

MACC deliverable D_D-EMIS_1.4

Updated inventory of Global and European regional emissions based on the RETRO system: Evaluation of the anthropogenic emissions used in the MACC project

Authors:

C. Granier, A. D'Angiola and J.-C. Raut (UPMC); B. Bessagnet and F. Meleux (INERIS)
H. Denier van der Gon (TNO); S. Kinne (MPI); J. Kaiser (ECMWF)
A. Heil and M.G. Schultz (FZJ Juelich); G. R. van der Werf (VUA)
C. Liousse, S. Darras, V. Pinot and A. Mieville (CNRS-LA)

Outline

1. Introduction
2. The MACCCity global emissions dataset
 - 2.a The ACCMIP emissions dataset
 - 2.b The MACCCity emissions
3. Evaluation of the MACCCity emissions
 - 3.a. The MACCCity dataset and the other inventories considered in this study
 - 3.b Results of the evaluation
4. Methodology to improve the speciation of VOCs in the MACCCity emissions
 - 4.a Observations of VOCs in different regions of the world
 - 4.b Definition of the ratios of VOCs and CO emissions
 - 4.c Development of three emissions distributions of VOCs
5. Importance of the VOCs speciation for the distribution of other compounds
 - 5.a description of the simulations
 - 5.b Results of the simulations
6. Availability of the emissions data: the ECCAD database
7. Conclusions and future work
8. References

1. Introduction

This report describes the final anthropogenic emissions dataset developed as part of the MCC project. Within MACC, a global dataset as well as a regional emissions (described in D_D-EMIS1.1) dataset were developed.

The latest developments in the global inventory (called MACCCity) will be described in Section 2. This global inventory has been developed in cooperation with the FP7 CitYZen (megaCITY - Zoom for the Environment) project. It was therefore decided to give for this dataset the acronym MACCCity. The global MACCCity and the regional TNO inventory described in D_D-EMIS1.1 have been evaluated through comparisons with other publicly available datasets: the results of these evaluations will be discussed in Section 3.

When comparing observations and model results using the MACCcity emissions, both the MACC modelling system and the MOZART-4 stand-alone simulations provided an underestimation of CO concentrations in the Northern hemisphere, when compared to observations done at different stations in the Northern hemisphere, as shown in Figure 1 for the Mace Head station in Ireland. The underestimation of CO concentrations could be due to an underestimation of surface emissions. It could also be due to an underestimation of the chemical production of CO from the oxidation of volatile organic compounds (VOCs). Within MACC, we have compared the emissions of CO and other species with other global and regional inventories (Section 3), and we have also evaluated the impact of the speciation of VOCs on the distribution of tropospheric compounds. We will describe the methodology and the first results we obtained in Sections 4 and 5. It should be noted that such a detailed work was not planned originally within MACC. Since the work on VOCs involve the development of new emissions for the different VOCs, several simulations and the analysis of observations and model results, we were only able to perform a few model simulations as part of the MACC project. The work will continue after the end of the project as part of MACC-II, and we expect to submit a paper on the results by the end of 2011. An acknowledgment of the MACC support will clearly be indicated in this paper.

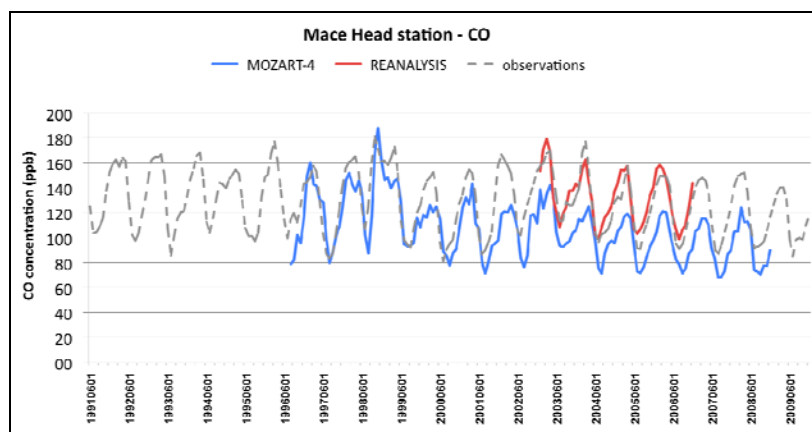


Figure 1: CO surface mixing ratio (ppbv) as observed at the Mace Head station, and from MOZART-4 and the MACC Reanalysis simulations

2. The MACCcity global emissions dataset

The MACCcity emissions have been developed as an extension of the ACCMIP emissions dataset developed for the on-going IPCC AR5 assessment. In 2008-2009, a group of international scientists developed a new emissions dataset covering the 1850-2000 period, based on the combination and harmonization of published and publicly available datasets (Lamarque et al., 2010). The new 1850-2000 harmonized emissions dataset is called ACCMIP (Emissions for Atmospheric Chemistry and Climate Model Intercomparison Project).

The year 2000 was chosen as the reference year, since 2000 emissions represent a combination of the best information available on existing regional and global inventories in the years 2008-2009 when the inventory was built. For each emission type, 10 emission sources were specified for 40 regions. ACCMIP emissions for historical years were drawn on the basis of several of the emission inventories discussed below and will therefore agree closely with some of them. For example, ACCMIP emissions at the global scale up to 2000 represent a combination of the HYDE, RETRO, PNNL and the Bond inventories described below. For ozone precursors, the ACCMIP emissions are based on a combination of the GAINS and

REAS emissions for Asia, on the EMEP emissions for Europe and on the EPA inventory for the USA. For SO₂, ACCMIP uses EPA data as a basis for the emissions in the USA. Details on the methodology used to generate the ACCMIP emissions are given in Lamarque et al., 2010.

The dataset provides distributions of emissions of sectoral, gridded anthropogenic emissions covering the historical period (1850–2000) in decadal increments at a horizontal resolution of 0.5° in latitude and longitude. Anthropogenic emissions are given as yearly averages.

As part of MACC, and together with colleagues from the CityZen project, an extension of the ACCMIP historical emissions dataset to the year 2011 has been developed. Within these two European projects, simulations of changes in the chemical composition of the atmosphere during the past decades have been performed. Since no global database existed which provided emissions of the main tropospheric gases for each year during the 1990-2011 period, a dataset was created, based on the 1990 and 2000 ACCMIP emissions, and the 2005, 2010 and 2020 emissions provided by RCP 8.5. This scenario was chosen, since it includes some information on recent emissions at the regional scale in Europe and North America. For anthropogenic emissions, a seasonal cycle was first applied sector by sector, the species were then lumped to the MOZART-3/MOZART-4 species (21 species), and finally emissions were interpolated on a yearly basis between the base years 1990, 2000, 2005, 2010 and 2020.

Usually anthropogenic emissions of volatile organic compounds are provided in all emissions inventories as “total VOC”, referring to a lump of all organic species: alkanes, alkenes, alkynes, alcohols, aldehydes, ketones and aromatic compounds. In most chemistry transport models (CTMs), individual VOCs are considered: therefore, these totals VOC need to be speciated into different individual species. Within the ACCMIP inventory, the distribution calculated for the RETRO inventory (<http://retro.enes.org>) was used as a basis for the speciation. For all VOC species of the RETRO inventory, an factor was calculated by dividing the emission of each individual species by the ‘Total VOC’ anthropogenic emission for each sector in each grid cell: this factor was calculated only for the year 2000. This speciation was then applied to the ACCMIP anthropogenic emissions. The emissions of the following individual VOC species were derived: ethane, propane and BIGALK (C>4 alkanes), ethane, propene and BIGENE (other alkenes and alkynes), methanol and ethanol, acetone and MEK (methyl-ethyl ketone, as a proxy for all other ketones), formaldehyde and acetaldehyde, and a lump species called TOLUENE representing benzene, xylene, toluene and ethyl-benzene. This VOC speciation methodology has not been revised since the RETRO inventory was developed several years ago. The MACCity inventory uses the same methodology for the VOC speciation as used in the ACCMIP dataset.

3. Evaluation of the MACCity emissions

3.a. The MACCity dataset and the other inventories considered in this study

A detailed comparison of the MACCity and other publicly available inventories is provided in the paper “Evolution of anthropogenic and biomass burning emissions of air pollutants at global and regional scales during the 1980-2010 period” by C. Granier, B. Bessagnet, T. Bond, A. D’Angiola, H. Denier van der Gon, G. J. Frost, A. Heil, J. W. Kaiser, S. Kinne, Z. Klimont, S. Kloster, J.-F. Lamarque, C. Lioussé, T. Masui, F. Meleux, A. Mieville, T. Ohara, J.-C. Raut, K. Riahi, M. G. Schultz, S. J. Smith, A. Thompson, J. van Aardenne, G. R. van der Werf, D. P. van Vuuren, which has been accepted for publication in *Climatic Change* in 2011. The names of the authors who are MACC partners is surlined.

The inventories that are considered in this study are given in Table 1 (anthropogenic inventories).

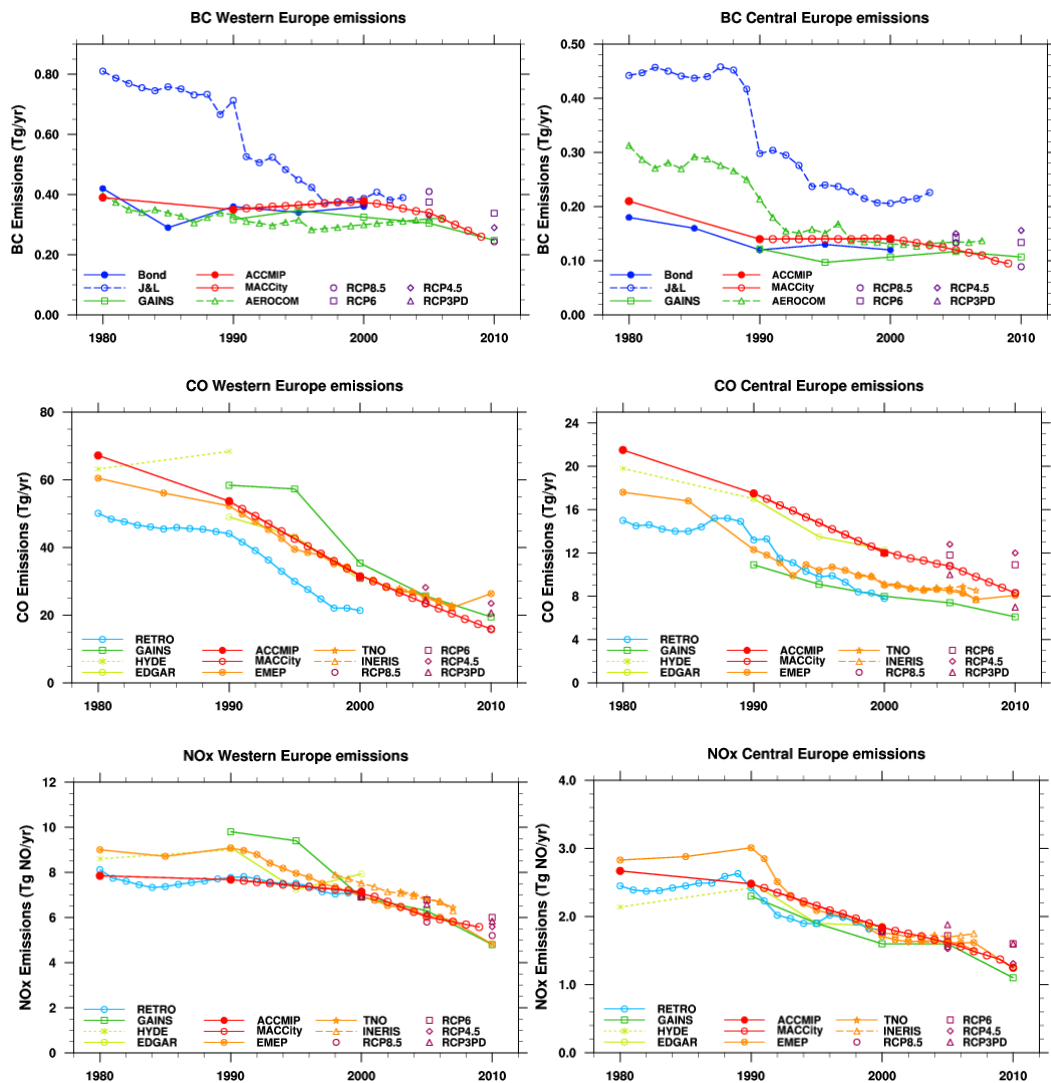
Inventories providing global emissions of all species considered, i.e. CO, NO _x , BC and SO ₂			
ACCMIP	1980-2010	0.5x0.5	http://ether.ipsl.jussieu.fr/eccad ftp://ftp-ipcc.fz-juelich.de/pub/emissions Lamarque et al., 2010
MACCity	1980-2010	0.5x0.5	http://ether.ipsl.jussieu.fr/eccad
RCPs	2000-2010	0.5x0.5	http://ether.ipsl.jussieu.fr/eccad ftp://ftp-ipcc.fz-juelich.de/pub/emissions/ http://www.iiasa.ac.at/web-apps/tnt/RcpDb
EDGAR v3	1990, 1995 2000	1x1	http://edgar.jrc.ec.europa.eu (Olivier et al., 2005)
HYDE	1980, 1990	1x1	Van Aardenne et al., 2001 http://www.pbl.nl/en/themasites/hyde/index.html
RETRO	1980-2000	0.5x0.5	http://retro.enes.org/data_emissions.shtml
GAINS	1990-2010		http://gains.iiasa.ac.at/gains
Global inventories providing a selected number of species			
BOND (BC)	1980-2000	1x1	http://www.hiwater.org/ (Bond et al., 2007)
J&L / Junker &Liousse (BC)	1980-2000	1x1	Junker and Liousse, 2008
AEROCOM (SO ₂ and BC)	1980-2006	1x1	http://dataipsl.ipsl.jussieu.fr/AEROCOM
PNNL (SO ₂)	1980-2005	0.5x0.5	Smith et al., 2004; Smith et al., 2010
I&P / Ito and Penner (BC)	1980-2000	1x1	Ito and Penner, 2005
Novakov (BC)	1980-2000	Not gridded	Novakov et al., 2003
Regional inventories			
EMEP	1980-2010	0.5x0.5	http://www.ceip.at/emission-data-webdab/emissions-used-in-emeep-models/
TNO	2003-2007	0.125 x 0.0625	ftp://neptunus.tno.nl/TNO/MEP/EM/MACC/ Denier van de Gon et al., 2010
INERIS	1998-2007	0.1x0.1 and 0.5x0.5	http://cityzen-project.eu/
EPA	1980-2008	Not gridded	http://www.epa.gov/ttn/chief/trends/index.html
REAS	1980-2010	0.5x0.5	www.jamstec.go.jp/frcg/research/p3/reas_h_a.html Ohara et al., 2007
ACCESS	2000 and 2006	0.5x0.5	http://www.cgrer.uiowa.edu/ACCESS/accs_index.htm Streets et al, 2003; Zhang et al., 2009
Garg	1985-2005	Not gridded	Garg et al., 2006

Table 1: List of anthropogenic emissions inventories considered in this study.

3.b Results of the evaluation

The results of the comparisons of the different inventories are given in the Granier et al. (2011) paper. In this document, we will just discuss the results of the comparison for Europe, and the overall conclusions of the evaluation.

Anthropogenic emissions for Western and Central Europe are shown in Figure 2. All the inventories show almost no changes in the BC emissions in Western Europe during the considered period, except from the J&L inventory, which provides emissions of about 0.8 Tg C/yr in the 1980s and a strong decrease afterwards resulting from estimated large changes in BC emission factors for diesel and gasoline use. The AEROCOM inventory shows a slight decrease up to the late 1990s, followed by a slight increase. In 2000, all inventories agree within 20%. The agreement between the ACCMIP/MACCity, AEROCOM, GAINS and RCPs emissions is rather good in 2005, while differences up to 66% exist between the different RCP emissions in 2010, which illustrates the difference in the assessment models used to generate the scenarios.



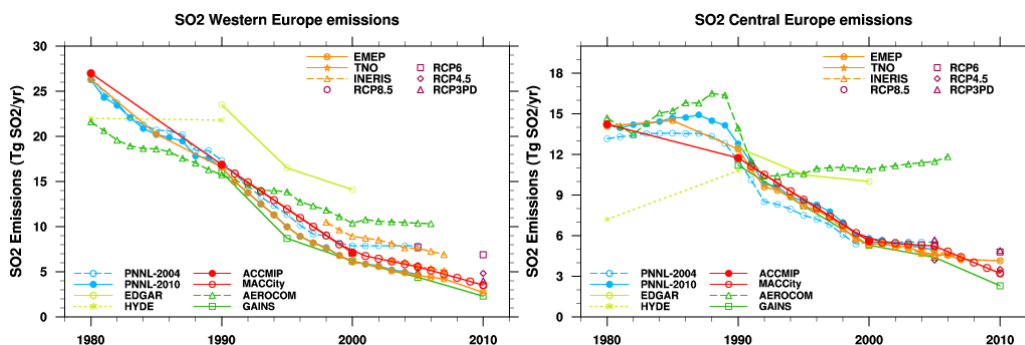


Figure 2: Evolution of the emissions of the emissions of BC (1st row), CO (2nd row), NO_x (3rd row) and SO₂ (last row) emissions in Western Europe (left column) and Central Europe (right column) from 1980 to 2010.

Large differences are observed in BC estimates for Central Europe. In 1980, the highest value is given by the J&L dataset, i.e. 0.44 Tg C/yr, while the lowest value, at 0.18 is given by the Bond inventory, i.e. a difference of a factor of 2.4. The two other available datasets, GAINS and AEROCOM provide values between these two extremes. In 1990 and 2000, the differences are similar, i.e. a factor of 2.5 in 1990 between the lowest and highest estimate, and a somewhat smaller factor of 1.9 in 2000. The rate of change is also quite different between the datasets. After 2000, the GAINS, Bond and ACCMIP/MACCity inventories show a slight decrease, while J&L and AEROCOM show a slight increase.

CO and NO_x emissions in Western and Central Europe show similar patterns of decreasing emissions during the considered period. One exception is the HYDE inventory which shows an increase in CO emissions in Western Europe up to 1990. In Western Europe, most inventories agree rather well: all the emissions, except for CO from RETRO, agree to within 20%.

Differences in Central Europe emissions are larger, i.e. 43 % and 32% in 1980 for CO and NO_x emissions, respectively. After 1990, more inventories are available. The ACCMIP/MACCity and EDGAR emissions are rather close, and about 33% higher than the RETRO, EMEP, TNO, INERIS and GAINS, which are close to each other. The difference between the lowest and highest emission reaches 60% in 1990 and 58% in 2000.

According to most inventories considered in this study, SO₂ emissions have decreased constantly in Western Europe during the past 30 years. The inventories differ by about 25% in 1980. From 1980 to 2000, the PNNL-2004, PNNL-2010 and ACCMIP global inventories agree very well with the EMEP regional inventory, and show a decrease of a factor of 3.8-4.5. The AEROCOM inventory also shows a decrease, but with a lower magnitude (factor 2.1). After 2000, the MACCity and EMEP inventories continue to show a decrease in the emissions, by a factor of about 2 between 2000 and 2010. Both inventories are close to RCP 8.5, 4.5 and 3PD in 2005, and to RCP 8.5 in 2010, while other RCPs predict slightly higher values in 2010. The PNNL-2004 and AEROCOM emissions remain rather constant after 2000, and PNNL-2004 values are close to RCP 6 values. The HYDE and EDGAR inventories display a rather different behavior when compared to the other inventories. The HYDE emissions stay rather

constant between 1980 and 1990. The EDGAR emissions, while decreasing between 1990 and 2000, display significantly higher values than the other inventories.

For Central Europe, large differences can be seen between the estimates of total SO₂ emitted. Most inventories provide rather similar totals in 1980, except for the HYDE values, which are more than a factor of 2 lower than the others. The PNNL-2004, PNNL-2010 and EMEP inventories predict a slight increase in the emissions up to year 1987, while the AEROCOM inventory shows a rather large increase up to 1986. In 1990, all the inventories agree within 40%. After the beginning of the 1990s, there is a very large difference between the EDGAR and AEROCOM inventories, which show either a slight decrease (EDGAR) or a 14% increase from 1990 to 2006 for the AEROCOM inventory. All the other inventories show a large decrease after 1990, with values in 2010 about 4.5 times lower than in 1990 for the MACCity, EMEP and PNNL-2010 inventories. The large decrease in the Central European emissions, as well as the decrease in Western Europe, is well documented and has been discussed in papers such as Vestreng et al. (2007). Therefore, the trends shown in the EDGAR and AEROCOM emissions in this part of the world seem inaccurate.

In order to provide a rough classification of the more and less well known emissions at the global scale and for the considered regions, Table 2 gives the ratio between the highest and lowest emissions for 1980, 1990, 2000 and 2005 for the four species considered in this work. Emissions for which the ratio is closest to one can be considered to be the values with the best consensus. It should be emphasized that consensus does not necessarily imply that uncertainty is low. In some cases, a higher level of consensus may be due to similar assumptions being used because of the lack of detailed information.

From Table 2, it is clear that, for the past three decades, large discrepancies remain for all four species considered. For 2000 and 2005 anthropogenic NO_x emissions exhibit reasonable (better than factor 1.7) agreement, and for several regions the agreement is better than 20%. Recent anthropogenic CO emissions also seem to be reasonably well in agreement with the exception of India (factor of 2 range) and Central Europe (factor 1.7). For SO₂ differences are at least a factor of 1.2 and often exceed a factor of 2. Interestingly, SO₂ differences are smaller for the period before year 2000. For anthropogenic BC the inventory differences after year 2000 are similar as for SO₂, but here the estimates for earlier years show greater diversity.

		1980	1990	2000	2005
BC anthropogenic					
	Global	1.53	1.52	1.13	1.28
	Western Europe	2.08	2.04	1.59	1.34
	Central Europe	2.45	2.50	1.92	1.76
	USA	2.38	2.74	1.53	1.48
	China	1.64	1.32	2.12	1.29
	India	1.99	1.95	1.78	2.27
CO anthropogenic					
	Global	1.27	1.31	1.28	1.09
	Western Europe	1.34	1.55	1.65	1.28
	Central Europe	1.43	1.56	1.58	1.73
	USA	1.87	1.67	1.69	1.66
	China	1.34	1.54	1.43	1.15
	India	1.31	2.01	1.97	2.00
NO_x anthropogenic					
	Global	1.13	1.18	1.17	1.15
	Western Europe	1.15	1.28	1.15	1.18
	Central Europe	1.32	1.24	1.16	1.23
	USA	1.27	1.41	1.15	1.33
	China	1.91	1.66	1.31	1.32
	India	2.17	2.11	1.68	1.39
SO₂ anthropogenic					
	Global	1.19	1.27	1.40	1.32
	Western Europe	1.25	1.49	2.33	2.36
	Central Europe	2.04	1.32	2.08	2.73
	USA	1.23	1.26	1.24	1.47
	China	1.54	1.66	1.78	1.68
	India	1.59	2.09	1.95	1.70

Table 2: Ratio between the lowest and highest emissions for each species and each region for the different periods considered in this study. Numbers lower than 1.3 appear in green, values between 1.3 and 1.7 are in yellow, and values higher than 1.7 are in red.

4. Methodology to improve the speciation of VOCs in the MACCity emissions

4.a Observations of VOCs in different regions of the world

We have worked on the improvement of the VOCs speciation in collaboration with the group of P. Monks (University of Leicester), and with colleagues from the CityZen project. We compiled all the available observational data on VOCs and CO in urban areas in the world (von Schneidmesser et al., 2010). The data is scarce and often consists of just short measuring campaigns of days-weeks-months, making it very hard to make an accurate analysis and comparison of the measured data among the different sites. The observations dataset consists of measurements in North and Latin American, Europe, Asia and Africa, listed below:

- 5-week measuring campaign during summer (August-September) in 28 locations in the US for the period 1998-2005,
- 2-week-campaign in March 2006 in Mexico City, Mexico, during the MILAGRO campaign
- 3-day measuring campaign in October-November 2002 in 3 sites in Santiago de Chile, Chile
- 1-day measuring campaign in July 1996 in Porto Alegre, Brazil
- Continuous hourly measurements in London, UK; the data analysed for this study corresponds to the period 1998-2009
- 30-minutes samples for 2 weeks in June 2007 in Paris, France
- 1-hour measuring campaign during 3 months (June 1993, and May and July 2004) in Athens, Greece
- 2-month measuring campaign during January-February 2001 in 43 Chinese cities
- yearly averages for 2002 for Ahmedabad, India
- 1-month measuring campaign during December 1998-January 1999 in Karachi, Pakistan
- 1-year measuring campaign during September 2002- August 2003 in Hong Kong, China
- measuring campaign in Tokyo, Japan, during the fall 2003 and the summers of 2003 and 2004
- 1-day measuring flight in August 2006 in Lagos, Nigeria, during the AMMA Campaign.

To analyse the consistency of the speciation of VOCs in our emissions inventory we calculated and compared the individual VOC to CO ratios in both emissions and observations. Figure 3 displays in black the ratios from the emissions data in a logarithmic scale for 6 hot spots and megacities in the world: Los Angeles (USA), London (UK), Tokyo (Japan), Mexico City (Mexico), Beijing (China) and Ahmedabad (India) for 10 individual VOC species. The observed ratios are given in red. The black lines correspond to the years for which observations are available, and the grey lines to the emissions ratios with no corresponding observational data.

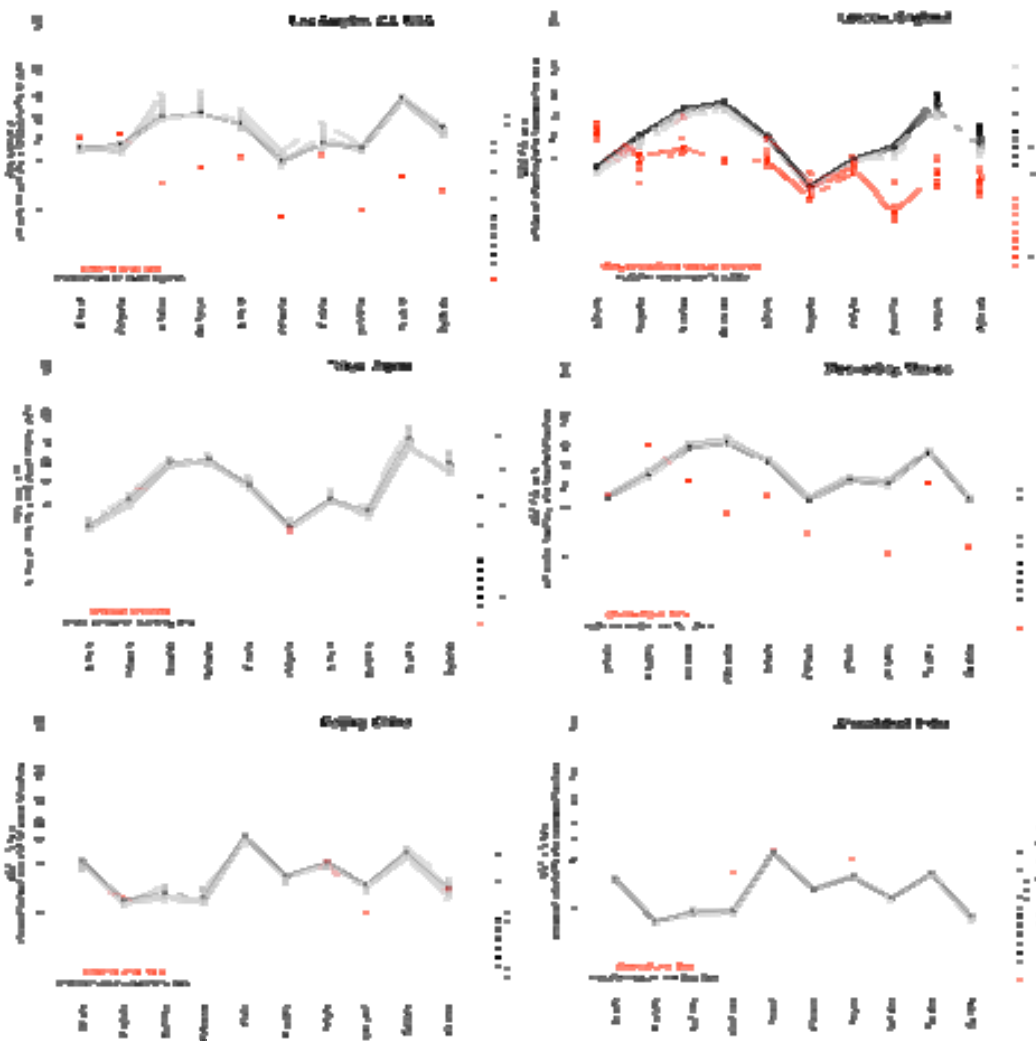


Figure 3: VOCs/CO ratios from observations and the corresponding values in the emissions data

It is clear that the observational ratios do not generally agree with emissions ratios. Though emissions and concentrations ratios are not expected to be proportional, a relationship between these quantities should be seen in the comparisons for the different cities. For some locations, the differences in the ratios for lighter alkanes and alkenes are reasonable, but for other species, such as toluene and higher alkanes, the differences can be of more than a factor of 10. We can also observe that the observational ratios vary among the developed and developing cities as originally expected due to the use of different technologies and fuel types: the ratios from London, LA and Tokyo follow a similar pattern, differing from those corresponding to Ahmedabad, Mexico city and Beijing.

We have proposed to evaluate the impact of the VOC speciation on the results of the simulations, and we developed a methodology for developing a new speciation of VOC emissions, based on the observations discussed above. We use the observed individual VOC:CO ratios as a proxy to distribute the total VOCs into the individual species required by the models by applying the ratios to the CO emissions inventory. Furthermore we propose to use regional ratios, corresponding to the different continents: North America, Europe, Japan, Latin America, Asia and Africa, in an attempt to better represent local conditions of the regions. We have for now developed three different datasets of VOCs, as described in the next section. Simulations performed using these datasets will help understanding the importance of the VOCs speciation in the global distribution of atmospheric compounds.

4.b Definition of the ratios of VOCs and CO emissions

Using the observations compiled by the Leicester group, we calculated the average, the maximum and the minimum values of these ratios for each considered regions, in an attempt to address the associated uncertainty to the new VOC speciation. Table 3 displays these numbers. The column of the right side indicates the sample size available in each region. The ratios were calculated by region: US measurements are used to define the ratios for North America, Latin America includes measurements performed in Mexico, Chile and Brazil; Europe consists of the observations form London, Paris and Athens; Asia includes China, Pakistan, India and Japan, and finally Africa is composed only by the measurement carried out in Nigeria.

North America		min	max	average	n°
1	ethane	2.1	12.6	5.69	20
2	propane	1.8	19	5.13	19
3	BIGALK	4.1	19.3	9.90	27
4	ethene	2.3	7.9	4.84	27
5	propene	0.7	2.35	1.15	28
6	BIGENE	0.1	0.4	0.17	26
7	TOLUENE	0.6	8.4	4.6	28
Asia					
1	ethane	1.11	58.12	5.87	52
2	propane	0.35	25.62	3.57	52
3	BIGALK	2.31	106.07	11.65	52
4	ethene	3.07	54.52	6.41	52
5	propene	0.53	11.12	1.53	52
6	BIGENE	0.15	5.48	0.55	50
7	TOLUENE	2.63	83.54	9.32	51
Latin America					
1	ethane	0.48	7.47	3.34	4
2	propane	9.26	42.1	23.32	4
3	BIGALK	4.98	35.34	17.0	4
4	ethene	5.76	8.52	7.13	4
5	propene	1.36	2.76	2.07	4
6	BIGENE	0.57	1.03	0.80	4
7	TOLUENE	5.27	14.51	11.13	4
Europe					
1	ethane	11.58	15.52	13.55	2
2	propane	0.3	4.57	3.06	3
3	BIGALK	5.92	28.25	15.95	3
4	ethene	2.72	5.95	4.34	3
5	propene	0.97	1.99	1.65	3
6	BIGENE	0.22	0.37	0.30	2
7	TOLUENE	7.82	11.05	9.44	3
Africa					
1	ethane	4.61	4.61	4.61	1
2	propane	0.58	0.58	0.58	1
3	BIGALK	11.80	11.80	11.80	1
4	ethene	3.64	3.64	3.64	1
5	propene	0.76	0.76	0.76	1
6	BIGENE	0.26	0.26	0.26	1
7	TOLUENE	6.01	6.01	6.01	1

Table 3: Observed VOC/CO ratios in different regions, with their minimum/average/maximum values.

4.c Development of three emissions distributions of VOCs

As we are only using observational ratios calculated for urban ratios, the new VOC speciation was only applied to hot spots or urban areas. We defined these areas by using a threshold of 150 inhabitants/km². The new speciation was applied to all urban areas in the world with a population density larger than 150 inhabitants/km², i.e. the regions shown in yellow in Figure 4.

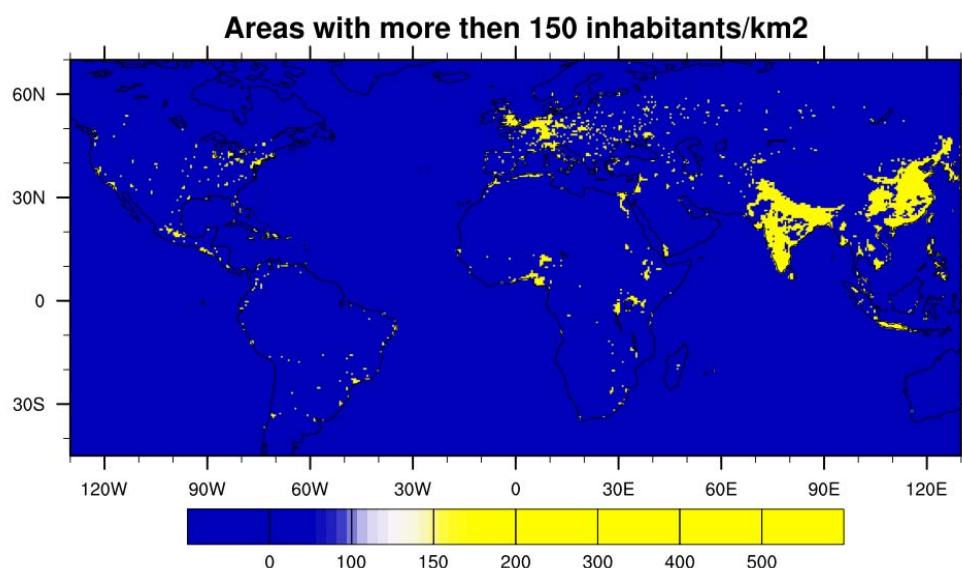


Figure 4: areas (in yellow) in which the new VOCs speciation is applied.

Following this procedure we computed 3 new emissions dataset with different VOC speciation using the 3 sets of ratios defined in Table 4:

1. STD run: VOC speciation as provided in the MACCity dataset, derived from the RETRO emissions inventory (base case).
2. AVE run: new VOC speciation using the average ratios
3. MIN run: new VOC speciation using the minimum ratios
4. MAX run: new VOC speciation using the maximum ratios.

In Figure 5 we can observe the difference in percentage in the VOC emissions between the MAX and the AVE emissions datasets for BIGENE (C>4 alkenes alkynes) and ethane. In both cases it is worth highlighting that emissions increase everywhere, especially in the Asian region where emissions increase by more than 80%. For ethane, European emissions increase by up to 30%, as well as in North and Central America. BIGENE emissions increase in Europe and North America between a few percent for Europe and the Americas.

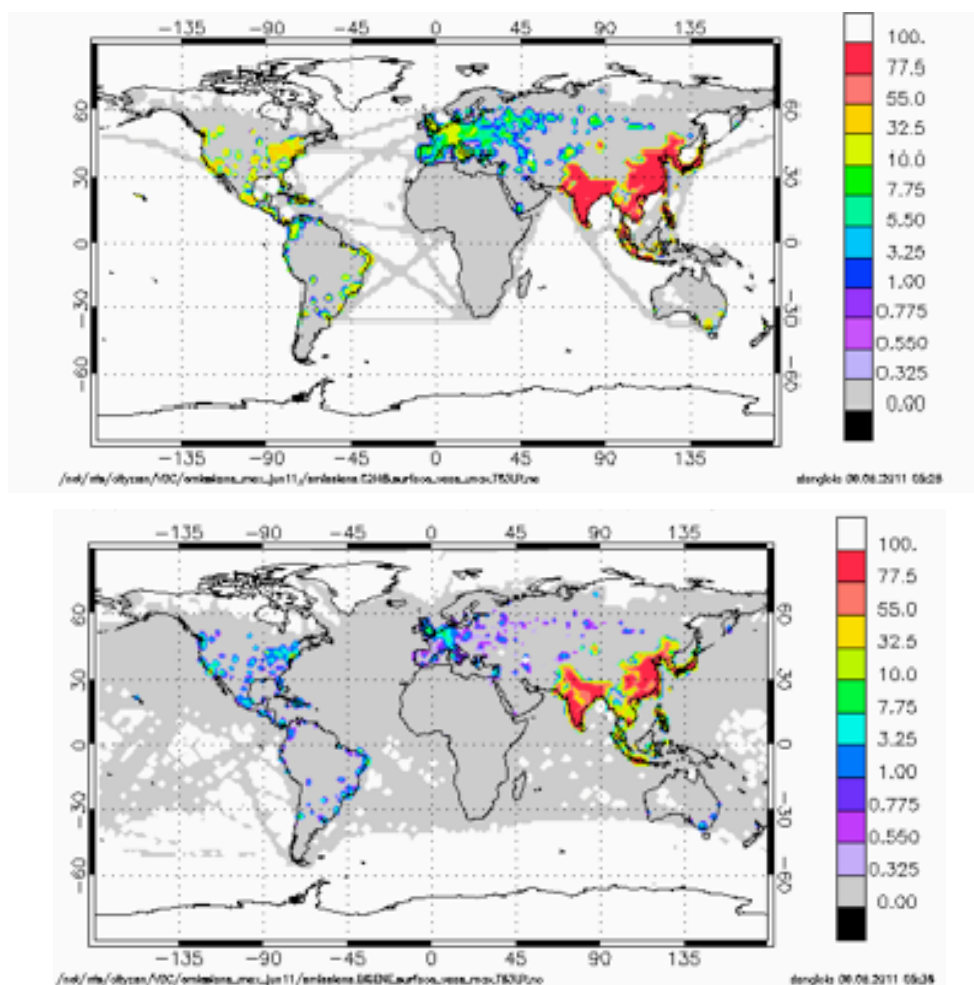


Figure 5: Percentage difference between the MAX and AVE emissions, for ethane (top) and BIGENE species.

5. Importance of the VOCs speciation for the distribution of other compounds

5.a description of the three simulations performed within MACC

We performed 4 runs of the stand-alone MOZART-4 model for the year 2005, where only anthropogenic emissions of VOCs change between the different simulations:

1. STD run: base case using STD VOC speciation.
2. AVE run: use of AVE VOC emissions
3. MIN run: use of MIN VOC emissions
4. MAX run: use of MAX VOC emissions.

5.b Results of the simulations

Figure 6 displays selected results for this sensitivity study. The differences in the CO surface distributions (summer and winter) and for ethane (summer) are shown, for the runs using the MAX and STD emissions. We can observe that, when using the speciation for the MAX ratios, CO concentrations increase during summer in the Northern hemisphere by up to 20%, while the Southern hemisphere is only slightly affected. The Asian region shows the higher increases, of

the order of 14-20%. On the other hand, ethane concentration during summer shows large differences between the two runs: concentrations increase up to 90% over Asia, between 60-70% over Europe and the North America and up to 50% in the Southern hemisphere.

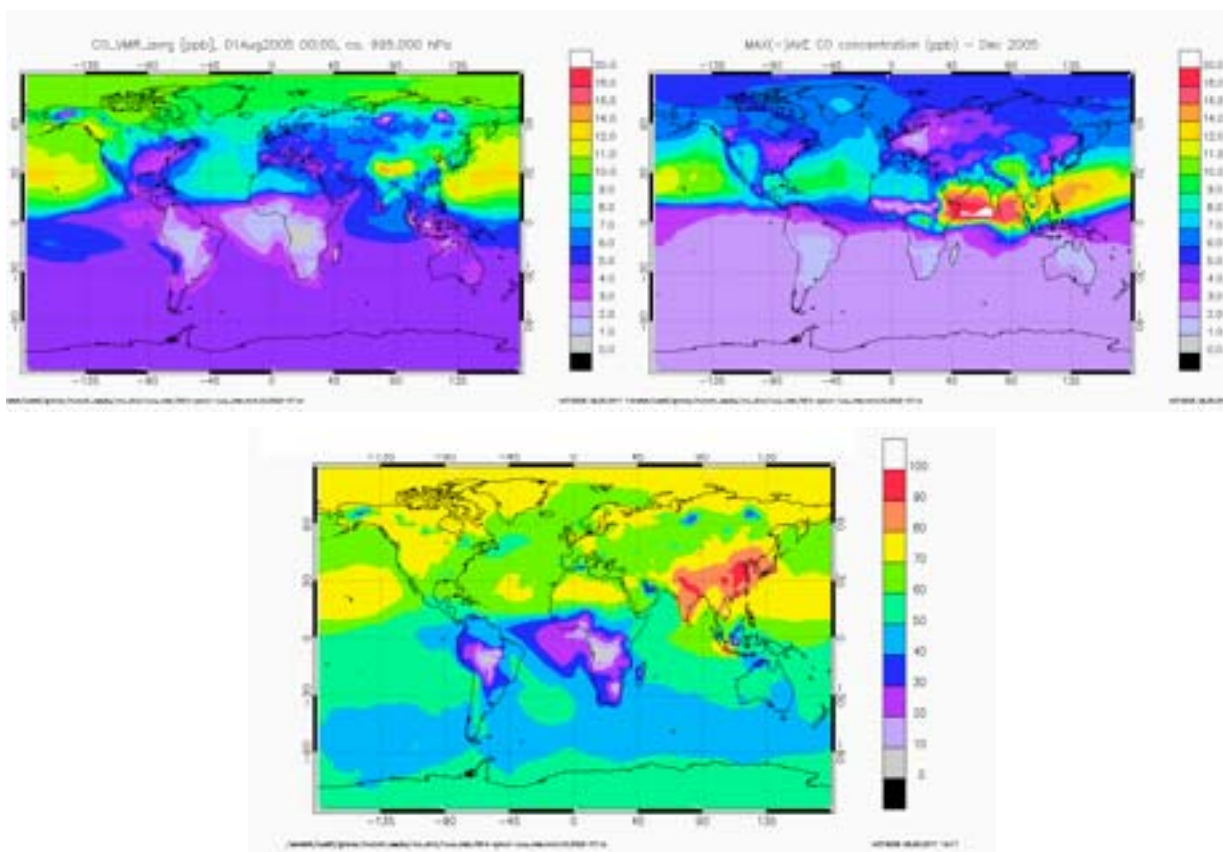


Figure 6: Percentage difference between the MAX and STD simulations for CO in summer (to left) and winter (top right) and for ethane in summer (bottom).

6. Availability of the emissions data: the ECCAD database

The ECCAD (Emissions of atmospheric Compounds and compilation of ancillary data) database provides access to a large set of inventories, as well as to ancillary data, i.e. data used in the parameterization of anthropogenic and natural emissions (<http://ether.ipsl.jussieu.fr/eccad>). The database includes all the inventories included in the GEIA/ACCENT emissions portal (geiacenter.org). It should be mentioned that, during the MACC-II project, the two databases will be merged.

ECCAD currently includes data on surface emissions as well as data on population, ecosystems, active fires and burned areas, land-use change, etc. Different sets of tools are available, such as the comparison of datasets, and the calculation of emitted totals at the global scale or for different regions. More tools are under development. The database has been tested and can be accessed through the site <http://ether.ipsl.jussieu.fr/eccad>.

The list of all data available in the ECCAD database is given in Figure 7.

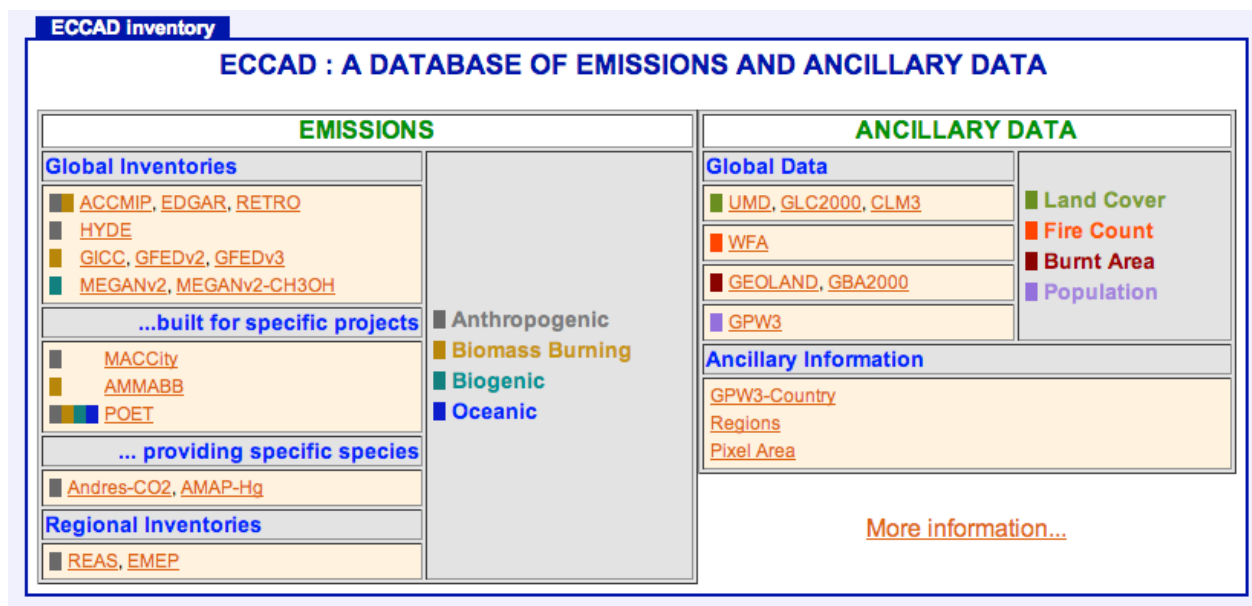


Figure 7: List of datasets currently available in ECCAD

The list of atmospheric compounds for which surface emissions are available as part of ECCAD is shown in Figure 8. Within ECCAD, an harmonization of the molecular mass for each VOCs considered in the database was performed. The MACCity dataset includes a large set of VOCs, which are also available through ECCAD.

Inventory by Sectors	Major Species												
	<small> Anthropogenic Biomass burning Natural • Biogenic •• Biogenic & Oceans </small>												
Totals	CO2	CH4	N2O	CO	NOx	NMVOCS	SO2	BC	OC	NH3	PM2.5	TPM	Hg
ACCMIP
EDGAR
RETRO
HYDE
GFED
GICC
MEGAN
MACCity
AMMABB
POET
Andres
Mercury
EMEP
REAS
Molecular mass (g mole-1)	44	16	44	28	30	72	64	12	12	17	-	-	200

Inventory by sectors	Other Species (1)																	
	<small>Anthropogenic</small> <small>Biomass burning</small> <small>Natural</small> • <i>Biogenic</i> • <i>Biogenic & Oceans</i>																	
Totals	Ethane (C2H6)	Propane (C3H8)	Butanes (C4H10)	Pentanes (C5H12)	Butanes & Higher Alkanes	Hexanes & Higher Alkanes	Ethene (C2H4)	Propene (C3H6)	Butenes & Higher Alkenes	Acetylene (Ethyne) (C2H2)	Other alkenes & higher alkynes	Methanol (CH3OH)	Other Alcohols	Total Alcohols	Formaldehyde (Methanal) (CH2O)	Acetaldehyde (Ethanal) (CH3CHO)	Other Aldehydes	
ACCMIP	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
RETRO	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
GICC	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
MEGAN	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
MACCity	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
AMMABB	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
POET	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Molecular mass (g mole-1)	30	44	58	72	58	86	28	42	56	26	56	32	46	32	30	44	44	

Inventory by sectors	Other Species (2)																	
	<small>Anthropogenic</small> <small>Biomass burning</small> <small>Natural</small> • <i>Biogenic</i> • <i>Biogenic & Oceans</i>																	
Totals	Acetone (C3H6O)	Other Ketones	Total Ketones	Total Acids	Benzene (C6H6)	Trimethyl benzene (C9H12)	Toluene (C7H8)	Xylène (C8H10)	Other Aromatics	Total Aromatics	Ethers	Esters	Other VOCs	Isoprene (C5H8)	Monoterpenes [C5H8]2	Sesquiterpenes C15H24	Chlorinated hydrocarb.	
ACCMIP	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
RETRO	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
GICC	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
MEGAN	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
MACCity	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
AMMABB	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
POET	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Molecular mass (g mole-1)	58	72	72	59	78	120	92	106	126	126	81	184	68	68	136	204	138	

Figure 8: List of the species included in the inventories available in ECCAD, including MACCity

7. Conclusions and future work

Within MACC and colleagues from the EU CitYZen project, we have developed a new inventory called MACCity, which is already widely used by the European as well as by the international community. The use of this dataset is discussed in this report, as well as in other MACC deliverables. The MACCity dataset is described in a publication (Granier et al., 2011) will has been accepted in 2011 for publication in Climatic Change.

We have started to evaluate the speciation of VOCs in the MACCity and other inventories. Based on observations, we have developed different datasets, and have started sensitivity studies. These studies will be continued after the end of MACC and, as indicated in the introduction, we expect to submit a paper on this work by the end of 2011.

The MACCity emissions dataset is now available as part of the ECCAD database, which also provides tools for the analysis of the emissions data.

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