Title: RF paper: China attribution to global radiative forcing - progress report by Bengang Li

Abstract: Current status and the main progresses of the RF paper are reported. Firstly, title, objectives, methods, outline and structure of the paper are introduced for discussion and confirmation. Then, results, tables and figures are presented for discussion by all participants. Finally, the main problems are listed for consideration and arrangement in the near future. Although the results of RF paper are interesting and promising, more detailed analysis are needed to make them more impressive and more informative. Also, the mechanism of communication and feedback among participants may be strengthen for more productive collaboration in the future.

RF paper:

China attribution to global Direct Radiative Forcing – progress report

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November 12~14, 2013. Paris

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- Goals
- Forcing agents
- Methods

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- Discussion
- Conclusion

Objectives

China Attributions…A good case study !

Focuses

Attribution of China to Global DRF

Impact of RoG on DRF over China

Time trends

What is new?

- ✓ To Attribute DRF of GHGs, aerosols, O3 and land use change
- ✓ To understand current importance of China economy in the context of global RF changes

Objectives

DRF, China, Global, RoG

States

Initial state: Pre- Industrial (PI), 1750

Perturbed state: Present Day (PD), 2000/2007/2012

Forcing Agents

GHGs: FF CO_2, LUC CO_2, CH_4, N_2O, CFCs/SF6, O_3

Aerosols: NOx, SOx, BC, POM

Land use change

Existing datasets & New emission inventories

Numerical modelling

Methods

Attributions, Source-receptor relationships

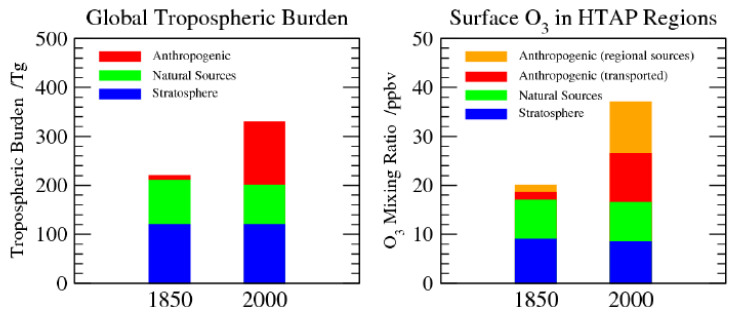


Figure 4.6. Source attribution for tropospheric O_3 over the globe (left) and for annual mean surface O_3 over the four HTAP regions (right) estimated by the report authors from source contributions in earlier published studies [*Berntsen et al.*, 2000; *Gauss et al.*, 2006; *Lelieveld and Dentener*, 2000; *Sudo and Akimoto*, 2007].

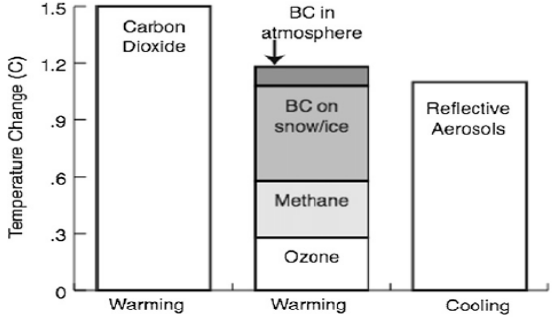


Figure 5.26. Estimates of the contribution of particular species to preindustrial to present-day Arctic (60° to 90° N) surface temperature trends. Values are based on the assessment of modelling and observations of Quinn et al., and do not include aerosol indirect effects. Reflective aerosols include sulphate and organic carbon. [Reprinted from Figure 41 of Isaksen, I. S. A., et al. (2009), Atmospheric composition change: Climate-chemistry interactions, *Atmospheric Environment, 43*(33): 5138-5192, with permission from Elsevier.]

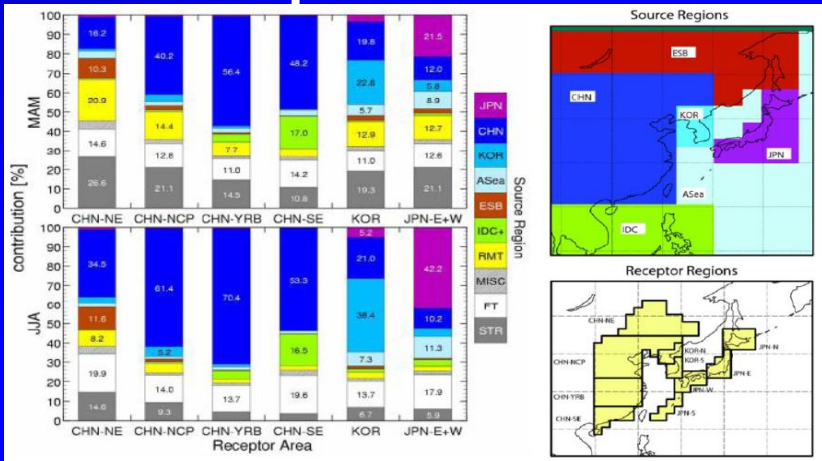
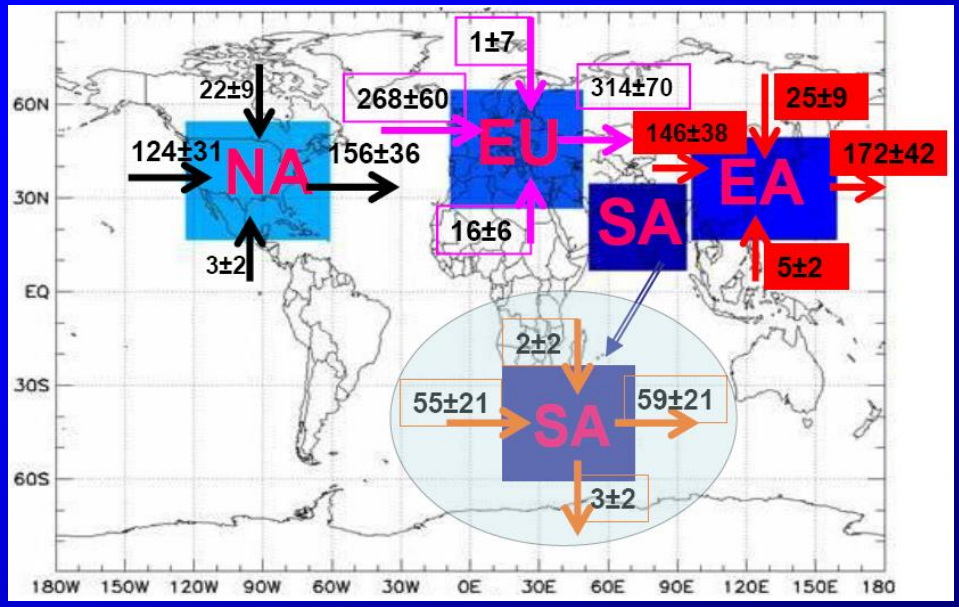


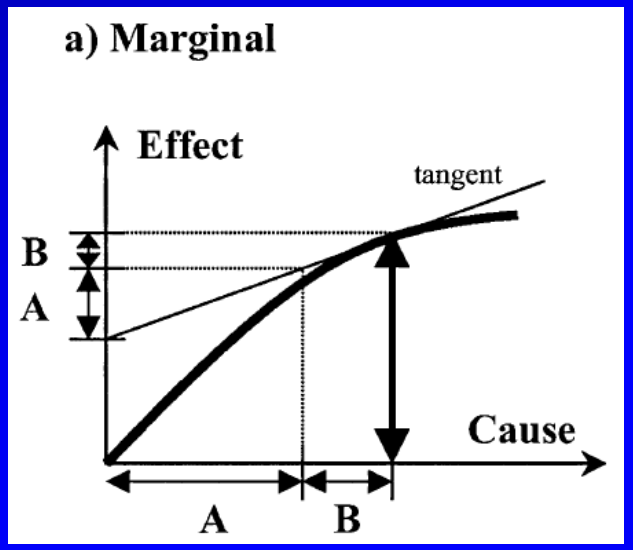
Figure 4.17. Seasonal mean percentage contribution from source regions to receptor regions in East Asia for spring (top) and summer (bottom) averaged over 6 years. Source regions are shown on the right and include Japan (JPN), China (CHN), Korea (KOR), adjacent marine regions (ASea), E. Siberia (ECB), SE Asia (IDC+), other N. Hemispheric mid-latitude regions (RMT), the free troposphere (FT) and stratosphere (STR). Receptor regions include NE China (CHN-NE), the North China Plain (CHN-NCP), Yangtze River basin (CHN-YRB), SE China (CHN-SE), Korea and mainland Japan (JPN-E+W). [Adapted from Figures 1, 4, and 5 in Nagashima, T., et al. (2010), The relative importance of various source regions on East Asian surface ozone, *Atmospheric Chemistry and Physics, 10*: 11305-11322.]

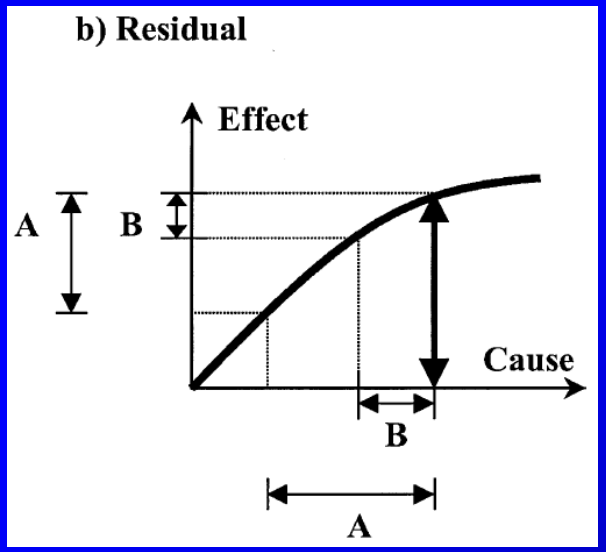


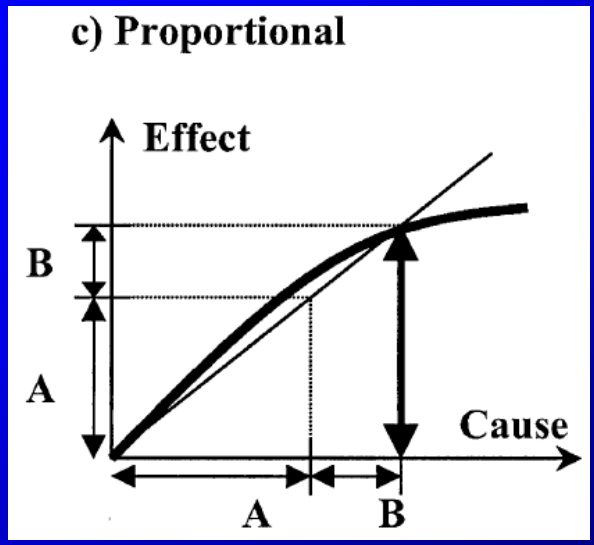
Methods

Emissions – Concentrations – DRE – DRF – Attributions & Impacts

$$E(t) \xrightarrow{\theta} Q(t) \xrightarrow{\phi} F(t) \xrightarrow{\psi} T(t)$$







Methods

Emissions – Concentrations – DRE – DRF – Attributions & Impacts

TABLE I

Summary of how the attribution methods match the criteria identified in Section 3

Criteria	NM	NR	P	D	TS	GTO	CR
1. Understandable	√	√	√	?	√	√	√
2. No paradoxical behaviour	√	√	√	×	√	√	√
3. Equiv. to simple linear	√	√	√	√	√	×	×
4. $\sum_j X_j(t) = X(t)$	√	√	√	√	√	√	√
5. Additive in space & time	√	×	√	√	√	√	√
6. Applicable to general case	√	√	×	?	√	√	√
7. Along causal chain	√	√	×	?	√	×	×
8. Alternative model forms equiv.	√	√	√	√	√	√	√
9. In/Dependent of future scenario	D	D	D	D	I	D	D

Trudinger and Enting, Comparison of formalisms for attributing responsibility for climate change: non-linearities in the brazilian proposal approach, Climatic Change 68: 67–99, 2005

Methods

NRM calculations (Models: OSCAR, INCA, LMD)

Three scenarios

Statistics for Global and China

NRM Calculations

Scenarios	Global average DRF	China average DRF
All Sources	A1	B1
China Sources Only	A2	B2
All Sources but China	A3	B3
Attribution of China to global DRF = (A1 - A3) / (A1 - A2 + A1 - A3)		
Impact of RoG* on DRF over China = (B1 – B2) / (B1 - B2 + B1 - B3)		

Outlines

Title: China attribution to global Direct Radiative Forcing (TBD)

Outlines & Structure

Introduction (DRF, Emissions, Attributions, China, Objectives)

Datasets (Forcing agents, PI & PD emissions, resolutions...)

Models (OSCAR, LMDz-INCA)

NRM calculation (Scenarios, Attributions, Impacts)

Result 1: PI & PD emissions (by agents, for Global & China)

Result 2: Attributions of China (PI & PD emission, **DRF**)

Result 3: China attribution & impact of RoG on **DRF** over China (by species, Present day)

Result 4: **DRF** caused by Total GHGs (Global & China, China attribution, Temporal trends)

Result 5: Attribution of China emitted GHGs to global **DRF** (by species, Temporal trends)

Result 6: **DRF** effects of landuse change of China

Discussions

Conclusions

Tables & Text

Tables & text in supplementary information

To be filled ➡ **PI emissions** of Global & China (Result 1)

To be filled ➡ **PD emissions** of Global & China (Result 1)

To be added ➡ **Model descriptions (OSCAR, LMDz-INCA)** (Methods)

NRM calculations (Scenarios, Attributions, Impacts) (Methods)

To be filled ➡ PI & PD DRE for Scenario “All sources”

To be filled ➡ PI & PD DRE for Scenario “China sources only”

To be filled ➡ PI & PD DRE for Scenario “All sources but China”

Figures in Maintext

Figure 1:
China attributions to global emissions (PI and PD) and DRF

Positive DRF
10.7 %
0.33 from
3.10 w/m2

Negative DRF
15.9 %
-0.09 from
-0.56 w/m2

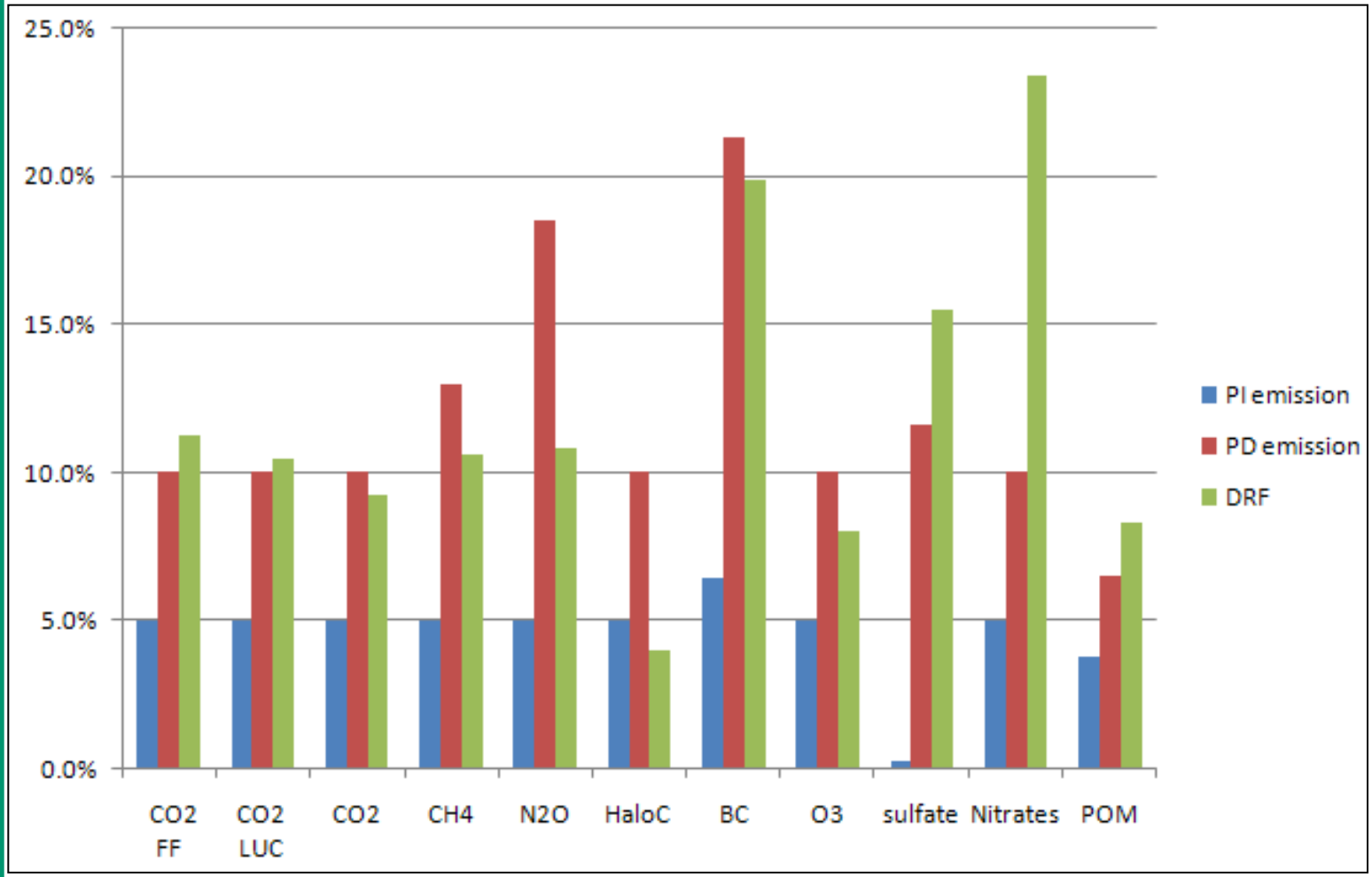
Nitrate: 23.4 %

BC: 19.9 %

Sulfate: 15.5 %

HaloC: 4.0 %

O3: 8.0 %



Figures in Maintext

Figure 2:

Contribution of China to the global DRF (left panel) and impact of RoG on DRF over China territory (right panel) at present day

FF CO2: 88.7 %

LUC CO2: 89.6 %

CH4: 89.4 %

N2O: 89.2 %

HaloC: 96.0 %

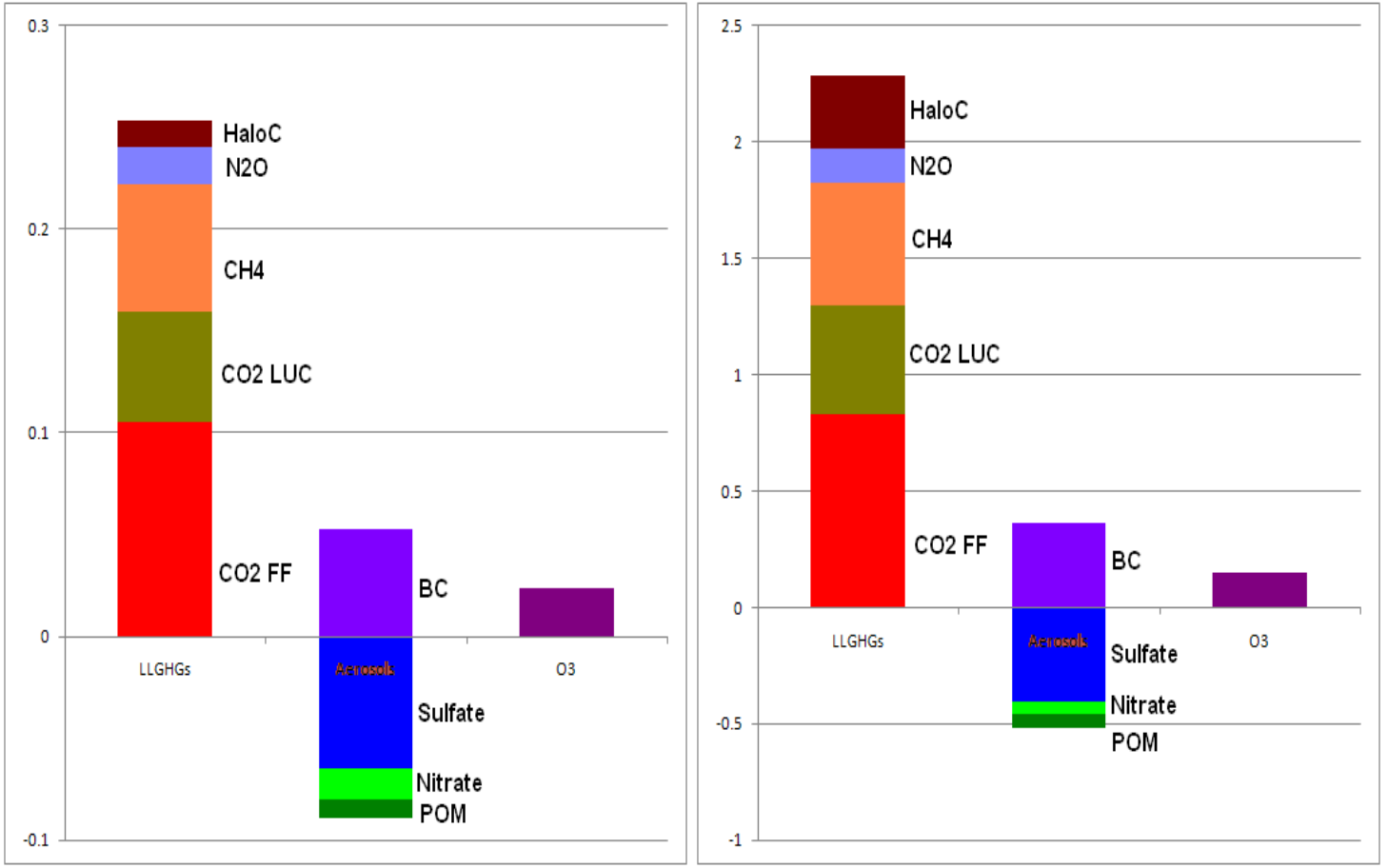
BC: 35.4 %
0.37 from 1.04

Sulfate: 31.5 %
-0.43 from -1.37

POM: 27.2 %
-0.068 from -0.25

O3: ???

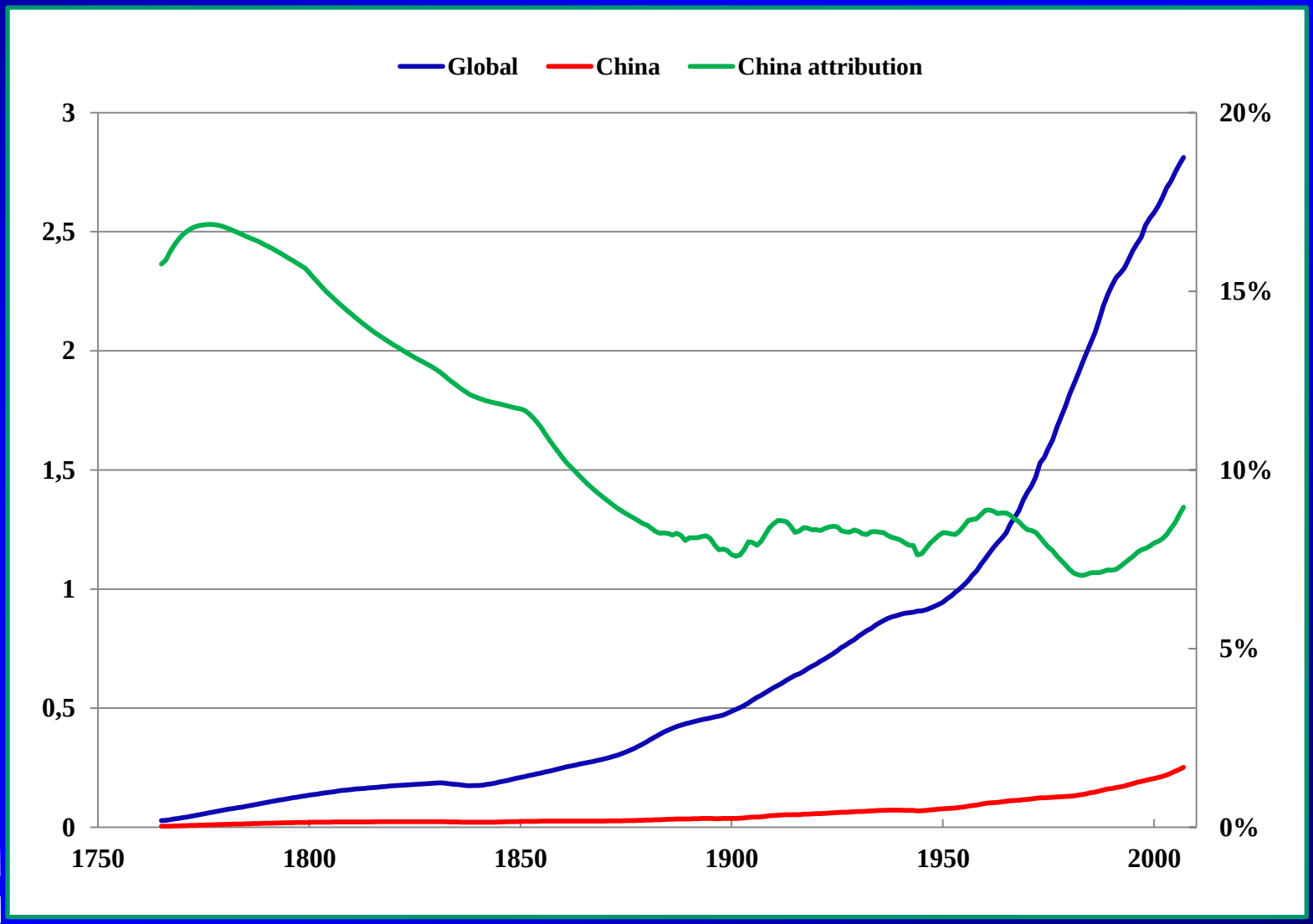
Nitrate: ???



Figures in Maintext

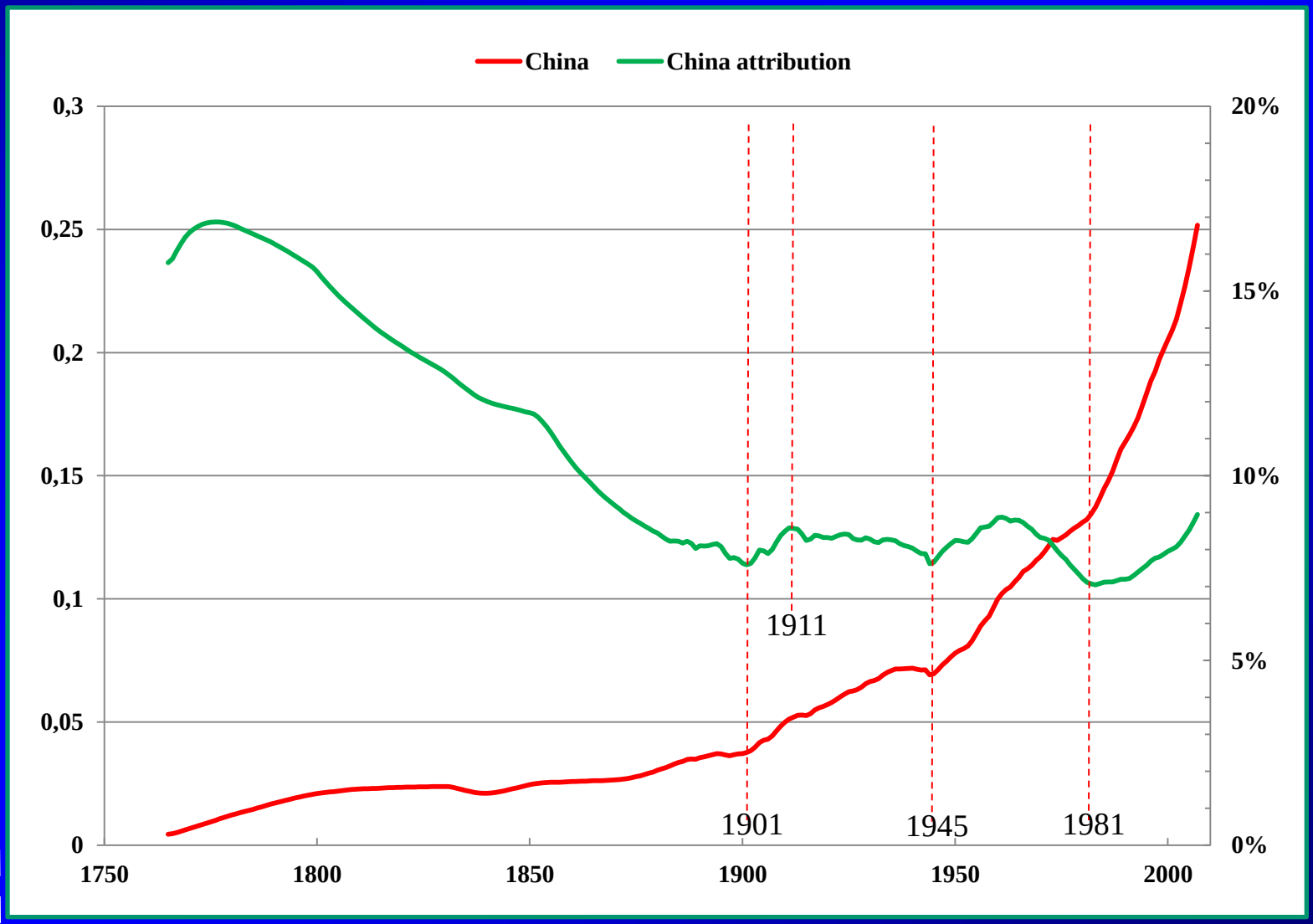
Figure 3:
DRF of GHGs and China's attribution during 1765 – 2007

GHGs DRF
9.0 %
0.25 from
2.81 w/m2



Figures in Maintext

Figure 3:
DRF of GHGs and China's attribution during 1765 – 2007

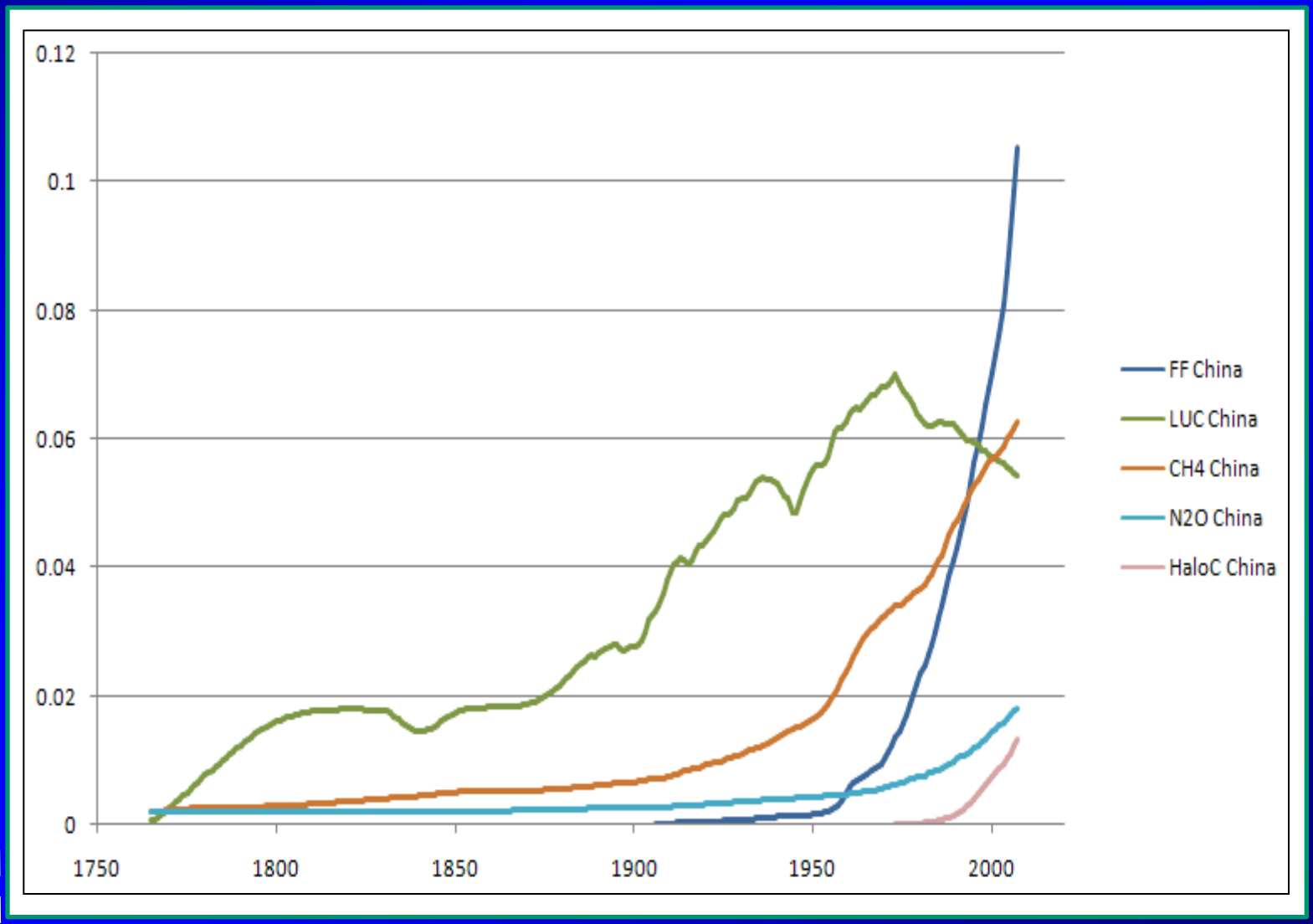


Turning Point
1901 – 1911
1937 – 1945
1980 –

Figures in Maintext

Figure 4:

Global DRF caused by GHGs emitted from China during 1765 - 2007



Figures in Maintext

Figure 5:

Attribution of China-emitted GHGs to the global DRF during 1765 - 2007

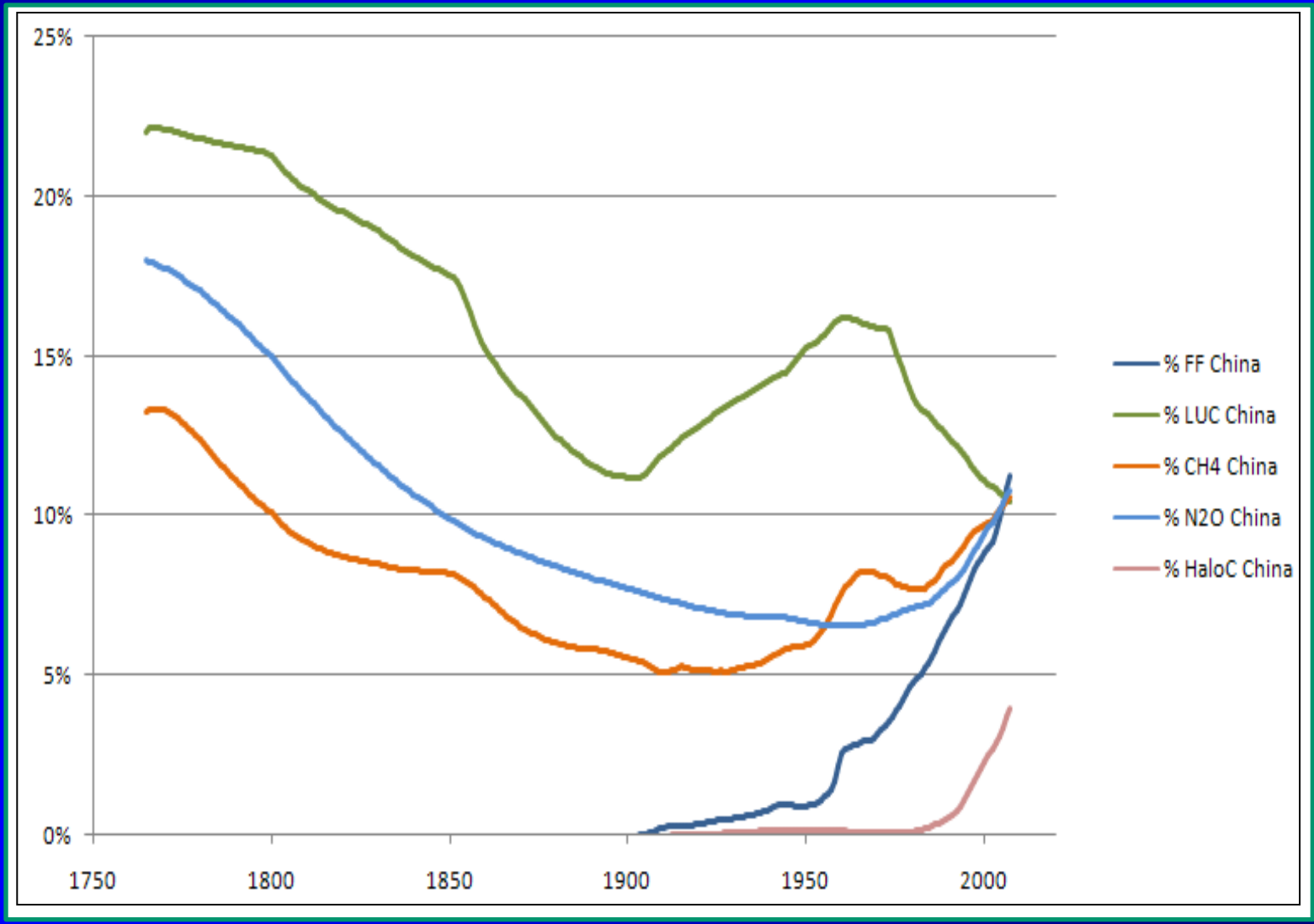


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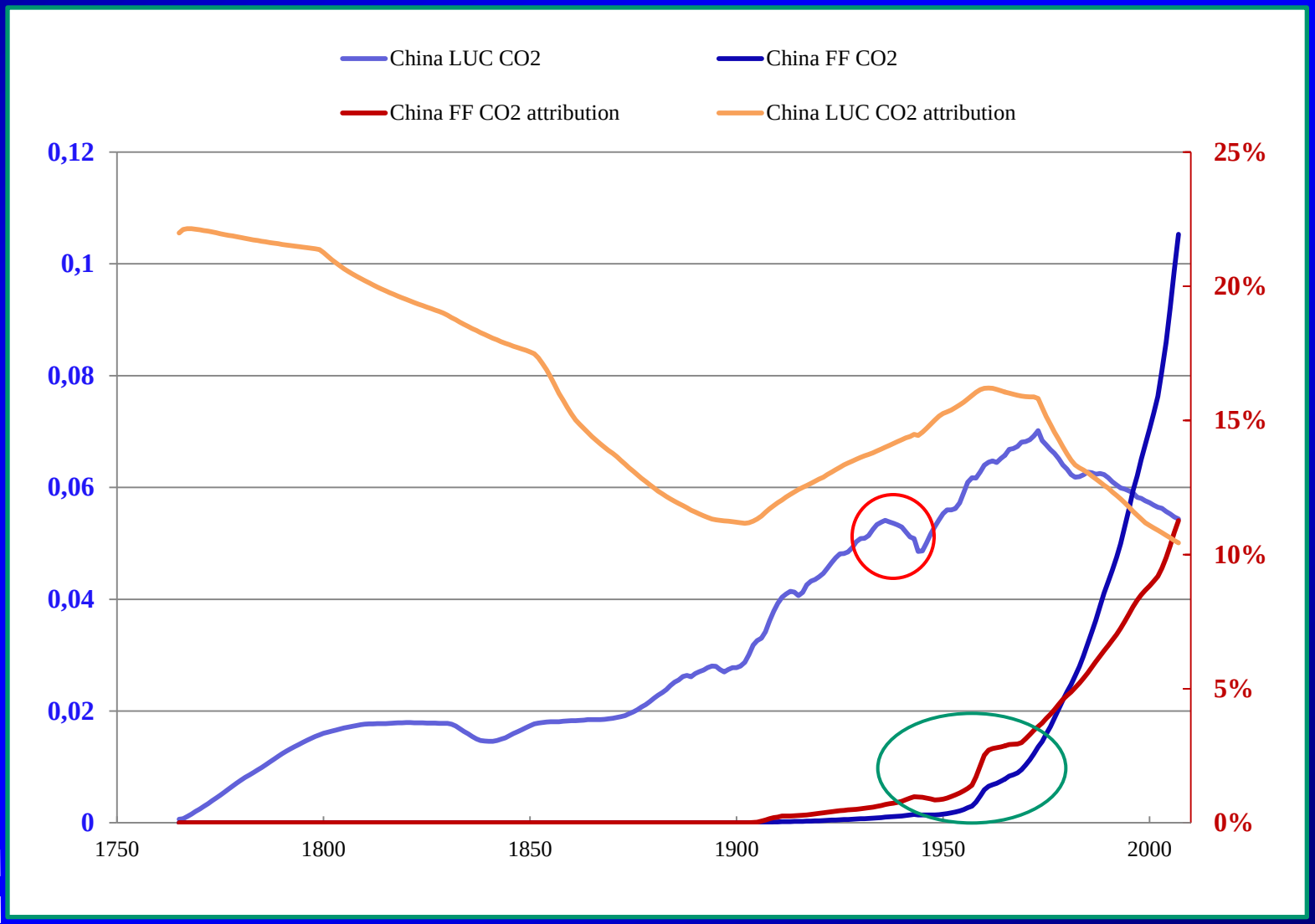
Figure 4~5:

DRF & Attribution of China-emitted CO2 during 1765 - 2007

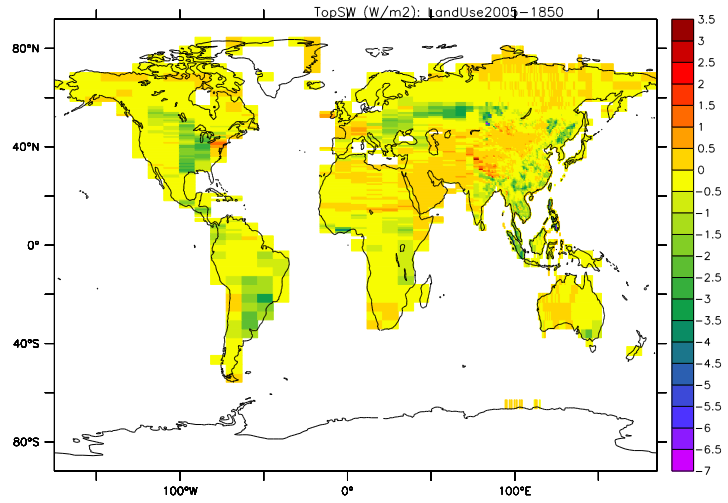


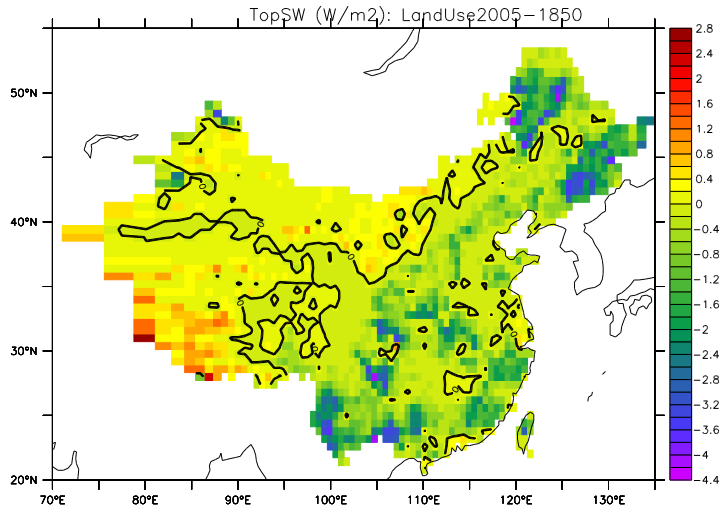
Figures in Maintext

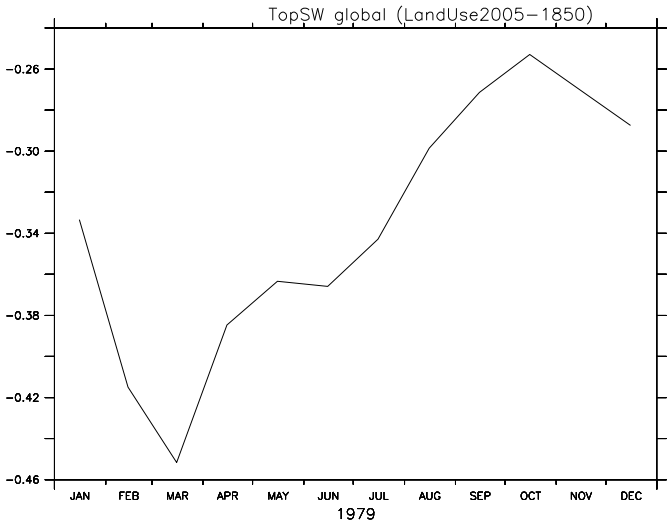
Figure 6:

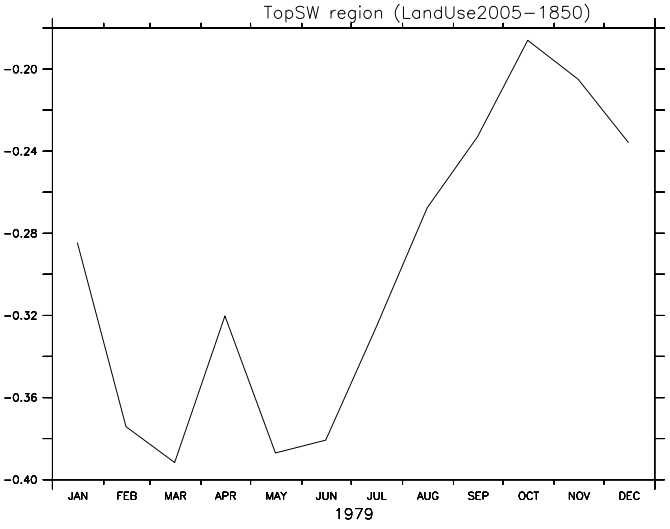
Solar radiative forcing (at TOA) due to landuse change, W/m2 (2005-1850, only albedo effect)

top	Globe	China
1	-0.3334	-0.2844
2	-0.4150	-0.3741
3	-0.4517	-0.3919
4	-0.3846	-0.3208
5	-0.3633	-0.3872
6	-0.3659	-0.3806
7	-0.3428	-0.3258
8	-0.2986	-0.2679
9	-0.2714	-0.2333
10	-0.2528	-0.1862
11	-0.2702	-0.2051
12	-0.2874	-0.2358
year	**-0.3360**	**-0.2991**









Problems

Manuscript revision…

- Emission data (PI & PD, Global & China)
- Model description (OSCAR & LMDz-INCA)
- Re-Calculation? (for O3 and Nitrates)
- Time trend of aerosols DRF?
- LUC related DRF (How to include?)
- Discussions
- Conclusions

Future

What we don't do in this paper?

- Future scenarios
- Cross-attributions of main regions (should be easy)
- Attribute climate change from emissions (causally)

Thanks !