July 2011, JICC @ IARC
RESEARCH AREA NO.: 2
THEME NO.: 8-1

TITLE: Evaluation of the greenhouse gas budget of terrestrial ecosystems in the Arctic region

PI: A.Ito
CO-PI: Y.Kim
CO-INVESTIGATOR: R.Suzuki, T.Nakai

MEMBER’S ROLES: GHG Modeling by A.Ito
RS validation data by R.Suzuki
Field observation by Y.Kim, T.Nakai, R.Suzuki
Severe global warming is expected to occur in the Arctic region.

Huge amount of carbon is stored as SOM in the Arctic region.

=> Strong GHG feedback.
But, high uncertainty.

Ping et al. (2008: Nature Geoscience)
OBJECTIVES:

(1) Point-scale modeling of carbon and nitrogen cycles at typical forests and rangelands in the circum-arctic region.

(2) Regional-scale modeling of terrestrial ecosystems putting special focus on greenhouse gas exchange.
METHODOLOGY:

(1) A process-based terrestrial ecosystem model (VISIT) is applied to typical boreal forests and wetland/tundra, using appropriate datasets of meteorology, soil, and vegetation.

(2) Based on the global-scale VISIT model, a regional model of terrestrial ecosystem is developed with a fine-mesh resolution. The simulation results are validated using remote sensing biomass data.
METHODOLOGY:

**VISIT** Vegetation Integrated SImulator for Trace gases

(Developed in NIES & FRCGC-JAMSTEC)

**Objectives**

- Atmosphere-ecosystem biogeochemical interactions
- Especially, major greenhouse gases (CO$_2$, CH$_4$, and N$_2$O) budget
- Assessment of climatic impacts and biotic feedbacks

**Carbon-cycle (Sim-CYCLE-based)**

- Photosynthesis (GPP)
- Net ecosystem productivity (NEP)
- Respiration (root, shoot, microbial)

**Nitrogen-cycle**

- Ammonium ($NH_4^+$) and Nitrate ($NO_3^-$)
- Nitrogen fixation ($N_2$)
- Denitrification
- Nitrification
- Mineralization
- Uptake
- Leaching
- Erosion

**Point-global, daily-monthly**

- CO$_2$: photosynthesis & respiration
- CH$_4$: production & oxidation
- N$_2$O: nitrification & denitrification
- LUC emission: cropland conversion
- Fire emission: CO$_2$, CO, BC, etc.
- BVOC emission: isoprene etc.
- Others: N$_2$, NO, NH$_3$, erosion
METHODOLOGY:

Estimation scheme for terrestrial CH$_4$ budget

(Ito and Inatomi, under review)
METHODOLOGY:

Wetland fraction used to estimate terrestrial CH₄ budget

(Ito and Inatomi, under review)
OUTCOMES OF 2010FY:

Test at ‘generic’ Alaska

=> Comparison at UAF site
OUTCOMES OF 2010FY: Circum-Arctic GHG Budget

NEP (biological CO$_2$ budget)

Major sinks in many boreal forests (note: it was largely offset by fire emission)

(Ito and Inatomi, unpublished data)

CH$_4$ emission

Major sources in Canada, Alaska, and West Siberia
OUTCOMES OF 2010FY: Circum-Arctic GHG Budget

Biomass burning

Major sources in Canada, Alaska, and East Siberia

N$_2$O emission

Major sources in croplands

(Ito and Inatomi, unpublished data)
OUTCOMES OF 2010FY: Circum-Arctic GHG Budget

NEP – fire emission
In Alaska, northern sources and southern sinks?

(Ito and Inatomi, unpublished data)
EXPECTED OUTCOMES OF 2011FY:

(1) Further site-level evaluation will be conducted using the field data from Dr. Y. Kim and Dr. R. Suzuki.

(2) It is expected that the model evaluation results will be published in an appropriate peer-reviewed journal.

=> Global CH₄ results: Biogeosciences Discussion

=> Model application to Poker Flat site, BOREAS sites, etc.

=> Spatial validation using satellite-based biomass data by Suzuki-san.
Global result (supplementary)

GWP (100-yr)
1 x CO₂
25 x CH₄
298 x N₂O

CO₂
NBP

CH₄
Wet
Oxy
Plant

N₂O
Emit

Will be included…
- Food consumption (CO2)
- Termite (CH4)
- Landfill (CH4)
- Ruminants (CH4)
- Biomass burning (CH4)