Supplementary information for

Cropland expansion promotes global warming by diminishing biogenic secondary organic aerosol radiative effects

Jialei Zhu[†], Joyce E. Penner[‡], Chaopeng Hong[§], Hao Liu[†], Xi Zhao[†], Junjun Deng[†], Cong-Qiang Liu[†], Qiang Zhang[¶*], Pingqing Fu[†*]

[†] Institute of Surface-Earth System Science, School of Earth System Science, Tianjin University, Tianjin 30072, China

[‡] Department of Climate and Space Sciences and Engineering, University of Michigan, Ann Arbor, MI 48109, USA

[§] Institute of Environment and Ecology, Tsinghua Shenzhen International Graduate School, Tsinghua University, Shenzhen, China

[¶] Department of Earth System Science, Tsinghua University, Beijing, China

Corresponding author Email: fupingqing@tju.edu.cn, qiangzhang@tsinghua.edu.cn

The PDF file includes:

Figs. S1 to S13

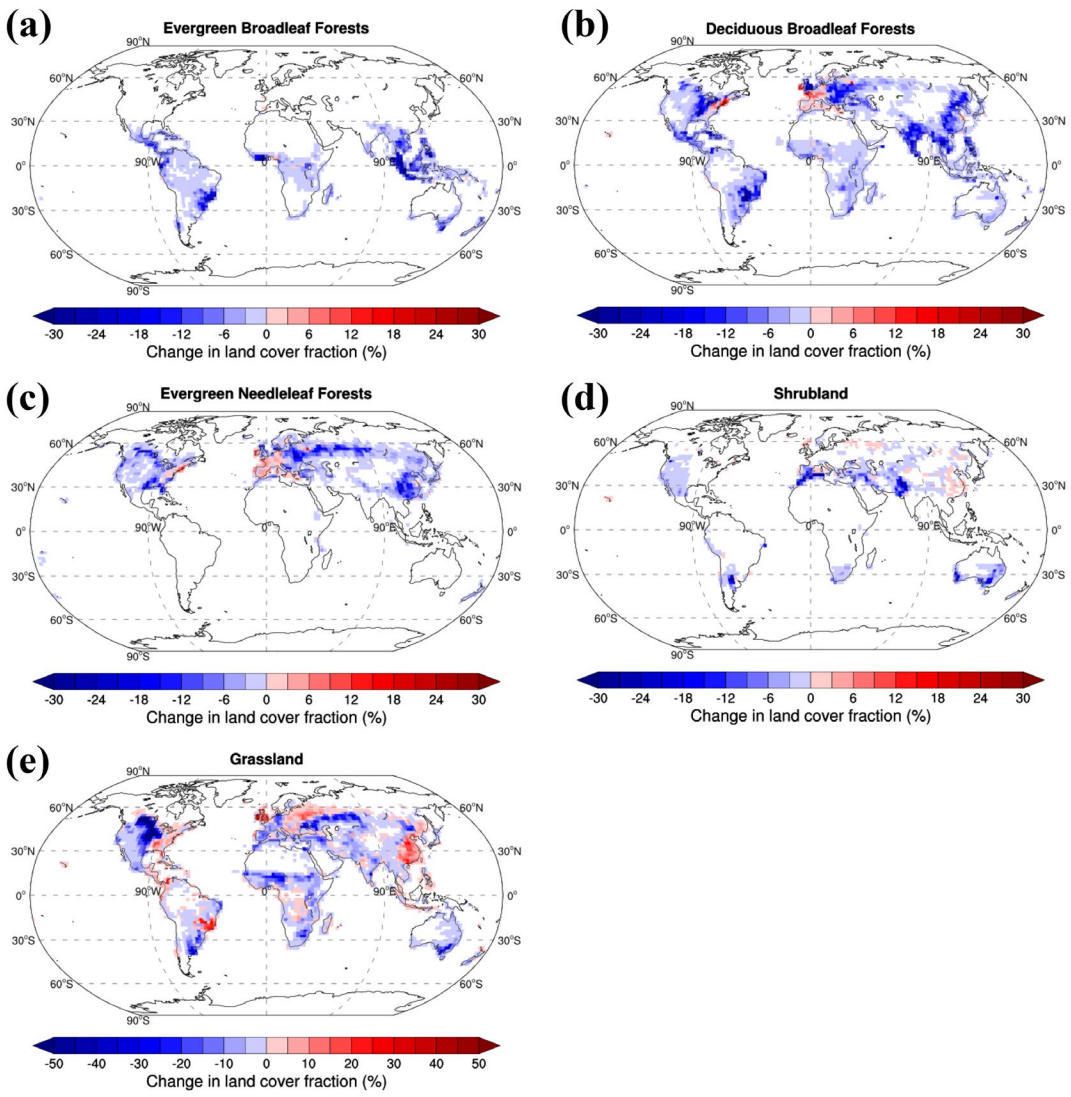

Figure S1. Changes in the percentage of vegetation cover of (a) evergreen broadleaf forests, (b) deciduous broadleaf forests, (c) evergreen needleleaf forests, (d) shrubs, and (e) grasslands from pre-industrial times to the 21st century

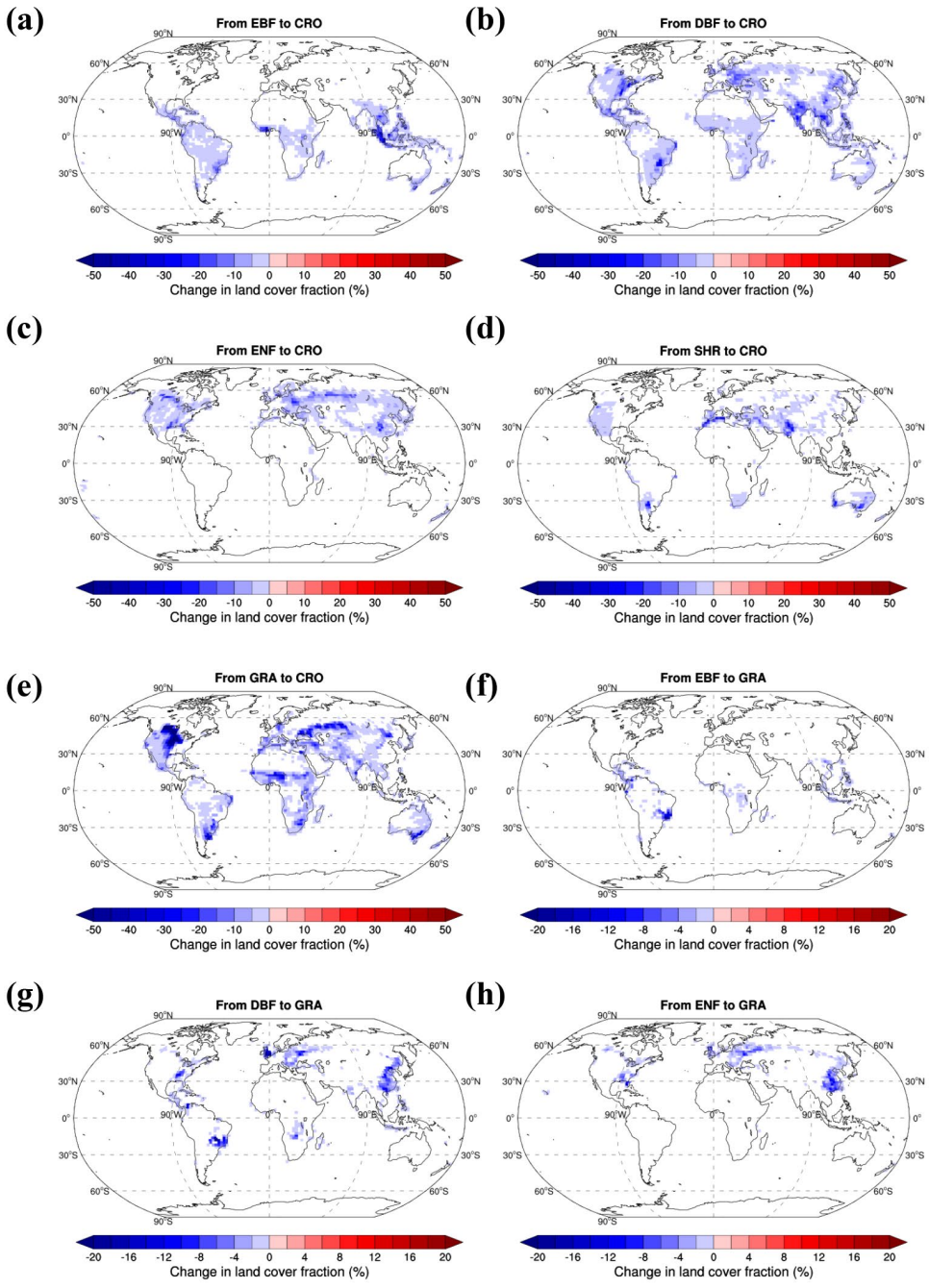

Figure S2. Changes in the percentage of cover of (a) evergreen broadleaf forests, (b) deciduous broadleaf forests, (c) evergreen needleleaf forests, (d) shrubs, and (e) grasslands to cropland and (f) evergreen broadleaf forests, (g) deciduous broadleaf forests, (h) evergreen needleleaf forests to grassland from pre-industrial times to the 21st century

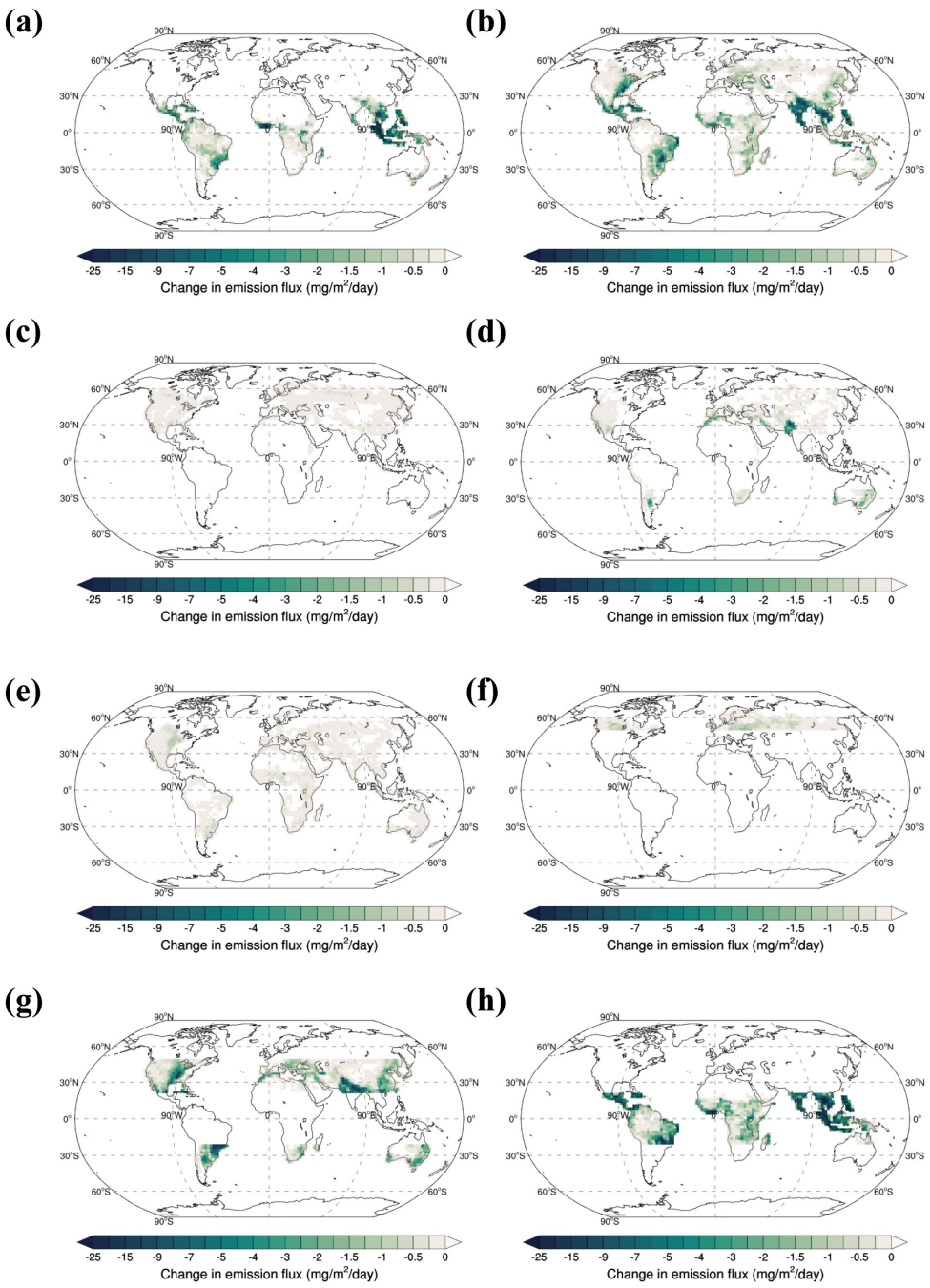

Figure S3. Changes in isoprene emission flux due to the vegetation cover change from (a) evergreen broadleaf forests, (b) deciduous broadleaf forests, (c) evergreen needleleaf forests, (d) shrubs, and (e) grasslands to cropland as well as due to the vegetation cover change in (f) high latitudes, (g) middle latitudes and (h) low latitudes.

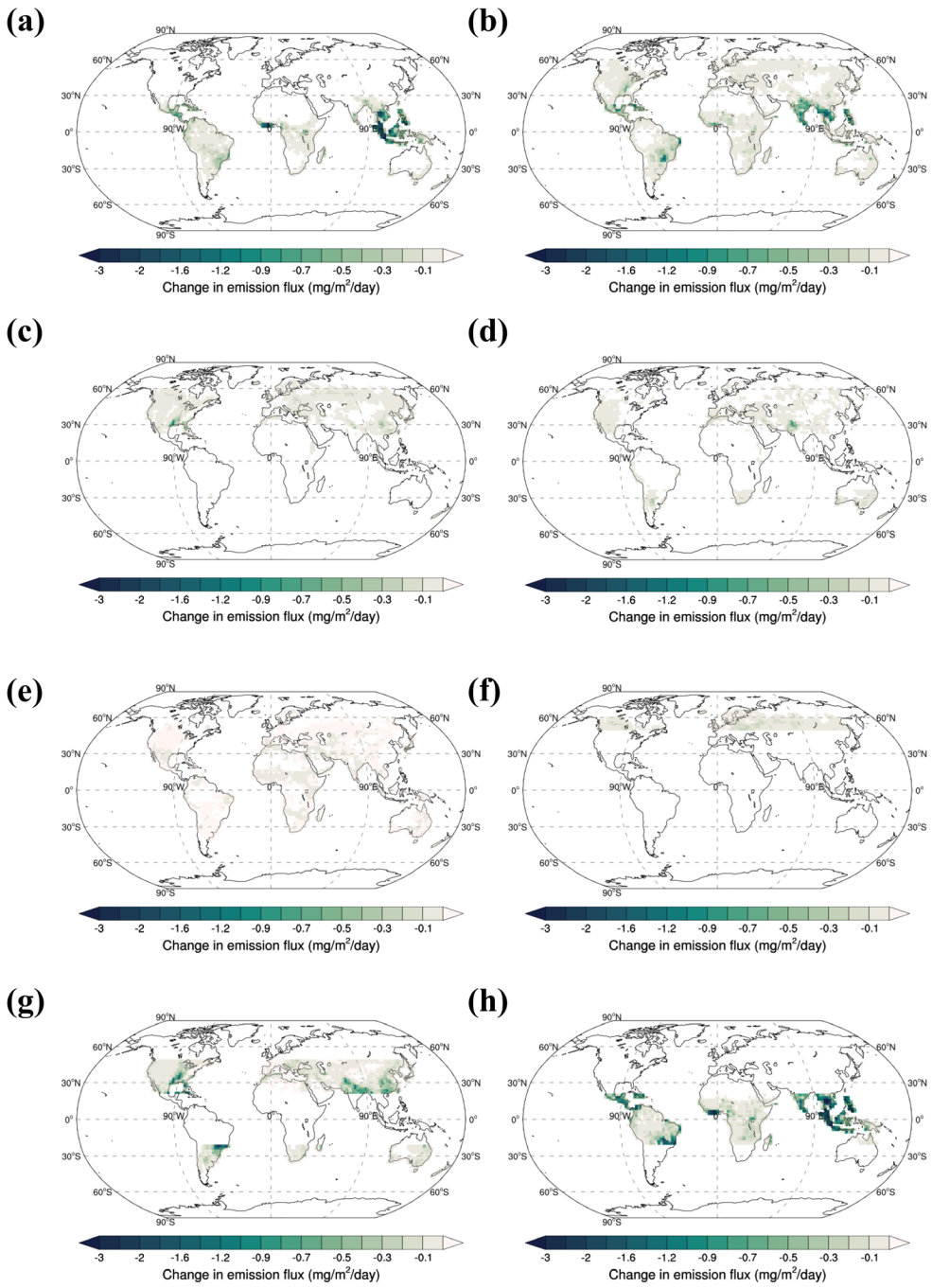

Figure S4. Changes in α-pinene emission flux due to the vegetation cover change from (a) evergreen broadleaf forests, (b) deciduous broadleaf forests, (c) evergreen needleleaf forests, (d) shrubs, and (e) grasslands to cropland as well as due to the vegetation cover change in (f) high latitudes, (g) middle latitudes and (h) low latitudes.

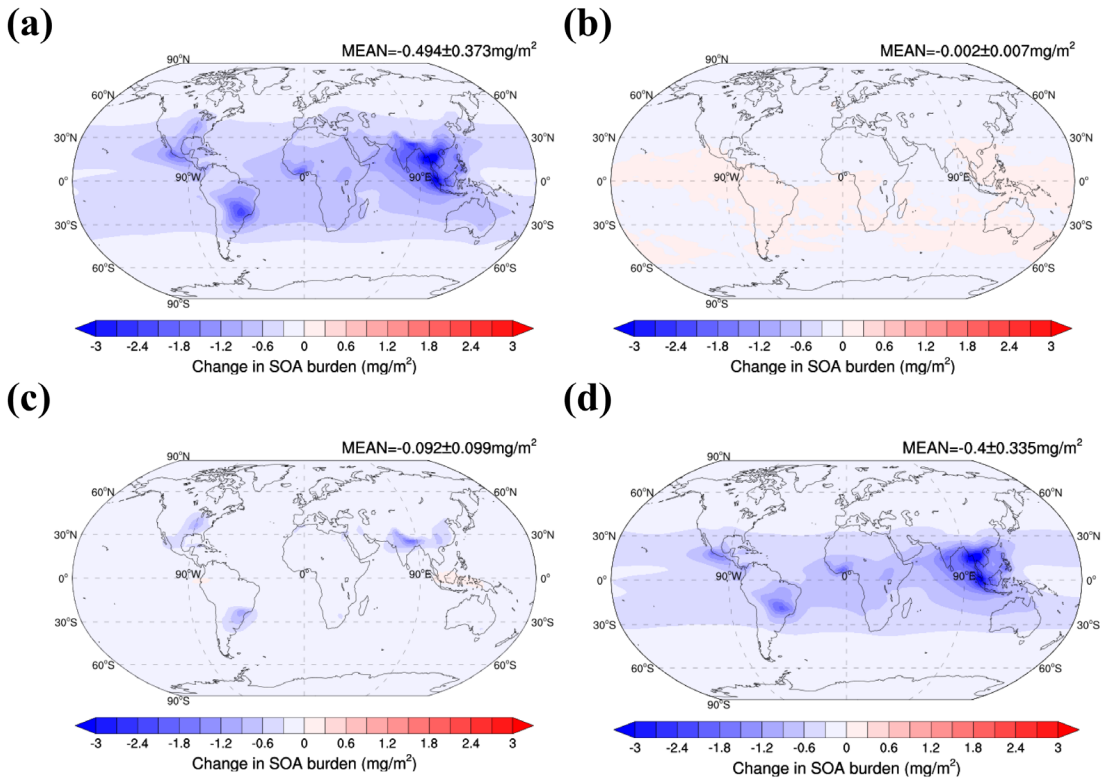

Figure S5. Changes in annual average SOA burden due to (a) total vegetation cover change as well as vegetation cover change in (b) high latitudes, (c) middle latitudes and (d) low latitudes.

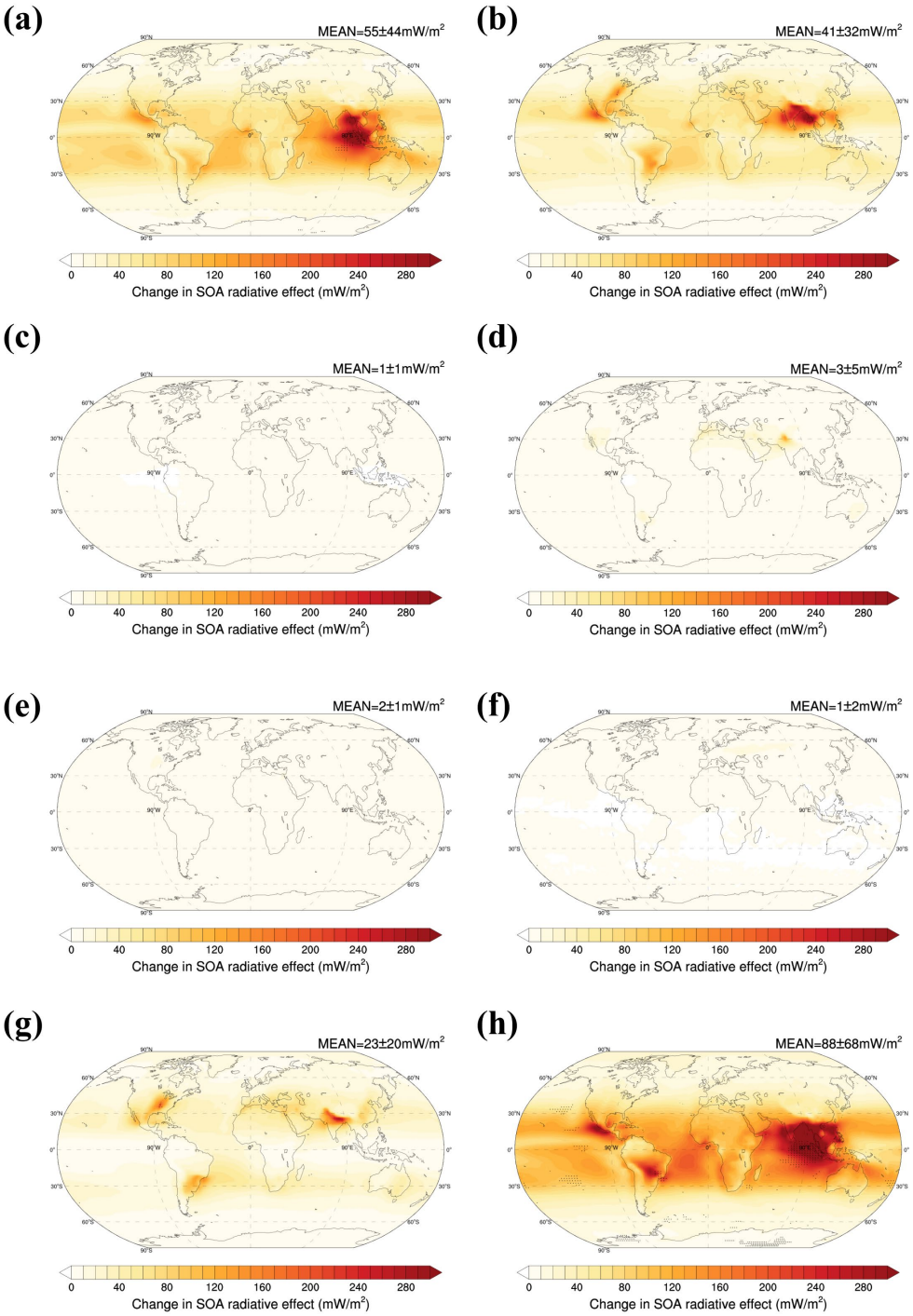

Figure S6. Changes in the direct radiative effect of SOA due to the vegetation cover change from (a) evergreen broadleaf forests, (b) deciduous broadleaf forests, (c) evergreen needleleaf forests, (d) shrubs, and (e) grasslands to cropland as well as due to the vegetation cover change in (f) high latitudes, (g) middle latitudes and (h) low latitudes.

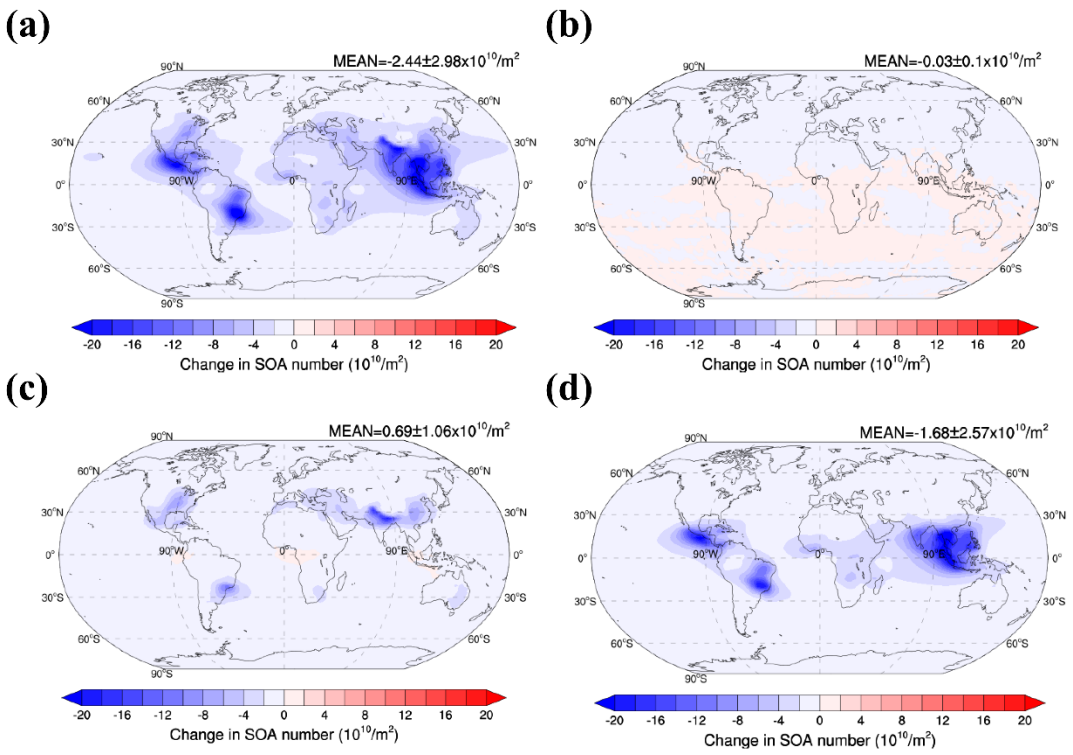

Figure S7. Changes in annual average column number concentration of accumulation mode SOA formed from new organic particle formation due to (a) total vegetation cover change as well as vegetation cover change in (b) high latitudes, (c) middle latitudes and (d) low latitudes.

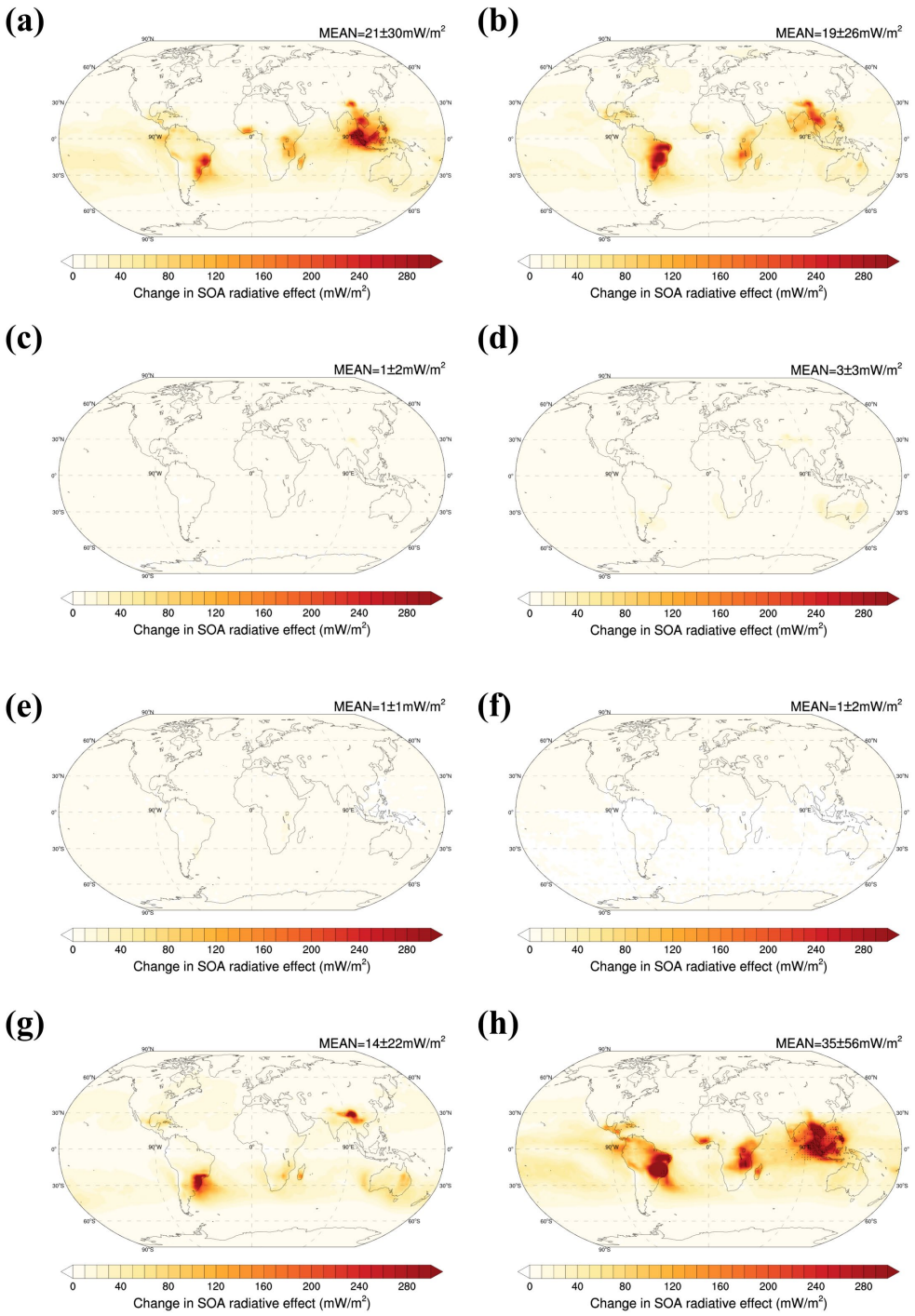

Figure S8. Changes in the indirect radiative effect of SOA due to the vegetation cover change from (a) evergreen broadleaf forests, (b) deciduous broadleaf forests, (c) evergreen needleleaf forests, (d) shrubs, and (e) grasslands to cropland as well as due to the vegetation cover change in (f) high latitudes, (g) middle latitudes and (h) low latitudes.

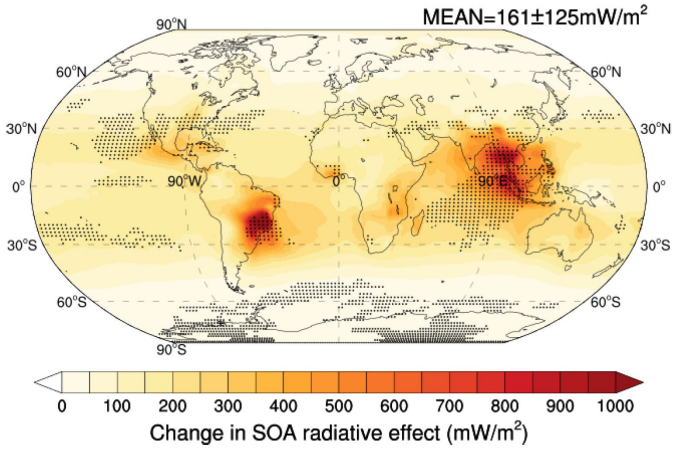

Figure S9. Changes in the total radiative effect (DRE+IRE) of SOA due to the change in vegetation cover from pre-industrial times to the 21st century

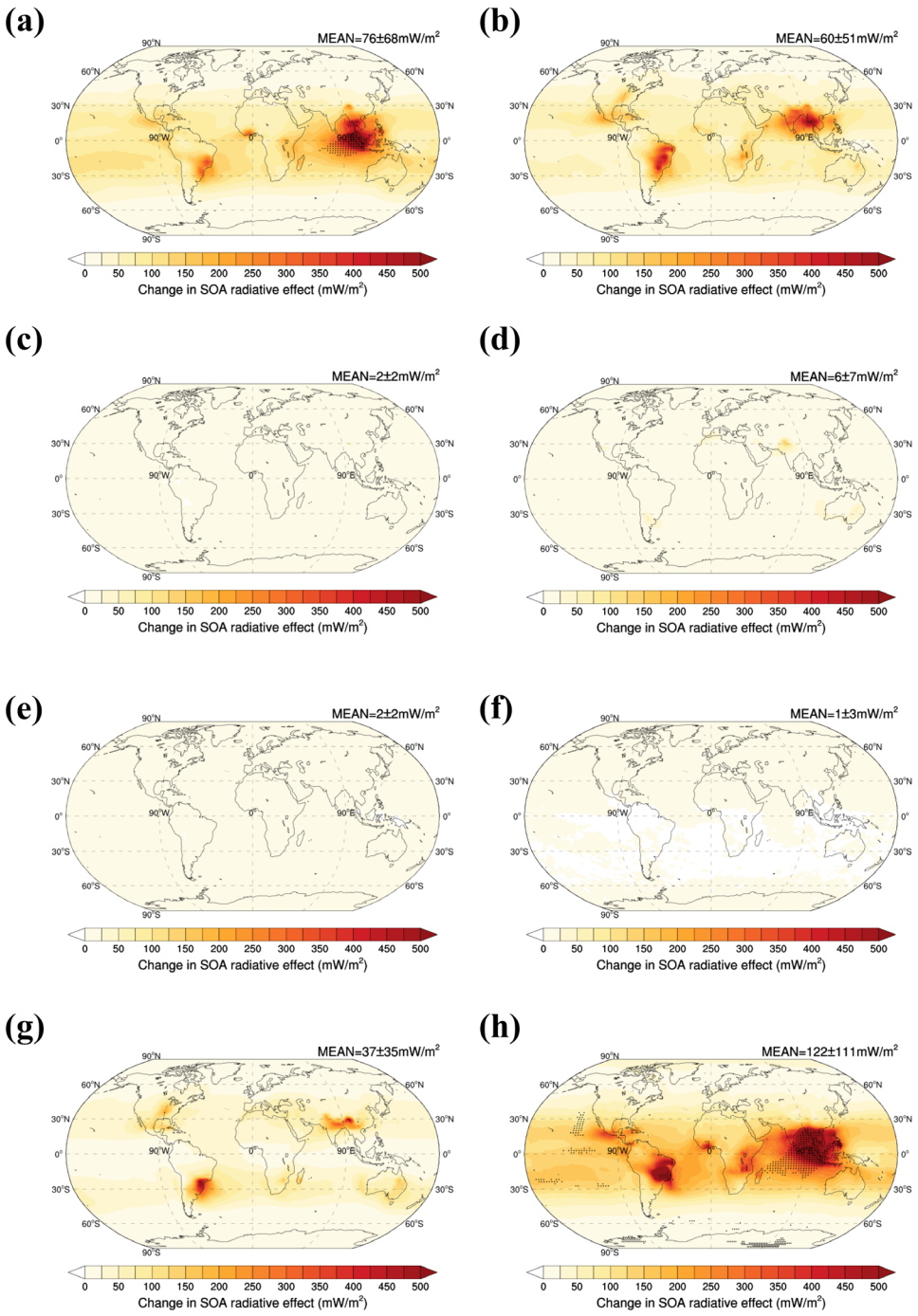

Figure S10. Changes in the total radiative effect (DRE+IRE) of SOA due to the vegetation cover change from (a) evergreen broadleaf forests, (b) deciduous broadleaf forests, (c) evergreen needleleaf forests, (d) shrubs, and (e) grasslands to cropland as well as due to the vegetation cover change in (f) high latitudes, (g) middle latitudes and (h) low latitudes.

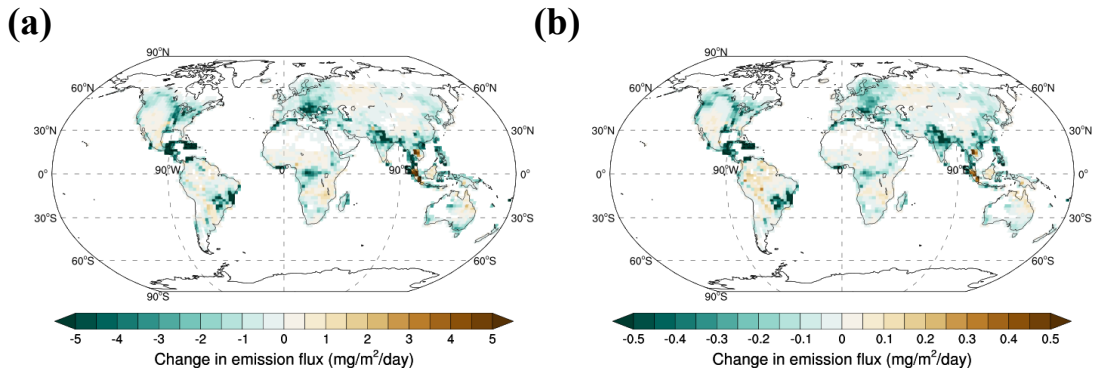

Figure S11. The difference in the isoprene (a) and α-pinene (b) emission flux due to vegetation cover changes between the future climate and contemporary climate.

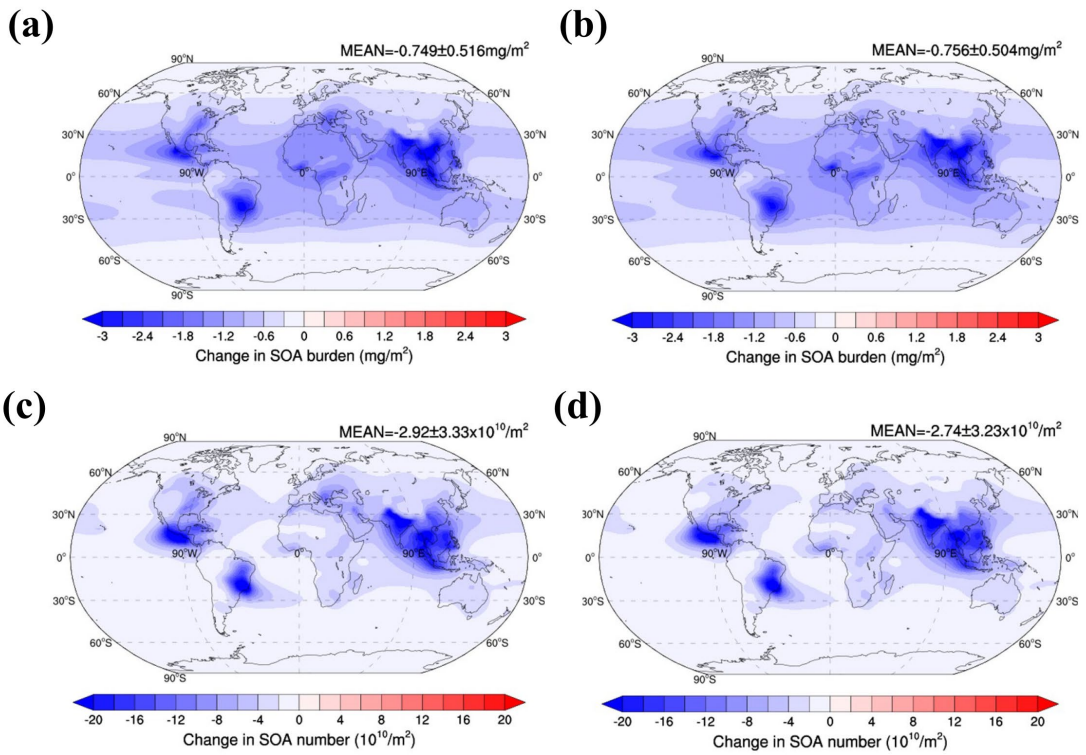

Figure S12. Changes in annual average SOA burden (a, b) and column number concentration of accumulation mode SOA formed from new organic particle formation (c, d) due to vegetation cover changes under future climate in EX_CLIM (a, c) as well as future climate and reduced anthropogenic emissions in EX_EMIS (b, d).

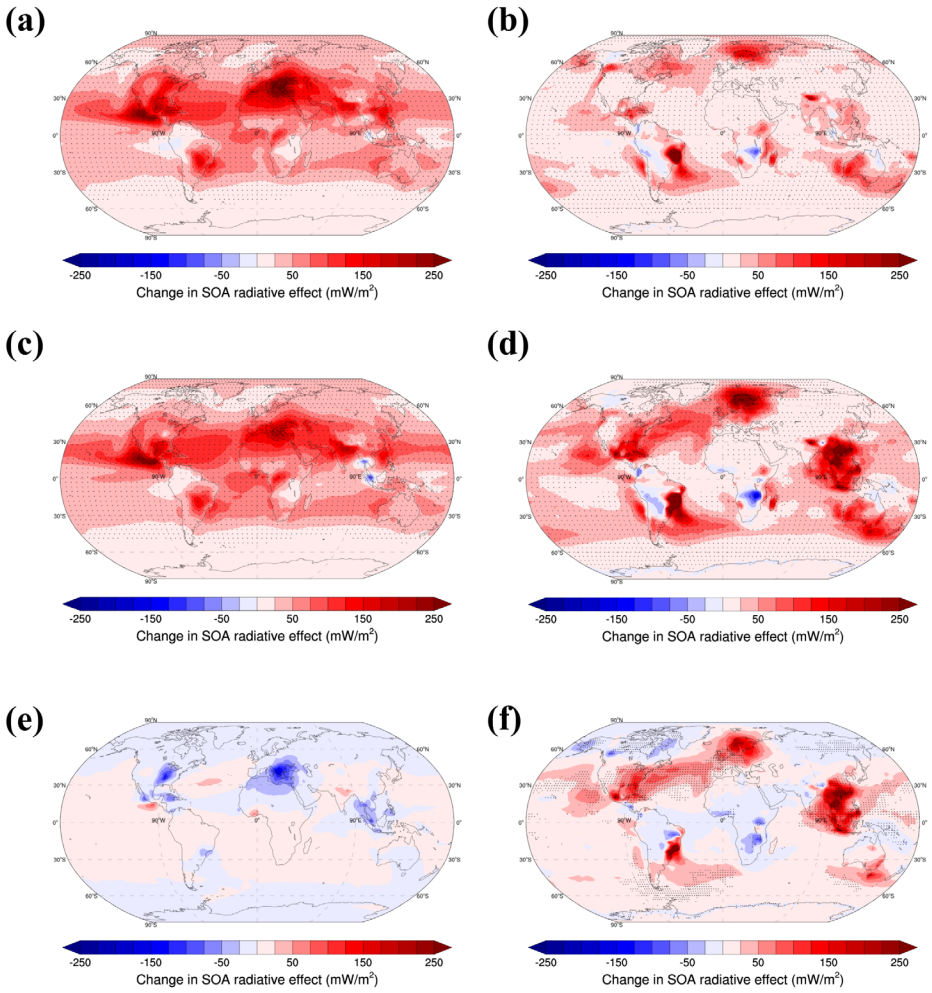

Figure S13. The differences in direct (a, c, e) and indirect (b, d, f) radiative effect between EX_CLIM and EX_BASE (a, b, effect of climate change in the future), EX_EMIS and EX_BASE (c, d, effect of climate change and reduced anthropogenic emissions in the future), EX_EMIS and EX_CLIM (e, f, effect of reduced anthropogenic emissions in the future). Differences significant at the 95% level according to a Students t test are depicted by black points.