Regional and sectoral attributions of recent climate change

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Introduction

- Determining **magnitude of climate change impacts regarding region or sector** is important to formulate climate change policy.
- Conventional method apportions the climate change impacts based on the associated cumulative CO_2 or GHG emissions, considering CO_2 or GHGs are the main contributors to global warming.
- However, such method may **ignore effects of aerosols and pollutants, land use albedo changes or carbon cycle uncertainties, or pull in large uncertainties** when using global warming potential (GWP) to estimate CO_2 equilibrium emissions for GHGs.
- The objective of this study is **to quantify regional and sectoral contributions to the climate change** by an updated integrated assessment (IAM) model - the SCM4OPT, using the most up-to-date emission and land cover datasets.

Method

- **Normalized marginal method** (Li et al., 2016)
- For each GHG emission, we performed three simulations:
  - ✓one 'normal' with all emissions included in the simulation ('all');
  - ✓one with country emissions reduced by a fraction ε ('$-\varepsilon_{Country}$'), here ε=1%;
  - ✓and one with all except the country emissions reduced by the same fraction ('$-\varepsilon_{RoG}$', for rest of the globe).
- Relative contribution α following the normalized marginal method: $\alpha = [Tem(all) - Tem(-\varepsilon_{Country})]/[2 \times Tem(all) - Tem(-\varepsilon_{Contry}) - Tem(-\varepsilon_{RoG})]$.
- The **S**imple **C**limate **M**odel for **OPT**imization (**SCM4OPT**) is used for climate change simulation.
- **Climate-related uncertainties:**

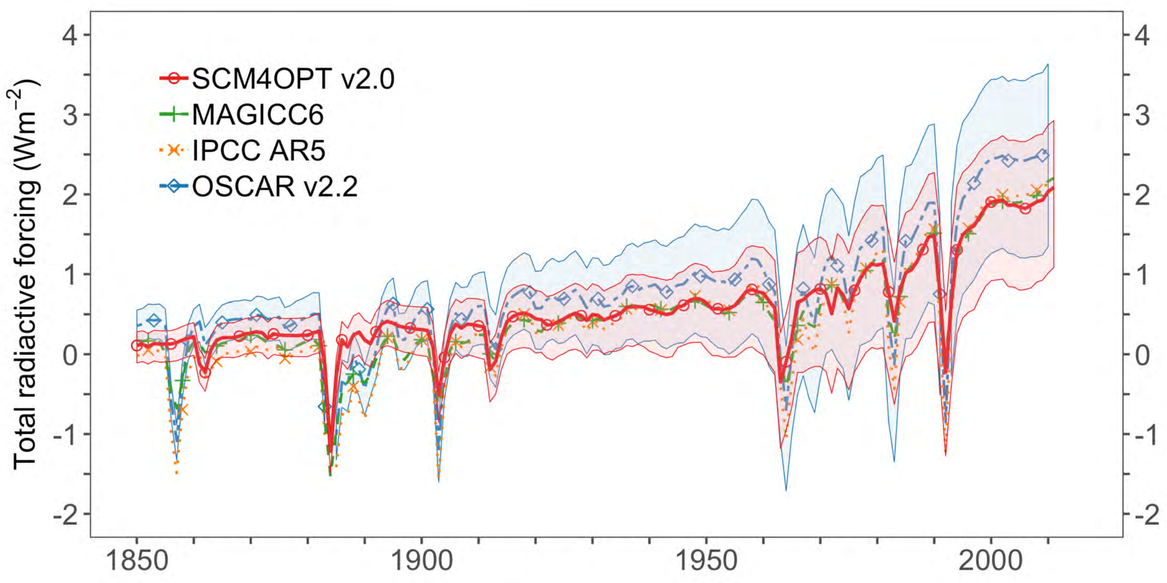

Figure 1: **Total radiative forcing simulated by SCM4OPT v2.0, compared with existing studies.**

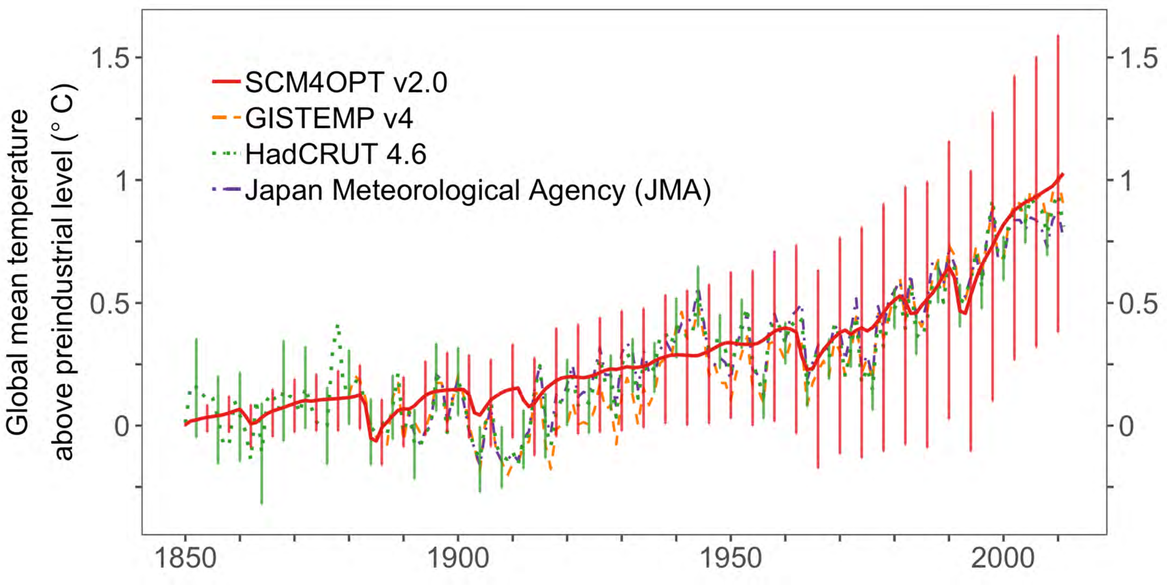

Figure 2: **Historical global mean temperature increase above preindustrial level, generated by SCM4OPT v2.0, compared with existing statistical records.**

Table 1: **Datasets of historical emissions.**

Source	Period	Emission	Format	Reference
CEDS	1750-2014	CO_2, CH_4, BC, CO, NH_3, NMVOC, NO_x, OC, SO2	Spatial (sectoral)	Hoesly et al. (2018)
EDGAR v4.3.2	1970-2012	CO_2, CH_4, N_2O, BC, CO, NH_3, NMVOC, NO_x, OC, SO_2	Regional and sectoral / Spatial (sectoral)	Aardenne et al. (2018)
EDGAR v4.2	1970-2008	CO_2, CH_4, N_2O, CO, NH_3, F-gases, NF_3, SF_6, NMVOC, NO_x, SO_2	Regional and sectoral /Spatial (sectoral)	JRC and PBL (2011)
PRIMAP v2.0	1850-2016	CO_2, CH_4, N_2O, F-gases, HFCs, PFCs, NF_3, SF_6	Spatial (sectoral)	Gutschow et al. (2016)
RCP historical	1850-2000	CH_4, BC, CO, NH_3, NO_x, OC, SO_2, VOC	Spatial (sectoral)	Lamarque et al. (2009)

Results

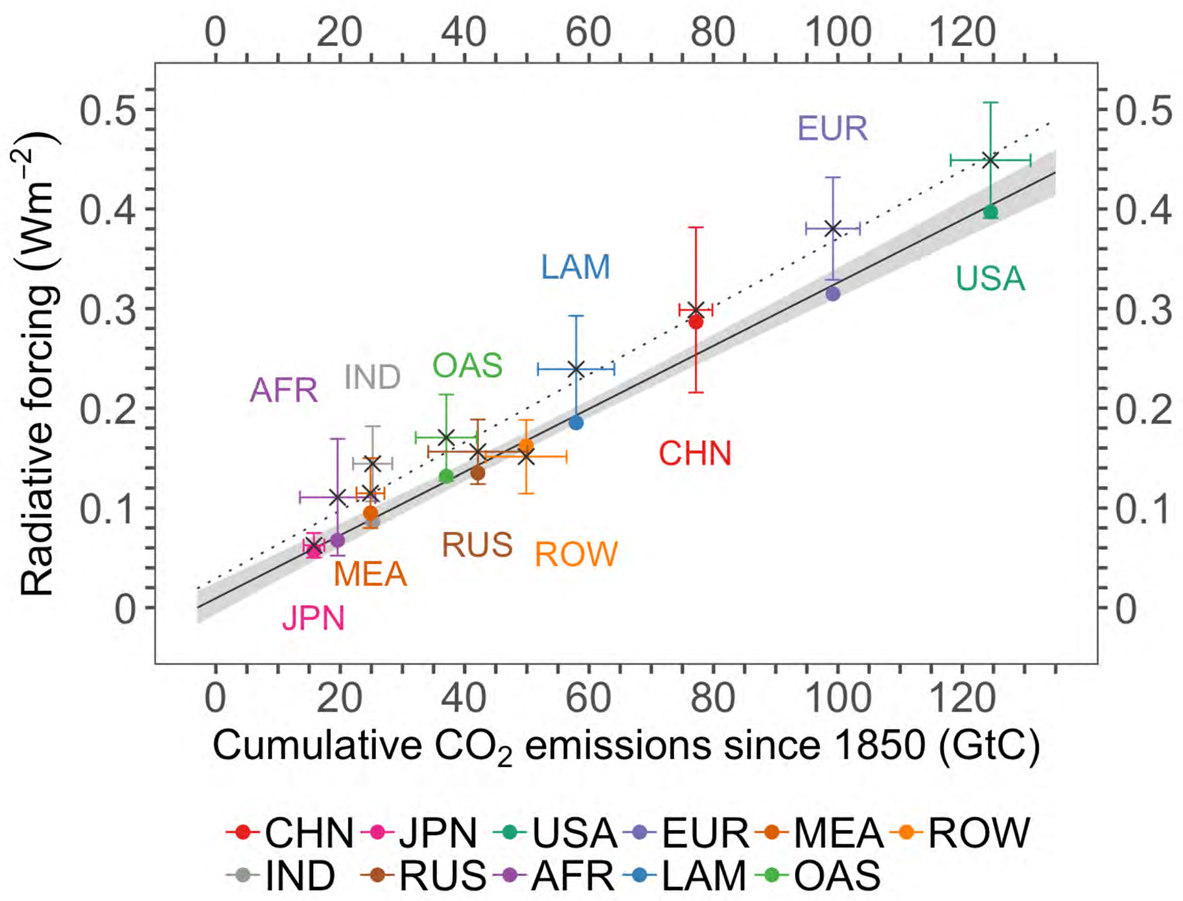

Figure 3: **The relationship between cumulative CO_2 emissions since 1850 and CO_2 induced or total radiative forcings.**

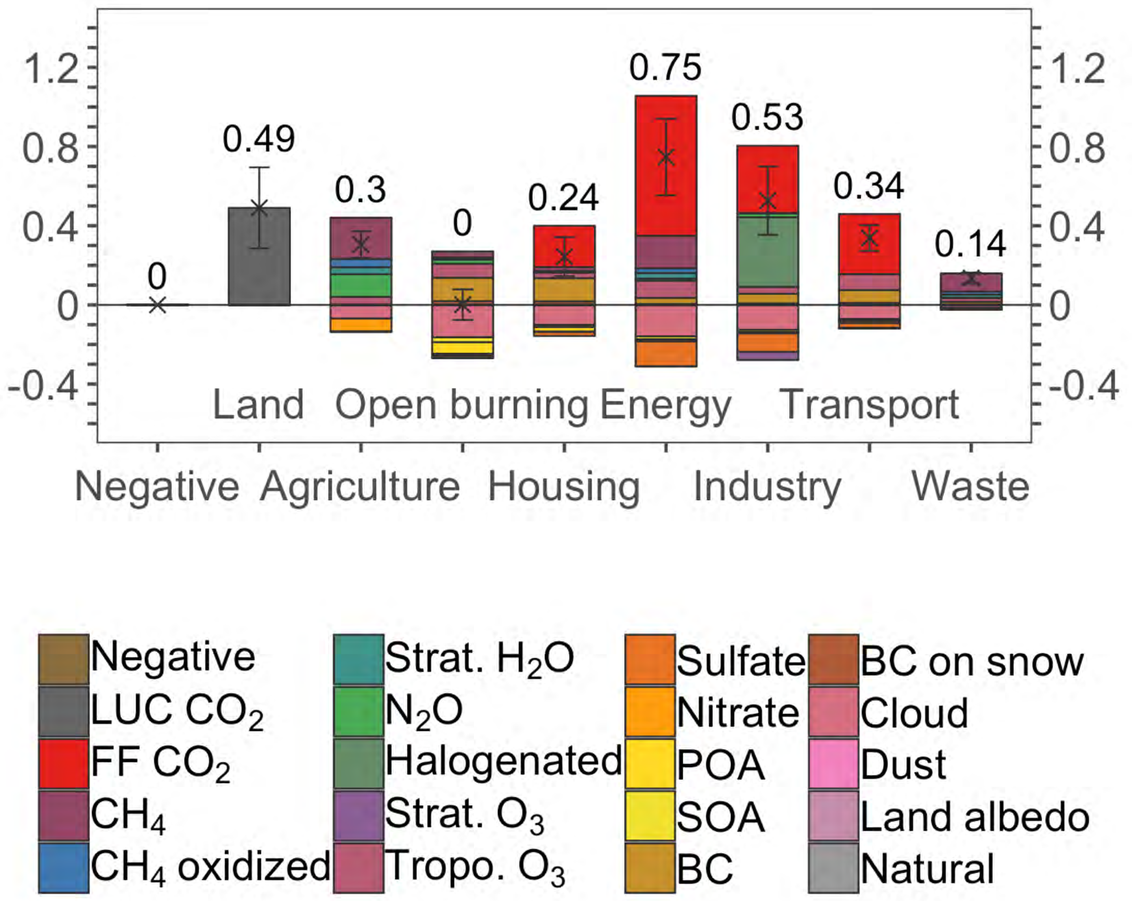

Figure 4: **Sectoral contributions by individual forcing agents.**

Conclusions

- **The USA, the European Union (EU) and China are three main contributors to current climate change (1850-2016), accounting for 18±4%, 15±3%and 12±4%, respectively**, considering possible emission and climate-related uncertainties.
- **Energy, industry and transport** sectors dominate historical contributions to climate change, as well as **land use CO_2**.