

**Are land-use change emissions in Southeast Asia decreasing or increasing?**

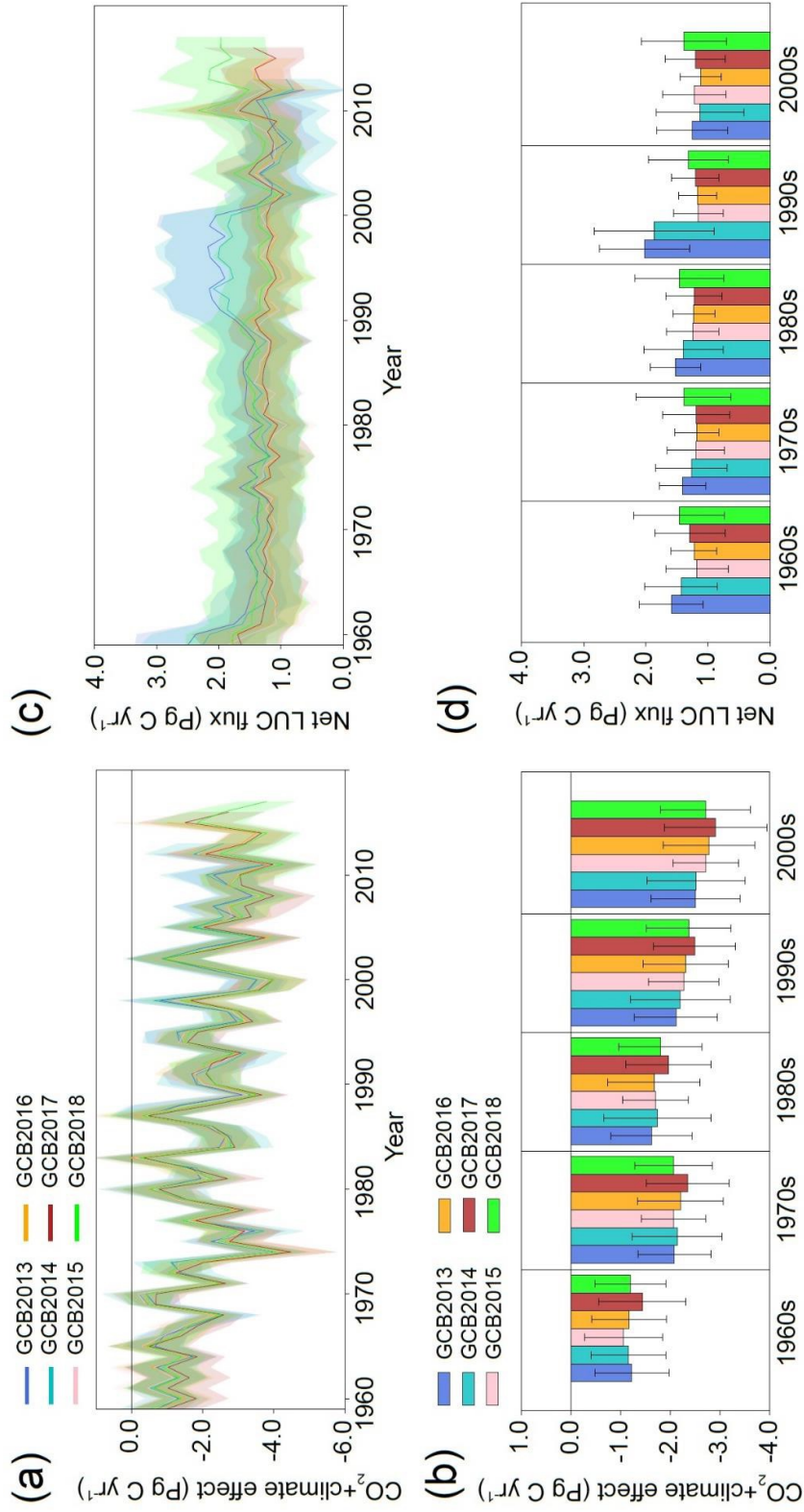
Masayuki Kondo<sup>1,2</sup>, Stephen Sitch<sup>3</sup>, Philippe Ciais<sup>4</sup>, Frédéric Achard<sup>5</sup>, Etsushi Kato<sup>6</sup>, Julia Pongratz<sup>7,8</sup>, Richard A. Houghton<sup>9</sup>, Josep G. Canadell<sup>10</sup>, Prabir K. Patra<sup>11</sup>, Pierre Friedlingstein<sup>12</sup>, Wei Li<sup>13</sup>, Peter Anthoni<sup>14</sup>, Almut Arneth<sup>14</sup>, Frédéric Chevallier<sup>4</sup>, Raphael Ganzenmüller<sup>7</sup>, Anna Harper<sup>12</sup>, Atul K. Jain<sup>15</sup>, Charles Koven<sup>16</sup>, Sebastian Lienert<sup>17</sup>, Danica Lombardozzi<sup>18</sup>, Takashi Maki<sup>19</sup>, Julia E. M. S. Nabel<sup>8</sup>, Takashi Nakamura<sup>20</sup>, Yosuke Niwa<sup>2</sup>, Philippe Peylin<sup>4</sup>, Benjamin Poulter<sup>21</sup>, Thomas A. M. Pugh<sup>22,23,24</sup>, Christian Rödenbeck<sup>25</sup>, Tazu Saeki<sup>2</sup>, Benjamin Stocker<sup>26</sup>, Nicolas Viovy<sup>4</sup>, Andy Wiltshire<sup>27</sup>, Sönke Zaehle<sup>25</sup>

<sup>1</sup>Institute for Space-Earth Environmental Research, Nagoya University, Nagoya, Aichi 464-8601 Japan, <sup>2</sup>Center for Global Environmental Research, National Institute for Environmental Studies, Tsukuba 305-8506, Japan, <sup>3</sup>College of Life and Environmental Sciences, University of Exeter, Exeter EX4 4QF, UK, <sup>4</sup>Laboratoire des Sciences du Climat et de l'Environnement, Institut Pierre Simon Laplace, 91191 Gif-sur-Yvette, France, <sup>5</sup>Directorate D – Sustainable Resources, Joint Research Centre of the European Commission, 21027 Ispra (VA), Italy, <sup>6</sup>Institute of Applied Energy, Tokyo, 105-0003, Japan, <sup>7</sup>Department of Geography, Ludwig-Maximilians-Universität München, 80333 Munich, Germany, <sup>8</sup>Land in the Earth System, Max Planck Institute for Meteorology, 20146 Hamburg, Germany, <sup>9</sup>Woods Hole Research Center, Falmouth, MA 02540-1644, USA, <sup>10</sup>Global Carbon Project, Commonwealth Scientific and Industrial Research Organisation–Oceans and Atmosphere, Canberra, ACT 2601, Australia, <sup>11</sup>Department of Environmental Geochemical Cycle Research, Japan Agency for Marine–Earth Science and Technology, Yokohama 236-0001, Japan, <sup>12</sup>College of Engineering, Mathematics and Physical Sciences, University of Exeter, Exeter EX4 4QF, UK, <sup>13</sup>Ministry of Education Key Laboratory for Earth System Modeling, Department of Earth System Science, Tsinghua University, Beijing, China, <sup>14</sup>Institute of Meteorology and Climate Research/Atmospheric Environmental Research, Karlsruhe Institute of Technology, 82467 Garmisch–Partenkirchen, Germany, <sup>15</sup>Department of Atmospheric Sciences, University of Illinois at Urbana–Champaign, Urbana, IL 61801, USA, <sup>16</sup>Earth Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA, <sup>17</sup>Climate and Environmental Physics, Physics Institute and Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland, <sup>18</sup>Climate and Global Dynamics, National Center for Atmospheric Research, Boulder, CO 80305, USA, <sup>19</sup>Meteorological Research Institute, Tsukuba 305-0052, Japan, <sup>20</sup>Japan Meteorological Agency, Tokyo 105-8431, Japan, <sup>21</sup>National Aeronautics and Space Administration Goddard Space Flight Center, Biospheric Science Laboratory, Greenbelt, MD 20771, USA, <sup>22</sup>Department of Physical Geography and Ecosystem Science, Lund University, 22362, Lund, Sweden, <sup>23</sup>Department of Geography, Earth and Environmental Science, University of Birmingham, Birmingham, B15 2TT, UK, <sup>24</sup>Birmingham Institute of Forest Research, University of Birmingham, Birmingham, B15 2TT, UK, <sup>25</sup>Max Planck Institute for Biogeochemistry, 07745 Jena, Germany, <sup>26</sup>Department of Environmental Systems Science, ETH Zürich, Universitätstrasse 2, 8092 Zürich, Switzerland, <sup>27</sup>Met Office Hadley Centre, Fitzroy Road, Exeter EX1 3PB, UK

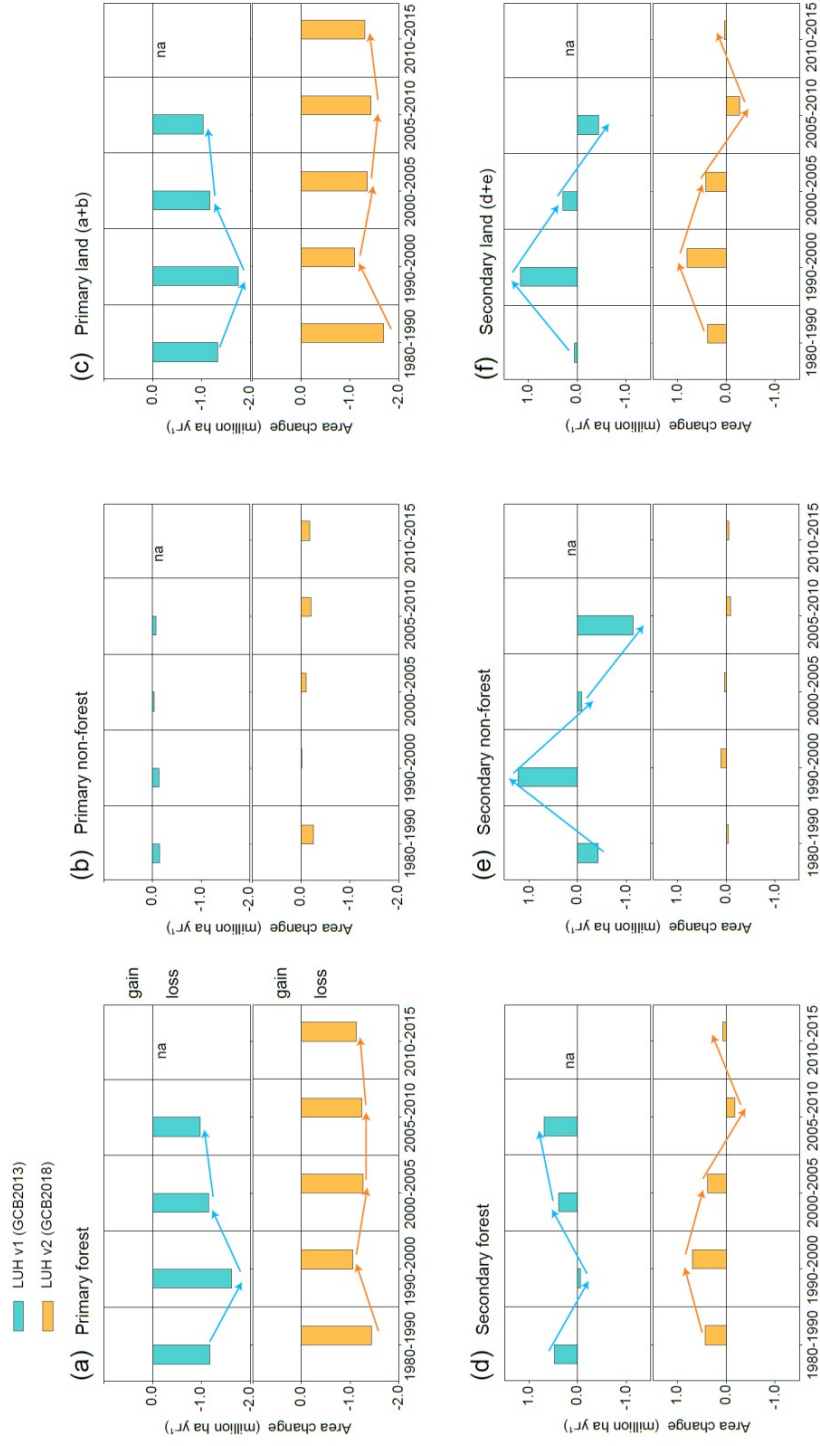
**Contents of this file**

Figures S1 to S4

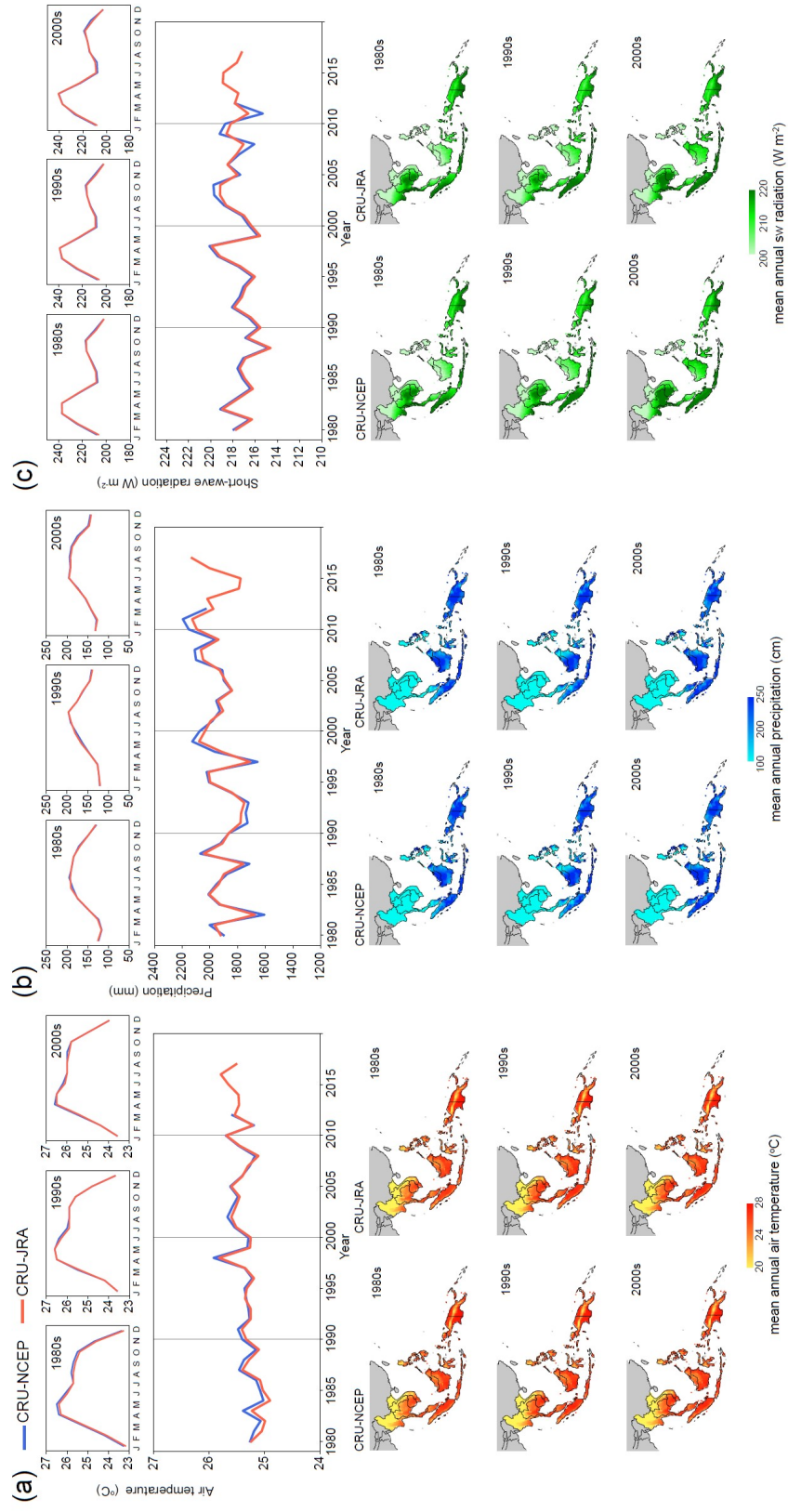
Table S1



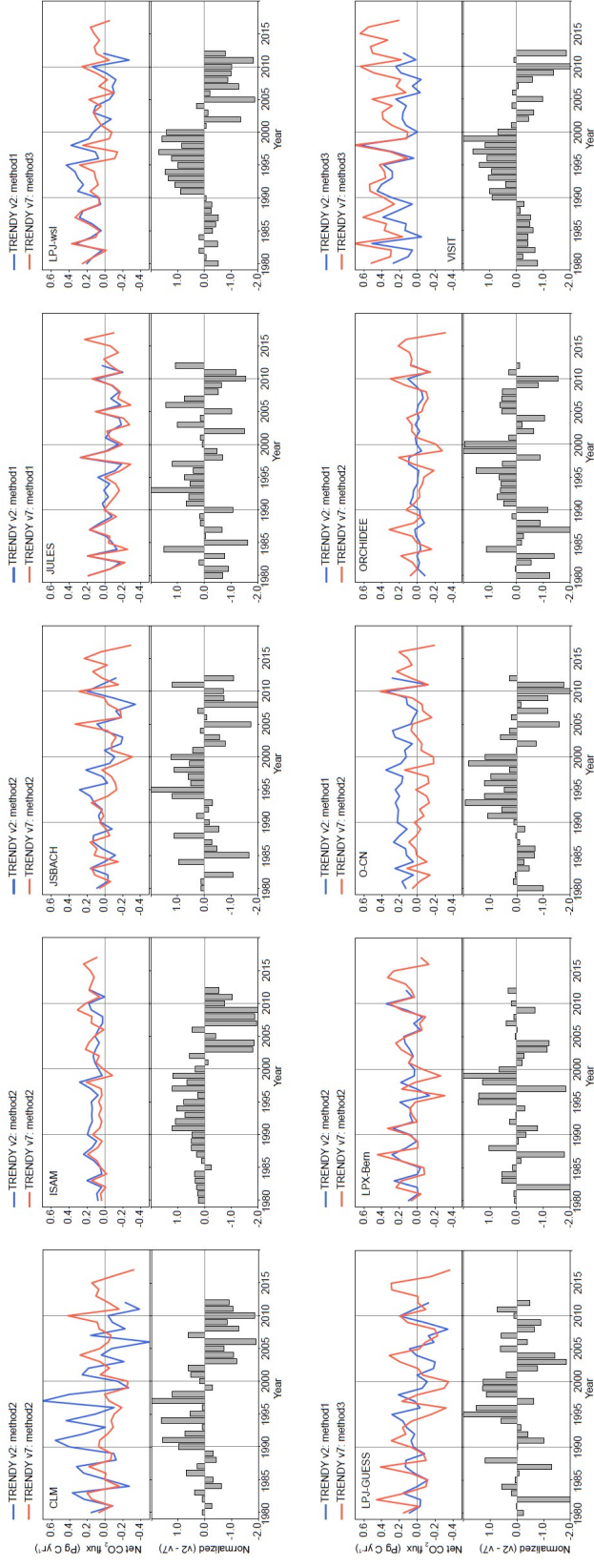
**Figure S1. Interannual variability of global land CO<sub>2</sub> fluxes reported by the GCB papers.** (a) Interannual and (b) decadal variability in the CO<sub>2</sub>+climate effect on the net land CO<sub>2</sub> flux, and (c), (d) those of the net LUC flux from Global Carbon Budget (GCB) 2013–2018.



**Figure S2. Decadal forest and non-forest area changes in Southeast Asia.** Changes in forest and non-forest area estimates for the period 1980–2015 by LUH v1 and v2. Results are shown for (a) primary forest, (b) primary non-forest, (c) primary land (a sum of primary forest and primary non-forest), (d) secondary forest, (e) secondary non-forest, and (f) secondary land (a sum of secondary forest and secondary non-forest).



**Figure S3. Temporal pattern of climate variables from CRU-NCEP and CRU-JRA.** Decadal mean seasonality, interannual variability, and decadal mean spatial variability of (a) air temperature, (b) precipitation, and (c) short-wave radiation from CRU-NCEP and CRU-JRA.



**Figure S4. Temporal variability in the net CO<sub>2</sub> flux by individual TRENDY v2 and v7 models. Interannual variability in the net CO<sub>2</sub> flux estimated by the 10 DGVMs (CLM, ISAM, JSBACH, JULES, LPJ-GUESS, LPX-Bern, O-CN, ORCHIDEE, and VISIT) are shown along with a normalized difference between TRENDY v2 and v7.**

Table S1. Forcing data used for TRENDY v2 and v7 simulations.

Forcing	TRENDY v2	TRENDY v7
Atmospheric CO <sub>2</sub>	Global mean annual CO <sub>2</sub> mixing ratio based on ice core measurements and stationary observations from NOAA	Global mean annual CO <sub>2</sub> mixing ratio based on ice core measurements and stationary observations from NOAA
Climate	Gridded daily and monthly data from CRU-NCEP	Gridded daily and monthly data from CRU-JRA55
Land-use and land-cover change	Gridded annual land-use and land-cover data from HYDE v3.1 or LUH v1	Gridded annual land-use and land-cover data from HYDE v3.2 or LUH v2