Ecosystem Modeling for Global Carbon Monitoring

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Observation and modeling

**Flux (JapanFlux)**
- EC method

**Experiment**
- FACE

**Soil**
- Flux (JapanFlux) - CO₂/CH₄/N₂O exchange

**Ecosystem (JaLTER)**
- Experiment
- Flux (JapanFlux)
- Ecosystem (JaLTER)
- Matter flow

**Flux (JapanFlux)**
- Flux (JapanFlux)
- CO₂/CH₄/N₂O exchange
- Flux (JapanFlux) - CO₂/CH₄/N₂O exchange

**Ecosystem (JaLTER)**
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- Flux (JapanFlux) - CO₂/CH₄/N₂O exchange
- Ecosystem (JaLTER)

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- Flux (JapanFlux) - CO₂/CH₄/N₂O exchange
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Observation and modeling

**JAXA & JAMSTEC**

### Data archive
- NOAA/AVHRR
- Landsat, SPOT
- TRMM etc.

### Land-use/cover change
- Deforestation

### Vegetation
- LAI, biome, etc.

### Topography
- SRTM
- cf. ASTER

### Greenhouse gases
- CO₂ level & flux
- CH₄ level & flux
- cf. SCIAMACHY, OCO

### Disaster
- Fire
- Flood Outbreak
- Etc.

### Future missions
- DESDynl
- GCOM etc.
Importance of database

Database is more than an assemble of individual data (i.e. synergy effect)
Modeling and earth observation

Database

GEOSS

Evaluation
Integration
Extrapolation
- scaling-up
- prediction

Human Management of Carbon Budget (cf. Kyoto Protocol)
Terrestrial ecosystem models

Vegetation Integrated Simulator for Trace gases

Objectives

• Atmosphere-ecosystem biogeochemical interactions
• Especially, major greenhouse gases (CO₂, CH₄, and N₂O) budget
• Assessment of climatic impacts and biotic feedbacks

Carbon-cycle
(Sim-CYCLE-based)

Nitrogen-cycle

Point-global, daily-monthly

- CO₂: photosynthesis & respiration
- CH₄: production & oxidation
- N₂O: nitrification & denitrification
- LUC emission: cropland conversion
- Fire emission: CO₂, CO, BC, etc.
- BVOC emission: isoprene etc.
- Others: N₂, NO, NH₃, erosion
Global Modeling

Land by VISIT (revised Sim-CYCLE: Ito & Oikawa);
Ocean by VGPM (Falkowski; K.Sasaoka [FRCGC])
Global mapping by VISIT

- **CO₂**: GPP, AR, HR, NEP
- **CH₄**: Production, Oxidation, Total
- **BB**: CO₂, CO, NMHC, BC
- **BVOC**: Isoprene, Monoterpene, Methanol, Acetone
- **Others**: N₂ fix., N₂ emit., NO emit., NH₃ volat.
Problems

1. There remain large uncertainties in model estimation
   <= model intercomparison (MIP)
   <= uncertainty in CC feedback and GW prediction (cf. IPCC AR4)
   => model development
   => advanced data use: validation and assimilation
   => more intimate linkage with observation (ex. GEOSS)

2. Little contribution to policy-relevant issues
   => from science to society
   => e.g., forest carbon sink in the Kyoto Protocol

   => GEO new task: Forest Carbon Tracking
   => MoE, Japan: Forest Carbon Monitoring System
   => ACTS: Asian Carbon Tracking for Society (by J.Kim)
Forest Carbon Tracking (GEO 2009-2011 Work Plan : AG-09-01 b))

Task main activities (in brackets potential contributors)

a. Consolidation of observational requirements and associated products (NIES, JRC, WHRC)
b. Coordinated assessment of tools and methodologies (GOFC-GOLD, JRC, WHRC)
c. Coordination of observations, including securing their continuity (JAXA, Norway, CSIRO-Australia, CEOS?)
d. Coordination of the production of reference datasets (FAO, GTOS, JRC)
e. Demonstration or pilot initiatives to show capabilities (Australia, Norway, FAO, ESA, Brazil, Niger)
f. Improvement of access to observations, datasets, tools and expertise and associated Capacity Building activities. (Australia, Norway, Rep. of Korea, FAO .)
Forest Carbon Monitoring Approach

Top-down approach
(Region & Country Level)

Subtopic 2 [Shimada JAXA]
Analysis of SAR Images

Subtopic 4 [Oguma NIES]
Estimating Forest Structure Parameters using Microwave

Subtopic 5 [Takeuchi UoT]
Using Remote Sensing to Understand Vegetation Disturbance

Subtopic 3 [Sekine MRI]
Analysis of Forest Inventories

Bottom-up approach
(Plot & Site Level)

Subtopic 6 [Ito NIES]
Evaluating Carbon Balance with Ecosystem Models

Developing Carbon Accounting Methods

Subtopic 1 [Yamagata NIES]
Developing Carbon Accounting Methods
Simulated carbon budget (potential)

Ito (2003) using the carbon cycle component
Disturbance (land-use change)

Fire

Deforestation

Source (Chapin et al. 2002)
Modeling of disturbance impact

Test case at the Pasoh forest (mature rainforest)
Forest Carbon Modeling System, 2008-2010

GERF B-81 (FCMS) project => GEOSS
- development of a full carbon accounting model
- impacts of disturbances at decadal time-scale
- satellite-oriented mapping of carbon budget in Asia
- evaluation of carbon emission and ecosystem services

Ecosystem model (VISIT)

50 ~ 200m mesh model
- land cover change
- soil & topography
- climate & hydrology
- human impact
Welcome to PlotNet.

As one of the strategies of the research projects (IGBP GCTE TEMA; DIVERSITAS DIWPA) that is aimed to solve the ecological phenomena in a large geographical scale in East Asia, PlotNet has started to gather permanent forest plot data in various parts of East Asia, and database-izes the data and perform meta-analysis. The research theme is to couple with a carbon-related research with species composition, and the population and community dynamics.

Database

The PlotNet Forest Database is designed to facilitate storage of, and access to existing forest plot data. You are encouraged to use and provide data. Please read Guideline for details.

Mailing List

Please send empty file to plotnet-ml-subscriber@hoshc.ees.hokudai.ac.jp for subscribing to plotnet ML.
PlotNet Forest Database

USER: guest  Plot Map

Drag the map with your mouse, or double-click to zoom. Click interested “Plot Name”.

Home
Member
- Login
- Change User info
- Create ID
Data
- List
- Map
- Search
- Download
- Registration
- Update
Activities
Links
Guidelines
PlotNet Forest Database

USER :  List of Plot

-Plot name:  Click to show detail information of data obtained in the plot
-Country:  The country where plot locates
-Region:  The region where plot locates
-Latitude/Longitude:  southern latitude and western longitude are signed as ".
-Altitude:  altitude in meters
-Dominant species:  Dominant species in the plot
-Litter measurement:  whether litter measurement is conducted in the plot
-DB:  the database in which plot data is archived. Click to go to the database

<table>
<thead>
<tr>
<th>PlotName</th>
<th>Country</th>
<th>Region</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Altitude</th>
<th>Dominant species1</th>
<th>Dominant species2</th>
<th>Litter measurement</th>
<th>db_name</th>
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<td>Kyushu</td>
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<td>130°27'51&quot;E</td>
<td>1300</td>
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<td>144°58'48&quot;E</td>
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<td>Abies homolepis</td>
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<td>143°09'E</td>
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Concluding remarks

- Terrestrial ecosystem (carbon cycle) model is an effective and necessary tool for ‘data-mining’ of different observational evidences.

- The models have been used for scientific research, but will be more used for policy-relevant issues and decision making in carbon management.

- Intimate collaboration between observational (GEOSS, FLUXNET, LTER, etc.) and modeling side should be stimulated.
  => to reduce uncertainty and make reliable prediction
Thank you
Validation using observational data

Takayama site

Fujiyoshida site

NEP (g CO₂ m⁻² day⁻¹)

CH₄ oxidation (g CH₄ m⁻² day⁻¹)

N₂O emission (g N₂O m⁻² day⁻¹)

Day of year

Takayama

Fujiyoshida

Immature soil