

# **comparison of anthropogenic emissions among AeroCom-II inventories**

**Xiaohua Pan, Mian Chin, Thomas Diehl  
and Angelika Heil**

# AeroCom emissions

	<b>AeroCom – II ACCMIP</b>	<b>ACCMIP</b>	<b>AeroCom –II HCA0 v1/v2</b>	<b>AeroCom - I</b>
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<b>temporal resolution</b>	1850,1980-2010 yearly monthly	1850-2100 decadal monthly	1980-2006 yearly	1750, 2000 yearly monthly
<b>spatial resolution</b>	0.5°x0.5°	0.5°x0.5°	1°x1°	1°x1°
<b>unit</b>	kg/m2/s	kg/m2/s	kg/grid/yr	kg/grid/yr
<b>species</b>	<b>BC, OC, SO<sub>2</sub>, CO, CH<sub>4</sub>, NH<sub>3</sub>, NO<sub>x</sub></b>	<b>BC, OC, SO<sub>2</sub>, CO, CH<sub>4</sub>, NH<sub>3</sub>, NO<sub>x</sub>, VOC</b>	<b>BC, OC, SO<sub>2</sub> updated SO<sub>2</sub></b>	<b>BC, OC, SO<sub>2</sub>, DU, SS, SOA</b>
<b>sectors</b>	8 anthr, ship, air 2 bb (GFED-2 and RETRO)	8 anthr, ship, air 2 bb (GFED-2)	8 anthrop 2 bb (GFED-2)	8 anthrop 2 bb (GFED-1)

# must know ... about AeroCom-II ACCMIP

- annual AeroCom-II ACCMIP emission (i.e. 1850, 1980 to 2000) were calculated from linear time interpolation of AEROCOM-II IPCC-AR5 decadal data
- inter-annual monthly biomass until 2008
- use of rcp8.5 scenario for 2000-2100 period
- addressed are: anthropogenic and biomass burning emissions of seven selected species
  - **BC, OC, CO, CH<sub>4</sub>, NH<sub>3</sub>, SO<sub>2</sub>, NO<sub>x</sub>**
- aircraft emissions are stored in separate (annual) files ... because of their 3D nature

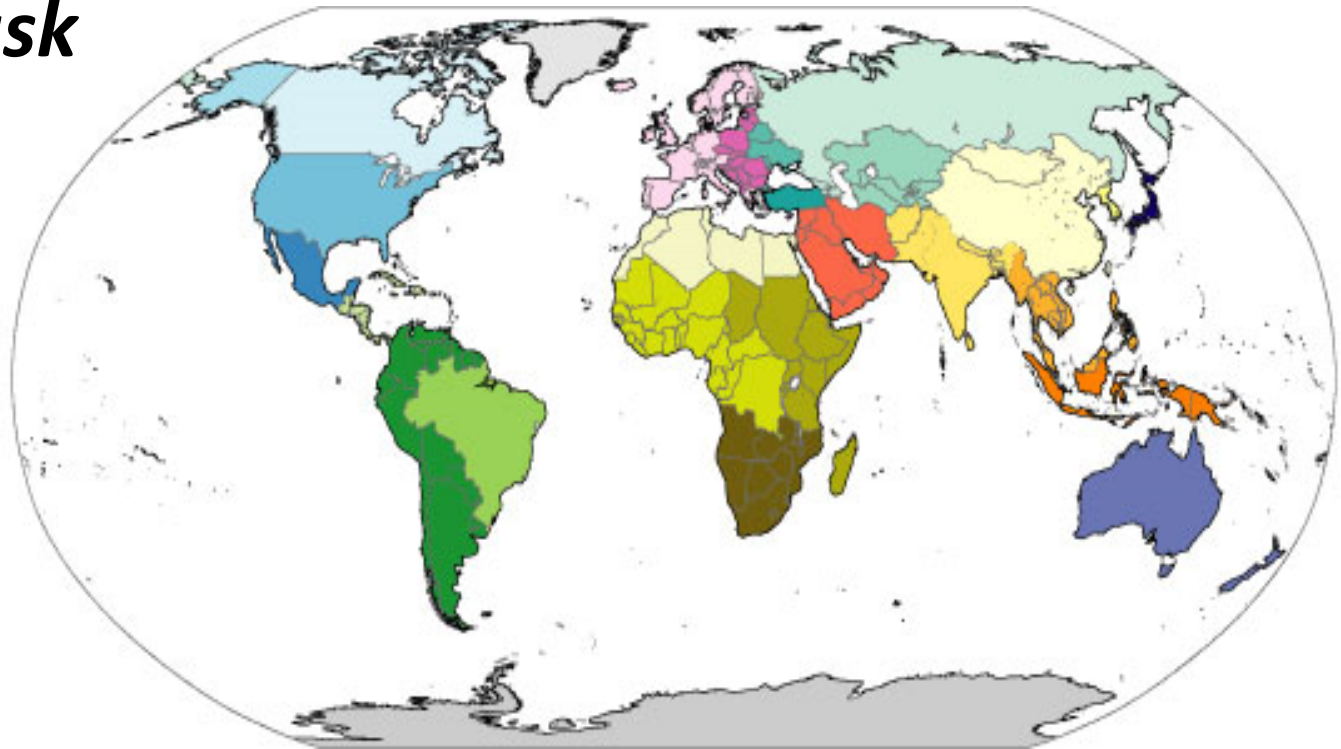
# ancillary data ... of AeroCom-II ACCMIP

- ***grid area***

- the grid area for each 0.5deg horizontal grid cell  
(in m<sup>2</sup> assuming an earth radius of 6371000 meters)

- ***region mask***

- based on  
IMAGE 24



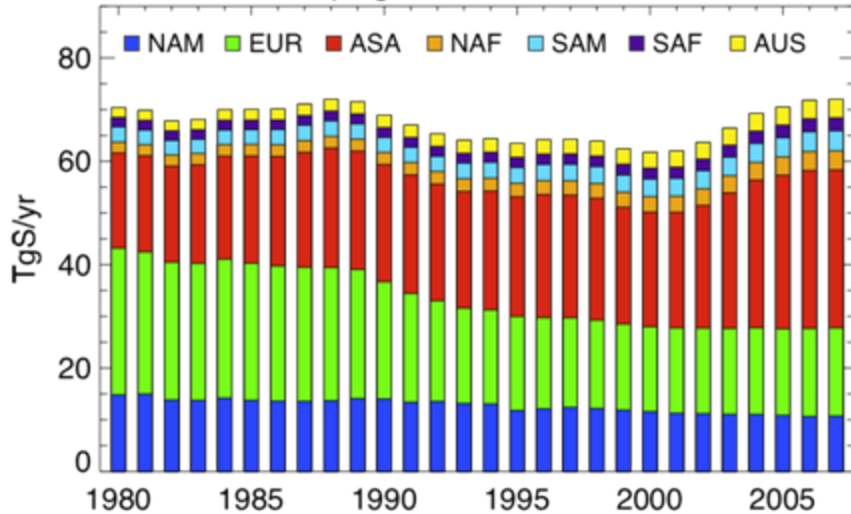
# must know ... AeroCom -II HCA0 v1/v2

yearly emission (1980 to 2006)

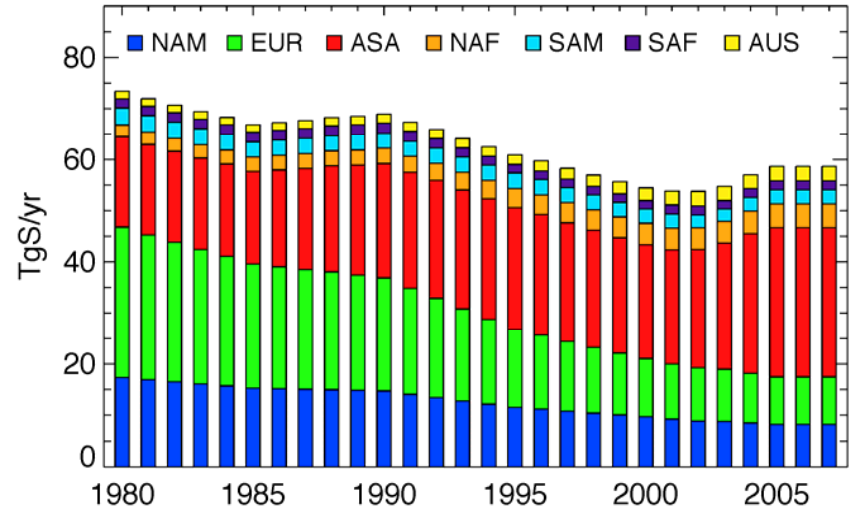
- **sub-micron aerosol**
  - **fossil fuel**
    - **BC** (spew,1996), **OC** (spew,1996), **SO<sub>2</sub>** (edgar,2000)
    - time-evolution by D.Streets
  - **wild-land fires**
    - **BC, OC, SO<sub>2</sub>** (GFED-2, before 1997 AVHRR-scaling)
  - **aircraft** ... by Boeing (61 altitudes)
  - **ship** ... by Eyring
- **volcanic aerosol**
  - **explosive** ... via TOMS satellite data
  - **continuous** ... from GEIA inventory

# HCA0 v1 vs HDA0 v2

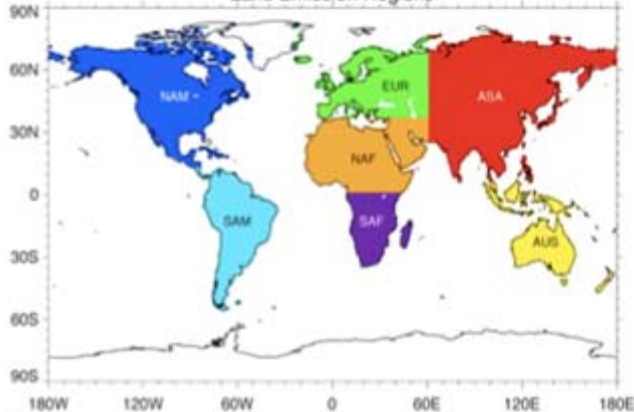
Anthropogenic sulfur emission



Anthropogenic sulfur emission



Land Emission Regions



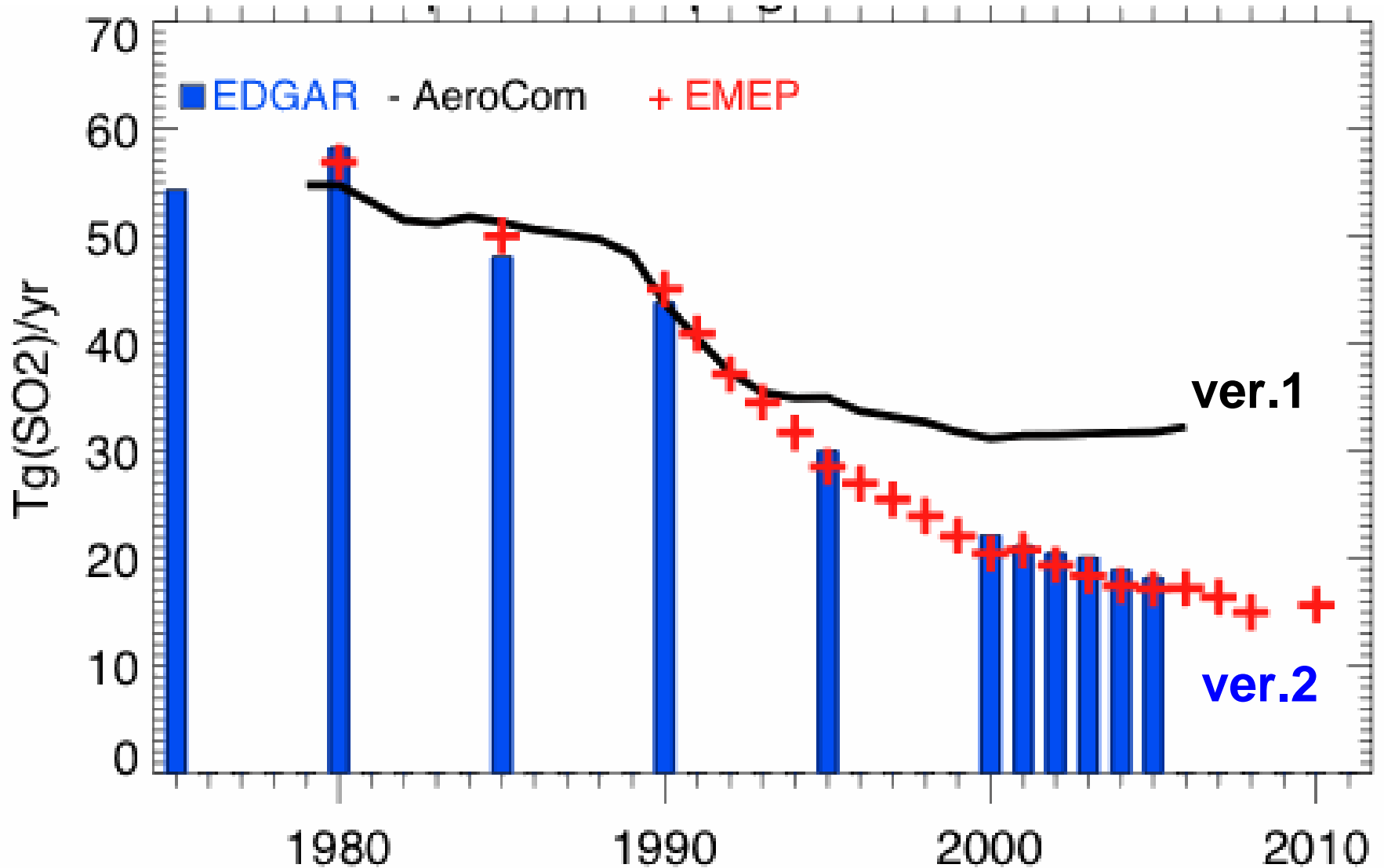
**new v2 has diff. SO<sub>2</sub>**

*edgar 2000 → edgar 4.1*

- less SO<sub>2</sub> over Europe

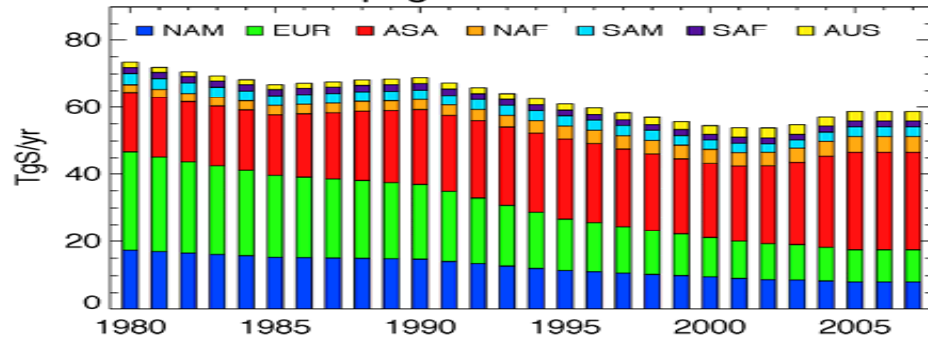
- more SO<sub>2</sub> over N.Africa

# anthrop. SO<sub>2</sub> emissions over EU

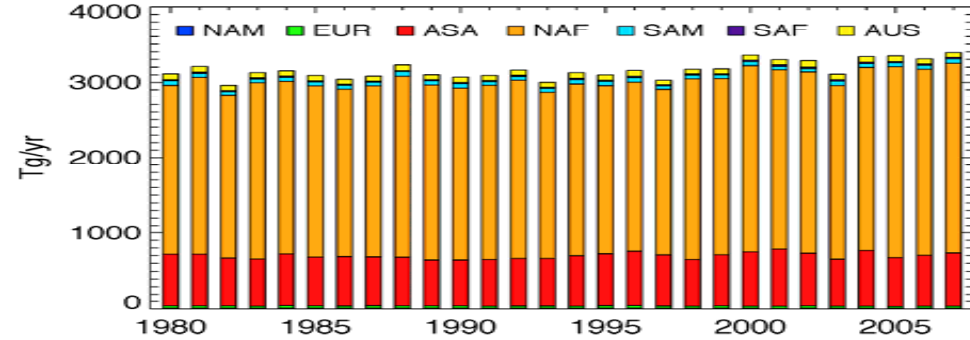


# AeroCom - II HCA0 v2

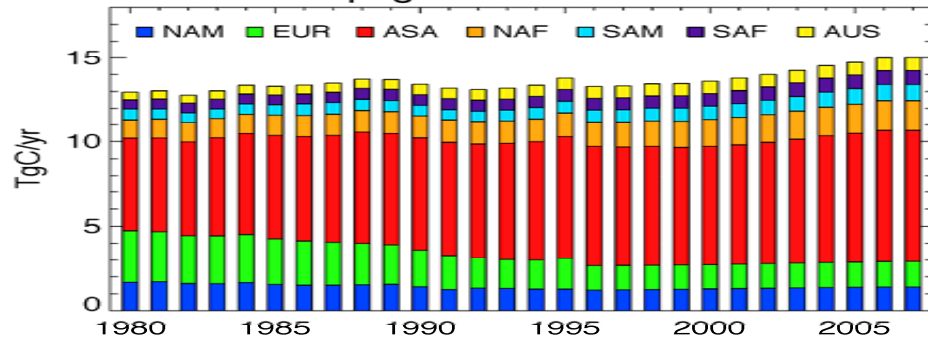
Anthropogenic sulfur emission



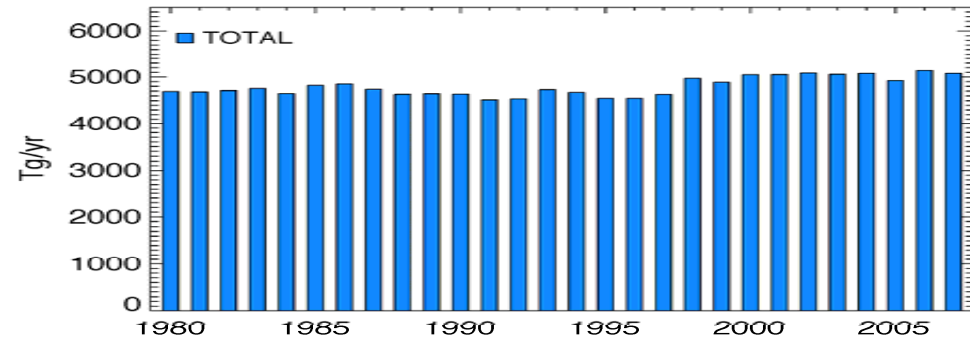
Dust emission



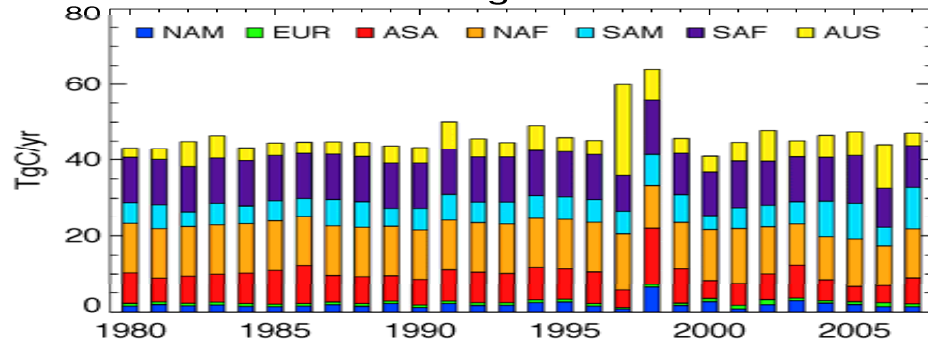
Anthropogenic BC+OC emission



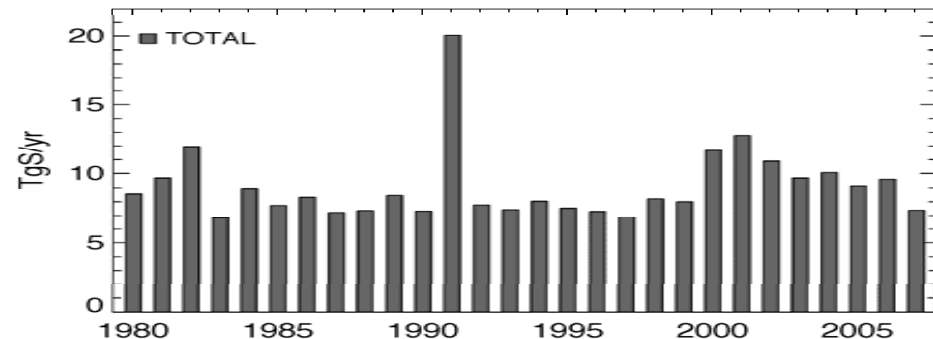
Sea salt emission



Biomass burning BC+OC emission



Volcanic SO2 emission





# comparisons

- **ACCMIP**

“IPCC: ACCMIP-hist. / rcp 8.5”

- **AeroCom-II ACCMIP**

“MACCity: ACCMIP MACCity”

- **AeroCom-II HCA0 v1/v2**

“AeroComHC: AeroCom-HC”

# anthropogenic emission - SO<sub>2</sub>

## ACCMIP

IPCC: ACCMIP-hist. / rcp 8.5

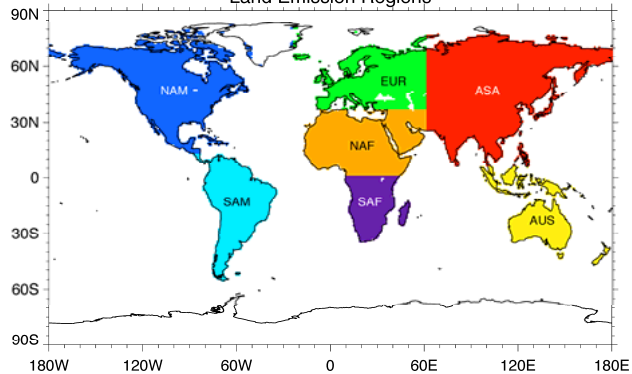
## AeroCom-II ACCMIP

MACCity: ACCMIP MACCity

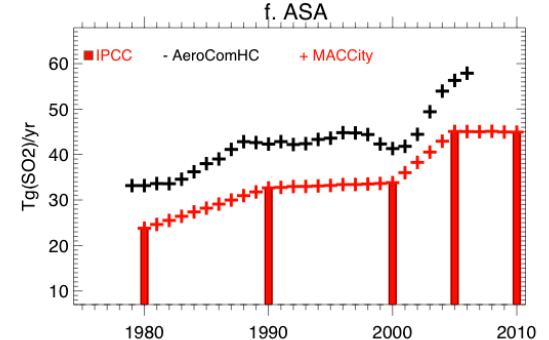
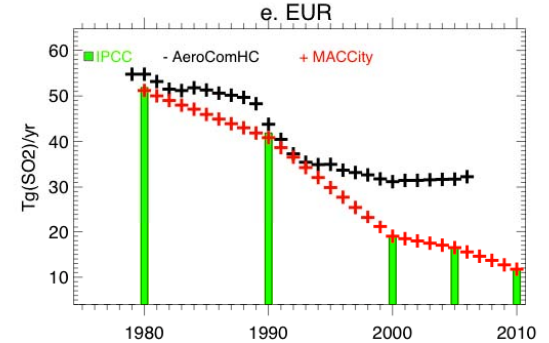
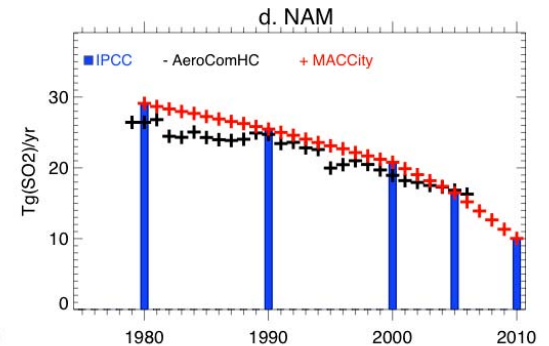
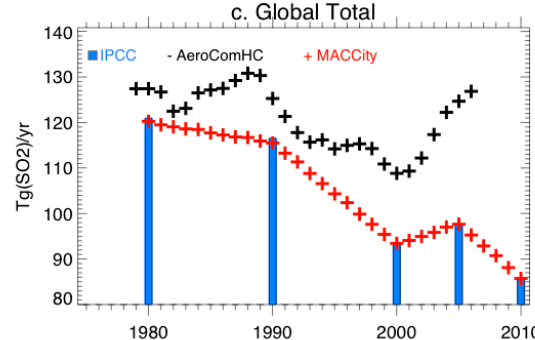
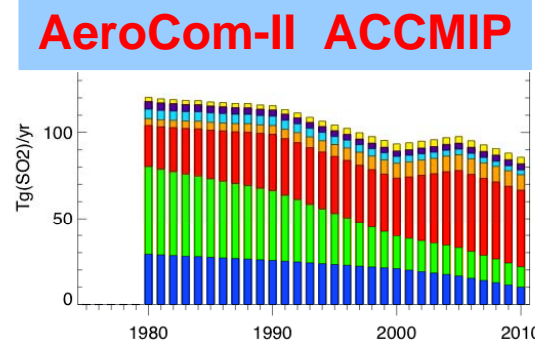
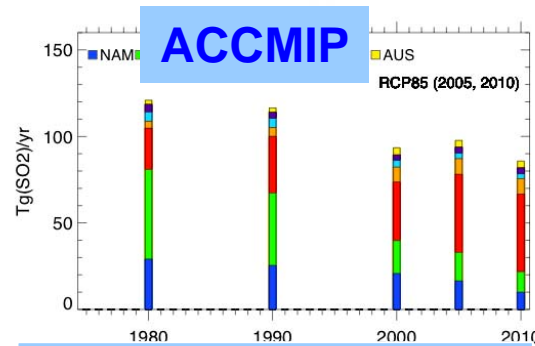
## AeroCom-II HCA0 v1/v2

AeroComHC: AeroCom-HC

Land Emission Regions



regional choices  
by Mian Chin



sectors\_IPCC ( before 2000) : ene dom ind tra wst awb  
sectors\_IPCC (2000 and after): ene dom ind tra wst awb slv agr  
sectors\_MACCity : ene dom ind tra wst awb slv agr  
sectors\_AeroComHC : anthro\_noship

# anthropogenic emission - BC

## ACCMIP

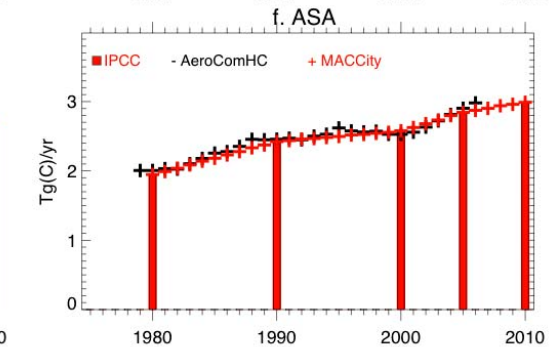
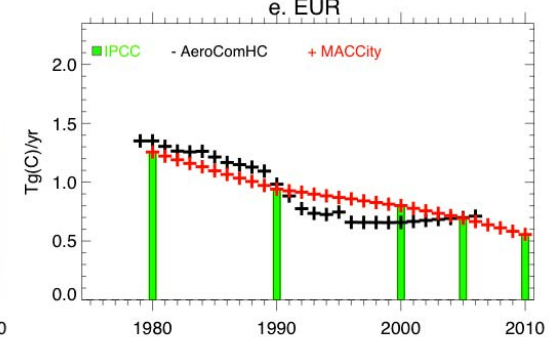
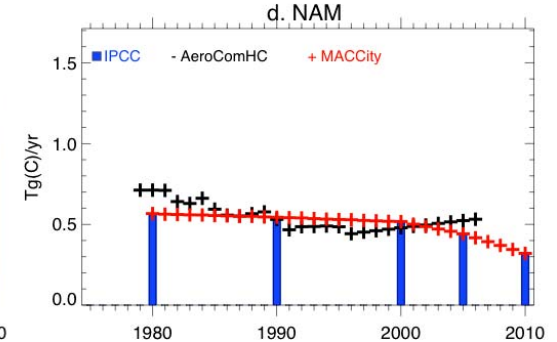
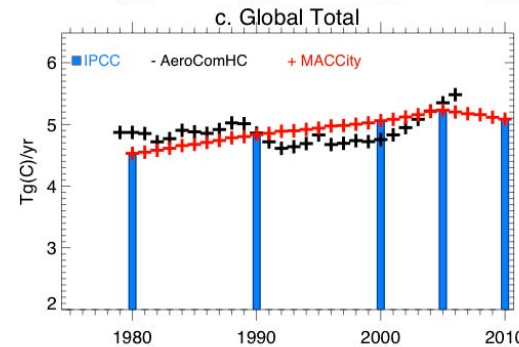
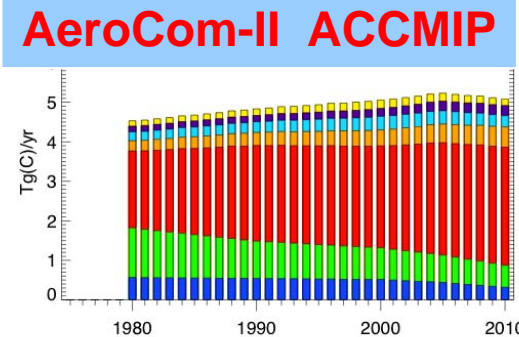
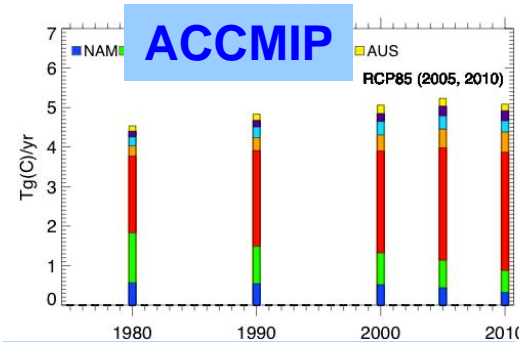
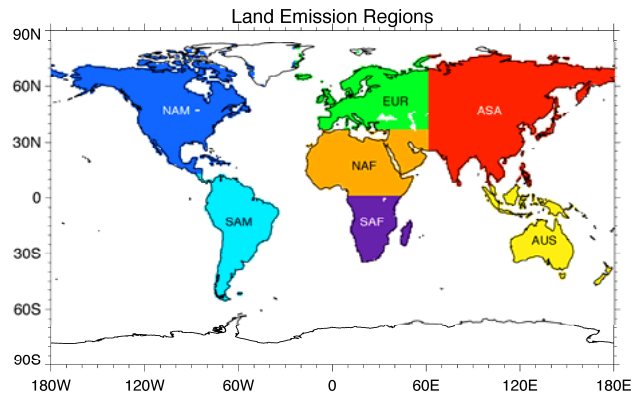
IPCC: ACCMIP-hist. / rcp 8.5

## AeroCom-II ACCMIP

MACCcity: ACCMIP MACCcity

## AeroCom-II HCA0 v1/v2

AeroComHC: AeroCom-HC



regional choices  
by Mian Chin

sectors\_IPCC ( before 2000 ) : ene dom ind tra wst awb  
sectors\_IPCC (2000 and after): ene dom ind tra wst awb slv agr  
sectors\_MACCcity : ene dom ind tra wst awb slv agr  
sectors\_AeroComHC : anthro\_noship

# anthropogenic emission - OC

## ACCMIP

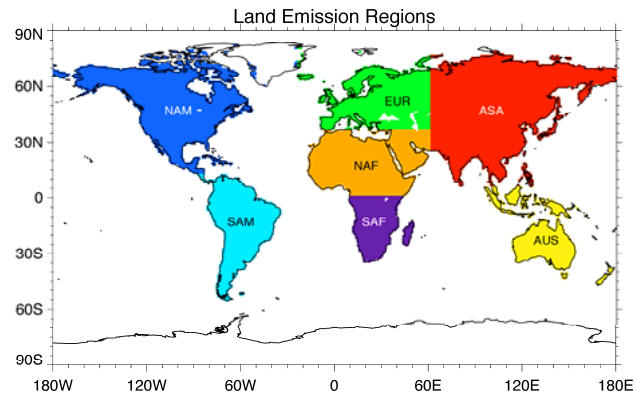
IPCC: ACCMIP-hist. / rcp 8.5

## AeroCom-II ACCMIP

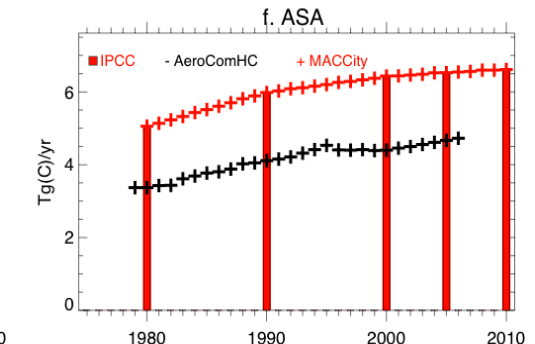
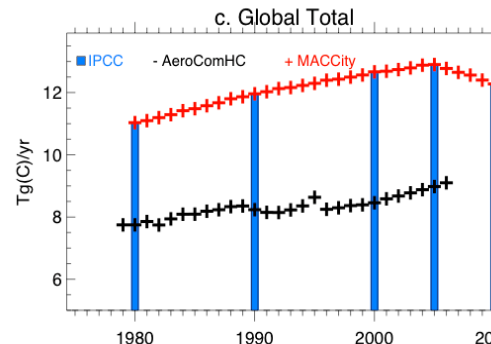
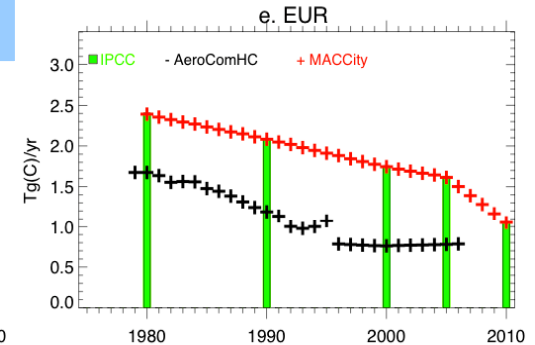
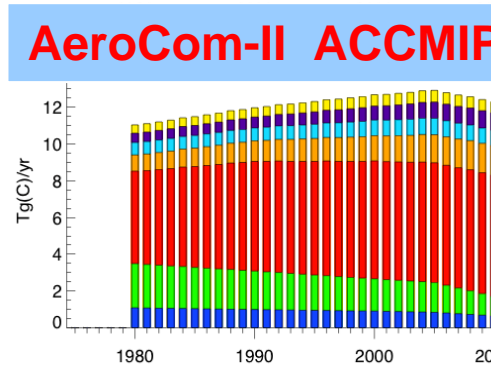
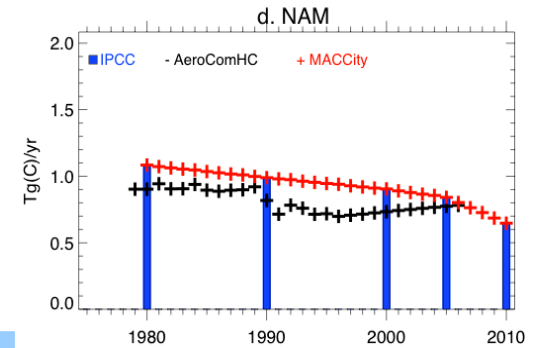
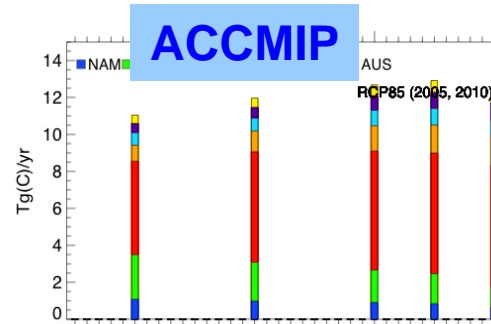
MACCity: ACCMIP MACCity

## AeroCom-II HCA0 v1/v2

AeroComHC: AeroCom-HC



regional choices  
by Mian Chin



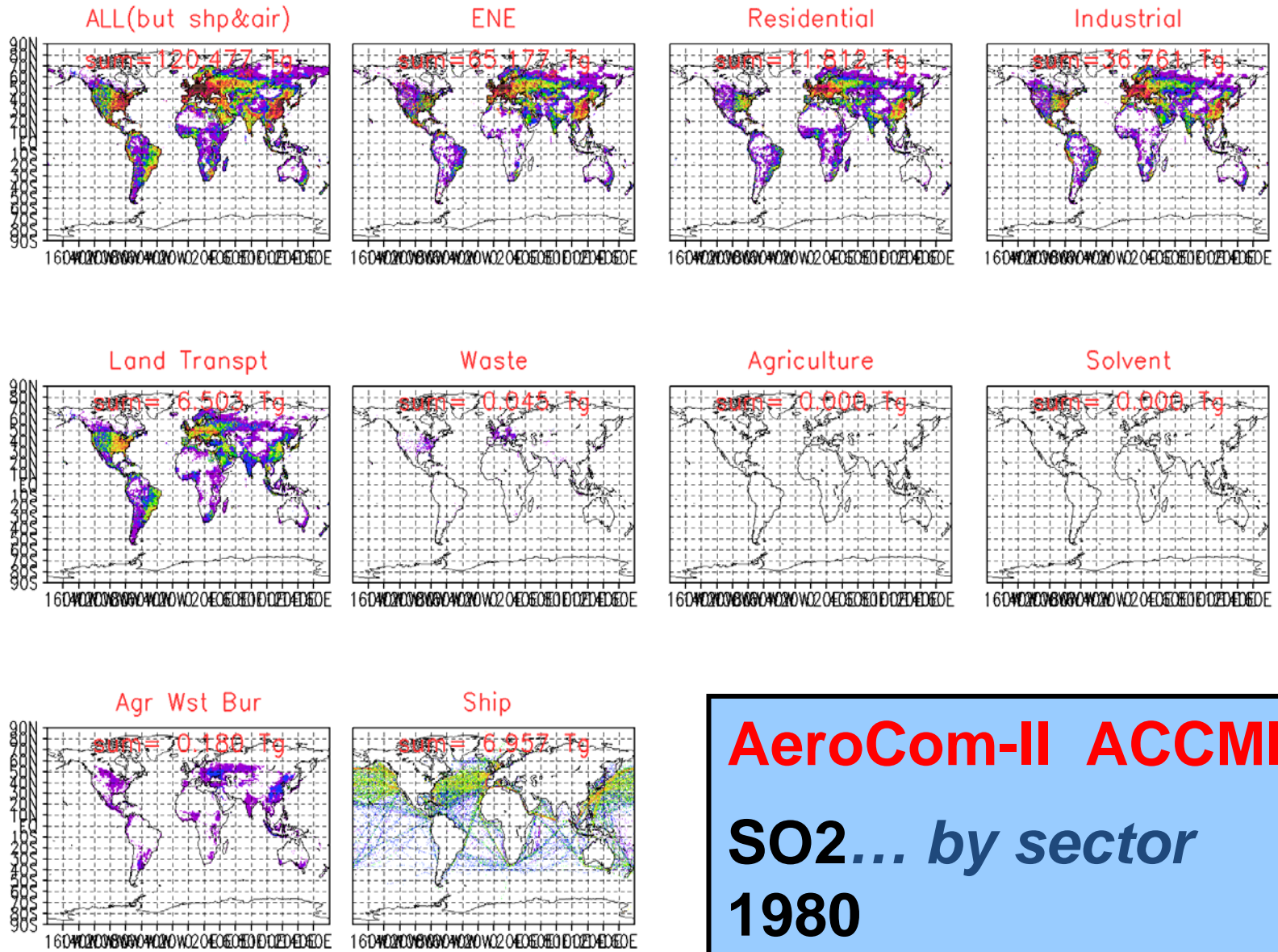
sectors\_IPCC ( before 2000) : ene dom ind tra wst awb  
sectors\_IPCC (2000 and after): ene dom ind tra wst awb slv agr  
sectors\_MACCity : ene dom ind tra wst awb slv agr  
sectors\_AeroComHC : anthro\_noship

# anthrop. SO<sub>2</sub>, BC and OC ... by sector

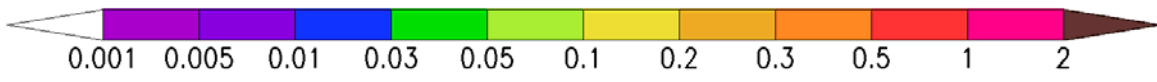
**AeroCom-II ACCMIP** vs **ACCMIP**

- species
  - SO<sub>2</sub>, BC and OC
- years
  - 1980, 1990, 2000 and 2010
- sectors
  - ene, ind, tra, dom, slv, agr, awb, wst
  - shp (ship)

# ACCMIP MACCity ANTHROP EMI S02 1980 GLB



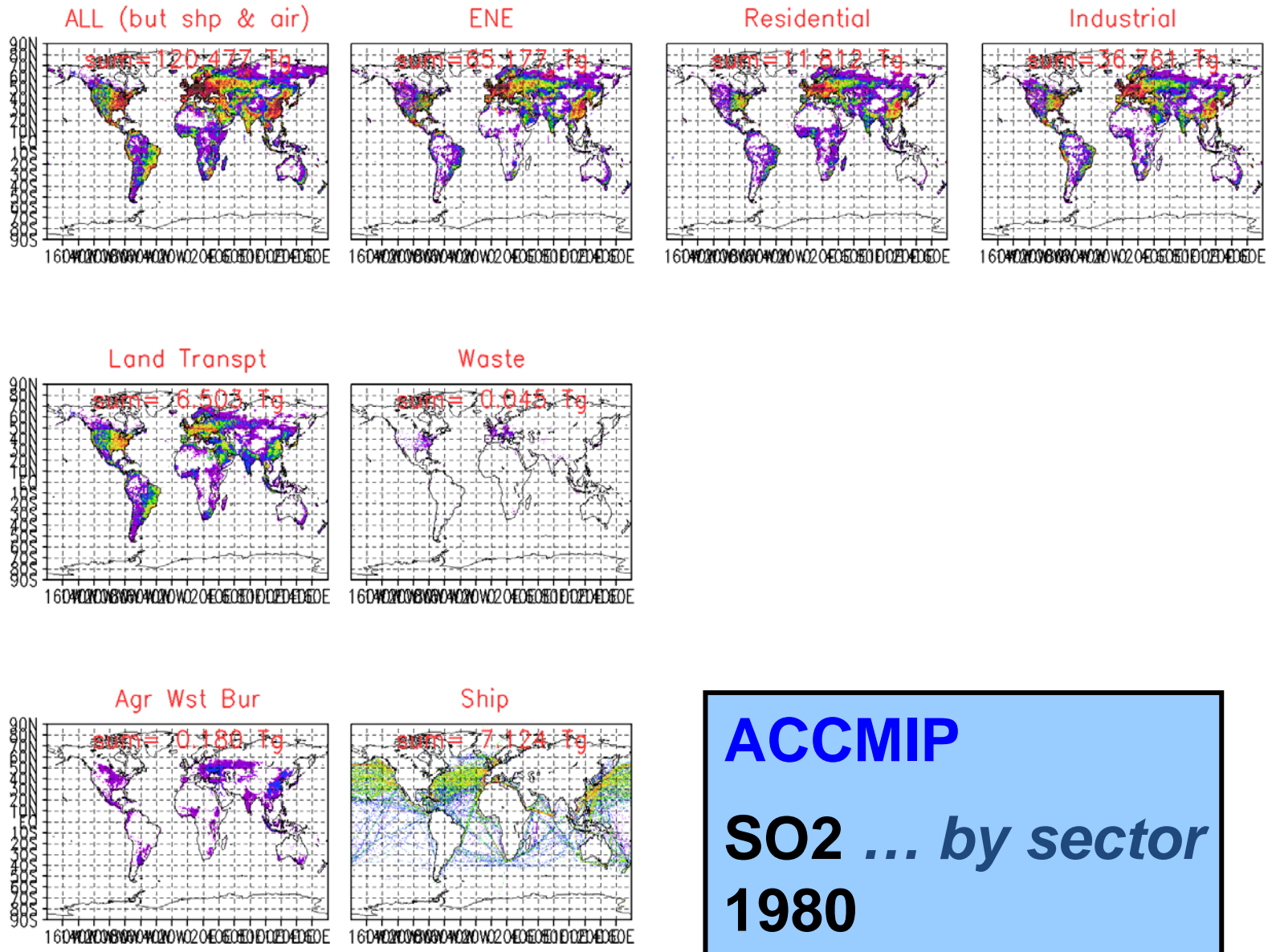
**AeroCom-II ACCMIP**  
**SO2... by sector**  
**1980**



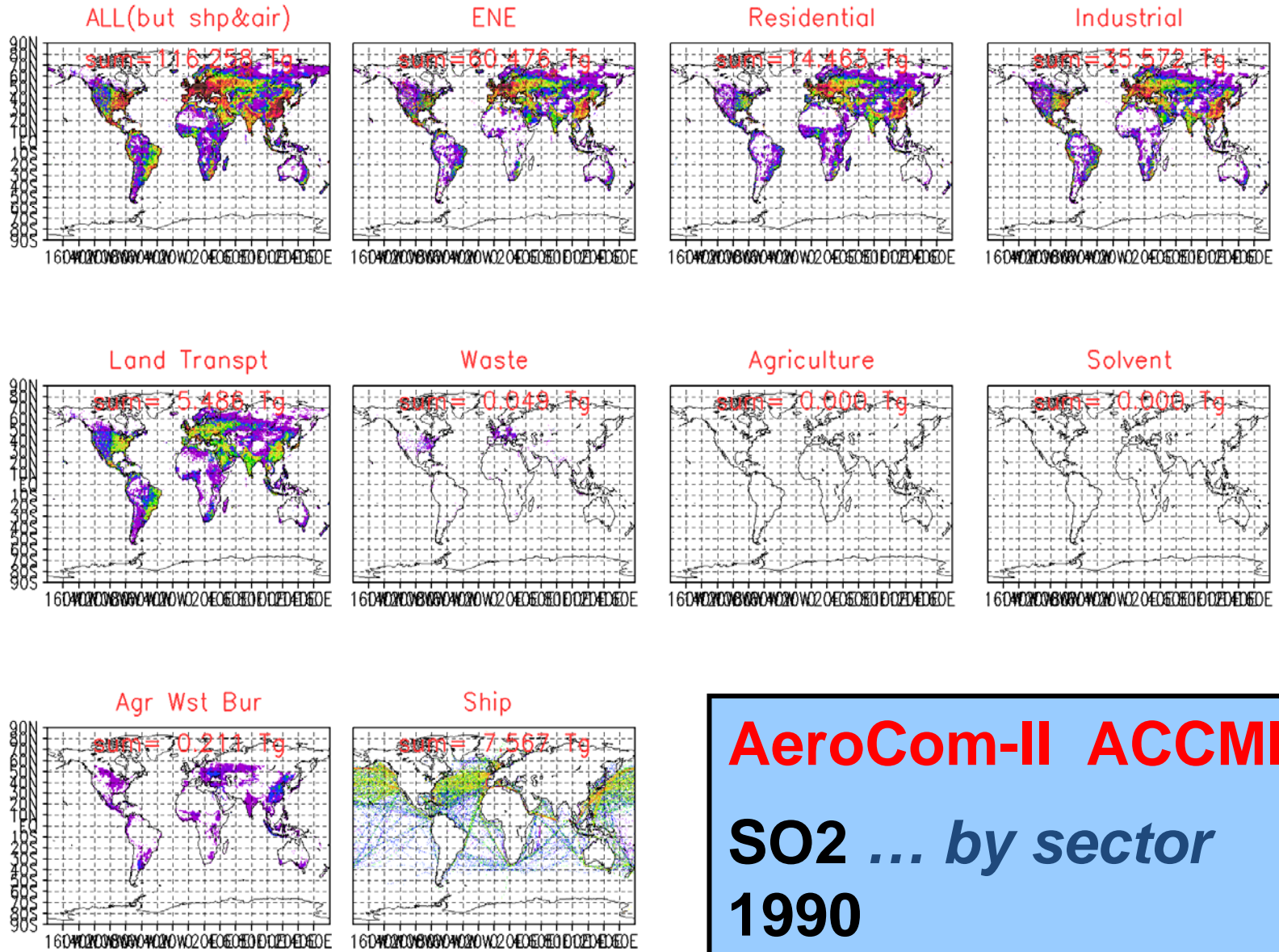
unit: g/m<sup>2</sup>/year



# IPCC\_historic ANTHROP EMI SO2 1980 GLB



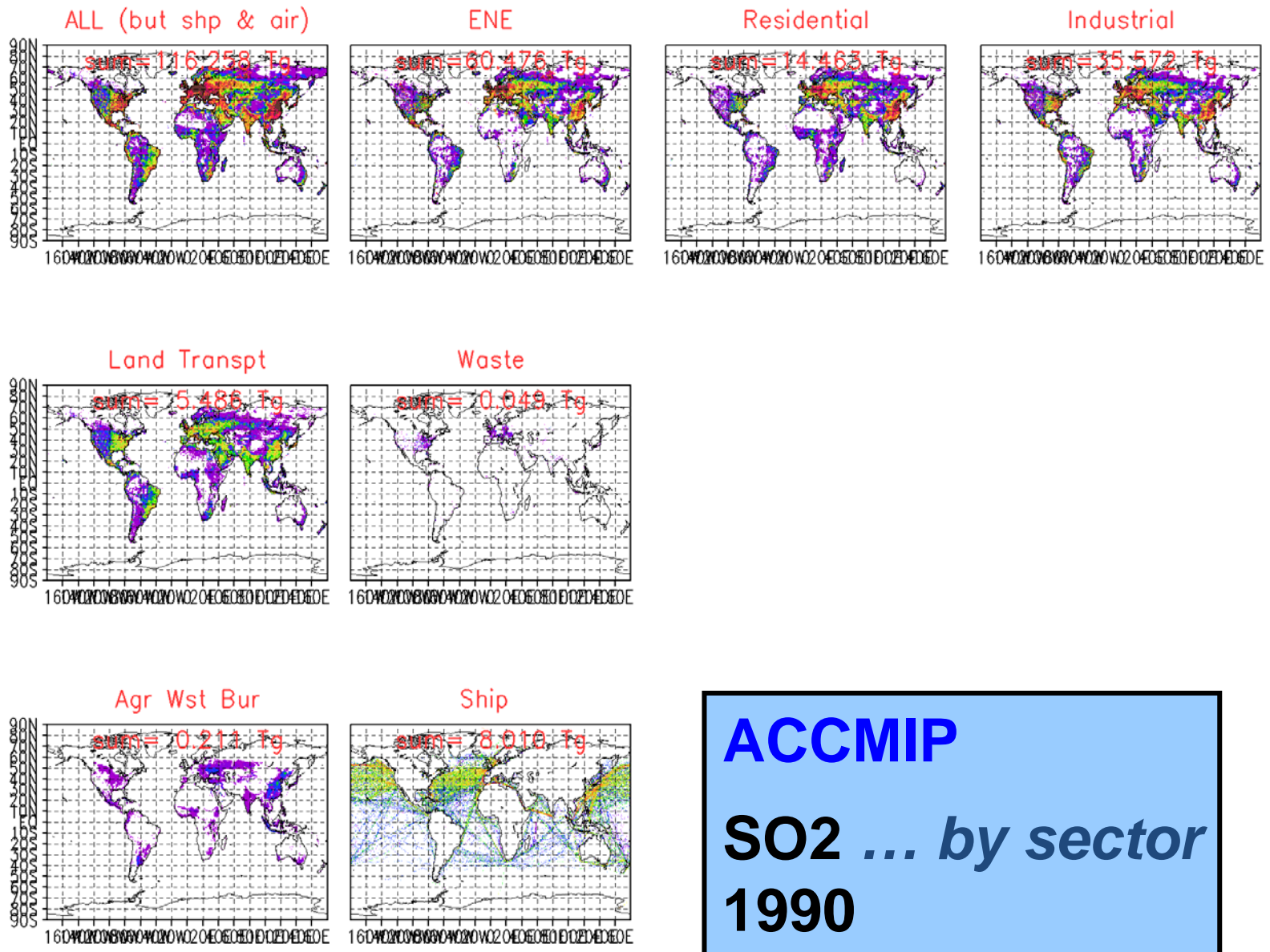
# ACCMIP MACCity ANTHROP EMI S02 1990 GLB



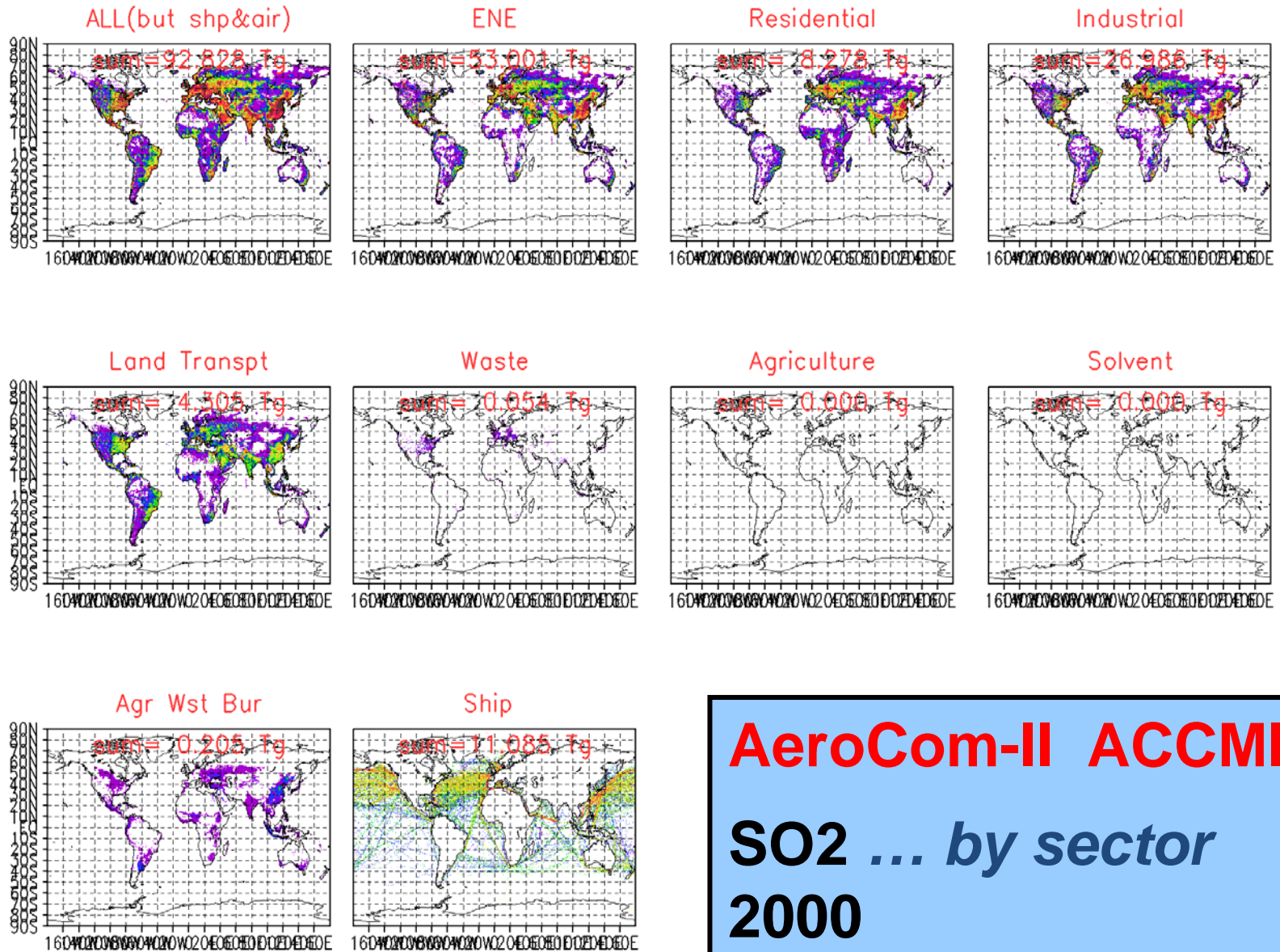
**AeroCom-II ACCMIP**  
**SO<sub>2</sub> ... by sector**  
**1990**



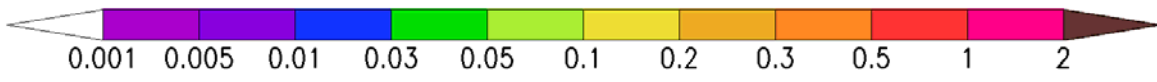
# IPCC\_historic ANTHROP EMI SO2 1990 GLB



# ACCMIP MACCity ANTHROP EMI S02 2000 GLB



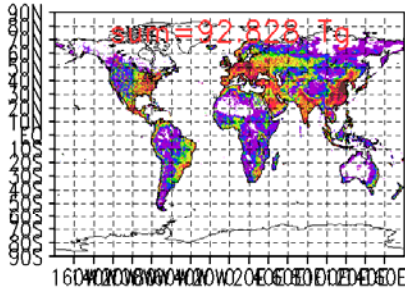
**AeroCom-II ACCMIP**  
**SO2 ... by sector**  
**2000**



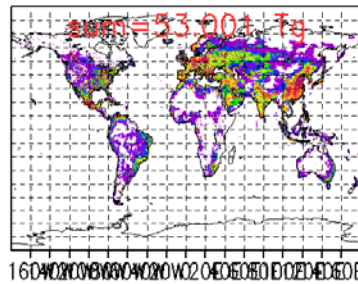
unit: g/m2/year

# IPCC\_historic ANTHROP EMI SO2 2000 GLB

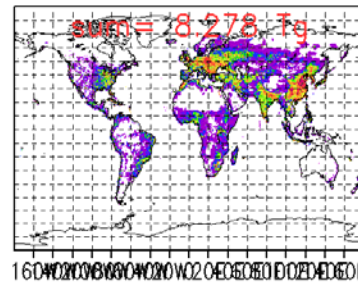
ALL (but shp & air)



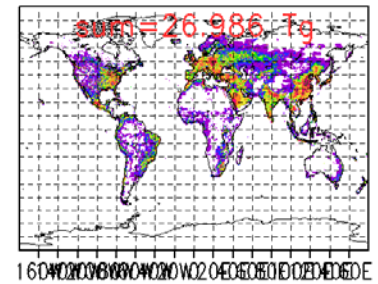
ENE



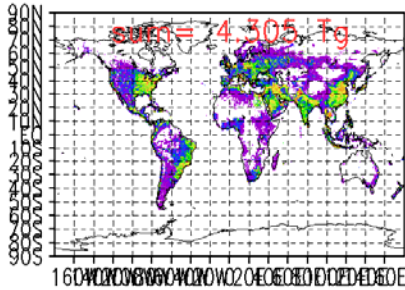
Residential



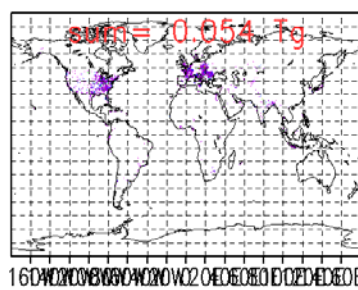
Industrial



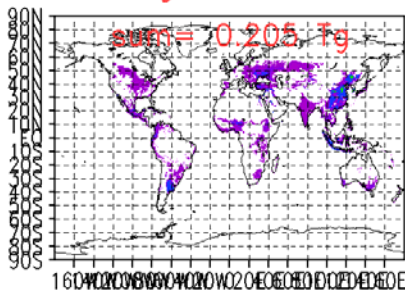
Land Transpt



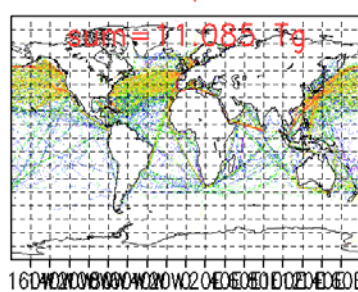
Waste



Agr Wst Bur



Ship



**ACCMIP**

**SO2 ... by sector**

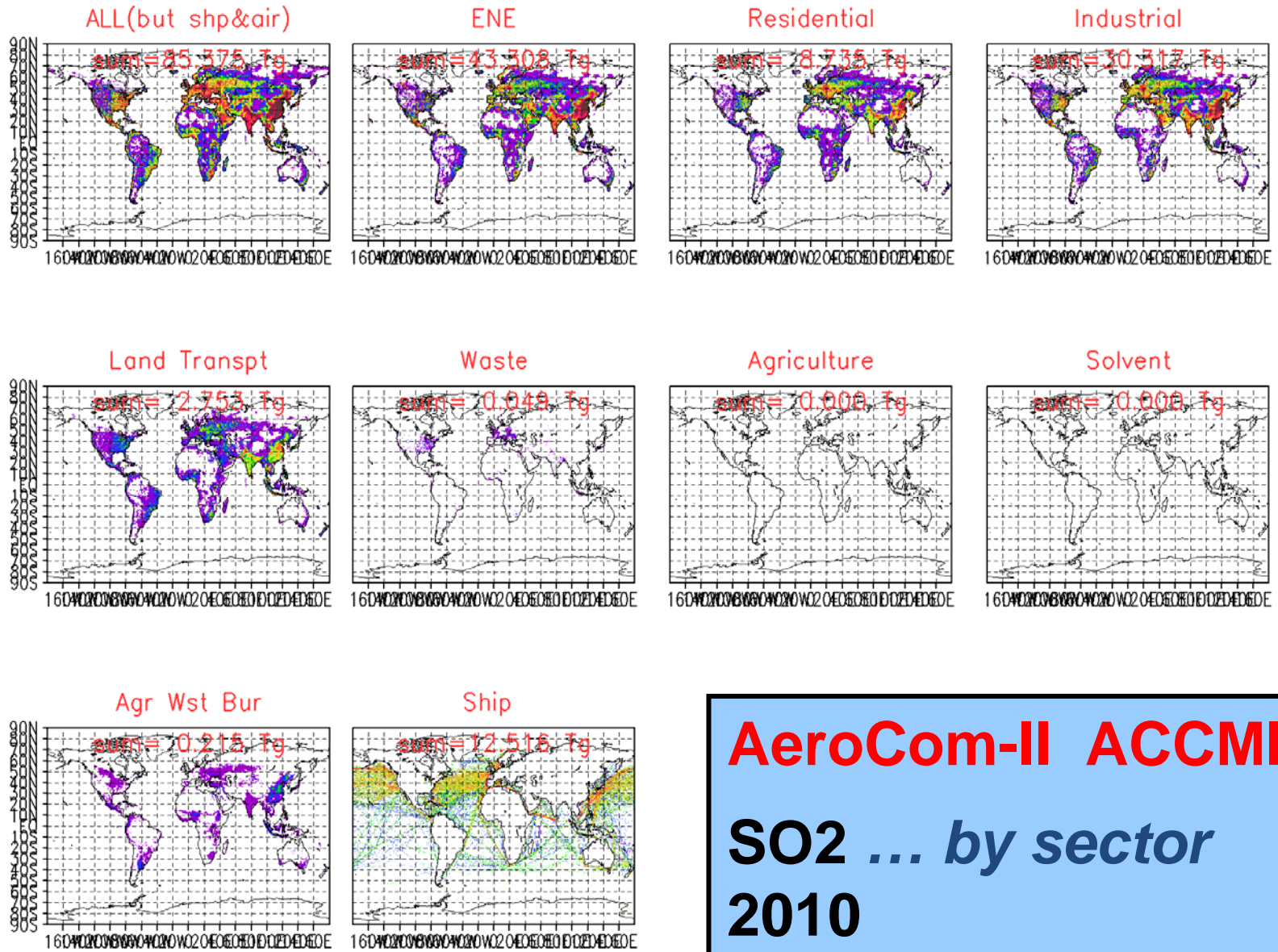
**2000**



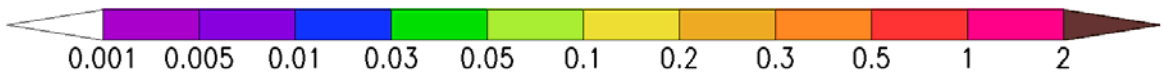
unit: g/m<sup>2</sup>/year



# ACCMIP MACCity ANTHROP EMI S02 2010 GLB

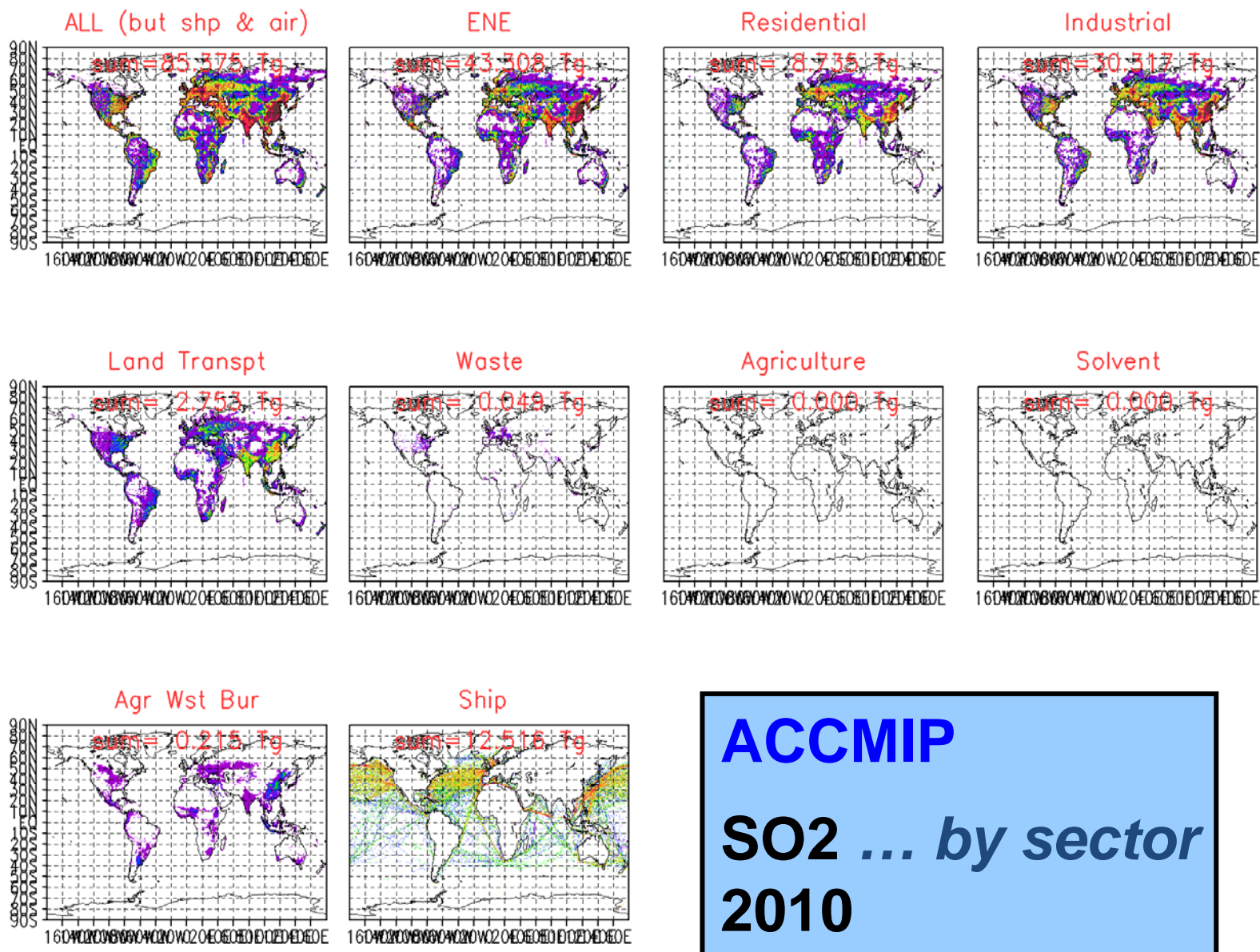


**AeroCom-II ACCMIP**  
**SO<sub>2</sub> ... by sector**  
**2010**

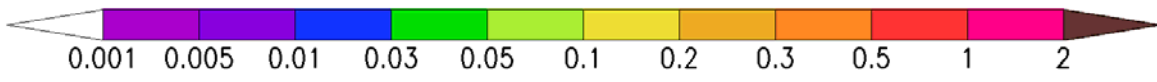


unit: g/m<sup>2</sup>/year

# IPCC\_RCP85 ANTHROP EMI SO2 2010 GLB



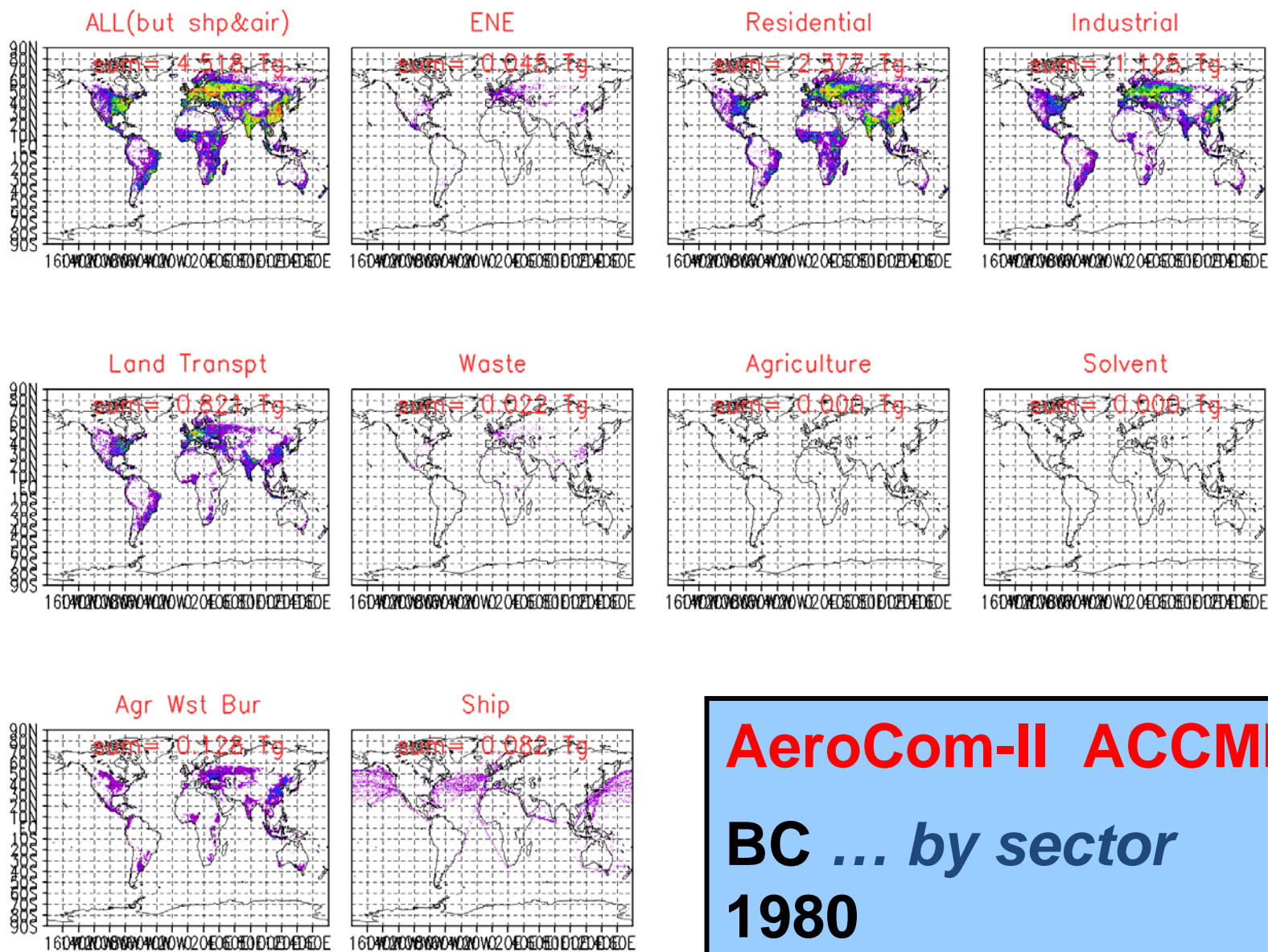
**ACCMIP**  
**SO2 ... by sector**  
**2010**



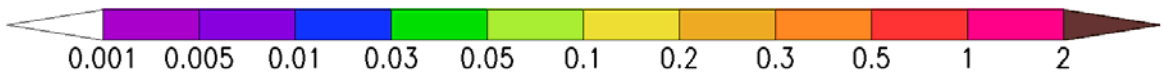
unit: g/m<sup>2</sup>/year



# ACCMIP MACCcity ANTHROP EMI BC 1980 GLB

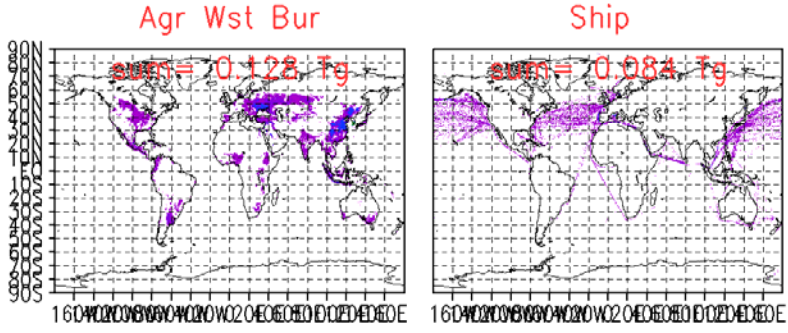
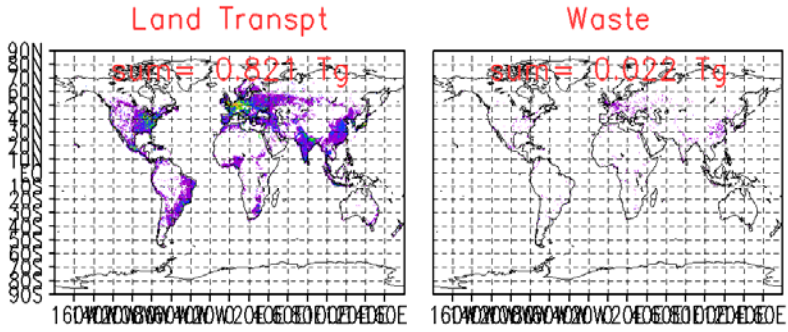
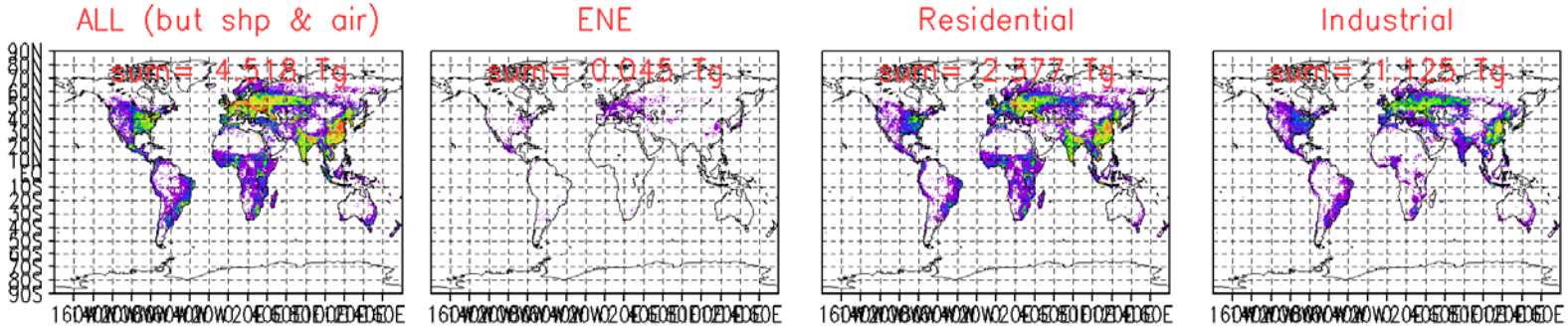


**AeroCom-II ACCMIP**  
**BC ... by sector**  
**1980**

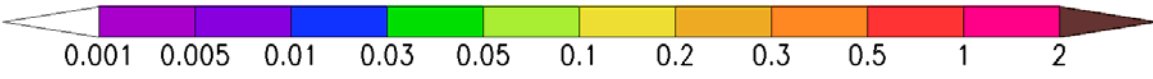


unit: g/m<sup>2</sup>/year

# IPCC\_historic ANTHROPO EMI BC 1980 GLB

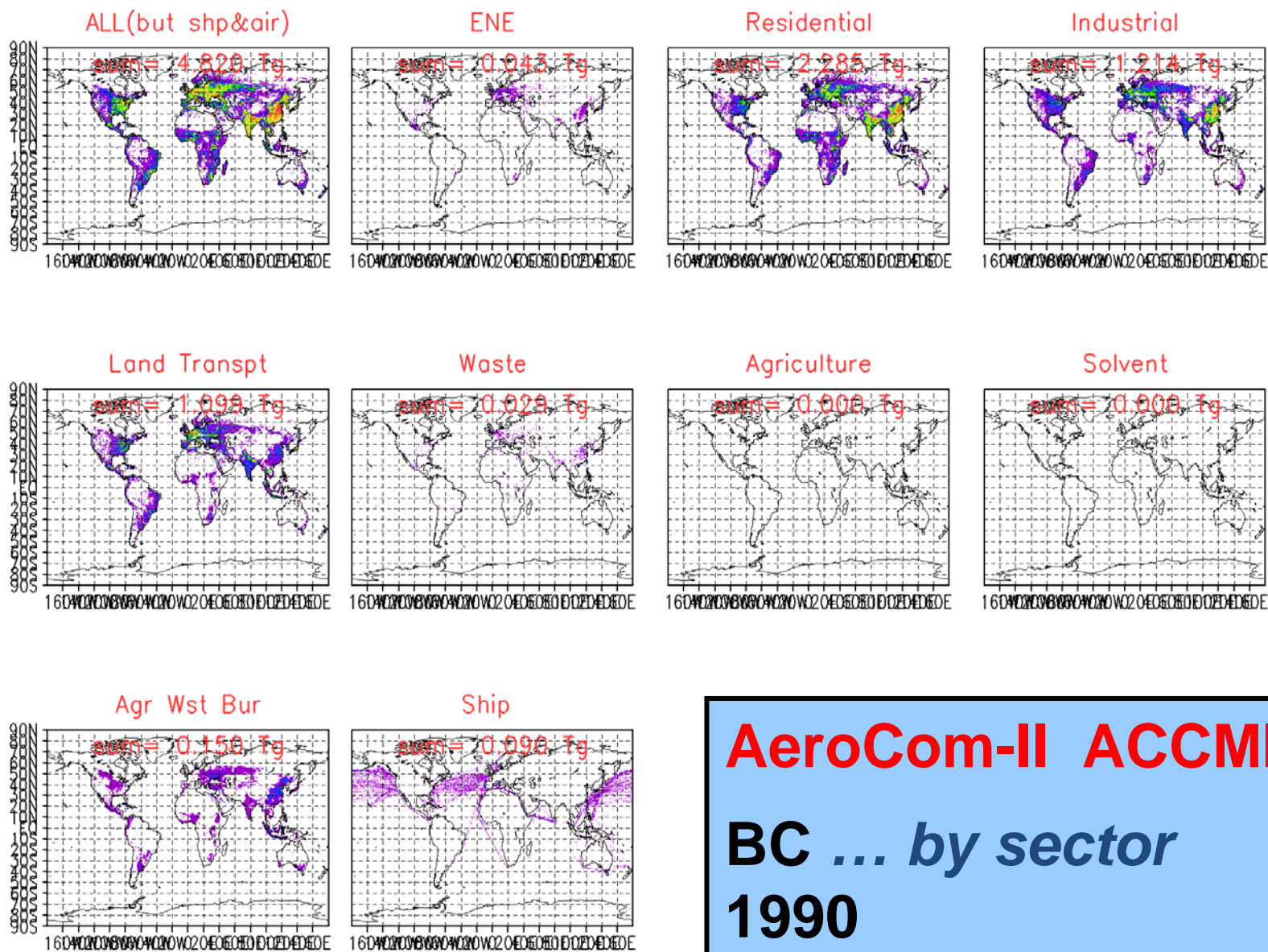


**ACCMIP**  
**BC ... by sector**  
**1980**

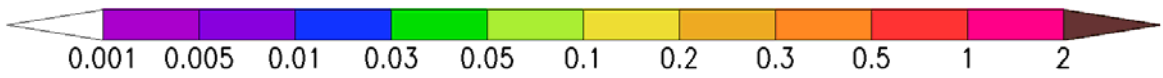


unit: g/m<sup>2</sup>/year

# ACCMIP MACCcity ANTHROP EMI BC 1990 GLB



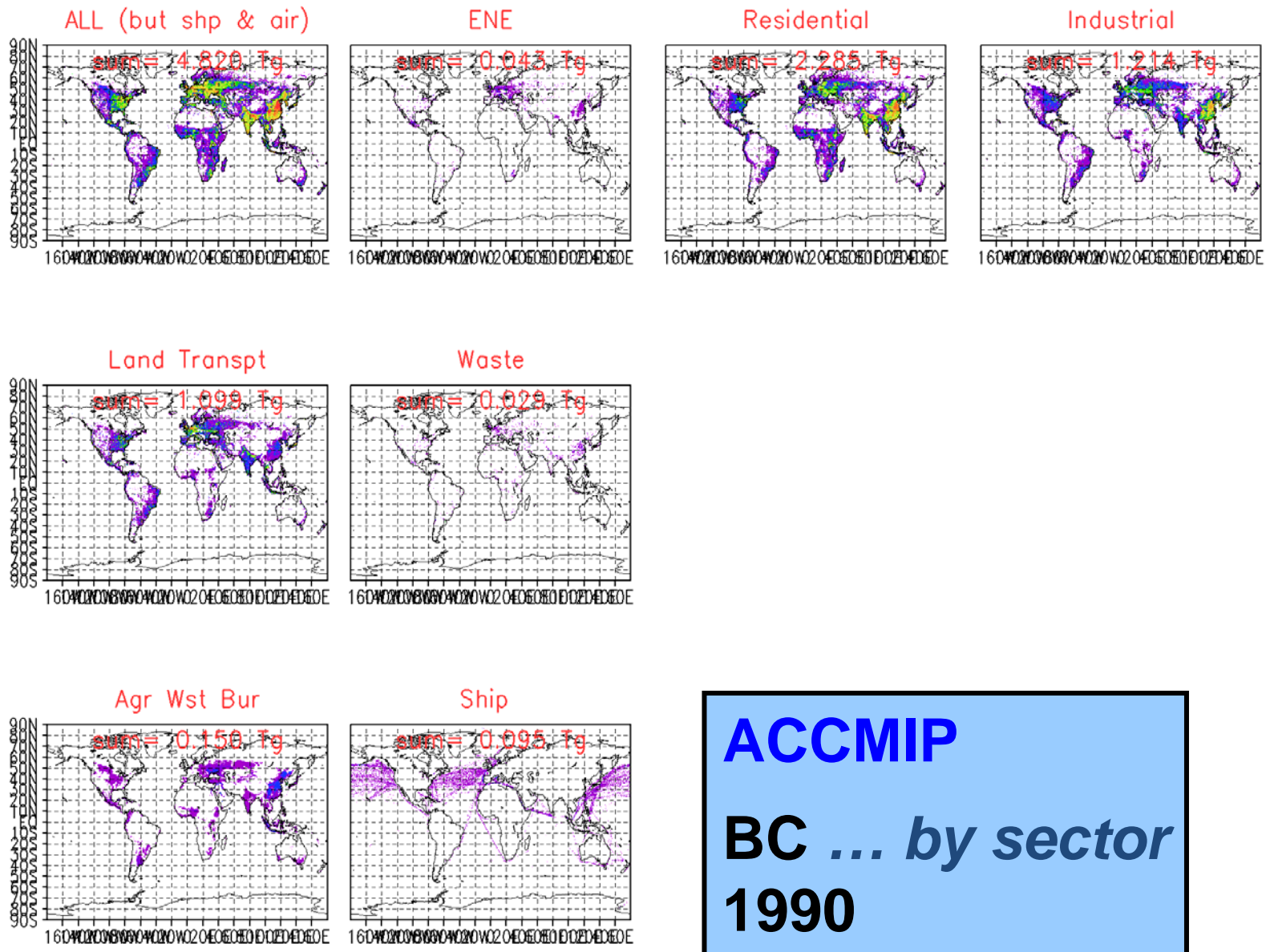
**AeroCom-II ACCMIP**  
**BC ... by sector**  
**1990**



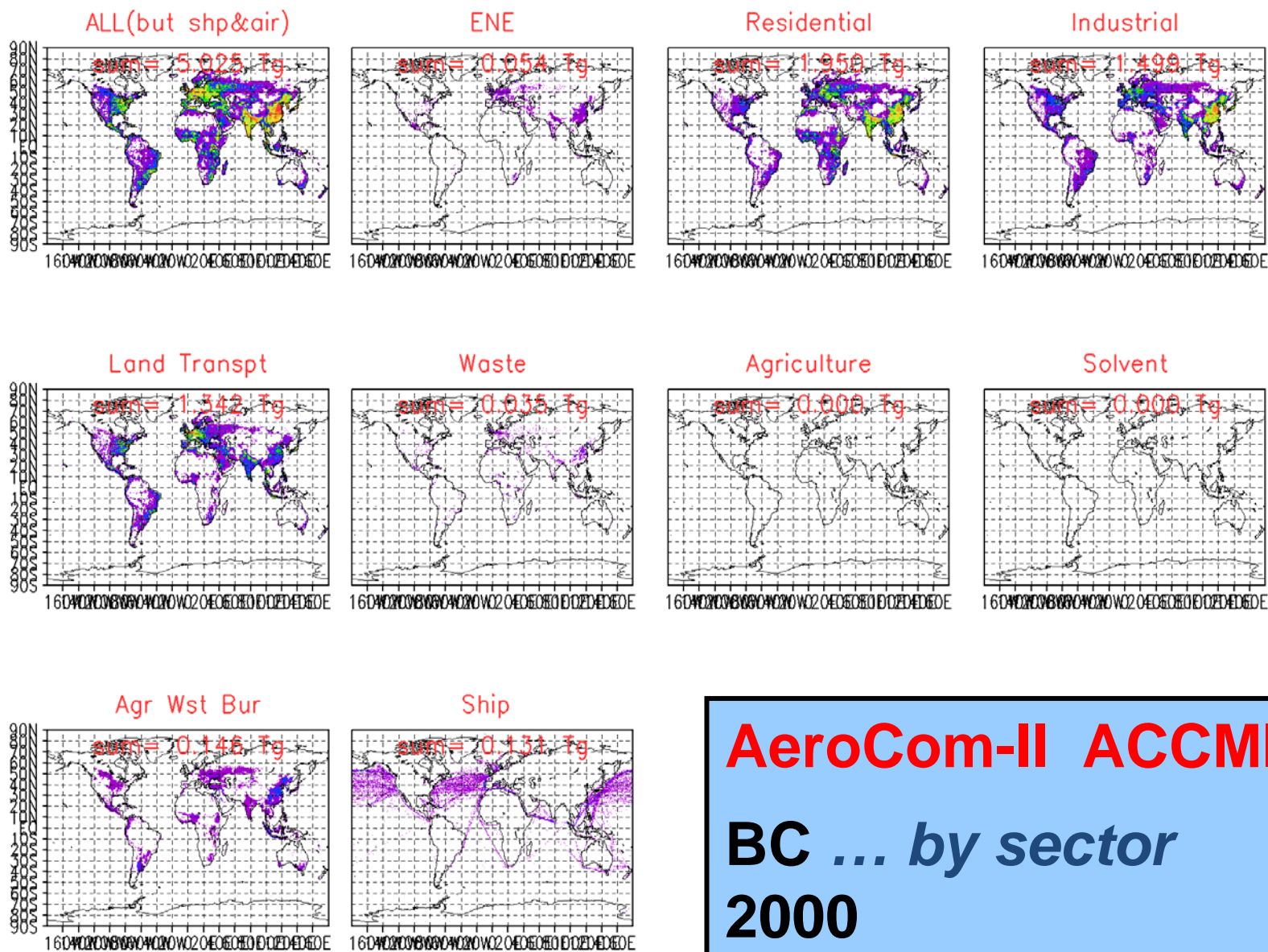
unit: g/m<sup>2</sup>/year



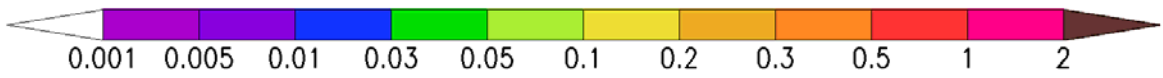
# IPCC\_historic ANTHROP EMI BC 1990 GLB



# ACCMIP MACCcity ANTHROP EMI BC 2000 GLB

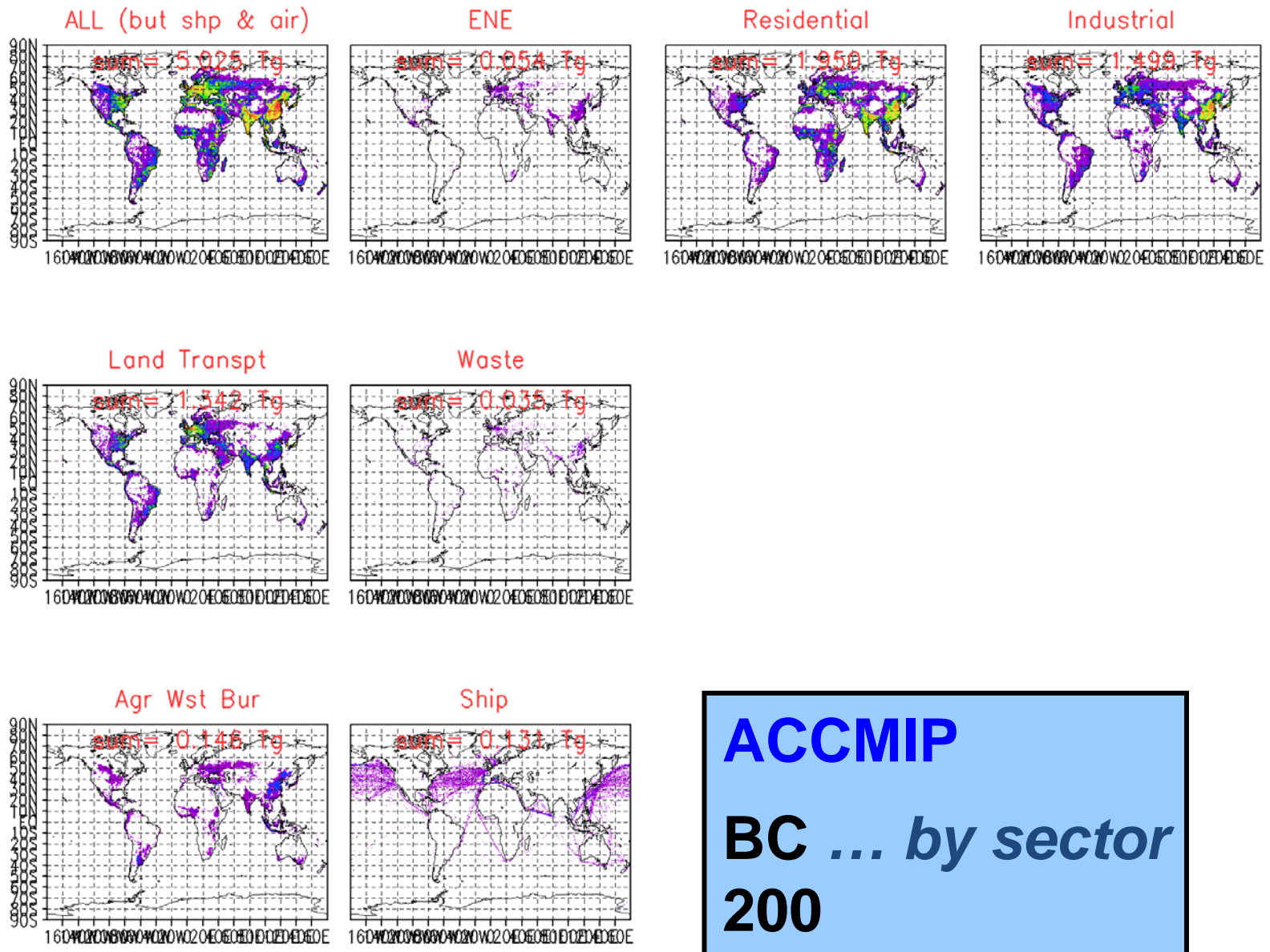


**AeroCom-II ACCMIP**  
**BC ... by sector**  
**2000**



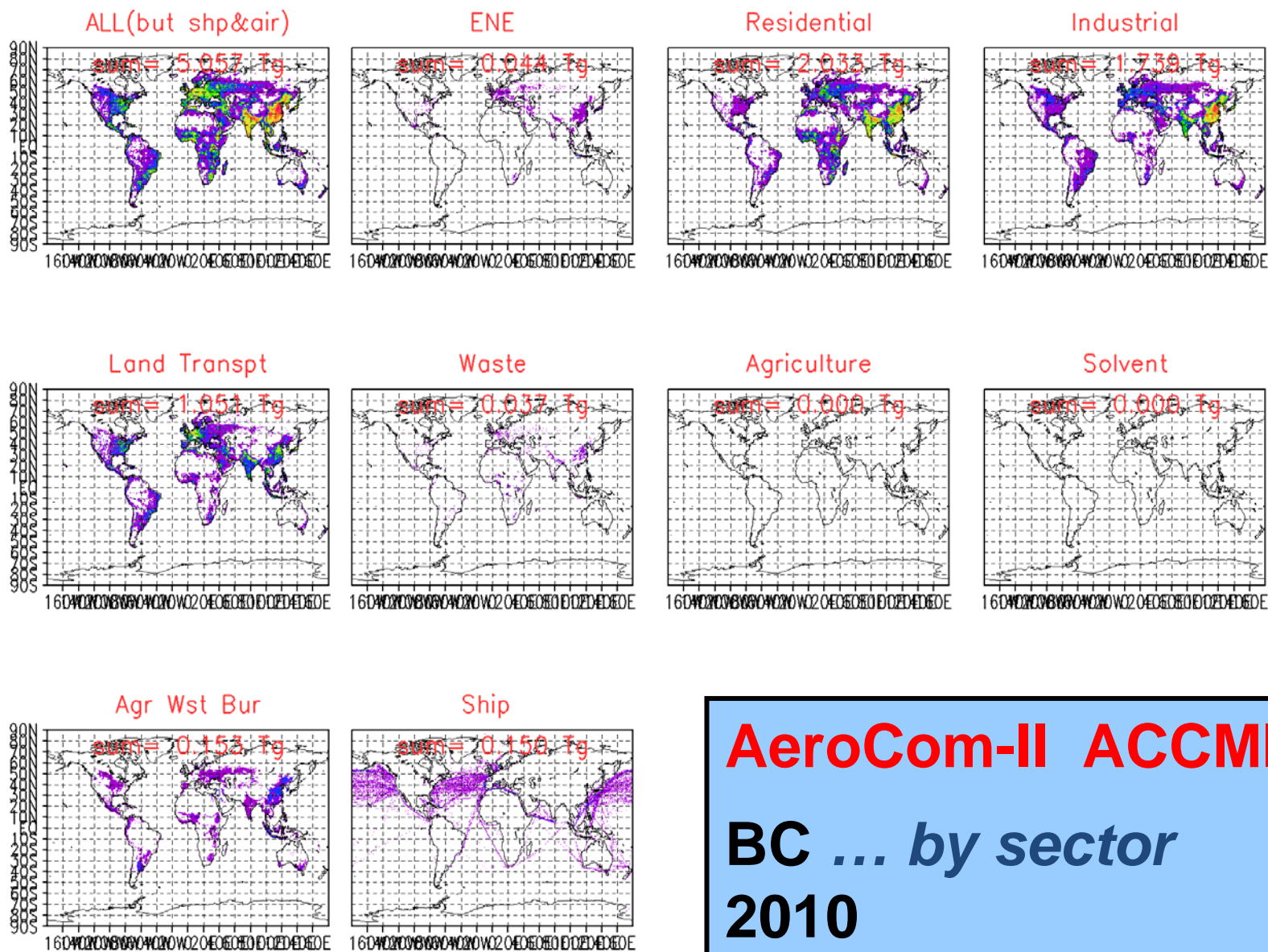
unit: g/m<sup>2</sup>/year

# IPCC\_historic ANTHROP EMI BC 2000 GLB

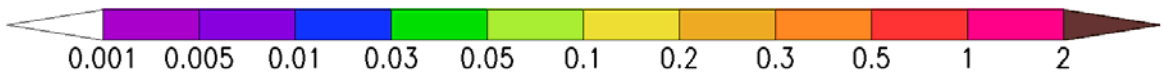




# ACCMIP MACCcity ANTHROP EMI BC 2010 GLB

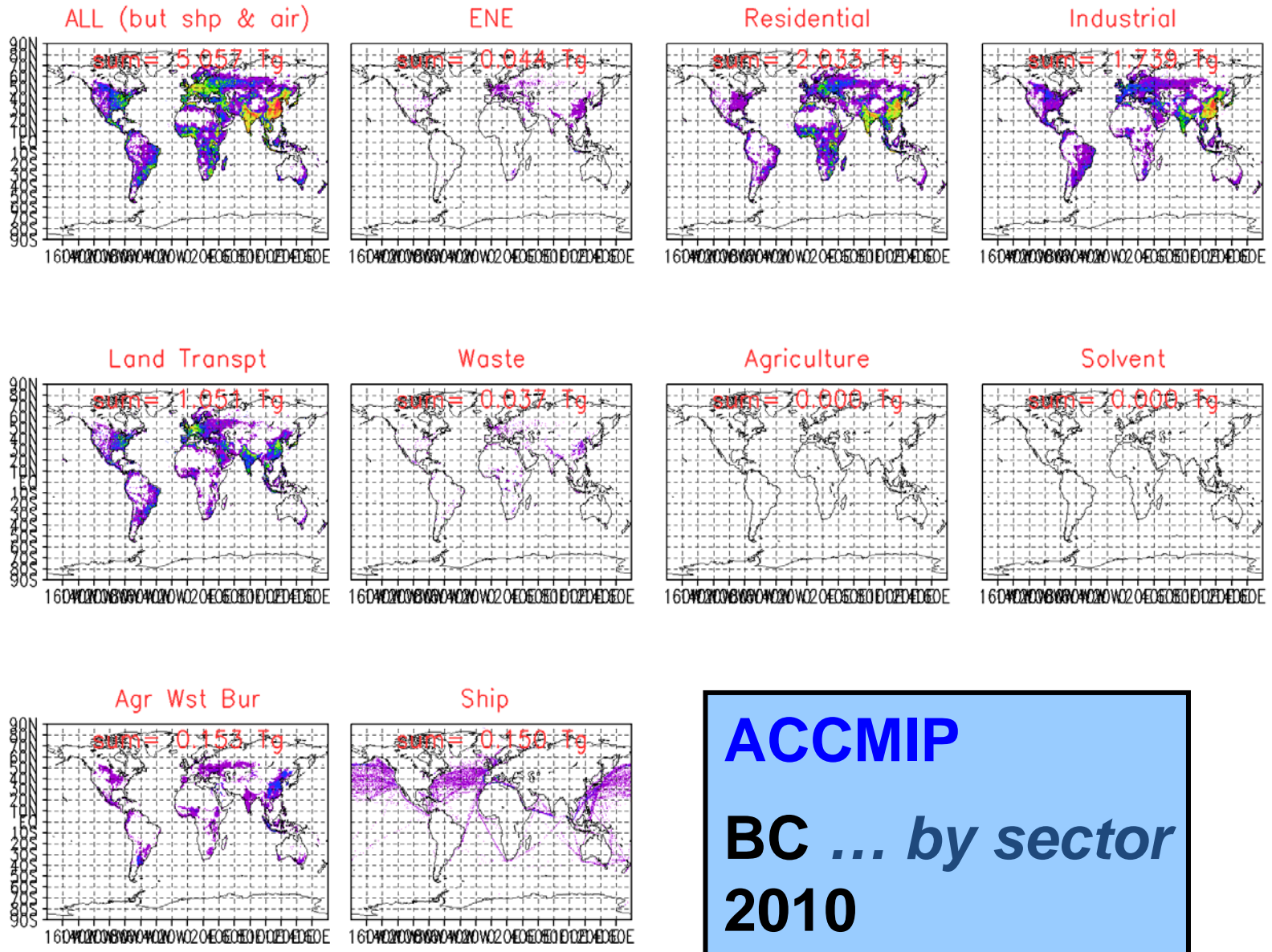


**AeroCom-II ACCMIP**  
**BC ... by sector**  
**2010**

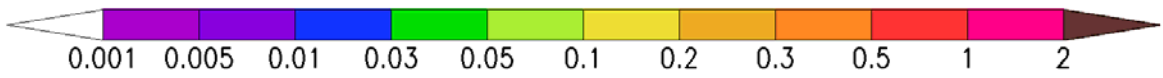


unit: g/m<sup>2</sup>/year

# IPCC\_RCP85 ANTHROP EMI BC 2010 GLB

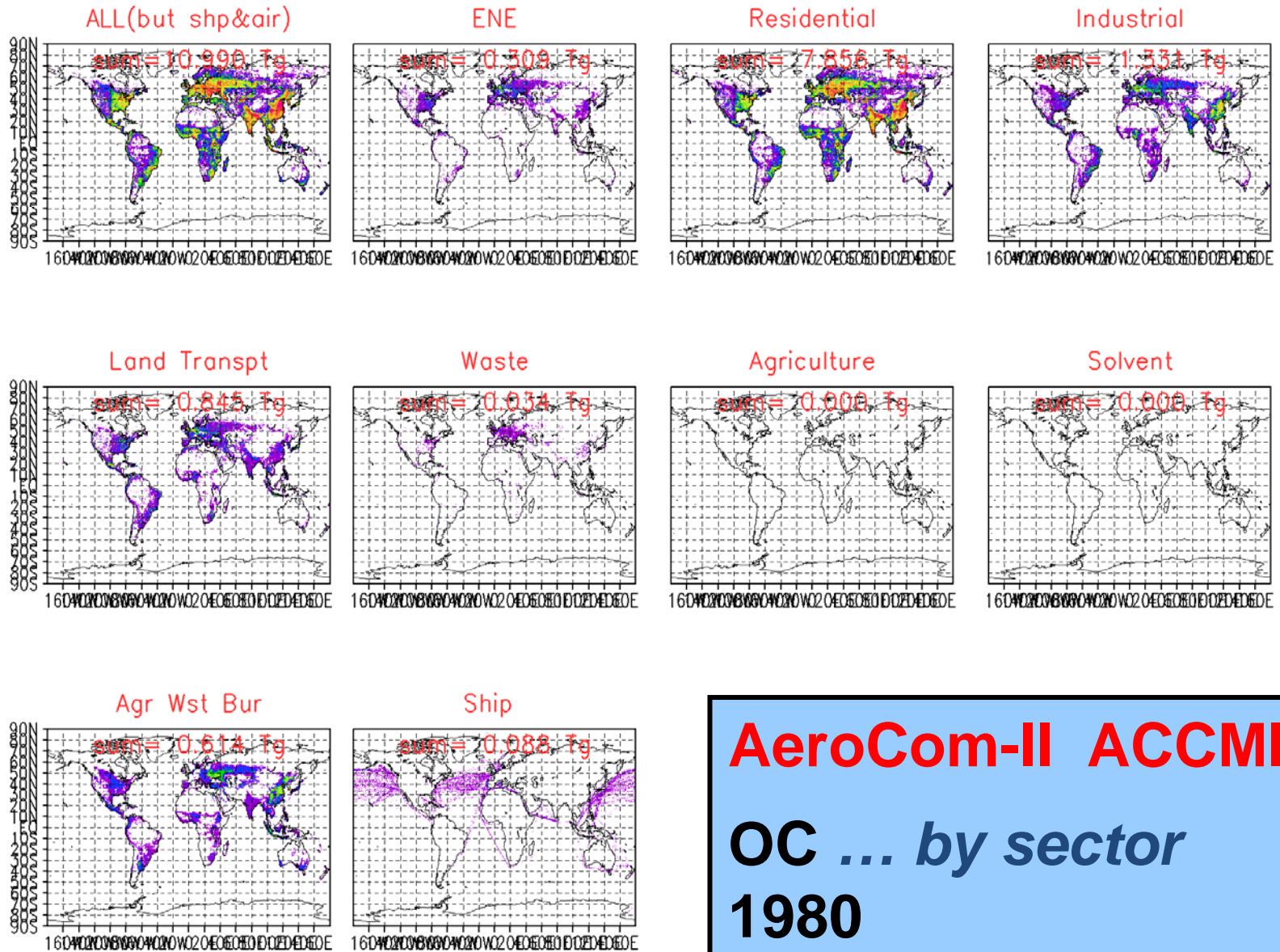


**ACCMIP**  
**BC ... by sector**  
**2010**

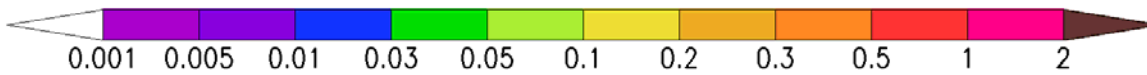


unit: g/m<sup>2</sup>/year

# ACCMIP MACCcity ANTHROP EMI OC 1980 GLB



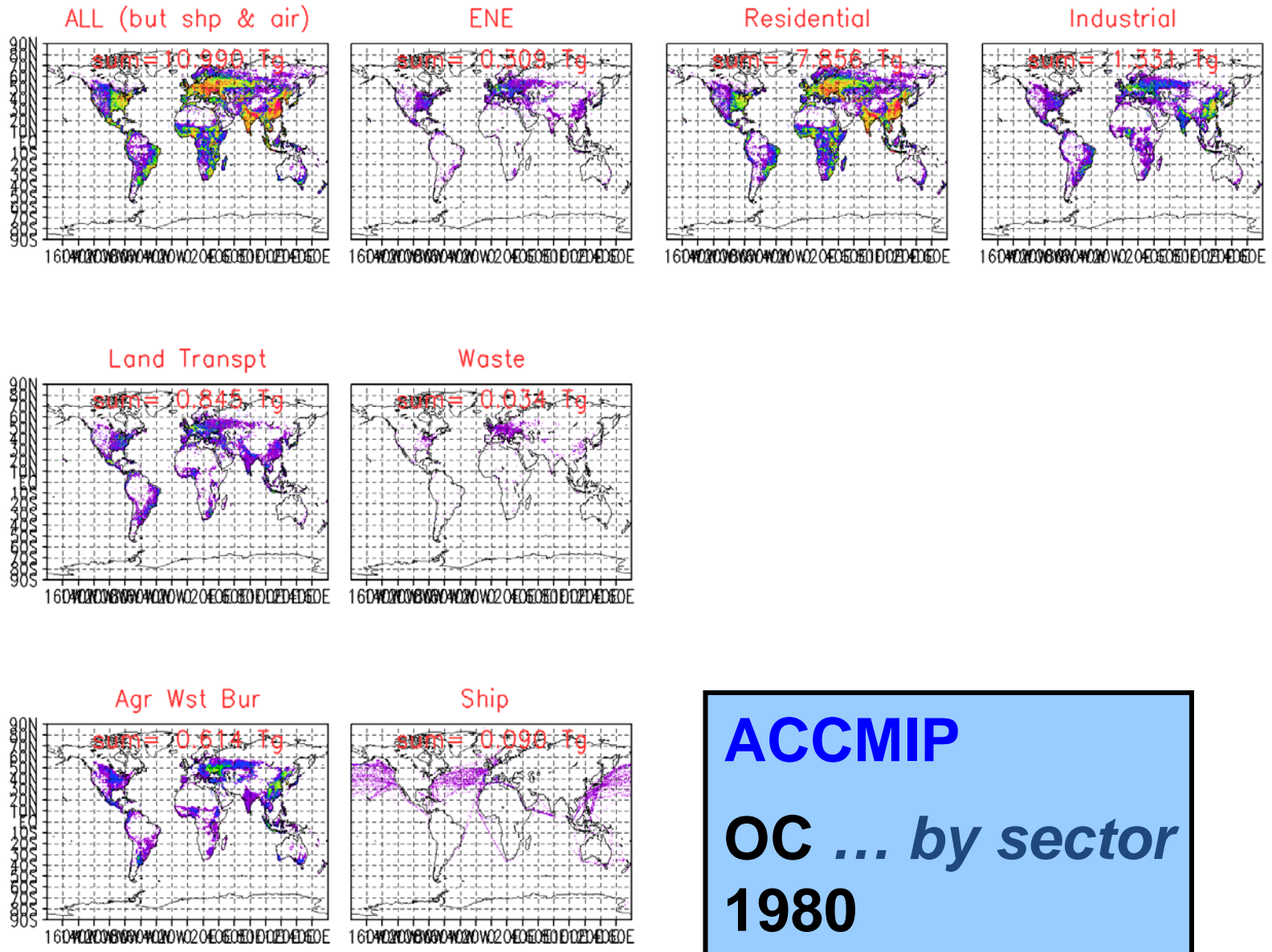
**AeroCom-II ACCMIP**  
**OC ... by sector**  
**1980**



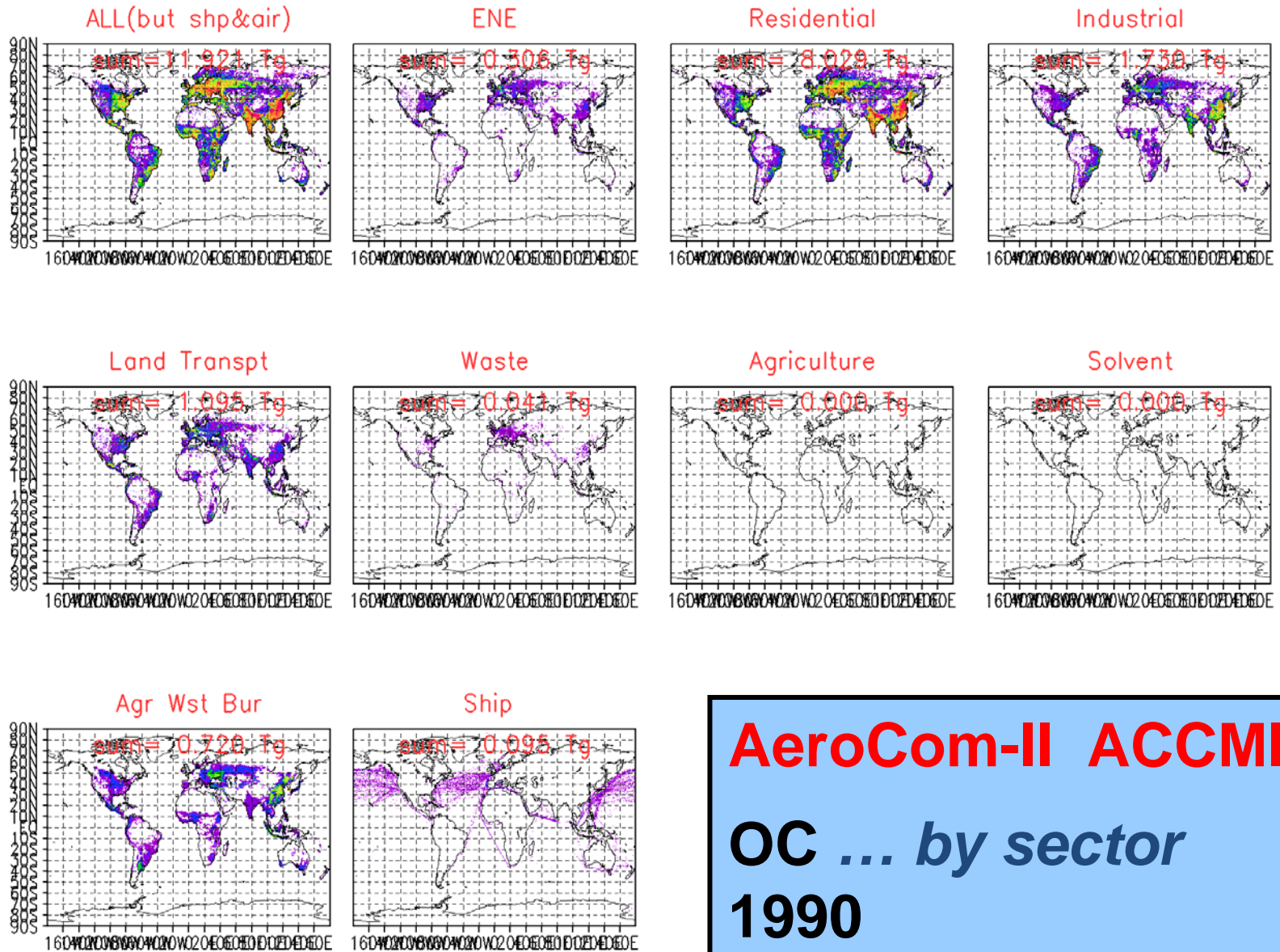
unit: g/m<sup>2</sup>/year



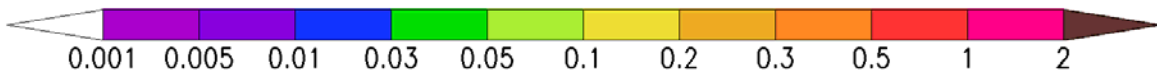
# IPCC\_historic ANTHROP EMI OC 1980 GLB



# ACCMIP MACCcity ANTHROP EMI OC 1990 GLB



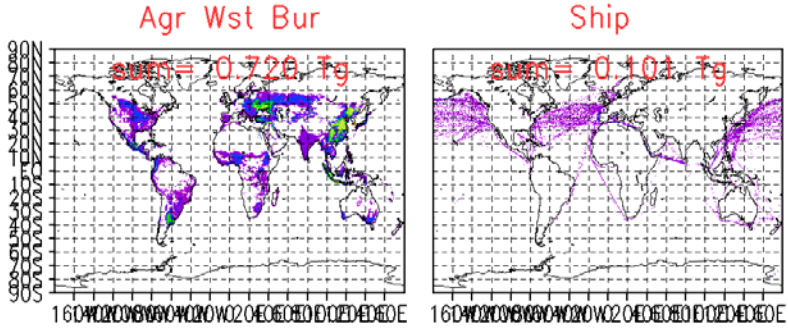
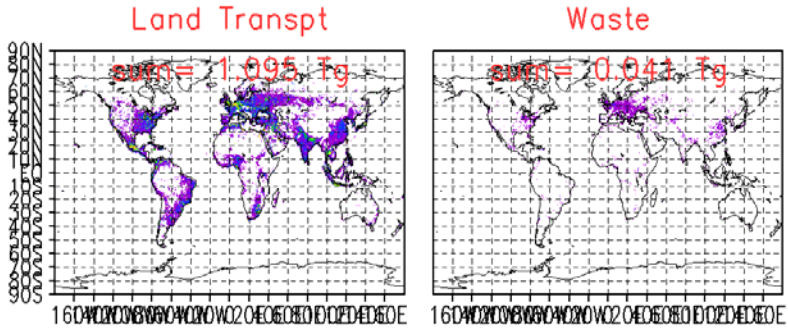
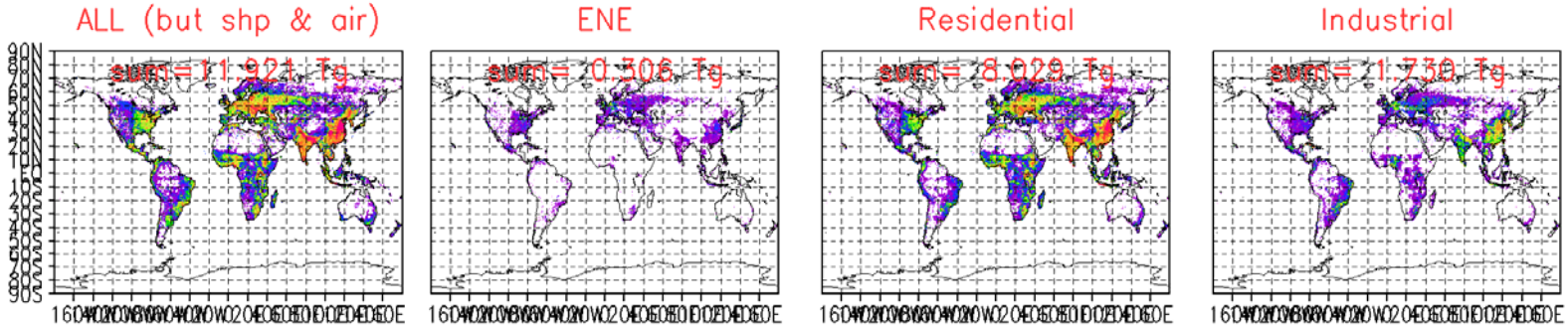
**AeroCom-II ACCMIP**  
**OC ... by sector**  
**1990**



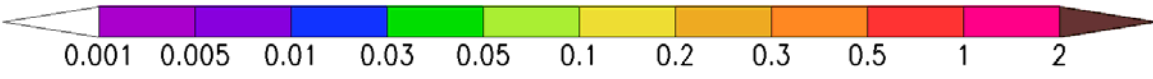
unit: g/m<sup>2</sup>/year



# IPCC\_historic ANTHROP EMI OC 1990 GLB

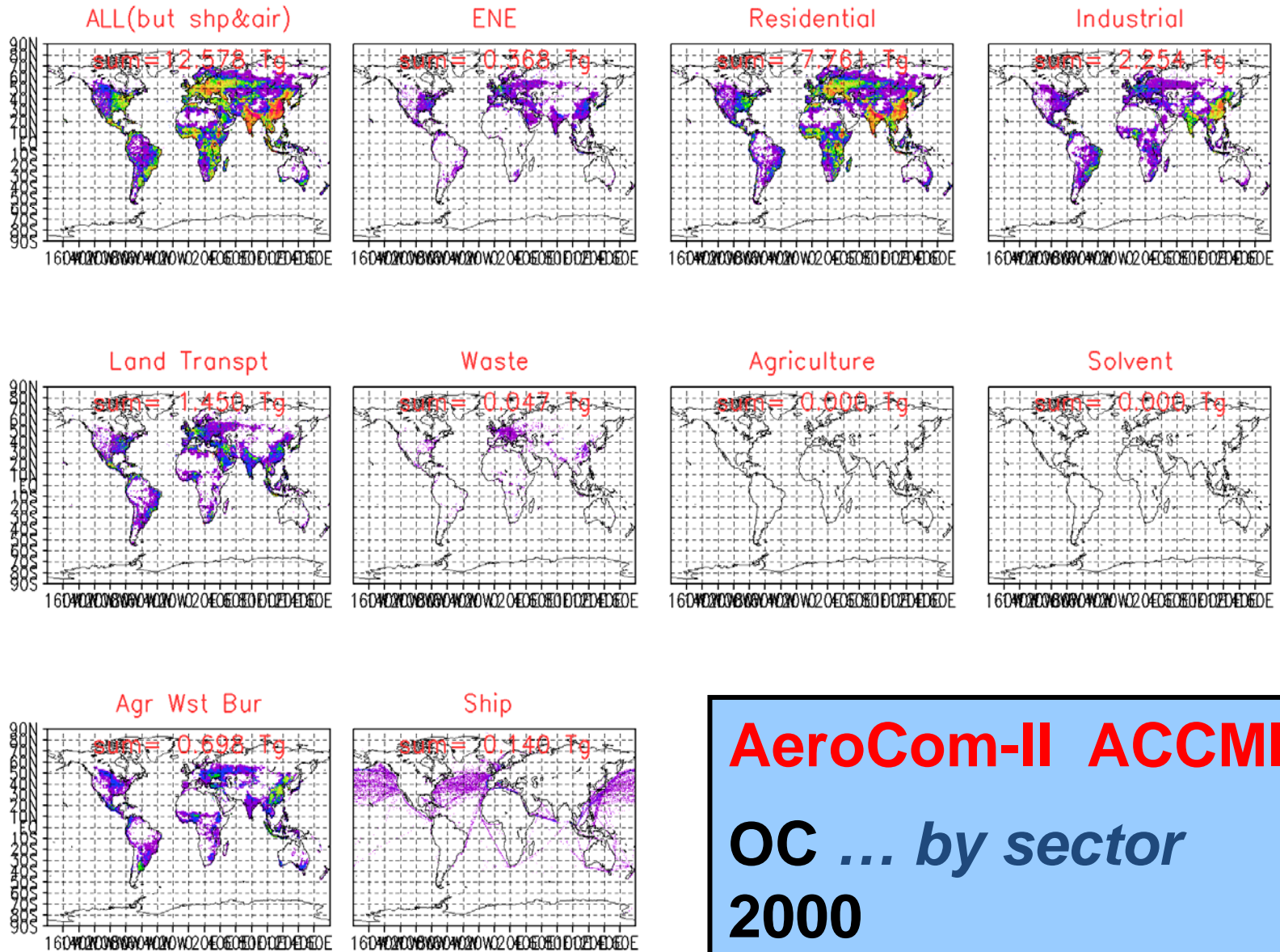


**ACCMIP**  
**OC ... by sector**  
**1990**

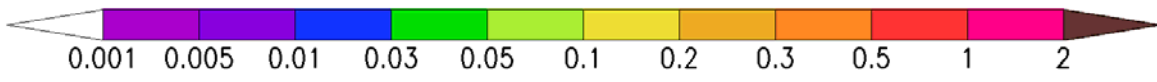


unit: g/m<sup>2</sup>/year

# ACCMIP MACCcity ANTHROP EMI OC 2000 GLB

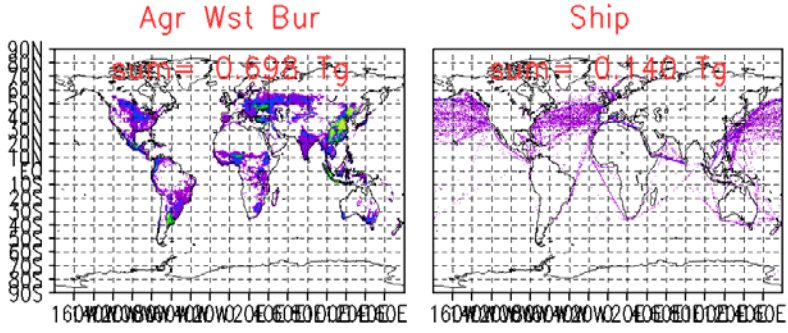
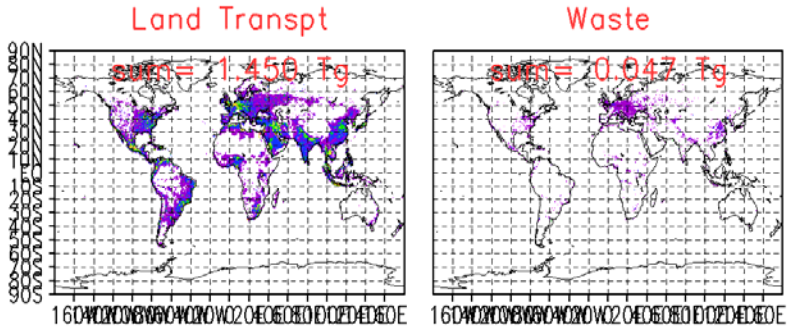
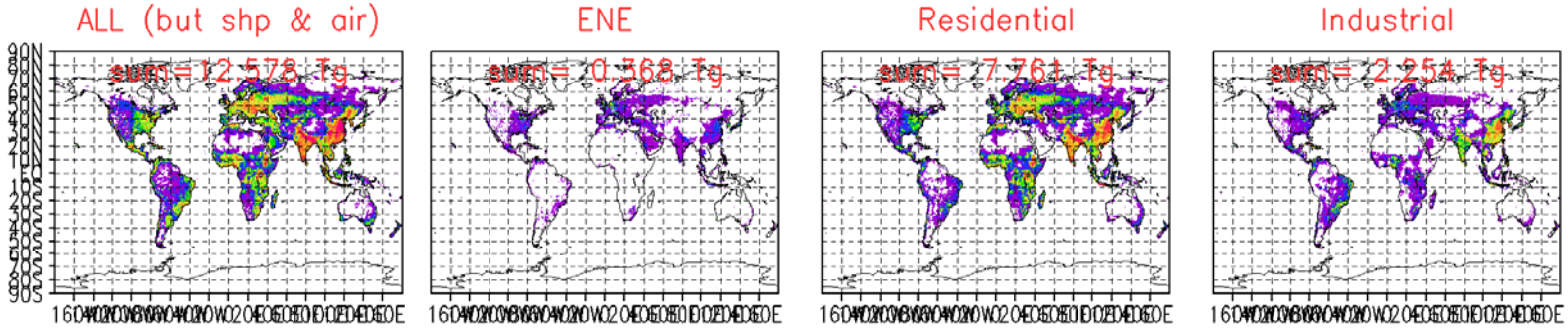


**AeroCom-II ACCMIP**  
**OC ... by sector**  
**2000**

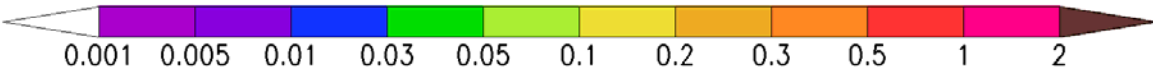


unit: g/m<sup>2</sup>/year

# IPCC\_historic ANTHROP EMI OC 2000 GLB



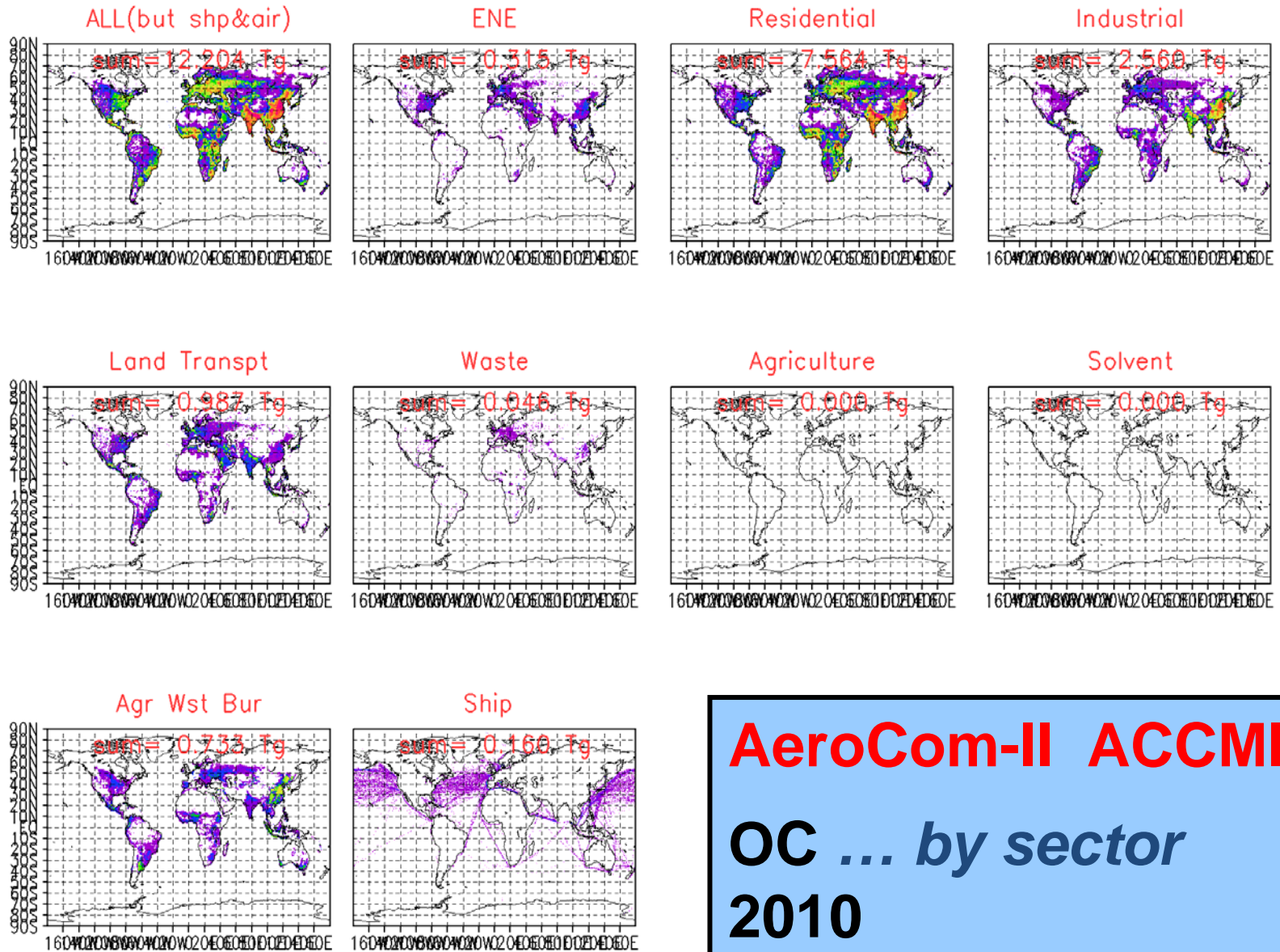
**ACCMIP**  
**OC ... by sector**  
**2000**



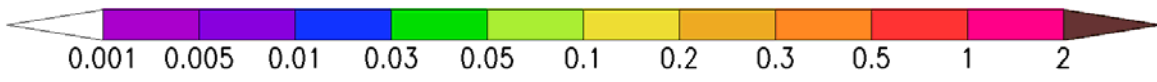
unit: g/m<sup>2</sup>/year



# ACCMIP MACCcity ANTHROP EMI OC 2010 GLB

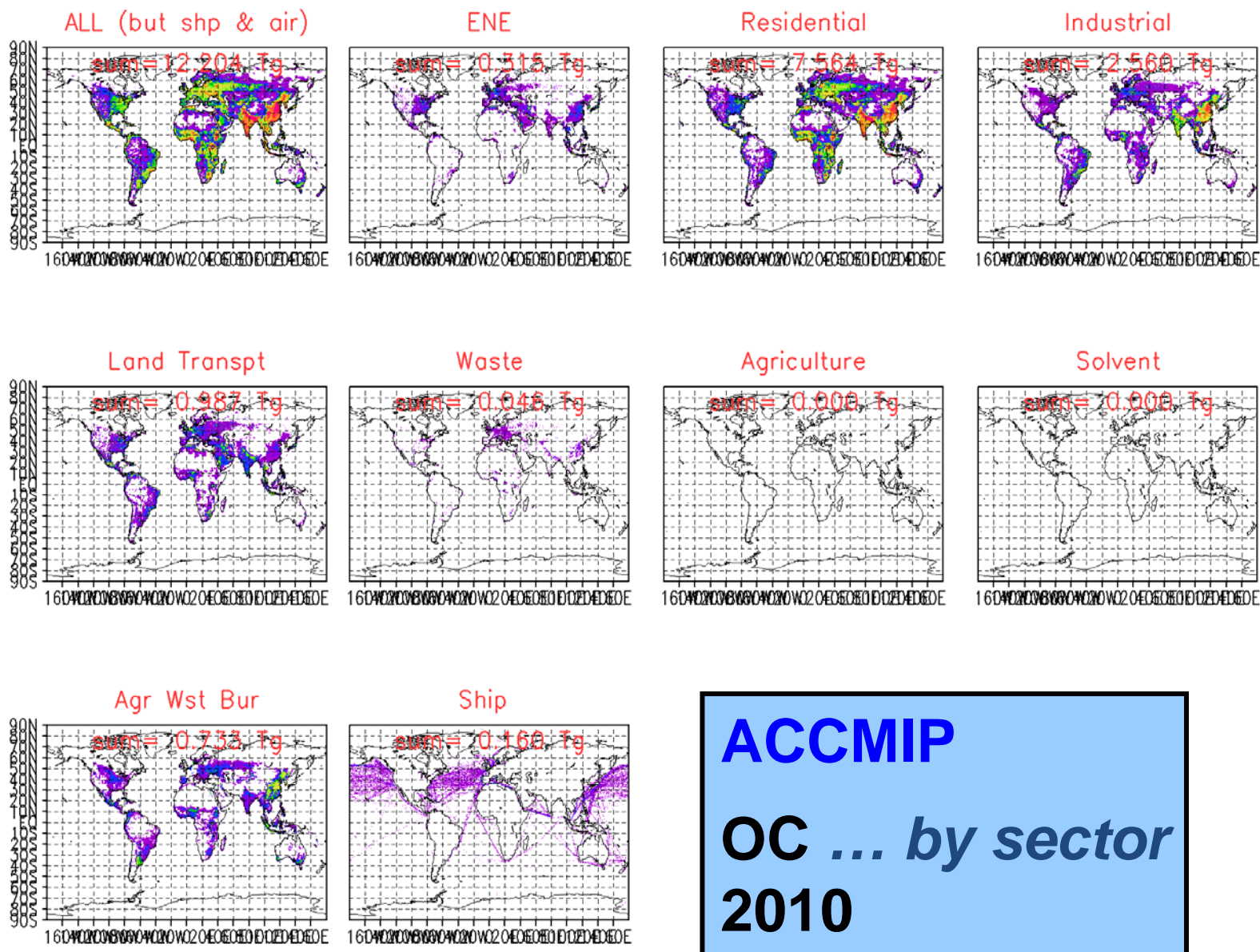


**AeroCom-II ACCMIP**  
**OC ... by sector**  
**2010**



unit: g/m<sup>2</sup>/year

# IPCC\_RCP85 ANTHROP EMI OC 2010 GLB



unit: g/m<sup>2</sup>/year

# conclusions (1)

**AeroCom-II ACCMIP vs. ACCMIP**

- **annual means are identical**
  - **except for ship-emissions** (2-6% smaller for only 1980 and 1990 in AeroCom (-II ACCMIP) due to the linear time interpolation procedure taking into account the **\*true\*** original timestamps)
  - **except for biomass burning emissions**
- **AeroCom biomass burning has strong inter-annual variations (1980 to 2006) - ACCMIP not**
- **AeroCom is CF compliant - ACCMIP not**

# conclusions (2)

- **AeroCom-II ACCMIP vs AeroCom-II HCA0 v1**  
*old SO<sub>2</sub> data*
  - **AeroCom ACCMIP has lower anthro. SO<sub>2</sub> emissions**
    - Europe after 1990 (~ half less) & Asia (~ 30% less)
  - **AeroCom ACCMIP has higher anthro. OC emissions**
    - Europe after 1990 (~ double) & Asia (~ 50% more)
  - anthrop. **BC** emissions are comparable