Emissions in the EMEP MSC-W model

Ágnes Nyíri

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Standard EMEP emission input

- Gridded annual emissions of NOx, SOx, NH3, NMVOC, CO, PM2.5 and PMco
- 11 SNAP source sectors (10 of them are anthropogenic)
- 50 x 50 km^2 polar stereographic (PS) projection, http://www.emep.int/grid/EMEP_domain.pdf
- Emission input provided for the extended EMEP domain for year 2013, input files emislist.POLL
- ASCII text files with 16 columns (unit is Mg/cell):

  EMEP_cc i j emis_high emis_low SNAP1-SNAP11
- http://www.ceip.at/ms/ceip_home1/ceip_home/webdab_emep database/emissions_emepmodels/

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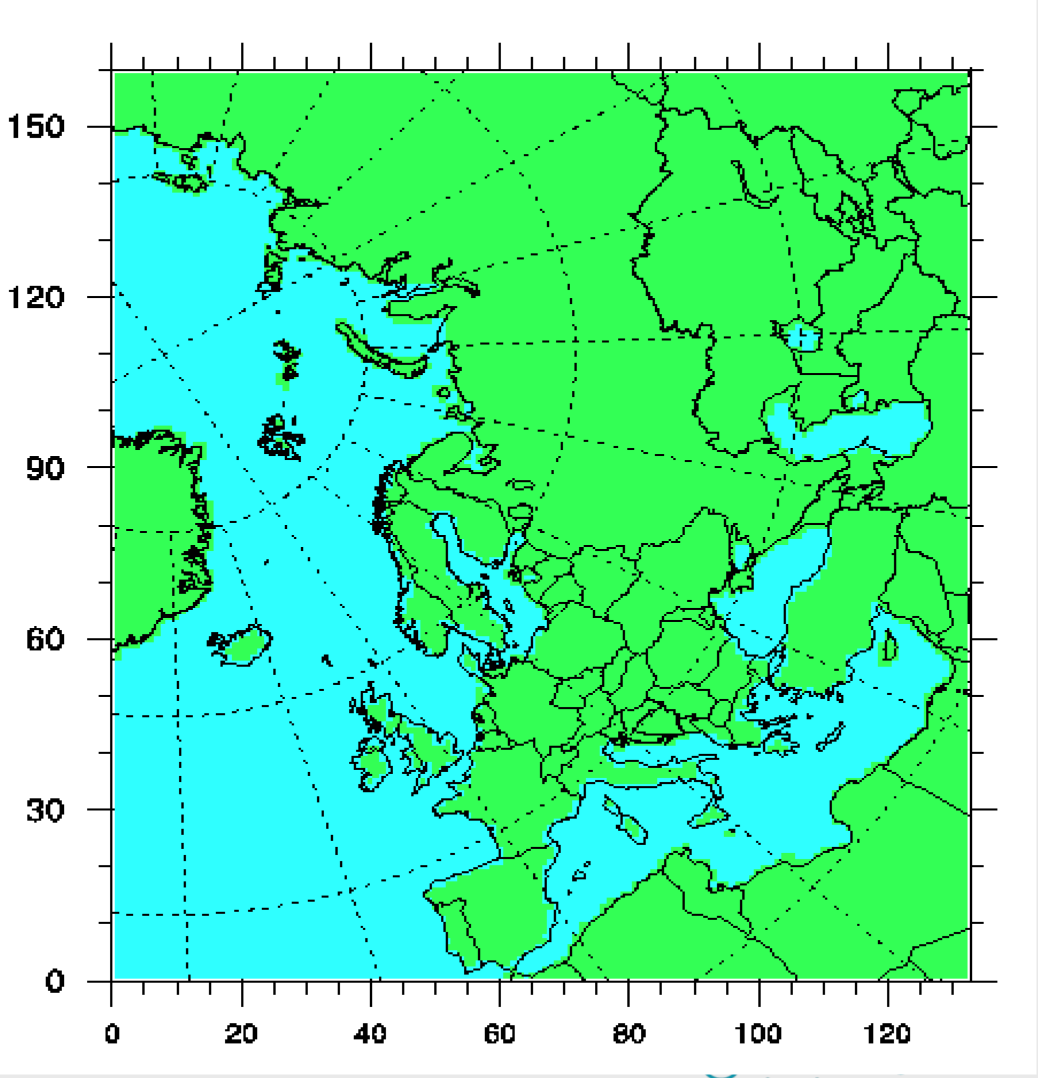
SNAP source sectors

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 (EECCA) domain

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



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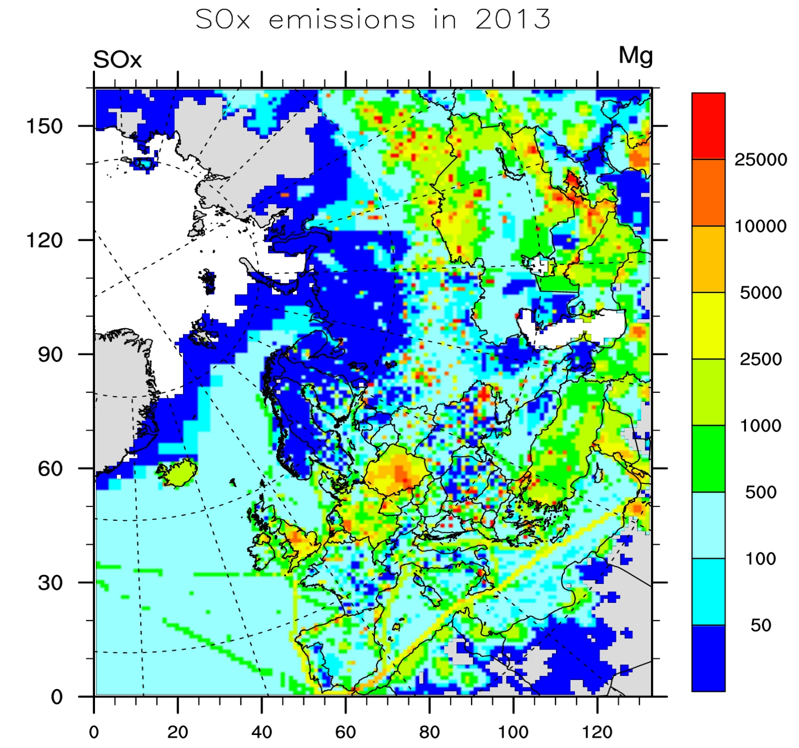
Example of standard EMEP emissions

Official SOx emissions for 2013 over the extended EMEP domain in 50 x 50 km² PS projection



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Emission input in new formats

- Since 2015 different formats of gridded annual emissions can be used and mixed under a common framework.
- 'Standard' ASCII emissions format with 16 columns.
  - Pros: easy to modify, easy to interpret the numbers
  - Cons: valid only for one specific grid projection, special tools are needed for visualization
- Countrywise NetCDF emisssions (each country and sector has its own field).
  - Pros: all info about the data in one file, the emissions can be reprojected in the code, easy to visualize countrywise with e.g. ncview, easy to add new countries
  - Cons: large number of fields (many zero fields), time-consuming to read in the model

Emission input in new formats

- Fraction type NetCDF emisssions (emission totals per grid are stored, in addition info about country fractions).
  - Pros: all info about the data in one file, the emissions can be reprojected in the code, compact form, faster to read in
  - Cons: difficult to interpret the content of the fields, difficult to add a new country, not possible to visualize contrywise
- Monthly fraction type NetCDf emissions (similar to the above, but with 12 monthly values for each field).
  - Pros and cons as above, but this format can not be combined with other formats.

Using & combining gridded emissions

- Emission files are controlled via "config_emep.nml".
  - Include ASCII emissions file (emislist.poll):
    emis_imputlist(1)\%name = '/PathToEmis/emislist.poll',
  - Include NetCDF emission file (Emis_TNO7.nc):
    emis_imputlist(2)\%name = '/PathToEmis/Emis_TNO7.nc',
  - To avoid double counting we choose which countries to include/exclude from which file. E.g. we include only NO and IT from ASCII, the rest is from NetCDF:
    emis_imputlist(1)\%incl(1:) = 'NO', 'IT',
    emis_imputlist(2)\%excl(1:) = 'NO', 'IT'

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Emission flexibility

- Flexible choice of horizontal resolution and projection
  - e.g. polar stereographic, longitude-latitude
- In ASCII format the emission grid projection and resolution must be the same as those of the meteorologoical data
- NetCDF emissions are re-projected to the grid of the meteorological data within the model

Emissions in the model

- Main modules to treat standard anthropogenic emissions
  - Emissions_ml.f90
  - EmisGet_ml.f90
  - EmisDef_ml.f90
- Some other emission sources are treated in other modules (e.g. Biogenics_ml, DustProd_ml, ColumnSource_ml)
- Resulting in molecules/(cm^3·sec) for the different pollutant species, which enters the chemistry

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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 rv4β 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

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Emissions in the model

- Chemical speciation (see User's Guide 2.2.7)
  - Some emission files include a group of compounds (e.g. NOx, SOx, 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 gives 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 2.1.9)
  - NOx 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 1º x 1ºx 610m, interpolated to correct grid during model run

- Road dust (optional, see User's Guide 2.1.8)
  - PM emissions from road traffic and road map
  - Input file RoadMap.nc (Europe, provided)
  - Input file AVG_SMI_2005_2010.nc (global, provided)

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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 2.1.11)
  - Global daily emissions stored at 0.2ºx0.2º 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, NOx, NMHC, PM2.5, PM10, OC and BC
  - Input file ForestFire_Emis_YYYY.nc (not provided)

Other biogenic emission sources

- Biogenic NMVOC (see User's Guide 2.1.4)
  - 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)

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Other biogenic emission sources

- Soil NO emissions (see User's Guide 2.1.7)
  - 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)

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Other biogenic emission sources

- Lightning (see User's Guide 2.2.8)
  - NOx emissions from lightning are included as monthly averages at 5.65º x 5.65º resolution.
  - Input files lightningMM.dat
- Volcanoes (see User's Guide 2.2.2)
  - SO_2 emissions from passive degassing of volcanoes are included for Etna and Stromboli.
  - Input file columnsource_location.csv contain locations and heights, while columnsource_emission.csv contains emission parameters.
  - To include SO_2 and ash emissions from the eruptions of Eyjafjallajökul (2010) or Grimsvötn (2011) we need "USE_ASH=T" (F by default) in config_emep.nml.

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Other biogenic emission sources

- Sea salt and dust (see User's Guide 2.1.12)
  - 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)
  - Input data in Soil_Tegen.nc, used in DustProd_ml.f90
  - Dust from arid surface is accounted for by soil moisture calculations in DustProd_ml.f90 using soil water index from met data and permanent wilting point from SoilTypes_IFS.nc

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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/