



Development and Evaluation of Global and Regional emissions for Atmospheric Modeling and Forecasting

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Questions (and **Answers?): Global Emissions**

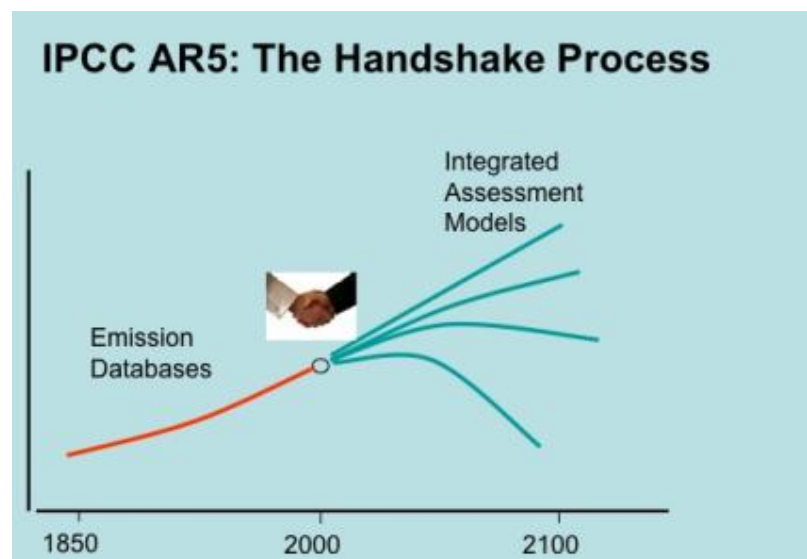
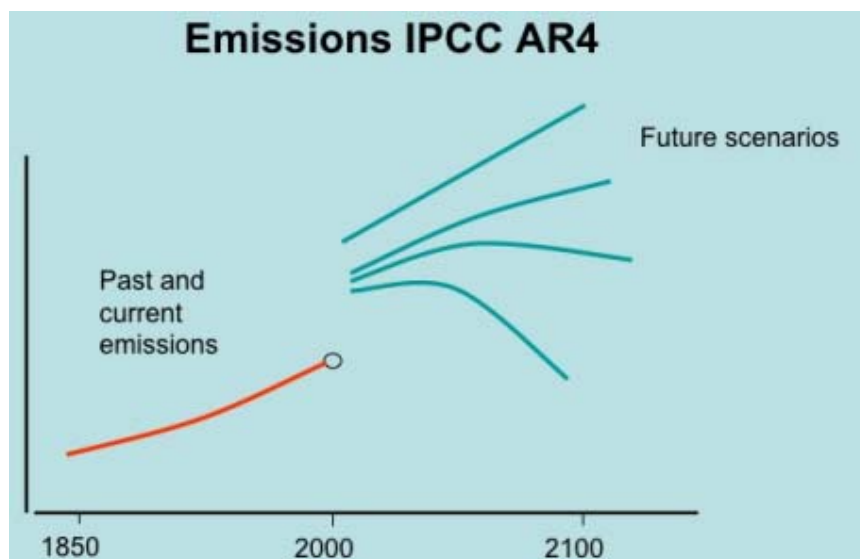
- 1. Do we have consistent historical emissions?**
 - 2. Can we trust current datasets/can we recommend a “best” dataset?**
 - 3. Can we compare emissions by sectors?**
 - 4. What about anthropogenic VOCs?**
- + Where can you find many of the datasets used here**

Followed by: Regional Emissions (Hugo)

1. Do we have consistent historical emissions?

The ACCMIP dataset

ACCMIP = Atmospheric Chemistry and Climate Model Intercomparison Project
Simulations in support to the the IPCC 5th Assessment report (2013)



- Consistency between past/current/future
- Dataset with documentation and references

More details: Lamarque et al., ACP 2010 ; van Vuuren et al., Clim. Change, 2011
Granier et al., Climatic Change, 2011; Lamarque et al, Climatic Change, 2011

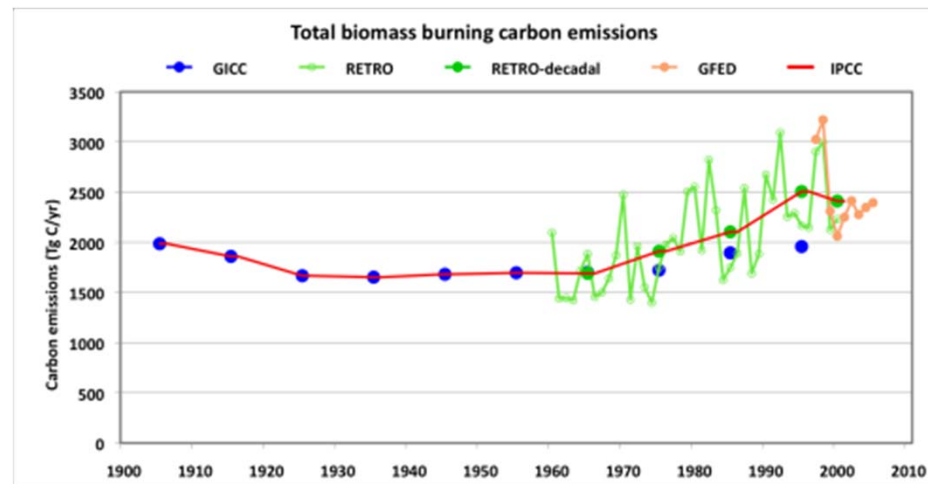
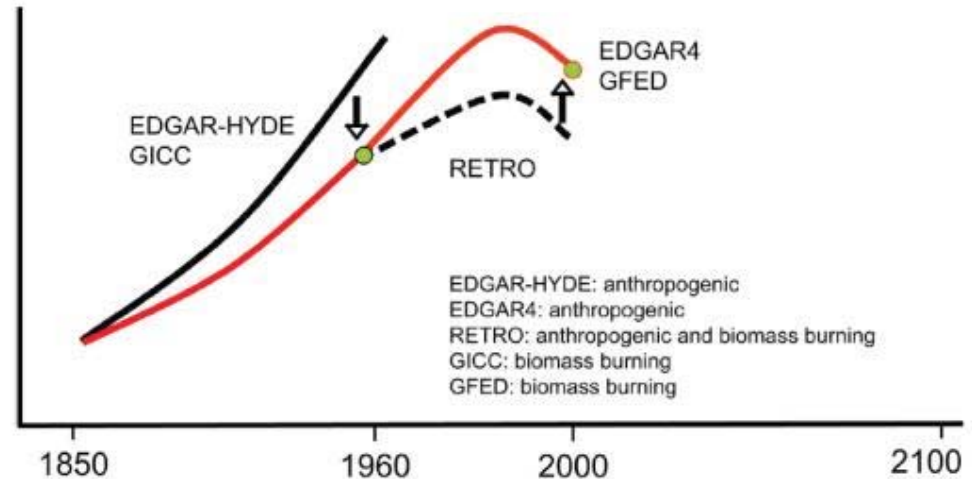
ACCMIP = Consistent long-term emissions dataset

Developed in 2008-2009 by
an international group

ACCMIP emissions dataset:

- Anthropogenic and biomass burning emissions
- Period covered: 1850 – 2000
- Available for each decade
- no seasonal variation
- 0.5x0.5 degree

Large set of species:
CH₄, CO, NO_x, SO₂, NH₃
Many VOCs
BC and OC



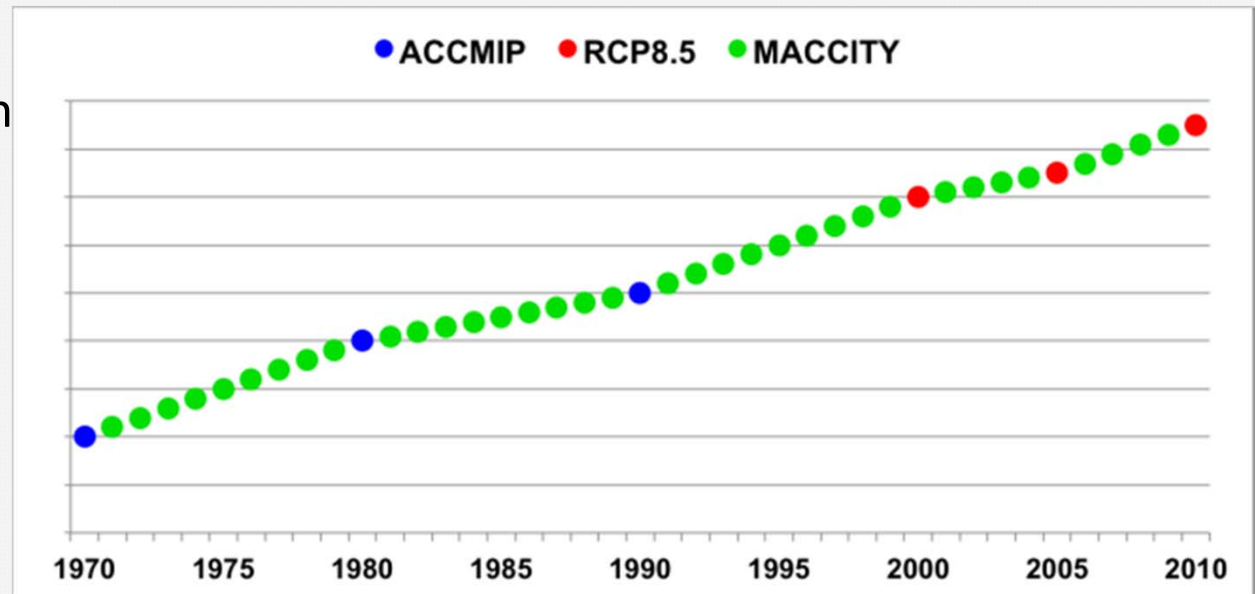
Global MACCity emissions inventory

(Developed as part of EU projects: MACC and CityZen + PEGASOS)

- 1960-2000: ACCMIP (described in Lamarque et al., 2010), decadal
- After 2000, no global emissions dataset available
- **(Emissions Update: common issue specially for global emissions)**
→ Use of one of the IPCC future scenarios (RCP 8.5) for 2005 and 2010 that uses some regional information for Europe, N. America & Asia

MACCity anthropogenic emissions:

- Linear interpolation for of ACCMIP emissions
- Implementation of seasonal emissions from the RETRO emissions (Schultz et al., 2007)



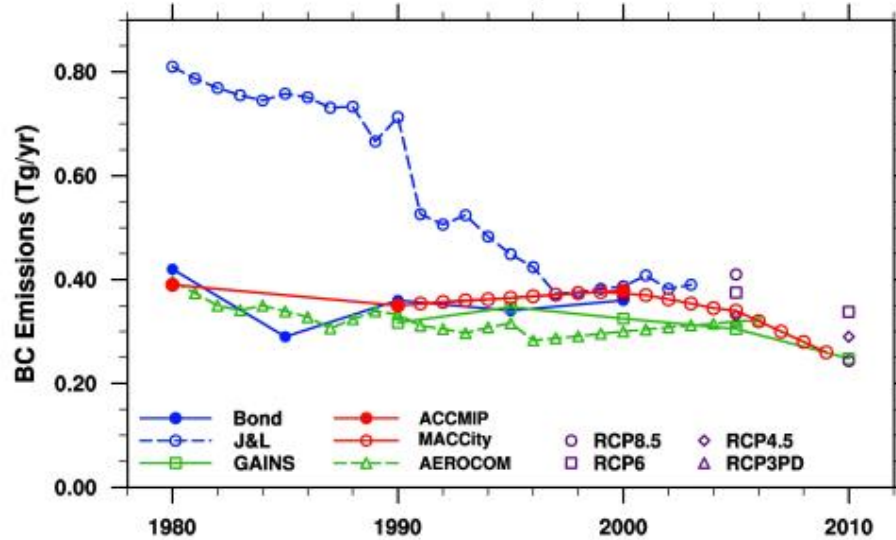
More information on MACCity in Granier et al., Climatic Change, 2011

2. Can we trust current datasets/can we recommend a “best” dataset

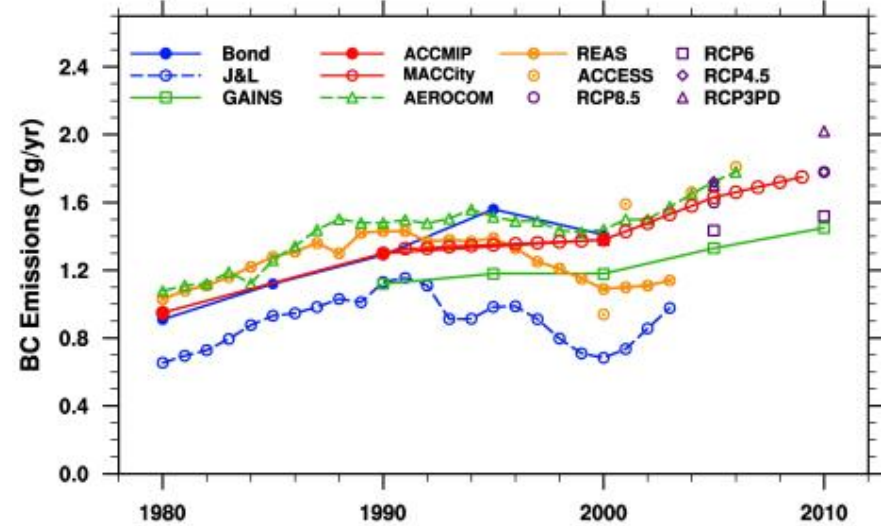
- Perform systematic evaluations of publicly available surface emissions**
- Open to all people willing to propose new data / analyze results**
- Start with the 1980-2010 period**
- Only publicly available gridded inventories considered so far**
- Focus on: CO, NO_x, SO₂ and BC (under way: CH₄, OC, total NMVOCs and NH₃)**
- Focus on total emissions, start to look at spatial distribution**

More details: Granier et al., 2011(26 authors)

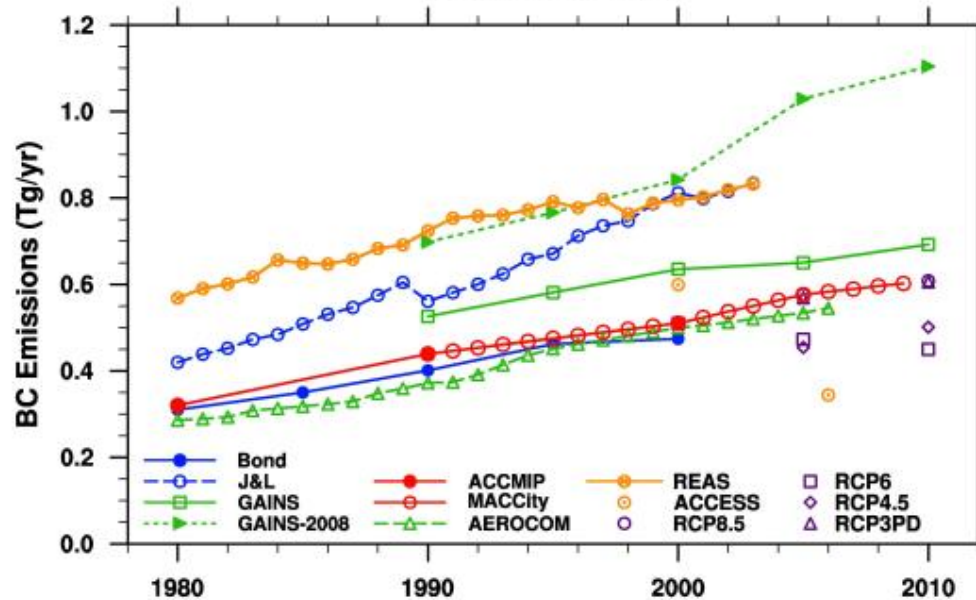
BC Western Europe emissions



BC China emissions

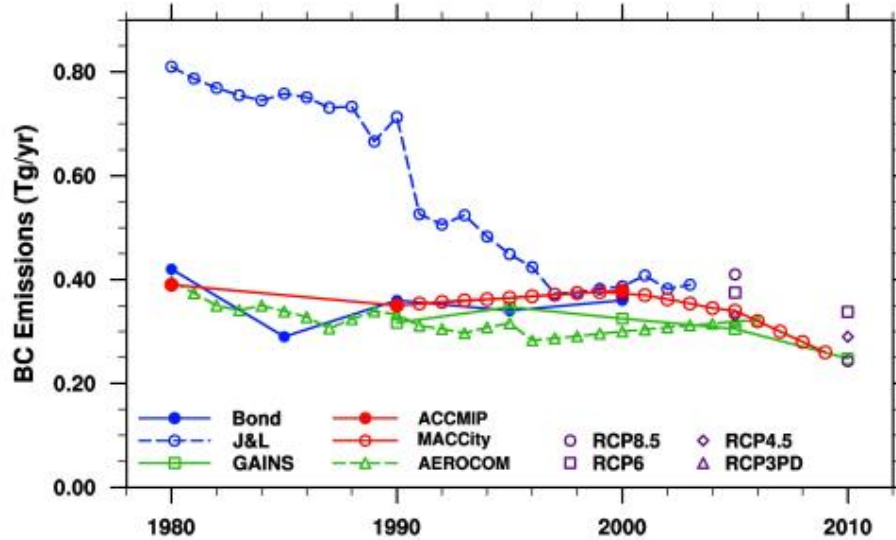


BC India emissions

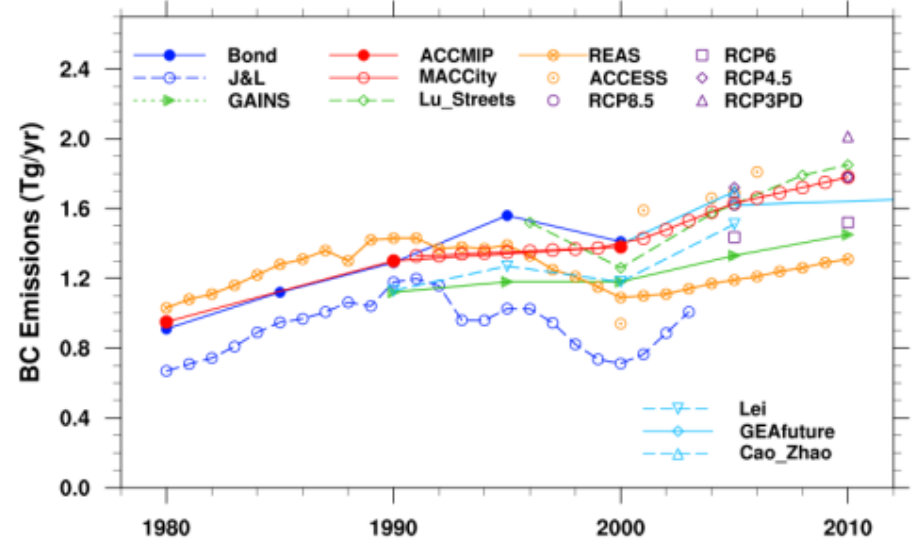


With more recent inventories

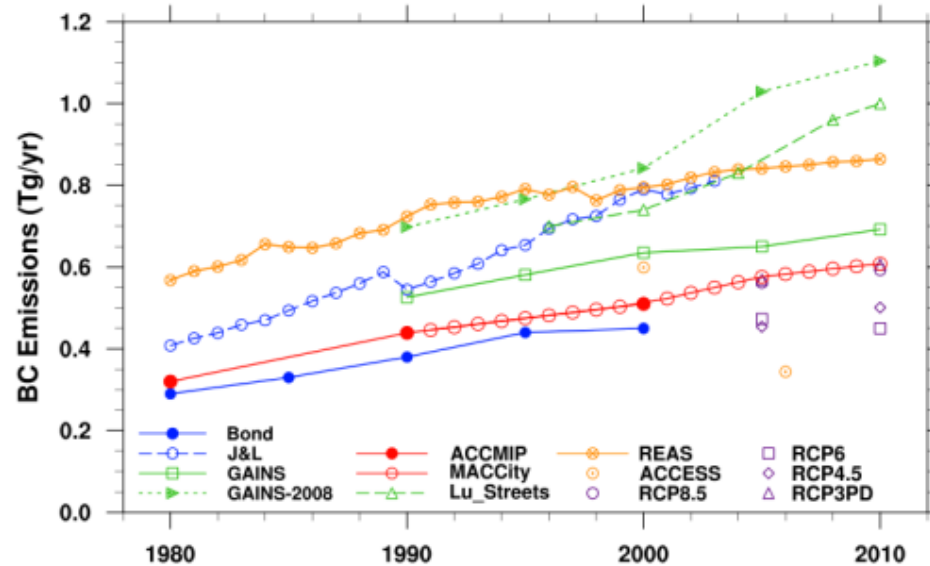
BC Western Europe emissions



BC China emissions

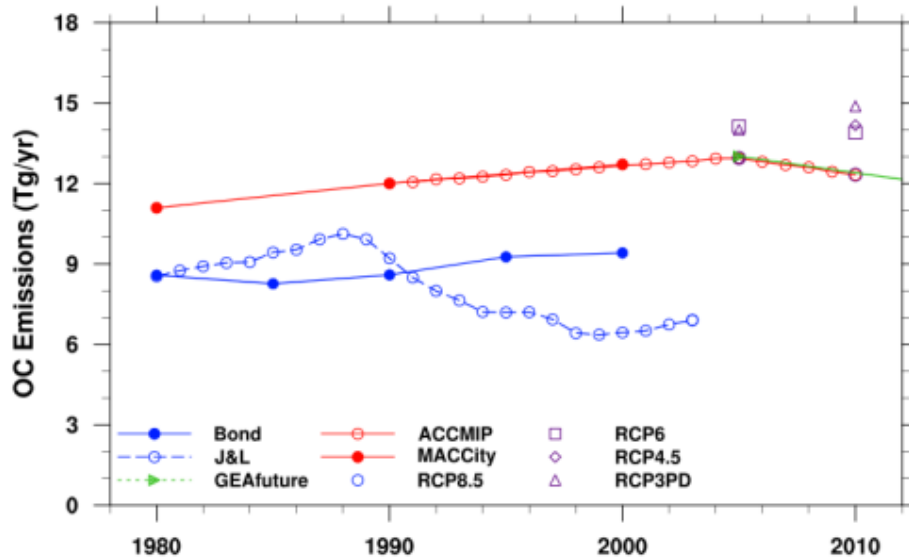


BC India emissions

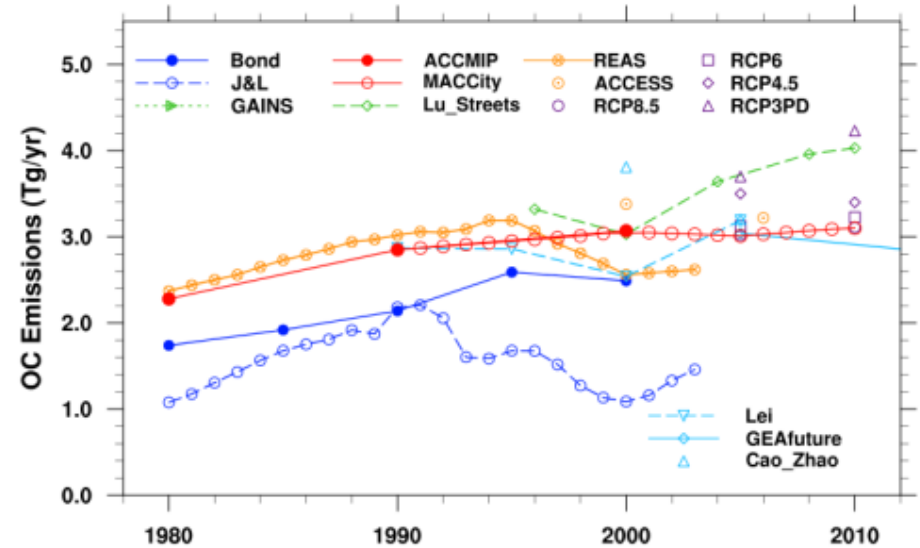


OC emissions (work under way)

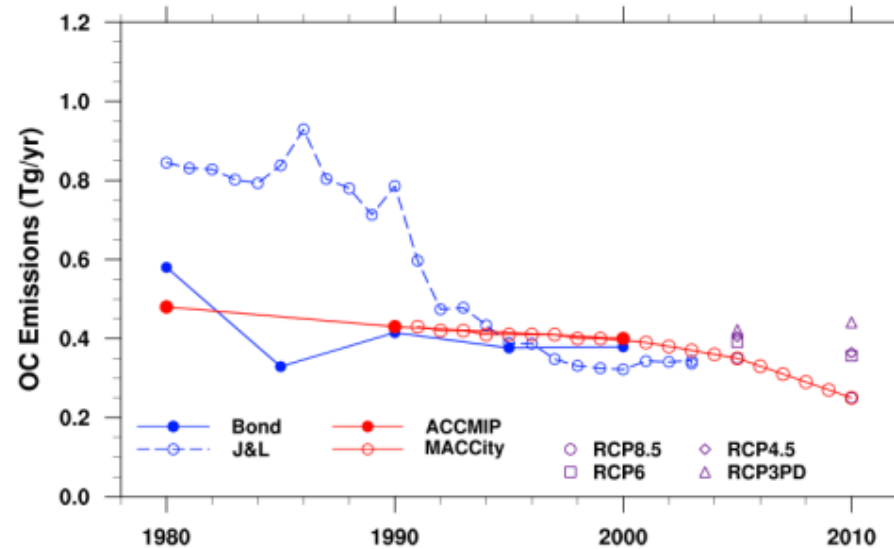
OC Total emissions



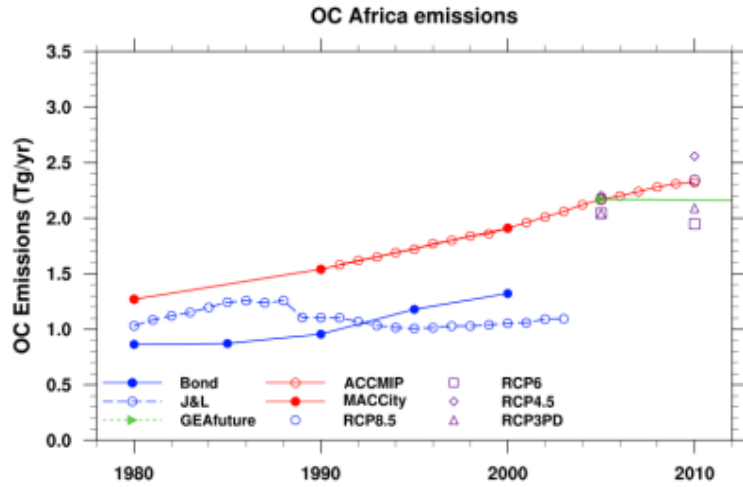
OC China emissions



OC Western Europe emissions



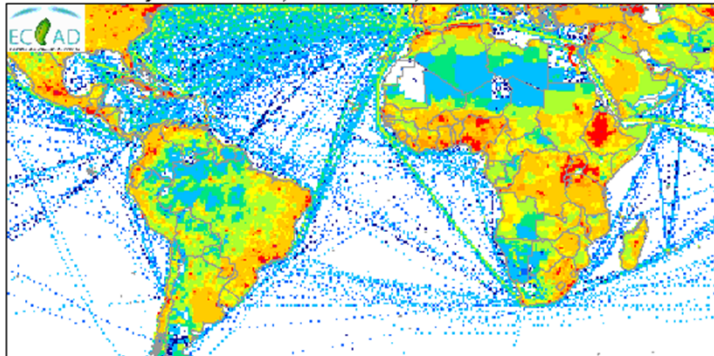
More OC comparisons



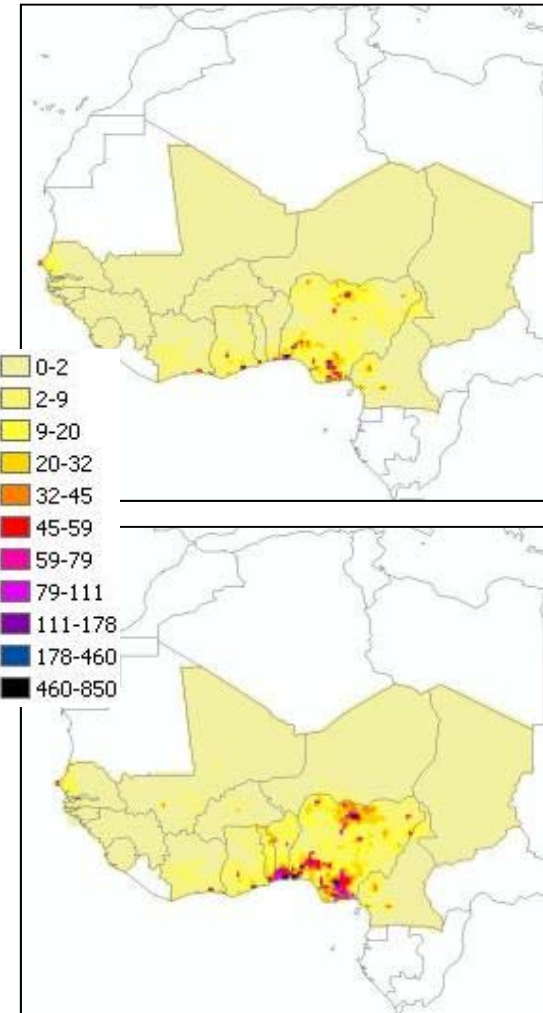
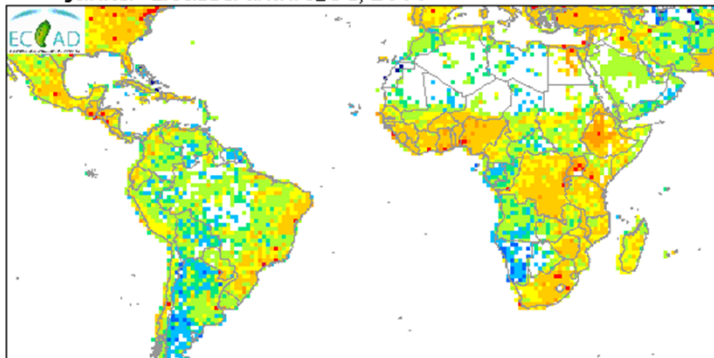
OC Emissions from Africa + South America = 29% of total

Based on a few new observations from C. Liousse's group

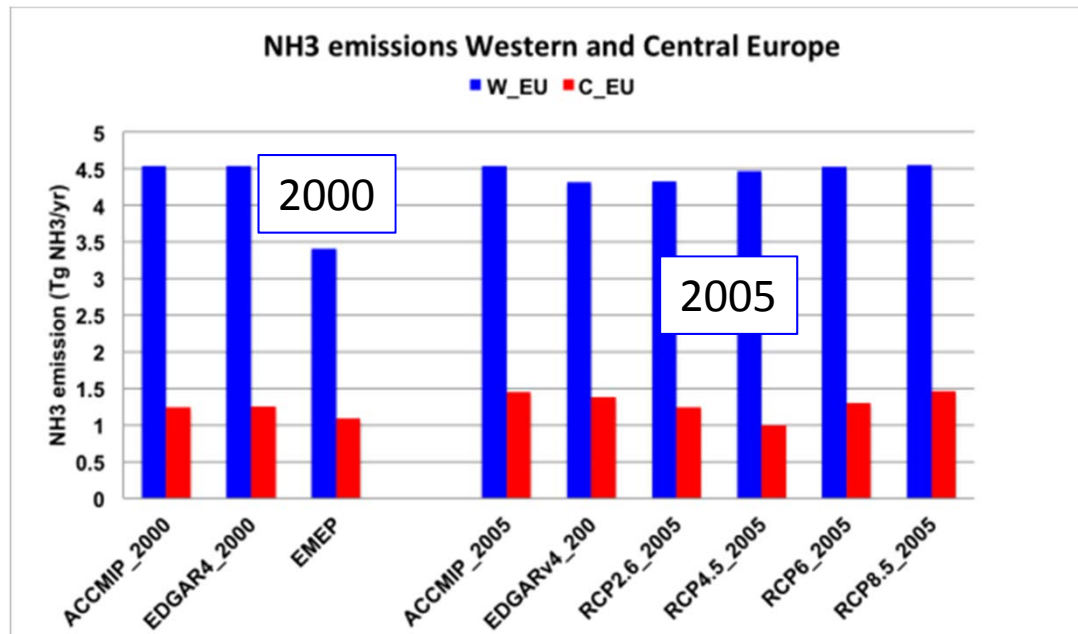
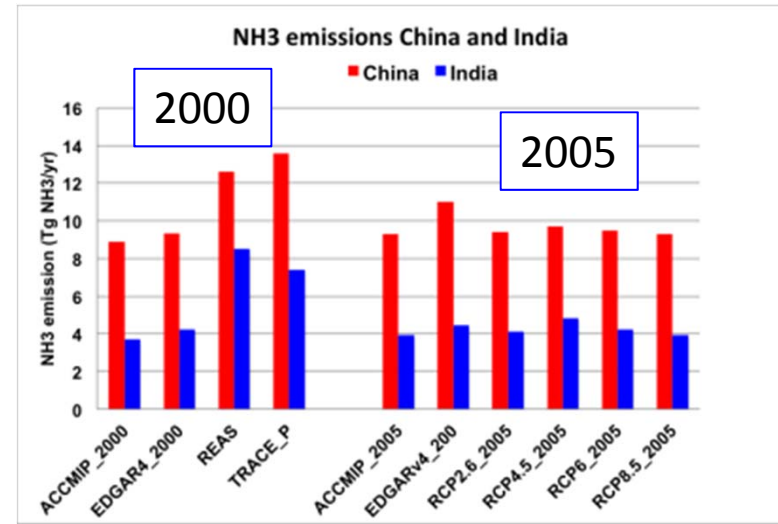
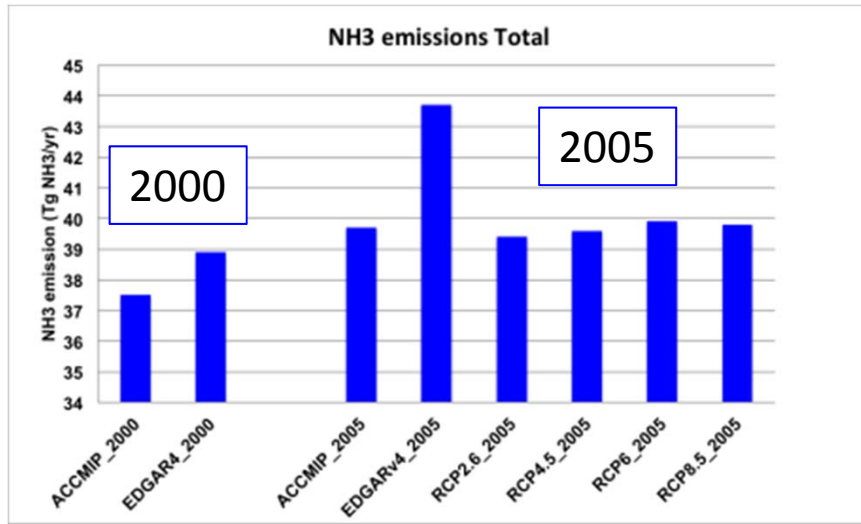
MACCity: anthro_OC, Sum sector, 2000-03



Junker-Liousse: anthro_OC, 2000



NH3 emissions (work under way)



Summary: ratio between highest and lowest emissions

		1980	1990	2000	2005
BC	Total	1.53	1.61	1.27	1.27
	Western Europe	2.08	2.04	1.29	1.28
	Central Europe	2.45	2.81	2.21	1.40
	USA	2.38	2.77	1.61	1.59
	China	1.64	1.31	2.12	1.29
	CO	Total	1.27	1.33	1.28
	Western Europe	1.34	1.55	1.77	1.30
	Central Europe	1.43	2.11	1.76	2.10
	USA	1.87	1.73	1.86	1.83
	China	1.34	1.54	1.43	1.17
NO_x	Total	1.10	1.25	1.23	1.19
	Western Europe	1.14	1.18	1.20	1.18
	Central Europe	1.32	1.41	1.24	1.25
	USA	1.27	1.41	1.19	1.43
	China	1.91	1.66	1.31	1.42
	SO₂	Total	1.19	1.28	1.54
Western Europe		1.25	1.49	2.35	2.35
Central Europe		2.04	1.37	2.08	2.71
USA		1.23	1.26	1.20	1.47
China		1.45	1.66	1.87	1.68

Green:
1 to 1.25

Yellow:
1.25 to 1.5

Orange:
1.5 to 1.75

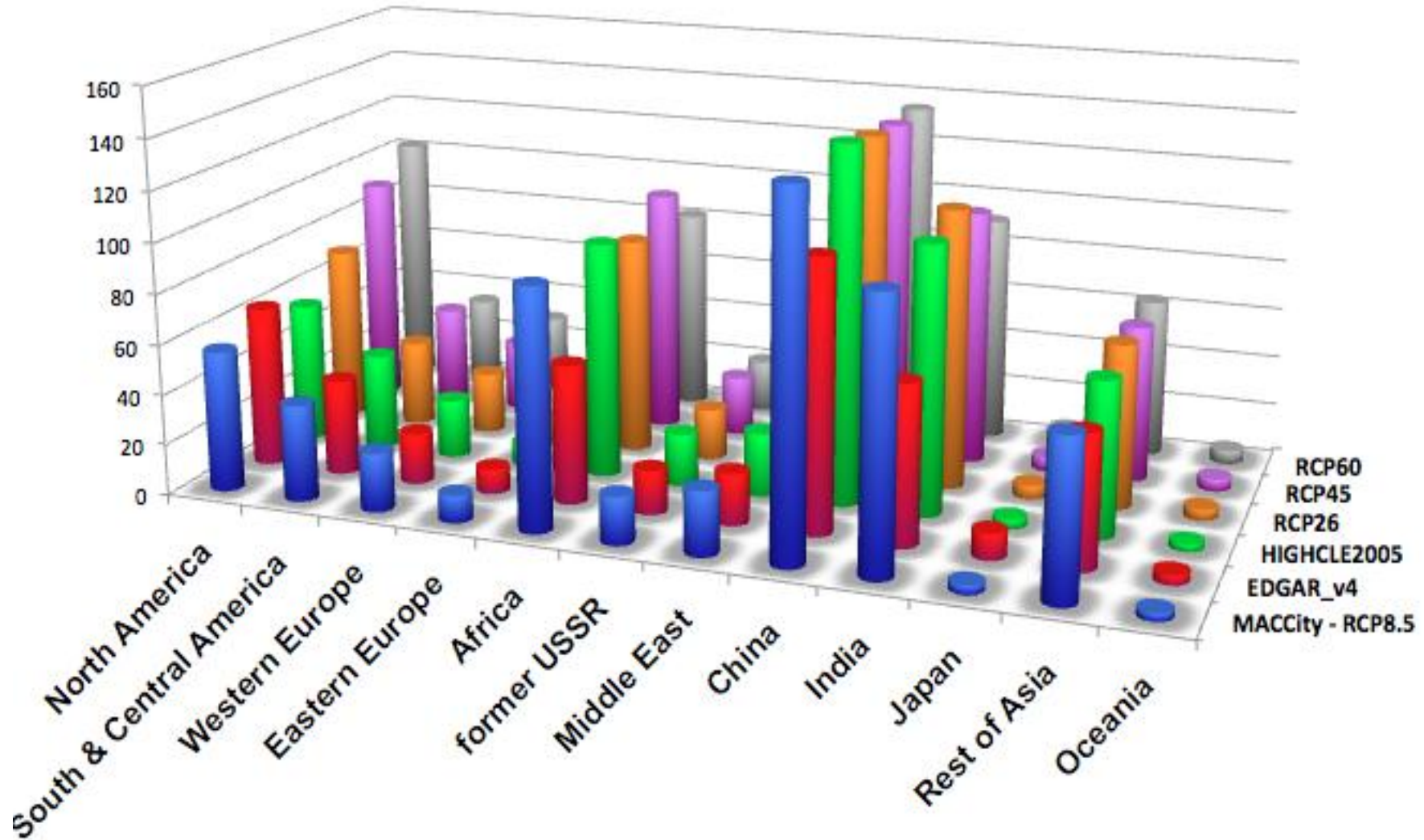
Grey:
Above 1.75

BUT: consensus ≠ accuracy

CO emissions from other global datasets for 2005

→ Inclusion of EDGAR-v42 (no BC and OC yet provided)

■ MACCity - RCP8.5 ■ EDGAR_v4 ■ HIGHCLE2005 ■ RCP26 ■ RCP45 ■ RCP60



3. Can we compare emissions by sectors?

Answer: not easily, since no common sectors description

Climate community:

Sector number	Sector name
1	Energy production and distribution
2	Industry (combustion and non-combustion)
3	Land transport
4	Maritime transport
5	Aviation
6	Residential and commercial
7	Solvents
8	Agriculture
9	Agricultural waste burning on fields
10	Waste
11	Open vegetation fires in forests
12	Open vegetation fires in savanna and grasslands
13	Natural emissions

European air quality community:

SNAP	Description
1	Public electricity and other energy transformation
2	Small combustion plants
3	Industrial combustion and processes with contact
4	Industrial process emission
5	Fossil fuel production
6	Solvent and product use
7	Road Transport
8	Other (non-road) transport and mobile machinery
9	Waste disposal
10	Agriculture
11*	Nature

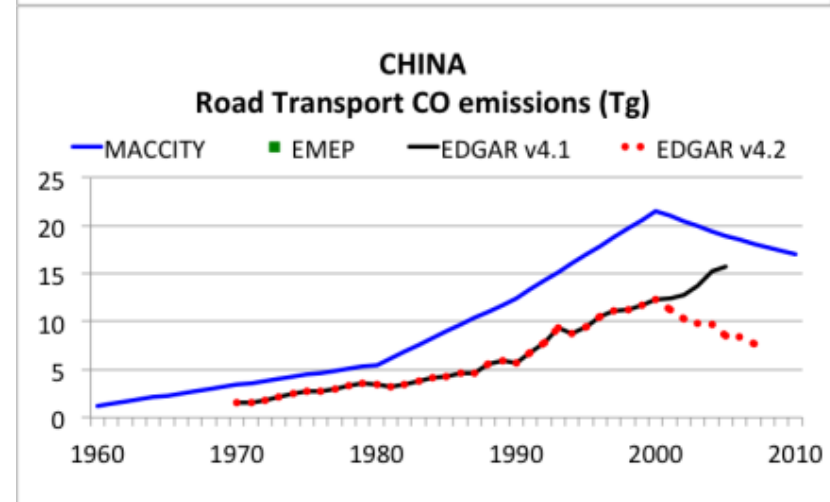
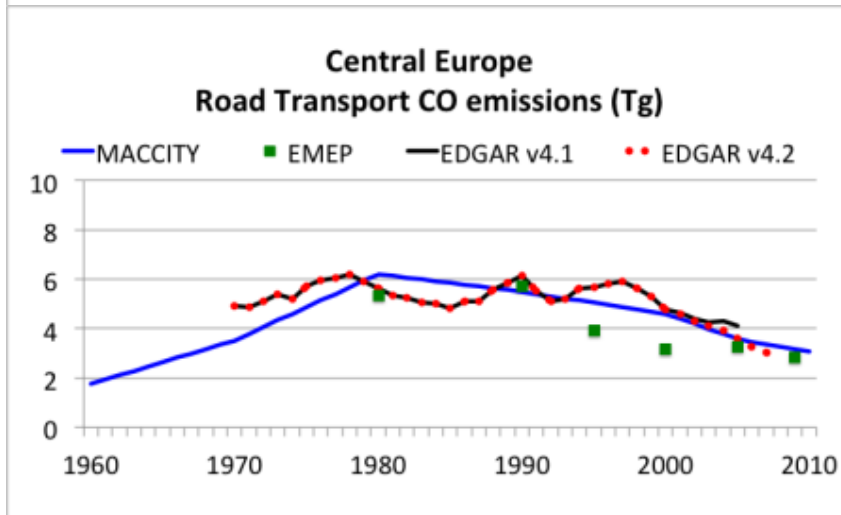
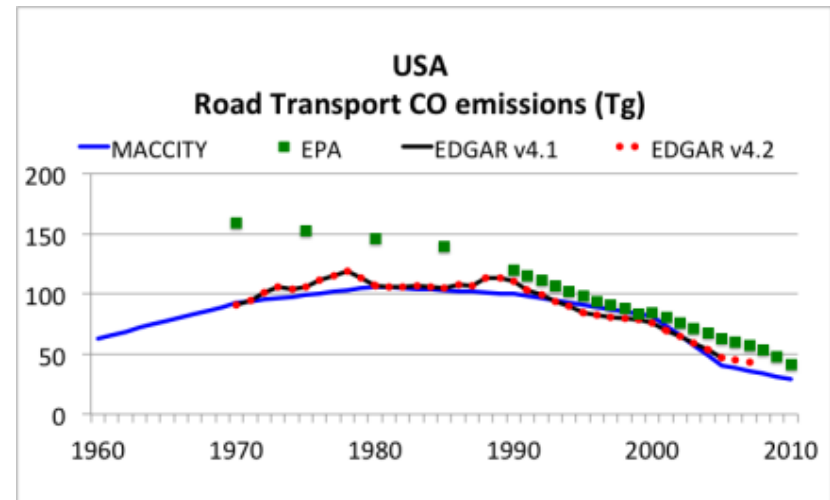
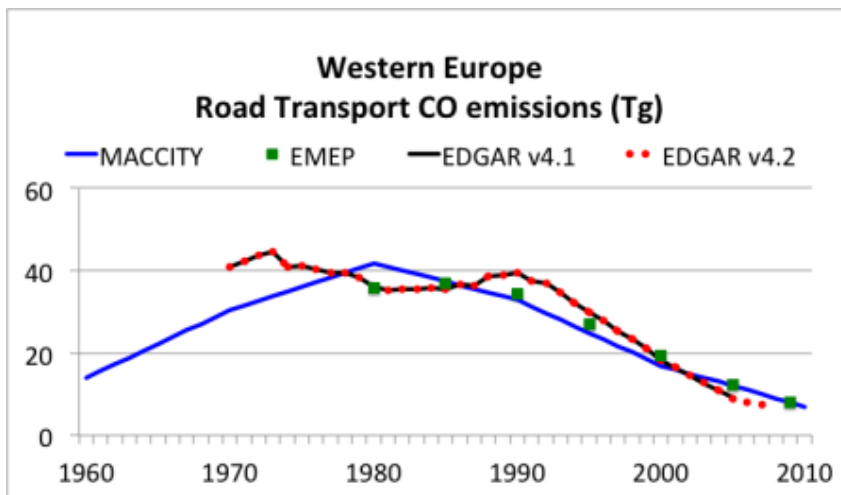
Other countries use different sectors split

Other issue:

→ Global inventories: provide BC and OC

→ Regional/regulatory inventories: provide only PMs

Road transport CO emissions for different regions



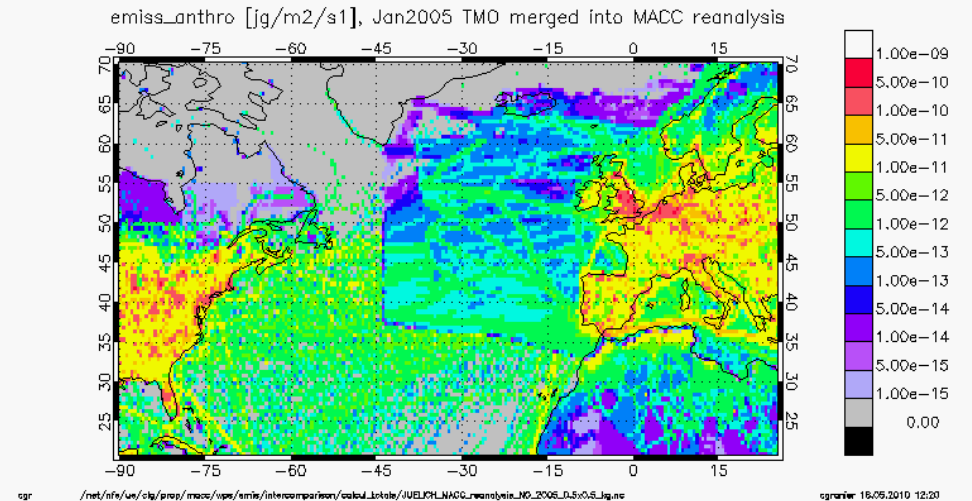
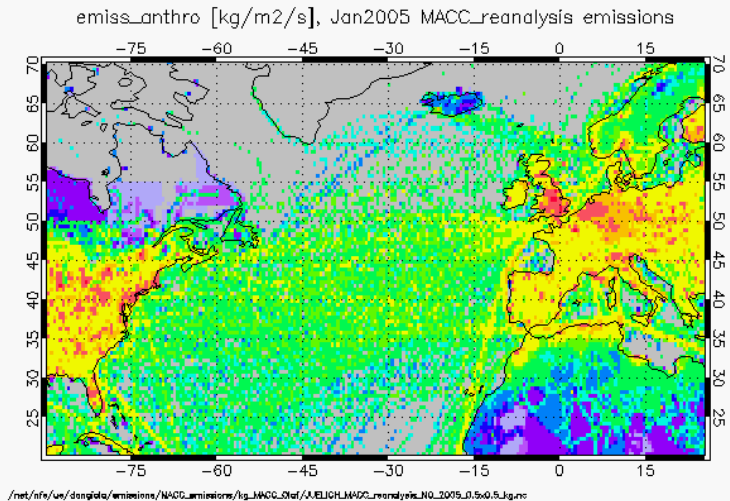
Another sector of growing importance: Maritime transport

Top 5 emitters of main air pollutants in 2005

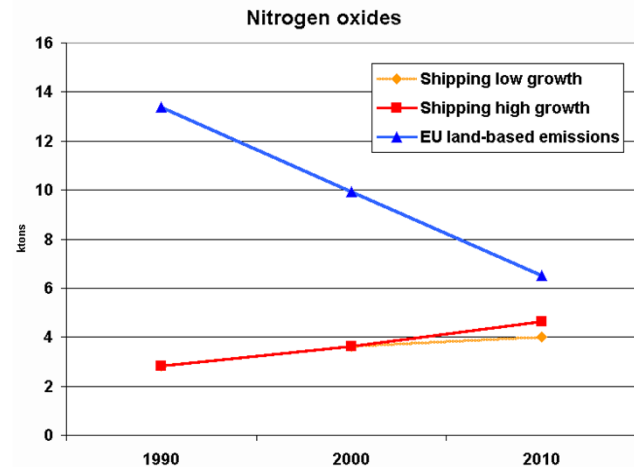
2005	Tg CO	2005	Tg NMVOC	2005	Tg NO ₂	2005	Tg SO ₂
China	103.20	China	17.22	China	22.45	China	36.36
Brazil	96.42	USA	11.56	USA	14.92	USA	10.81
USA	61.52	Brazil	10.47	Int. shipping	12.98	Int. shipping	7.87
India	52.77	Russia	8.39	India	8.19	India	7.41
Indonesia	49.65	Indonesia	8.22	Russia	4.30	Russia	6.71

Ship emissions: large discrepancies between global and regional emissions

→ Will be addressed in MACC-II in collaboration with the ACCESS European project (management of the Arctic)



Changes in NO_x emissions in Europe 1990-2010: ships will be the largest contributor to NO_x emissions by ~2015-2020



4. What about anthropogenic VOCs

VOCs emissions reported only as total NMVOCs

Not much information on VOCs speciation

Many studies: VOCs speciation based on the RETRO emissions inventory (<http://retro.enes.org>), based on a speciation developed by TNO in the 1990s

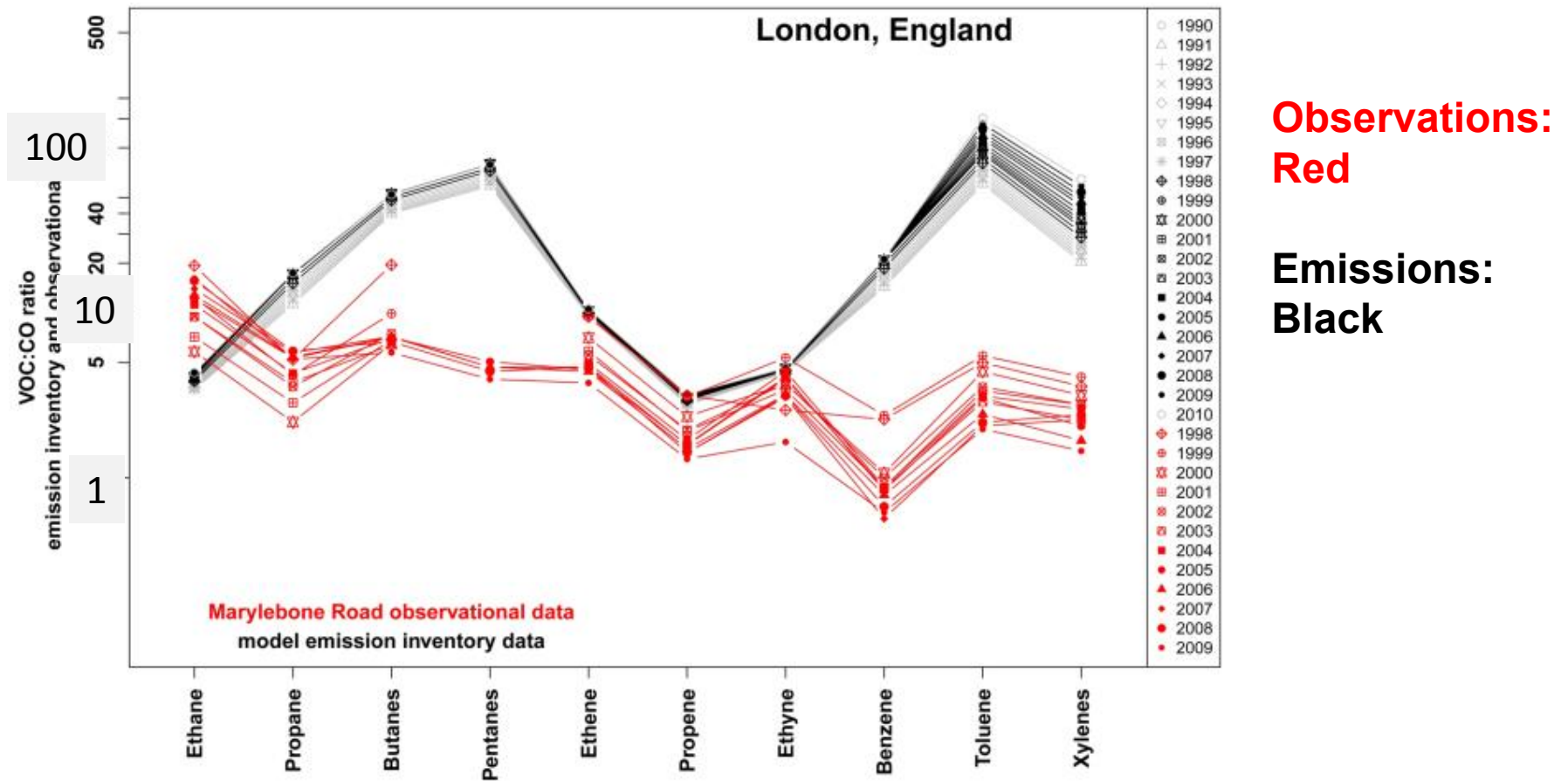
Methodology:

$$[\text{Emission VOC}_x] = [\text{Total VOCs emissions}] * R (\text{lat,lon})$$

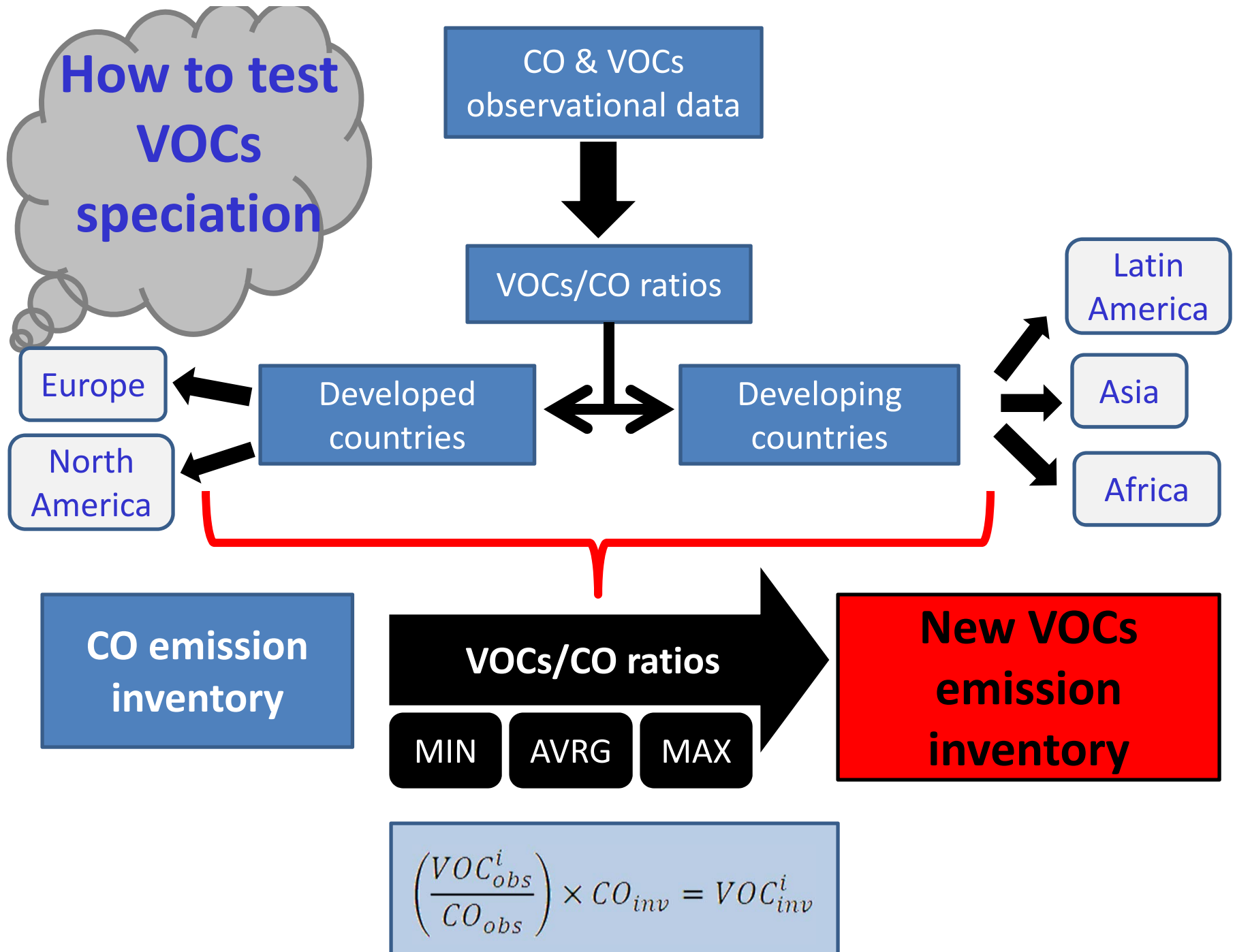
- ✓ No recent data available
- ✓ R remains CONSTANT for ALL years

Ongoing study: collaboration with U. Leicester, UK

- Collect individual VOCs data when available (not many!)
- Von Schneidemesser et al. (Atm. Env., 2010)
- Compare VOCs/CO ratio: observed concentrations and emissions

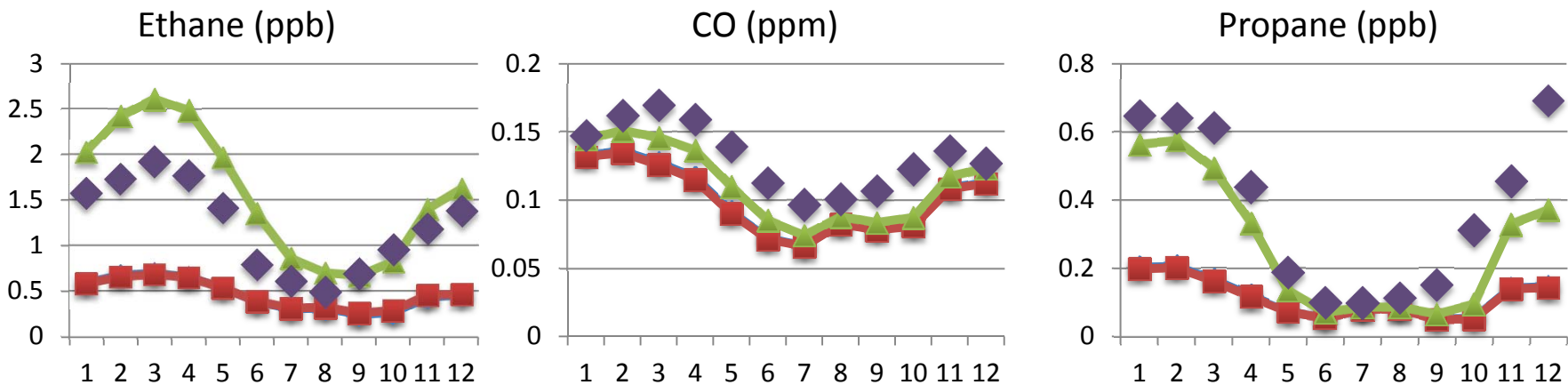


LONDON (Marylebone Road)

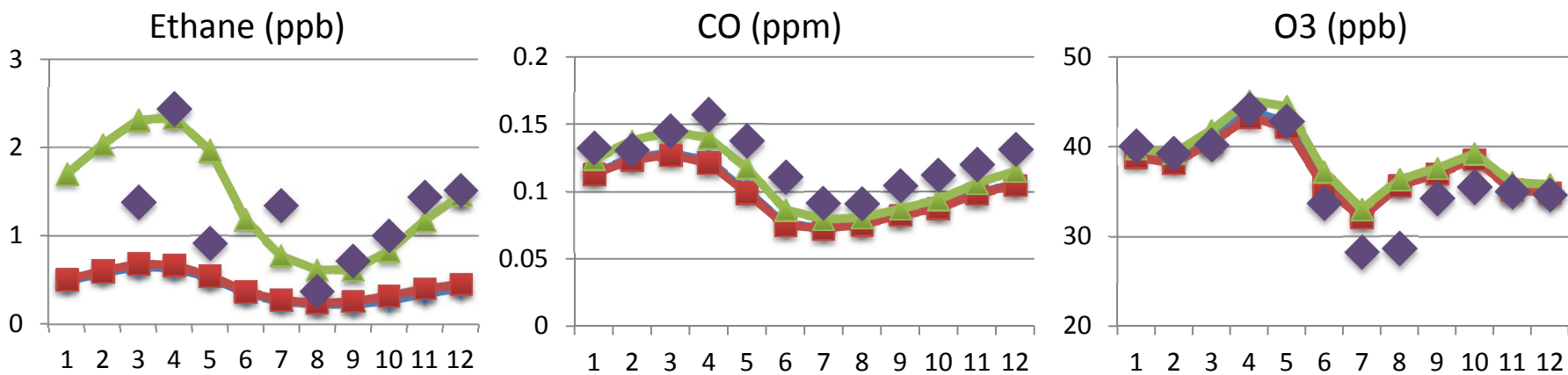


b) Observational stations (year 2005)

i) Trinidad Head (USA)



ii) Mace Head (Ireland)



■ STD
 ■ AVRG
 ■ MAX
 ■ Observations

1. Do we have consistent historical emissions?
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 4. What about anthropogenic VOCs?
- + Where can you find many of the datasets used here**

The ECCAD database

- <http://eccad.sedoo.fr>
- Login : enter email
- Registration : fill in form

The screenshot shows the ECCAD - GEIA DATABASE website. The header includes the site title, user name 'Claire Granier', and navigation links for 'Data Selection' and 'List of Species'. The main content area is titled 'Emissions of atmospheric Compounds & Compilation of Ancillary Data' and is divided into 'Emissions Inventories' and 'Ancillary Datasets'. The 'Emissions Inventories' section is further split into 'GLOBAL INVENTORIES' and 'REGIONAL INVENTORIES'. The 'GLOBAL INVENTORIES' list includes ACCMIP RCPs, RETRO, EDGAR3.2FT2000, MACCity, Junker-Liousse, HYDE1.3, Andres_CO2, AMAP_Mercury, GFASv1.0, GFED3, GFED2, GICC, AMMABB, MEGANv2, MEGANv2-CH3OH, and POET. The 'REGIONAL INVENTORIES' list includes TNO-MACC (Europe), EMEP (Europe), SAFAR-India (India), and REAS (Asia). Below these lists, there are sections for 'Developed for ongoing projects' with IS4FIRES, GUESS-ES, and ChArMEx (Mediterranean). The 'Ancillary Datasets' section is divided into four categories: LAND COVER (UMD, CLM3, GLC2000), FIRES (WFA, GEOLAND, GBA2000), POPULATION (GPW3_Population), and GEOGRAPHICAL INFORMATION (GPW3, Region_ACCMIP, Pixel_Area). The left sidebar contains navigation links like 'Home', 'Data Access', 'Data Catalogue', 'Emission Calcul.', 'Project', 'Users', 'Partners', and logos for cnes, GEIA, CNRS, IGAC, AIRMES, and ILEAPS. The footer includes the text 'This site is developed and tested with Mozilla Firefox and Google Chrome', 'ECCAD v6.0.1', and '©2006-2012 CNRS/SEDOO'.

THE ECCAD - GEIA DATABASE Claire Granier

Shortcuts : [Data Selection](#) [List of Species](#)

Emissions of atmospheric Compounds & Compilation of Ancillary Data

Emissions Inventories

■ Anthropogenic ■ Biomass burning ■ Natural

GLOBAL INVENTORIES

- ACCMIP RCPs RETRO EDGAR3.2FT2000
- MACCity Junker-Liousse HYDE1.3 Andres_CO2 AMAP_Mercury
- GFASv1.0 GFED3 GFED2 GICC AMMABB
- MEGANv2 MEGANv2-CH3OH
- POET

Developed for ongoing projects

- IS4FIRES
- GUESS-ES

REGIONAL INVENTORIES

- TNO-MACC (Europe) EMEP (Europe)
- SAFAR-India (India) REAS (Asia)

Developed for ongoing projects

- ChArMEx (Mediterranean)






















Ancillary Datasets

LAND COVER	FIRES	POPULATION	GEOGRAPHICAL INFORMATION
■ UMD CLM3 GLC2000	■ WFA GEOLAND GBA2000	■ GPW3_Population	■ GPW3 Region_ACCMIP Pixel_Area









This site is developed and tested with Mozilla Firefox and Google Chrome

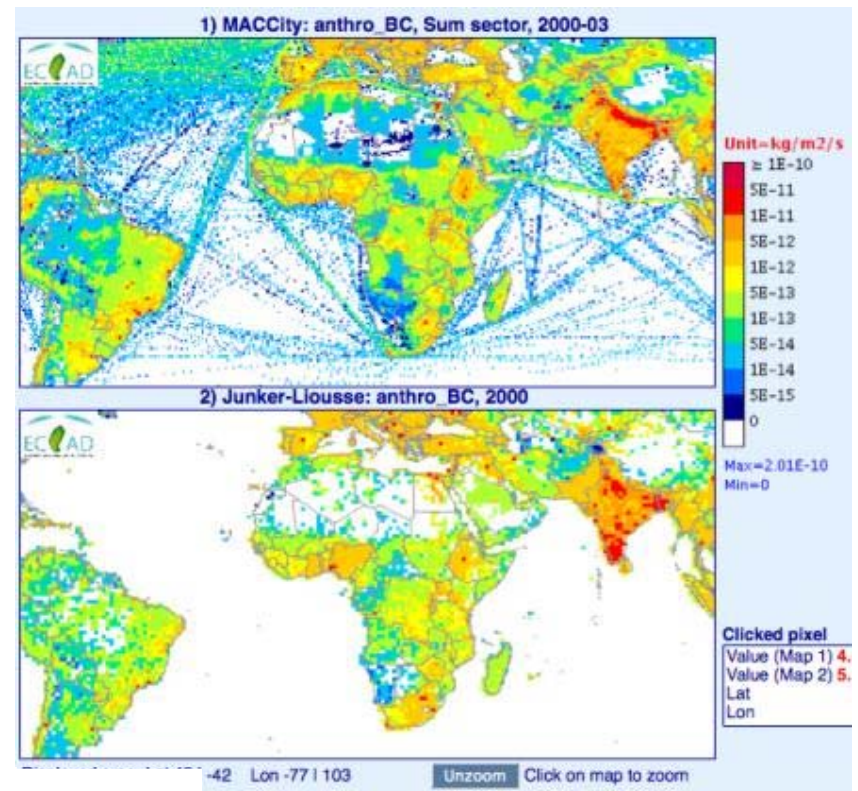
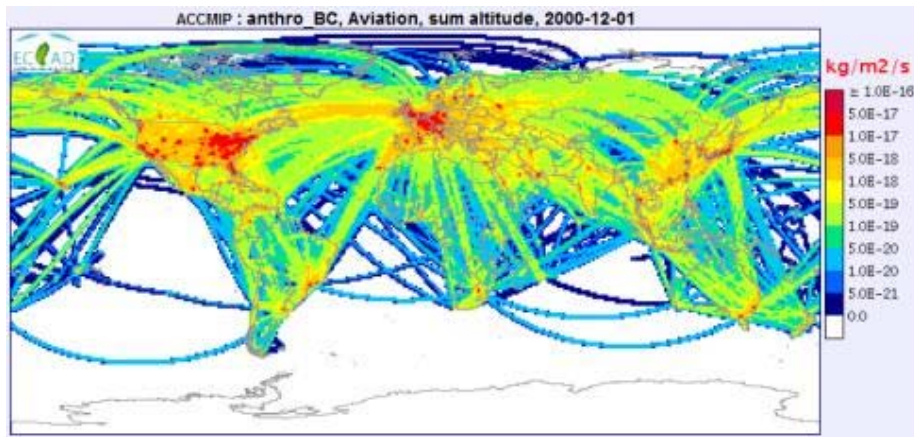
ECCAD v6.0.1
©2006-2012 CNRS/SEDOO

Datasets

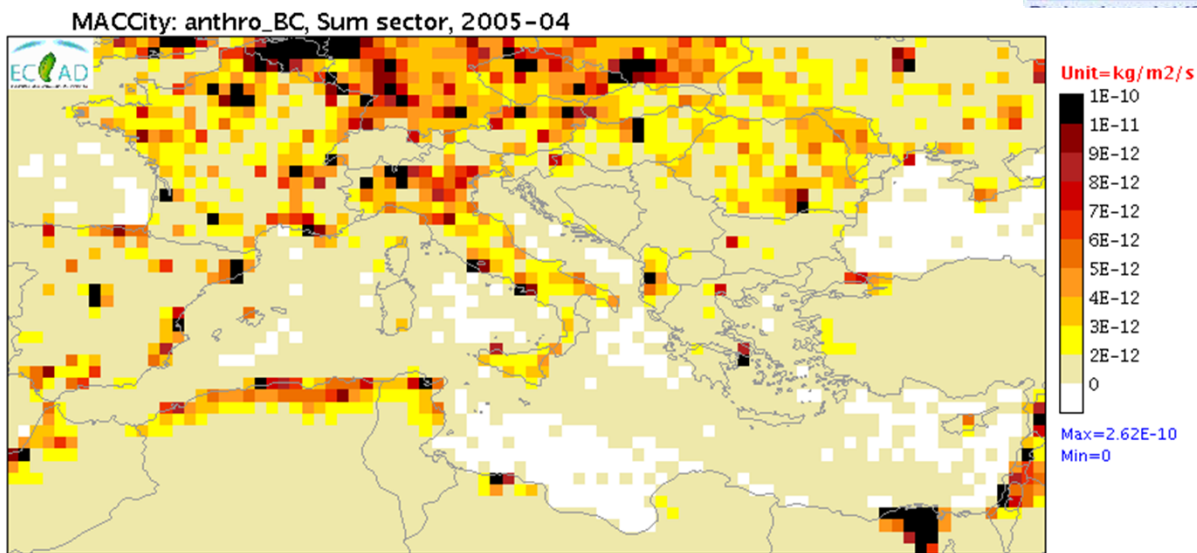
Product <i>release year</i>	Temporal Coverage	Time Resolution	Category <i>Species: mouse over</i>	Grid size	Data provider	Metadata
GLOBAL INVENTORIES						
ACCMP <i>2010</i>	1850 - 2000	Decadal Decadal (seasonal)	Anthropogenic Biomass burning	0.5°		
RCPs <i>2010</i>	2005 - 2100	Decadal Decadal (seasonal)	Anthropogenic Biomass burning	0.5°	RCPs	
RETRO <i>2005</i>	1960 - 2000	Monthly	Anthropogenic Biomass burning	0.5°		
EDGAR3_2FT2000 <i>2005</i>	2000	Year	Anthropogenic Biomass burning	1°		
MACCity <i>2010</i>	1990 - 2010	Monthly	Anthropogenic			
Junker-Liousse <i>2008</i>	1860 - 2003	Decadal/Yearly	Anthropogenic			
HYDE1.3 <i>2001</i>	1890 - 1990	Decadal	Anthropogenic			
Andras_CO2 <i>2007</i>	1751 - 2003	Decadal / Yearly	Anthropogenic			
AMAP_Mercury <i>2005</i>	1995 - 2000	Half-decadal	Anthropogenic			
GFED3 <i>2010</i>	1997 - 2009	Monthly	Biomass burning			
GFED2 <i>2005</i>	1997 - 2005	Monthly	Biomass burning			
GICC <i>2010</i>	1900 - 2005	Decadal (seasonal) / Monthly	Biomass burning	0.5°		
AMM4BB <i>2009</i>	2000 - 2006	Daily	Biomass burning	0.5°		
MEGANv2 <i>2009</i>	2000	Year (seasonal)	Biogenic	0.5°		
MEGANv2-CH3OH <i>2011</i>	2003 - 2009	Yearly (seasonal)	Biogenic	0.5°		
POET <i>2003</i>	1990 - 2000	Yearly Monthly Yearly (seasonal)	Anthropogenic Biomass burning Biogenic / Oceanic	1°		
GLOBAL INVENTORIES DEVELOPED FOR ONGOING PROJECTS						
GUESS-ES <i>2011</i>	1970 - 2009	Monthly	Biomass burning Biogenic	1°		

Datasets

Product <i>release year</i>	Temporal Coverage	Time Resolution	Category <i>Species: mouse over</i>	Grid size	Data provider	Metadata
REGIONAL INVENTORIES						
TNO-MACC Europe <i>2009</i>	2003 - 2007	Yearly	Anthropogenic	0.5°		
EMEP Europe <i>2007</i>	1980 - 2020	Yearly	Anthropogenic	0.5°		
REAS Asia <i>2007</i>	1980 - 2020	Yearly	Anthropogenic	0.5°		
REGIONAL INVENTORIES DEVELOPED FOR ONGOING PROJECTS						
ChArMEx Mediterranean <i>2012</i>	2000	Varied	Anthropogenic Biomass burning Biogenic / Oceanic	0.25/0.5/1°		

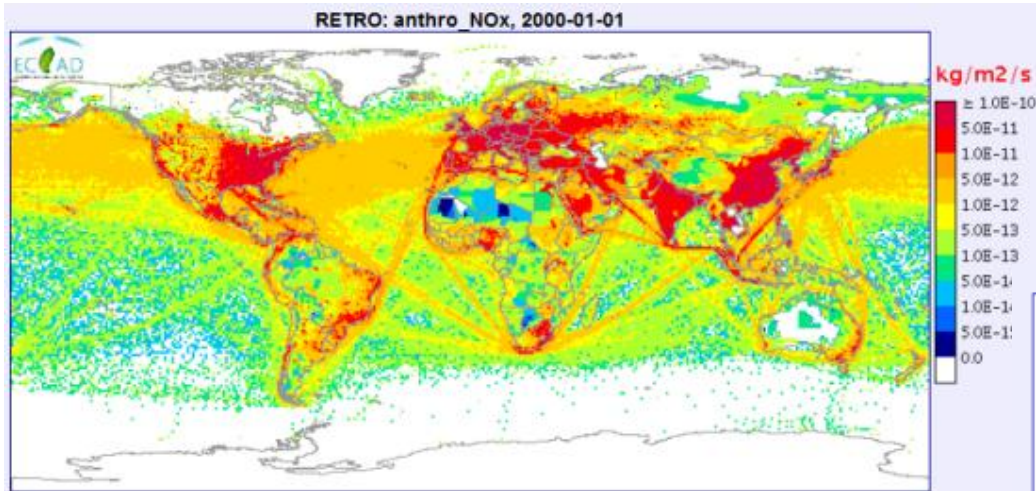


Example of ECCAD data/output



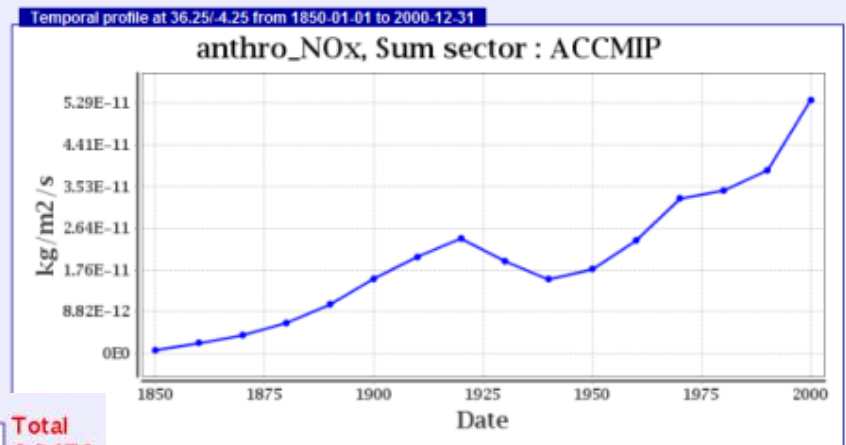
Lat: 29.5=>51.5, Lon: -7.5=>36.5

Visualization of emissions distributions

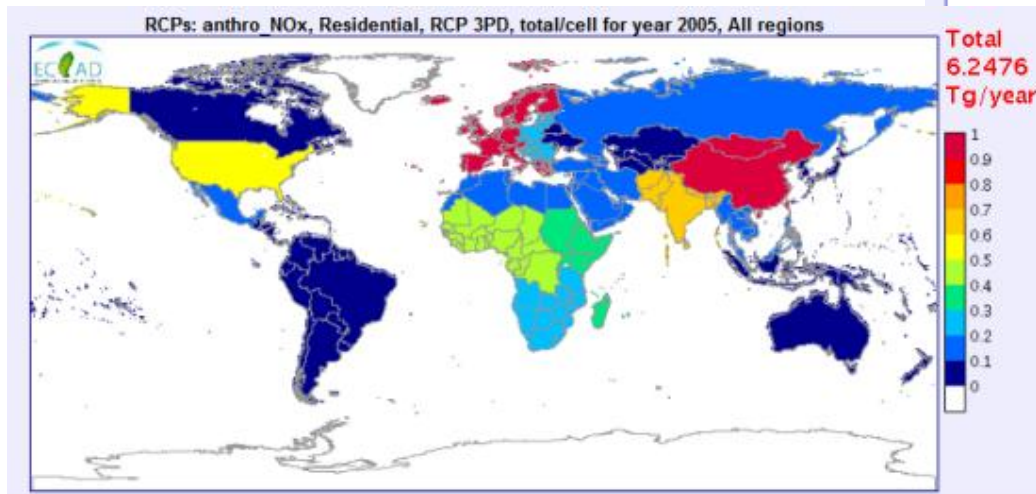


ECCAD tools

Temporal variation at a location



Total emitted for different regions



Tools development determined by users requests

Biogenic emissions in ECCAD

name	MEGANv2	MEGANv2-CH3OH	GUESS-ES	POET
author	A. Guenther T. Dhul (NCAR)	Stavrakou et al. (BIRA-IASB)	Arneth et al. Schurgers et al.	S. Wallens J.F. Müller, A. Guenther
model	MEGANv2.0	MEGANv2.1	LPJ-GUESS	vegetation canopy model
period	2000	2003 - 2009	1970 - 2009	1990
spatial resolution	0.5 x 0.5 deg.	0.5 x 0.5 deg.	1 x 1 deg.	1 x 1 deg.
compounds	acetaldehyde acetone methane CO ethane ethene formaldehyde isoprene methanol monoterpenes other ketones propane propene sesquiterpenes toluene	methanol	isoprene monoterpenes	<u>acetone</u> <u>CO</u> <u>ethane</u> <u>ethene</u> <u>isoprene</u> <u>methanol</u> <u>monoterpenes</u> <u>NOx</u> propane <u>propene</u>

Coming soon: a MEGAN2 dataset from 1970 to 2010 for 15-20 species

Next steps

GEIA Conference on emissions: June 11-13 in Toulouse, France

Workshop on ship emissions: September 5-6 in Hamburg, Germany

IGAC Conference: Beijing, September 17-21

Issues that Limit Emissions Research

