Results of the workshop “GMES and Emission Inventories” and some reflections on GEIA activities

John Van Aardenne (EEA, jva@eea.europa.eu)
Overview of the presentation

a. Looking back on GEIA

b. The European Environment Agency (replacement of poster)

c. Results of the workshop "GMES and Emission Inventories"

d. Looking forward to GEIA
a. 8th GEIA workshop, Bilthoven, The Netherlands, 3-4 November 1997.
### a. Datasets in the ECCAD and GEIA database

<table>
<thead>
<tr>
<th>Product</th>
<th>Release Year</th>
<th>Temporal Coverage</th>
<th>Time Resolution</th>
<th>Category</th>
<th>Grid size</th>
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<td>2000</td>
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<td>2009</td>
<td>1990 - 2000</td>
<td>Yearly</td>
<td>Anthropogenic/Biomass burning</td>
<td>1°</td>
<td>POST</td>
<td><img src="image" alt="POST" /></td>
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</table>

### Other emissions datasets:
- RAINS-Asia (NOx 1990-2030)
- Quantify (2000-2100)
- EDGAR-POLES (2000-2100)
- CIRCE (2005-2050)
- EDGAR-HTAP (2000-2005)

### Acknowledgements:
Wageningen University, University of Iowa, RIVM/PBL, Utrecht University, Max Planck Institute for Chemistry, Joint Research Centre

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*Au revoir*  
European Environment Agency
a. Gridded emissions 1992 (4.5° lat. X 7.5° lon.)

Figure 5. Geographical distribution of NOx emissions from fossil fuel combustion for 1986.
Gridded emissions present day (5 km x 5 km resolution)

E-PRTR: NO\textsubscript{x} emissions from non-industrial combustion (ton/grid)
http://prtr.ec.europa.eu/DiffuseSourcesAir.aspx

European Environment Agency
a. Combining emission inventory datasets: 1996 (GEIA 1985 NOx inventory)

Figure 1. Regional inventories overlaid on (a) the default SOx global inventory and (b) the default NOx global inventory (Benkovitz et al. (1996) from the in press version)
a. Combining emission inventory datasets present day (EDGAR-HTAP)

<table>
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<tr>
<th>Order of priority</th>
<th>1. EMEP</th>
<th>2. UNFCCC</th>
<th>3. REAS</th>
<th>4. GAINS</th>
<th>5. EDGARv4</th>
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<td></td>
<td>x</td>
<td>x</td>
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<td>x</td>
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<tr>
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<td>BC</td>
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</table>

Fig.1 Chemical substances and geographical region covered by the EDGAR-HTAP datasets used with decreasing order of priority in the procedure to compile the available data into one global emission dataset.

EDGAR-HTAP: a harmonized gridded air pollution emission dataset based on national inventories
The European Environment Agency (EEA)

The EEA helps to achieve significant and measurable improvement in Europe's environment by providing timely, targeted, relevant and reliable information to policy-makers and the public.

http://www.eea.europa.eu
b. EEA: a selection of information

Annual submission of the greenhouse gas inventory of the European Union to the United Nations Framework Convention on Climate Change and the Kyoto Protocol

Also LRTAP and NECD inventories (air pollutants)

The EMEP/EEA air pollutant emission inventory guidebook provides guidance on estimating emissions from both anthropogenic and natural emission sources (LRTAP/NECD inventories).

Air pollution by ozone across Europe during summer 2011

The EEA GHG and AP data viewer can show emission trends for the main sectors and allows for comparisons of emissions between different countries and activities.
<table>
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<td>7 232</td>
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<td>166</td>
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<td>158</td>
<td>159</td>
<td>151</td>
<td>163</td>
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<td>7.9 %</td>
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<td>55</td>
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<td>76</td>
<td>83</td>
<td>74</td>
<td>81</td>
<td>-18 %</td>
<td>9.2 %</td>
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<tr>
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<td>Mg</td>
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<td>103</td>
<td>100</td>
<td>99</td>
<td>117</td>
<td>113</td>
<td>113</td>
<td>110</td>
<td>120</td>
<td>-17 %</td>
<td>9.4 %</td>
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</tr>
<tr>
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<td>1 560</td>
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<td>1 473</td>
<td>1 431</td>
<td>1 392</td>
<td>1 374</td>
<td>1 348</td>
<td>1 295</td>
<td>1 333</td>
<td>-15 %</td>
<td>2.9 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PM&lt;sub&gt;10&lt;/sub&gt;</td>
<td>Gg</td>
<td>2 292</td>
<td>2 290</td>
<td>2 217</td>
<td>2 181</td>
<td>2 180</td>
<td>2 133</td>
<td>2 080</td>
<td>2 048</td>
<td>1 989</td>
<td>1 912</td>
<td>1 969</td>
<td>-14 %</td>
<td>3.0 %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
b. Selection of relevant datasets to view or download

European Pollutant Release and Transfer Register (E-PRTR)

e.g. E-PRTR diffuse emissions dataset
- 32 maps with distribution of air pollutant emissions from diffuse sources.
- NOx, SOx, CO, NH3, CO2 an PM10
- Complement facility level data on emissions
- Emissions and grid data available for download (repres. Year 2008 situation)

AirBase - The European air quality database
- air quality data delivered annually
- establishing exchange of information and data from networks and individual stations measuring ambient air pollution within the Member States
- latest dataset: 2010 data
c. Results of the workshop “GMES and Emission Inventories”

GMES Services and Emission Inventories

workshop October 2011

ETC/ACM Technical Paper 2011/13
December 2011

Justin Goodwin, Peter de Smet,
Laurence Rouil, John van Aardenne
c. Aims of the workshop

- Organised by the EEA and its Topic Centre on Air Pollution and Climate Mitigation; Held in Copenhagen on 10-11 October 2011

- 45 participants from various communities: emission inventory, satellite observation, in-situ observation and atmospheric modelling. Scientists, GMES services developers, national representatives in charge of emission inventories (UK, NL, France), CEIP gave presentations

- Objective: showcase existing collaboration and activities and highlight options where in the near future inventories could support GMES services and where GMES services and other observational datasets could improve emission inventory information for science and policy

- [http://acm.eionet.europa.eu/docs/meetings/111010_gmes-emissinv_ws/meeting111010.html](http://acm.eionet.europa.eu/docs/meetings/111010_gmes-emissinv_ws/meeting111010.html)

- Many actors, activities, datasets, expectations……
c. Setting the scene

- Two perspectives concerning emissions
  - **Scientific issues:** challenging the accuracy, most up-to-date data and sources. Generally driven by modelling and research activities
  - **Regulatory reporting:** issued from nationally reported inventories conform to agreed standards and methods valuing consistency and transparency over accuracy and detail

- Application of emissions data in of modelling for policy purposes (air quality assessments, reporting) and scientific analysis:
  (a) raises new requests/concerns for emissions and encourage convergence of both approaches
  (b) requires insight from Global to Regional (EU) to (sub) national scale

- Larger emphasis on verification of emission inventories:
  - Because inconsistencies of measurements and modelling (**not only due to EI**)
  - For compliance checking (especially for the implementation of the Kyoto protocol and GHG)
c. New requirements to emission inventories

- Spatial resolution of the emission inventories: both for scientific and policy support inventories (e.g. LRTAP inventories). How to use expertise developed in the countries?

- Need for more consistency between available datasets: CLRTAP/EMEP, GMES/MACC, E-PRTR. With different datasets different modelled maps will be published! Key role of the CEIP/TFEIP, the EEA, FAIRMODE…

- Improved temporal resolution: for forecasting systems and to explain some pollution peaks and episodes (supposed to be reported according to the AQD)

- Speciation of chemical species to develop appropriate chemical schemes and be able to compare with high resolution observations
c. Possible links of inventories and the GMES initiative

- Development by the EC of a set of operational services dedicated to Global Monitoring of the Environment and Security. Services for the atmosphere are developed in the so-called MACC/MACC2 projects coordinated by ECMWF.

- GMES services are based on in-situ and Earth observations, and modelling.

- Air quality and global atmospheric composition forecasting and mapping services need emission inventories

- Main contributions from the GMES services (or other similar collaborations):
  - providing independent verification issuing in-situ or Earth Observation data
  - providing more spatially or temporally detailed proxies (not only from the Atmosphere services but rather from the land ones)
  - providing techniques for natural and international emissions sources:
    - dusts, forest fires, volcanoes, international shipping lanes...
  - Development of a new high resolution (8km) emission inventory at the European scale (MACC/TNO)
Providing independent verification

Air Pollutant and greenhouse emissions via inverse modelling, the UK experience, Alistair Manning (UK Metoffice). (presented during workshop)

This type of analysis sometimes included in preparation of national inventories (integration)

F-gases emissions through inverse modelling, Stefan Reimann (EMPA, CH) (presented during workshop)
Providing more spatially or temporally detailed information

**Figure S6.** The calculated total relative change in NO$_2$ concentration before and during the economic recession at cities with population greater than 500,000. The areas considered for each city correspond to the average of the closest co-located grid cell and the surrounding 8 grid cells. The mid-date of the economic recession was estimated as the date with the observed highest rate of NO$_2$ column decrease (minimum NO$_2$ first derivative with respect to time) after 2008.

Providing techniques for natural and international emissions sources

NRT production of daily FRP maps

- **GFASv0**
  - up to 16 May 2011
  - MODIS & SEVIRI FRP observations
  - ~125 km resolution

- **GFASv1.0**
  - since 17 May 2011
  - MODIS FRP assimilation
  - ~50 km resolution

MACC Daily Fire Products Wednesday 1 September 2010
Average of Observed Fire Radiative Power Areal Density [mW/m²] max value = 0.09 W/m²

http://gmes-atmosphere.eu/fire

Forest fire NRT emissions, Johannes Kaiser (ECMWF, UK)
(presented during workshop)
High resolution spatial emission inventories

25 m² land use map of the Netherlands. Comparison of E-PRTR spatial allocation of diffuse emissions sources with high resolution national emission inventories; example The Netherlands, Wim van der Maas (RIVM, NL)

High resolution emission mapping in the UK linked to national reporting, Ioannis Tsagatakis (AEA, UK)
c. Recommendations from the workshop (selection with relevance for GEIA)

- “Develop Guidance for estimating emissions estimates with high (i) Spatial (1x1km – 5x5km areas with vertical detail), (ii) Temporal (hourly, daily, monthly) and (iii) Species (PMs, NMVOC, PAHs & HMs) resolution”.

- “Improve consistency between emission inventory calculations and E-PRTR/EU-ETS/LCPD and other industrial data reported under national or EU legislation”

- “Investigate feasibilities of data exchange between national high resolution data and GMES services.”

- “Investigate the ability of countries that don’t have highly detailed data, to gather and report it.”

- “Develop centralised Emissions Inventory Datasets such as speciation profiles, temporal profiles and EU wide spatial proxies (e.g. roads, agriculture, residential, industrial areas)”
c. Recommendations from the workshop (selection with relevance for GEIA)

• “Development of validation and verification (independent checking on accuracy and uncertainty) techniques for national inventories and large point sources using inverse modelling and satellite EO data. Validation needed to find missing sources and provide independent information on non-EU emission trends.”

• “Continued development of In-Situ data provisions and metadata catalogue with reference to datasets that would support emissions inventory development (e.g. traffic monitoring).”

• “Continue to develop proxy datasets of value for mapping national emissions inventories at 5x5km and below.”

• “Continue to evaluate and utilise methods to estimate emissions from natural and international source (e.g. shipping, forest fires, dust and volcano emissions).”
A. Models should not venture into “cherry picking” when it comes to applying emission inventories in their studies.

B. Issues that limit emissions research:

Solution 1: Don’t be afraid of policy supporting inventories…….

Solution 2: Combining datasets maybe less difficult than it seems….

Standardization of sectors
Exchange of proxy datasets
Utilize online tools
Use modelers expertise in combining/“fudging” datasets
A. Difference between year 2000 and other years (value 2000 = 1.0): Total NOx emissions (Gg)
A. Difference between year 2000 and other years (value 2000 = 1.0): NOx Road transport (Gg)

- World (EDGARv4.2)
- Annex I (UNFCCC)
- EU27 (UNFCCC)
- Japan (UNFCCC)
- Russian Federation (UNFCCC)
- United States of America (UNFCCC)
- China (EDGARv4.2)
- India (EDGARv4.2)
A. Models should not venture into “cherry picking”

A sample of the first few entries when searching “emissions” in ACP journal

<table>
<thead>
<tr>
<th>Observation/model representative year</th>
<th>Inventory used</th>
<th>Inventory representative for</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>RCP harmonized emissions data</td>
<td>2000</td>
</tr>
<tr>
<td>2007-2011</td>
<td>EDGARv4.1</td>
<td>2005</td>
</tr>
</tbody>
</table>

See previous slides: it should be obvious that a year x inventory has limited applicability in year x + 2

Action: Use emissions data representative for study year, if not available, author/reviewer should make sure that an attempt is made to explain the expected error/uncertainty in the study result.
B. Issues that limit emissions research

Use and development of emission inventory for research projects, Claire Granier (pres. At GMES and Emissions Inventories workshop)
B. Make use of policy supporting emission inventories

Don’t be afraid of policy supporting inventories like LRTAP and UNFCCC!

- Reviewed with quality criteria in mind (incl. completeness, consistency and transparency)
- In most cases minimum quality assured via inventory guidance documentation
- More recent data available and often complete time series (e.g. 1990-2010)
- Often include point source information (LPS, ETS) or are on grid
- Can be post-processed with other inventories, leaving time to focus on other regions/sectors with no data

Disclaimer: still accompanied by uncertainties, incompleteness, and limitations like any inventory “no dataset is perfect”
B. Combining datasets maybe less difficult than it seems ……

**Standardization of sectors:**
Take stock of earlier work and the expertise by persons involved.
- ACCMIP documentation on combining inventories (sectors and countries2region)
- EDGAR-HTAP study
- UNFCCC/LRTAP guidance documentation

**Exchange of proxy datasets**
- Some data already now available via GEIA, E-PRTR, indirectly via download of gridded datasets (e.g. EDGAR)
- If funded by public money projects should make available the underlying proxy datasets (or selection thereof if copyright is an issue)
- Reviewers-editors should encourage exchange of information in publ. process
- Order of feasibility: (spatial, temporal, chemical)

**Utilize online tools to combine different datasets**
- Allow read in of country-sector level data
- Facilitate export of data by country and sector (comparison, quality control)
- Select format readable by non-experts (increase community)
- Make sure tools work 😊
Thank you for your attention

Questions, feedback, suggestions for collaboration activities..........  
John Van Aardenne (EEA, jva@eea.europa.eu)