International Air Emission Inventories status and inventory improvements

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Overview of presentation

What do we know:

- End product for the HTAP model exercise: global gridded emission inventories
- Relative importance of different sectors to global emissions

Methodology of emission inventory calculation

- Methodologies to calculate emission budgets
- Spatial/temporal Allocation of emission budgets
- Overview of existing large scale emission inventories

Quality of large scale emission inventories

- Inventories used in 2007 interim assessment report
- Results and recommendations from HTAP discussion
- 8. “Expert” estimate on uncertainty

Way forward: improvement of inventories for assessment if international air pollution

- Plan of action under TF HTAP
- Methodology and first results of EDGAR-HTAP emission inventory 2000-2005
- Issues of inventory work: outreach/projects
- Emission inventories in prep for possible IPCC model runs.

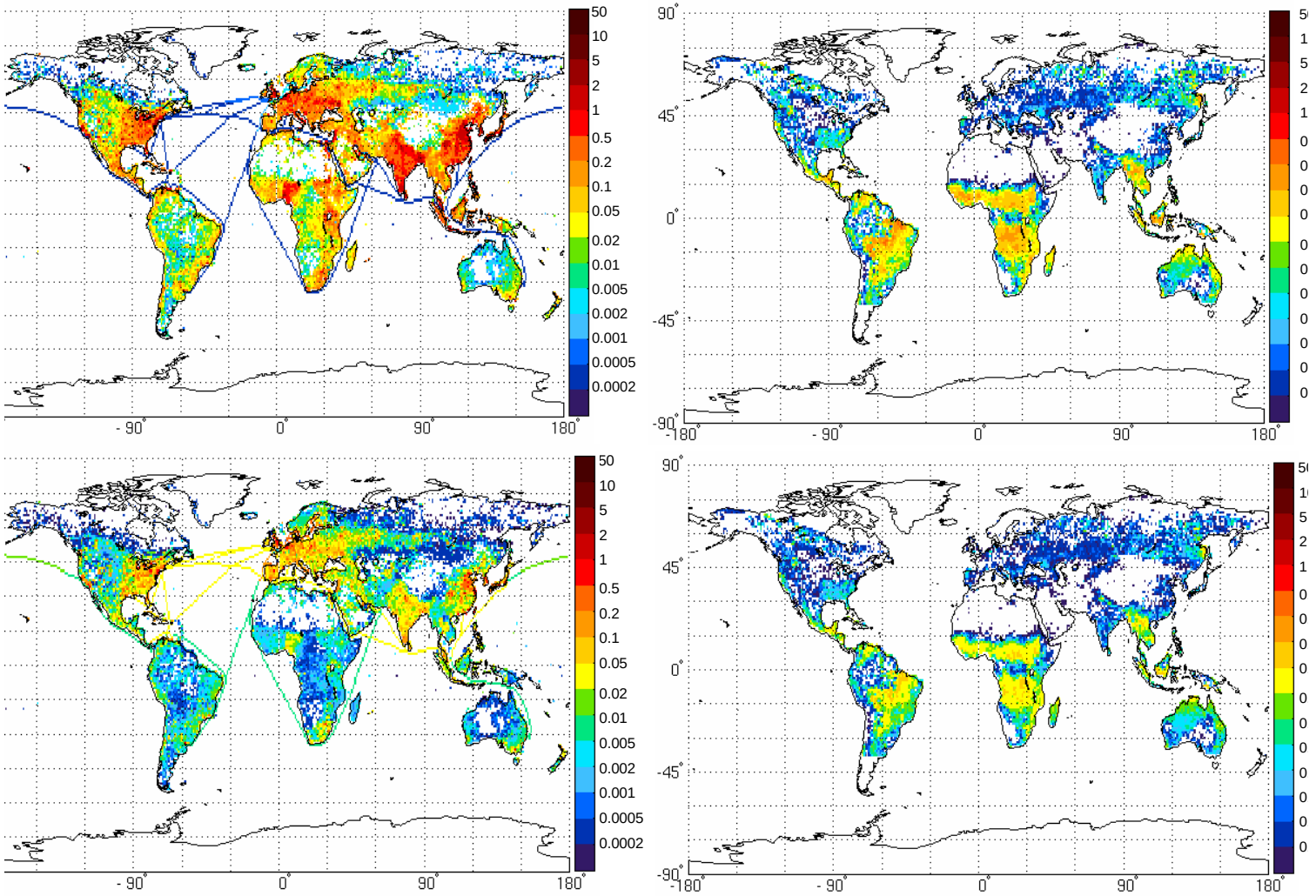
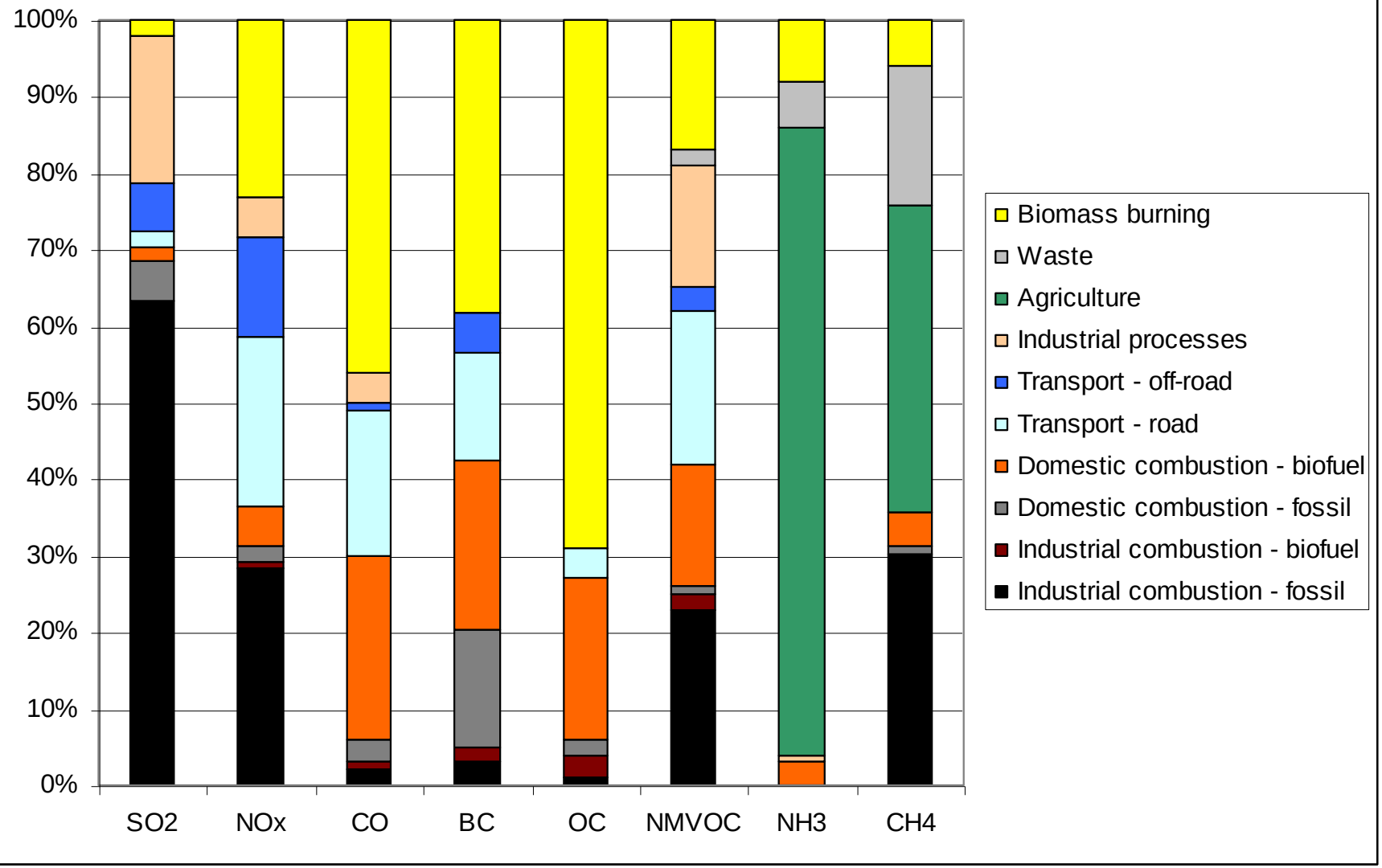


Figure 4-2. Geographical distribution of global emissions. Global emissions of carbon monoxide (top panels) and nitrogen oxides (bottom panels) from anthropogenic sources (left panels) and biomass burning (right panels), gridded at 1° × 1° resolution, taken from the EDGARv32FT2000 dataset (units 10^9 kg m^{-2} s^{-1}).

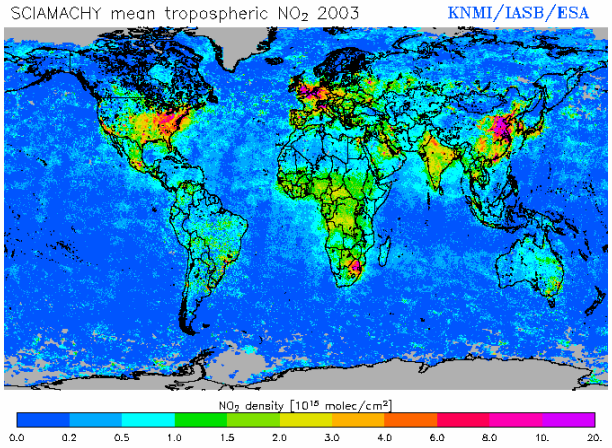
Relative importance of different sectors to global emissions



Relative importance of different sectors to global emissions (% of total emissions).
For NMVOC and CH4, the sector 'Industrial combustion – fossil' includes emissions from exploration and distribution of oil and gas. (Source: TF HTAP 2007 Interim Assessment Report, Chapter 4)

Methodologies to calculate emission budgets

Cost / human investment



Satellite observations?

Continuous emissions monitoring

Source sampling

ons modeling

Technology based emission factor calculation

Implied emission factor calculation

extrapolation of existing emissions data

Reliability of emission data

Simplified equation of emission factor approach

EMISSION = AD x EF (1-(IC x RE)) **Implied EF**

AD = activity data by sector and technology
EF = uncontrolled emission factor by sector, technology, compound
IC = installed capacity of abatement measure by sector, technology
RE = removal efficiency of abatement measure, by compound

EDGARv3: public power plants

AD: BTC in public power plant (TJ, year)
EF: country/region factor (kg/TJ, year)

EDGARv4: public power plants

AD:	**BTC in public power plant (TJ, year)**
TECH:	**% GF0: grate firing**
	% PW0 Pulverized coal wet bottom
	% PD0 Pulverized coal dry bottom
	% FB0 Fluidized bed (size unknown)
	% BO0 Boiler for gas/liquids
	% IC0 Internal combustion engine
	% GT0 Gas turbine (size unknown)
-EF:	**uncontrolled EF by TECH, country (kg/TJ)**
-EOP:	**% of ESP installed, year**
	% of Fabric filter “
	% of Cyclone “
	% Wet scrubber “
-EOP_EF:	**% reduction of EF by EOP**

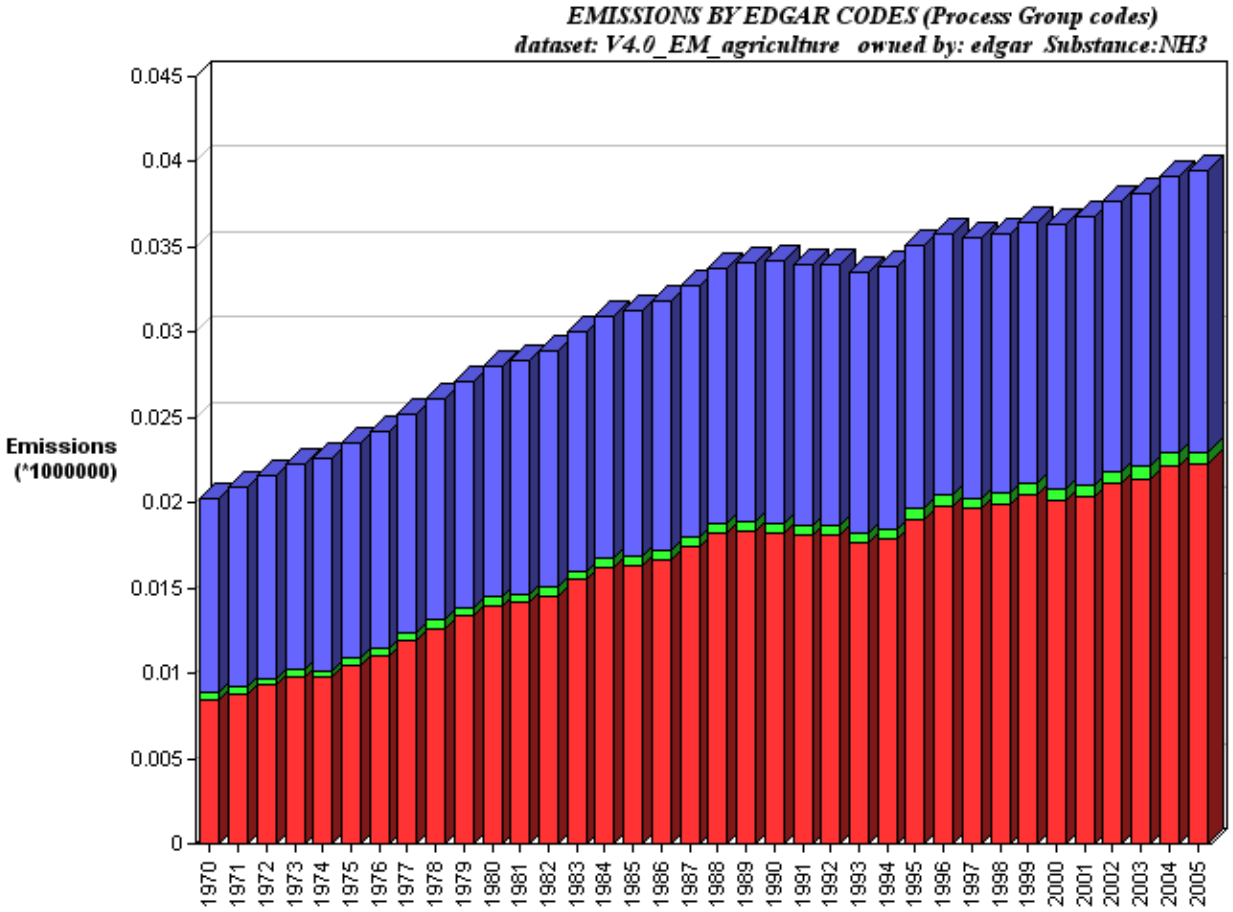
$$E(x_i, y_j)_{A,C,yr} = E(country)_{A,yr} \; x \; \frac{Indicator(x_i, y_j)_{A,C,yr}}{\sum Indicator(x, y)_{A,C,yr}}$$

x_i, y_j : **lower left corner of 0.1x0.1 degree grid cell**
E: **emissions**
A: **activity**
yr: **year**

Indicators:
- Power plants (installed capacity and/or CO_2 emissions per grid cell: ref. CARMA)
- Road density (km of roads per grid cell: VMAP)
- Animal density (FAO and rural population)
- Grassland/cropland (Univ. Maryland)
- Ships (updated COADS dataset)
- Population, rural, urban (CIESIN)
- Rice cultivation (IRRI *)

- industrial production map
- mining (surface/underground)
- refining
- aircraft

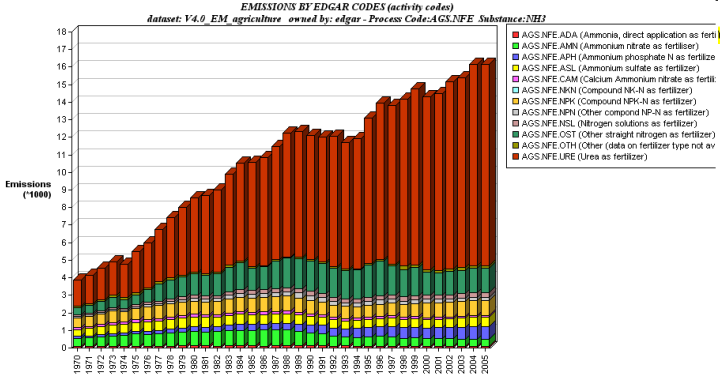
Spatial allocation of emission budgets: NH3 from agriculture

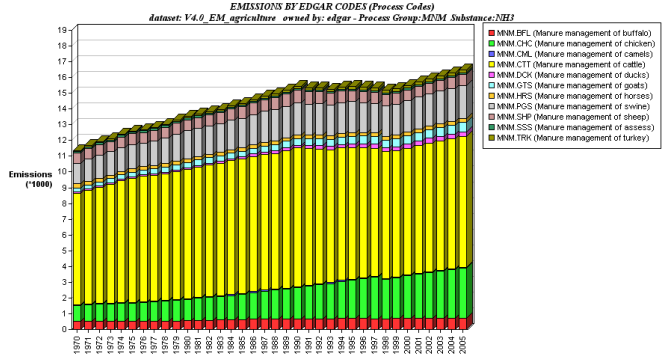


animal density (FAO)
rural population (CIESIN/HYDE)

cropland map
(mod. Univ. Maryland)

cropland-grassland map
(mod. univ. Maryland)





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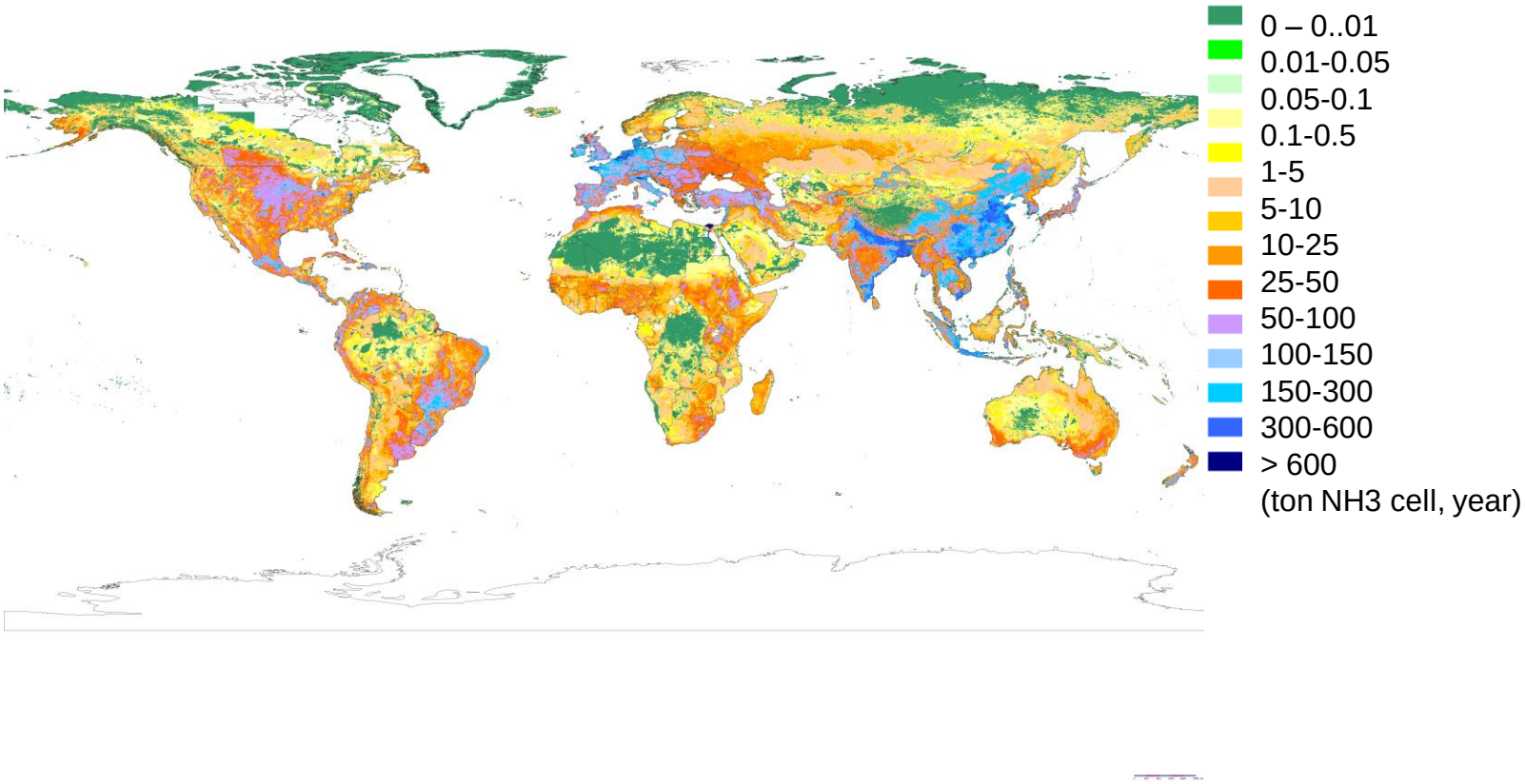
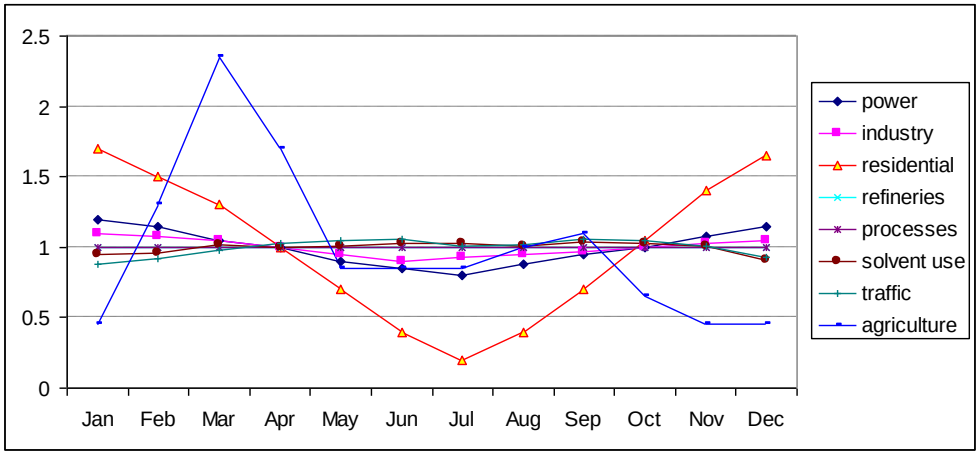
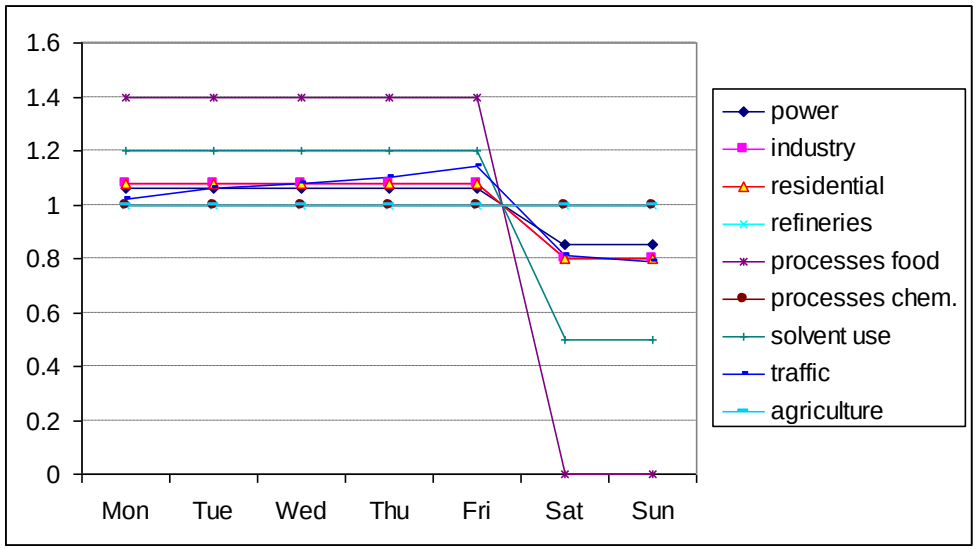
Spatial allocation of emission budgets: NH3 from agriculture (2005)



Extern: power plant map

Temporal allocation of emission budgets





LOTOS time profiles, Veldt (1992)

Overview of existing large scale emission inventories

	Individual studies	Project-based calculations	Emission databases	Inventory compilations
CO	-	RETRO, QUANTIFY, POET	EDGAR, RAINS	GEIA
NH_3	Bouwman et al. (1997)	-	EDGAR	GEIA
NO_x	-	RETRO, QUANTIFY, POET,	EDGAR, RAINS	GEIA
NMVOC (total)	-	RETRO, QUANTIFY, POET	EDGAR	GEIA
NMVOC (speciated)	-	RETRO, QUANTIFY, POET	EDGAR(v2)	GEIA
SO_2	Stern (2005)	QUANTIFY	EDGAR, RAINS	GEIA, AEROCOM
BC	Bond et al. (2004)	QUANTIFY	EDGAR, RAINS	GEIA, AEROCOM
OC	Bond et al. (2004)	QUANTIFY	EDGAR, RAINS	AEROCOM
CH_4	-	QUANTIFY	RAINS	UNFCCC

Overview of global, gridded anthropogenic emission inventories with compounds included that are relevant for studies of hemispheric transport of air pollutants
(Source: TF HTAP 2007 Interim Assessment Report, Chapter 4)

New developments:
HTAP emission compilation
IPCC harmonization exercise

Assessment for hemispheric transport of air pollution requires global gridded emission inventories of (SO2, NOx, NMVOC, NH3, CH4, OC, BC, PM, and CO)

- The quality of emission inventories varies widely
- For developed countries, some sector inventories are of high quality, as they have been crosschecked by field studies and laboratory tests and through air quality modeling (e.g. emissions power plants)
- For developing and newly industrializing countries, the quality of emission inventories is lower and sometimes poor:
  - lack of actual emissions measurements and intensive ambient observations, incompleteness of the activity data, and absence of test-based emission factors.
  - A shorter history of inventory development lack of expertise and capable institutions.
  - Fast changes in socio-economic system

Expert estimate on uncertainty

Table 1.14 Indication of uncertainty estimate for ozone and aerosol precursors. Source: Olivier et al., 1999b.

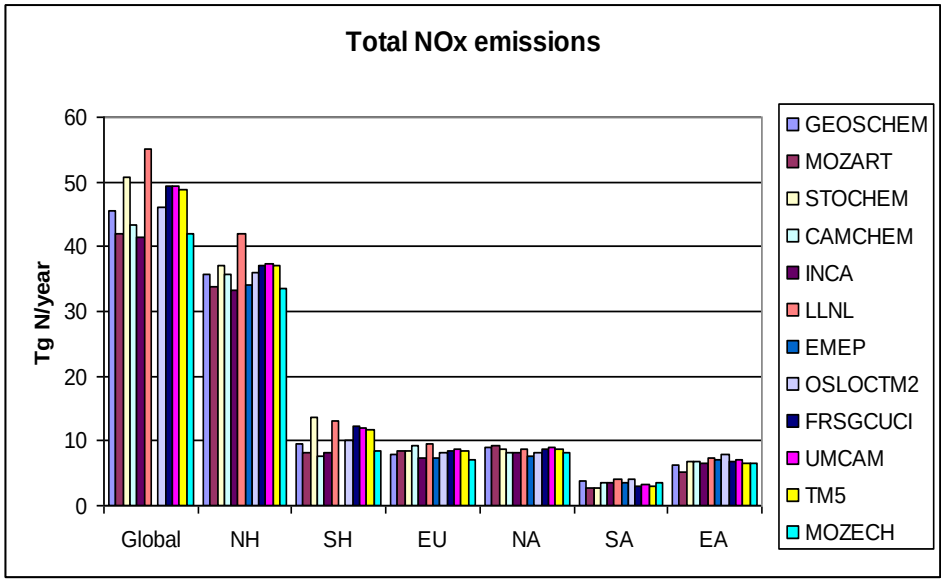
Main source	Sub-category	Activity data	Emission factors CO	Emission factors NO_x	Emission factors SO_2	Emission factors NMVOC	Global total and regional emissions CO	Global total and regional emissions NO_x	Global total and regional emissions SO_2	Global total and regional emissions NMVOC
Fossil fuel use	Fossil fuel combustion									
	Fossil fuel production		-	-	-		-	-	-	
Biofuel	Biofuel combustion									
Industry/ solvent use	Iron & steel production									
	Non-ferro production									
	Chemicals production									
	Cement production		-	-	-	-	-	-	-	-
	Solvent use		-	-	-		-	-	-	
	Miscellaneous									
Landuse/ waste treatment	Agriculture		-	-	-	-	-	-	-	-
	Animals (excreta; ruminants)		-	-	-	-	-	-	-	-
	Biomass burning									
	Landfills		-	-	-	-	-	-	-	-
	Agricultural waste burning									
	Uncontrolled waste burning		-	-	-		-	-	-	
Natural sources	Natural soils		-		-	-	-		-	-
	Grasslands		-	-	-	-	-	-	-	-
	Natural vegetation			-	-			-	-	
	Oceans/wetlands			-	-	-		-	-	-
	Lightning		-		-	-	-		-	-
			CO	NO_x	SO_2	NMVOC	CO	NO_x	SO_2	NMVOC
All sources		-	-	-	-	-	M	M	M	L

Notes: Expert judgement of uncertainty ranges, which were assigned with the following classification in terms of order of magnitude of the uncertainty in mind: S = small (10%); M = medium (50%); L = large (100%); V = very large (>100%). "-" Indicates that the compound is not applicable for this source or that emissions are negligible.

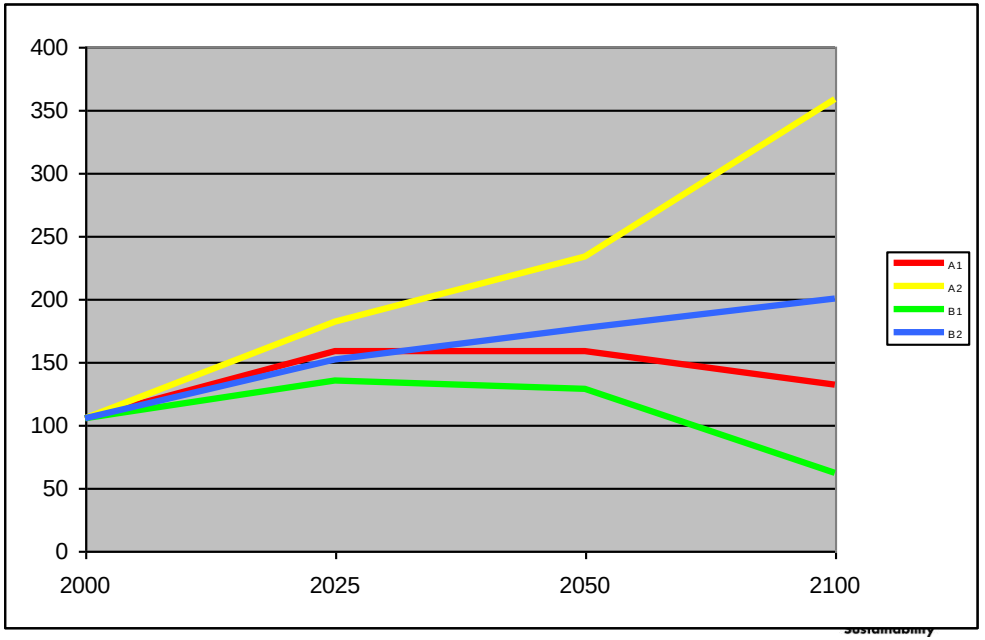
Courtesy: Jos Olivier

~10% **~50%** **~100%**

Tendency for harmonized emission data for modelling (HTAP/IPCC)



Learn from variety in emission budgets



Scenario interpretation require consistent starting point.

Recommendations of Emission workshop (Beijing, 2006) and Interim Assessment report 2007.

Improve the quality of emission methodology and inventories for sources that are poorly known:

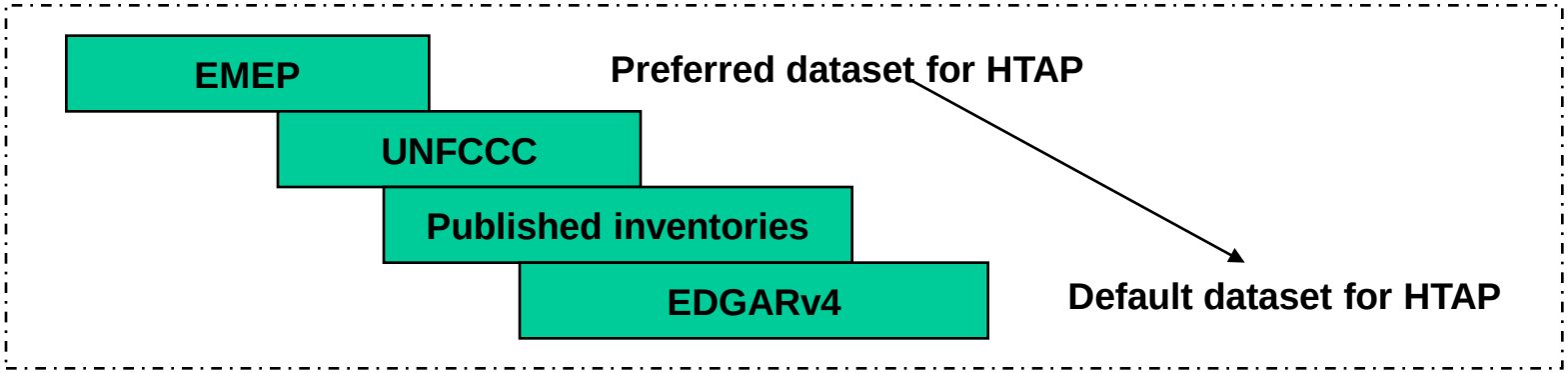
- biomass burning (agricultural waste, biomass for heating and cooking, and forest fires)
- small and medium scale industry and energy production,
- transport
- domestic use of coal

A. Improvements can only be achieved through improved data capture in cooperation with experts from different countries bringing in knowledge of the local conditions

B. There is thus a strong need to update any emission data base to hold as recent data as possible due to rapidly changing emissions in emerging economies.

B. Update emissions data to hold as recent data as possible.

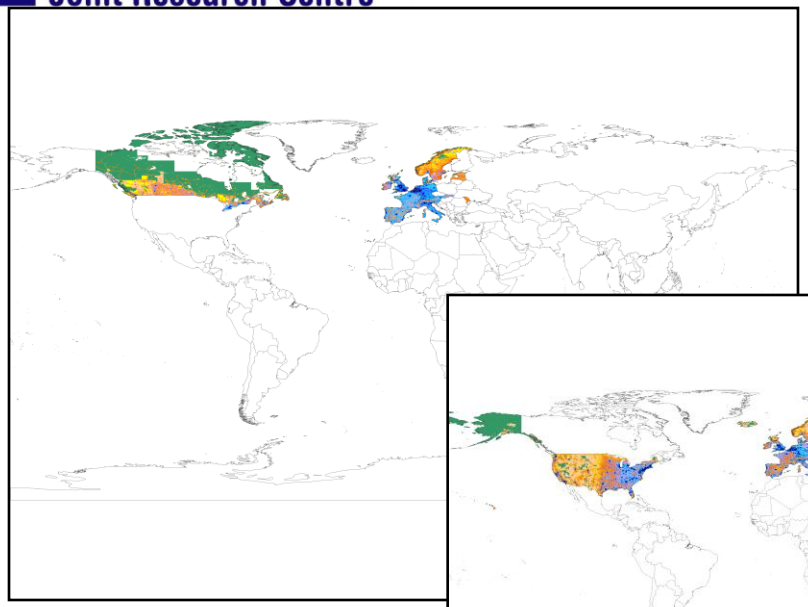
- Compiling dataset of EMEP, UNFCCC and other inventories for the period 2000-2005 with as following principle:



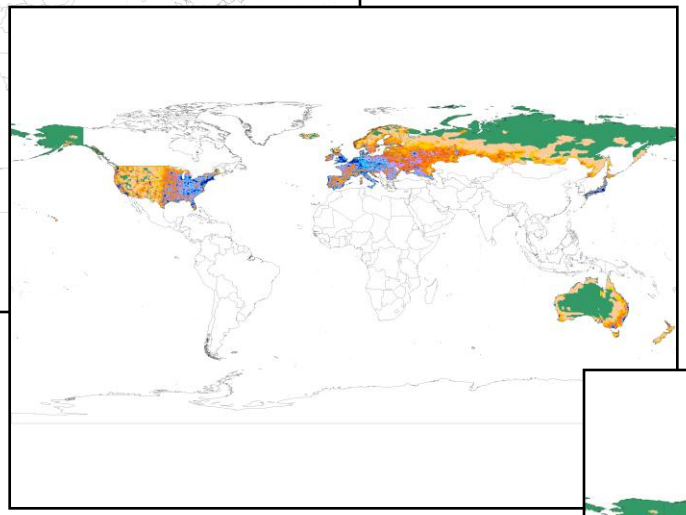
Data stored in EOLO application (EDGAR OnLine Open access)

provide uniform gird allocation to variety of emission inventories

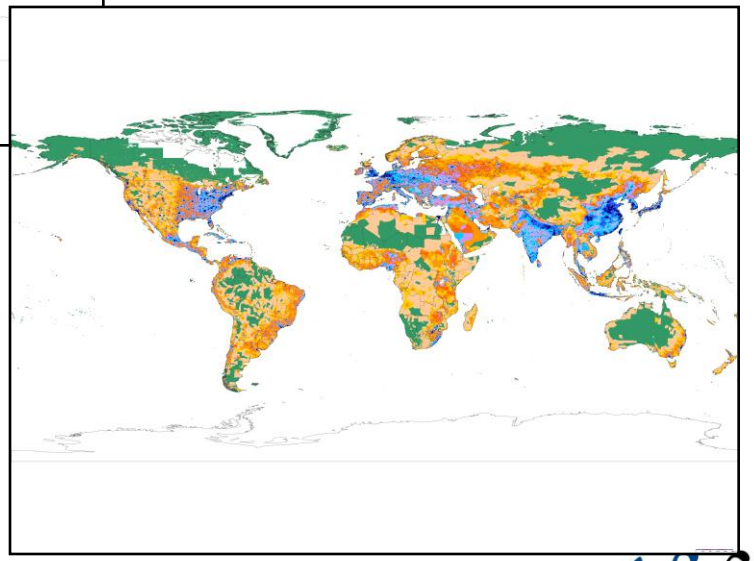
Results (year 2000)



EMEP



UNFCC



EDGAR

- 0 – 0..01
- 0.01-0.05
- 0.05-0.1
- 0.1-0.5
- 1-5
- 5-10
- 10-25
- 25-50
- 50-100
- 100-150
- 150-300
- 300-600
- > 600

(ton NO2 cell, year)

6. Overview of existing large scale emission inventories (optional)

Websites with global data:
- GEIA
- WRI (CAIT/WRI Earth-trends)

Websites with LPS data:
- EPER
- NEIT

National inventories
Regional inventories
Global inventories

[1] Greenhouse gas
[2] Air pollutants
[3] Aerosol
[4] POPs, HM

Real time

"IPCC" harmonization and scenario exercise 1890-2100 on 0.5⁰ grid)

EDGARv4: 1970-2005 [1.2.3] on 0.1° grid

RETRO: 1960-2000 [2] on 0.5⁰ grid

QUANTIFY: 2000-2100 [1.2.3] on 1° grid

AEROCOM: 1750+2000 [2,3]

GAINS 2000-2030 [1.2,3]

REAS: 1980-2020 [1.2,3]

SPEW: 1850-1996 [3]

TRACE-P: 1990-2000 [1.2,3]

UNFCCC [1,2]

and others

RAINS-Asia 1990-2020

RAINS-Europe 1990-2030

SRES: 1990-2100 [1.2.3] (on 1° grid) (IS92a etc)

EDGAR: 1890-2000 [1.2.(3)] on 1° grid

GEIA v1: 1985

EMEP [2,3,4]

CDIAC: 1750-2004 [1]

Akimoto et al: Asia 1980s [2]

Hameed, Dignon: 1980s [2]

past: <1990 | present: 1990-2006 | future: >2007

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