



*Norwegian
Meteorological Institute
met.no*

Emissions in the EMEP MSC-W model

Ágnes Nyíri



Standard emission input

- Gridded annual emissions
 - NO_x, SO_x, NH₃, NMVOC, CO, PM_{co}, PM_{2.5}
 - Input files **emislist.POLL**
 - Emission input provided for the extended EMEP domain for year 2010
 - 50 x 50 km² polar stereographic (PS) projection, http://www.emep.int/grid/EMEP_domain.pdf
 - 10 anthropogenic SNAP source-sectors
 - ASCII text files with 16 columns:
EMEP_cc i j emis_high emis_low SNAP1-SNAP11



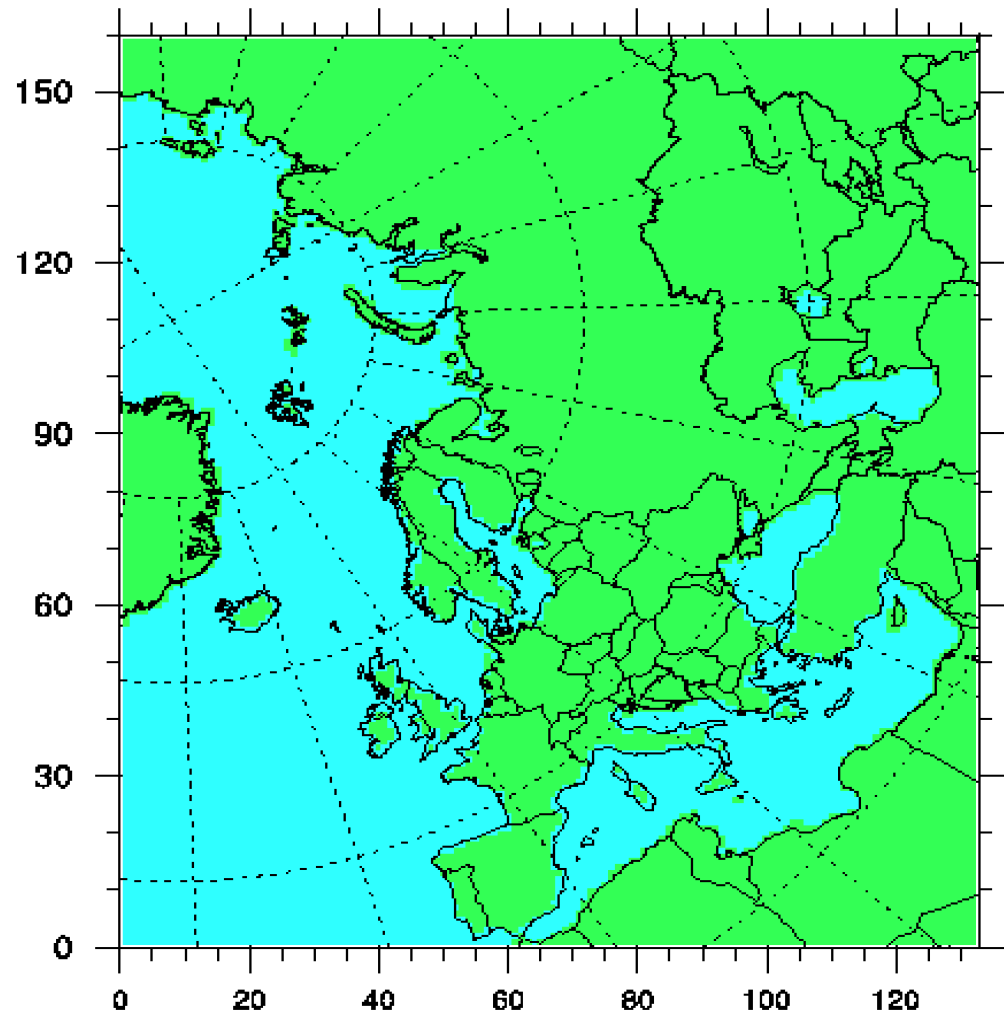
SNAP source-sectors

SNAP 1	Combustion in energy and transformation industries
SNAP 2	Non-industrial combustion plants
SNAP 3	Combustion in manufacturing industry
SNAP 4	Production processes
SNAP 5	Extraction and distribution of fossil fuels and geothermal energy
SNAP 6	Solvent use and other product use
SNAP 7	Road transport
SNAP 8	Other mobile sources and machinery
SNAP 9	Waste treatment and disposal
SNAP 10	Agriculture
SNAP 11	Other sources and sinks



Extended EMEP domain

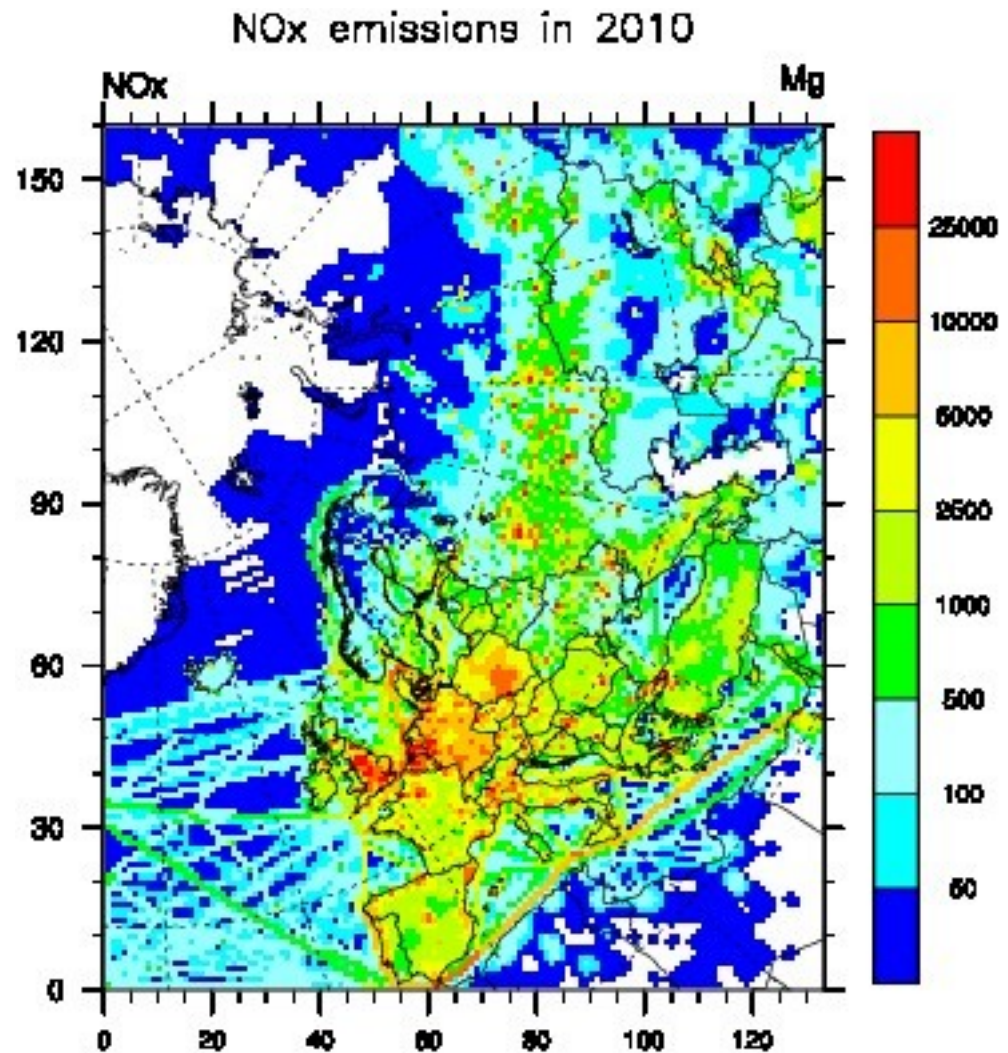
Grid indexes used in emission files, counting starts at the lower-left corner of the grid domain.





Example of emission data

- Official NO_x emissions for 2010 over the extended EMEP domain in 50 x 50 km² PS projection





Other resolutions/projections used in the EMEP MSC-W model

- Flexible choice of horizontal resolution and projection
- Polar stereographic (PS) grid examples
 - 50 x 50 km² PS grid (standard EMEP)
 - 10 x 10 km² and 25 x 25 km² PS grids have also been used in EMEP status reports to show effect of grid resolution
 - 150 x 150² km PS grid was the standard EMEP grid until 1997



Other resolutions/projections used in the EMEP MSC-W model

- Longitude-latitude (LL) grid examples
 - $0.1^\circ \times 0.1^\circ$ LL and $0.2^\circ \times 0.2^\circ$ LL grids have been used in EMEP status reports to show effect of grid resolution/projection
 - TNO (MACC) grid: $0.125^\circ \times 0.0625^\circ$ LL (TNO7), $0.25^\circ \times 0.125^\circ$ LL (TNO14), $0.5^\circ \times 0.25^\circ$ LL (TNO28), $1^\circ \times 0.5^\circ$ LL (TNO56)
 - $0.25^\circ \times 0.25^\circ$ LL grid in EuroDelta-3 project
 - $0.5^\circ \times 0.5^\circ$ LL and $1.0^\circ \times 1.0^\circ$ global runs



Emission support

- ❑ Only standard EMEP emissions are provided with the open source code
- ❑ There might be restrictions on distribution of other emissions
- ❑ If you need non-standard emissions
 - ❑ Specify exactly what you need and what are your plans with the emission data
 - ❑ Contact the owner of emissions if restricted data
 - ❑ When permission to use the data is granted, we might be able to help with conversion into EMEP model input format



New type of emission input

- Emissions in netCDF format
 - $0.125^\circ \times 0.0625^\circ$ lon-lat data for Europe (MACC), can be scaled using femis.dat (some limitations)
 - $0.5^\circ \times 0.5^\circ$ lon-lat data global (ECLIPSE)
 - Emissions are interpolated to correct grid in the model (same grid as meteorological data)
 - Better grid flexibility
 - The new emission system is under testing, but included in the open source model code
 - Restrictions on use of the fine scale emissions



Emissions in the model

- Main modules to treat standard anthropogenic emissions
 - EmisDef_ml.f90
 - EmisGet_ml.f90
 - Emissions_ml.f90
- Some other emission sources are treated in other modules (e.g. Biogenics_ml, DustProd_ml)
- Resulting in molecules/(cm³·sec) for the different pollutant species, which enters the chemistry



Emissions in the model

- Vertical distribution (see User's Guide 2.2.5)
 - Default distribution based upon SNAP sectors
 - Input file **EmisHeights.txt** → EmisGet_ml.f90

No.	Sources	Height of Emission Layer (m)					
		0-92	92-184	184-324	324-522	522-781	781-1106
1	Combustion in energy and transformation industries			15	40	30	15
2	Non-industrial combustion plants	100 ^(a)	0 ^(a)				
3	Combustion in manufacturing industry	10	10	15	30	30	5
4	Production processes	90	10				
5	Extraction and distribution of fossil fuels and geothermal energy	90	10				
6	Solvents and other product use	100					
7	Road transport	100					
8	Other mobile sources and machinery	100					
9	Waste treatment and disposal	10	15	40	35		
10	Agriculture	100					

Notes: (a) Up to version rv4 β SNAP-2 was split 90% into the lowest layer, then 10% in the next lowest.



Emissions in the model

- **Temporal distribution (see User's Guide 2.2.4)**
 - Monthly and day-of-week time factors specific to pollutant, country and SNAP source-sector
 - Input files **MonthlyFac.POLL** and **DailyFac.POLL**
 - Degree-day factors for SNAP2 (function of daily temperatures in grid cells) (User's Guide 2.1.5)
 - Input file **DegreeDayFactors.nc**
 - Hourly time factors specific to day-of-week and SNAP source-sector
 - Input file **HOURLY_FACS**



Emissions in the model

- Chemical speciation (see User's Guide 2.2.7)
 - Some emission files include a group of compounds (e.g. NO_x, SO_x, NMVOC, PMs)
 - Specified normally for each SNAP source-sector
 - Input files **emissplit.defaults.POLL** describe the default splits
 - More detailed or different specification (e.g. for particular countries or SNAP sectors) can also be given in optional files
 - Input files **emissplit.specials.POLL** describe the special splits



Emissions in the model

- VOC speciation (see User's Guide 2.2.7)
 - Specified for each SNAP source-sector
 - “Lumped molecule” approach
 - Input file `emissplit.defaults.voc` describes the default split
 - Input file `emissplit.specials.voc` is required when forest fires are included

SNAP	C2H6	NC4H10	C2H4	C3H6	C5H8	OXYL	CH3OH	C2H5OH	HCHO	CH3CHO	MEK	GLYOX	MGLYOX	UNREAC
1	12.559	14.836	2.406	4.376	0.000	9.479	0.000	0.000	55.691	0.034	0.620	0.000	0.000	0.000
2	12.589	39.790	8.174	10.767	0.000	18.632	0.000	3.912	5.586	0.207	0.089	0.000	0.000	0.255
3	4.996	35.610	9.044	2.089	0.000	18.323	0.561	3.034	24.134	0.059	1.347	0.000	0.000	0.805
4	2.652	34.519	5.458	4.257	0.142	13.380	1.176	31.414	0.077	0.978	1.608	0.000	0.000	4.337
5	17.842	79.895	0.018	1.569	0.008	0.505	0.000	0.000	0.078	0.000	0.000	0.000	0.000	0.085
6	0.444	44.052	0.244	0.678	0.008	17.904	6.101	16.416	0.011	0.000	9.965	0.000	0.000	4.176
7	4.832	36.698	6.796	10.896	0.000	35.051	0.000	0.000	2.700	2.606	0.421	0.000	0.000	0.000
8	3.775	47.416	6.636	10.608	0.000	24.676	0.000	0.000	3.115	3.261	0.235	0.146	0.117	0.014
9	25.718	36.778	5.237	1.830	1.153	7.881	0.427	2.439	16.060	0.000	0.093	0.000	0.000	2.383
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000



Other emission sources

- **Aircraft** (optional, see User's Guide 2.1.8)
 - NO_x emissions from aircraft from QUANTIFY
 - Calculated on annual basis and distributed to monthly files according to seasonal variation
 - Input file **AircraftEmis_FL.nc** (not provided)
 - Spatial resolution 1° x 1°x 610m, interpolated to correct grid during model run

- **Road dust** (optional, see User's Guide 2.1.7)
 - PM emissions from road traffic and road map
 - Input file **RoadMap.nc** (Europe, provided)
 - Input file **AVG_SMI_2005_2010.nc** (global, provided)



Other biogenic emission sources

- Natural SO₂ (see User's Guide 2.2.1)
 - Monthly gridded emission files: **natso2MM.dat**
 - DMS (dimethyl sulfide) emissions from sea
- Forest fires (optional, see User's Guide 2.1.10)
 - Global daily emissions stored at 0.2°x0.2° resolution from “Fire Inventory from NCAR” (FINNv1) from year 2005
 - For earlier years 8-daily fire emissions from “Global Forest Emission Database” (GFED-2)
 - Pollutants included: SO₂, CO, NO_x, NMHC, PM_{2.5}, PM₁₀, OC and BC
 - Input file **ForestFire_Emis_YYYY.nc** (not provided)



Other biogenic emission sources

- **Biogenic NMVOC (see User's Guide 2.1.3)**
 - Foliar emissions of isoprene (and monoterpenes) are calculated in the model for each grid cell and model time-step (function of temperature, solar radiation, land-cover)
 - BVOC emission potentials for four forest types are given in input file **EMEP_EuroBVOC.nc**
 - Default emission potentials for other land-cover types are included in **Inputs_LandDefs.csv**
 - Land-cover input files **Landuse_PS_5km_LC.nc** (EMEP) and **LanduseGLC.nc** (global)



Other biogenic emission sources

- Soil NO emissions (see User's Guide 2.1.6)
 - Emissions of NO from soil are specified as function of N-deposition and temperature
 - Depends on ecosystems, thus detailed land-cover data is required
 - Pre-calculated N-depositions in input file `annualNdep.nc`
 - Land-cover input files `Landuse_PS_5km_LC.nc` (EMEP) and `LanduseGLC.nc` (global)



Other biogenic emission sources

- **Lightning** (see User's Guide 2.2.8)
 - NO_x emissions from lightning are included as monthly averages at 5.65° x 5.65° resolution
 - Input files **lightningMM.dat**

- **Volcanoes** (see User's Guide 2.2.2)
 - SO₂ emissions from passive degassing of volcanoes are included for Etna and Stromboli
 - Input file **VolcanoesLL.dat** contain location, height and emission in kt/yr
 - To include SO₂ and PM emissions from the 2010 eruption of Eyjafjallajökul **volcanoes.csv** and **eruptions.csv** are needed



Other biogenic emission sources

- Sea salt and dust (Svetlana's talk on 25 April)
 - The model calculates sea salt aerosols with diameters up to 10 μm
 - The model include windblown dust within the model domain and dust produced outside, but transported to the model grid (e.g. Saharan dust through boundary conditions)



More information about emissions

- Section 6 in “**The EMEP MSC-W chemical transport model - technical description.**” Atmos. Chem. Phys. 12, 7825-7865, 2012. *Simpson et al.*
- <http://www.atmos-chem-phys.net/12/7825/2012/>
- The paper has been sent to course participants in file **EMEP_MSCW_Documentation.pdf**