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FAO WS on soil C
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Nationwide agricultural soil C calculation system for GHG inventory and NDC – Japan’s experience

Yasuhito SHIRATO
Institute for Agro-Environmental Science, NARO

National Agriculture and Food Research Organization

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Soil C model: useful tool for future prediction and spatial evaluation

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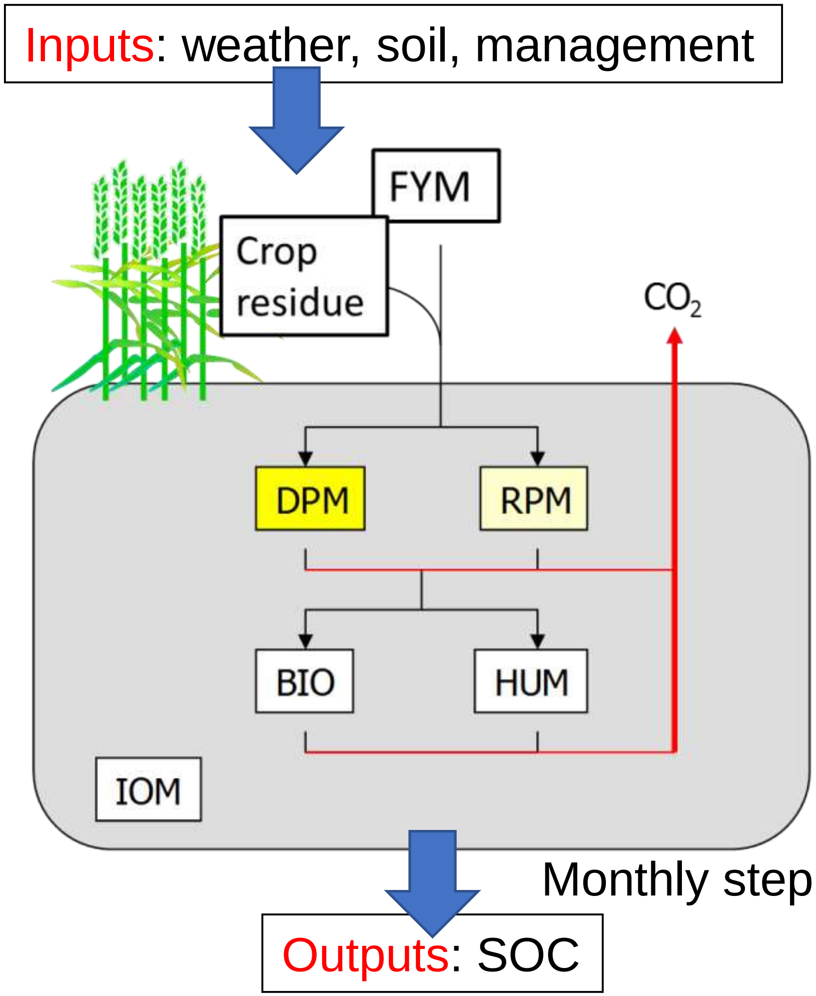
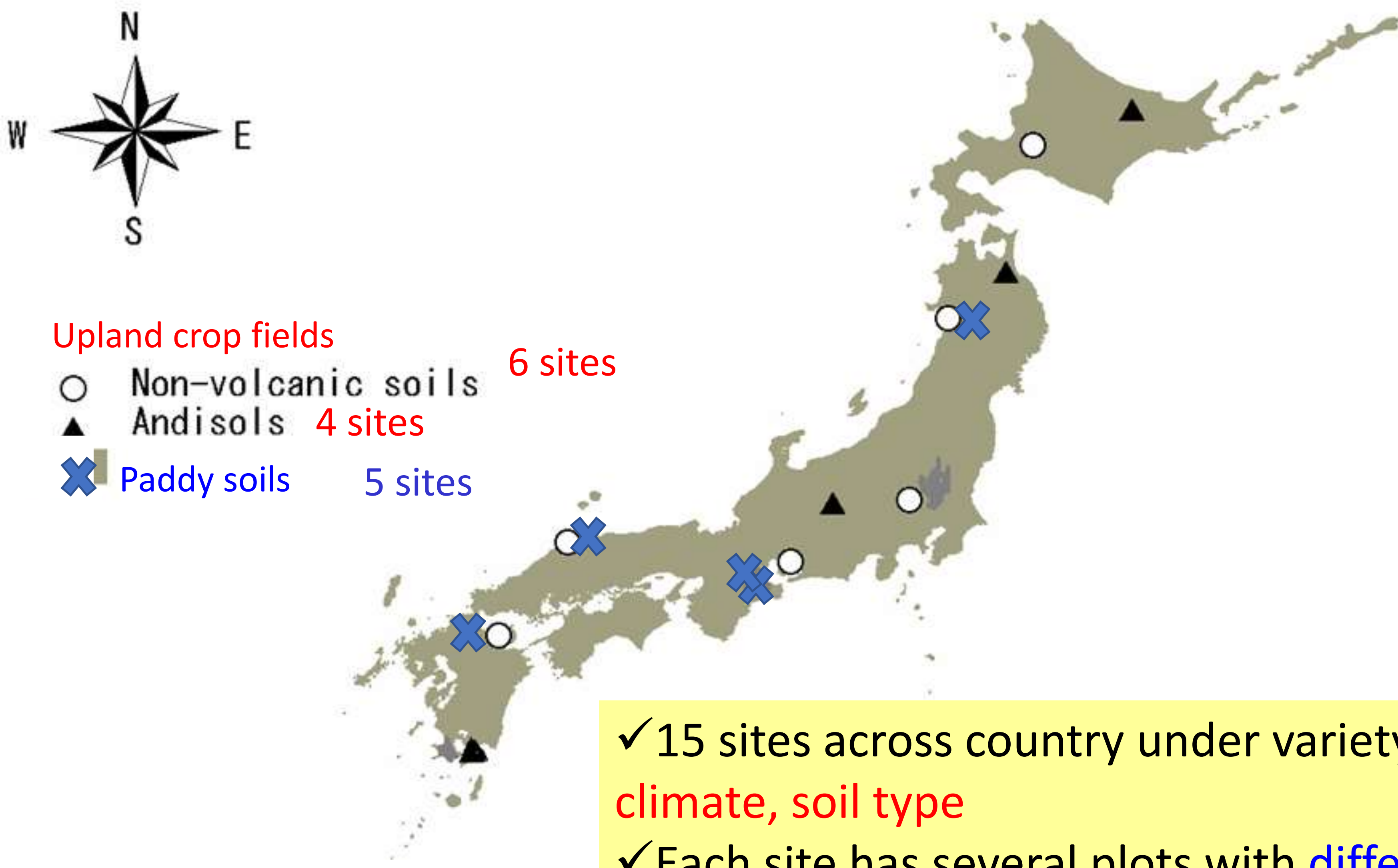
Rothamsted Carbon (RothC) model



- One of widely used soil C models developed in UK.
- Simpler structure has advantage for model modification
- Not validated in Japan

Long-term experiments for model validation



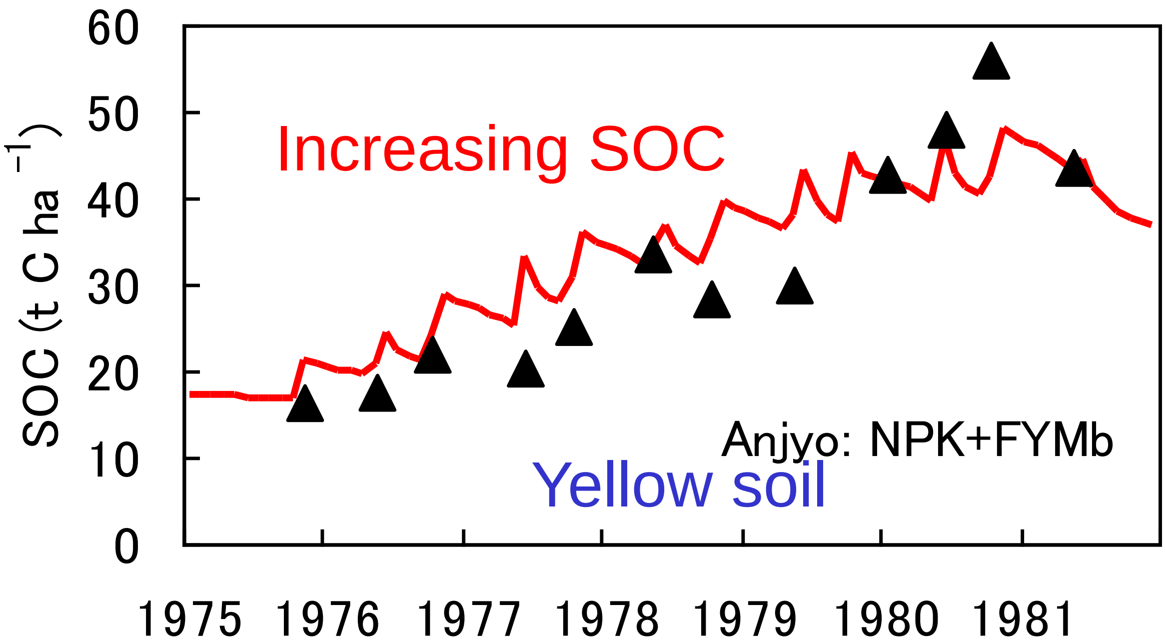
✓15 sites across country under variety of climate, soil type

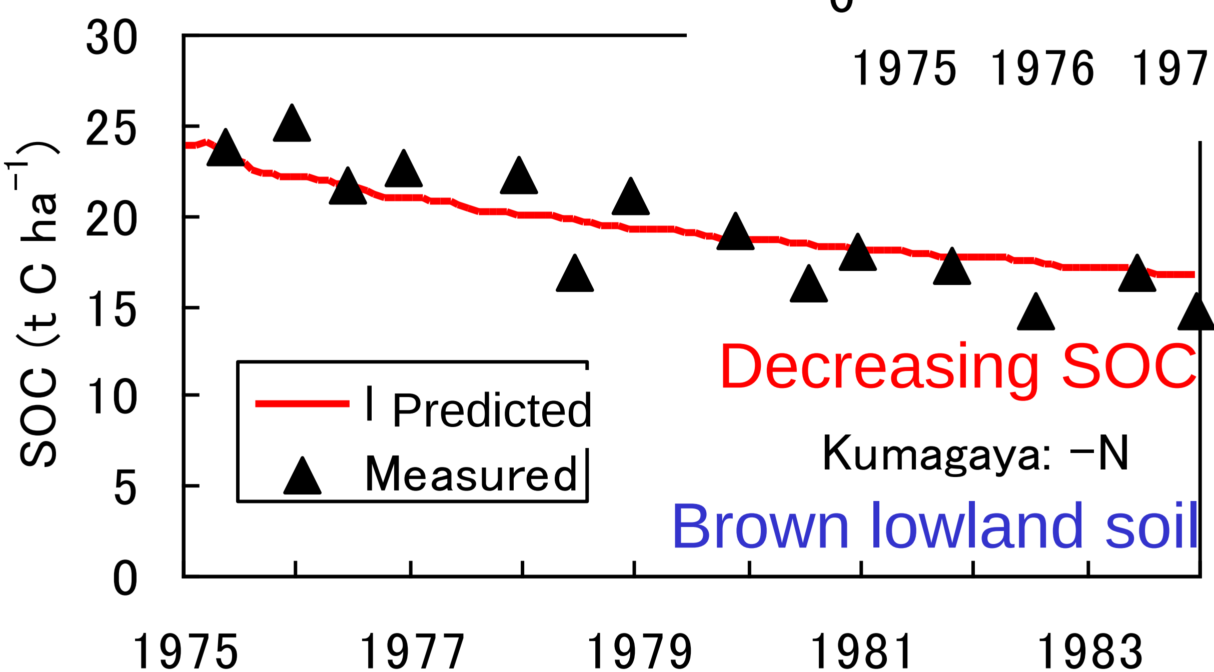
✓Each site has several plots with different management (NPK, manure, straw, etc.)

Performance of RothC in non-volcanic upland soils

Good performance

Without any modification or calibration

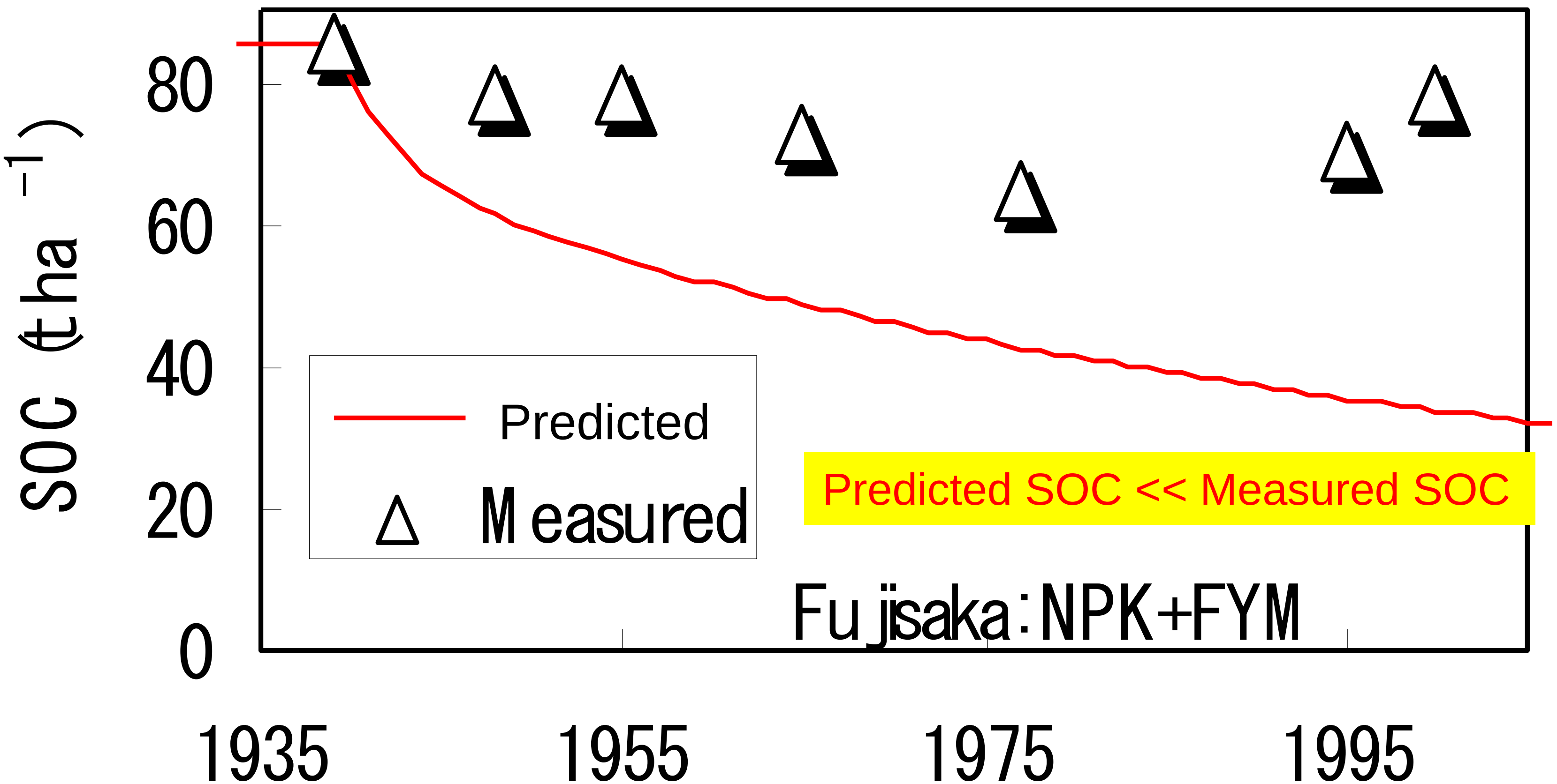




- 6 sites under various weather condition.
- Various soil types.
- Various management

(Shirato & Taniyama, 2003)

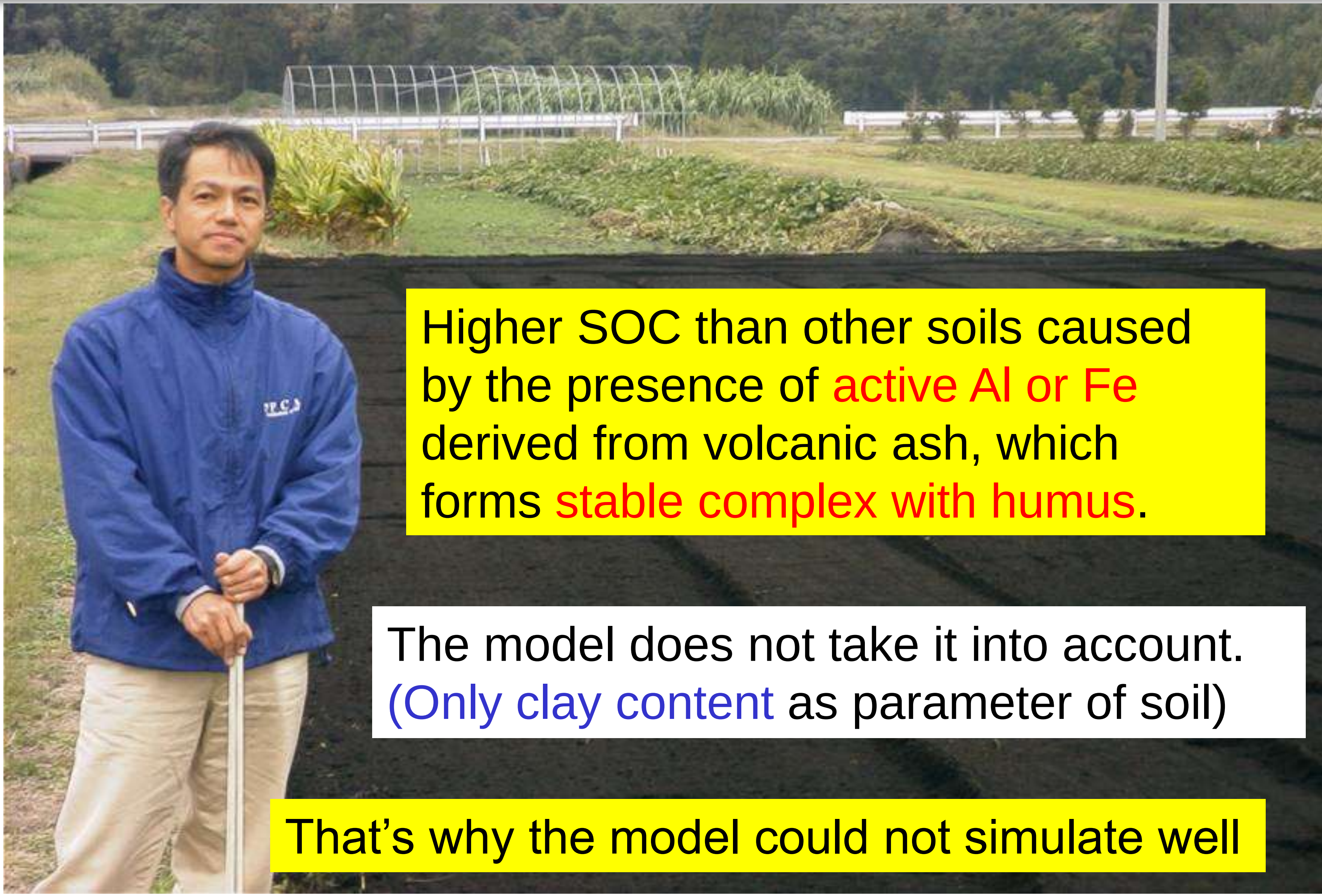
But in Andosols……



The model underestimated the SOC

(Shirato et al., 2004)

Andosols have high C concentration



Higher SOC than other soils caused by the presence of active Al or Fe derived from volcanic ash, which forms stable complex with humus.

The model does not take it into account.
(Only clay content as parameter of soil)

That’s why the model could not simulate well

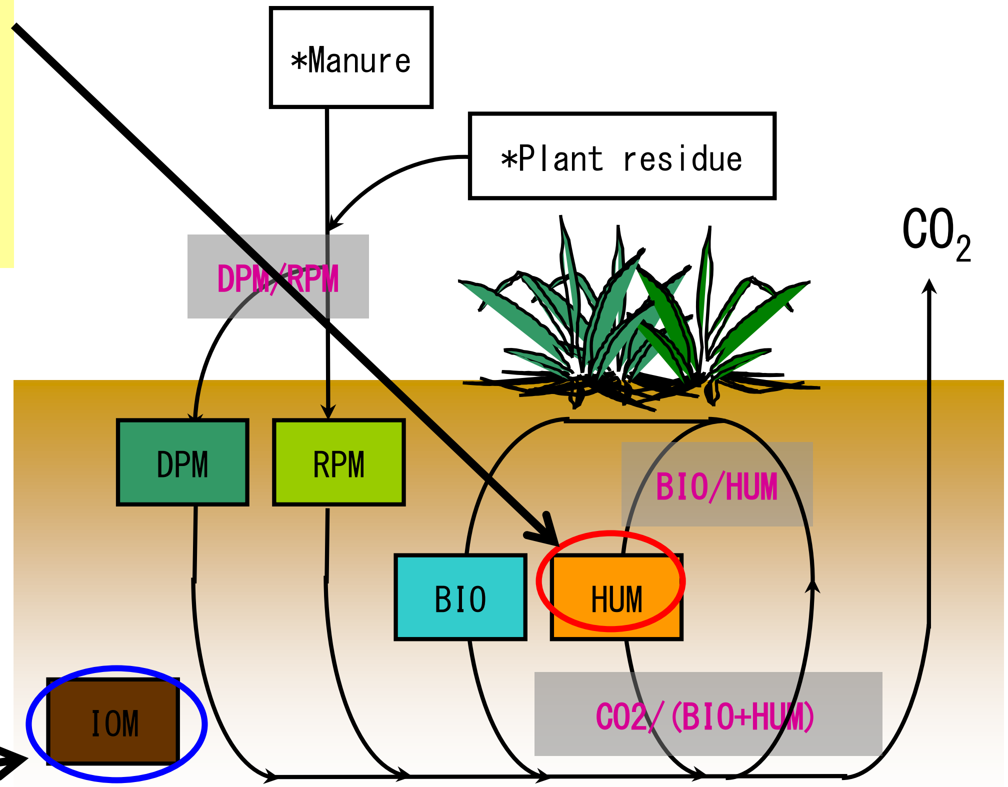
How to modify the RothC for Andosols

Active Al or Fe derived from volcanic ash forms stable complex with humus ➔ Slow decomposition

1. Changing HUM decomposition rate constant
   by dividing with a factor(F), which changes with the amount of active Al or Fe

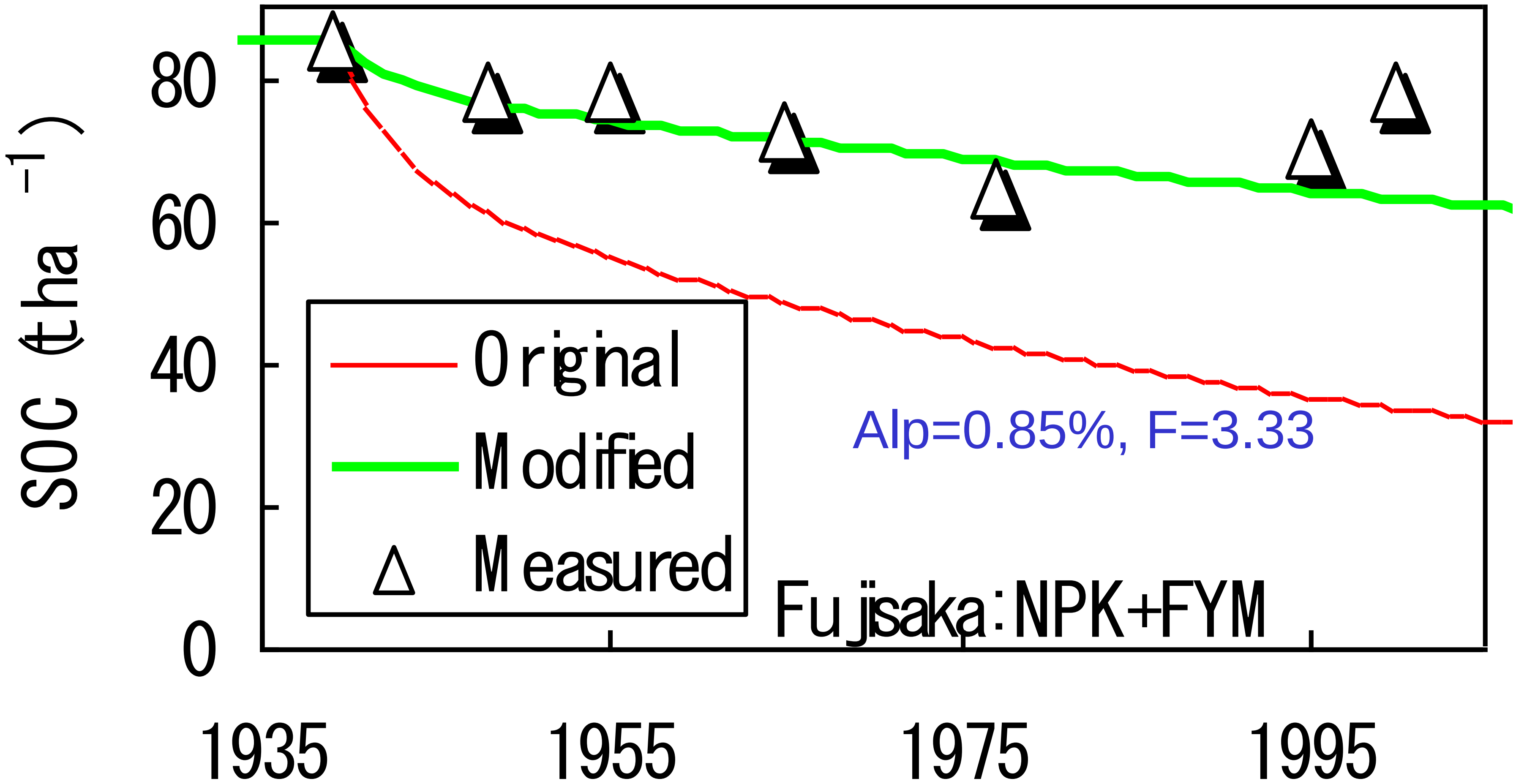
F=2.50 Alp + 1.20 (Alp: Pyrophosphate extractable Al)

In soils with much Al-humus complex, SOC decompose slowly



2. IOM=0

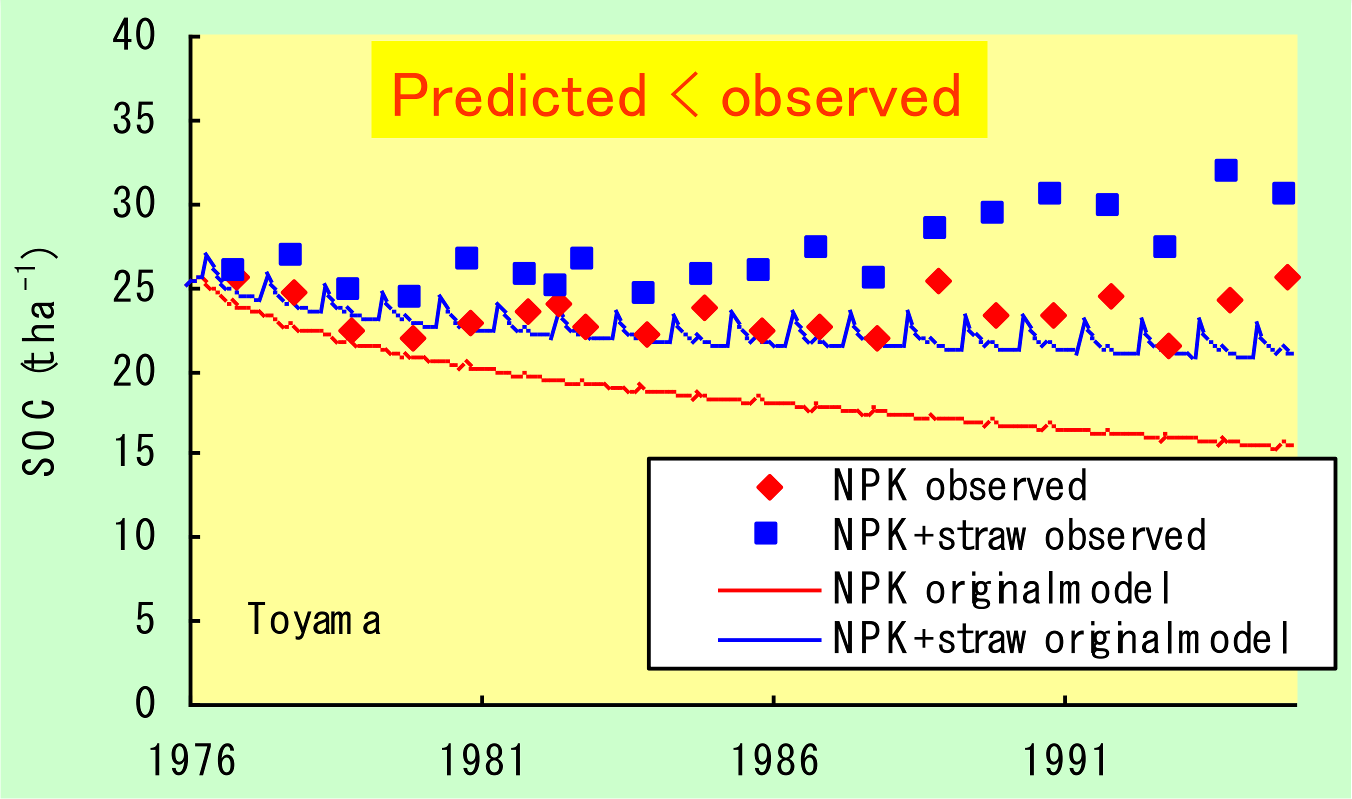
Modified model for Andosols



Better performance than original model

(Shirato et al., 2004)

What happen in paddy soils ?



The model underestimated SOC, as expected
(slower decomposition because of anaerobic condition)

(Shirato & Yokozawa, 2005)

How to modify the RothC for paddy soils?

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- Predicted SOC < observed

  ➔Slower decomposition in paddy soils than upland (expected)
- Rice growing period: anaerobic condition ➔ decomposition may slow
- How about in non-rice growing period?

  Paddy soils have different microorganism composition (e.g. Smaller proportion of fungi, which play major role in decomposing lignin or cellulose, than bacteria)

  ➔ decomposition may slower than upland soils, too.

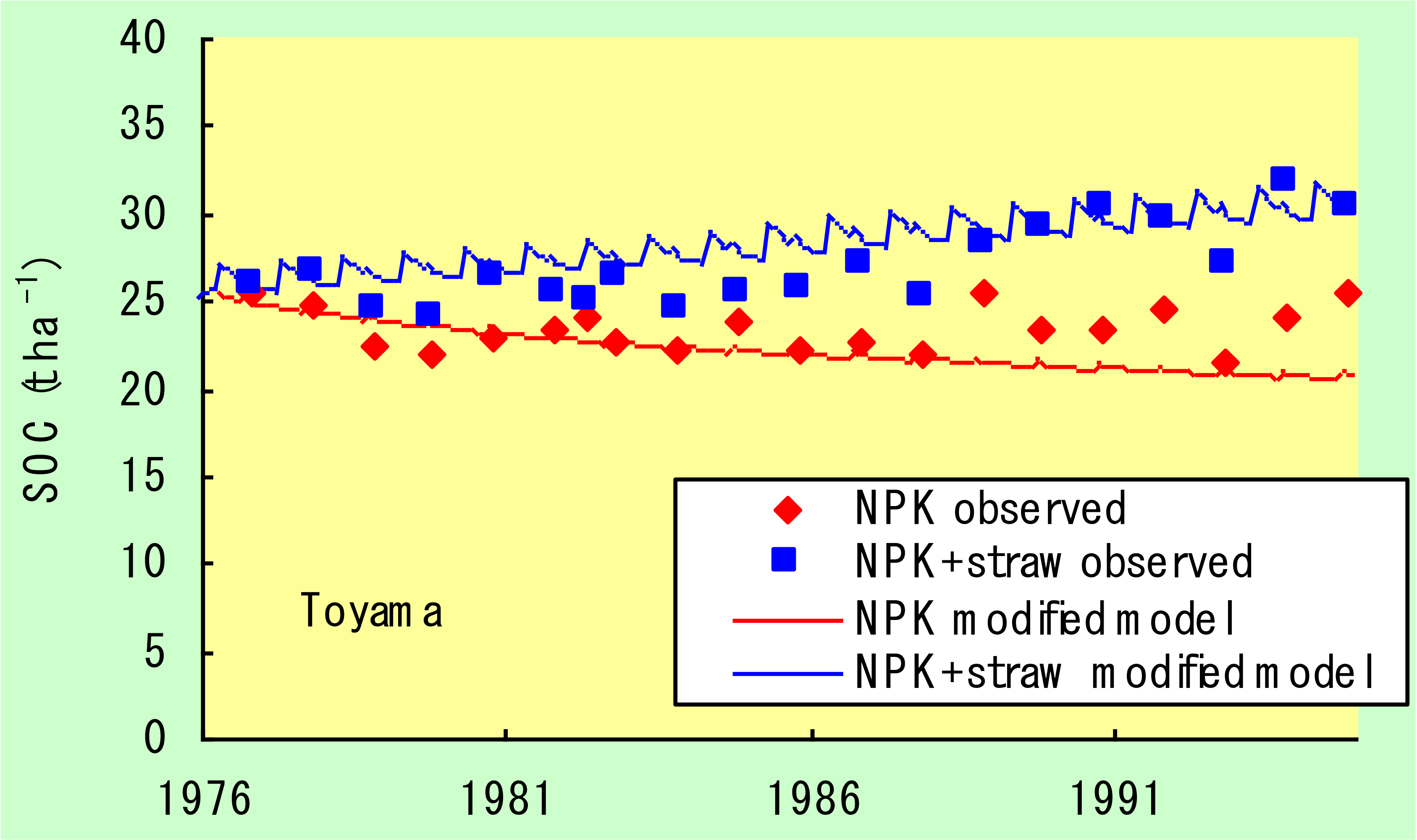
Decided to modify the model by…

1.Changing the decomposition rates of the RothC during the submergence period (summer) and the period without submergence (winter), separately.

2. Find out the optimum combinations of the decomposition rate.

Modified model for paddy soils

0.2 and 0.6 times slower decomposition rate, in rice growing season (submerged) and other period, respectively



Good agreement

(Shirato & Yokozawa, 2005)

Validation and modification of the RothC: Japanese version

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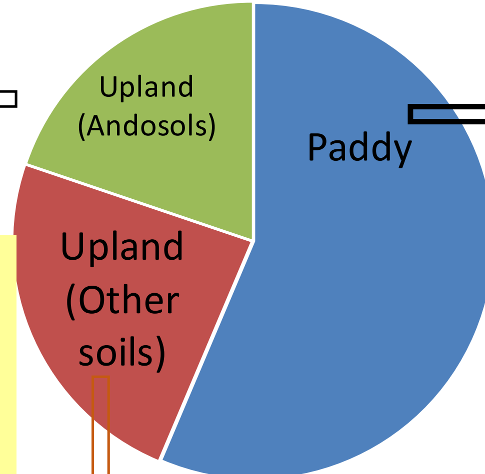
Andosols

Arable soils: ~500 million ha



Paddy soils

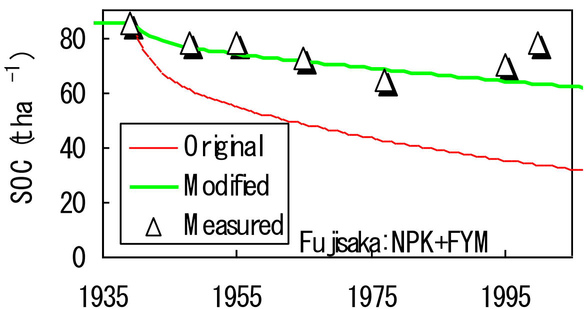
Stable humus with active Al
➔Slow decomposition of "HUM" pool

Anaerobic condition
➔Slow decomposition

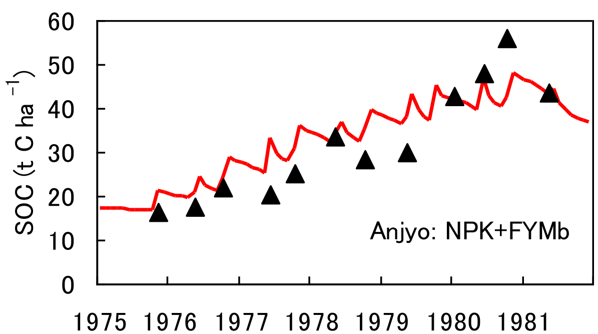
Modified model

Original RothC: successful

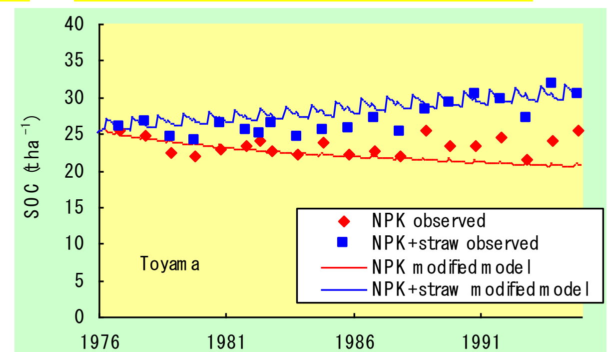
Modified model



(Shirato et al., 2004)



(Shirato & Taniyama, 2003)

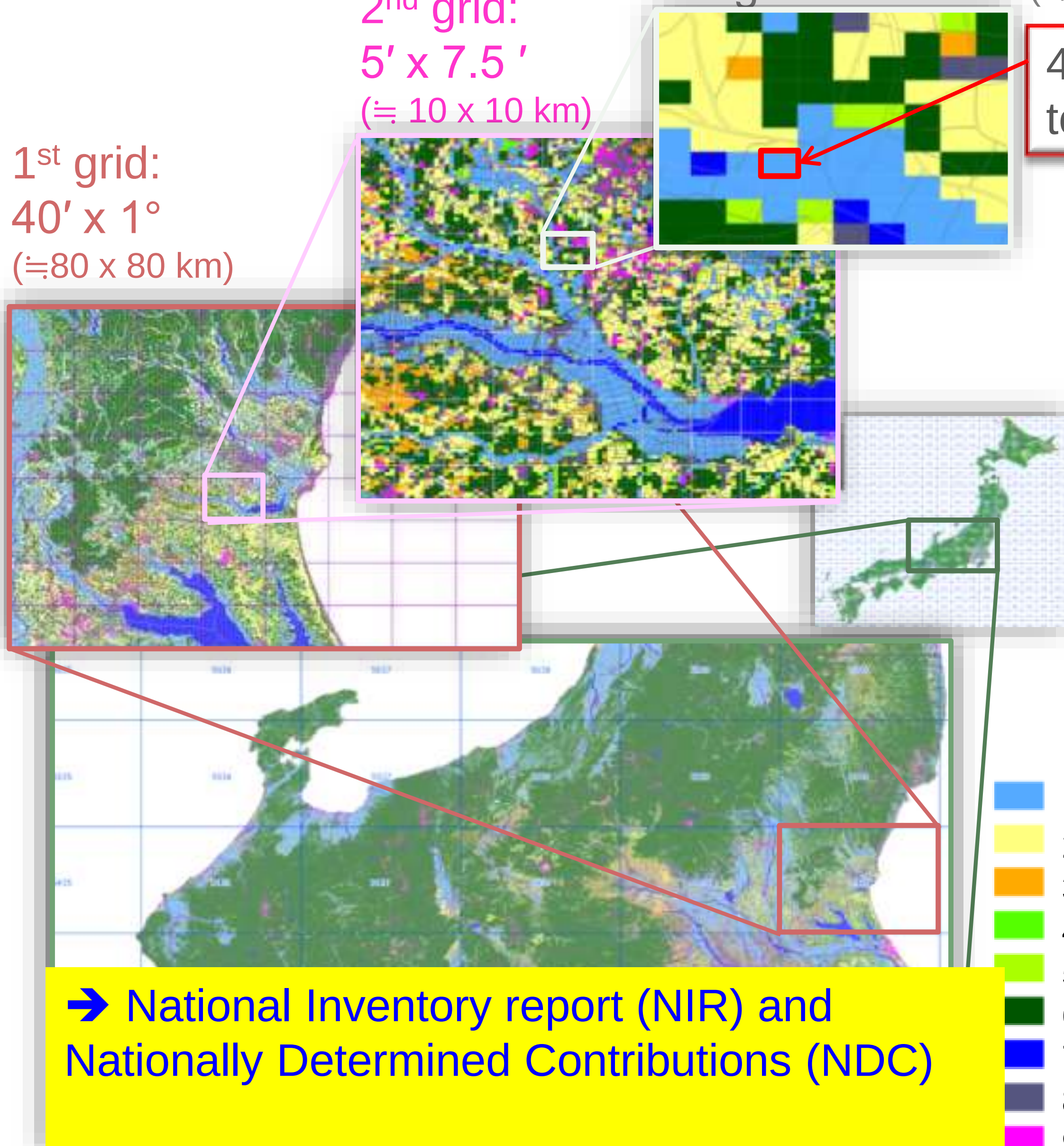


(Shirato & Yokozawa, 2005)

➔Nationwide soil C calculation system by using 3 versions

Nationwide calculation system of soil C

Spatial resolution: 100m × 100m grid



➔ National Inventory report (NIR) and Nationally Determined Contributions (NDC)

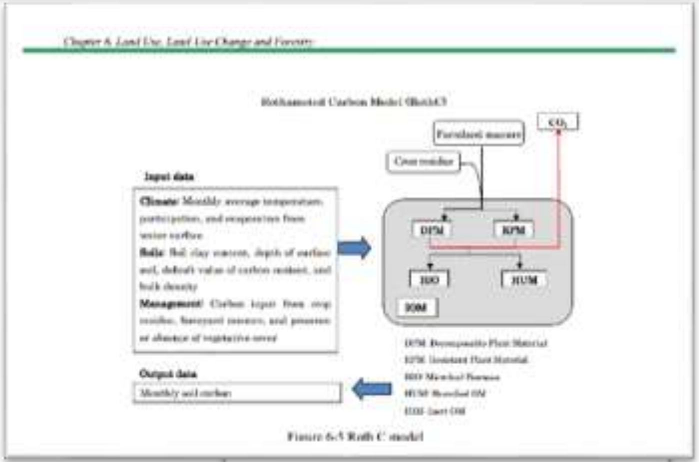
✓Soil map
✓Land use map (1976, 1987, 1991, 1997, 2006, 2020)

✓Weather (1km)
✓Agricultural activity (47 prefecture)

1 paddy
2 cropland
3 orchard
4 managed grassland
5 unmanaged grassland
6 forest lands
7 wetlands
8 settlements
9 other lands

Contribution to Japan's NIR and NDC

- NIR: RothC model calculation is used for CO2 emission/removal derived from changes in the amount of soil C in cropland & grassland from NIR 2015.



- NDC: Cropland & grazing land management: 7.9 Mt-CO2* removal in 2030 by increasing organic matter input to soils

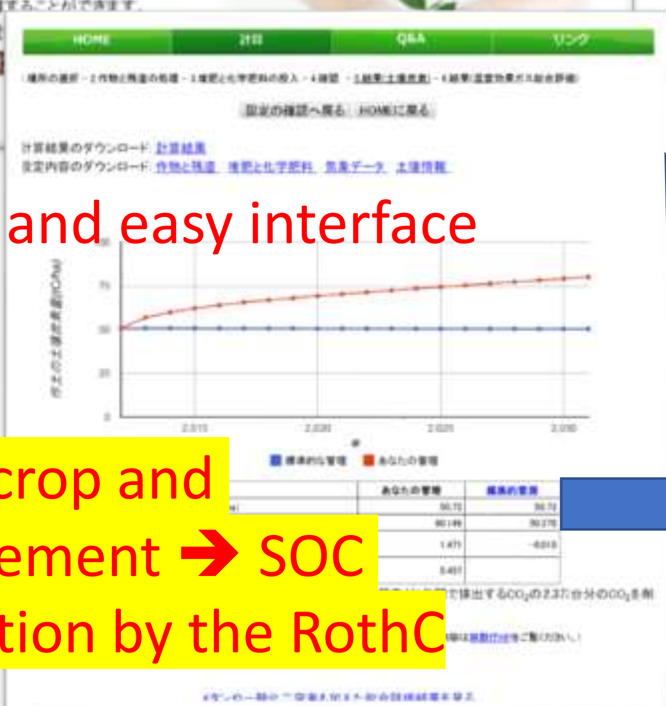

National Greenhouse Gas Inventory Report of JAPAN

2022

Ministry of the Environment, Japan

*Intended Nationally Determined Contributions (INDC): Greenhouse Gas Emission Reduction Target in FY2030 (Ministry of Foreign Affairs of Japan)

Web-based decision-support tool visualizing soil C and GHGs emission



Click on map to get weather and soil data of the field

Simple and easy interface

Select crop and management ➔ SOC calculation by the RothC

Total GWP calculation, too

	あなたの管理	標準的管理
土壌炭素の増減によるCO_2 (tCO_2/ha/年)（プラスが排出、マイナスが吸収）	-3.34	0.5
メタン (g-CH_4/m^2/年)	10.00	10.00
CO_2換算 (tCO_2/ha/年)	3.40	3.40
N_2O (kg-N_2O/10a)	[illegible]	0.07
CO_2換算	[illegible]	0.20
うち化学[illegible]	[illegible]	0.02
CO_2換算 (tCO_2/ha/年)	0.05	0.05
うち堆肥由来 (kg-N_2O/10a)	0.08	0.01
CO_2換算 (tCO_2/ha/年)	0.23	0.03
うち作物残渣由来 (kg-N_2O/10a)	0.04	0.04
CO_2換算 (tCO_2/ha/年)	0.11	0.11
化石燃料由来のCO_2 (tCO_2/ha/年)	2.02	2.02
合計 (tCO_2/ha/yr)（プラスが排出、マイナスが吸収）	2.47	6.12

https://soilco2.rad.naro.go.jp/

Asian Network of long-term experiments

Highlight the importance of long-term field monitoring

ALTENA
Asian Long-Term Experimental Network for Agriculture

Since 2017

- Most of studies published on long-term field experiments are from Europe and north America.
- Not many from Asia. Networking long-term experiments in Asian countries can add new value.
- Enormous variation in climate, soil type, and cultural practices.