Integrated Global Carbon Observations

Beverly Law
Prof. Global Change Forest Science
Science Chair, AmeriFlux Network
Oregon State University
Total Anthropogenic CO$_2$ Emissions (2008)

- Fossil fuel emissions: 8.7 PgC
- Land use change emissions: 1.2 PgC

Deforestation and forest degradation contribute approximately 12% of total anthropogenic emissions.

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
Observations need to be integrated across time and space scales
CO$_2$ Atmospheric in situ Observation Network
Remote sensing GHG concentrations

• Combine with high precision in situ observations to increase coverage
• GOSAT (JAXA) - revolution in observing carbon from space
• Sciamachy, IASI, AIRS (current)
• Future: OCO2, GOSAT2, ASCENDS
• Significant work required to understand biases and errors
• Needs: High precision, geographic mapping, small footprint, ability to sense CO$_2$ near the earth’s surface

GOSAT CO$_2$ retrieval

Sciamachy CO$_2$ retrieval c.f. Carbon Tracker
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
FLUXNET: Global Terrestrial Flux Observations

- Carbon/water/energy fluxes
- Meteorology, soil and plant variables
- Multiple biomes and disturbances in a broad range of climate
- Standardized database, shared protocols (Law et al. FAO 2008)
Moderate Resolution Remote Sensing
Deforestation

(Huang et al. 2009)
MODIS ‘Active Fire’ Observations
Integration for Regional Mapping of Terrestrial Carbon

Terrestrial Carbon Modeling

Sources
- Biosphere CO₂ Flux Observations
- Inventories Carbon Stocks

Sinks

Understanding of terrestrial carbon processes

Spatial data: Land-use, land cover, meteorology

Maps of Terrestrial Carbon Stocks and Fluxes (Law et al. 2006)
Terrestrial carbon model

Atmospheric Transport model

Climate and weather fields

Atmospheric measurements

Remote sensing
Atmospheric CO₂

optimized
Fluxes

optimized
model parameters

Georeferenced emissions inventories

Eddy-covariance flux towers

Biogeochemical pCO₂

Surface observation pCO₂ nutrients

Ocean time series

Biomass soil carbon inventories

Water column inventories

Remote sensing of Vegetation properties
Growth
Land cover /use
Fires
Biomass
Radiation

Ocean carbon model

Coastal studies

Lateral fluxes

Terrestrial carbon model

rivers

Data assimilation
North American Carbon Program (NACP) Integration of Observations

- **Diagnosis, attribution, and prediction** to understand status and trends in sources and sinks of carbon on land in adjacent ocean regions

- **Decision support** for policy, management

- Terrestrial ecosystem flux observations (CO$_2$, water vapor, heat fluxes)
- Ocean and atmosphere in situ measurements
- Inventories and accounting systems
- Global satellite data
- Models to integrate these observations for spatial maps of carbon stocks and fluxes
- Develop an operational system for policy relevant carbon information
Summary

- Global carbon community very active and some aspects well-integrated
  - NACP, ICOS, FLUXNET, ...
- Other aspects need more work (forest and soil inventories)
- Open databases – strong need for coordination to fill gaps, avoid duplication
- Plans to create Carbon Community of Practice based on IGCO science team & an online information portal (subject to securing funding)