Validation of the DNDC-Rice model to evaluate nitrogen balance at a paddy-field for single-cropping of rice in Japan

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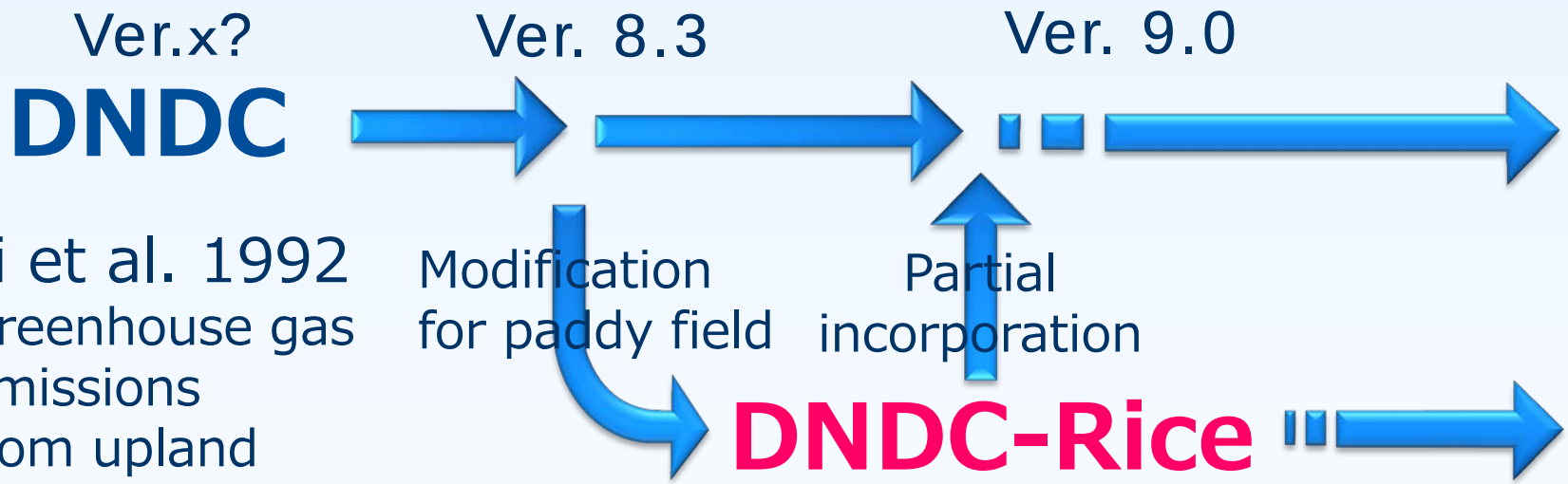
DNDC-Rice



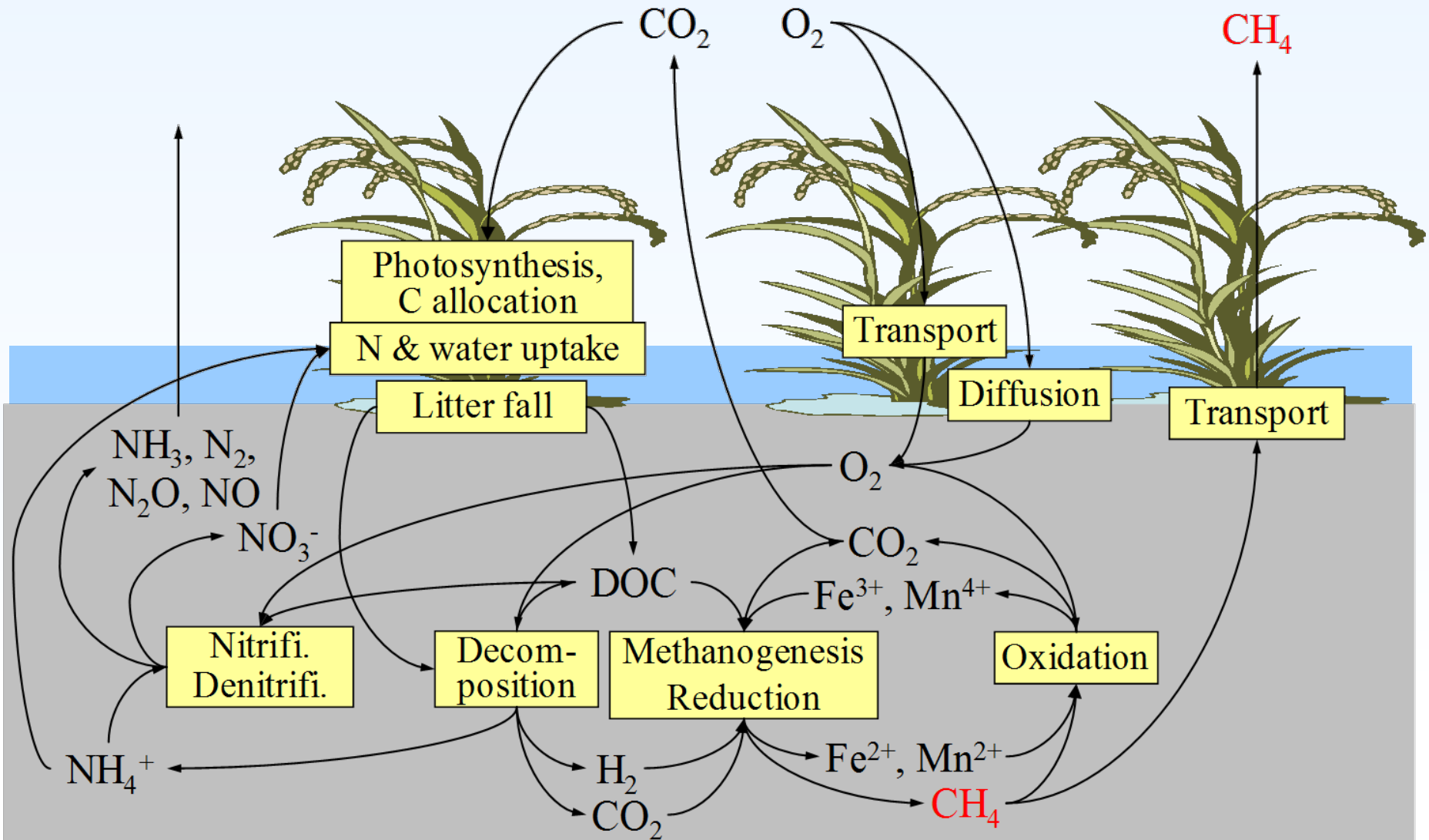
Fumoto et al., 2008

CH_4 emission from rice paddies

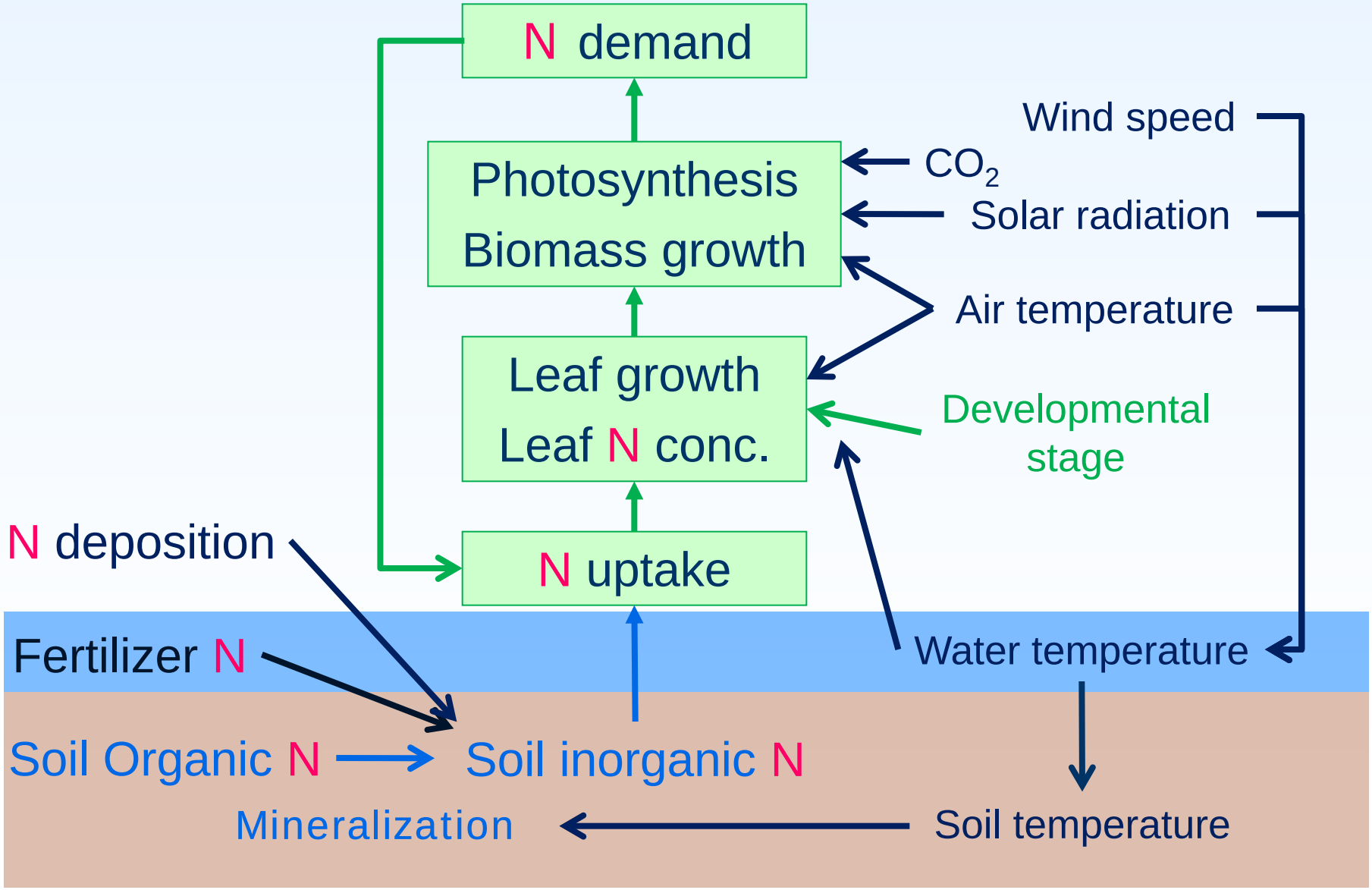
Rice growth

Fumoto et al. 2008, 2010, and 2013 (Japan)
Smakgahn et al. 2009 (Thailand)
Katayanagi et al. 2012 (Philippines)
Katayanagi et al. 2013 (Japan, N balance)
Hayano et al. 2013 (Japan, National scale)

Schematic description of the soil biogeochemistry sub-model of DNDC-Rice



N-dependent rice growth model in DNDC-Rice



Is DNDC-Rice available for estimation of N balance at a paddy field?

- Evaluate effect of high CO_2 and high air temperature to nutrient cycling in future

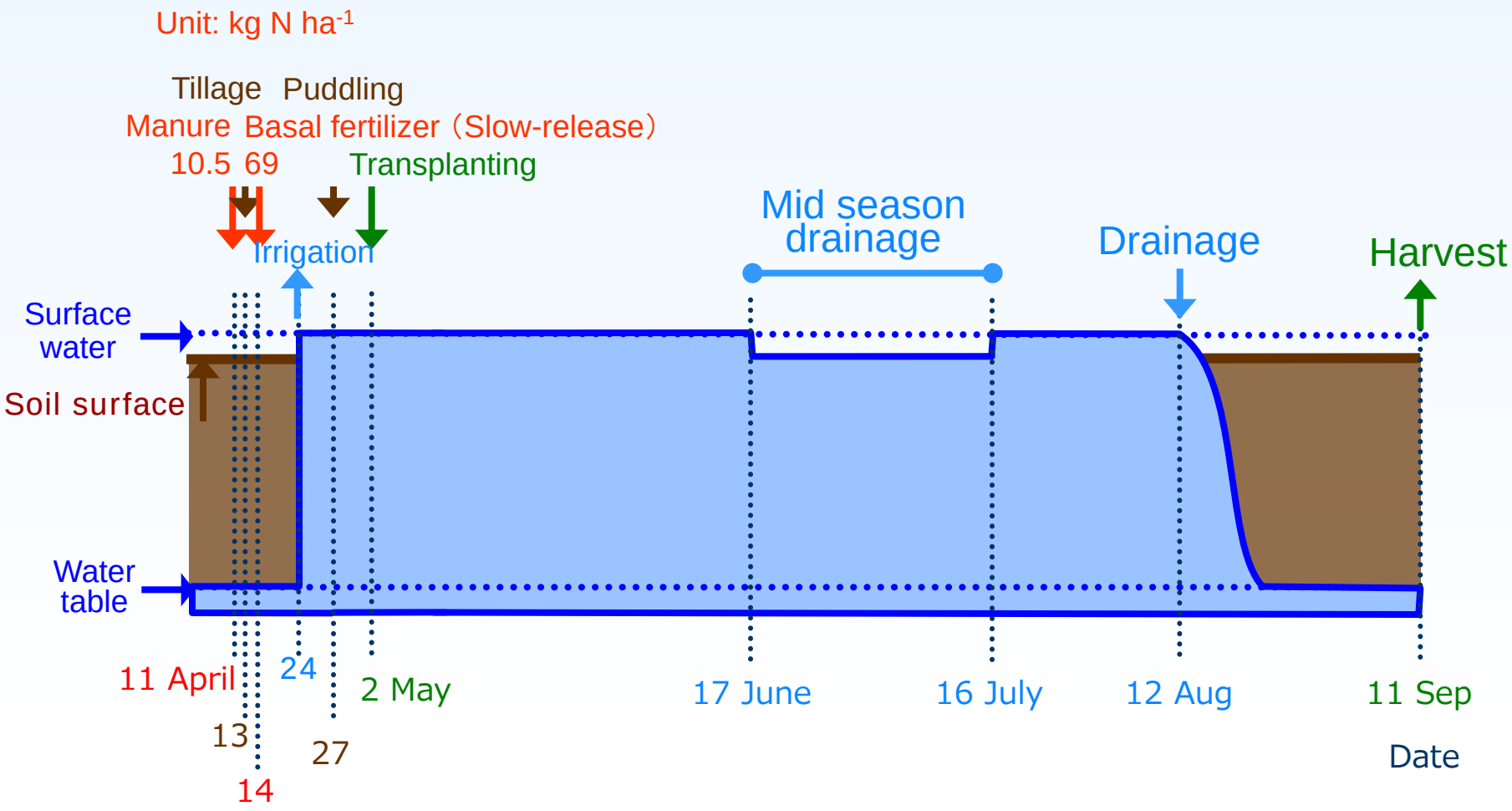
Research Site

Mase, Tsukuba, Ibaraki, Japan
36.0536°N, 140.0272°E
Paddy field
Cropping season
in 2009

Soil chemical and physical properties

- Soil Type Fluvisols
- Texture LiC (Sand 40.7%; Silt 27.1%; Clay 32.2%)
- pH(H_2O) 4.79
- Total Carbon 25.4 g C kg^{-1}
- Total Nitrogen 1.90 g N kg^{-1}
- Bulk density 0.82 Mg m^{-3}
- Hydraulic conductivity
  - 0-20cm 2.50 x 10^{-2} m S^{-1}
  - 20-40cm 3.25 x 10^{-5} m S^{-1}

Field management



Modification of DNDC-Rice

1. Include Langmuir isotherm to calculate available NH_4^+-N in soil

$$C_s=(k_1C)/(1+k_2C)$$

C_s: soil adsorbed NH_4^+-N (mgN kg^{-1})
C: equilibrium concentration of NH_4^+-N in the soil solution (mg L^{-1})
k_1: constant
k_2: constant

2. Adjust N release late from slow release N fertilizer based on the product info.

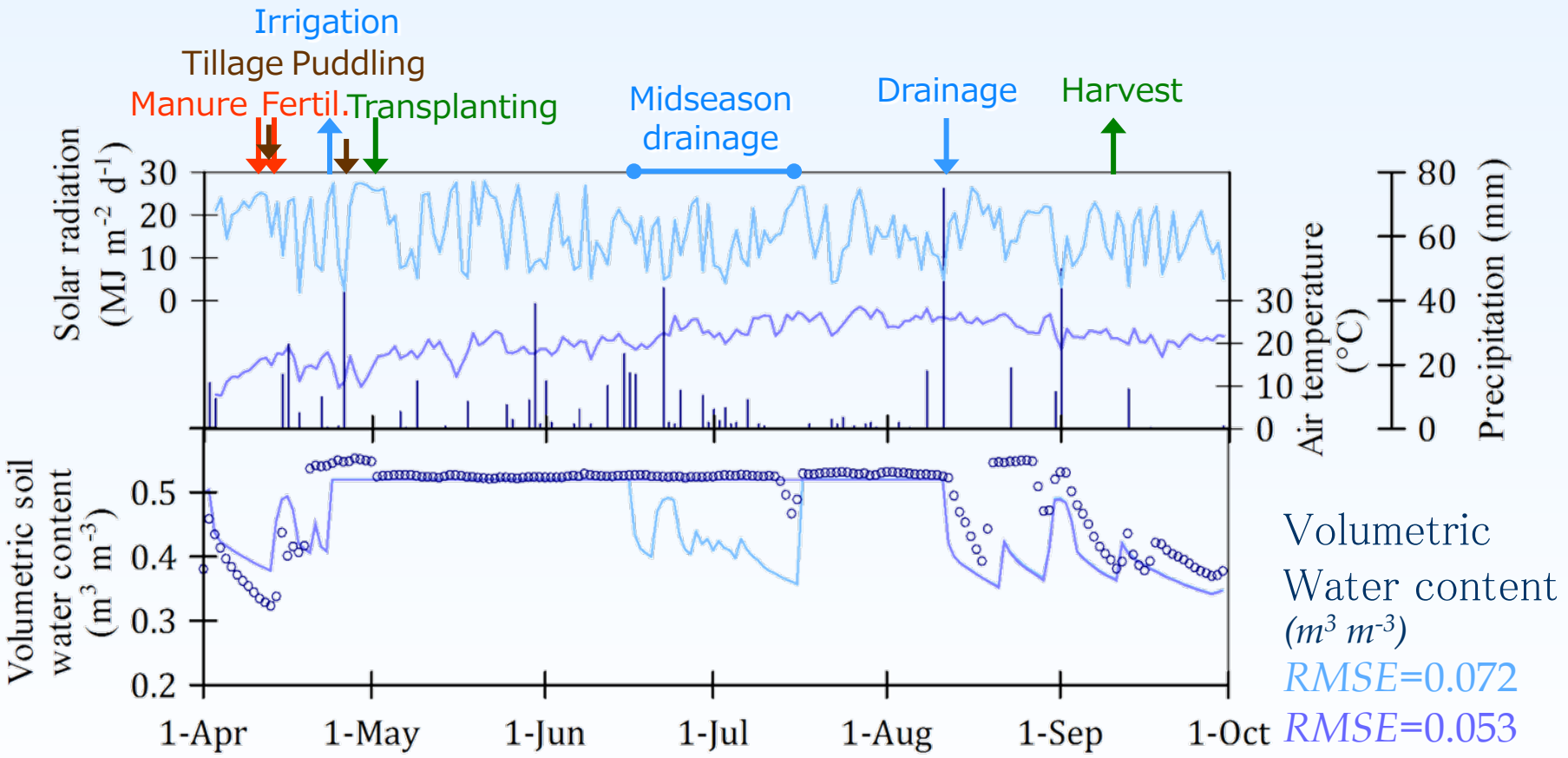
Validation of DNDC-Rice

Temporal variability

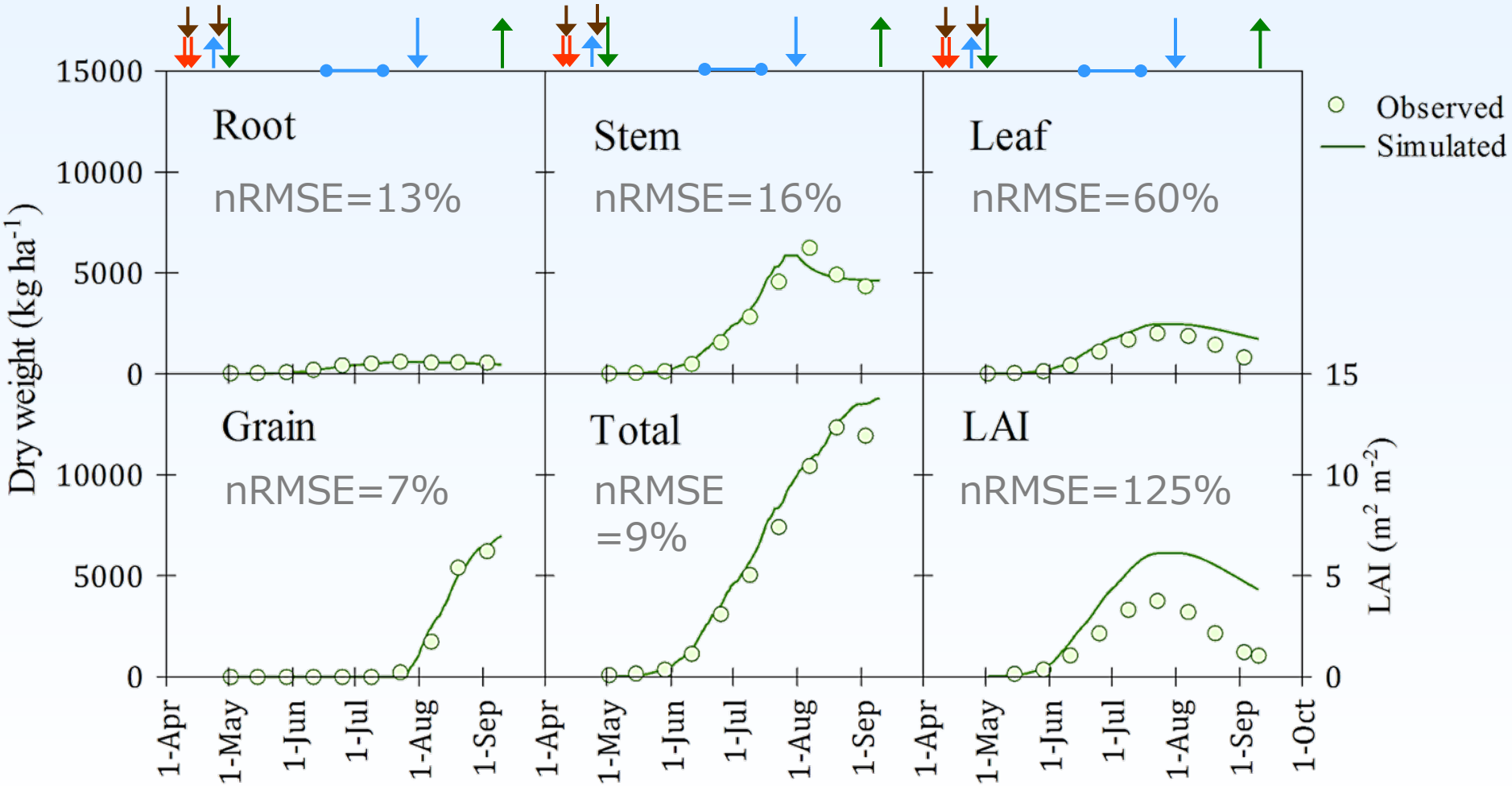
- Soil water content at 0-20 cm depth
- Dry weight of rice root, stem, leaf, and grain
- Leaf nitrogen content
- Leaf Area Index (=Leaf area/m^2)

Nitrogen balance during the cropping season

- **Input** N fertilizer, Manure, seedlings, N in rain*, Irrigation water*, dry N deposition*, N fixation
- **Output** Yield, straw, N_2O*, N_2*, NH_3*

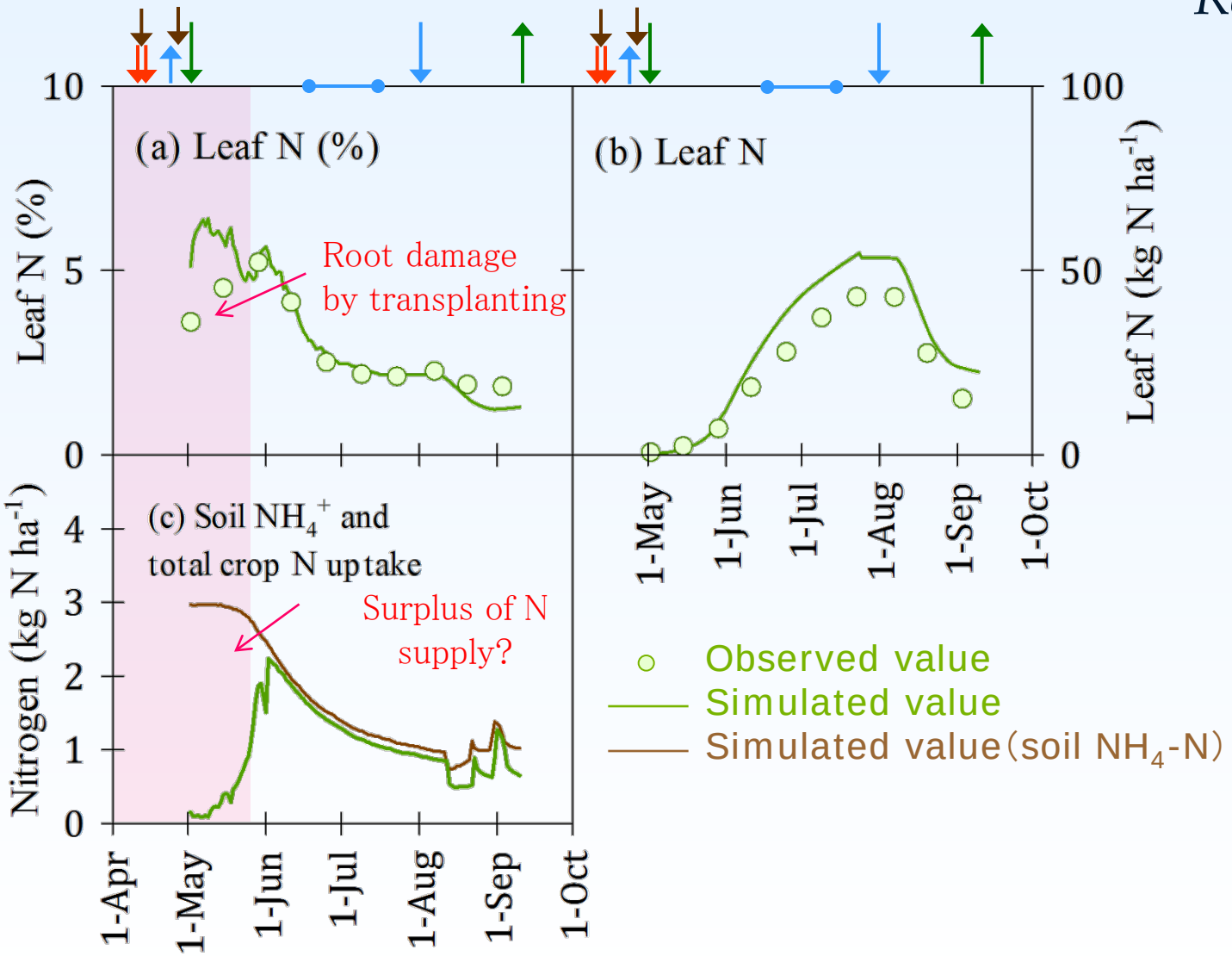


Temporal variability of solar radiation, daily mean air temperature, precipitation, and volumetric soil water content during the growing period in 2009



Temporal variability of observed and simulated aboveground biomass and Leaf Area Index (LAI)

Katayanagi *et al.* (2013)

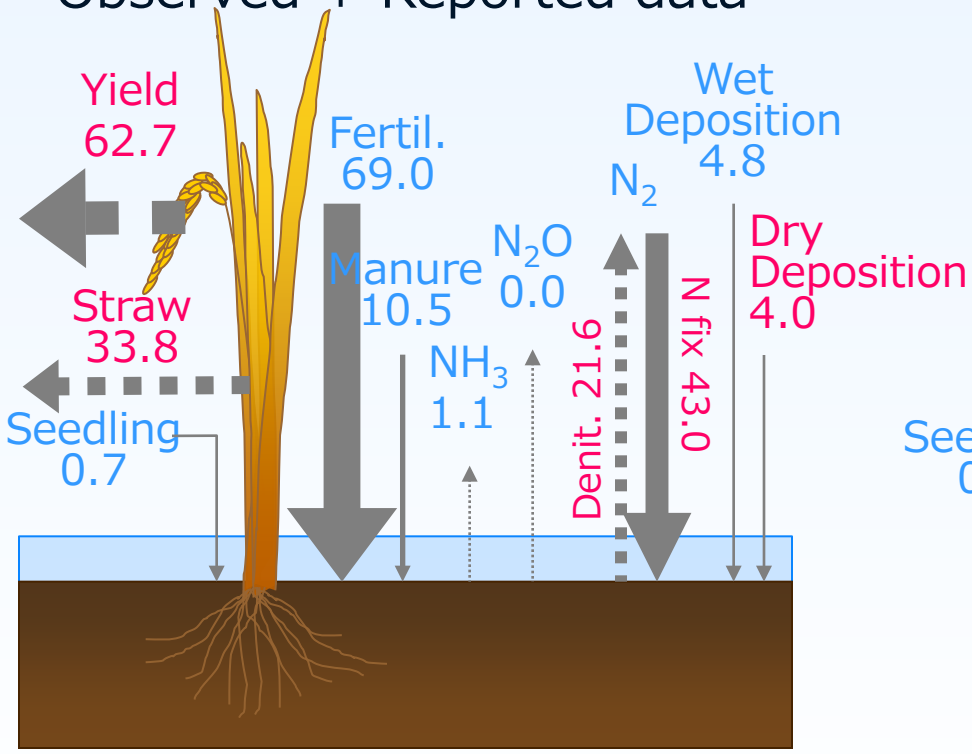


Temporal variability of leaf N content, amount of leaf N, soil NH4-N and total crop N uptake during the growing season in 2009

Katayanagi *et al.* (2013)

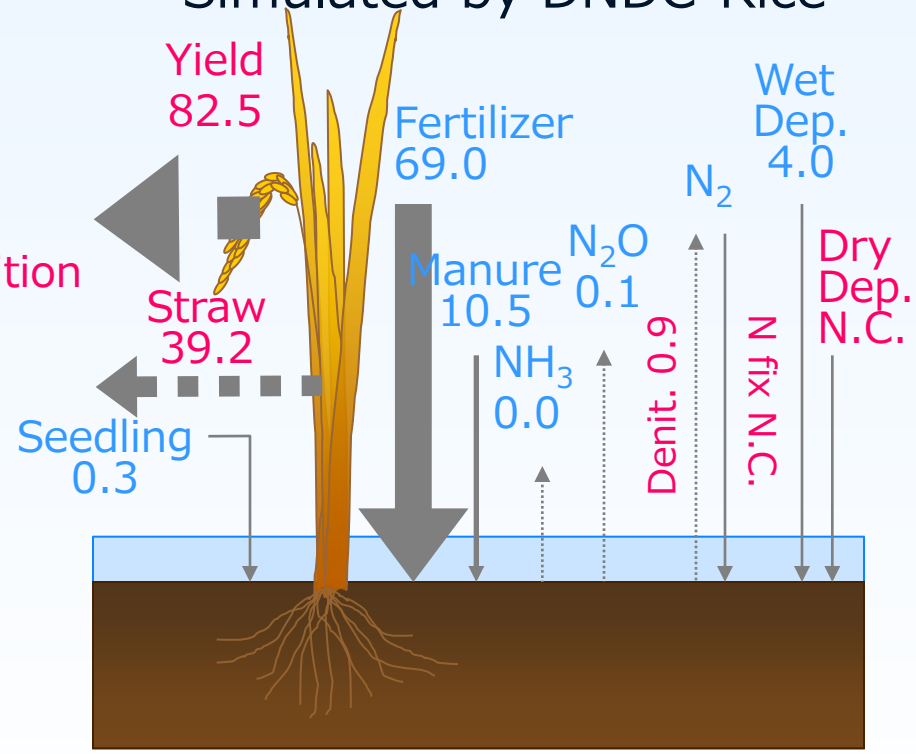
Nitrogen balance during the cropping season

Observed + Reported data



Input		Output		Balance
132.0	_	119.2	=	12.8

Simulated by DNDC-Rice



Input		Output		Balance
83.8	_	122.6	=	-38.8

Unit; kg N ha^{-1}; Denit. = denitrification; N.C.=Not calculated

Katayanagi *et al.* (2013)

Is DNDC-Rice available for estimation of N balance at a paddy field?

DNDC-Rice will be available after adding some modification:

- Rice N uptake
  - Content of available N in soil
  - N uptake by rice
- Dry N deposition
- N fixation
- Denitrification (N_2 emission)
- Soil water content

Katayanagi *et al.* (2013)

Field measurements for modification

N uptake by rice

N mineralization rate

Available N in soil

N release rate from slow release Fertilizer

NH3 emission

Dry and wet N deposition


Thank you for your attention !

Statistics

$$RMSE = \sqrt{\frac{(F_i - A_i)^2}{N}}$$

$$nRMSE = \frac{RMSE}{\bar{A}} \times 100$$

nRMSE: normalized root mean square error

F_i: the simulated value of item i

A_i: the observed value of item i

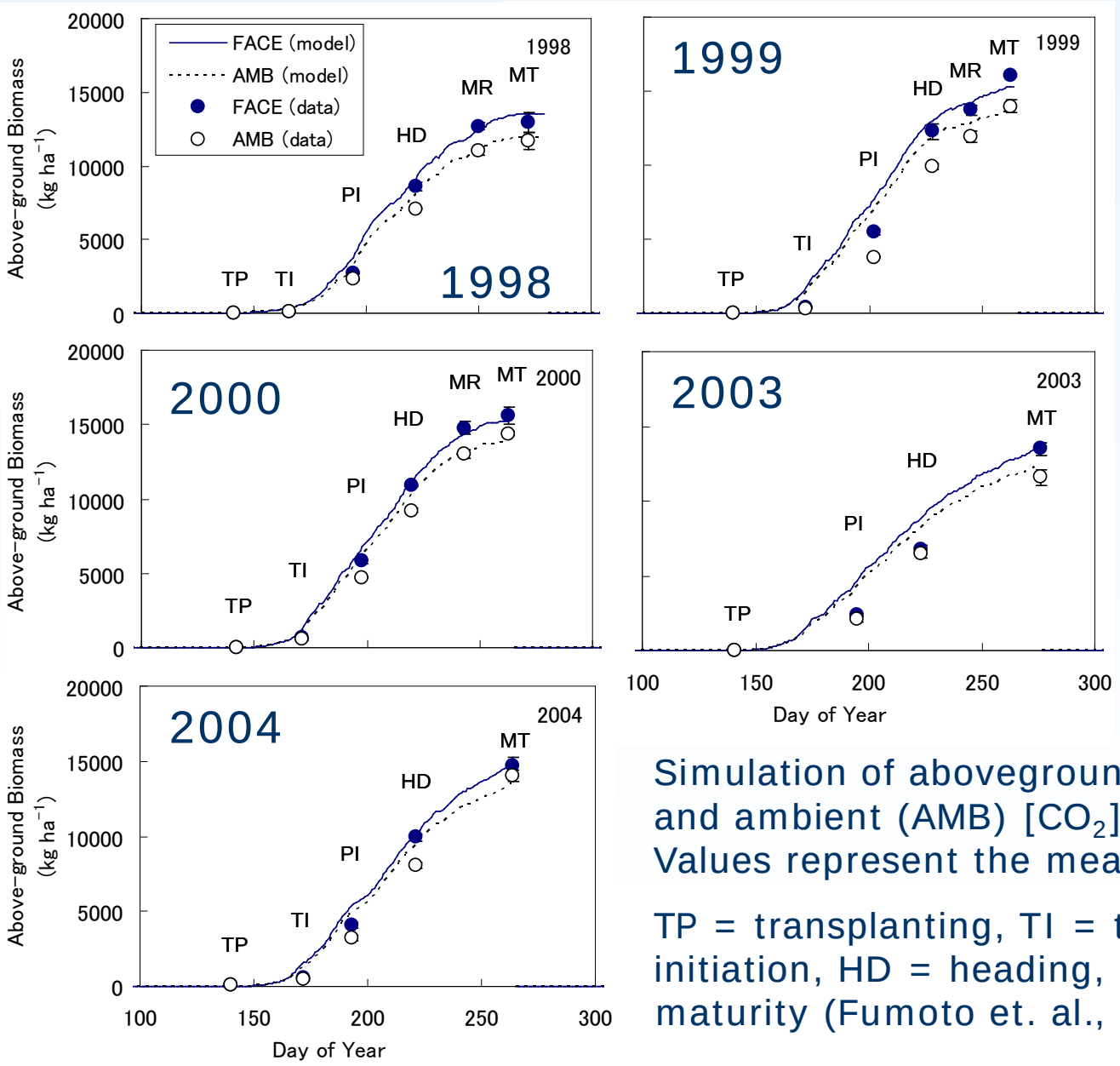
N: the number of samples

A: the mean of the observed values, A_i

Tsukuba FACE

http://www.niaes.affrc.go.jp/outline/face/english/index.html

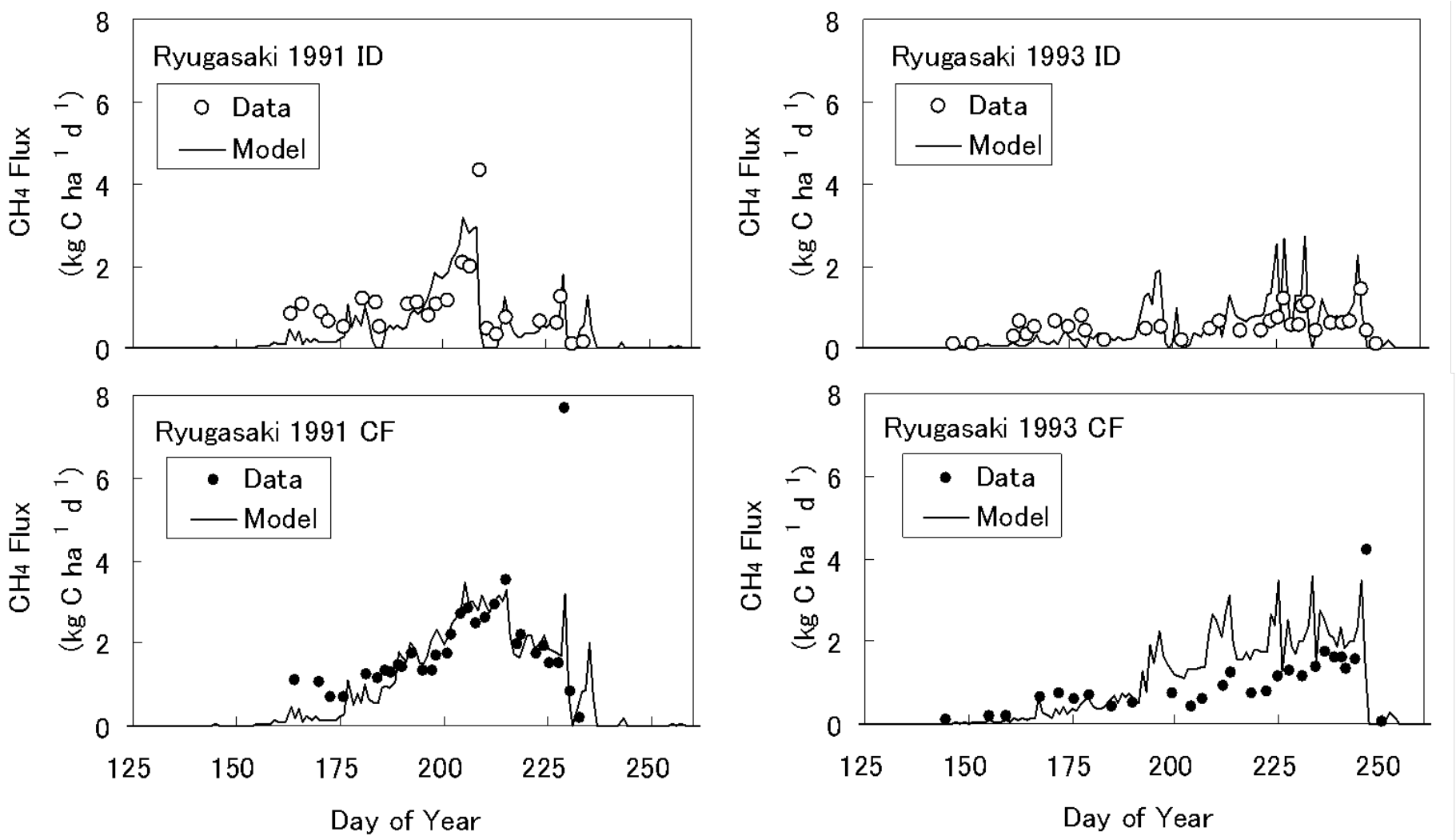
Validation on rice growth under different CO_2 concentration



Simulation of aboveground biomass under FACE and ambient (AMB) [CO_2] in Shizukuishi, Japan. Values represent the mean ± S.D. (n = 4).

TP = transplanting, TI = tillering, PI = panicle initiation, HD = heading, MR = mid-ripening, MT = maturity (Fumoto et. al., 2013).

Validation on methane emission and water managements



Simulation of CH_4 emission from a rice field with intermittent drainage (ID) and continuous flooding (CF) (Fumoto et al., 2010)