Terrestrial Monitoring and GHG Inventories

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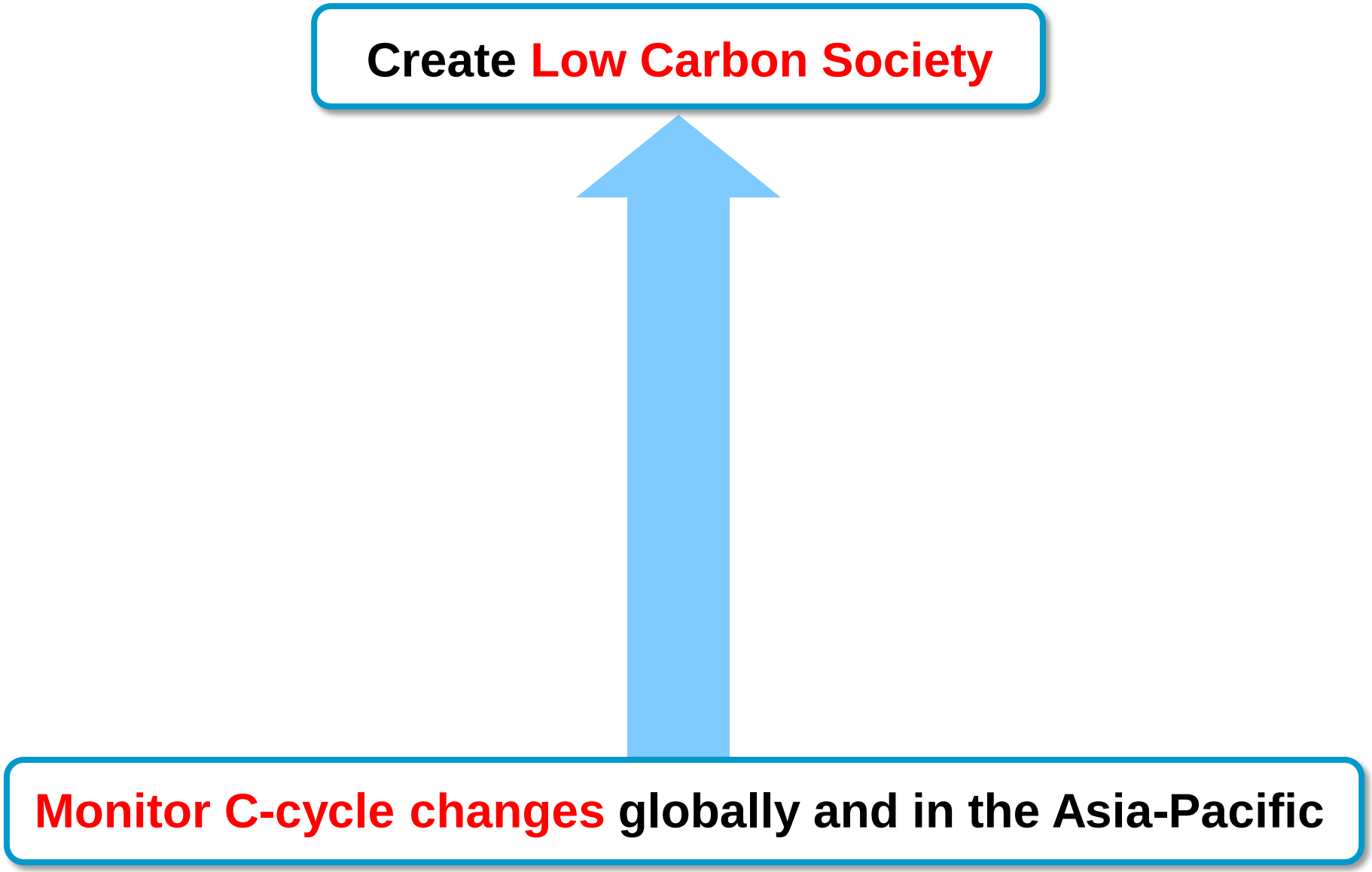
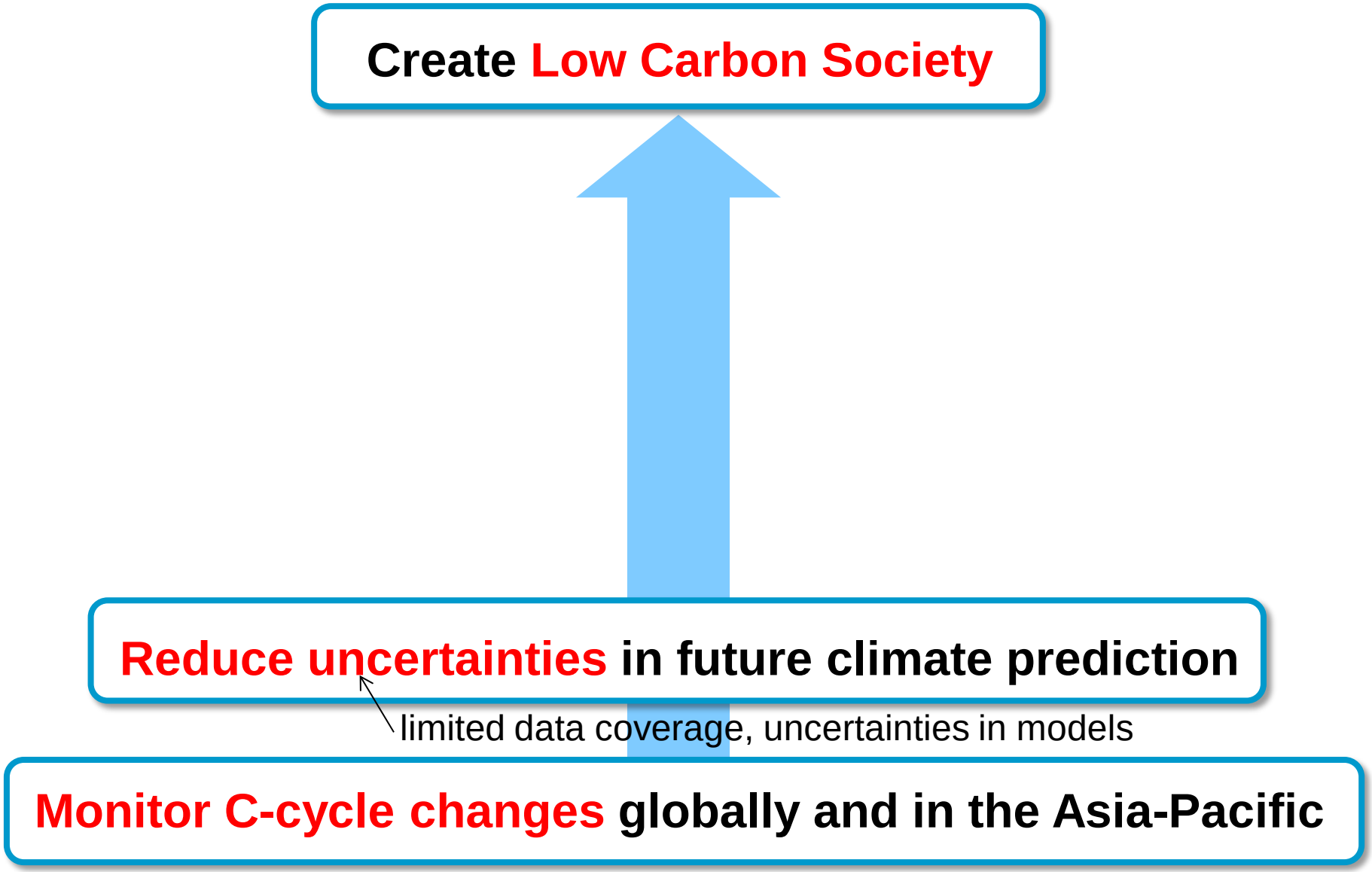
1. Background and Needs
2. Recent Progress in Integrated Observation and Analysis System for Global Carbon Management
3. Summary

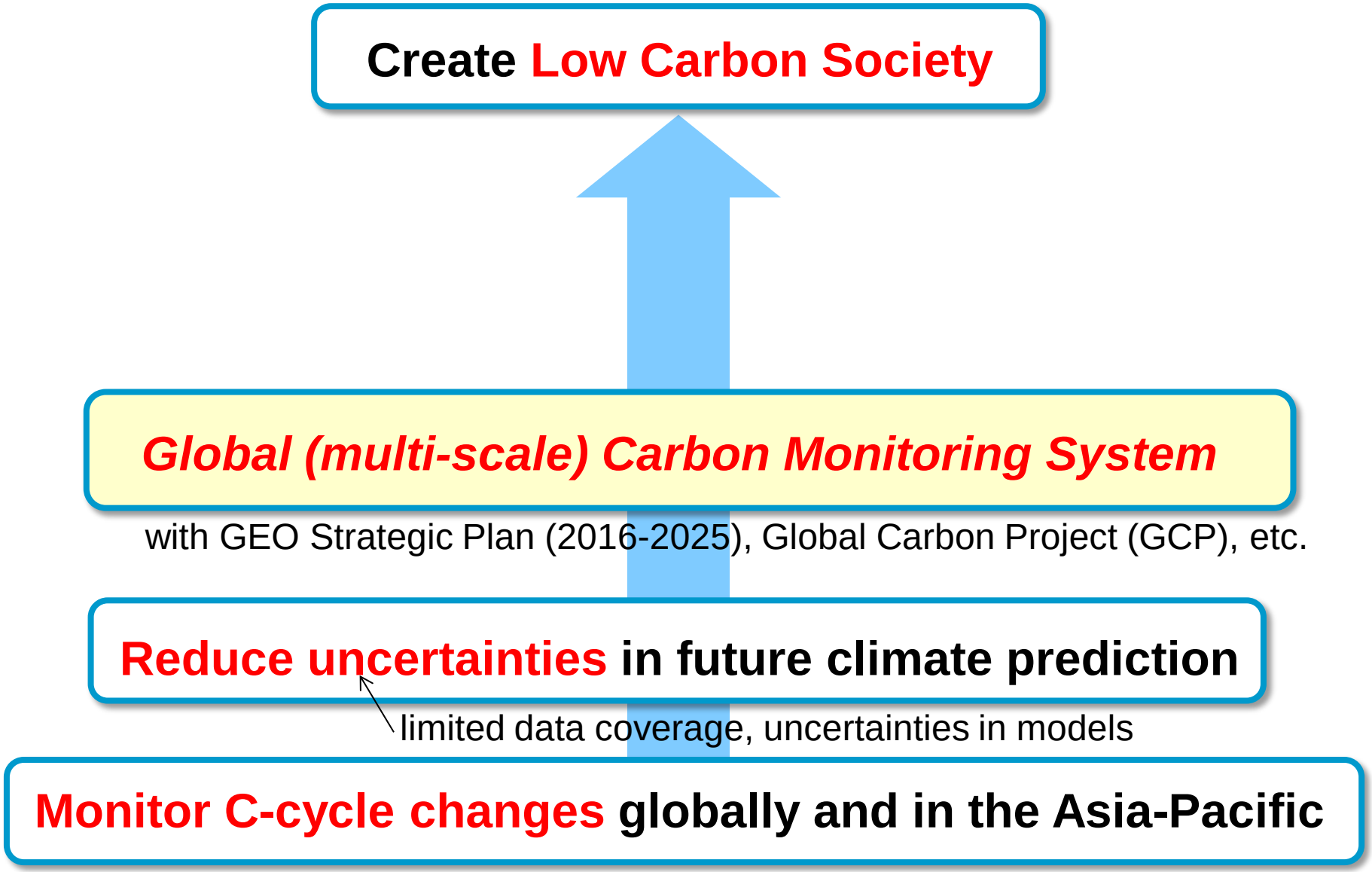
Background and Needs in Global C Management



Background and Needs in Global C Management



Background and Needs in Global C Management



Background and Needs in Global C Management

Create Low Carbon Society

Evaluate mitigation and adaptation policies in multi-scale

Global (multi-scale) Carbon Monitoring System

with GEO Strategic Plan (2016-2025), Global Carbon Project (GCP), etc.

Reduce uncertainties in future climate prediction

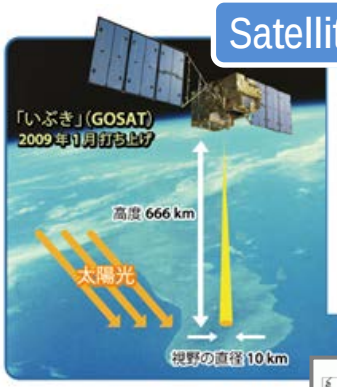
limited data coverage, uncertainties in models

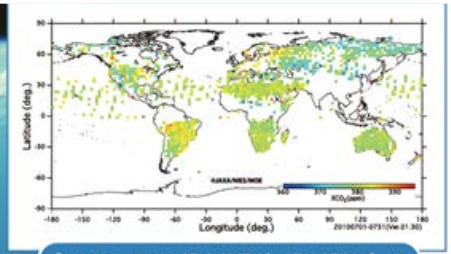
Monitor C-cycle changes globally and in the Asia-Pacific

2-1401 Integrated Observation and Analysis System for Early Detection of Carbon Cycle Change Globally and in Asia-Pacific Region

Integrated observing system for GHGs and their surface fluxes globally and in the Asia-Pacific

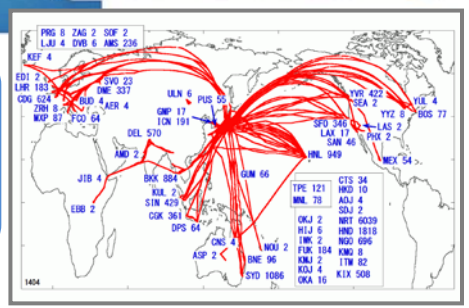
Satellite-based GHGs monitoring

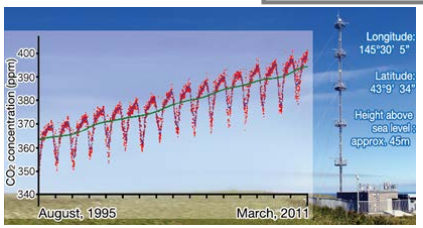


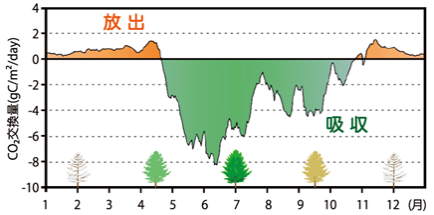


「いぶき」による温室効果ガス濃度観測データ

Airplane- and Ship-based monitoring of GHGs





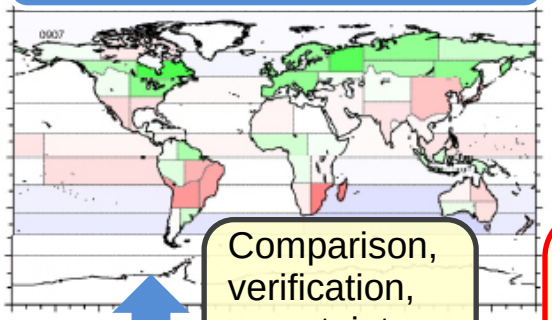


Ground-based monitoring of GHGs concentration and their fluxes

Improved estimates of regional fluxes using atmospheric inverse models

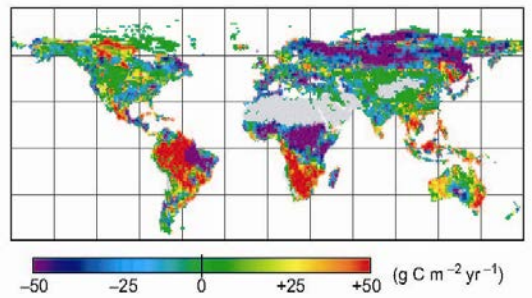
Improved estimates of terrestrial surface fluxes based on bottom-up approaches

Top-down approach



Comparison, verification, uncertainty assessment

Bottom-up approach



Integrated system for combining top-down and bottom-up approaches

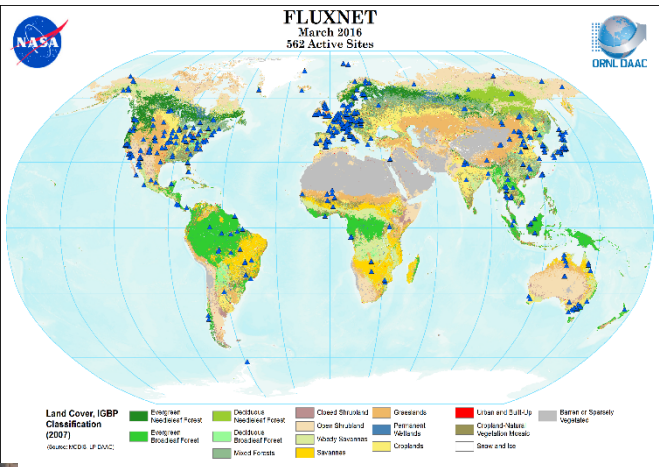
Parameter optimization
Data assimilation

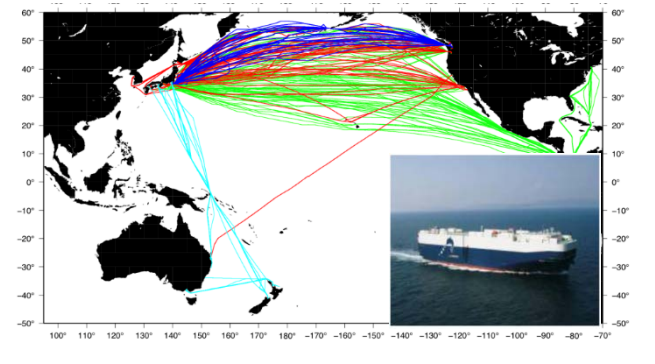
Better estimation of temporal & spatial distributions of GHGs concentration and their fluxes

- National & regional estimates of CO_2 sink-source distributions
- Detection of large source from urban area, fire, etc.

- Early detection of C-cycle and environmental changes in A-P region
- Better mitigation & adaptation assessment for environment and society

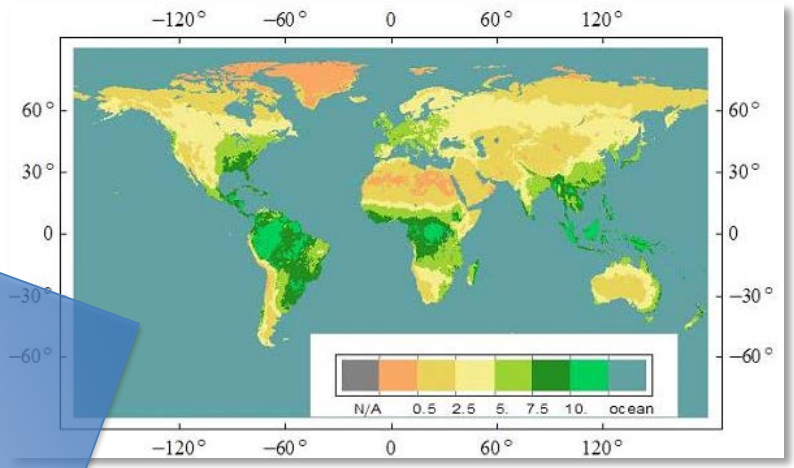
Recent progress in studies of Bottom-up approach





Recent progress in studies of Bottom-up approach

Up-scaled sink/source distribution (biosphere)



Verification and optimization of process models

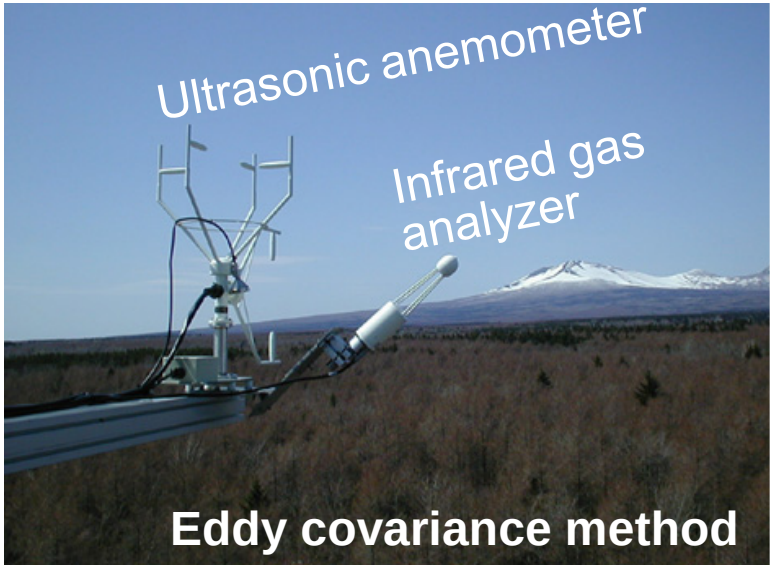
Ground-based observations for C-sink and source

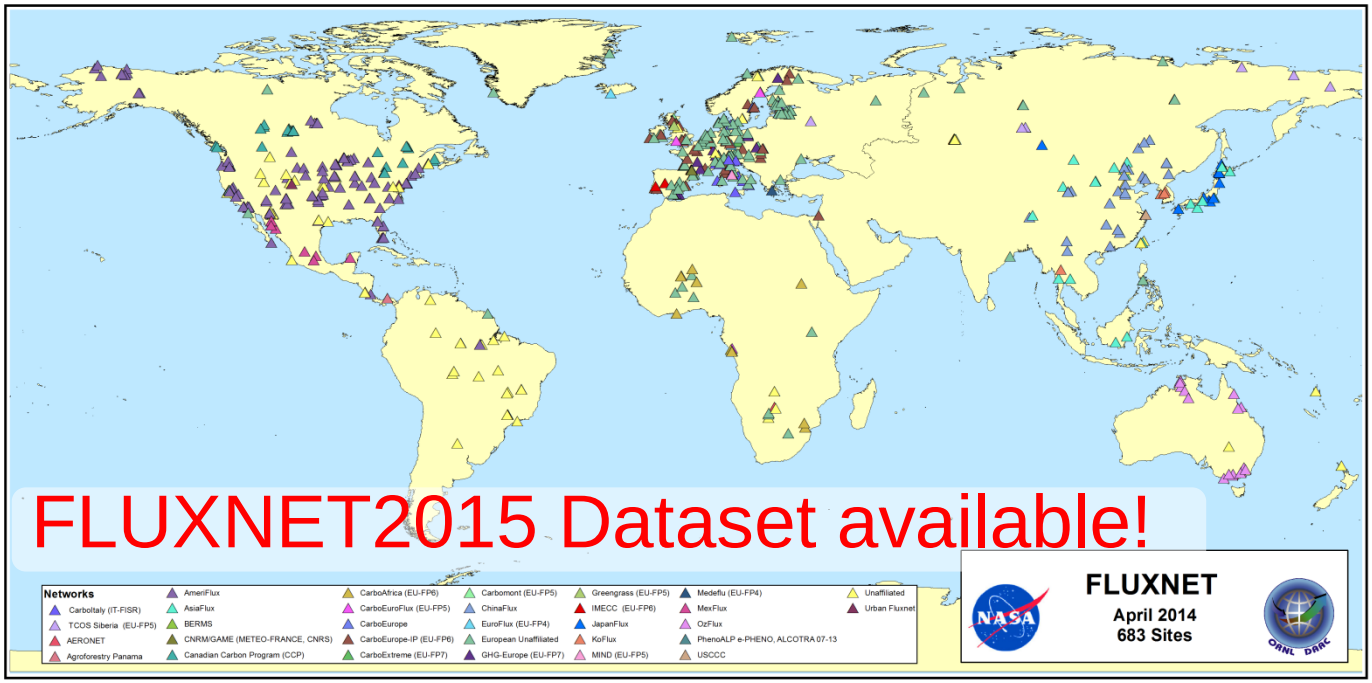
C-budget estimations based on network observation

FLUXNET (1996~)

World-wide network for monitoring CO_2, H_2O, and energy exchanges between terrestrial ecosystems and the atmosphere (> 600 sites)

Archiving CH_4, N_2O flux data (started)



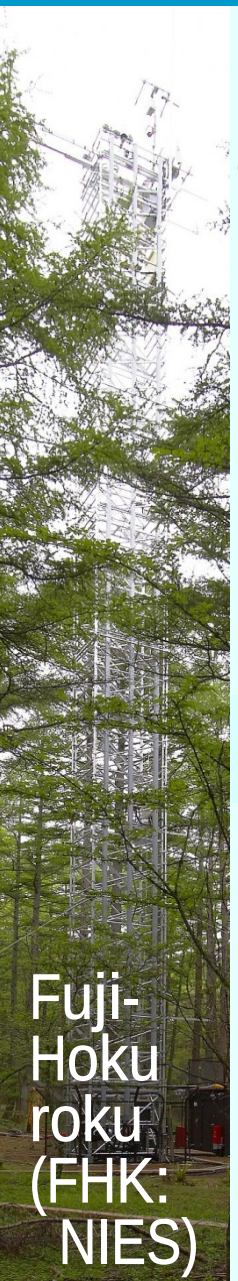


Location of FLUXNET sites

http://fluxnet.ornl.gov

Long-term monitoring of energy, water vapor, CO_2 fluxes by eddy covariance method

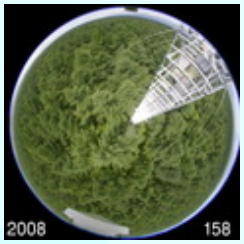
JapanFlux



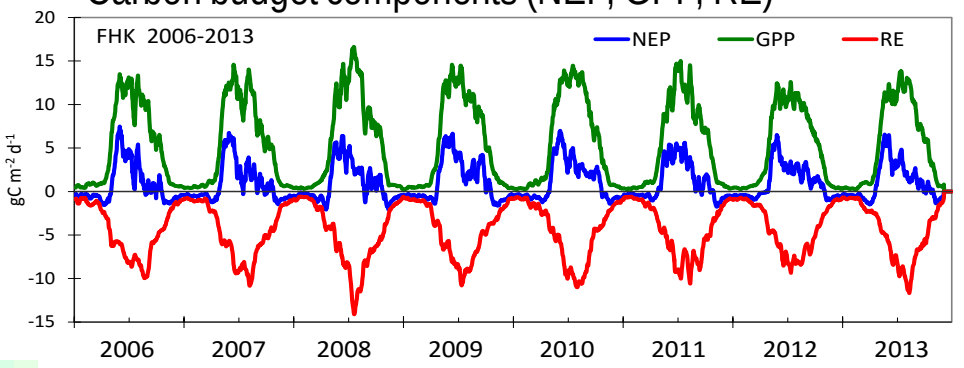
Fuji-Hoku roku (FHK: NIES)

Canopy:

- Meteorology
- Fluxes of CO_2/H_2O/CH_4/energy
- Spectral reflectance

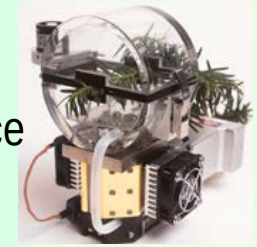


Carbon budget components (NEP, GPP, RE)



Leaf:

- Photosynthesis
- Spectral reflectance
- C/N, Chlorophyll



C-Cycle in the forest:

- Soil environment (temp, water, heat flux, C/N, …)
- Respiration (Soil, root, etc.)
- Tree census, litter fall , fine root, CWD

Soil chamber

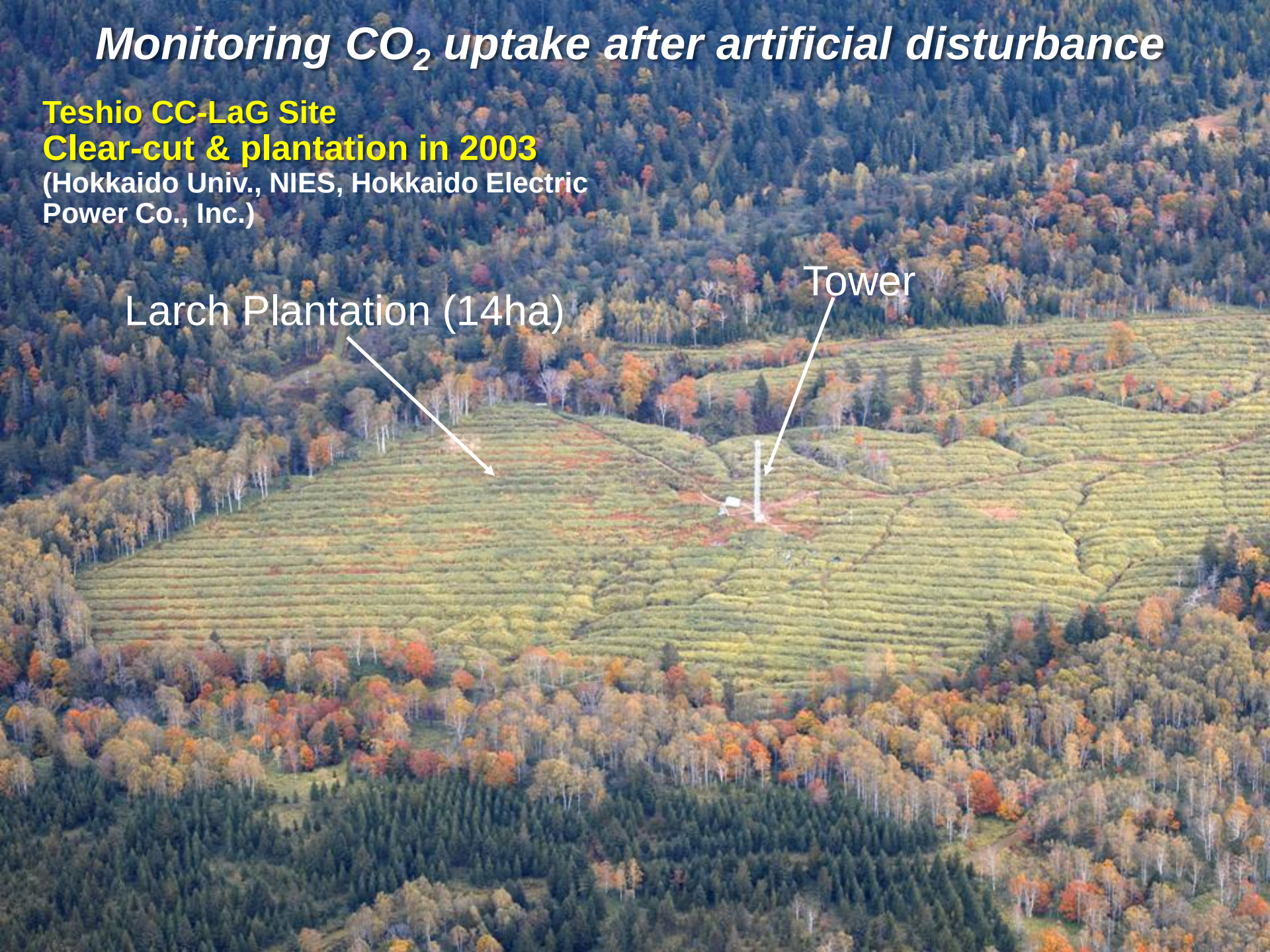
Canopy access tower

Monitoring CO_2 uptake after artificial disturbance

Teshio CC-LaG Site

Clear-cut & plantation in 2003

(Hokkaido Univ., NIES, Hokkaido Electric Power Co., Inc.)



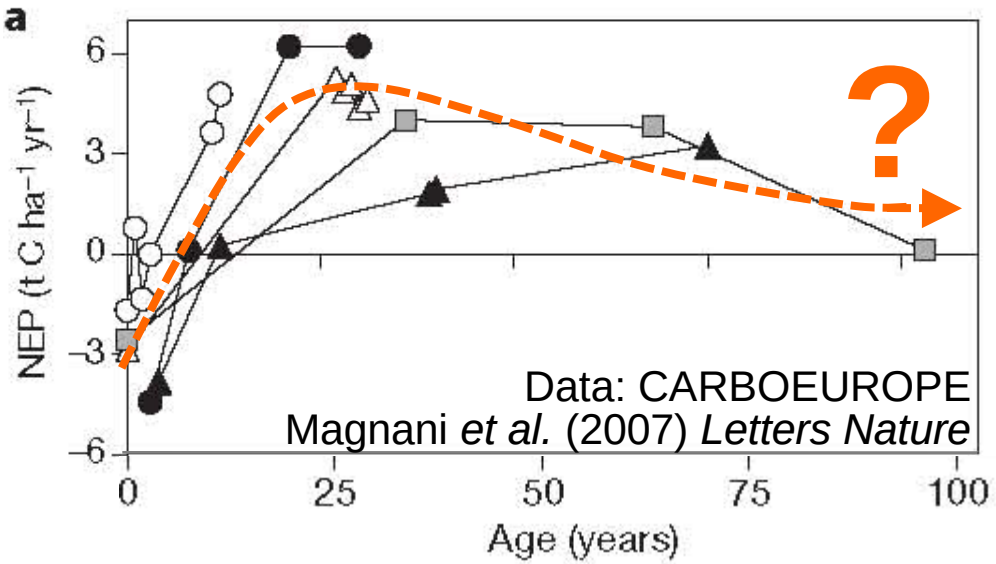
Monitoring CO_2 uptake after artificial disturbance

Teshio CC-LaG Site
Clear-cut & plantation in 2003
(Hokkaido Univ., NIES, Hokkaido Electric Power Co., Inc.)

Larch Plantation (1

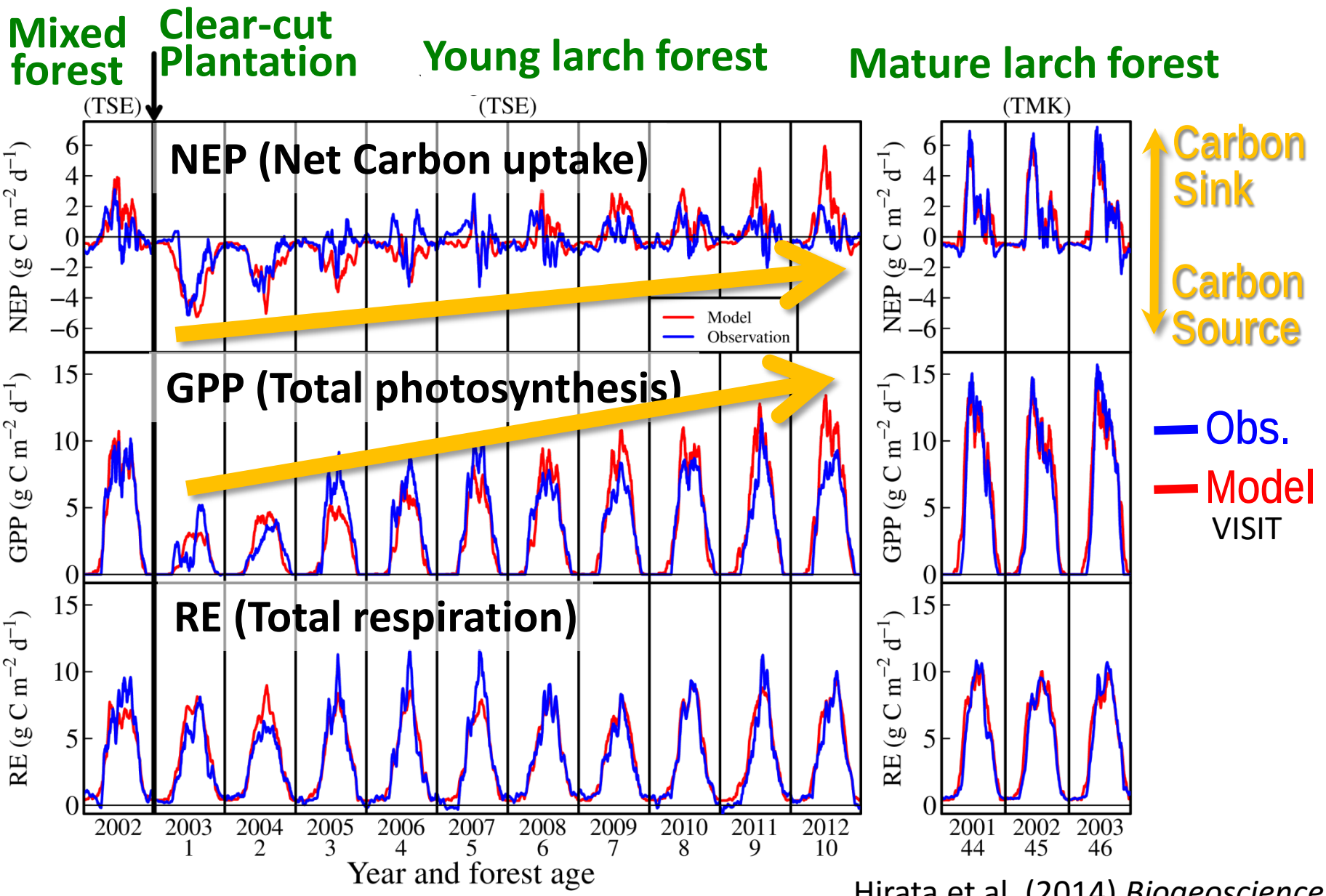
How does the C-uptake rate change with the years after disturbance?

Annual C-uptake



Years after disturbance

Terrestrial model validation to improve disturbance impacts

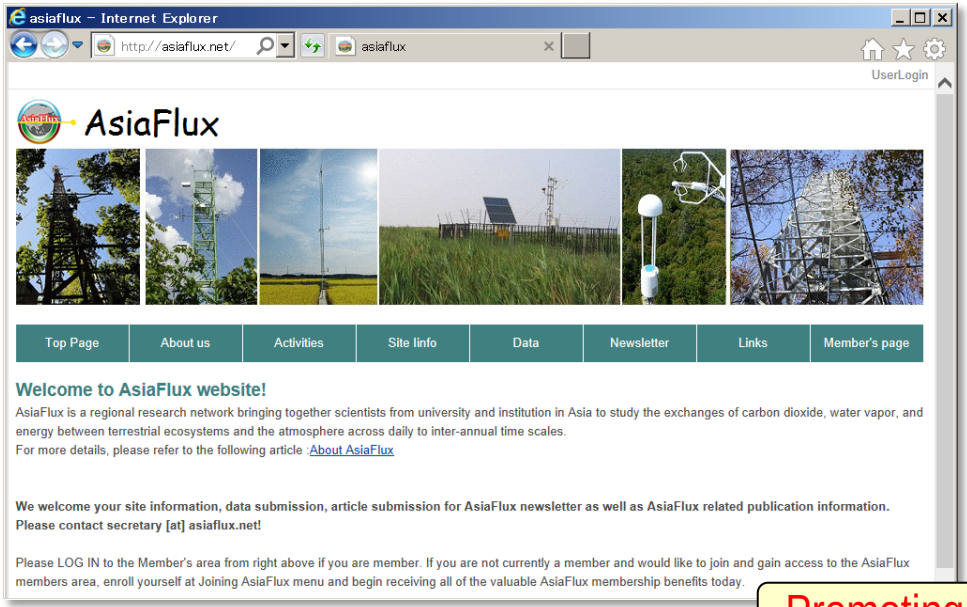


Hirata et al. (2014) *Biogeosciences*

AsiaFlux: A Regional Network in FLUXNET

AsiaFlux Tsukuba Office (CGER/NIES)

http://asiaflux.net

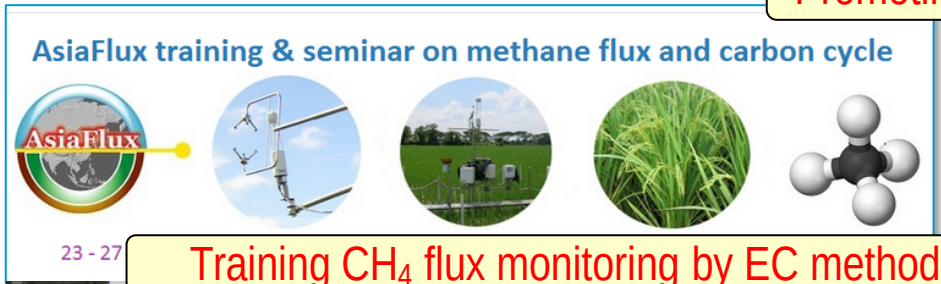


Location of AsiaFlux sites

Number of sites registered: 102

Number of datasets in the database: 125 (34 sites)

Promoting managed ecosystem monitoring (Rice paddy, etc.)



Training CH_4 flux monitoring by EC method

AsiaFlux: A Regional Network in FLUXNET

AsiaFlux Tsukuba Office (CGER/NIES)

http://asiaflux.net

Location of registered sites in East Asia

Sites in Mongolia

Kherlenbayan Ulaan

Southern Khentei Taiga

Site Information

http://asiaflux.net/index.php?page_id=103

Observation Period and Data Availability

Measurement Period	from March 2003 to present
Measurement Frequency	Continuous
Data Availability	2003-2006 in AsiaFlux Database

Contact

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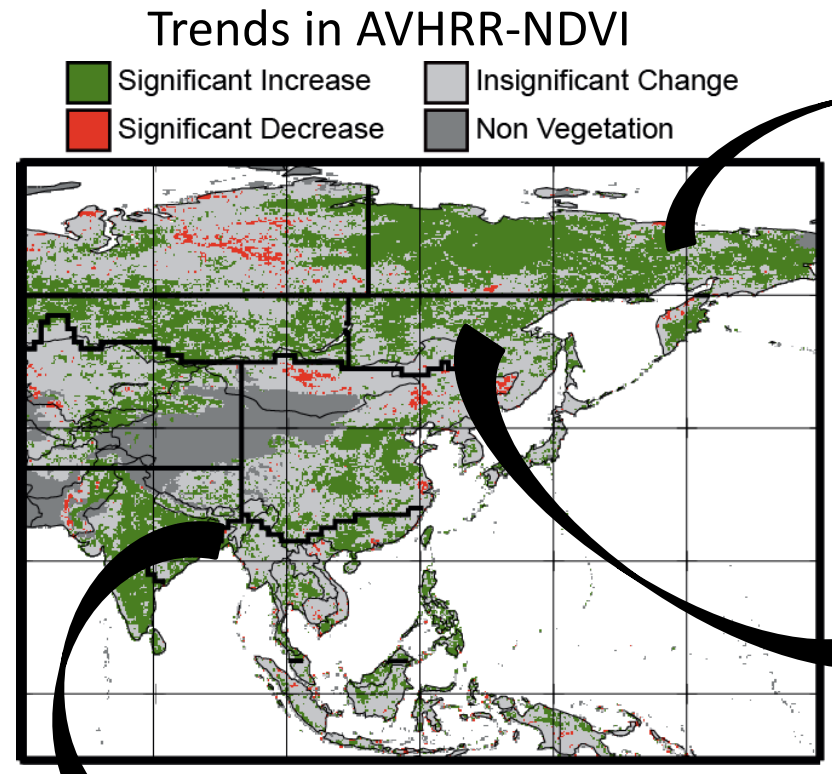
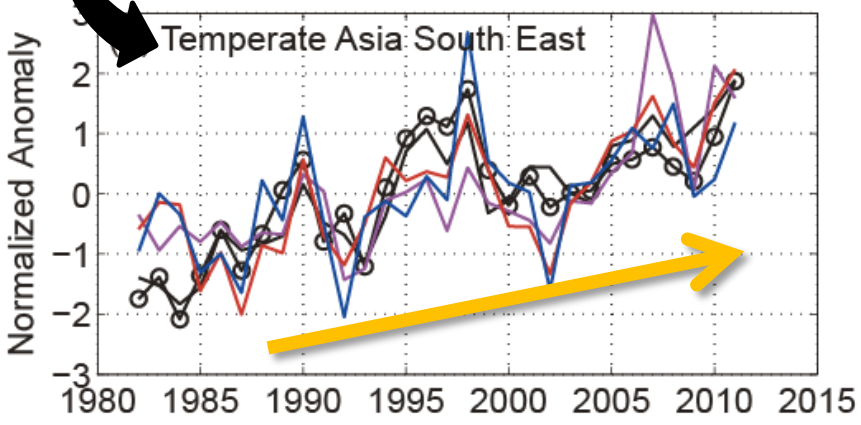
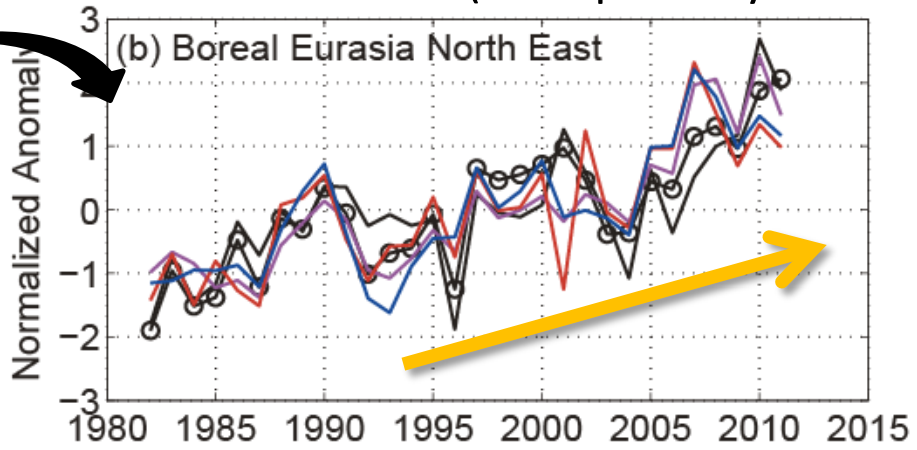
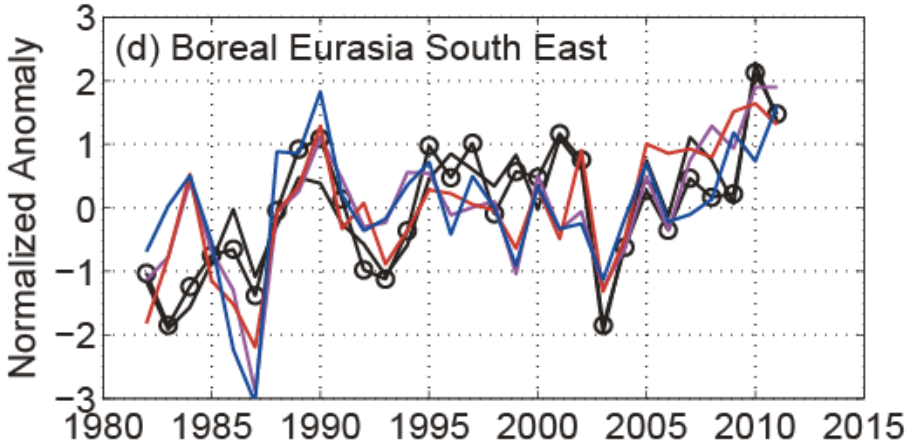
Detect Increasing Trends in NDVI & Productivity in Siberia

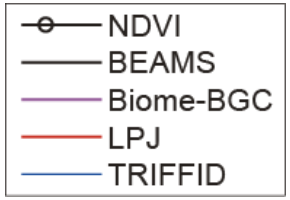




Trends in NDVI and GPP (total photosynthesis)







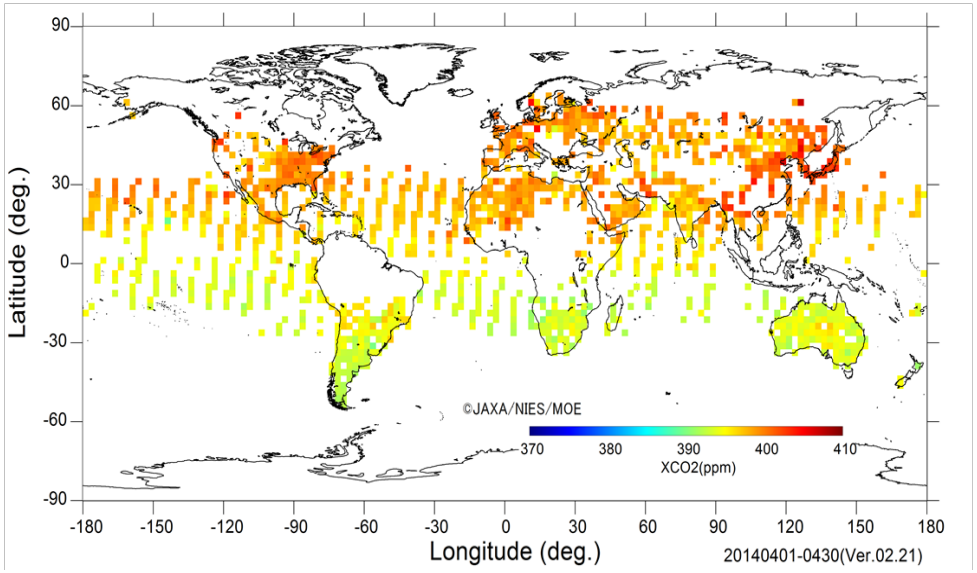
Ichii *et al.*, *Remote Sens*, 2013

Recent progress in studies of Top-down approach

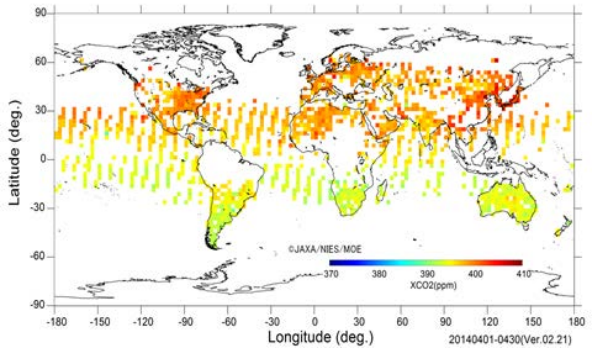
CONTRAIL: Atmospheric CO_2 and other trace gas observation using commercial airlines

http://www.cger.nies.go.jp/contrail/

GOSAT Project



Recent progress in studies of Top-down approach

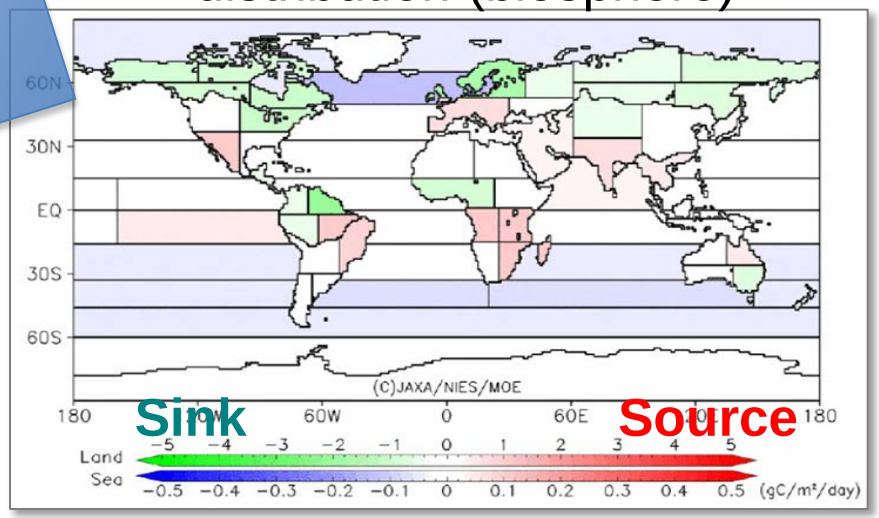


High quality atmospheric CO_2 concentration data observed by various platforms

Inverse analysis so that the difference between observed and modeled CO_2 concentration becomes minimum.

Subtract anthropogenic emission

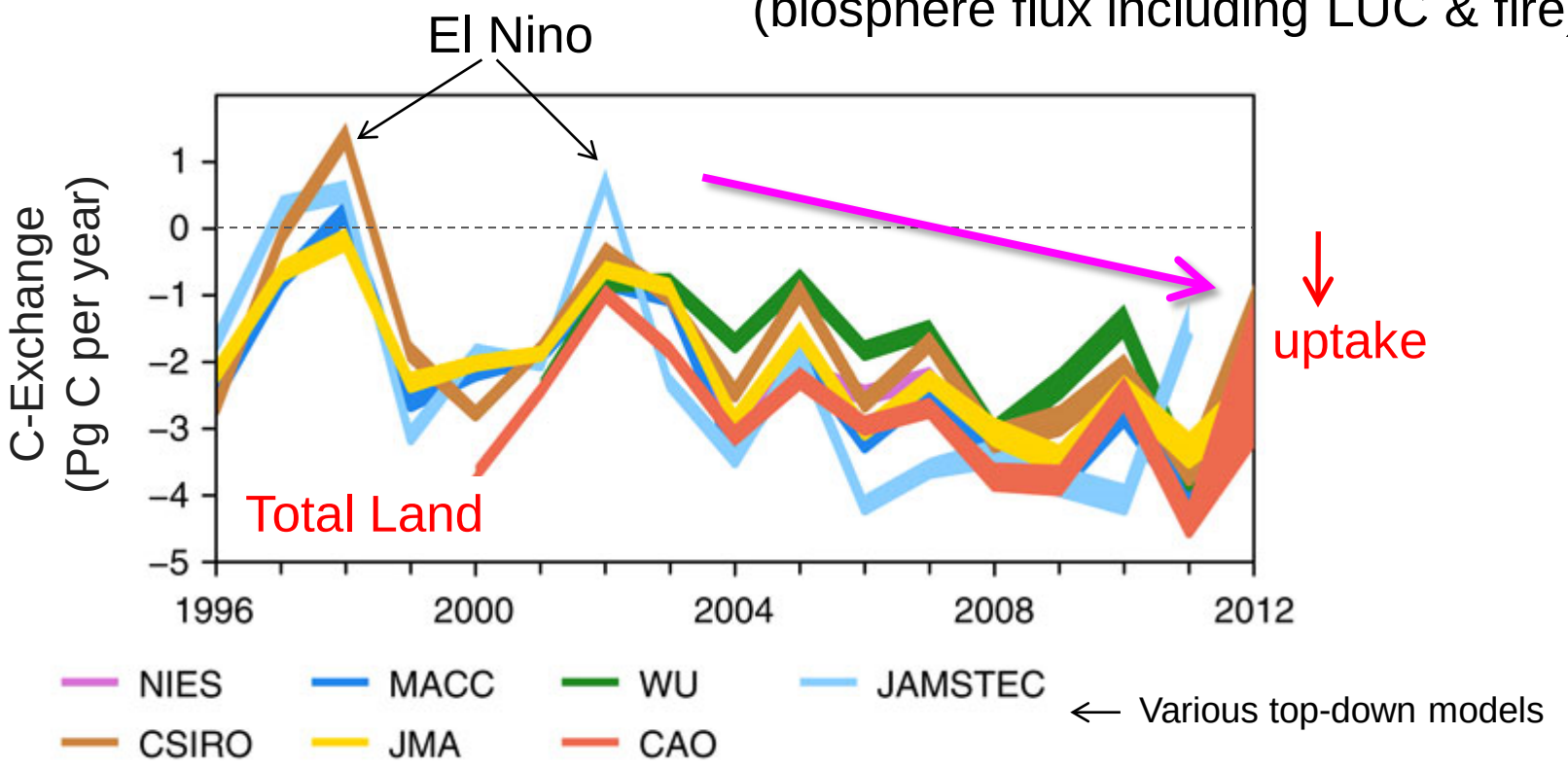
Global & regional sink/source distribution (biosphere)



Estimate sink/source distribution based on atmospheric concentration data

Top–down assessment of the carbon budget since the mid 1990s

(biosphere flux including LUC & fire)



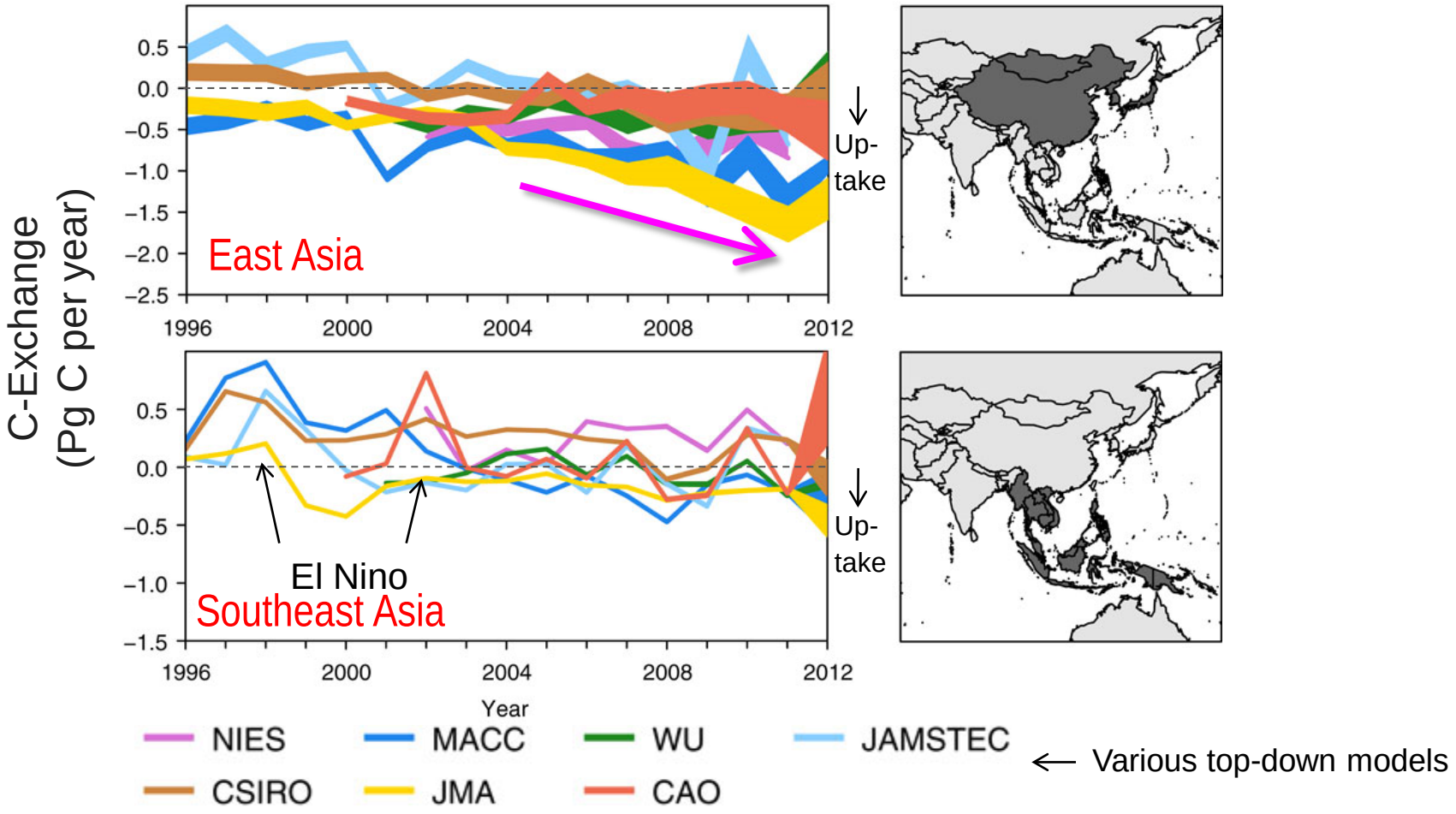
- The width of each curve: Range obtained by different FFC emissions (CDIAC*, EDGAR** & IEA*** inventories)
- Uncertainty in the FF emissions contributes 32% to the uncertainty in land biosphere sink change.

*CDIAC (Carbon Dioxide Information Analysis Center, 2013); **EDGAR (Emission Database for Global Atmospheric Research, ver.4.2); ***IEA (International Energy Agency, 2014)

Thompson *et al*., 2016, *Nature Communications*

Top–down assessment of the Asian carbon budget since the mid 1990s

(biosphere flux including LUC & fire)

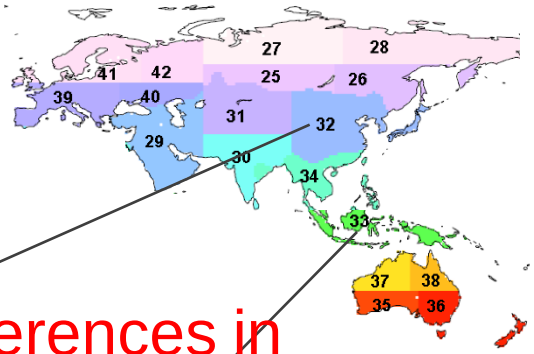


- East Asia: The annual CO_2 sink increased, accounting for ~35% of the increase in the global land biosphere sink.

Thompson *et al.*, 2016, *Nature Communications*

Data-Driven Top-down vs Bottom-up CO_2 Fluxes

Inter-comparison between Top-down & Bottom-up approaches

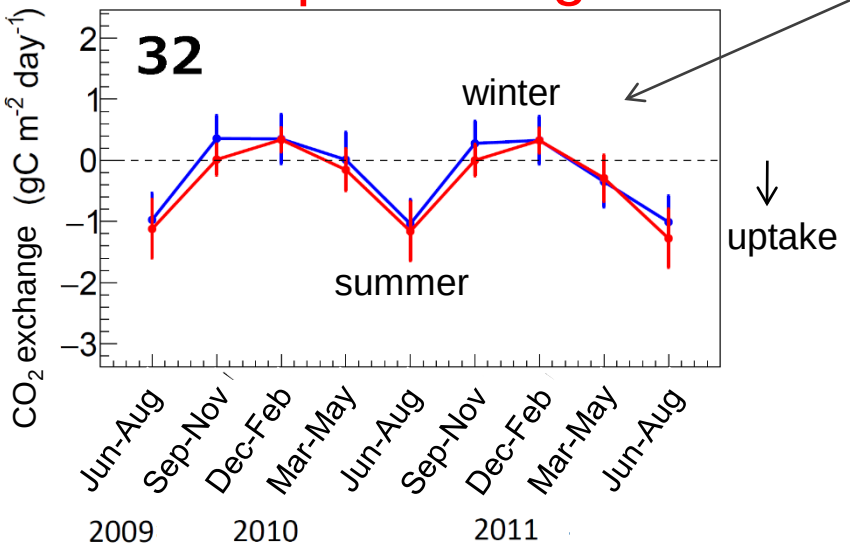


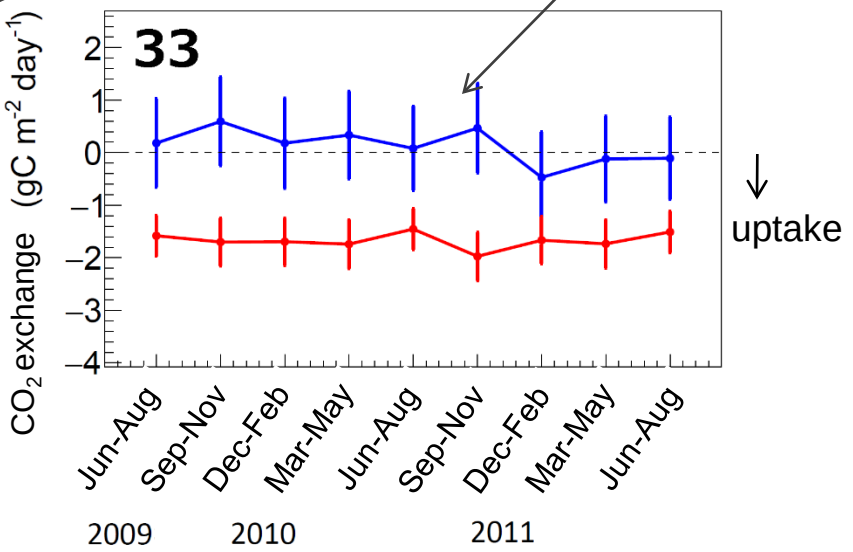
GOSAT Level 4A

Upscaling with FLUXNET & remote sensing data

Consistent in boreal and temperate regions

Large differences in tropical regions





JAMSTEC-NIES Press release:
http://www.nies.go.jp/whatsnew/2015/20150717/20150717.html

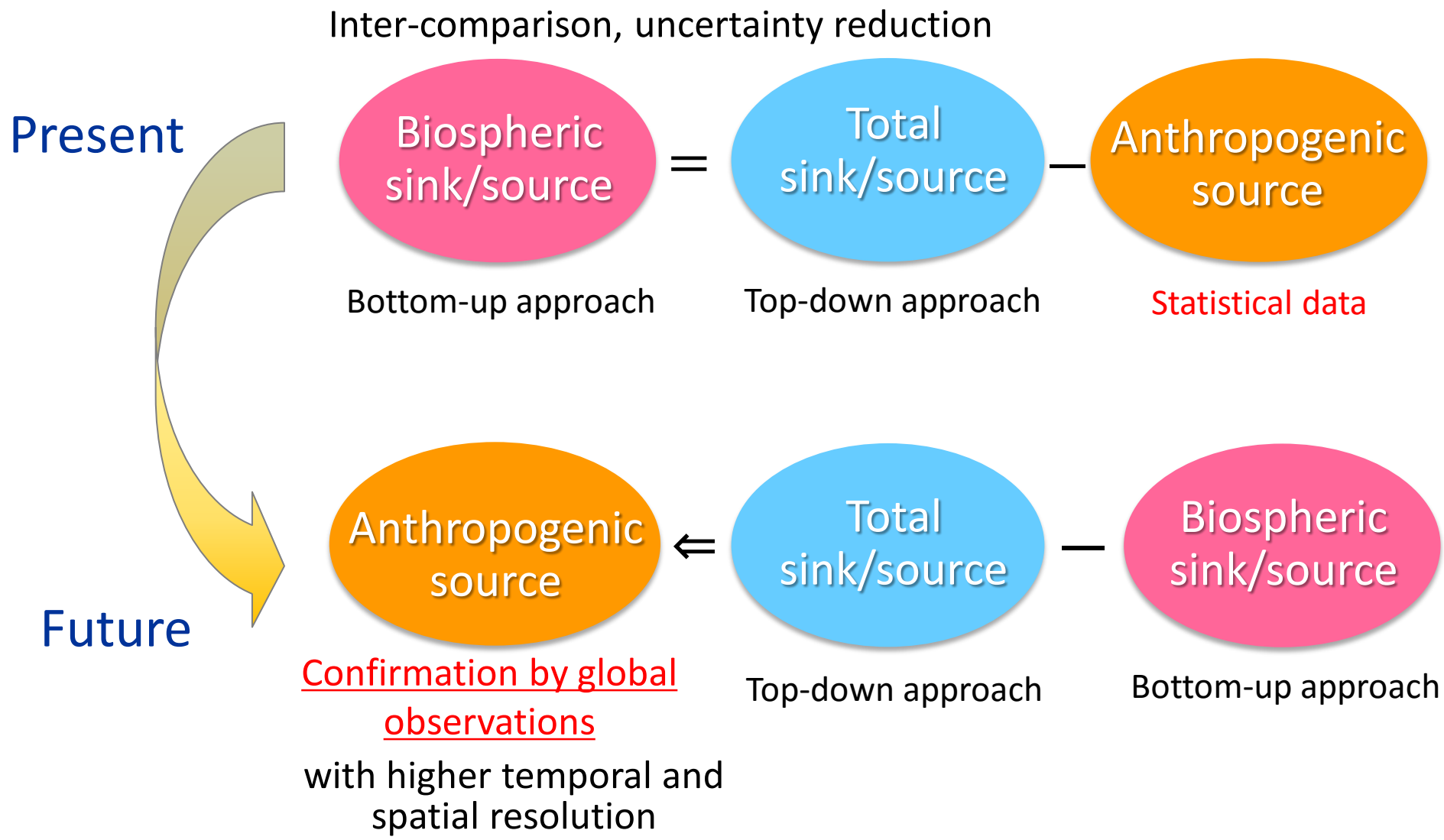
Kondo *et al*. *JGR*, 2015

Next Challenge:

Detect Large C Emissions from Land Use Change

- Plantation, Cropland expansion
- Biomass burning
- River export…

Summary and the Next Challenge



Summary

For accurate C source/sink estimates for Global C Monitoring to assess mitigation and adaptation policies, we urgently need:

- Multi-platform observations & integration into improved data analysis/assimilation systems for C-fluxes particularly in Asia-Pacific, especially tropical regions
- Changes in terrestrial biomass to be used as an independent validation of terrestrial C-flux estimation

To evaluate human impacts on the changes in C-fluxes and stocks, we have to have:

- Improved estimates of **emissions from land-use change**, **fires**, and **other anthropogenic sources**
- Confirmation of anthropogenic sources by top-down and bottom-up approaches