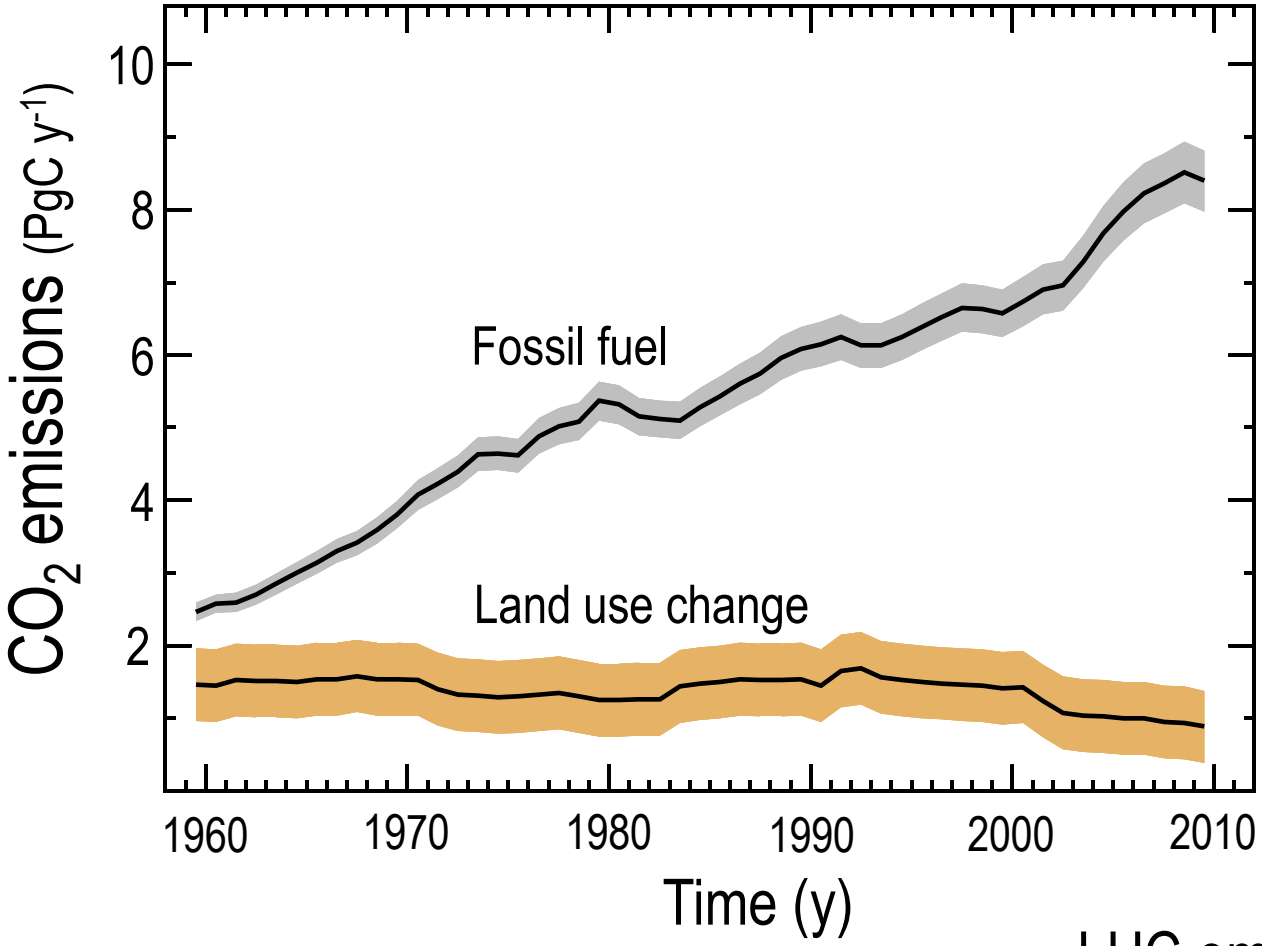
Science Objectives to Address Policy & Management Needs

- Detect and understand changes in forest ecosystems, feedbacks to climate
- Effects of deforestation, afforestation, and degradation on the land-based carbon sink
  - Carbon budgets (soil, above and belowground vegetation)
  - Interaction with changing climate (e.g. water cycle)
- Effects of climate and management on natural adaptation
  - Vulnerability to shifts in distribution of species, biomes
  - Mitigation effects in the face of climate change

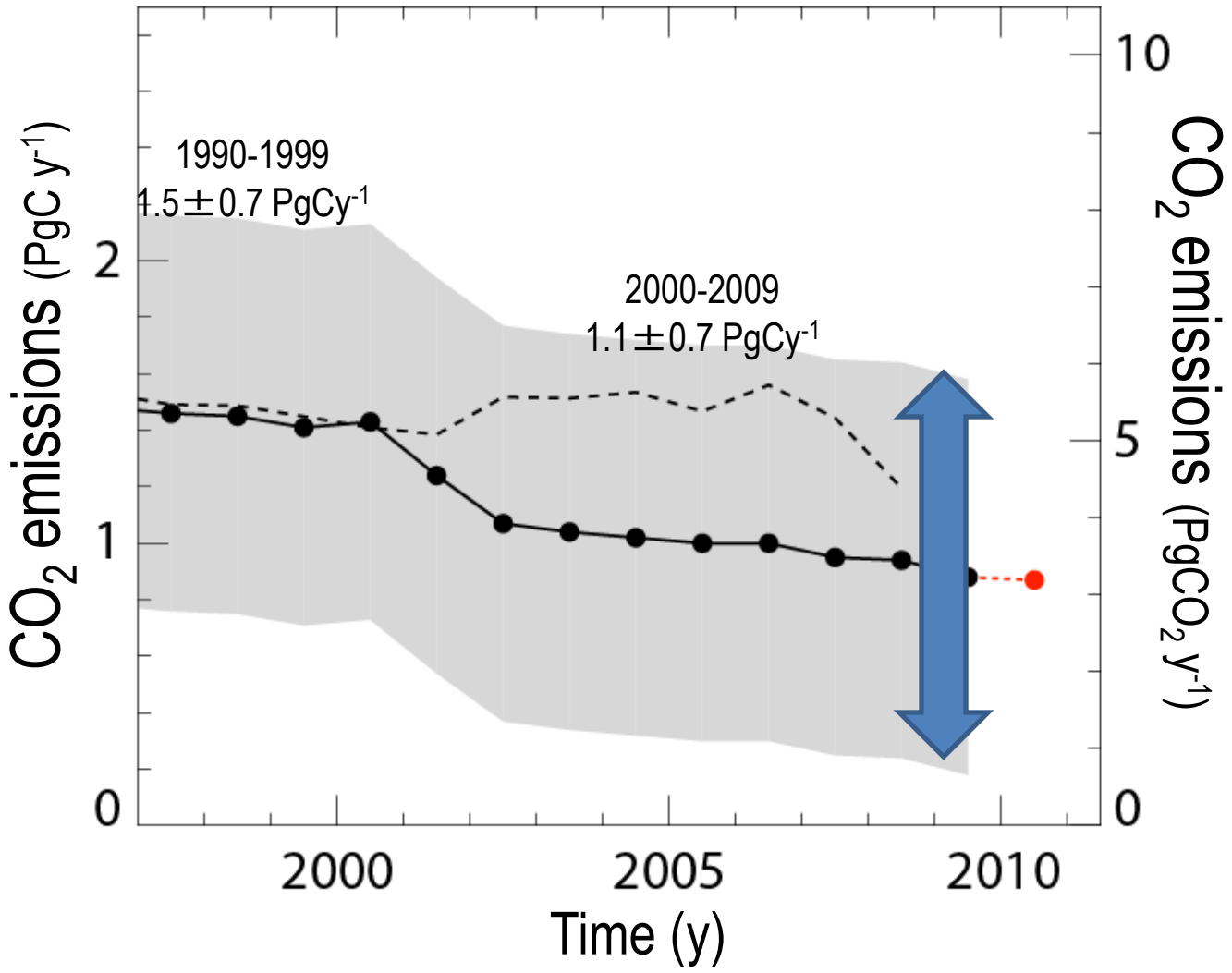
CO_2 Emissions from Land Use Change (1960-2009)



LUC emissions now ~10% of total CO_2 emissions

Updated from Le Quéré et al. 2009, Nature Geoscience

CO_2 Emissions from Land Use Change



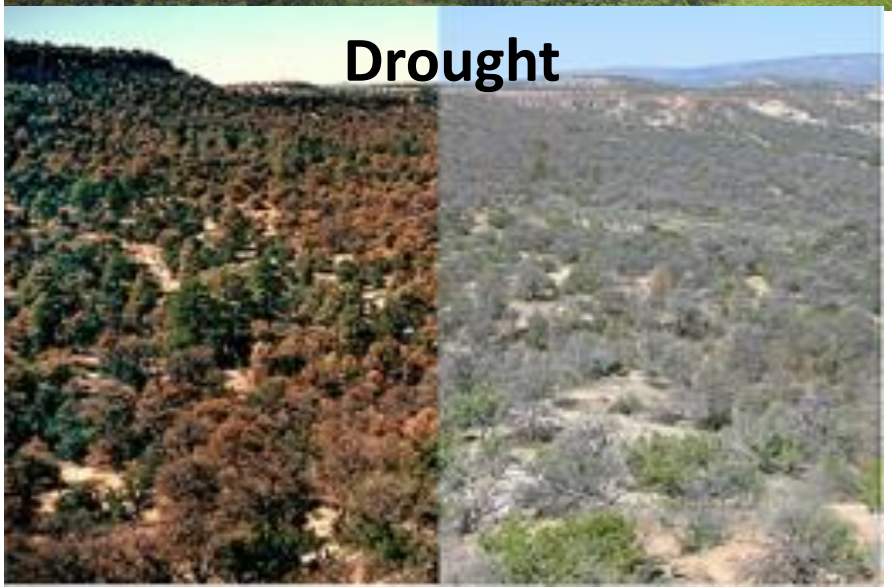
1990s
Emissions: 1.5±0.7 PgC

2000-2005
Emissions: 1.3±0.7 PgC

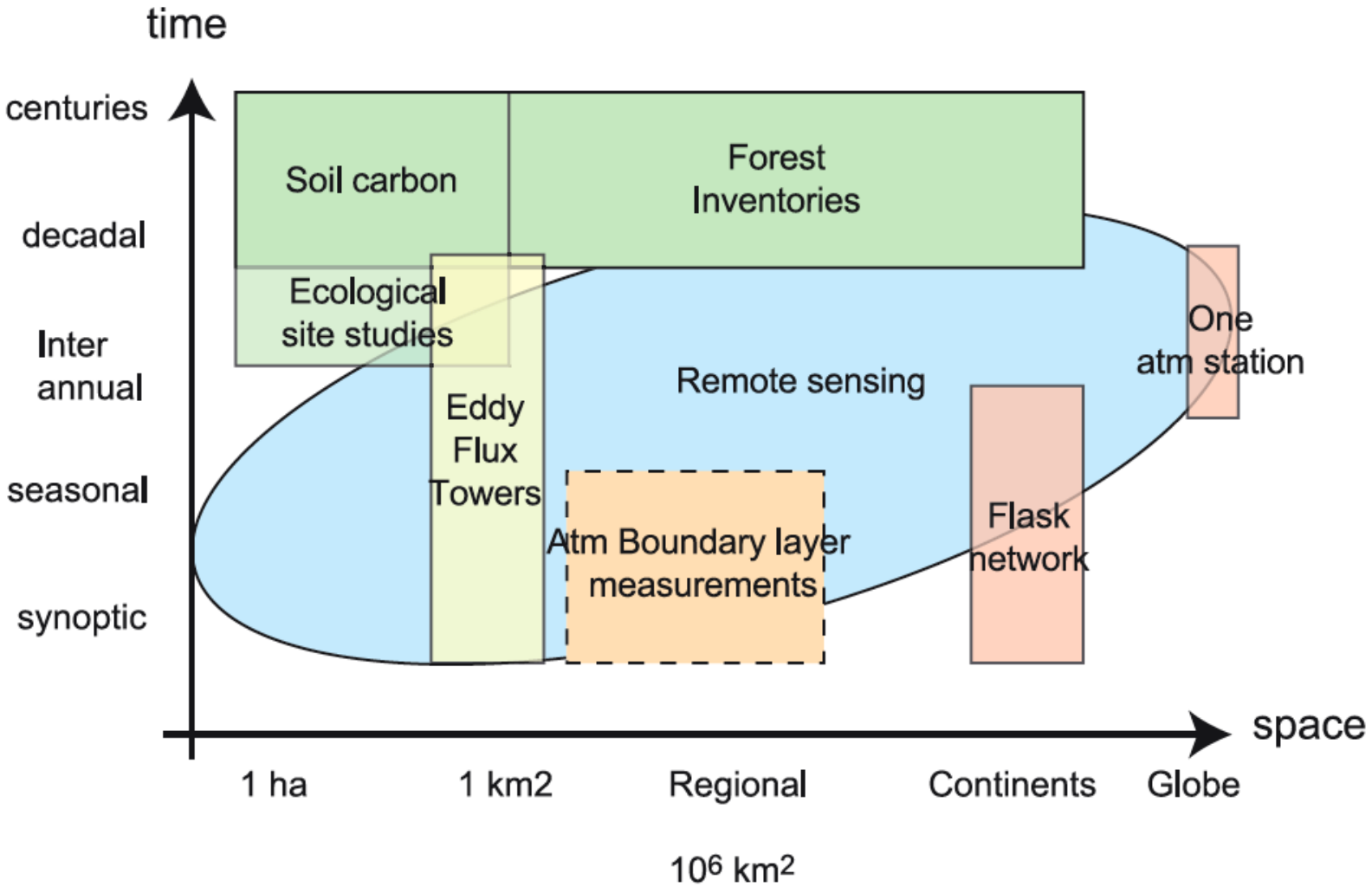
2006-2010:
Emissions: 0.9±0.7 PgC

Friedlingstein et al. 2010, Nature Geoscience; Data: RA Houghton, GFRA 2010

Carbon in Plants and Soil Vulnerable to Land Use, Drought, Fire, Insects/Diseases

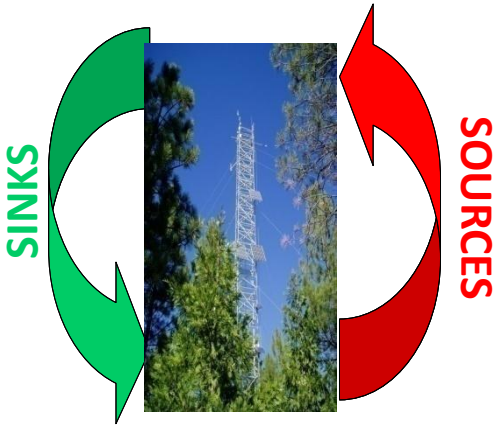


Observations Need to be Integrated Across Time and Space Scales



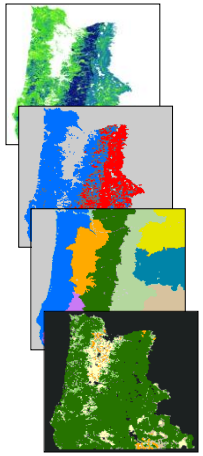
Integration for Regional Mapping of Terrestrial Carbon

Terrestrial Carbon Modeling

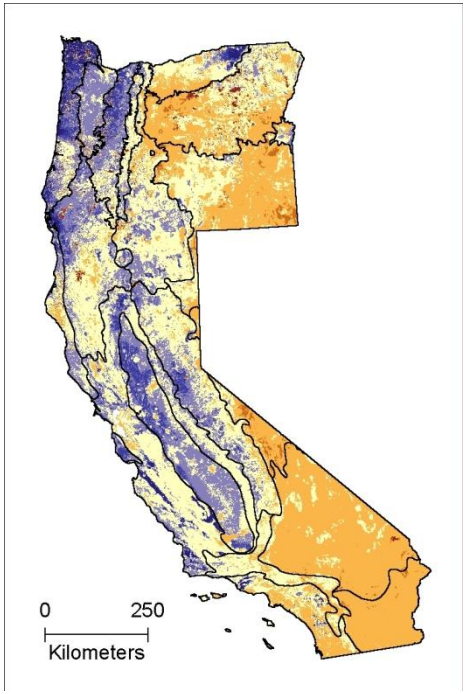


Biosphere CO_2 Flux Observations

Inventories Carbon Stocks



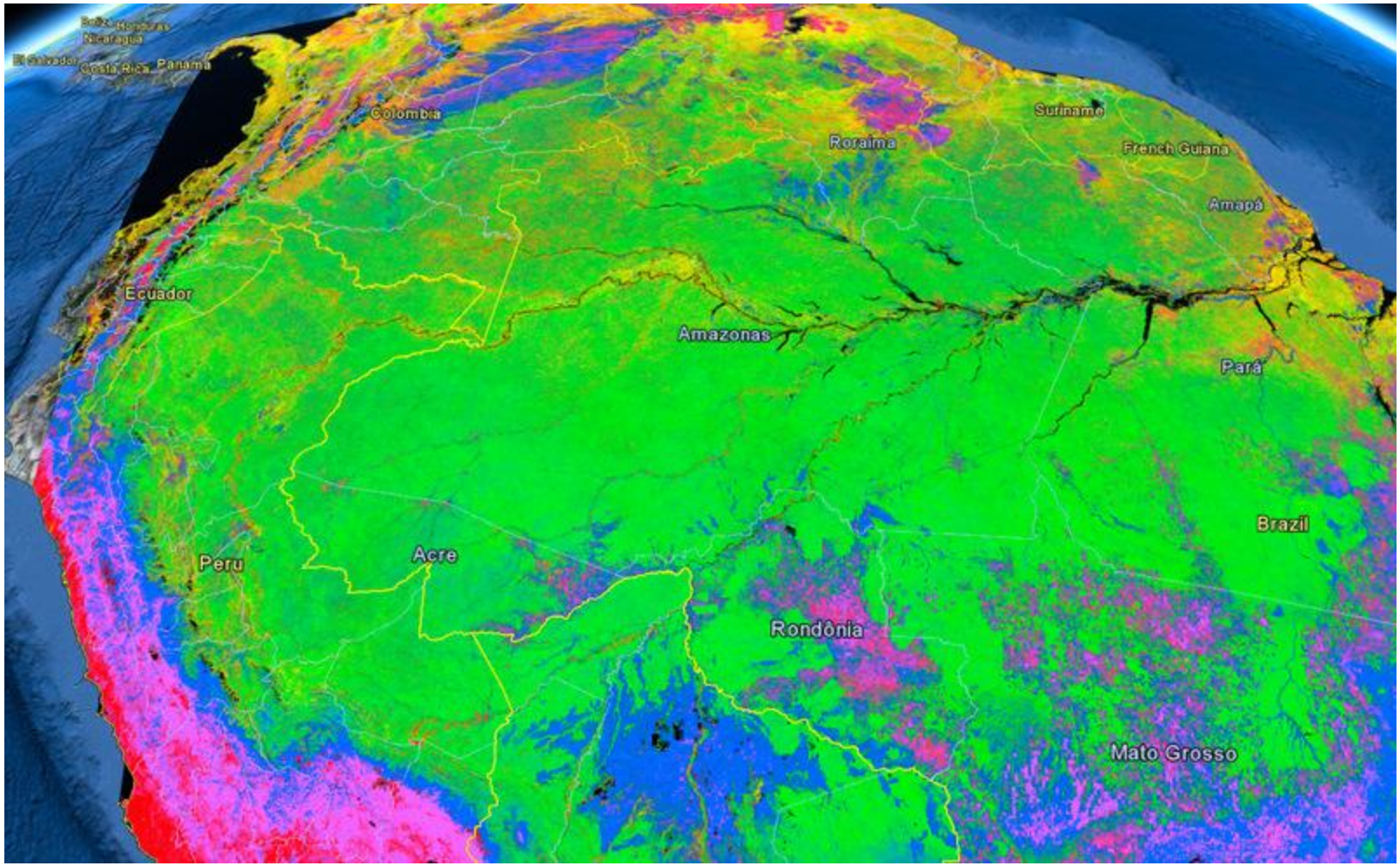
Spatial data: Land-use, land cover, meteorology



Maps of Terrestrial Carbon Stocks and Fluxes

Understanding of terrestrial carbon processes

Monitoring Deforestation



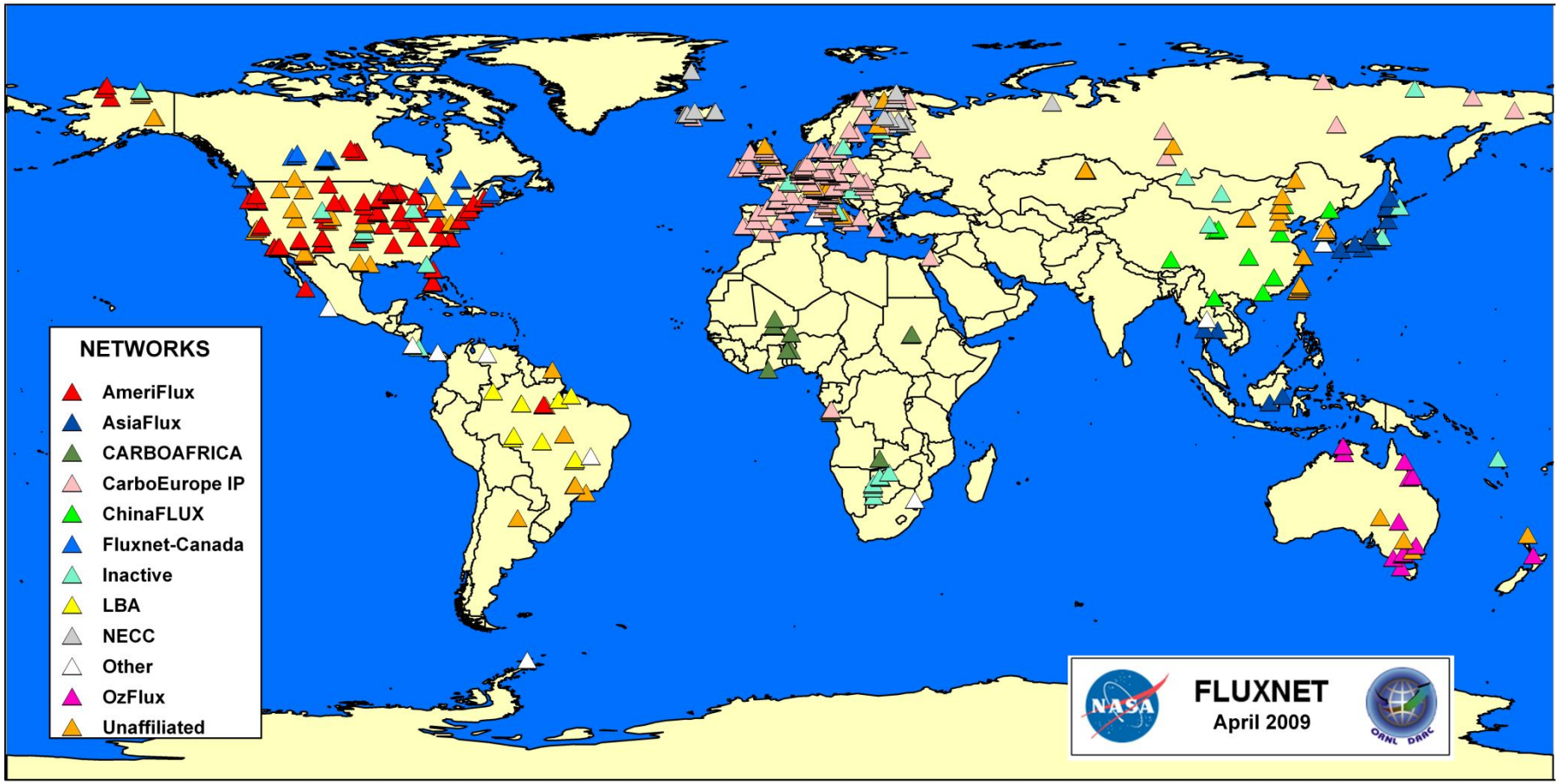
To qualify for payments under REDD, countries must be able to quantify reductions in deforestation against a historical baseline

Deforestation and Degradation Uncertainty

- Total annual change in *forest area* has an uncertainty of 10-25% in northern forests, up to 100% in tropical forests
- Uncertainties in *emissions* are high for annual values and trends (25 -100%) due to uncertainties in parameters used to translate area into CO_2 emissions
- Improved observations and integration with modeling will reduce uncertainty

(UN-REDD, NRC 2010)

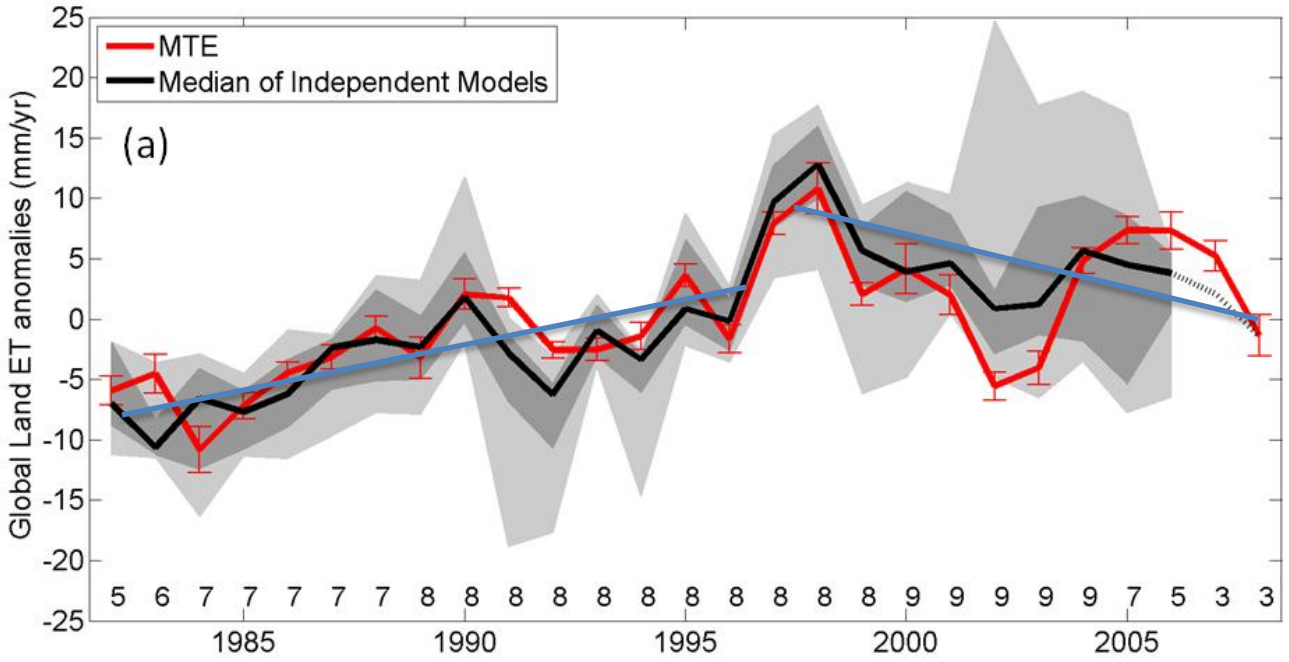
FLUXNET: A Global Network of Observation Sites
500+ Sites, 10 Regional Networks, 45 Countries



Quantify and understand causes of variation in terrestrial exchange of carbon, water and energy with atmosphere

www.fluxdata.org

It's Not Just About CO_2:
Decline in Trend of Global Land Evapotranspiration

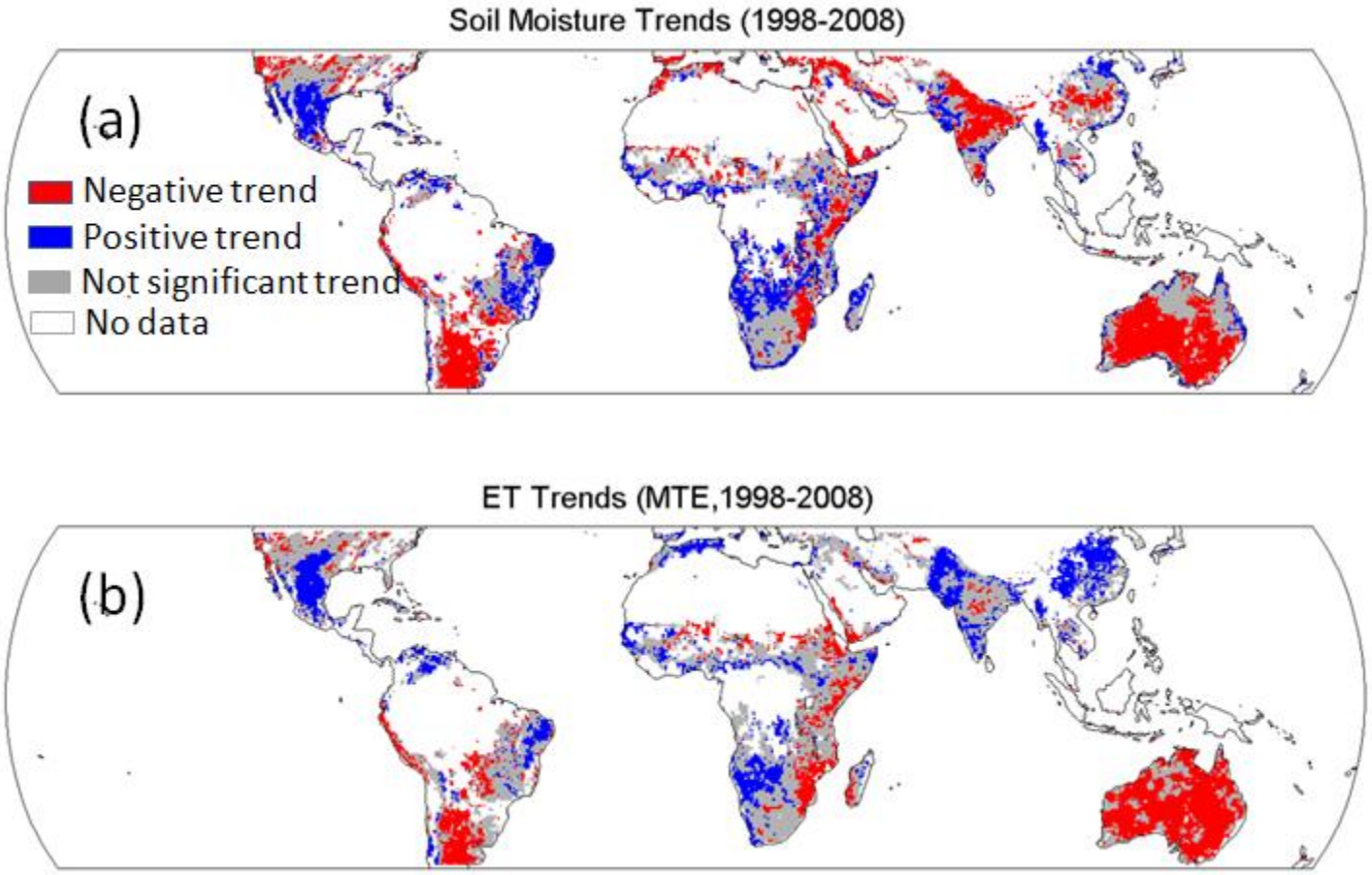


- Data-driven estimate of global land ET using tower flux, meteology, remote sensing data and models
- Implications to feedbacks to climate

Jung et al. (2010), Nature

Soil Moisture Limits Evapotranspiration Trends

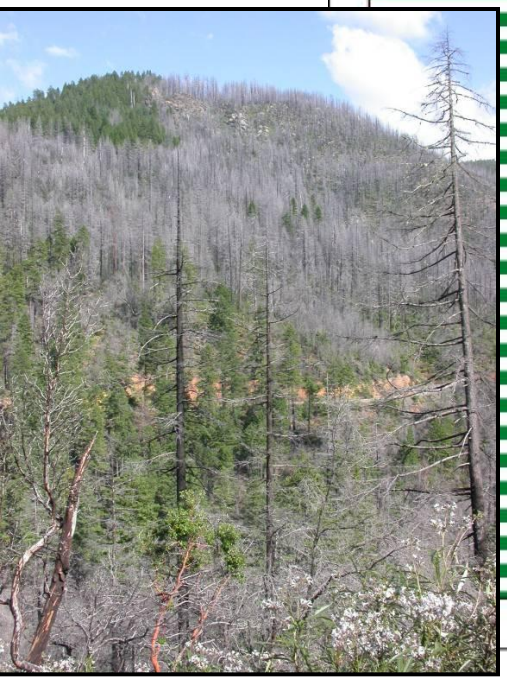
Identified by integration of tower fluxes, remote sensing & models

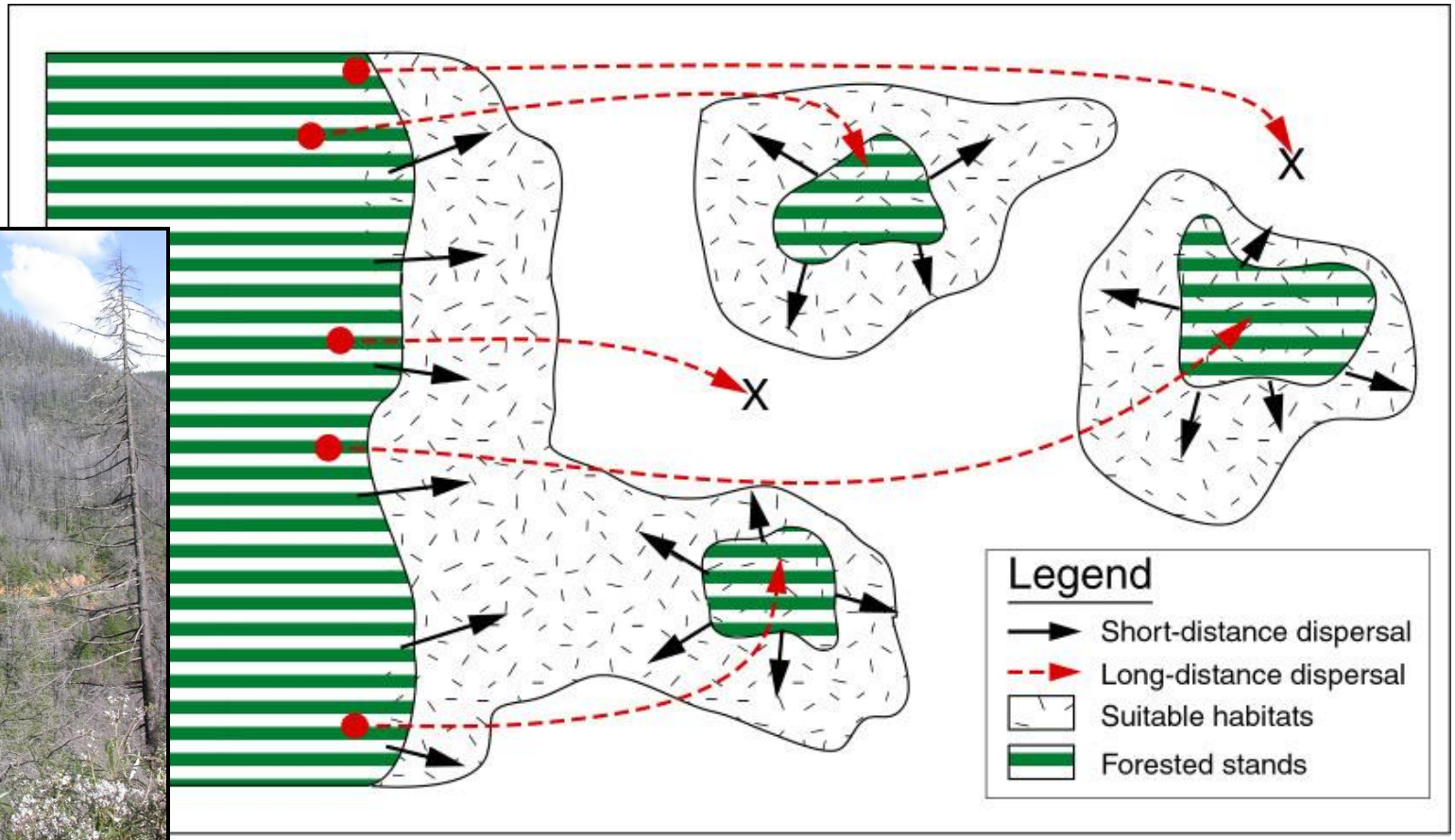


Negative trend (red) = drier soil, decreasing ET

Jung et al. (2010), Nature

Forest Species Migration Under Climate Change:
Integration of Observations and Models to Predict Potential





Long-term in situ observations of dispersal, habitat, and species distribution used to develop and parameterize models

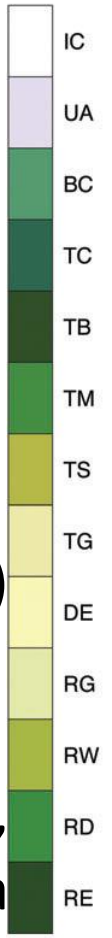
Simulated Vulnerability to Biome Changes (1990-2100)

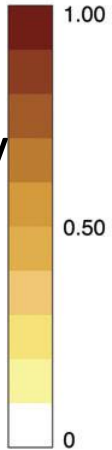
Simulations suggest 10-50% of global land may be highly vulnerable (fair comparison with remote sensing land cover)

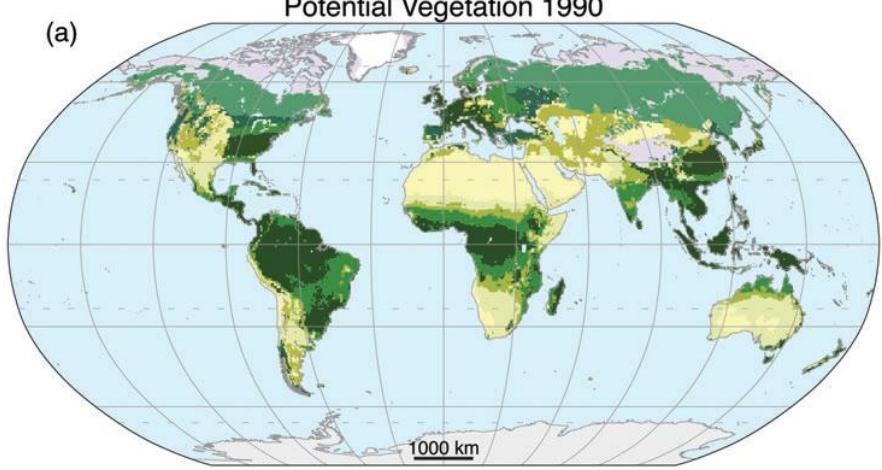
Field observations detected biome changes in 20th -century, yet there is a lack of spatial data on vulnerability

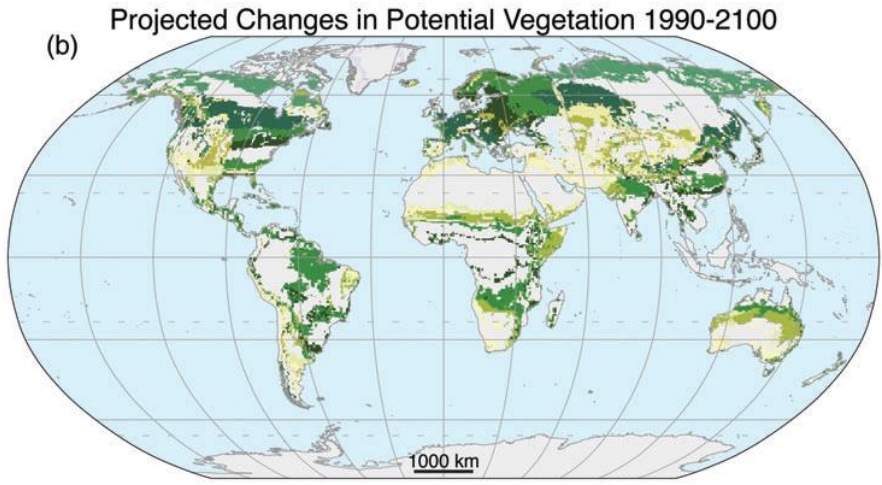
Hinders identification of priority areas for adaptation measures

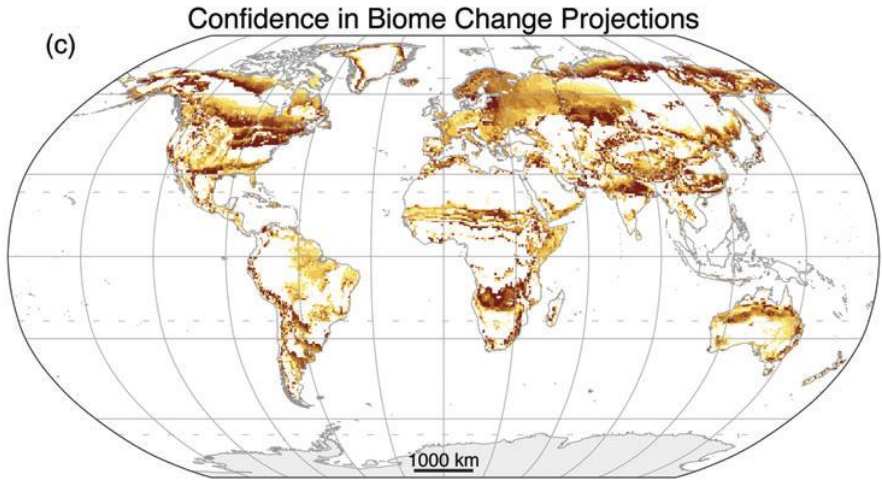
(Gonzalez et al. 2010)









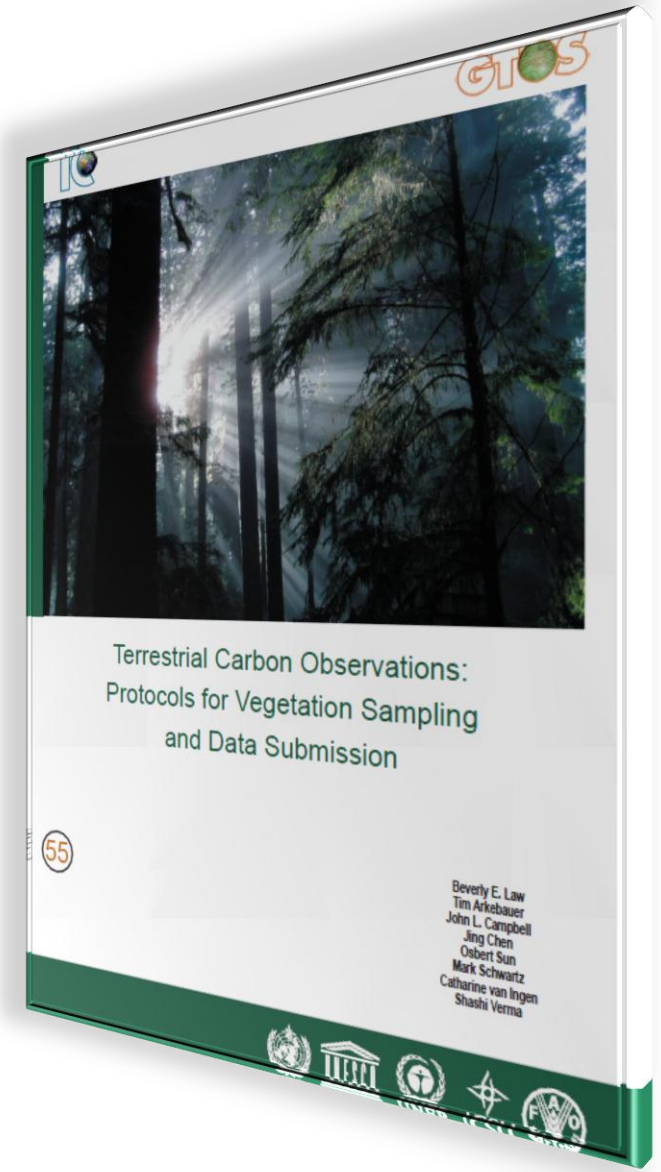


Summary of Need for Systematic Forest Observations and Integration

- Changes in terrestrial carbon sources and sinks
- Changes in water cycle, energy balance
- Natural or ‘ecological’ adaptation, vulnerability

Protocols for Data Collection and Submission

- Need:
  - Uniform methods, standards for high quality observations
  - Uniform database for global assessments
- Important standards/definitions:
  - Carbon stocks in vegetation and soil, productivity, component fluxes
  - Vegetation types, structure
  - Land use
- Reference for other documents (ECV, GEO Carbon Report)



Challenges and Gaps
Land Ecosystems

- Some countries without resources for inventories
- Consistent *in situ* methodology
- Sustained, systematic measurements
  - e.g. soil carbon monitoring, NPP, total biomass, species
- Remote sensing – gaps in coverage over time
- Data sharing – transparent, timely, standardized
- Observation/model integration – transition from research to application

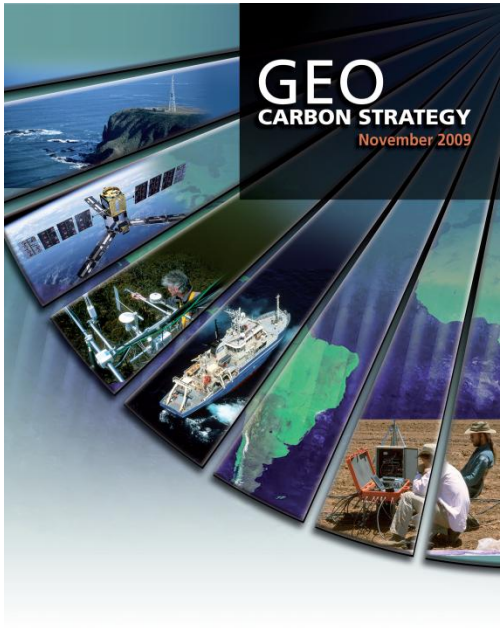
Extras

Soil Carbon Monitoring

- Soil carbon is probably the best indicator of soil quality. soil carbon loss ~ land degradation
  - Soil and ecosystem C in plantations and reforested areas tends to be lower than natural forests
- Higher uncertainty than most other pools
- Certain soil C pools (e.g. permafrost soils) are highly vulnerable to decomposition
- Deforestation and tillage cause rapid oxidation of plow-layer soil carbon (location of highest concentrations)
- Soil carbon monitoring is needed to understand and predict net long-term effects of deforestation, reforestation and afforestation

GEO Integrated Global Carbon Observations

- **Provide** long-term observations required to improve the understanding of the current state and future behavior of the global carbon cycle
- **Monitor** and **assess** the effectiveness of carbon sequestration and/or emission reduction activities on global atmospheric CO_2 levels



GEO GROUP ON EARTH OBSERVATIONS