pre-industrial emissions

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NCAR, CNRS, NASA-GFSC, NOAA-GFDL

overview

- to quantify anthropogenic aerosol impacts …
  … pre-industrial aerosol loads must be known

- pre-industrial fine mode aerosol (pollution/fires)
  - how are these estimated ?
    - AeroCom 1 (Dentener) vs. IPCC 5 (Larmarque)

- pre-industrial coarse mode aerosol (landuse→dust)
  - usually ignored
    - new satellite based estimates (Ginoux)

AeroCom 1 emissions

Dentener

- **Emissions – baseline**
  - **fossil fuel**
    - **POM** **SPEW** ***by Bond*** ***1996***
    - **BC** **SPEW** ***by Bond*** ***1996***
    - **SO2** **IIASA (Rains)** ***by Cofala*** ***2000***
      - ***reg. gridding by Edgar 3.2***
  - **Large scale fires**
    - **POM** **GFED** ***by vder Werf*** ***1997-2001***
    - **OC** **GFED** ***by vder Werf*** ***1997-2001***
    - **SO2** **GFED** ***by vder Werf*** ***1997-2001***

AeroCom 1 historic

fossil- / bio- fuel

- **BC/POM**
  - **biofuel use by country** ***with data back to 1890***
  - **diff. cooking in US** ***electricity 1960 – wood 1870***
- **SO2**
  - **multiply with *Andreae/Merlit* emission factor 0.3 (SO2/CO) using CO data *by Aardenne (Edgar) and by Susott***
  - **scale back in time before 1890 with population data *by Hyde***
  - **scale up by factor 2 north of 45N *(small impact)***

AeroCom 1 historic

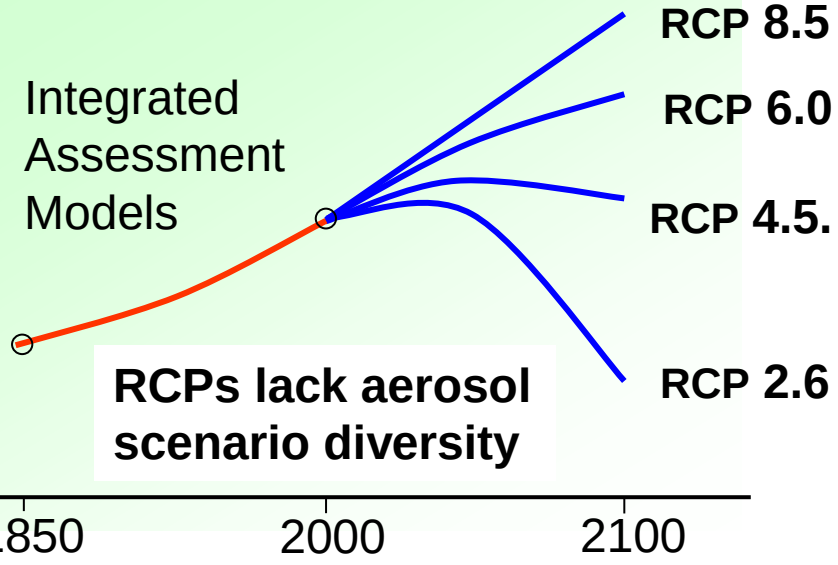
Large scale fires

- take 1997-2002 GFED 1 average *by vanderWerf*
- use 1985 land-cover *by Olson*
- use population ratio *by Hyde* (1990→1750)
- increase hi-latitude burning 2 times above current due to fire prevention *by Brenkert*
- wet forest fires: scaled by population
- grassland fires: 60% scaled by pop
- agricultural fires: 60% scaled by pop
  - 40% happen anyway

ACCMIP emissions *Lamarque*

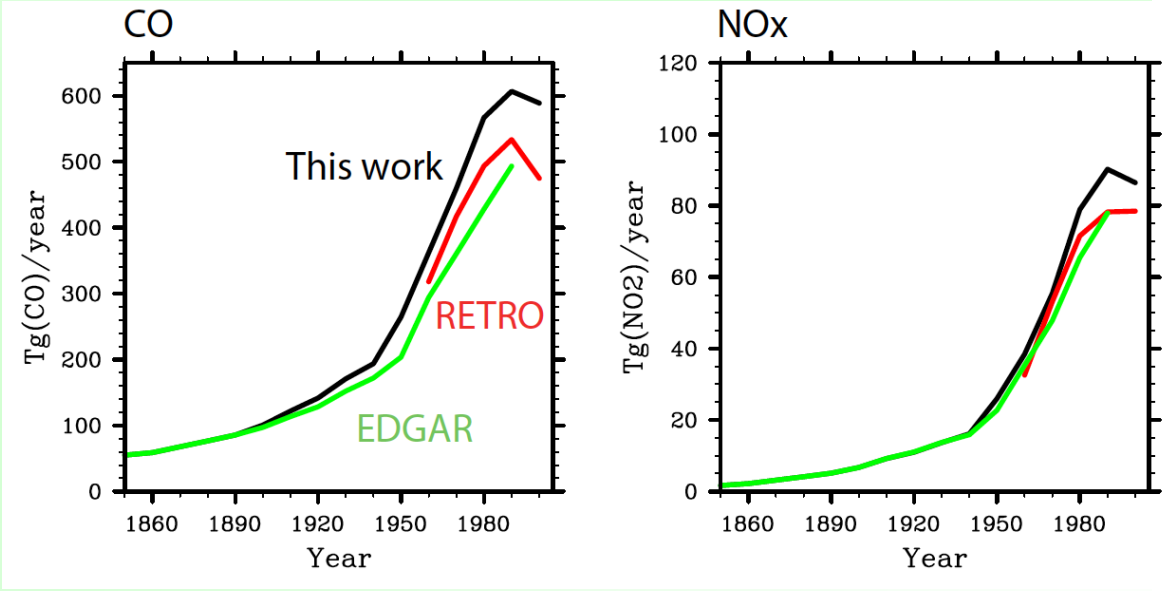
- **Emissions – baseline** **year 2000**
  - **anthropogenic (land, ship aircraft)**
  - **biomass burning (aerosol and O3 pre-cursors)**
    - **SO2 (Smith), BC/OC (Bond)**
- **Emissions - temporal change** **decadal: 1850-2100**
  - **use existing inventories**
    - **RETRO, EDGAR-Hyde**

Species	EDGAR-HYDE EDGAR 1890-2000	RETRO 1960-2000	Smith et al. 1850-2000	Bond et al. 1850-2000	Junker and Liousse 1860-1997
CH4	x				
CO	x	x			
NOx	x	x			
NMVOC	x	x			
NH3	x				
SO2			x		
OC				x	x
BC				x	x



ACCMIP historic

- general
  - define scaling factors for year 2000 emissions
    - 10 sectors (emission types)
    - 40 regions
- 1960-2000
  - RETRO
- 1890-1990
  - EDGAR-Hyde
- before 1890
  - scaling of EDGAR-Hyde to population / CO-emi



global averages

- **AeroCom 2**

Tg /year	2005	1750	anthropogenic
SO2	127 (154)	6	121 (148)
OC	51	42	9.1
BC	10.6	5.2	5.4

- **ACCMIP**

	2005	1850	anthropogenic
SO2	113 (140)	3	110 (137)
OC	34	21	13
BC	7.9	2.6	5.3

(SO2 volcanic included)

global averages

- **AeroCom 2**

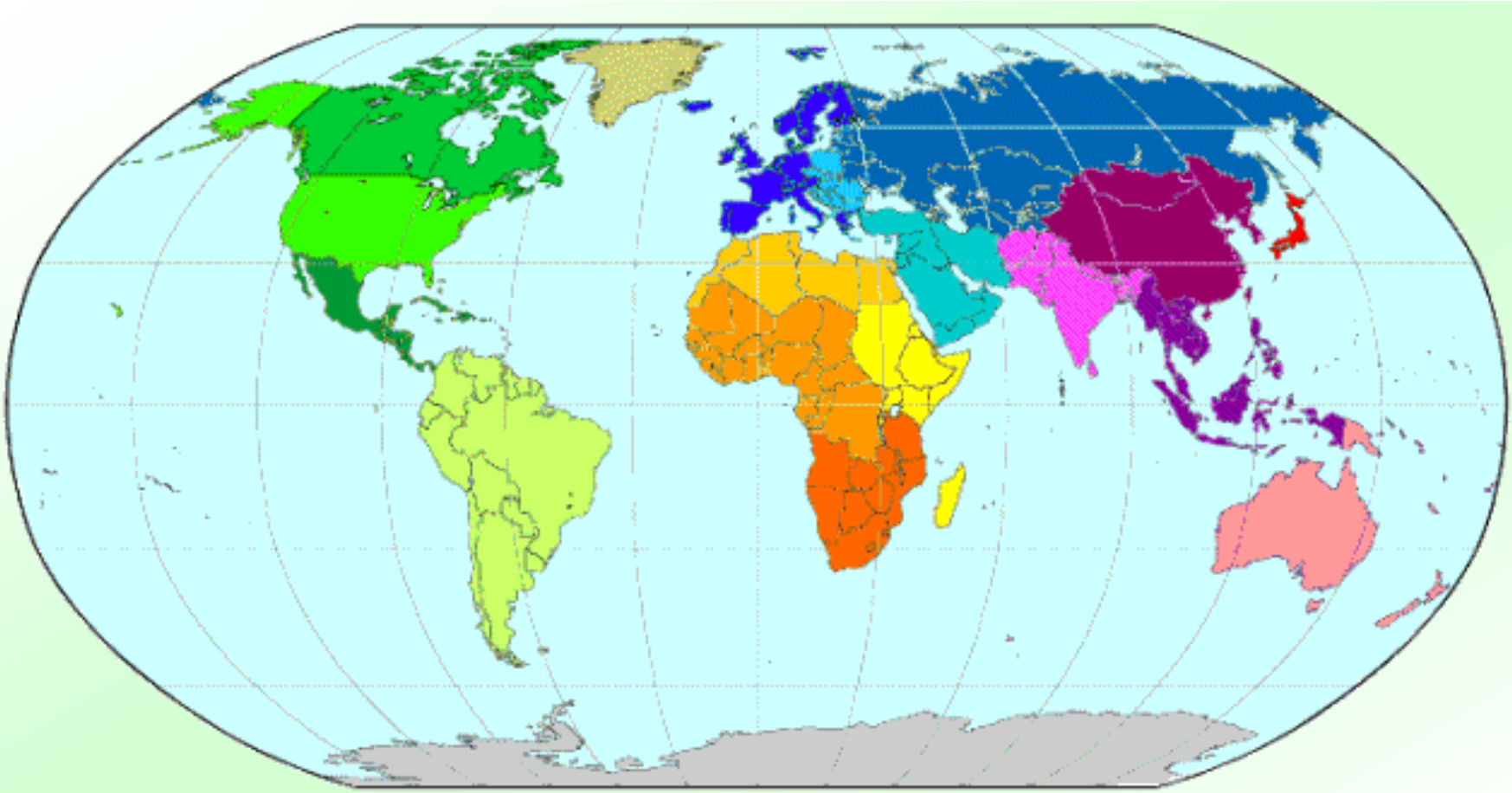
Tg /year	2005	1750	anthropogenic
SO2	127 (154)	6	121 (148)
OC	51	42	9.1
BC	10.6	5.2	5.4

- **AeroCom 1**

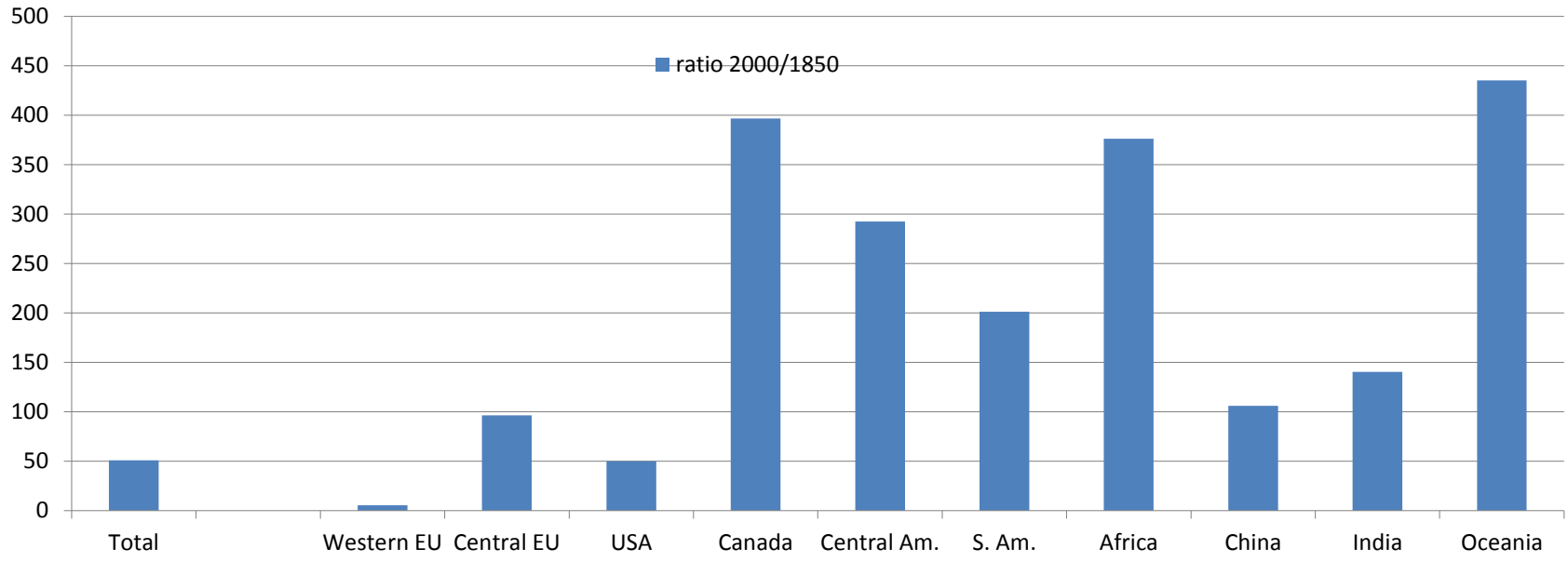
	2000	1750	anthropogenic
SO2	113 (142)	2	110 (137)
OC	47	24	13.0
BC	7.7	2.4	5.3

(SO2 volcanic included)

regional choices



regional SO2 changes



ACCMIP (emission 2000 / emission 1850) ratios

regional SO2 changes

	SO2			
	AMIP 1850	**AMIP 2000**	**AC 1750**	**AC 2000**
Total	2.04	104.1	**0.12** (1.5) [31]	**109** (113)[142]
				(+fire) [+ volc]
Western Europe	1.29	7.06		
Central Europe	0.058	5.59		
USA	0.3	14.99		
Canada	0.006	2.38		
Central America	0.013	3.8		
South America	0.019	3.82		
Africa	0.015	5.64		
China	0.18	19.1		
India	0.047	6.59		
Oceania	0.006	2.61		

regional OC changes

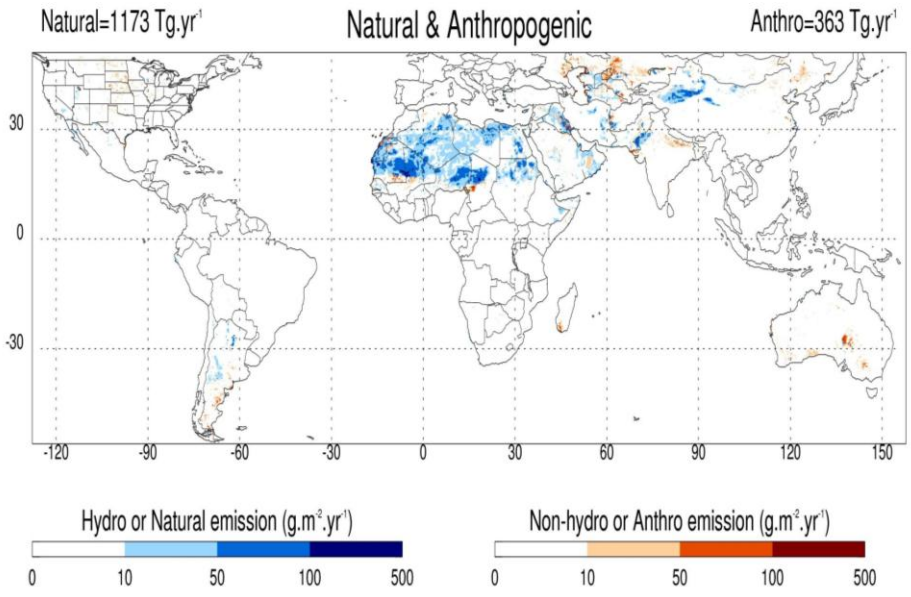
	OC			
	AMIP 1850	**AMIP 2000**	**AC 1750**	**AC 2000**
Total	4.64	12.72	**1.6** (14) [33]	**13** (47) [66]
				(+fire) [+soa]
Western Europe	0.746	0.4		
Central Europe	0.337	0.386		
USA	1.235	0.511		
Canada	0.098	0.063		
Central America	0.0265	0.345		
South America	0.0454	0.826		
Africa	0.106	1.916		
China	0.837	3.069		
India	0.388	2.047		
Oceania	0.0035	0.075		

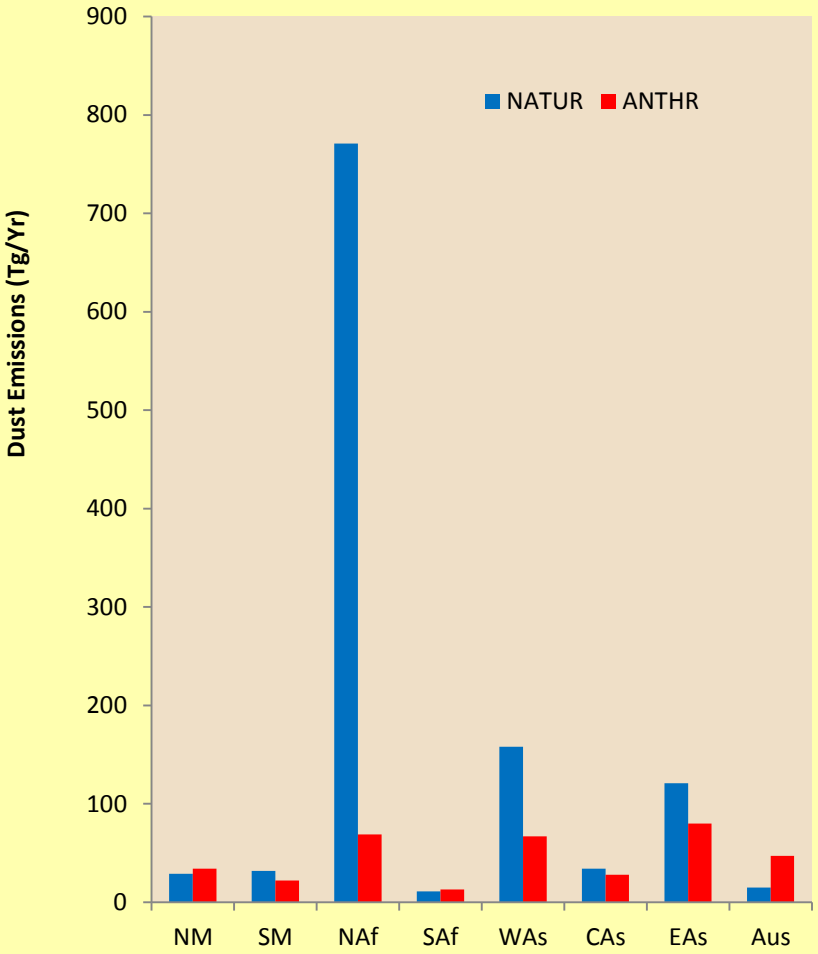
regional BC changes

	BC			
	AMIP 1850	**AMIP 2000**	**AC 1850**	**AC 1850**
Total	1.050	5.160	**0.38** (1.4)	**4.7** (7.7)
				(+ fire)
Western Europe	0.296	0.380		
Central Europe	0.059	0.141		
USA	0.234	0.370		
Canada	0.018	0.044		
Central America	0.004	0.110		
South America	0.010	0.335		
Africa	0.024	0.523		
China	0.178	1.379		
India	0.085	0.629		
Oceania	0.000	0.042		

anthropogenic dust ..?

- via MODIS deep blue spectral signature
  - By P.Ginoux





take home message

- there is diversity for pre-industrial emissions
- unless the pre-industrial state is well established … how certain are anthropogenic effects (e.g. forcing, CCN concentration)
- anthropogenic dust contribution (e.g. from land-use change) complicate matters
- extra efforts needed to better estimate the pre-industrial atmospheric state