

Impact assessment of changes in the emission of SO₂ and BC on rice productivity in Asia

5 Nov. 2018

24th AIM-WS International WS

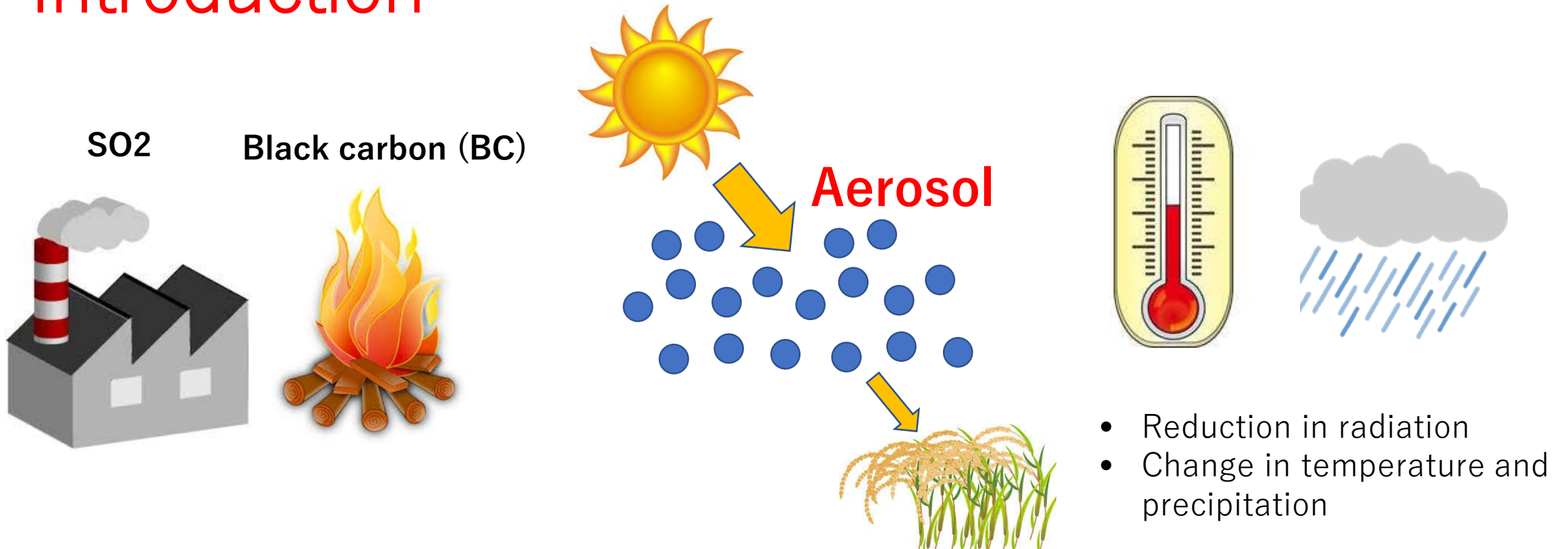
@NIES, Tsukuba, Ibaraki

Yuji Masutomi¹ and Toshihiko Takemura²

1: College of Agriculture, Ibaraki University

2: Research Institute for applied mechanics, Kyusyu University

Introduction

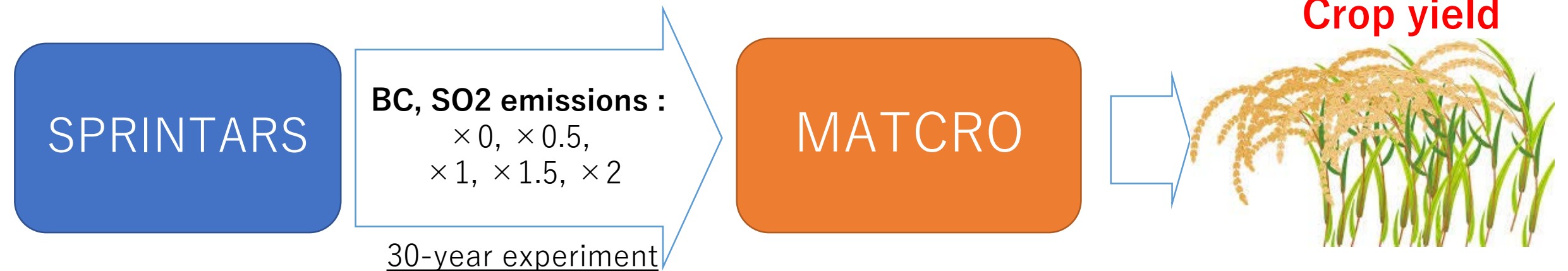


SO2 and BC emission **cause climate change** through atmospheric aerosols.

- **Question:** How large is the impacts of climate change on rice productivity due to the change in SO2 and BC emissions?

Method

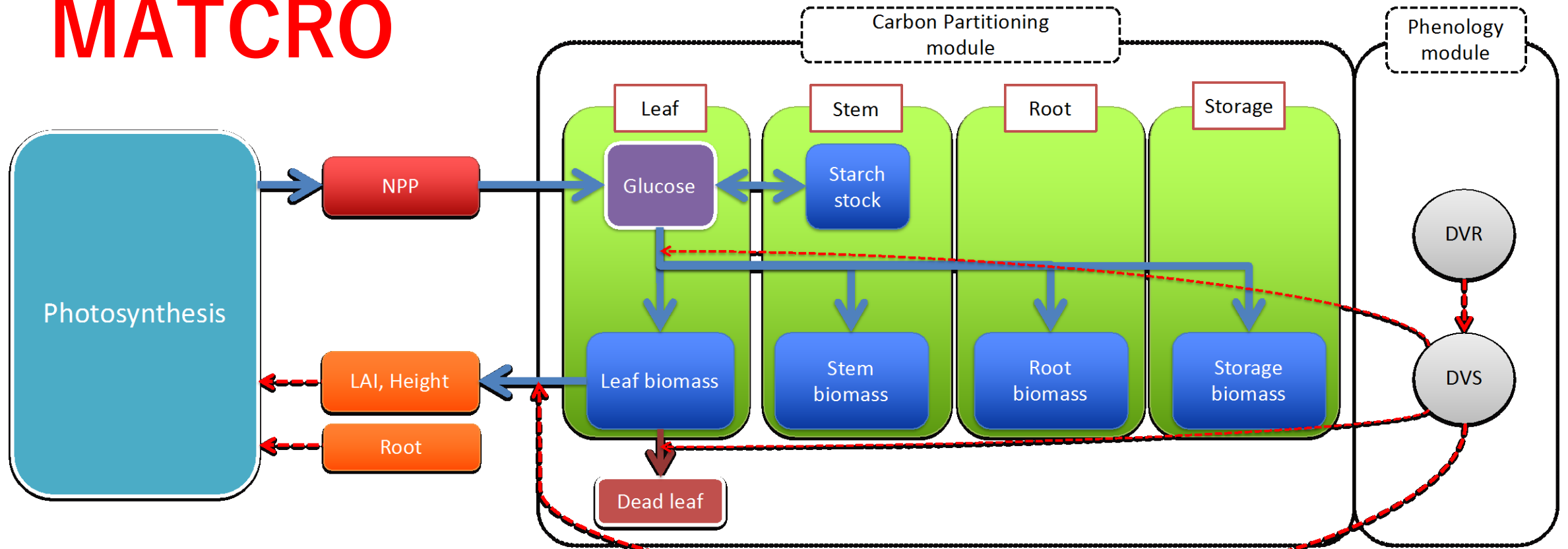
- Sensitivity analysis



- **Atmos. Model:** **SPRINTARS** (Takemura et al., 2000,2002,2005)
- **Crop Model:** **MATCRO** (Masutomi et al., 2016a,b)

We quantitatively assess the impacts of the changes in the emission of SO₂ and BC, by comparing rice yields simulated for each emission scenario.

MATCRO



Based on crop physiology

Geosci. Model Dev., 9, 4133–4154, 2016
www.geosci-model-dev.net/9/4133/2016/
 doi:10.5194/gmd-9-4133-2016
 © Author(s) 2016. CC Attribution 3.0 License.



A land surface model combined with a crop growth model for paddy rice (MATCRO-Rice v. 1) – Part 1: Model description

Yuji Masutomi¹, Keisuke Ono², Masayoshi Mano³, Atsushi Maruyama², and Akira Miyata²
¹College of Agriculture, Ibaraki University, 3-21-1, Chuo, Ami, Inashiki, Ibaraki 300-0393, Japan
²Institute for Agro-Environmental Sciences, NARO, 3-1-3, Kannondai, Tsukuba, Ibaraki 305-8604, Japan
³Graduate School of Horticulture, Chiba University, 648 Matsudo, Matsudo-shi, Chiba 271-8510, Japan

Correspondence to: Yuji Masutomi (yuji.masutomi@gmail.com)

Received: 5 February 2016 – Published in Geosci. Model Dev. Discuss.: 24 February 2016
 Revised: 15 July 2016 – Accepted: 22 July 2016 – Published: 21 November 2016

Geosci. Model Dev., 9, 4155–4167, 2016
www.geosci-model-dev.net/9/4155/2016/
 doi:10.5194/gmd-9-4155-2016
 © Author(s) 2016. CC Attribution 3.0 License.



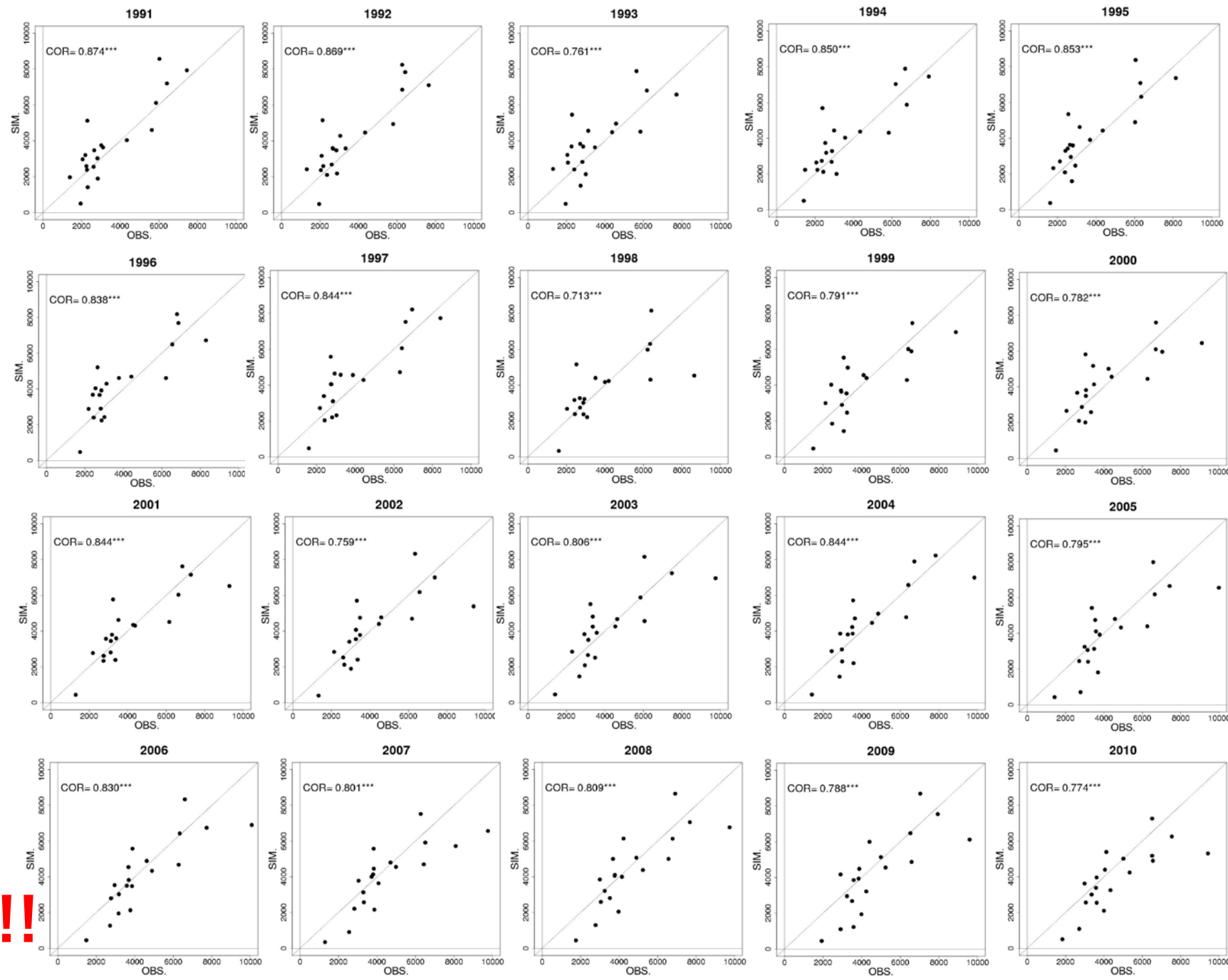
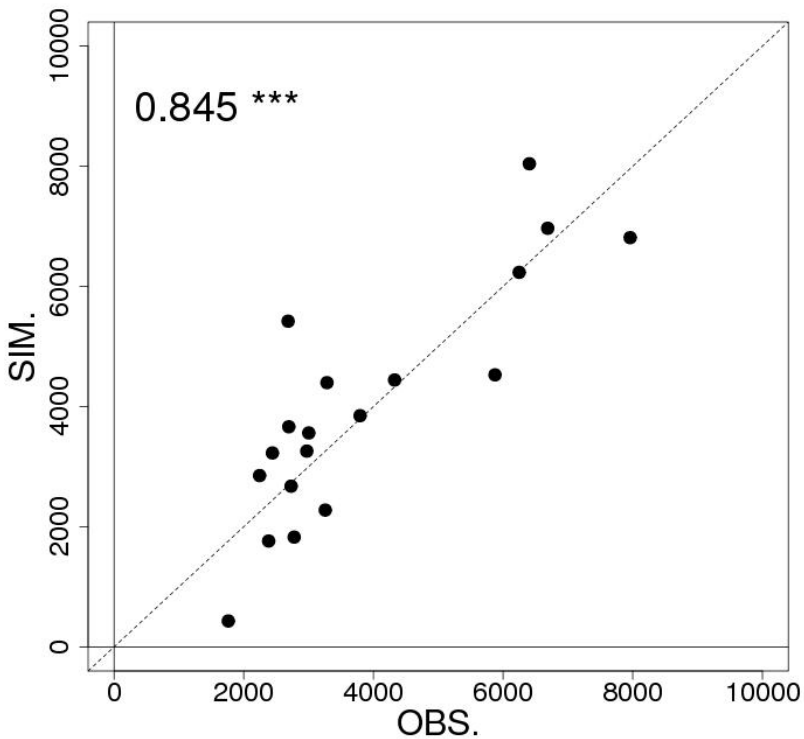
A land surface model combined with a crop growth model for paddy rice (MATCRO-Rice v. 1) – Part 2: Model validation

Yuji Masutomi¹, Keisuke Ono², Takahiro Takimoto³, Masayoshi Mano⁴, Atsushi Maruyama², and Akira Miyata²
¹College of Agriculture, Ibaraki University, 3-21-1, Chuo, Ami, Inashiki, Ibaraki 300-0393, Japan
²Institute for Agro-Environmental Sciences, NARO, 3-1-3, Kannondai, Tsukuba, Ibaraki 305-8604, Japan
³Institute for Global Change Adaptation Science, Ibaraki University, 3-21-1, Chuo, Ami, Inashiki, Ibaraki 300-0393, Japan
⁴Graduate School of Horticulture, Chiba University, 648 Matsudo, Matsudo-shi, Chiba 271-8510, Japan

Correspondence to: Yuji Masutomi (yuji.masutomi@gmail.com)

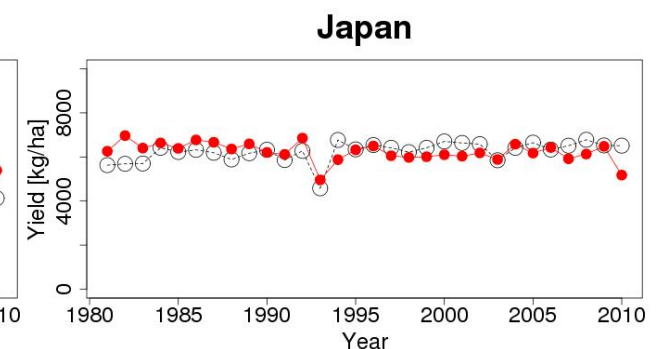
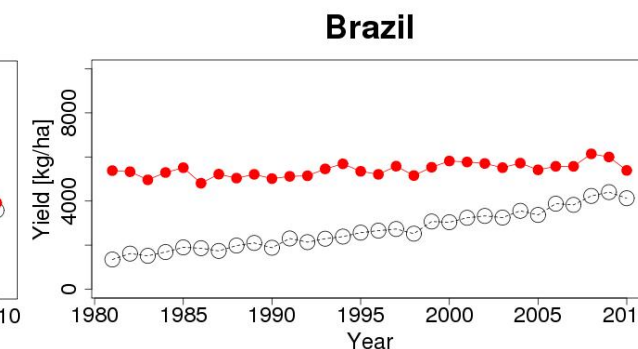
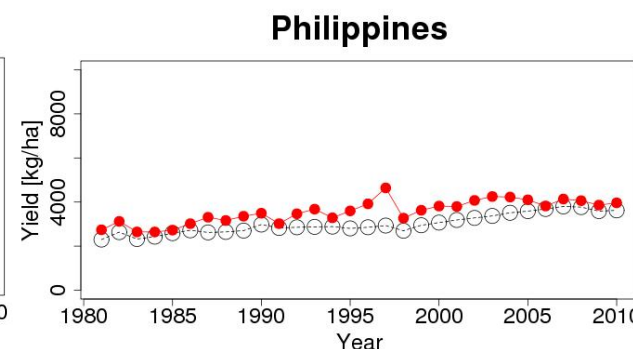
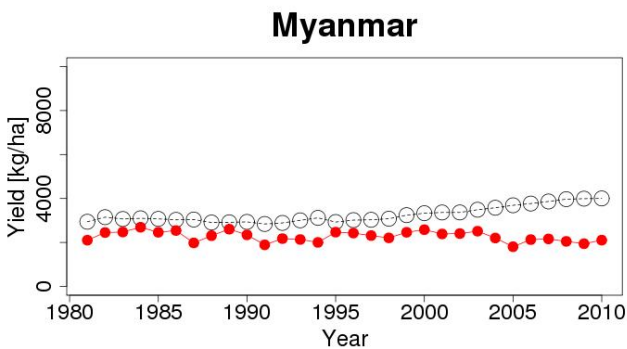
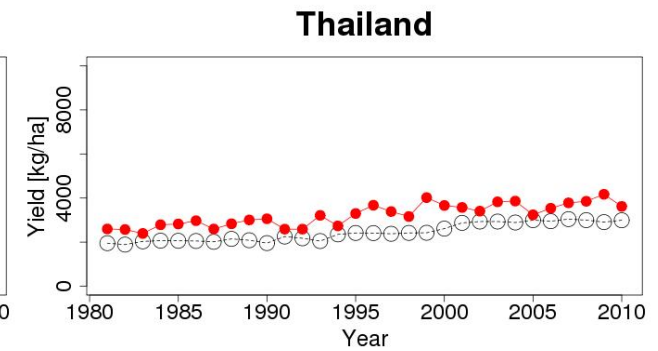
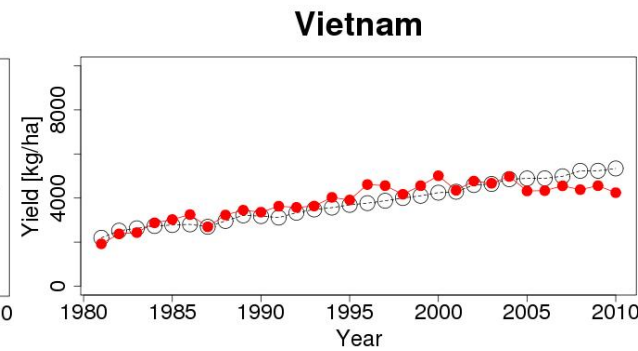
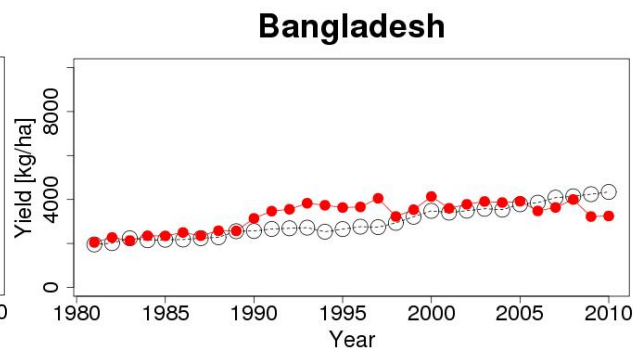
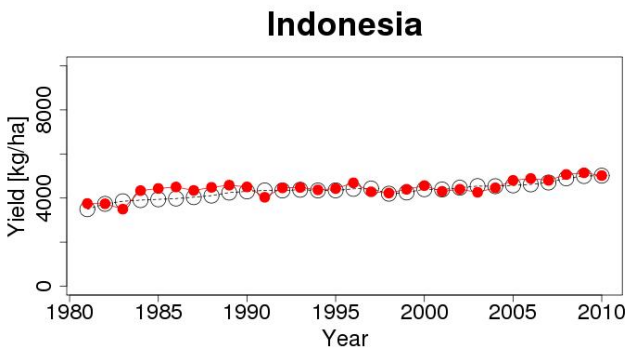
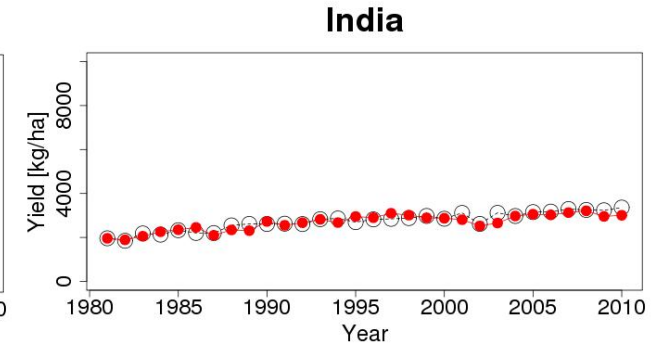
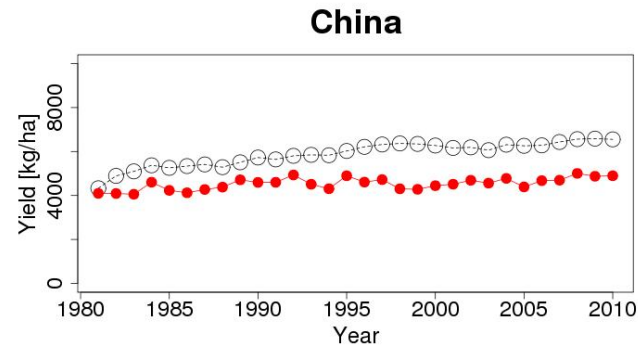
Received: 5 February 2016 – Published in Geosci. Model Dev. Discuss.: 19 February 2016
 Revised: 16 October 2016 – Accepted: 7 November 2016 – Published: 21 November 2016

Validation on yield simulation of MATCRO



Good performance!!

Validation on yield simulation of MATCRO

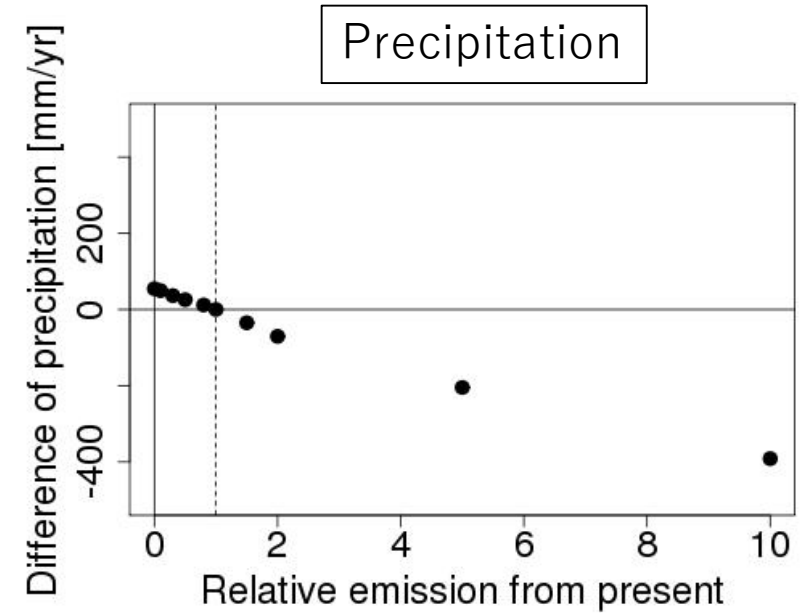
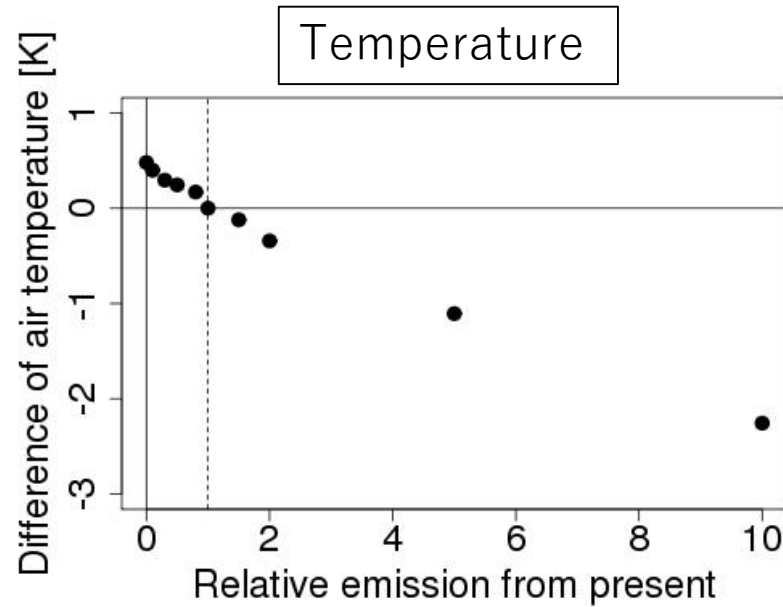
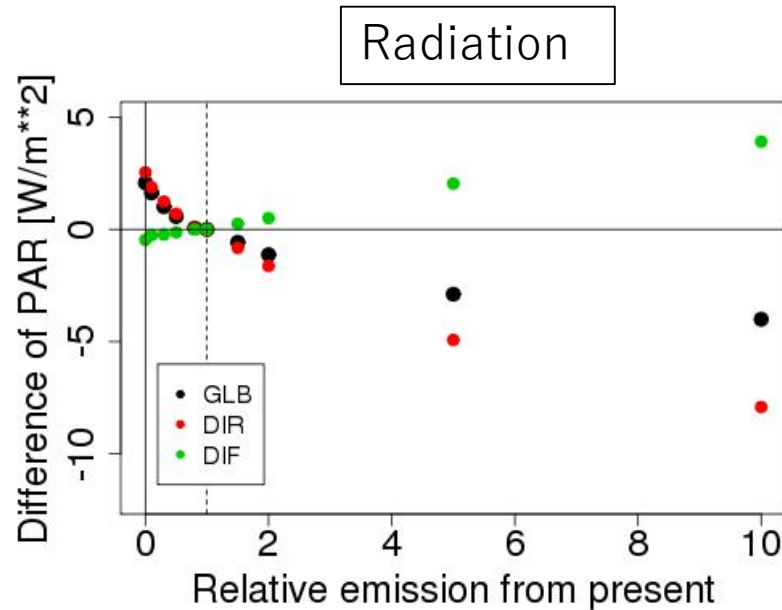


Good performance!!

Results

Climate change due to changes in SO2

- Global mean change in radiation, temperature, and precipitation



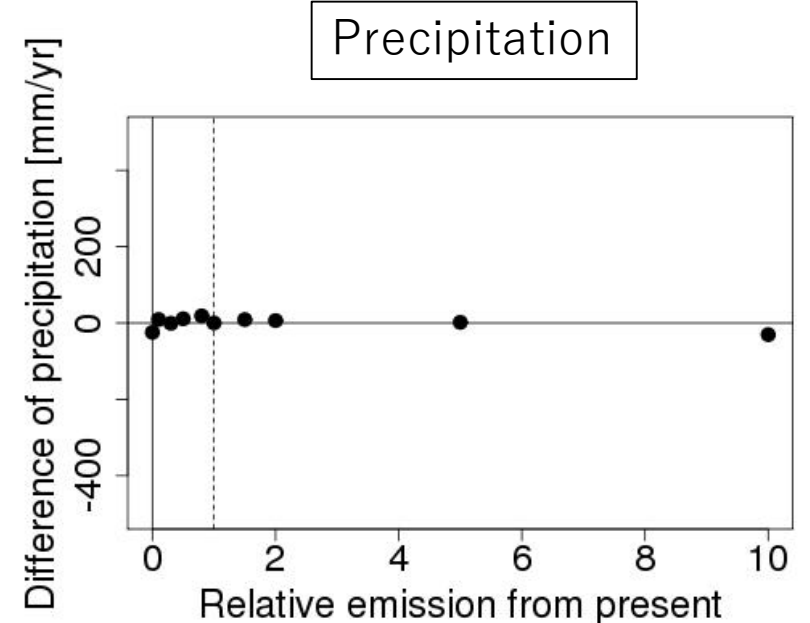
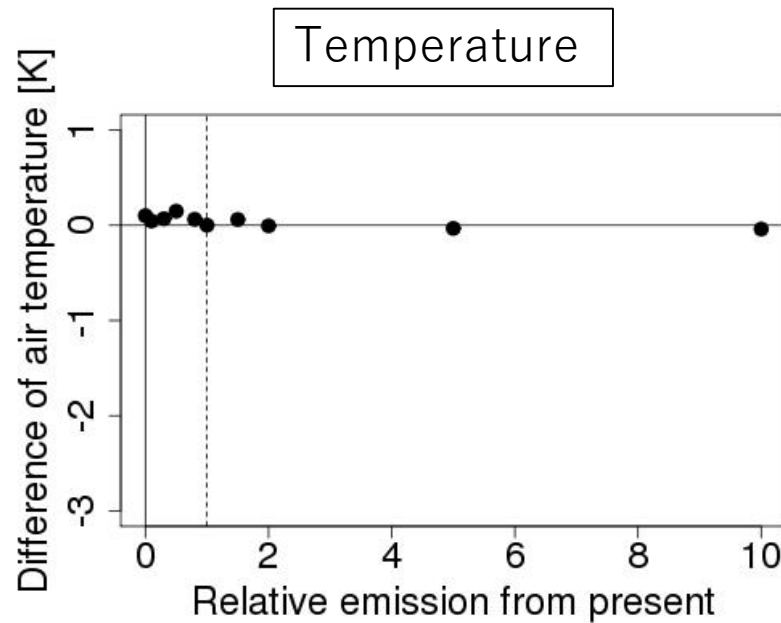
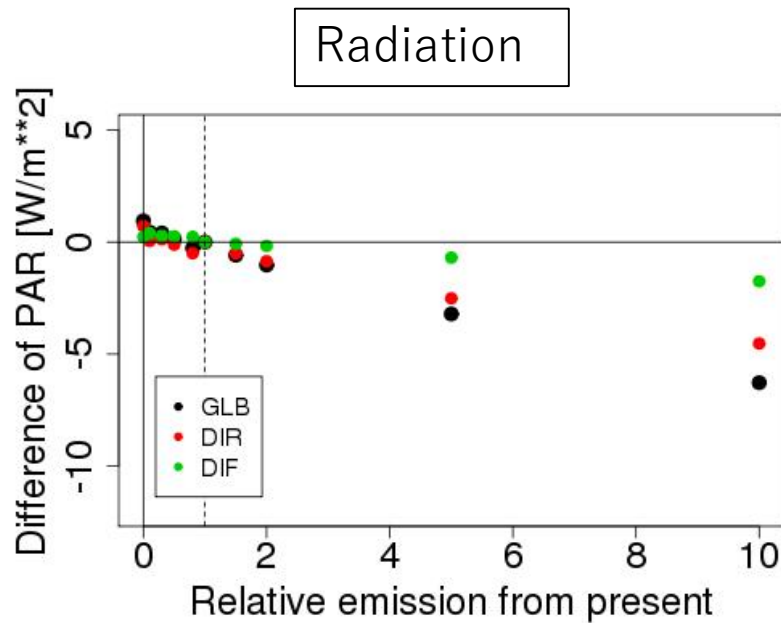
- $\text{SO}_2 \uparrow \Rightarrow \text{DIR} \downarrow$
-> **Negative(-)**
- $\text{SO}_2 \uparrow \Rightarrow \text{DIF} \uparrow$
-> **Positive(+)**

- $\text{SO}_2 \uparrow \Rightarrow \text{TMP} \downarrow$
-> **Positive(+)**
- $\text{SO}_2 \uparrow \Rightarrow \text{PRE} \downarrow$
-> **Negative(-)**

- $\text{SO}_2 \uparrow \Rightarrow \text{PRE} \downarrow$
-> **Negative(-)**

Climate change due to changes in BC

- Global mean change in radiation, temperature, and precipitation



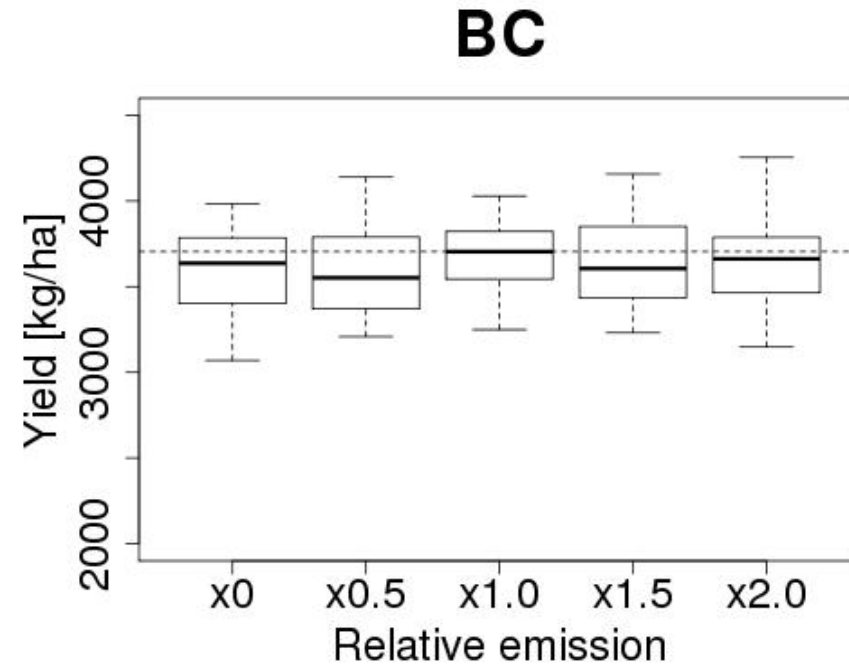
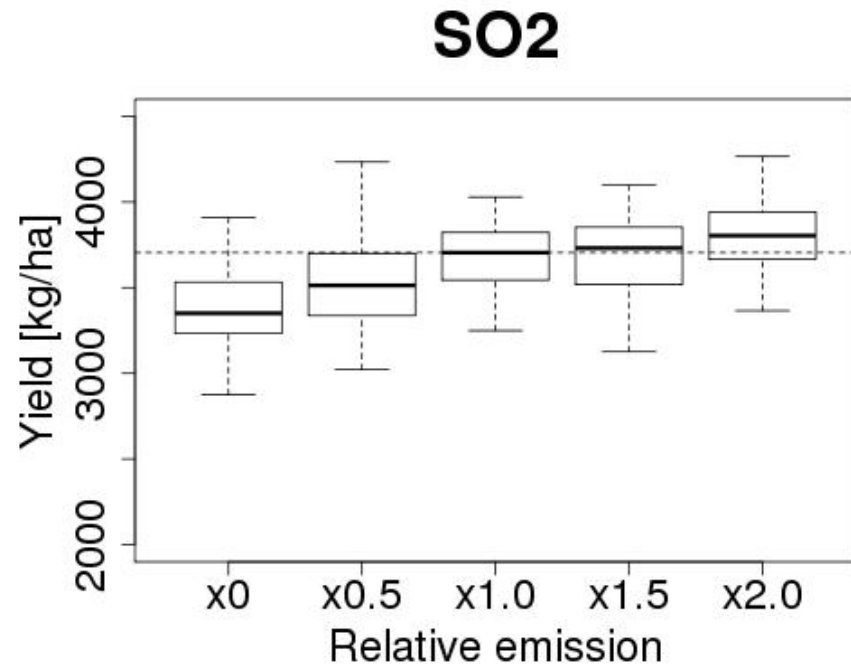
• BC \uparrow \Rightarrow DIR \downarrow
-> **Negative(-)**

• BC \uparrow \Rightarrow DIF \downarrow
-> **Negative(-)**

• BC \uparrow \Rightarrow TMP
-> **NO impact**

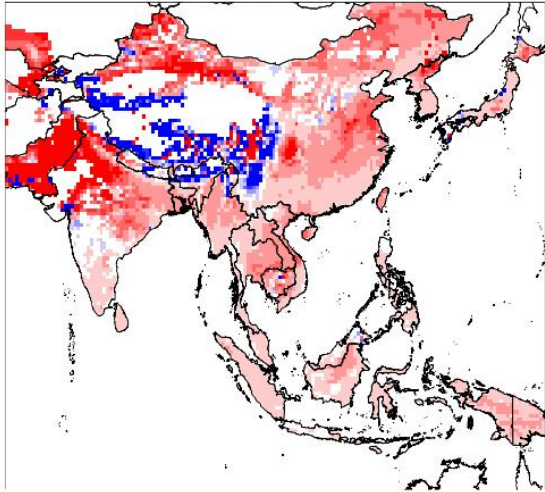
• BC \uparrow \Rightarrow PRE
-> **NO impact**

Global change in rice yields due to the changes in emission of SO₂ and BC

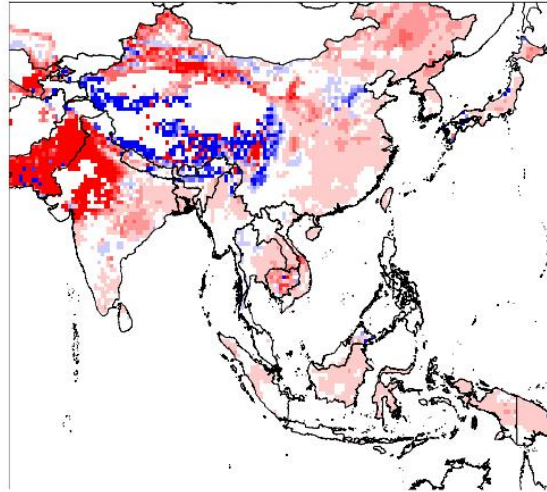


- ✓ The reduction in the emission of SO₂ decreases global rice yields
- ✓ The changes in the emission of BC have no large impacts

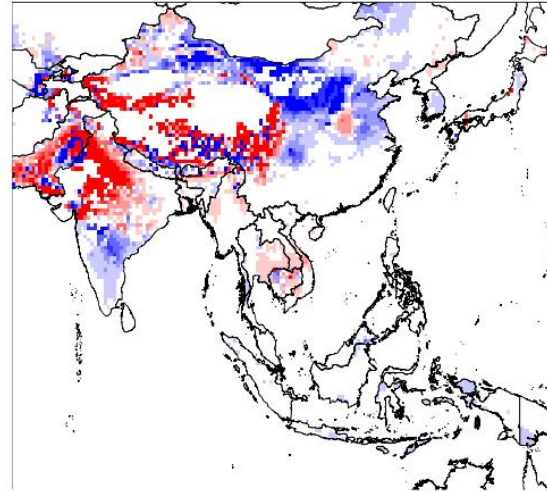
SO2 x0



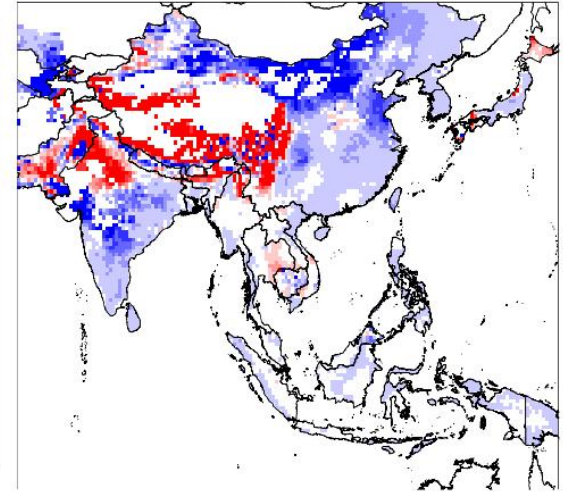
SO2 x0.5



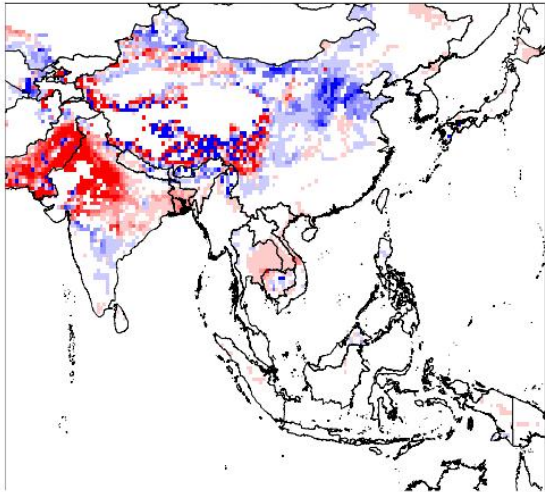
SO2 x1.5



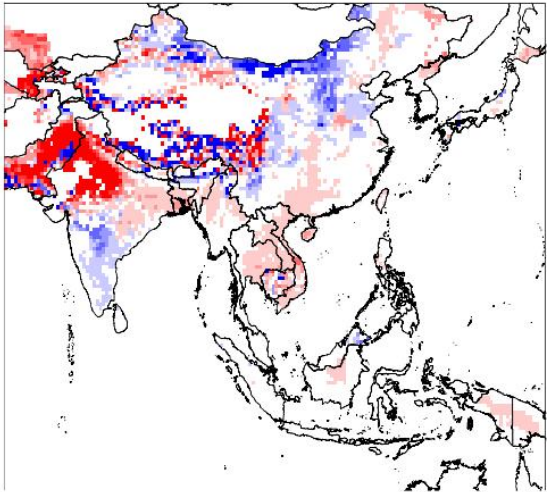
SO2 x2



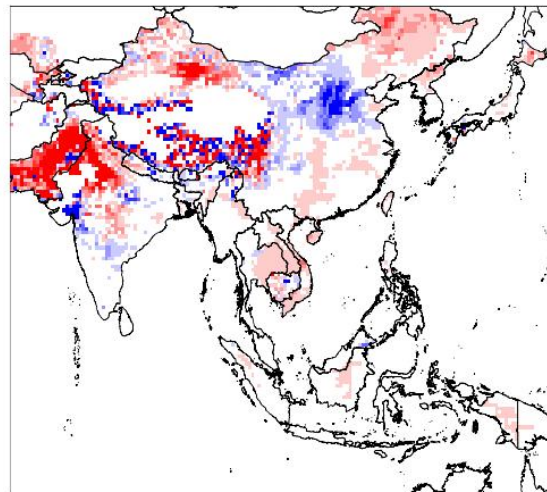
BC x0



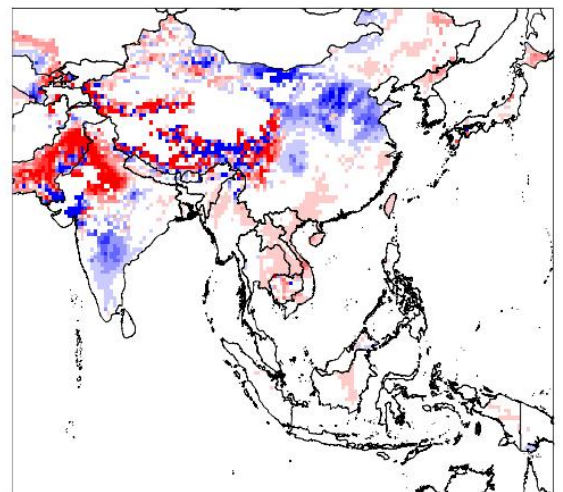
BC x0.5



BC x1.5



BC x2



%

33

27

21

15

9

3

-3

-9

-15

-21

-27

-33

- ✓ There are **large spatial difference** in the impacts
- ✓ Reduction in SO2 has negative impacts in many regions

Summary

✓ Global

- ✓ Reduction in SO₂ decreases rice yields.
- ✓ Change in BC has no impact on rice yields.

✓ Regional

- ✓ There are **large spatial difference** in the impacts on rice yields.
- ✓ Reduction in SO₂ has negative impacts in many regions.

✓ Message

- ✓ We should consider regional impacts on crop yields when we reduce the emission of SO₂ and BC.